15 October 2005

CARE/JRA4: Status Report of the 2nd Quarter of 2005
Title: Next European Dipole (NED)

Coordinator: A. Devred (CEA & CERN), Deputy: A. den Ouden (TEU)

Participating Laboratories and Institutes:

Institute (Participant Number)	Acronym	Country	Coordinator	Scientific Contact	Associated to
CCLRC-RAL (20)	CCLRC	GB	P. Norton	D.E. Baynham	
CEA/DSM/DAPNIA (1)	CEA	F	R. Aleksan	A. Devred	
CERN (17)	CERN	CH	G. Guignard	D. Leroy	
CIEMAT (16)[a)]	CIEMAT	S	A. Faus-Golfe	F. Toral	CSIC
INFN/Milano-LASA (10)	INFN-Mi	I	S. Guiducci	G. Volpini	INFN
INFN/Genova (10)	INFN-Ge	I	S. Guiducci	P. Fabbricatore	INFN
Twente University (11)	TEU	NL	A. den Ouden	A. den Ouden	
Wroclaw University (15)	WUT	PL	M. Chorowski	M. Chorowski	

[a)] New collaborator with respect to CARE Annex I.

Main Objectives: Research and Development on high performances Nb_3Sn cables and high field magnets design and manufacturing to push the technology beyond present LHC limits.

Cost:

Total Expected Budget	Allocated EU Funding
2093 k€	**980 k€**

OUTLINE

1 MANAGMENT

Table 1.a: List of participants and of their implication in the NED Work Packages (**C**: Coordination, X: Participation). The overall management is carried out by CEA.

Number	Participant	WP1 M&C	WP2 TSQP	WP3 CD	WP4 IDI	WG MDO[a)]
1	**CEA**	**C**	X	X	X	X
10	**INFN**	X	**C**	X		
	INFN-Ge	X		X		
	INFN-Mi	X	**C**	X		
11	**TEU**	X		X		
15	**WUT**	X	X			
16	**CSIC**	X				**C**
	CIEMAT	X				X
17	**CERN**	X		**C**		X
20	**CCLRC**	X	X		**C**	X
	CCLRC-RAL	X	X		**C**	X

[a)] The Working Group on Magnet Design and Optimisation (WGMDO) is an extension of scope with respect to CARE Annex 1.

Table 1b: Calendar of meetings, workshops and events (co)organized by NED or with NED contributions in 2004.

NA/JRA Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CARE steering meeting		**23 Paris**				**24-25 Warsaw**					**5 Hamburg**	
NED steering meeting	**8 CERN**		**25 CERN**				**8 CERN**			**28-29 Saclay**		
NED ESAC meeting			**24 CERN**									
HHH network meeting			**22-24 WAMS Archamps**								**8-12 HHH CERN**	
Participation to meetings of other collaborations												
US-LARP						**17-18 LAPAC FNAL**						
Conferences & workshops with activity contrib.												
EPAC'04							**5-9 Lucerne**					
ASC'04										**3-8 Jacksonville**		

Table 1b (Cont.): Calendar of meetings, workshops and events (co)organized by NED or with NED contributions in 2005.

NA/JRA Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CARE SC meeting				**5-6 CERN**					**5-6 Paris**		**21-25 CERN**	
NED SC meeting	**20 CERN**			**14 CERN**			**7 WUT**				**24 CERN**	
NED ESAC meeting												
HHH/AMT meeting			**3-4 Beam Loss CERN 22-23 Insulation CERN**						**26-27 Tooling CERN**	**24-28 ECOMAG Frascati**		
Meetings of other collab.												
US-LARP						**1-2 Review FNAL**					**2-4 Review CA**	
Conf. & workshops with NED contrib.												
PAC'05					**16-20 Knoxville**							
SPIE								**28-02 Warsaw**				
CEC /ICMC'05								**29-02 Keystone**				
EUCAS'05									**11-15 Vienna**			
MT'19									**19-23 Genova**			

Table 1c: List of meetings, workshops and events (co)organized by or pertinent to NED in 2004.

Date	Title /Subject	Location	Main Organizer	Number of Participants	Comments and Web Site
Jan 8	NED SC	CERN	CEA&CERN	10	http://lt.tnw.utwente.nl/project.php?projectid=9
Mar 22-24	WAMS	Archamps	CERN	100	http://amt.web.cern.ch/amt/events/workshops/WAMS2004/wams2004_index.htm
Mar 24	NED ESAC	CERN	CEA&CERN	15	http://lt.tnw.utwente.nl/project.php?projectid=9
Ma 25	NED SC	CERN	CEA&CERN	12	http://lt.tnw.utwente.nl/project.php?projectid=9
May 19	NED WGCC	CERN	TEU	7	http://lt.tnw.utwente.nl/project.php?projectid=9
May 19	NED WGMDO	CEA	CEA	9	http://lt.tnw.utwente.nl/project.php?projectid=9
Jul 8	NED SC	CERN	CEA&CERN	15	http://lt.tnw.utwente.nl/project.php?projectid=9
Oct 28	NED WGCC	CEA	TEU	7	http://lt.tnw.utwente.nl/project.php?projectid=9
Oct 29	NED SC	CEA	CEA	23	http://lt.tnw.utwente.nl/project.php?projectid=9
Nov 8-11	CARE-HHH	CERN	CERN	50	http://care-hhh.web.cern.ch/care-hhh/
Dec 17	NED WGMDO	CIEMAT	CIEMAT	7	http://lt.tnw.utwente.nl/project.php?projectid=9

Table 1c (Cont.): List of meetings, workshops and events (co)organized by or pertinent to NED in 2005.

Date	Title /Subject	Location	Main Organizer	Number of Participants	Comments and Web Site
Jan 20	NED SC	CERN	CEA&CERN	22	http://lt.tnw.utwente.nl/project.php?projectid=9
Feb 2	NED WGCC	LASA	INFN-Mi	6	http://lt.tnw.utwente.nl/project.php?projectid=9
Mar 3-4	HHH Beam Losses	CERN	CERN	50	http://care-hhh.web.cern.ch/care-hhh/
Mar 22-23	HHH/AMT Insulation	CERN	CERN	25	http://amt.web.cern.ch/amt/
Apr 13	NED WGMDO	CERN	CIEMAT	8	http://lt.tnw.utwente.nl/project.php?projectid=9
Apr 14	NED SC	CERN	CEA&CERN	18	http://lt.tnw.utwente.nl/project.php?projectid=9
May 3	NED WGCC	CERN	TEU	8	http://lt.tnw.utwente.nl/project.php?projectid=9
Jun 14	NED WGMDO	CCLRC	CIEMAT	11	http://lt.tnw.utwente.nl/project.php?projectid=9
Jul 7	NED SC	WUT	CEA&CERN	14	http://lt.tnw.utwente.nl/project.php?projectid=9
Oct 26-28	HHH/AMT	Frascati	CERN		http://amt.web.cern.ch/amt/
Nov 22	NED WGCC	CERN	TEU		
Nov 22	NED WGMDO	CERN	CIEMAT		
Nov 24	NED WGMDO	CERN	CEA&CERN		

Table 1d: List of milestones and deliverables due in 2004.

Deliverable Number	Milestone Number	Name	Work Package/Task Number	Delivered by	Planned (in months)	Achieved (in months)	EDMS Number
11		Final Report on Wire and Cable Specifications	CD/3.3	CERN	6	6	475443
		Report on Specifications for Conductor Insulation	IDI/4.2	CCLRC	6	7	548037V5
		Report on Definition of the Test Programme for Conductor Insulation[a)]	IDI/4.3&4.4	CCLRC&CEA	7	10	548038V2
		Status Report on Conductor Development[b)]	CD/3.4	CERN	-	3	Restricted Access
12		Design Report on 15 T Dipole Magnet	CD/3.2	CERN	12	13	555826
		Interim Report on Quench Protection	TSQP/2.3	INFN-Mi	12	13	555756

[a)] Scope of report has been extended to include test programme on innovative insulation (Task 4.4).

[b)] The milestone entitled “First Results on Wire Development” that was due on 30 June 2005 has been split into two “Status Reports” due on 15 December 2004 and 15 December 2005.

Table 1d (Cont.): List of milestones and deliverables due in 2005.

Deliverable Number	Milestone Number	Name	Work Package/Task Number	Delivered by	Planned (in months)	Achieved (in months)	EDMS Number
23		Report on Heat Transfer Facility Commissioning[a)]	TSQP/2.2	CEA&WUT	3		
24		Report on Quench Computation	TSQP/2.3	INFN-Mi	6		
		Status Report on Conductor Development[b)]	CD/3.4	CERN	-		
		Interim Report on Heat Transfer Measurements	TSQP/2.2	CEA	9		

[a)] Report has been delayed until December 2005, due to delay in cryostat delivery (received at CEA on 20 September).

[b)] As already mentioned, the milestone entitled “First Results on Wire Development” that was due on 30 June 2005 has been split into two “Status Reports” due on 15 December 2004 and 15 December 2005.

2 DISSEMINATION

2.1 List of talks

Table 2.1: List of review talks given by NED Collaborators in 2004.

#	Title	Speaker and lab	Location	Date
1	NED Status Report	A. Devred (CEA&CERN) and T. Taylor (CERN) on behalf of the NED Collaboration	KEK, Tsukuba, Japan	9 March 2004
2	Next European Dipole (NED) Overview	A. Devred (CEA&CERN) on behalf of the NED Collaboration	Journées de l'Association Française de Froid, Belfort, France	25 May 2004
3	Next European Dipole (NED) Overview	A. Devred (CEA&CERN) on Behalf of the NED Collaboration	Department Of Energy (DOE), Washington, DC, USA	16 June 2004
4	Status of the Next European Dipole (NED) Activity of the Coordinated Accelerator Research in Europe (CARE) Project	A. Devred (CEA&CERN) on Behalf of the NED Collaboration	Applied Superconductivity Conference, Jacksonville, FL	6 October 2004

Table 2.1 (Cont.): List of review talks given by NED Collaborators in 2005.

#	Title	Speaker and lab	Location	Date
1	Next European Dipole (NED) Overview	A. Devred (CEA&CERN) on behalf of the NED Collaboration	CERN	4 February 2005
2	Superconducting High Field Accelerator Magnets: Status and Perspectives	A. Devred (CEA&CERN) on behalf of the NED Collaboration	SPIE International Congress on Optics and Electronics, Warsaw	30 August 2005
3	Next European Dipole (NED) Status Report	A. Devred (CEA&CERN) on behalf of the NED Collaboration	European Conference on Applied Superconductivity, Vienna	12 September 2005
4				

2.2 List of papers

Table 2.2: List of papers issued by NED collaborators in 2004.

#	CARE document type and number	Title	Author(s) and Lab(s)	Reference	Date
1	N/A	High field accelerator magnets beyond LHC	A. Devred (CEA&CERN)	*Proceedings of the 2003 IEEE Particle Accelerator Conference*, IEEE Catalogue 03CH37423, pp. 146–150, 2003	2003
2	N/A	High field accelerator magnet R&D in Europe	A. Devred (CEA&CERN), D.E. Baynham (CCLRC), L. Bottura (CERN), M. Chorowski (WUT), P. Fabbricatore (INFN-Ge), D. Leroy (CERN), A. den Ouden (TEU), J. M. Rifflet (CEA), L. Rossi, O. Vincent-Viry (CERN), G.Volpini (INFN-Mi)	*IEEE Trans. Appl. Supercond.*, Vol. 14 No. 2, pp. 339-344, 2004	2004
3	Conf-04-005-HHH	Performance limits and IR design of a possible LHC luminosity upgrade based on NbTi SC magnet technology	F. Ruggiero, O. Brüning, R. Ostojic, L. Rossi, W. Scandale, T. Taylor (CERN), A. Devred (CEA&CERN)	*Proceedings of the 2004 European Particle Accelerator Conference*, pp. 608-610, 2004	2004
4	Conf-04-020-NED	Status of the Next European Dipole (NED) Activity of the Coordinated Accelerator Research in Europe (CARE) Project	A. Devred (CEA&CERN), B. Baudouy (CEA), D.E. Baynham (CCLRC), T. Boutboul (CERN), S. Canfer (CCLRC), M. Chorowski (WUT), P. Fabbricatore, S. Farinon (INFN-Ge), H. Félice (CEA), P. Fessia (CERN), J. Fydrich (WUT), M. Greco (INFN-Ge), J. Greenhalgh (CCLRC), D. Leroy (CERN), P. Loverige (CCLRC), F. Michel (CEA), L. R. Oberli (CERN), A. den Ouden (TEU), D. Pedrini (INFN-Mi, J. Polinski (WUT), V. Previtali (CERN), L. Quettier, J. M. Rifflet (CEA), J. Rochford (CCLRC), F. Rondeaux (CEA), S. Sanz (CIEMAT), S. Sgobba (CERN), M. Sorbi (INFN-Mi), F. Toral-Fernandez (CIEMAT), R. van Weelderen (CERN), P. Védrine (CEA), O. Vincent-Viry (CERN), G. Volpini (INFN-Mi)	*IEEE Trans. Appl. Supercond.*, Vol. 15 No. 2, pp. 1106-1112, 2005.	2004
5	Con-04-037-NED	Future accelerator magnet needs	A. Devred (CEA&CERN), S. Gourlay (LBNL), A. Yamamoto (KEK)	*IEEE Trans. Appl. Supercond.*, Vol. 15 No. 2, pp. 1192-1199, 2005	2004

Table 2.2 (Cont.): List of papers issued by NED collaborators in 2005.

#	CARE document type and number	Title	Author(s) and Lab(s)	Reference	Date
1		Insulation Development for the Next European Dipole	S J Canfer, E Baynham, R J S Greenhalgh (CCLRC)	presented at CEC/ICMC'05, Keystone, CO, Aug 29-Sep 2, 2005	2005
		Superconducting High Field Accelerator Magnets: Status and Perspectives	A. Devred (CEA&CERN), on belhalf of the NED Collaboration	Presented at SPIE International Congress on Optics and Electronics, Warsaw, Poland, Aug 29-Sep 2, 2005	2005
2		Status of the Next European Dipole (NED) Activity of the Coordinated Accelerator Research in Europe (CARE) Project	A. Devred (CEA&CERN), on belhalf of the NED Collaboration	presented at EUCAS'05, Vienna, Austria, Sep 11-15, 2005	2005
3		Study of the protection system for the cosine-theta Nb3Sn prototype of the NED dipole	V. Granata, M. Sorbi, G.Volpini, D. Zamborlin (INFN-Mi)	presented at MT'19, Genova, Italy. Sep18-23, 2005	2005
4		Critical current measurements on Niobium-Tin conductors for the NED project	A. den Ouden (TEU), T. Boutboul (CERN), D. Pedrini (INFN-Mi), V. Previstali (CERN), L. Quettier (CEA), G. Volpini (INFN-Mi)	presented at MT'19, Genova, Italy. Sep 18-23, 2005	2005
5		Magnetization measurements of Nb3Sn wires for the Next European Dipole (NED)	M. Greco (INFN-Ge), P. Fabbricatore (INFN-Ge), C. Ferdeghini (INFM, Università di Genova), U. Gambardella (INFN-LNF).	presented at MT'19, Genova, Italy. Sep 18-23, 2005	2005

3 RESOURCES

3.1 Additional Staff Hiring

Table 3.1: Temporary Staff Hiring.

#	Lab	Job Type	Duration	Work subject	Status
1	INFN-Mi	Fellow	6 months	Quench protection computation (supervisor: G. Volpini)	Hired (251104)/Terminated (240505)
2	WUT	Fellow	7 months	Cryostat design (supervisor: M. Chorowski)	Hired (171104)/Terminated (160605
3	WUT	Fellow	7 months	Cryostat design (supervisor: M. Chorowski)	Hired (171104)/Terminated (160605)
4	INFN-Mi	Fellow	6 months	Critical current measurements (supervisor: G. Volpini)	Early 2006
5	CEA	Postdoc	1 year	Innovative insulation development (supervisor: F. Rondeaux)	Spring 2006
6	CEA	Postdoc	1 year	Heat transfer measurement (supervisor: B. Baudouy)	Spring 2006

3.2 Budget

Table 3.2a: Estimated budget for the first 18 months (January 1st 2004 to June 30 2005).

JRA4	Participant (cost model)	Permanent Staff including indirect cost (Euros)	Additional Staff including indirect cost (Euros)	Durable Equipment including indirect cost (Euros)	Consumables and Prototyping including indirect cost (Euros)	Travel including indirect cost (Euros)	Expected costs including indirect cost (Euros)	Direct cost	Subcontract	Indirect cost	Requested funding (Euros)
1	CEA (FC)	199,000	5,000	0	65,000	8,000	277,000	179,000	0	98,000	43,000
10	INFN (AC)	0	15,000	0	7,000	11,000	33,000	27,500	0	5,500	22,000
11	TEU (FC)	36,000	0	0	5,000	4,000	45,000	28,000	0	17,000	18,000
15	WUT (AC)	0	8,500	0	39,500	4,000	52,000	47,495	24,968	4,505	52,000
17	CERN (AC)	0	0	0	400,000	0	400,000	400,000	400,000	0	400,000
20	CCLRC (FC)	135,000	138,000	0	40,000	4,000	317,000	167,000	0	150,000	45,000
	Grand total	**370,000**	**166,500**	**0**	**556,500**	**31,000**	**1,124,000**	**848,995**	**424,968**	**275,005**	**580,000**

Table 3.2b: Executed budget for the first 12 months (January 1st 2004 to December 31st 2004).

JRA4	Participant (cost model)	Permanent Staff including indirect cost (Euros)	Additional Staff including indirect cost (Euros)	Durable Equipment including indirect cost (Euros)	Consumables and Prototyping including indirect cost (Euros)	Travel including indirect cost (Euros)	Expected costs including indirect cost (Euros)	Direct cost	Subcontract	Indirect cost	First received payment (Euros)
1	CEA (FC)	157,537			19,724	10,063	187,324	118,745	0	68,579	32,250
10	INFN (AC)	0	2,784	0	5,258	3,203	11,245	9,370	0	1,874	16,500
11	TEU (FC)	27,578	0	0	1,553	2,093	31,224	17,739	0	13,485	12,490
15	WUT (AC)	0	2,191.58	0	26,655.81	1,416.05	30,263.44	29,548	25,968	716	38,994
17	CERN (AC)	0	0	0	91,906	0	91,906	91,906	91,906	0	300,000
20	CCLRC (FC)	71,151	0	0	11,026	8,130	90,307	48,802	0	41,505	33,750
	Grand total	**256,262**	**4,975**	**0**	**156,123**	**24,905**	**442,265**	**316,106**	**117,874**	**126,159**	**433,984**

Table 3.2c: Requested budget for the next 18 months (January 1st 2005 to June 30 2006).

JRA4	Participant (cost model)	Permanent Staff including indirect cost (Euros)	Additional Staff including indirect cost (Euros)	Durable Equipment including indirect cost (Euros)	Consumables and Prototyping including indirect cost (Euros)	Travel including indirect cost (Euros)	Expected costs including indirect cost (Euros)	Direct cost	Subcontract	Indirect cost	Requested funding (Euros)
1	CEA (FC)	358,116	41,667	0	92,500	24,000	516,283	0	0	516,283	45,000
10	INFN (AC)	0	15,000	0	25,750	7,000	47,750	39,792	0	7,958	47,750
11	TEU (FC)	139,334	0	0	30,000	4,500	173,834	105,693	0	68,141	69,534
15	WUT (AC)	0	6,308	0	12,844	2,584	21,736	18,113	0	3,623	21,736
17	CERN (AC)	0	0	0	350,000	0	350,000	350,000	350,000	0	350,000
20	CCLRC (FC)	274,000	0	0	33,300	16,500	323,800	163,967	0	159,833	26,250
	Grand total	**771,450**	**62,975**	**0**	**544,394**	**54,584**	**1,433,403**	**677,565**	**350,000**	**755,838**	**560,270**

4 STATUS OF THE WORK

4.1 Work Package 1: Management and Communication (M&C)

2004 Summary

The NED Steering Committee (SC) has met four times (8 January, 25 March, 8 July and 29 October), while the NED External Scientific Advisory Committee (ESAC) has met once (24 March) and has produced a report.

The NED work breakdown structure has been implemented by E. Deluncige (CERN) into the CERN Engineering Data and Management Service (EDMS):
https://edms.cern.ch
under CERN/AT Department/CARE. This service is used to release, circulate, track and store documents. Access is restricted to members of the NED collaboration (as identified in EDMS 547908).

A dedicated web page has been set up by A. den Ouden (TEU):
http://lt.tnw.utwente.nl/project.php?projectid=9
The webpage is updated regularly with all information pertinent to the NED JRA and is accessible by the general public.

Detailed implementation plans of the three technical Work Packages (Thermal Studies and Quench Protection or TSQP, Conductor Development or CD, and Insulation Development and Implementation or IDI) have been established and launched and all collaborators have started their activities. In addition, the Activity scope has been extended, thanks to the setting up of a Working Group on Magnet Design and Optimization (WGMDO), supported by CCLRC and by additional resources from CEA, CERN and CIEMAT, a CARE Associated Laboratory who has decided to join the NED collaboration.

Three status reports have been produced

- 2nd quarter of 2004: EDMS 548027
- 3rd quarter of 2004: EDMS 548028
- Yearly report for 2004: EDMS 548030V4

2005 Summary

The NED Steering Committee (SC) has met three times: 20 January and 14 April at CERN and 7 July at WUT.

A total of 6 papers (4 contributed and 2 invited) have been given at international conferences pertinent to NED.

4.1.1 Activity Coordination

The NED JRA is coordinated by A. Devred (CEA&CERN), helped by A. den Ouden (TEU).

The following actions have been carried out and/or are foreseen

- ✓ 19–21 November 2003: participation of A. Devred (CEA&CERN) and A. den Ouden (TEU) to CARE Kick Off meeting at CERN
- ✓ 13 January 2004: visit of A. Devred (CEA&CERN) to INFN-Ge
- ✓ 16 January 2004: visit of P. Védrine (CEA) and A. Devred (CEA&CERN) to CIEMAT
- ✓ 27 January 2004: visit of A. Devred (CEA&CERN) to TEU
- ✓ 13 February 2004: A. Devred (CEA&CERN), P. Lebrun and L. Rossi (CERN) to INFN-Mi
- ✓ 23–24 February 2004: participation of A. Devred (CEA&CERN) to 1st CARE Steering Committee and Dissemination Board meetings in Paris, France
- ✓ 19 March 2004: visit of F. Rondeaux and P. Védrine (CEA), A. Devred (CEA&CERN) to CCLRC
- ✓ 22–24 March 2004: participation to Workshop on Accelerator Magnets Superconductor (WAMS) organized within the framework of AMT Work Package of HHH Network Activity
- ✓ 13 April 2004: visit of A. Devred (CEA&CERN) and M. Pojer (CERN) to INFN-Ge
- ✓ 2–3 June 2004: visit of B. Baudouy and F. Michel (CEA), A. Devred (CEA&CERN), R. Van Weelderen (CERN) to WUT
- ✓ 24–25 June 2004: participation of A. Devred (CEA&CERN) and A.den Ouden (TEU) to 2nd CARE Steering Committee and Dissemination Board meetings in Warsaw, Poland
- ✓ 24 August 2004: visit of M. Chorowski (WUT) to CEA/Saclay
- ✓ 2–5 November 2004: participation of A. Devred (CEA&CERN) to 1st CARE general meeting at DESY
- ✓ 11-12 November 2004: participation of a number of NED collaborators to the HHH/AMT network meeting organised at CERN.
- ✓ 3-4 March 2005: participation of a number of NED collaborators to the HHH meeting on Beam-Generated Heat Deposition and Quench Levels in LHC Magnets organised at CERN.
- ✓ 22-23 March 2005: participation of a number of NED collaborators to the HHH/AMT meeting on Insulation & Impregnation Technique organised at CERN.

4.1.2 Meetings

4.1.2.1 Steering Committee Meetings

The oversight of the NED JRA is ensured by a Steering Committee (SC) made up of

- E. Baynham (CCLRC)
- A. Devred (CEA&CERN), Chairman
- D. Leroy (CERN)
- J.M. Rifflet (CEA)
- G. Volpini (INFN-Mi)
- A. den Ouden (TEU), Secretary

SC meetings are held every three months. Available copies of the presentations and minutes of the meetings have been loaded into EDMS and are posted on the NED website.

The following actions have been carried out and/or are foreseen

- ✓ 8 January 2004: meeting at CERN
  participants: E. Baynham (CCLRC), A. Devred (CEA&CERN), D. Leroy, L. Oberli and O. Vincent-Viry (CERN), P. Fabbricatore (INFN-Ge), G. Volpini (INFN-Mi), A. den Ouden (TEU)
  special guests: L. Rossi (CERN), H. ten Kate (CERN&TEU)
  agenda+talks: EDMS 548032; also available on NED website
- ✓ 25 March 2004: meeting at CERN
  participants: B. Baudouy and J.M. Rifflet (CEA), A. Devred (CEA&CERN), D. Leroy and R. van Weldeeren (CERN), F. Toral (CIEMAT), G. Volpini (INFN-Mi), E. Baynham and S. Canfer (CCLRC), A. den Ouden (TEU)
  special guests: A. Yamamoto (KEK), S. Gourlay (LBNL)
  agenda+talks: EDMS 548033; also available on NED website
- ✓ 8 July 2004: meeting at CERN
  participants: E. Baynham and S. Canfer (CCLRC), A. Devred (CEA&CERN), F. Rondeaux and P. Védrine (CEA), T. Boutboul, D. Leroy, L. Oberli, V. Previtali, O. Vincent-Viry, R. van Weldeeren (CERN), P. Fabbricatore and S. Farinon (INFN-Ge), M. Sorbi (INFN-Mi), A. den Ouden (TEU)
  special guests: –
  agenda+talks: EDMS 548034; also available on NED website
- ✓ 29 October 2004: meeting at CEA/Saclay
  participants: S. Canfer (CCLRC), A. Devred (CEA&CERN), H. Felice, L. Quettier, J.M. Rifflet, F. Rondeaux, P. Védrine (CEA), T. Boutboul, D. Leroy, L. Oberli, V. Previtali, R. van Weldeeren (CERN), M. Greco (INFN-Ge), D. Pedrini, M. Sorbi, G. Volpini (INFN-Mi), A. den Ouden (TEU), M. Chorowski, J. Polinski (WUT)
  special guests: R. Aleksan (CPPM), P. Debu, M. Durante (CEA), B. Adamowicz (Kryosystem)
  agenda+talks: 548035; also available on NED website
- ✓ 20 January 2005: meeting at CERN
  participants: S. Canfer, E. Baynham (CCLRC), A. Devred (CEA&CERN), F. Michel, J.M. Rifflet (CEA), T. Boutboul, P. Fessia, D. Leroy, L Oberli, D. Richter, W. Scandale, C. Scheuerlein, N. Schwerg, S Sgobba (CERN),

P. Fabbricatore, S. Farinon, M. Greco (INFN-Ge), F. Broggi, V. Granata, M. Sorbi, G. Volpini (INFN-Mi), A. den Ouden (TEU)
agenda+talks: 548036; also available on NED website

✓ 14 April 2005: meeting at CERN
participants: S. Canfer, E. Baynham (CCLRC), A. Devred (CEA&CERN), T. Boutboul, L Oberli, C. Scheuerlein, R. Schmidt, S Sgobba, R. Van Weldeeren (CERN), F. Toral (CIEMAT), S. Farinon, M. Greco (INFN-Ge), V. Granata, M. Sorbi, G. Volpini (INFN-Mi), A. den Ouden (TEU), S. Petrowicz, M. Chorowski (WUT)
agenda+talks: 575731

✓ 7 July 2005: meeting at WUT
participants: S. Canfer (CCLRC), A. Devred (CEA&CERN), F. Michel, J.M. Rifflet (CEA), T. Boutboul, D. Leroy, L Oberli, S Sgobba, R. Van Weldeeren (CERN), M. Greco (INFN-Ge), M. Sorbi, G. Volpini (INFN-Mi), A. den Ouden (TEU), S. Petrowicz, M. Chorowski (WUT)
agenda+talks: 604114

⇒ next meeting: 24 November 2005 at CERN

4.1.2.2 External Scientific Advisory Committee Meetings

The NED JRA Coordinator is assisted by an External Scientific Advisory Committee (ESAC). The charges and composition of the committee are defined in EDMS 548039. The committee is made up of

- J.L. Duchateau (CEA)
- P. Lebrun (CERN)
- L. Rossi (CERN)
- R.M. Scanlan (formerly LBNL, retired)
- J.B. Strait (FNAL), Chairman
- H.H.J. ten Kate (CERN&TEU)

The following actions have been carried out and/or are foreseen

✓ 24 March 2004: first meeting at CERN
agenda: EDMS 548039; presentations available on NED website

✓ 29 March 2004: first ESAC report (EDMS 548041)
agenda+talks: 548035; also available on NED website

⇒ next meeting: Spring of 2006

4.2 Work Package 2: Thermal Studies and Quench Protection (TSQP)

Work Package 2 includes two main Tasks:

- development and operation of a test facility to study and characterize heat transfer to helium through Nb_3Sn conductor insulation

(involving CEA and WUT, under the supervision of B. Baudouy, CEA)

- quench protection computation

(carried out by INFN-Mi, Task Leader: G. Volpini)

2004 Summary

The first part of the Task on heat transfer measurements was to design and build and new He-II, double-bath cryostat. CEA wrote detailed specifications that were handed out to WUT in June 2004. WUT performed a call for tender in the Summer of 2004 and selected Kryosystem in Poland to manufacture the cryostat. Work was started in the Fall of 2005 and a Production Readiness Review was held at Saclay on 29 October 2004.

After completing a literature survey of relevant material properties (EDMS 555753), INFN-Mi has carried out detailed quench computations based on the 88-mm-aperture, cosθ-layer design chosen as Reference Design V1 for NED in conclusion of Task 3.2. The computations study the influence of various parameters such as: magnet length (1, 5 and 10 m), operating current (15, 22 and 29 kA), value of external dump resistor (15, 25, 35 and 45 mΩ), quench detection delay (30, 40 and 50 ms) and quench protection heater length. They are carried out using two independent codes: QLASA, originally developed at INFN-Mi for solenoids and subsequently adapted to accelerator magnet coil configuration by means of suitable geometric approximations, and QUABER, a collection of scripts written in MAST and run with the commercial interface SABER that was developed at CERN to study LHC magnet protection. An interim report (EDMS 555756) summarizes the results obtained for a 1-m-long and a 5-m-long magnet.

2005 Summary

Some delays have been encountered in the manufacturing of the cryostat and of the enclosed heat exchanger. Preliminary reception tests were held at WUT during the 3rd week of April, which revealed some problems. The problems were fixed in May-June 2005 and another round of tests were carried out at WUT on 6-8 July 2005. These tests included thermal and leak tests in liquid helium environment at 4.2 K and were deemed successful. The cryostat was then transported by road to CEA/Saclay, where it arrived on 20 September 2005. It is now being prepared for tests in He II and commissioning. The first measurements are expected to take place in early 2006.

Quench computations have been carried out for a 10-m-long magnet relying on the reference 88-mm-aperture, cosθ, layer design. They confirm the results already obtained for smaller lengths: the hot spot temperature always remains below 300 K and the maximum voltage can be limited to 800 V by an adequate choice of dump resistor. This implies that that such type of magnet is safe to operate, thanks mainly to the choice of strand and cable parameters made early on. In addition, the two softwares that have been used (QLASA and QUABER) appear to yield similar results. To wrap up this Task, computations are now being run on a more challenging has 160-mm-aperture, cosθ slot design. The final report on this Task should be

delivered in the oncoming month. A summary paper was presented at the Magnet Technology Conference (MT'19) in Genova.

4.2.1 TSQP WP coordination

As already mentioned, the TSQP Work Package is articulated around two main tasks: Heat Transfer Measurements (2.2) and Quench Computation (2.3). Task 2.2 is coordinated by B. Baudouy (CEA), while Taks 2.3 is coordinated by G. Volpini (INFN-Mi). The Task Leaders report to the NED Steering Committee and, ultimately, to the NED/JRA Coordinator.

4.2.2 Heat Transfer Measurements

The following actions have been carried out and/or are foreseen

4.2.2.1 Drafting of Test Facility Specifications

- ✓ 28 January 2004: preparatory meeting at CEA/Saclay
  participants: B. Baudouy, P. Chesny, B. Hervieu, F. Michel and J.M. Rifflet (CEA), A. Devred (CEA&CERN)
- ✓ 27 February 2004: programme proposal issued by B. Baudouy (CEA; EDMS 548123)
- ✓ March 2004: review of programme proposal by P. Lebrun and D. Leroy (CERN) and approbation by SC meeting
- ✓ 4 May 2004: cryostat specification issued by B. Baudouy, B. Hervieu and F. Michel (CEA; EDMS 548129V1)
- ✓ May 2004: specification submitted for review to P. Lebrun and R. Van Weelderen (CERN) and M. Chorowski (WUT)
- ✓ 8 June 2004: final cryostat specification issued by B. Baudouy, B. Hervieu and F. Michel (CEA; EDMS 548129V2)

Sub-Task completed

4.2.2.2 Cryostat Design and Fabrication

- ✓ 3 June 2004: preparatory visit to Kryosystem (Poland)
  participants: B. Baudouy, F. Michel (CEA), A. Devred (CEA&CERN) R. van Weelderen (CERN), M. Chorowski, J. Fydrych and J. Polinski (WUT), B. Adamowicz, G. Michalski and G. Strychalski (Kryosystem)
- ✓ July 2004: start of technical design at WUT
- ✓ July 2004: start of tendering procedure
- ✓ 10 August 2004: redefinition of WUT budget allocation
- ✓ August 2004: contract attribution to Kryosystem
- ✓ 29 Ooctober 2004: Production Readiness Review at CEA Saclay
  participants: B. Baudouy, F. Michel (CEA), R. van Weelderen (CERN), M. Chorowski, J. Polinski (WUT), B. Adamowicz (Kryosystem)
  report: EDMS 548154)
- ✓ 17 November 2004: hiring of Grzegorz Michalski and Maciej Matkowski at WUT (additional staff; till 30 June 2005)
- ✓ Early April 2005: completion of manufacturing
- ✓ 20-22 April 2005: preliminary reception tests at WUT, in
  participants: B. Baudouy and F. Michel (CEA) and of M. Chorowski and J. Polinski (WUT)
  Test report: EDMS 587176

- ✓ 2 May 2005: set of recommendations issued by B. Baudouy, F. Michel (CEA) and A. Devred (CEA&CERN) – EDMS 587176
- ✓ 6 May 2005: report on mechanical design study issued by M. Chorowski and J. Polinksi (WUT) – EDMS 592247
- ✓ 12 May 2005: first status report on repairs issued by M. Chorowski and J. Polinksi (WUT) – EDMS 592246
- ✓ 19 May 2005: Comments on status report issued by B. Baudouy and F.Michel (CEA) – EDMS 593633
- ✓ 3 June 2005: second status report on repairs issued by M. Chorowski and J. Polinksi (WUT) – EDMS 598854
- ✓ 3 June 2005: second version of report on mechanical design study issued by M. Chorowski and J. Polinksi (WUT) – EDMS 592247V2
- ✓ 6-8 July 2005: second round of reception tests at WUT
  participants: B. Baudouy and F. Michel (CEA) and of M. Chorowski and J. Polinski (WUT)
  Test report: EDMS 609237
- ✓ 20 September 2005: reception of cryostat at CEA

Sub-Task completed

4.2.2.3 Cryogenic Module Design and Fabrication

- ✓ 22 June 2004: design specifications issued by B. Baudouy and F. Michel (CEA; EDMS 548139, based on design study reviewed in EDMS 548137)
- ✓ 1st July 2004: call for tender issued by F. Michel (CEA)
- ✓ 15 July 2004: reception of answers to call for tender
- ✓ 17 September 2004: purchase requisition to be issued by F. Michel (CEA)
- ✓ 10 October 2004: contract awarded to Kryosystem.
- ✓ Early April 2005: completion of manufacturing

Sub-Task completed

4.2.2.4 Facility Integration and Qualification

⇒ Cryostat is now being readied for tests in He II and commissioning.

4.2.2.5 Measurements and Analyses

Not started

4.2.3 Quench Protection Computation

The following actions have been carried out and/or are foreseen

- ✓ 5 March 2004: draft computation programme issued by M. Sorbi and G. Volpini (INFN-Mi; EDMS 555747)
- ✓ March 2004 SC meeting: discussion of computation programme
- ✓ April–June 2004: compilation of material properties (EDMS 555753)
- ✓ June-October 2004: first computations on Reference Design V1 (88-mm-aperture, $\cos\theta$, layer design)
- ✓ November-December 2004: extended computations on Reference Design V1
- ✓ 25 November 2004: hiring of Valeria Granata by INFN-Mi (additional staff for 6 months)
- ✓ 3 February 2005: first version of interim report (EDMS 555756; EU milestone)

authors: V. Granata, M. Sorbi, G. Volpini, D. Zamborlin (INFN-Mi)

✓ 13 April 2005: second version of interim report (EDMS 555756V2)
authors: V. Granata, M. Sorbi, G. Volpini, D. Zamborlin (INFN-Mi)

⇒ 30 Ocotber 2005: final report (INFN-Mi); EU deliverable

Table 4.2a: Status of the lowest Sub-Tasks level in the TSQP WP (as of 15 October 2005).

WBS #	Title	Original begin date (Annex 1)	Original end date (Annex 1)	Estimated Status	Revised end date
2.1	TSQP WP Coordination				
2.2	Heat Transfer Measurements				
2.2.1	Drafting of Test Facility Specifications	1 January 2004	31 March 2004	Completed	8 June 2004
2.2.2	Cryostat Design and Fabrication	1 April 2004	31 Dec. 2004	Completed	8 July 2005
2.2.3	Cryogenic Module Design and Fabrication	1 April 2004	31 Dec. 2004	Completed	8 July 2005
2.2.4	Facility Integration and Qualification	1 January 2005	31 March 2005	30 %	31 December 2005-
2.2.5	Measurements and Analyses	1 April 2005	31 Dec. 2006	Not started	-
2.3	Quench Protection Computation	1 April 2004	30 June 2005	90 %	31 December 2005-

Table 4.2b: Status with respect to the milestones and deliverables due in the TSQP WP (as of 15 October 2005).

WBS #	Title	Responsible Lab(s)	Due date in Annex 1	Status	Revised delivery date
2.2.4	Report on Heat Transfer Facility Commissioning (deliverable)	CEA and WUT	1 April 2005	Not started	31 December 2005
2.2.5	Interim Report on Heat Transfer Measurements (milestone)	CEA	31 December 2005	Not started	30 June 2006
2.2.5	Final Report on Heat Transfer Measurements (deliverable)	CEA	31 December 2006	Not started	-
2.3	Interim Report on Quench Protection (milestone)	INFN-Mi	31 December 2004	Completed	13 April 2005
2.3	Final Report on Quench Protection (deliverable)	INFN-Mi	30 June 2005	Ongoing	31 December 2005

4.3 Work Package 3: Conductor Development (CD)

Work Package 3 includes three main Tasks:

- conductor development
  (under CERN supervision, Task Leader: L. Oberli)
- conductor characterization
  (involving CEA, CERN, INFN-Mi, INFN-Ge and TEU, under the supervision of A. den Ouden, TEU)
- FE wire model to simulate cabling effects
  (involving CERN and INFN-Ge and TEU, under the supervision of S. Farinon, INFN-Ge)

The CD Work Package is the core of the program and will absorb about 70% of the EU funding.

2004 Summary

CERN has investigated two different magnetic designs, referred to as $\cos\theta$ layer design and $\cos\theta$ block design and has considered 3 apertures: 88 mm, 130 mm and 160 mm. These investigations, described in a report (EDMS 555826), led to the definition of wire and cable parameters used as a basis for conductor specifications. The 88-mm-aperture, $\cos\theta$ layer design has been chosen as a baseline for NED (Reference Design V1 as defined in EDMS 555825). One particularity of this design is that it calls for a wide cable (26 mm) made up of 40 stands of large diameter (1.25 mm) and high critical currents ($\geq$ 1636 A at 4.2 K and 818 A at 15 T and 4.2 K). This reliance on a large conductor and a large transport current is a deliberate choice that differentiates the NED program from what is done in the USA where the emphasis is put on achieving the highest possible critical current density and on adapting conductor and magnet design so as to optimize performances with respect to this parameter.

After writing comprehensive wire and cable specifications and a detailed technical questionnaire (EDMS 475443), CERN has issued a call for tender in June 2004 and has selected in November 2004 Alstom/MSA, in France, and ShapeMetal Innovation (SMI), in the Netherlands, to be the main wire and cable contractors. After discussion with CERN, the two companies have established development plans made up of two R&D steps (referred to as STEP1 and STEP2) followed by final production. For Alstom/MSA, which promotes the "Enhanced Internal Tin" process, STEP1 is devoted to a Taguchi-type plan to study the influence of salient parameters on workability and performances, while STEP2 will be devoted to a tuning of critical current density. For SMI, which promotes the "Powder In Tube" process, STEP1 is devoted to iterations on an existing, 1-mm-diameter, wire design, which has reached a non-copper critical current density of 2500 A/mm^2 at 4.2 K and 12 T, while STEP2 will be devoted to a scale-up to larger-size billets. The results of STEP1 are expected in the Fall of 2005, while those of STEP2 are expected in the Summer of 2006. Both companies have started the procurements of raw materials.

A Working Group on Conductor Characterization (WGCC) made up of representatives from CEA, CERN, INFN-Mi, INFN-Ge and chaired by A. den Ouden (TEU) has been set up in the Spring of 2004 to oversee wire I_C and magnetization measurements. The Working Group has initiated a cross-calibration of the various test facilities available to perform these measurements. In parallel, INFN-Ge has undertaken a series of magnetization measurements with different types of apparatus to evaluate their respective pertinence, including a SQUID magnetometer at INFM, Genova, a Vibrating Sample Magnetometer (VSM) at LNF and an

AC-susceptibility magnetometer available in house. These measurements were carried out either as a function of field, to assess effective filament diameter and the amplitude of flux jumps, or as a function of temperature, to study the nature and size of the various superconducting phases.

An effort has been launched by INFN-Ge to develop a FE mechanical model of un-reacted wires so as to simulate the effects of cabling and derive optimum billet layout. This model was first applied to an old, ITER-type, internal-tin wire design produced by Alstom/MSA (EDMS 548087). However, to be accurate, it requires a detailed knowledge of the properties of the materials that make up the wire in their cold work state at the end of drawing. CERN has undertaken a literature survey of these properties and has launched a series of nano-hardness and micro-hardness measurements on cross-cuts of the Alstom/MSA ITER-type wire to check and complement these data. The nano-hardness measurements are sub-contracted to a laboratory of Ecole d'Ingénieurs de l'Arc Jurassien (EIAJ, located in Le Locle, near Lausanne, Switzerland) while the micro-hardness measurements are performed in house. Two reports (EDMS 548100 for EIAJ and EDMS 548116 for CERN) summarize these measurements.

2005 Summary

Both industrial sub-contractors have received their raw materials and have started assembling and transforming STEP1 billets. For this stage, the Alstom/MSA plan includes four to five 20 kg billets (maximum yield of ~2 km at 1.25 mm diameter), while the SMI plan includes four 3 kg billets (maximum yield of ~400 m at 1 mm diameter). Alstom/MSA has encountered some problems in the preparation of the Sn rods used in billet assembly, which has required the design and manufacturing of a new shaving tooling, resulting in a 2-month delay. A temporary solution has been found and CERN has performed QA tests to verify the suitability of the process. All sub-elementary billets have now been assembled and transformed and the processing of the final billets is underway. The first batch of strands will be ready in October for heat treatment optimization. SMI has produced 2 billets with Ta tubes (from 2 different sources) around the Nb tubes to act as anti-diffusion barriers and 2 billets with modified powder composition to boost tin content. The drawing-down of the Ta-lined billets was accompanied by a high breakage rate, attributed to poor quality of the Ta tubes. The first of the two billets with optimized powder content yielded a unit length of 360 m at 1-mm diameter and its transport-current properties are now under investigation.

The cross-calibration program launched by the Working Group on Conductor Characterization has proven more difficult than anticipated. Three rounds of "virgin" test wires have been circulated among the various laboratories and have pointed out a number of problems and discrepancies in sample preparation and instrumentation as well as in measurement procedures. The first round included a reference, LHC-type, NbTi wire, and two Nb_3Sn wires: one 1.26-mm-diameter ECN PIT wire provided by TEU and one 0.83-mm-diameter EM Internal Tin wire provided by INFN-Mi (the EM wire samples were either "virgin" or extracted from a Rutherford-type cable). The second round relied again the 1.26-mm-diameter ECN PIT wire, while the third round included a 1-mm-diameter, SMI, ternary $Nb(Ta)_3Sn$, PIT wire, also provided by TEU. INFN-Mi and TEU have now achieved a good convergence on I_C measurements (results for the SMIT PIT wire samples agree within 2%) while CEA is still in the process of upgrading its test facility. The third round also included "virgin" and "deformed" samples of the 1.26-mm-diameter ECN PIT wire to evaluate cabling degradation (the wire was rolled down at CERN with diameter reductions of 0.30, 0.35, 0.40

and 0.45 mm, but only the samples with a 0.35-mm diameter reduction were tested). The INFN-Mi and TEU measurements of these samples show a larger dispersion (5 to 7%) than for the SMI PIT wire measurements (which may be due to heterogeneity in the wire itself); the I_C degradation between deformed and virgin samples is estimated around 40%. A status report on the cross-calibration program was presented at the Magnet Technology Conference (MT'19) in Genova.

Detailed investigations have been carried out by INFN-Ge to study the magnetization of 1.26-mm-diameter ECN PIT wire samples. Measurements performed with a SQUID magnetometer as a function of temperature clearly showed two transitions: one for a temperature of 17.4 K, corresponding to the transition of the reacted Nb_3Sn rings on the inner part of the tubes, and one around 9.2 K, corresponding to the transition of the un-reacted Nb on the outer part of the tubes. Comparison of the associated Nb_3Sn- and Nb-shielded volumes enables one to determine the depth of the tube walls that has been reacted. The value inferred from the magnetization measurement is in good agreement with the physical value determined from SEM observations. A summary of these measurements was presented at the Magnet Technology Conference (MT'19) in Genova.

Data from the nano- and micro-hardness measurements have been analyzed and cross-checked with available literature data, yielding a summary table of relevant material properties (Young's modulus, yield strength, maximum elongation and ultimate tensile strength) in the cold work state of the wire at the end of drawing (EDMS 567375). These data will be used in the FE model to study the behavior of two types of internal tin wires developed by Alstom/MSA: the old, ITER-type design and the new NED design (EDMS 575661). In parallel, tensile tests have been carried out at CERN (EDMS 592009) and at the BundesAnstalt für Materialforschung (BAM), in Berlin, on samples of the old ITER-type wire while complementary nano-hardness measurements on longitudinal cuts of this wire have been sub-contracted to EIAJ.

4.3.1 CD WP coordination

As already mentioned, the CD Work Package is articulated around three main poles: conductor development (encompassing Tasks 3.2, 3.3, 3.4 and 3.6), conductor characterization (encompassing Tasks 3.5 and 3.7), and mechanical studies (extension of scope with respect to CARE Annex I, initiated by INFN-Ge and partially supported by CERN).

The conductor development pole was launched by D. Leroy (CERN) and is presently coordinated by L. Oberli (CERN). A working Group on Conductor Characterization (WGCC), chaired by A. den Ouden (TEU) has been set up to coordinate the conductor characterization efforts, while S. Farinon (INFN-Ge) is the principal investigator on the mechanical model. The Pole Coordinators report to the NED Steering Committee and, ultimately, to the NED/JRA Coordinator.

4.3.2 Design of a 15 T Dipole Magnet

The following actions have been carried out

- ✓ September 2003–July 2004: preliminary design computations carried out by O. Vincent-Viry (CERN) under D. Leroy supervision (CERN)

- ✓ November 2003: report on 2D magnetic induction analytical calculation issued by O. Vincent-Viry (CERN; EDMS 431540)
- ✓ January 2004 SC meeting: first presentation of preliminary design computations by O. Vincent-Viry (CERN)
- ✓ 4 May 2004: meeting at CEA to review magnetic configurations and choice of 88-mm-aperture, $\cos\theta$ layer as Reference Design V1 (EDMS 555825)
  participants: H. Félice, L. Quettier, J.M. Riflet, P. Védrine (CEA), A. Devred (CEA&CERN), D. Leroy and O. Vincent-Viry (CERN)
- ✓ 2 August 2004: seminar at CERN by O. Vincent-Viry (CERN) on preliminary magnet designs
- ✓ 16 February 2005: first version of preliminary design report issued by D. Leroy and O. Vincent Viry (CERN; EDMS 555826)
- ✓ 26 July 2005: final version of preliminary design report issued by D. Leroy and O. Vincent Viry (CERN; EDMS 555826V2); EU deliverable

Sub-Task completed

4.3.3 Specifications on Wire and Cable

The following actions have been carried out

- ✓ 11 May 2004: first draft specification issued by D. Leroy (CERN) and communicated to A. Devred (CEA&CERN)
- ✓ 14 May 2004: first draft reviewed by A. Devred (CEA&CERN)
- ✓ 18 May 2004: second draft specification issued by D. Leroy and communicated to A. Devred (CEA&CERN) and A. den Ouden (TEU)
- ✓ 1 June 2004: third draft specification issued by D. Leroy and communicated to NED SC
- ✓ 4 June 2004: Specification Committee Meeting at CERN
  participants: T. Boutboul, P. Bryant (Chairman), P. Lebrun, D. Leroy, L. Oberli, L. Rossi (CERN), H.H.J. ten Kate (CERN&TEU)]
- ✓ 18 June 2004: final specification and technical questionnaire issued by D. Leroy (CERN; EDMS 475443); EU deliverable

Sub-Task completed

4.3.4 Wire Development

The following actions have been carried out and/or are foreseen

- ✓ 12 December 2003: preparatory visit to Alstom/MSA, France
  participants: A. Devred (CEA&CERN), D. Leroy, T. Boutboul and L. Oberli (CERN)]
- ✓ 15 December 2003: preparatory visit to European Advanced Superconductors (EAS, Germany)
  participants: A. Devred (CEA&CERN), D. Leroy and L. Oberli (CERN) + SMI representative
- ✓ 27 January 2004: preparatory visit to ShapeMetal Innovation (SMI, The Netherlands)

participants: A. Devred (CEA&CERN), D. Leroy, T. Boutboul, and A. Unervick (CERN) + EAS representatives
- ✓ 21 June 2004: call for tender issued to Alstom/MSA, EAS, Outokumpu Copper (OK Cu, Finland), Outokumpu SI (OKSI, Italy) and SMI
- ✓ 20 August 2004: meeting at CERN with SMI and EAS to prepare answer to call for tender
- ✓ 23 August 2004: meeting at CERN with OK to prepare answer to call for tender
- ✓ 24 August 2004: meeting at CERN with Alstom to prepare answer to call for tender
- ✓ 6 September 2004: tenders' opening at CERN; selection of Alstom/MSA and SMI
- ✓ 24 September 2004: sending of orders to CERN Finance Division
- ✓ 15 November 2004: contracts' signature by Alstom/MSA and SMI
- ✓ 15 December 2004: first progress reports issued by Alstom/MSA and SMI (restricted access)
- ✓ 17 May 2005: visit of T. Boutboul, D. Leroy, L. Oberli (CERN) to Alstom/MSA
- ✓ 28 June 2005: visit of T. Boutboul, D. Leroy, L. Oberli (CERN) to SMI
- ✓ 14 September 2005: visit of T. Boutboul, L. Oberli (CERN) to Alstom/MSA
- ⇒ Fall 2005: delivery of first batch of R&D wires (STEP1)
- ⇒ 15 December 2005: second progress reports issued by Alstom/MSA and SMI
- ⇒ Summer 2006: delivery of second batch of R&D wires (STEP2)
- ⇒ Fall 2006: final wire production; EU deliverable

4.3.5 Wire Characterization

The following actions have been carried out and/or are foreseen

4.3.5.1 Definition of Measurement Procedures

- ✓ March 2004: setting up of Working Group on Conductor Characterization (WGCC), chaired by A. den Ouden (TEU)
  WGCC charges and composition: EDMS 548084
- ✓ 19 May 2004: first Working Group meeting at CERN
  participants: L. Quettier (CEA), V. Previtali (CERN), P. Fabbricatore and M. Greco (INFN-Ge), D. Pedrini, G. Volpini (INFN-Mi), A. den Ouden (TEU)
  Talks: EDMS 567255
- ✓ June 2004-October 2004: first round of test wires for cross-calibration purposes
- ✓ 28 October 2004: second Working Group meeting at CEA
  participants: L. Quettier (CEA), V. Previtali, T. Boutboul (CERN), M. Greco (INFN-Ge), D. Pedrini, G. Volpini (INFN-Mi), A. den Ouden (TEU)
- ✓ November 2004-January 2005: second round of test wires for cross-calibration purposes
- ✓ 22 February 2005: third Working Group meeting at INFN-Mi

participants: L. Quettier (CEA), A. Devred (CEA&CERN), T. Boutboul and V. Previtali (CERN), M. Greco and P. Fabbricatore (INFN-Ge), D. Pedrini, G. Volpini (INFN-Mi)
Talks and Minutes: EDMS 576267

- ✓ 3 May 2005: fourth Working Group Meeting at CERN
  participants: L. Quettier (CEA), T. Boutboul, D. Leroy, L. Oberli (CERN), M. Greco (INFN-GE), D. Pedrini, G. Volpini (INFN-Mi), A. den Ouden (TEU)
  Talks: EDMS 593632
- ✓ May-July 2005: third round of test wires for cross-calibration purposes (includes deformed wires by rolling)
- ⇒ 22 November 2005: fifth Working Group Meeting at CERN
- ⇒ 31 December 2005: first interim report on wire characterization; EU milestone
- ⇒ 31 October 2006: final report on wire characterization; EU deliverable

4.3.5.2 Wire I_C Measurements

4.3.5.2.1 Wire I_C Measurements at CEA

- ⇒ June 2004-June 2005: cross-calibration program

4.3.5.2.2 Wire I_C Measurements at INFN-Mi

- ⇒ June 2004-June 2005: cross-calibration program

4.3.5.2.3 Wire I_C Measurements at TEU

- ⇒ June 2004-June 2005: cross-calibration program

4.3.5.3 Wire Magnetization Measurements at INFN-Ge

- ✓ 21 January 2004: preparatory meeting at CERN
  participants: A. Devred (CEA&CERN), D. Leroy (CERN) and P. Fabbricatore (INFN-Ge]
- ✓ 23 March 2004: first report on preliminary measurements issued by P. Fabbricatore and M. Greco (INFN-Ge)
- ✓ 23 March 2004–13 April 2004: review of preliminary measurements by A. Devred (CEA&CERN) and D. Leroy (CERN)
- ✓ June 2004-July 2005 2005: participation to cross-calibration program defined by WGCC

4.3.6 Cable development and manufacturing

Not started

4.3.7 Cable Characterization

Not started

4.3.8 Mechanical Studies

These studies are an extension of scope with respect to CARE Annex I and are supported by additional resources provided by INFN-Ge and CERN.

The following actions have been carried out and/or are foreseen

- ✓ 28 January 2004: parameters of mechanical model for 19-subelement, internal tin wire issued by A. Devred (CEA&CERN; EDMS 548087)
- ✓ 30 January 2004: mesh proposal issued by S. Farinon (INFN-Ge)

- ✓ Early February 2004: review of mesh proposal by A. Devred (CEA&CERN), D. Leroy (CERN) and C. Verwaerde (Alstom/MSA)
- ✓ 25 March 2004: informal discussion of preliminary computation results participants: A. Devred (CEA), D. Leroy (CERN), S. Farinon (INFN-Ge), C. Verwaerde and P. Mocaer (Alstom/MSA)]
- ✓ 9 June 2004: meeting at CERN to review material properties and discuss computation results
  participants: A. Devred (CEA&CERN), T. Boutboul, P. Fessia, D. Leroy and S. Sgobba (CERN), S. Farinon and R. Musenich (INFN-Ge), P. Loverage (CCLRC)
- ✓ 7 July 2004: meeting at CERN to review material properties and discuss computation results
  participants: A. Devred (CEA&CERN), T. Boutboul, P. Fessia, L. Oberli M. Pojer and S. Sgobba (CERN), P. Fabbricatore and S. Farinon (INFN-Ge)
- ✓ September 2004: first contract issued to EIAJ to perform nano-indentation measurements on an un-reacted, internal-tin wire cross-section
- ✓ 14 October 2004: visit to EIAJ, Le Locle (CH)
  participants: T. Boutboul, C. Scheuerlein, S. Sgobba (CERN)
  trip report: EDMS 520095
- ✓ 29 October 2004: first report issued by EIAJ on nano-indentation measurements (EDMS 548100)
- ✓ 11 November 2004: meeting at CERN to review nano-indentation measurements performed at EIAJ
  participants: A. Devred (CEA&CERN), T. Boutboul, P. Fessia, D. Leroy, L. Oberli, V. Previtali, D. Richter and S. Sgobba (CERN), P. Fabbricatore and S. Farinon (INFN-Ge)
- ✓ 11 November 2004: first report issued by C. Scheuerlein (CERN) on micro-hardness measurements at CERN (EDMS 548116)
- ✓ 22 November 2004: meeting at CERN to review micro-hardness measurements
  participants: A. Devred (CEA&CERN), T. Boutboul, C. Scheuerlein, S. Sgobba and W. Scandale (CERN)
- ✓ 15 February 2005: second report issued by C. Scheuerlein (CERN) on micro-hardness measurements at CERN (EDMS 567297)
- ✓ 15 February 2005: meeting at CERN to update table of material properties to be used in FE model
  participants: A. Devred (CEA&CERN), T. Boutboul, D. Leroy, C. Scheuerlein, S. Sgobba (CERN)
- ✓ 17 February 2005: report issued by T. Boutboul (CERN) on RRR measurements at CERN (EDMS 567365)
- ✓ 22 February 2005: table of material properties issued by S. Sgobba and C. Scheuerlein (CERN; EDMS 567375)
- ✓ 23 March 2005: note issued by T. Boutboul and L. Oberli (CERN) defining new parameters of internal tin wire (EDMS 575661)
- ✓ April 2005: second contract issued to EIAJ to perform nano-indentation measurements on a longitudinal cross-section of an un-reacted, internal-tin wire

- ✓ 9 May 2005: first version of report on UTS measurements at CERN issued by C. Scheuerlein (CERN; EDMS 567375)
- ✓ 6 June 2005: second version of report on UTS measurements at CERN issued by C. Scheuerlein (CERN; EDMS 567375V2)
- ✓ 6 October 2005: meeting at CERN to discuss results of tensile tests performed at BAM
  participants: A. Devred (CEA&CERN), T.Boutboul, L. Oberli, C. Scheuerlein (CERN)

Table 4.3a: Status of the lowest Sub-Tasks level in the CD WP (as of 15 October 2005).

WBS #	Title	Original begin date (Annex 1)	Original end date (Annex 1)	Estimated Status	Revised end date
3.1	CD WP Coordination				
3.2	Design of a 15 T Dipole Magnet	1 January 2004	31 Dec. 2004	Completed	July 2005
3.3	Specifications on Wire and Cable	1 April 2004	30 June 2004	Completed	On time
3.4	Wire Development	1 July 2004	30 June 2006	Started	30 September 2006
3.5	Wire Characterization				
3.5.1	Definition of Measuring Procedures	1 January 2004	30 June 2005	80%	31 October 2005
3.5.2	Ic measurements at CEA	1 July 2005	30 June 2006	Started	31 December 2006
3.5.3	Ic measurements at INFN-Mi	1 July 2005	30 June 2006	Started	31 December 2006
3.5.4	Ic measurements at TEU	1 July 2005	30 June 2006	Started	31 December 2006
3.5.5	Wire Magnetization Measurements	1 July 2005	30 June 2006	Started	31 December 2006
3.6	Cable Development	1 July 2005	31 Dec. 2006	Not started	15 December 2006
3.7	Cable Characterization	1 October 2005	31 Dec. 2006	Not started	-
3.8	Mechanical Studies[a)]	1 January 2004	31 Dec. 2005	33%	-

[a)] Extension of scope with respect to CARE Annex I.

Table 4.3b: Status with respect to the milestones and deliverables due in the CD WP (as of 15 October 2005).

WBS #	Title	Responsible Lab(s)	Due date in Annex 1	Status	Revised delivery date
3.2	Design Report (deliverable)	CERN	31 December 2004	Completed	July 2005
3.3	Final Report on Wire and Cable Specifications (deliverable)	CERN	30 June 2004	Completed	On time
3.4	Progress Report on Wire Development (milestone)	CERN	30 June 2005[a)]	Completed Not started	15 December 2004 15 December 2005
3.4	Production of Final Wire (deliverable)	CERN	30 June 2006	Not started	15 December 2006
3.5	Intermediate Results on Wire Characterization (milestone)	CEA, INFN-Ge, INFN-Mi, TEU	31 December 2005	Started	28 February 2006
3.5	Final Report on Wire Characterization (deliverable)	CEA, INFN-Ge, INFN-Mi, TEU	30 June 2006	Not started	31 December 2006
3.6	Production of Final Cable (deliverable)	CERN	31 December 2006	Not started	-
3.7	Final Report on Cable Performances (deliverable)	TEU	31 December 2006	Not started	-

[a)] The CARE Annex I milestone entitled “First Results on Wire Development” that was due on 30 June 2005 has been split into two “Status Reports” due on 15 December 2004 and 15 December 2005.

4.4 Work Package 4: Insulation Development & Implementation (IDI)

Work Package 4 includes two main Tasks:

- conventional insulation development
  (carried out by CCLRC/RAL, Task Leader: S. Canfer)
- innovative insulation development
  (carried out by CEA, Taks Leader: F. Rondeaux)

2004 Summary

CCLRC and CEA have written an engineering specification for the NED conductor insulation (EDMS 548037) and a coordinated Test Programme for the conventional and innovative insulations (EDMS 548038).

CCLRC has started investigations on glass fiber sizings and epoxy resin fillers and is developing an experimental set up to perform fracture tests based on a double-cantilever beam (DCB).

The start of the work on Innovative Insulation at CEA (Task 4.4) has been delayed, pending the hiring of a technician to support the activity of the chemistry laboratory.

2005 Summary

Screening testing of candidate materials for Conventional Insulation has progressed well. CCLRC has developed a standardised laminate production system and relies on three tests for screening: (1) inter-laminar fracture test, (2) short-beam shear test and (3) electrical breakdown test. The standard laminates leave sufficient material for radiation testing.

To gain experience and validate the inter-laminar fracture tests, three know systems of epoxy resins have been investigated: (1) a brittle system made up of DGEBA resin with an acid anhydride hardener (HY918, Ciba), (2) a tough system, made up of DGEBA resin with an aliphatic amine hardener (Jeffamine D-400), and (3) an intermediary system, made up of DGEBF resin, a PPGDGE flexibiliser and an aromatic amine hardener (HY5200, Ciba). All samples were prepared using as received E-glass tapes with commercial sizing, and the tests were performed at room temperature and at 77 K. As expected, the brittle system yields the lowest work of fracture (~0.45 kJ/m^2 at room temperature), while the toughest system yields the highest one (~1 kJ/m^2 at room temperature), and the intermediary system is in between (~0.8 kJ/m^2 at room temperature). The results are in the same order, but 20 to 40% higher at 77 K.

Furthermore, CCLRC has investigated the issue of fibre glass sizing. The sizing that coats the filaments of commercial fibre tapes is a mixture of organic materials that is not intended for high temperature use, and, if left in place, can result in undesirable carbon residues at the end of the Nb_3Sn reaction cycle. In practice, the sizing is removed from the tapes (by carbonization in air at temperatures in the 350-450 ºC range) prior to conductor wrapping and winding. However, removing the sizing renders the tape fragile and easy to tear off by friction, which complicates the manufacturing process. In addition, sizing removal has proved to have a bearing on the mechanical and electrical performances of the final insulation system. CCLRC has identified an improved sizing material, which is a commercial polyimide produced by Hydrosize, NC, USA that may sustain the Nb_3Sn reaction cycle without

deleterious degradation. This sizing has been applied to glass and quartz fibre fabric by JPS Glass, SC, USA.

To assess the suitability of the polyimide sizing, CCLRC has undertaken a comparative test on standard laminates made up of conventional S-glass tapes (as received, de-sized and heat treated for 60 hours at 660 ºC in a vacuum after de-sizing) and of polyimide-sized, S-glass and quartz fabrics provided by JPS (as received and heat-treated for 60 hours at 660 ºC in a vacuum without de-sizing). The laminates were vacuum-impregnated with a system made up of DGBEF resin (DER354P, Dow) and a DETDA hardener (HY5200, Vantico). (This system was chosen because it is both relatively radiation stable and has a low viscosity, and, thereby, seems the best suited to NED application). The work of fracture measured on the conventional, as-received, S-glass sample is 0.49 kJ/m^2 at room temperature, which puts the resin system into the brittle category (not unexpected given the nature of the hardener that was chosen). No meaningful work of fracture could be measured on the conventional, de-sized, heat-treated, S-glass sample. Indeed, the sample failed through the glass layer and not in an inter-laminar fashion, thereby indicating that the glass was adversely affected by heat treatment. The results on the polyimide-sized, S-glass samples are very promising: the work of fracture on the sample made up of as-received fabric is 0.7 kJ/m^2 at room temperature and stays at 0.67 kJ/m^2 on the sample made up of heat-treated fabric. The short-beam shear strengths measured at 77 K are above ~90 MPa for all samples, save for the conventional, de-sized, heat-treated, S-glass sample where it falls to 69 MPa. Finally, electrical breakdown tests were carried out on conventional, heat-treated, de-sized and not de-sized S-glass samples and on heat-treated, polyimide-sized S-glass samples. The voltage measured on the conventional, de-sized sample and on the polyimide-sized sample are both in excess of 30 kV/mm, while the one measured on the sample made up of conventional S glass, heat-treated without de-sizing, is degraded to 2.5 kV/mm.

The work on the Innovative Insulation is still on hold pending the hiring of a technician in the chemistry lab at CEA, which has been further delayed until the end of 2005. To compensate this delay, it has been decided to re-allocate part of the EU funding to hire a postdoc at CEA.

4.4.1 IDI WP Coordination

The IDI Work Package is coordinated by E. Baynham (CCLRC). The conventional Insulation Task (4.3) is headed by S. Canfer (CCLRC) while the Innovative Insulation Task (4.4) is headed by F. Rondeaux (CEA). The Work package and Task Leaders report to the NED Steering Committee and, ultimately, to the NED/JRA Coordinator.

4.4.2 Specifications' Drafting

The following actions have been carried out

- ✓ 6 May 2004: draft specifications issued by S. Canfer (CCLRC)
- ✓ 11 May 2004: conference call on insulation specifications
- ✓ participants: S. Canfer and J. Greenhalgh (CCLRC), F. Rondeaux (CEA), A. Devred (CEA&CERN), A. den Ouden (TEU)
- ✓ 11 May 2004: Version 2 of specifications issued by S. Canfer (CCLRC; EDMS 548037V1)
- ✓ 25 May 2004: Version 2.2 of specifications issued by S. Canfer (CCLRC; EDMS 548037V2)

- ✓ 1 June 2004: Version 2.3 of specifications issued by S. Canfer (CCLRC; EDMS 548037V3)
- ✓ 23 June 2004: Version 2.3b of specifications issued by S. Canfer (CCLRC; EDMS 548037V4)
- ✓ 16 July 2004: final specifications (EDMS 548037V5); EU milestone

Sub-Task completed

4.4.3 Conventional Insulation

The following actions have been carried out and/or are foreseen

- ✓ 27 July 2004: first draft of conventional insulation Test Programme (EDMS 548038V1)
- ✓ 12 August 2004: second draft of conventional insulation Test Programme
- ✓ 27 October 2004: final insulation Test Programme (including Test Programme for innovative insulation; EDMS 548038V2); EU milestone
- ✓ 30 September 2004: completion of Literature Survey (Sub-Task 4.3.1)
- ✓ 30 November 2004: completion of Tooling Preparation (Sub-Task 4.3.2)
- ✓ 31 December 2004): completion of Component Supply (Sub-Task 4.3.3)
- ⇒ 1 January 2005 – 30 September 2005: Iterative Tests (Sub-Task 4.3.4)
- ⇒ 1 October 2005 – 31 December 2005: Data Analysis (Sub-Task 4.3.5)
- ⇒ 1 July 2005 – 30 June 2006: Irradiation Tests (extension of scope with respect to CARE Annex I)
- ⇒ 30 June 2006: final report on conventional insulation; EU deliverable

4.4.4 Innovative Insulation

The following actions have been carried out and/or are foreseen

- ✓ 6 May 2004: preparatory meeting at CEA
- ✓ participants: J.M. Rifflet, F. Rondeaux and P. Védrine (CEA), A. Devred (CEA&CERN); conclusions of this meeting are reported above
- ✓ 30 August 2004: first draft of innovative insulation Test Programme
- ✓ September 2004: final innovative insulation Test Programme (added to EU milestone on conventional insulation Test Programme)
- ⇒ 1 January 2005 – 31 December 2005: Tape Weaving Trial (Sub-Task 4.4.1)
- ⇒ 1 January 2005 – 30 June 2006: Characterization Tests (Sub-Task 4.4.2; scope has been modified with respect to CARE Annex I)
- ⇒ 30 June 2006: final report on innovative insulation; EU deliverable

Table 4.4a: Status of the lowest Sub-Tasks level in the IDI WP (as of 15 October 2005).

WBS #	Title	Original begin date (Annex 1)	Original end date (Annex 1)	Estimated Status	Revised end date
4.1	IDI WP Coordination				
4.2	Specifications' Drafting	1 April 2004	30 June 2004	Completed	22 July 2004
4.3	Conventional Insulation				
4.3.1	Literature Survey	1 July 2004	30 Sept. 2004	Completed	On time
4.3.2	Tooling Preparation	1 October 2004	30 October 2004	Completed	31 Dec. 2005
4.3.3	Component Supply	1 October 2004	31 Dec. 2004	Completed	On time
4.3.4	Iterative Tests	1 January 2005	30 Sept. 2005	70%	31 December 2005
4.3.5	Data Analysis	1 October 2005	31 Dec. 2005	Not started	-
4.3.6	Irradiation tests[a)]	1 July 2005	30 June 2006	Not started	-
4.4	Innovative Insulation				
4.4.1	Tape Weaving Trial	1 July 2004	31 Dec. 2004	Not started	30 June 2006
4.4.2	Characterization Tests[b)]	1 July 2004	30 June 2005	Not started	31 Dec. 2006

a) Extension of scope with respect to CARE Annex I.

b) Modification of scope with respect to CARE Annex I.

Table 4.4b: Status with respect to the milestones and deliverables due in the IDI WP (as of 15 October 2005).

WBS #	Title	Responsible Lab(s)	Due date in Annex 1	Status	Revised delivery date
4.2	Report on Specifications for Conductor Insulation (milestone)	CCLRC	30 June 2004	Completed	22 July 2004
4.3&4.4	Report on Definition of the Test Programme (milestone)[a)]	CCLRC&CEA	31 July 2004	Completed	27 October 2004
4.3	Report on Conventional Insulation (deliverable)	CCLRC	31 December 2005	Not started	30 June 2006
4.4	Report on Innovative Insulation (deliverable)	CEA	30 June 2005	Not started	31 Dec. 2006

a) Scope of report has been extended to include test programme on innovative insulation (Task 4.4).

4.5 Working Group on Magnet Design and Optimization (WGMDO)

2004 Summary

CCLRC, CEA, CERN and CIEMAT have decided to join forces in order to create an informal Working Group on Magnet Design and Optimization (WGMDO), whose charges and composition are defined in EDMS 547882.

The Working Group is made up of

- H. Félice (CEA)
- P. Fessia (CERN)
- P. Loveridge (CCLRC)
- J. Rochford (CCLRC)
- S. Sanz (CIEMAT)
- F. Toral-Fernandez (CIEMAT), Technical Secretary
- P. Védrine (CEA), Chairman

This Working Group is an extension of scope with respect to CARE Annex 1. It is supported by CCLRC (whose contribution foreseen to Task 3.2 has been shifted to this end) and by additional resources from CEA, CERN and CIEMAT.

The Working Group has agreed on a common set of design parameters for a high field dipole magnet and has selected a number of magnetic configurations to be studied and compared: $\cos\theta$ layer, $\cos\theta$ slot, ellipse-type, motor-type, common coil and double helix. The comparison will be carried out in three steps: 1) comparison of 2-D magnetic designs, 2) comparison of 2-D mechanical designs and 3) comparison of 3-D designs. Each partner has chosen one or two configurations and has started to work on 2-D magnetic design.

2005 Summary

CCLRC/RAL has chosen to investigate the Reference Design V1, $\cos\theta$, layer design and to assess the feasibility of a double-helix magnetic configuration. The $\cos\theta$ optimization was carried out using software supplied by the commercial company Vector Fields (VF), which has close links with the RAL magnet group. At first, the software was used to construct a 2D parameterized FE model, which includes the option of modelling the nonlinear effects of iron and a non-uniform current density in the conductor winding (as generated by the slightly-keystoned, NED Rutherford-type cable). A number of test case were run to check that the optimiser provided by Vector Fields is working and to look at the effect of changing the objective functions. The output from the full model has now been compared with ROXIE and it gives the same results for the same geometry and field. Investigations are being carried out to determine whether the optimizer routines from both packages yield the same solutions, given the same starting point. The work to look at the feasibility of a helical dipole has just started. A basic model capable of being used with the VF optimiser programme has been built and is ready to run.

In parallel, CCLRC/RAL has started the development of a 2D mechanical model of Reference Design V1 based on ANSYS. The model is done in two steps. The first step is made up of the coil assembly, the ground plane insulation, pairs of austenitic steel collars and keys. It is used to describe the collaring process during which the collars are implemented

around the insulated coil assembly and clamped by means of the keys so as to pre-compress the coil azimuthally. The second step includes the aforementioned collared-coil assembly completed by a two-piece, horizontally-split, iron yoke and a welded outer shell that holds the coldmass together. The two yoke halves are assembled around the collared-coil assembly in such way that there remains a gap at their midplane. The room-temperature coil pre-compression after collaring and the yoke midplane gap after shell welding must be optimized so as to ensure that, when the magnet is cold and energized, the coil remains under compression and the yoke midplane gap is closed, thereby providing a very stiff support against the Lorentz forces. The first step of the model is now fully operational, while the details of the second step are being worked out.

CEA has worked on the 2D magnetic analysis of the 88-mm, 130-mm and 160-mm-aperture ellipse-type design using ROXIE. It has been shown that, in each case, accelerator-field quality can be reached by optimizing the conductors location and that the peak field on main field ratio is very advantageous. Nevertheless, the Lorentz forces involved are huge a lot of attention has to be paid to the mechanical design. CEA is presently developing a mechanical model of the 130-mm aperture design based on CASTEM.

CERN has furthered the electromagnetic optimization of Reference Design V1 using ROXIE. The optimization was carried out with respect to

- conductor geometry (to minimize high-order multipole field coefficients and improve radial positioning of conductor blocks in 2D cross-.section),
- iron shape (to minimize the effect of iron saturation),
- size and implementation of ferromagnetic shims (to compensate the effects of persistent magnetization currents).

This optimization is leading to the definition of a new reference design that will be identified as Reference Design V2.

CIEMAT has worked on the 2D magnetic analysis of the 88-mm- and 130-mm-aperture motor-type design and of the 88-mm-aperture common coil design (using ROXIE). Starting from the set of design parameters agreed upon by the Working Group, the field quality has been optimized in the cross-section while keeping an eye on the mechanical behavior since the Lorentz forces are quite large. For both configurations, the number of design variables is enough to get an optimum field quality, as well as a good ratio between peak and bore fields, but the motor-type magnet yields a very high fringe field together with a poor superconductor volume efficiency.

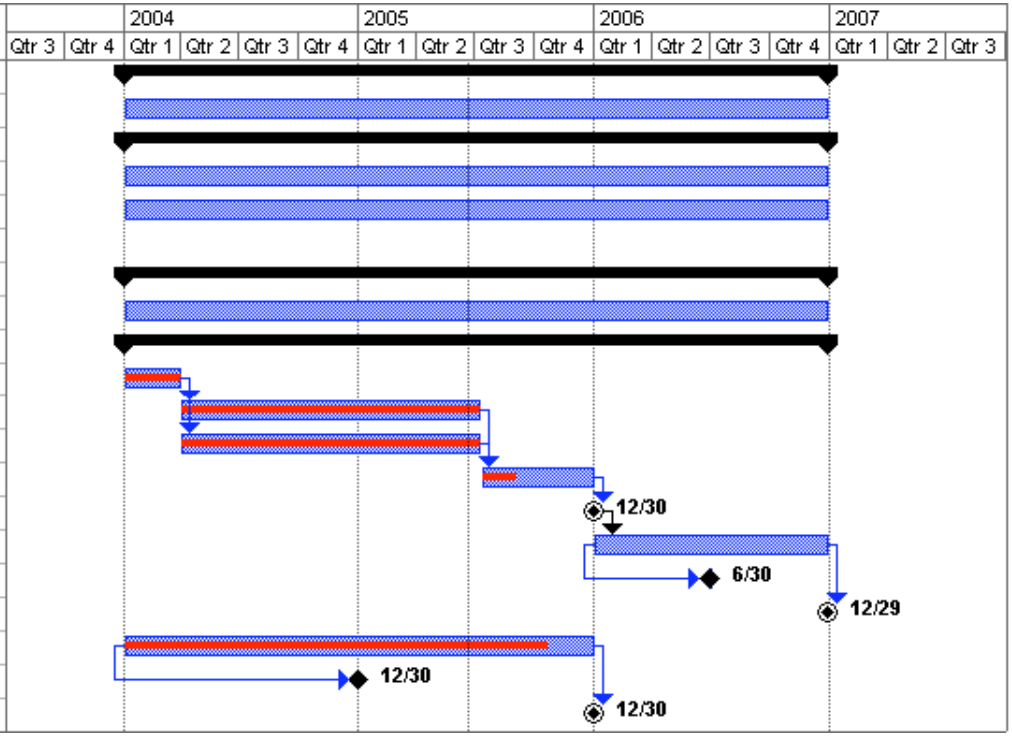
The following actions have been carried and/or are foreseen

- ✓ 19 May 2004: brainstorming session at CEA/Saclay
  participants: H. Felice, L. Quettier and P. Védrine (CEA), A. Devred, (CEA&CERN), P. Fessia (CERN), S. Sanz and F. Toral (CIEMAT), P. Loveridge and J. Rochford (CCLRC)
  preparatory document: EDMS 547883
  minutes: EDMS 547884
- ✓ 23 November 2004: meeting at CERN to discuss CCLRC computations on NED baseline (88-mm-aperture, $\cos\theta$, layer) design
  participants: D.E. Baynham and P. Loveridge (CCLRC), A. Devred, (CEA&CERN), D. Leroy (CERN)

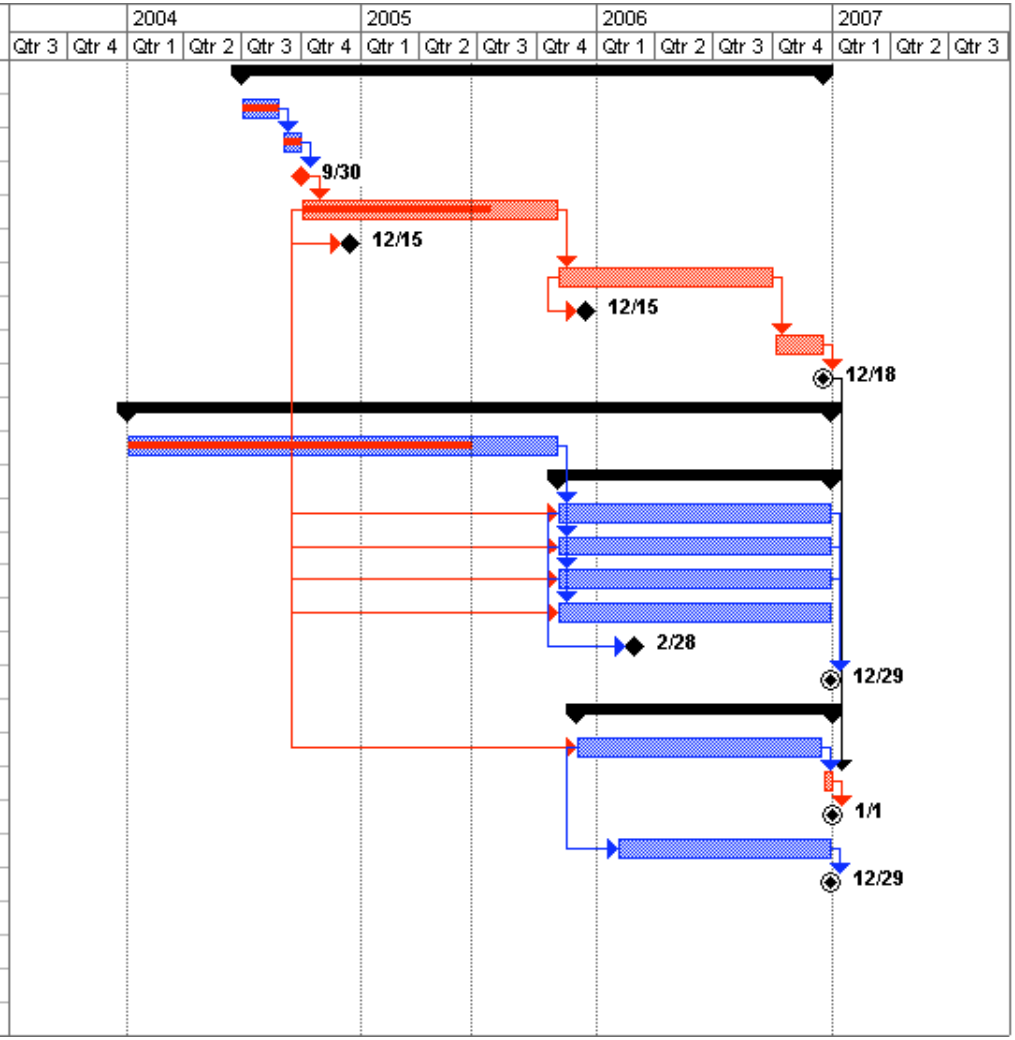
- ✓ 17 December 2004: WGMDO meeting at CIEMAT to review 2-D magnetic designs
  participants: P. Loveridge, J. Rochford (CCLRC), H. Felice, P. Védrine (CEA), A. Devred (CEA&CERN), S. Sanz, F. Toral (CIEMAT)
  talks and minutes: EDMS 547885
- ✓ 27 January 2005: visit of P. Loveridge (CCLRC) to CEA to discuss FE modelling
  participants: P. Loveridge (CCLRC), M. Ségréti and P. Védrine (CEA), A. Devred (CEA&CERN)
- ✓ 13 April 2005: meeting at CERN to discuss CCLRC progress on ANSYS model of NED Reference Design V1
  participants: E. Baynham, P. Loveridge (CCLRC), A. Devred (CEA&CERN), P. Fessia and M. Pojer (CERN)
- ✓ 13 April 2005: WGMDO meeting at CERN
  participants: E. Baynham, P. Loveridge, J. Rochford (CCLRC), H. Félice (CEA), A. Devred (CEA&CERN), P. Fessia, N. Schwerg (CERN), S. Sanz and F. Toral (CIEMAT)
  talks and minutes: EDMS 581911
- ✓ 14 June 2005: WGMDO meeting at CCLRC to review progress on 2-D magnetic and mechanical designs
  participants: E. Baynham, S. Canfer, C. Densham, J. Greenhalgh, P. Loveridge, J. Rochford, (CCLRC), H. Félice (CEA), A. Devred (CEA&CERN), N. Schwerg (CERN), S. Sanz and F. Toral (CIEMAT)
  talks and minutes: EDMS 600861
- ✓ 23 June 2005: meeting at CERN to discuss CCLRC progress on ANSYS model of NED Reference Design V1
  participants: E. Baynham (CCLRC/RAL), A. Devred (CEA&CERN) and D. Leroy (CERN)
- ✓ 1 September 2005: start date of Federico Regis at CERN, as unpaid associate supported by a Associazione Sviluppo Tecnologico e Scientifico Piemonte (ASP) grant, to work on NED mechanical design under the supervision of P. Fessia (CERN)
- ✓ 27 September 2005: CERN/AT/MAS seminar of N. Schwerg (CERN) on "Optimization of the coil cross section for NED"
- ✓ 6 October 2005: meeting at CERN to discuss CCLRC progress on ANSYS model of NED Reference Design V1
  Participants: E. Baynham, P.Loveridge (CCLRC/RAL), A. Devred (CEA&CERN), D. Leroy (CERN)
- ⇒ 22 November 2005: next WGMDO meeting at CERN

5 APPENDIX 1: UPDATED IMPLEMENTATION PLAN (GANTT CHART) FOR THE NED/JRA AS DESCRIBED IN THE TECHNICAL ANNEX OF CARE CONTRACT (EDMS 548031)

Next European Dipole Joint Research Activity
1 Management and Communication (M&C)
1.1 Activity Coordination
1.2 Meetings
1.2.1 Steering Committee Meetings
1.2.2 External Scientific Advisory Committee Meetings
2 Thermal Studies and Quench Protection (TSQP)
2.1 Work Package Coordination
2.2 Heat Transfer Measurements
2.2.1 Drafting of Test Facility Specifications
2.2.2 Cryostat Design and Fabrication
2.2.3 Cryogenic Module Design and Fabrication
2.2.4 Facility Integration and Qualification
Commisioning of Heat Transfer Facility (deliverable)
2.2.5 Measurements and Analyses
Interim Report on Heat Transfer Measurements (milestone)
Final Report on Heat Transfer Measurements (deliverable)
2.3 Quench Protection Computation
Interim Report on Quench Performance (milestone)
Final Report on Quench Protection (deliverable)

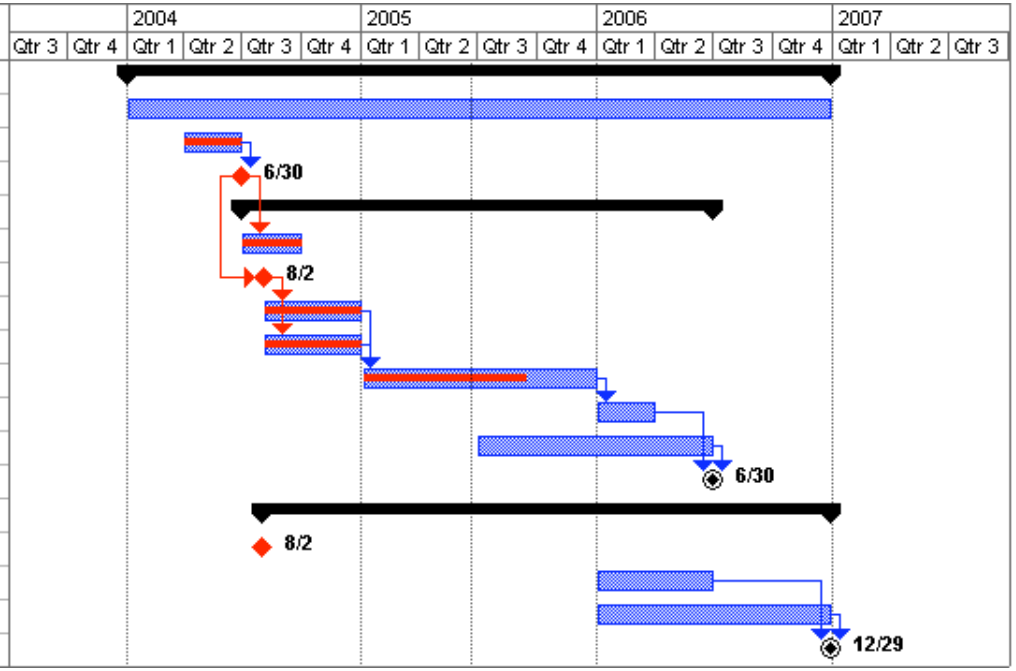


Next European Dipole Joint Research Activity
3.4 Wire Development
3.4.1 Call for tender
3.4.2 Contracts preparation
Contract Signature
3.4.3 Step 1
Progress Report (milestone)
3.4.4 Step 2
Progress Report (milestone)
3.4.5 Final production
Final Wire Production (deliverable)
3.5 Wire Characterization
3.5.1 Definition of Measuring Procedures
3.5.2 Wire Ic Measurements
3.5.2.1 At CEA
3.5.2.2 At INFN-Mi
3.5.2.3 At TEU
3.5.3 Wire Magnetization Measurements
Interim Report on Wire Characterization (milestone)
Final Report on Wire Characterization (deliverable)
3.6 Cable Development
3.6.1 Cabling Trial
3.6.2 Final Production
Final Cable Production (deliverable)
3.7 Cable Characterization
Report on Cable Performance (deliverable)



NB: the CARE Annex I milestone entitled “First Results on Wire Development” that was due on 30 June 2005 has been split into two “Status Reports” due on 15 December 2004 and 15 December 2005.

Next European Dipole Joint Research Activity
4 Insulation Development and Implementation (IDI)
4.1 Work Package Coordination
4.2 Specifications' Drafting
Report Specifications for Conductor Insulation (milestone)
4.3 Implementation Study of Conventional Solution
4.3.1 Litterature Survey
Definition of the Test Programme (milestone)
4.3.2 Tooling Preparation
4.3.3 Component Supply
4.3.4 Iterative Tests
4.3.5 Data Analysis
4.3.6 Irradiation Tests
Report on Conventional Insulation (deliverable)
4.4 Implementation Study of Innovative Solution
Definition of the Test Programme
4.4.1 Tape Weaving Trial
4.4.2 Characterization Tests
Report on Innovative Insulation (deliverable)



NB:

- Task 4.3.6 is an extension of scope with respect to CARE Annex I,
- The scope of Task 4.4.2 has been modified with respect to CARE Annex I.