MD on injection quality – longitudinal and transverse parameters

Wolfgang Bartmann, Thomas Bohl, Karel Cornelis , Heiko Damerau,
Lene Drosdal, Chiara Bracco, Brennan Goddard, Verena Kain

MD plan

1. Effect of beam quality in longitudinal plane on injection losses
2. Effect of scraping on injection losses
   1. Operational emittances: 2.5 μm
   2. Nominal emittances: 3.5 μm
   3. Larger than nominal emittances: >7 μm

- All injections using beam 1 in TI2 as we are more sensitive for injection losses there
- In parallel: UFO MD on beam 2
- 12 bunch injections + a few 36 bunch injections
- Transfer line collimators @ 4.5 s throughout MD

Reference: 12 bunch injection

- Clean reference: scraper settings **(H = -8.1 mm, V = 2.2 mm)**

- Emittance: **H = 2.5 um, V 1.9 um**

2011-06-30 17:28:51.958: Beam losses are within thresholds.

Monitor name	max loss	reference thres...	dump threshold	filter factor	ratio to dump
BLMEI.04R2.B2E10_TCTH.4R2.B2	0.0461	0.0	2.3168	1.0000	2%
BLM2I.04R2.B1I10_MBRC_MBRC	0.0510	0.0	2.3168	1.0000	2%
BLMEI.04L2.B1E20_TDI.4L2.B1	0.1206	1.5	23.1680	180.0000	1%
BLMEI.04L2.B1E10_MRXA	0.1759	1.2	23.1680	1.0000	1%
BLMEI.06L2.B1E10_MSIB	0.0398	0.4634	4.6336	8.0000	1%
BLMQI.03L2.B1E10_MQXA	0.0136	0.0	2.3168	1.0000	1%
BLMQI.06R2.B2E30_MQML	0.0216	0.0	2.3168	1.0000	1%
BLMQI.06R2.B1I10_MQML	0.0120	0.0	2.3168	1.0000	1%
BLMQI.04L2.B1E10_MQY	0.0028	0.2317	2.3168	1.0000	0%
BLMQI.04L2.B1E20_MQY	0.0010	0.047	2.3168	1.0000	0%

Losses: 1 % of dump threshold
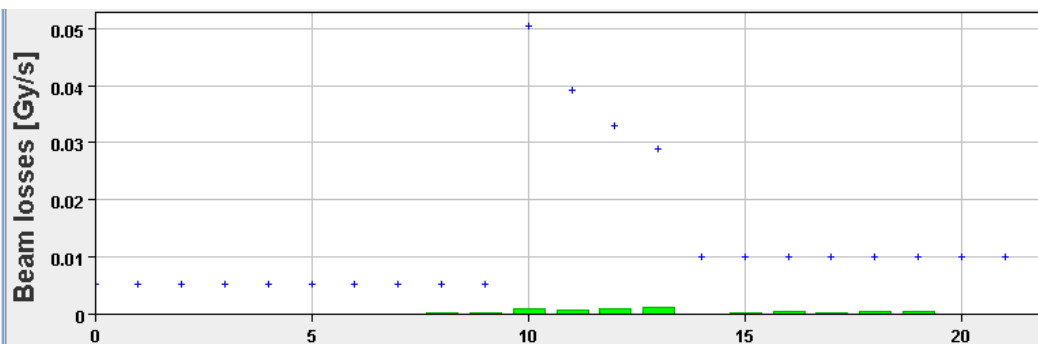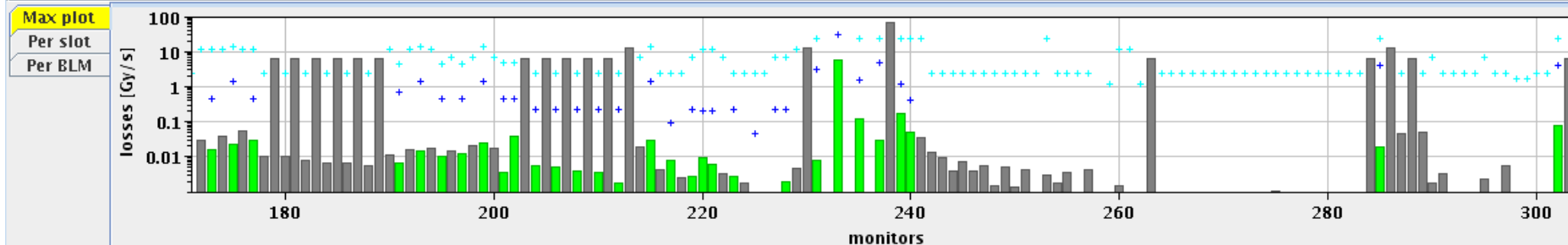
| monitor	loss	threshold
TI2.BLMI.29015	0.0001	0.0050
TI2.BLMI.29053	0.0009	0.0505
TI2.BLMI.29104	0.0007	0.0392
TI2.BLMI.29208	0.0008	0.0329
TI2.BLMI.29237	0.0012	0.0289
TI2.BLMI.29320	0.0000	0.0100
TI2.BLMI.29404	0.0001	0.0100
TI2.BLMI.29468	0.0003	0.0100
TI2.BLMI.29504	0.0001	0.0100

Effect of longitudinal parameters

Most cases gave low/same losses as reference:

- Bad radial steering

- Satellites from PS

- RF on for all booster rings

- SPS 800 MHz on wrong harmonic

- Radial steering affected the scraping efficiency – but: radial steering can move the beam at the scraper → increase losses

- Longitudinal parameter changes similar increase in losses as sudden oscillations down the line from MSE ripple.

Losses from sudden oscillation down the line

Losses on TCDIs

Losses on TDI, triplet,…ALICE,…up to Q6R2
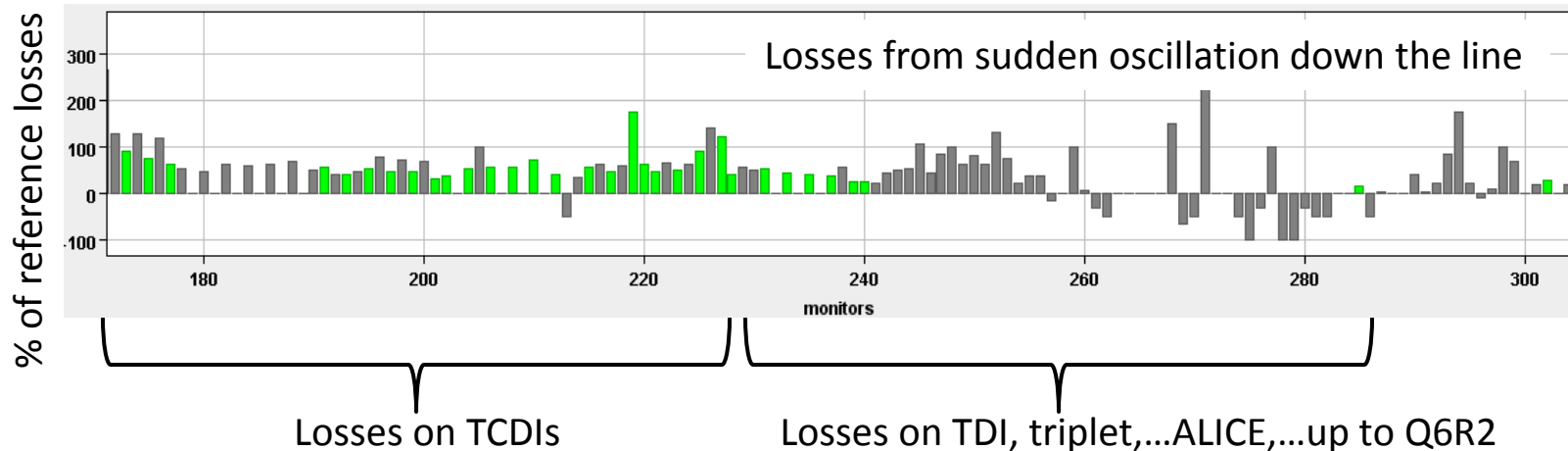
- **Increased injected bunch length into the SPS**: **4.1 → 4.9ns (SPS BQM warning, but no interlock)**
  → Observed losses on the TDI/MQX
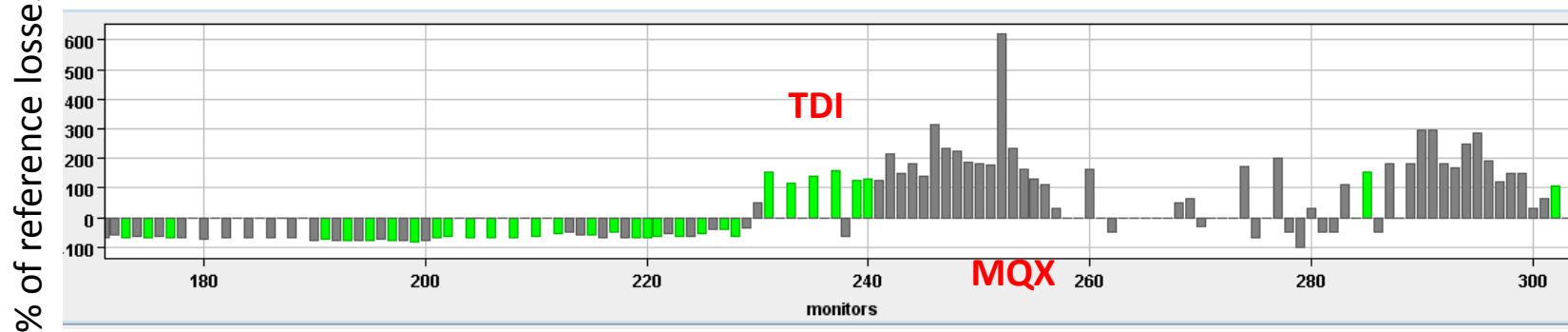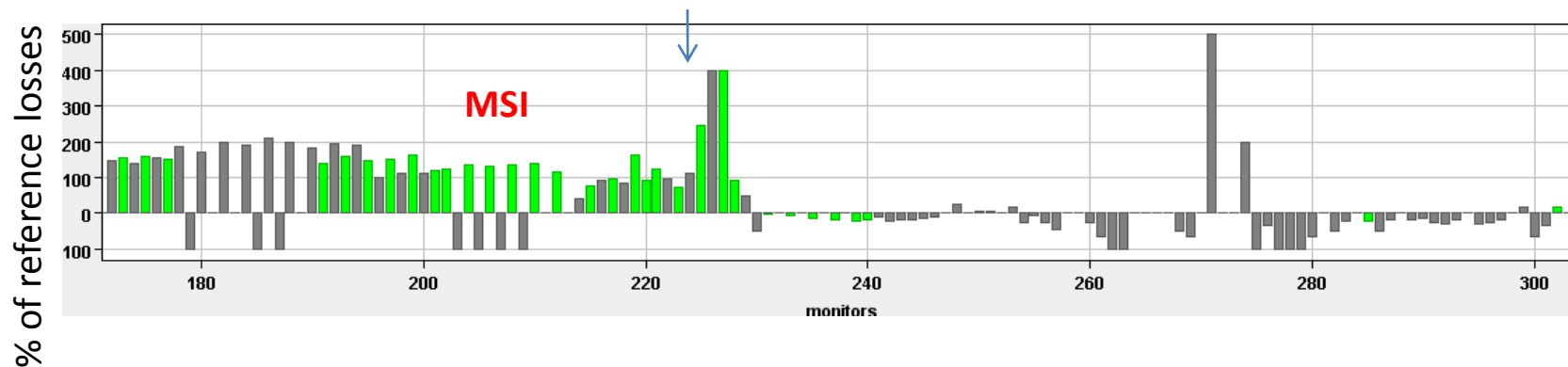

- **Increased dp/p at extraction**: **bunch length at extraction: 1.5 → 2.2 ns**
  → Losses on the TCDIs
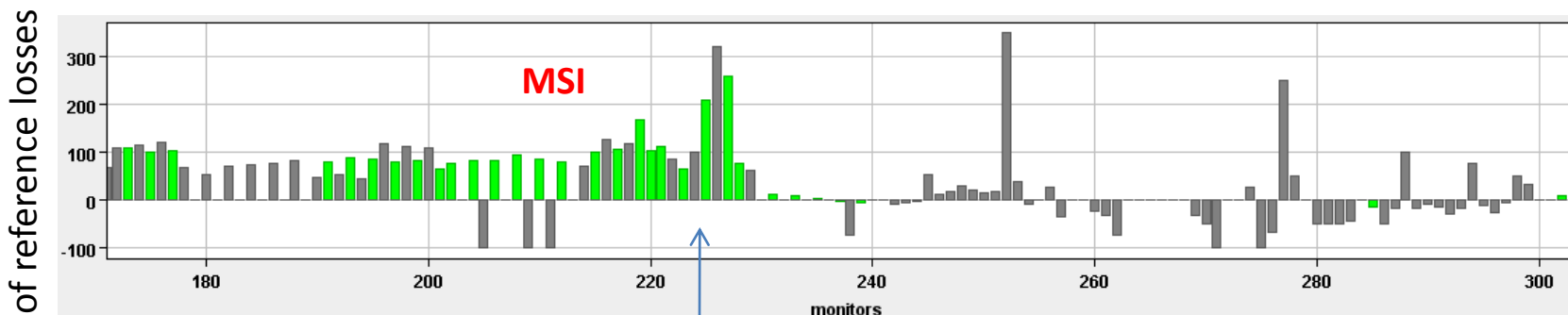
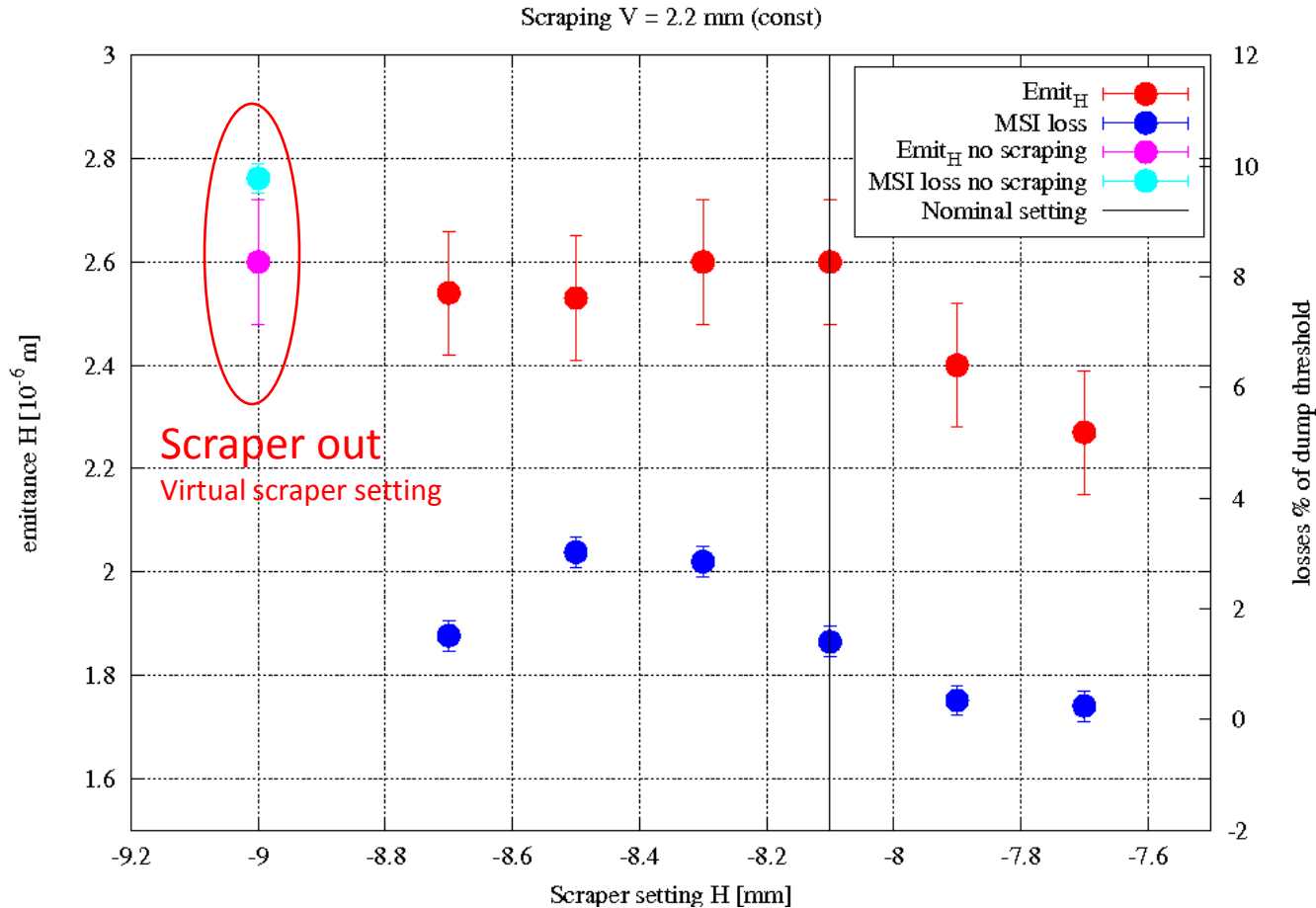**Turned off the 800 MHz in SPS**
→ Losses on the TCDIs
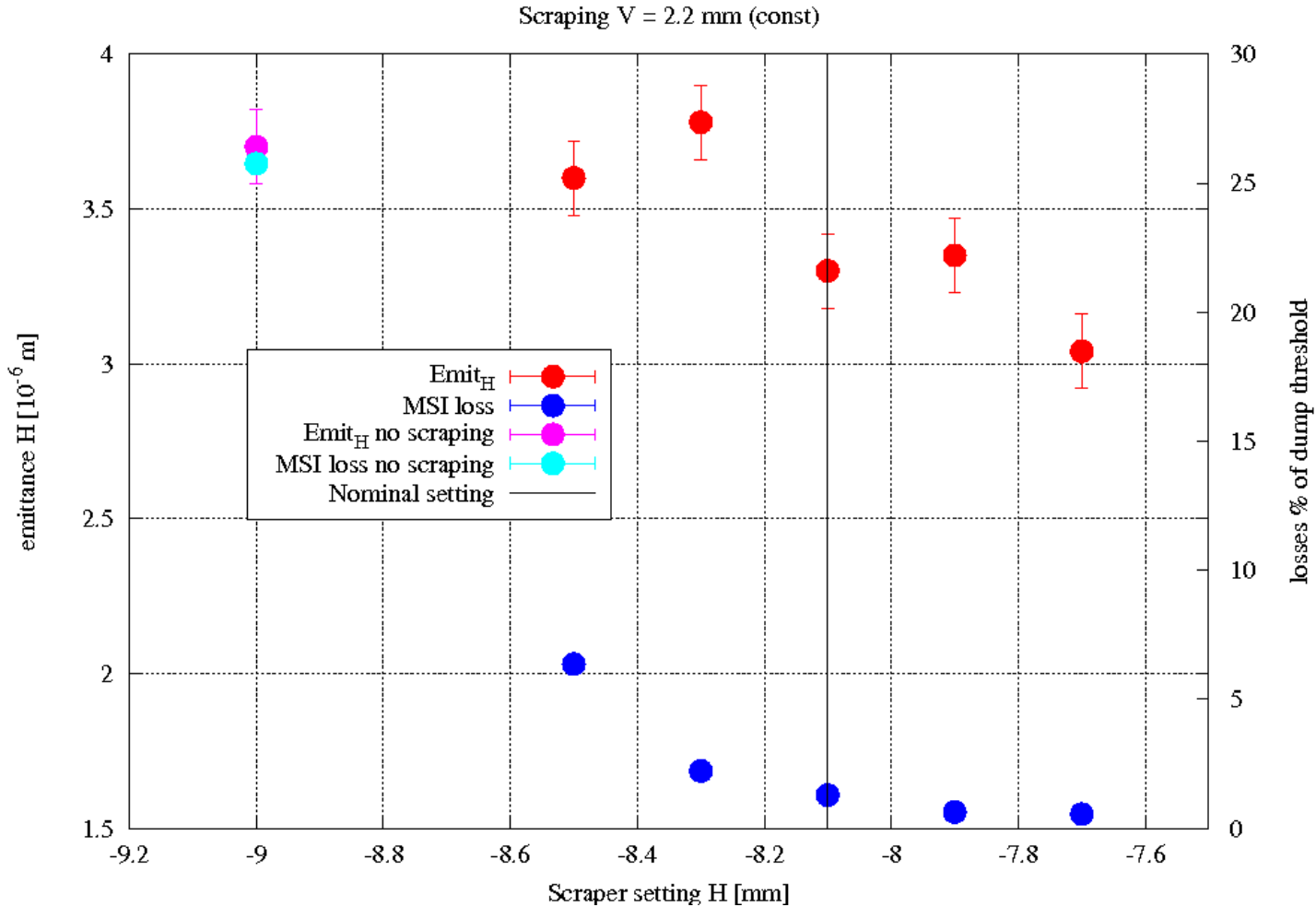
Effect of scraping – no blowup

- Effect of H scraper, V scraper constant

Scraping V = 2.2 mm (const)

- Nominal scraper setting: emittance not affected, losses affected → scraping tails

Nominal emittances - H
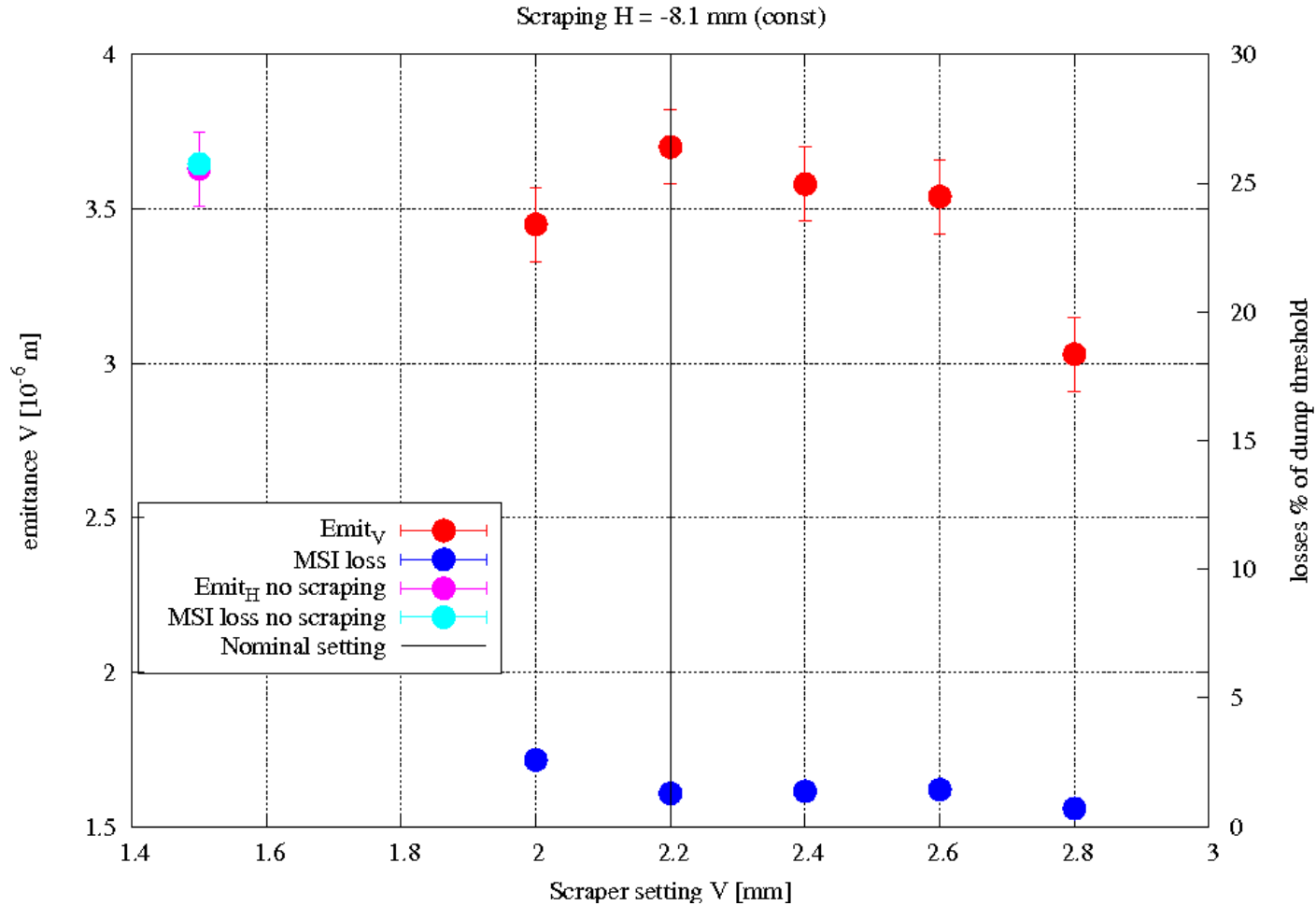
- Blow up with screen in TT10

- 1 % losses ~ 3.4 mm emittance in H for correct scraping

Nominal emittances - V

- Blow up with screen in TT10

Scraping H = -8.1 mm (const)

- With 3.5 mm still only scraping tails

Very blown-up beams - emittance scan

- Used two screens in TT10 → emittance > 7 mm
- Cutting into beam core at all times
- Scanned H scraping, V scraping constant

- Remaining intensity: function of scraper position:
  - Remove all particles with amplitudes larger than scraper pos – remaining intensity N(scraper pos):

$$N(x) = \int \rho(r_x) \cdot dr_x = N_0 \cdot (1 - e^{-\frac{(x-x_0)^2}{2\cdot\sigma^2}})$$

  - → can get beam position @ scraper (+ initial emittance)

Result of scraper scan H with large emittance

- B = initial beam size
- C = beam position wrt scraper
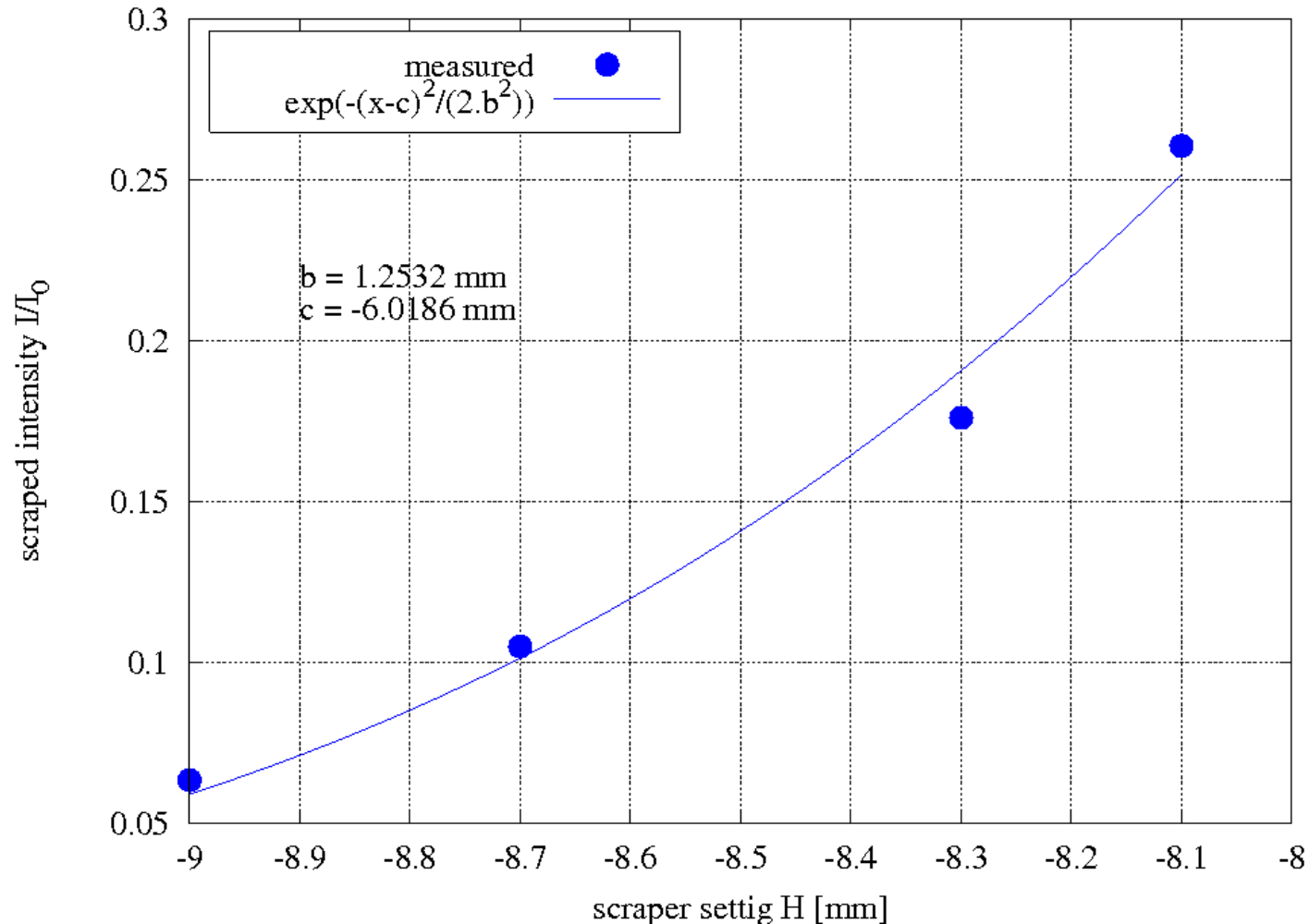
Conclusion

- We are very sensitive to scraping in the SPS – scraper settings and beam position at scrapers
  → We need to further investigate the evolution of the beam position at the scraper – SPS MD time

- Not so sensitive to the longitudinal parameters – and the SPS BQM also blocks in most cases

- If scraping is set up properly and the beams are Gaussian,
  3.5 um emittances give similar loss levels as our operational beams – with TCDIs at 4.5 s

- Not done yet:
  - Check of sensitivity to transfer line steering