Status of injection loss mitigation

W. Bartmann for ABT, EPC, RF, BI, FLUKA,
OP teams

MPP, 21-Oct-11

Mitigation techniques

- Overinjection and MKI failure
  - Interlocking and good procedure
- TL showers:
  - Local shielding between TCDIs and LHC
  - Beam scraping in SPS
  - Opening TCDIs
  - BLM sunglasses
  - Moving/adding TCDIs
  - Improve stability of MSE
- Uncaptured beam
  - Local shielding after TDI
  - Minimisation of capture losses
  - Injection and abort gap cleaning
  - Carefully monitoring beam quality in injectors (transv. beam size and shape, bunch length, satellites)
  - BLM sunglasses

TCDI Shielding

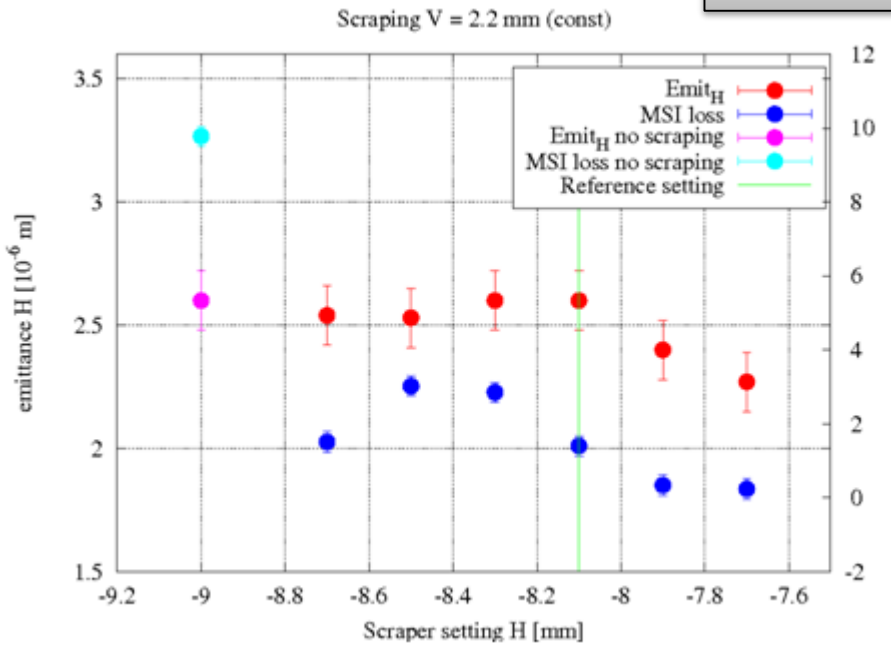
Simulations by Vittorio Boccone: factor 4-5 loss reduction expected

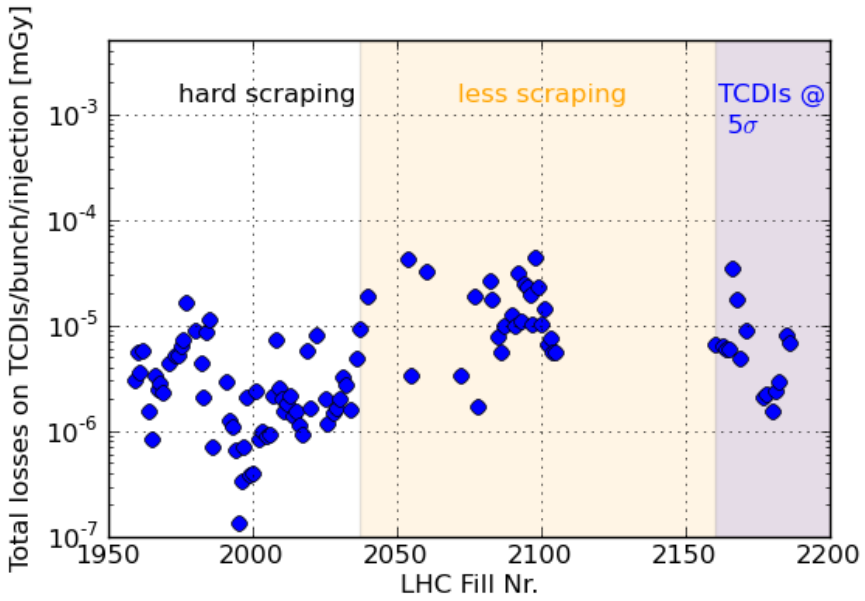
- TI 2 shielding: factor ~2 reduction measured
- TI 8 shielding: factor 2.5 – 3 reduction measured

SPS scraping: Losses on TCDI BLMs in TI 2

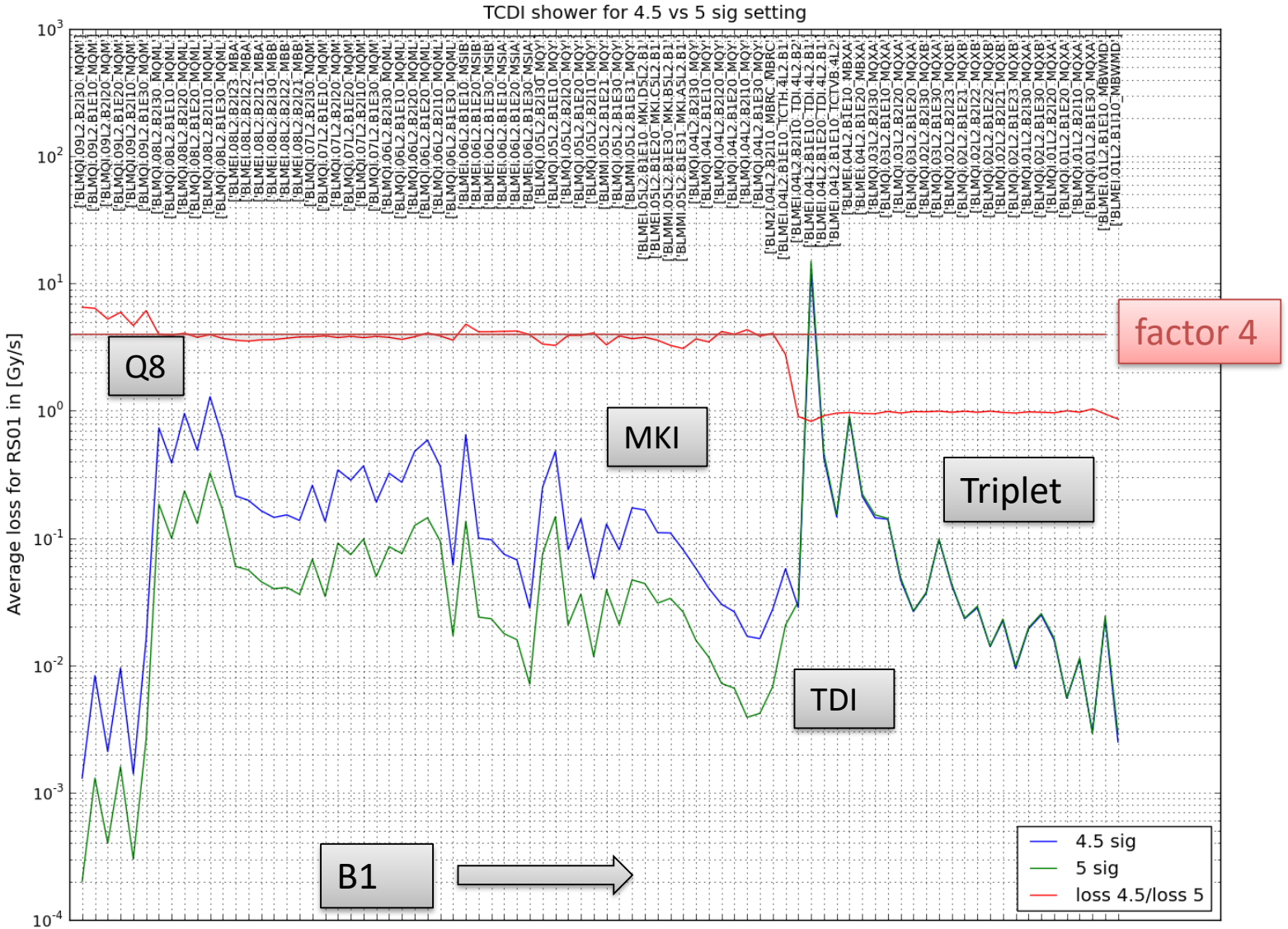
- Scraping the tails has strong effect on injection losses
- In optimum position without touching beam core
- Currently reduced scraping due to activation of SPS equipment

V. Kain, L. Norderhaug Drosdal





Open TCDI gap: loss shower on LHC BLMs for B1

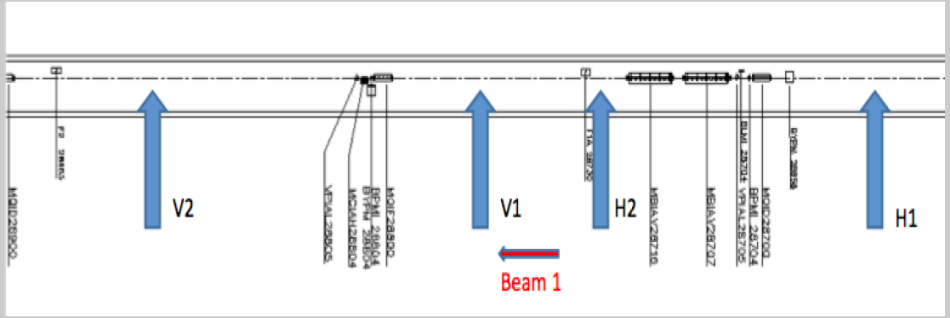


Move/add TCDIs

Results of studies by Eliana Gianfelice:

- New locations for TCDIs in TI 2 and TI 8
- FLUKA simulations started
- impact of Q20 optics to be checked
- MD desirable to distinguish loss patterns

New collimator positions (schematic).



Proposed TI2 collimators, re-matched

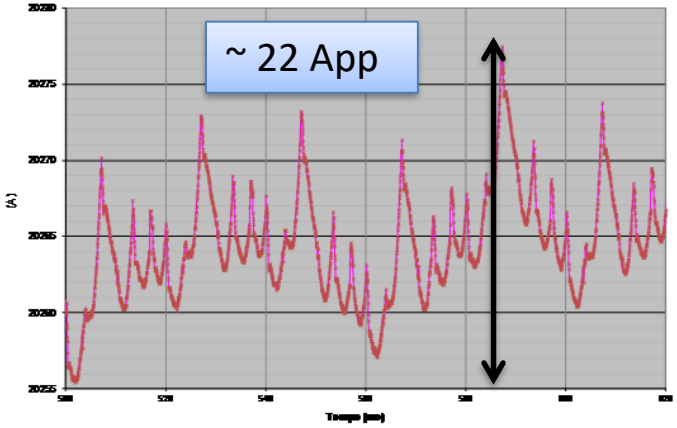
	position(m)	β_x(m)	D_x(m)	σ_x^β (μm)	σ_x^p (μm)	$\Delta\mu_x$ (deg)
TCDIH.NEW1	2846.230	26.2	1.121	437	482	0
TCDIH.NEW2	2867.631	35.0	-0. 006	506	3	62.6
TCDIH.29050	2971.0	83.8	-1.986	782	854	60.9

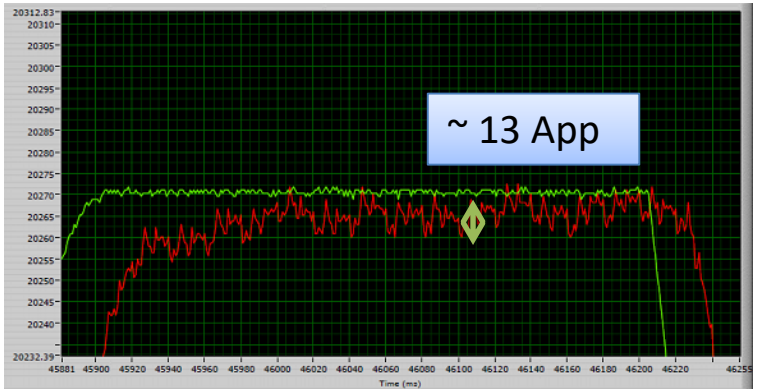
	position(m)	β_y(m)	D_y(m)	σ_y^β (μm)	σ_y^p (μm)	$\Delta\mu_y$(deg)
TCDIV.NEW1	2879.4	24.1	0.089	420	38	0
TCDIV.NEW2	2905.0	46.1	0.277	580	119	64.5
TCDIV.29012	2952.0	32.5	0.100	487	43	63.5

MSE stability

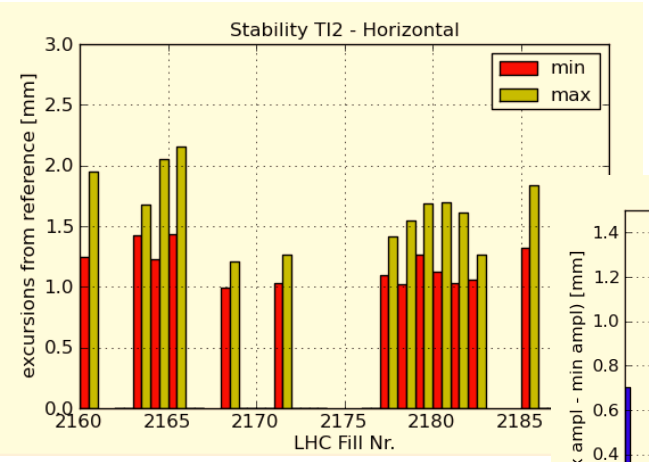
Gilles Le Godec for EPC:

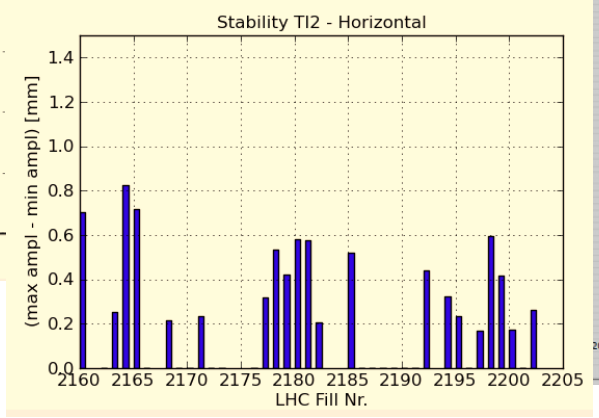
- Peak-to-peak ripple improved by factor 2.4
- Cycle to cycle reproducibility measured and improved by 38% on LHCION2 cycle
- Should be measured on LHC1 cycle

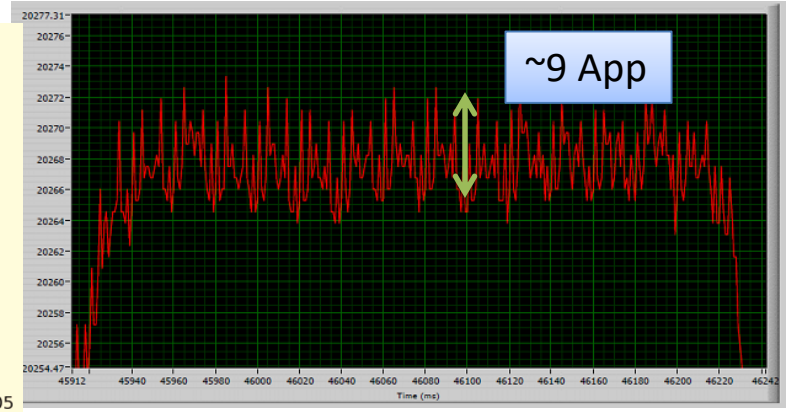




V. Kain







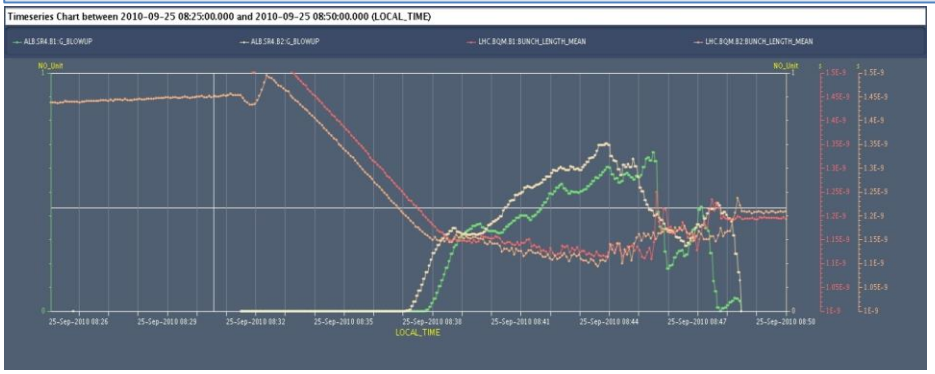
Capture

P. Baudrenghien for the RF team:

- SPS bucket length is double of LHC bucket due to RF frequency ratio 200/400 MHz
- MD on reducing injection losses by increasing nominal matched voltage of 3.5 MV to 6 MV (currently in operation)
- Running with mismatched voltage causes bunch length shrinking after capture → long. emittance blow up needed to reach the aim of 1.2 ns long bunches

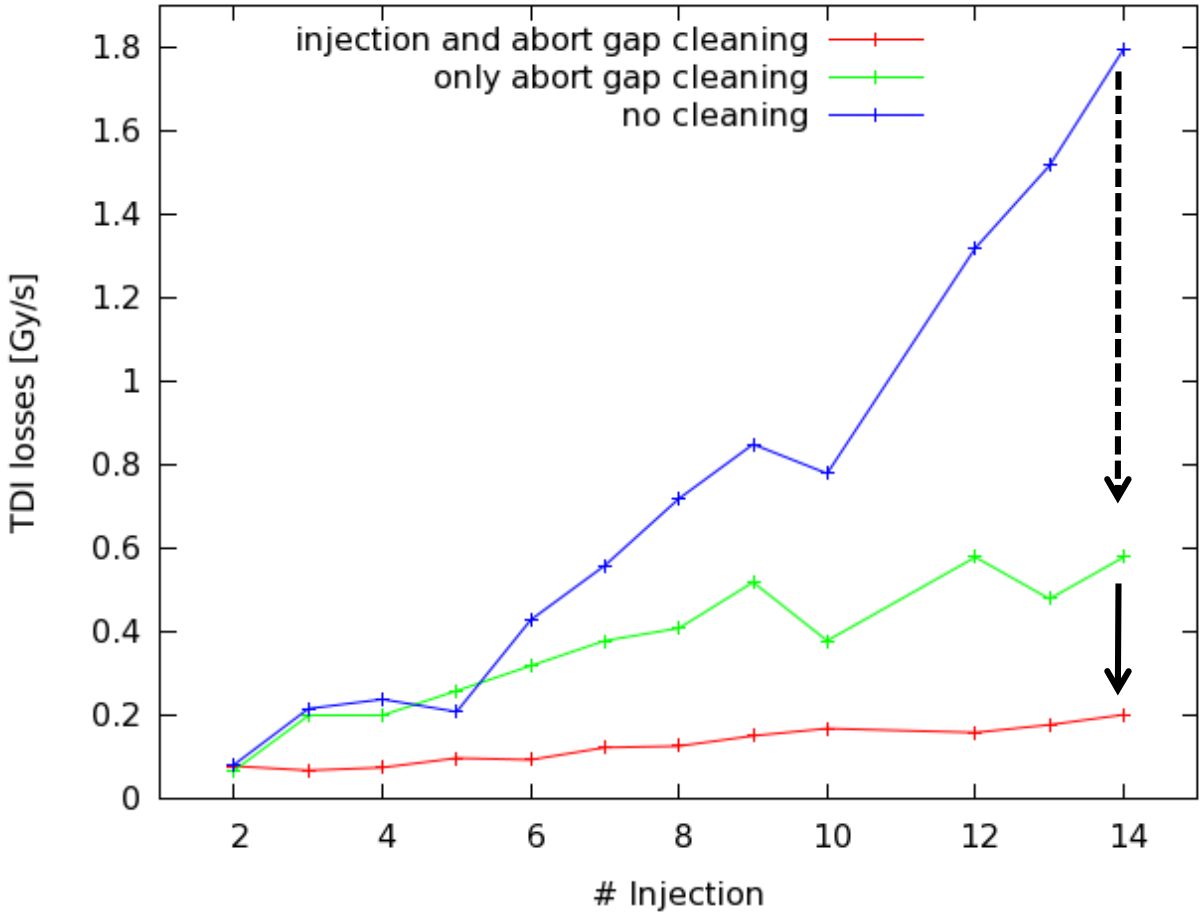
Bunch Length Mean and Noise Amplitude during Ramp

P. Baudrenghien for RF team



Injection and abort gap cleaning

E. Gianfelice, B. Goddard, W. Hoefle, V. Kain, M. Meddahi, J. Uythoven, D. Valuch,...



For later injections losses decreased by:

a factor 3 for AGC only

a factor 9 for injection and AG cleaning

Both operational

Mitigation techniques with expected future gain

	MITIGATION	POTENTIAL FUTURE GAIN
TL Shower	Local shielding between TCDIs and LHC	Presently less gain than expected from simulations; difficult to increase shielding, in particular for TI 8
	Beam scraping in SPS	No gain with present emittances, for future bigger emittances probably worse;
	Opening TCDIs	No gain for TI 2 (already at 5 sig), but possible gain for TI 8 (at 4.5 sig), Machine Protection!
	BLM sunglasses	With LICs at certain positions and removed filters gain of factor 5 possible, Machine Protection!
	Moving/adding TCDIs	Potentially significant gain, under study
	Improve stability of MSE	Ripple improvement and phase stabilisation in place since 3 days, effect to be checked
Uncaptured beam	Local shielding after TDI	No gain: on hold
	Minimisation of capture losses	No gain: trade-off with mismatch and resulting bunch length reduction
	Injection and abort gap cleaning	No gain: trade off with luminosity
	Carefully monitoring beam quality in injectors	No gain in losses but better detection of bad beam quality early in the chain
	BLM sunglasses	With LICs at certain positions and removed filters gain of factor 5 possible, Machine Protection!