

TE-ABT Activities for LS2

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LS2 DAYS

29-30 SEPTEMBER 2015

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

Overview

- Assumptions
- Main deliverables
- List of activities which take place and when
 - Maintenance
 - Consolidation
 - Projects
- List of interfaces (other groups)
- Comments on resources needed
- Concerns

Assumptions

- ELENA starts operation in 2016
 - Transfer line installation and commissioning in 2017
- Linac4 starts operation in 2016 (half-sector test)
- PSB 160 MeV H- injection system equipment ready for connection end 2016
- SPS 100 ns ion injection system is not planned for LS2
- LHC series installation of upgraded MKI kickers for HL-LHC still considered as “option” (i.e. not planned for LS2)

Main deliverables to end of LS2

- Essential **maintenance** of systems to ensure highest availability during operation
- **Consolidation** of aged, end-of-life or outdated equipment, to ensure reliable long-term operation
- New/upgraded systems for **projects**:
 - New 160 MeV H- injection system for PSB
 - Upgrade extraction/transfer/injection systems for PSB, BT line and PS, for 2 GeV beams
 - Upgrades SPS kickers, ZS septa and protection devices to cope with new beam parameters
 - Displacement and upgrade of SPS beam dump kicker system
 - Prototype upgraded LHC injection kicker MKI beam screen
 - Upgrade LHC beam dump triggering and diagnostics

Maintenance: Controls and electronics (across full complex)

Controls maintenance	YETS15/16	EYETS16/17	YETS17/18	LS2
Visual inspections of racks and connectors				
Re-calibration of sensors				
Checking of interlocks, connections and safety related systems				
Replacement of damaged, defective or outdated cards				
Upgrade of software (FESA, PLC, Supervision, Expert)				
Rotation of spare and operational electronics modules				
General maintenance (new functionalities, small repairs & modification)				

Maintenance: Kickers (across full complex)

Kicker maintenance	YETS15/16	EYETS16/17	YETS17/18	LS2
Visual inspections, verification of fluid and gas levels				
Endoscopic inspections (MKD generators)				
Replenishment and repairs of hydraulic fluid leaks				
Dismounting and checks of high current contacts				
Checking of interlocks and safety related systems				
Electrical and magnetic measurements and recalibrations				
Replacement of aged or defective switches (thyratrons, FHCTs)				
Measurement and recalibration of terminating resistor loads				
Sublimation (MKI kickers)				
General maintenance (new functionalities, small repairs & modification)				

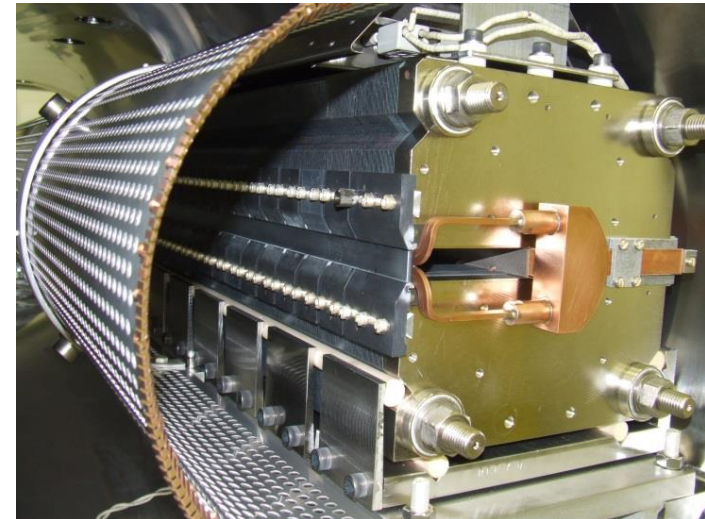
Maintenance: Septa (across full complex)

Septa maintenance	YETS15/16	EYETS16/17	YETS17/18	LS2
Visual inspections of striplines, connectors and hydraulic systems				
Replenishment and repairs of hydraulic fluid leaks				
He pressure/leak tests of hydraulic coil cooling circuits				
Emptying of MST/E water circuits, cleaning of filters				
Regeneration of 3M fluorinert dielectric liquid for HV feedthroughs				
Replacement of end-of-life HV cable				
Preventive exchange of end-of-life septa *				
Full-movement tests and re-calibration of position sensors				
HV conditioning checks for HV septa				
General maintenance (new functionalities, small repairs & modification)				

Maintenance: replacement of septa

- YETS 15/16
 - SMH.42 PS proton injection septum
 - SMH.16 PS proton extraction septum
 - SEH.31 PS CT ES septum
- EYETS 16/17:
 - SEH.23 PS East hall extraction septum
 - 6 MSE septa in SPS LSS4
 - SMH.42 PS proton injection septum
- YETS 17/18
 - SMH.16 PS proton extraction septum
- LS2
 - 1 MSE septum in SPS LSS2

New MST SPS extraction septum



Consolidation

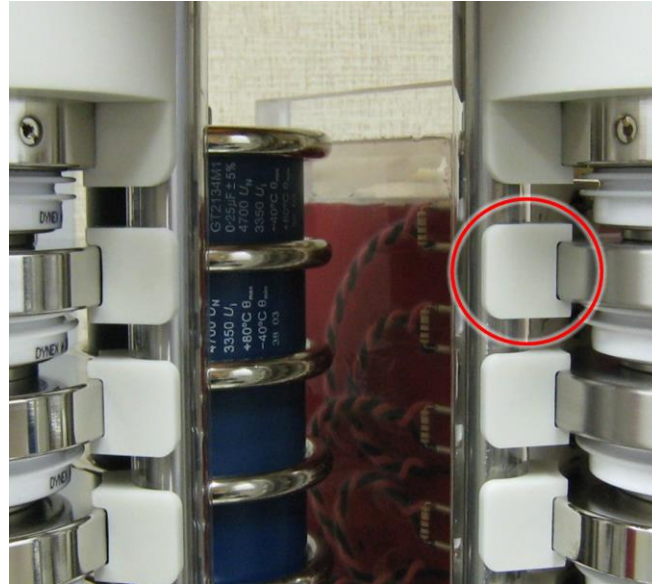
Machine	Location	Consolidation item	YETS 15/16	EYETS16/17	YETS 17/18	LS2
LHC	P2, P8	MKI injection kicker fast interlocking and protecton (x8 MKI)				
LHC	P6	MKD kicker generator switch HV consolidation (x30 generators)				
LHC	P6	MKB dilution kicker generator switch HV consolidation (x20 generators)				
LHC	P6	MKD/MKB electronics and controls consolidation				
SPS	LSS1	Exchange of MKP4 (x1 magnet)				
SPS	LSS2	Pulling of new 300 kV HT cable for ZS septa				
SPS	BA1,2,4,6	Safety-related consolidation of electronics and controls				
PS	B359	Refurbish KFA71-79 proton extraction kicker hydraulics				
PS	B359, 365	Consolidate KFA45 and KFA71-79 proton kicker electronics and controls				
PS	B359,B367	Reconfigure CT/MTE electronics and controls				
PS	B359, 365, 367	Safety-related consolidation of electronics and controls				
PS	B359	Consolidate PS septa electronics and controls				
AD	B195	Restart 450 kA horn test bench				
AD	B195	Consolidate electornics and controls for ignitron eradication				
ISOLDE	B179	Consolidate modulator power supplies				

Major consolidation: LHC MKD generator switches

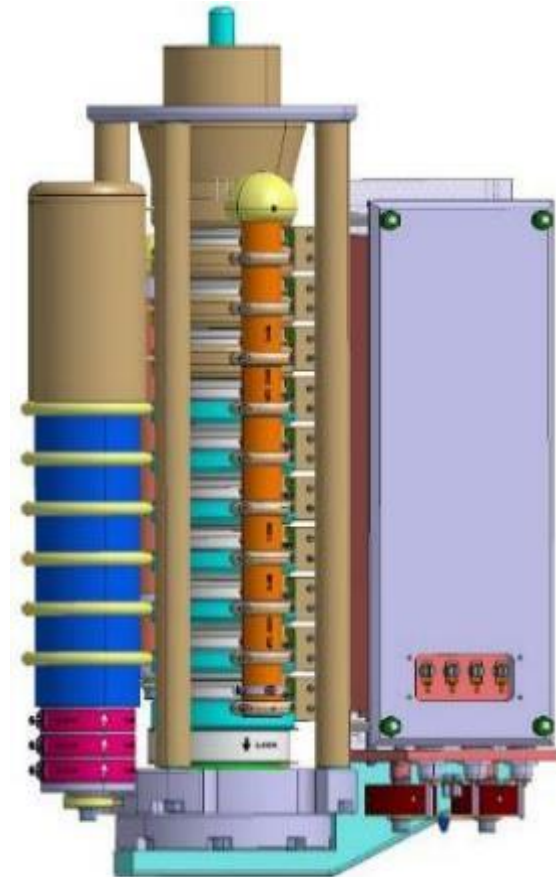
MKD generators in UA67



Weakness in HT insulation in GTO switch stack



New 30 kV MKD GTO switch stack

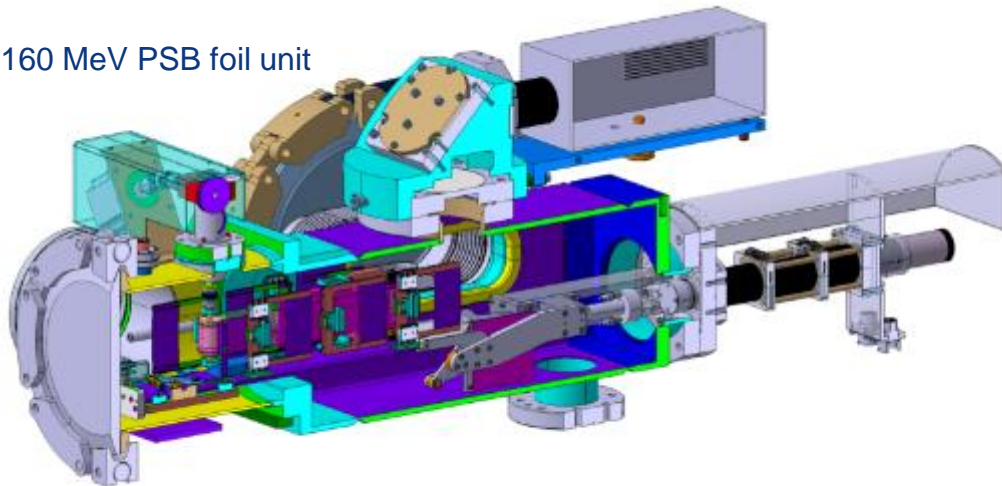


- In UA63/67
- 30 Generators (plus 4 spares)
- 68 HT switch stacks
- 680 individual GTO wafer switches
- Needs removal and refurbishment of installed generators
- In parallel with HL-LHC triggering/control improvements

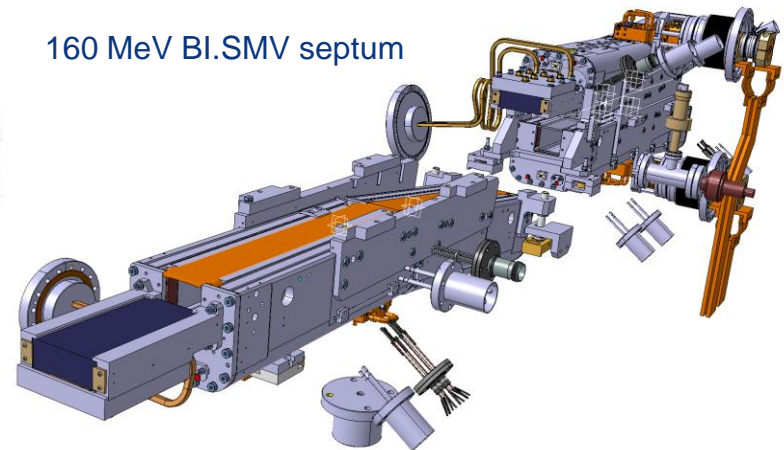
Projects: LIU-PSB 160 MeV H- injection

Machine	Location	LIU item	YETS 15/16	EYETS16/17	YETS 17/18	LS2
L4		Injection chicane test stand installation + half sector test	During 2016			
L4-PSB	BI line	160 MeV transfer line distributor BI.DIS				
L4-PSB	BI line	160 MeV transfer line septum BI.SMV				
PSB	16L1,1L1	160 MeV injection bumpers KSW (x16)				
PSB	1L1	160 MeV injection chicanes magnets BSW (x16)				
PSB	1L1	160 MeV injection foil handlers (x4)				
PSB	1L1	160 MeV injection system support structures (x4)				

160 MeV PSB foil unit



160 MeV BI.SMV septum

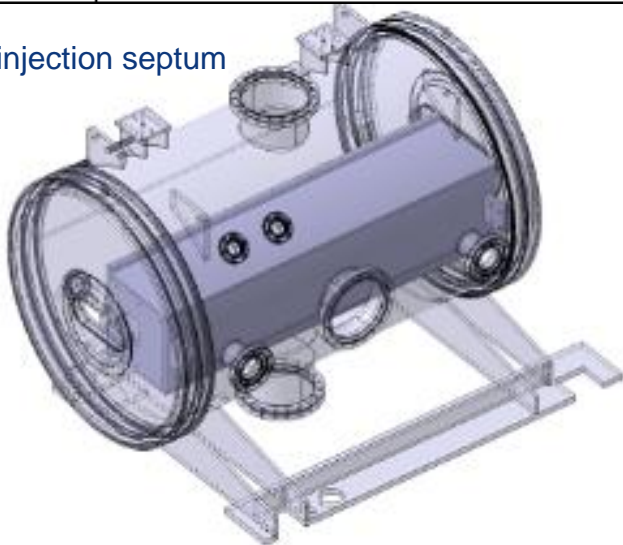


- 160 MeV H- injection equipment still on track for completion at end 2016, in case of anticipated Linac4 connection

Projects: LIU-PSB/PS 2 GeV transfer

Machine	Location	LIU item	YETS 15/16	EYETS16/17	YETS 17/18	LS2
PSB	14L1	2 GeV extraction kicker KFA14				
PSB	15L1	2 GeV extraction septum BE.SMH15				
PBS-PS	BT line	2 GeV BT line recombination kickers KFA10 (x2)				
PBS-PS	BT line	2 GeV BT line recombination kicker KFA20				
PBS-PS	BT line	2 GeV BT line recombination septa SMV.10 (x2)				
PBS-PS	BT line	2 GeV BT line recombination septum SMV.20				
PS	45	2 GeV injection kicker KFA45				
PS	42	2 GeV injection septum SMH42				
PS	42	2 GeV injection bumper BSW42				

2 GeV PS injection septum



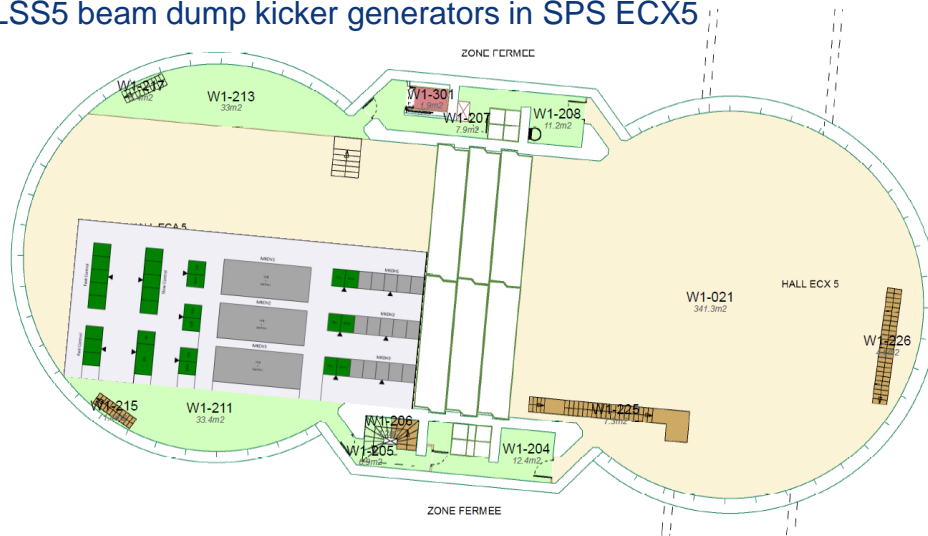
PS injection kicker generators



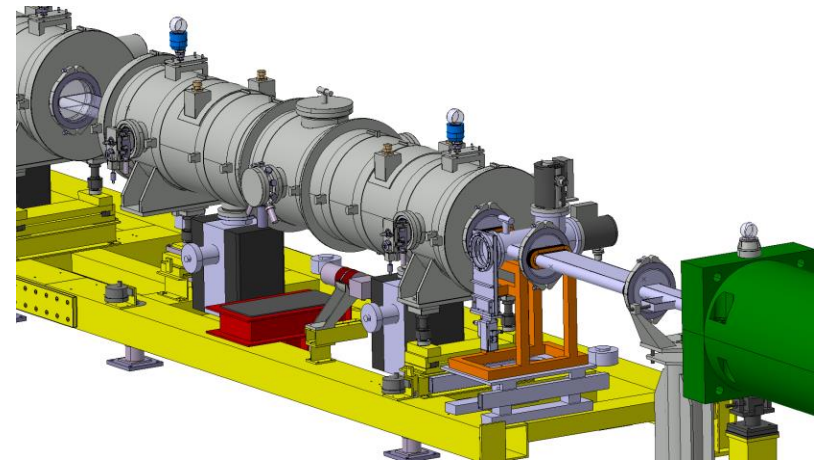
Projects: LIU-SPS upgrades

Machine	Location	LIU item	YETS 15/16	EYETS16/17	YETS 17/18	LS2
SPS	LSS4,ECA4	Reconfiguration MKE LSS4 extraction kickers				
SPS	LSS5	Beam dump system displacement to LSS5 (MKDH and MKDV kickers)				
SPS	LSS1	Reconfiguration LSS1				
SPS	LSS1	Injection kicker MKP beam heating mitigation				
SPS	LSS1	Electrostatic septa ZS impedance reduction				
SPS	LSS1	Electrostatic septa ZS ion trap upgrade				
SPS	LSS4, 6	Extraction protection device TPSG upgrade				
SPS	LSS4, 6	Extraction kicker MKE impedance reduction				

LSS5 beam dump kicker generators in SPS ECX5



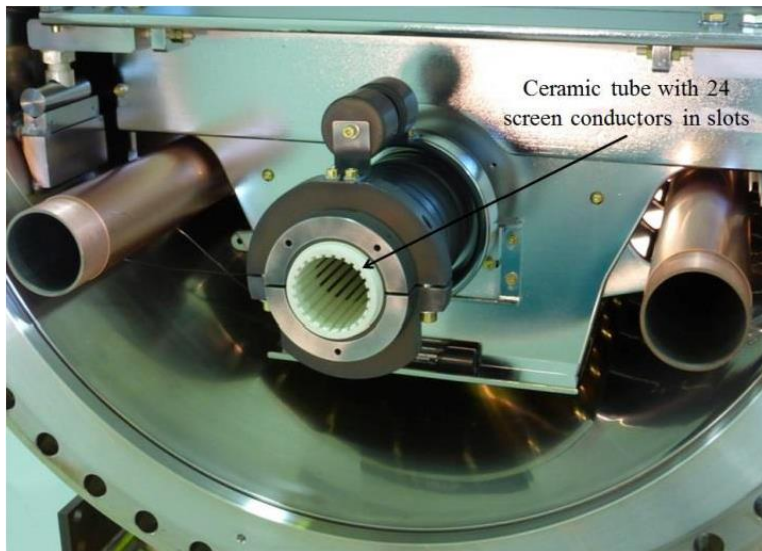
ZS septa with pumping on vacuum tank



Projects: HL-LHC

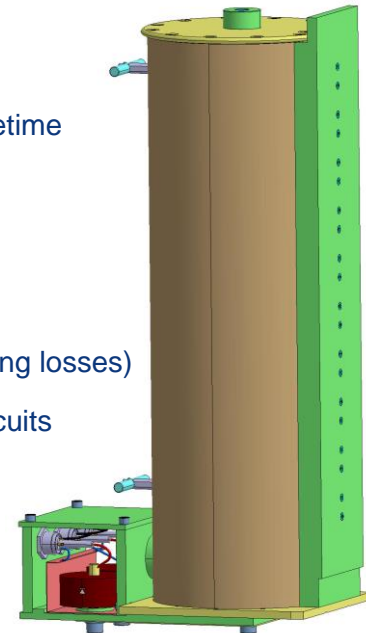
Machine	Location	HL-LHC item	YETS 15/16	EYETS16/17	YETS 17/18	LS2
LHC	P2/P8	Install prototype MKI with upgdgraded beam screen				
LHC	P2,P8	Refurshishment MKI (x8) with upgdgraded beam screen (option)				
LHC	P6	Upgrade of MKD switch trigger transformers (x60)				
LHC	P6	Upgrade of MKB switch trigger transformers (x20)				
LHC	P6	Upgrade of MKD generator electronics and controls (x30)				
LHC	P6	Upgrade of MKB generator electronics and controls (x20)				

MKI injection kicker showing ceramic beam screen



Trigger transformer upgrade:

- Larger switching current to improve GTO lifetime
- Reduced stray inductance
- Pin compatibility with present version
- Reduction of T_{rise} by ~ 100 ns
- Increase of $I_{ref100\%}$ by ~ 1 % (less switching losses)
- Secondaries with independent magnetic circuits



Interfaces (maintenance, CONS, projects)

- TE-VSC: vacuum components, acceptance and leak tests
- TE-EPC: connections, tests, power supplies, consignment
- TE-MPE: interlocking upgrades, tests, BIS loops
- EN-HE: handling jigs, magnet + generator exchange and transport
- EN-EL: electrical distribution, cabling and decabling (incl. HV)
- EN-CV: hydraulic circuits and modifications, interventions
- EN-MME: production of components and assemblies
- EN-MEF: configuration, integration, alignment and survey
- EN-STI: materials tests and validation, AD horn striplines/test
- EN-ICE: PLC and PXI support for deployment
- BE-BI: integrated instrumentation
- BE-CO: standards, software versions, test periods, modules, FECs
- BE-OP: recommissioning and tests
- DG-RP: WDP, interventions, classification, storage
- GS-SE: infrastructure modifications, CE

Resources

- FTE: covered for presented baseline, provided posts requested in present strategic manpower plan (MPP) are allocated including new FLEX needs
 - Need posts opened in 2017 to be ready for LS2
- Options/non-baseline items are not covered
 - Series HL-LHC MKI upgrade
 - 100 ns SPS injection system for ions
- FSU: will require increase in effective from ~13 to ~17 on the ABT part of TE05 and TE08 during LS2
 - Need to be hired in 2018 for training

Concerns

- The “maintenance” lists and manpower do not take into account any elements that may need additional work due to problems observed between now and LS2. Typically we have 30% more work in reality (which invariably impacts planned CONS items)
- During LS2 will there be a recabling of SPS LSS2, to replace radiation damaged cables?
 - Last campaign was in the winter stop 2008/9: cable lifetime to analyse
 - Zone is much more activated in 2015 with more protons to NA
 - In LS2 all ZS will be dismantled for upgrade
 - Strong ALARA justification for all groups concerned
 - FTE/FSU resources for this not counted in foreseen maintenance planning
- Lacking space for workshop and temporary storage: needed for work preparation and assembly. Urgent to solve this now, in time for LS2
- Most equipment manipulation linked to high remnant doses (in range of 10 μ Sv/h to 10 mSV/h on some devices)
 - Crucial to plan globally timing and details of interventions accordingly, with best knowledge of expected activation levels.

Concerns: re-commissioning after LS2...

...is going to be a big challenge

- Completely new type of injection system in all 4 PSB rings
 - All PSB to PS transfer elements upgraded or new, for 2 GeV
 - A new SPS beam dump system to commission
 - Plus the other new systems to bring up in parallel in all injectors, like main SPS RF
 - Expert resources required for re-commissioning of injectors while LHC LS2 shutdown activities still be ongoing (Q2/Q3/Q4 2020). Priority and strategy to be clearly defined.
- Thorough preparation and coordination of equipment and beam re-commissioning will be essential

Summary

- LS2 will be very concentrated
 - Full maintenance activities after long running period
 - Large consolidation program
 - Many LIU-critical project deliverables
 - All ABT equipment will be “touched” and will require a full re-commissioning.
- Resources planned are adequate for baseline activities
- Concerns (e.g. temporary storage) should be addressed now, in time to find solutions
- More detailed lists and resource breakdowns on <https://edms.cern.ch/document/1549705/1>



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