First collimation results with the baseline 15 cm ATS optics

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

Outline

- Introduction
  - Halo / debris tracking
  - Simulation setups
- Preliminary halo tracking results
  - Loss maps comparison
  - Impacts in arc 81
- Preliminary debris tracking results
  - Comparison with nominal case
- Conclusion

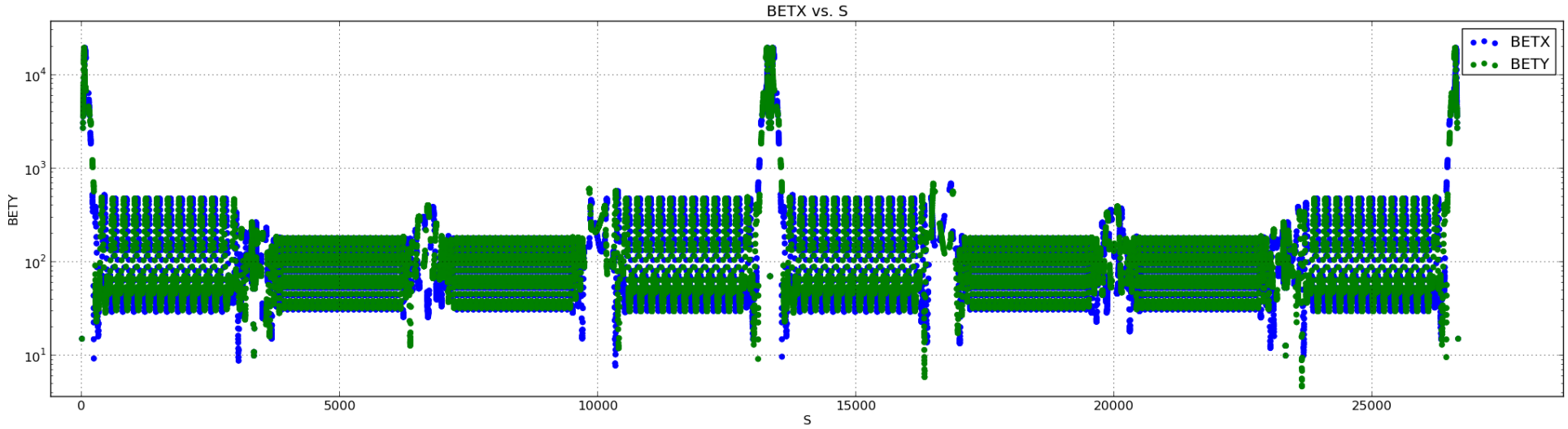
Introduction

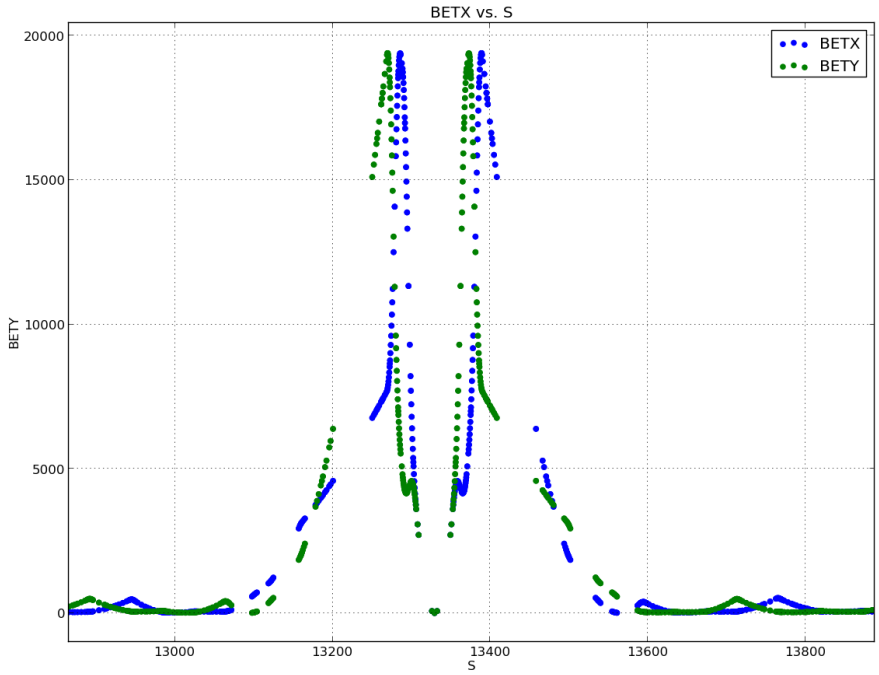
- Goal: predict collimation cleaning for HL-LHC
- Setting up multi-turn halo simulation for the baseline optics choices: ATS optics
- ATS: Achromatic Telescopic Squeeze
  - Baseline option: $\beta^* = 15$ cm
- First attempt to use this optics with the collimation version of SixTrack for loss maps
  - Tracking halo / debris
- /!\ preliminary results, for discussion
  - Focus on simulation setup
  - Preliminary settings for collimators
  - Aperture layout not finalised

Halo / debris

- 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

ATS optics: β_X β_Y





- Thin optics, IP1/IP5: $\beta^* = 15$ cm
- Latest layout: as-built 2012
- Different β functions and orbits in different arcs
- Sequence curtesy of R. de Maria

Simulation parameters

- $\epsilon_N = 3.75$ mm.mrad, $\epsilon_X = \epsilon_Y = 0.503\text{e-}09$
- IP1/IP5: $\beta^* = 15$ cm
- Crossing angle X1 = 142.5, X2 = 80, X5 = -142.5, X8 = 130
- Parallel separation OFF (collisions)

- Halo: 6 σ in the considered plan (= setting of primary)
  Smear = 0.0015 σ, no pencil beam.
- 6.4 million particles, 200 turns

- Debris: distributions of dp/p and kicks from FLUKA
- 177 000 particles, 2 turns

Collimator settings

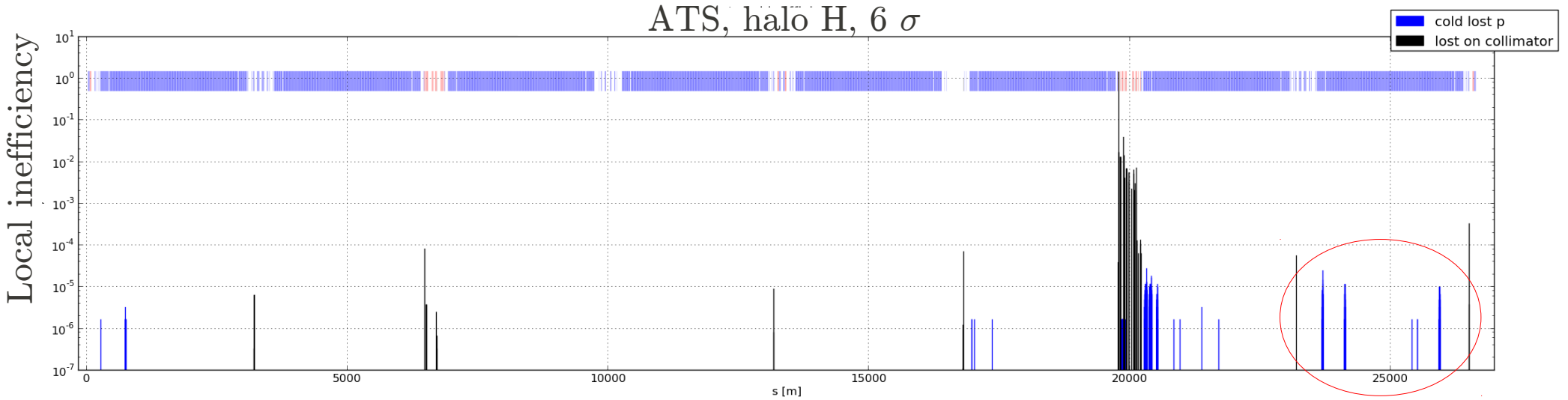
Coll. setting	σ
TCP IR7	6.
TCSG IR7	7.
TCLA IR7	10.
TCP IR3	12.
TCSG IR3	15.6
TCLA IR3	17.6

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)

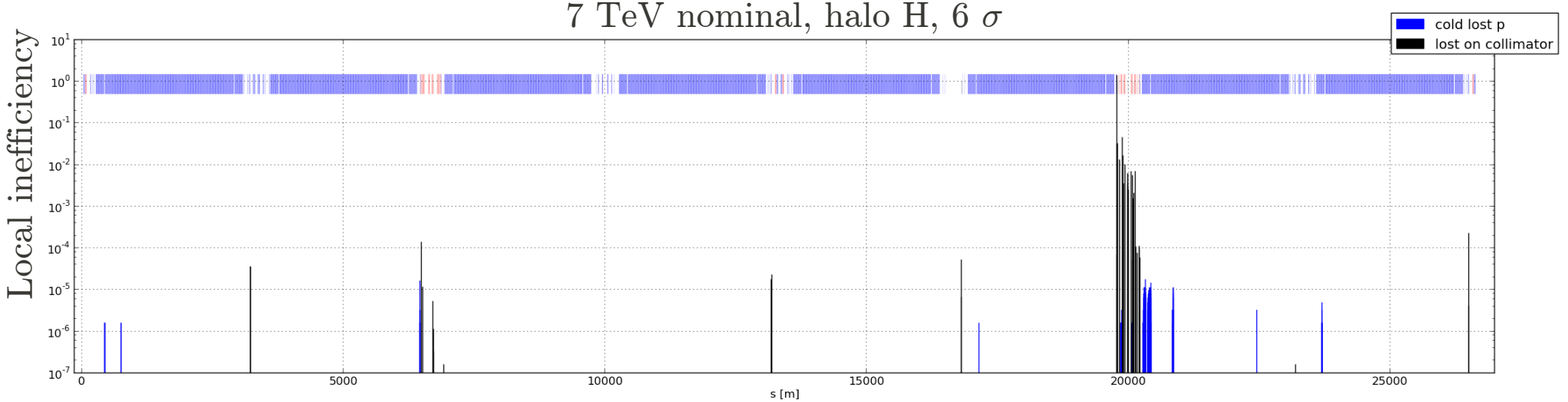
ATS halo tracking

Preliminary halo loss map ATS / 7 TeV nominal

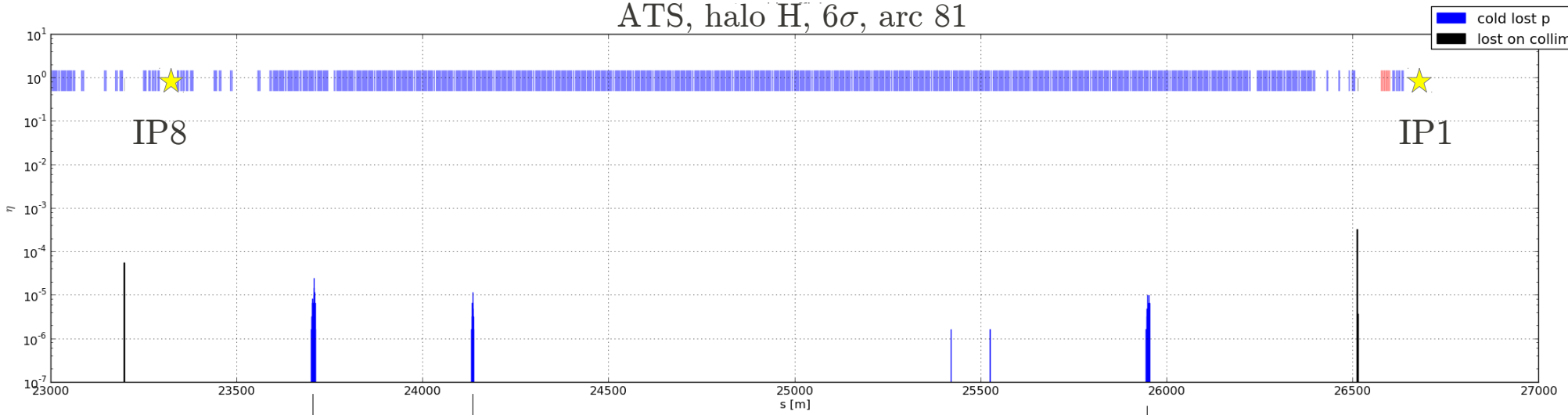


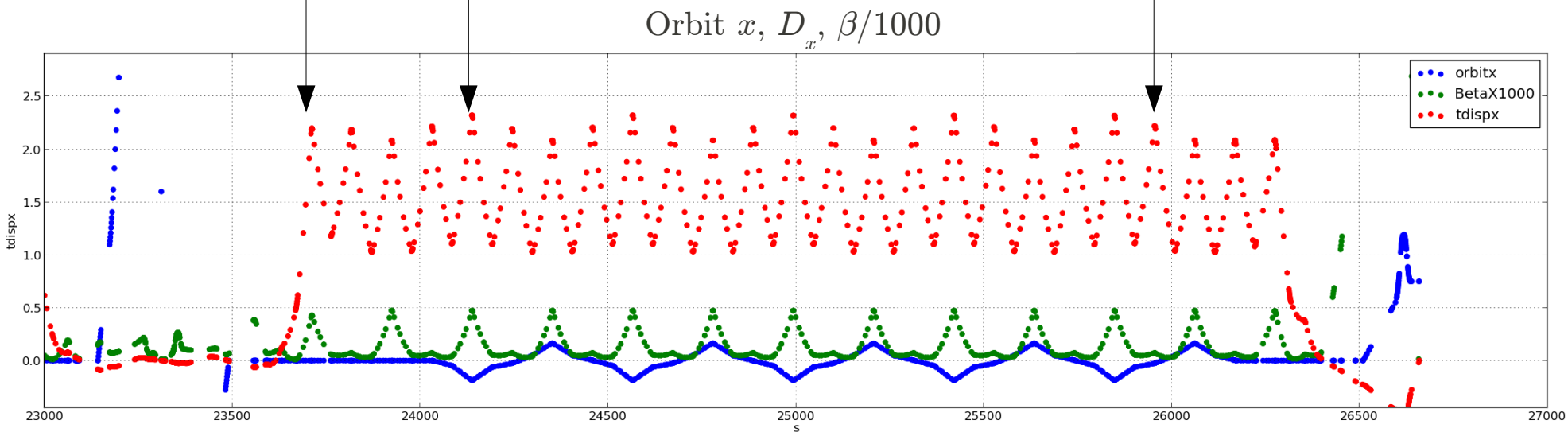
Low losses in IR3

Losses in arc 81 at the level of the losses in the Dispersion Suppressor right of IR7



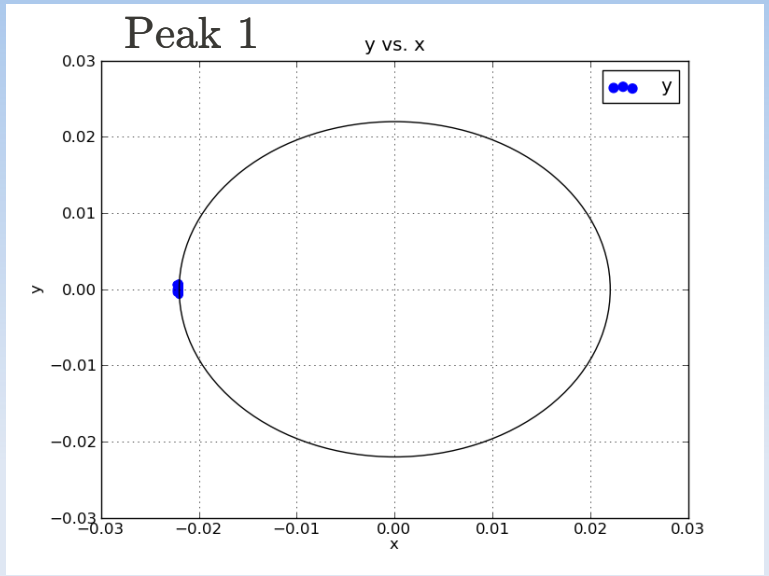
Preliminary ATS halo tracking Peaks in arc 81

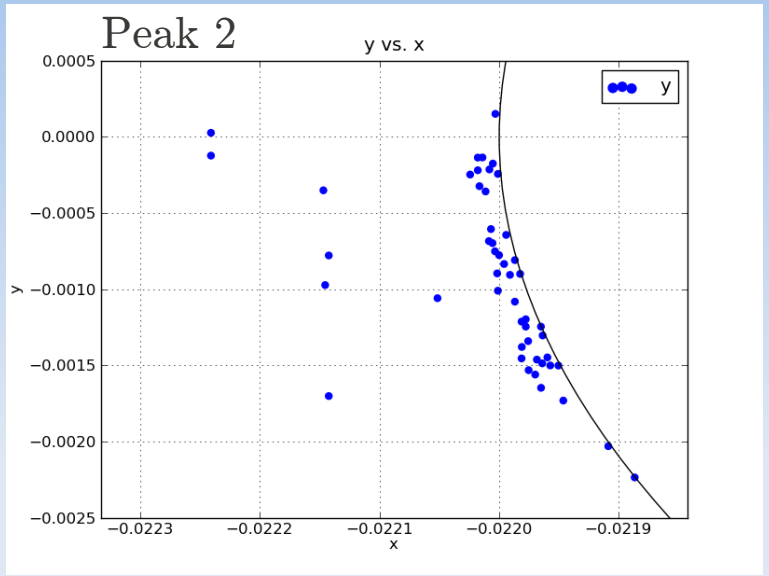


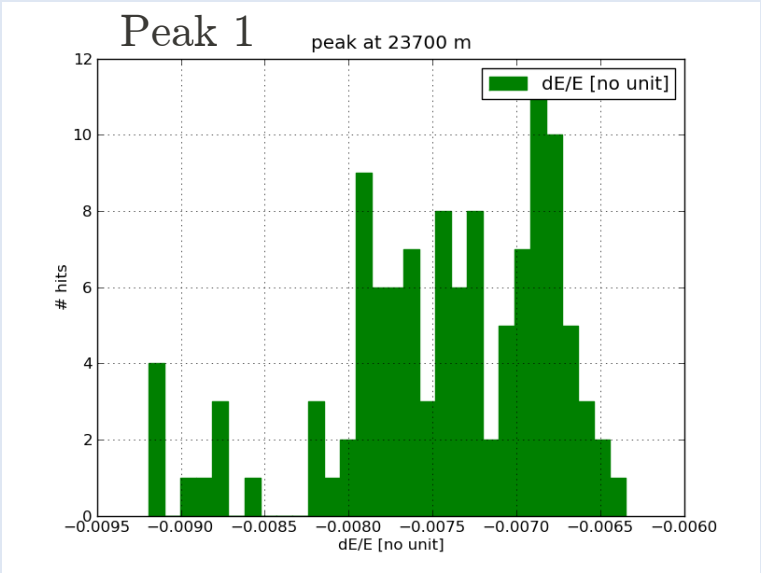


- All losses correspond to a dispersion maximum
- 2 first peaks also correspond to a maximum of the beta function
- 2nd peak also corerspond to orbit < 0

Transversal distributions in the areas of the losses



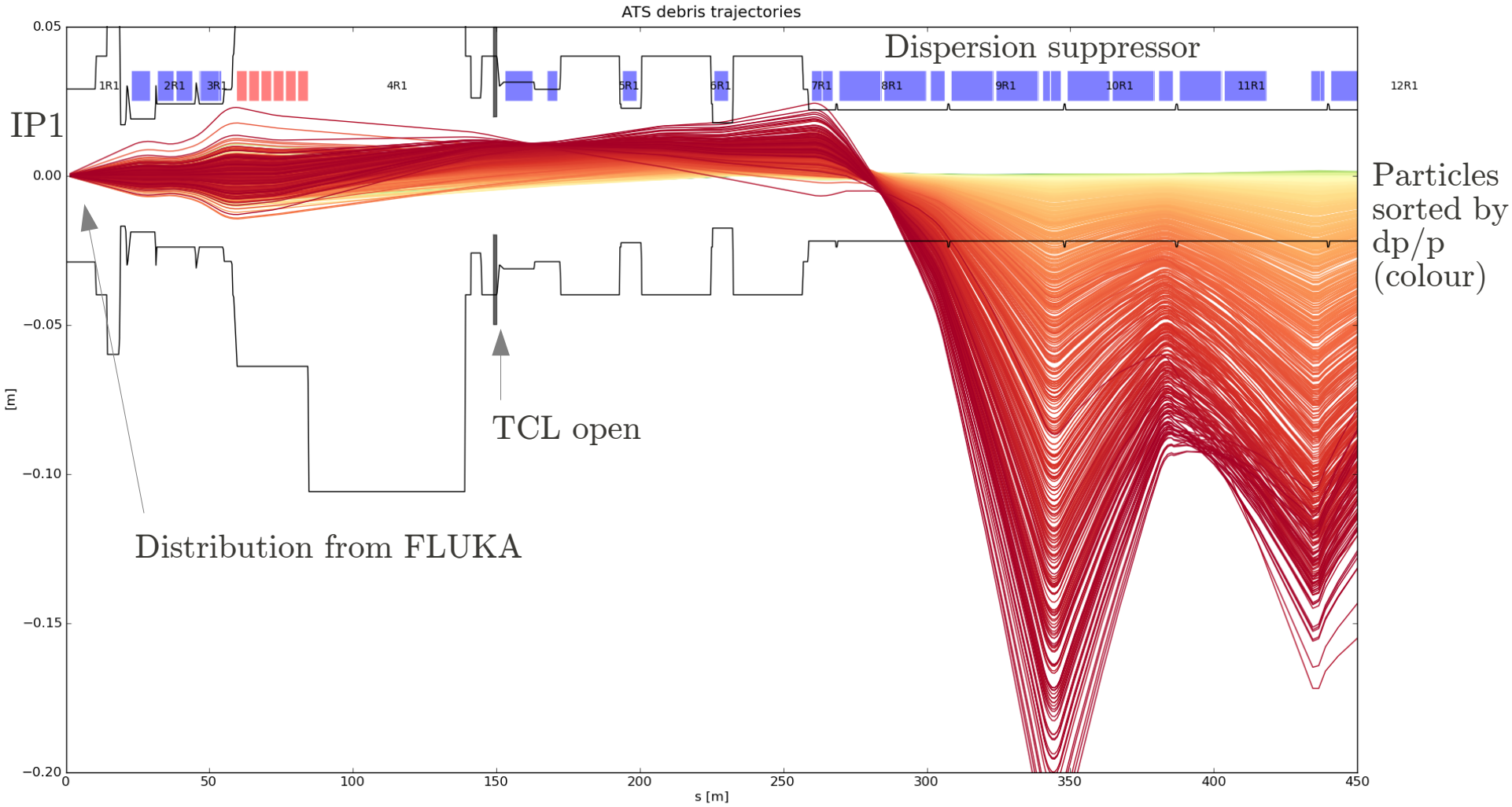




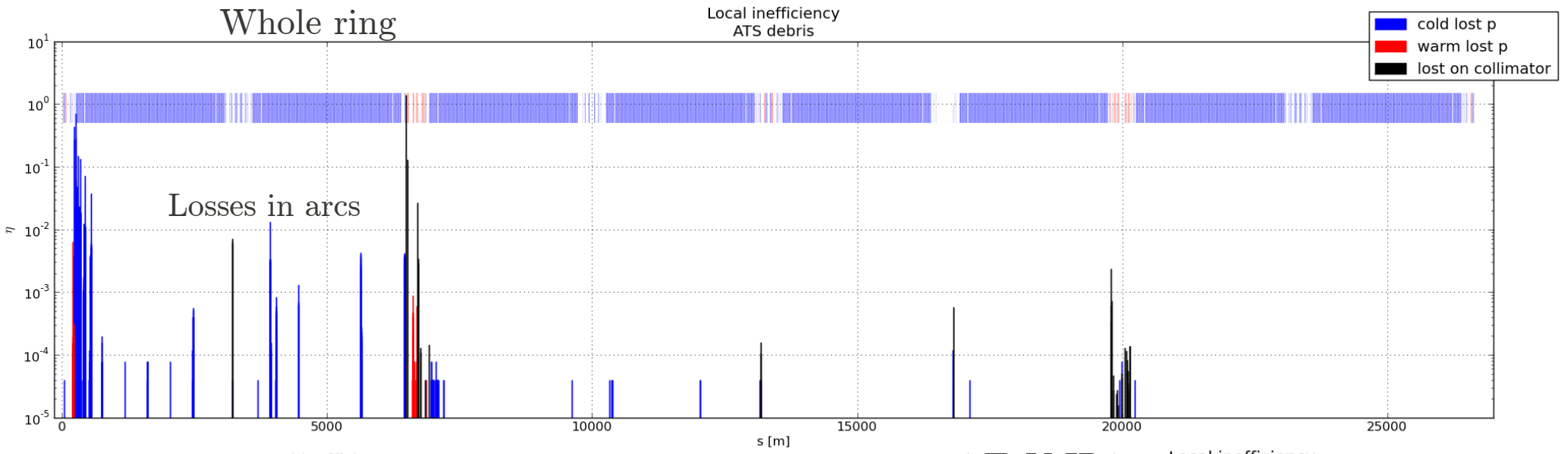
- All particles are lost at horizontal negative values
- -0.022 m = aperture
- Consistent with the dispersion peaks
- Loss peaks 1&2:
  local maximum of beta function

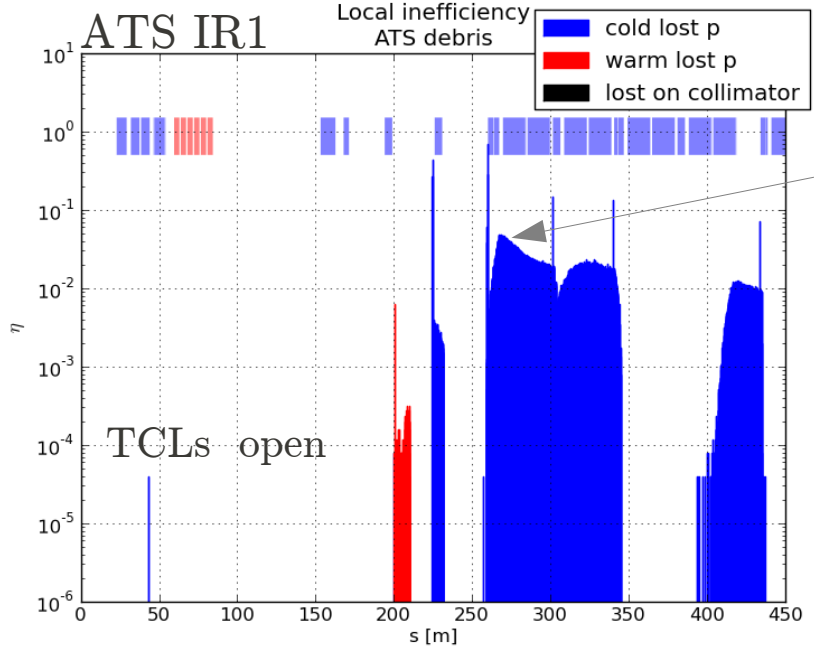
ATS Debris tracking

ATS debris trajectories

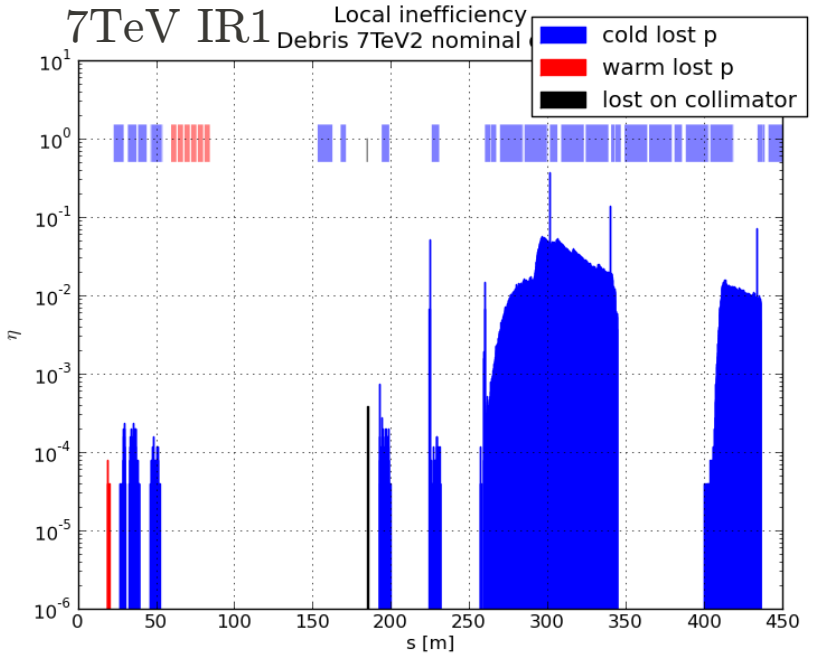


Preliminary loss map
ATS debris, 2 turns

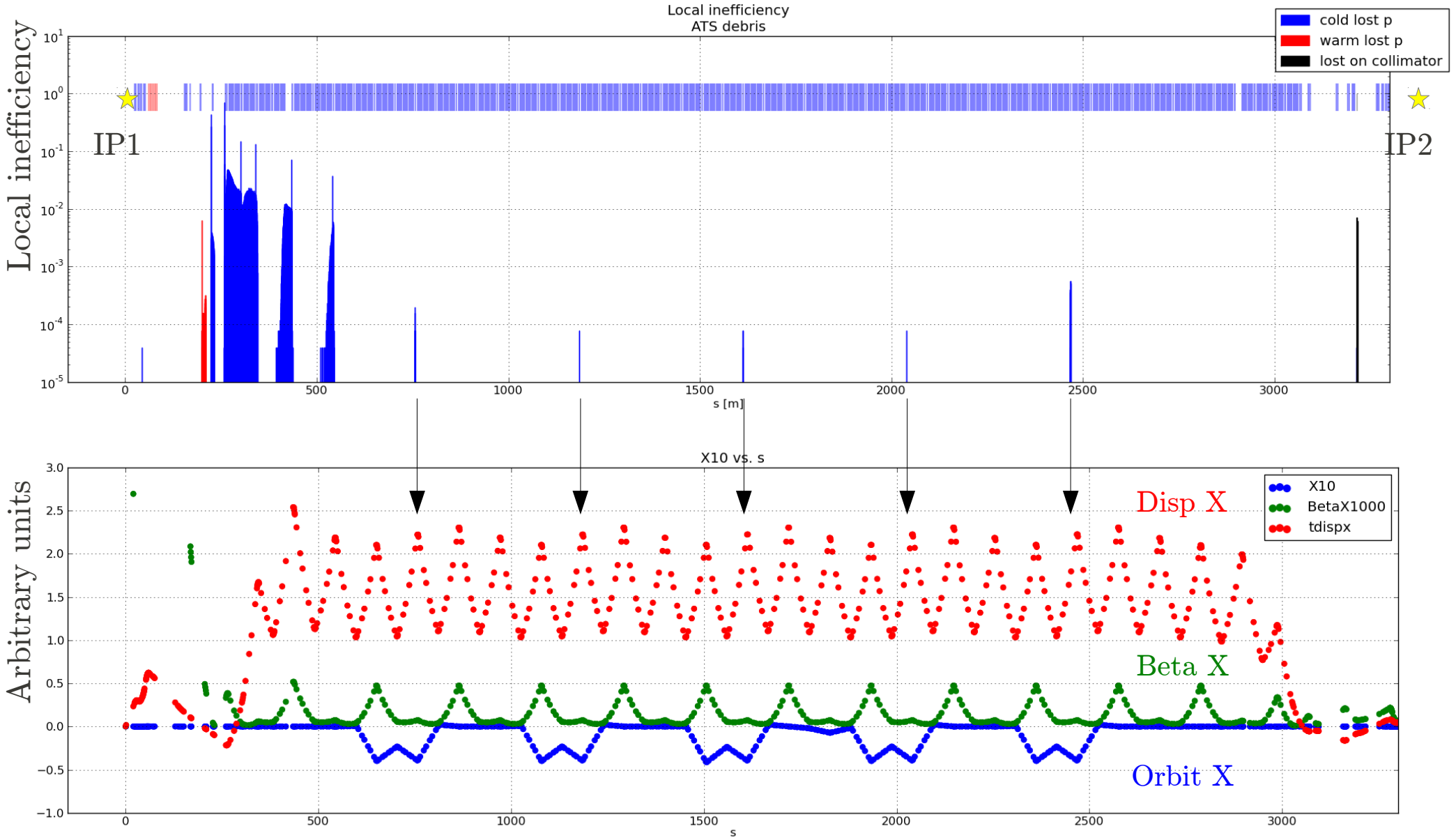




Higher losses in Q7 and cell 8



Preliminary ATS loss map: Loss in arc 12

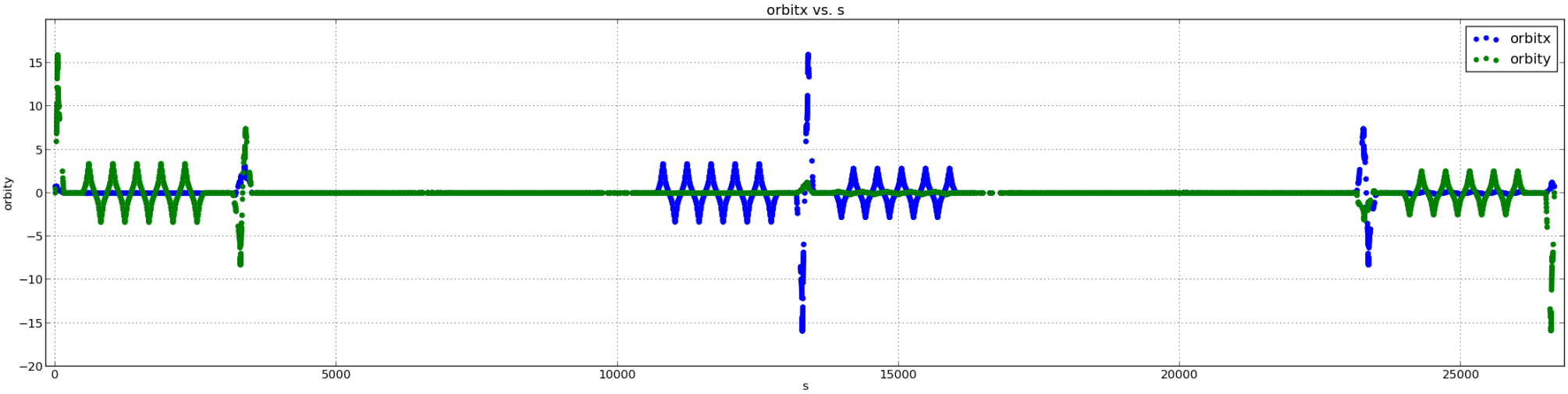


Conclusion

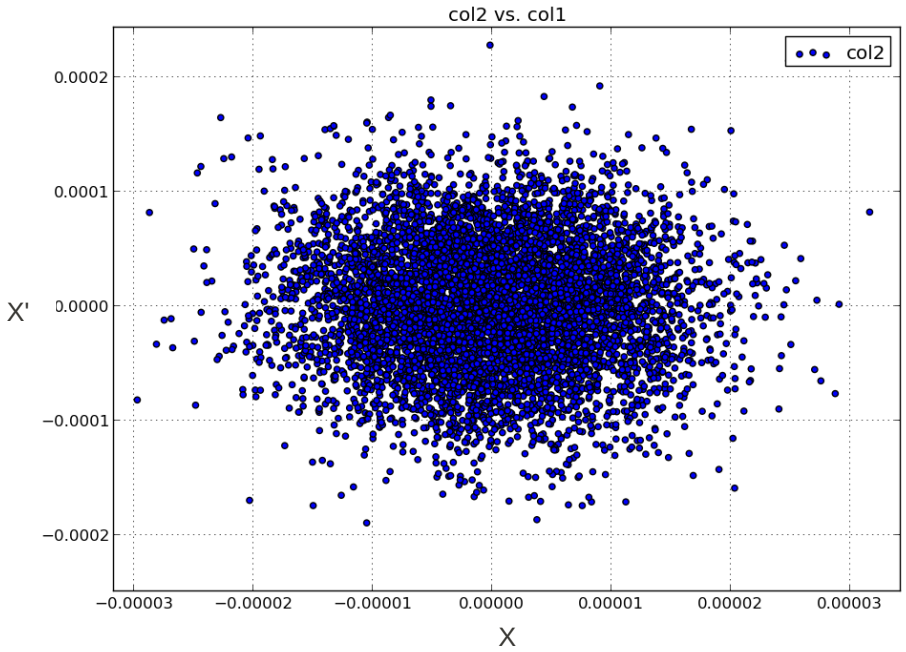
- Presented first simulation for cleaning with ATS optics at 7 TeV → Preliminary results!
  - Case study: $\beta^* = 15$ cm, Hor/Ver halo 6/5.9 σ
  - IP1 debris tracking
- Full simulation chain (including loss maps with preliminary aperture model) running smoothly
- New possible limitations:
  - Losses in arc 81 for Beam 1
- Immediate follow-up
  - Simulations with different TCL settings
  - Simulations for the other beam
  - Finalise the aperture model for present ATS layout
  - Consider different IR collimation layout (DS collimators)

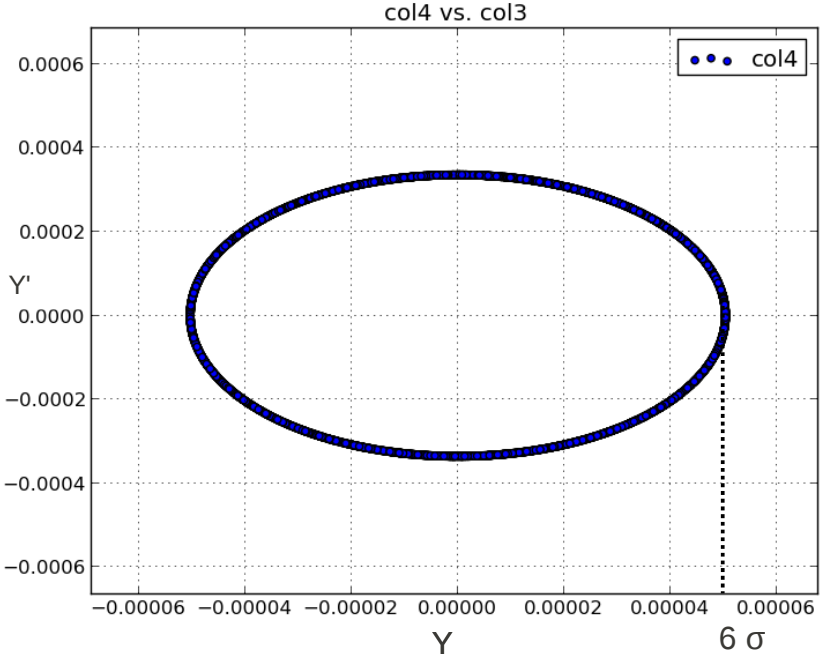
Thanks for your attention

ATS optics: closed orbit



Example of initial distribution at IP1 (V)

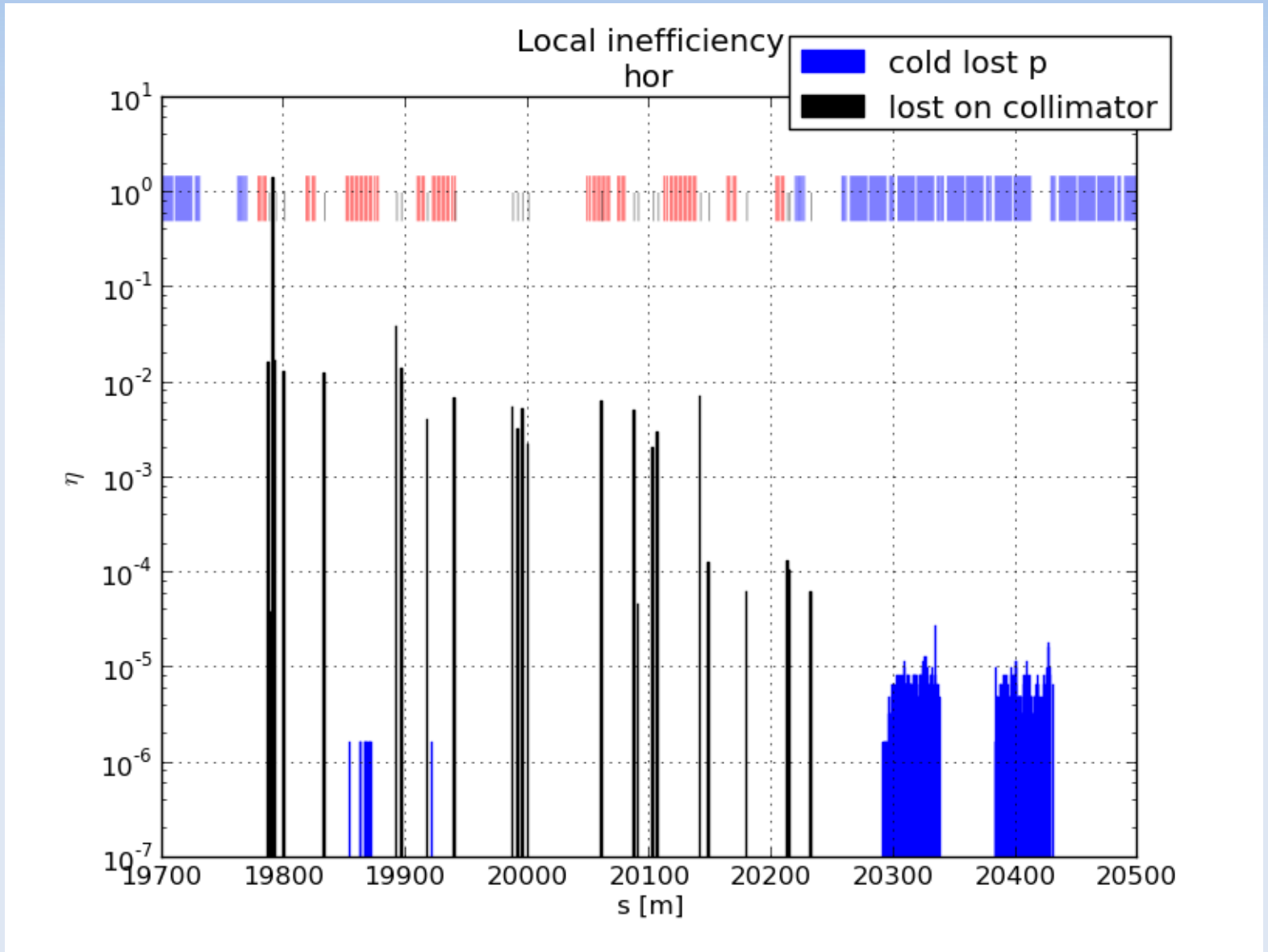




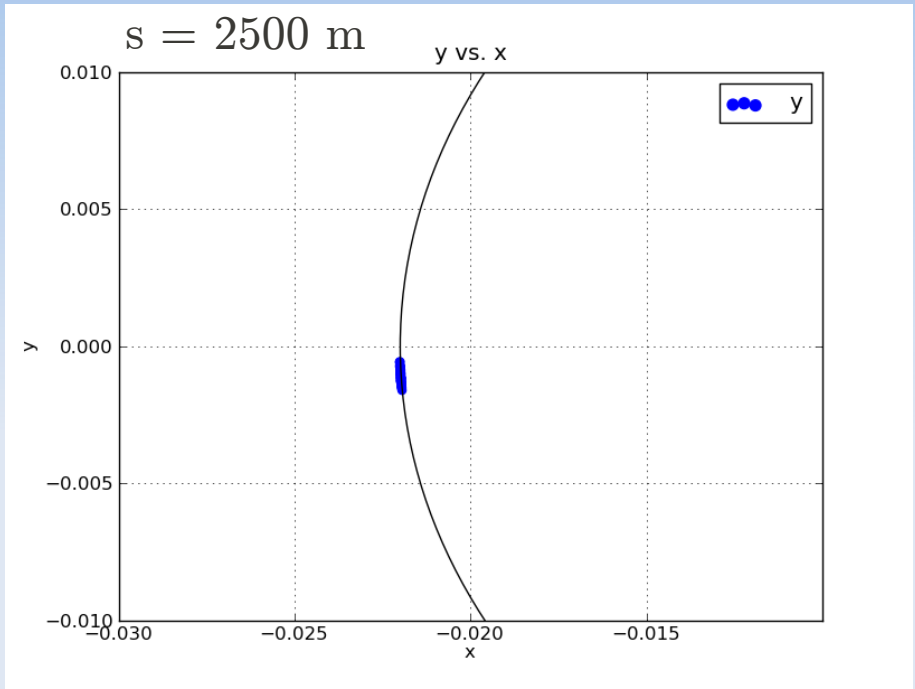
- Phase space
- Distribution centered around 0

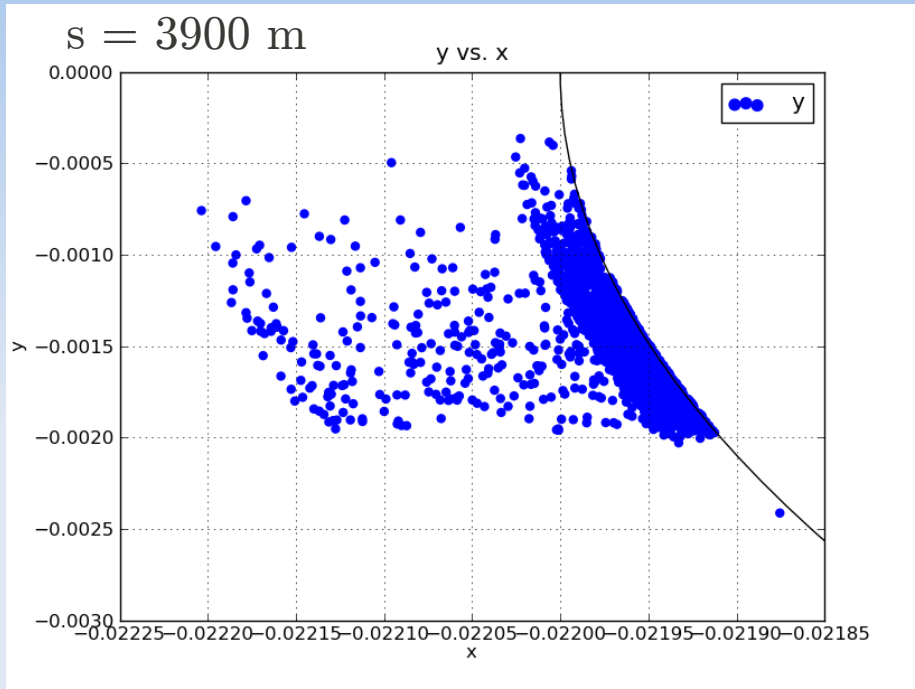
- Phase space
- 6 σ vertical halo
- $\sigma = 8.68\ \mu$m
- $(\beta^* = 15\ \text{cm},\ \ \epsilon = 3.75\ \mu\text{m})$

ATS loss map, halo H, 6 σ Zoom IR7

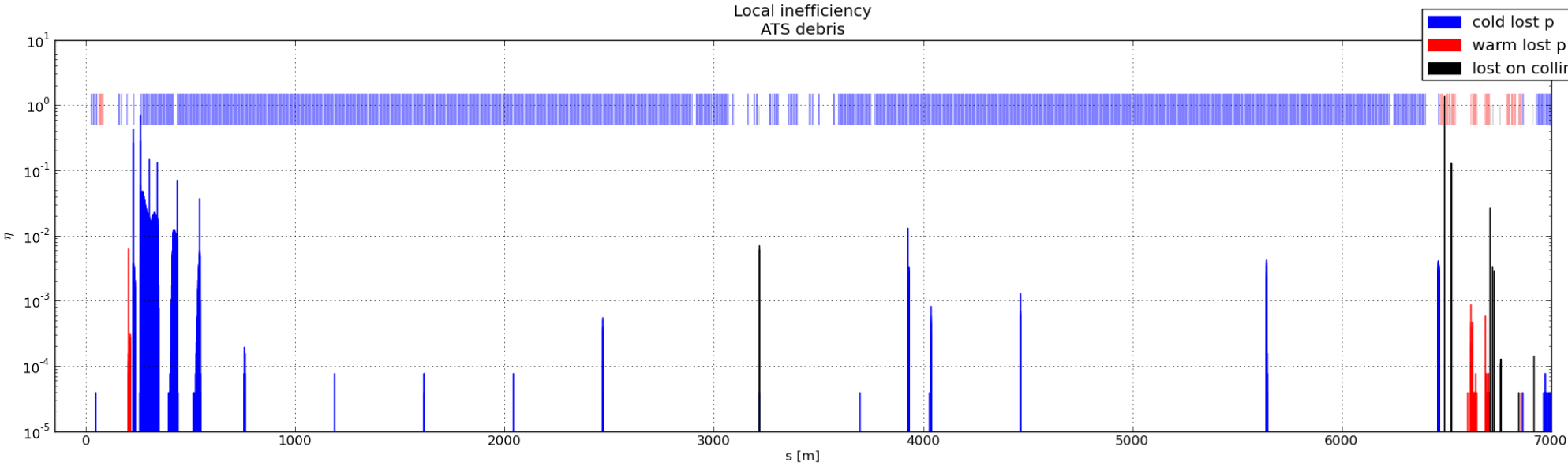


Transversal distributions of losses





Preliminary loss maps: Peaks in arcs 12 & 23



Simulation Setup