



## LHC Injectors Upgrade

# First high intensity studies in SPS 2018

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# Introduction

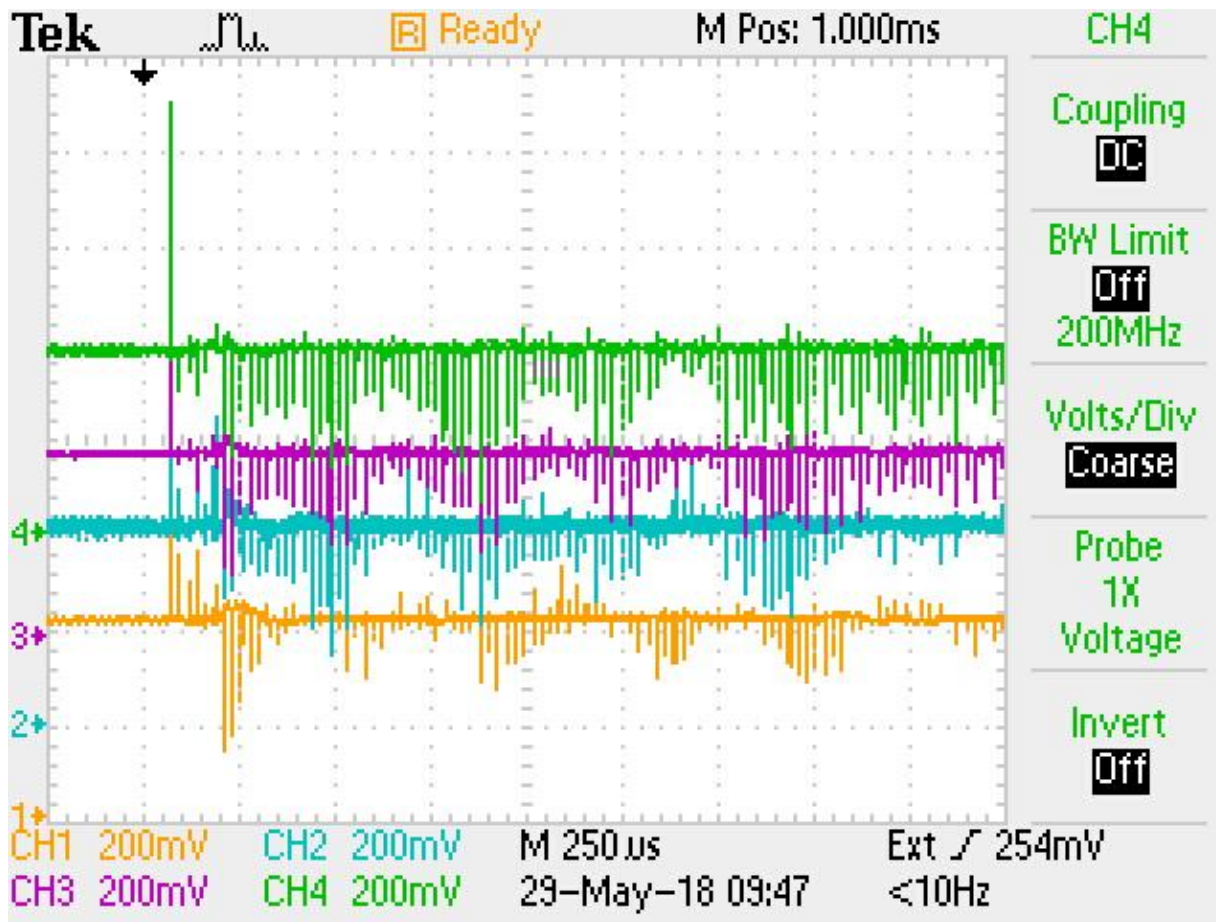
- **Recently, the PS is able to deliver 25 ns BCMS beams with  $>2.5e11$  p/b**
  - Nice bunch length distribution (see slides of Heiko)
  - Optimization of bunch rotation in PS ongoing
- **High intensity studies in SPS planned for Thursdays this year**
  - Normally in parallel to north area physics
  - Preparatory studies on short parallel MD cycle (injected  $2.5e11$  p/b)
- **Accumulated some beam time with high intensity 25 ns beams**
  - Power converter problem (MBE) prohibited North Area physics for a week
  - **Ad-hoc mini scrubbing run performed** (alternating with HiRadMat and other preparatory work)



# Measured RF voltage for $2.5e11$ p/b

- **Thomas' measurements**

- All 4 cavities (long and short) run into RF power limitation
- RF voltage drops to ~half in long cavities ... to be taken into account for interpretation of results

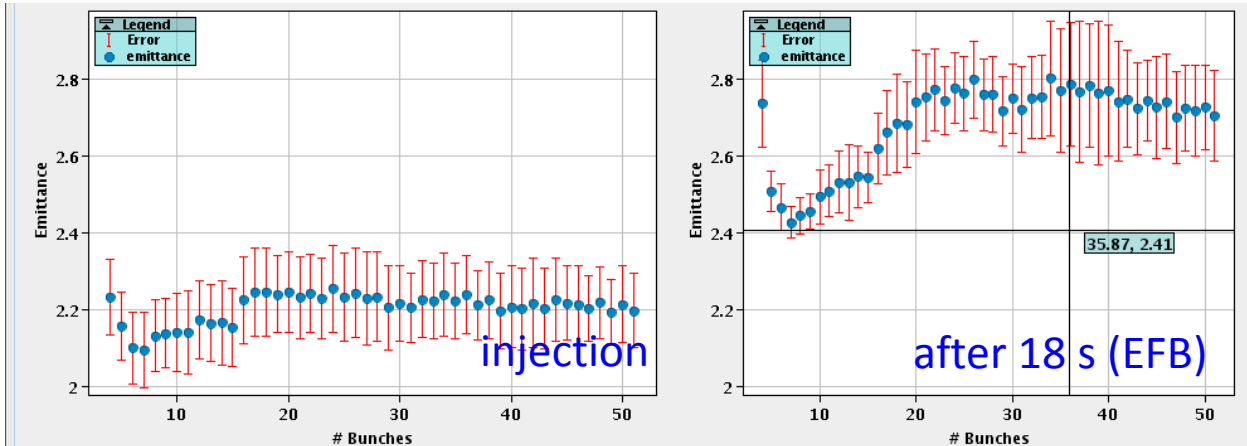


# First emittance observations on long cycle

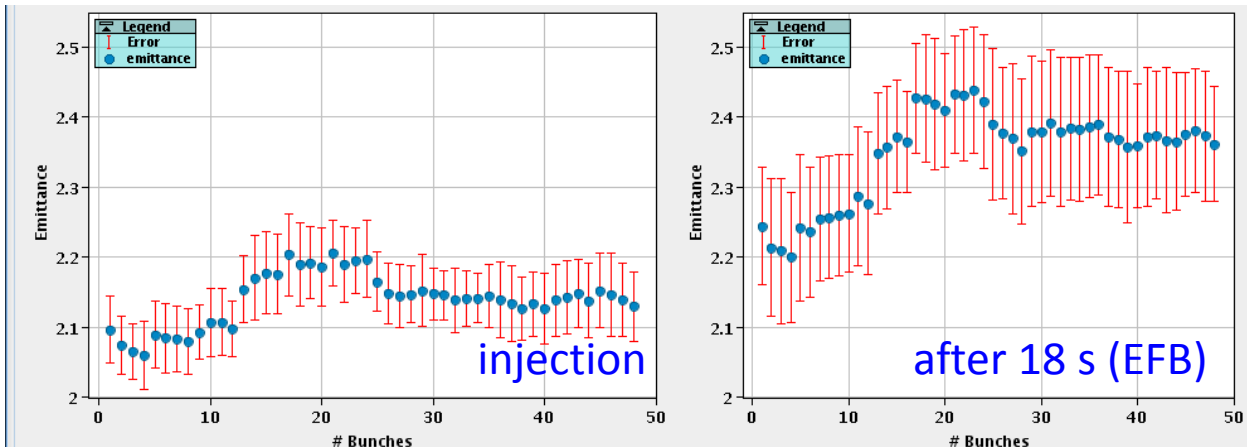
- Thursday MD block on May 31<sup>st</sup>

- 20 s flat bottom cycle (“scrubbing cycle”)
- 48 bunches of BCMS beam with  $1.9 \times 10^{11}$  p/b injected
- Clear transverse emittance growth along flat bottom with **e-cloud pattern** along the batch

Horizontal:



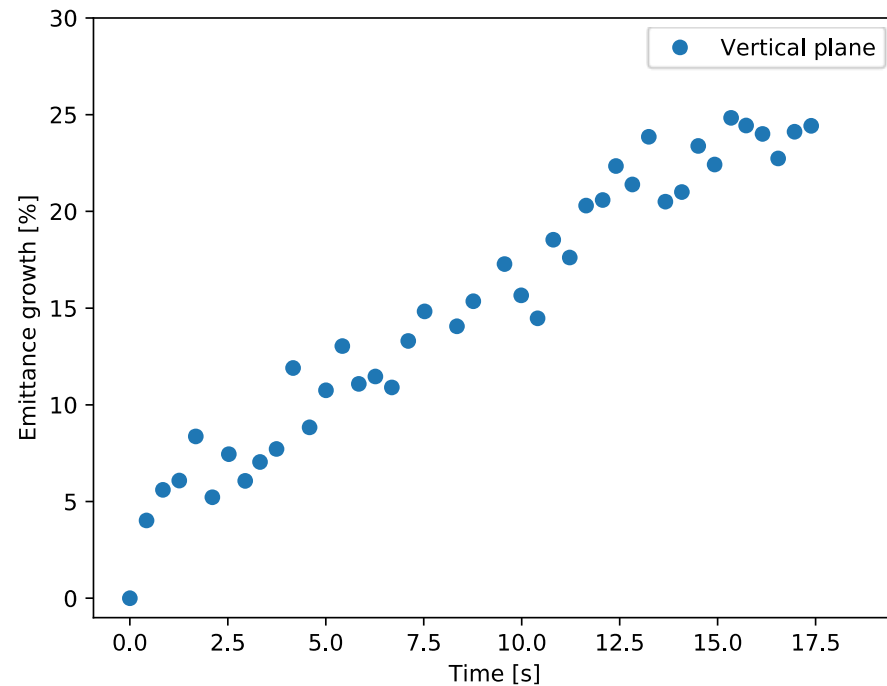
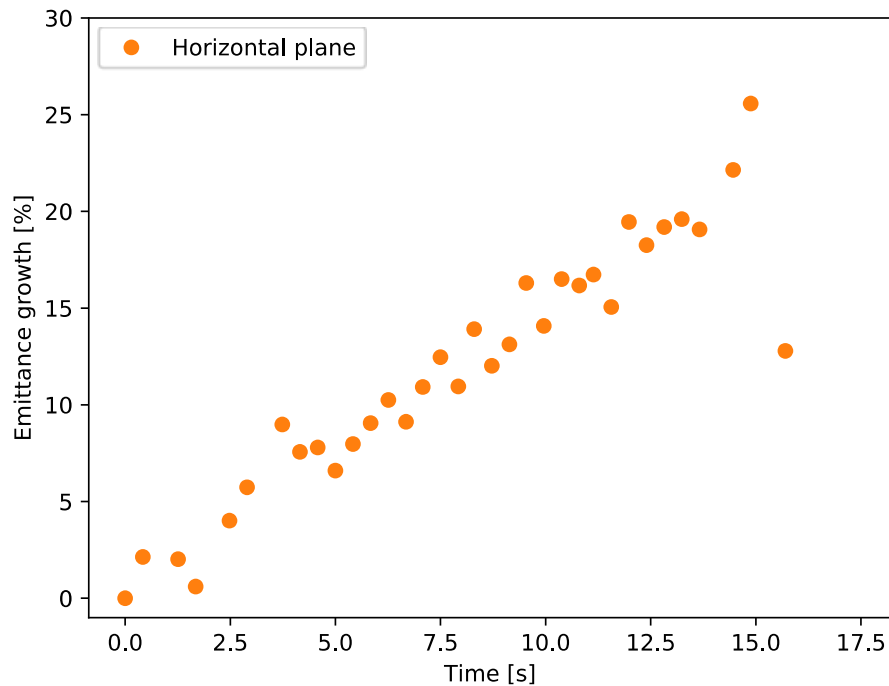
Vertical:





# Emittance growth along flat bottom

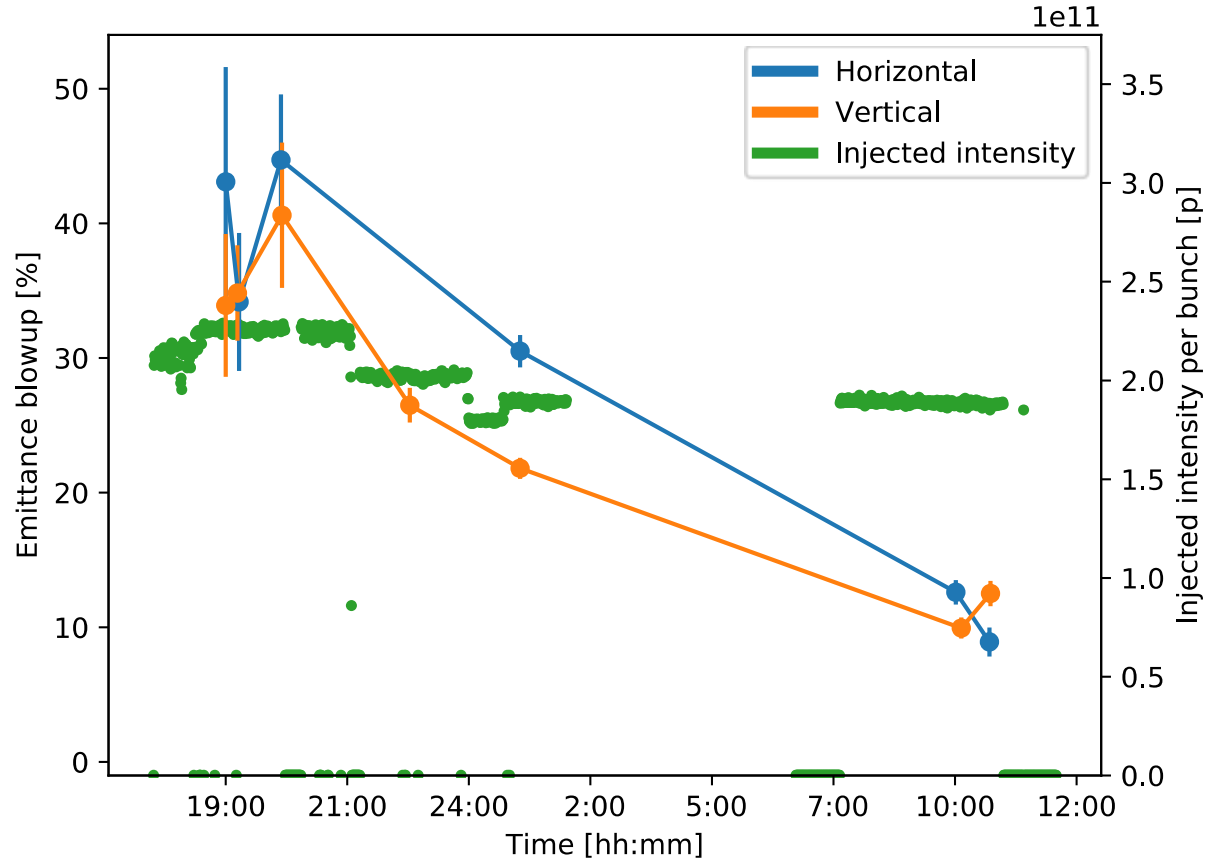
- **First results from BGI**
  - Measurement example for  $\sim 2e11$  p/b injected
  - Emittance growth appears to be continuous
  - Optimization of BGI settings with BI expert ongoing





# Mini scrubbing run 2<sup>nd</sup>-3<sup>rd</sup> June

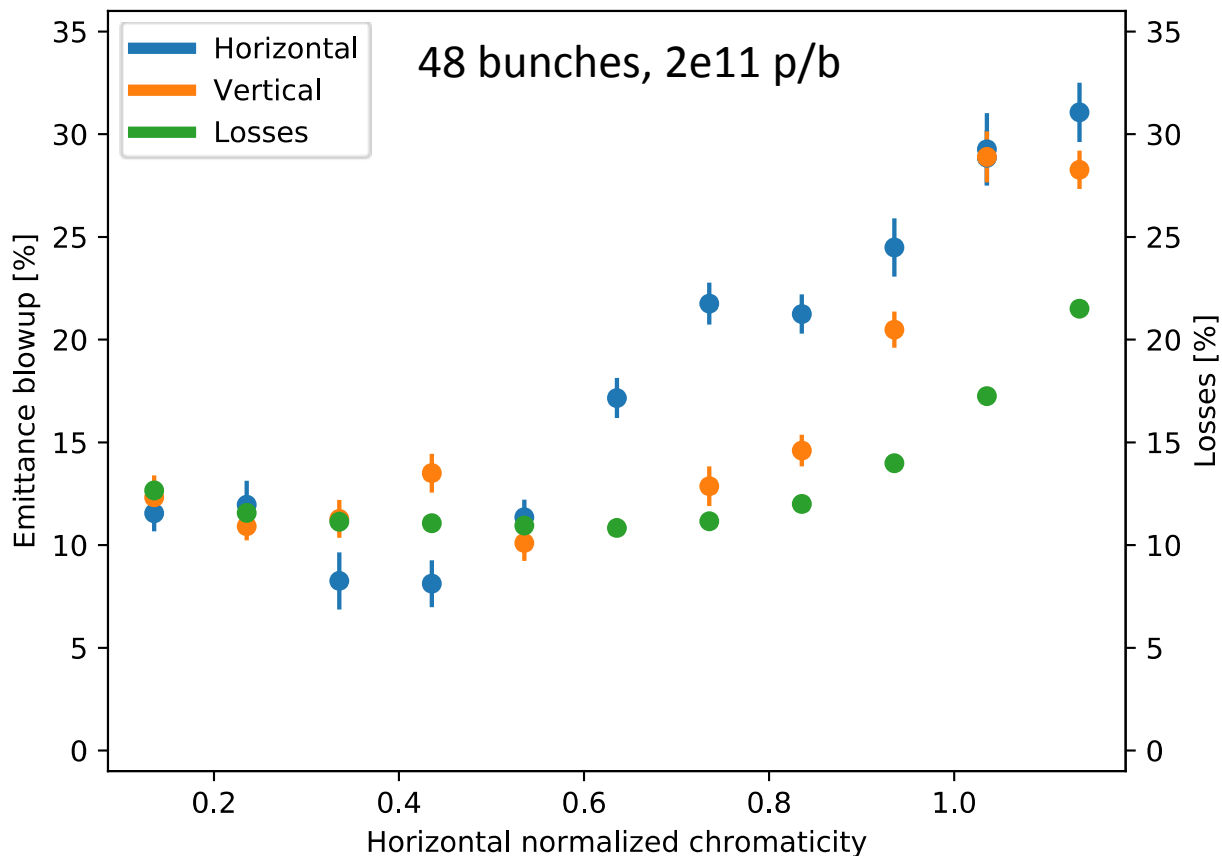
- Alternating high intensity BCMS beam with 4 batches with other activities
- Regular emittance measurements for 48 bunches for monitoring evolution
  - Clear improvement observed





# Dependence on horizontal chromaticity

- **Horizontal chromaticity has clear impact on**
  - losses (as seen in the past)
  - transverse emittances in both planes – to be understood





# Summary & Outlook

- **Summary**

- Running into RF power limitation on all 4 cavities on flat bottom for  $2.5 \times 10^{11}$  p/b
- Initially very strong emittance growth with 48 bunches, continuous along flat bottom – profiting from improvements on wirescanner application and BGI commissioning
- Emittance blow-up significantly reduced after a weekend of scrubbing with 4 batches – (first time observed so clearly in SPS)
- Horizontal chromaticity has strong impact on losses AND on emittance growth

- **Outlook**

- Check compatibility of high intensity 25 ns beam on flat bottom with ZS sparking (try to avoid cycling the ZS voltage to minimize risk, given that we are running already with 1 ZS less)
- Further optimization of cycle (800 MHz and other longitudinal settings, transverse damper, tunes)
- Further conditioning possible?
- Studies of flat bottom losses (e.g. for different RF voltages)
- Dependence of losses and emittance growth on working point
- Studies of the horizontal instability observed last year
- This is just the beginning of this years' studies ...