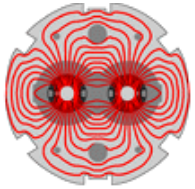
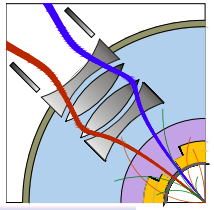
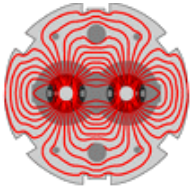


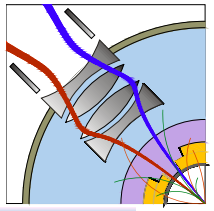


SLHC –PP WP6

LHC IR UPGRADE - PHASE I



Summary

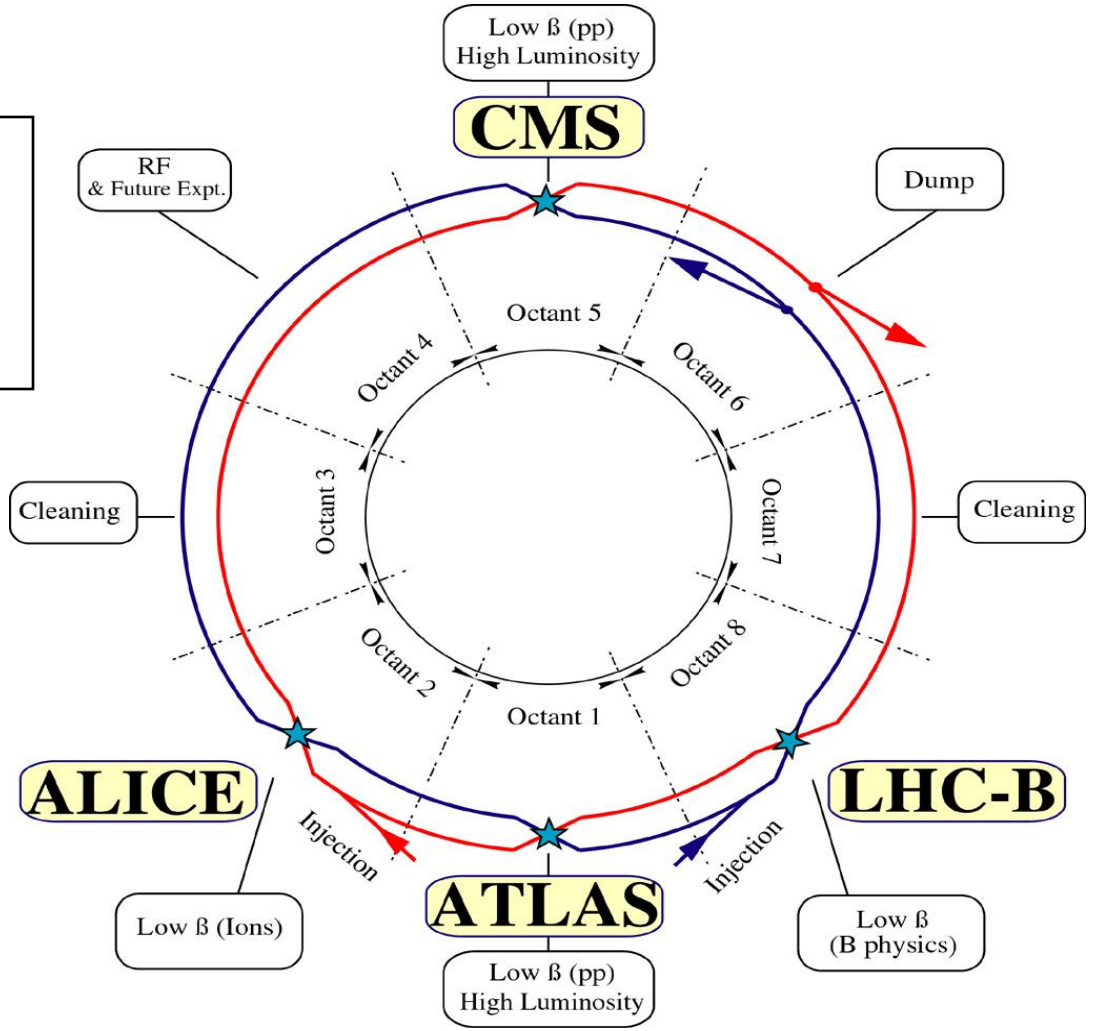


- The present triplet and the tunnel reality
- The goal of LHC IR Upgrade - Phase I
- The emerging layout
- Preliminary parameters of the low-β quadrupoles and correctors
- Improving the thermal performance
- EU-FP7 SLHC-PP WP6
  - Objectives
  - Participants
- Management requests
- Proposal for organizing the activities – discussion

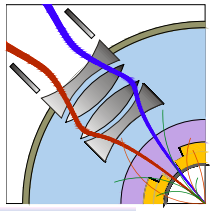
LHC Insertions

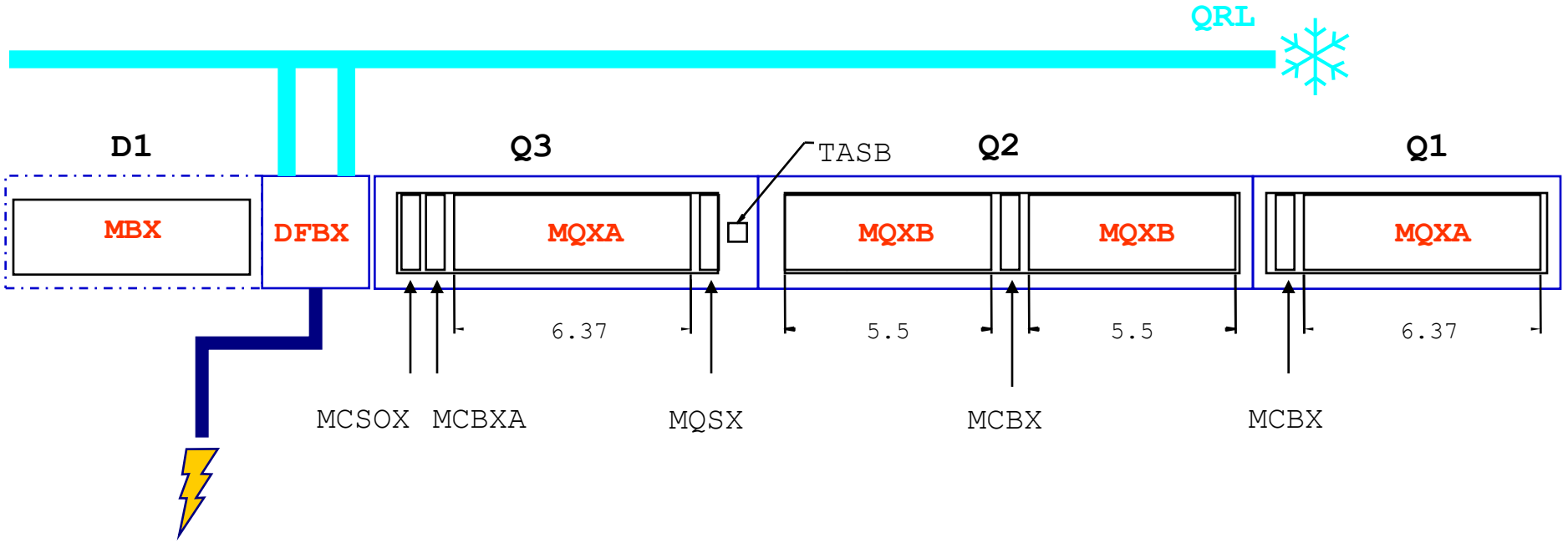
Experimental insertions in points 1, 2, 5, 8 contain low-beta triplets.

In total, eight triplets are installed.



The LHC low-β triplet



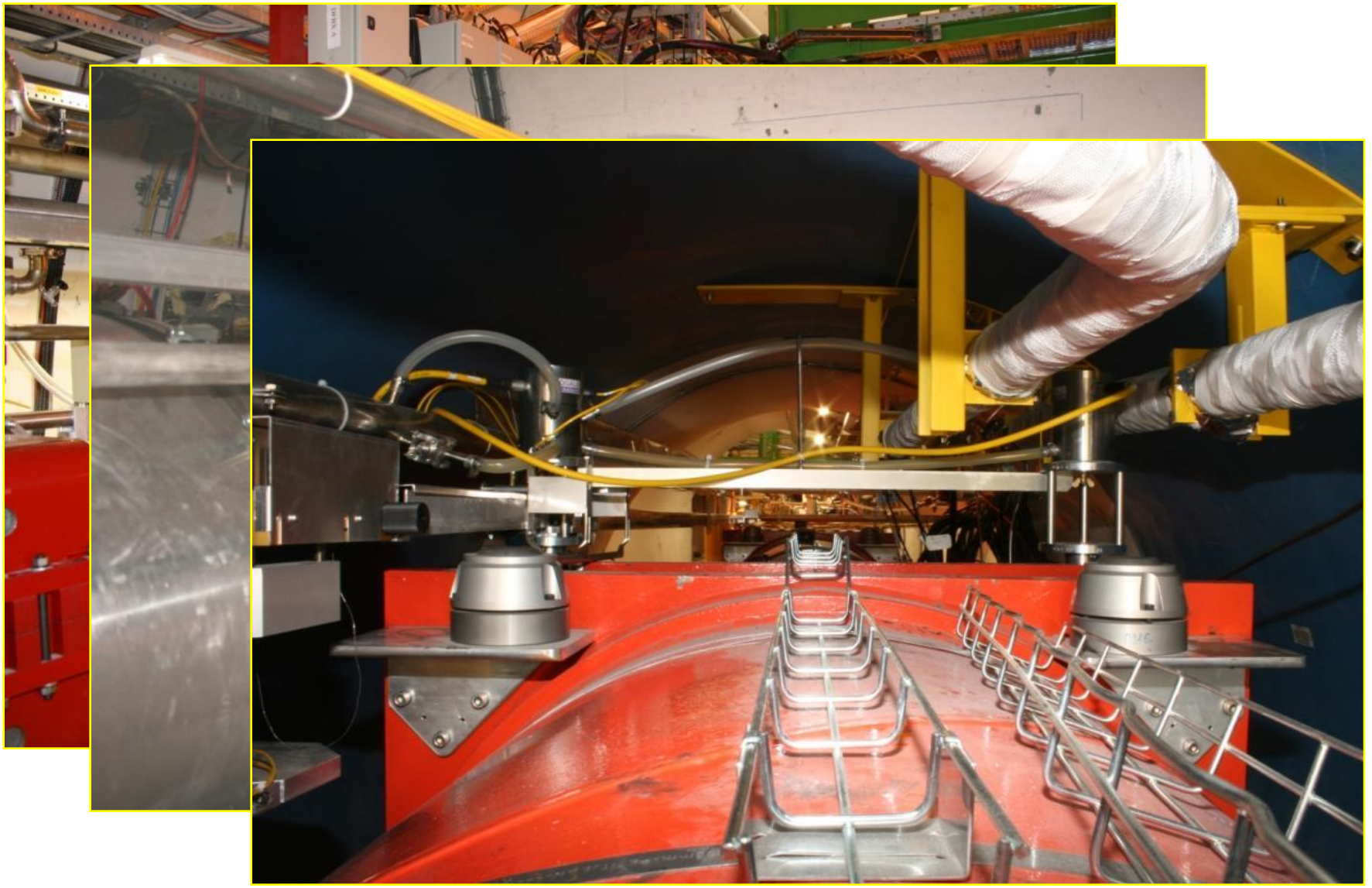


IR 1 and 5, D1 is a normal conducting dipole.

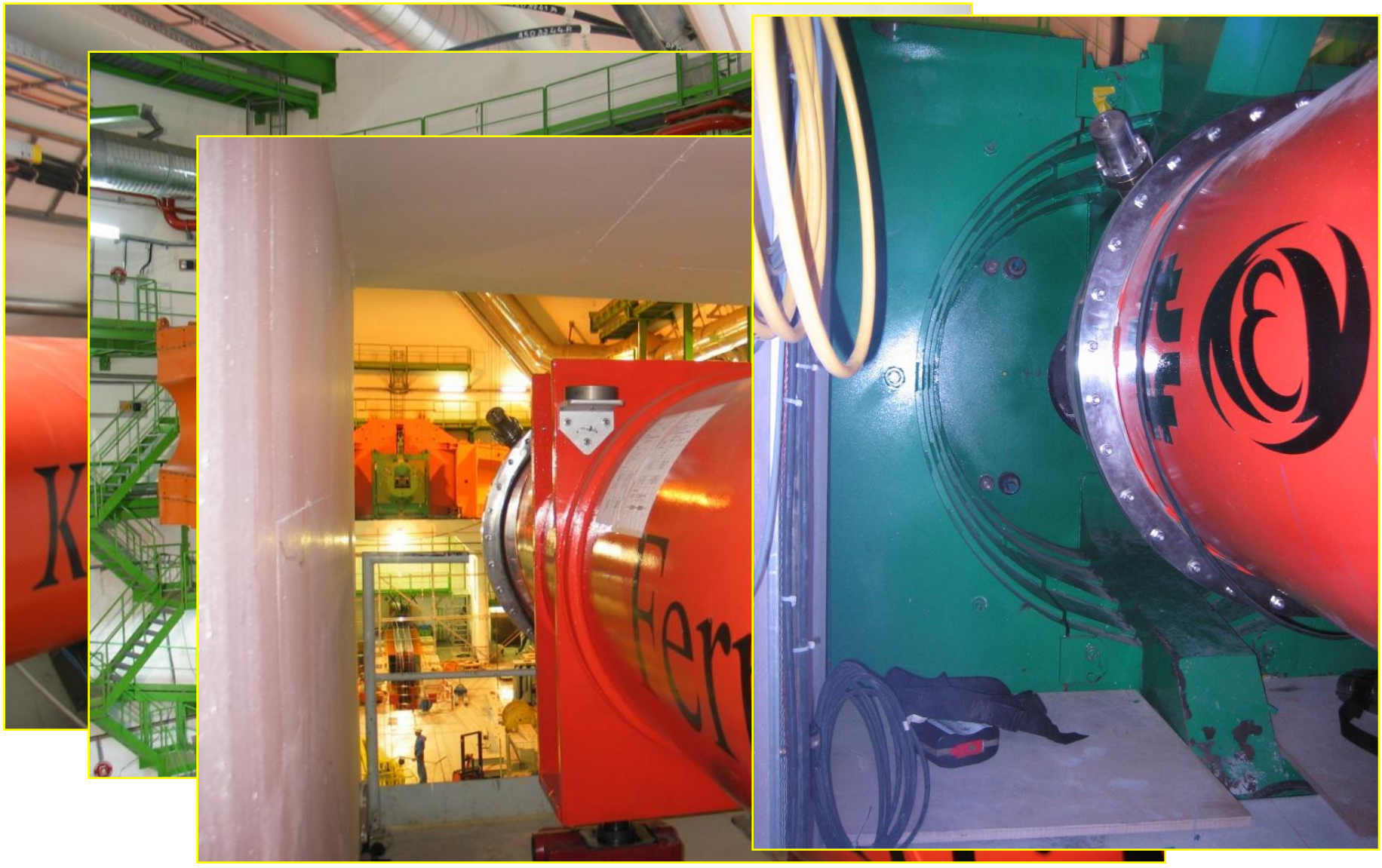
Triplets were designed and built by a collaboration of five laboratories: BNL, CERN, Fermilab, KEK, LBNL.

Low-β triplet – full view

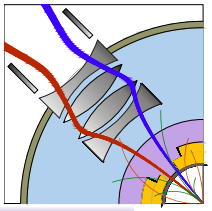
Low-β triplet in IP1



Low-β triplet in IP5



LHC IR Upgrade - Phase I



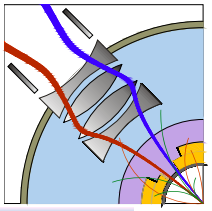
Goal of the upgrade:

Enable focusing of the beams to $\beta^*=0.25$ m in IP1 and IP5, and reliable operation of the LHC at 2 10^{34} $cm^{-2}s^{-1}$ on the horizon of the physics run in 2013.

Scope of the Project:

1. Upgrade of ATLAS and CMS interaction regions. The interfaces between the LHC and the experiments remain unchanged at ± 19 m.
2. Replace the present triplets with wide aperture quadrupoles based on the LHC dipole cables (Nb-Ti) cooled at 1.9 K.
3. Upgrade the D1 separation dipole, TAS and other beam-line equipment so as to be compatible with the inner triplet aperture.
4. The cooling capacity of the cryogenic system and other main infrastructure elements remain unchanged.
5. Modifications of other insertion magnets (e.g. D2-Q4) and introduction of other equipment in the IR to the extent of available resources.

The emerging concept



Triplet:

- Composed of four cryo-quadrupoles of similar length (~ 8 m).
- Cold bore+beam-screen engineered as magnet protection elements. The beam screen cooled at 40-60 K.
- Interconnections (He-pipes, PIM and BS) identical in IR1 and IR5.
- Dipole and multipole correctors lumped in a separate cryo-unit located in between D1 and Q3.

Powering

- Each magnet protected separately. Energy extraction included in the main circuit.
- All delicate equipment moved into shielded areas. DFBX linked to the triplet through a link (HTS or LTS).

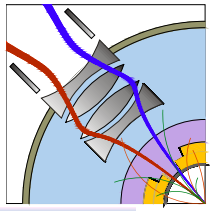
Matching Section

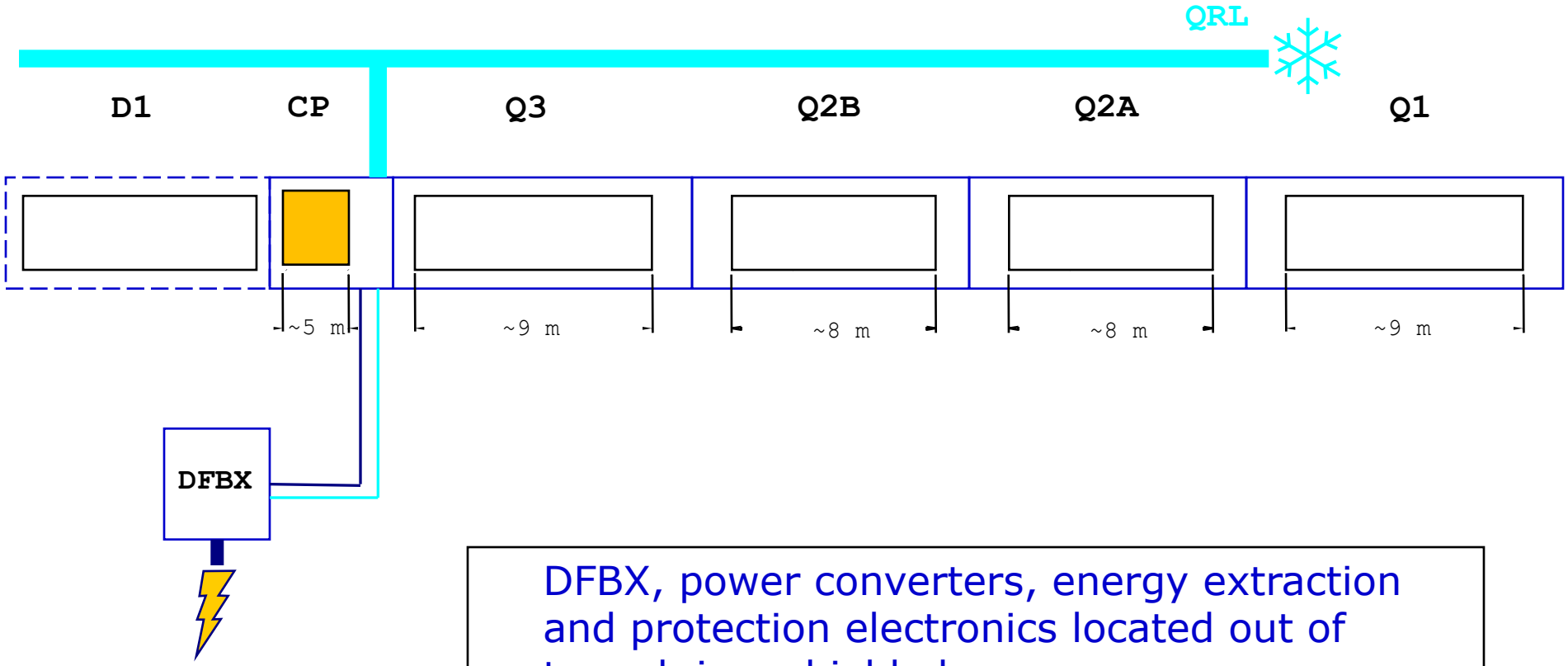
- D2, Q4 and Q5 moved by about 15 m towards the arc to improve the flexibility of the insertion.

Low-beta quadrupoles

- The ultimate parameters: $\beta^*=0.25$ m, n1=7, using definitions for nominal LHC. This leads to a beam-stay-clear of ~95 mm and coil ID of ~ 110 mm.
- Magnet aperture and length to take into account optimal use of existing cable.

The emerging layout



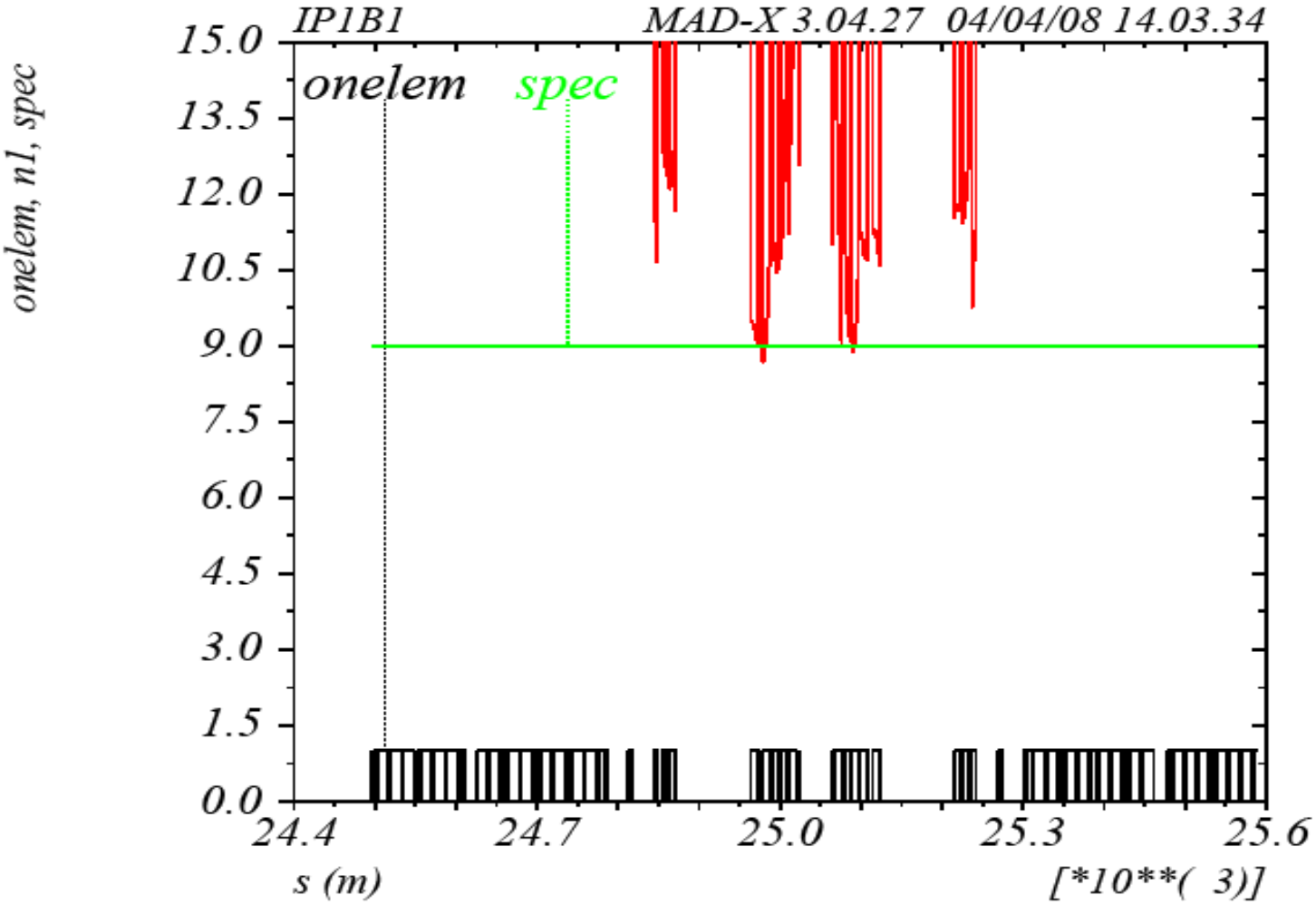


DFBX, power converters, energy extraction and protection electronics located out of tunnel, in a shielded area.

Quadrupoles powered in series at 11 kA.

All correctors powered at 600 A.

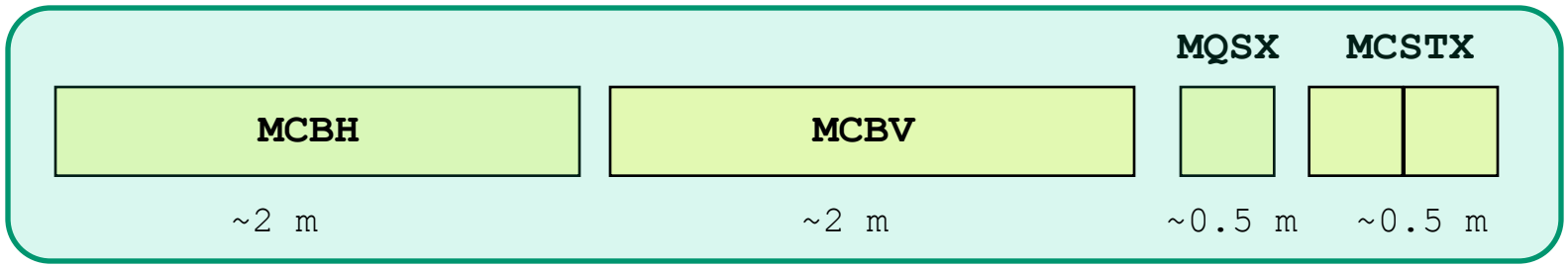
On going-optics study



Courtesy of Stephane Fartoukh

A possible corrector cryo-unit CP

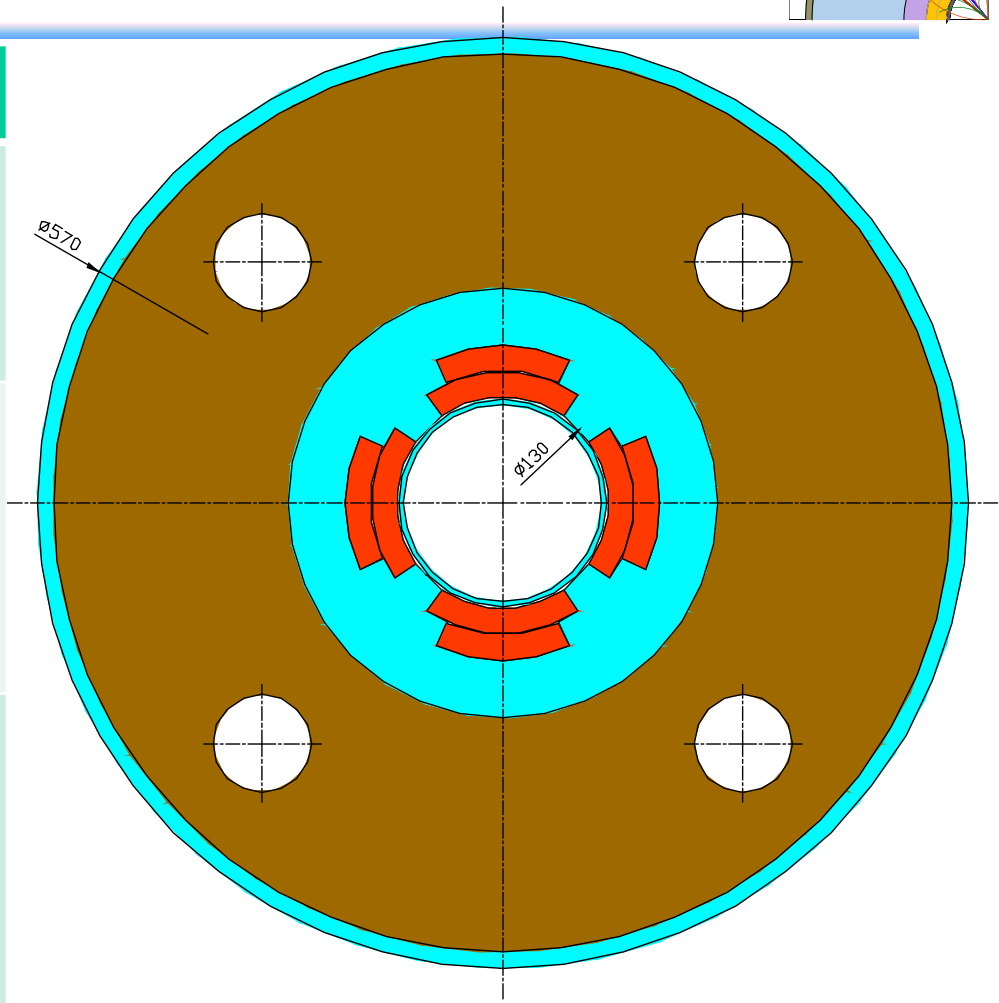
CP: a cold mass containing all correctors



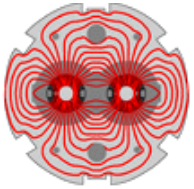
	Current	Integrated strength (field)	Aperture (identical to quads)
MCBX	+/- 600A	~ 6 Tm/ (~3 T)	110-130mm
MQSX (a2)	+/- 600A	~ 20 T (~40 T/m)	110-130mm
MCSX (b3)	+/- 100A	~ 0.01 Tm (~0.05T@17mm)	110-130mm

Preliminary Low-β Quadrupole parameters I

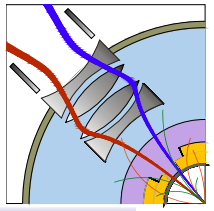
Fixed parameters	
Sc cable	LHC dipole cables (detailed parameters in LHC Design report, CERN-2004-003, p.157.)
Collar material	Nippon Steel YUS 130 thickness 3mm. Material according to spec LHC-MMS/98-198/G03 EDMS n.102691
Yoke material	Cockerill Low Carbon Steel thickness 5.8 mm. Material according to spec IT-2421/LHC
Cold mass outer diameter	570 mm (iron yoke 550mm and shell thickness 10 mm).



Cross section courtesy of E. Todesco, F. Borgnolutti



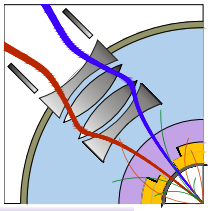
Preliminary Low-β Quadrupole parameters II



Present hypothesis	
Magnet aperture	from 110 mm to 130 mm
Gradient	From 130 T/m to 110 T/m
Quadrupole length	Q1=Q3 from 9m to 11m Q2a=Q2b from 7m to 9 m
Working point	80% of quench current

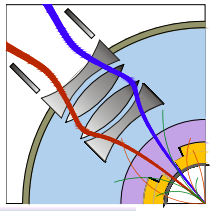
Parametric layout-magnet studies: E. Todesco LIUWG meeting 20/03/08

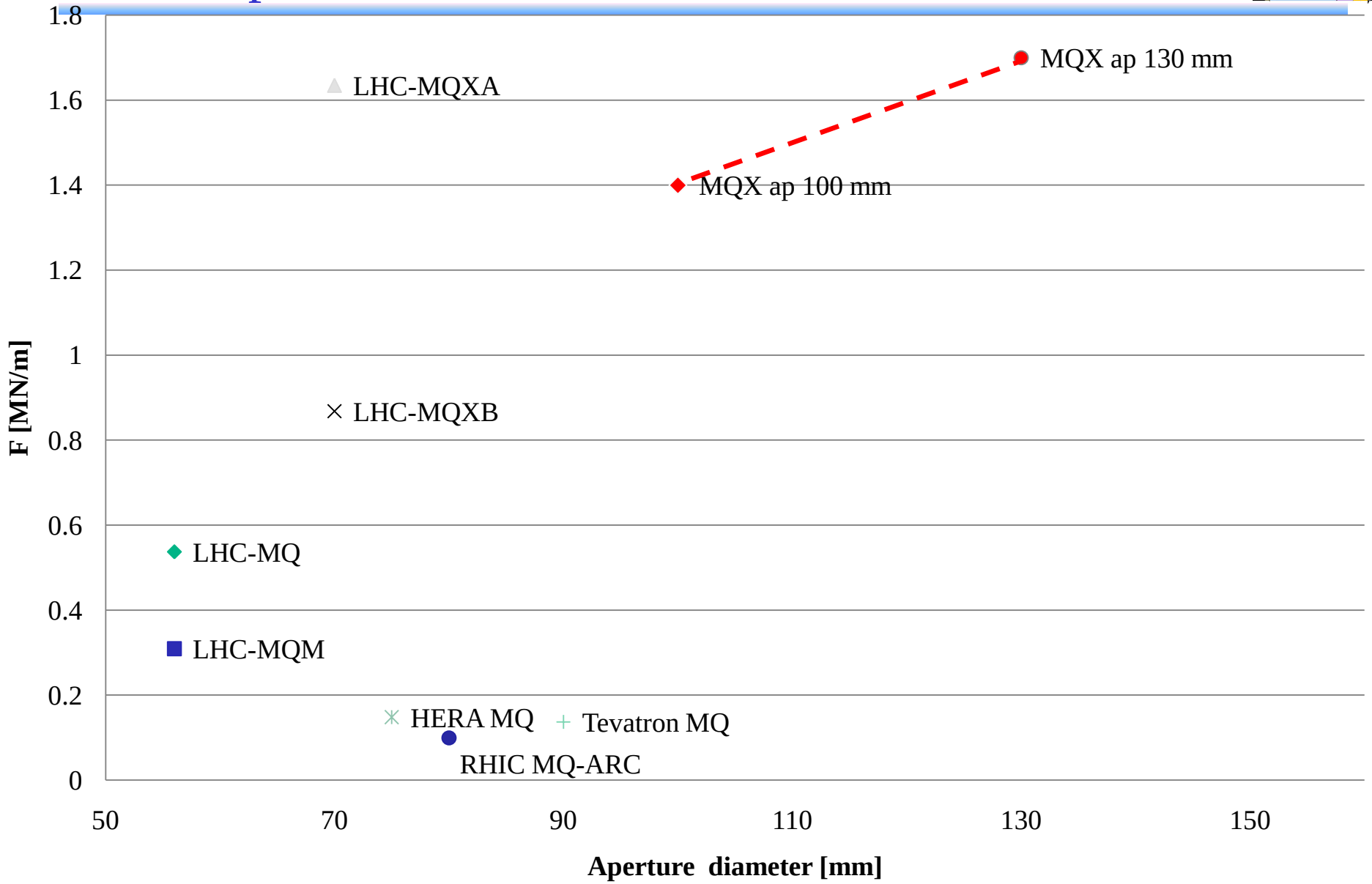
Preliminary Low-β Quadrupole parameters II



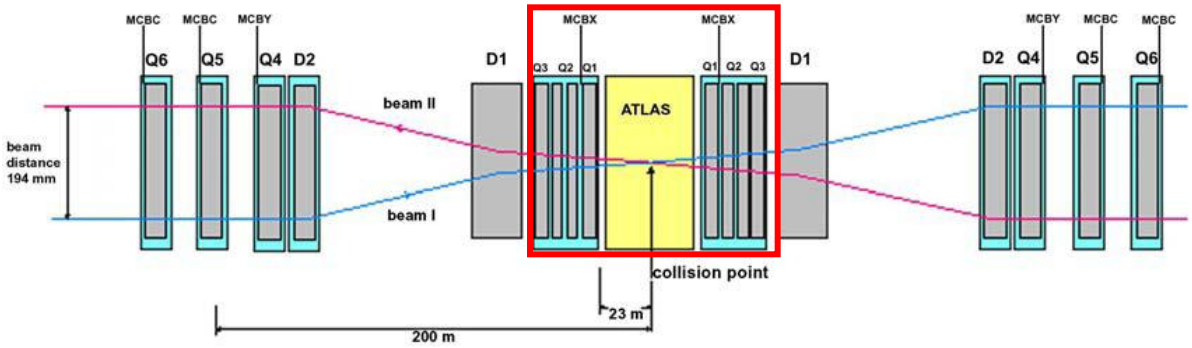
Present hypothesis	
Use of cable:	length of final magnets will be set in function of optics requirement but also for the best use of the available cable unit length: Inner layer unit 450 m Outer layer unit length 740 m
Insulation	the cable insulation is under study at the moment a scheme made of 3 layers of the following thicknesses: 1st layer 50µm 2nd layer 75 µm 3rd layer (adhesive) 55 µm
Heat exchange related factors:	1 heat exchanger 100/104 mm ID/OD [85/89] 2 parallel heat exchangers: 71/75 mm ID/OD [61/65] 4 parallel heat exchangers: 51/54 mm ID/OD [44/49]

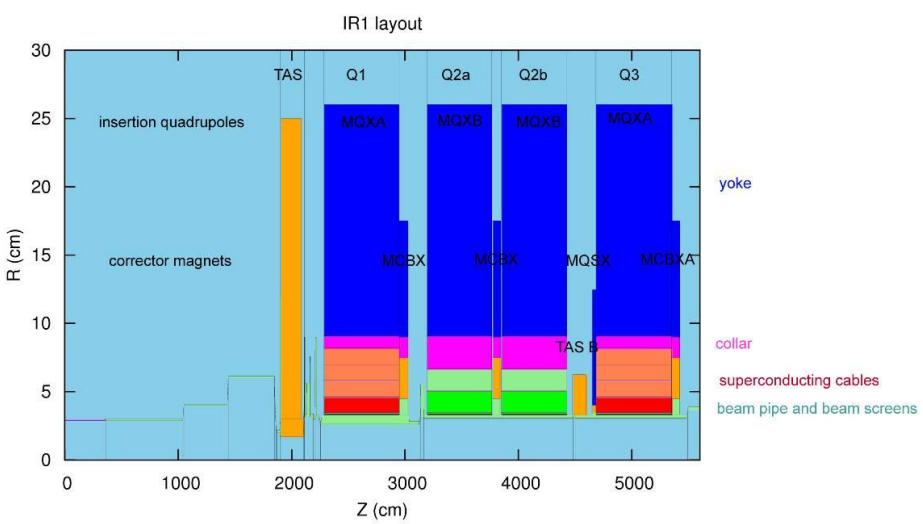
LHC IR upgrade phase I: magnet horizontal forces and aperture

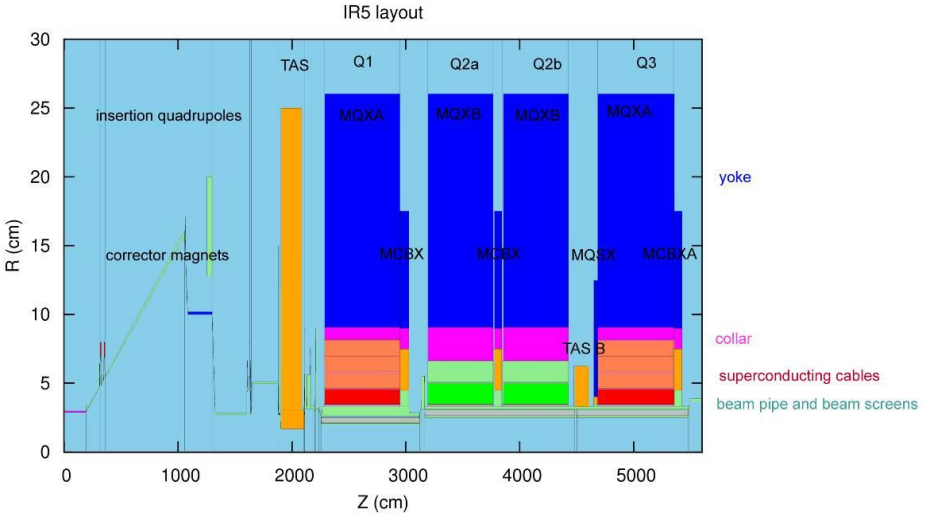




Models of LHC baseline IR1 and IR5



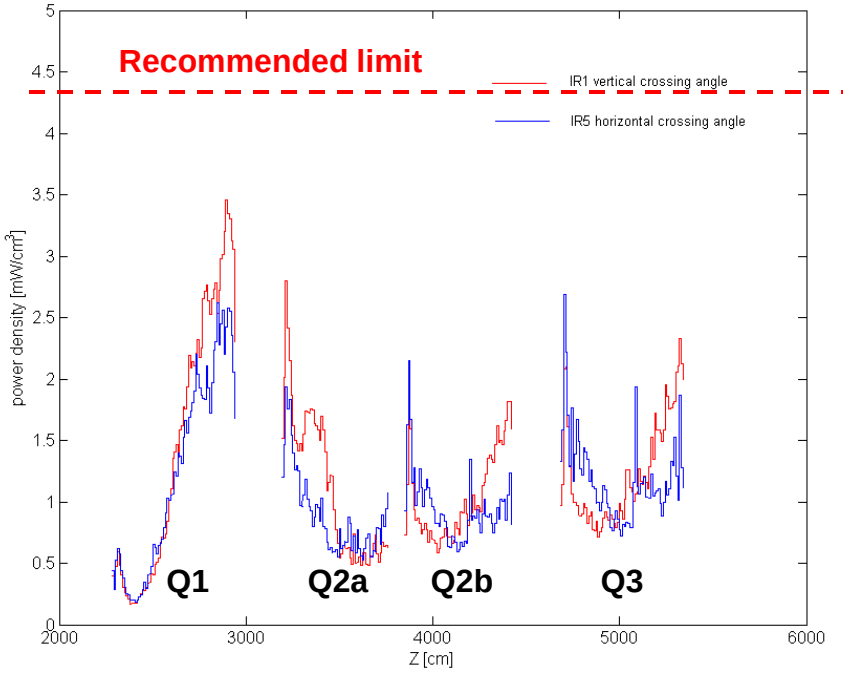




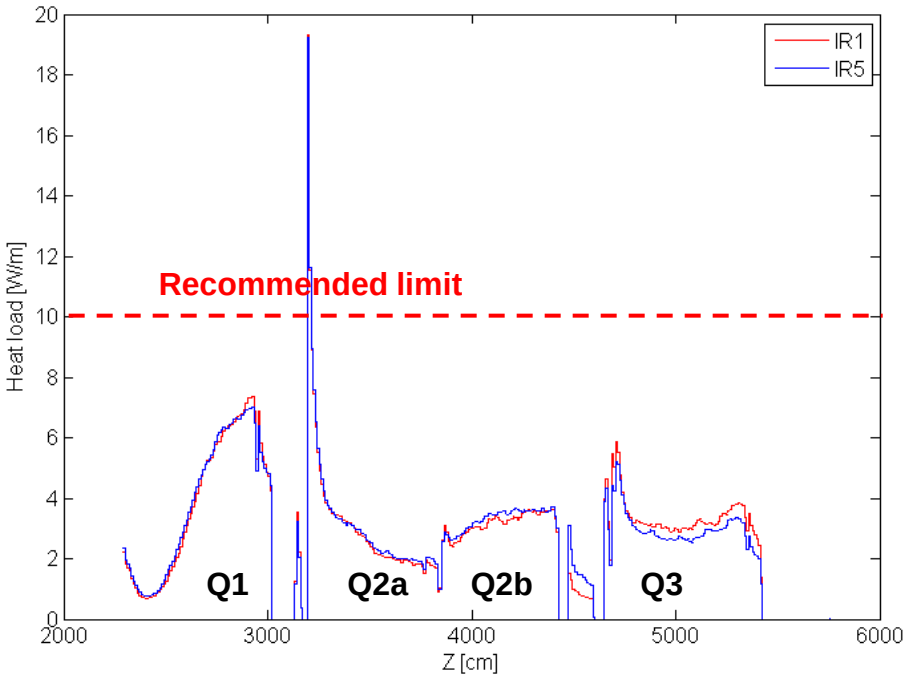
Courtesy C. Hoa

Energy deposition along the present triplet: today

Peak energy deposition in coil



Heat load in magnets along triplet



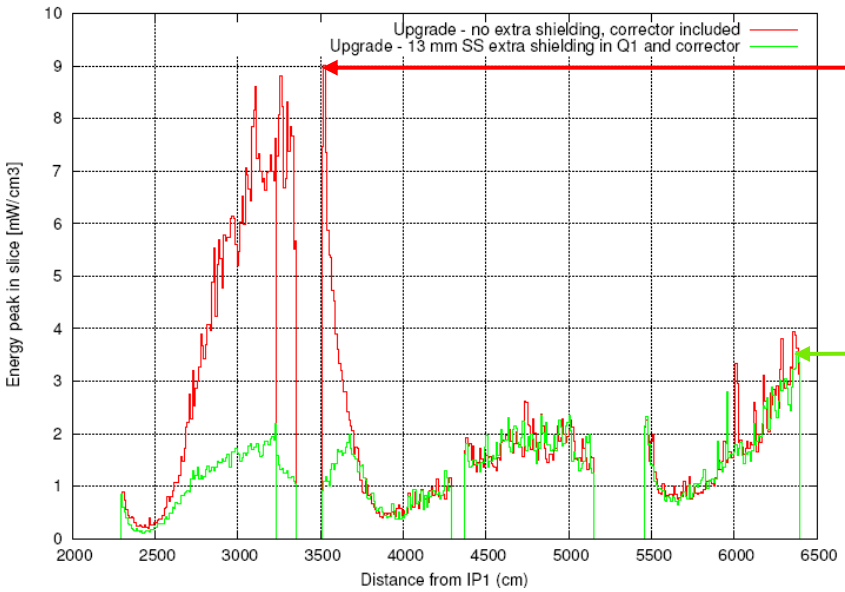
Total in magnet: 28.6W 23.5W 23.5W 25.8W

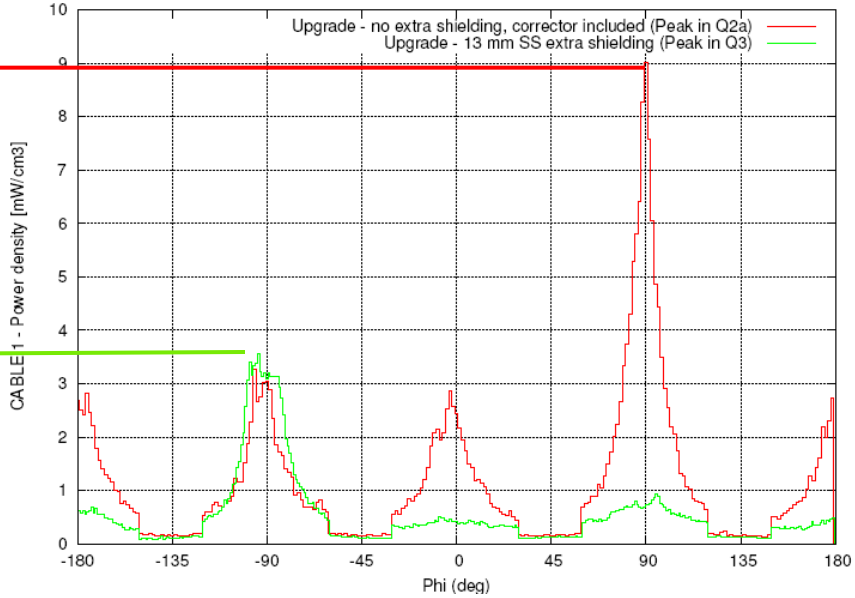
Liner in Q1 and MCBX of thickness 6.5 mm (stainless steel)
Length of triplet 31 m
Magnet apertures 70 mm
Half crossing angle 142.5 mrad

Luminosity= 1.0 *10^{34} $cm^{-2}s^{-1}$

Courtesy of
Elena Wildner, AT/MCS
Francesco Cerutti, AB/ATB
Marco Mauri, AB/ATB
Alessio Mereghetti, AB/ATB

The new triplet: reducing heat load in the coils

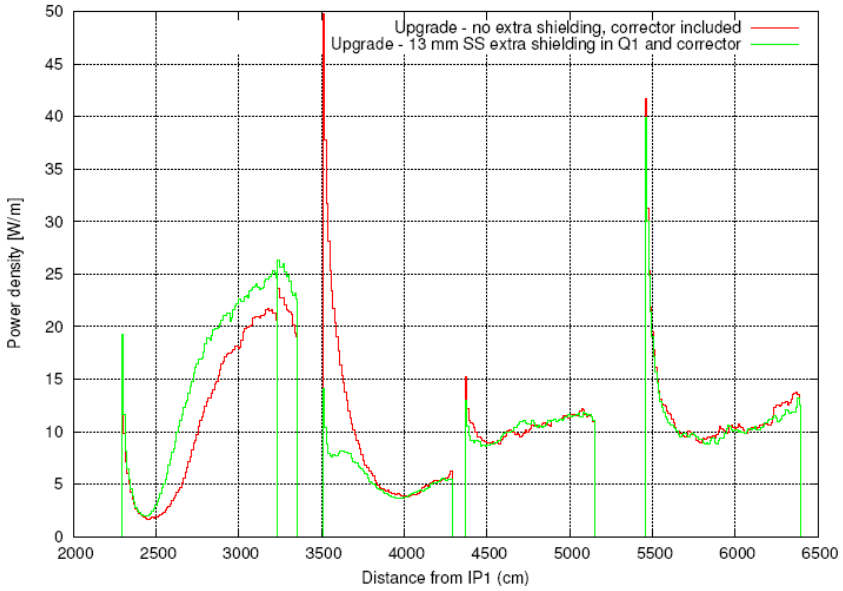




Peak energy deposition in each longitudinal bin, with and without proposed shielding

Azimuthal distribution at the longitudinal position of the peak, with and without proposed shielding

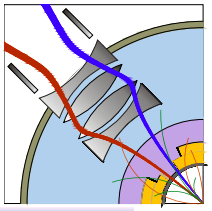
The Resulting Total Heat Load



	No Shielding [W]	13mmSS [W]
Q1	105.0	138.2
Corr	25.8	29.5
Q2a	69.9	44.1
Q2b	82.0	81.5
Q3	111.9	108.0

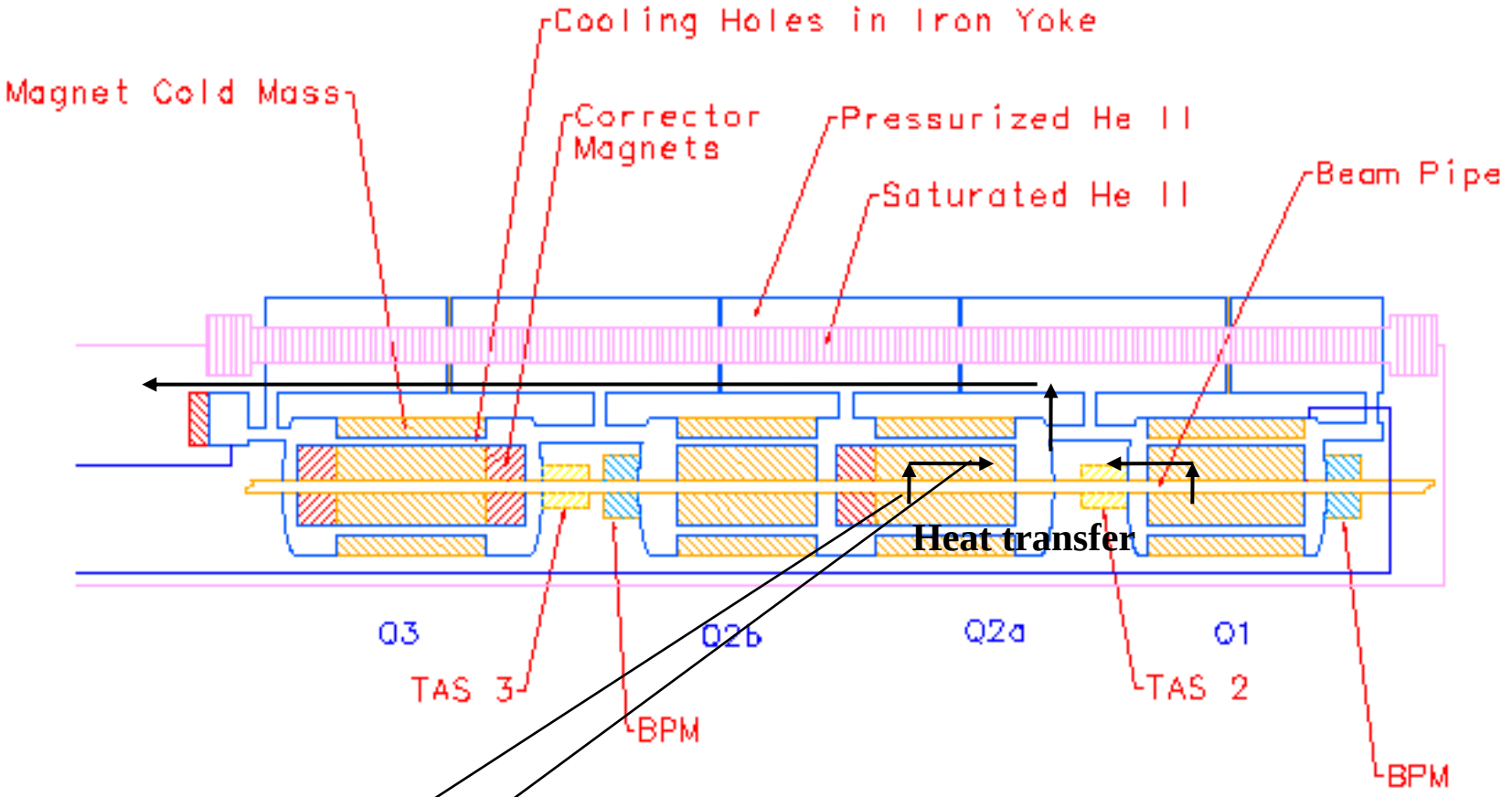
Liner in Q1 and MCBX of thickness 13 mm (stainless steel)
Length of triplet 41 m
Magnet apertures 130 mm
Half crossing angle 225 µrad

Improving global heat transfer efficiency



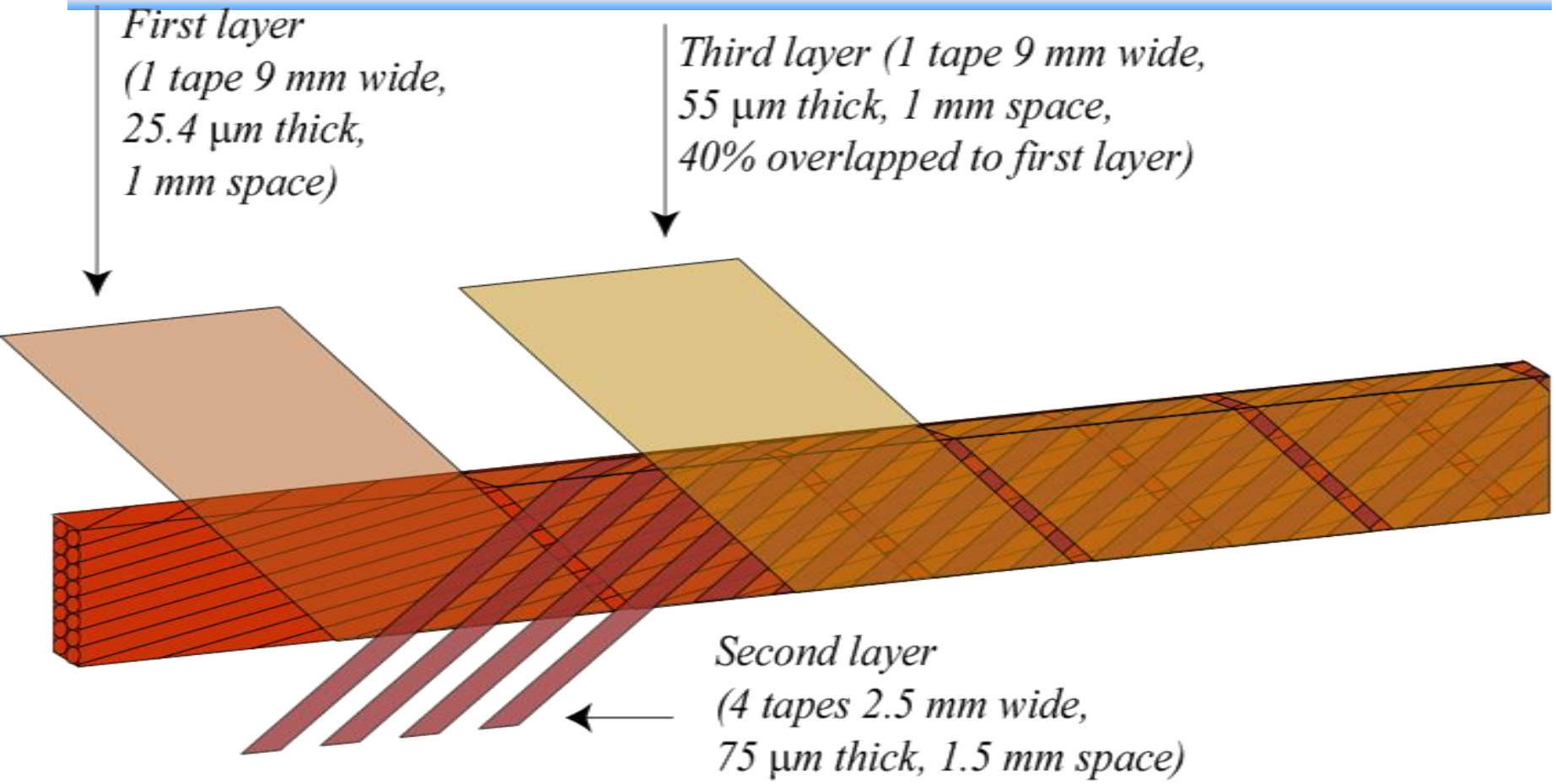
- In order to evacuate the deposited heat is necessary to provide adequate channels through
  - Heat exchanger
  - Yoke longitudinal and radial cooling channels
  - Collar radial cooling channels
  - Beam pipe annulus
  - Coil insulation

CLASSIFICATION OF HEAT EXTRACTION PATHS



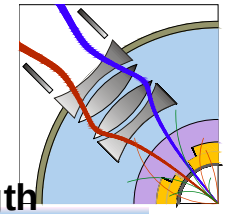
ΔTcoil: typically 80-90 mK available down from 2.17 K max
ΔTcoil-freeA (radial): typically 60-70 mK available around 2.050 K
ΔTfreeA-bHX (longitudinal): typically 80-90 mK available around 1.98 K
about 160 mK remains for heat transfer to cold source and up to cold compressors

A possible way to deal with high energy deposition: enhanced porosity insulation

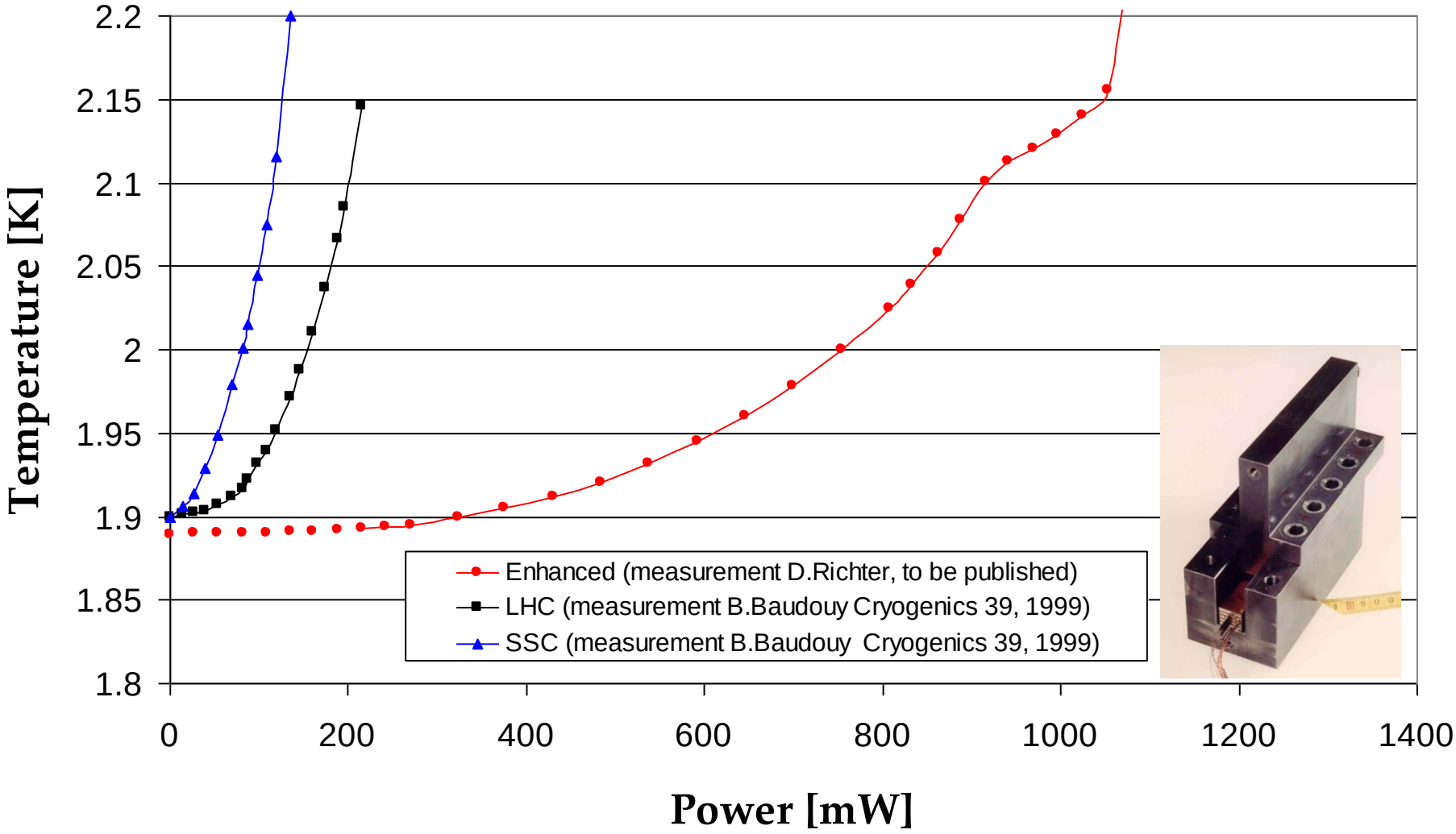


Courtesy of
D. Tommasini, AT/MCS

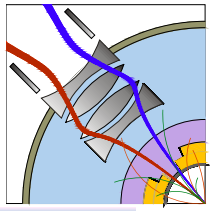
1st heat transfer tests



Power per cable edge (normalized to LHC inner layer ~ 2 mm) per meter of length



A joint R&D and construction effort



CERN

CEA and CNRS France

CIEMAT

STFC

EU-FP 7 SLHC-PP program

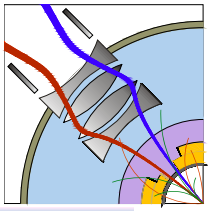
LHC IR upgrade phase I

France

Special contribution

US LARP

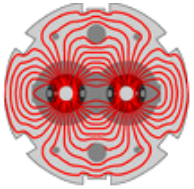
CERN



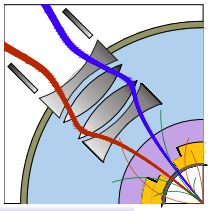
Development of Nb-Ti quadrupole magnet prototype

Objectives

- Designing the Nb-Ti quadrupole for the interaction regions of the LHC upgrade for higher luminosity.
- Manufacturing and cold testing a one meter long model of Nb-Ti quadrupole to qualify the procedure retained and the actual field quality
- Constructing and testing a full scale prototype made of a complete quadrupole with the cryostat and the correctors, as a basis for preparing the manufacture of the 16 quadrupoles needed for the high-luminosity interaction regions S-ATLAS andCMS2.



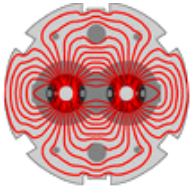
SLHC-PP WP6: timescale



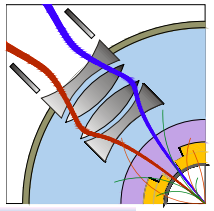
Deliverables task 6.1	Description	Nature	Delivery date	
6.1.1	Basic design of the triplet	R	M12	01/04/2009
6.1.2	Complete Interaction region design	R	M36	01/04/2011

Deliverables task 6.2	Description	Nature	Delivery date	
6.2.1	Construction of model	D	M18	01/10/2009
6.2.2	Assessment of the design	R	M24	01/04/2012

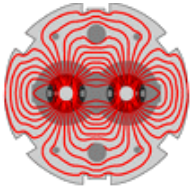
Deliverables task 6.2	Description	Nature	Delivery date	
6.3.1	Construction corrector magnet package	P	M26	01/06/2012
6.3.2	Prototype quadrupole magnet	P	M32	01/12/2011
6.3.3	Test of complete quadrupole prototype	R	M34	01/02/2012



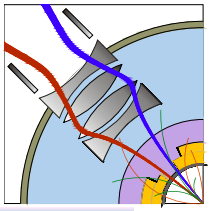
SLHC-PP WP6: timescale milestone



Milestones	Description	Nature	Delivery date	
6.1	Qualification of magnet component	O	M08	01/12/2008
6.2	Basic magnet design	O	M12	01/04/2009
6.3	Complete cold mass design	O	M18	01/10/2009
6.4	Complete cryomagnet design	O	M22	01/02/2010
6.5	Cryogenic and power test of the model	O	M22	01/02/2010
6.6	Electrical test of collared coil	O	M28	01/08/2010
6.7	Cold test of cornet	O	M28	01/08/2010

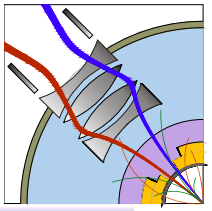


Laboratory contribution



	Task 6.1 Design of advanced Nb-Ti SC quadrupole	Task 6.2\Construction and testing of short models	Task 6.3 Construction and testing of a full scale prototype
CERN	Coordination Magnet design Cryostat design	Coordination Coil manufacturing Cold mass assembly Cold test Corrector cold test	Coordination Long prototype quad Cryostating
CEA-Saclay	Magnet design	Coil manufacturing	Assist CERN in long quad assembly
CIEMAT	Corrector design	Manufacturing corrector short model	Corrector prototype manufacturing
CNRS-IN2P3	Cryostat design		Cryostat manufacturing Cryostat tooling design
STFC	Corrector design	Manufacturing corrector short model	Corrector prototype manufacturing

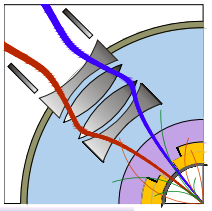
Foreseen man-power



WP6 Development of Nb-Ti quadrupole					
Participant	CERN	CEA-Saclay	CIEMAT	CNRS-IN2P3	STFC
Person-month per participant	72	49	30	18	24

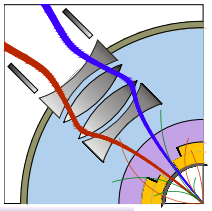
Request:
We would need the name of the task leader for each lab and if possible of the personnel in order to prepare an efficient communication

Checking available information



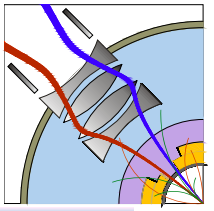
Institute	Task leader	Contributor
CERN	P. Fessia (WP 6 leader) Cryostat: V. Parma Correctors: M. Karppinen Low β quadrupole: P. Fessia	
CEA/Saclay	Maria Durante Jean-Michel Rifflet	Michel Segreti Mélanie Bruchon Bertrand Baudouy Françoise Rondeaux Pierre Manil
CIEMAT	F. Toral	
CNRS/IN2P3		
STFC	Simon Canfer	James Rochford

Management Request 1



- FP7: All costs of personnel working on a project may be eligible, i.e, we need to fill timesheets for every individual working for SLHC-PP
- **Request:**
  - Provide a list of members working in the WP, in agreement with the concerned beneficiaries.
  - Define the member role – *instructions and templates will be provided*
    - Individual
    - Supervisor
    - Beneficiary supervisor
    - Activity/WP supervisor
  - DEADLINE: May 5th

Time Sheets



Timesheet for EU-funded staff working at CERN

JANUARY 2008

First Name			
Last Name			
CERN Id.			
Email			
Project(s) Acronym			
Supervisor			
Activity (if relevant)			
CERN code(s) charged			

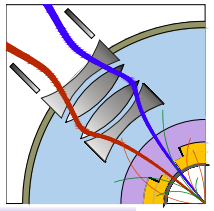
	WP		0			0			0	CERN holiday	Vacation	Sickness	Other/unpaid leaves	Other work	TOTAL	Nature of other work / comments
JANUARY 2008	hours	hours	hours	hours	hours	hours	hours	hours	hours	hours	hours	hours	hours	hours	hours	
01 Tue			0			0			0						0	
02 Wed			0			0			0						0	
03 Thu			0			0			0						0	
04 Fri			0			0			0						0	
05 Sat			0			0			0						0	
06 Sun			0			0			0						0	
07 Mon			0			0			0						0	
08 Tue			0			0			0						0	
09 Wed			0			0			0						0	
10 Thu			0			0			0						0	
11 Fri			0			0			0						0	
12 Sat			0			0			0						0	
13 Sun			0			0			0						0	
14 Mon			0			0			0						0	
15 Tue			0			0			0						0	
16 Wed			0			0			0						0	
17 Thu			0			0			0						0	
18 Fri			0			0			0						0	
19 Sat			0			0			0						0	
20 Sun			0			0			0						0	
21 Mon			0			0			0						0	
22 Tue			0			0			0						0	
23 Wed			0			0			0						0	
24 Thu			0			0			0						0	
25 Fri			0			0			0						0	
26 Sat			0			0			0						0	
27 Sun			0			0			0						0	
28 Mon			0			0			0						0	
29 Tue			0			0			0						0	
30 Wed			0			0			0						0	
31 Thu			0			0			0						0	
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Author Name :	
Date and signature	

Supervisor Name :	
Date and signature	

Apr

Management Request 2

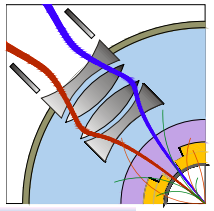


- Annex I contains defined dates for EU DELIVERABLES and EU MILESTONES. Typical granularity is:

WP	
Task 1	**Task 2**
D 1.1	D 2.1
M 1	M 2
D 1.2	D 2.2
D 1.3	

- **Request:**
  - Produce a proper WBS of your WP (broken down in tasks and subtasks), with internal deliverables to help/ensure that EU deliverables are attainable on schedule, within budget
  - DEADLINE: May 5th

WP1 deliverables and milestones



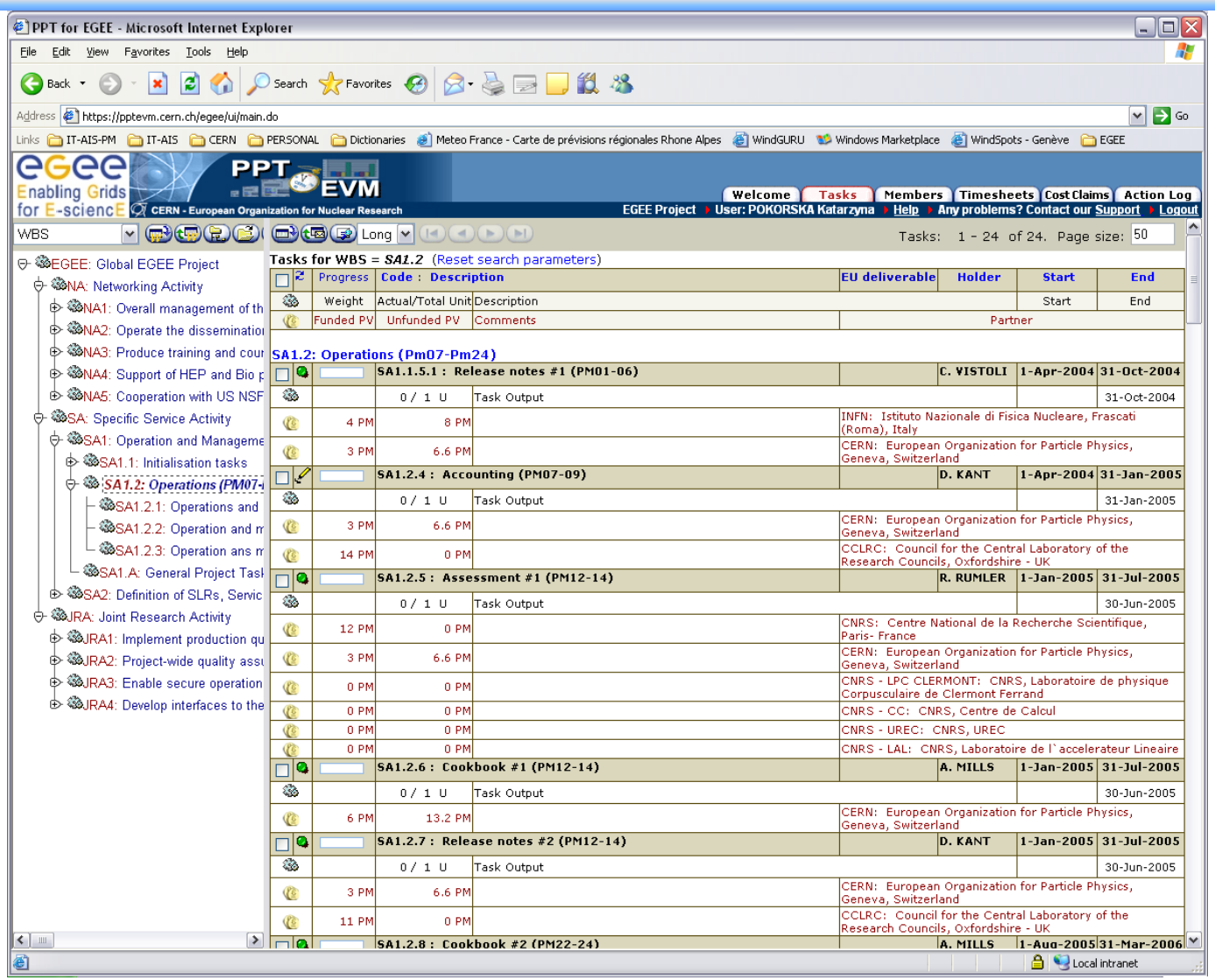
EU Deliverables and Milestones

WP1: SLHC Project Management					
Task 1: Steering of the Consortium and project follow-up			Task 2: Dissemination		
M 1.1	Kick-off meeting	M01			
			D 2.1	SLHC-PP Web Site	M03
M 1.2	Annual Meeting 1	M12			
D 1.1	Periodic report	M14			
M 1.3	Annual Meeting 2	M24			
D 1.2	Periodic report	M26			
M 1.4	Annual Meeting 3	M36			
D 1.3	Periodic report	M38			
D 1.4	Final Report	M38			

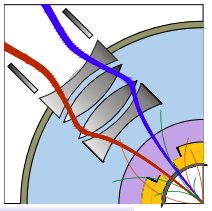
Internal Deliverables and Milestones

D1.1 Periodic Report		
D 1 1 1	Time sheets Consolidation	M3
D 1 1 2	Time sheets Consolidation	M6
D 1 1 3	Time sheets Consolidation	M9
D 1 1 4	Time sheets Consolidation	M12
D 1 1 5	WPs Progress Report	M12
D 1 1 6	Form C Consolidation	M13

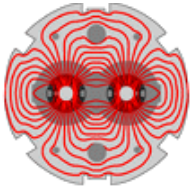
PPT EVM, an example from EGEE



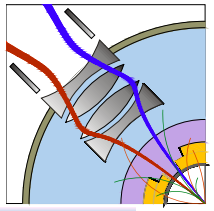
Management Request 3



- Members are assigned to partners
- Members are assigned to tasks or subtasks
- Tasks and subtasks have a defined duration
- **Request:**
  - Define the assignments above for your WP
  - DEADLINE: May 5th



Preliminary proposal for 1st activities



- CIEMAT: evaluate feasibility of the MCBX corrector with a 600 A current:
  - CERN would provide 1st conceptual design
  - CIEMAT perform quench protection analysis and mechanical analysis
- STFC: evaluate feasibility of the MQSX corrector with a 600 A current
  - STFC would provide 1st conceptual design
  - STFC perform quench protection analysis and mechanical analysis
- CEA-Saclay
  - detailed mechanical analysis of the low beta quad when a 1st set of main parameters (aperture, collar thickness and conductor distribution have been fixed)
  - Participation in model coil winding (model length ~ 3m).
- CNRS-IN2P3: pre-study of integration of cold masses and cryostat