Recent observations on bunch length splitting in LHC Beam 1

M. Hostettler, G. Arduini, G. Papotti
LBOC, 20.11.2012

Overview

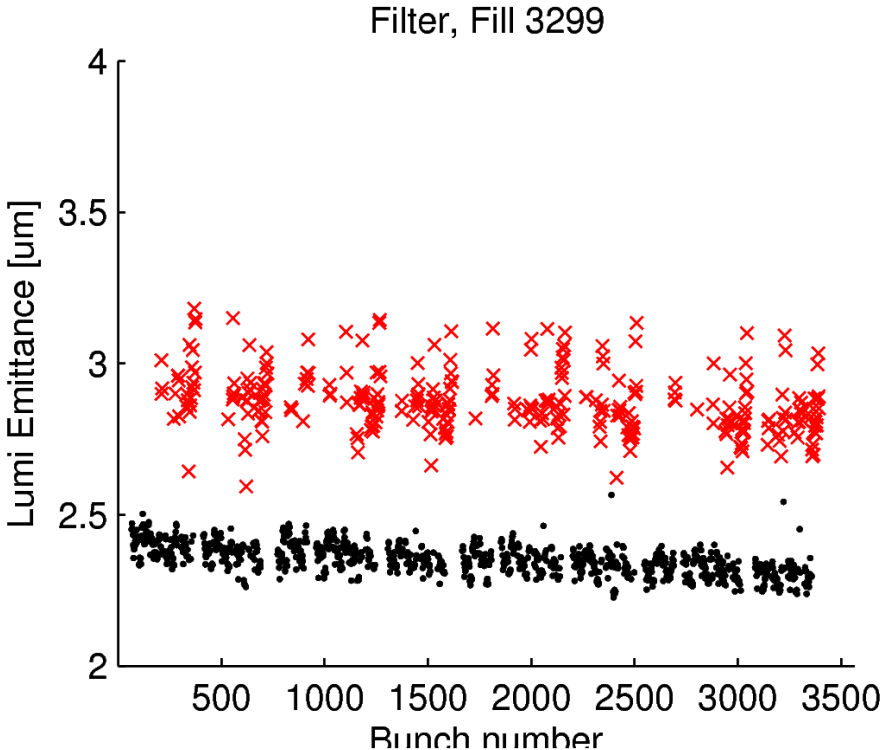
- Observations on transverse emittance blow-up
  - Blown-up bunch detection, statistics
- Observations on bunch length
  - Length histogram splitting for B1
  - Correlation with emittance blow-up
  - Influence of bunch shape?

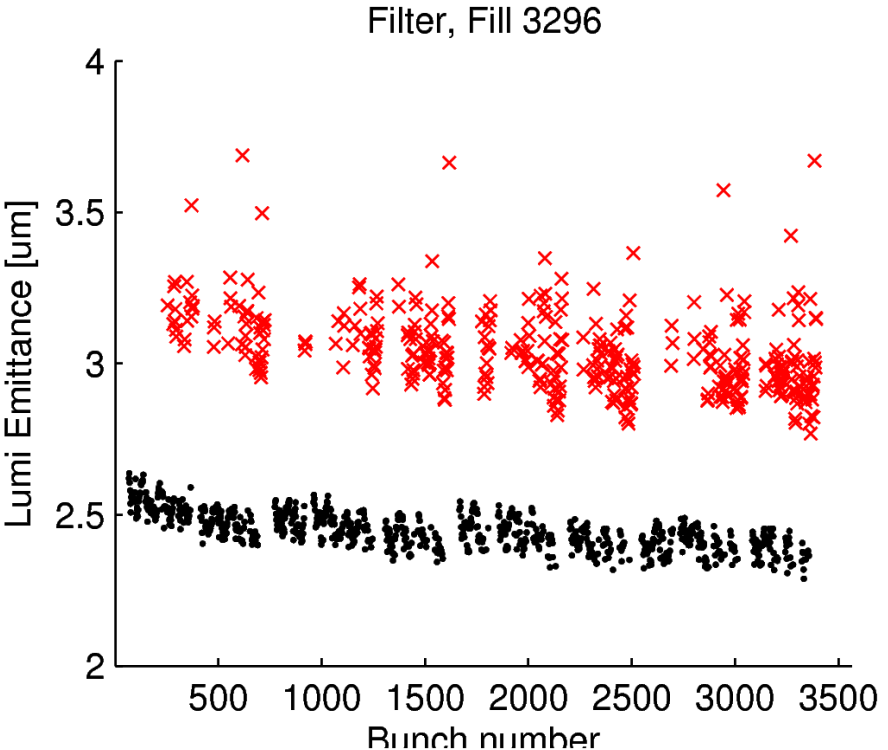
Transverse emittance blow-up

- Selective transverse blow-up observed on many of the recent fills at the start of SB
  - Observations based on the convoluted emittance derived from luminosity
  - Plane and beam yet unknown
- Not present at injection
  - no direct measurement available
- No explanation yet

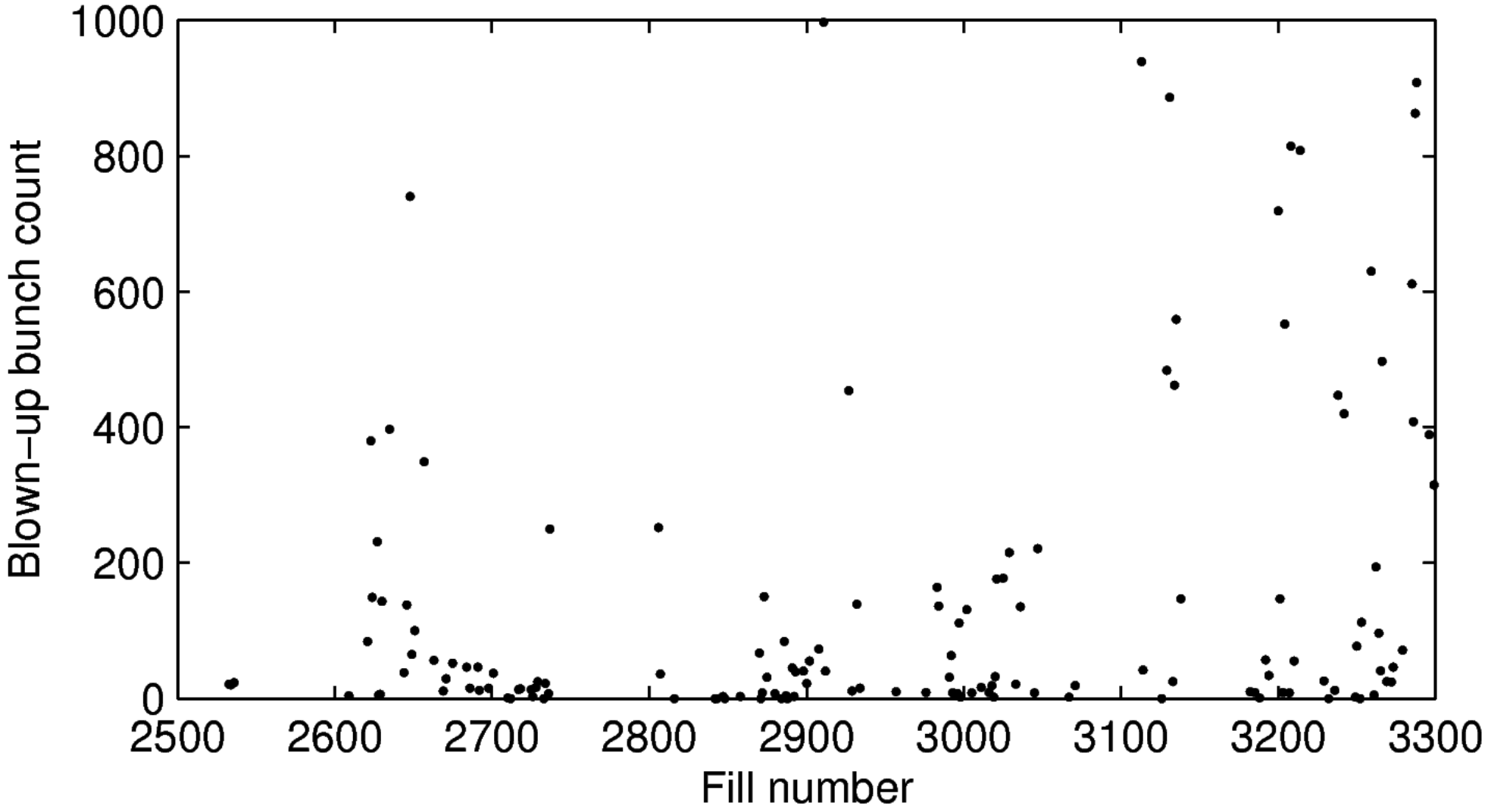
Blown-up bunch detection

- Do a histogram of emittances, find low peak
- Consider bunches with emittances of 0.5um around the peak as not blown up
- Works reasonably well for most of the fills

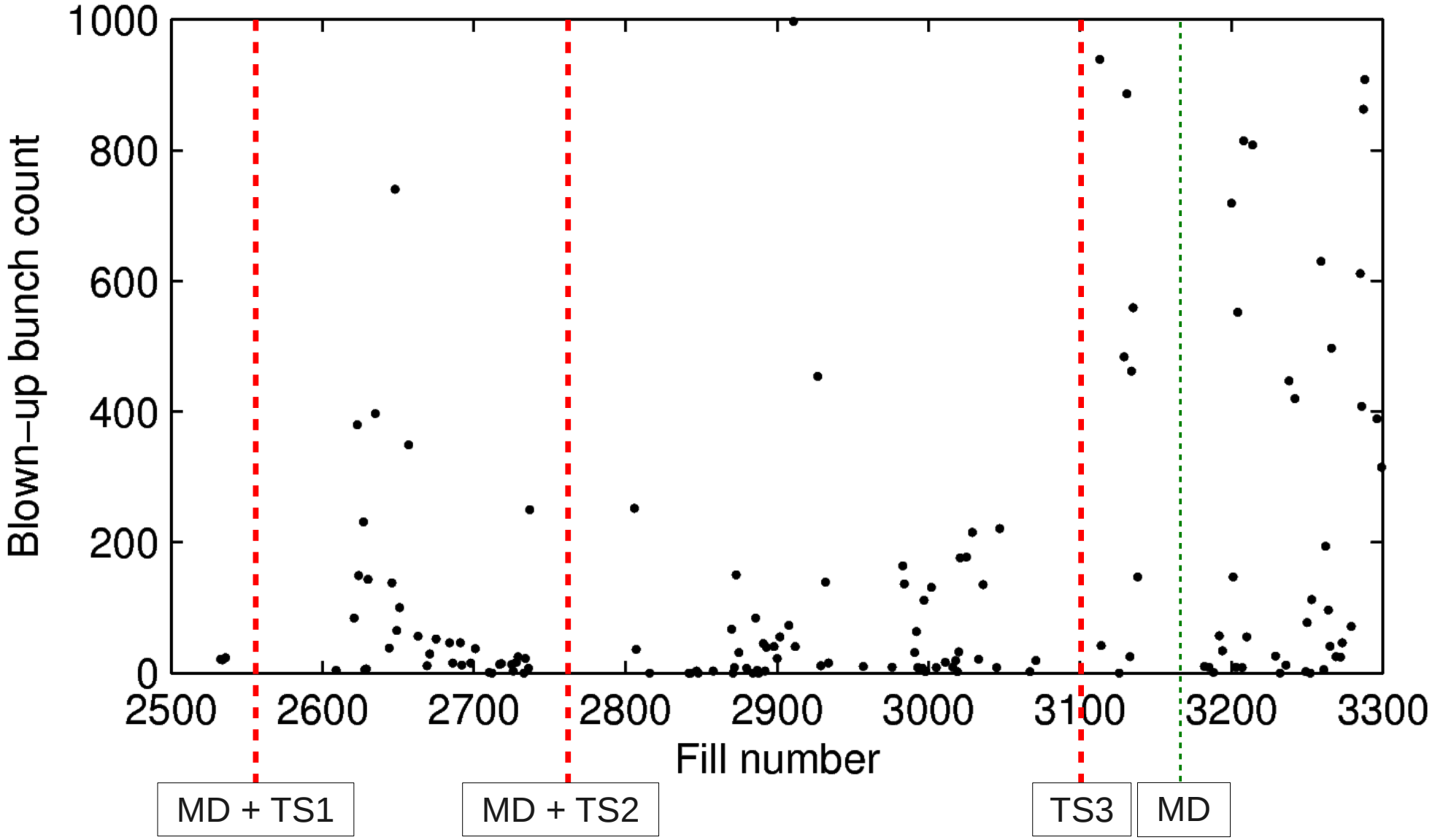




Transverse emittance blow-up

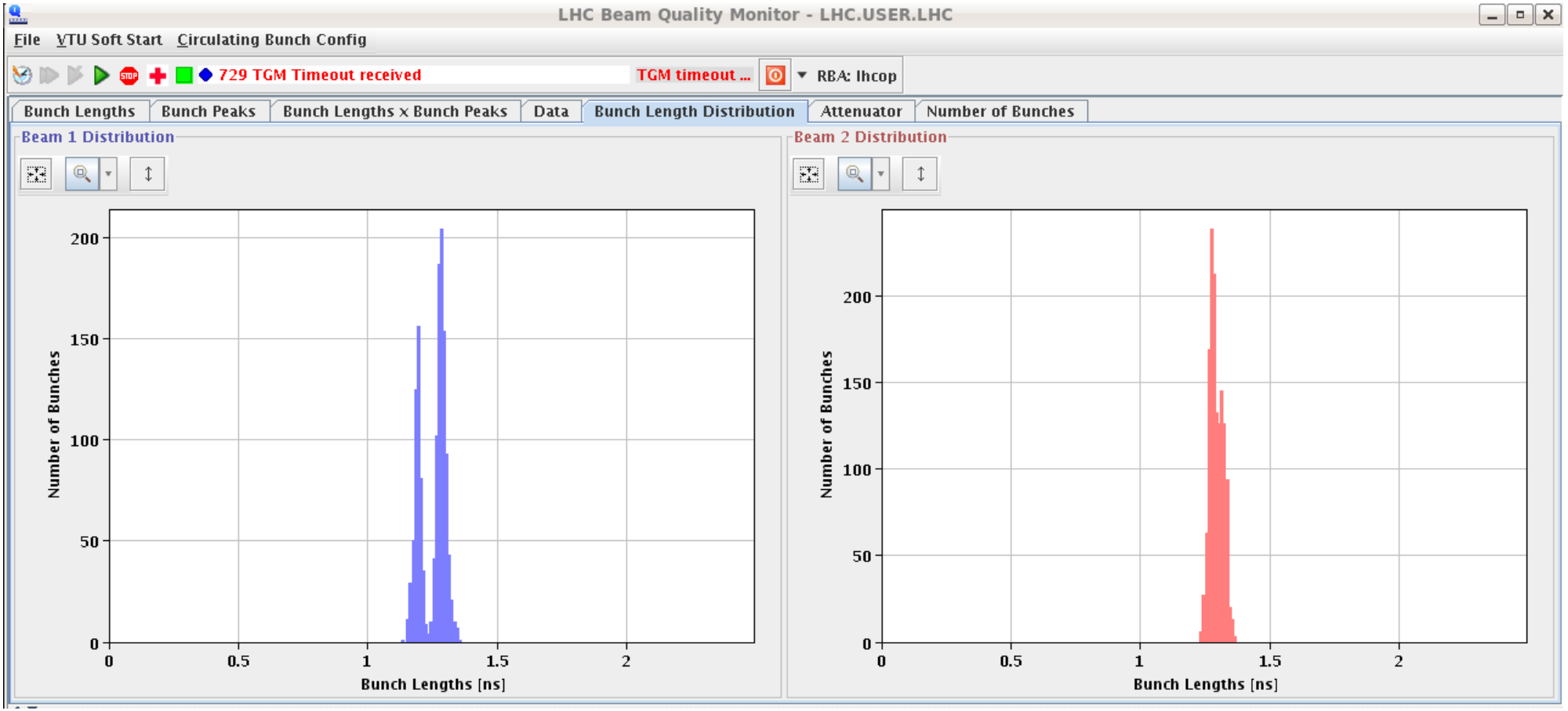


Transverse emittance blow-up



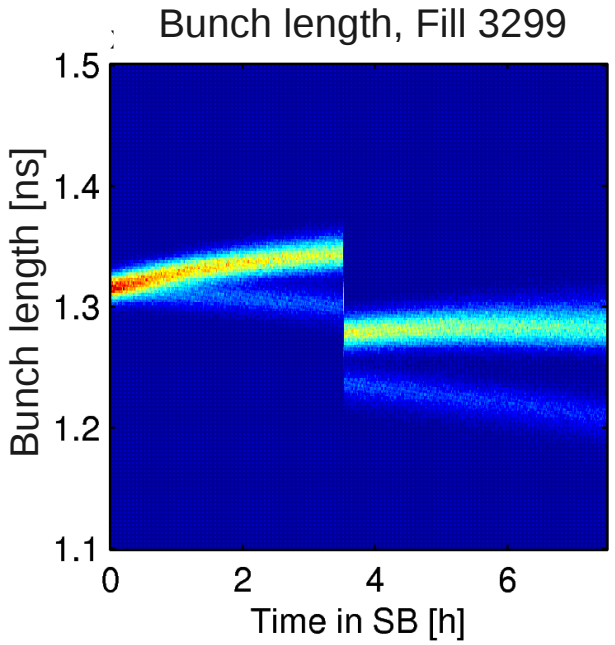
Beam 1 bunch length splitting

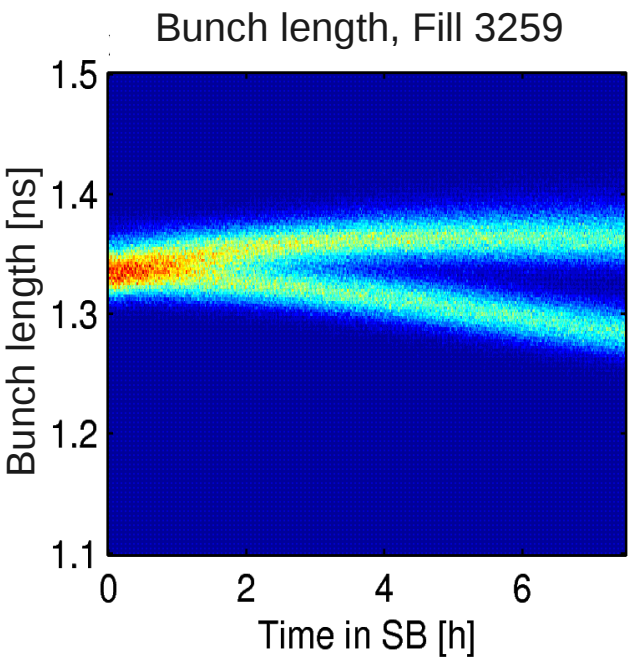
- First noticed on BQM fixed display for Beam 1 after RF voltage increase (start of November)



Effect of RF voltage increase?

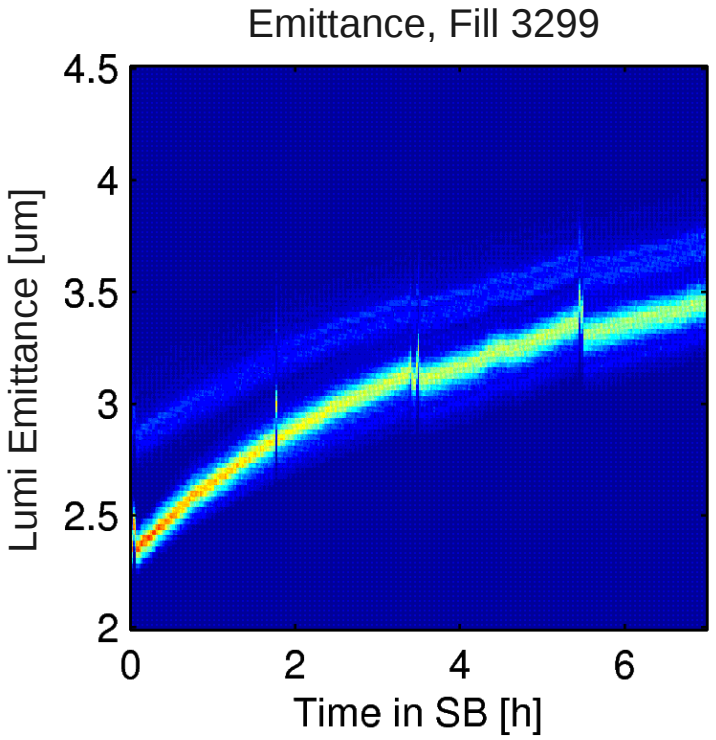
- Very unlikely, as
  - the splitting starts at the start of SB, before any increase in RF voltage
  - splitting is also present in fills with no RF voltage increase (e.g. 3259, 2012-11-03)

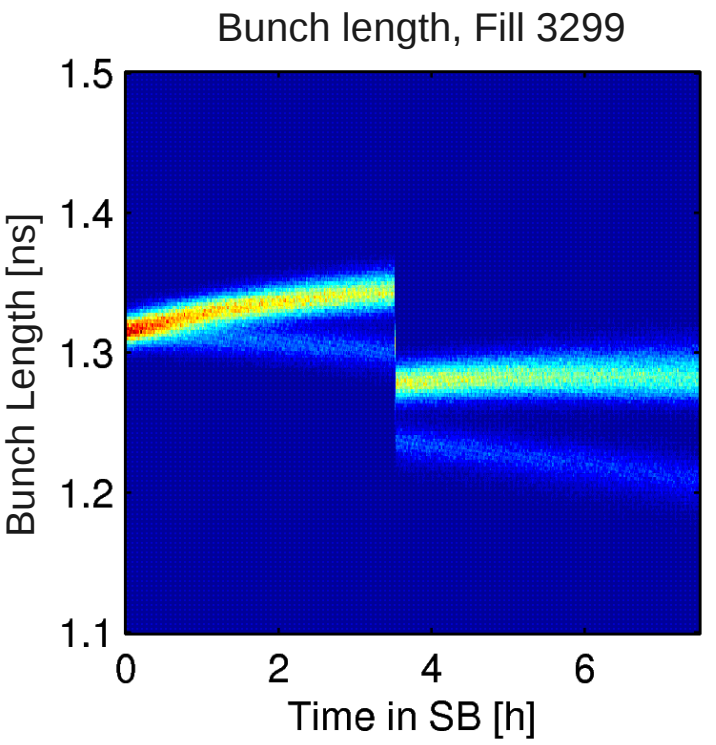




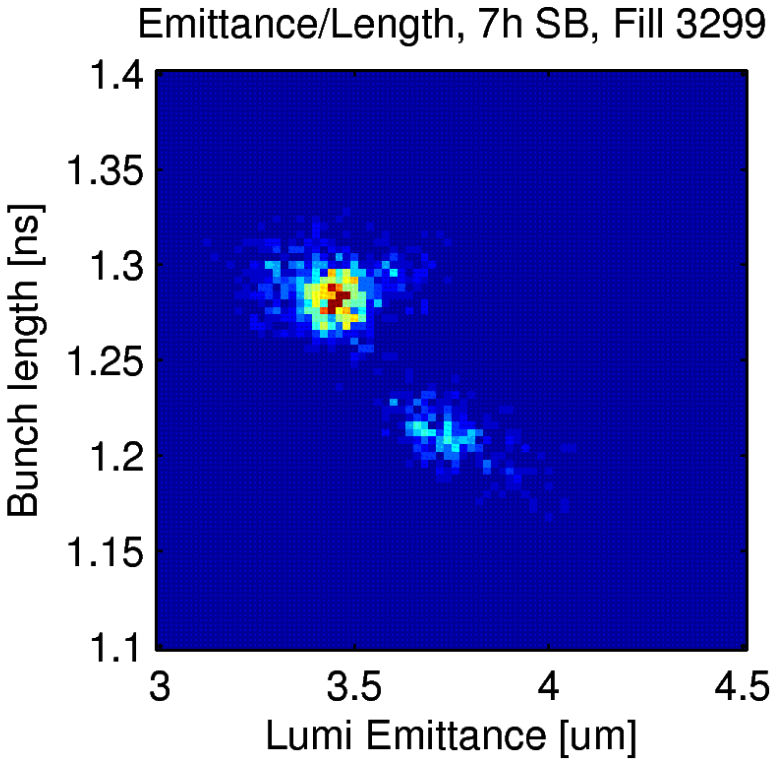
Correlation with emittance blow-up?

- Plausible: Bunch length splitting observed for fills with selective transverse blow-up
- Selective transverse blow-up present at the start of SB



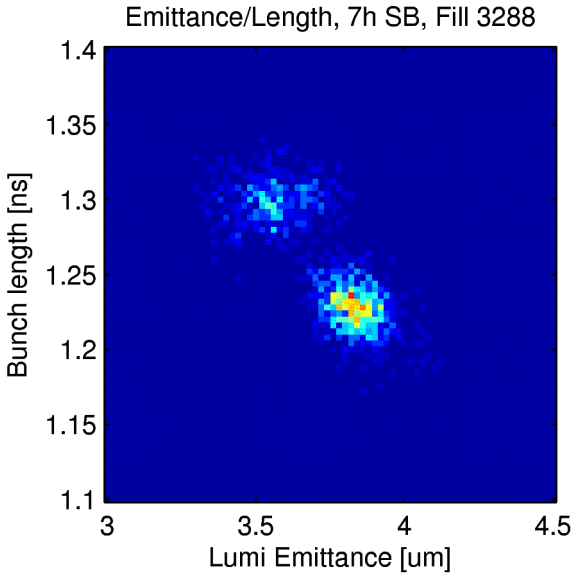


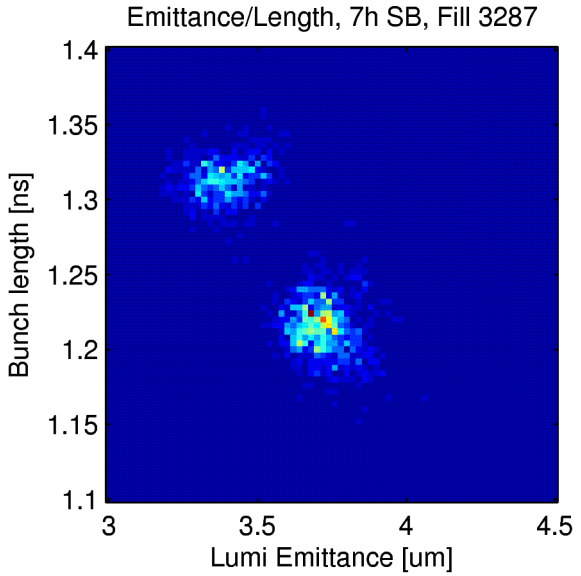
Correlation with emittance (7h SB)

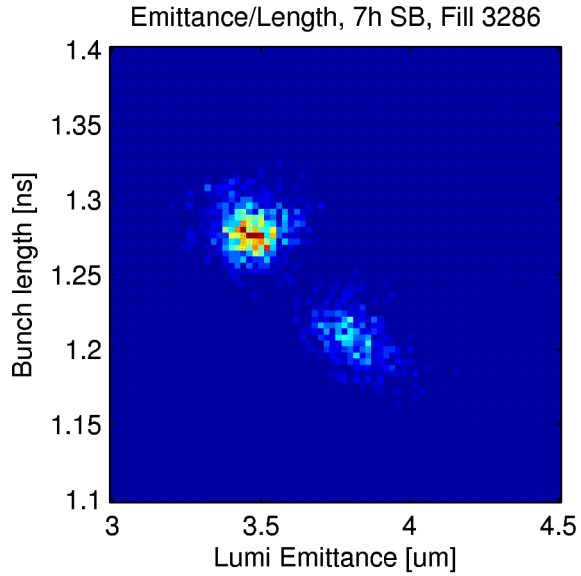


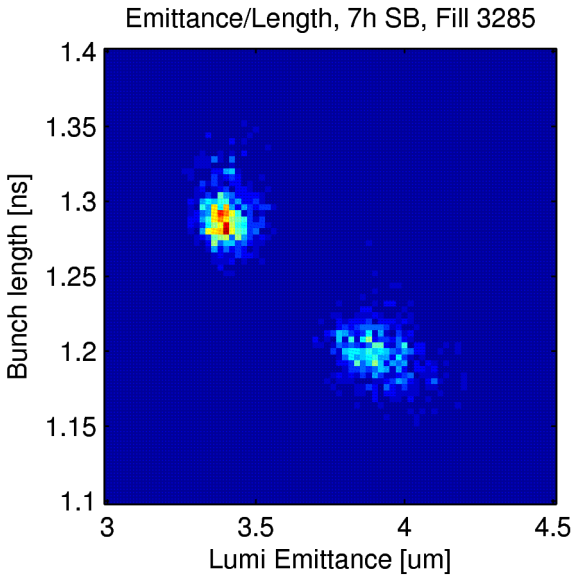
- 2D histogram: Emittance (from luminosity) vs. bunch length (from BQM)
- Two 'islands' of bunches
  - ~1.3ns bunches with (normal) ~3.5um emittance
  - ~1.2ns bunches with (blown-up) ~3.8um emittance
- Holds for other recent fills, further examples follow

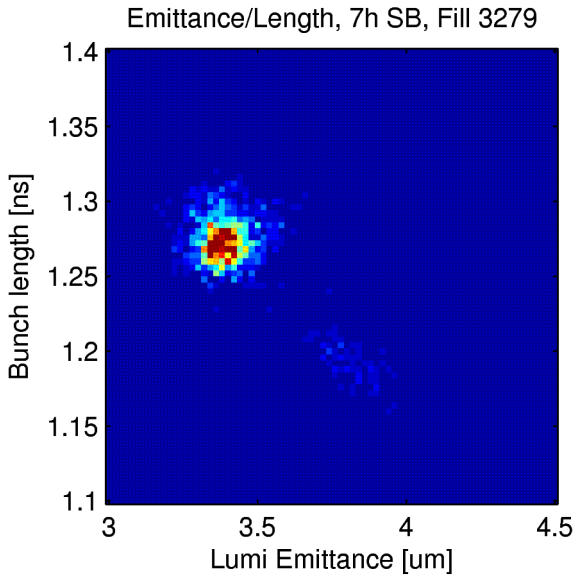
Correlation with emittance (7h SB)

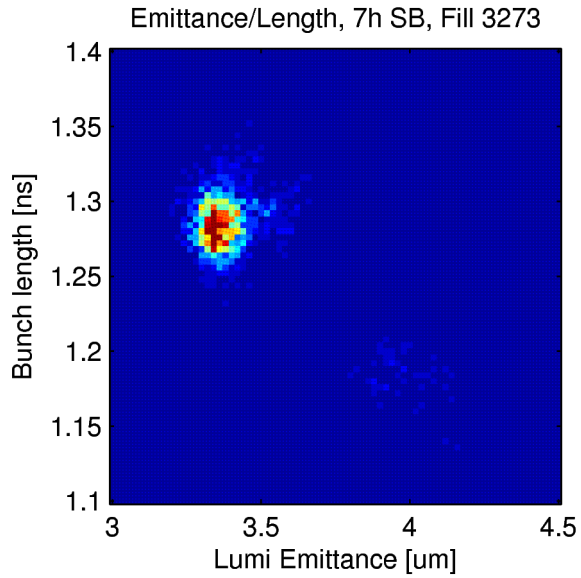






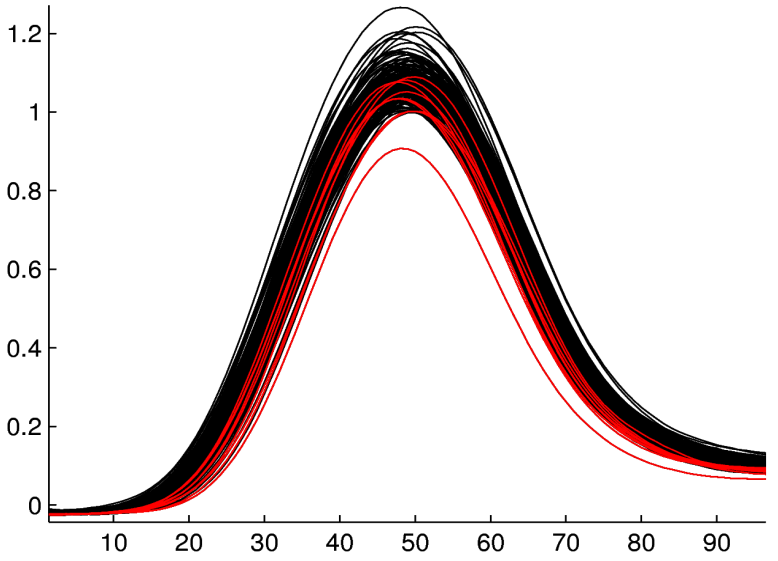






Bunch shape?

- Could the emittance blow-up change the shape of the affected bunches, affecting the BQM length measurement?
- Cross-check with the 40 GS/s scope in point 4
  - Ongoing work with Philippe Baudrenghien
  - Preliminary results do not show a significant change in shape
  - Length fitting and comparison to be done

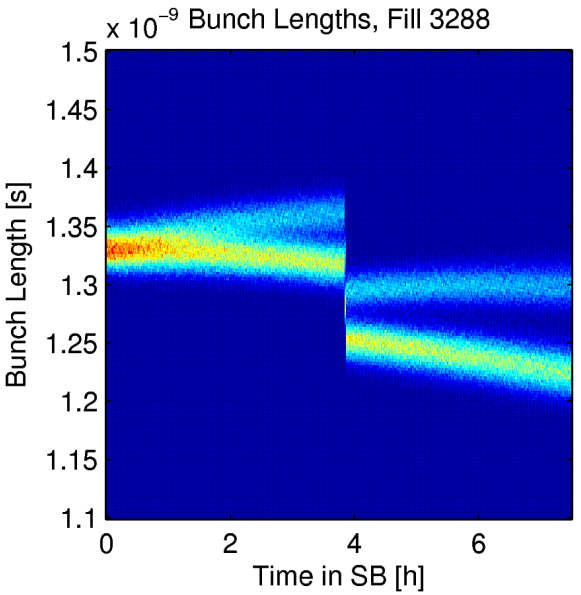


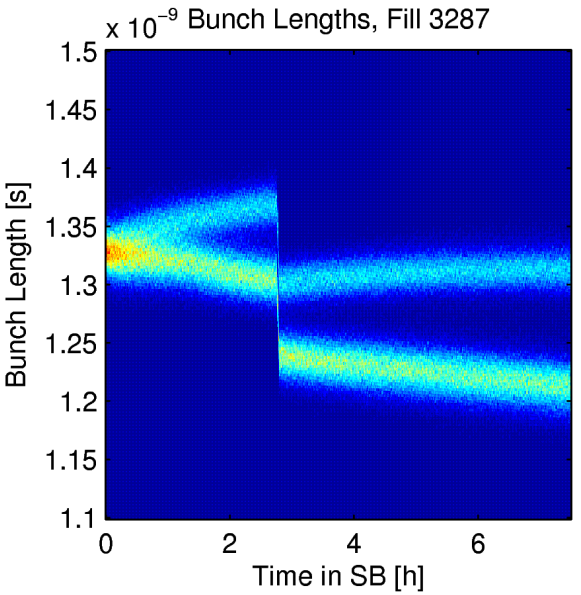
Conclusions

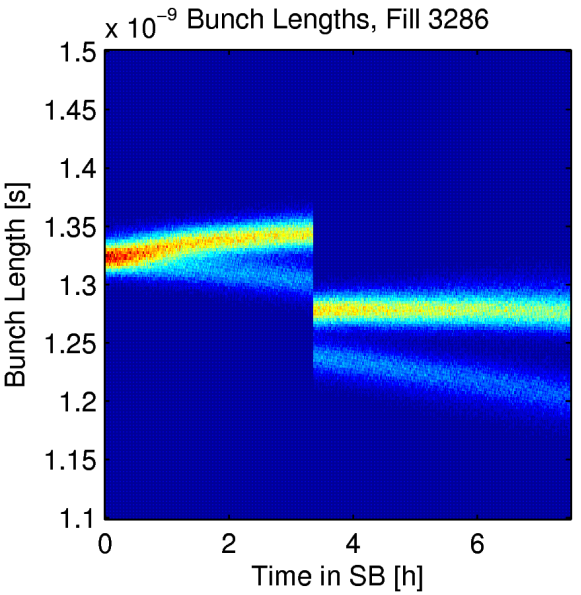
- Recent fills (after TS3) suffering from selective emittance blowup
  - Beam and plane unknown
  - No explanation yet
- Bunch length splitting common for Beam 1 in recent fills
  - Results indicate a correlation with emittance
  - Bunch shape and it's effects to be analyzed

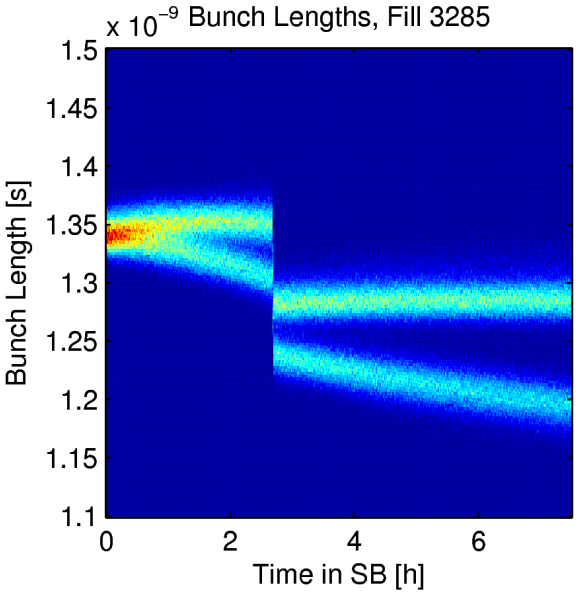
Backup slides

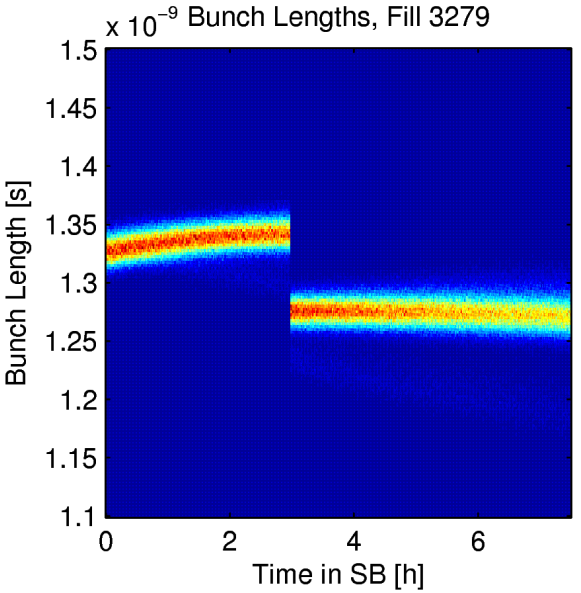
Bunch length evolution

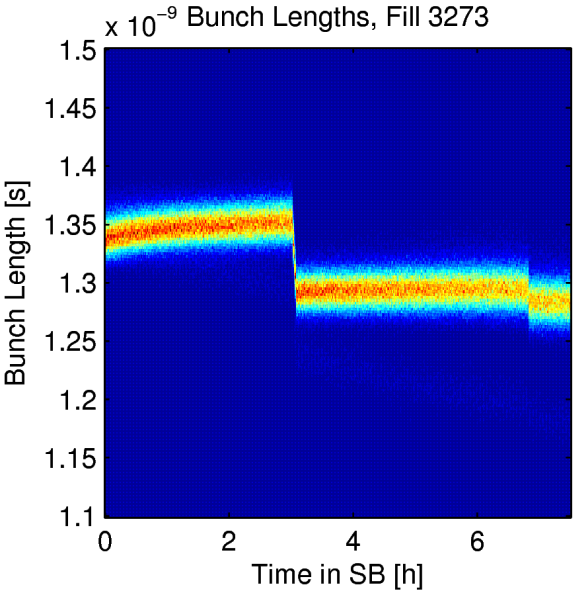




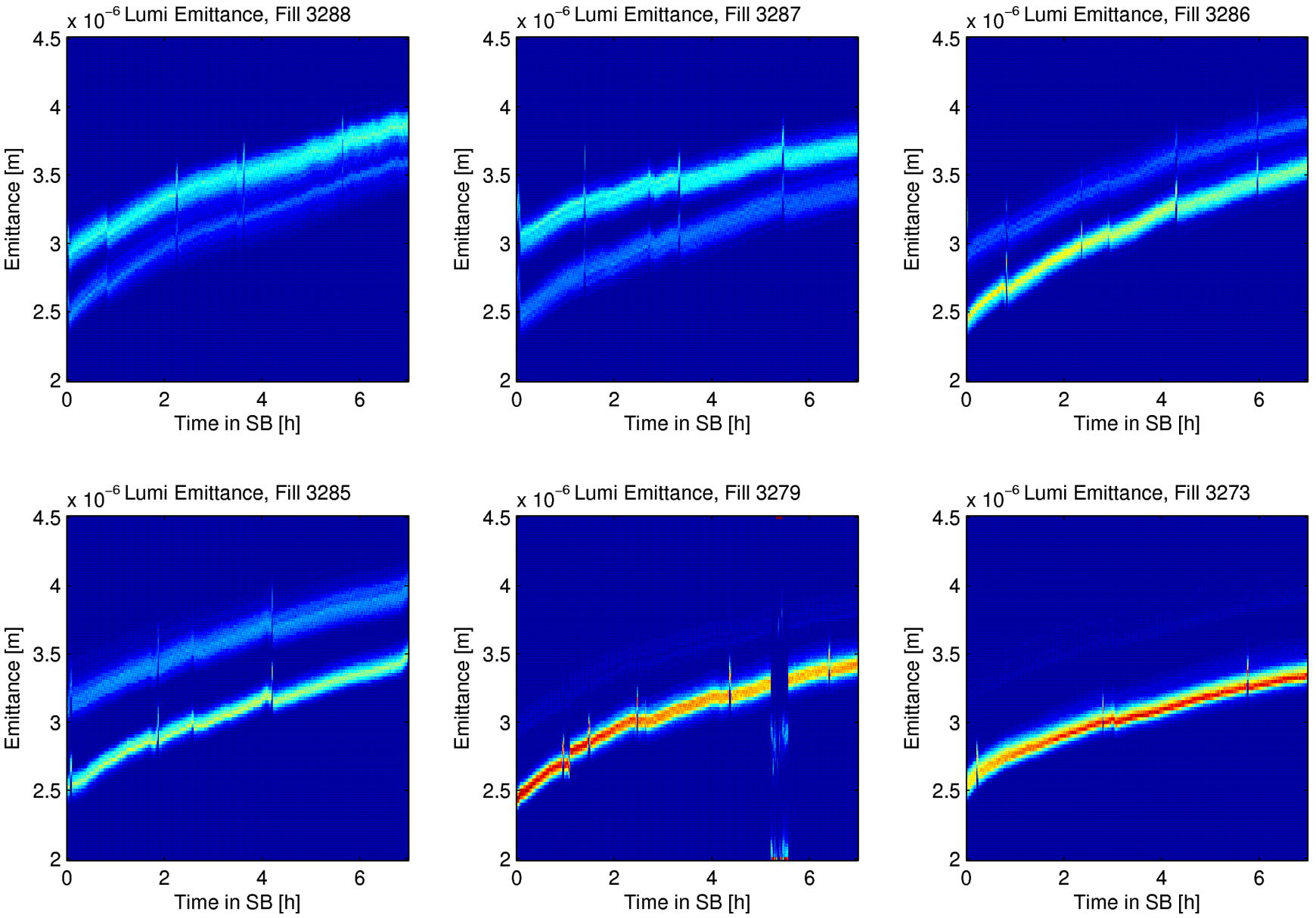




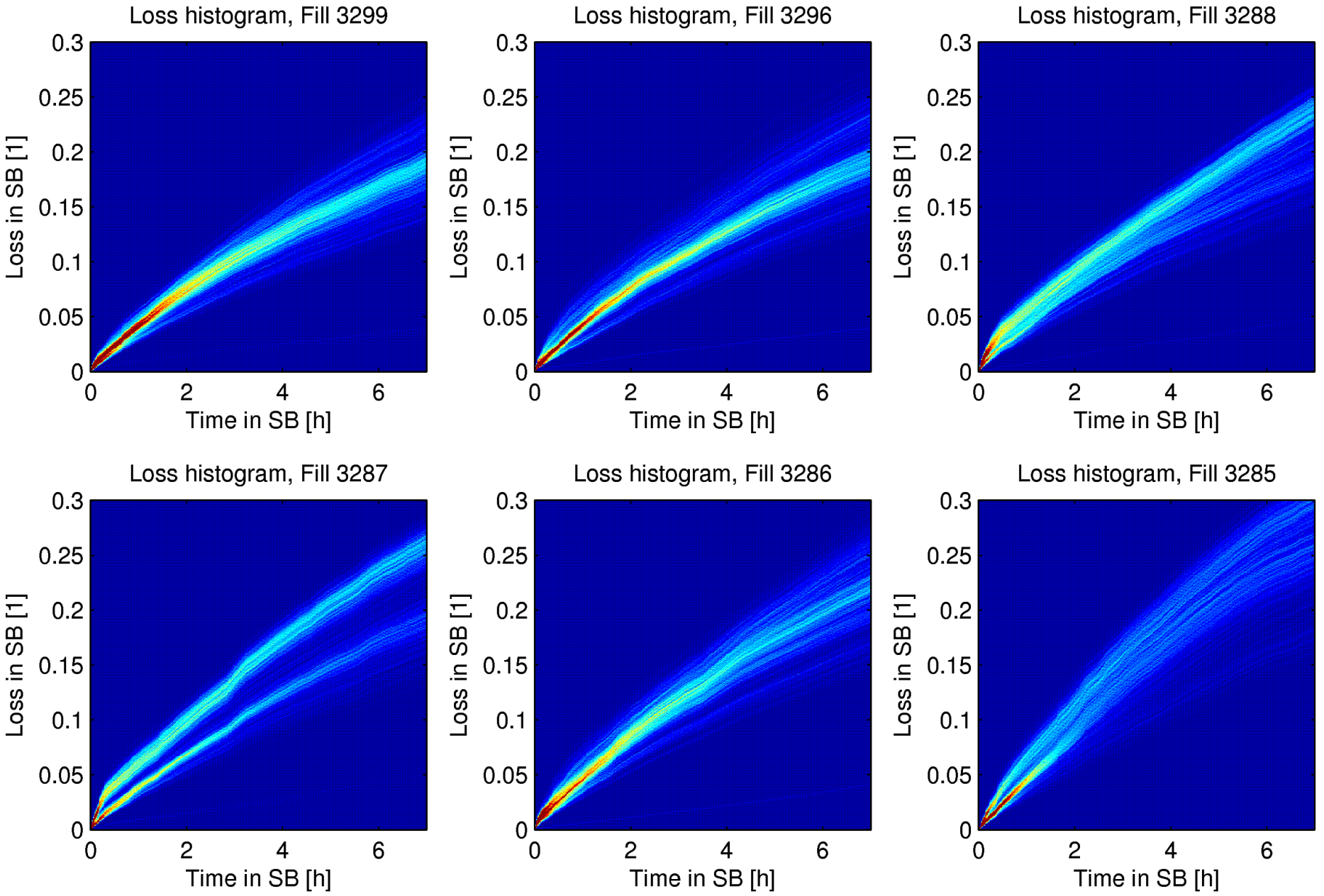




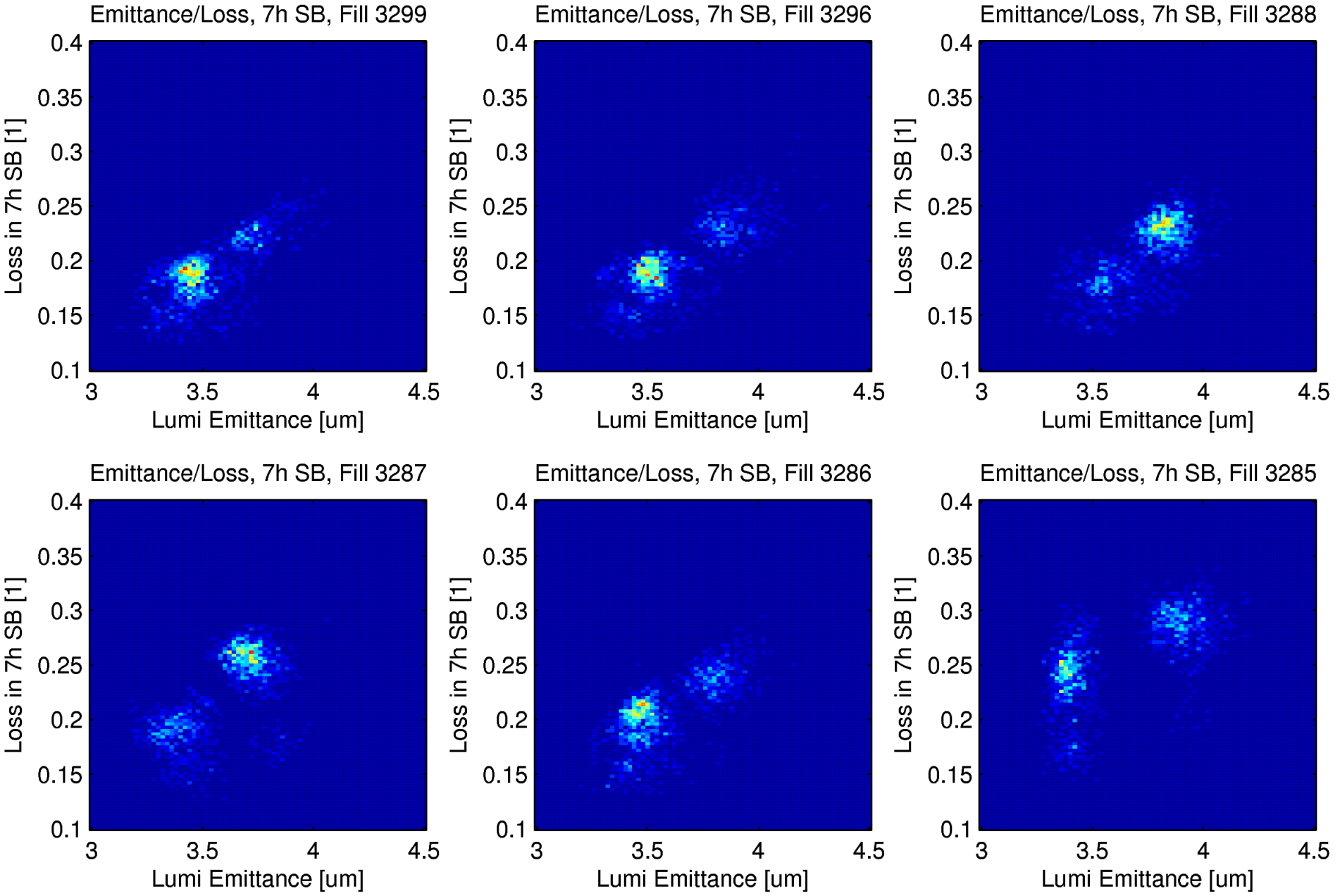
Emittance evolution



Loss histogram evolution



Loss vs. emittance (7h SB)



Loss vs. Bunch length (7h SB)