



Injector MD planning 2011: schedule and requests

G. Rumolo

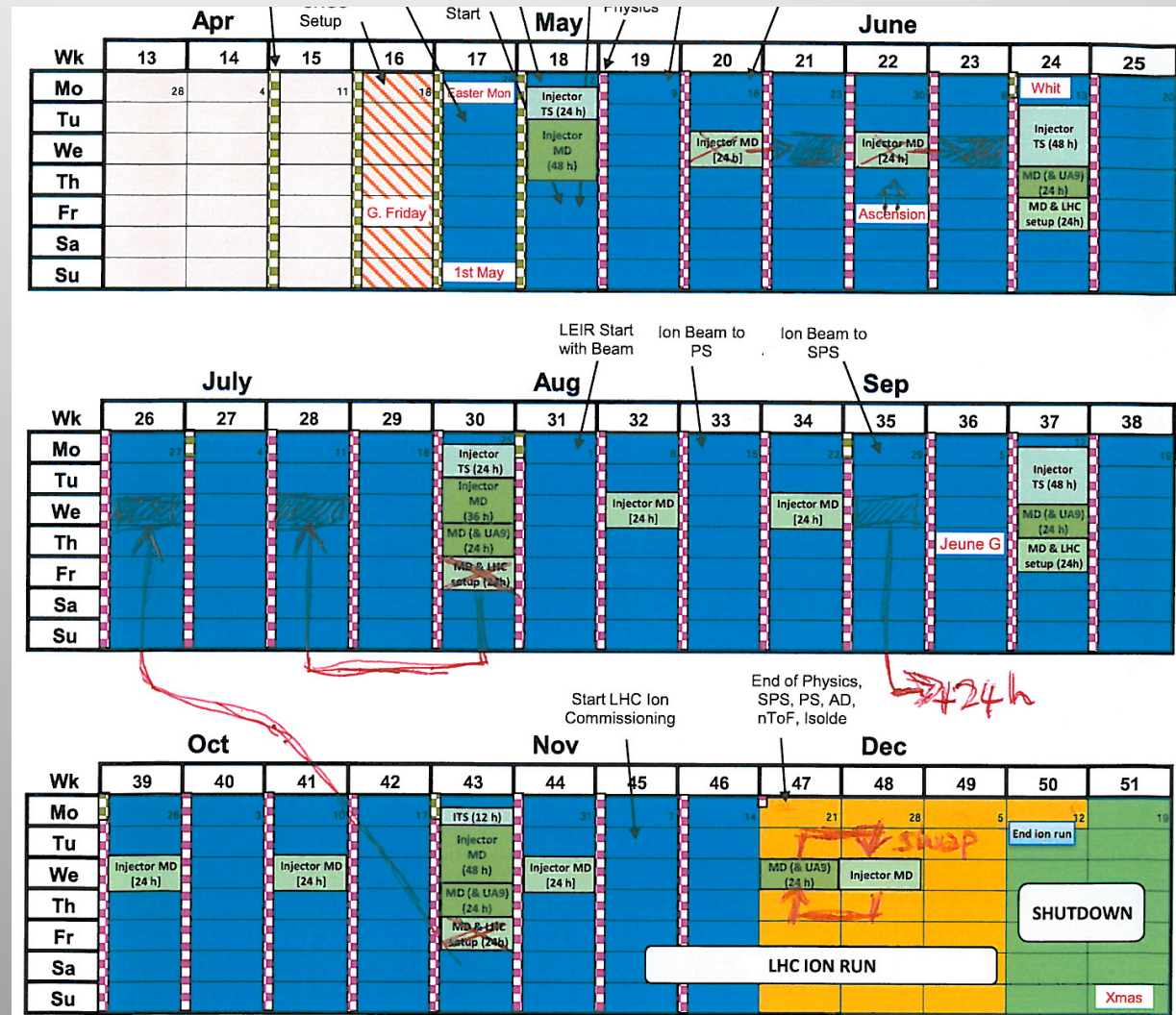
- 2011 Injector Schedule vs. 2010
- MD subjects, goals & requests
- Some general remarks

A few lessons learnt in 2010

- First year of MDs with LHC in operation (schedule usually determined at the LHC level)
- The efficiency of the **non-parallel SPS MDs** (real MD time vs. scheduled time) is usually around 50%
 - The **dedicated blocks** frequently suffered from being placed directly after technical stops
 - Surprisingly enough, the most efficient dedicated MD block was the one that was last minute advanced by 2 weeks because of an unscheduled LHC stop!
 - The **floating blocks** were affected by the parallel LHC requests (especially when requiring coasts)
 - Sometimes perfectly efficient, as they were synchronized with LHC physics stores
 - Sometimes strongly perturbed or even fully canceled due to the LHC (especially those on Fridays during the LHC set-up or with parallel LHC tests)
- MD coordinator and users need to be **very flexible** (and prepared), as schedules tend to change very rapidly, following the needs of LHC
- **Parallel SPS MDs** were usually efficient, and frequently prolonged beyond the officially assigned day hours, physics permitting
 - But how much will they suffer this year with the dedicated LHC fill mode?
- Most of the **PSB and PS MDs** could take place in parallel during physics operation and also profit from the priority given during the official MD time (however, problem with the users...)

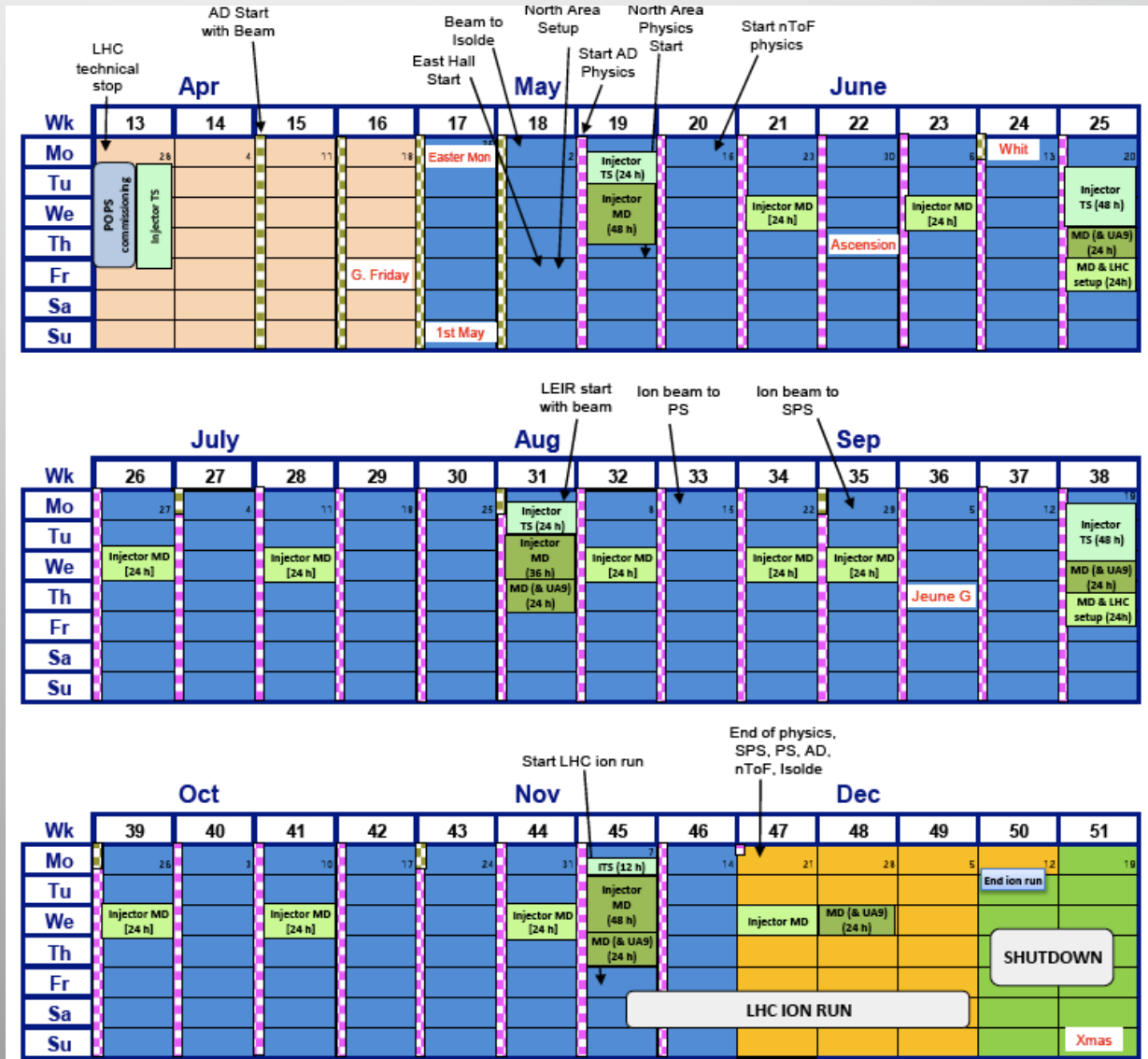
Injector schedule 2011: request for changes of the first schedule (after discussions with T. Bohl)

- Add at least one extra block of 24h to overcompensate the loss of dedicated hours with floating time.
- De-phase the Wed blocks in June-July to avoid MD before long weekend of Ascension
- From last year's experience, MDs during LHC set up are not highly efficient, so replace them with Wednesday blocks and keep them only when there's no dedicated MD time during the TS
- This year it should be attempted to better coordinate floating MDs with the LHC stores....



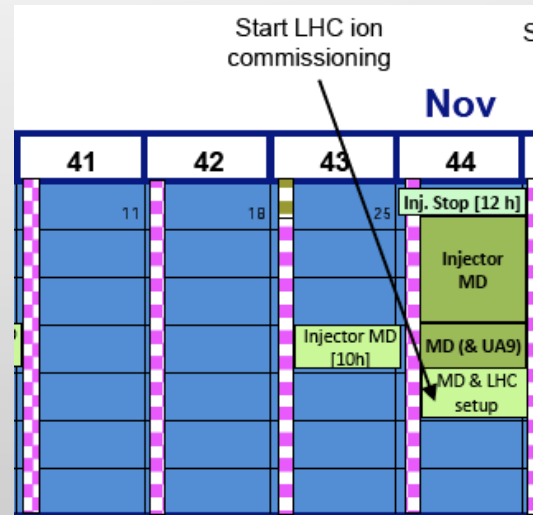
Injector schedule 2011 v1.2

- 24h MD floating blocks almost every second week
- MD requests have been submitted, deadline Jan 31st 2011: quite large volume of requests for the optimization of the LHC beams and upgrade studies
- MD time frequently also used to set up not only MD but also physics cycles (e.g. ion set up, NA61 preparation, UA9, HiRadMat, etc.)

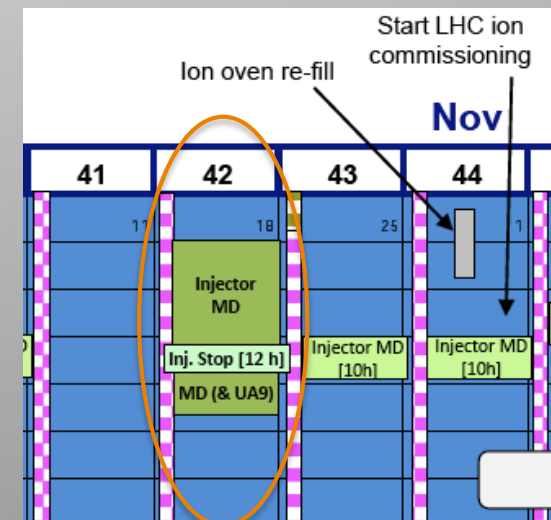


Maybe propose further changes?

- In 2010, the full dedicated MD block of Week 44 was moved to Week 42 on Mon Oct 18th!
 - All MDs had to be rescheduled and took place successfully over the 48h (Tue-Wed of Week 42)
 - Maybe benefited from the Technical Stop after the MD block?
 - It was discussed at the **last MSWG** that moving the TS after the MD block has also the advantage of not requiring the 8 or 12h cool-down for high intensity beams!
- ⇒ **Can we propose it for at least some of the MD blocks in the 2011 schedule?**



2010, v1.8

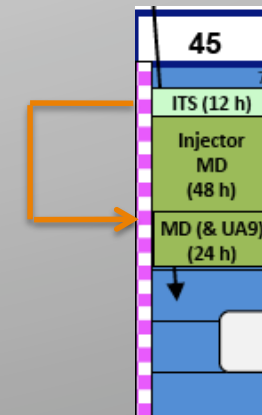
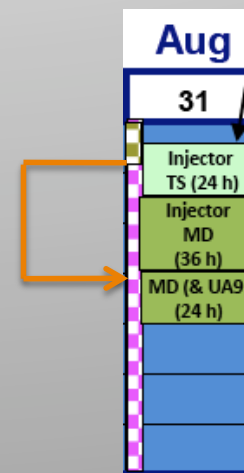
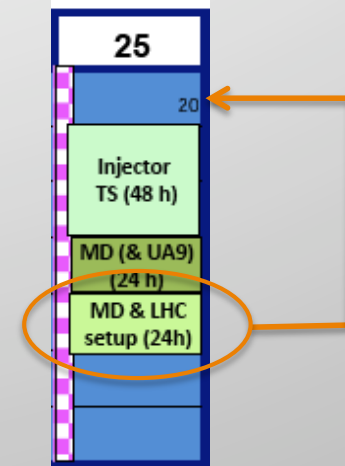
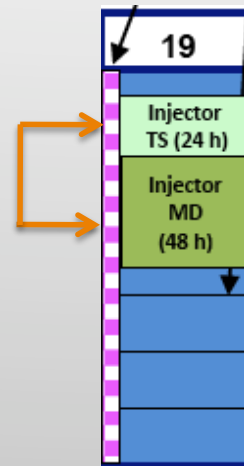


2010, v1.9

Maybe propose further changes? 2011 schedule

- **Week 19:** exchange TS and MD block (what about LHC?)
- **Week 25:** move the MD block to Monday
- **Weeks 31 or 45:** possibly shift the Technical Stop between MD and UA9 (to share with UA9 the recoveries from TS)

⇒ **Drawback:** when the Technical Stop is placed after the MD block, any hardware change requested for the MD (e.g. liner or dipole magnet exchange for electron cloud mitigation MDs in the frame of the SPS upgrade studies) must be planned long before the MD takes place!



Either one?

New MD web page (thanks to Sophie Dawson and Benoît Salvant)

Machine Development Planning

https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2011/

CERN Accou...anagement Euro-exchangeCHF OP Webtools LHC latest news Meteo-Chamonix.org CERN impedance webpage Old APC 2010 MD Planning emetral BTE Desktop PS optics files Controls

2011 Machine Development Planning

- Home
- Submit MD Time Request
- Submit MD Results to MD Coordinator
- MD reports to MSWG
- Long MD Sessions
- Floating MD Sessions
- MD Sessions in Parallel with Physics
- SPS Physics and MD Cycles
- MD Requirements in terms of cycles

MD Coordinator:

[Giovanni Rumolo](#) (BE-ABP-ICE)

Deputy: [Yannis Papaphilippou](#) (BE-ABP-LIS)

Injector Schedule and MD Documents

- [Current Injector Schedule](#)
- [Current LHC Schedule](#)
- [Injector Schedule History](#)
- [MD Planning 2010](#)

[Coupling between the different machines \(to be entered in the CBCM\)](#)

[Further explanations of coupling between the machines](#)

[SPS RF MMI Mapping](#)

Machine Development Steering Links

- [LHC Beam Operation Committee](#)
- [LIU Day \(Thoiry, Dec 1st 2010\)](#)
- [SPS Upgrade Study Team](#)
- [PSB Upgrade Working Group](#)
- [Strategy talk 2010 by E. Metral \(August 6th 2010\)](#)
- [Status and Prospects for the 150ns Beam Injectors](#)

News:

MD subjects

→ 2010 MDs included mainly (<https://espace.cern.ch/be-dep/MSWG/2010%20MD%20reports/Forms/AllItems.aspx>):

- Set up of the **nominal and ultimate LHC beams** (and beyond)
- PSB: instabilities, instrumentation, machine performance
- PS: RF studies (including longitudinal instabilities), space charge at injection, TMCI at transition, injection loss studies, etc.
- SPS:
 - ✓ Upgrade studies (electron cloud, low γ_t)
 - ✓ Collimator tests, BBLR, emittance growth, ...
- Also plenty of time on setting up cycles for the ion run, for UA9

→ 2011 MD requests as of today:

- LHC beams for operation and MDs (mostly to be carried out by the chain PSB/PS/SPS)
- PSB, PS, SPS upgrades (LIU) or oriented to HL-LHC
- Machine performances
- Hardware/instrumentation tests
- Novel measurement methods or techniques

Sorted by machine on following slides →→→

Some goals of 2011 MDs

- Responses to questions relevant for both LHC beam production and LIU activities
- Define performances across the injector chain of the **75 ns, 50 ns and 25 ns beams** from nominal to ultimate intensities
 - ✓ Determine the **smallest transverse emittances** that can be achieved for nominal intensities, or the **highest intensity** that can be achieved with nominal transverse emittances
 - ✓ Study and optimize the evolution of the **emittances** along the injector chain in different configurations (e.g. single- or double-batch transfer PSB-PS, nominal or low γ_t optics in the SPS)
 - ✓ Rely on the instrumentation (Wire Scanners, BCTs, FBCTs) for that
 - Identify how **space charge** affects the injection efficiency into the different machines (PSB, PS, SPS)
 - Determine **intensity limitations** and study the efficiency of techniques to circumvent them

Linac2

- Study the **increase in intensity of Linac2**, taking into account the source, RFQ sparking, RF beam loading and losses (R. Scrivens)
 - Presently ~168mA, need to exchange some RF tubes, which are presently saturated, to push this value higher (maybe next TS?)
- Origin of the **new hot spots** in the BI line (G. Bellodi, E. Effinger, G. Rumolo, R. Scrivens)
 - Set up the control of the BLMs installed during the shutdown
 - Check losses and compare values for different focusing settings
- ...

PSB

all requests submitted jointly by supervisors + A. Blas, M.E. Angoletta, C. Carli

- INCA deployment (CO)
- LHC beams:
 - Studies on restoring **pure h=2 beams** in the PSB
 - The main aim is to study the capture efficiencies for small emittance beams. Is there any gain in emittance versus injection losses over present LHC single batch beams?
 - Maybe use it also for high intensity beams and use bunch merging when needed?
 - Revive **double batch variants** of LHC 50 and 75ns beams
 - Prepare 8 Booster bunches ($4 \times h=2$) to be transferred into 9 PS buckets ($h=9$) with $h+1$ bunch spacing (C. Carli's new production scheme in the PS)
- Performance/Linac4 upgrade
 - Test and deploy **digital RF control system**
 - Instabilities, impedance sources
- Hardware/instrumentation
 - New PUs in extraction line
 - BLMs at extraction septum
 - New loss monitor in the dump line (B. Dehning et al.)

PS

all requests submitted by G. Métral on behalf of the PS Upgrade WG and by the RF team (H. Damerau, S. Hancock)

- PS upgrade:
 - Set up of new magnetic cycle with **2GeV double injection** (requires ramp down at 1.4 GeV for second injection) and relative space charge MDs
 - Working point adjustment at low energy with quads and with PFWs
 - Head-tail instabilities, emittance growth at low energy
 - **TMCI** at transition crossing
 - Electron cloud and **transverse instabilities** at extraction energy
- RF list:
 - Multi-bunch LHC beams with more than 0.35eVs at ejection
 - **Coupled-bunch instabilities** on the flat-top at 75ns spacing
 - New gymnastics for 25 and 50ns spacing without triple splitting
 - Validation of the second gap relay on beam stability
 - Test and implementation of an ejection bucket selector
 - Test of a new one-turn-delay feedback using C11
 - 100ns spacing for p-Pb
 - 10MHz cavity counter phasing to produce low rf voltage under conditions of severe beam loading
- Others:
 - Lengthen the spill from today's 400ms to 600ms on user EASTB (Dirac) in order to increase the efficiency and free cycles for other users (O. Hans)

SPS

a list of requests submitted by the SPSU Study Team

- Re-establish low loss **nominal 25 ns beam**, reference measurements for e-cloud (scrubbing?)
 - 1st MD of 16 hours minimum (4h OP + 8h RF + 4h) + scrubbing time
 - Request to have few MD hours with the same 25ns beam for the tests on the e-cloud monitors, microwave measurements and pressure data each time a new liner/dipole is exchanged (this is useful for more general comparison)
 - Note, 75 ns and 50 ns nominal beams will be operational before 1st MD ...
- Limitations of **achievable “above nominal” intensity beams**, increase of intensity in steps with time for optimization
 - 50 ns first, and then 25 ns beam
 - At least 2 MD blocks with time for set-up, optimization and measurements
- **Transverse emittance** preservation:
 - Accurate and systematic measurements during each MD
 - Minimize the blow-up
 - Study origin of blow-up, if unavoidable
- **Electron cloud**:
 - For given spacing, dependence on bunch current and emittances
- **Impedance** identification (transverse + HOM longitudinal)
 - transverse – parallel MDs
 - Longitudinal -- with 75, 50 and 25ns beams of variable (low) intensity for heating
- **TMCI**
 - threshold in a double RF system
 - behaviour in multi-bunch
- **Double RF system** (stability and emittance blow-up) with nominal LHC beam

SPS

more requests by the SPSU Study Group + H. Bartosik, Y. Papaphilippou

- **Low gamma transition (γ_t) studies**

Parallel

- Optics studies (chromaticity correction, nonlinear optimization, working point, optics functions, ...)
- Matching of transfer line TT2/TT10
- Studies on instability thresholds (single bunch)
- Impedance localization versus nominal optics
- Collective effects and instabilities with nominal LHC beams (multi-bunch)
 - Behaviour with electron cloud
 - Acceleration
 - Find minimum longitudinal emittance/bunch length needed for beam stability at 450GeV
 - Evolution of transverse emittances
- Study compatibility of 6D beam parameters at 450 GeV/c with Q20 with LHC → inject into LHC?
- Pursue the idea of injecting fixed target type of beams above transition (new user and MD cycle needed)

Dedicated

SPS

Electron cloud and feedback system

- The aim is to measure or estimate the **accumulation of surviving electrons** using the SPS electron cloud diagnostics, which is enough to try this experiment (M. Jimenez)
 - Inject 6 or 7 batches (or the needed number or the maximum number) with 50 ns spacing and $1.1E+11$ ppb. The idea is to fill entirely the SPS in order to be as close as possible to the condition of LHC filling. Last year's measurements in the LHC have shown a coupling between batches when the spacing is smaller than $10\mu\text{s}$ so we should be able to reproduce something equivalent in the SPS.
 - The accumulation of surviving electrons is of major importance since, if it occurs, it can partly cancel the benefit of the scrubbing.
- Tests for a **wide band feedback** system against electron cloud instabilities or TMCI (W. Höfle)
 - Joint effort with LARP collaborators (MD schedule compatible with visitor planning)
 - Need parallel time 4x4 hours and then dedicated time in the long MD blocks 2x6 hours with a possibility of access. The dedicated time should be in two different MD blocks.

SPS

BI studies (L. Jensen)

- Most dedicated measurements only need a single LHC bunch on MD1 cycle (4s flat bottom). Measurements with bunch trains can be coordinated with other users (e.g. SPS Upgrade studies with BI expert)
- **Wire scanners** (all, rotational and linear):
 - Calibrate with beam the two scans (IN/OUT) for constant energy
 - Find optimal settings for LHC type beams in terms of the voltage for the photo-multiplier (gain) and attenuation as a function of the selected acquisition-type (single-bunch, batch), filling pattern (single bunch, batch), total intensity (pilot → nominal)
 - Assess the available analogue signal bandwidth
- **Fast BCT**
 - To quantify the dependency of beam position on the intensity values as a function of filling pattern. This should be done by correlating the BCT values acquired for different values of the beam position as it passes through the transformer.
 - To investigate further any means to provide full 40MHz digital bandwidth for the SPS Fast BCTs as a function of the filling pattern
- **BGI** (transverse) and **BSRT** (longitudinal): will be tested but it's not clear when and how.
- **LHC-BPMs**: 3 during 2011 and need to check that Verena's application is compatible
- **SPS Head-tail monitor**: attenuators have been added, tests needed

SPS

Miscellaneous

- **Collimator** studies:
 - Tests with two different LHC collimator prototypes (one from CERN and one from SLAC), need at least 6 x 12h with coast (R. Assmann et al.)
 - Pressure measurements connected with jaw movements and desorption yields (for protons and ions), need at least 2 x 6h (G. Bregliozzi et al.)
- Commission a **new transverse emittance blow-up**, once the hardware and software are in place, need 3 x 4h (W. Höfle)
- SPS **emittance lifetime studies** in view of an installation of crab cavity in the SPS (R. Calaga et al.): at least 3 x 8h with coast at 55, 120, 270 GeV/c
- Study of the **BBLR interaction and compensation** for a separation of about $10-11\sigma$, of interest for the HL-LHC scenarios (F. Zimmermann et al.), need 2 x 12h with coast at 120 GeV/c
- Measurement of **nonlinear errors** with localized orbit bumps (R. Tomás, G. Franchetti, et al.), probably on parallel cycle
- MDs necessary for the **NA61 set up** (from MSWG on Jan 14th, some iterations with I. Efthymipoulos and O. Berrig): request ongoing

A rapid calculation of the requested MD hours for the dedicated SPS studies (optimistic)

1. SPS upgrade

- 36h (25ns beam optimization, scrubbing) + 36h (25ns beam to be used again for liner/magnet exchanges, instrumentation)
 - 24h (25ns ultimate) + 24h (50ns ultimate) with detailed emittance measurements
 - 24h (miscellaneous studies and tests with different flavors of 25, 50, 75ns beams)
 - 36h (low γ_t multi-bunch beams)
 - 12h (wide band feedback)
 - 12h (more e-cloud studies, e.g. Miguel's reflectivity coefficient studies, or double harmonic)
- 204h

2. Collimator tests: 84h

3. Crab cavity and emittance growth studies: 24h

4. BBLR: 24h



out of 434h (floating + dedicated), i.e. 77%

Closing remarks

→ MDs in the PSB/PS

- They usually do not require dedicated time and they have priority during the MD blocks (floating or dedicated)
- PSB:
 - There is always one PSB cycle guaranteed in the supercycle for MDs. More are possible, depending on the physics users
 - MD users are in limited number (4 + 2 LHC_MD) and the beams loaded on these users change according to the MD planning. Therefore, beams used for MDs should be always archived at the end of the MD to be sure that the same beam conditions can be then recovered on a future MD session
- PS:
 - Two MD users permanently assigned to PS upgrade studies (MD3 and TSTPS)

→ MDs in the SPS

- Number of requested SPS MD hours at the limit
 - Already now above last year's efficiency
 - New MD requests not yet present in the current balance
- Set up of cycles
 - MD cycles: part of the MDs
 - Physics cycles (including UA9): should not be at the expense of MD time