



# Next European Dipole (NED) Status Report

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on behalf of the NED Collaboration



CARE General Meeting  
DESY  
4 October 2004

# What is NED?



- NED is a Joint Research Activity (JRA) aimed at integrating **high-field, superconducting accelerator magnet R&D** in Europe so as to get ready for LHC upgrade and beyond.
- It is also meant to bring **Nb<sub>3</sub>Sn superconductor technology to maturity** and to help European laboratory and European industry to bridge the gap with their American counterpart.
- The NED/JRA is tightly connected to the **HHH/AMT Work Package**.

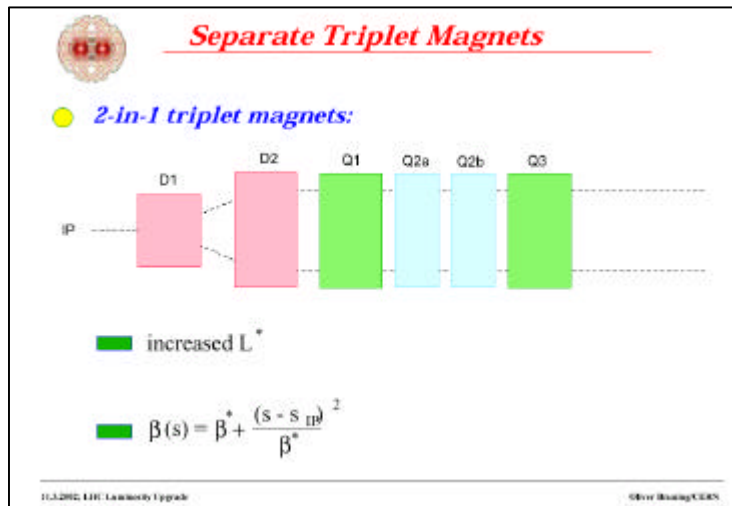
# NED Scientific Goals



- The scientific goals of the initial NED proposal were
  1. to revisit **magnetic and mechanical designs** of accelerator magnet coils made from brittle materials,
  2. to address **coil cooling issues** under high beam losses,
  3. to promote **high performance Nb<sub>3</sub>Sn wire development** in collaboration with European industry (aiming at a non-Cu  $J_c$  of **1500 A/mm<sup>2</sup> at 4.2 K and 15 T**),
  4. to improve mechanical robustness and radiation hardness of **Nb<sub>3</sub>Sn conductor insulation**,
  5. to design, build, and test **a large aperture (88 mm), high field (15 T conductor peak field) dipole magnet model** that pushes the technology well beyond present LHC limits.

# NED Applications

- The proposed magnet model serves two main purposes



1. getting ready for LHC IR upgrade, e.g., by studying the feasibility of scenarios requiring large-aperture, high-field or high-field gradient dipole or quadrupole magnets.



2. upgrade of CERN/FRESCA cable test facility (presently limited to a 10-T background field) to offer unique services to the entire applied superconductivity community.

- Also, it is **complementary** to the US-LHC Accelerator Research Program (LARP), whose primary focus is on quadrupole magnets.

# EU-Led Peer Review



- The peer-reviewers called up by the EU in July 2003 endorsed rather strongly the proposal, wrote very **encouraging** words in their report and initially recommended **a full funding**.
- However, in a final round of cuts, they received the wrong information that CERN was already supporting such a program and ended up suggesting **to cap the EU contribution at 25% of the requested funding** (*i.e.*, **~1 M€** instead of **~4 M€**).
- It turns out that the only Nb<sub>3</sub>Sn program supported by CERN is **a collaboration with Twente University (The Netherlands)**, that was started in 1996 (with a different and less ambitious objective), and that is suffering from heavy delays (primarily because of lack of resources).

# NED Program

- To cope with the dramatic limitation on EU funding, the NED Program was divided into **two phases**
  - Phase I groups together all the tasks related to **Nb<sub>3</sub>Sn conductor development and characterization**, and includes some limited studies on conductor insulation and magnet design,
  - Phase II groups together all the tasks related to **the detailed design, manufacturing and testing** of the dipole magnet model.
- **Phase I has been approved** as part of the CARE project (~13 staff.year over 3 years; total cost: ~2 M€; EU grant: 979 k€).
- The NED collaborators are still struggling to find the funding necessary to carry out Phase II (total cost: ~4 M€).

# NED Collaborators



- At present, **eight institutes** are collaborating to NED
  - CCLRC/RAL (UK),
  - CEA/DSM/DAPNIA (France),
  - CERN/AT (International),
  - CIEMAT (Spain),
  - INFN/Genova (INFN-Ge, Italy),
  - INFN/Milan (INFN-Mi, Italy),
  - Twente University (TEU, The Netherlands),
  - Wroclaw University of Technology (WUT, Poland).

# Steering Committee



- The oversight of the NED/JRA is ensured by a **Steering Committee (SC)** made up of
  - E. Baynham (CCLRC/RAL),
  - A. Devred, Chairman (CEA & CERN),
  - D. Leroy (CERN),
  - A. den Ouden, Secretary (TEU),
  - J.M. Rifflet (CEA),
  - G. Volpini (INFN-Mi).
- The SC meets **every three months**, usually at CERN to limit travel costs; the first four meetings were held on 8 January (CERN), 25 March (CERN), 8 July (CERN) and 29 October (CEA/Saclay); the next meeting is scheduled for 20 January 2005 (CERN).

# External Scientific Advisory Committee

- The JRA Coordinator is helped by **an External Scientific Advisory Committee (ESAC)** made up of
  - J.L. Duchateau (CEA; link with ITER Program),
  - H.H.J. ten Kate (CERN & TEU),
  - P. Lebrun (CERN),
  - L. Rossi (CERN; link with HHH/AMT Network Work Package),
  - R.M. Scanlan (retired from LBNL; link with US National Program on Nb<sub>3</sub>Sn wires for HEP applications),
  - J.B. Strait, Chairman (FNAL; link with US-LARP Program).
- The ESAC meets **once a year**; the first meeting was held on 24 March (at the end of HHH/AMT WAMS workshop), and the first report was issued on 29 April; the next meeting will be called in the Fall of 2005.

# NED Phase I



- The Phase I of NED is articulated around four Work Packages and a Working Group

- 1 Management & Communication (M&C),
- 2 Thermal Studies and Quench Protection (TSQP),
- 3 Conductor Development (CD),
- 4 Insulation Development and Implementation (IDI),
- 5 Magnet Design and Optimization (MDO) Working Group.

# M&C Work Package



- All information pertinent to NED are posted on a web page mastered by A. den Ouden (TEU; NED representative to the CARE Dissemination Board)

<http://lt.tnw.utwente.nl/project.php?projectid=9>

- A tree structure has been defined and will be implemented shortly into the CERN Engineering Data Management Service (EDMS); it will be used to approve, circulate, track and store documents.

# NED Budget Request

| 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)                 | 128,887   | 0  | 0   | 37,500  | 3,000                                  | 169,387  | 108,637        | 0              | 60,750         | 70,785                    |
| 15   | WUT (AC)                 | 0   | 6,500  | 0   | 4,500   | 2,000                                  | 13,000   | 10,833         | 0              | 2,167          | 13,000                    |
| 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                    |
|      | <b>Grand total</b>       | <b>761,003</b>                                  | <b>63,167</b>                                    | <b>0</b>  | <b>543,550</b>  | <b>52,500</b>                          | <b>1,420,220</b>                               | <b>673,229</b> | <b>350,000</b> | <b>746,991</b> | <b>552,785</b>            |

- The bulk of the requested money will go to CERN and will be used entirely to to pay for the conductor development subcontracts.

# NED Temporary Staff Hiring

| # | Lab     | Job Type | Duration  | Work subject   | Status    |
|---|---------|----------|-----------|--|-----------|
| 1 | INFN-Mi | Fellow   | 6 months  | Quench protection computation (supervisor: G. Volpini) | Approved  |
| 2 | WUT     | Fellow   | 10 months | Cryostat design (supervisor: M. Chorowski)             | Pending   |
| 3 | CEA     | Postdoc  | 1 year    | Heat transfer measurement (supervisor: B. Baudouy)     | Fall 2005 |

# NED Papers

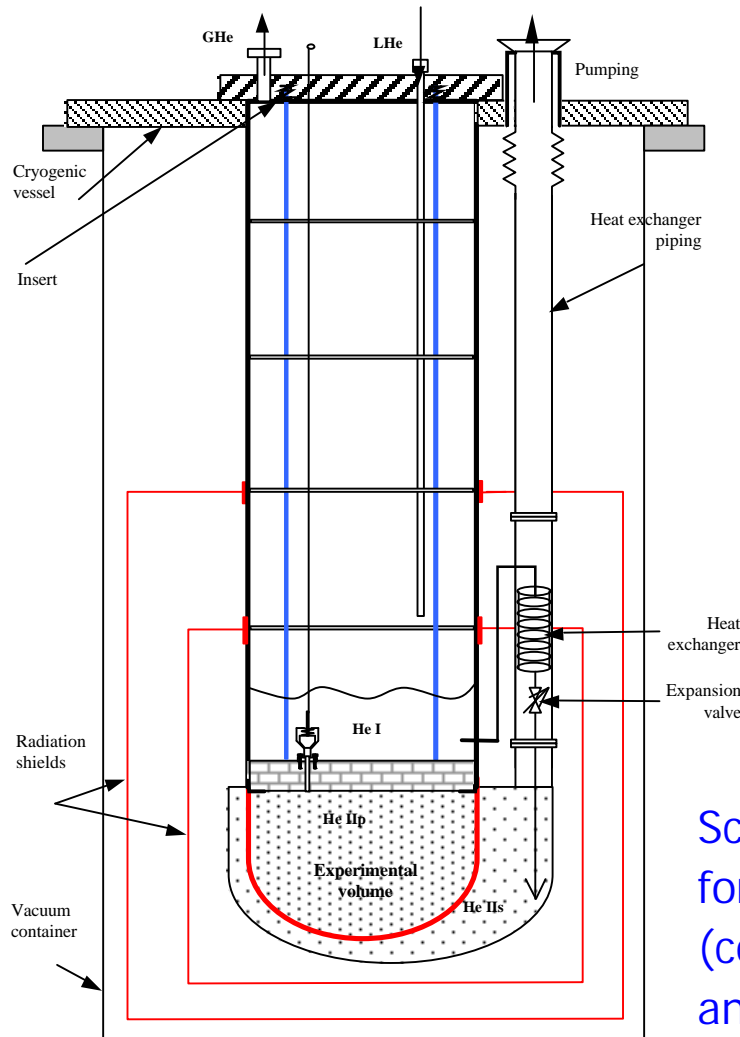
| # | CARE document type and number | Title  | Author(s) and Lab(s)  | Reference   | Date |
|---|-------------------------------|--|---|---|------|
| 1 | N/A                           | High field accelerator magnets beyond LHC  | A. Devred (CEA&CERN)  | <i>Proceedings of the 2003 IEEE Particle Accelerator Conference</i> , 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. Fabbriatore (INFN-Ge), D. Leroy (CERN), A. den Ouden (TEU), J. M. Rifflet (CEA), L. Rossi, O. Vincent-Viry (CERN), G. Volpini (INFN-Mi)   | <i>IEEE Trans. Appl. Supercond.</i> , Vol. 14 No. 2, pp. 339-344, 2004  | 2004 |
| 3 | Conf-04-005                   | 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)  | <i>Proceedings of the 2004 European Particle Accelerator Conference</i> , pp. 608-610, 2004                       | 2004 |
| 4 | TBD                           | 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. Fabbriatore, 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. Prevtali (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 Weelderden (CERN), P. Védrine (CEA), O. Vincent-Viry (CERN), G. Volpini (INFN-Mi) | To appear in the Proceedings of the Applied Superconductivity Conference, Jacksonville, FL, October 3–8, 2004     | TBD  |
| 5 | TBD                           | Future accelerator magnet needs  | A. Devred (CEA&CERN), S. Gourlay (LBNL), A. Yamamoto (KEK)  | To appear in the Proceedings of the Applied Superconductivity Conference, Jacksonville, FL, October 3–8, 2004     | TBD  |

# TSQP Work Package



- The TSQ Work Package includes two main Tasks
  - development and operation of a test facility to measure heat transfer to helium through conductor insulation (CEA and WUT; Task Leader: B. Baudouy, CEA),
  - quench protection computation (INFN-Mi; Task Leader: G. Volpini).

# Heat-Transfer Measurement Task

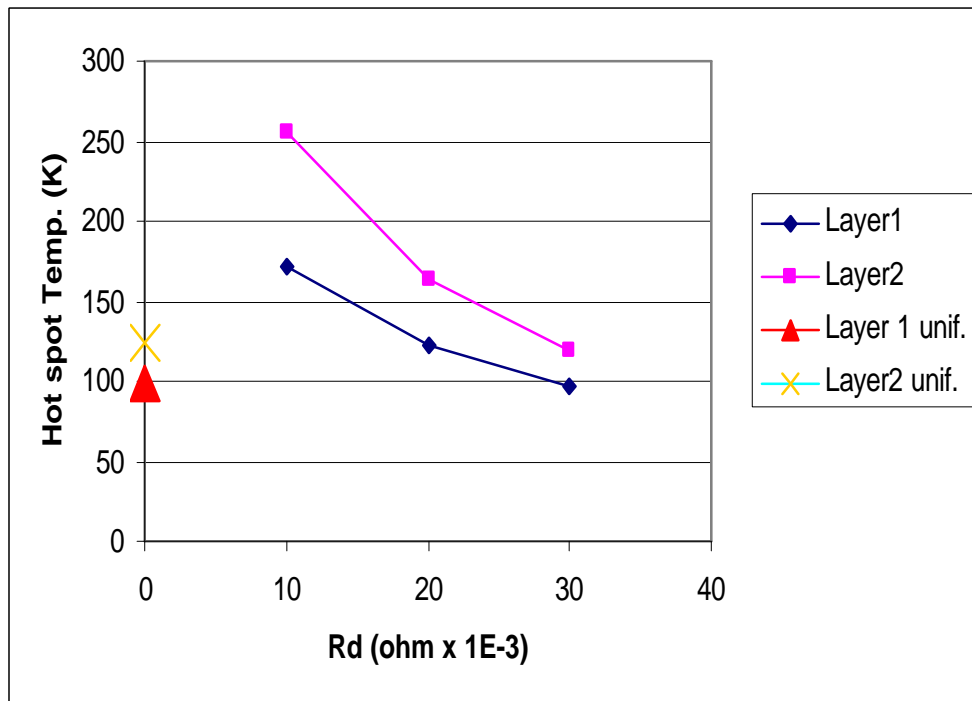


- CEA has designed a new pressurized, He-II, double-bath cryostat.
- The cryostat is being manufactured under WUT supervision and is scheduled for delivery to Saclay in the first quarter of 2005.

Schematic of double-bath cryostat for heat-transfer measurements (courtesy F. Michel, B. Baudouy and B. Hervieu, CEA)

# Quench Protection Task

- INFN-Mi has completed a survey of [thermal properties](#) and is now undertaking systematic quench protection studies, starting from [the 88-mm-aperture,  \$\cos q\$ , layer design](#) chosen as reference for NED.



Hot-spot temperature computations for the NED, 88-mm-aperture,  $\cos q$ , layer baseline design (courtesy G. Volpini and M. Sorbi, INFN-Mi)

# TSQP Planning

| 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 | Specifications                         | 1 January 2004                | 31 March 2004               | Completed        | 8 June 2004      |
| 2.2.2 | Cryostat design and manufacturing      | 1 April 2004                  | 31 Dec. 2004                | Ongoing          | On time          |
| 2.2.3 | Heat exchanger manufacturing           | 1 April 2004                  | 31 Dec. 2004                | Ongoing          | On time          |
| 2.2.4 | Facility integration and commissioning | 1 January 2005                | 31 March 2005               | Not started      | -                |
| 2.2.5 | Measurements and data analysis         | 1 April 2005                  | 31 Dec. 2006                | Not started      | -                |
| 2.3   | Quench protection computation          | 1 April 2004                  | 30 June 2005                | Ongoing          | On time          |

- Collaboration between CEA and WUT is off to a good start –enthusiasm of team compensates lack of human resources.
- All tasks are **on time!**

# TSQP Milestones and Deliverables

| WBS # | Title   | Responsible Lab(s) | Due date in Annex 1 | Status      | Revised delivery date |
|-------|---|--------------------|---------------------|-------------|-----------------------|
| 2.2.4 | Report on test facility commissioning (deliverable)         | CEA and WUT        | 1 April 2005        | Not started | -                     |
| 2.2.5 | Interim report on measurements (milestone)                  | CEA                | 31 December 2005    | Not started | -                     |
| 2.2.5 | Final report on measurements (deliverable)                  | CEA                | 31 December 2006    | Not started | -                     |
| 2.3   | Interim report on quench protection computation (milestone) | INFN-Mi            | 31 December 2004    | Ongoing     | On time               |
| 2.3   | Final report on quench protection computation (deliverable) | INFN-Mi            | 30 June 2005        | Not started | -                     |

- Same comments as above.

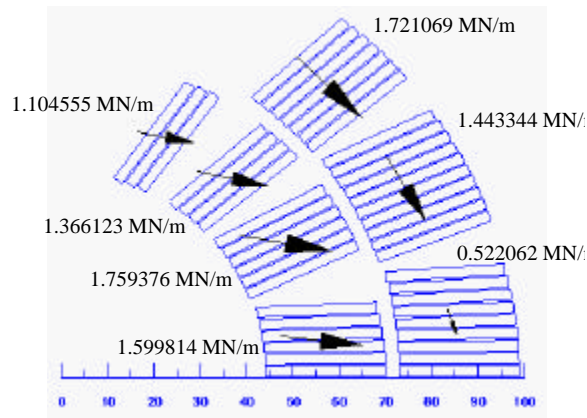
# CD Work Package



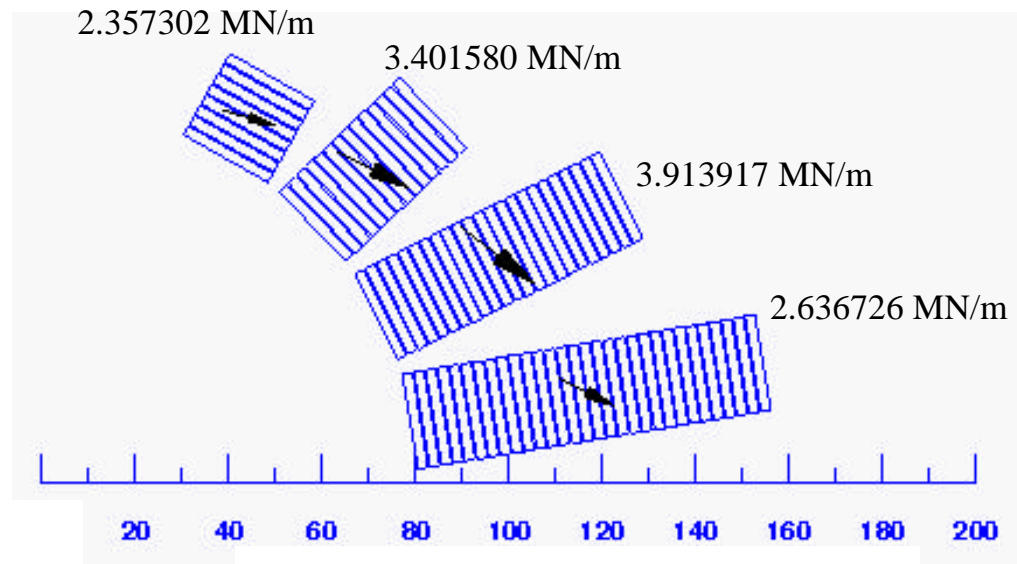
- The CD Work Package includes four main Tasks
  - preliminary magnet design aimed at deriving meaningful conductor specifications (CERN; Task Leader: D. Leroy),
  - wire and cable development through two industrial sub-contracts, investigating two different manufacturing processes: Enhanced Internal Tin and Powder in Tube, (under CERN supervision; Task Leader: D. Leroy),
  - wire and cable characterization (CEA, INFN-Ge, INFN-Mi, and TEU; Task Leader: A. den Ouden, TEU),
  - mechanical FE analysis of cabling effects (INFN-Ge; Task Leader: S. Farinon).

# Preliminary Design Task (1/2)

- To derive meaningful conductor specifications, CERN has investigated two types of  $\cos\theta$  dipole magnet designs: a layer-type and a slot-type.
- The investigation was carried out for three apertures: 88 mm, 130 mm and 160 mm and aimed at a 13-to-15-T bore field.



88-mm-aperture,  
layer type



88-mm-aperture, slot type

(Courtesy D. Leroy and O. Vincent-Viry)

# Preliminary Design Task (2/2)

- The preliminary design study led to the definition of **strand and cable parameters** suitable to NED.
- The study shows that at **4.2 K** the bore field stays around **14 T** with a quench field of **~15 T** on the conductor.
- Hence, to reach bore fields higher than **15 T** the magnet should be operated at **1.9 K** (note that the He-II operation may also be required to improve cooling under high beam losses).
- The 88-mm-aperture,  $\cos\theta$ , layer design is chosen as **the reference design**.

# NED Strand Characteristics

- The main NED strand characteristics are
  - diameter 1.250 mm,
  - effective filament diameter  $< 50 \mu\text{m}$ ,
  - Cu-to-non-Cu ratio  $1.25 \pm 0.10$ ,
  - filament twist pitch 30 mm,
  - non-Cu  $J_c$  1500 A/mm<sup>2</sup> at 4.2 K and 15 T,
  - minimum critical current 1636 A at 12 T,  
818 A at 15 T,
  - $N$ -value  $> 30$  at 4.2 K and 15 T,
  - RRR (after heat treatment)  $> 200$ .
- It is also requested that the billet weight be higher than 50 kg.

# NED Cable Characteristics

- Although the final cable dimensions will only be decided later on, the main cable parameters used in the reference, 88-mm-aperture, cos $q$  layer design are

|  |                            |
|--|----------------------------|
| – width                                    | 26 mm,                     |
| – mid-thickness                            | 2.275 mm at 50 MPa,        |
| – keystone angle                           | 0.22 degrees,              |
| – number of strands                        | 40,                        |
| – minimum critical current                 | 58880 A at 4.2 K and 12 T, |
| ( <i>with field normal to broad face</i> ) | 29440 A at 4.2 K and 15 T, |
| – RRR (after heat treatment)               | > 120,                     |
| – minimal cable unit length                | > 145 m.                   |

- The cable critical currents assume a cabling degradation of 10%.

# Conductor Development Task (1/2)



- Following a market survey and a call for tender under CERN rules, **two contracts** for the production of a few hundred meters of cables have been awarded late September to
  - **Alstom/MSA, France** (Enhanced-Internal-Tin process),
  - **SMI, the Netherlands** (Powder-In-Tube process), with **EAS, Germany** as subcontractor.
- The contracts will be monitored by CERN and extend over **a 2-year period**.
- Discussions are ongoing with OAS, Finland, who may join the program without receiving EU-funding.

# Conductor Development Task (2/2)



- We are somewhat disappointed that SMI and EAS have not formed a joint venture as they intended to in 2003.
- CERN has imposed **two safeguards** on the SMI contract
  - the R&D phase includes **a 50 kg billet** to demonstrate the ability **of scaling up the process** to a near-industrial production,
  - the financial loss in case of failure is capped to **30% of the total amount of the contract**.
- In spite of the commercial risks, we are fully convinced that the potentials of the Powder-In-Tube process needs to be investigated further and weighted against the more conventional Internal-Tin process promoted by Alstom/MSA.

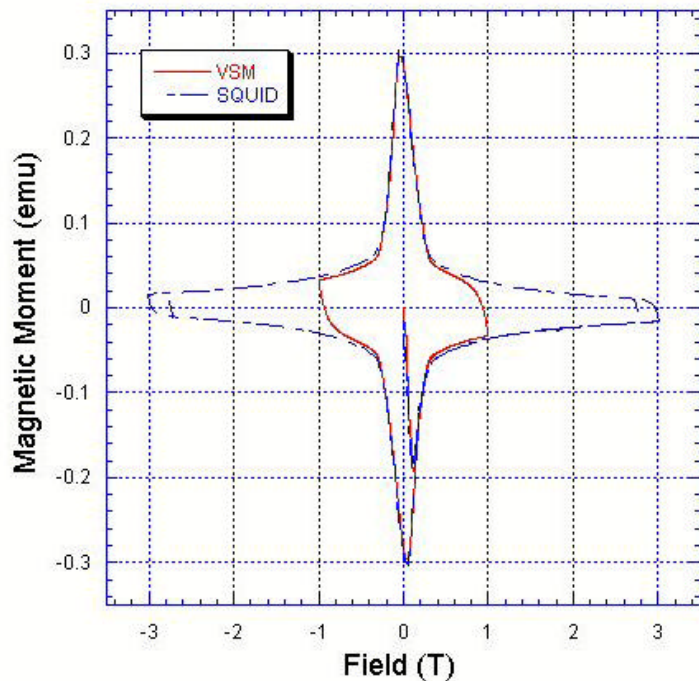
# Conductor Characterization Task (1/2)



- Representatives of interested parties (CEA, CERN, INFN-Ge, INFN-Mi and TEU) have set up a **Working Group on Conductor Characterization (WGCC)**, Chaired by A. den Ouden, TEU.
- The WGCC is charged with **the definition and development of standardized procedures** to measure the critical current, magnetization and RRR of virgin, deformed and extracted strands and has the responsibility for **certification of the measured data**.
- Following the example of the VAMAS program, the WGCC has initiated **a cross-calibration program of critical current test facilities**, whose conclusions are due in June 2005.

# Conductor Characterization Task (2/2)

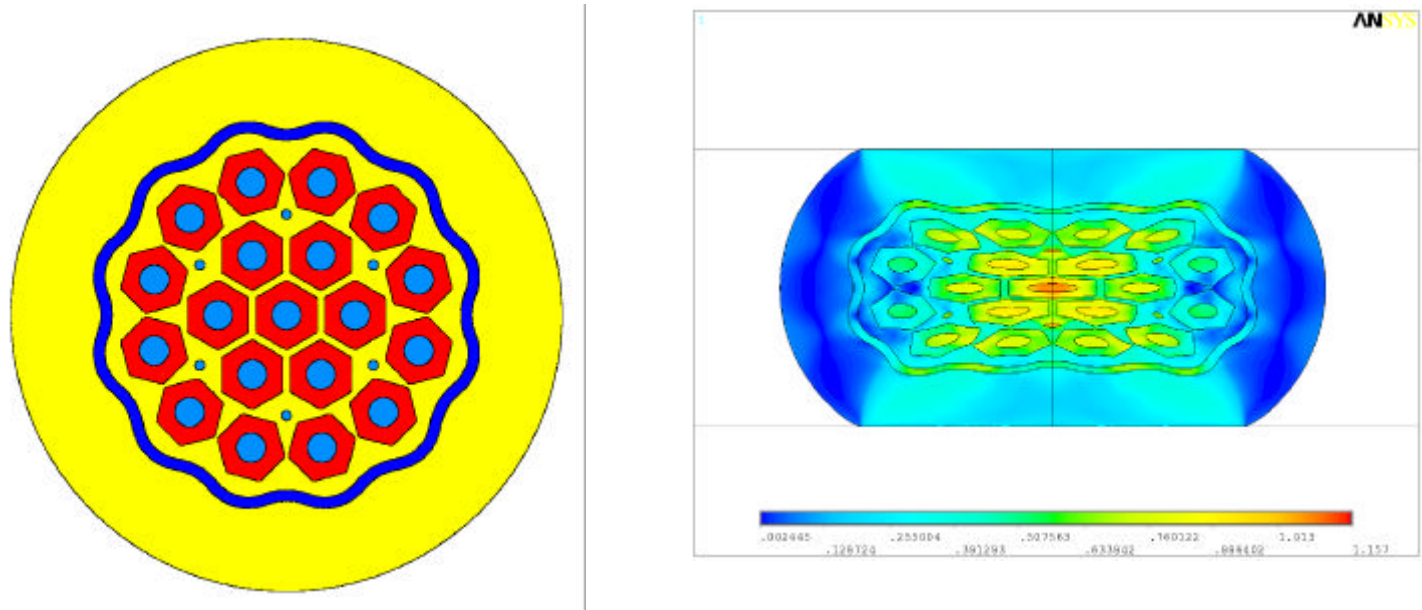
- Magnetization measurements will be performed under the supervision of INFN-Ge using a SQUID magnetometer and a Vibrating Sample Magnetometer (VSM).



Exploratory magnetization measurements on a 5-mm-long Nb<sub>3</sub>Sn wire sample exposed to a transverse field cycle (SQUID measurements are courtesy of C. Ferdeghini, INFN/Genova; VSM measurements are courtesy of U. Gambardella, INFN/Frascati)

# Mechanical FE Analysis Task

- INFN-Ge is developing a mechanical FE model to simulate the effects of cabling on un-reacted, Nb-Sn wires and optimize their design.



Examples of mechanical FE model for an old “internal-tin” wire design and of Von Mises strain due to a diameter reduction of about 40% (courtesy S. Farinon, INFN-Ge)

# CD Planning

| WBS # | Title                                 | Original begin date (Annex 1) | Original end date (Annex 1) | Estimated Status | Revised end date  |
|-------|---------------------------------------|-------------------------------|-----------------------------|------------------|-------------------|
| 3.1   | CD WP Coordination                    |                               |                             |                  |                   |
| 3.2   | Preliminary design                    | 1 January 2004                | 31 Dec. 2004                | 90% complete     | On time           |
| 3.3   | Conductor specifications              | 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                 | 1 July 2004                   | 30 June 2006                | Ongoing          |                   |
| 3.5.1 | Definition of procedures              | 1 January 2005                | 30 June 2005                | Ongoing          | On time           |
| 3.5.2 | Ic measurements at CEA                | 1 July 2005                   | 30 June 2006                | Started          | 31 October 2006   |
| 3.5.3 | Ic measurements at INFN/Mi            | 1 July 2005                   | 30 June 2006                | Started          | 31 October 2006   |
| 3.5.4 | Ic measurements at TEU                | 1 July 2005                   | 30 June 2006                | Started          | 31 October 2006   |
| 3.5.5 | Magnetization measurements at INFN/Ge | 1 July 2005                   | 30 June 2006                | Started          | 31 October 2006   |
| 3.6   | Cable development and manufacturing   | 1 July 2005                   | 31 Dec. 2006                | Not started      | 15 December 2006  |
| 3.7   | Cable characterization                | 1 October 2005                | 31 Dec. 2006                | Not started      | -                 |

- Start date of 3.4 delayed by **3 months** due to longer contract negotiations than anticipated.
- End date of 3.4 delayed accordingly.
- End date of 3.5 delayed to match that of 3.4.
- End dates of 3.6 and 3.5 not moved due to some built-in slack in initial program.

# CD Milestones and Deliverables

| WBS # | Title   | Responsible Lab(s)         | Due date in Annex 1 | Status      | Revised delivery date                |
|-------|---|----------------------------|---------------------|-------------|--------------------------------------|
| 3.2   | Report on preliminary design (deliverable)          | CERN                       | 31 December 2004    | Ongoing     | On time                              |
| 3.5   | Conductor specifications (deliverable)              | CERN                       | 30 June 2004        | Completed   | On time                              |
| 3.4   | Progress report on wire development (milestone)     | CERN                       | 30 June 2005        | Not started | 31 December 2004<br>31 December 2005 |
| 3.4   | Wire unit lengths (deliverable)                     | CERN                       | 30 June 2006        | Not started | 30 September 2006                    |
| 3.5   | Interim report on wire characterization (milestone) | CEA, INFN/Ge, INFN/Mi, TEU | 31 December 2005    | Started     | 31 December 2004<br>31 December 2005 |
| 3.5   | Final report on wire characterization (deliverable) | CEA, INFN/Ge, INFN/Mi, TEU | 30 June 2006        | Not started | 31 October 2006                      |
| 3.6   | Cable unit lengths (deliverable)                    | CERN                       | 31 December 2006    | Not started | 15 December 2006                     |
| 3.7   | Report on cable characterization (deliverable)      | TEU                        | 31 December 2006    | Not started | -                                    |

- Same comments as above.

# IDI Work Package



- The IDI Work Package includes three main Tasks
  - redaction of an engineering specification and definition of characterization tests,  
(CCLRC and CEA ; Task Leader: E. Baynham),
  - studies on “conventional” insulation systems relying on ceramic or glass fiber tape and vacuum-impregnation by epoxy resin  
(CCLRC; Task Leader: E. Baynham),
  - studies on “innovative” insulation systems relying on pre-impregnated fiber tapes and eliminating the need for a vacuum impregnation  
(CEA; Task Leader: F. Rondeaux).

# Insulation Specification

- A basic engineering specification for the conductor insulation of a 15-T dipole magnet has been developed under CCLRC supervision.
- The main parameters are
  - thickness 0.2 mm per conductor face,
  - dielectric strength 1 kV inter-turn in He at 300 K,
  - compressive strength > 200 MPa at 300 K and 4 K,
  - short-beam shear strength > 50 MPa at 4 K,
  - transverse tensile strength > 25 MPa at 4 K,
  - thermal contraction 0.3-0.4% between 300 & 4 K,
  - thermal conductivity > 20 mW/K at 4 K,
  - thermal cycle > 10,
  - running cycle > 100.

# Insulation Development Tasks



- CCLRC is undertaking a test program for **conventional insulation** that will address
  - glass fiber **sizing issues**,
  - **radiation-hard resin** alternatives, such as cyanate esters,
  - improved **filler materials**, such as nanoclays or dendritic powders.
- CEA will pursue its ongoing development on **innovative, ceramic-based insulation**, concentrating more specifically on
  - optimization of **nature and weaving** of the fiber tape pre-impregnated with ceramic precursors,
  - characterization of **mechanical properties** after heat treatment.

# IDI Planning

| WBS # | Title                   | Original begin date (Annex 1) | Original end date (Annex 1) | Estimated Status | Revised end date |
|-------|-------------------------|-------------------------------|-----------------------------|------------------|------------------|
| 4.1   | IDI WP Coordination     |                               |                             |                  |                  |
| 4.2   | Specification 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             | Ongoing          | On time          |
| 4.3.3 | Component supply        | 1 October 2004                | 31 Dec. 2004                | Ongoing          | On time          |
| 4.3.4 | Iterative tests         | 1 January 2005                | 30 Sept. 2005               | Not started      | 31 Dec. 2005     |
| 4.3.5 | Irradiation tests       | 1 July 2005                   | 30 June 2006                | Not started      | 30 June 2006     |
| 4.4   | Innovative Insulation   |                               |                             |                  |                  |
| 4.4.1 | Tape weaving trial      | 1 July 2004                   | 31 Dec. 2004                | Not started      | 31 Dec. 2005     |
| 4.4.2 | Characterization tests  | 1 July 2004                   | 30 June 2005                | Not started      | 30 June 2006     |

- Scope of 4.3.5 has been modified to include radiation tests and the end date has been moved to **30 June 2006**.
- Start date of 4.4 delayed until **1 January 2005** due to lack of human resources at CEA (permanent staff contribution).
- End date of 4.4 delayed accordingly.

# IDI Milestones and Deliverables

| WBS #   | Title   | Responsible Lab(s) | Due date in Annex 1 | Status      | Revised delivery date |
|---------|---|--------------------|---------------------|-------------|-----------------------|
| 4.2     | Engineering specifications (milestone)          | CCLRC              | 30 June 2004        | Completed   | 22 July 2004          |
| 4.3&4.4 | Test Programme definition (milestone)           | CCLRC&CEA          | 31 July 2004        | Completed   | August 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 | 30 June 2006          |

- Same comment as above.

# MDO Working Group (1/3)



- The MDO Working Group is made up of representatives from CCLRC, CEA, CERN and CIEMAT  
(Chairman: P. Védrine, CEA, Technical Secretary: F. Toral, CIEMAT).
- Its main charge is to address the following questions
  - How far can we push the conventional,  $\cos\theta$ , layer design in the aperture-central-field parameter space (especially when relying on strain-sensitive conductors)?
  - What are the most efficient alternatives, in terms of performance, manufacturability and cost?

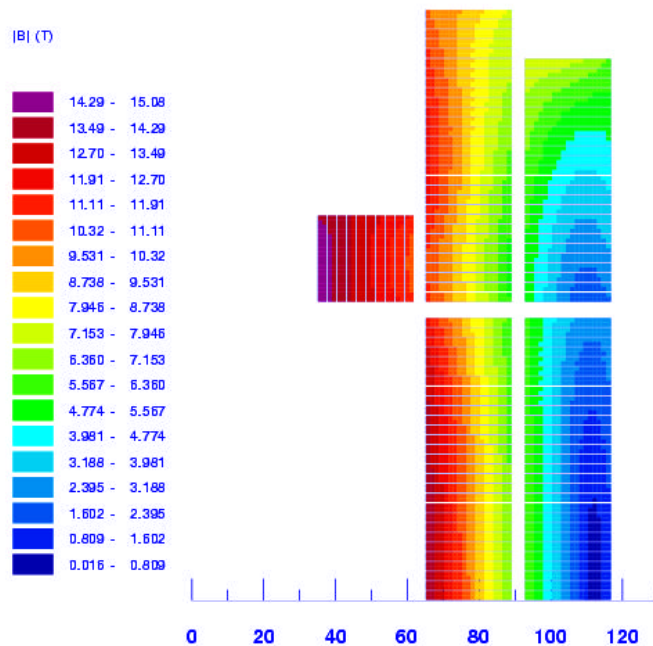
# MDO Working Group (2/3)



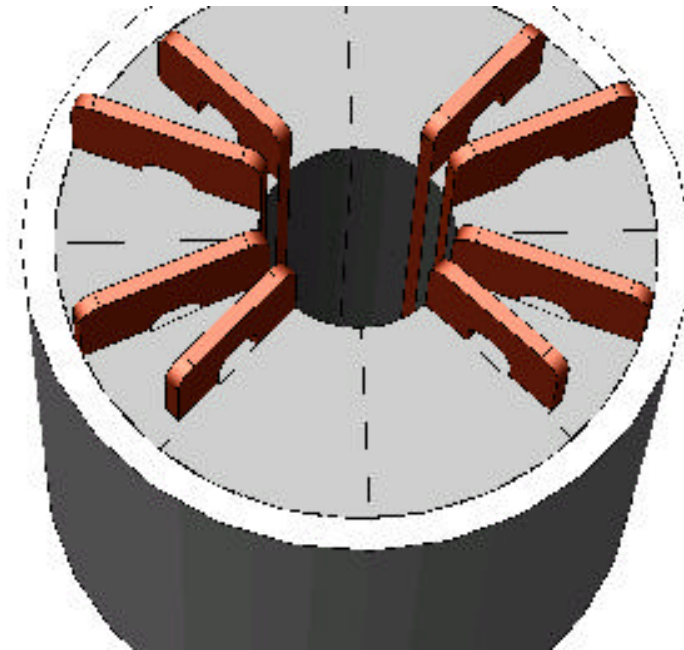
- The MDO WG has selected
  - a number of **magnetic configurations** to be studied,
  - ranges of **design parameters**,
  - **terms of comparison** between solutions.
- Each Institute participating to the WG will completely study one or two configurations.
- Results of the comparative study are expected by **December 2005**.
- Preliminary results of this study have been shared with the Fusion community (“EFDA” Dipole).

# MDO Working Group (3/3)

- Examples of alternative dipole magnet configurations to be optimized and compared



Window-frame design  
proposed by CEA  
(courtesy H. Felice and P. Védrine)



Motor-type design  
proposed by CIEMAT  
(courtesy S. Sanz and F. Toral)

# Conclusion



- All the tasks of the CARE/NED JRA have been launched and are well under way.
- In particular, the initial choices made in 2003 regarding the conductor development program have been comforted by the conclusions of the Workshop on Accelerator Magnet Superconductors (WAMS) organized in March 2004 within the framework of the HHH/AMT Work Package and the industrial subcontracts have been signed at the end of September.
- The program is initiating the desired synergies among the various European partners involved.
- The NED collaborators are still struggling to find the necessary funding to carry out the model magnet manufacturing and test at the 2008 horizon as initially foreseen.