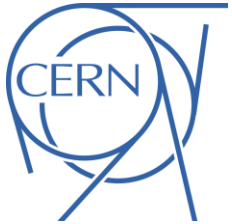
CERN, 18 March 2013
ICFA Mini-Workshop
on Beam-Beam Effects in Hadron Colliders (BB2013)



Operational aspects

Session summary

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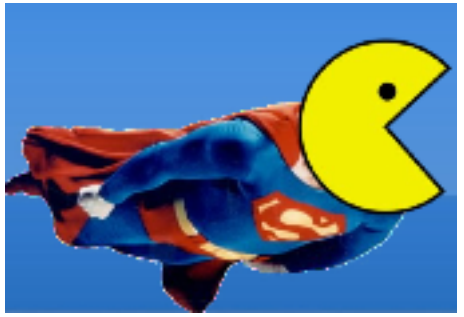
list of talks

- Needs and requirements from the LHC physics experiments
  - Richard Jacobsson
- Luminosity levelling techniques: implications for beam-beam interactions
  - Tatiana Pieloni, Bruno Muratori
- Implementation and experience with luminosity levelling with offset beams
  - Delphine Jacquet
- Diagnostics needs for beam-beam studies and optimization
  - Rossano Giachino
- Luminosity measurements and optimization - consequences for beam-beam effects
  - Witold Kozanecki
- Consequences of missing collisions - beam stability and Landau damping
  - Xavier Buffat
- Observations from LHC operation
  - Michi Hostettler



luminosity levelling

- levelling might not be required for IP1/5 after LS1 (if 25 ns)
  - levelling needed for HL-LHC
  - at least gain operational experience for HL-LHC in run 2

- wish/constraint list on levelling techniques by experiments
  - local, individual, minimum overhead for commissioning, stable, robust, safe, …

- possibilities: by transverse offset, by beta*, with crabs, with cogging
  - cogging: all IPs simultaneously, no simulations available
  - crabs in HL-LHC: for geometric factor, levelling not thoroughly studied yet, could introduce noise
  - long and stable luminous region is vital

- probable: mix of beta* + transverse offset

levelling by transverse offset

- levelling by offset very successful so far for IP8 and IP2
  - simple and independent IP to IP
- bunches with HO collisions are always stable
  - levelling by transverse offset can be used for one IP, not for all
    - need HO tune spread elsewhere
- recommend at least one head-on collision for each bunch
  - collide quickly (limited by power supplies)
  - collide during squeeze
  - collide IP1/5 first
  - one IP/plane before the other one
- Alice ok with levelling by separation after LS1
    - TPC trips: what tolerances on orbit? no problems around 5 sigma, but what about orbit corrections and lumi optimization

beta* levelling

- might squeeze already with colliding beams to gain stability
  - required for Pb operation in run 2
- need good orbit control to avoid accidental separation
- complexity?
  - none if IP1/5 move together (after IP2 and 8 at final beta*)
  - if IPs independent, then need optics corrections at each matched point and new controls mechanisms
- what is the required range?
  - be smart and chose one in which collimators stay put
  - otherwise worry about loss spikes (will extrapolate from MD experience)
- pseudo-flat beams?
- LHCb to be guinea pig to test beta* levelling
  - operation's point of view: likely to be not-independent across IPs

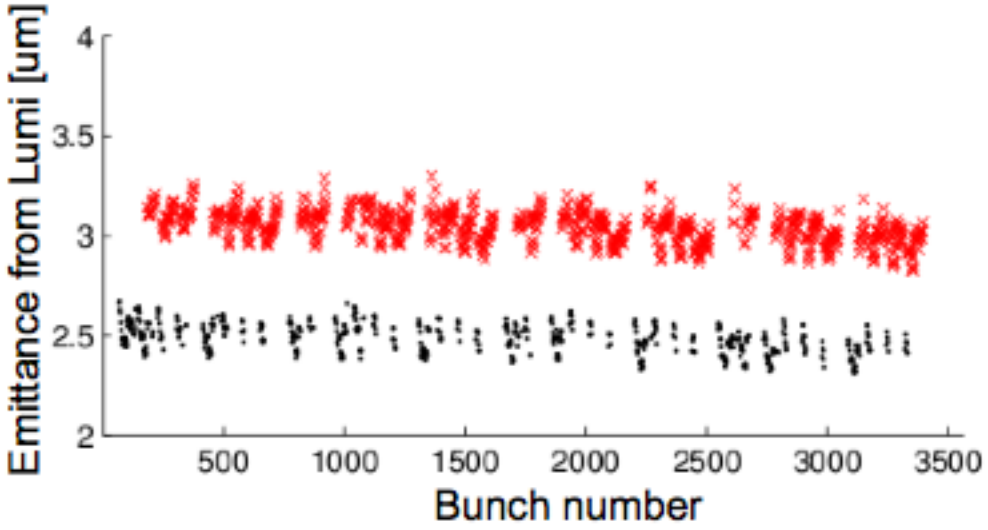
beam parameters after LS1

- "25 ns is a must"
  - 25 but no less
  - nominal is ideal (i.e. 25 ns and 1e34 $cm^{-2}s^{-1}$)
  - when is scrubbing too slow? when fallback to 50 ns?
    - what is the maximum acceptable pile-up ?
    - at 25 ns, max pile up = 60 acceptable
      - but not a reason to prefer 50 ns
    - invest on 25 ns scrubbing for operation until LS2
  - no more satellite operation for Alice

- desire for non-colliding bunches for background studies
  - likely problematic for stability
  - can find a parameter set that guarantee stability and still useful?
    - 1e10 ppb too little, 8e10 ppb acceptable

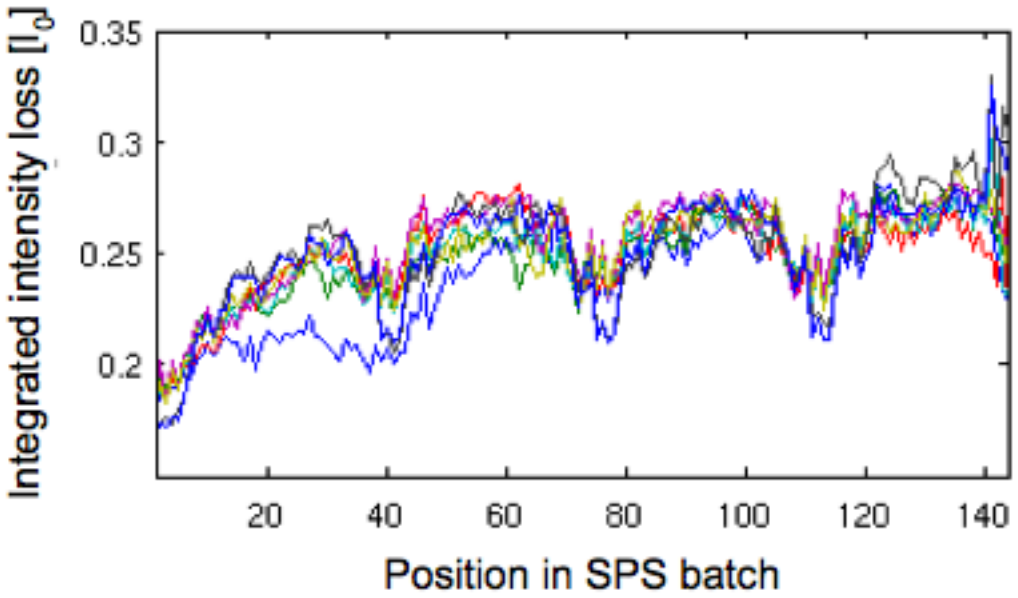
end-of-squeeze instability

- instability at end-of-squeeze not understood
  - bb detuning to be included in stability studies already at end-of-squeeze
  - discussion on contribution to stability from LR and octupoles
    - and extrapolation to 7 TeV
  - suggestion: additional linear coupling at end-of-squeeze
- little losses, but costly in luminosity
  - 2.5um -> ~0.73e33 $cm^{-2}s^{-1}$, 3um -> ~0.63e33 $cm^{-2}s^{-1}$



loss pattern on beam 1

- reproducible pattern observed but not understood
  - develops after hours in collisions
  - correlated to longitudinal losses (bunch length increase)
  - not visible in the other ring
- suggestions to investigate specific lumi and RF noise



diagnostics needs

- "bunch-by-bunch everything" key for bb understanding
  - need less bandwidth for normal operation, higher bandwidth during instabilities (how fast?)
  - need trigger to other instruments when instability detected
- to be improved
  - emittance emittance emittance
  - Headtail monitor
  - Diamonds for beam losses
  - BTF… already exists and operational
  - would prefer continuous monitoring of chromaticity!
- need Schottky, Halo Monitor
  - Halo Monitor: request exists, but no manpower allocated yet
    - useful for stability

luminosity measurements and optimization

- target 2% absolute error on instantaneous luminosity
  - achieved: 2011: 1.8%; 2012: 2.8% (preliminary)
- during VdM scans need different parameter space than physics operation
  - single bunches
    - no parasitic encounters
    - can't use end-of-fills as cannot use trains (LR!)
  - need gaussian bunches for xy factorization
    - from injectors, and conserved at LHC
  - smaller bunch charge
    - reduce orbit distortions and dynamic β during scan
  - bigger size (higher β and not-so-small emittance)
    - vertexing resolution, on B-G imaging & quantification of non-factorization effects
- need to refine understanding of HO bb effects during scans
  - dynamic beta scan distortions, impact of in-plane orbit distortions during scans, non-factorizability