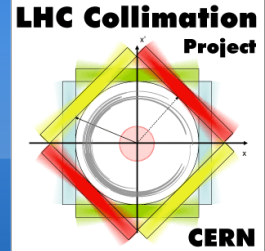


Simulations of HL halo loss and IR losses

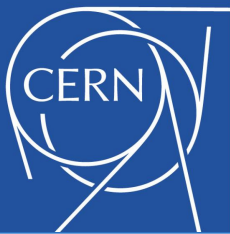
*R. Bruce, F. Cerutti, R. de Maria,
A. Marsili, S. Redaelli*



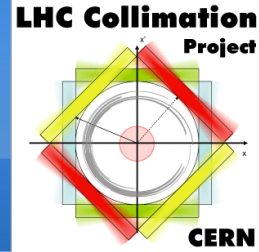
Outline



- Introduction: SixTrack
 - Halo / debris tracking
 - Trajectories
 - Results validation with measurements
- Halo: ATS results
 - Comparison with 7TeV nominal
- Debris tracking
 - Loss maps
 - TCL scan
- Conclusion



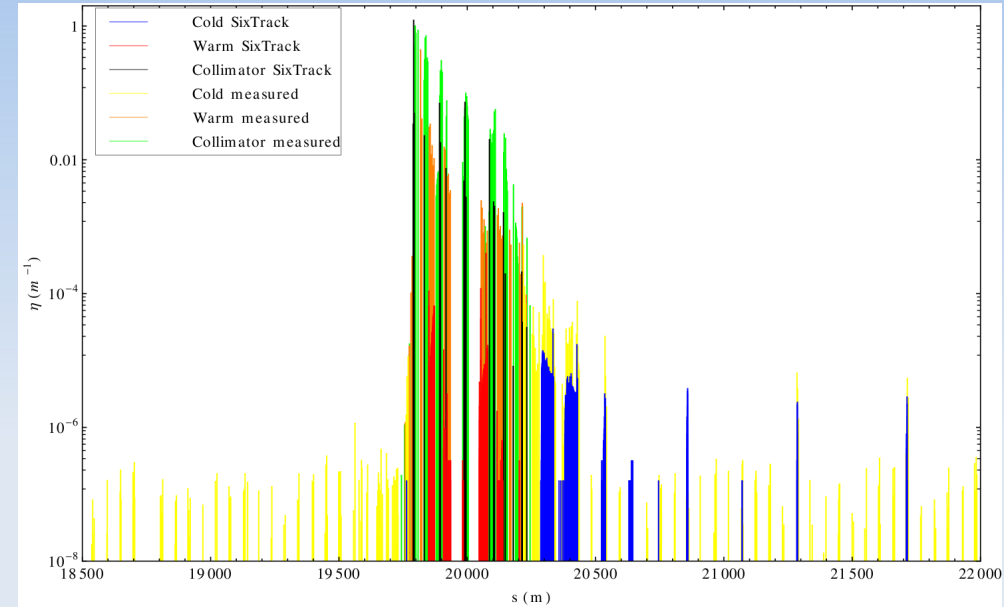
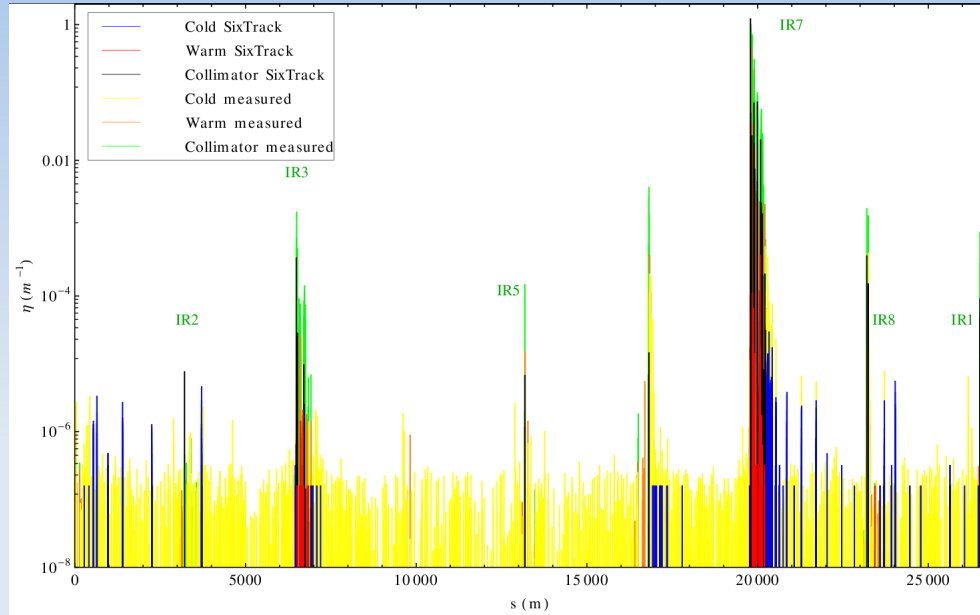
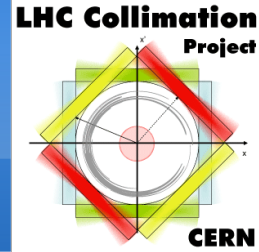
Introduction: Simulation set-up



- Collimation version of SixTrack
 - Particles tracked around the ring
 - 6 dimensions: x, x', y, y', l, E
 - Records scattering / absorption by collimators
- Post-processing: particles lost on aperture
- SixTrack was very successfully used for system design. Very good agreement with measured loss maps.
- Final energy deposition studies rely on complete simulations by FLUKA
- Good experimental basis: validated results
 - Comparison measurements / simulations



LHC & IR7: comparison measurement / simulation

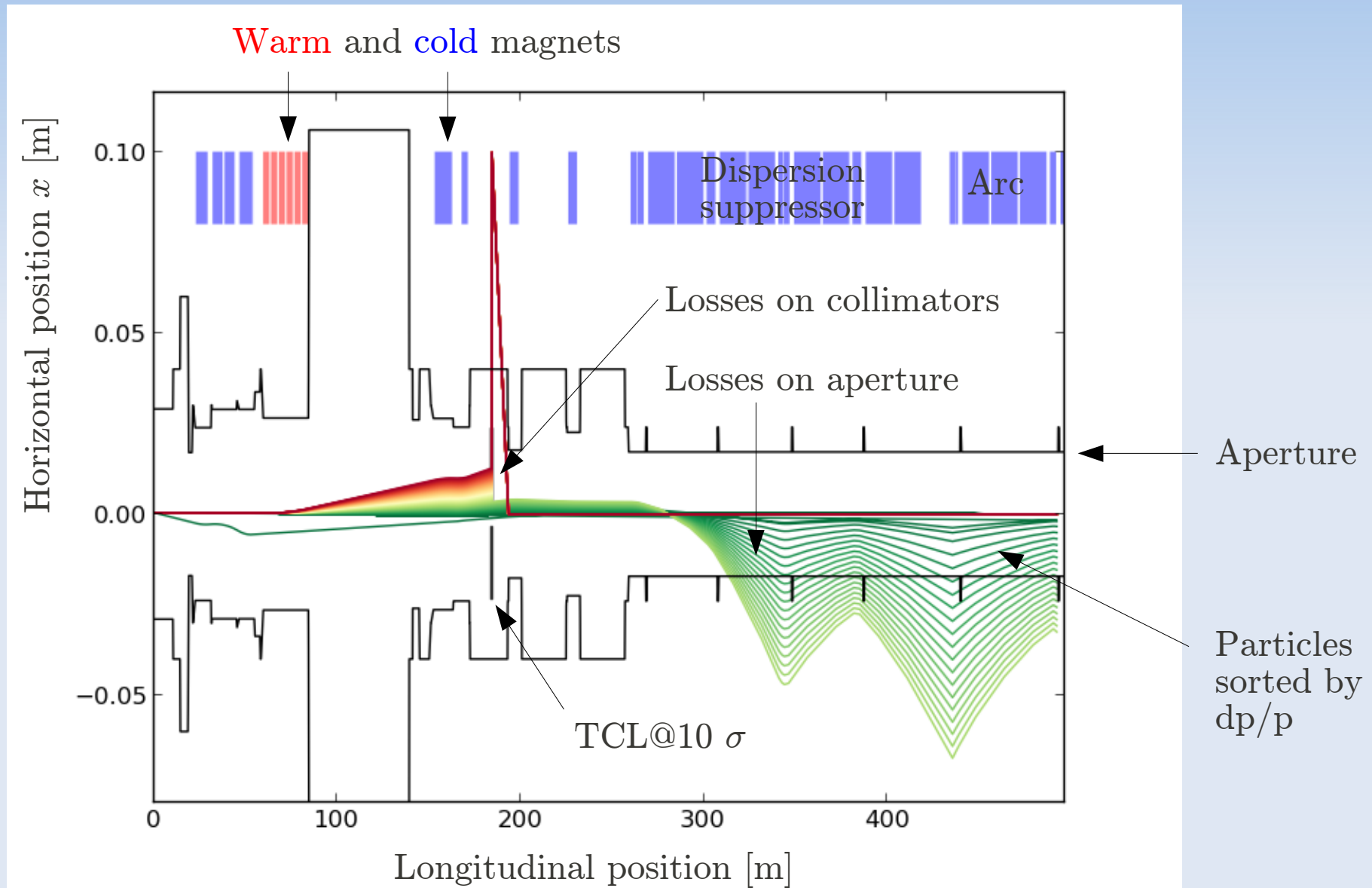


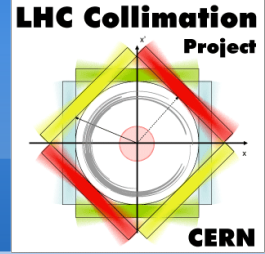
- Very good agreement in the arcs
- Losses at collimators underestimated (secondary showers?)

R. Bruce, CERN.

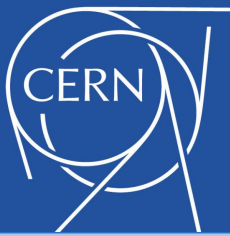
- **Halo loss simulations** for collimation cleaning
 - Principal assessment of collimation performance
 - Limitations in dedicated betatron and momentum cleaning insertion regions (IR3 and IR7)
 - IR loads from incoming beams (tertiary collimators)
 - Multiturn simulations
- **Debris loss simulation:** tracking debris from Interaction Points (IPs) around the ring
 - Tracking of protons that experience collision
 - Two effects: shift in momentum, extra kicks (x' , y')
 - Distributions simulated by the FLUKA team
 - Most particles lost immediately downstream of IP

Particle tracking: “flat” dp/p distribution

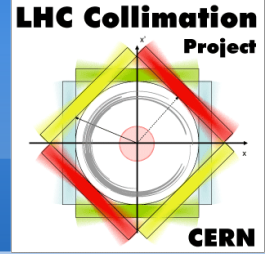




ATS halo tracking



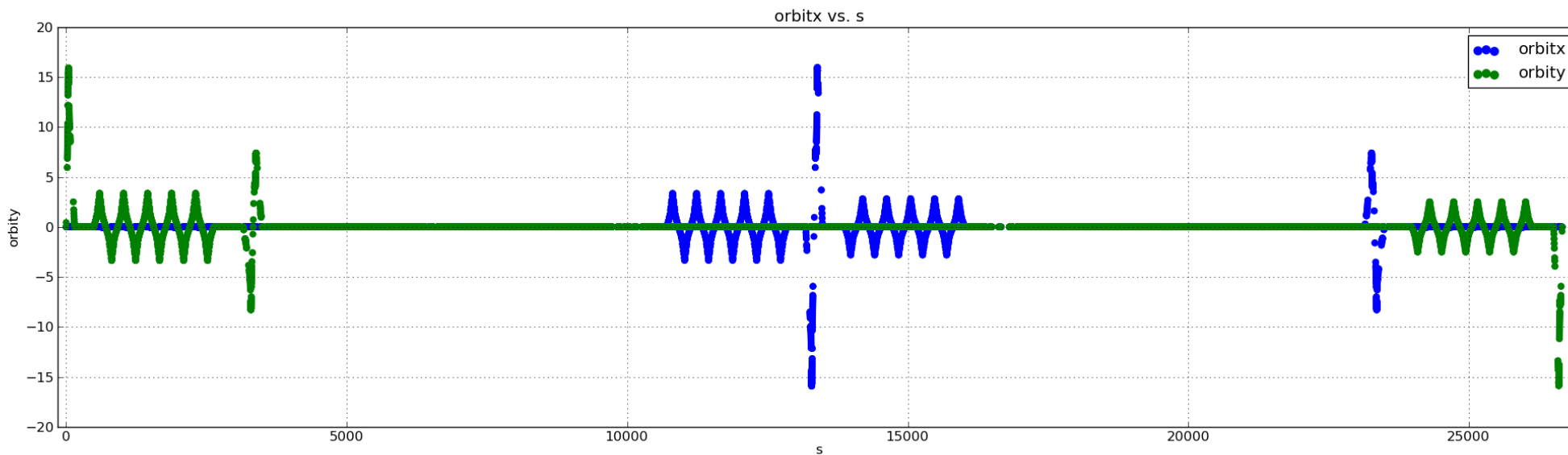
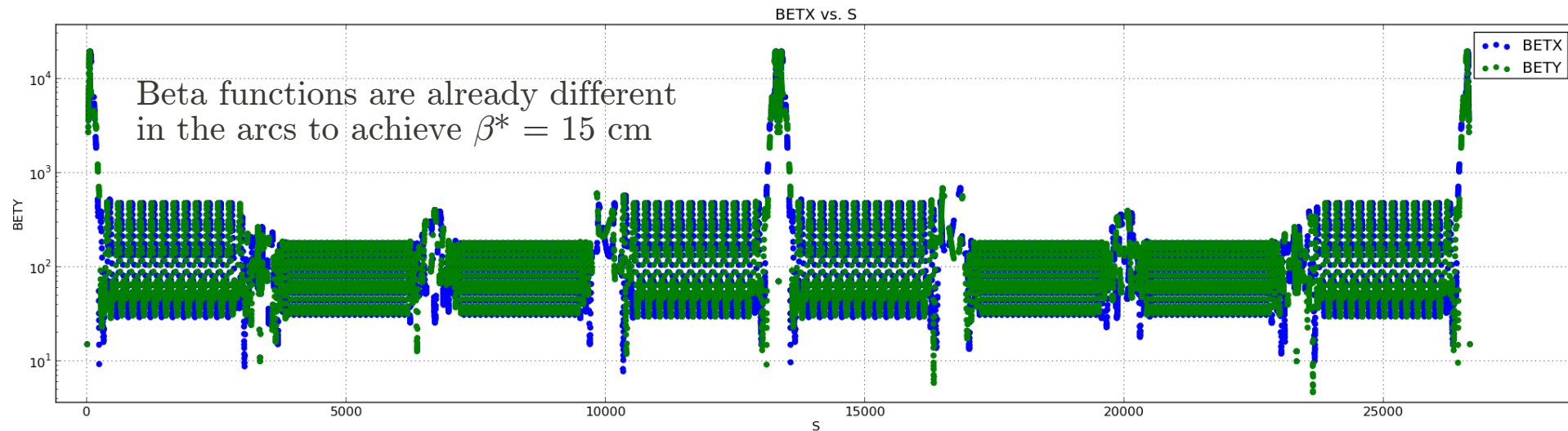
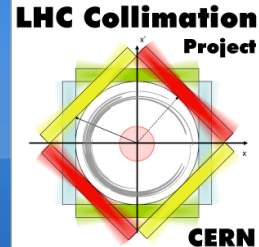
First results for ATS optics



- ATS: $\beta^* = 15$ cm
- Preliminary results:
 - Collimator hierarchy not fully decided
 - Preliminary aperture for post-processing
 - Work still in progress
- Used for first comparison with nominal case
- Debris: evaluate the (specific) need for protection in dispersion suppressors.



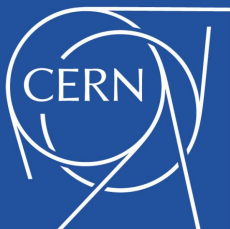
ATS: Achromatic Telescopic Squeeze



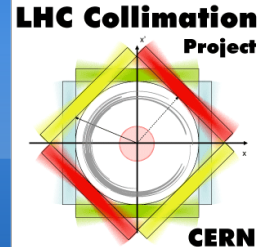
Coll. setting	σ
TCP IR7	6.
TCSG IR7	7.
TCLA IR7	10.
TCP IR3	12.
TCSG IR3	15.6
TCLA IR3	17.6

Coll. setting	σ
TCLP	12.
TCLI	open
TCSTCDQ IR6	7.5
TCDQ IR6	8.
TDI	open
TCT IR1/5/8	8.3
TCT IR2	12.

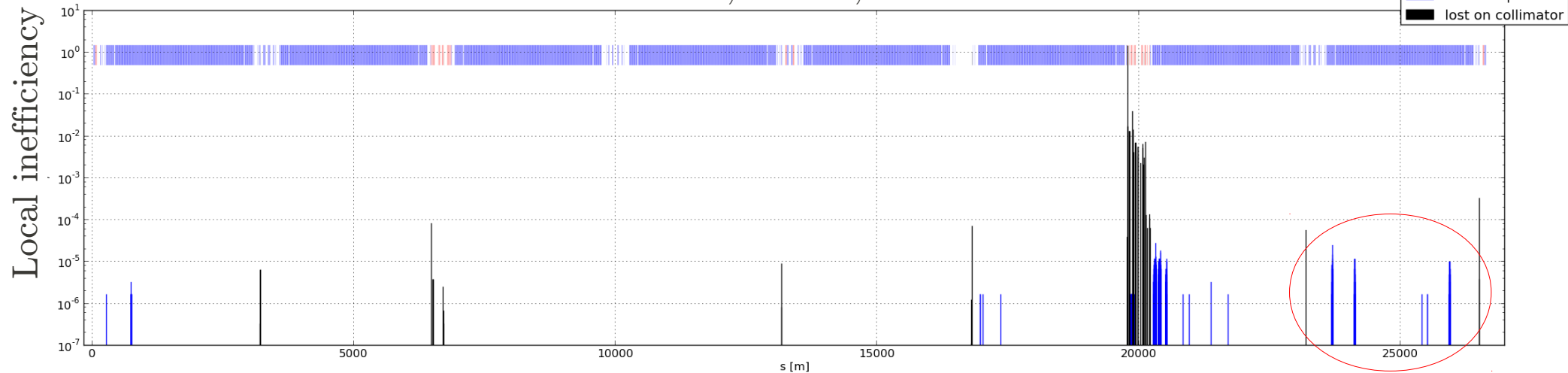
- Nominal settings at 7 TeV
- Note: TCT partially closed in IR2/8 (to be reconsidered)



Preliminary loss maps ATS / 7 TeV nominal

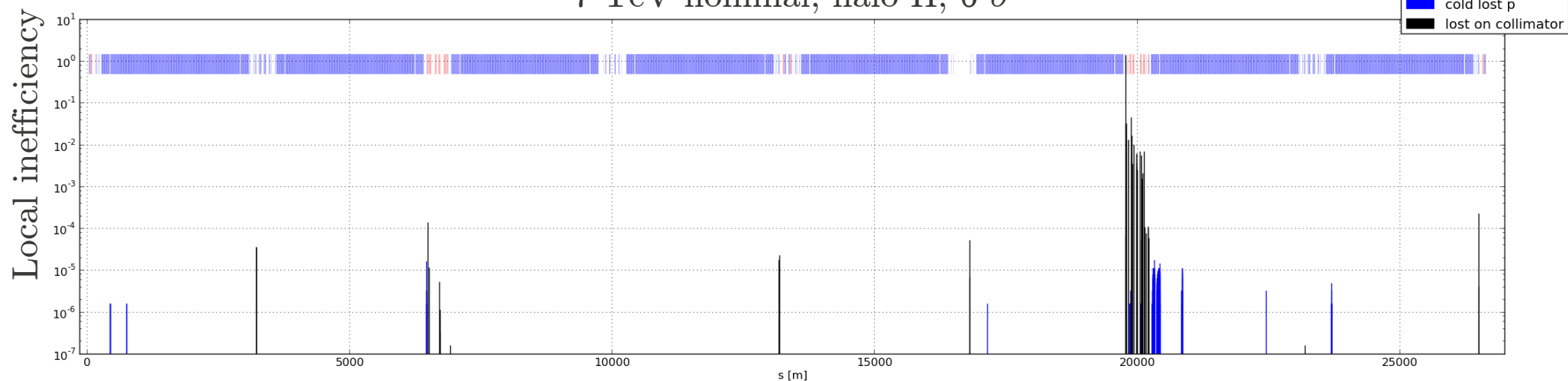


ATS, halo H, 6σ



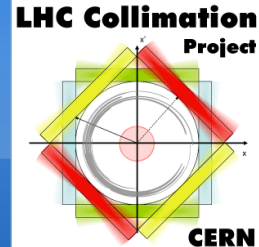
Losses in arc 81 at the level of the losses in the dispersion suppressor right of IR7 (detailed discussion tomorrow)

7 TeV nominal, halo H, 6σ

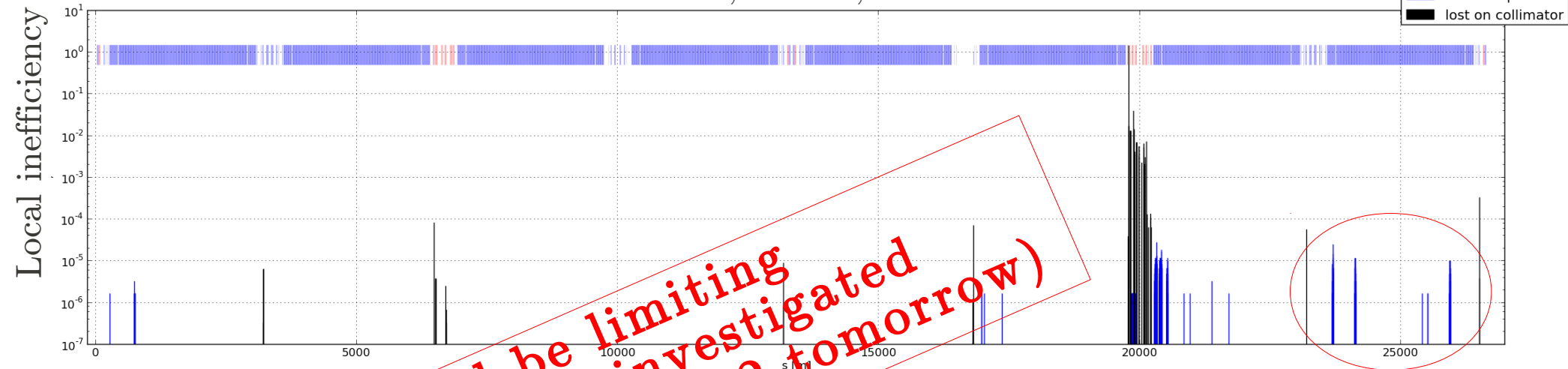




Preliminary loss maps ATS / 7 TeV nominal



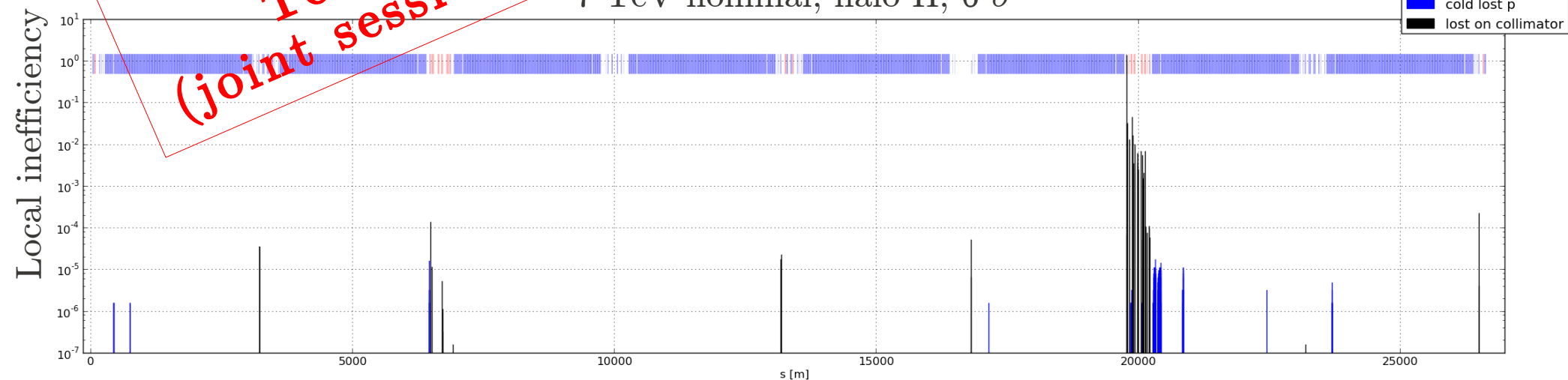
ATS, halo H, 6σ

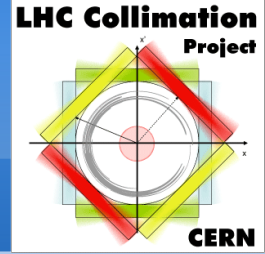


**To be further investigated
Could be limiting
(joint session with WP2 tomorrow)**

Losses in arc 81 at the level of the losses in the dispersion suppressor right of IR7 (detailed discussion tomorrow)

7 TeV nominal, halo H, 6σ

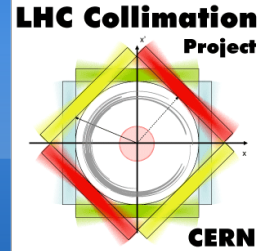




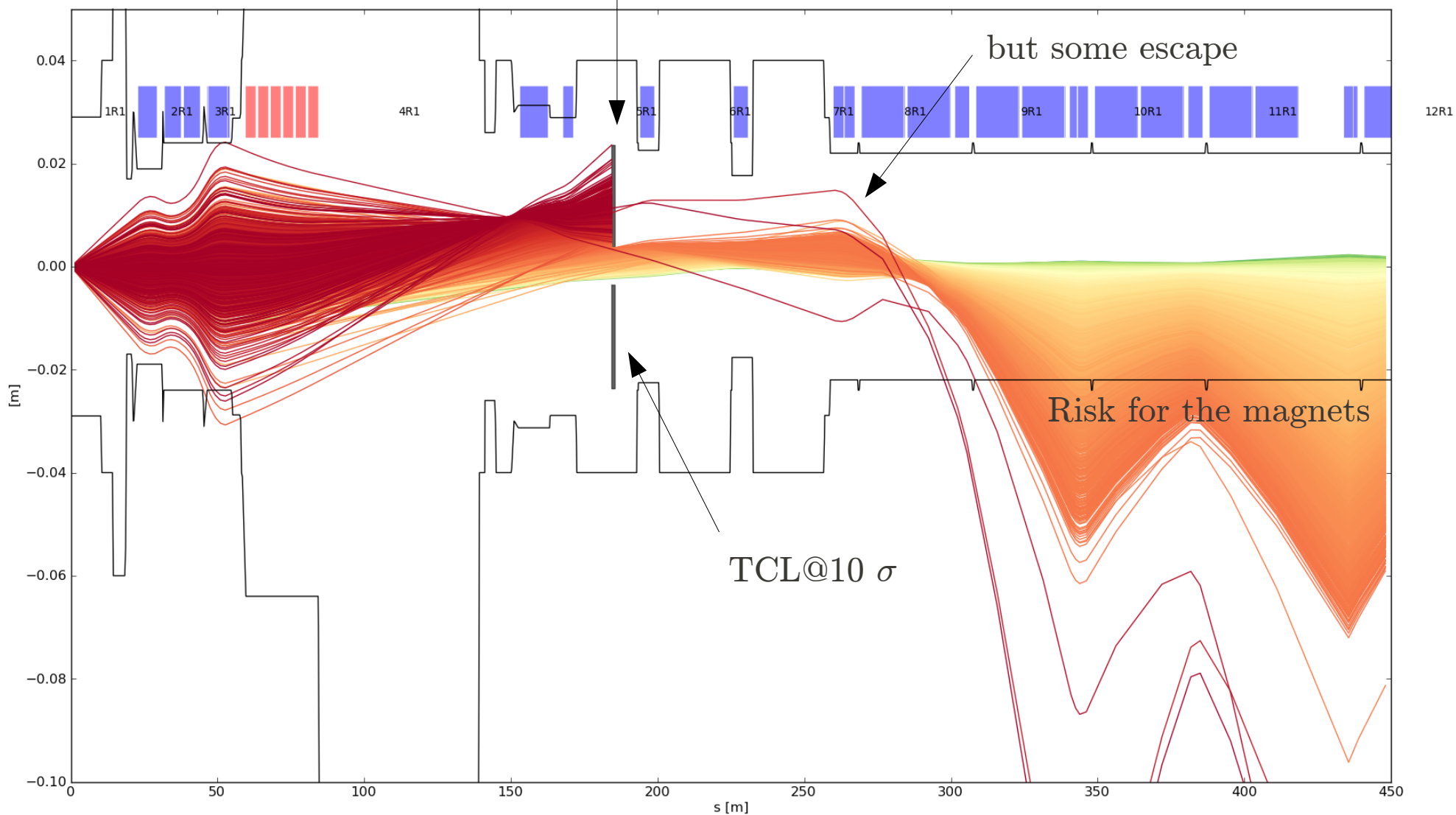
Debris tracking



4TeV example: 6400 collisions first turn, sorted by dp/p

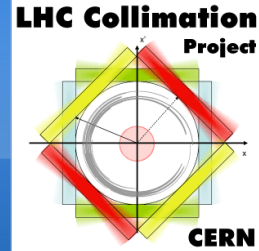


Protons of high dp/p are absorbed by the TCL

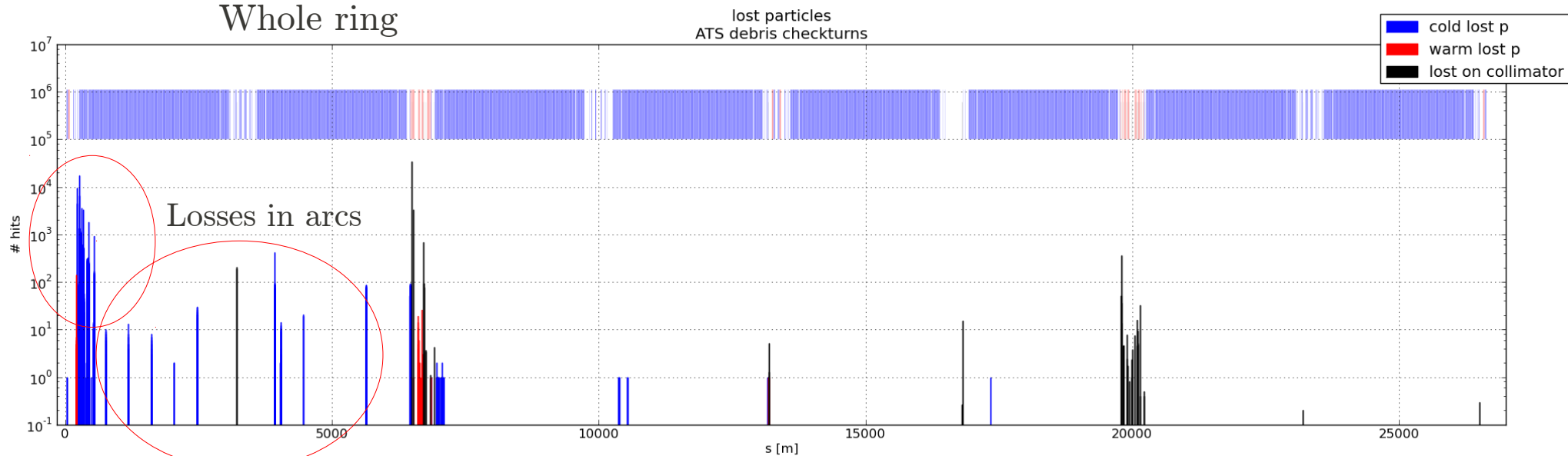




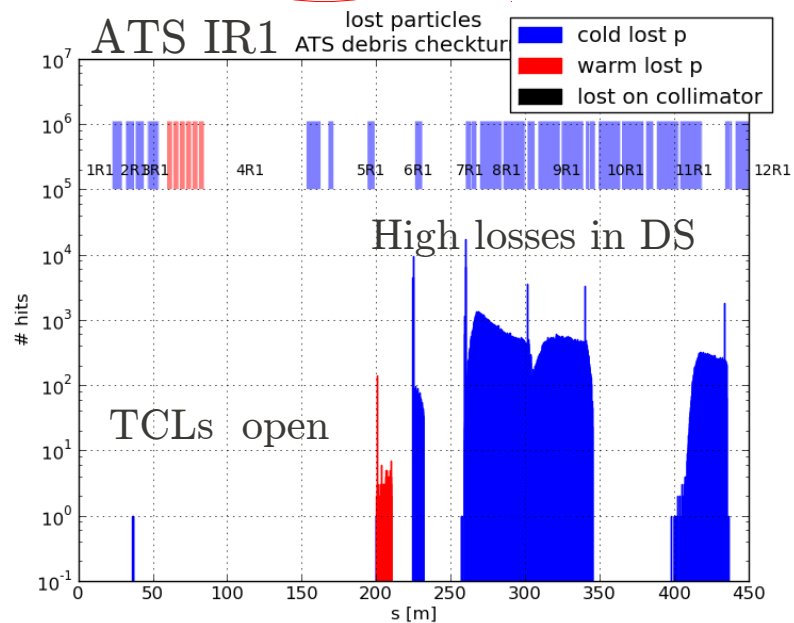
Preliminary loss map ATS debris, 2 turns



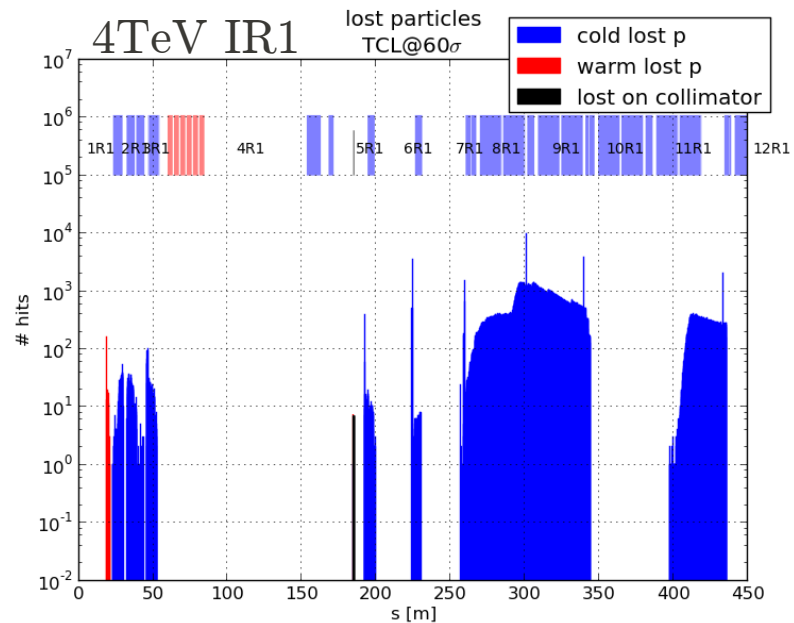
Whole ring

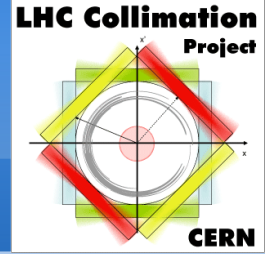
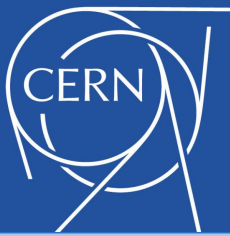


ATS IR1



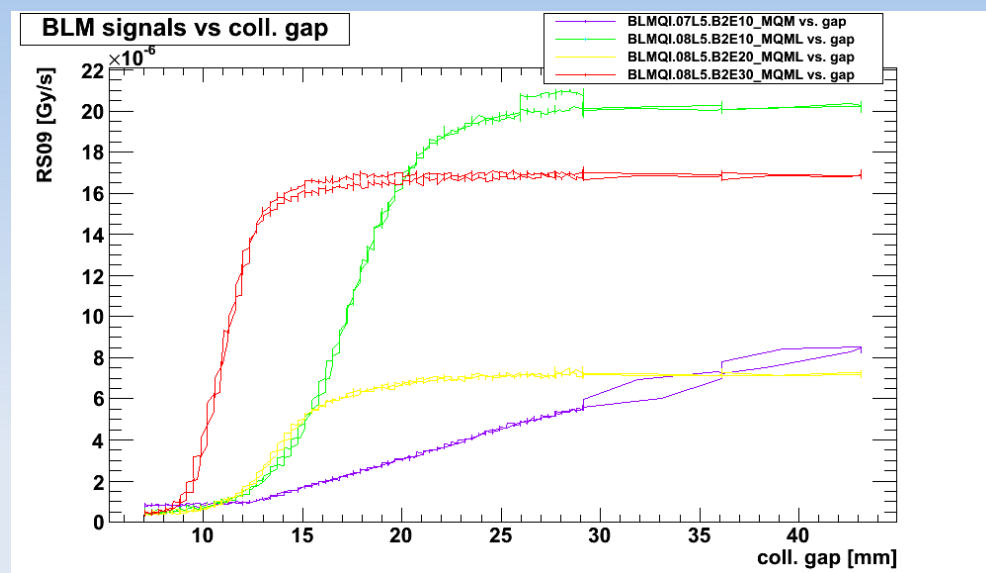
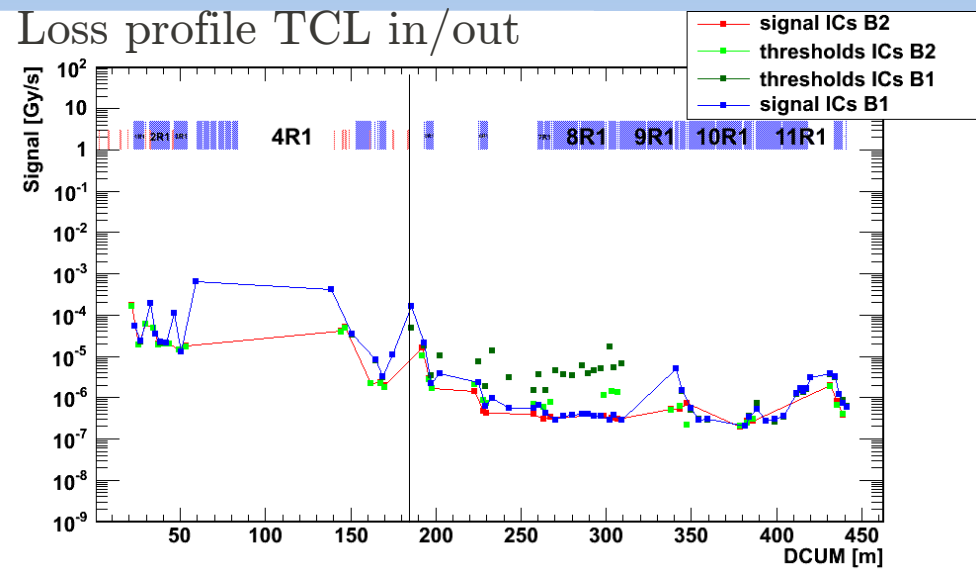
4TeV IR1



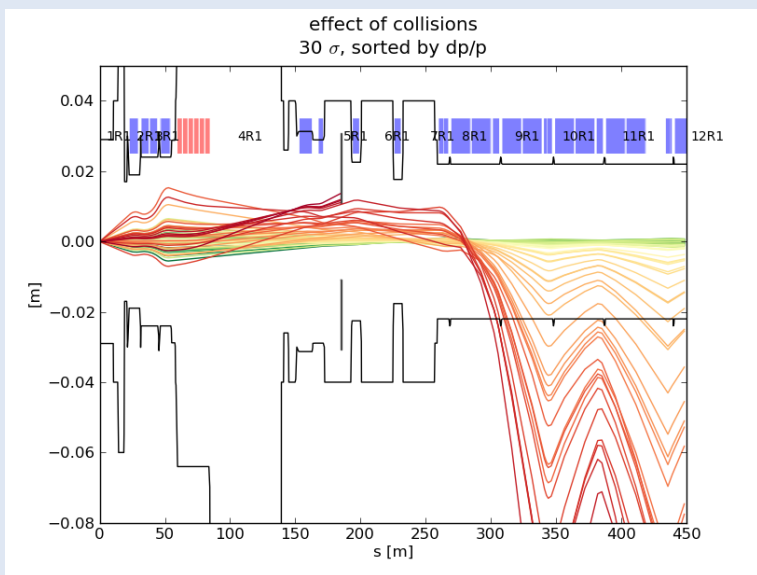
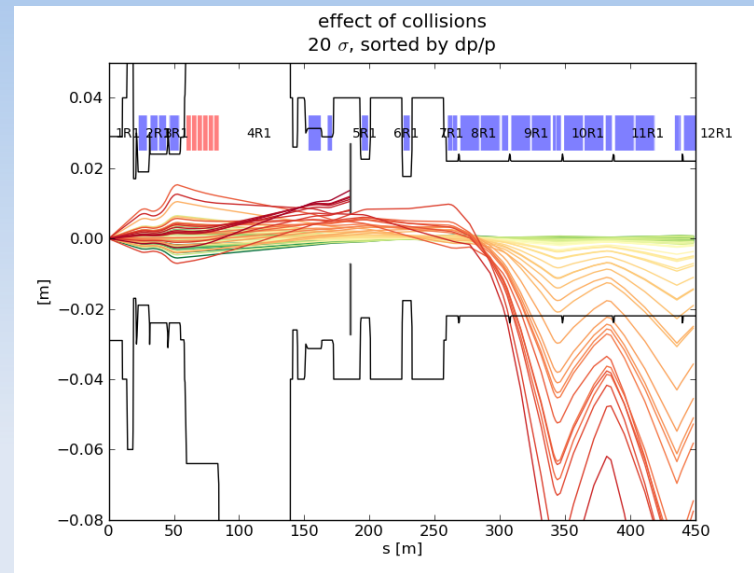
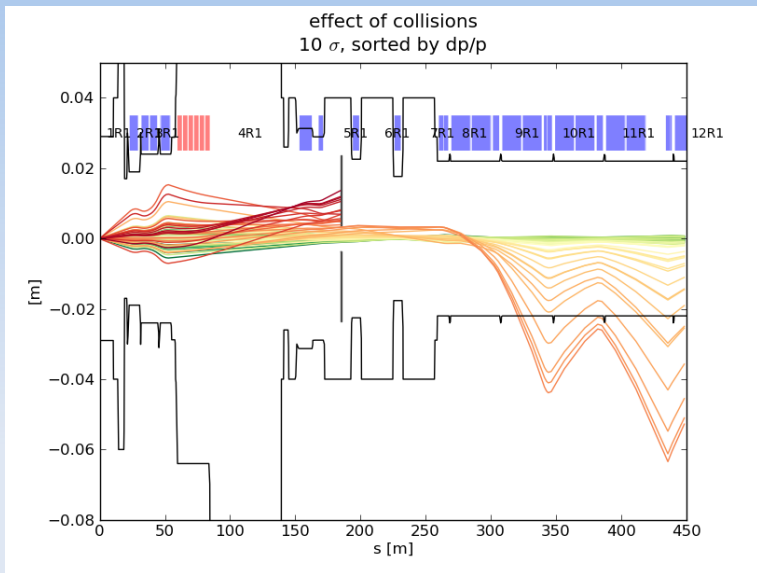


Debris tracking benchmarking at 4 TeV: TCL scans

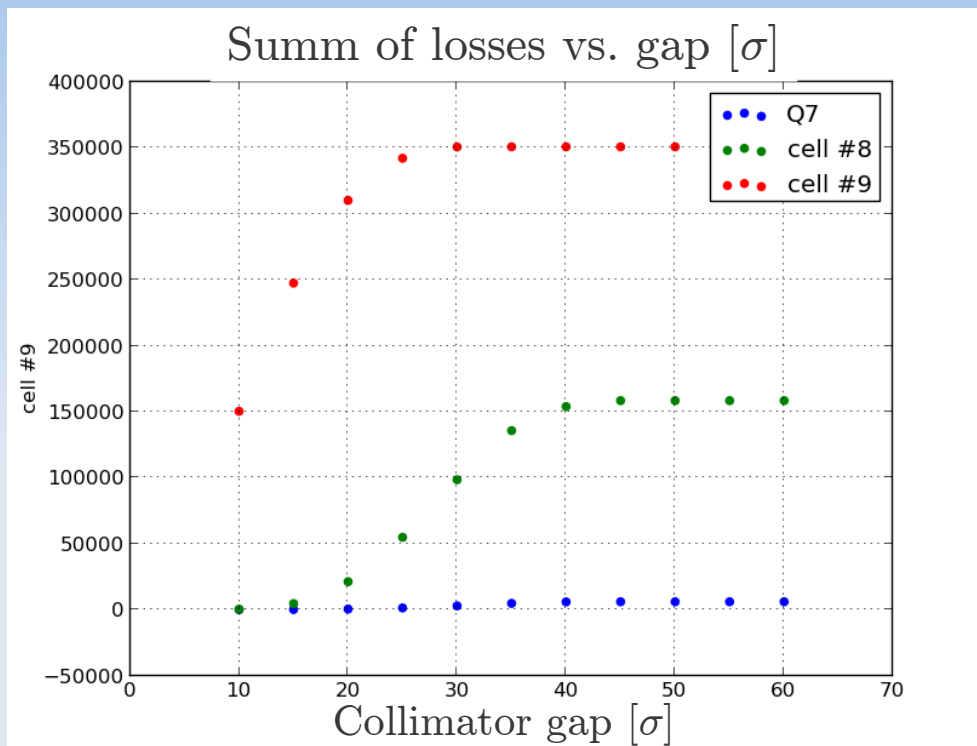
Measured losses at 4 TeV: TCL scan out



- Loss at TCL decrease: TCL retracting
- Losses downstream TCL increase: losing protection
- Different loss evolutions depending on the position
- Can we reproduce such behaviours?

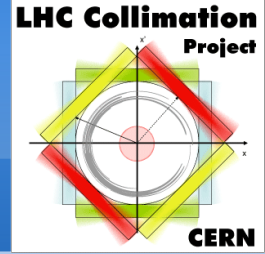


- At first turn
- More and more particles survive TCL
- Particles with higher dp/p
- Lost closer to the TCL



- Sum of aperture losses in Q7, cell 8, cell 9
- Work in progress: Trying to match these results to the measurements
- The furthest the losses are, the sooner they increase
- Very encouraging result

- First results, with halo and debris tracking, for different optics
- Halo tracking validated by loss maps
- Ongoing effort to understand in details TCL scan SixTrack simulations knowing the measurements
- Discovered possible new limitations: peaks in arc 81
- Outlook
 - Test different TCL settings for protection
 - Still perfect machine. Add errors
 - Only IP1: simulation from other IPs
 - Simulate B2



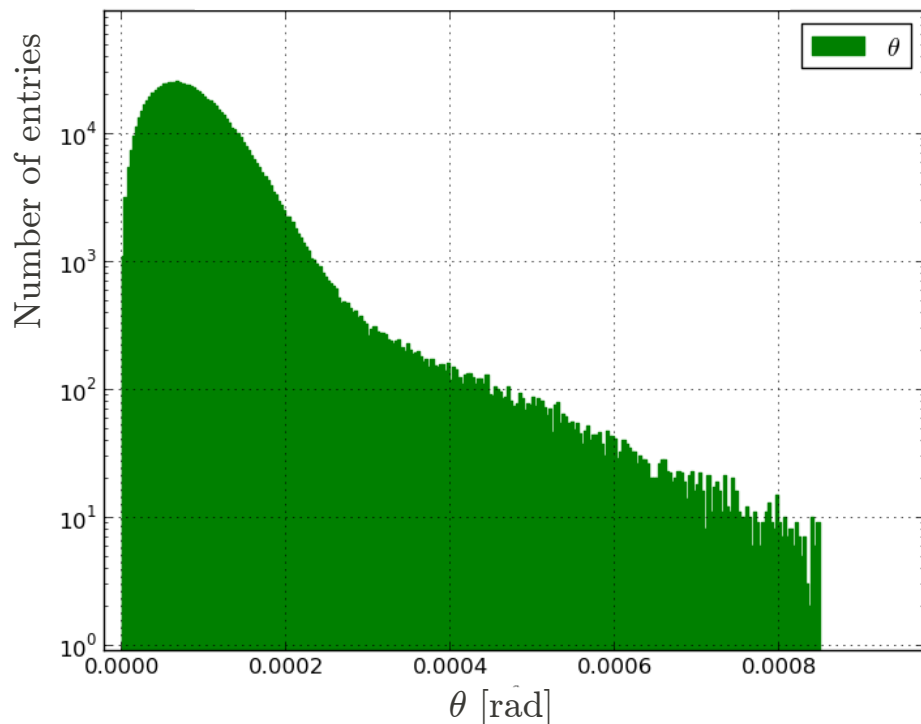
Thank you for your attention

- Distributions of protons with θ and dp/p from FLUKA
- Only inelastic contributions
- $x' = \tan(\theta)\sin(\varphi)$
- $y' = \tan(\theta)\cos(\varphi)$ } $\varphi \in [0 ; 2\pi]$
- Distribution of θ is cut at the opening of the TAS
- Distribution of dp/p is cut at 0.1

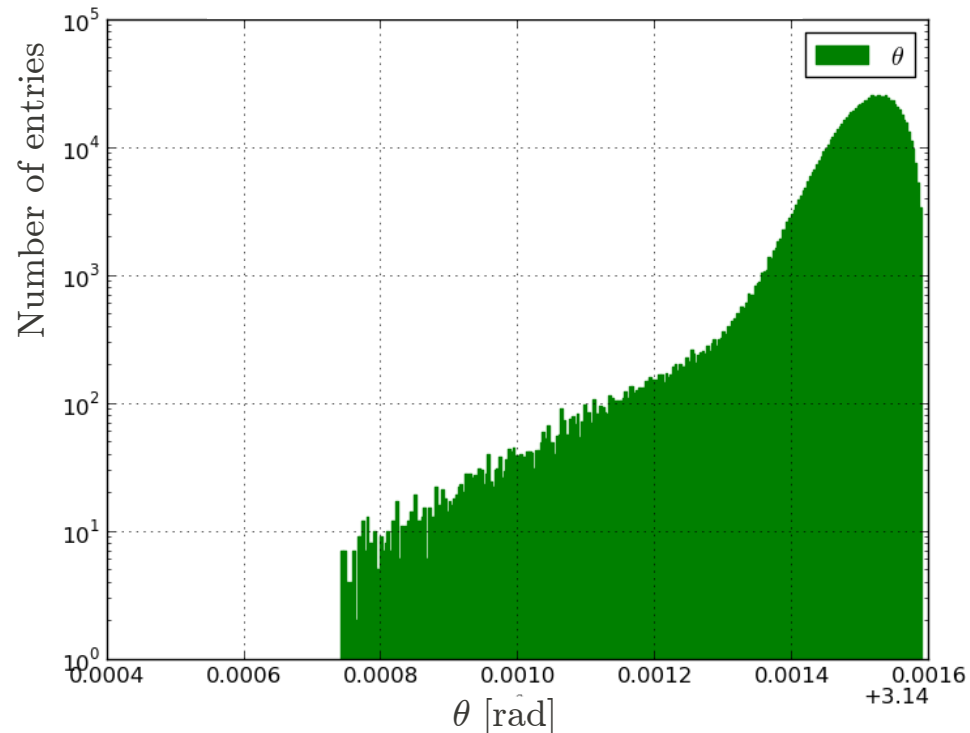


Distributions of θ (4 TeV)

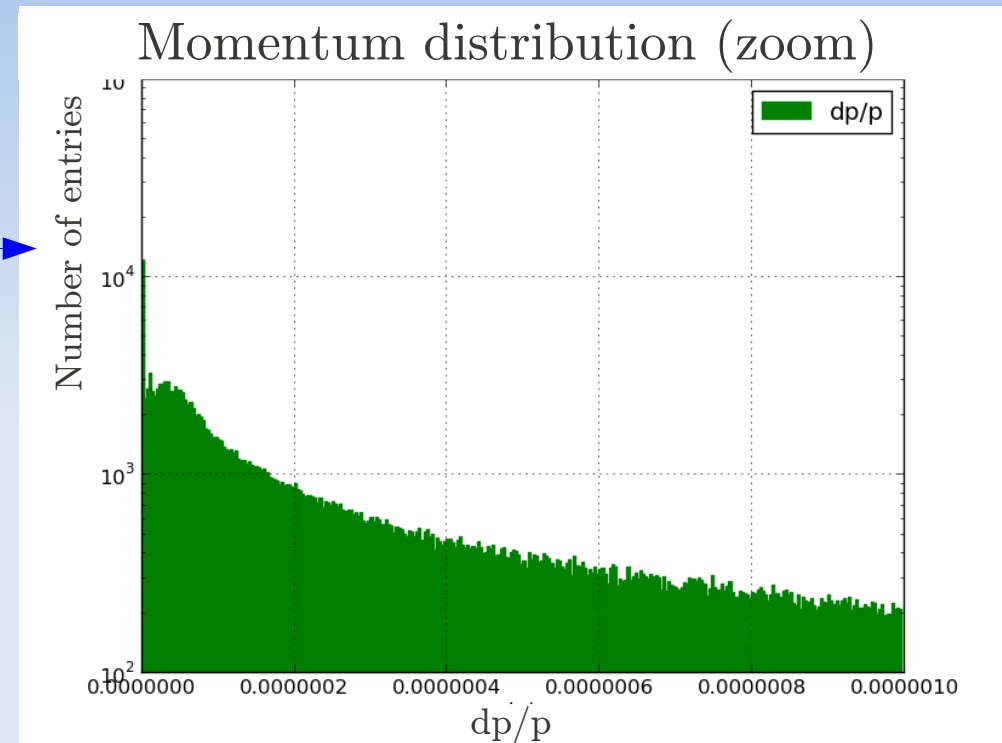
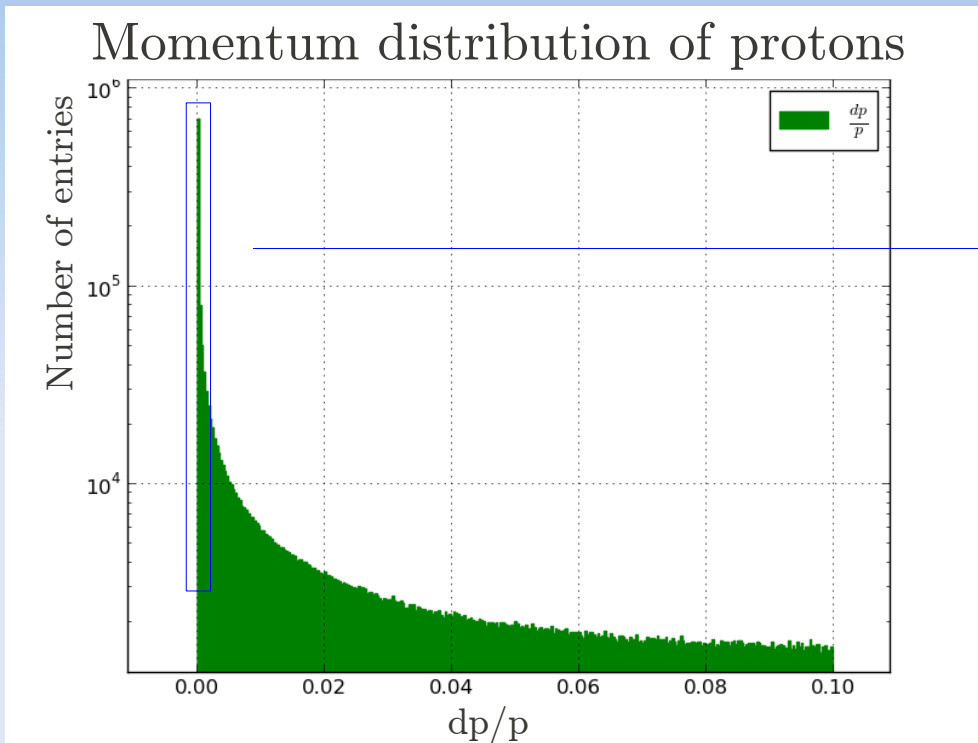
Distribution of θ around 0



Distribution of θ around π



- Effect of the cut
- Used to generate the extra kicks in x' and y'
- These distributions are wider than the nominal ones.



- Most protons with small dp/p , but long tail (cut)
- Protons with higher θ or dp/p would be lost anyway during tracking: momentum & betatron acceptance