BI Activities for LS2

Ray Veness for BE-BI

LS2 DAYS

29-30 SEPTEMBER 2015

http://indico.cern.ch/event/436424/

Scope

- Covers LHC and injector chain
  - Protons and ions
- Does not cover AWAKE, ELENA, ISOLDE or other non-LHC machines in detail
  - however, these projects will use significant resources
- Activities include
  - LIU, HL-LHC, Consolidation, operations
- General maintenance
  - First estimate made based on experience from LS1
- *'Known unknowns'*
  - Activities that are likely to come in addition for LS2

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- Introduction
  - BI project goals upto LS2
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  - Conclusions

Project goals upto LS2

- YETS 15
  - Half-sector test for LINAC4
  - Early installations for LIU
  - Prototypes for LIU and HL-LHC
- 2016
  - ELENA, AWAKE and HIE-ISOLDE installations
  - Half-sector test for LINAC4
- EYETS 16
  - Milestone for possible LINAC4 connection
  - LIU and HL-LHC prototypes needing validation before LS2
- YETS 17
  - Work that can be completed pre-LS2
- LS2
  - Energy upgrades for LIU

Beam Instrumentation

- Very broad range of instrumentation:
  - complex multi-technology instruments such as the Synchrotron Radiation Telecscope (BSRT) or the Beam-Gas Ionisation monitor (BGI) which has in-vacuum structures, high-voltage, electro-magnets, gas injection) to,
  - BPMs and BLMs with robust and reliable designs. Installed in large numbers (~4'000 BLMs in the LHC) and often with some operational redundancy
- However, all have mechanics, electronics, cabling and other services, racks, dedicated software, and industrial controls
- All instruments require a strong expert BI presence in the CCC for re-commissioning
  - This will be particularly true for LIU with new instruments and beam parameters across the whole injector chain
  - This is often incompatible with continuing installations in downstream accelerators

Beam-Gas Ionisation (BGI) monitor in the LHC

Beam Loss Monitor (BLM) in the LHC

Looking back to LS1

Machine Complex	In-Vacuum Beam Instruments		Non-Vacuum Beam Instruments	
	Total in place	Removed	Total in place	Removed
PS	457	87	159	159
SPS	496	63	410	30
LHC	1220	73	3993	2300
Total	2173	223	4562	2489

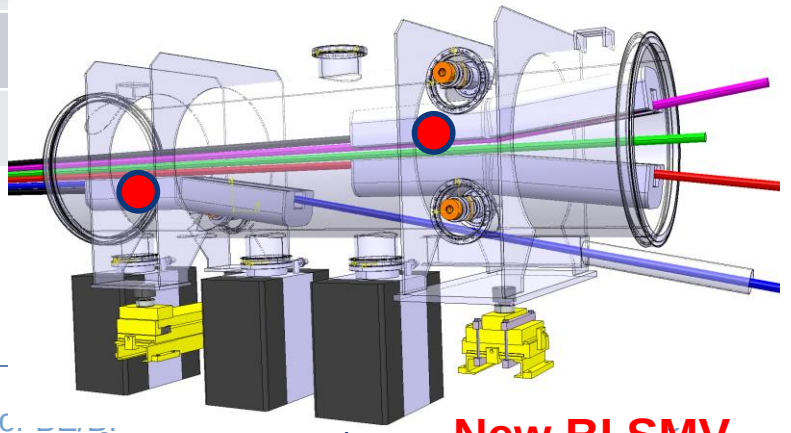
- Typical activities
  - Participation in CERN-wide projects (eg, SMACC, LSS1 cabling, layout changes)
  - Consolidation and maintenance of instruments (eg, impedance issues in LHC-BSRTM, fatigue lifetime in LHC-BWS)
  - New or replacement instruments (eg, SPS-BWSRE, LHC-BGV)
  - Controls upgrades to LHC electronics and software

Learning from LS1

- **LS1 was a great success for BI, with 99.5% of pre-planned installations completed and much more, however:**
- **Production issues led to delays in installation**
  - Closer communication developed with MME, both for design and production
  - Regular meetings now set-up with MPE-EM for circuit board design and production
  - Earlier communication of requests to VSC will allow resource allocation for staff and their leak-detection contractor
    - Working on clear agreement for vacuum acceptance criteria
- **Scheduling issues**
  - Integrate with MEF link person from the start to ensure coordination of schedules between different machines and with re-commissioning
  - Earlier start to BI follow-up meetings to ensure a ‘running start’ for shutdowns
  - BI now have a clearer picture of the critical instruments for operations from the BOSS (Beamline Operational Spares Strategy) project
- **Cabling**
  - Many BI projects require significant cabling and scheduling requires coordination at the sector level
  - Clear, early feedback from EL before LS1 helped us to optimize the use of BI resources.

Installations in 2015 and YETS 15-16

Machine	Project	Description	MME	VSC	EL
LINAC3	LIU	ITL and ITM grids		4	
LINAC2	Cons.	Faraday cup modifications		2	
PSB	Cons.	Replace BTP.BTV10	1	1	
L4/PSB	LIU	Install BTV for L4T half-sector test		1	
PSB	LIU	Integrate BI.SMV position plates	Done		Y
PS	LIU	Install 2 Wall Current Monitors	Done	2	
PS	LIU	Install high-bandwidth BPM	1	1	Y
PS-EA	Cons.	Replace 5 ‘marguerite’ BPMs	6	6	Y
PS&PSB	Cons.	DCCT electronics			
PS	LIU	Diamond BLM cabling			



Courtesy: M Hourican

New BI.SMV

Installations in 2015 and YETS 15-16

Machine	Project	Description	MME	VSC	EL
SPS	HL-LHC	Electro-optical BPM prototype install.	1	1	8
SPS	Op.	Gated tune cables			Y
SPS	Op.	BPM cabling in TT10			Y
SPS-NA	Cons.	Replace TBIU assembly		1	
LHC	AFP	BPM and DOROS electronics		1	Y
LHC	Op.	DOROS installation in IP2 and 8			Y
LHC	Op.	Installation of Schottky electronics			Y
LHC	HL-LHC	Installation of BSRT coronagraph			
LHC	HL-LHC	Installation of CryoBLM in 5L and 7R			Y

Totals for 2015 and YETS 15

10 instruments to build (in progress)

20 vacuum qualifications

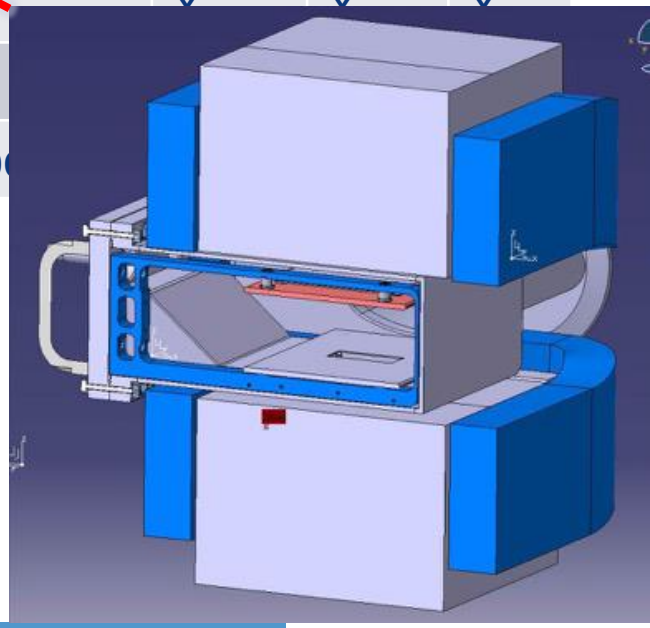
11 cabling projects with 93+ new cables

Installations in 2016 and E

Machine	Project	Description			
ELENA	ELENA	ELENA instrumentation			
SPS	AWAKE	AWAKE instrumentation			
L4/PSB	LIU	BTV and FBCT for half-sector			
L4/PSB	LIU	H^0/H^- current monitor for half-s			
L4/PSB	LIU	BLMs for half-sector test			
L2/PSB	Cons.	Replace BCTs			
PSB	LIU	Modify BI.BTV30	1	1	
PSB	LIU	Refurbish and reinstall BR.TMD BCTs	Y	4	
PSB	LIU	New wire scanner prototype	2	1	Y
PSB	LIU	BLMs for monitoring and observation	Y	N	220
PSB	LIU	Ring trajectory measurement system	N	N	250
PSB	LIU	New tune pickups in 3L1 (New-TBD)	5	4	N
PSB/BTP	LIU	New wideband pickup	1	1	Y

Installations in 2016 and EYETS 16-17

Machine	Project	Description	MME	VSC	EL
PS	Cons.	Re-build SEMs for 48-52-54	4	4	N
PS	LIU	New BGI prototype	1	1	Y
PS	Cons.	BTV for septa 16 and 57	?	?	N
SPS	LIU	Fast BCT ring upgrade	Y	Y	Y
SPS	LIU	Diamond BLM prototypes			
LHC	HL-LHC	BBLR wire-in-collimator prototyp			



Totals for 2016 and EYETS 16

30+ instruments to build (ex. AWAKE and ELENA)

32+ vacuum qualifications

13+ cabling projects with 470+ new cables

Installations in 2017 and YETS 17-18

Machine	Project	Description	MME	VSC	EL
PSB	LIU	SEM for injection matching	1	1	Y
PS	LIU	New wire scanner prototype (TBD)	1	1	Y
LHC	HL-LHC	New prototype head-tail monitor	2	2	Y

Totals for 2017 and YETS 17

4 instruments to build
4 vacuum qualifications
3 cabling projects

Installations in LS2

Machine	Project	Description	MME	VSC	EL
PSB	LIU	BT.BTV10 and 30 (advance?)	2	2	N
PSB	LIU	New wire scanners	9	8	Y
PS	LIU	New SEM for injection in sector 42	1	1	Y
PS	LIU	New wire scanners	6	5	Y
PS	LIU	New BLMs for ring	Y	N	160
SPS	LIU	New wire scanners	6	5	Y
SPS	LIU/Con	New BLMs in TT2/TT10/FTA/FTN	Y	N	192
SPS	Op.	New orbit system (MOPOS)	N	N	Y
SPS	LIU	New beam dump instruments (TBD)	Y	Y	Y
LHC	HL-LHC	New BGV installation	Y	Y	Y
LHC	HL-LHC	New wire scanner prototype	2	1	Y

Totals for LS2

28+ instruments to build

23+ vacuum qualifications

12 cabling projects with 352+ new cables

Maintenance in LS2 (first estimate)

Machine	Instrument	Description	Days in tunnel	Vacuum sectors vented
PS comp.	BWS	Replace scanner wires	26	6
PS comp.	SEM	Maintain 25% of SEMs	26	12
PS comp.	All other	BPMs, BTVs, BCTs BLMs etc	93	0
SPS comp	BWS	Replace scanner wires	12	6
SPS comp	SEM	Maintain 50% of SEMs	2	1
SPS comp	All other	BPMs, BTVs, BCTs BLMs etc	66	0
LHC	BWS	Replace scanner wires	16	2
LHC	BSRT	Verification of mirror + maintain	20	1
LHC	BGI	Change MCPs + maintain	5	4
LHC	BQS	Maintain	10	2
LHC	All other	BTVs, BPMs, BCTs BLMs etc	123	0

Totals for LS2 Maintenance

399 days of maintenance in the tunnel

34 vacuum sectors vented for maintenance work

Example: New wire scanners for LIU

- New design of a key transverse beam profile instrument with faster, higher precision performance for the new LIU beam parameters
  - Prototype was installed in the SPS during LS1
  - 2nd prototype, optimized for the PSB will be installed in EYETS 16,
  - A pre-series installation in the PS was recently requested by LIU, and is under discussion
  - Then a series of ~22 to be manufactured with MME and qualified by VSC for installation in PSB, PS, SPS during LS2
  - An LHC bakeout compatible prototype for HL-LHC is also planned for LS2
- Project management
  - Design and production in collaboration with MME
  - Materials and components have been qualified by VSC
  - Industrialization and detailed design are in progress
  - Requires new, custom electronics and new cabling in all locations

Prototype installation in SPS

Laboratory validation

Example: New Beam Loss Monitoring for LIU

Development of up-to-date Beam Loss Monitoring Systems for the LHC Injectors. In short:

- Build a generic, highly configurable and high-performance system
- Flexible acquisition for multiple detector types
- Use reprogrammable parts to target all injectors' requirements

Progress summary:

- Design and pre-series production of all electronic modules completed
- Advanced Firmware and Software available
- Prototype installation with 36 channels in operation at PSB ring
- Validation of conformity to specifications is on-going with dedicated MDs.

PSB installation

Acquisition & Processing Rack

Summary of support requested from other groups

- MME
  - Currently planned projects see requests for at least 73 instruments that will be produced between now and LS2
  - Many designs are in progress with MME, most others are scheduled
- VSC
  - At least 79 instruments are expected to require vacuum qualification
  - Each will also require at least one leak test from the VSC sub-contractor
  - In addition, some 34+ sectors will need to be opened for maintenance tasks
- EL
  - 38 projects or instruments identified so far with 915 new cables
  - Cable requests (DIC) made for most major projects.
  - BI would appreciate an early reply from EL for these requests as it will have a major impact on installation priorities
- MPE-EM
  - Some 1500+ electronics card with 50+ different designs will be requested for production upto LS2
- BE-CO
  - Completion of controls upgrades to injectors and LHC
- Survey, transport and RP are always key partners for any installation activities

'*Known unknowns*' for LS2

- **Consolidation and operational issues arising between now and LS2**
  - Looking back, the LHC-BWS, LHC-BSRT, PS-BWS, gave issues during run 1
  - Other instruments, eg , LHC-BQS, and PS SEM grids revealed major issues when accessed during LS1
  - These lead to activities that are high priority but can be difficult to schedule and require specialised resources in BI
  - This added ~5 FTE-years of additional 'expert' work during LS1
- **New operational requests**
  - Beam instrumentation needs to respond to operational needs which can evolve during the run
    - Flexible instruments such as BLMs may need to be added or moved
    - Additional requirements may be imposed on existing instrumentation
- **Radiation damage to cables and other components,**
  - Experience from LS1, particularly in the SPS and target areas shows this is likely to cause additional cabling and electrical work

Planning and Resources summary

- We have agreed with MEF to integrate a (part-time) planner from MEF to assist with coordination of BI schedules
  - Have opted for pre-LS2 installation where possible, but some projects are limited by resources, development work, cabling or machine operation requirements
  - We need to maximise early interventions during LS2 to free-up personnel for commissioning
- Additional support from FSU is foreseen, but following LS1 experience this may need to be increased or complemented by other sources such as the Russian BLM team successfully used in LS1
  - Resource leveling across all machines plus between interventions and re-commissioning is key for BI
- Will need to re-prioritise closer to LS2
  - Requests for work and progress on projects will evolve upto (and through) LS2
  - This is a dynamic process!

Conclusions

- Activities for LIU and HL-LHC are well defined and followed-up with the project (schedules and resources)
  - There are many critical LIU milestones for LINAC4 connection in EYETS and energy upgrade in LS2
  - Options to advance work to earlier shutdowns have been fully exploited
  - Urgently need input from EL on which cabling campaigns can go ahead and when, to allow resource optimization in BI
- First estimates made for consolidation and maintenance, but this is still evolving and in some cases awaiting funding decisions
- A number of new activities will arise between now and the end of LS2
  - It is imperative that some slack is maintained in terms of planning and resources to cope with this (often high-priority) work
- We request a significant workload from other groups (in particular MME, VSC, EL, MPE, CO) but communications are good and improvements from LS1 have been implemented
  - More details are available in working documents used in coordination meetings
- Help from MEF and LS2 project management are essential for:
  - Managing schedules for the same resources across the different machines
  - Coordinating co-activities due to re-commissioning whilst shutdown still in progress in ‘downstream’ machines

Thanks for your attention

Thanks to the many, both inside and outside BI for their contributions and useful comments