Review of the Cryogenic By-pass for the LHC DS collimators

Ph. Lebrun *on behalf of*
the Review Committee

CERN, Kjell Johnsen auditorium
26 May 2011

Mandate

- The proposed DS collimators require an important modification of the continuous cryostat: addition of a cryogenic by-pass (QTC) as well as modifications to the position of the DFBA and SSS. The aim of the review is to assess the risks to the LHC integrity associated to modifying the existing continuous cryostat. The outcome of the review will be used as input to the DS collimator review of June 2011.
- Specifically
  - Review the proposed technical design of the QTC and its integration
  - Assess the impact and potential risks with the concerned technical systems
  - Review the proposed implementation and risks: work organization, strategy for manufacturing, testing and installation
  - Review other proposed modifications to the continuous cryostat
  - Review estimated cost, resources and planning

Miscellanea

- Review appointed by EN and TE Department Heads
- Reporting line
  - EN and TE Department Heads
  - LMC and Director of A&T
- Date of the review: Thursday 26 May 2011 (full day)
- Place of the review: Kjell Johnsen auditorium, 30/7-018
- Review committee:
  - J. Bremer/TE
  - A. Dudarev/PH
  - C. Hauviller/EN
  - Ph. Lebrun/DG (chair)
  - D. Perini/PH

08:30 - 12:30 **Morning: open session**

All presentation time slots include 5 minutes for questions

08:30 **Introduction** *10'*
Speaker: Philippe Lebrun (CERN)

08:40 **Project overview, boundary conditions, configuration, cost & schedule** *30'*
Speaker: Vittorio Parma (CERN)

09:10 **Mechanical design of cryogenic by-pass** *20'*
Speaker: Delio Duarte Ramos (CERN)

09:30 **Mechanical design of collimators** *20'*
Speaker: Alessandro Bertarelli (CERN)

09:50 **New short connection cryostat & modifications to the SSS** *20'*
Speaker: Jean-Philippe Tock (CERN)
Material: **Slides**

10:10 **Modifications to the DFBs & transfer line extensions** *20'*
Speaker: Antonio Perin (CERN)

10:30 **Coffee break** *20'* (30/7-012)

10:50 **Cryogenic design, including operational considerations** *20'*
Speaker: Rob van Weelderen (CERN)

11:10 **Electrical circuit modification, including operational considerations** *20'*
Speaker: Andrzej Siemko (CERN)

11:30 **Vacuum design, including operational considerations** *20'*
Speaker: Paul Cruikshank (CERN AT-VAC)

11:50 **Reserve for discussion** *40'*

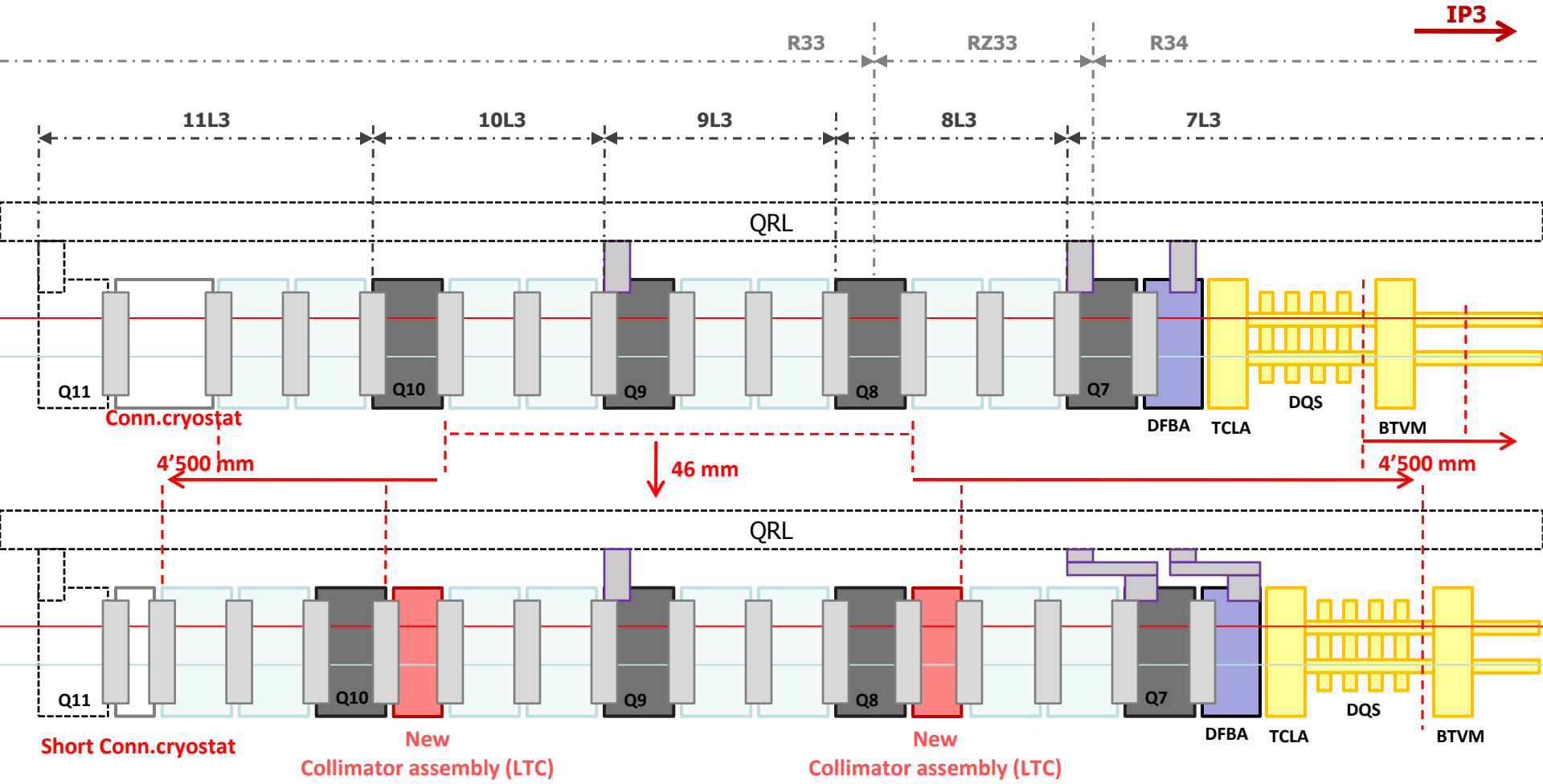
14:00 - 16:00 **Afternoon: closed session**

- Discussions
- Additional information to morning presentations (on request)
- Draft recommendations

Location: 30-6-019

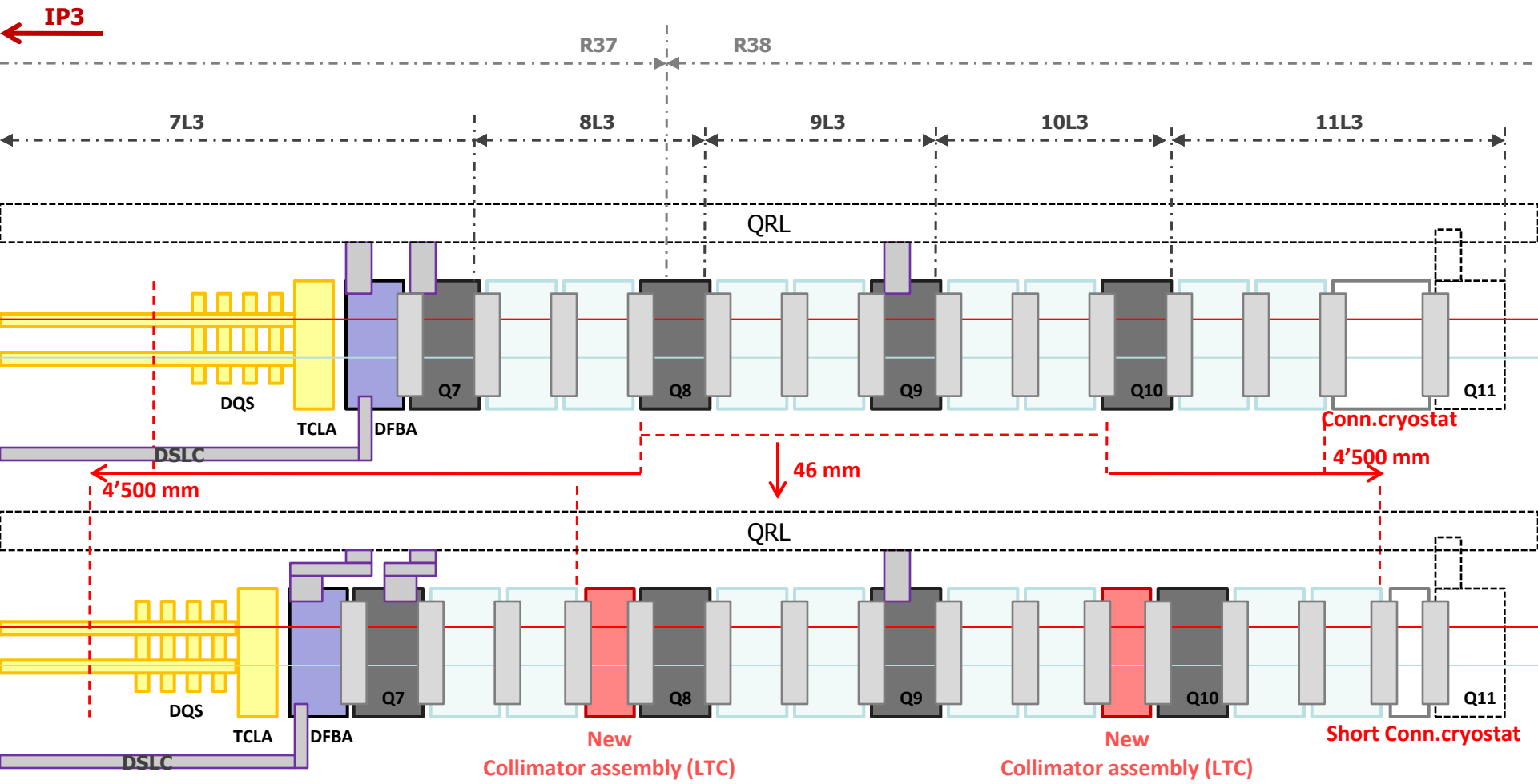
16:00 - 16:30 **Afternoon: presentation of first conclusions (Kjell Johnsen Auditorium)**

DS collimators:
Left side of point 3



V. Parma

DS collimators:
Right side of point 3



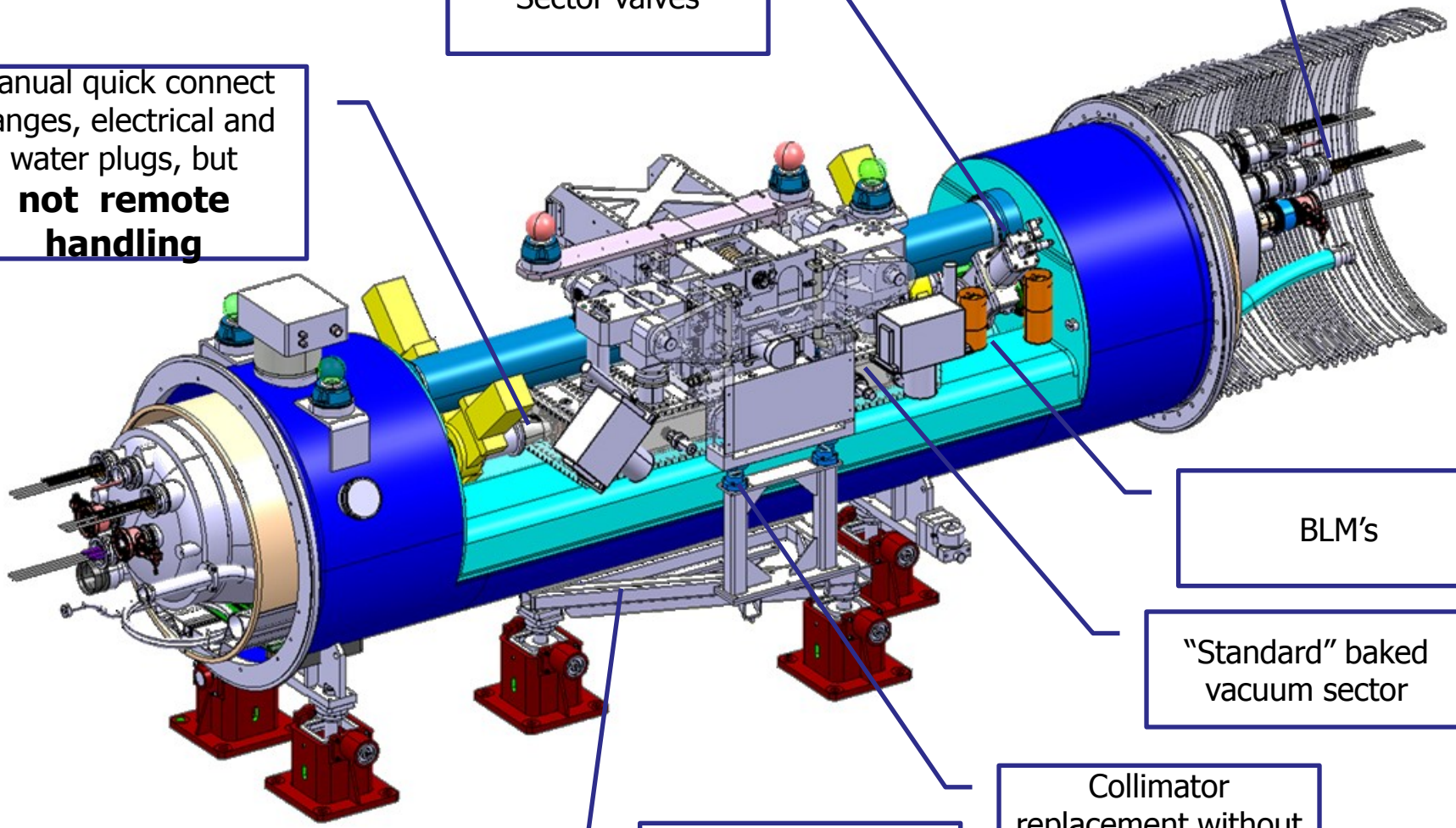
V. Parma

Main hardware 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

OTC layout

4.0 m + 0.5 m + 0.5 m = **4.5 m** installation length



Standard interconnects

Sector valves

Manual quick connect flanges, electrical and water plugs, but **not remote handling**

BLM's

"Standard" baked vacuum sector

Collimator replacement without re-alignment

Collimator with independent support/alignment

D. Duarte Ramos

Cost Estimate (P+M)

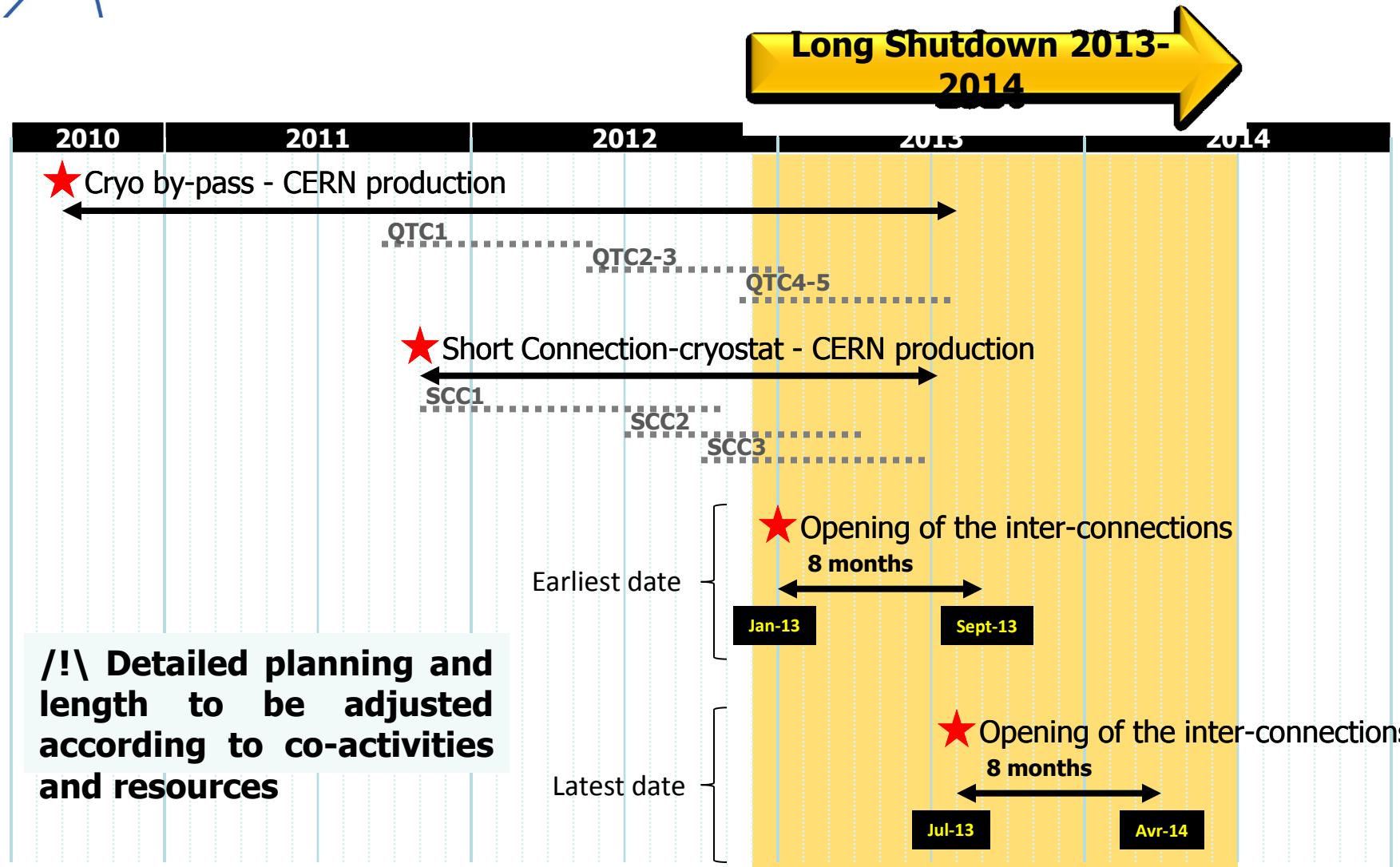
Department/Group	WP name	WP responsible		2011	2012	2013	2014	Totals M Cost [kCHF]	Totals Staff [FTE.y]
TE/MSC	DS collimators Technical Coordination	V.Parma	Total M [kCHF]	0.00	0.00	0.00	0.00	0.00	
			Total P [FTE.y] - staff/fellows	0.5	0.5	0.7	0.5		2.2
EN/MEF	Configuration management and QA	S.Chemli	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

To date, M expenditure

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

V. Parma

General schedule



J. Coupard

General findings [1/3]

- The review committee
  - wishes to acknowledge the good preparation of the review, the quality of the presentations by the speakers and the open spirit of discussions
  - however remarks that presentations were made available very late on the INDICO site, thus precluding thorough preparation by the reviewers
  - is impressed by the amount of design work performed and engineering resources engaged for a project which is not yet approved
- The cryogenic by-pass for the DS collimators
  - is an important and complex project, involving many systems and interfaces
  - information presented however does not allow to assess all possible risks; this would require the results of some ongoing and yet-to-be-done studies
- In response to the specific questions of the mandate, the review committee has found that
  - the technical design of the project is essentially done
  - its integration is partially studied but not yet completed
  - its impact and potential risks within the concerned technical systems are generally correctly addressed
  - work organization, manufacturing and testing strategies are broadly defined
  - logistics and installation have to be considered in relation with many other co-activities competing for resources during the shutdown

General findings [2/3]

- The review committee wishes to draw attention on the following elements of technical, organizational and schedule risks
  - the project does not only consist in building and installing new equipment, but also involves profound modifications, refurbishing and displacement of critical items, for which no spares exist (DFBA, DSLC)
  - integration and installation in a very crowded tunnel area will require a number of *ad hoc* solutions, e.g. numerous *in situ* welds, some of which will have to be performed with non-standard procedures: that implies specific risk, to be mitigated by thorough preparation, planning and execution follow-up (refrain from improvisation!)
  - the general planning presented shows parallelism within the project between manufacturing/testing of components and tunnel activities: this may indicate absence of contingency and conflict of resources (e.g. for specialized staff such as qualified welders)
  - as stated in the presentations, the execution schedule will eventually be determined by the level of co-activity and resources available; in view of the pressure of other shutdown activities and the complexity of the project, "latest date" installation planning should therefore not be considered as a viable option: the project should make full use of the installation planning "window"

General findings [3/3]

- Overall, the review committee estimates that
  - the cryogenic bypass (QTC), although complicated in design and heavily constrained in space occupancy, appears technically feasible; pending proper manufacturing and installation, it should permit operation of the collimator while maintaining all functionalities of the LHC technical systems concerned – cryogenics, powering, vacuum - in the DS region
  - the new connection cryostats and transfer line extensions essentially make use of technical solutions already implemented elsewhere in the machine, and thus should not bring particular issues
  - *in situ* modifications to the electrical feed boxes (DFBA) and superconducting links (DSLC) are more delicate, but also appear feasible with proper preparation and care
  - a major element of risk for the project stems not so much from the *exotica* of new or modified components, but rather from the removal and reinstallation of a significant number of standard LHC components and of their ancillaries in a very crowded and intricate area of the machine

Specific remarks and questions [1/2]

- Overview, configuration, cost & schedule
  - the effort made to re-use standard solutions and components for the QTC is appreciated, but should not be pushed to the point where it unduly over-constrains the design
  - in view of the tight general schedule, is a full prototype of the QTC really necessary?
  - a proper risk analysis of the proposed modifications to civil engineering in the area around Point 3 should be performed
- Mechanical design of the QTC
  - In view of their transverse space occupancy close to the beams, are RF-shielded sector valves absolutely necessary?
  - Assembly of He vessel around bus bars is a change from usual practice of separating sheet-metal work from electrical buswork assembly: risk of damage during welding requires mitigation measures and enforcement of procedures
  - Assembly of vacuum vessel around cold mass: risks of deformation (addressed), risk of damage, issue of cleanliness during welding carbon steel: mitigation measures and enforcement of procedures required
- New SCC and modifications to SSS
  - options taken already applied successfully at other locations in the machine
  - new SCC to be built provides opportunity to improve weak points of existing ones

Specific remarks and questions [2/2]

- DFBA & DSLC modifications and cryogenic line extensions
  - jumper extensions: similar to already done (P2)
  - DFBA critical element (no spare): concern about interventions in very crowded area, also affecting ancillaries and cabling
  - modification to DSLC (cut, shorten, displace and reconnect), to be performed in awkward location: concern, needs thorough study and preparation to mitigate risk
- Cryogenic design
  - the need for a continuous He IIp annular duct around the He IIs pipe is not clearly established: potential for simplification?
  - a criterion for minimum He II cross section per bus bar channel to ensure their safe cooling in all conditions, including accidental (e.g. degraded insulation vacuum) should be formulated and its fulfillment checked
- Electrical circuits
  - cross-talk due to proximity of bus bars could create a protection issue (spurious triggering of QPS): mitigation solution presented, likely to work
  - 3-D analysis of field errors in region of QTC lyre must be performed
  - quench hot-spot calculations to be done for specific configuration of bus bars in QTC, with assessment of consequences of potential temperature difference between M1 and M3