3rd LHC Collimation Upgrade Specification Meeting
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Status of multi-turn tracking of protons from IR debris

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Acknowledgements: R. Bruce, T. Weiler

Outline

- ☑ Scope
- ☑ Multi-turn tracking
- ☑ Examples
- ☑ Loss maps
- ☑ Outlook

Scope

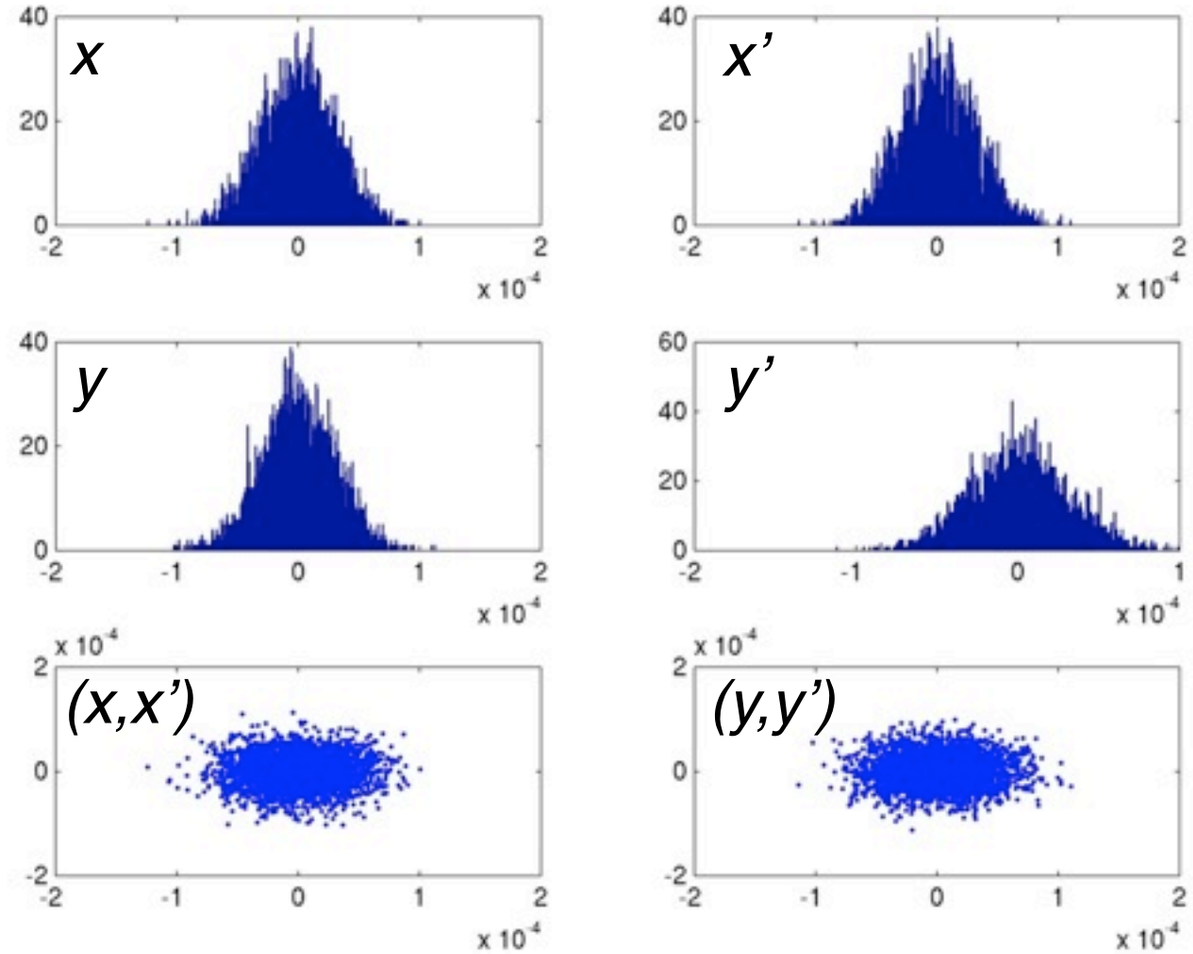
- We need tools to track the product of collisions around the ring
  - *Multi-turn tracking*
  - *Precise treatment of large off-momentum errors*
  - *Model the interaction with the collimators*
- Natural choice: SixTrack version for Collimation studies
  - *For the moment, different simulation setup to study the interaction of primary protons on the collimators of IR7/3*
- Need to setup tracking using external input distributions from IP1/2/5
  - *Done in the past (T. Weiler, F. Roncarolo, et al.) within different scopes*
- Today: only discuss proton simulations

Multi-turn tracking from IP1

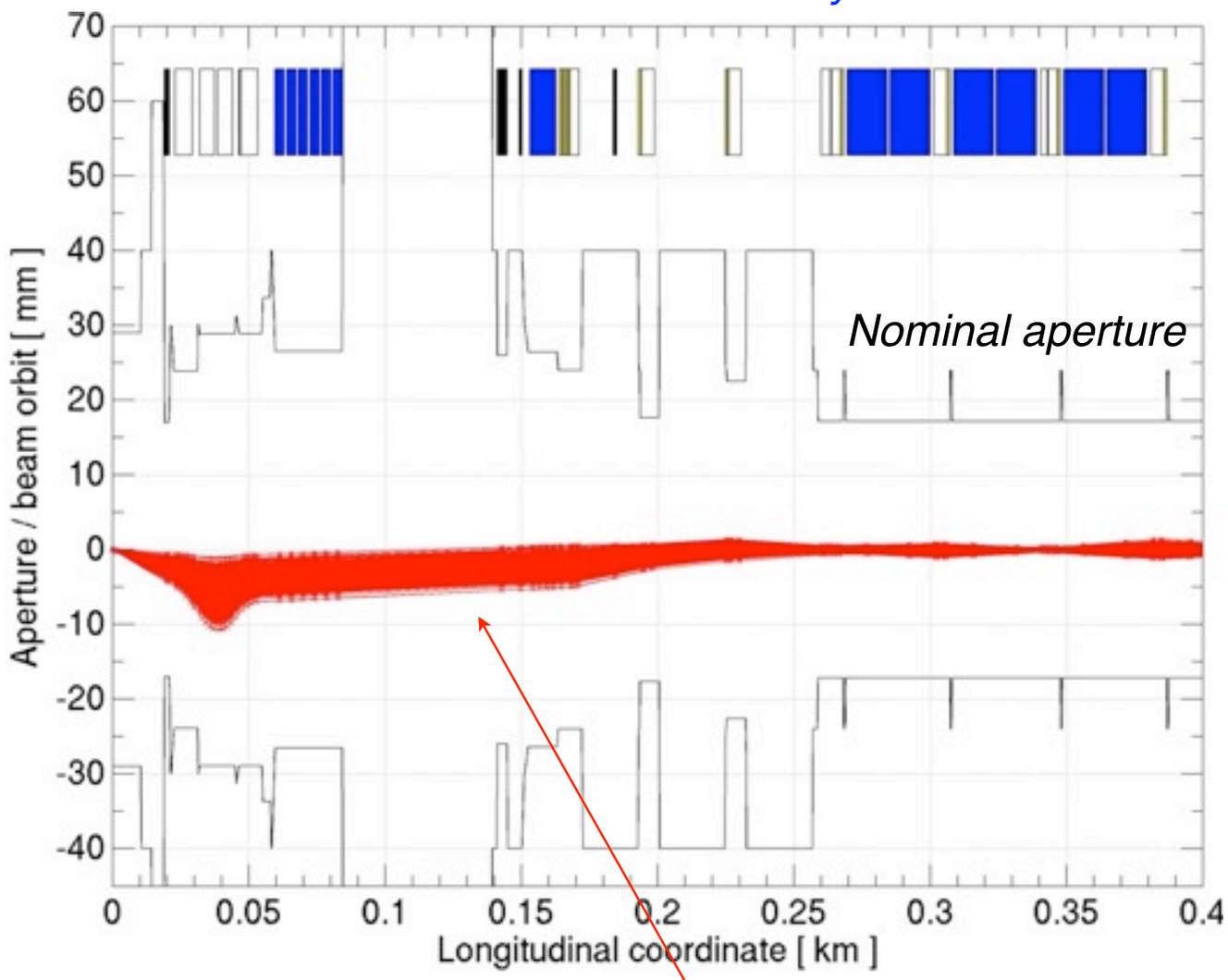
Example:
***start tracking in IP1**, 3.5 TeV (2011 config)*

Initial distributions generated off-line
Crossing and separation:
computed by SixTrack
Then, standard tracking with collimators

Input distributions in IP1

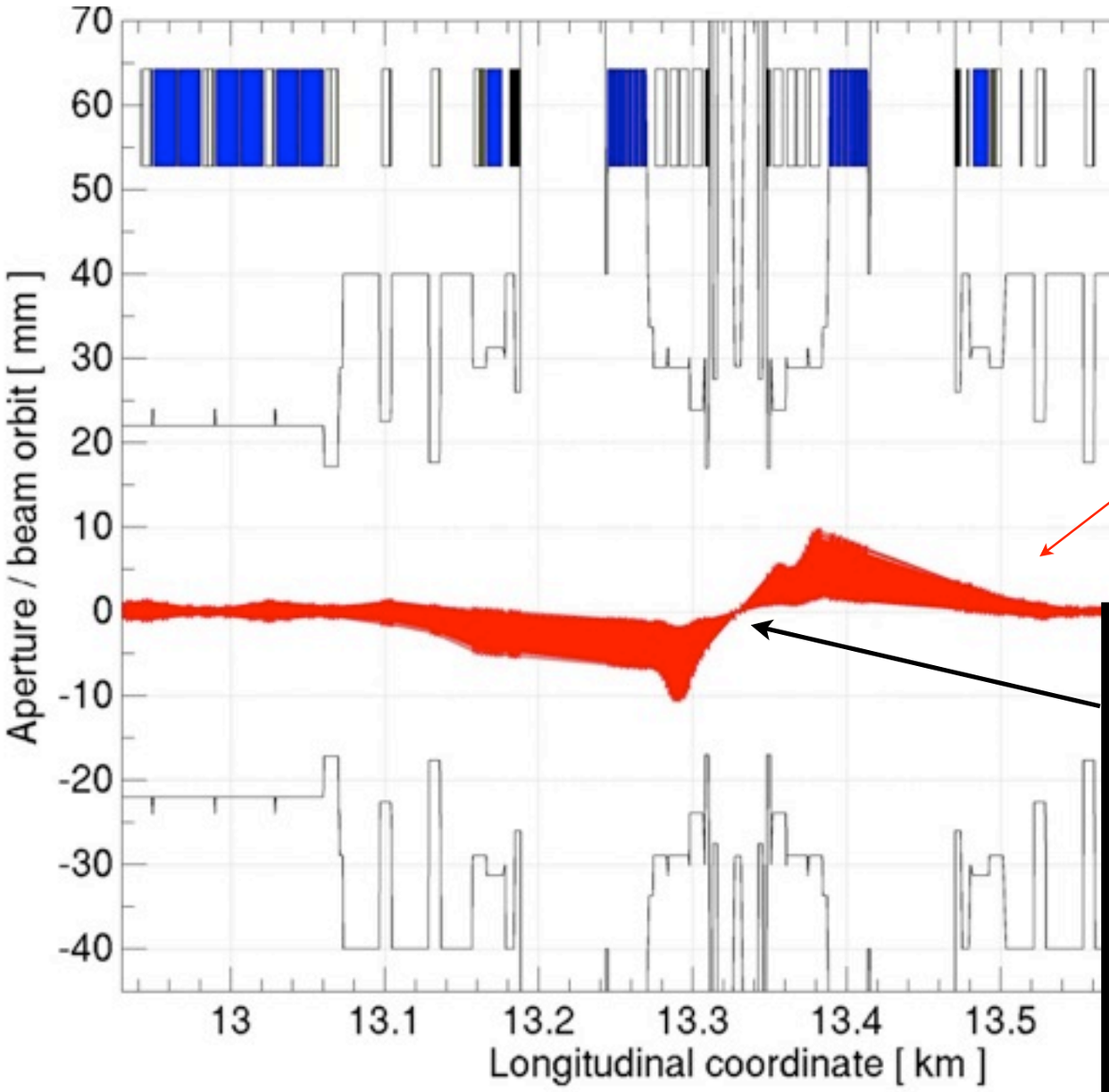


Layout elements



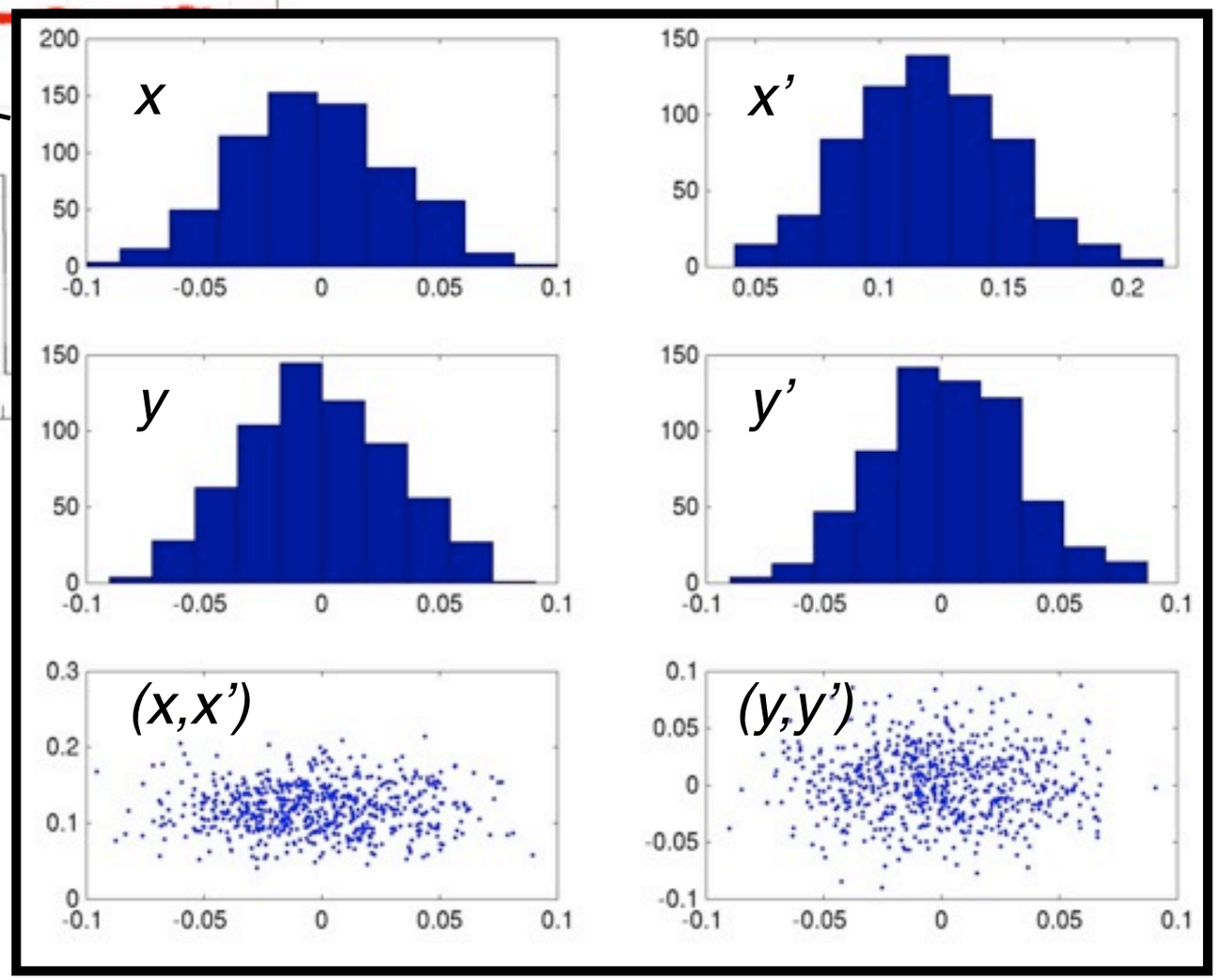
Nominal bunch, on-momentum,
640 trajectories
Shown: Vertical (crossing) plane

Example: tracking results



Trajectories in IP5

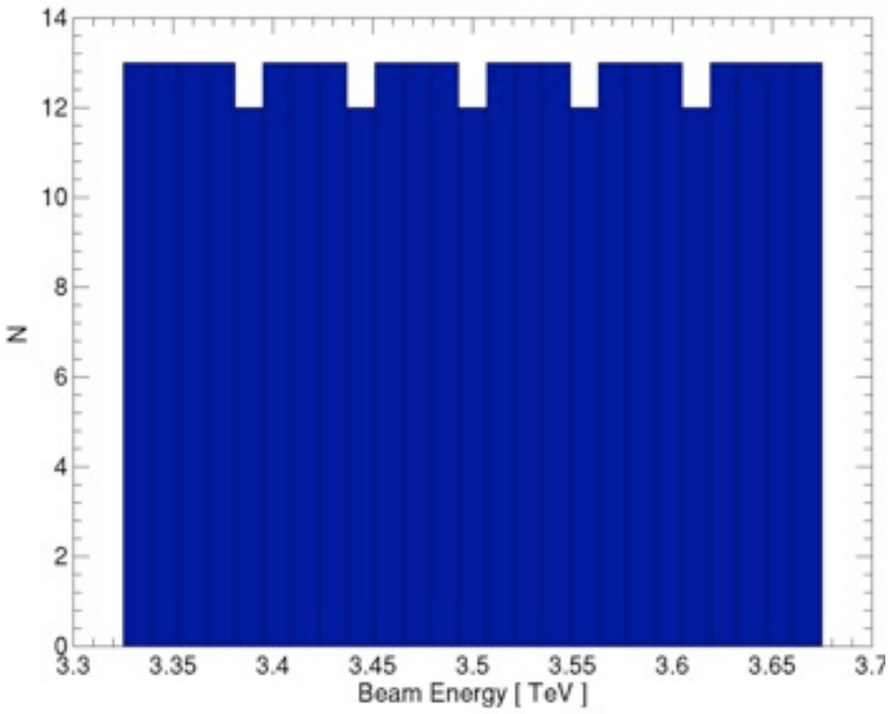
IP5 transverse distributions

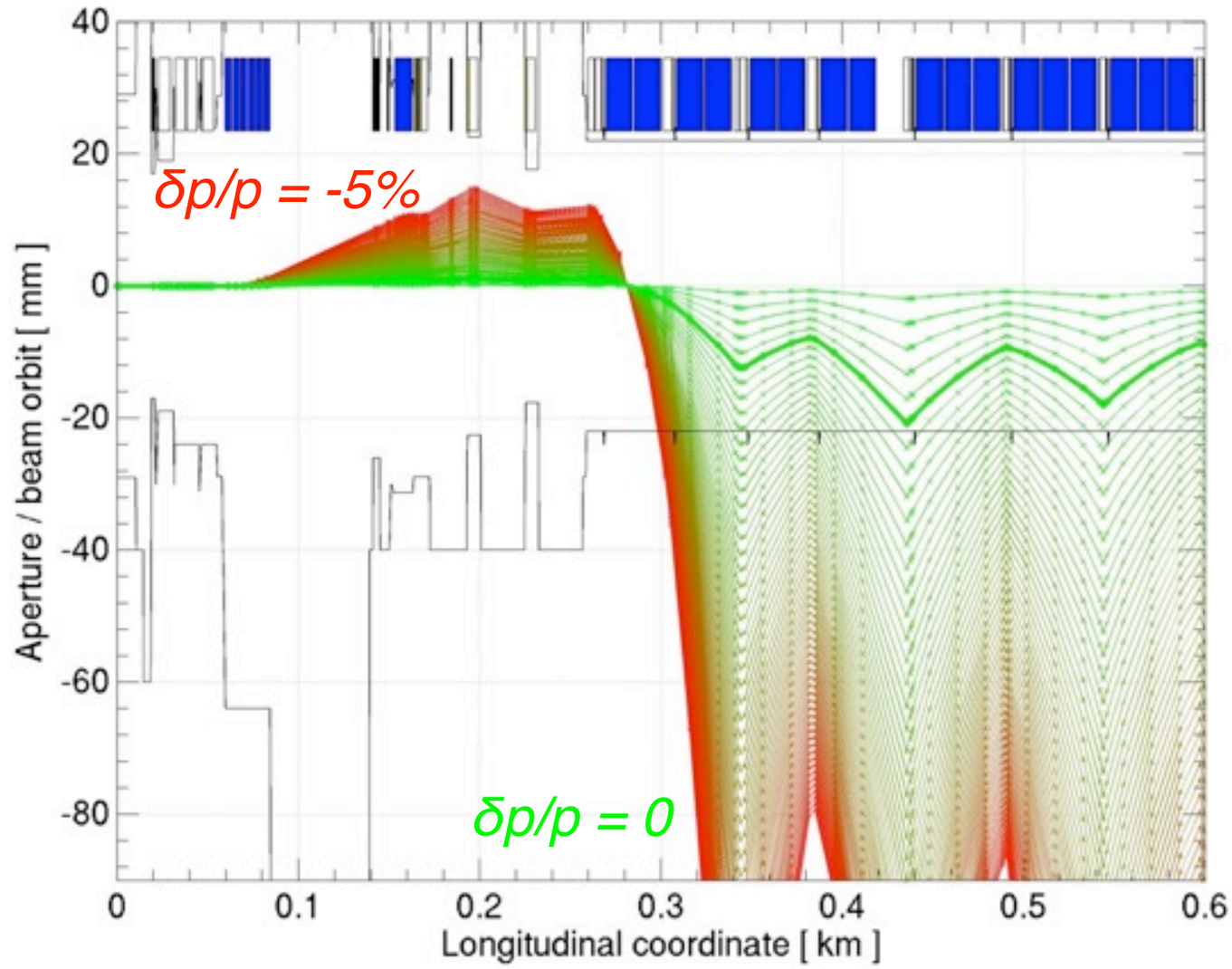


Developed tools to check distributions at various elements around the ring
→ will use them for particle distributions at the cryo-collimator locations

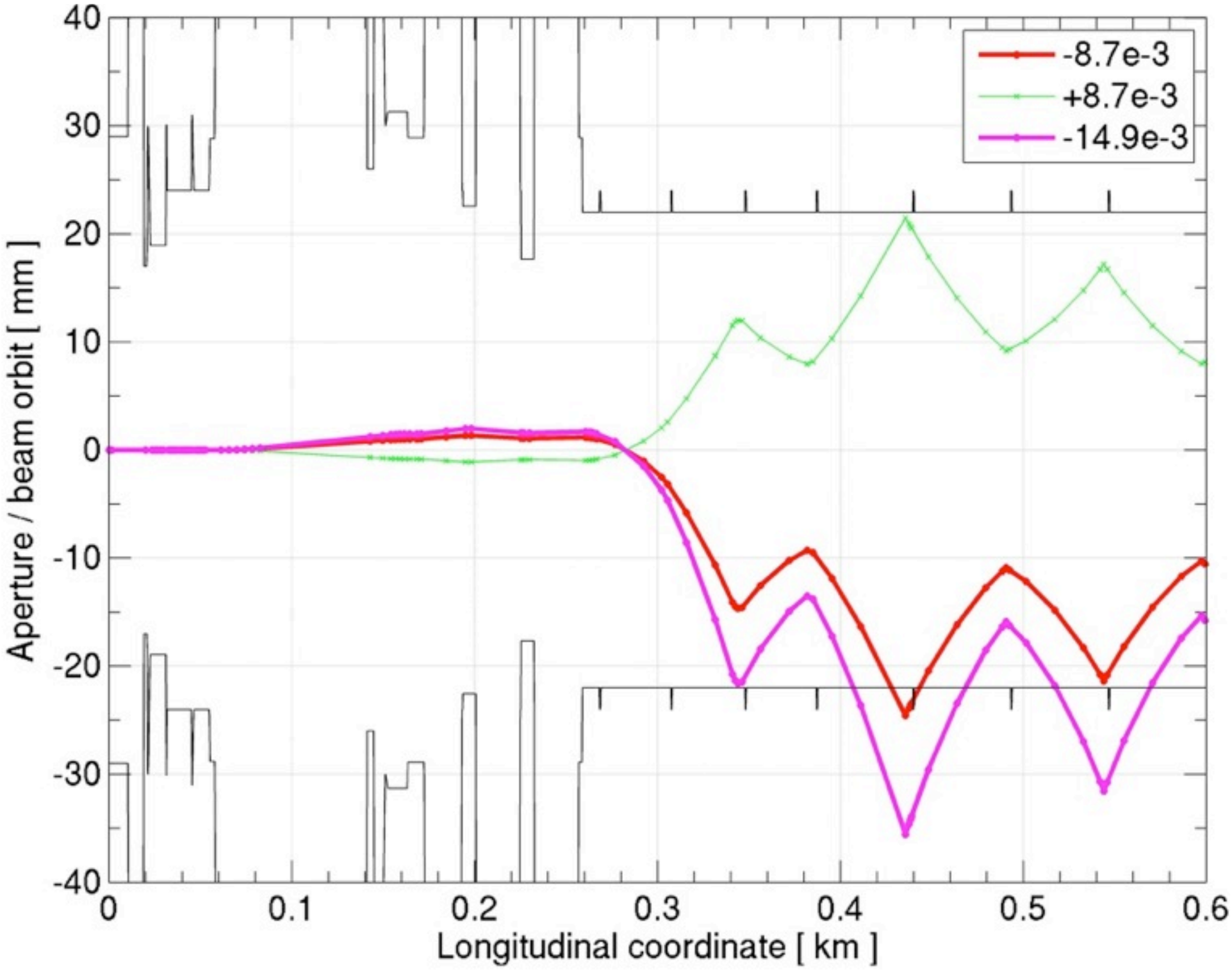
Tracking of off-momentum particles

Case study: flat distribution of δp/p, zero initial betatron amplitude at IP1

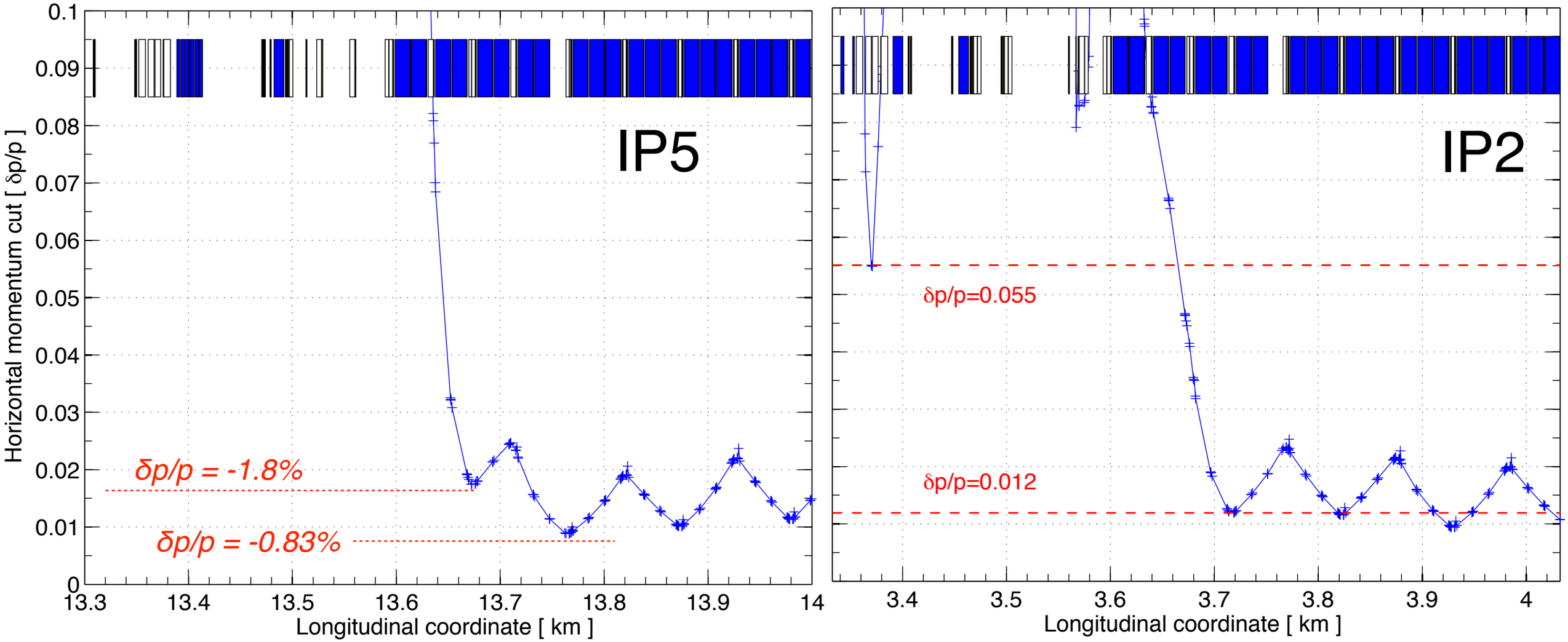




Acceptance for A_β=0



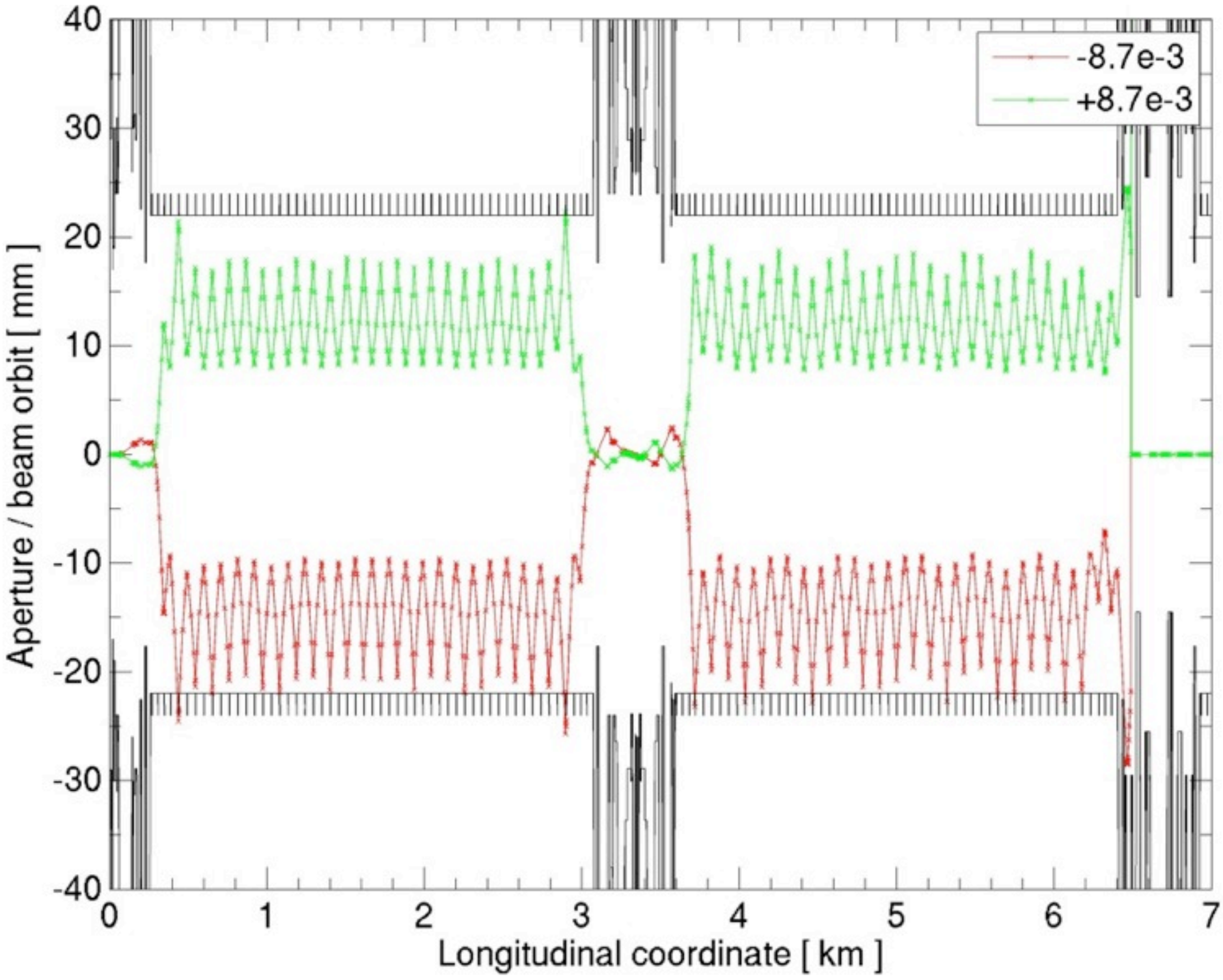
Analytical models



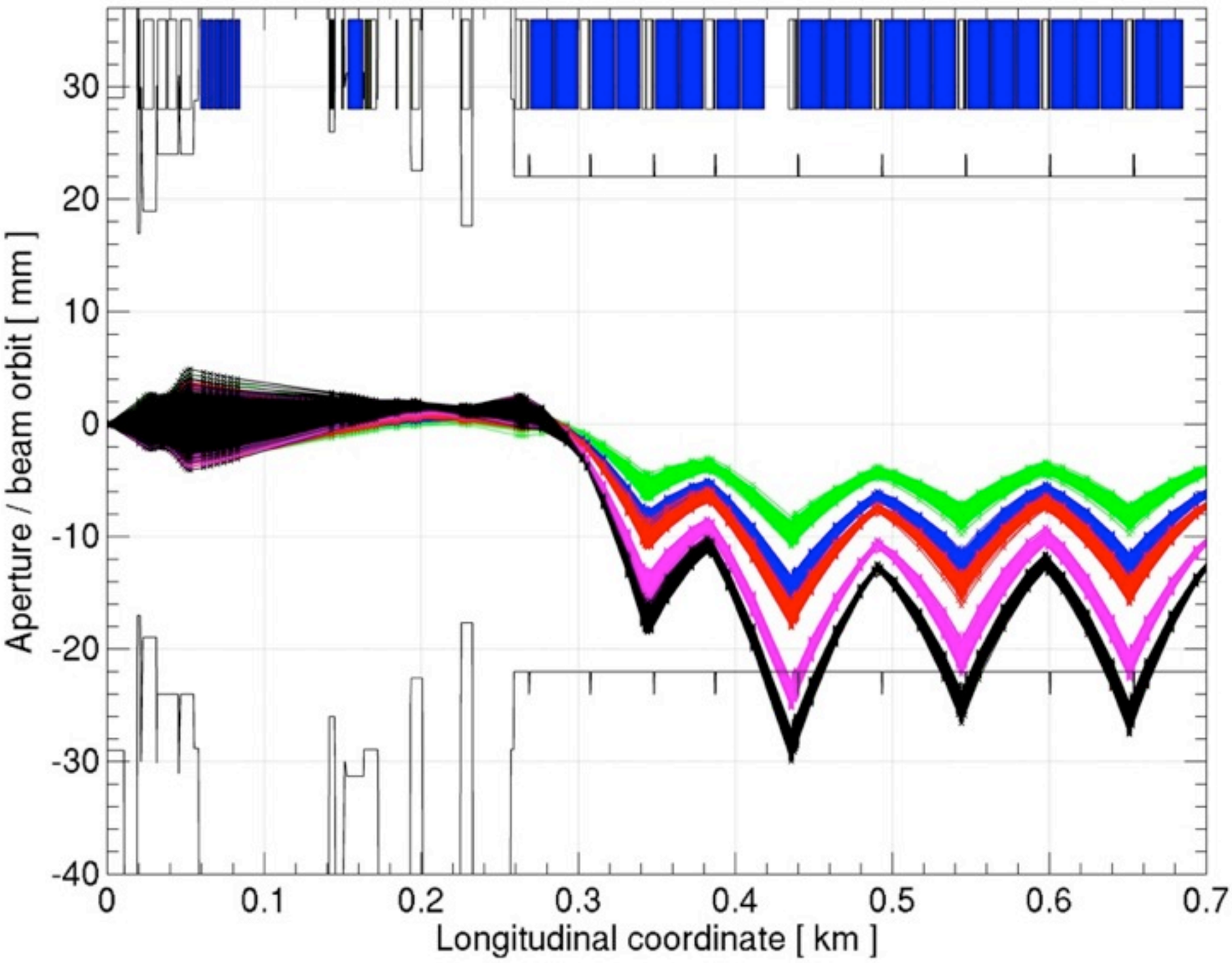
$$\left(\frac{\delta p}{p}\right)_{\mathrm{cut}} = \frac{A(s)/2 - \Delta_{\mathrm{CO}}(s)}{D_x(s)}$$

Approximated linear model

Following the particles around the ring...



More realistic IP distributions



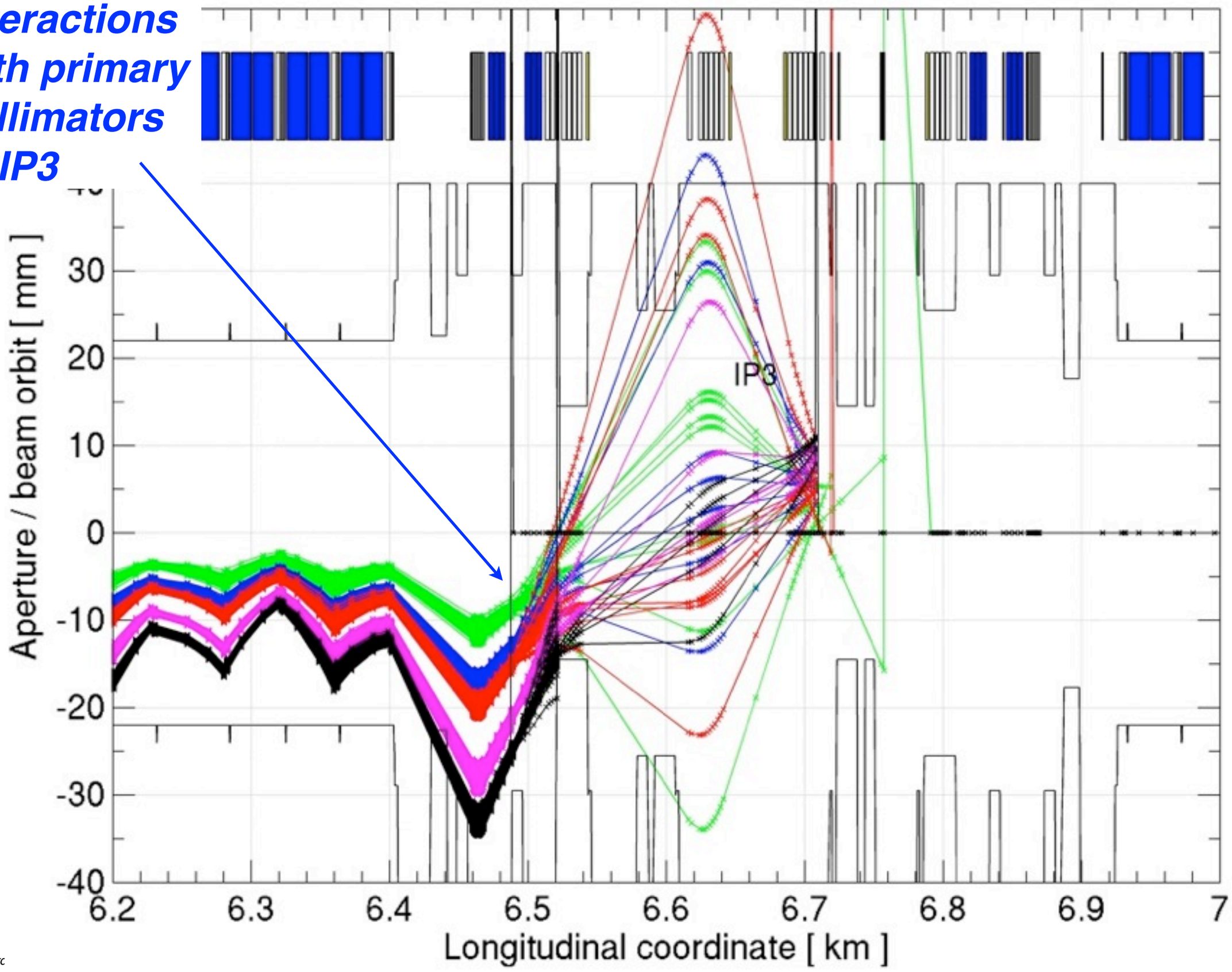
Real betatron distributions for different δp/p!
Color coding:

0.4 %
0.6 %
0.7 %
1.0 %
1.2 %

Momentum acceptance can be re-computed with the betatronic transverse distributions

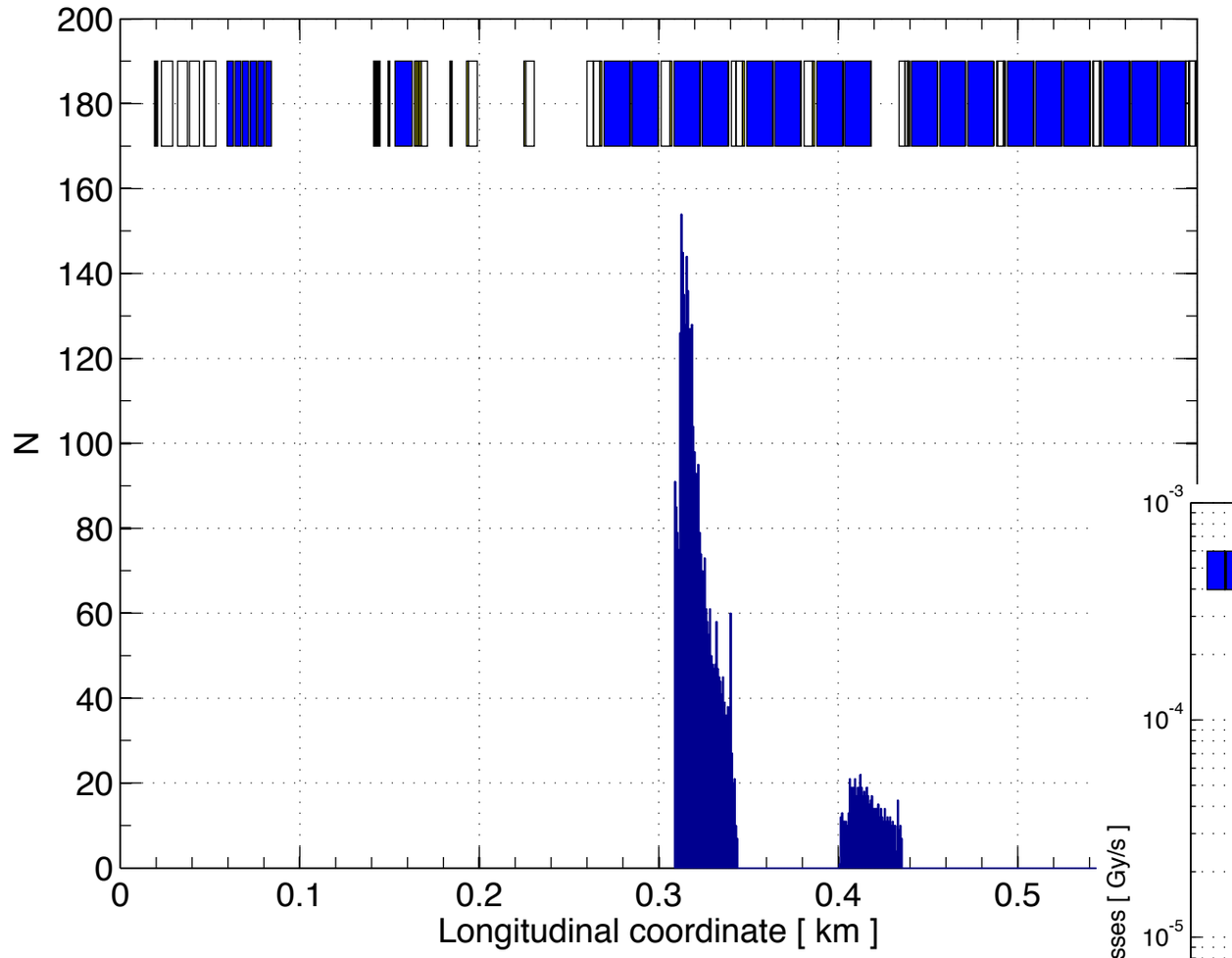
Tracking of off-momentum bunches

Interactions with primary collimators of IP3

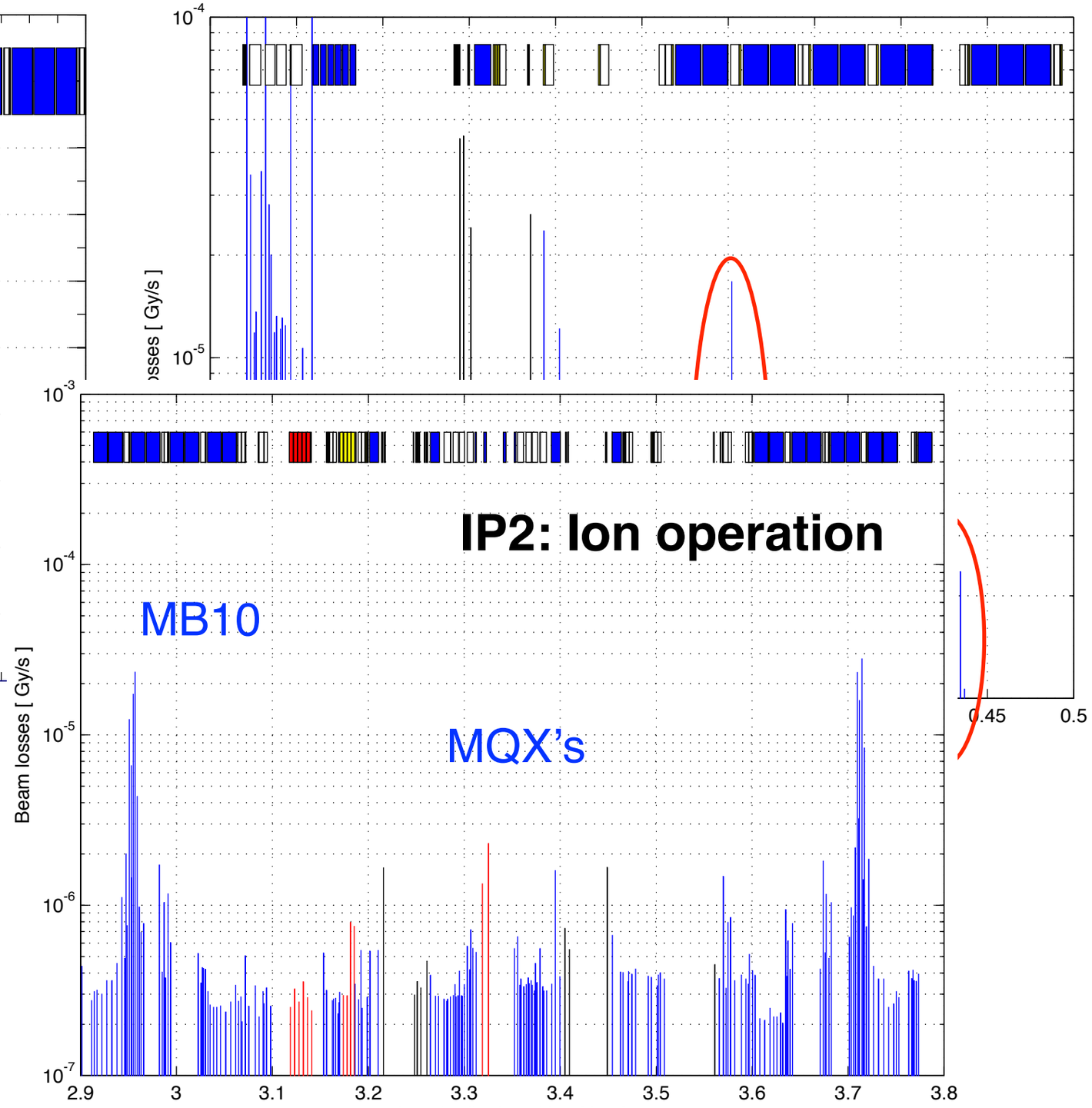


Example of loss maps from IR1

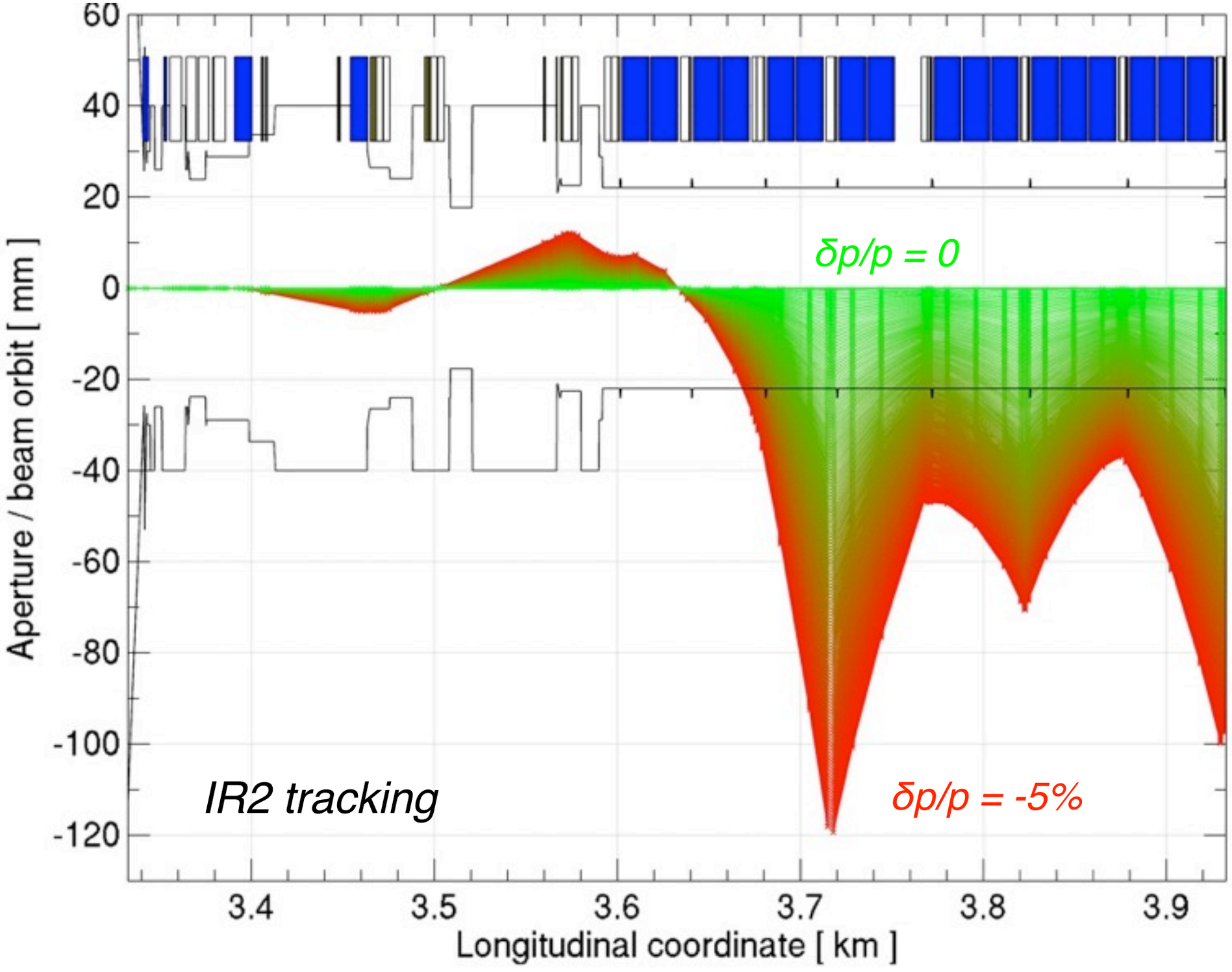
Example: zero A_β with δp/p cut at 5%



Measurements in physics (fill 2242)



A look at other IPs



Outlook

- Presented the status of tracking tools for single- and multi-turn losses of IR products
  - *SixTrack with collimation routines were prepared to study what leaks out of the IPS*
- Tools are ready to start detailed simulations!
  - *Tracking under control.*
  - *Can produce loss maps for present machine layout!*
  - *Still to improve and fully debug preliminary setup to start in different IPs*
  - *Comparison with analytical models to check dynamics of off-momentum particles*
- Need realistic particle distributions from the p-p collisions!
  - *See previous talk by Francesco*
- **What comes next:**
  - *Simulations with real distributions from FLUKA*
  - *Comparison with 2011 data at 3.5 TeV*
  - *Study dependence on beam and machine configurations (Xing) to define a solid layout for DS collimators*