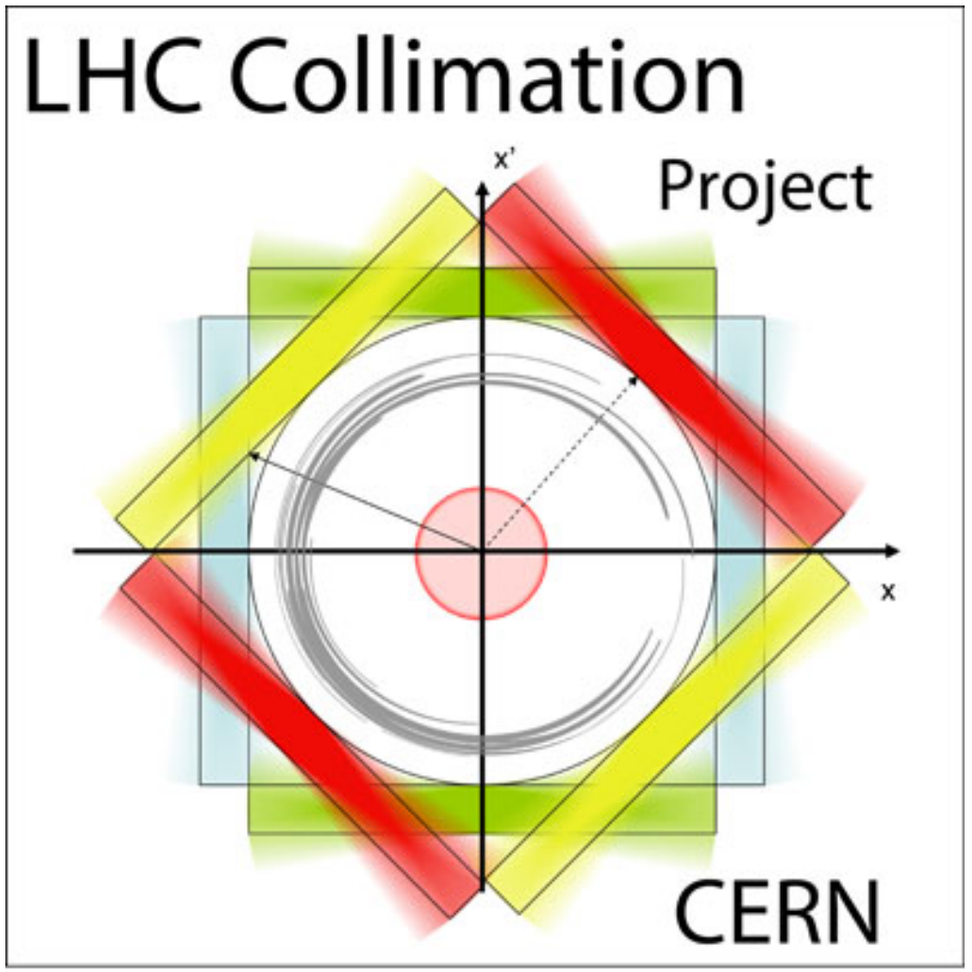
Collimation setup



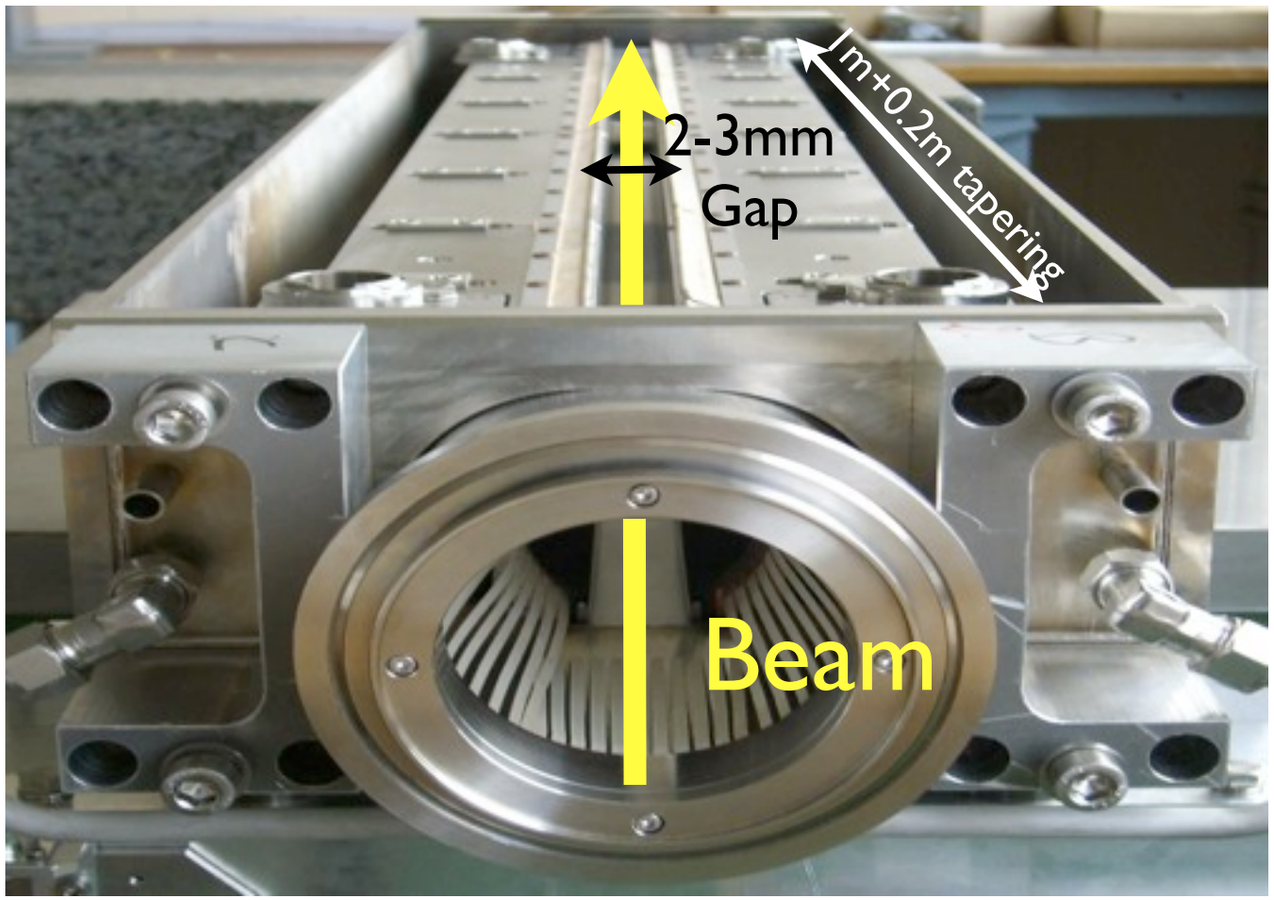
B.Salvachua and S.Redaelli
for the Collimation Team

LHC Optics Measurement and Corrections Review,
17-18 June 2013

OMC Review 2013

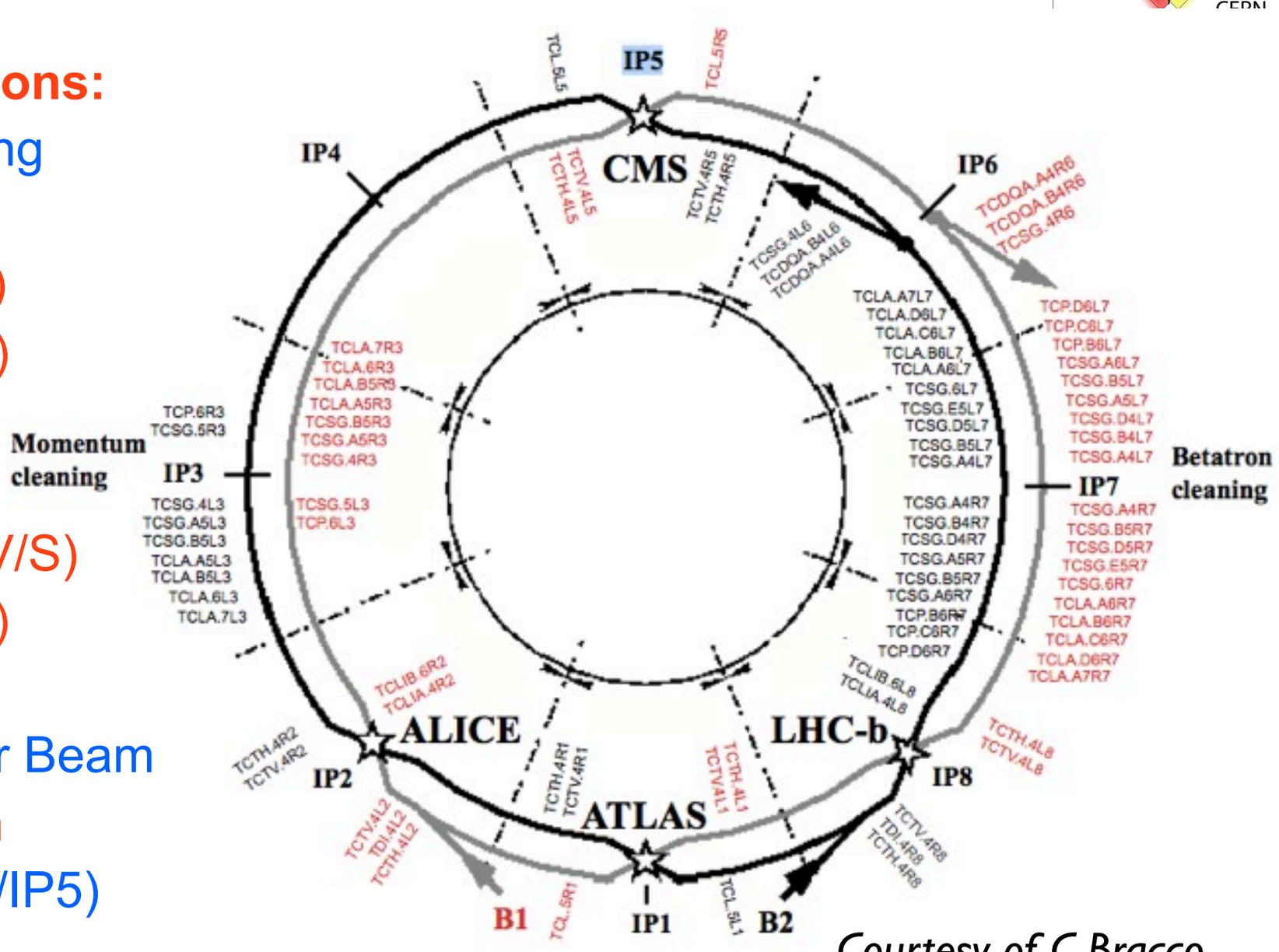
Outline

- Introduction
- Collimation alignment strategy
- Collimators with BPMs
- Look at 2012 commissioning
- First thoughts for after LS1
- Collimators during sector tests
- Implications for special runs
- Summary



LHC Collimation Layout

- **Two warm cleaning insertions:**
  - IR3: momentum cleaning
    - 1 Primary (H)
    - 4 Secondaries (H/S)
    - 4 Shower Abs. (H/V)
  - IR7: betatron cleaning
    - 3 Primaries (H/V/S)
    - 11 Secondaries (H/V/S)
    - 5 Shower Abs. (H/V)
- **Local cleaning at triplets**
  - 8 tertiaries: 2 per IP per Beam
- **Physics debris absorption**
  - 2 TCL (1 per beam IP1/IP5)



Courtesy of C.Bracco

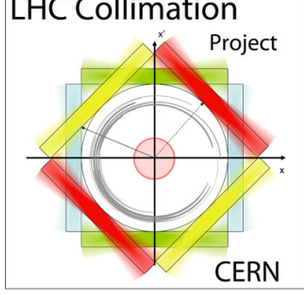
8 passive absorbers for warm magnets in IP3/IP7

Transfer lines (13 collimators)

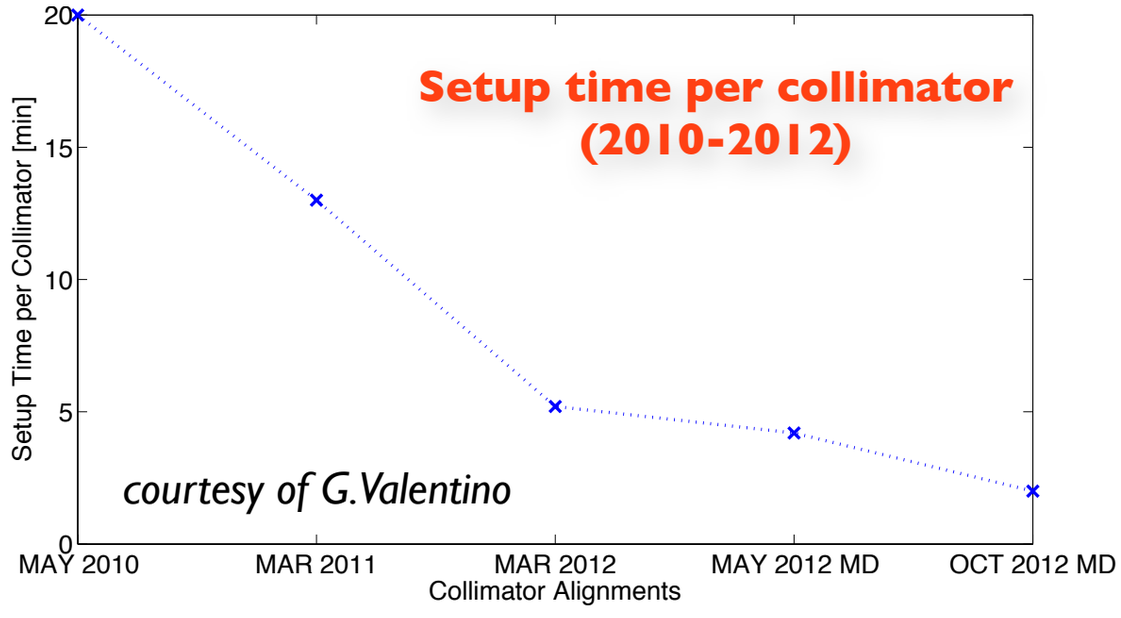
Injection and dump protection (10 collimators)

Total of 108 collimators (100 movable) as of 2012
4-8 more after LS1 (TCL's)

Collimation Alignment



- Collimators are (and should be) the first line protection and therefore be the elements closest to the beam. Protection and cleaning functionalities of the system rely on respecting a complex collimator hierarchy for a given aperture - see previous talk.
- Collimator alignment takes time:
  - Alignments are done by touching the beam halo with both jaws in dedicated low intensity fills.
  - Big effort was done in the past years to make this as fast as possible (still ensuring the safety of the system) see Evian 2012 collimation talk



** fastest alignment achieved in MD with collimators pre-adjusted close to the beam

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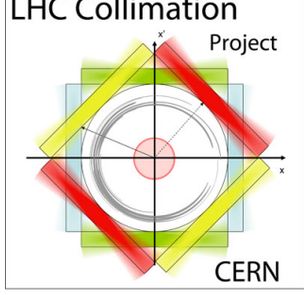

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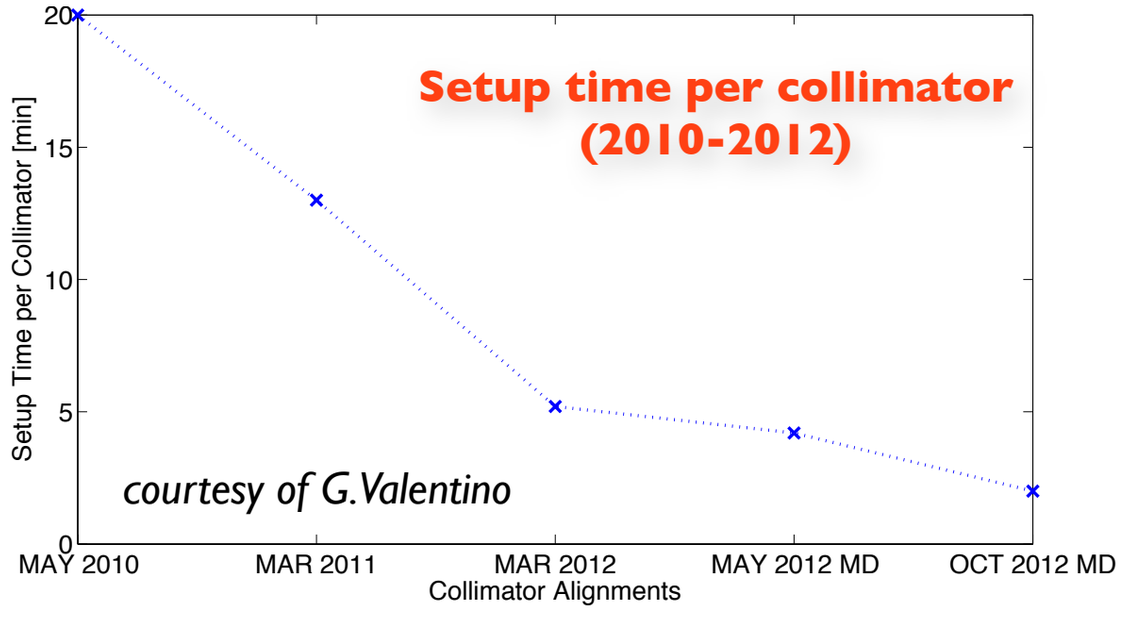

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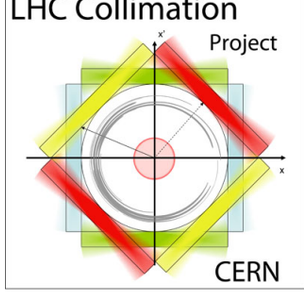

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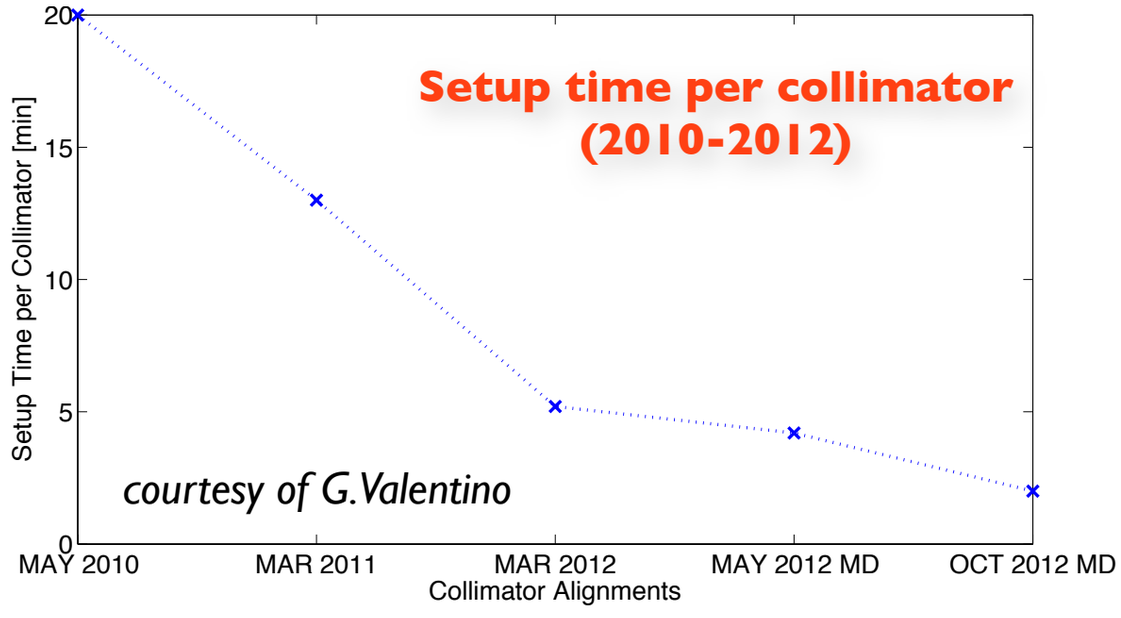

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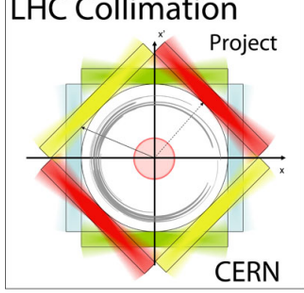
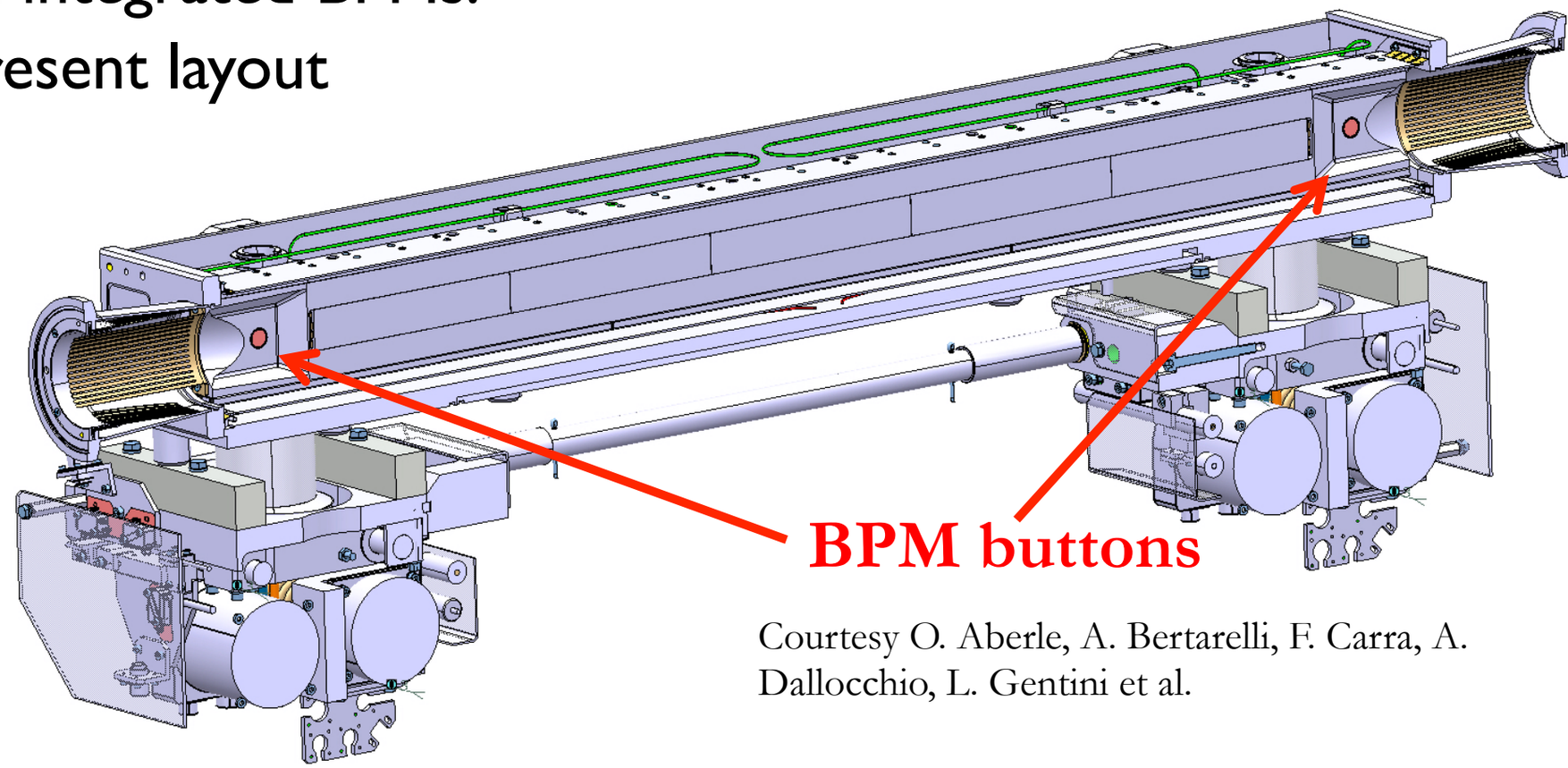
Collimators with BPMs



- 16 Tungsten TCTs in all IRs and 2 Carbon TCSGs in IR6 will be replaced by new collimators with integrated BPMs.
- No changes in the present layout

Some improvements are in the pipeline for the TCT but this is just for the IR configuration (and TCSG in IR6)

We cannot rely on this for the whole system configuration

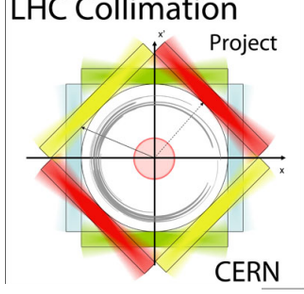


Courtesy O. Aberle, A. Bertarelli, F. Carra, A. Dallocchio, L. Gentini et al.

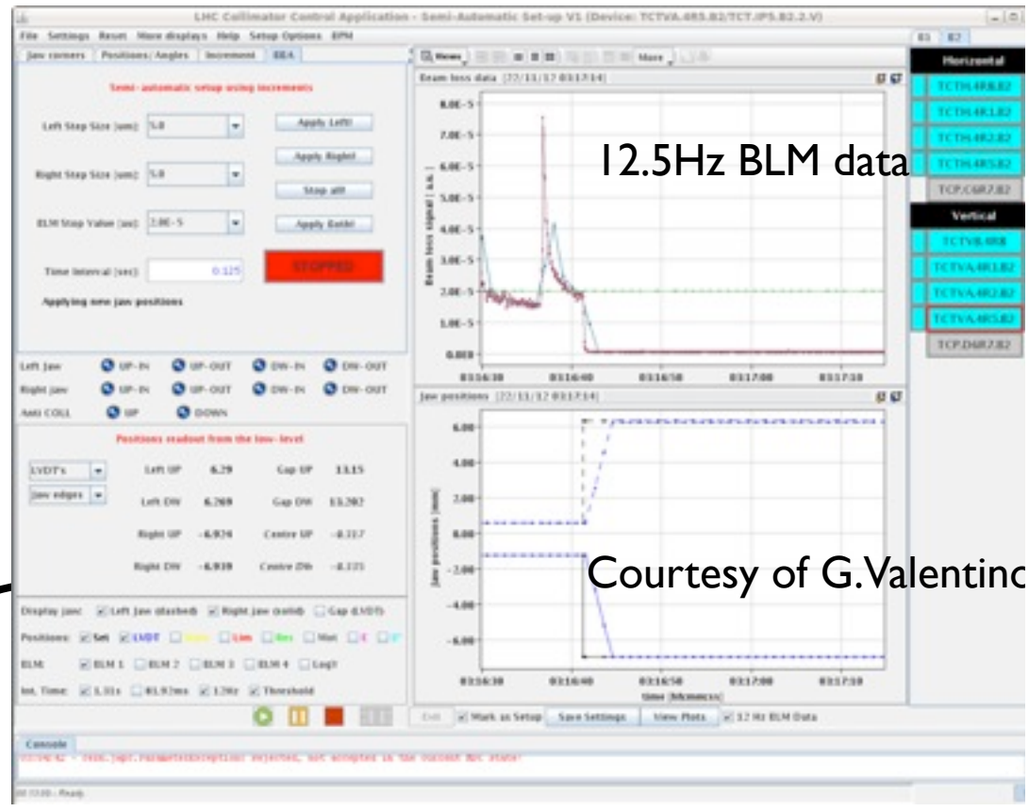
Collimators with BPMs:

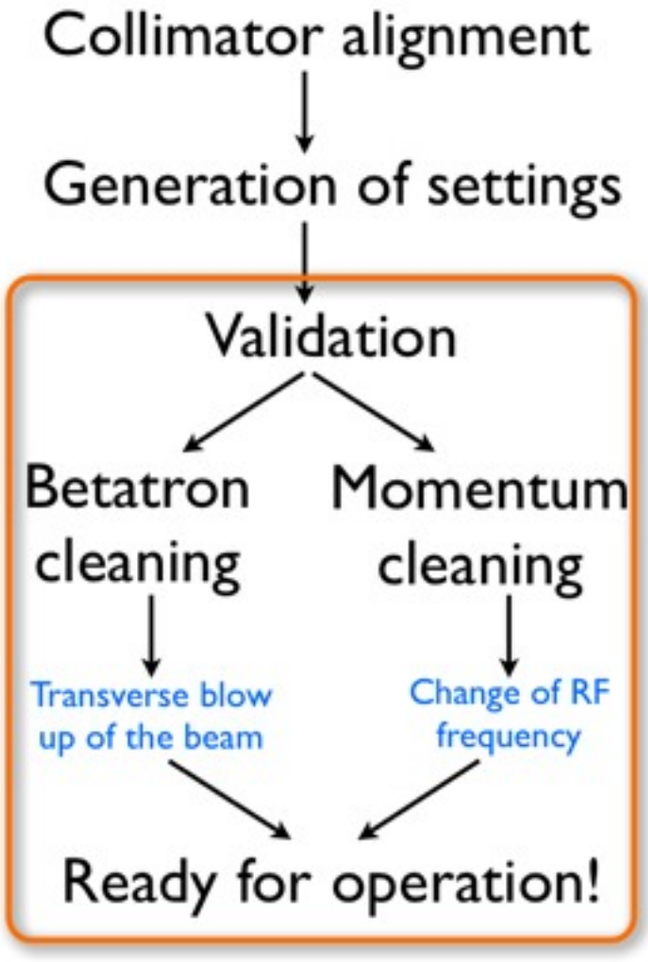
- We will prototype and at the SPS and then implement the same procedure at the LHC, after Sep. 2014.
- They will be fully commissioning: controls, interlocks, etc.
- G.Valentino starting a fellow to continue this work
- However, we will still need dedicated commissioning time at the LHC (tentatively 1-2 shifts) that we will add to the final schedule.

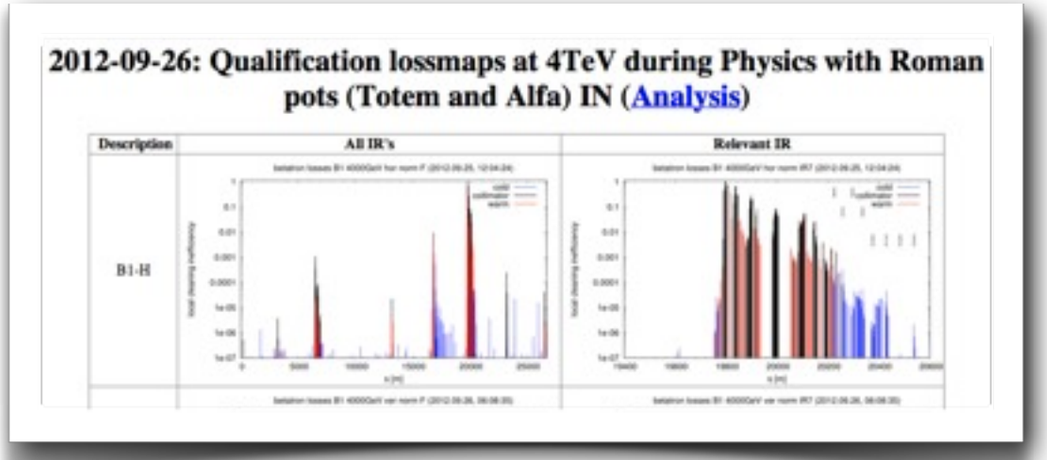
Alignment tools



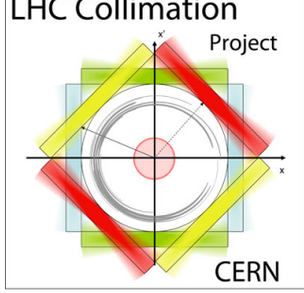
A set of tools are already set in place to make the whole process as **fast** as **reliable** and **reproducible** as possible





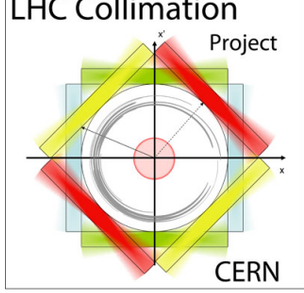


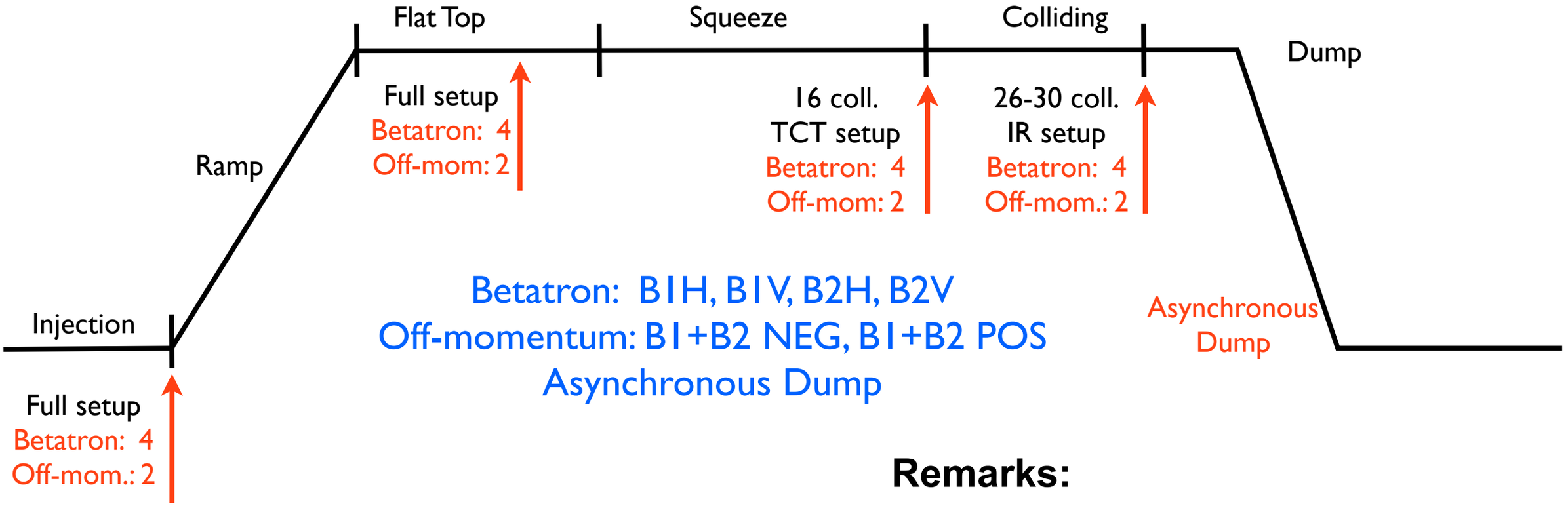
Tools for after LS1



- Consolidate existing tools for BLM-based alignment.
- Improving tool for setting checks and automatic parameters import into settings database (see MPP workshop in March)
- New dedicated tools for BPM collimators (in collaboration with BI and OP) prototyping at the SPS after Sep. 2014.
- Ongoing discussion with logging and CO teams to improve collimation data handling (BLM, ...)

Required setups





Betatron: B1H, B1V, B2H, B2V
Off-momentum: B1+B2 NEG, B1+B2 POS
Asynchronous Dump

This assumes separated functions

energy ramp

optics change (squeeze)

collisions

These 2 processes are separated now but they might be merged in the future

Shift of TCT's centers

Remarks:

- Beam-based alignment to get the collimators center
- But orbit and optics should be corrected
- Specially at top energy where we rely on the nominal beam sizes to calculate the final openings of the collimators
- Important to keep beta error SMALL!

We will have to change our commissioning strategy if $\Delta\beta/\beta \gg 10\%$ at top energy

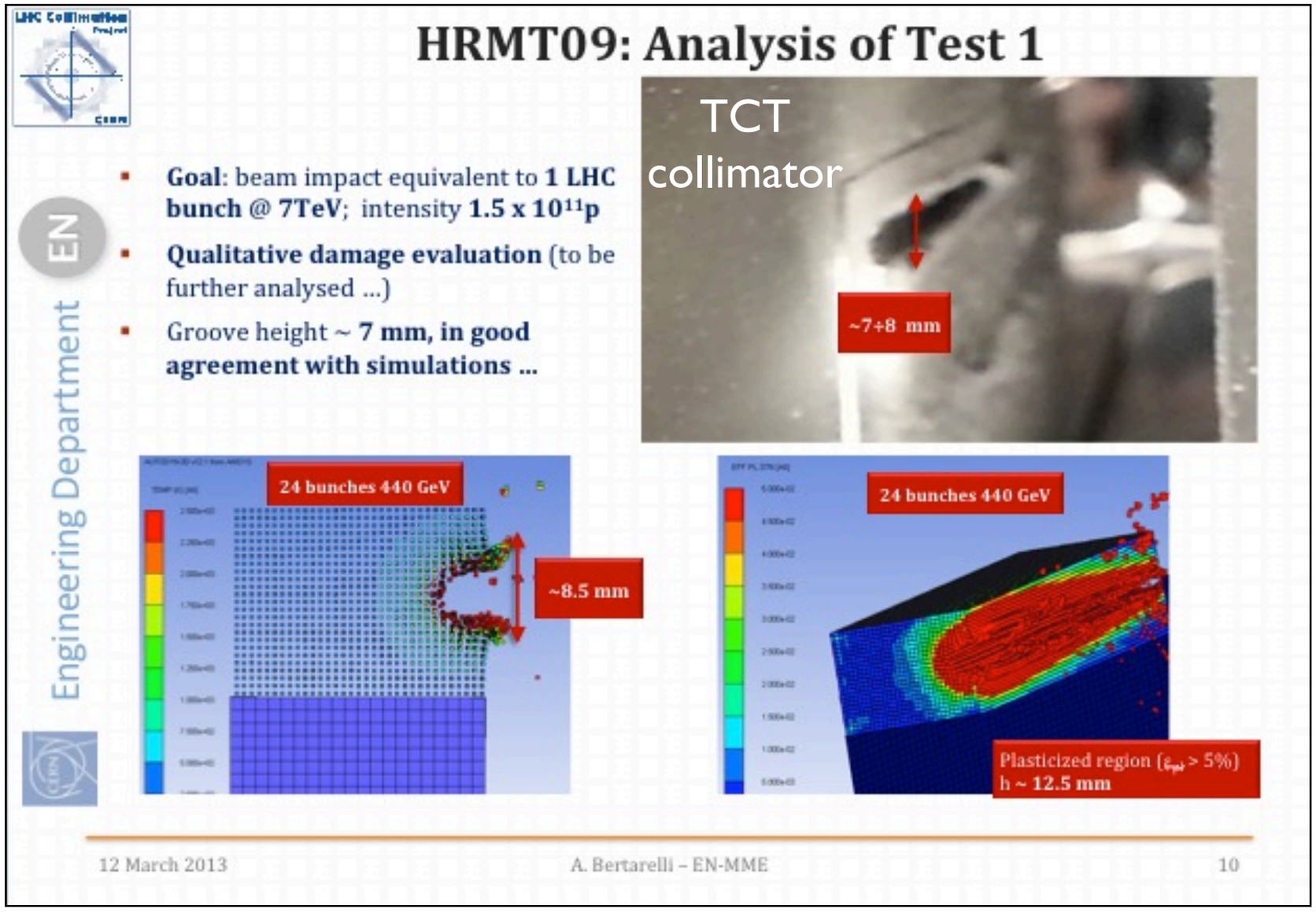
Some reminders

- Even at injection energy collimation is needed
- With unsafe stored energy ⇒ Full collimation system is needed

New TCT damage limit updated during the MPP workshop 2013:

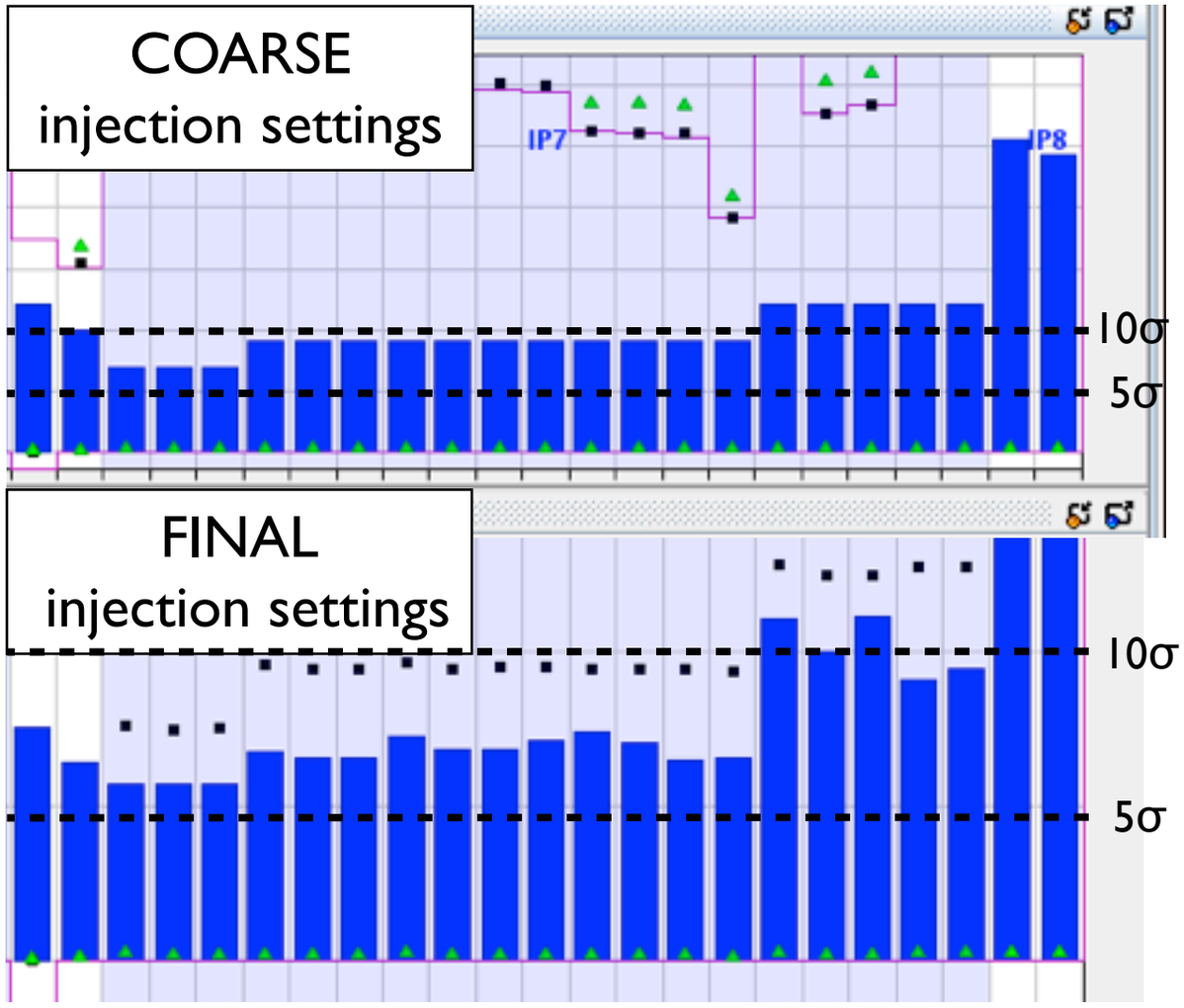
Equivalent to 1 bunch @ 7TeV into TCTs

Onset of Plastic damage with 5×10^9 p (< pilot bunch)@ 7TeV

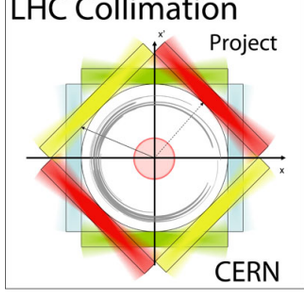


In 2012

- 14th March: Collimator settings for start up (coarse)
- 16-17th March: Ramp and Squeeze with collimator injection settings
- 21st March: setup at injection, next ramp with collimation functions (BB sizes and injection centers)
- 29th March: setup flattop
- 30th March: setup collisions
- 31st March: setup squeeze



Overall strategy



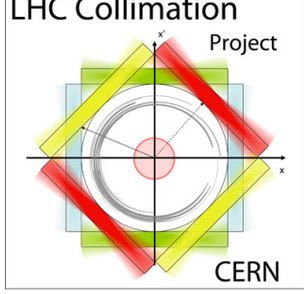
We take 2012 commissioning as a good example to recall the general strategy for collimation setup after LS1.

1. Start injection (450GeV) with pilot or few nominal bunches:
   - Can stay at COARSE settings (**no alignment needed**) the system is still protected although cleaning will suffer but we are still “safe”.
2. Need **good understanding of orbit and aperture** for beam close to unsafe intensities:
   - Injection alignment
   - Collimators at injection settings during ramp
3. Continue with orbit and optics corrections at top energy, all done with injection settings.
   Depending on machine status we can decide to close collimators during the ramp using injection alignment or to keep collimators open at injection settings until alignment at flat top is done.

We should minimize the time spent in additional alignments of collimators in favor of a commissioning scenario with detailed setups occurring at:

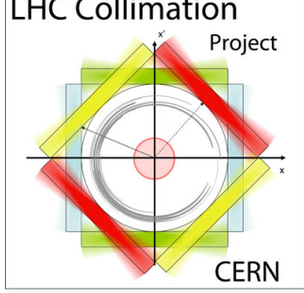
- **optics corrected**
- **machine configuration with Nominal Bunch Int. and final IR knobs.**
- **known aperture.**

Collimator during sector tests



- Collimators used as “mini” dumps in the insertions concerned - same strategy as in first sector tests.
  - See SR’s talk at the extended LTC meeting in 2008.
- No specific requirements in terms of measurements from our side.
- In the past tests, worked with the BI team to check instrumentation (BLM’s, BPM’s).
- First connectivity checks of BPM-collimators.

Special cycles



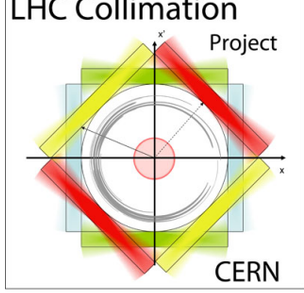
Various “advance” operation modes under consideration:

- Combined ramp and squeeze
- Collisions during squeeze / beta leveling
- “Relaxed” TCSG settings at flat-top for impedance improvements
- …

We see no show stopper, however…

… it is important to define soon a baseline to prepare the required tools.

Summary



- We reviewed the set of tools available for new alignments and validation after LS1
- Still some improvements need to be done on:
  - consolidation of the old tools,
  - automatic checks and
  - collimators with BPMs handling tools.

- We take commissioning of 2012 as a good baseline for collimation setups, we agree to follow a **similar strategy after LS1 with addition of commissioning of Collimators with BPMs**
- The overall collimation setup strategy relies on excellent performance of the orbit and optics correction.
- Of course if the machine performs as well as in previous years with small beta-beat corrections and perfect orbit stability we will profit from it during the setup of collimators at top energy