

PS Beam Commissioning Schedule

Frank Tecker, BE-OP

Many thanks to

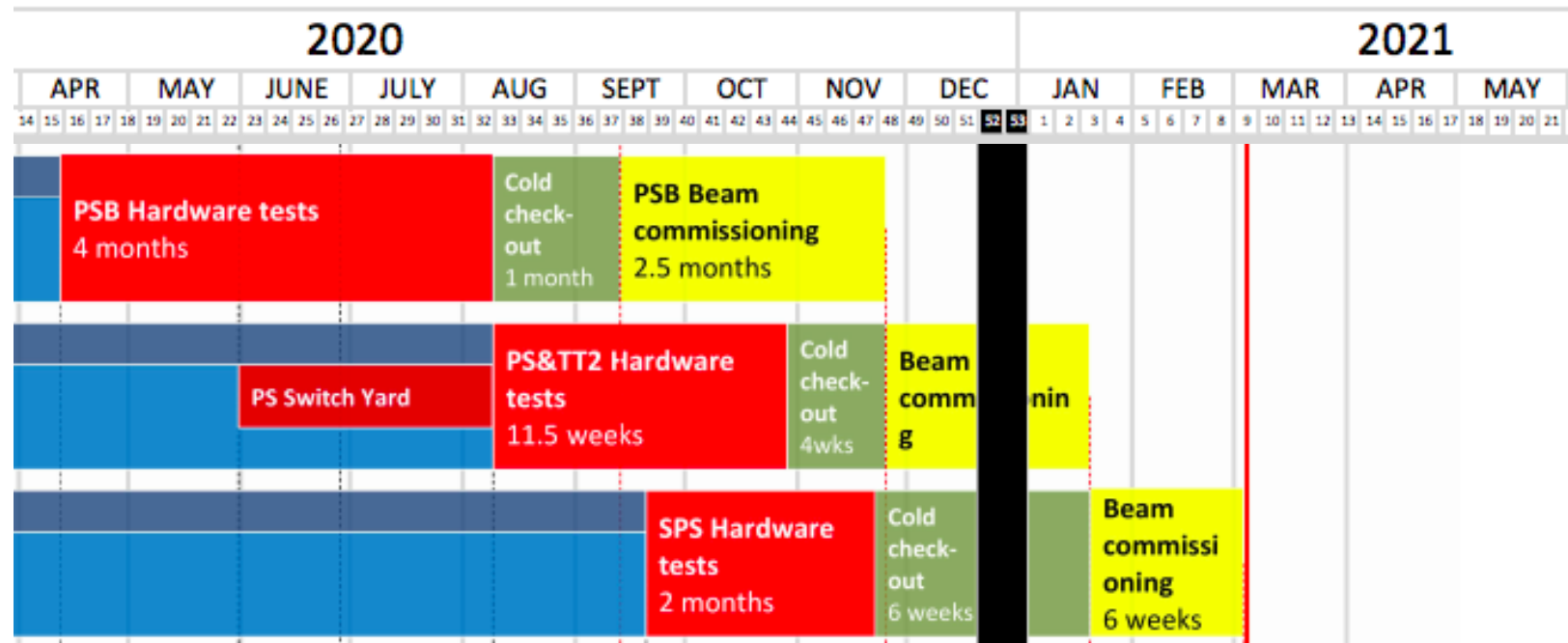
D.Cotte, H. Damerau, M.Delrieux, O.Hans, A.Huschauer

LS2 Master Schedule

- 6 weeks foreseen for PS beam commissioning
- Interrupted by 2 weeks Christmas shutdown !!!
 - Keep service running (CO, water, etc.)
 - No lock-out
 - Access system by TI
 - Holidays

=> effective 4.5-5 weeks

- Fast restart examples
 - 2010 AMS run
 - 2013 Jan restart



Beams required

- SPS (from week 3/2021) (from K.Li's presentation)
 - LHCIndiv
 - MTE low intensity (core only, $5e11$, $2\mu s$) after 1 week
 - MTE low int (islands only, $5e12$, $8\mu s$) after 2 weeks
(can we use full MTE?, island only not 'clean' in the PS, loose core)
 - LHCProbe after 3 weeks
 - Multi-bunch beams (12b, 24, 36, 48, 72) after 3 weeks
 - Standard or BCMS? (not big difference for the PS RF)
 - MTE full beam after 4 weeks
- NTOF from week 3/2021 (new target, assume intensity ramp-up later)
- AD from week 12/2021 (RF side should follow other beams)
- EAST from week 18/2021

Assumptions / Prerequisites

- Hardware tests/Cold checkout finished, all possible tests without beam done
 - New injection equipment (polarity,...)
 - BPM alignment offsets after main unit renovation
 - new RF beam control validated without beam, existing one prepared for beam, 10 MHz cavity phasing
 - Interlocks (new internal dump, interlock when in chamber to PSB extraction BIC + SIS interlock, interlock from BCT (TOF parasitic beam on EAST not extracted), BLM,...)
 - External conditions (will have been renovated), some will have to be done when EIS are working
 - Optics definitions, YASP configuration
 - Magnetic checks of PFW circuits foreseen
- Injection line PSB->PS commissioned up to BT dump
 - known Twiss parameters
 - BTP line magnets polarity checks, HW tests done
- 2 GeV injection cycles prepared (had a first check for RF already)
 - Shorter ramp time needed (~30 ms less)
 - POPS regulation should allow first ramp up modification
- Plan in DSO tests for SPS, TOF, (AD, EAST later), ...

Injection (~2 weeks)

- First beam: TOF-like low intensity, LHCIndiv
- Coarse B-field setting
- BTP line commissioning (30m, 6 quadrupoles)
 - BPM setup (should be like BT)
 - Kick response
- BPM commissioning, first turn, orbit
- Injection bump setup
 - First delay and amplitude optimization, bump closure (YASP, MatLab tool)
 - To be redone after main magnet alignment with synchronization measurements
- kick response matrix measurements
 - corrector polarity, low energy quads
- Multi-turn SEM grid measurement (dedicated time, circulating beam $< \sim 30$ turns)
 - Essential for injection matching
 - (kick strength to kill the beam to be verified)
 - Interleave with other commissioning (time for analysis needed, maybe several iterations)
- Commissioning low-beta injection quadrupoles (large emittance beams) later

Initial RF setup (~1-2 weeks) – Orbit alignment

- New RF beam control from the start
- Old system kept as much as possible as back-up, can be switched PPM
- RF capture, acceleration
- Transition crossing
- single bunch acceleration to 14/26 GeV

- Orbit check at 14 GeV for main unit alignment (40 MU refurbished)
 - Measure orbit, calculate magnet movements
 - Align the magnets
 - Remeasure orbit

- k-modulation for low-energy quads

Transverse Feedback

- Upgrade during LS2
 - Digital control (similar to PSB)
 - Power amplifier
- Standard HW-check verification of knob, functions (gain, tune offset), BPM attenuation and gain procedure, kicker response
- Essential for MTE and LHC beams
- Commissioning with expert
- Measure/optimize damping time of injection oscillations
- 1-3 days for a beam - in parallel with other activities

Extraction / TT2

- Most critical for MTE beam
- Depends very critically on orbit at dummy septum 15/septum 16!
- Very limited orbit correction at high energy (3 correctors)
- We will consider it when aligning the main magnets
 - Could require another iteration of main unit movements (+2/3 days)
- Optimize the shadowing TPS15/SMH16 with diamond BLMs
- Final setup for all other beams after MTE

- TT2 setup, kick response, Twiss parameters (SEM)
- TOF beam to D3 dump

Further RF setup

- 1 week 200 MHz set-up – blowups for high intensity beams
 - New system - Old system as backup
 - at least 2 days for cavity setup
- 2-3 days 40/80 MHz cavity with new controller (LHC beams)
- 2 days 10 MHz 1-turn delay FB (for multi-bunch)

New Instrumentation post-LS2

- **Wire Scanners** (all new, old ones removed, 54H,64V,65H,68H,85V)
 - Extensive cross-check campaign done for 54H
 - Commissioning needed with BI experts present
- **(Turn-by-turn) SEM grids**
 - 1st prototype successfully tested
 - 2 more to be installed and commissioned
 - kick strength to kill beam to be verified
 - New 'Ralentisseur' final verification with beam
- **BLMs**
 - Work well in the PS ring, higher bandwidth, higher sensitivity, no saturation
 - TT2/TT10, FTN, (EAST) need to be commissioned
- **BGI** (not critical for commissioning)
 - Horizontal gave very promising results
 - FESA class to be finalised, application being written
 - Vertical (SS84) to be commissioned

Global planning (some items interleaved)

- **Week 1-2** (TOF-like low intensity, LHCIndiv)
 - DSO test, Interlocks, Ext. conditions, BTP, Injection, bumper, LE orbit, kick response, dedicated injection matching
 - BPMs, SEM grids, wire scanners, TFB
 - Phase loop lock before injection, RF capture, radial loop, acceleration
- **Week 2-3**
 - RF transition crossing, single bunch to 14/26 GeV, 14 GeV orbit alignment, extraction, TT2
- **Week 4** (MTE core/islands)
 - 200 MHz setup (blowup for high-intensity beams)
 - Stop beam for Christmas shutdown (Wed/Thu?)
- Christmas shutdown
- **Week 5**
 - Restart and recover previous commissioning state
 - Finalize LHCIndiv/LHCprobe and TOF setup, continue MTE
- **Week 6** (start multi-bunch LHC setup)
 - 40/80 MHz cavity with new controller
 - 10 MHz 1-turn delay FB (for multi-bunch)
- Later AD, EAST

Remarks

- Equipment groups work mainly during daytime, it would be **essential** to have the beam **commissioning coordinators** also **on normal working hours** (at least during the first 6 weeks of the start-up).
This would improve communication and would help everybody to keep up with planning changes according to the technical progress
- More time needed between TOF/EAST beam permits and physics start!
 - Had delays on the experimental zone readiness this year -> delayed beam permit
- Reference magnet
 - measurement system dis-/reassembled
 - Setup with eddy current compensation card in reference magnet (was not present this year)

Conclusion

- Hardware commissioning progress very important
- Christmas shutdown needs to be incorporated as well as possible
 - Reduces effective time
- A lot of new essential equipment and instrumentation needs to be commissioned
 - RF beam control
 - Transverse feedback
 - Wire scanners
 - Multi-turn SEM grids
- Should be able to get the required beams ready in time for the SPS if there are no major hiccups