

OVERVIEW OF THE MDs IN 2008

E. Métral

**NEW
STRUCTURE!**

- ◆ **3 types of Machine Developments (MDs)**
 - **In parallel with physics** (working days from 08:00 to 18:00): PSB/PS/"SPS"
 - **5 "Wednesday" dedicated MDs** (08:00 - 16:00)
 - **3-day injector MDs, with or without beam to LHC** (72 h from 08:00 to 08:00)
- ◆ **Distribution of the dedicated MD sessions in 2008 is available on the web in the accelerator schedule:** <http://ab-div.web.cern.ch/ab-div/Schedules/Schedule2008.pdf>
- ◆ **Form available on the web to submit MD requests:** http://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/MD_request_form_last.htm
- ◆ **Form available on the web to submit MD results:** https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/MD_Results_form.htm

REMINDER CONCERNING THE ORGANIZATION

- ◆ **Results and steering** \Rightarrow APC
- ◆ **As in 2007 I will organize** ~ weekly meetings to discuss the planning of the next week's MDs + **weekly discussions with Rende for the supercycles**
- ◆ **It is very important for me to have an idea of the MD results to steer accordingly the next studies** \Rightarrow Please fill the web form asap after the MD!

2008 Injector Accelerator Schedule Draft

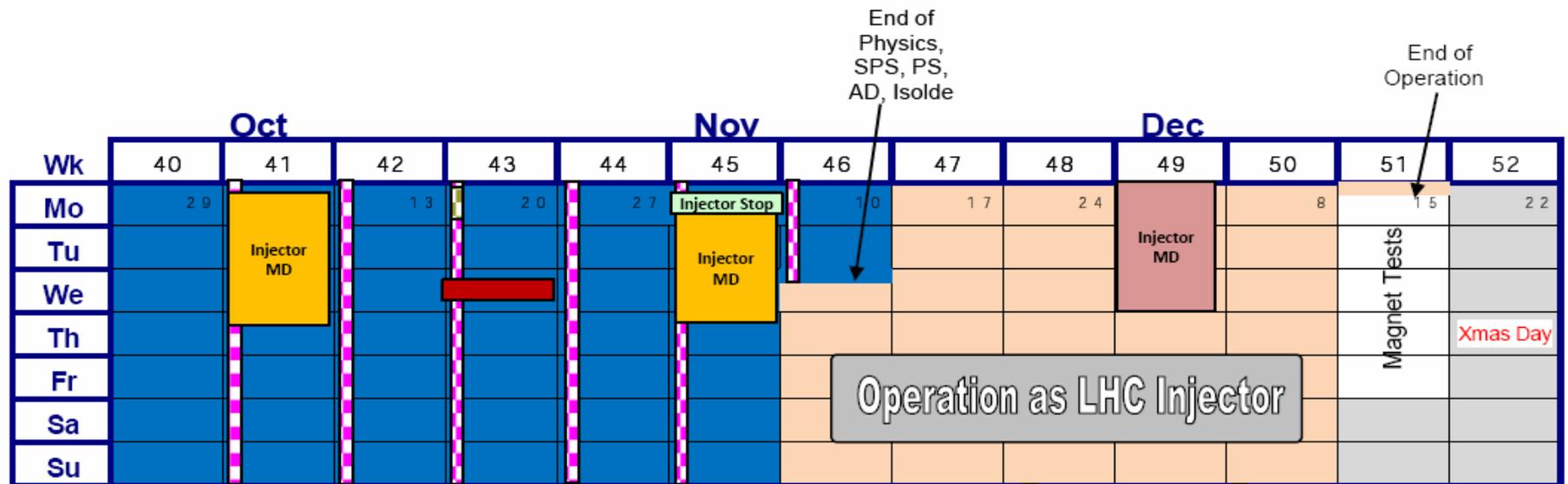
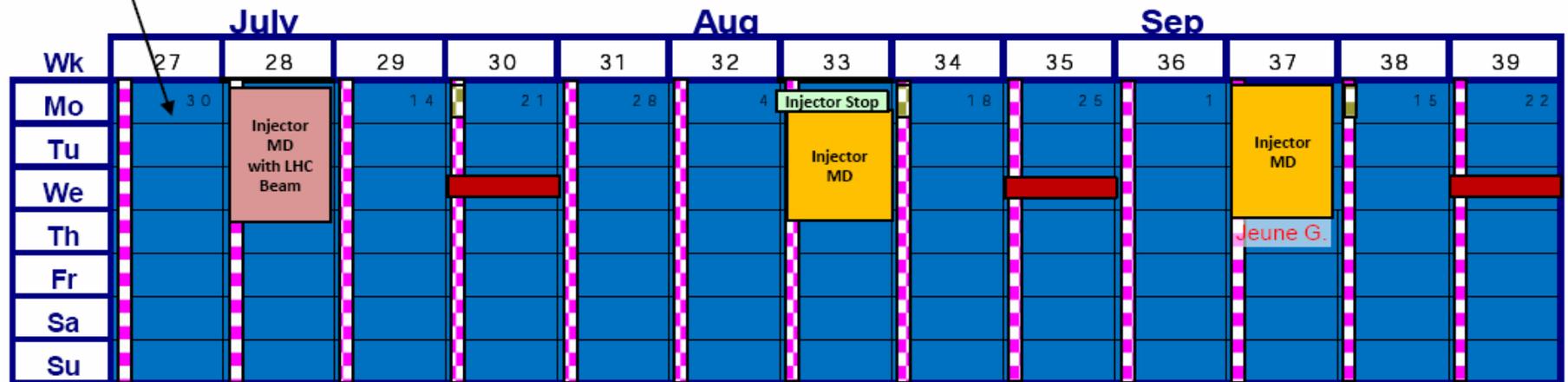
	Jan				Feb				Mar																
Wk	1	2	3	4	5	6	7	8	9	10	11	12	13												
Mo		7	14	21	28	4	11	18	25	3	10	17	Easter ²⁴												
Tu	1	400 kV EL Substation Maintenance				Shutdown																			
We																									
Th																									
Fr																								G. Friday	
Sa																									PS Magnet Tests
Su												Linac2 HW Tests													

	Apr				May				June				
Wk	14	15	16	17	18	19	20	21	22	23	24	25	26
Mo	31	7	14	21	28	5	Whit. ²	T12/TI8 ⁹	26	2	Injector Stop	16	23
Tu	Linac2 HW Tests		PSB Machine Checkout		SPS Machine Checkout			Setup with Beam			SPS Scrubbing Run		
We													
Th	PSB HW Tests		PS Machine Checkout		1 May/AS								
Fr				SPS HW Checks									
Sa	PS HW Tests												
Su													

Linac2 Start with Beam
 PSB Start with Beam
 PS Start with Beam
 Beam to Isolde
 SPS Start with Beam
 Isolde Physics Start
 LHC Startup with Beam
 East Hall Start
 North Area & CNGS Setup
 SPS Physics Start
 AD Start with Beam
 Start AD Physics



MTE Available for Commissioning



End of Physics, SPS, PS, AD, Isolde

End of Operation

Operation as LHC Injector

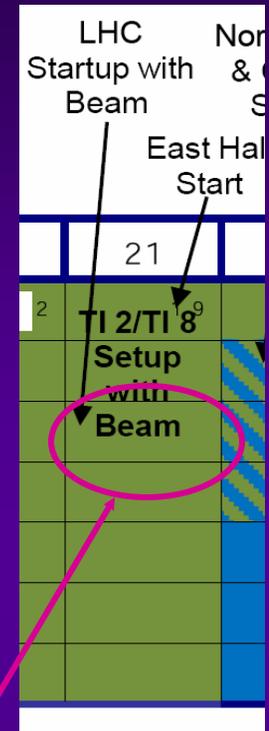
- Injector complex MD (parasitic Physics beams may be available)
- Injector Complex MD with Beam to LHC
- MTE Setup and Development with Beam to LHC
- Injector Stop Technical Stop for the Injector Chain
- Weeks with MTE commissioning without extraction
- AD Physics
- AD Setting-up & Studies
- nToF Physics

OUTLINE

- ◆ **TI2 / TI8 setup with beam**
- ◆ **May 21st : Commissioning of the LHC**
- ◆ **MTE commissioning in the PS**
- ◆ **SPS scrubbing run**
- ◆ **Main SPS supercycle foreseen in 2008**
- ◆ **Main studies**
 - **LINAC2**
 - **PSB**
 - **PS**
 - **SPS**
- ◆ **Summary of the required beams**
- ◆ **Summary of the required SPS cycles**
- ◆ **Use of the SPS cycles in the different Long MDs**
- ◆ **Preliminary MD planning during the Long MDs**
- ◆ **Preliminary MD planning during the 5 “Wednesday” MDs**
- ◆ **Preliminary // MD planning**

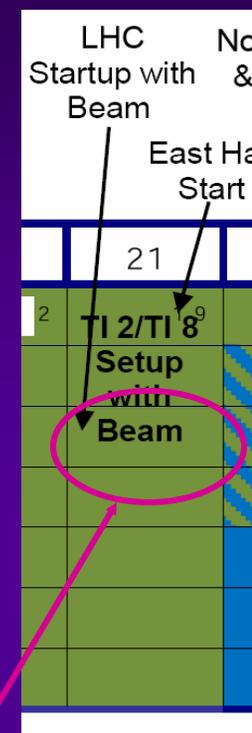
TI2 / TI8 SETUP WITH BEAM

- ◆ Commissioning by OP crew in collaboration with the experts, up to 72 LHC bunches (1 injection) for LHC transfer line
- ◆ For the commissioning of higher intensity beams and further interleaved cycling tests \Rightarrow MD time is needed (see later)



May 21st : COMMISSIONING OF THE LHC

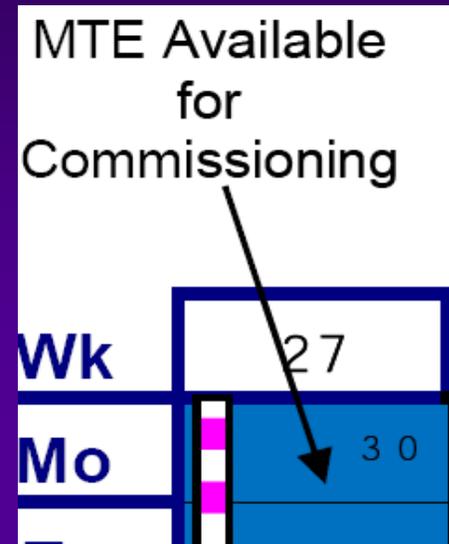
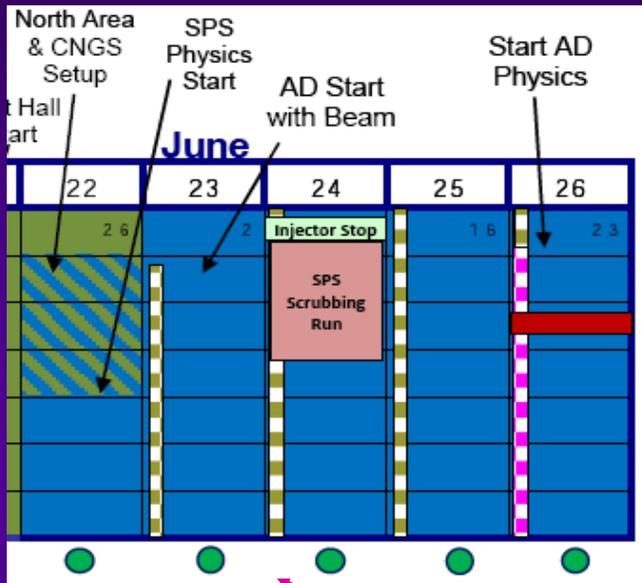
- ◆ Start each machine with LHC pilot **and pass to the next one**
- ◆ Then each machine sets up the other beams



May 21st

MTE COMMISSIONING IN THE PS

⇒ In 2 steps:



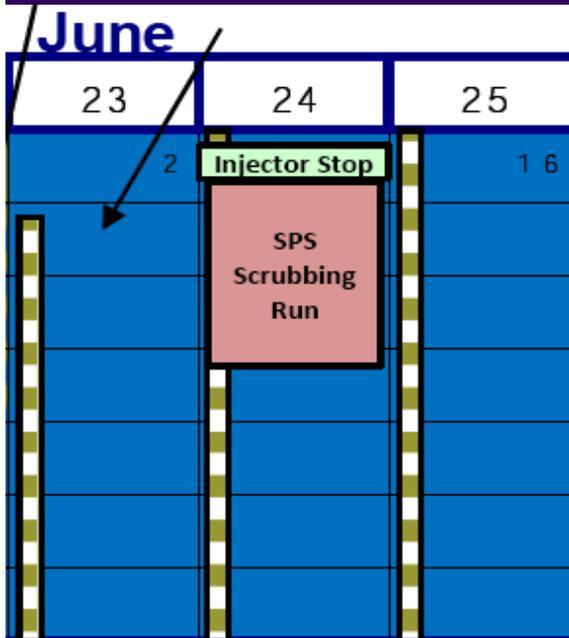
5 weeks with MTE commissioning without extraction (kickers not ready)

Start commissioning with extraction (kickers ready)

⇒ 5 “Wednesday” dedicated MDs are foreseen in weeks 26, 30, 35, 39 and 43, if needed

SPS SCRUBBING RUN

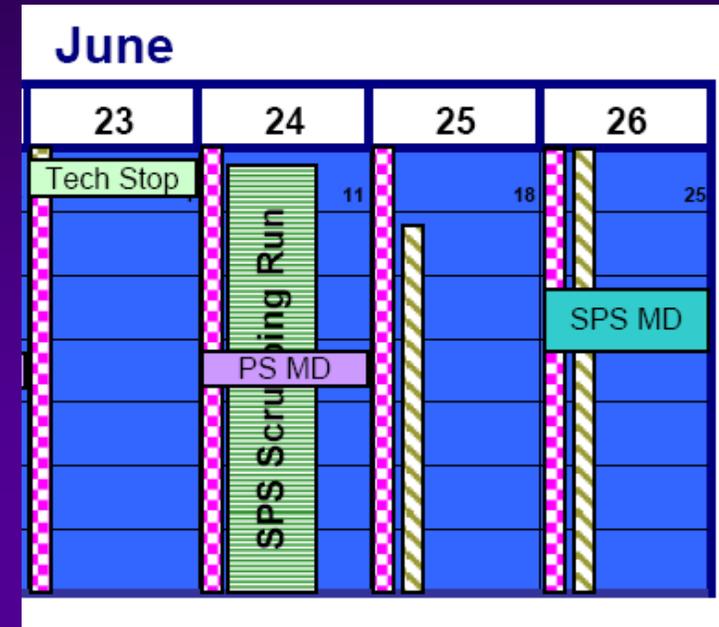
In 2008



⇒ The nominal LHC beam has to be ready at SPS entrance for W24

⇒ Reduced period compared to the past

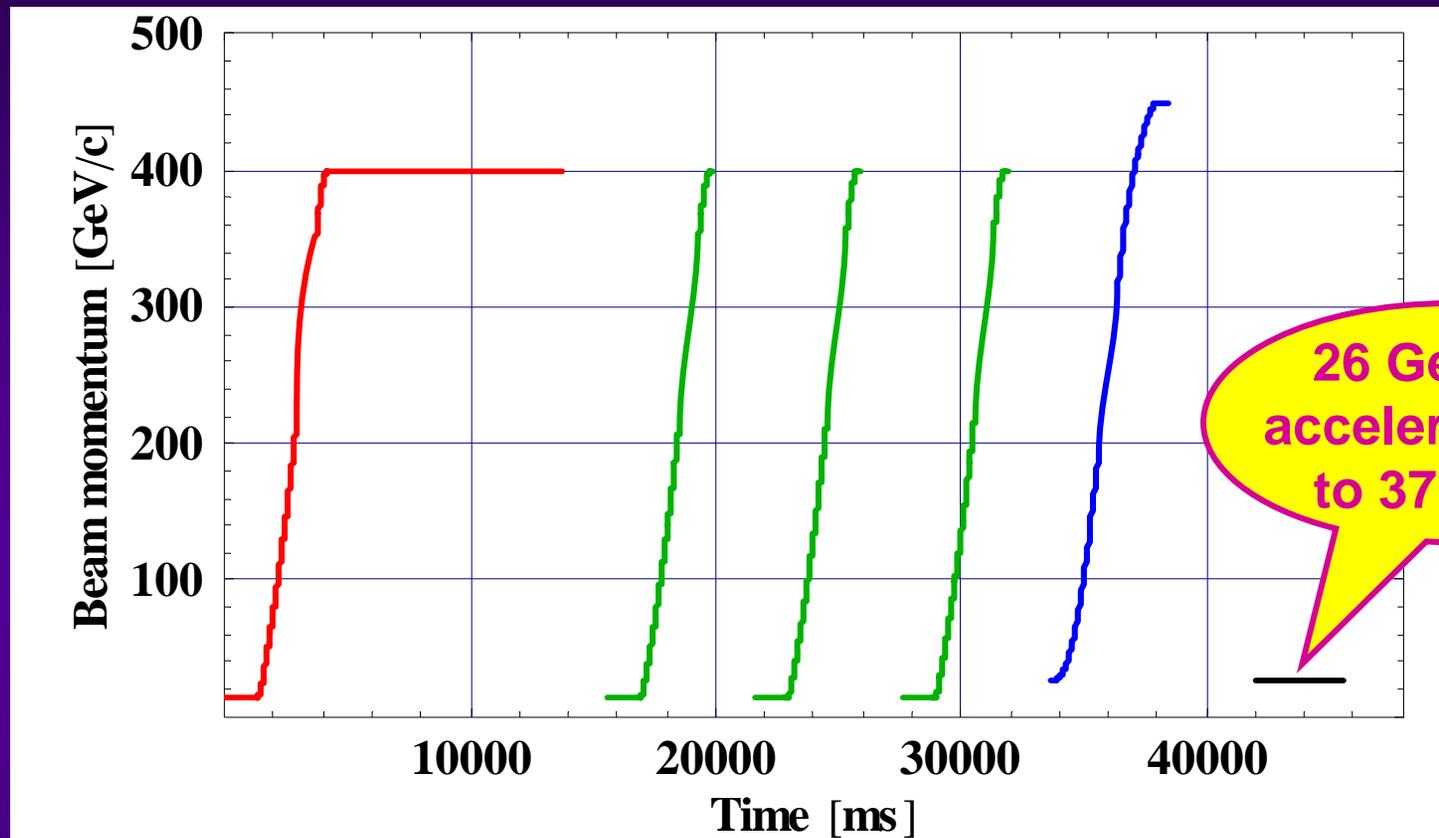
In 2007



- ◆ Main aim: Scrubbing of the SPS for LHC nominal beam + FT
- ◆ In the past: 26 GeV/c flat cycle of 43.2 s (36 BPs). Beam dump at 42.3 s ⇒ Duty cycle of almost 100% ($42.3 / 43.2 = 98\%$)
- ◆ In 2008 a supercycle with a pilot beam sent to the LHC is required
- ◆ (In the past the coast was tested during the cold checkout *to be able to go in coast from time to time to study the beam lifetime*)

9/75

MAIN SPS SUPERCYCLE FORESEEN IN 2008



26 GeV/c or
acceleration up
to 37 GeV/c

- ◆ Long FT (13 BP) + CNGS1 (5) + CNGS2 (5) + CNGS3 (5) + LHC pilot (7) + MD (5) = 40 BP = 48 s
- ◆ Later, when LHC is filling properly we will have to switch to an LHC filling supercycle \Rightarrow 2008 super cycle configurations

MDs in LINAC2

- ◆ 1) Study and reduction of losses on the LINAC2 transfer line
⇒ 2 × 2 h //
 - **Contact person:** R. Scrivens
 - **Goal:** Improve the operational users
 - **Beam:** 2/12 cycles with an MD user (beam will be dumped in the LBE line)

- ◆ 2) Deployment of new controls for the 4-ppm power supplies in the injection line ⇒ 2 × 4 h dedicated
 - **Contact person:** K. Hanke
 - **Goal:** Improve stability of the injection efficiency into the PSB
 - **Beam:** Variety of ≠ combinations of cycles in the PSB and in the PS to check the compensation of the PS stray field
 - **Preferred periods:** 1st MD asap + 2nd second later (in case we need to improve the system and re-measure)
 - **Requirements:** PU in the Booster injection line

**VERTex LOcator
detector (LHCb)**

MDs in PSB (1/8)

- ◆ **1) VELO high rate test $\implies 8 \times 4 \text{ h //}$**
 - **Contact person: K. Hanke**
 - **Goal: Test of Velo detector components to beam exposure at \neq intensities**
 - **Beam: Dedicated user in the PSB which can be adjusted according to specs, scheduled through the ABOC on a weekly basis**
 - **Preferred periods: Throughout the year**
 - **Requirements: Provided by LHC-b**

MDs in PSB (2/8)

- ◆ 2) Study the systematic error of the fast wire scanners; test the wire scanners on ring 1 which are equipped with new electronics
⇒ 8 × 4 h //
- **Contact person:** K. Hanke
- **Goal:** Have an emittance measurement in the PSB for the LHC beams
- **Beam:** Variety of operational beams, in particular the low emittance LHC beams
- **Preferred periods:** Throughout the year
- **Requirements:** Fast wire scanners

MDs in PSB (3/8)

- ◆ 3) Study of the limitations of the C04 RF system \Rightarrow 2 x 4 h dedicated
 - **Contact person:** K. Hanke
 - **Goal:** Understand the limitations of the RF system for high-intensity beams. Important in view of operation with Linac4
 - **Beam:** High-intensity beam

- ◆ 4) Investigate operation scenarios of the PSB with Linac4 \Rightarrow 2 x 4 h //
 - **Contact person:** K. Hanke
 - **Goal:** Investigate operation scenarios of the PSB with Linac4
 - **Beam:** To be defined; dedicated

MDs in PSB (4/8)

- ◆ **5) Studies on the production of the 25 and 75ns LHC beams at intermediate intensities $\Rightarrow 4 \times 4$ h //**
 - **Contact person: K. Hanke**
 - **Goal: Try to produce these beams with nominal emittance but reduced intensity, if possible without using the sieve**
 - **Beam: LHC25A+B, LHC75A+B**
 - **Preferred periods: During the first part of the year**
 - **Requirements: Fast wire scanners, measurement line, transformers**

MDs in PSB (5/8)

- ◆ 6) Possibly re-align magnets depending on results of orbit measurement \Rightarrow 1 \times 8 h dedicated
 - **Contact person:** K. Hanke
 - **Goal:** Improve orbit
 - **Beam:** No beam; dedicated; to be synchronized with PS alignment
 - **Preferred periods:** In the very beginning of the run, to be synchronized with PS alignment
 - **Comments:** This is not a "real" MD, just to note that we might require a stop (synchronized with the PS)

MDs in PSB (6/8)

Italian
centre for hadron-
therapy

◆ 7) CNAO LLRF $\Rightarrow 2 \times 8$ h // in June

- **Contact person:** M.E. Angoletta
- **Beam:** One dedicated user in the PSB supercycle, beam only on ring 4, properly dumped
- **Preferred period:** Will depend on the CNAO collaborators, and more precisely on when they will have their electronics ready
- **Goal:** Test with beam CNAO's LLRF, i.e. electronics and FPGA + DSP programming

MDs in PSB (7/8)

- ◆ **8) Digital beam control prototype for the PSB \Rightarrow 15 \times 8 h // in September-October**
 - **Contact person: M.E. Angoletta**
 - **Beam: One dedicated user in the PSB supercycle, beam only on ring 4, properly dumped**
 - **Preferred period: To be specified later on, as it depends on the LHC startup and on the availability of RF staff**
 - **Context: A digital beam control prototype will be installed in the PSB BOR to control the beam on PSB ring 4**
 - **Goal: (i) with it we'll carry out a feasibility study on exporting the digital beam control technology from LEIR to the other CPS machines. (ii) a time-optimal synchro algorithms should be tested, which will reduce greatly the time needed to carry out the beam synchronization at the end of each cycle**

MDs in PSB (8/8)

- ◆ 9) PSB intensity limits $\implies n \times 4$ h (may be some dedicated)
 - **Contact person: M. Chanel**
 - **Goal: Study experimentally longitudinal and transverse stability issues at 160 MeV for LINAC4**

MDs in PS (1/18)

- ◆ 1) Radiation tests $\Rightarrow 1 \times 4 \text{ h //}$
 - Done in 2006 with the classical CT
 - Done in 2007 with the CT in the presence of the QKE16CT to displace the losses
 - Should be done in 2008 with the new MTE to complete the picture
 - Contact person: S. Gilardoni

- ◆ 2) GammaT jump studies (for PS operational beams and PS2)
 $\Rightarrow n \times 8 \text{ h //}$
 - Contact person: S. Aumon (for PS) and W. Bartmann (for PS2)
 - Goal: Study of beam instabilities development at transition
 - Beam: SFTPRO or CNGS or TOF or MTE single bunch
 - Preferred periods: After end of commissioning of new power converters
 - Requirements: Q measurements, BLMs, FWS, Fast signals on OASIS

MDs in PS (2/18)

- ◆ **3) Setup and test of the PS transverse feedback system $\Rightarrow 4 \times 4 \text{ h // } + 2 \times 4 \text{ h dedicated}$**
 - **Contact person: F. Blas**
 - **Goal: Put in operation in one plane (H) the transverse feedback that should ease the operation for producing a stable and reproducible beam for LHC. The hardware for the second plane should be available in 2009**
 - **Beam: Low intensity, $5E12$, machine filled for the Wednesday MDs LHC beams for the parallel MDs**
 - **Preferred periods: asap after the PS start-up**
 - **Requirements: Q measurement system operational (not mandatory; would help)**

MDs in PS (3/18)

- ◆ **4) Optics and trajectory of AD beam in TT2-FTA lines $\Rightarrow 1 \times 8$ h //**
 - **Contact person: E. Benedetto**
 - **Goal: Last year a new matched optics has been implemented for AD and only a qualitative check was possible**
 - **Beam: AD beam: 1) low intensity, for optics measurements at the SEMgrids in TT2, to be sent to D3; 2) full intensity, to the AD target**
 - **Preferred periods: asap, it should be during AD_MD time as well, since the beam will not be available for the physics**
 - **Requirements: 1) bunch profile and intensity measurements in PS; 2) SEM grids&wires + MTV201 in TT2; 3) BLM in TT2; 4) dipole correctors in TT2; 5) transfo in FTA; 6) camera at the AD target (Simone will check w. E. Bravin the possibility to digitalize its signal)**

MDs in PS (4/18)

- ◆ **5) n-ToF beam: Optics and dispersion measurements and (if needed) rematching of TT2-FTN line $\Rightarrow 2 \times 4$ h //**
 - **Contact person: E. Benedetto**
 - **Goal: Check the matching for the n-ToF beam in TT2 line (at the beginning we will use for the n-ToF beam the same optics as for LHC-protons, scaled to 20 GeV/c). Then, if needed!, a 2nd MD to do a rematching of the line and perform new measurements to check it**
 - **Beam: 20 GeV/c beam, single bunch, "lower" intensity than n-ToF**
 - **Preferred periods: Autumn'08 (?)**
 - **Requirements: SEMgrids/wires, MTVs in TT2 and in FTN, BLM, transfos, bunch profiles measurements in the PS**

MDs in PS (5/18)

- ◆ 6) Losses at in injection (High-intensity and CNGS) \Rightarrow 1 x 8 h dedicated (for matching measurements)
 - **Contact person:** S. Gilardoni
 - **Goal:** Understand the losses under Rte. Goward
 - **Beam:** Low intensity, pencil-like beam, CNGS nominal
 - **Requirements:** BLMs in BTP line and PS, Wires in PS
- ◆ 7) Losses during classical CT (High-intensity and CNGS) \Rightarrow 1 x 4 h dedicated (for scan with septum position)
 - **Contact person:** S. Gilardoni
 - **Goal:** Improve PS loss map simulations
 - **Beam:** CNGS or SFTPRO
 - **Requirements:** BLMs in PS

MDs in PS (6/18)

- ◆ 8) Measure dynamical aperture in particular at injection (Operational beams) $\Rightarrow n \times 4 \text{ h} //$
 - **Contact person:** S. Gilardoni
 - **Goal:** Last measurements done in '80s...
 - **Beam:** Single or two bunches beam, moderate intensity
 - **Preferred periods:** After middle august
 - **Requirements:** Q measurements, BLMs in PS

- ◆ 9) MTE capture studies like $1/4^{\text{th}}$ unstable $\Rightarrow n \times 4 \text{ h} //$
 - **Contact person:** S. Gilardoni
 - **Goal:** Control islands sharing of intensity and emittances
 - **Beam:** MTE Single bunch, intermediate-high intensity large emittance
 - **Preferred periods:** Once MTE beam single bunch large emittance intermediate-high intensity available
 - **Requirements:** BLMs, FWS, xx'

MDs in PS (7/18)

- ◆ **10) Transition optics (Operational beams) $\Rightarrow n \times 4$ h //**
 - **Contact person: S. Aumon**
 - **Goal: Study of the working point and optics with new power converters**
 - **Beam: SFTPRO or CNGS or TOF or MTE single bunch**
 - **Preferred periods: After end of commissioning of new power converters**
 - **Requirements: Tune measurements, BLMs, FWS**

- ◆ **11) Test with PU radial loop (Operational beams) $\Rightarrow n \times 4$ h dedicated MDs (or with poor slow extraction)**
 - **Contact person: S. Aumon**
 - **Goal: Understand behavior of radial loop at transition**
 - **Beam: SFTPRO or CNGS**
 - **Requirements: CODD, BLMs, Tomoscope**

MDs in PS (8/18)

- ◆ **12) PS beam based realignment (Operational beams) \Rightarrow // + access(es)**
 - **Contact person: M. Martini**
 - **Goal: Introduce Main dipole displacements to optimize aperture**
 - **Beam: h16 first beam available**
 - **Preferred periods: During first 2 weeks of the run**
 - **Requirements: CODD**

MDs in PS (9/18)

- ◆ 13) RF studies in the PS (decreasing order of priority)
 - a) 50ns LHC beam
 - 1 × 8 h //
 - Motivation: Interest in the 50 ns variant has been resuscitated to try and satisfy the need for low luminosity in IP2
 - Contact person: S. Hancock
 - b) h8/h16 phase and radial loop behaviour during 3.5 GeV/c splitting
 - 1 × 8 h //
 - Beam: SFTPRO, $I_p < 1 \times 10^{13}$ ppp
 - Motivation: The splitting at 3.5 GeV/c of the fixed target beam degraded on a couple of occasions last year, apparently due to a spontaneous phase drift of the h=16 component. This problem needs to be understood
 - Contact person: S. Hancock

MDs in PS (10/18)

- **c) Revisiting the question of low-intensity limit for the LHC25 and LHC75 users \Rightarrow Jointly with the SPS**
 - $2 \times 8 \text{ h //}$
 - **Beam: LHC25 + LHC75, $N_b < 0.2 \times 10^{11} \text{ ppb}$**
 - **Motivation: LHC commissioning will require low-intensity beams, yet the absolute limit due to hardware is only approximately known. This MD would also allow the SPS to track beam quality as a function of intensity**
 - **Contact person: M. Schokker**

**PSB should also be involved:
How do we do? BU in the PSB with
the sieve or in SPS...**

MDs in PS (11/18)

- **d) Coupled bunch feedback tests with C11 as a kicker cavity**
 - **2 × 8 h dedicated**
 - **Beam: LHC25, $N_b = \text{Max}$**
 - **Requirements: Modified C11 high-level**
 - **Motivation: Feedback components at one and two harmonics below the RF one have caused problems for the 10MHz high-level on high-intensity LHC beams. In view of the ultimate solution of a dedicated wideband system, the idea here is to use the spare cavity tuned below the RF frequency instead of adding the feedback components to the accelerating cavities**
 - **Contact person: H. Damerau**

MDs in PS (12/18)

- **e) Rebucketing instead of conventional fine synchronization for LHC proton beams \Rightarrow Jointly with the SPS**
 - 1 \times 8 h dedicated (parasitic for non-LHC users)
 - Beam: LHC75, $N_b = 1.3 \times 10^{11}$ ppb
 - Motivation: The coarse and fine synchros work in competition with each other. Replacing the latter with a rebucketing step – as for ions – could improve the phase reproducibility of the delivered beam
 - Contact person: H. Damerau

- **f) 200MHz voltage calibration**
 - 1 \times 4 h dedicated
 - Motivation: Knowledge of the 200MHz voltage has long been a missing ingredient for understanding PS blow-ups
 - Contact person: H. Damerau

See APC 15/02/08 \Rightarrow No decision yet to remove the C201/C206 from the PS before nTOF has been produced. Studies this year:

- Compare meas. vs simulation for the BU (as in the past)
- Meas. BU as a function of voltage
- Limit of maximum emittance BU we can do...

MDs in PS (13/18)

- **g) Testing a modified MHS with an additional serial input**
 - 2 × 8 h dedicated (parasitic for standard beam control)
 - **Beam: TSTLHC25**
 - **Requirements : Modified MHS modules with a serial phase offset input**
 - **Motivation: A new precision delay module to adjust the phase relationship between the different harmonic groups of 10 MHz cavities has been developed and built. However, implementation has been delayed until the start-up 2008. In the meantime, an alternative proposal to control relative phase directly – avoiding any frequency dependence – could be tested if a prototype is forthcoming**
 - **Contact person: H. Damerau**

MDs in PS (14/18)

- **Comment:** Additional development during start-up:
 - Commissioning the LHC proton beam control with the new clock delay modules installed
 - Commissioning the new frequency programme (proper switching for the ion frequency programme will be implemented in a transparent fashion later)
 - Implementing uniform software across all MHS, including the modification for a “blanking” resync

MDs in PS (15/18)

- ◆ **14) Long LHC cycle $\Rightarrow 5 \times 8$ h //**
 - **Contact person:** R. Steerenberg
 - **Motivations:** In case of failure of the rotating machine, the only way to inject the LHC beam would necessitate the use of a slow LHC 6 BP cycle. It is imperative to study and optimize the LHC beam performance with this cycle before the LHC start-up
 - **Beam:** Super cycle with 6 free BPs
 - **Preferred periods:** Early in the run, but not during setting-up of other beams
 - **Requirements:** All!
 - **Comments:** Depending on the availability of number of BP in SC this might require dedicated MD time

MDs in PS (16/18)

- ◆ 15) 5-CM PFW measurements \Rightarrow 10 \times 8 h //
 - **Contact person:** R. Steerenberg
 - **Motivations:** PS working point control + MTE nonlinear chromaticity measurements necessary
 - **Beam:** Several 1, 2 or 3 BP cycles
 - **Preferred periods:** Early in the run, but not during setting-up of other beams and preferably synchronized with P. Freyermuth's shift rota
 - **Requirements:** GOOD WORKING TUNE MEASUREMENT!

MDs in PS (17/18)

- ◆ **16) New orbit measurement system and YASP@PS tests \Rightarrow 5 \times 8 h //**
 - **Contact person:** R. Steerenberg
 - **Motivations:** CODD and ABS replacement
 - **Beam:** Normal operational type beams
 - **Preferred periods:** Not known yet, depending on HW installation state

- ◆ **17) New (LHC-type) BLM tests in PS \Rightarrow 3 \times 8 h //**
 - **Contact person:** R. Steerenberg
 - **Motivations:** Future BLM replacement
 - **Beam:** Normal operational type beams
 - **Preferred periods:** Not known yet, depending on HW installation state

- ◆ **18) MPS regulation tests (during HW test period, not really MD time, but to be followed up) \Rightarrow R. Steerenberg**

MDs in PS (18/18)

- ◆ 19) InCA MDs \Rightarrow 4 \times 4-6 h (preference during the day as some external collaborators are involved)
 - **Contact person:** S. Deghaye
 - **Motivations:** InCA (= Injector Control Architecture) will be the high-level control system for the PS complex accelerators
 - **Dates:**
 - April 17th (there is no beam)
 - During the MD block of week 33
 - During the MD block of week 41
 - During the MD block of week 49

- ◆ 20) Scrubbing run in the PS, methods to keep the bunches long \Rightarrow Possible? dedicated...

MDs in SPS (1/21)

- ◆ 1) RP studies \Rightarrow 2 \times 8 h // with LHC but dedicated vs. FT&CNGS
 - **Contact person:** H. Vincke
 - **Study of the air activation and release from the TT10 stack (8 h)**
 - **Study of the radiation levels on top of the TDC2 tunnel in the North area vs losses at the TT20 splitters (8 h). These MDs are LHC compatible but they imply interruptions to FT and CNGS physics**

- ◆ 2) Switching between different SCs \Rightarrow few h at beginning + few h at end of each dedicated Long MD (when no beam sent to LHC)
 - **Contact person:** OP
 - **Goal: Reduce the time needed for the switching between different SCs (in particular to prepare for the period when the LHC will ask to inject many bunches)**

MDs in SPS (2/21)

- ◆ **3) LHC BLM signal at the LHC collimator (calibration of the BLM signal)**
⇒ 2 × 2 or 4 h dedicated
 - **Contact person: B. Holzer**
 - **Goal: Verification of the simulations in preparation for the LHC running**
 - **Beam: injected beam (26 GeV/c); SPS cycling; intensity anywhere between 5E9 (e.g. 1 LHC pilot bunch) up to 1E11 (e.g. 1 LHC nominal bunch)**
 - **2 MDs: 1) inject and cycle at 26 GeV/c; ramping off 2) extract the beam after exactly one turn in the SPS**
 - **Preferred periods: Preferably during the SPS start-up week 20 and 21**
 - **Requirements: wire scanner, LHC collimator, BCTDC in SPS, BCTF TT10, BCTF in SPS, logging of everything + Experts for injection oscillations**

MDs in SPS (3/21)

- ◆ 4) Frequency spectrum of beam losses at LHC and SPS collimators
⇒ 1 × 4 h during Long MD
 - **Contact person:** B. Holzer
 - **Goal:** Preparation for the LHC. Comparing the frequency spectrum of the losses at the LHC horizontal collimator to the SPS horizontal and vertical collimators (BRCH and BRCV) should help to disentangle the origins of the losses
 - **Beam:** Coast at 270 GeV/c, maximum $7e11$ protons
 - **Preferred periods:** 1 week after the "Scraper MD on tail repopulation" requested by H. Burkhardt
 - **Requirements:** LHC type collimator, SPS collimators and scrapers

MDs in SPS (4/21)

- ◆ **5) Matching monitor in the SPS \Rightarrow 2 \times 8 h dedicated**
 - **Contact person: E. Benedetto**
 - **Goal: Test the equipments and algorithms in view of their future use in the LHC. In Sept.'07 similar measurements have already been done, but a pixel offset was systematically found in some areas of the images. The camera will be recalibrated by the manufacturer in April-May and it is important both to test it and to perform new/clean measurements**
 - **Beam: MD4 or LHCindiv, 1-4 bunches, $I=1.1e11$ ppb (or more), $E^*=1\mu\text{m}$; beam dumped @ 1ms after injection**
 - **Preferred periods: The first MD should be in May-June, the second one later in the year**
 - **Requirements: Fast acquisition camera in BA5. The camera has to be installed at the beginning of the dedicated MDs and taken out at the end to avoid radiation damage. Access in BA5 needed**

MDs in SPS (5/21)

◆ 6) BBLR \Rightarrow 3 \times 6 h // + 1 \times 6 h dedicated

- **Contact person:** F. Zimmermann
- **Goal:** Long-range beam-beam effect and its compensation \Rightarrow (1) determine the parameters of an early-separation upgrade, (2) demonstrate feasibility of compensation, (3) understand dependence of beam lifetime on beam-beam distance and sensitivity to tune, (4) noise sensitivity
- **Beam:** Beam energy: 37 GeV/c or 55 GeV/c (for several seconds), beam intensity: 1-12 LHC-type bunches with $\sim 2e10$ protons each
- **Preferred periods:** Some MD(s) before mid July
- **Requirements:** BBLRs, orbit measurement, emittance measurement, on line visualization of lifetime, possibly scraper, beam loss monitor

MDs in SPS (6/21)

- ◆ **7) Scraper MD on tail repopulation \Rightarrow 1 \times 4 h during Long MD**
 - **Contact person: H. Burkhardt**
 - **Goal: Determine the source of the major horizontal tail repopulation observed in previous MDs. Measure to which extent this depends on the beam conditions and can be due to IBS**
 - **Beam: Coast at 270 GeV/c, normally 7E11 protons total from about 12 bunches. Ideally 2-3 different coast, differing in bunch intensity or energy to check on IBS**
 - **Preferred periods: asap**
 - **Requirements: Standard + BLM taken care of by participants**
 - **Comments: A very short first technical check is needed some time before the MD just to make sure the scrapers can be moved**

MDs in SPS (7/21)

- ◆ **8) Commissioning of the LHC transfer lines with high intensity beams (more than 72 bunches). Commissioning of interleaved operation of the LHC transfer lines with FT and CNGS operation \Rightarrow 2 \times 16 h during Long MD**
 - **Contact person: J. Uythoven**
 - **Goal: This has never been done before and will be required for LHC operation. It should be operational well in time before LHC needs these kinds of beams, so any possible problems can be sorted out without the LHC waiting**
 - **Beam: 2 \times 72 bunches, 3 \times 72 bunches, 4 \times 72 bunches. Total intensity up to 60 % of nominal LHC intensity**
 - **Preferred periods: First MD in July. Second MD at least a few weeks later**
 - **Requirements: All transfer line instrumentation. Especially multibunch acquisition on the BPMs**
 - **Comments: MD could be done together with other LHC high intensity (RF) MDs. Would also like to check the interleaved operation together with FT and CNGS cycles**

MDs in SPS (8/21)

- ◆ 9) Tests with the LHC collimator in the SPS \Rightarrow 3 \times 8 h during Long MD
 - **Contact person:** S. Redaelli
 - **Goals:** 1) Tests on time structure of beam loss measurement, 2) Study of absolute beam loss signals, 3) Study of beam-based collimator calibration, 4) Test of fast BLM acquisition with collimator movements
 - **Beam:** 270 GeV/c protons, stored beam, various intensities, usage of collimator
 - **Preferred periods:** To be combined with the request by the BLM team
 - **Comments:** Additional collimator tests will be done parasitically with injected SPS beam

MDs in SPS (9/21)

◆ 10) Rephasing of the LHC beam at flat top in the SPS

- **Contact person:** P. Baudrenghien
- **1st option:** If the SPS start-up planning stays as it is (v2.3), there will be LHC beam with acceleration up to 450 GeV/c all the time from the first day of SPS operation. In this case the rephasing will be commissioned in parallel with setting up of the LHC beam
- **2nd option:** Assuming that the SPS start-up planning does change and that extraction to LHC is required only by middle of July, then we will have the following request:
 - 5 × 4h (dedicated or //) in the period between SPS start-up and 09 July 2008
 - The sessions should be equally spaced in the period between SPS start-up and 09 July 2008
 - Initially, top energies and beams: 270 GeV/c (or 450 GeV/c) with any LHC beam (preference to start with a low intensity beam)
 - Finally, top energy and beam: 450 GeV/c with nominal LHC beam

MDs in SPS (10/21)

◆ 11) RF studies with LHC 25 ns

- **(a) LHC beam at different intensities with constant longitudinal parameters**
 - 2 × 8 h
 - **Contact person: T. Bohl**
- **(b) Achieving nominal parameters at 450 GeV/c**
 - 2 × 8 h
 - **Contact person: T. Bohl**
- **(c) Study of controlled emittance blow-up (reproducibility issue and dependence on 800 MHz settings)**
 - 2 × 8 h
 - **Contact person: J. Tuckmantel**
- **(d) PS-SPS transfer (capture/flat-bottom losses): (i) for beam rotated in double-step voltage in PS, (ii) with re-bucketing in PS (instead of fine synchronisation)**
 - 2 × 4 h ⇒ **Joint MD with PS RF team**
 - **Contact person: T. Bohl**

MDs in SPS (11/21)

- ◆ 12) LHC beam with 50/75 ns bunch spacing - to see results of RF settings in the PS on LHC beam quality at 450 GeV/c
 - 1-2 × 8 h
 - **Contact person:** T. Bohl

- ◆ 13) RF studies with coasts \Rightarrow 270 GeV/c or 120 GeV/c
 - **(a) Slow controlled longitudinal emittance blow-up (LHC test bed), low intensity**
 - 1 × 4 h
 - **Contact person:** J. Tuckmantel
 - **(b) Beam stability in a double harmonic RF system, high intensity**
 - 2 × 8 h
 - **Contact person:** E. Shaposhnikova

MDs in SPS (12/21)

- ◆ 14) Single bunch, parasitic MD cycle, 26 GeV/c
 - (a) Variable intensity with constant longitudinal parameters (quadrupole frequency shift as a function of intensity to monitor longitudinal impedance)
 - 2 × 8 h
 - Contact person: E. Shaposhnikova
 - (b) Short bunches with small emittance (exact values will be given later)
 - 2 × 8 h
 - Contact person: E. Shaposhnikova

**h = 2 + vertical shavers
(as done in the 1999!) ⇒
New beam to be prepared
for SPS MDs**

MDs in SPS (13/21)

- ◆ 15) Transverse impedance measurements + Fast vertical single-bunch instability + Localization (what can we do to improve our knowledge and find out potential impedance sources?) $\Rightarrow n \times 8 \text{ h} //$
 - **Contact person:** H. Burkhardt + B. Salvant + R. Calaga
 - **Goal:** Keep track of their evolutions + identify responsible equipments
- ◆ 16) LHC nominal beam in the SPS $\Rightarrow n \times 8 \text{ h}$ dedicated
 - **Contact person:** OP
 - **Goal:** Set up the beam once more and train people

MDs in SPS (14/21)

- ◆ 17) BI MDs \Rightarrow 6 \times 4 h // + 6 \times 4 h dedicated during Long MD
 - **Contact person:** R. Steinhagen
 - **(a) Continuous beta-beat measurement based on the BBQ-type acquisition chain**
 - **Motivation:** Betatron function is important for LHC luminosity + critical beam parameter of the LHC Cleaning System
 - **Step 1 (dedicated MDs):** Dedicated installation for 4 BPMB-type BPMs (single plane) to verify the principle
 - **Step 2 (parallel MDs - late summer):** Once the MDs using above configuration yielded satisfactory results we mainly aim to split the BPM signals and to make the dynamic beta-beat acquisition chain transparent w.r.t. the Wide-Band-Time-Normaliser acquisition electronic. While 'step 1' expected without greater complications, we may require more frequent (but shorter) access to BB5 during this phase to exchange to be tested signal splitters.
 - **Step 3 (end 2008/2009) :** Provided above tests are successful, we should re-evaluate the measurement performance and potentially discuss a test deployment to either the IR7 or one of the IPs

MDs in SPS (15/21)

- **(b) Q' through continuous head-tail phase shift**
 - **Motivations:** It was shown that the present LHC baseline Q' measurement technique through slow RF dp/p may be sufficient for even nominal LHC operation. However, this technique is ultimately limited by the range and modulation speed the LHC RF cavities can support. We would like to exploit the known continuous head-tail phase oscillations dependence on Q' and higher order effects for a possible fast measurement of Q' without any RF modulation
- **(c) fast/continuous measurements of Q'' , Q''' based on the side-exciter method and full beam-transfer-function (BTF) around the tune resonance**
 - **Motivation:** The following additional studies are planned to be carried out in parallel to regular PS/PSB & SPS operation: bunch-selector and improvements of the BBQ detection technique

MDs in SPS (16/21)

- **Beam: (a) and (c) coast at 270 GeV/c, 1-12 bunches, variable bunch intensities and emittances possible. (c) also: cycling machine with $p > 270$ GeV/c and reasonably long flat-top or injection plateau (> 2.4 s). We can help in case the SPS lattice (orbit, Q,Q') are not restored or properly calibrated at the start of our MD, but kindly ask to get an additional 30-45 minutes allotted for the setup procedure in this case**
- **Preferred periods: ~ evenly distributed over the year, for the programme described in a) we might need a short access in BB5 to modify/change the acquisition electronic. BB5 is under the SPS tunnel access control but not directly affected by beam radiation levels. Please contact me for details**

MDs in SPS (17/21)

- ◆ 18) Controlled transverse emittance blow-up $\Rightarrow n \times 4 \text{ h //}$
 - **Contact person: D. Manglunki**
 - **Preferred period: Not before end of June**

- ◆ 19) MDs towards operational LHC beams
 - **Contact person: J. Wenninger**
 - **(a) LHC sequencer tests for injection (also possible without LHC...)**
 - **(b) Revisit the problem of the electrostatic separators with high intensity LHC beams**
 - ...

MDs in SPS (18/21)

◆ 20) e⁻ cloud build-up studies

- **Contact person: G. Rumolo**
- **A series of vacuum chambers have been installed in the SPS with different coatings equipped with e-cloud monitors to study the electron cloud multipacting ⇒ Studies during the scrubbing run + when LHC beams**
 - **514: 3 pairs of antennas**
 - **517: Two C-magnets: one for exchangeable samples with different coatings and one spare**
 - **518:**
 - **1) Detector XSD1 with stainless steel screen and collector as a reference**
 - **2) Cleaning enamel electrode**
 - **3) Detector XSD2 with TiN coated screen and collector**
 - **4) Detector EcEx with electrode and collector (R. Macek type)**
 - **5) Detector SDneg with NEG coated screen and collector, surrounded from both sides by two other NEG coated chambers with two baffles. These chambers could be baked (activated)**

MDs in SPS (19/21)

◆ 21) e⁻ cloud instability studies + TMCI studies ⇒ 6 × 6 h // + 2 × 8 h dedicated during Long MD

Planned in the framework of LARP

- **Contact person:** W. Hofle
- **Motivations:** To establish the feasibility of a feedback system at ~700 MHz to cure single bunch instabilities in particular as observed with the LHC type beam of high intensity; Characterize instability by time domain and frequency domain measurements with wideband transverse pick-ups; beam transfer function measurements if possible
- **Beam:** 1) LHC type beam 3×10^{10} - 1.3×10^{11} p/b, 72 bunches, possibility of up to 4 batches during long MDs; possibly with a little ramp to 37 GeV/c on the parallel MDs, mainly 26 GeV/c on the parallel MDs; Long MDs to study with several batches. 2) High intensity single bunch, MESPS
- **Preferred periods:** 1) week 24 (9-12/06) during scrubbing run, 2) week 33 (11-14/08) parallel sessions in 3 blocks of two days
- 1 block single bunch time to be defined
- 2 blocks multi bunch, one of which the week before the scrubbing the other in week 32; depending on results achieved by August we will see if more time required later
- **Requirements:** Head tail monitor, RF transverse pick-ups (will be organized by Wolfgang) fast BCT logging LHC 25 ns transverse monitor Tune measurement (BBQ?) transverse emittance (wire scanners) some of the e-cloud monitors

MDs in SPS (20/21)

- ◆ 22) Test of the LHC beta-beating application in the SPS $\Rightarrow 4 \times 4$ h //
 - **Contact person:** R. Tomas
 - **Motivation:** Use the SPS as a test-bed for the LHC optics measurement and correction establishing connections to the LHC on-line model
 - **Beam:** 10^{10} p/b, 1 batch, 12 bunches per batch, 26 GeV/c
 - **Preferred periods:** The earlier the better, to be ready for the LHC
 - **Requirements:** 1000 turn-by-turn BPM system, Horizontal and vertical kickers

MDs in SPS (21/21)

- ◆ 23) 2 requests from LHCCWG held on 13/02/2008
 - (a) 1st priority: Check what happens in the SPS if we inject 2 bunches, 1 with high intensity (LHCINDIV in the PS) and 1 with low (LHCPILOT in the PS)
 - Contact person: E. Métral
 - (b) 2nd priority: Check that we can still produce the 50 ns beam in the PS \Rightarrow It is in the list of the PS MDS
 - Motivation: This 50 ns option is interesting again to try and satisfy the need of low luminosity in IP2

Discussion with W. Herr (14/02/08): With the 50 ns beam (without changing anything) the luminosity is reduced by a factor 2 (2 times less bunches) and the long range effects are also reduced by a factor 2. If in addition, the transverse emittances are 10-15% smaller then one can almost completely forget about long-range beam-beam effects!

Summary of the required beams

- ◆ **W24: Nominal LHC beam at SPS entrance**
- ◆ **New beam to be prepared for SPS MDs \Rightarrow $h = 2$ + vertical shavers (as done in the 1999!) \Rightarrow Will be used for impedance measurements, TMCI \Rightarrow asap: W25/26?**
- ◆ **W33: 50/75 ns beam at SPS entrance**

Summary of the required SPS cycles (1/2)

◆ (Main) operational supercycle

- Long FT (13 BP) + CNGS1 (5) + CNGS2 (5) + CNGS3 (5) + LHC pilot (7) + MD (5) = 40 BP = 48 s

26 GeV/c
or 37 GeV/c

◆ Scrubbing run

- In 2008 a supercycle with a pilot beam sent to the LHC is required (may try also the usual coastable one) \Rightarrow Should be tested during the cold checkout

◆ SPS Long MDs

- LHC nominal 450 GeV/c
- 270 GeV/c coastable
- 55 GeV/c

Summary of the required SPS cycles (2/2)

SPS super-cycles / 'pure' LHC

LHC nom. SC ~ 21+ s

- Flat bottom 26 GeV, 10.8 s, 4 injections
- Ramp ~ 8 s
- Flat top 450 GeV, 0.5 s

For the synchro

LHC pilot SC, 8.4 s, ~ same as 2006

- Flat bottom 26 GeV, 60 ms, 1 injection
- Ramp ~ 4.2 s
- Flat top 450 GeV, 0.5 s

**FT of ~ 100 ms in fact
(power consumption)**

LHC 270 GeV coastable, 28.8 s (or 2BPs shorter ?)

- Flat bottom 26 GeV, 10.8 s, 4 injections
- Ramp to 270 GeV ~ 5 s
- Intern. flat top 270 GeV, 2 s
- Ramp to 450 GeV (no beam !)

For the remnant field

~~LHC 120 GeV coastable, length ~ same as 270 GeV~~

- ~~• Flat bottom 26 GeV, 10.8 s, 4 injections~~
- ~~• Ramp to 120 GeV ~ 5 s~~
- ~~• Intern. flat top 120 GeV, 2 s~~
- ~~• Ramp to 450 GeV (no beam !)~~

~~LHC 55 GeV coastable ??, low intensity, length ~ 16 s ?~~

- ~~• Flat bottom 26 GeV, 60 ms, 1 injection~~
- ~~• Ramp to 55 GeV ~ 1.5 s~~
- ~~• Intern. flat top 55 GeV, 5 s~~
- ~~• Ramp to 450 GeV (no beam !)~~

Courtesy of J. Wenninger

Use of the SPS cycles in the different Long MDs

- ◆ W24 (beam to LHC): **Scrubbing cycle**
- ◆ W28 (beam to LHC): **450 GeV/c**
- ◆ W33 (No beam to LHC): **450 GeV/c**
- ◆ W37 (No beam to LHC): **270 GeV/c (coast) + 55 GeV/c**
- ◆ W41 (No beam to LHC): **270 GeV/c (coast)**
- ◆ W45 (No beam to LHC): **270 GeV/c (coast)**
- ◆ W49 (beam to LHC): **?**

Preliminary MD planning during the Long MDs (1/6)

◆ W24 (beam to LHC): Scrubbing cycle

⇒ SPS

- e⁻ cloud build-up studies, G. Rumolo
- e⁻ cloud instability studies, W. Hofle

Preliminary MD planning during the Long MDs (2/6)

◆ W28 (beam to LHC): 450 GeV/c

70 h like this...

⇒ SPS

- 8h: **Achieving nominal parameters at 450 GeV/c**, T. Bohl
- 8h: **Rephasing of the LHC beam at flat top in the SPS**, P. Baudrenghien
- 16h: **Commissioning of the LHC transfer lines with high intensity beams (more than 72 bunches)**, J. Uythoven
- 8h: **e^- cloud (build-up & instability) studies**, G. Rumolo + W. Hofle
- 8h: **Matching monitor in the SPS**, E. Benedetto
- 8h: **LHC beam at different intensities with constant longitudinal parameters**, T. Bohl
- 8h: **Study of controlled emittance blow-up (reproducibility issue and dependence on 800 MHz settings)**, J. Tuckmantel

⇒ PS

- 4h: **Setup and test of the PS transverse feedback system**, F. Blas
- 8h: **Coupled bunch feedback tests with C11 as a kicker cavity**, H. Damerau
- 4h: **Test with PU radial loop**, S. Aumon
- 6h: **Long LHC cycle (if dedicated time needed)**, R. Steerenberg

Preliminary MD planning during the Long MDs (3/6)

60 h like this...

◆ W33 (No beam to LHC): 450 GeV/c

⇒ SPS

- 3h at the beginning: **Switching between different SCs, OP**
- 8h: **Achieving nominal parameters at 450 GeV/c, T. Bohl**
- 16h: **Commissioning of interleaved operation of the LHC transfer lines with FT and CNGS operation, J. Uythoven**
- 8h: **LHC beam at different intensities with constant longitudinal parameters, T. Bohl**
- 8h: **Study of controlled emittance blow-up (reproducibility issue and dependence on 800 MHz settings), J. Tuckmantel**
- 6h: **PS-SPS transfer (capture/flat-bottom losses), T. Bohl, Joint MD with PS RF team**
- 6h: **MDs towards operational LHC beams, J. Wenninger**
- 6h: **e⁻ cloud (build-up & instability) studies, G. Rumolo + W. Hofle**
- 8h: **LHC beam with 50/75 ns bunch spacing - to see results of RF settings in the PS on LHC beam quality at 450 GeV/c, T. Bohl**
- 3h at the end: **Switching between different SCs, OP**

- #### ⇒ PS
- 4h: **InCA MDs (during the day as some external collaborators are involved), S. Deghaye**

Preliminary MD planning during the Long MDs (4/6)

◆ W37 (No beam to LHC): 270 GeV/c + 55 GeV/c

70 h like this...

⇒ SPS

- 3h at the beginning: **Switching between different SCs, OP**
- 6h: **BBLR, F. Zimmermann**
- 8h: **Matching monitor in the SPS, E. Benedetto**
- 4h: **Scraper MD on tail repopulation, H. Burkhardt**
- 6h: **Tests with the LHC collimator in the SPS, S. Redaelli**
- 4h: **Slow controlled longitudinal emittance blow-up, J. Tuckmantel**
- 8h: **Beam stability in a double harmonic RF system, high intensity, E. Shaposhnikova**
- 8h: **Continuous beta-beat measurement based on the BBQ-type acquisition chain, R. Steinhagen**
- 8h: **Q' through continuous head-tail phase shift, R. Steinhagen**
- 8h: **Fast/continuous measurements of Q'', Q''', R. Steinhagen**
- 3h at the end: **Switching between different SCs, OP**

⇒ PS

- 4h: **Setup and test of the PS transverse feedback system, F. Blas**

Preliminary MD planning during the Long MDs (5/6)

◆ W41 (No beam to LHC): 270 GeV/c

69 h like this...

⇒ SPS

- 5h at the beginning: **Switching between different SCs, OP**
- 10h: **Tests with the LHC collimator in the SPS, S. Redaelli**
- 4h: **Frequency spectrum of beam losses at LHC and SPS collimators, B. Holzer**
- 8h: **Beam stability in a double harmonic RF system, high intensity, E. Shaposhnikova**
- 8h: **Continuous beta-beat measurement based on the BBQ-type acquisition chain, R. Steinhagen**
- 8h: **Q' through continuous head-tail phase shift, R. Steinhagen**
- 8h: **Fast/continuous measurements of Q'', Q''', R. Steinhagen**
- 5h at the end: **Switching between different SCs, OP**

⇒ PS

- 5h: **InCA MDs (during the day as some external collaborators are involved), S. Deghaye**
- 8h: **Coupled bunch feedback tests with C11 as a kicker cavity, H. Damerau**

Preliminary MD planning during the Long MDs (6/6)

◆ W45 (No beam to LHC): 270 GeV/c

60 h like this...

⇒ SPS

- 6h at the beginning: **Switching between different SCs, OP**
- 8h: **Tests with the LHC collimator in the SPS, S. Redaelli**
- 10h : **MDs towards operational LHC beams, J. Wenninger**
- 8h: **Continuous beta-beat measurement based on the BBQ-type acquisition chain, R. Steinhagen**
- 8h: **Q' through continuous head-tail phase shift, R. Steinhagen**
- 8h : **Fast/continuous measurements of Q'', Q''', R. Steinhagen**
- 6h at the end: **Switching between different SCs, OP**

⇒ PS

- 6h: **InCA MDs (during the day as some external collaborators are involved), S. Deghaye**

Preliminary MD planning during the Long MDs (6/6)

◆ W49 (beam to LHC): ?

⇒ SPS

- 8h : **MDs towards operational LHC beams, J. Wenninger**
- ...

⇒ PS

- **4-6h: InCA MDs (during the day as some external collaborators are involved), S. Deghaye**

Preliminary MD planning during the 5 “Wednesday” MDs (1/5)

◆ W26:

⇒ SPS

- ?

⇒ PS

- **8h: Losses at in injection (High-intensity and CNGS) ⇒ 1 × 8 h dedicated (for matching measurements), S. Gilardoni**

Preliminary MD planning during the 5 “Wednesday” MDs (2/5)

◆ W30:

⇒ SPS

- ?

⇒ PS

- 4h: **Losses during classical CT (High-intensity and CNGS), S. Gilardoni**
- 4h: **200MHz voltage calibration, H. Damerau**

Preliminary MD planning during the 5 “Wednesday” MDs (3/5)

◆ W35:

⇒ SPS

- ?

⇒ PS

- 8h: **Testing a modified MHS with an additional serial input,**
H. Damerau

Preliminary MD planning during the 5 “Wednesday” MDs (4/5)

◆ W39:

⇒ SPS

- ?

⇒ PS

- 8h: **Testing a modified MHS with an additional serial input,**
H. Damerau

Preliminary MD planning during the 5 “Wednesday” MDs (5/5)

◆ W43:

⇒ SPS

- ?

⇒ PS

- ?

Preliminary // MD planning

◆ Early in the year:

- **5-CM PFW measurements (in the PS), R. Steerenberg**
- **LHC BLM signal at the LHC collimator (calibration of the BLM signal), B. Holzer** ⇒ During the start-up of the SPS (week 20 and 21)
- **Test of the LHC beta-beating application in the SPS, R. Tomas**
- **Rephasing of the LHC beam at flat top in the SPS, P. Baudrenghien**
- **Setup and test of the PS transverse feedback system, F. Blas**
- **Optics and trajectory of AD beam in TT2-FTA lines, E. Benedetto**
- **Long LHC cycle (in the PS), R. Steerenberg**
- **BBLR (in the SPS), F. Zimmermann**
- **Impedance measurements, E. Shaposhnikova + H. Burkhardt + B. Salvant + R. Calaga**