FP7-IA HFM JRA proposal

- The proposal is under discussion: we welcome input from potential partners
- Outline
  - Motivation
  - General description
  - Proposed Work Packages

Future magnet needs

	Field	Aperture (mm)	Rad. load	e.m. Forces	Peak field	Radiation Hardness	Heat removal	Temp. margin
Low-beta insertion quadrupoles	>140 T/m	>130	high	large	>9 T	increased	very good	large
Slim dipole in front of Q1	8 T	70	high	large	>9 T	increased	very good	large
Dipole corrector in front of Q1	4 T -6 T	>130	high	as lhc	9 T	increased	very good	large
Dogleg dipole	5 T	>56	high	as lhc	9 T	increased	very good	large
Dispersion suppressor dipole	12 T	>56	high	large	>12 T	increased	very good	large
Multipole correctors	Moderate	>130	High	as lhc	9 T	increased	very good	large
Muon decay ring	4-6 T	large	high	?	9 T	increased	very good	large

2 categories: max field <9 T : Nb-Ti technology
Max field >9 T up to 15 T : Nb_3Sn technology

Common points:

Radiation hardness, heat removal and temperature margin

and

The Low-beta quad, dispersion suppressor dipole and slim dipole need the Nb_3Sn Jc at maximum coil fields >9 T and in some cases >13 T

Work program

To be seen in conjunction with the CERN program on HFMs

- **Support Studies**
  - Study thermal properties
  - Study radiation resistance of components and coils
- **Model magnets**
  - Design build and tests short dipole model (1 m - 1.5 m)
  - Design build and tests short corrector model
- **HTC prospecting**
  - Design build and tests a 20 T dipole insert

OPTIONS:

- **Long prototype magnet**
  - Design build and tests long prototype magnet (4 m)
    Dipole or quadrupole: to be decided later depending on LHC needs
- **Design build and tests short twin aperture dipole model (1 m)**

NED history and future requirements

- FP6 NED project for a 1 m long, 12 T bore field, 88 mm aperture model
- reduced version was approved (25% funded): preparation of the technologies needed for the model
  - Conductor development
  - Design studies (i.e. magnet design, thermal studies)
  - Component development (i.e insulators)
- NED magnet was intended to upgrade the FRESCA facility to a 12T cable test station
- The FRESCA facility upgrade is still strongly needed: key element for HFM conductor development and QA
- Putting together the FRESCA needs and some common issues on the envisaged dipole needs:
- Build a 1.5 m long, 13T bore field, 100 mm aperture model magnet, to
  - Upgrade FRESCA
  - Constitute a test bed for the LHC and $\tilde{\nu}$ dipole magnets
- Conductor: Profit from NED development and CERN HFM program

Prospecting towards 20 T: HTS

- Aim: make HTS insert in the 1 m model to provide ΔB ~6 T in a background field
- Get an idea how to build dipole coils in HTS
- Technology demonstrator of possibilities to use HTS conductor in an accelerator magnet environment
- To regain Europe's place on this technology

Corrector model

- A short Nb_3Sn corrector model (sextupole or octupole)
- Wound from a single wire conductor in a shell around a large (130 mm) aperture
- To test how to get large, higher order gradients in a small space with a large temperature margin and good radiation hardness

WP1

Management and Coordination

- **Task**
  - Manage the package
- **Deliverables**
  - Follow -up of the progress in the technical WPs
  - Regular reporting to EU and participants' management (yearly report)
  - Planning
  - Financial follow up (quarterly report)
- **Budget:** Material, travel 0.16 M€, Personnel 0.12 M€

WP2

Support Studies

- **Tasks**
  - Radiation resistance studies on materials for SC magnets
    - Nb3Sn
    - Insulation
  - Thermal stability studies
    - Heat deposition models
    - Heat removal models
    - Heat removal measurements

- **Deliverables and milestones** — start M1

radiation resistance of Nb3Sn certified	M48
radiation resistant insulation certified	M48
radiation resistant impregnation certified	M48
Heat deposition and heat removal model with experimental validation.	M12
Thermal coil design parameters for dipole and quad design	M24

- **Budget:** Material 0.8 M€ Personnel 1.99 M€

WP3

High Field Dipole Model

- **1.5 m long, 13 T, 100 mm aperture dipole model magnet**
  - Design coil and cold mass
- **Tasks**
  - Conductor qualification
  - Make a design for the model
  - Tooling construction and installation
  - Produce the coils
  - Produce the cold mass
  - Test the model
- **Deliverables and milestones** start M1
  - Tooling installed M8
  - Conductor qualified M10
  - Design report M15
  - Coils M24
  - Cold mass M30
  - Cold test M33
- **Budget:** Material 0.9 M€ Personnel 1.02 M€

WP4

Very High Field Dipole Insert

- **1 m long, HTS dipole insert to approach 20 T**
  - **ΔB ~6 T in a background field**
  - **Bi-2212 round wire (Rutherford cable) or YBCO 2nd generation tape**
  - **Technology demonstrator of possibilities to use HTS conductor in an accelerator magnet environment**
  - **To regain Europe's place on this technology**
- **Tasks**
  - **Conductor qualification**
  - **Make a design for a solenoid insert into a 100 mm aperture solenoid**
  - **Produce the solenoid coils and assemble the insert.**
  - **Test the solenoid insert (in 100 mm 15 T solenoid at LASA-Milano)**
  - **Make a design for a dipole insert into a 100 mm aperture dipole**
  - **Produce the dipole coils and assemble the insert.**
  - **Test the dipole insert (in 1 m model at CERN)**
- **Planning M18 - M48**
- **Budget: Material 0.4 M€ Personnel 0.82 M€**

WP5

Corrector model in Nb_3Sn

- **Short model of a corrector magnet (sextupole or octupole)**
  - **Corrector coil using a single wire conductor**
- **Tasks**
  - **Conductor qualification**
  - **Make the design**
  - **Produce the coils and assemble the model**
  - **Test the model**
- **Planning M1 - M48**
- **Budget: Material 0.3 M€ Personnel 0.46 M€**

FP7-IA-HFM

			Material (MŪ)	Staff (MŪ)			
		Total	**2.56**	**4.41**		**1-Jan-09**	**31-Dec-12**
	WP title	**deliverables**	**Material (MŪ)**	**FTE cat2**	**FTE cat3-4**	**begin**	**end**
Work package			**2.56**	**23.7**	**19.5**	**01-Jan-09**	**31-Dec-12**
WP-HFM-1	Management and coordination	Follow -up of the progress in the technical WPs Regular reporting to EU and participantsÕ management (yearly report) Planning Financial follow up (quarterly report)	0.16	1.2	0	01-Jan-09	31-Dec-12
WP-HFM-2	Support studies	1) radiation resistance of Nb3Sn certified 2) radiation resistent insulation certified 3) rediation resistent impregnation certified 4)Heat deposition and heat removal model with experimental validation. 5)Thermal coil design parameters for dipole and quad	0.8	12.5	7	01-Jan-09	31-Dec-12
WP-HFM-3	High field dipole model	1.5 m long, 13T, 100 mm aperture model dipole magnet	0.9	4	6	01-Jan-09	30-Sep-11
WP-HFM-4	Very High field dipole insert	1 solenoid insert for 100 mm bore 1 dipole insert for 100 mm bore	0.4	4	4	01-Jun-10	31-Dec-12
WP-HFM-5	Corrector model in Nb3Sn	short model of a single conductor wound Nb3Sn corrector	0.3	2	2.5	01-Jun-10	31-Dec-12
WP-HFM-opt1	High field long prototype	4 m long, 180 T/m, 130 mm aperture quadrupole magnet or 4 m long, 13 T, 100 mm aperture dipole magnet	1.2	6	7	01-Jun-10	31-Dec-12
WP-HFM-opt2	Two-in-One high field dipole model	1 m long, 12 T bore field, 60 mm aperture two-in-one dipole model	0.7	4	5	01-Jun-10	31-Dec-12

Partners

- **Partners have been contacted recently with a request to form a collaboration**
  - **CEA-Saclay** — **Positive answer, details to be worked out**
  - **STFC-RAL** — **Positive answer, details to be worked out**
  - **CIEMAT** — **Positive answer, details to be worked out**
  - **Univ. Twente** — **Positive answer, details to be worked out**
  - **Univ. Wroclaw** — **Positive answer, details to be worked out**
  - **INFN Milano** — **Positive answer, details to be worked out**
  - **INFN Genova** — **Declined**
  - **Univ. Genève** — **Positive answer, details to be worked out**
  - **FZ Karlsruhe** — **Positive answer, details to be worked out**
  - **CNRS Grenoble** — **Positive answer, details to be worked out**
  - **Univ Tampere** — **Positive answer, details to be worked out**

WP option 1

High Field prototype

- **4 m long prototype magnet**
  - 13 T, 100 mm aperture dipole or 180 T/m, 130 mm aperture quadrupole, to be studied depending on LHC relevance
  - Coil manufacturing technology scale-up (shrinkage, expansion during reaction)
  - Mechanical support/pre-stress structure scale-up
- **Tasks**
  - Make a design for the prototype
  - Tooling construction and installation
  - Produce the coils
  - Produce the cold mass
  - Test the model
- **Deliverables and milestones** start M18
  - Tooling M30
  - Design report M30
  - Coils M39
  - Cold mass M45
  - Cold test M48
- **Budget:** Material 1.2 M€ Personnel 1.33 M€

WP option 2

Two-in-one high field dipole model

- **1 m long, 12 T bore field, 60 mm aperture two-in-one dipole model**
  - **Intended to show the way for the LHC dispersion suppressor upgrade**
- **Tasks**
  - **Conductor qualification**
  - **Make a design for the model**
  - **Produce the coils**
  - **Produce the cold mass**
  - **Test the model**
- **Planning M18 - M48**
- **Budget: Material 0.7 M€ Personnel 0.92 M€**