



LS1 start-up experience

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OUTLINE

- LS1 main modifications
- Schedule
 - Hardware test
 - Cold check-out
 - Set-up with beam
- Summary

LS1 main modifications

- New access system
- Extensive machine re-alignment
- New main dump (=> ejection line dismantled)
- New digital RF control system and transverse feedback modifications
- Power supply renovation
 - FGC3 (renovate to FGC3s 94 multipoles in addition to already renovated 32 orbit correctors)
 - POW-V (GM) -> MIL1553 (FESA)
- Controls upgrade
 - Change of many FECs (~**75%** of ALL PSB FECs renovated!)
 - OASIS new FECs (15), new scopes (30), new MUXs (6), new cabling (600 analog signals).
 - Commissioning done by PSB operators before the hardware test.
 - Timings: 82 CTRVs and ~500 LTIM devices
 - INCA server, LSA database
 - GM to FESA migration, new FESA classes
 - RF, Pow, Timings, Kickers, functions
 - Remark: Controls piquet service has been stopped
- New extraction BIC (first BIC for PSB)
- Upgrade of diagnostics (BLMs, orbit, BPMs + BCTs in transfer lines)
- Limited cabling campaign and cable identification
- Some civil engineering work and upgrade of lifting equipment

Schedule

- Hardware test (5 weeks)

April																					May													
W14					W15					W16					W17					W18														
31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4
Hardware					Tests																													

- Cold check-out (3.5 weeks)

May																											
W19					W20					W21					W22												
5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1
PSB cold check-out																											

- Set-up with beam (3 weeks)

June																																		
W22					W23					W24					W25					W26														
26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
					Setting-up 4 rings low intensity H=1 4Rings = 400E10 (3 turns)					Setting-up higher intensity 4rings = 3000E10					Beam to the PS																			

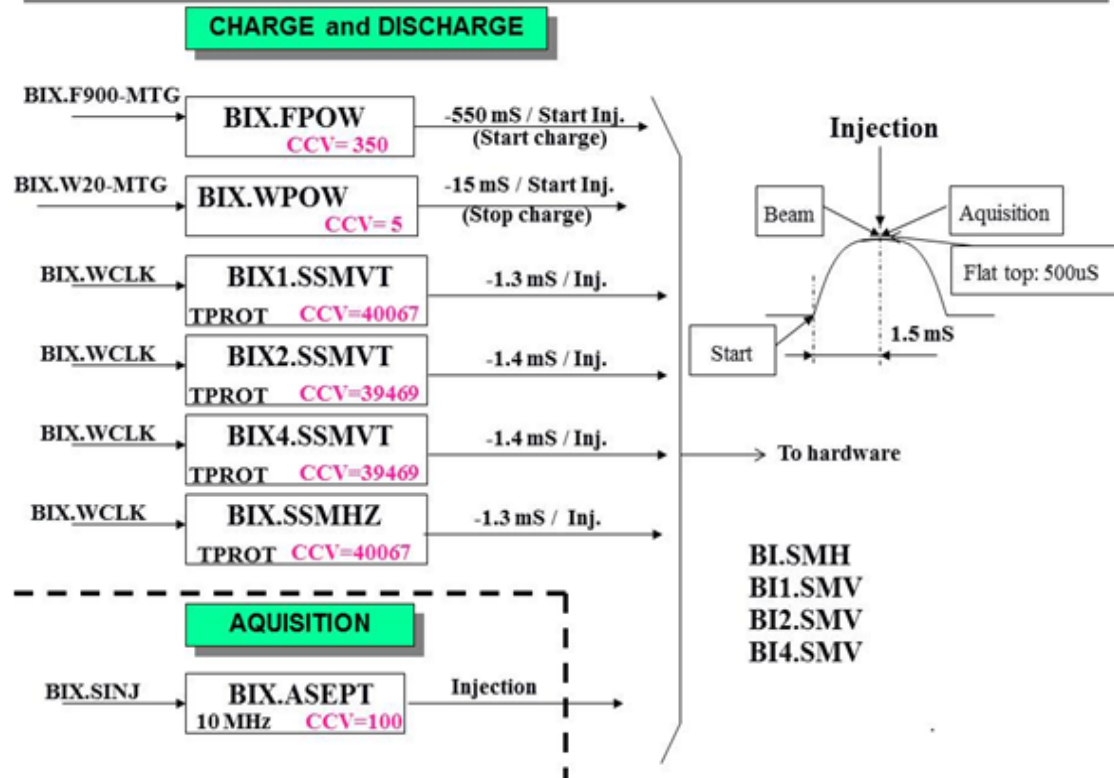
Hardware test

- One PSB operator was available in the CCC from 6h to 21h to ensure support for the hardware tests (under equipment responsibility) and dry-runs (organised by BE-CO).
 - 2014-04-09 - Dry Run - PSB PowM1553, CBMIA
 - 2014-04-15 - Dry Run - PSB PowM1553 All Power Converters
 - 2014-04-16 - Dry Run - PSB FGCs RDA2 and RDA3
 - 2014-04-24 - Dry Run - PSB FGCs RDA3 (2nd)
 - 2014-04-29 - Dry Run - PSB Septum
 - 2014-04-28 - Dry Run - PSB Kickers
 - 2014-04-28 - Dry Run - PSB FGCs RDA3 (final)
 - 2014-04-28 - Dry Run - PSB BI
 - 2014-04-30 - Dry Run - PSB RF
- Septum leak intervention
- Main issues
 - CO configuration tools missing (CCDB to LSA)
 - Responsibilities after controls philosophy change

Cold check-out

- 3.5 weeks for the PSB
- 3 shifts per day including
- OP organized the cold
 - Checklists covering
 - Injection (quads, beam)
 - Main Power Supply (m)
 - Including Trim power
 - Ring: Transverse shave
 - Ring: FGCs (orbit corre)
 - Extraction (quads, be)
 - Beam instrumentation
- Daily evening meeting progress/issues

TIMING INJECTION SEPTA: BI1,2,4.SMV & BI.SMH



Trig-Acquisition	BIX.ASEPT	c:275
Trig-Warning	BIX.WPOW	C:260
Trig-Forwarning	BIX.FPOW	C:-275

Devices	Min	Max	Ref	Knobs	PPM	Trig-Start	Timing	Laser	OASIS	Signal
BI.SMH	2000	3500	3118			BIX.SSMHZ	C:273.7		BI.SMH1L1-AS	
BI1.SMV	10000	20000	17790			BIX1.SSMVT	C:273.7		BI1.SMV-AS	
BI2.SMV	10000	17000	14220			BIX2.SSMVT	C:273.6		BI2.SMV-AS	
BI4.SMV	10000	17000	14140			BIX4.SSMVT	C:273.6		BI4.SMV-AS	

Setup with beam

- First beam in the machine rapidly
 - Monday 2nd June first beam injected into the BI line around lunchtime
 - First beam (1 turn; 40E10) injected in R3, lost after 5 ms
 - In the afternoon small intensity accelerated in all 4 rings
 - Tuesday optimising injection, debugging instrumentation, RF setting-up
 - Wednesday ejection to the new dump
- First beam sent to the PS 17th June (3 days earlier than in planning)
- 2.5 months after first beam, we were still not at nominal performance (ISOGPS 2600E10ppp; should be ~3200E10ppp).

Main issues at restart with beam

- Access system: many issues concerning all machines; several lost patrols, etc.
- Beam stoppers: cabling to the External Conditions was forgotten in the renovation specifications and thus not present, which led to beam being dumped on the beam stoppers
- Cotton in the cooling circuits of the main magnets, led to overheating of two magnets and tripped the MPS
- Short circuit on BT.BHZ10; longer intervention
- BTY line quadrupole and steerers with inverted polarity
- Wrong alignment of the injection line pick-ups and wrong/forgotten alignments of several ring magnets
 - Despite steady push alignment data available in GEODE only very late -> cross-check of alignment results not possible
 - Some magnets cannot be aligned due to inaccessible alignment screws -> being followed up now
- No acquisition of new injection BPMs available (new system)
- No extraction BPM acquisition available (FESA class not ready); steering with analogue signals
- SEM grid vertical plane not working
- Some issues with applications
- BLMs: several BLMs not working
- FGC3s had many issues (acquisition, ppm copy, communication problems...)
- ISOLDE line bending magnets pulsing at wrong values, in particular critical for BTY.BVT301, which switches between the two targets (only BIC prevented sending beam to the wrong target...)

General remarks

- Systematic check by operators of each OASIS channel with test signal during HW commissioning proved extremely beneficial
- Hardware commissioning should be improved for certain systems; operations team has not much information of what gets checked by equipment specialists
- Magnet polarity measurements should be done in the future
- More rigorous application checks needed
 - Already very extensive check-out list should be extended (also including other systems not on the list)
- Interlock checks (BIS, SIS, EC) have to be added to procedures
- After long shutdown many equipment experts took their well-deserved vacation, but this sometimes led to problems during restart (many single-expert systems!); also avoid restart during holiday periods if possible

Summary

- First beam in the machine rapidly
 - Instrumentation not full operational at startup; still following up issues with certain new instruments
 - Controls changes went relatively smooth on CO side, but the problems were handed over to equipment groups that were often too late with their developments, also because the CO tools were not ready in time
- The nominal performance took longer
 - Issues due to incomplete/wrong alignment influenced machine performance until the restart 2015
 - Digital LL-RF commissioning took ~6 months (see A. Findlay's presentation MSWG 24/04/2015) with final performance only now (but excellent support from RF team!)