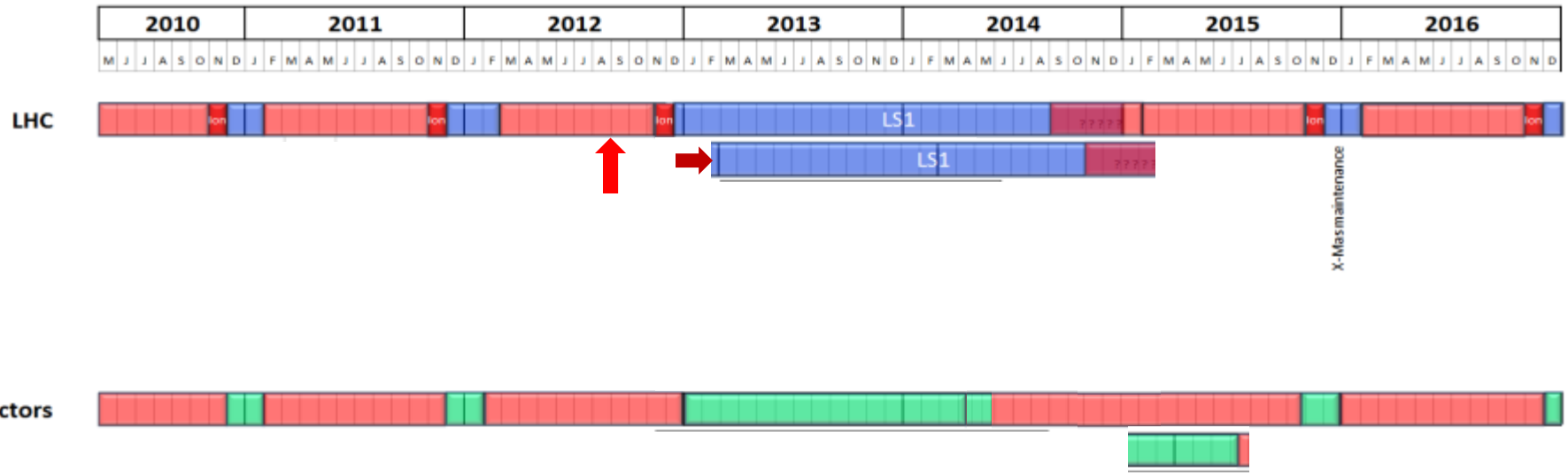
Long Shutdown 1 (LS 1) Plan

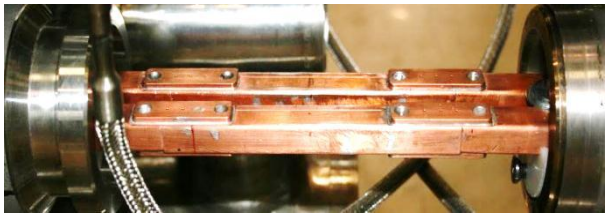
Frédérick BORDRY

WHAT IS LS1?

- Not a project, but a time-frame (~~Nov-2012 to August-2014~~) **(Feb-2013 to Nov-2014)**
- Numerous projects and activities:
  - SMACC (Superconducting Magnets And Circuits Consolidation)
  - R2E (Radiation to Electronics)
  - Massive shutdown maintenance after more than 3 years of operation
  - Several major consolidations
  - A lot of projects (Linac 4, HIE-Isolde, Elena, LIU, HL-LHC, 107, ….)
- Compared to previous shutdowns, an exceptional number of …
  - Simultaneous activities (co-activities) – **Planning and safety**
  - Non-CERN workers (FSU, collaborations, contracts,…)- **Logistics: Registration, training, transport, parking, access, dosimeter, EPI, catering, accommodation,…)**



Why LS1? - Main goals



Main priorities

- Repair defectuous interconnects (powering at 7 TeV)
- Consolidate ALL interconnects with new design
  - 10-15 % of interconnections to be opened and to be re-welded
  - 100% (10'170) to be consolidated
- Finish off pressure release valves (DN200; 4 sectors: 2-3, 4-5, 7-8, 8-1)
- Bring all necessary equipment up to the level needed for 7TeV/beam
- Repair He leaks (sectors 3-4 and 4-5)
- R2E (mainly Pt1, Pt5 and Pt 7)

- Maintenance of all the systems after 3 years of operation
- Consolidations

Priorities set for LHC machine

- P0: Safety
- P1: Beam to 7TeV, nominal performance
- P2: Reliable operation improvement
- P3: CERN approved projects
- P4: no CERN approved projects

Chamonix: Session 5 and 6 *(13 talks)*

January 2012

Session 5

• LS1 general planning and strategy for LHC, LHC injector	Katy Foraz
• Powering tests before LHC warm-up: What is new from Chamonix 2011?	Mirko Pojer
• LHC consolidation of the superconducting circuits	Jean-Philippe Tock
• R2E strategy and activities during LS1	Anne-Laure Perrot
• Vacuum upgrade	Jose Miguel Jimenez
• Cryogenics system: strategy to achieve nominal performance and reliable operation	Laurent Tavian

Session 6

• LHC experiments upgrade and maintenance	Marzio Nessi
• QPS upgrade and machine protection during LS1	Reiner Denz
• EN-EL upgrade and consolidation	Francois Duval
• EN-CV upgrade and consolidation	Mauro Nonis
• Access strategy in the accelerator complex and experimental areas	Rui Nunes
• RF upgrade program in LHC injectors and LHC machine	Erk Jensen
• What is the maximum reasonable energy?	Ezio Todesco

IEFC workshop: Sessions 5 and 6 *(12 talks)*

March 2012

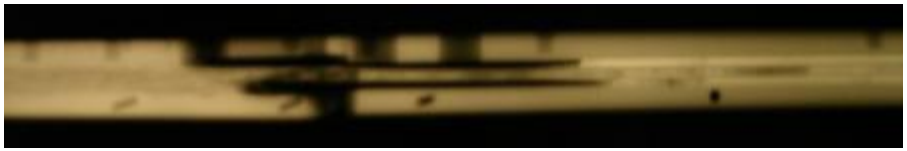
Session 5

• A global view of the LS1 timeline in the injector chain	D. Mcfarlane
• What is foreseen to be operational during LS1	V. Chohan
• Access system upgrade in the PS complex	E. Sanchez- Corral Mena
• RF systems	E. Jensen
• Magnet activities	J. Bauche
• Beam transfer systems	L. Ducimetière

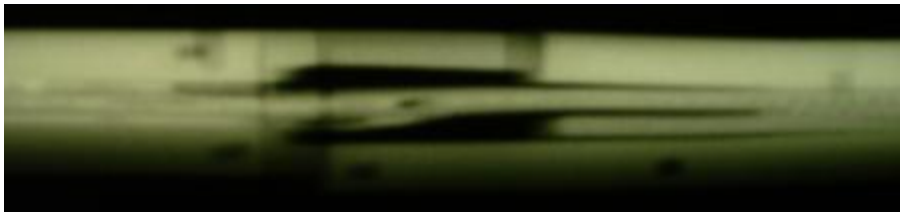
Session 6

• Vacuum systems	J.A. Ferreira Somoza
• Survey	D. Missiaen
• Power converters: SPS transformers and any other major works	G. Le Godec
• Cooling and ventilation activities	M. Battistin
• Electrical distribution activities	F. Duval
• Cabling activities	D. Ricci

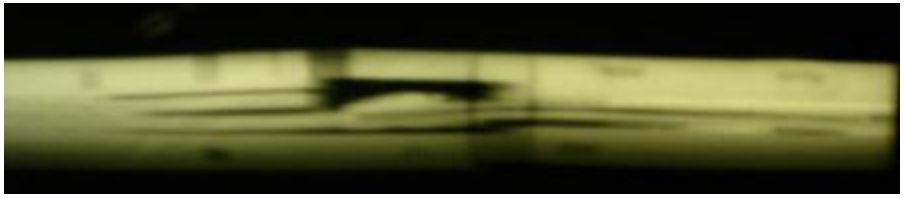
Sample pictures



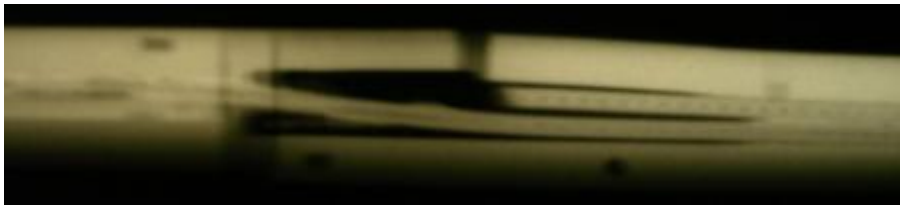
Sample 1 (61 μΩ)



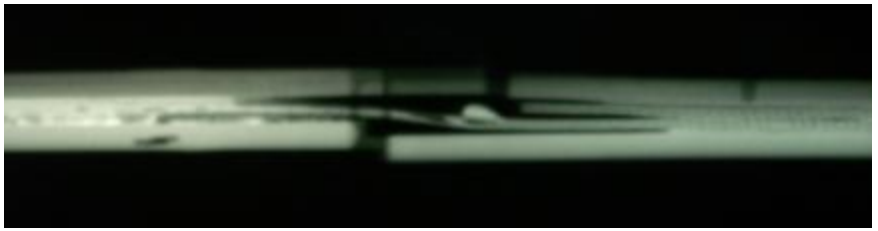
Sample 2A left (32 μΩ)



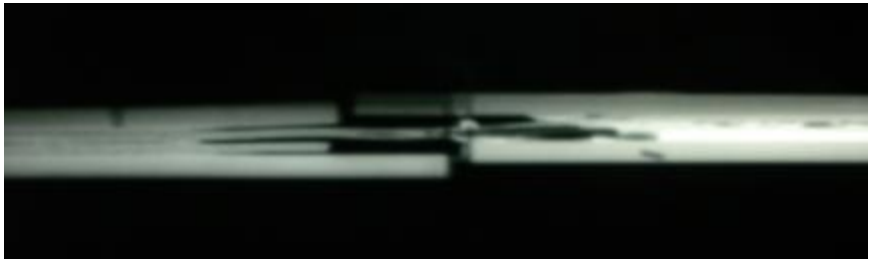
Sample 2A right (43 μΩ)



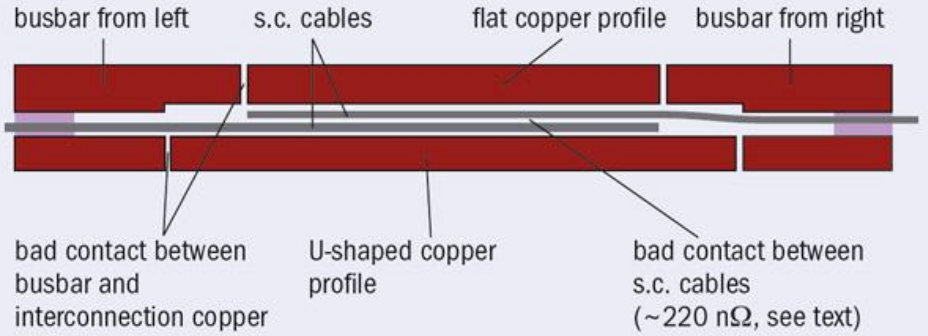
Sample 2B (42 μΩ)



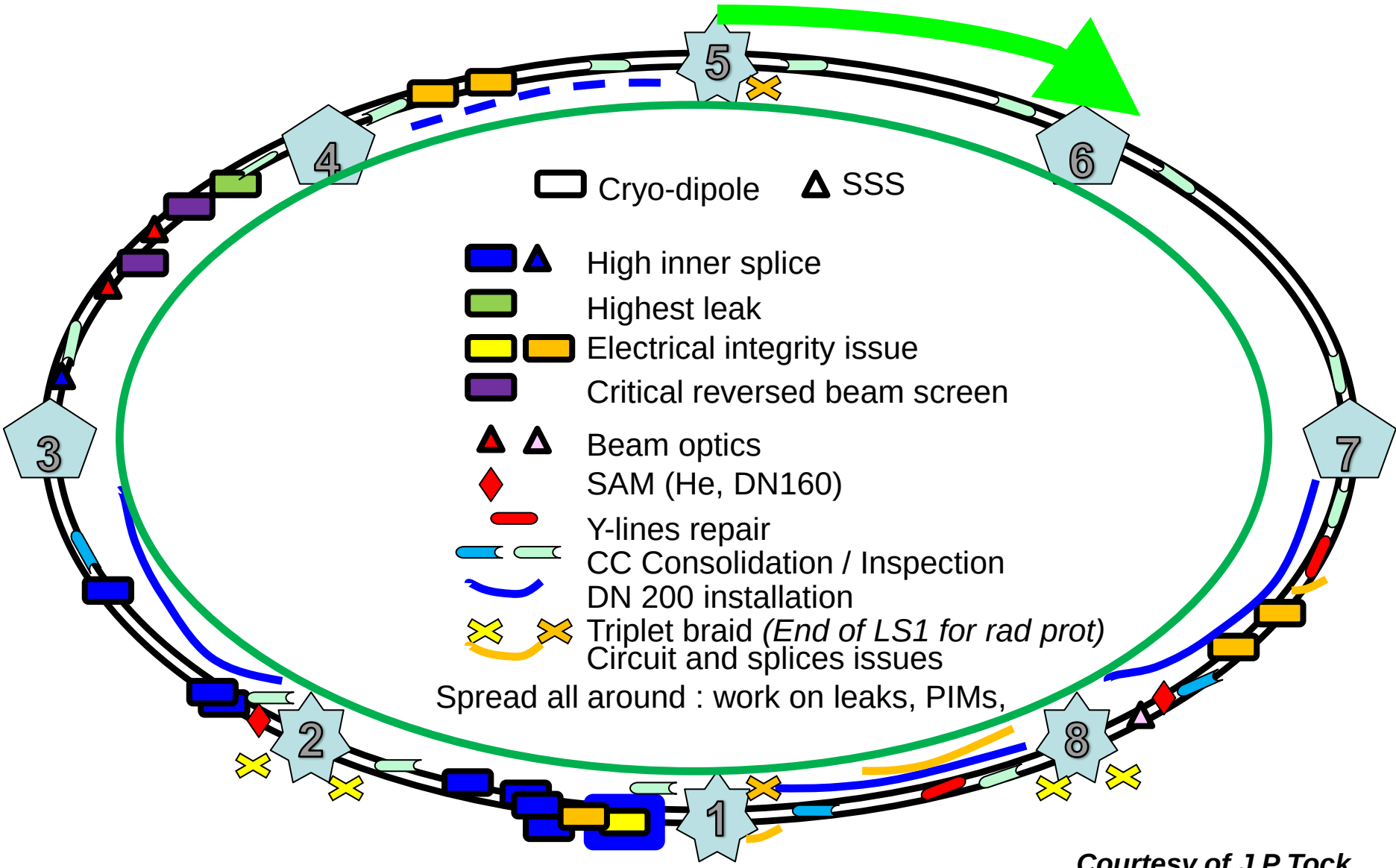
Sample 3A left (26 μΩ)



Sample 3A right (43 μΩ)



SMACC planning :Start at P5 / clockwise

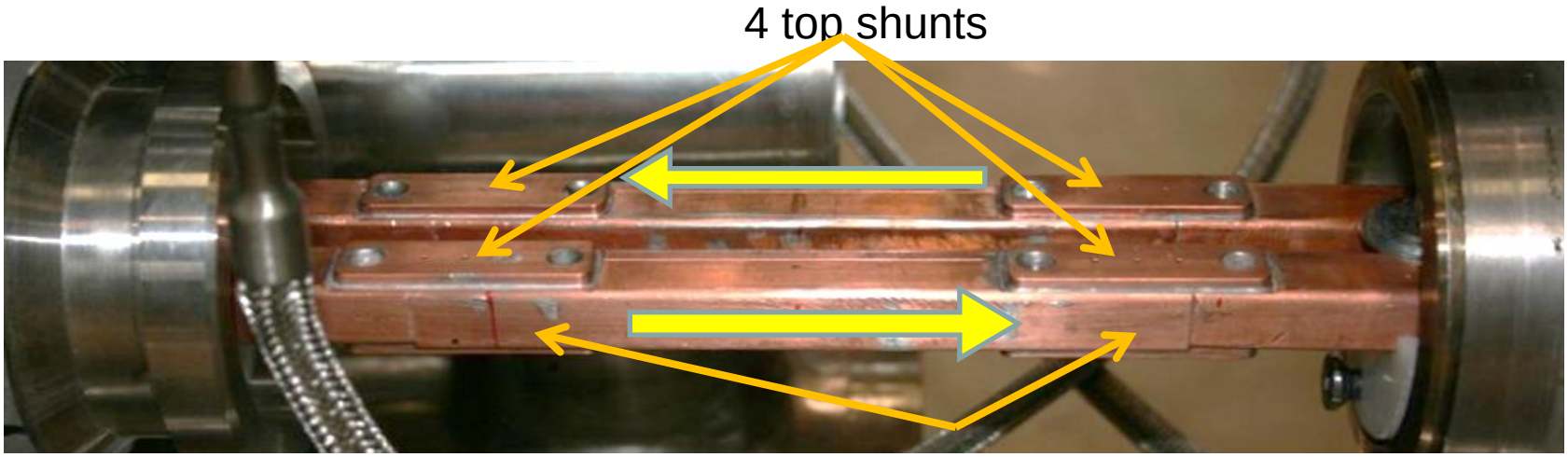


Courtesy of J.P Tock

Goal : Special interventions completed before the train arrives

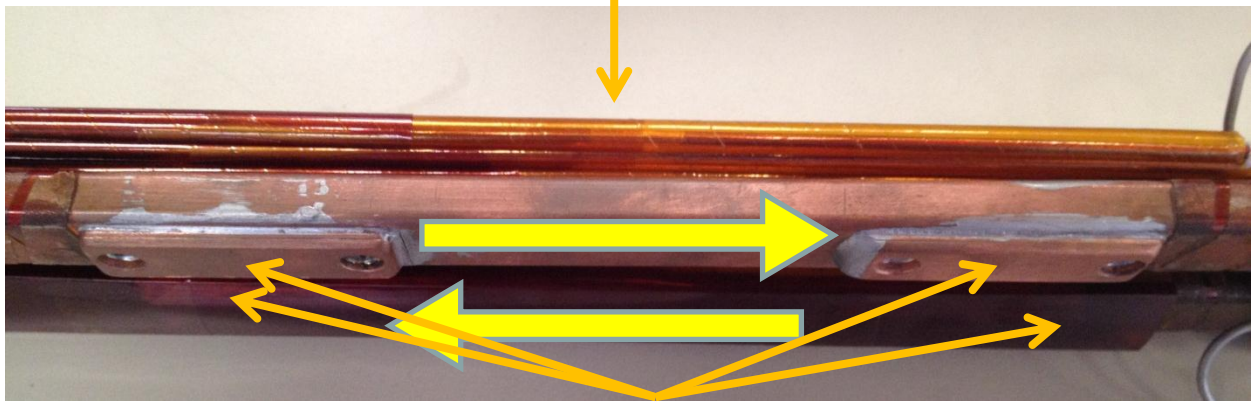
SMACC: 13kA splices consolidation

Dipole



Design endorsed [2nd Splices Review (Nov 2011)]

Quadrupole



SMACC: 13kA splices consolidation

3rd LHC Splices review: production readiness review

12th to 14th of November 2012

Monday: Splices consolidation: Production and quality assurance

Tuesday: Linked activities, organization

Wednesday morning: CSCM

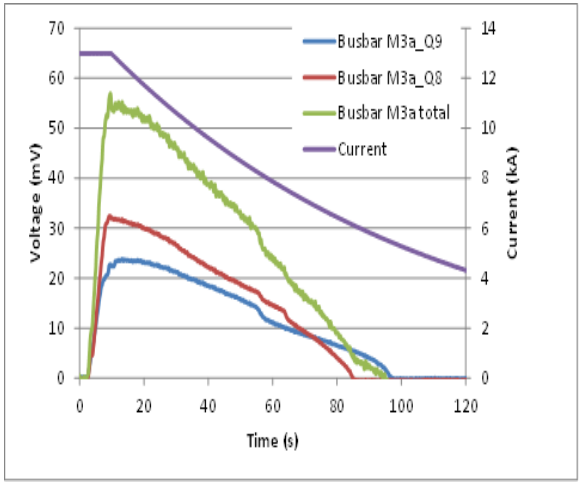
Wednesday afternoon: Conclusions

SM18 test:

- the final validation of all insulation and splice related hardware and tooling for the 13kA splice consolidation;
- the final validation of all official production and QA procedures;
- the qualification test of the new interconnection thermal shield design.

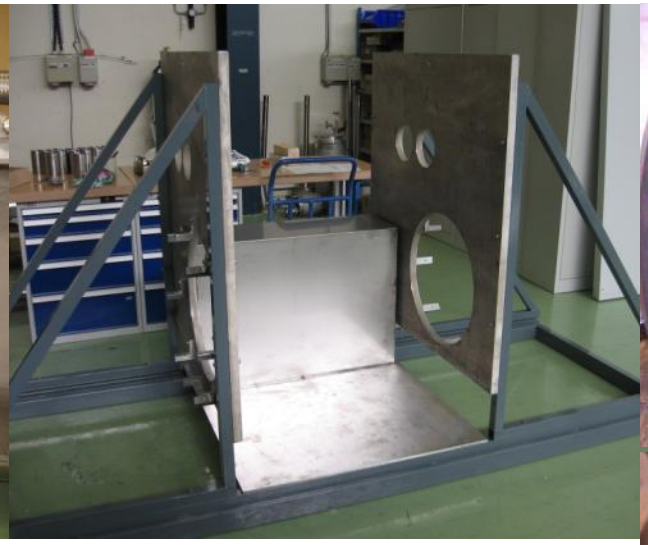
A stress test was performed by applying 20'000 current cycles at 14kA, several quench propagation measurements, and an additional thermal cycle.
After finalizing the warm-up and reopening of the setup, the interconnection resistance measurements will provide information regarding any signs of fatigue.

Will be continued by a new complete assembly on a mock-up in Bldg180

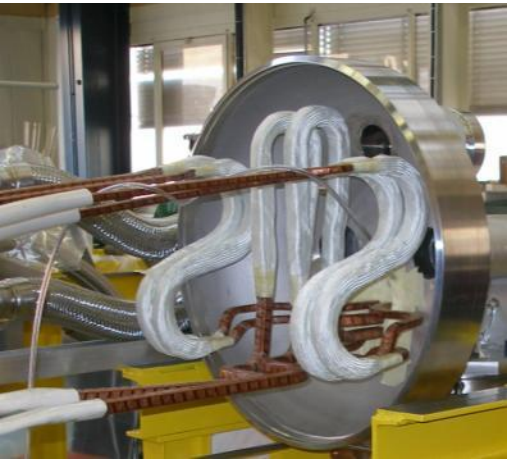


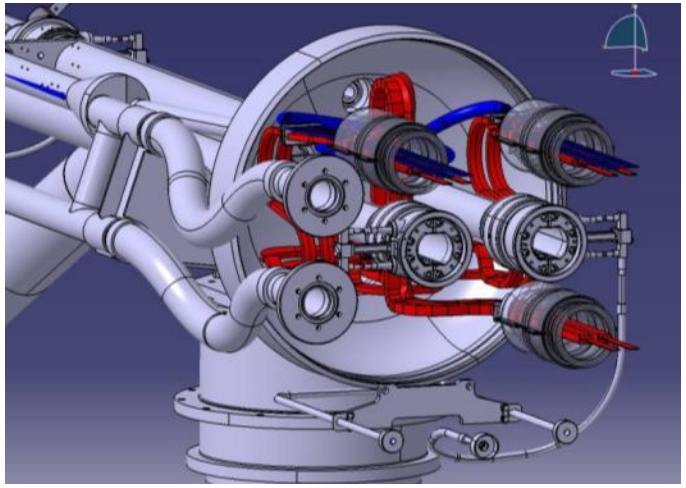
SMACC: DFBA consolidation

+ Solution under development for in-situ consolidation of 13kA splices (mock-ups)



+ Consolidation of busbars : need ? Procedure ? Resources ?





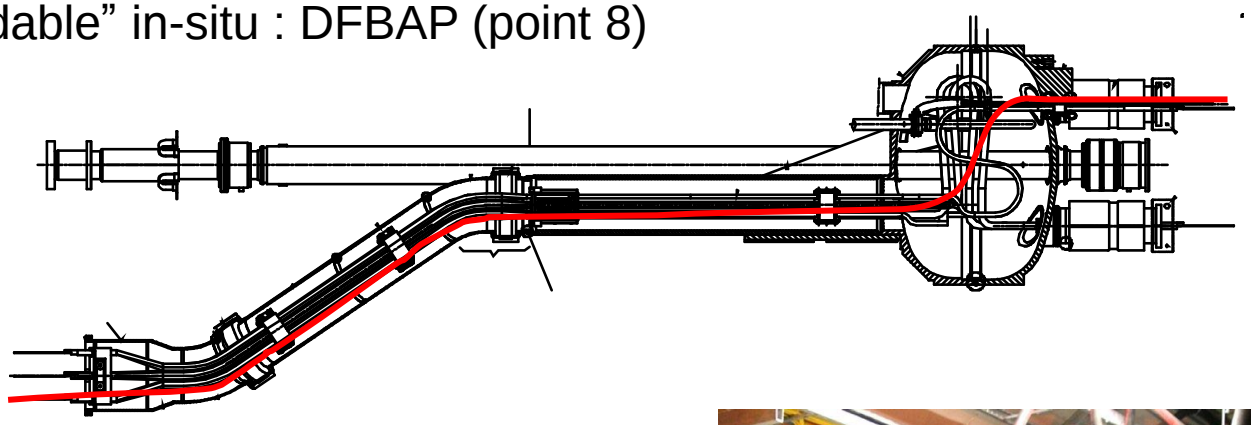
Courtesy of J-P Tock

+ Strategy to be defined for DFBA not “upgradable” in-situ (DFBAK [6L]& P [8R]

SMACC: special DFBA consolidation

+ Work on DFBA “un-consolidable” in-situ : DFBAP (point 8)

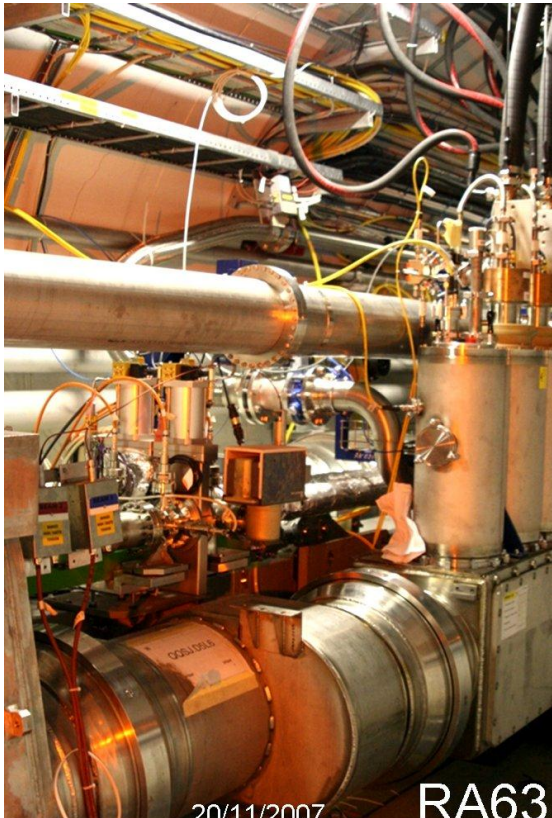
Use of a long copper bypass
Solution to be developed
Especially joining techniques
And integration procedures



+ Work on DFBA “un-consolidable” in-situ : DFBAK (point 6)

- Will be disconnected,
- Then transported to UX65 (workshop to be installed)
- Opened, consolidated and reassembled
- Transported back to the tunnel
- Re-interconnected

Extrawork for special intervention team and TE-CRG
But known procedures



Courtesy of J-P Tock

Superconducting Magnets And Circuits Consolidation

SMACC J.Ph. Tock #230

Open/Close IC [DN200]
A Musso (A Chrul) #34
- -Opening/ Closure of IC
  - Partial and complete
  - W bellows & ther. shields
- -Installation of DN200

Main arc splices cons.
F Savary (H Prin) #57
- -Sleeves cutting
- -BB surfacing
- -Shunt installation
- -Insulation
- -Splice de- & resoldering [15%]
- - Experts

Quality Assurance
R Ostojic #39
- -Electrical QC: #17
- Welding QC: # 6
- -Beam vacuum QC: #6
- -Open/close IC QC: #4 (6)
- -QA manager support : #2
- -Audits: #3

Special interventions "SIT"
N Bourcey (G Maury) #18
- -Cryomagnets exchange
- -Connect. Cryostat cons.
- -PIMs
- -Specific issues
- -Heavy NCs

TIG welding [EN-MME]
S Atieh (D Rey) #16
- - Orbital & manual

ELQA [TE-MPE]
K Dahlerup
(G D'Angelo) #23
- -Continuity
- -HV test

Leak Test [TE-VSC]
P Cruikshank
(C Garion) #19
- -Beam lines
- -Cryogenics lines
- -Insulation vacuum

DFBA [TE-CRG]
A Perin (O Pirotte) [#12 (TBC)]
- -Splices and BB

Project Office M Pojer (R Giachino) #11
- -Radiation protection
- -Safety, Access
- -General logistics
- -Pressure test
- -Link to visits, media
- -Coordination with
  - Survey, BLM, Instrumentation, Transport, LS1 planning, QPS, cryogenics,…
  - Test teams on a chain of IC
- -Reporting tools
- -Administrative support (Budget, human resources, scientific secretary)

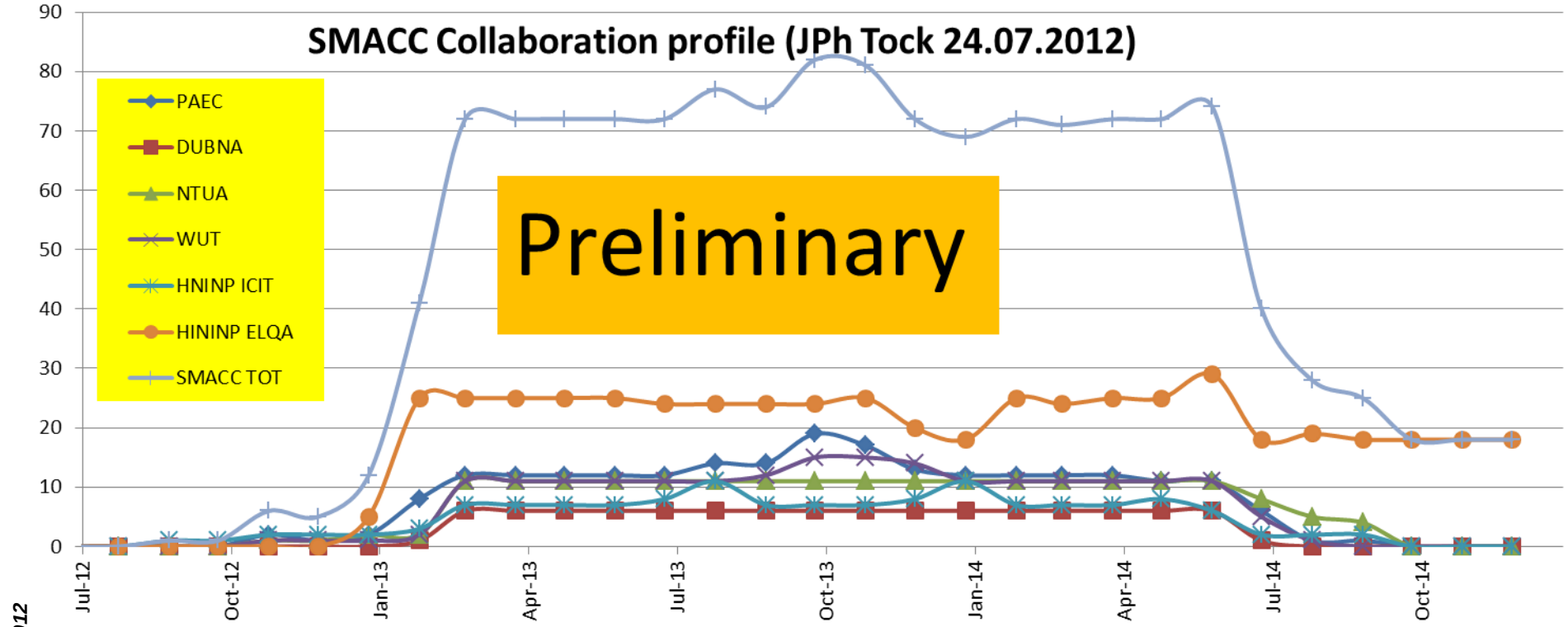
Collaborations

Collaboration	#stable	#peak	Country	Activity	Signature
NTUA	11	11	GR	Opening and closure of interconnection (Part I)	25.07.2012 To be amended
WUT	11	15	PL	Opening and closure of interconnection (Part II)	September 2012 (TBC)
HNINP-ICIT	7	11	PL	Vacuum QA	12.09.2012
HNINP-ELQA	25	29	PL	ELQA	12.09.2012
PAEC	12	19	PAK	Cutting and welding	25.09.2012
DUBNA	6	7	RU	DN200 Installation	In a PH agreement
SMACC	**72**	**92**			

Rooms reserved at the Foyer Hostel Schumann St Genis
Shuttle service under organisation

Courtesy of J-P Tock

Collaborations cont'd

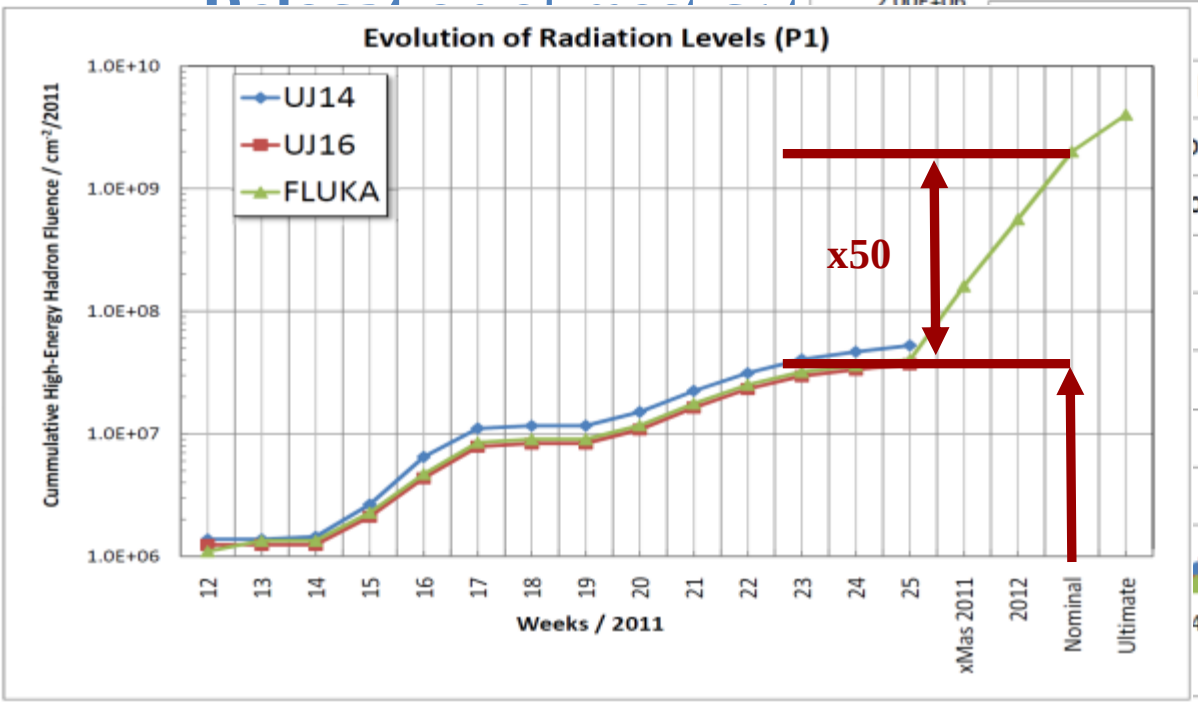


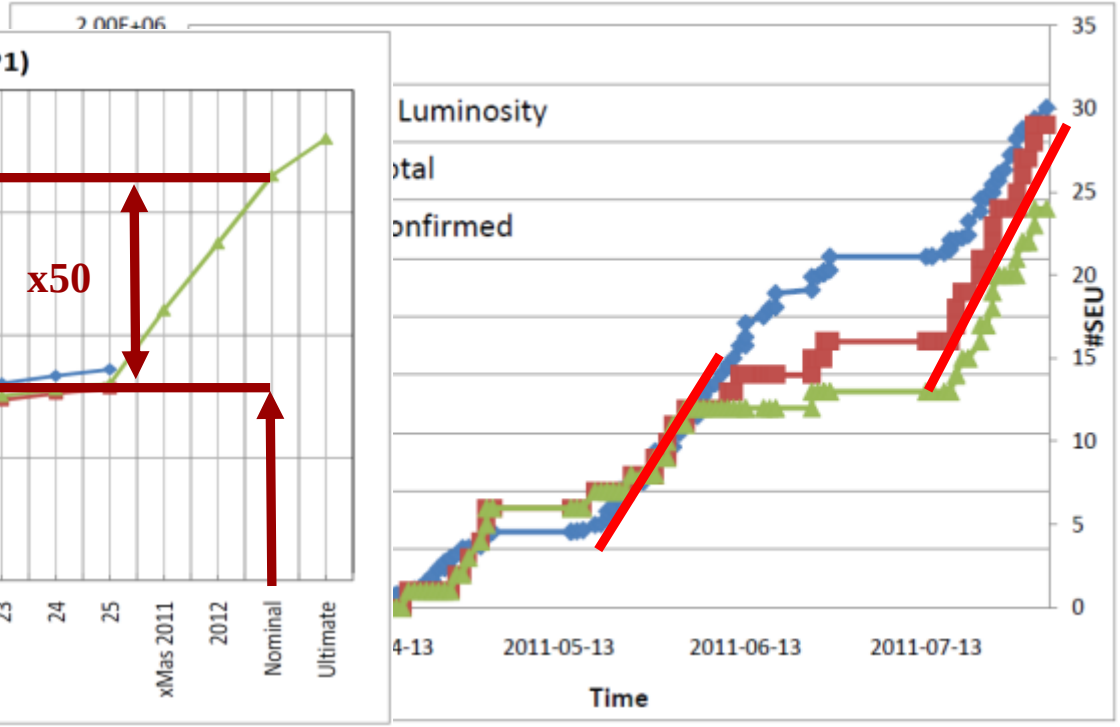
- About 1400 man-months for SMACC / 7 MCHF
- Rotation after 6-9 months in some cases so extra work/training

Courtesy of J-P Tock

RADIATION TO ELECTRONICS (R2E)

- **2011 Operation** shows us:
  most critical equipment
  (mitigation measures integrated "on-the-fly" if possible)
  Evolution of **radiation levels** compared with expectations
  (possible additional weak-points)
- **2011/12 xMas Break** (and Technical Stops):





R2E Activities during 2013/2014

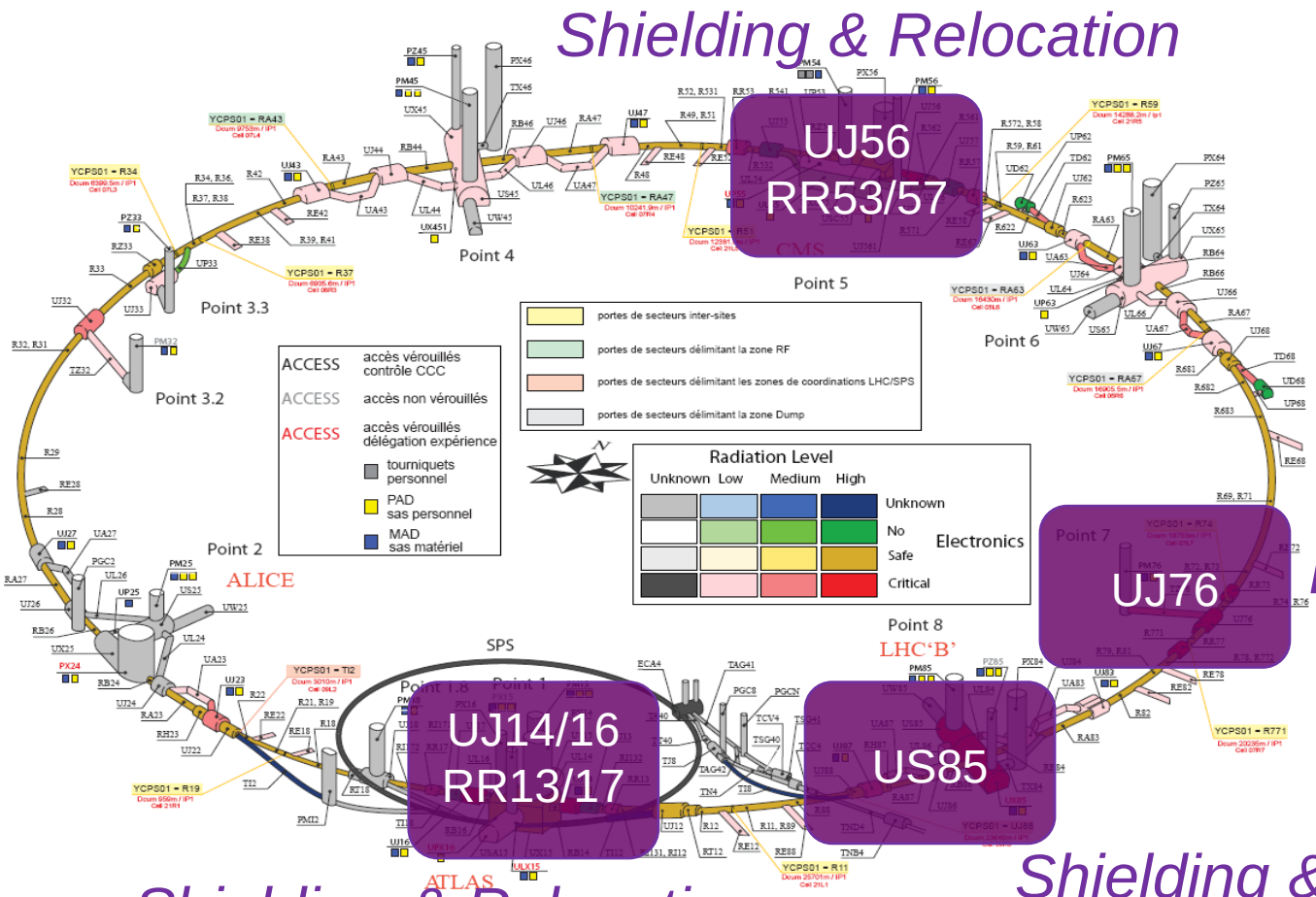
- **Major work impacting LHC areas**
  - Shielding improvements
  - Relocation
  - **Important:**
    - **Re-installation of 4 points in ~1 year!!!**
    - **NO margin in planning so far**
- **Parallel R&D and Development**
  - Rad-Tol Power-Converters
    - FGClite final development and deployment
    - 120A, 600A & 4/6/8kA prototyping
  - SCL Studies (development, CE-studies)
  - Important requirement
    - Irradiation test facility (PCs, BI, Cryo,…)
- **Injector chain related activities**

Focus of Today is Here

To Be Taken Into Account (Resources, Time)

LHC Relocation & Shielding

Main critical areas considered for LS1



Shielding & Relocation Activities Status

Integration studies

Shielding

Points 1, 5, 7 & 8 ✓

Relocation

Point 1 ✓

Point 5 ✓

Point 8 ✓

Point 7 — **Finished Under approval**

2011 & 2012

Planning – LS1

R2E activities in

Point 1 ✓

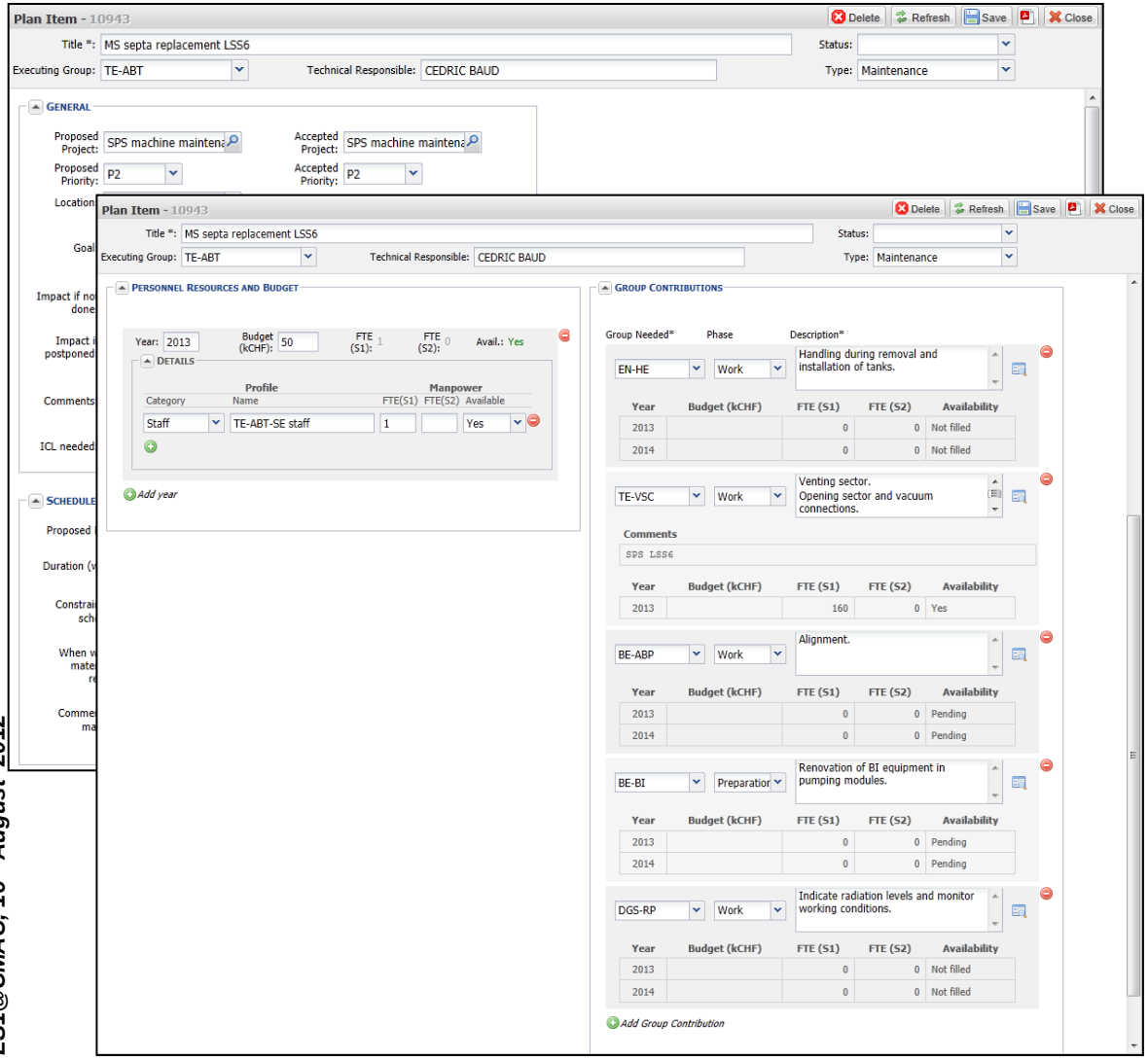
Point 5 ✓

Point 7 ✓

Point 8 ✓

All integration & planning sequences are finished

PLAN.CERN.CH



To prioritize and to take decisions, it is essential to know:

- What groups intend to do ?
- What is the goal, and the impact if it is postponed or not done ?
- Activity duration and when could be done ?
- Are the resources of the requester available ?
- **What is the support needed from other groups, and are the resources of the support groups available ?**

Plan data Analysis

- SMACC: OK (DFBA upgrade should be finalised)
- R2E: OK (in spite it's very tight)

- Equipments are OK with their own works, their maintenance, consolidation and main projects (Chamonix and IEFC workshop presentations and special meetings)

- Clear confirmation of the support group overload and especially for EN-EL (cabling and fibre activities) and EN-CV

- Prioritization MUST be done

LS1 day : 12th June 2012

The aim is to announce the results of the survey and analysis of which activities will be performed during the first long shutdown (LS1), which activities might be performed subject to the availability of resources (call for extra manpower), and which activities will be postponed.

The LS1 day will also provide the latest update on LHC & injector planning.

The support groups will present their activities and organization during LS1. The aim is to crosscheck the requests from other groups and experiments, to avoid missing something and misunderstandings.

A summary of the LS1 day will be presented at the LMC meeting on June, 27th and at IEFC meeting on July 13th .

08:30 - 09:30	Methodology & Decisions *1h0'* Speaker: Frederick Bordry (CERN)
09:30 - 10:00	Update planning LHC *30'* Speaker: Katy Foraz (CERN)
10:00 - 10:20	Coffee break
10:20 - 10:50	Update planning injectors *30'* Speaker: Simon Baird (CERN)
10:50 - 11:20	Vacuum activities and organisation during LS1 *30'* Speaker: Dr. Jose Miguel Jimenez (CERN)
11:20 - 11:50	Survey activities and organisation during LS1 *30'* Speaker: Dominique Missiaen (CERN)
11:50 - 12:20	Site Engineering activities and organisation during LS1 *30'* Speaker: Dr. Luigi Scibile (CERN)
12:20 - 14:00	Lunch break
14:00 - 14:45	Electrical activities and organisation during LS1 *45'* Speaker: Francois Duval (CERN)
14:45 - 15:30	Cooling and Ventilation activities and organisation during LS1 *45'* Speaker: Mauro Nonis (CERN)
15:30 - 15:50	Coffee break
15:50 - 16:10	Handling activities and organisation during LS1 *20'* Speaker: Ingo Ruehl (CERN)
16:10 - 16:40	Controls activities and organisation during LS1 *30'* Speaker: Eugenia Hatziangeli (CERN)
16:40 - 17:10	Industrial Controls activities and organisation during LS1 *30'* Speaker: Philippe Gayet (CERN)

Activities which CANNOT be done during LS1

- **Booster cable cleanup campaign (all the work for Booster 2 GeV during LS2)**

- **Replacement irradiated cables SPS Sector 1 +, TCC2-TDC2*, (but TCC2 : vacuum renovation between Splitter 1 and Splitter 2 => to review for the replacement of the irradiated cables)***

- **Cable clean-up campaign SPS-Pt 5**

- **Cabling preparatory work for Linac4 connection to the PSB (160 MeV)**

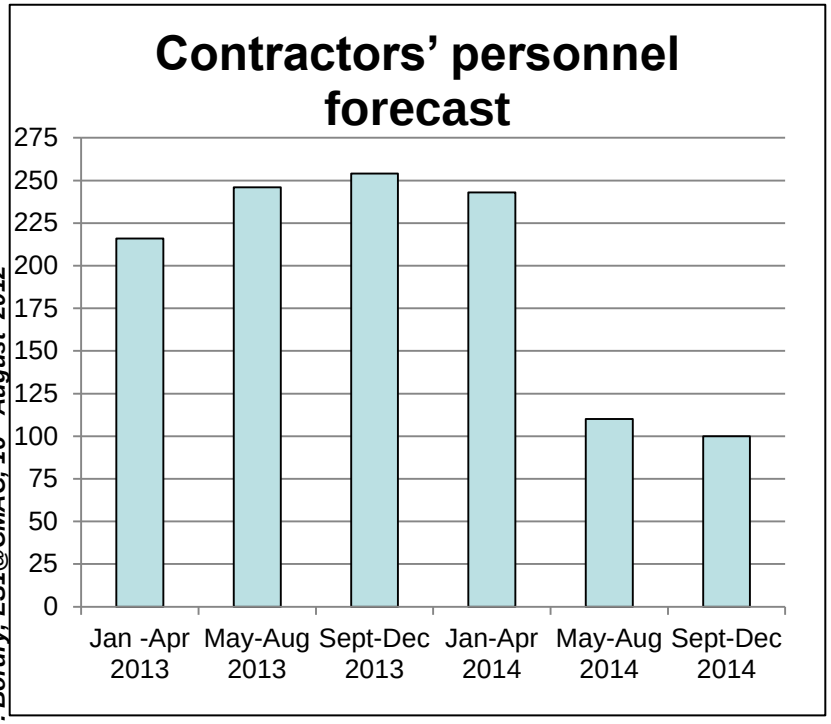
BUT: LIU cabling: PSB, PS and SPS priority 1 should be done during LS1 or at least during the 1st winter stop (2015-2016)
(i.e - trajectory measurement in PSB to prepare H^- injection
- new wall current monitor in PS for ghost bunch detection
- fibre duct in one SPS sector for the new MOPOS test)

- **Recommendation: to take advantage of the LS1 and/or the 2 winter stops before LS2 to trace PSB and SPS cables for the LS2 cleanup campaign**

Cooling & Ventilation activities (EN-CV)

LS1 is the only possibility to perform a complete maintenance round between 2009 and 2018:

- Maintenance work 2013: 103'000 hrs (+ 45% wrt values 2012)
- Maintenance work 2014: 84'000 hrs (+18% wrt values 2012).

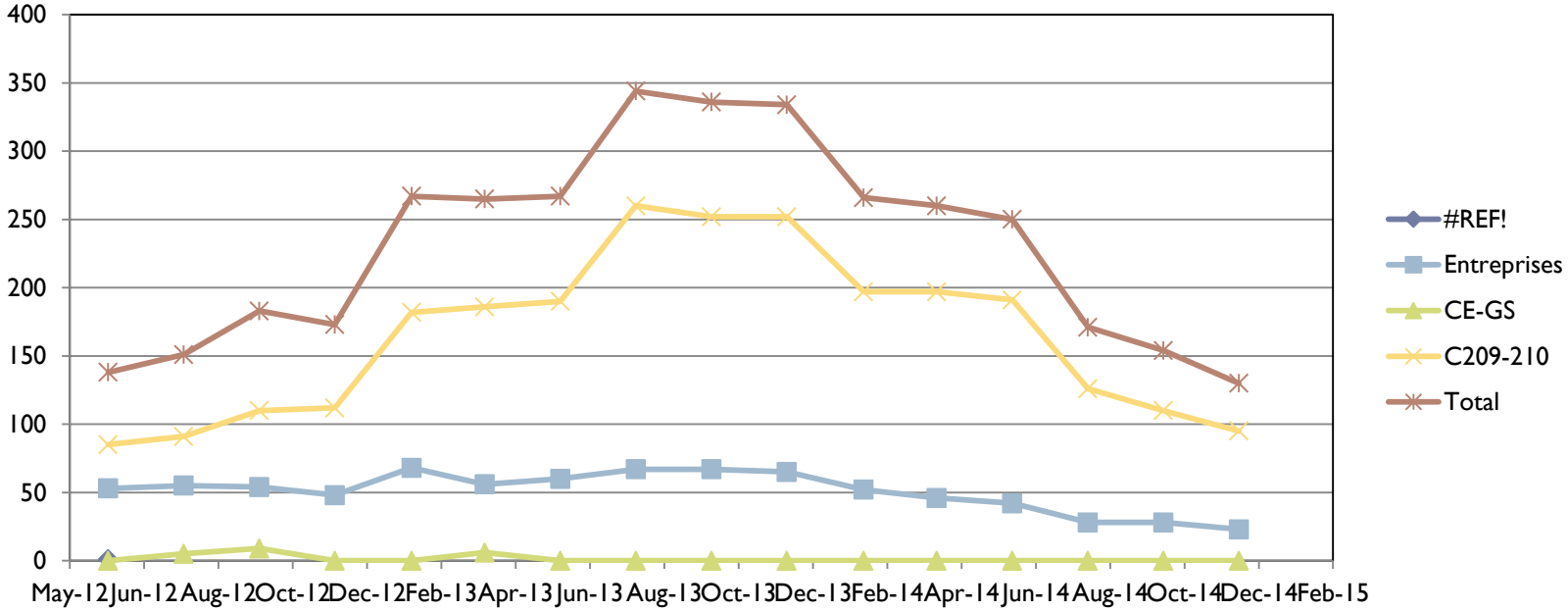


- New major supply & installation contracts: 27
- Orders via existing contracts: >40 orders

Activity concentrated between March 2013 - beginning 2014; after that date only second round of (lighter) maintenance allowed.

Courtesy of Mauro Nonis

Electrical distribution and cabling activities (EN-EL)



	2012				2013						2014					
	Jun-12	Aug-12	Oct-12	Dec-12	Feb-13	Apr-13	Jun-13	Aug-13	Oct-13	Dec-13	Feb-14	Apr-14	Jun-14	Aug-14	Oct-14	Dec-14
Entreprises	53	55	54	48	68	56	60	67	67	65	52	46	42	28	28	23
CE-GS	0	5	9	0	0	6	0	0	0	0	0	0	0	0	0	0
FSU	0	0	10	13	17	17	17	17	17	17	17	17	17	17	16	12
C209-210	85	91	110	112	182	186	190	260	252	252	197	197	191	126	110	95
Total	138	151	183	173	267	265	267	344	336	334	266	260	250	171	154	130

The maximum number of people must be consider with the addition of 100 people in the EL group (65 staffs, 6 fellows, 10 PJAS, 10 contractors people, 9 UPAS, USAS & Tech)

This is an estimate based on semester manpower for projects, it has to be updated once the LHC and Injectors work schedule established

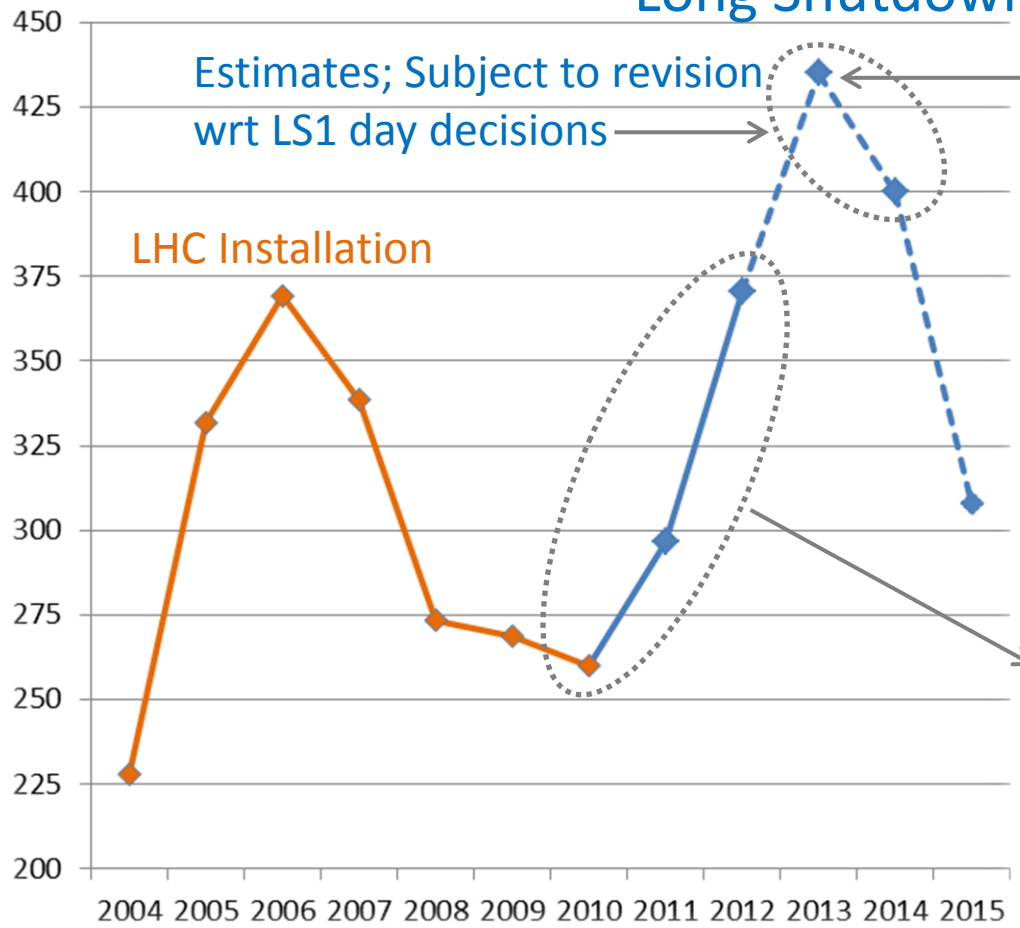
Courtesy of François Duval

Industrial support; FSU contracts evolution & forecast

2004 to mid 2011: S107, S108

Since mid-2011: S144, S145, S146

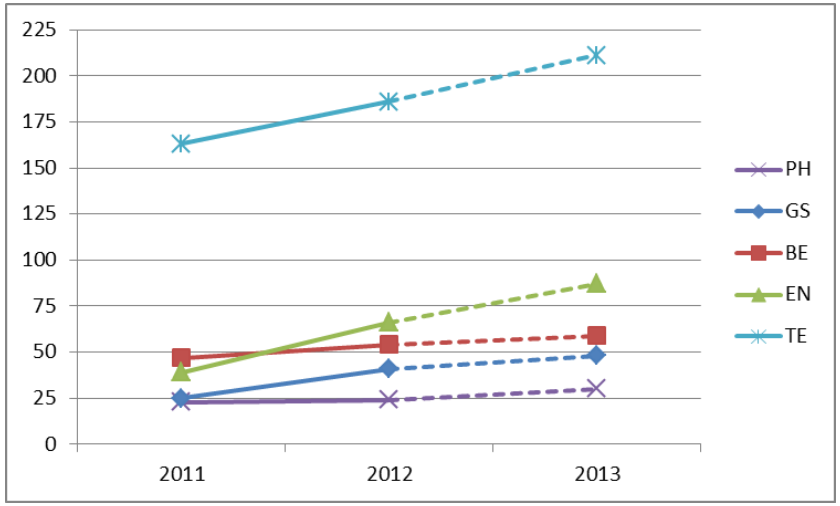
FSU resources (FTE)



Courtesy of D. Delikaris

Per Department (FTE)

2013	FSUnits	FTE	%
BE	5	59	14%
EN	8	87	20%
GS	4	48	11%
PH	3	30	7%
TE	14	211	49%
TOTAL	34	435	100%

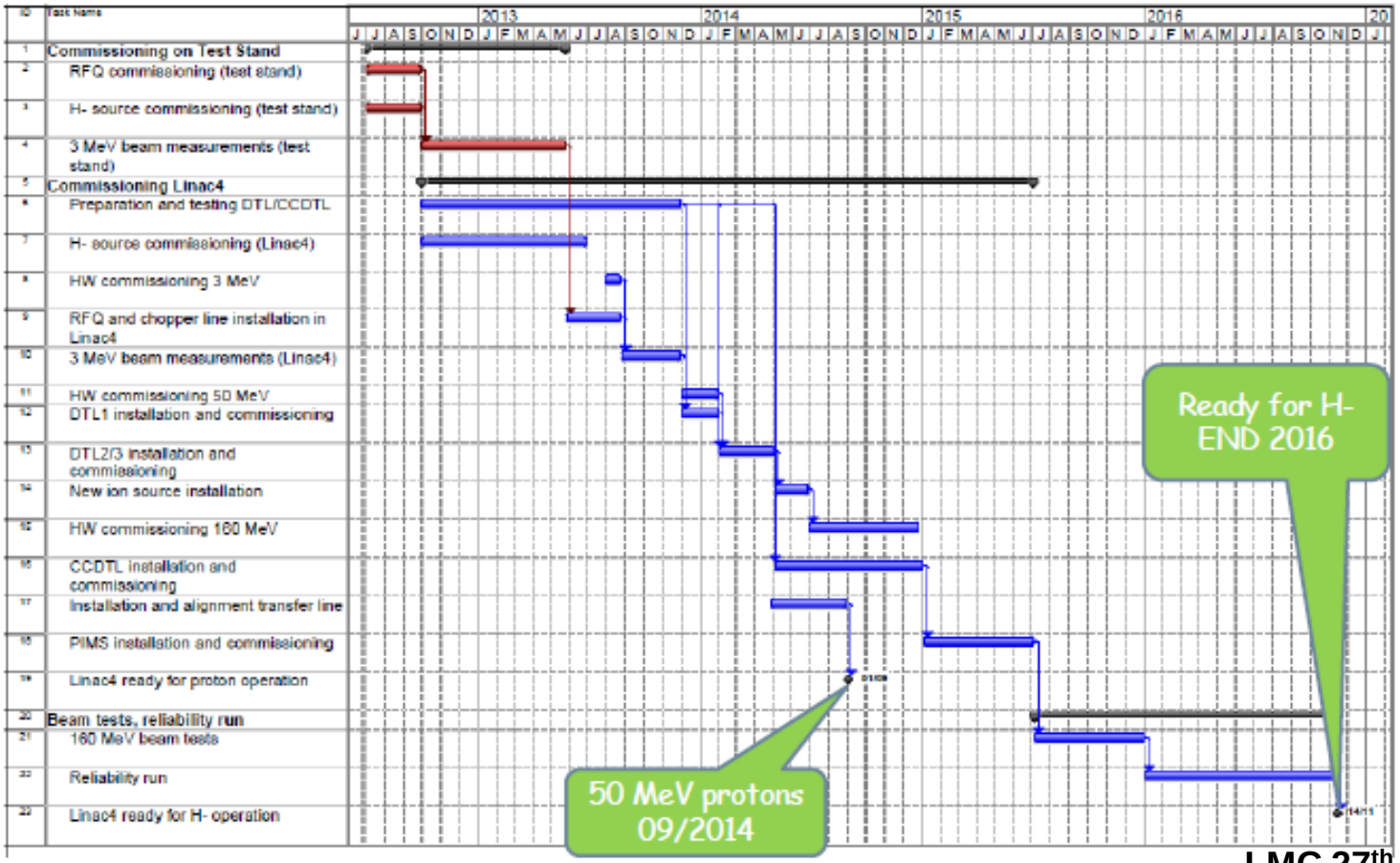


2011-2012:
LS1 support build-up (76 FTE) and new activities (34 FTE)

2013: 65 additional FTE expected

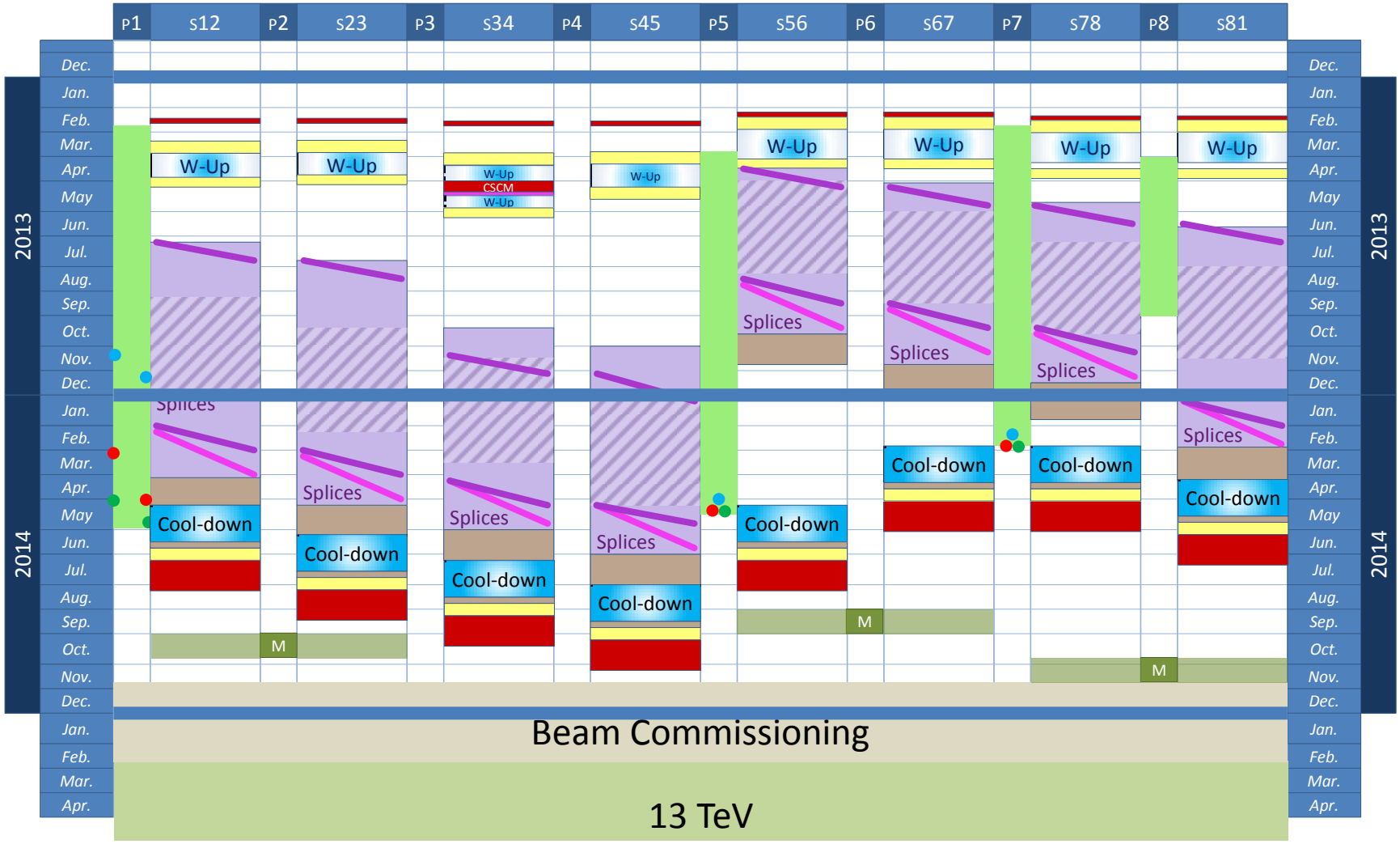
Linac 4 new schedule proposal: H^+ by end 2014 and H^- by end 2016

Proposed New Plan



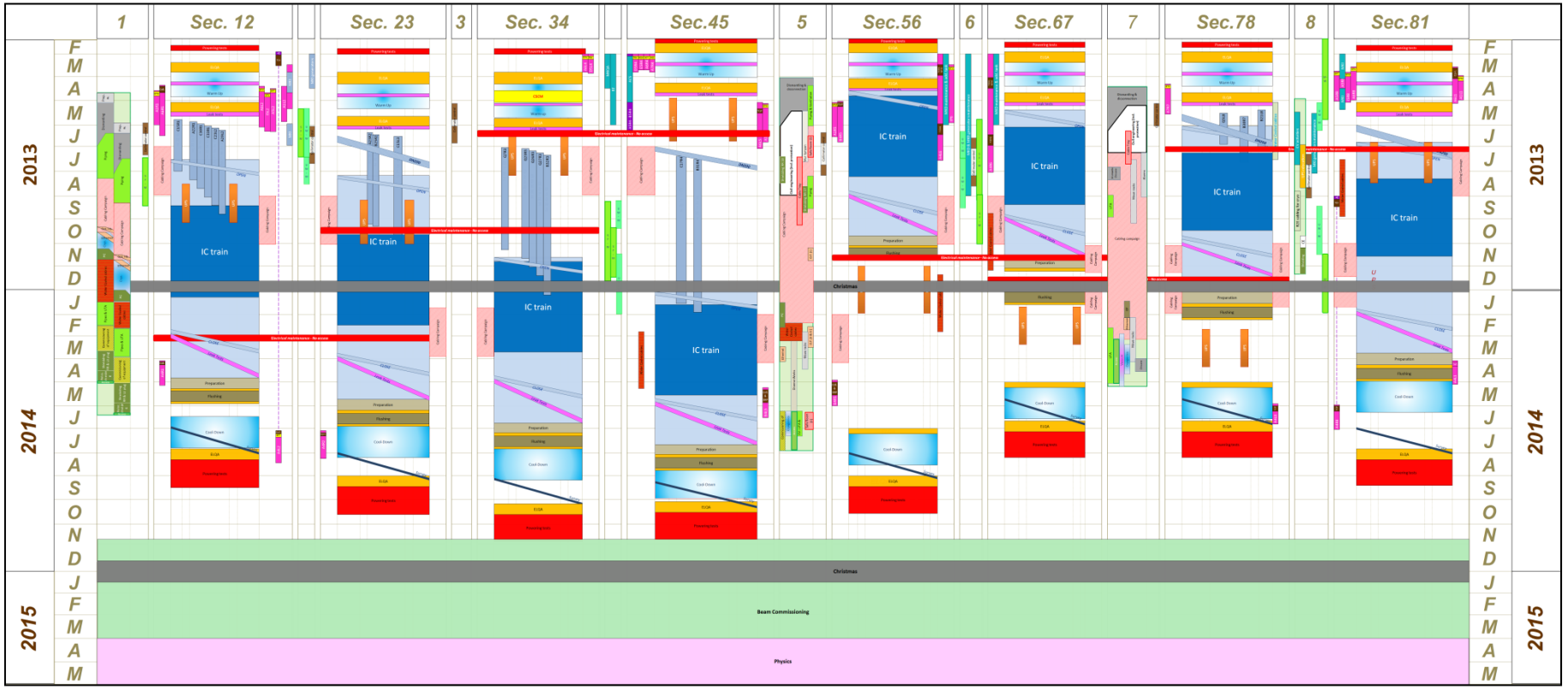
LMC 27th June 2012
Maurizio Vretenar

New LHC LS1 schedule



Courtesy of Katy Foraz

LHC schedule (detailed)



EDMS 1227656 (rev1.0, July 26th, 2012)

No contingency

LS1 key dates (to be confirmed for LHC injectors)

	LS1 start	LS1 end	Physics start	Xmas stop in 2015		Comment
LHC	11/02/2013	15/11/2014	01/04/2015	30/11/2015		Xmas 2012 and 2014: 4 weeks stop
SPS ring						Xmas 2012 and 2014: 4 weeks stop
Option A	11/02/2013	01/09/2014		30/11/2015		No contingency for SPS Power Transformer commissioning and major control software revision
Option B	11/02/2013	15/11/2014		30/11/2015		Just ready for LHC injection
North area						
NA61	11/02/2013		A or B	30/11/2015		
NA62	03/12/2012		A or B	30/11/2015		Extra Shutdown in 2015 or Compensatory measures in 2015
NA others	03/12/2012		A or B	30/11/2015		
PSB ring	11/02/2013	30/05/2014		30/11/2015		Xmas 2012 and 2014: 4 weeks stop
PS ring	11/02/2013	15/06/2014		30/11/2015		Xmas 2012 and 2014: 4 weeks stop
Isolde	03/12/2012		15/06/2014	30/11/2015		
nTof	03/12/2012		15/07/2014	30/11/2015		
AD	03/12/2012		15/07/2014	30/11/2015		Shutdown 4-5 months beginning 2015
East Hall	03/12/2012		15/07/2014	30/11/2015		

- Option B: under study to allow the SPS Sector 1 irradiated cable replacement
- Additional cost of running all the non-LHC physics programs (except CNGS) from December 2014 to March 2015 is under evaluation

Conclusion [1/2]

- LS1 focus on LHC upgrade (towards 7 TeV: interconnects, R2E and consolidations) and LHC injectors maintenance

  LHC injectors and experimental facilities closure in 2013: Resources redirected towards LHC upgrade and consolidation

- **New start date from 3rd July 2012 :**

  Extension of 2012 physics run and proton-lead run at beginning of 2013

=> LHC: Beam back late in 2014 (15th Nov) and physics at 13 TeV scheduled April 2015 (pilot run beginning 2015)

- Massive and solid preparation work: Ready to go !
- Need to continue to review and optimise the support activities.
- Still some open points (DFBA, CSCM, quadrupole diodes,...)

Conclusion [2/2]

- Some activities (maintenance, consolidation, LIU,...) cannot be done during 2013-2014 due to overload of EL and CV groups (study to extend SPS shutdown to include replacement of irradiated cable: TDC2 and SPS sector 1 but almost no North Area physics in 2014)

- Proposal to postpone the beam commissioning of LINAC 4 (smoothing of the project and not a hold)

- Non LHC experimental areas: planning is under study with the new changes (LHC and NA61 run in 2013 up to 11th Feb.) but must be optimized for decisions:
  - restart later in 2014 and no shutdown 2014-2015 (extra cost and special cases: AD-Elena and NA62?)

- Safety shall be our priority during LS1 - Logistics will be crucial
- Extra and missing costs should be defined (to cope with the new schedule): collaborations, FSU, more work than foreseen

Final conclusion

Accelerators:

LS1 ≡ LHC 7 TEV

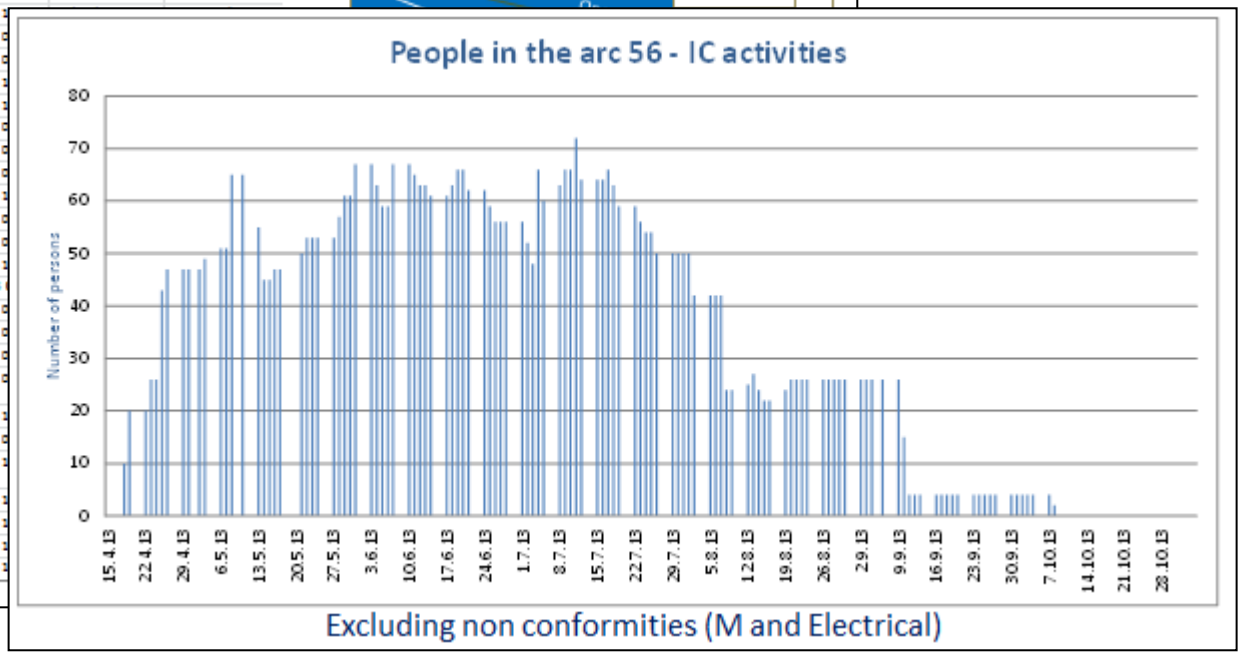
LS2 ≡ LIU

LS3 ≡ HL-LHC

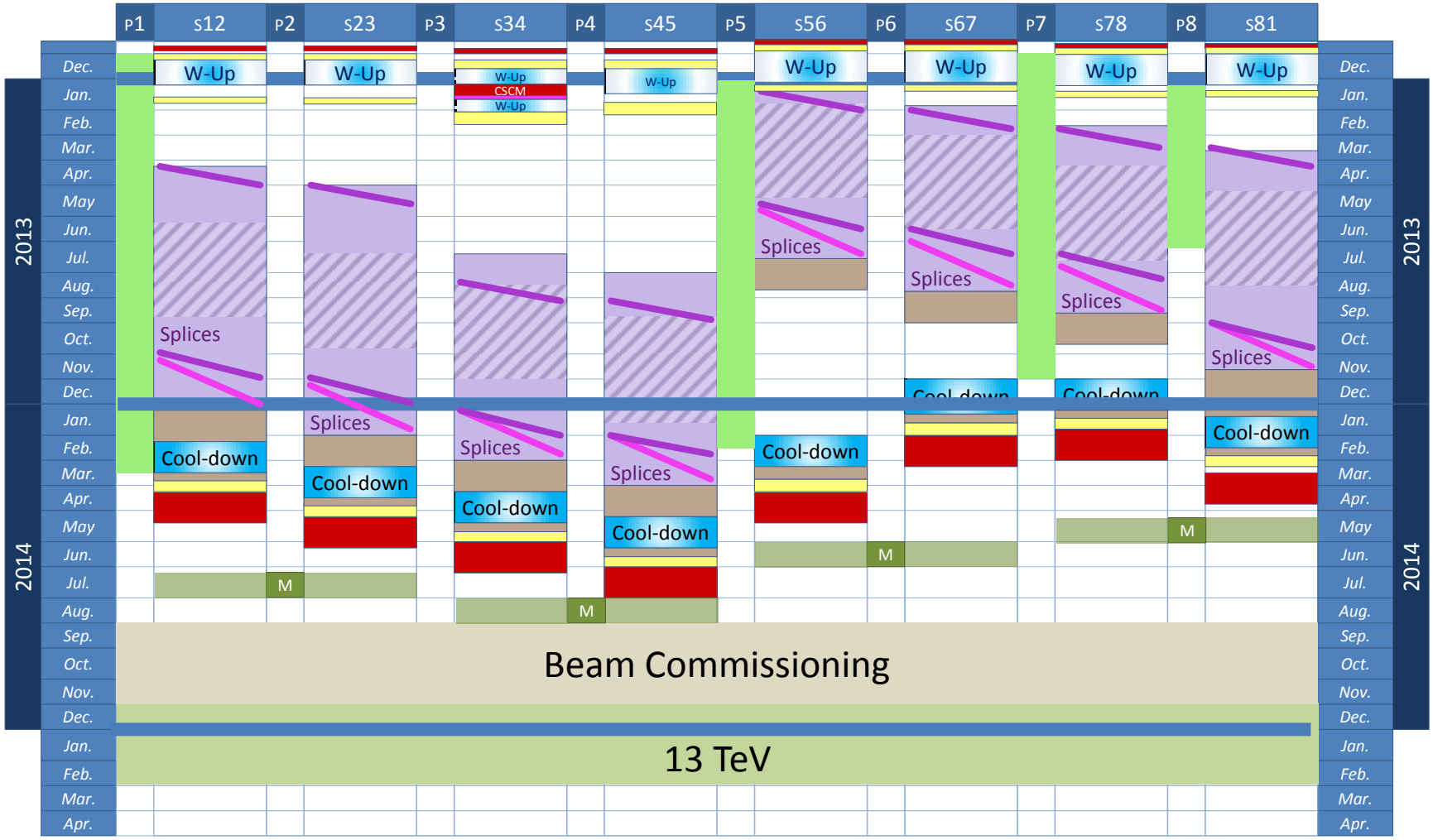
EN

Detailed train arc 56

Task Name	Duration	Start	Finish	Predecessors
Interconnections activities 56	130 days	18/04/13 13:00	23/10/13 12:00	
Opening W and remove thermal insulation	5 wks	18/04/13 13:00	15/05/13 12:00	55540.5 days
Inspection beam line	5 wks	23/04/13 08:00	15/05/13 17:00	95540.5 wks
Protection beam line	5 wks	23/04/13 08:00	15/05/13 17:00	95540.5 wks
Train 56	74 days	25/04/13 13:00	12/08/13 12:00	
Cutting M sleeves	5 wks	25/04/13 13:00	04/06/13 12:00	103540.5 wks
Removal of IC splices electrical insulatio	5 wks	05/05/13		
QC	5 wks	08/05/13		
Desoldering 55 (Hp 15%)	5 wks	16/05/13		
QC	5 wks	21/05/13		
soldering 55 (Hp: 15%)	5 wks	28/05/13		
QC	5 wks	31/05/13		
Busbars surface machining	5 wks	07/06/13		
shunt splices installation	5 wks	14/06/13		
QC splices/shunts	5 wks	18/06/13		
Mounting insulation & QC	5 wks	21/06/13		
Welding M sleeves	5 wks	04/07/13		
Welding QC (M lines)	5 wks	08/07/13		
PAQ HV and continuity test	60 days	08/05/13		
Spools 55	12 wks	08/05/13		
13 kA 55	12 wks	08/05/13		
PIMs repairing	1 wk	04/07/13		
IC electrical non conformities (find pb, solution and HV test)	12 wks	15/05/13		
VAC sectors leak test (M lines) clamps syste	4 wks	17/07/13		
Vac leak test beam lines	1 wk	11/07/13		
IC Non Conformities on M lines (leaks, find pb, solution and new leak test)	5 wks	31/07/13		
Ball test	3 days	28/05/13		
half shells installation on beam lines	5 wks	02/09/13		
Closure W	4 wks	27/08/13		
VAC Leak test	7 wks	05/09/13		

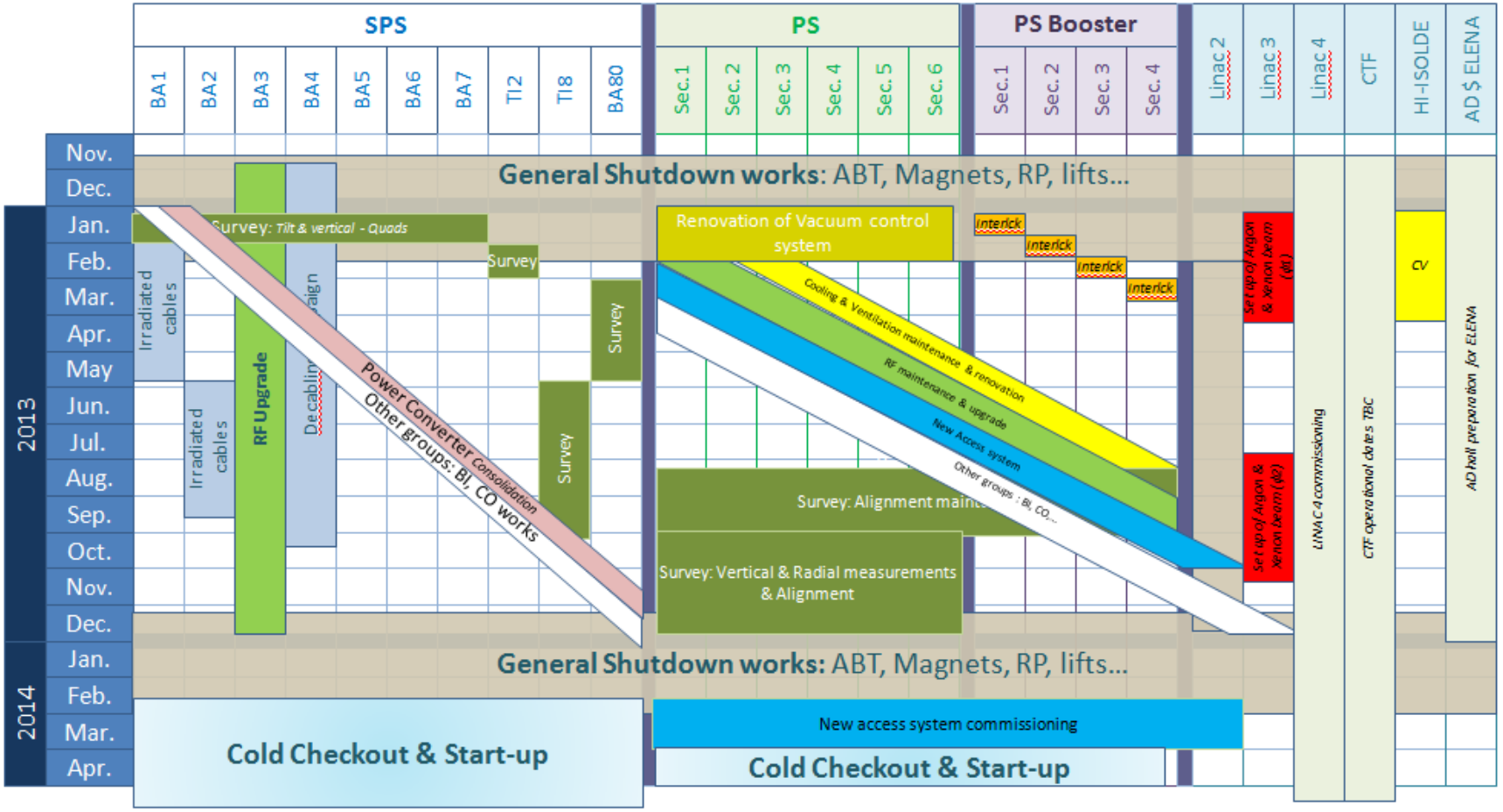


LS1 schedule presented 12th June 2012



Katy Foraz

LS1 Global Schedule of LHC injectors



Global schedule done before the decision to delay by 2.5 months LS1