Project overview, boundary conditions, configuration, cost & schedule

V.Parma,

CERN, TE-MSC

With input from the Collimator Upgrade Project Team,

In particular: R.Assmann, V.Baglin, M.Bajko, P.Bestman, A.Bertarelli, C.Bertone, J.Coupard, S.Chemli, K.Dahlerup-Petersen, J.C.Guillaume, Y.Muttoni, D.Ramos, A.Perin, J.Ph.Tock, R.Van Weelderen, R.Principe, A.Rossi, S.Russenchuck, ...and many others

Outline

- Motivation
- DS Collimators in IR3, description, implications
- Organization, costs and budgets
- Changes to technical systems (cryogenics, vacuum, powering…)
- Hardware modifications and status:
  - New equipment
  - Tunnel integration issues
- Where are we now?
  - Surface and tunnel schedules
- Summary and Outlook

Collimation Upgrade Part 1 (2010 – 2013)

- Start date of project: **1.7.2010**
- End date of project: **31.12.2013**
- Total cost to completion: **35.5 MCHF**
- Deliverables:
  - Improve collimation efficiency by factor 5-10.
  - Implement flexibility in loss location (IR3 or IR7).
- Profile:
  - 2010: 4 MCHF
  - 2011: 11 MCHF
  - 2012: 15 MCHF
  - 2013: 5.5 MCHF

What:

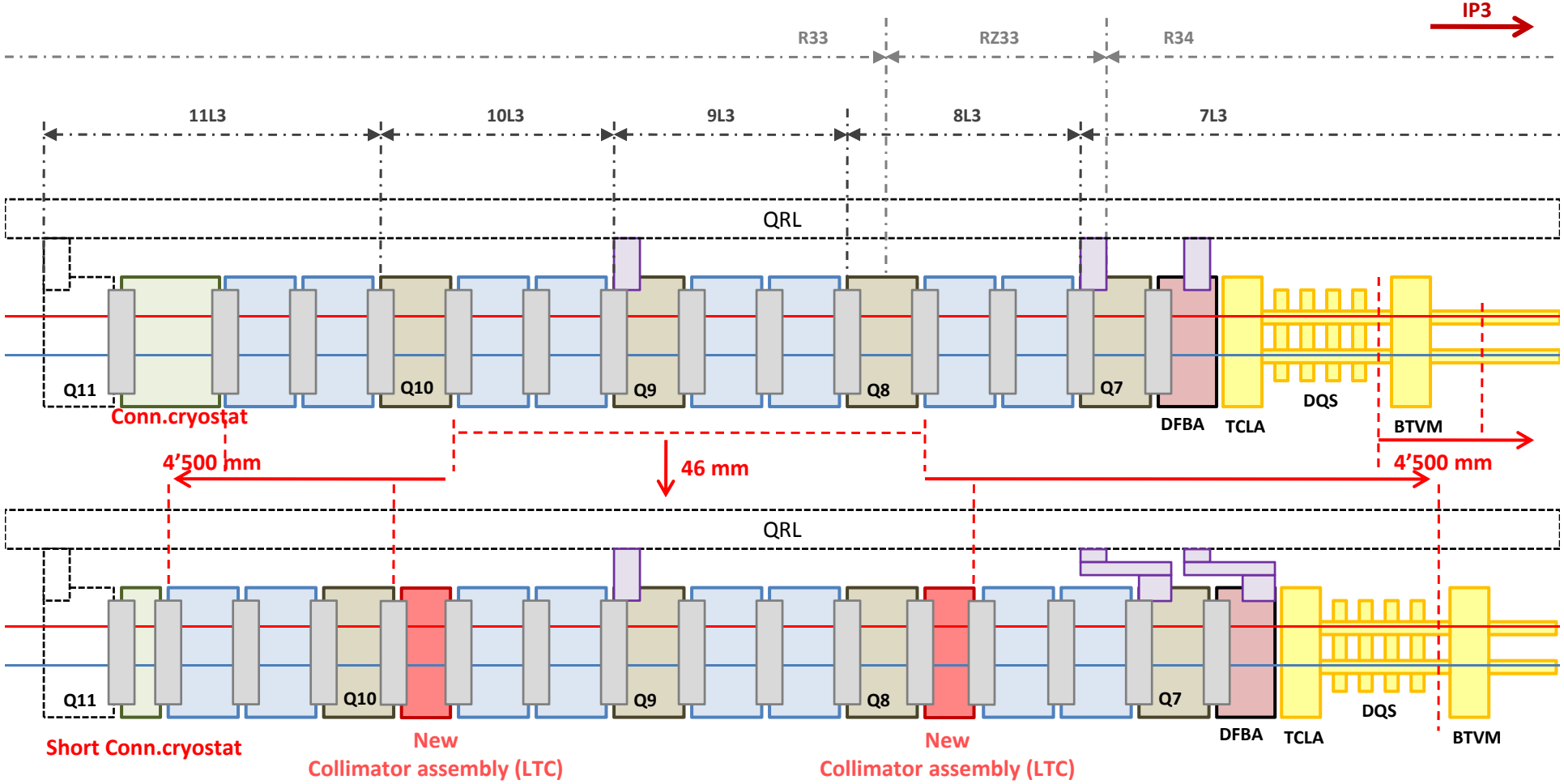
Upgrade of IR3 DS's with warm collimators (DS collimator or cryo-collimator).

Moving magnets to create space.

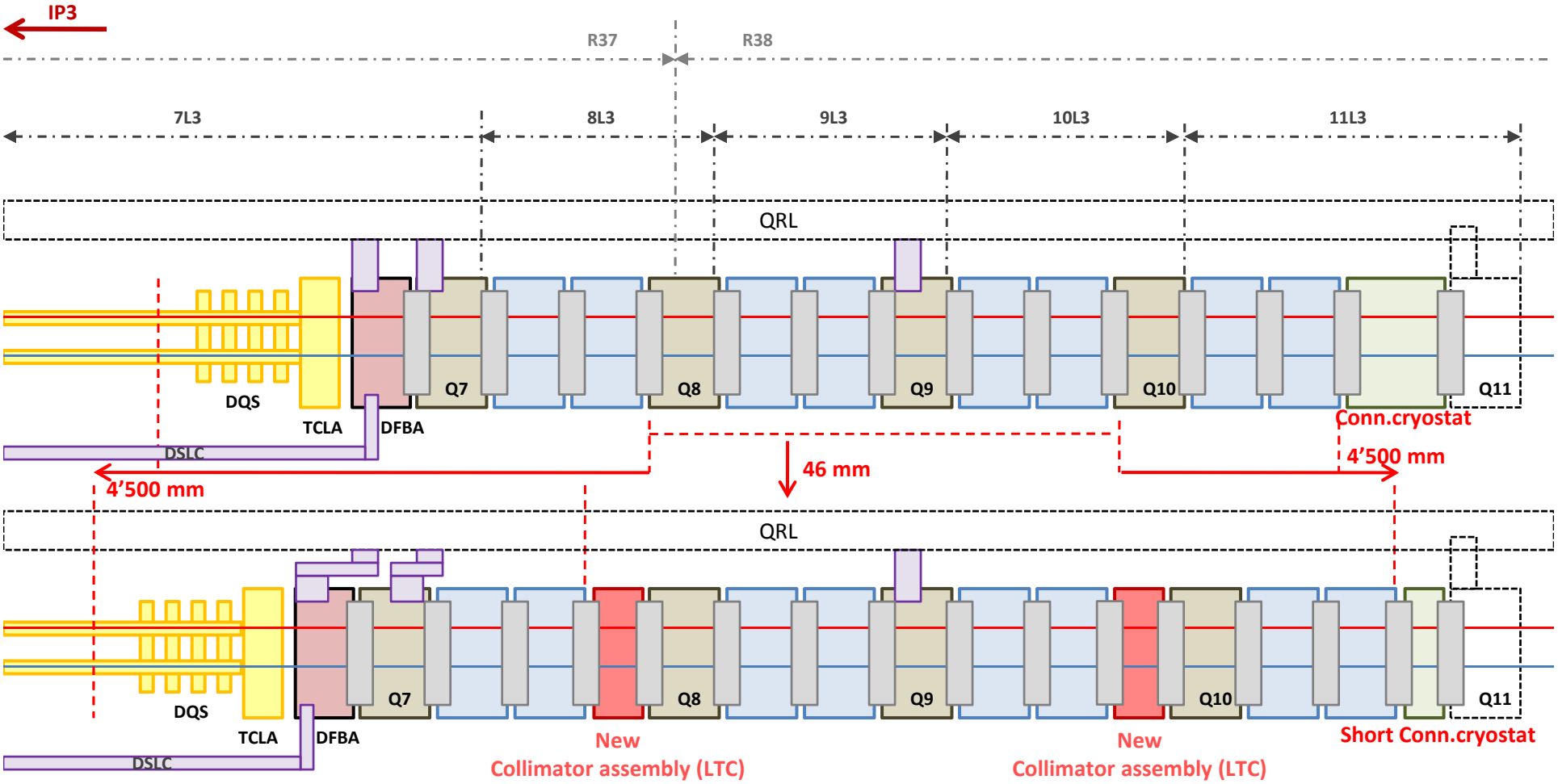
Installation of vertical collimators in IR3 to have the possibility to move betatron cleaning into IR3 in case of SEU problems in IR7.

Installation of **high luminosity collimators**?

DS collimators:
Left side of point 3



DS collimators:
Right side of point 3



Background

- DS collimator first proposed in **2009-2010**
- **Cryostat by-pass** initially based on design work for **FP420** (forward physics experiment), a TS-MME/LHC-CRI development in **2006** (now considerably re-engineered by TE-MME)
- **1st half 2010.** Technical Working Group with the goal of reviewing specifications, feasibility for installation in the 2012 shut-down, and reviewing the integration of the DS collimators within the LHC technical systems (https://espace.cern.ch/dscollimator). Generated most of the input for the Engineering Specification EDMS 1092553 (https://edms.cern.ch/document/1092553/0.3)
- **Review in July 2010:** http://indico.cern.ch/conferenceDisplay.py?confId=100156

  Conclusion: "*The work on adding DS collimators and upgrading the IR3 collimation system during the 2012 shutdown must start now*"
- **Chamonix 2011**: review need of DS collimator based on LHC results in June 2011

Work Breakdown Structure

		Responsibles	Auxiliary collimators in DS zone of IR3 TCLD
I	Project Management		
I.1	LHC Collimation Upgrade Management	R.Assmann	x
I.2	LSS Technical coordination	O.Aberle	
I.3	DS Technical coordination	V.Parma	x
I.4	Quality Assurance	A.Rossi	x
I.5	Baseline configuration management and QA	S.Chemli	x
II	Coordination of Installation		
II.1	Scheduling and Coordination	J.Coupard	
II.1.1	Scheduling of surface preparation		x
II.1.2	Scheduling of underground works and installation		x
II.1.3	Coordination on-site		x
II.2	Layout Database	S.Chemli	x
II.3	Integration Office	Y.Muttoni	
II.3.1	Integration studies		x
II.3.2	Installation non conformities		x
II.4	Survey activity	P.Betsmann	
II.4.1	Alignment of machine elements		x
II.4.2	Smoothing of the machine elements		x
II.5	Transport and Handling operation	C.Bertone	x
III	Operation		
III.1	Electrical Quality Assurance	N.Catalan	x
III.2	Hardware commissioning To be completed ??	O.Aberle & V.Parma	x
III.2.1	Collimators	O.Aberle, A. Masi	
III.2.1.1	10 TCS/TCP		
III.2.1.2	4 TCLD		x
III.2.1.3	2 TCT, removal of 2 TCTVB ?		
III.2.1.4	14 TCTx in IP 1, 2, 5 and 8		
III.2.2	Cryostats & Cryogenics	V.Parma	x
III.3	Remote commissioning / MP tests	A.Rossi & S.Redaelli	x
IV	Safety		
IV.1	Safety Engineering and Environment	C.Colloca	x
IV.2	Radiation Protection	S.Roesler	x

(A.Rossi)

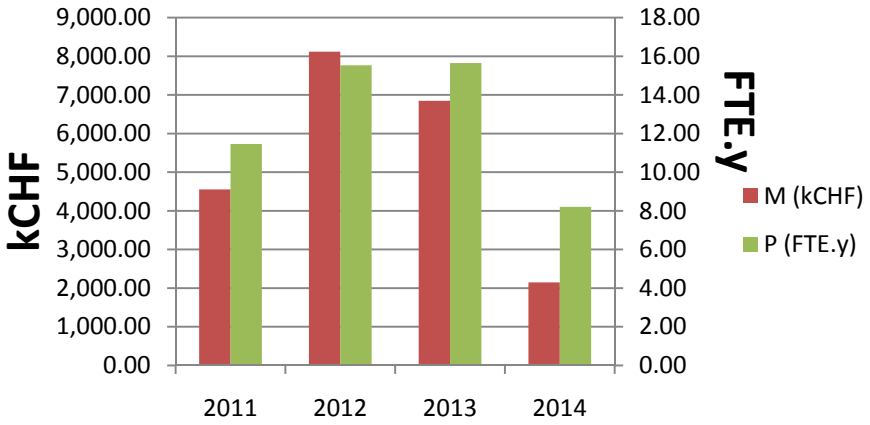
Work Breakdown Organization

V	**Activities**		
	V.1 LHC systems upgrade studies		
	V.1.1 IR3 optics and layout	M.Giovannozzi	x
	V.1.2 Impedance from collimators	E.Metral	x
	V.1.3 Collimation Performance	A.Rossi	x
	V.1.4 Integration and layout studies	Y.Muttoni	x
	V.1.5 Cryogenics systems	R.Van Weelderen	x
	V.1.6 Vacuum systems	V.Baglin	x
	V.1.7 Magnet Electrical systems	K.Dahlerup-Petersen	x
	V.2 LHC equipment Engineering (Design, Production & Testing)		
	V.2.1 Collimators Engineering and Mfct (before final testing on surface)	A.Bertarelli	
	V.2.1.1 DS collimator module (TCLD with support)		x
	V.2.1.2 TCT with integrated BPM (TCTP)		
	V.2.1.3 Phase 1+ Collimators (TCP - TCSG)		
	V.2.1.4 Phase 2 Collimators (TCSM)		
	V.2.1.5 FLUKA studies	F.Cerutti	x
	V.2.2 Collimators manufacturing external to CERN (contracts)	O.Aberle	
	V.2.2.1 Contract for 6 TCSG (plan A)		
	V.2.2.2 Contract for 18 TCTP		
	V.2.2.3 Contract for 34 TCSM Phase 2 collimators		
	V.2.3 Collimators final assembly and testing before installation (B 252)	O.Aberle, A. Masi	x
	V.2.3.1 10 TCS/TCP + 3 spares		
	V.2.3.2 4 + 1 TCLD		
	V.2.3.3 2 TCT for Alice		
	V.2.3.4 18 TCTP		
	V.2.4 DS Cryostat Equipment Eng & Mfct		
	V.2.4.1 Short Connection Cryostat (LE)	J.Ph.Tock	x
	V.2.4.2 DS collimator bypass cryostat (QTC)	A.Bertarelli	x
	V.2.4.3 Bus-bars	R.Principe	x
	V.2.4.4 Cryo-magnets interconnection components	J.P.Tock	x
	V.2.5 Cold powering tests (SM18)	M.Bajko	x
	V.2.5.1 QTC Cold testing		
	V.2.5.2 SCC Cold testing		
	V.2.6 Cryogenics equipment		
	V.2.6.1 Modification of DFBA	A.Perin	x
	V.2.6.2 Cryogenic line exstensions	O.Pirotte	x
	V.2.6.3 SSS modifications (instrumentation & PID)	R.Van Weelderen	x
	V.2.7 Vacuum equipment		
	V.2.7.1 Beam vacuum	V.Baglin	x
	V.2.7.2 Insulation vacuum	P.Cruikshank	x
	V.2.7.3 Control	P.Gomes	x
	V.2.8 Transport system		

(A.Rossi)

Cost Estimate (P+M)

Department/Group	WP name	WP responsible		2011	2012	2013	2014	Totals M Cost [kCHF]	Totals Staff [FTE.y]
TE/MSC	DS collimators Technical Coordination	V.Parma	Total M [kCHF]	0.00	0.00	0.00	0.00	0.00	
			Total P [FTE.y] - staff/fellows	0.5	0.5	0.7	0.5		2.2
EN/MEF	Configuration management and QA	S.Chemli	Total M [kCHF]	0.00	0.00	0.00	0.00	0.00	
			Total P [FTE.y] - staff/fellows	0.15	0.15	0.15	0.15		0.6
EN/MEF	Planning, Layout and Integration	J.Coupard	Total M [kCHF]	51.00	34.00	34.00	34.00	153.00	
			Total P [FTE.y] - staff/fellows	0.2	0.4	0.4	0.3		1.3
TE/CRG	Modifications and new cryogenics systems/equipment DS	R.Van Weldereen	Total M [MCHF]	130.00	460.00	560.00	570.00	1,720.00	
			Total P [FTE.y] - staff/fellows	0.6	1.1	1.1	1.1		3.9
TE/VCS	Modifications and new vacuum systems/equipment DS	V.Baglin	Total M [kCHF]	746.87	1,218.06	179.58	42.45	2,186.95	
			Total P [FTE.y] - staff/fellows	0.4	1.4	2.4	1.2		5.4
TE/MPE	QPS modifications and new systems	K.Dahlerup-Petersen	Total M [kCHF]	0.00	0.00	20.00	0.00	20.00	
			Total P [FTE.y] - staff/fellows	0	0.1	0.1	0		0.2
EN/EL	Modifications of Electrical System and Cabling	J.C.Guillaume	Total M [kCHF]	0.00	50.00	800.00	100.00	950.00	
			Total P [FTE.y] - staff/fellows	0.3	0.3	0.3	0		0.9
EN/CV	Modification of CV system	M.Nonis	Total M [MCHF]	0.00	0.00	0.00	0.00	0.00	
			Total P [FTE.y] - staff/fellows	0	0	0	0		0
EN/MME	Engineering, Design & Manufacture of DS collimators (4+1)	A.Bertarelli	Total M [kCHF]	2,167.00	1,601.00	396.00	0.00	4,164.00	
			Total P [FTE.y] - staff/fellows	5.46	4.83	2.45	0		12.74
TE/MSC	Supply of special components to EN/MME	P.Fessia	Total M [kCHF]	544.00	544.00	272.00	0.00	1,360.00	
			Total P [FTE.y] - staff/fellows	1	1	0.5	0		2.5
TE/MSC	Engineering, Design & Manufacture of Short Connection Crystats (2+1)	J.Ph.Tock	Total M [kCHF]	760.00	2,725.00	760.00	0.00	4,245.00	
			Total P [FTE.y] - staff/fellows	1.3	1.8	0.5	0		3.6
TE/MSC	Tunnel IC work and components	J.Ph.Tock	Total M [kCHF]	50.00	326.00	1,281.00	625.00	2,282.00	
			Total P [FTE.y] - staff/fellows	0.5	1.1	3.1	3.1		7.8
TE/MSC	Cold power testing of cryostat assemblies	M.Bajko	Total M [kCHF]	50.00	200.00	200.00	0.00	450.00	
			Total P [FTE.y] - staff/fellows	0	1	1	0		2
TE/MPE	Modifications to magnet electrical circuits, ELQA	N.Catalan Lasheras	Total M [kCHF]	0.00	600.00	600.00	200.00	1,400.00	
			Total P [FTE.y] - staff/fellows	0.5	0.5	0.5	0.5		2
BE/BI	Modification to existing and new beam instrumentation	B.Dehning	Total M [kCHF]	0.00	0.00	0.00	0.00	0.00	
			Total P [FTE.y] - staff/fellows	0	0	0	0		0
GS/SE	Civil engineering modifications	J.Osborne	Total M [kCHF]	0.00	0.00	100.00	0.00	100.00	
			Total P [FTE.y] - staff/fellows	0.15	0.15	0.15	0		0.45
EN/HE	Transport and handling assistance	C.Bertone	Total M [kCHF]	55.00	359.00	1,596.00	558.00	2,568.00	
			Total P [FTE.y] - staff/fellows	0.4	1.2	2.3	1.35		5.25
BE/ABP	Alignment and Survey	P.Bestman	Total M [kCHF]	0.00	0.00	50.00	17.00	67.00	
			Total P [FTE.y] - staff/fellows	0	0	0	0		0
			Overall Total M [kCHF]	4,553.87	8,117.06	6,848.58	2,146.45	21,665.95	
			Overall Total P [FTE.y] -	11.46	15.53	15.65	8.2	0	50.84



Up to date, M expenditures:

- < 3 MCHF (estimate)
- Includes design studies (also commited)
- Components/materials ordered (end caps, supports, raw material…)

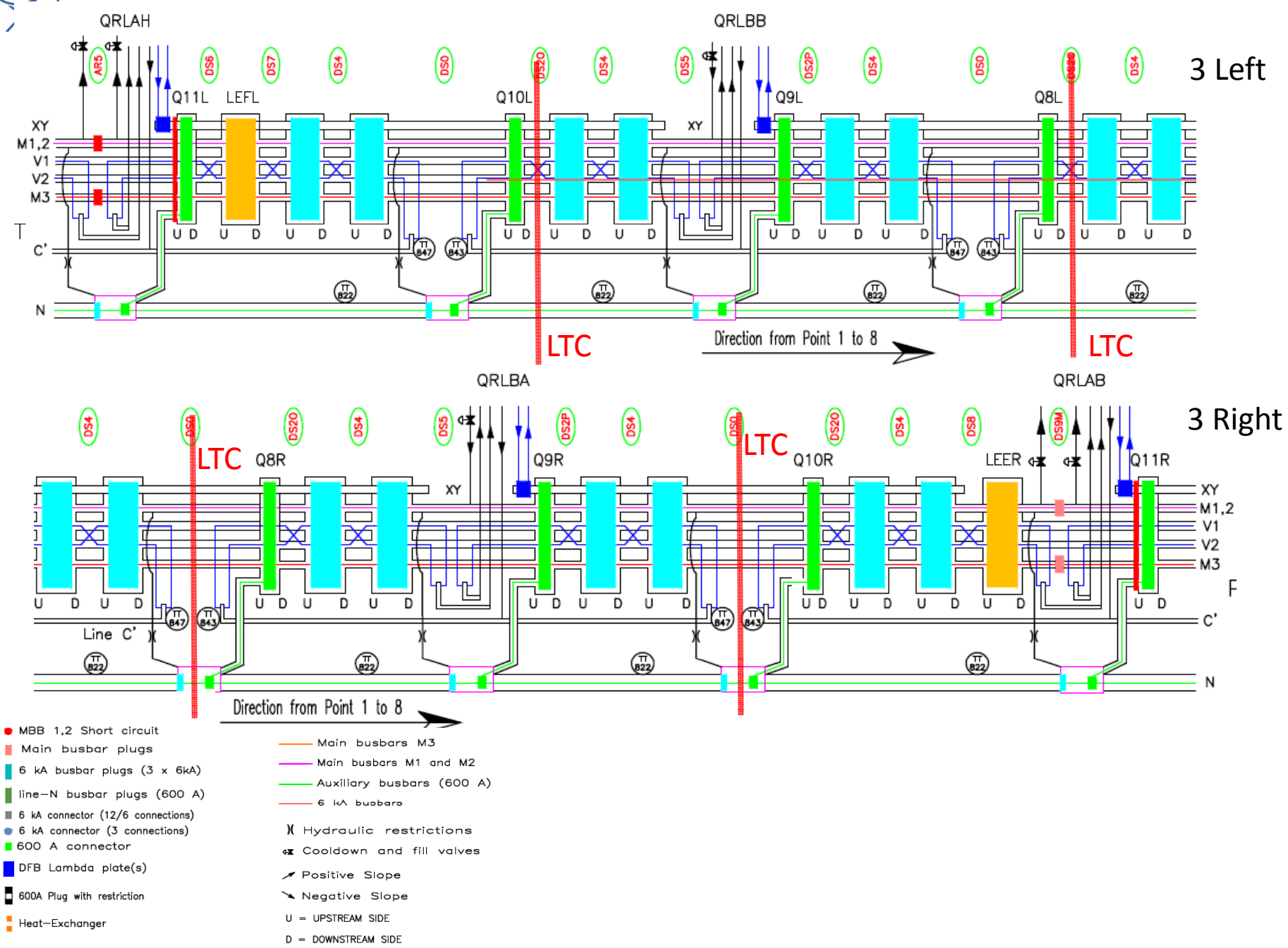
Main H/W implications (3L+3R)

- Disconnect and remove:
  - 16 dipoles, 8 SSS, 2 Connection Cryostats, 2 DFBA
- Displace by 4.5 m:
  - TCLA, DQS, BTVM (3L only, displacement to de defined)
- Important cable re-layout work:
  - ~600 cables to be shortened, ~800 cables to be extended (warm and cooled cables)
  - Re-routing (through new cable duct UP33/R34); connections
- Civil engineering:
  - Remove, displace and fix jacks to ground
  - Grind passage wall (3-5 cm) on 2x100m length
  - Drilling new cable duct UP33/R34 ?
- Modification of jumpers of Q7, Q9 and DFBAs (on surface or in the tunnel)
- Shortening of DSLC (cryostat+superc.cables) in 3R
- Produce new equipment:
  - 4 (+1) DS collimator assemblies (LTC)
  - 2 (+1) Short Connection Cryostats (SCC)
  - 2 QRL extensions
- Re-install and interconnect DFBA, magnets, SCC, LTC

Strategic choices for new H/W

- Reuse of all possible existing component designs and technology (no R&D!):
  - Minimise risk of unexpected problems
  - Reduce design effort
  - Use *on-the-shelf* LHC spares (cryostat, vacuum, cold mass components)
  - Reduce procurement lead-time
  - Activate options on LHC contracts (e.g. End-caps, support posts)
- Keep interconnects standard
  - Standard tunnel installation (tools, assembly procedures, QA)
- Test all units in operating conditions in SM18 (power tests)
- Preparation for tunnel integration in SMI2 (as for magnets)
- Installation of collimators *in-situ* (can be staged) after installation of QTC
- Collimator integration compatible with “fast” removal if faulty (as for other collimators) and bridging with warm beam tubes

Primary technical systems affected by inserting the LTCs (3 L and 3 R)



Systems to be “bridged” and “extended”

Maintain functional continuity to:

Beam lines (beam vacuum):

1. V1, V2

Electrical powering:

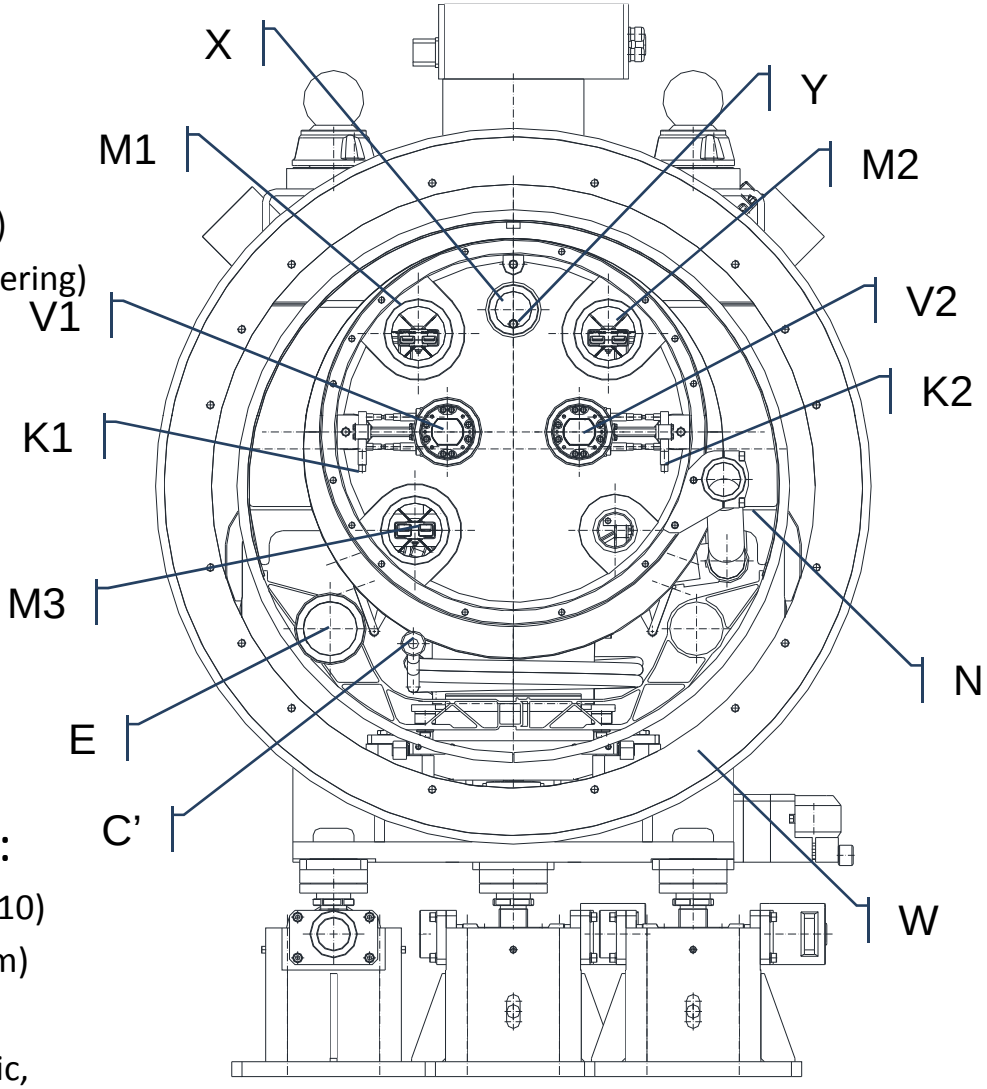
1. M1, M2, M3 and corrector spools (magnet powering)
2. Aux.BB line (line N, only 600 A cables, correctors powering)

Cryogenics:

1. Pressurised HeII bath (line L)
2. Sub-cooled HeII (lines X, y)
3. C’, KD1, KD2 lines (4.5 K) for IR3L; none for IR3R (but needed to thermalise cryostat components)
4. Thermal shield line (line E)

Insulation vacuum:

1. Insulation vacuum (line W)

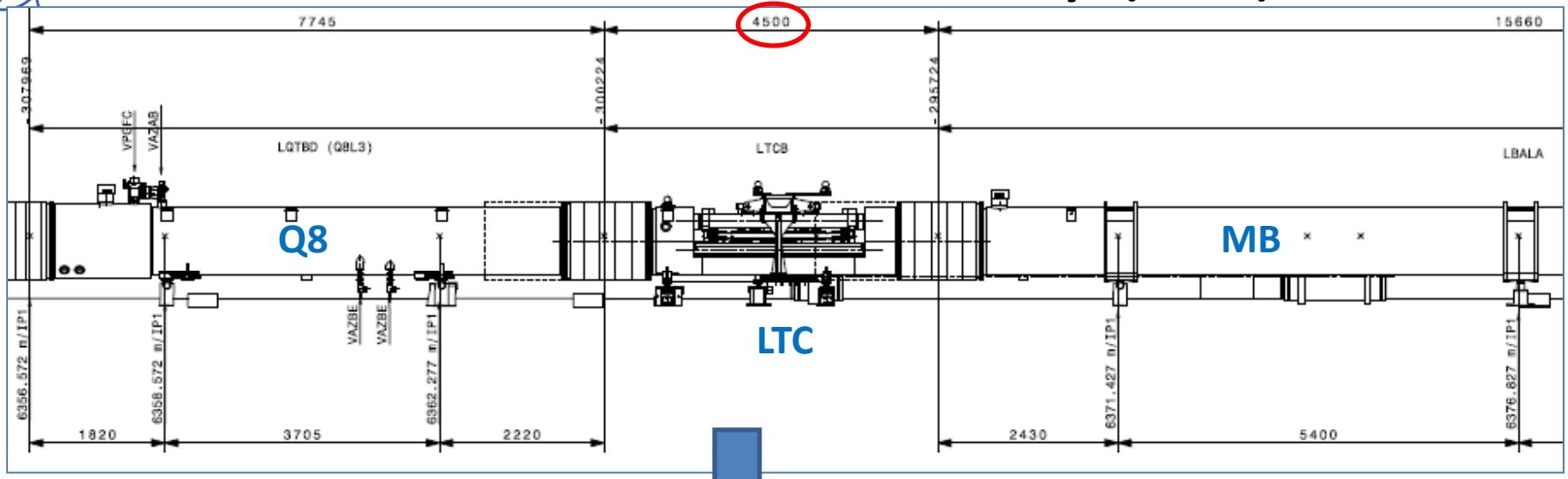


(courtesy: D.Ramos)

While extending the continuous cryostat:

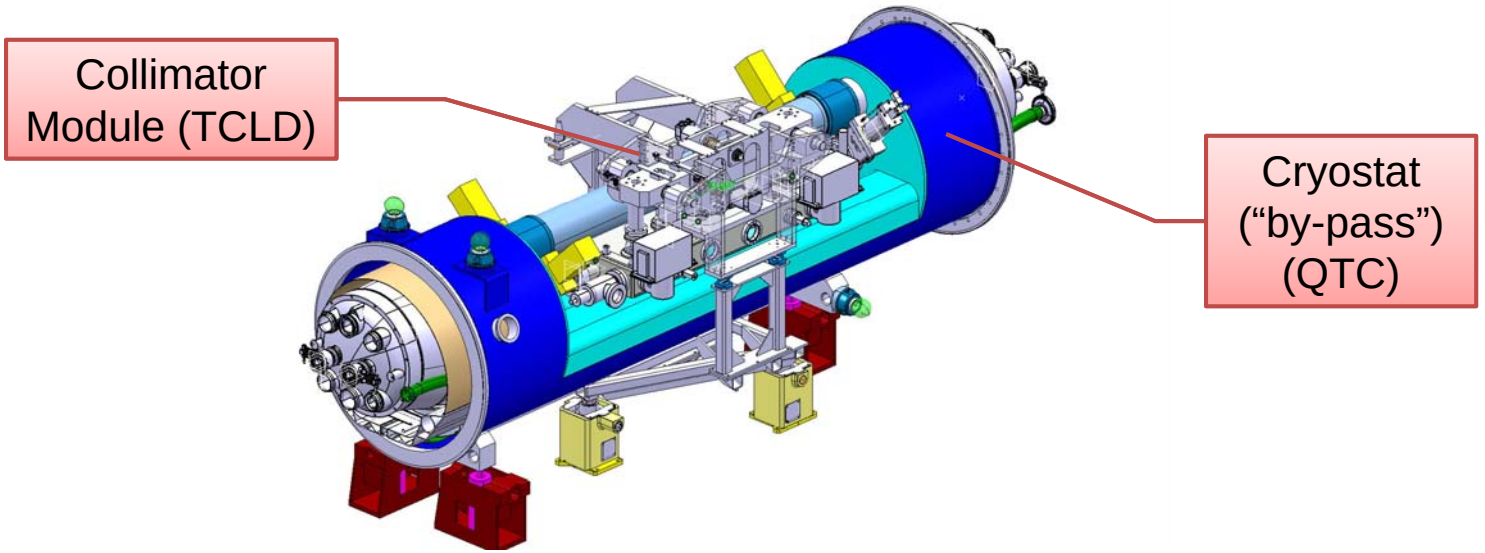
1. New optics (J.M. Jowett, ABP-LCU meeting, 19/10/2010)
2. Longer and new circuits (electrical, cryogenic, vacuum)
3. Displace interfering equipment (e.g. BTVM)
4. Re-match interfaces with systems (electrical, cryogenic, vacuum...)

DS Collimator Assembly (LTC)

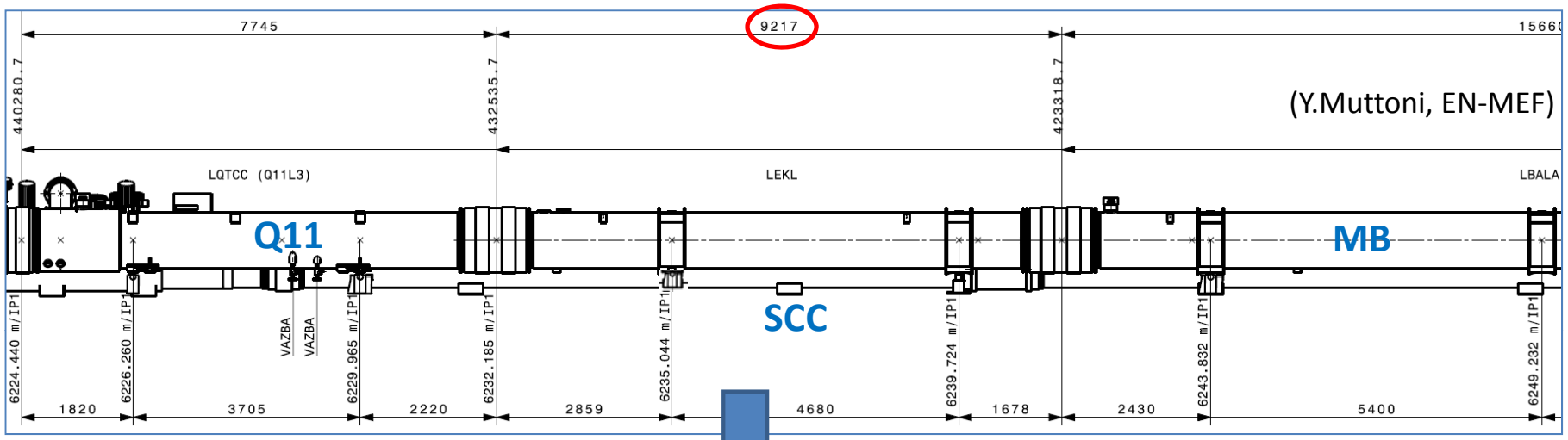


(Y.Muttoni, EN-MEF)

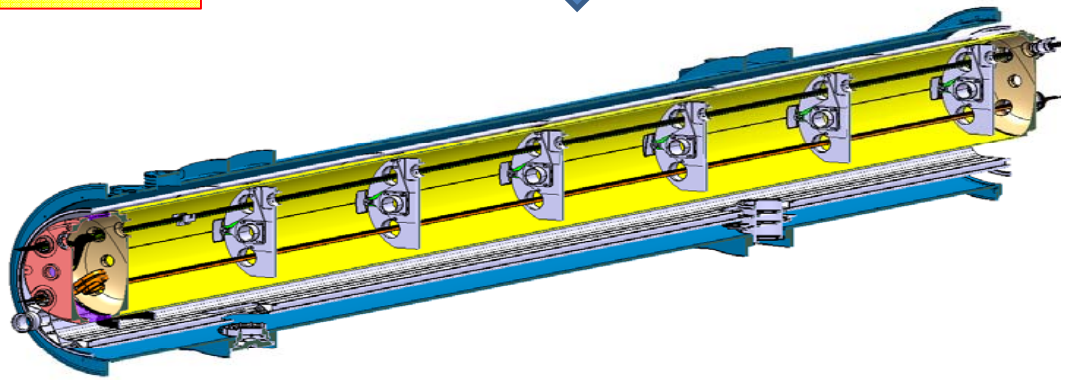
See Delio's and Alessandro's talks



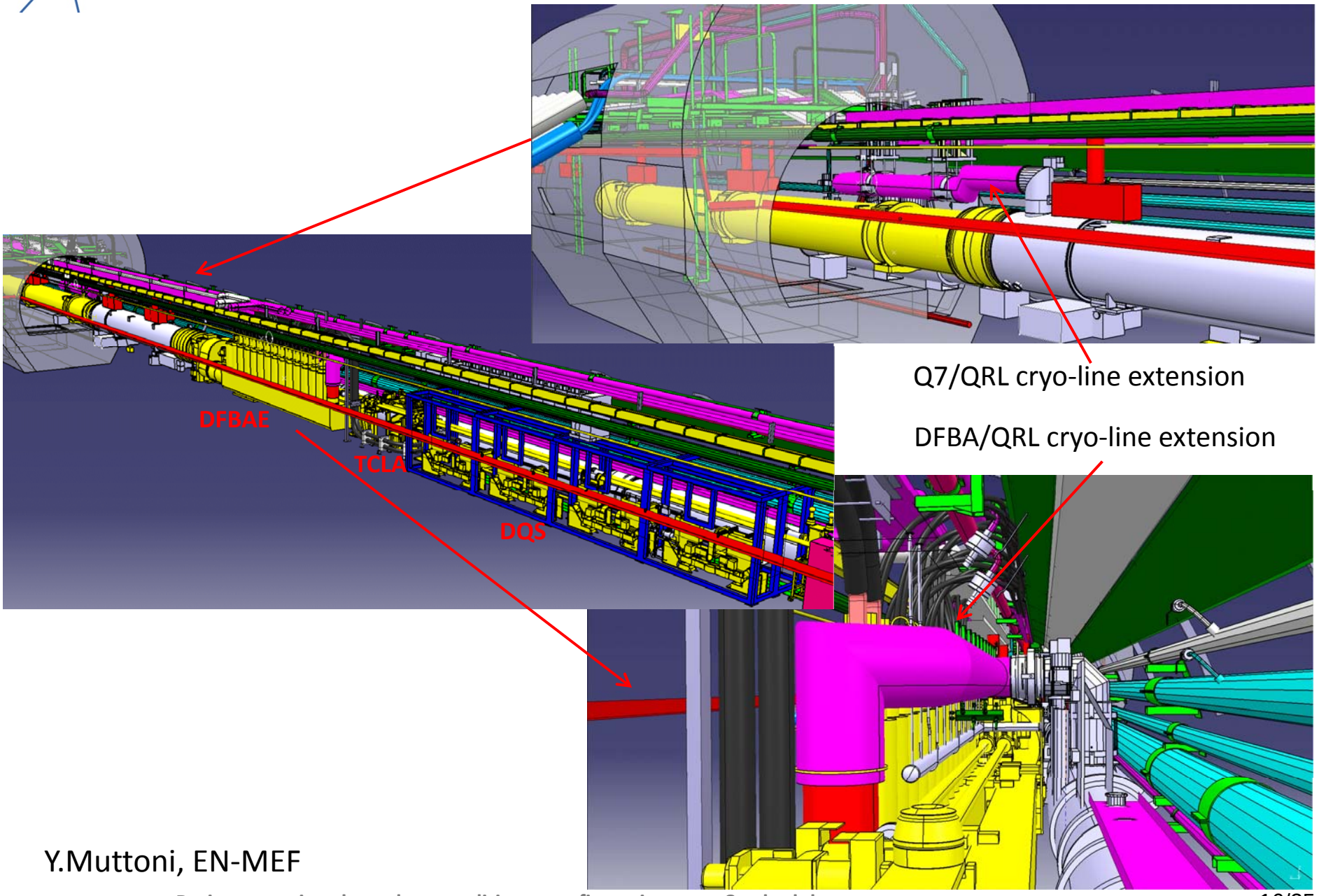
Short Connection Cryostats



See J.Ph.Tock's talk



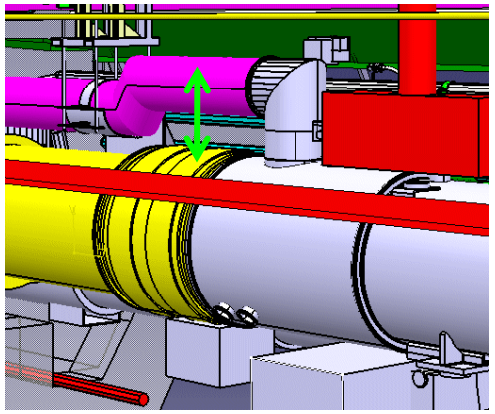
Integration studies, 3L



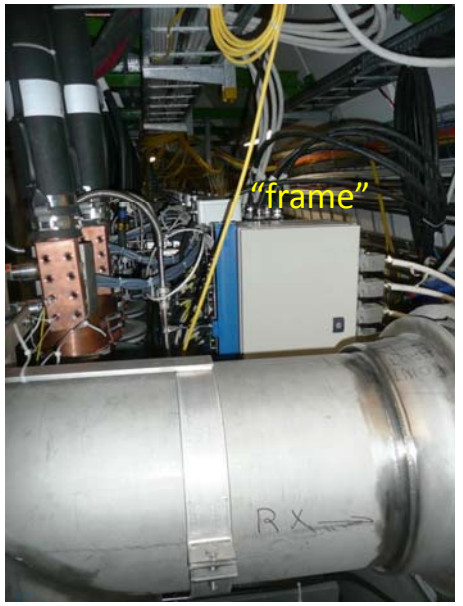
Y.Muttoni, EN-MEF

Integration studies P3

- Tackled issues 3L:
  - A) Interference between cryo-extension and Q7 interconnect (soldering machine)
  - B) Integration of “frame” with proximity equipment (interference with cryo-extension)
  - C) Drill a new cable duct for cables re-routing?
  - QPS racks position wrt radiation. Fluka simulation maps in progress (EN-STI)
  - New longitudinal position found for BTVM



A)



B)

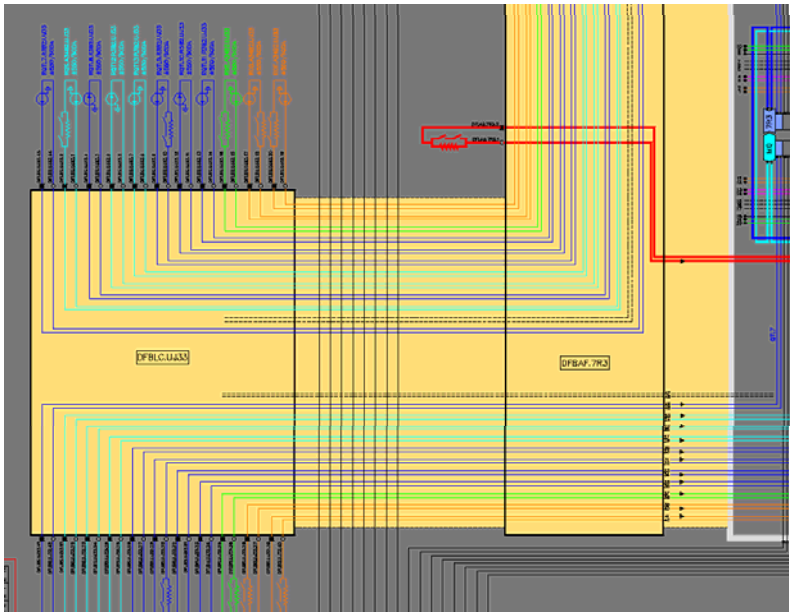
C)

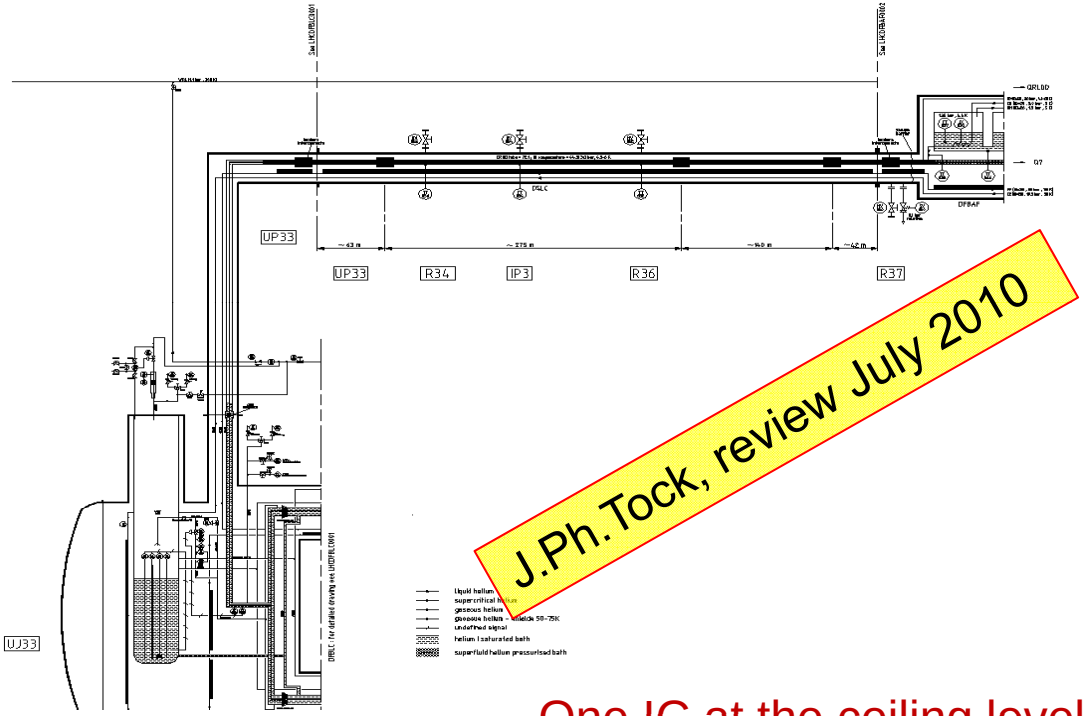
- Studies 3R OK (more straight-forward), but DSLC to be shortened (next slides)…

- Main components: Relayout and Integration
  - DSLC shortening (1/3)

CRG responsibility: Infos from R Van Weelderen, A Perin, O Pirotte

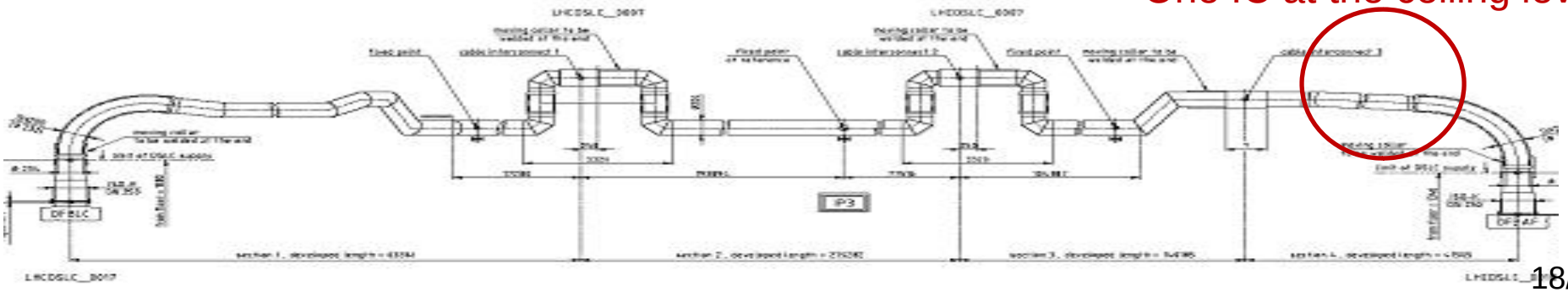
+ Only in R3 (34)





J.Ph.Tock, review July 2010

One IC at the ceiling level



- Main components: Relayout and Integration
  - DSLC shortening (2/3)

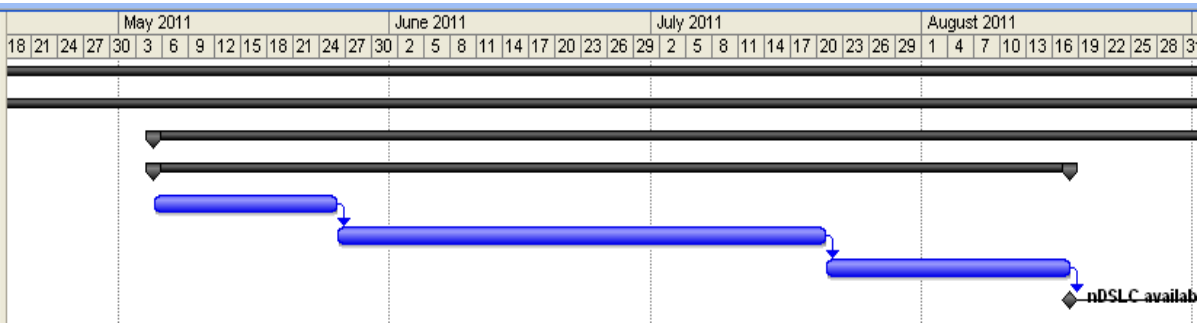
CRG responsibility: Infos from R Van Weelderen, A Perin, O Pirotte

+ One IC to cut

+ DSLC to be shortened in the last section

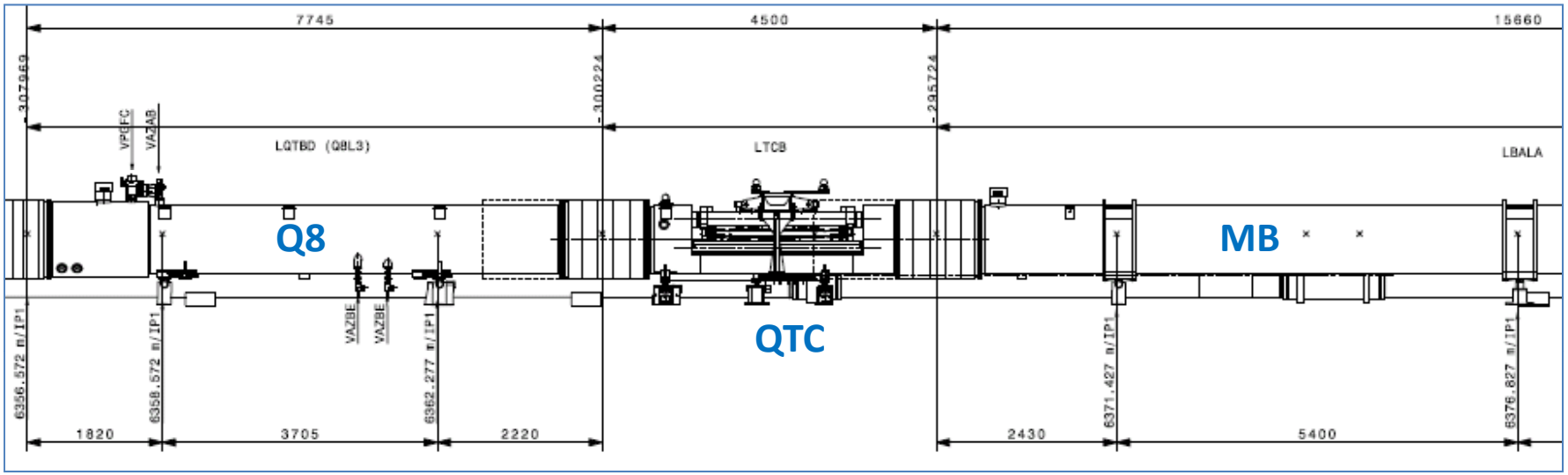
+ Procedure for IC available but not the experienced staff any more (CERN and contractor)

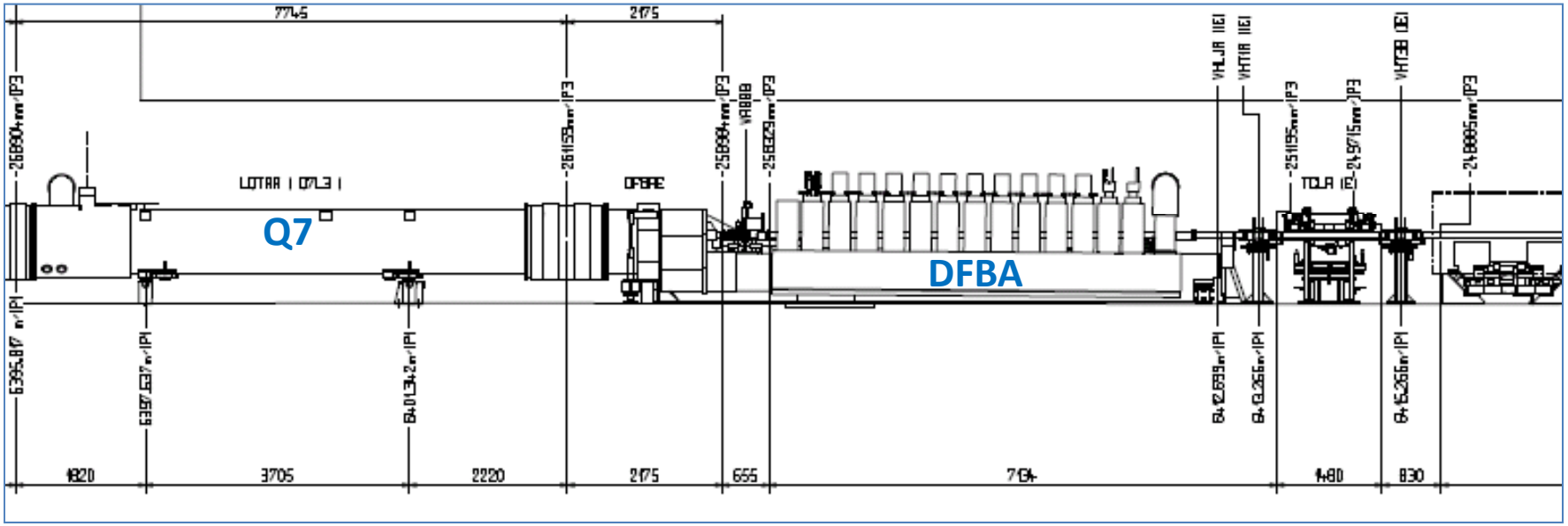
	Task Name	Duration	Start	Finish	Pr
1	DS Collimators (TCRYO) P3	'60 days?	Thu 4/1/10	Thu 2/28/13	
26	Shortened CC for P3	607 days	Thu 7/1/10	Fri 10/26/12	
38	Jumpers extensions	160 days	Thu 5/5/11	Wed 12/14/11	
43	DSLC	75 days	Thu 5/5/11	Wed 8/17/11	
44	Design	3 wks	Thu 5/5/11	Wed 5/25/11	
45	Procurement	2 mons	Thu 5/26/11	Wed 7/20/11	44
46	Fabrication	1 mon	Thu 7/21/11	Wed 8/17/11	45
47	nDSLC available for IC	0 days	Wed 8/17/11	Wed 8/17/11	46



Layout drawings (views of 3L)

Layout drawings **almost ready for released**





Summary of main H/W activity

- Status of DS Collimators (See Delio's+Alessandro's talks)
  - Design of Cryostat and Collimator Module well advanced (manufacturing drawings being released)
  - Long-lead components and material procurement under way
  - Manufacturing and assembly of first unit to start in coming weeks
- Status of Short Connection Cryostats (See Jean-Philippe's talk)
  - Short Connection Cryostat engineering almost completed
  - Schedule and budget are under control
  - No show stopper identified
- Modifications of Q7 and DFBA jumpers and new cryo-links not critical (see J.Ph.Tocks's and Antonio's talks)

- Still in progress:
  - Study of cold testing and bench connections (SM18) for power testing of Collimator by-pass and Short Connection Cryostats (next slide)

Testing of QTC and SCC

- Construction testing:
  - Pressure test (construction integrity)
  - Dimensional checks (mechanical interfaces)
  - Leak tests
  - Electrical tests (@RT): continuity, HV
  - ...
- Qualification testing @ cold (SM18):
  - Envisaged tests:
    - Leak-tightness @ cold (insulation+beam vacua)
    - HV tests (before CD, @cryo)
    - Continuity and splices measurements
    - RRR measurements
    - Powering tests of all circuits (connected in series) @ ultimate current
    - Magnetic measurements (SCC only)
    - Thermal cycle(s)
    - Cryostat T measurments on QTC prototype
    - ...
  - Diagnostics instrumentation (T gauges, Vtaps...) needed

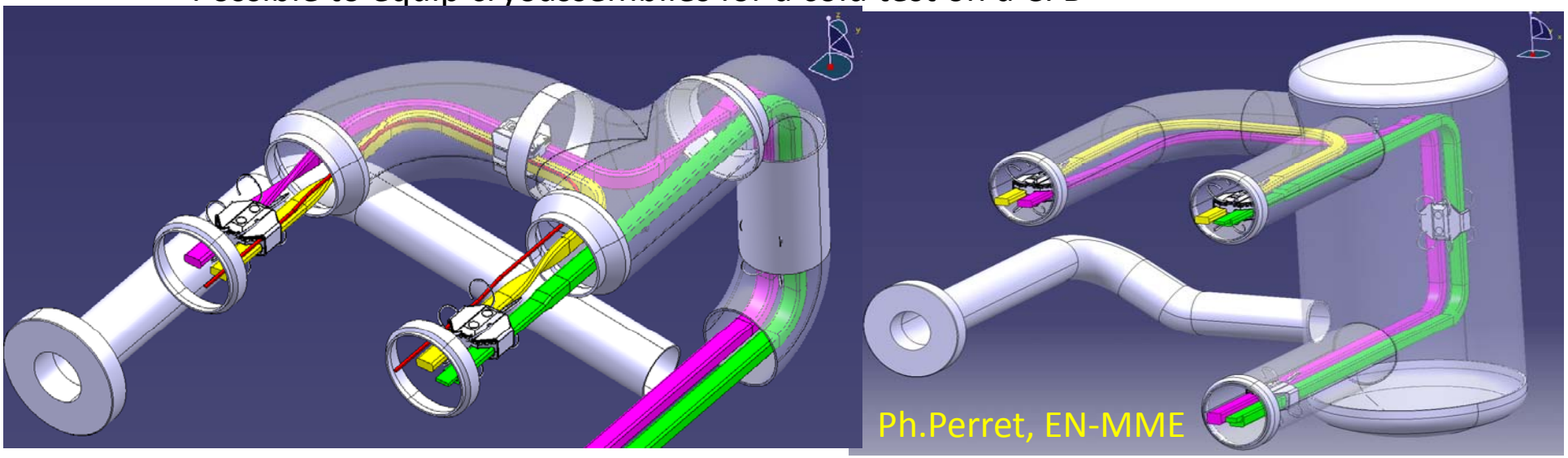
Test-bench connections (feasibility study)

Goals:

- Check feasibility both from cryo assembly side and CFB side
- Conceptual design of SCC equipment (also QTC?)
- Estimate time to complete detailed design of SCC equipment

Results:

- Possible to equip cryoassemblies for a cold test on a CFB



Powering all busbars (Main and spool pieces)

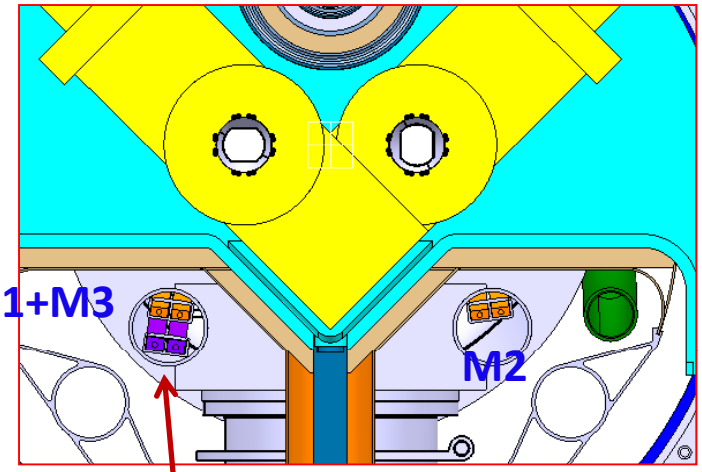
Allow for magnetic measurements (Anticryostat): Only for SCC: new extension required

- Benches needs to be modified but “reasonable” : To be followed-up by MSC-TF (M Bajko)
- Evaluation of time required to complete the design of the components required to equip the SCC for cold test (likely valid also for QTC)

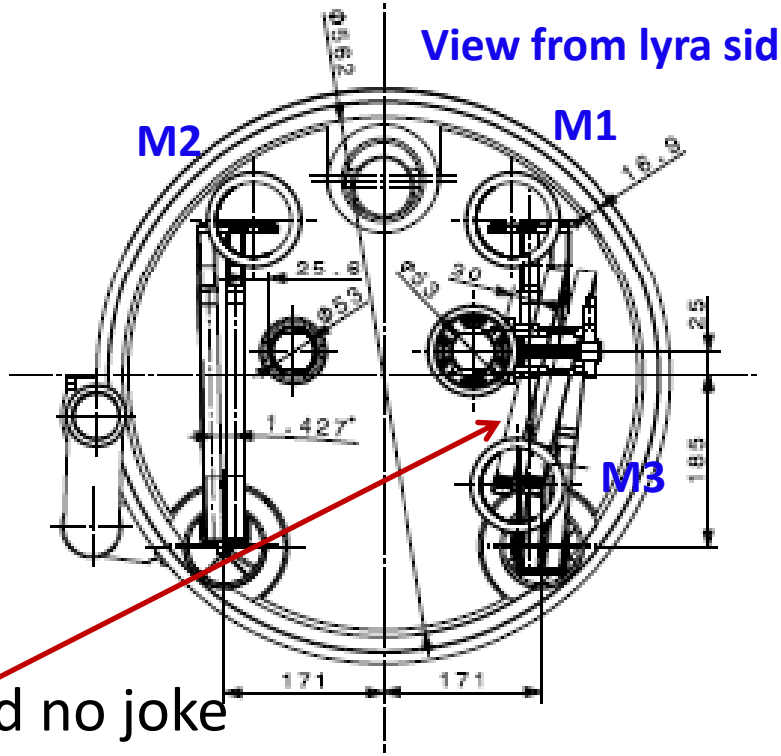
(J.Ph.Tock)

New BB arrangement: EM effects?

View from connection side



View from lyra side



- M1, M3 routed superposed, and no joke
- New routing in lyra

Issues:

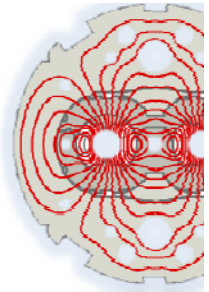
- Stray field to beam?
- EM cross-talk between M1 and M3

See presentation A.Siemko (Roxie calculations: S.Russenschuck)

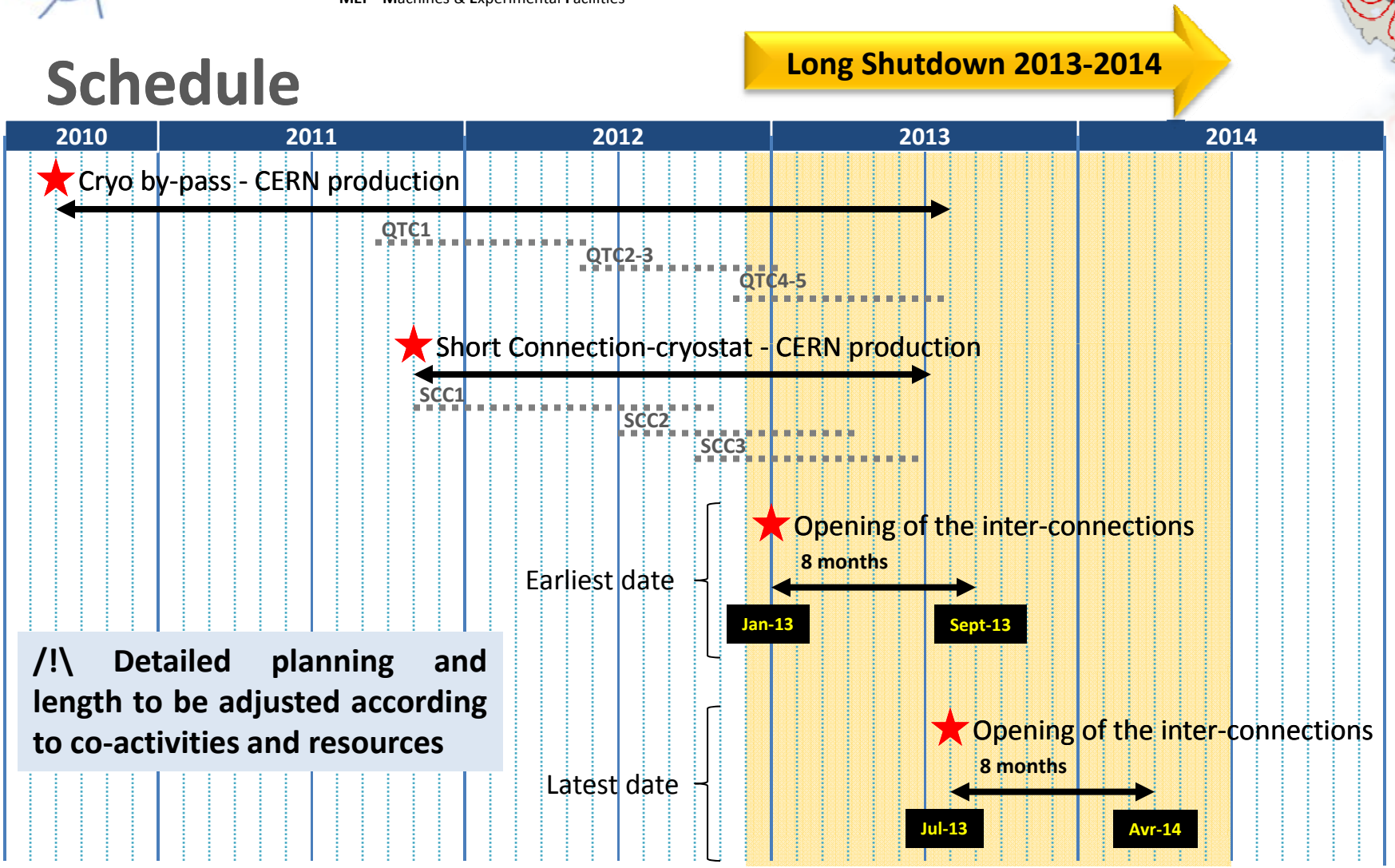
Tunnel work for DS collimators

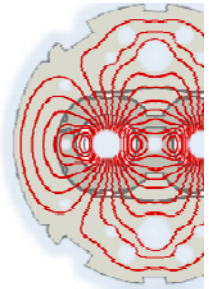
- Working assumptions:
  - All magnets up to surface (dipoles from PMI2, quads from P4)
  - Works on one (extended) shift, with night transport
  - 3L and 3R mostly parallel work
  - DFBAs moved and stored in P4 (underground)
  - 4 teams for cabling (DS, LSS&DFBA, connections, water-cooled cables)
- Limitations:
  - Planning not merged with other activities/projects
  - No resource sharing with other activities/projects (especially interconnects!)
  - No transport sharing with other activities/projects
  - …no contingency!

→ Minimum of 8 months of tunnel activity

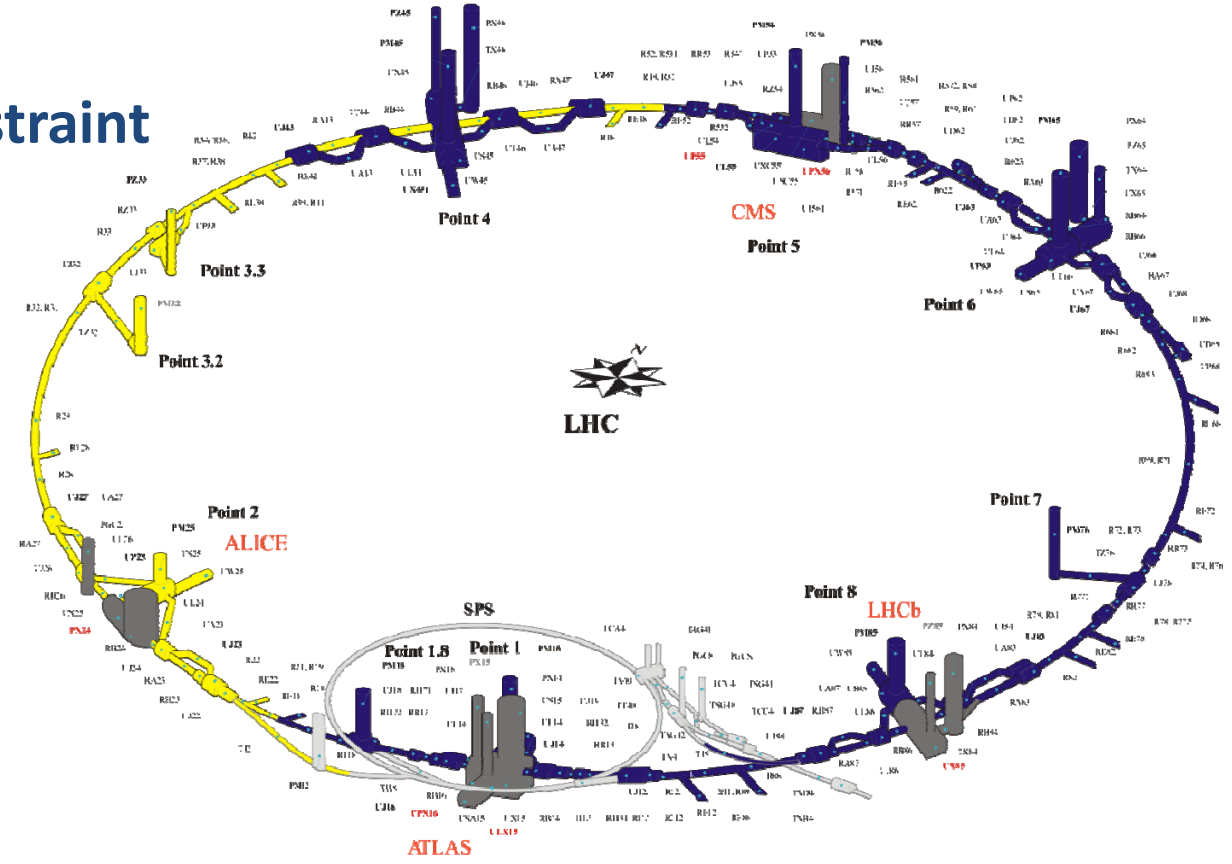


Schedule


Long Shutdown 2013-2014
2010
2011
2012
2013
2014
Cryo by-pass - CERN production
QTC1
QTC2-3
QTC4-5
Short Connection-cryostat - CERN production
SCC1
SCC2
SCC3
Opening of the inter-connections
8 months
Earliest date
Jan-13
Sept-13
/!\ Detailed planning and length to be adjusted according to co-activities and resources
Opening of the inter-connections
8 months
Latest date
Jul-13
Avr-14



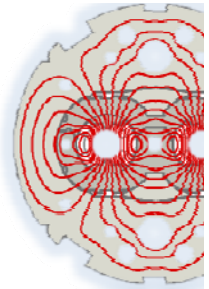
- **Main co-activity**
  - Splice consolidation
- **Main logistics constraint**
  - Transports
- **Main risk**
  - Heavy handling



Summary and Outlook

- The DS collimator project in IR3, aimed at improving collimation efficiency (factor 5-10), has started in July 2010, is now structured and progressing full steam
- The DS collimators part requires a challenging re-layout and integration study, which is almost completed and no technical show-stopper have been identified
- The design of the new DS equipment (DS collimators, and Short Connection Cryostats) is well advanced, and is close to completion
- Procurement of other long-lead components under control
- Construction of the first units (QTC and SCC) is to start (summer 2011)
- A pre-study for cold testing of the QTC and SCC was made, more work to be done but feasible
- Planned availability dates of the QTC and SCC: mid 2012-mid 2013
- First draft schedule for 2013 shut-down, yields a ~8 months minimum installation for the DS collimators
- This preliminary schedule needs consolidation and matching with those of other shut-down projects (resources allocation, co-activity, transport sharing, etc.) so its duration could be considerably longer (up to 3 months?).

Thank you
for your attention!

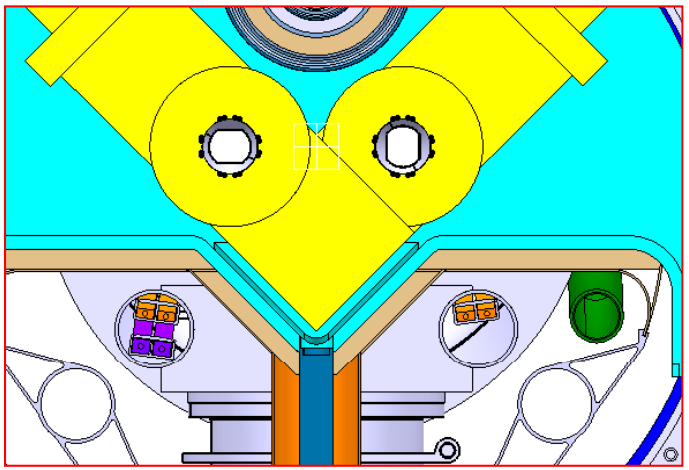


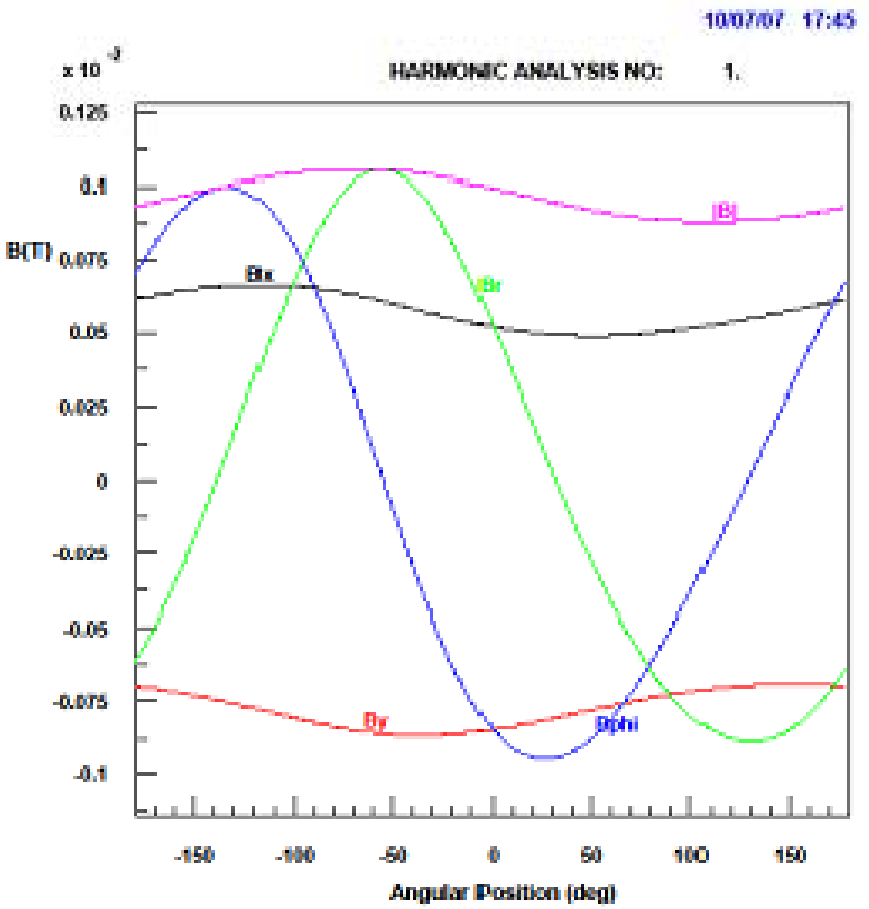
System impacted

- **Cryogenic magnets**
  - **Interconnections, busbars, connection cryostat, jacks…**
- **DFBA** (no spare)
- **DSLC**
- **Cables = re-pulling the cables**
- **Water cooled cables**
- **Cryo-link between machine and QRL**
- **Civil engineering**
- **Cooling pipes**

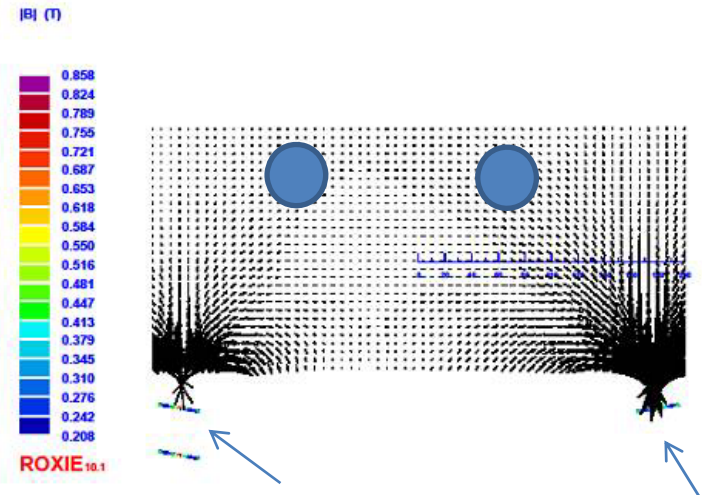
BB stray field to beam

Roxie calculations: S.Russenschuck





Negligible effect on beam



D Quad+dipole BB

F Quad BB

(LHC Collimation Working Group, July 2010)

Comparison of DOSE below LHC cryostat around the DS-Collimator