Beam loss studies of the PS CT Extraction

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Acknowledgements

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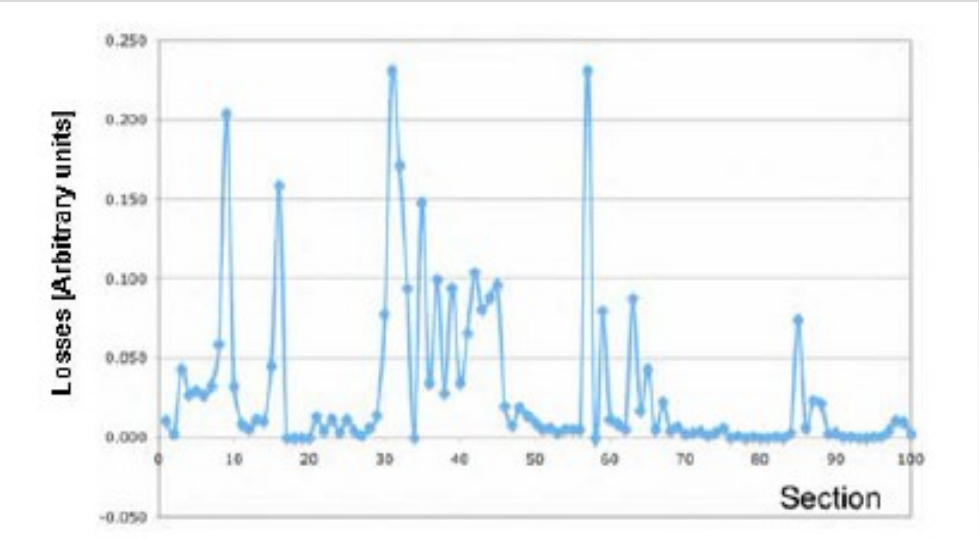
Outline

- Review of previous work
- Code upgrade
- New Simulations & Results
- Considerations
- Future steps

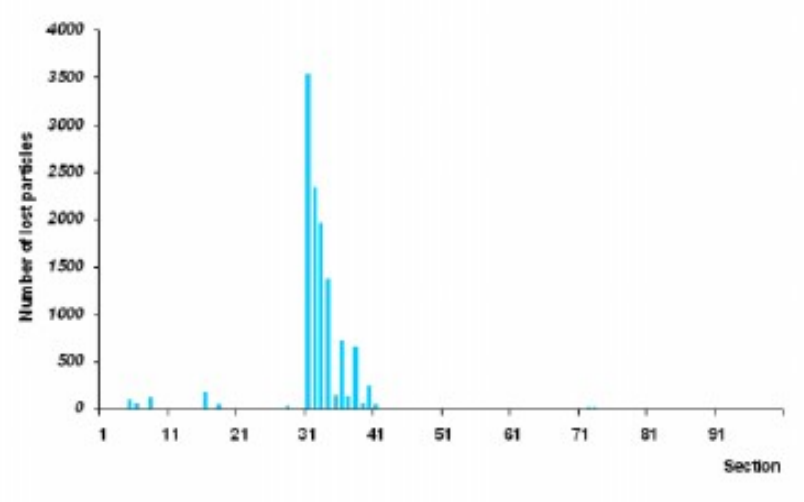
Review of previous work

- *The ultimate goal was to have **robust tools for beam loss studies in low energy synchrotrons** and use them for the design of the collimation system in the new PS2 machine.*
- *Simulations tools are the ones used for Collimation studies in LHC.*
- *Tools benchmarking with PS CT Extraction losses.*
- ***Procedure:** A bunch of particles is tracked through a thin lens lattice (generated by MADX), undergo scattering processes in the collimator (K2) and, finally loss locations are determined by means of an external program and the aperture model.*
  - *Thin lens model: High-order terms of edge-effects are not symplectic in thin lens. Thin multipoles were included and tune and chromaticity matching were performed*
  - *K2: Scattering processes revised for low energies. Molybdenum included in the list of materials.*

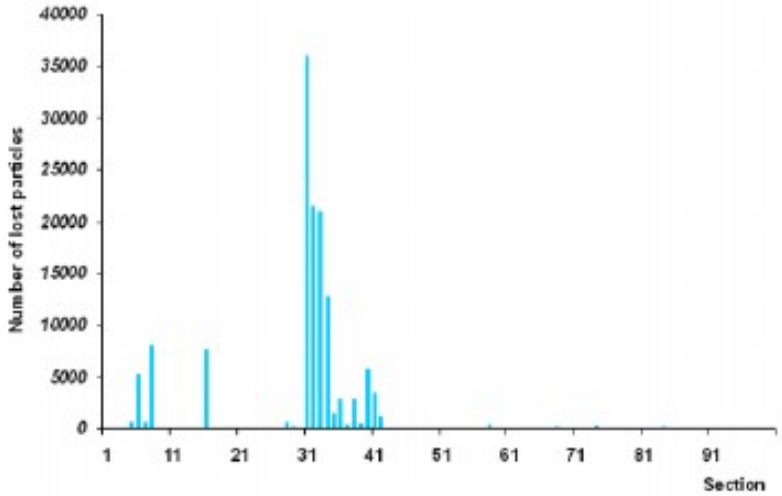
Review of previous work



PS CT Beam Losses measure during 2006



Results External Distribution (MARS)



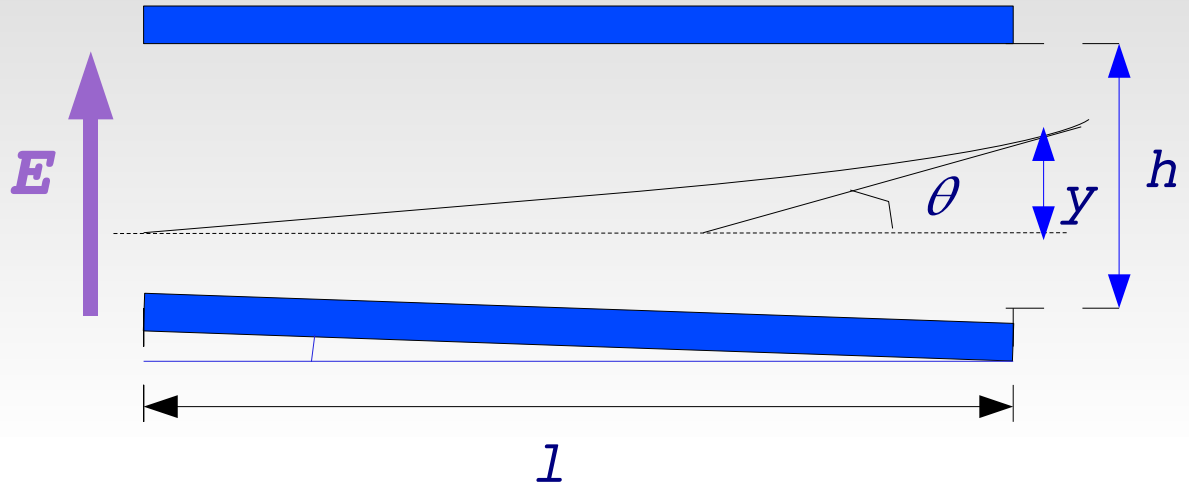
Results Sixtrack Distribution

Code upgrade

- *Previously the septum was modeled as a collimator: 1)Infinite towards outside – septum 0.1mm and 2)Passive element - no kick included.*
- *Only particles hitting the collimator were tracked. But due to bumped closed orbit not only scattered particles are lost.*
- *Scattering processes are randomly but absorption is the most probable one (¾ out of 1).*
- *Halo generator allows to create a distribution in only one the planes + 1 sigma in the other + longitudinal coordinates. (Collimation studies either in horizontal o vertical plane)*
- *So in order to improve the simulations:*
  - *Code modified to track **ALL** particles.*
  - *Halo generator modified to allow definition in **both** planes.*
  - *Inclusion of a Septum-like element (see next slide).*

Code upgrade

- *The septum can be modeled as follows:*



- *Angle and offset in our case:*

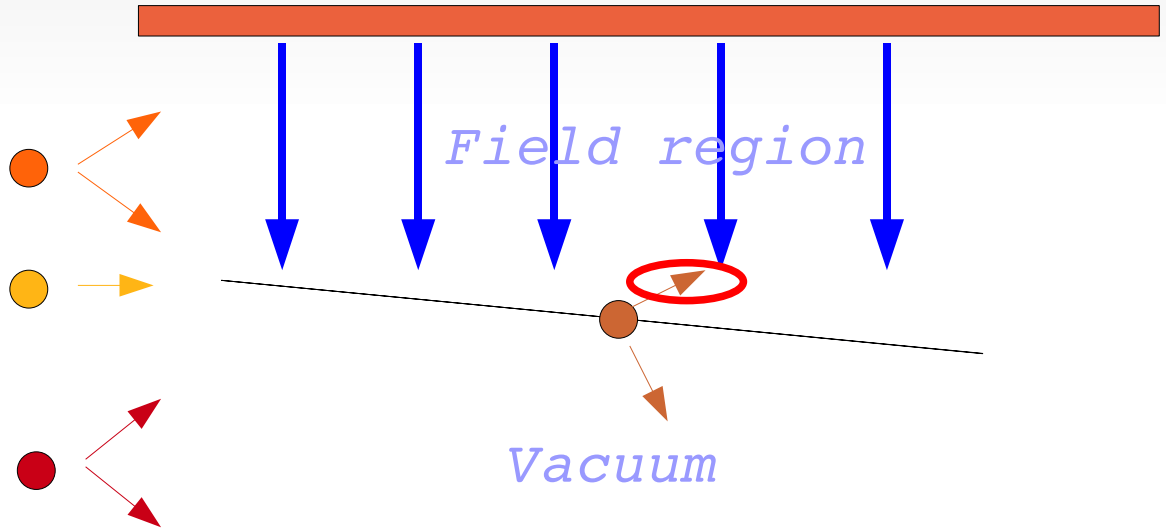
$$\theta = \arctan\left(\frac{E_0 \cdot l}{p \cdot \beta}\right) = \arctan\left(\frac{V \cdot l}{h \cdot p \cdot \beta}\right) = \arctan\left(\frac{170 \cdot 10^3 \cdot 1.85}{0.027 \cdot 14 \cdot 10^9 \cdot 0.9955}\right) = 0.00083 rad$$

$$y = \frac{E_0 \cdot l^2}{2 \cdot p \cdot \beta} = \frac{V \cdot l^2}{2 \cdot h \cdot p \cdot \beta} = \frac{170 \cdot 10^3 \cdot 1.85^2}{2 \cdot 0.027 \cdot 14 \cdot 10^9 \cdot 0.9955} = 0.00077309 m$$

- *Setpum angle (2003): -0.216 mrad. Depending on Operation*

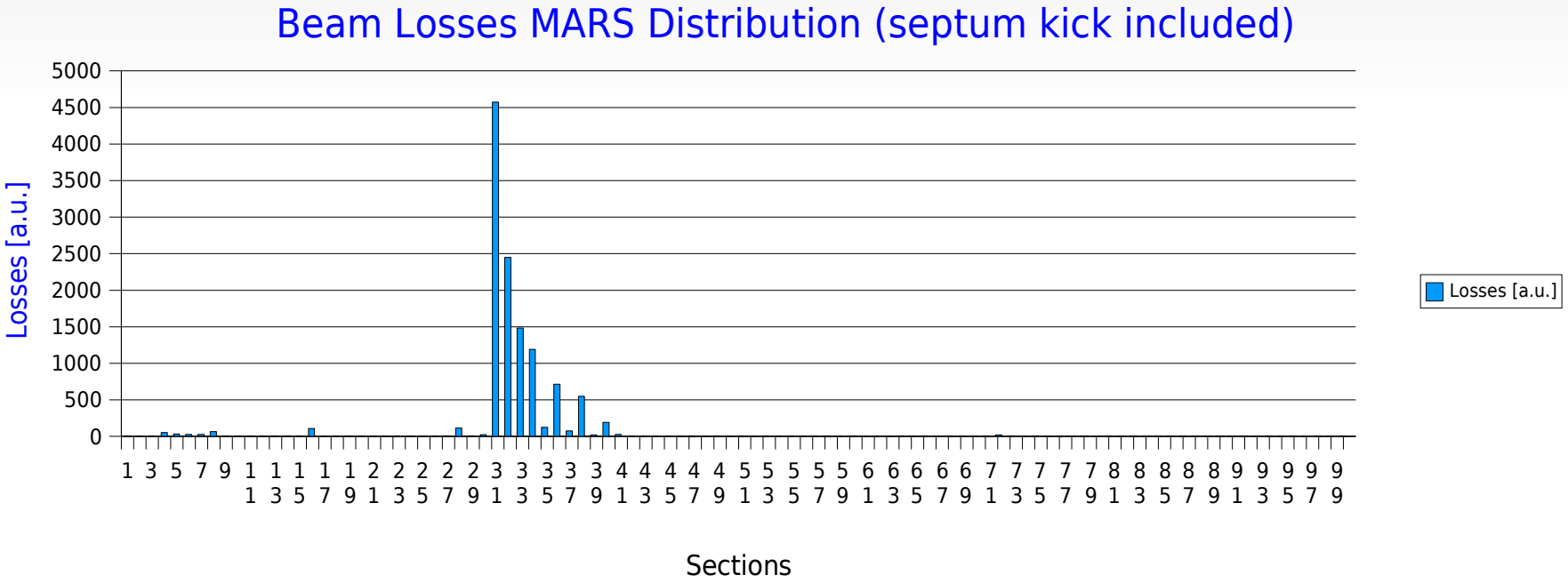
Code upgrade

- *In the code when a particle goes above the septum receives a kick and eventually can go into the septum.*
- *Still the multiple Coulomb scattering has to be modified in order to include the effect of the outer edge of the septum.*



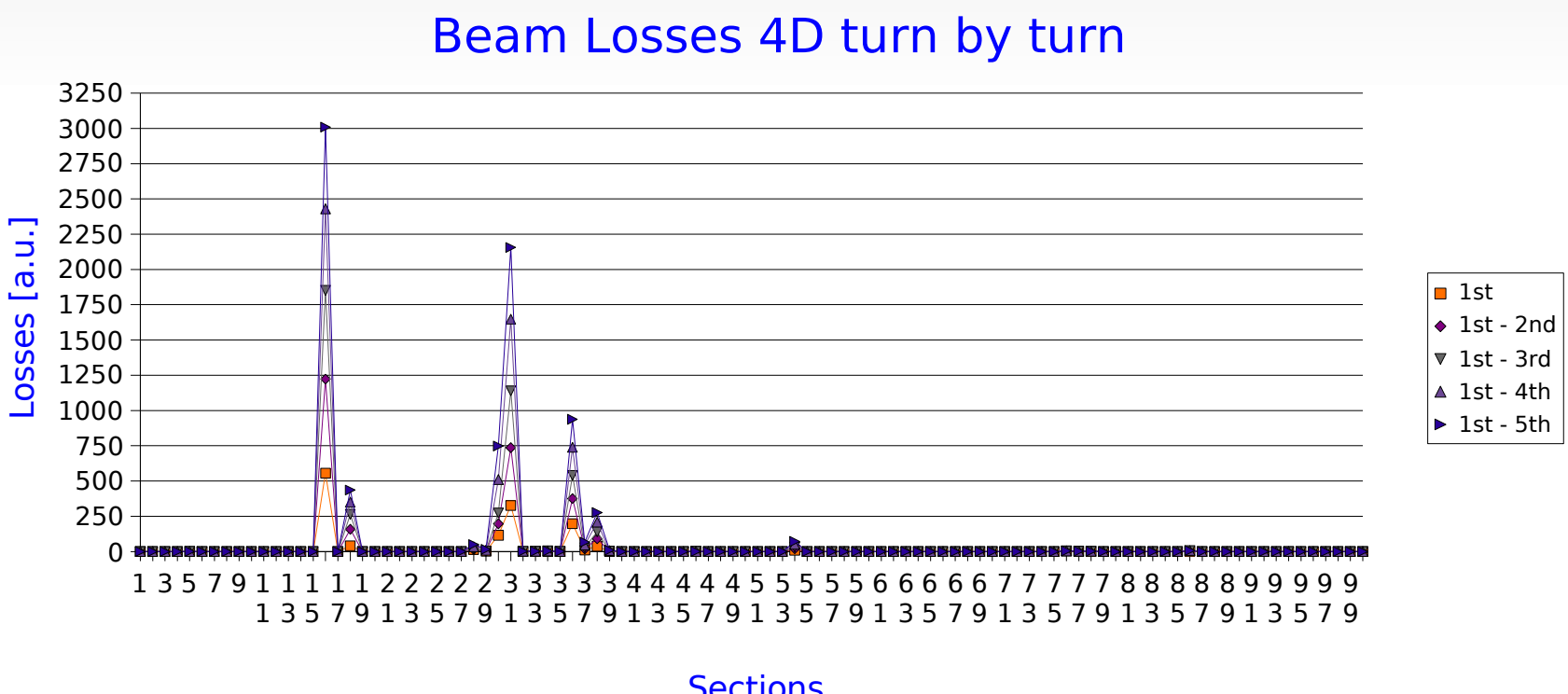
New Simulations & Results

- *A kick of 0.83mrad was added to all particles to simulate the effect of the setpum.*
- *No major differences are observed with respect to previous results.*

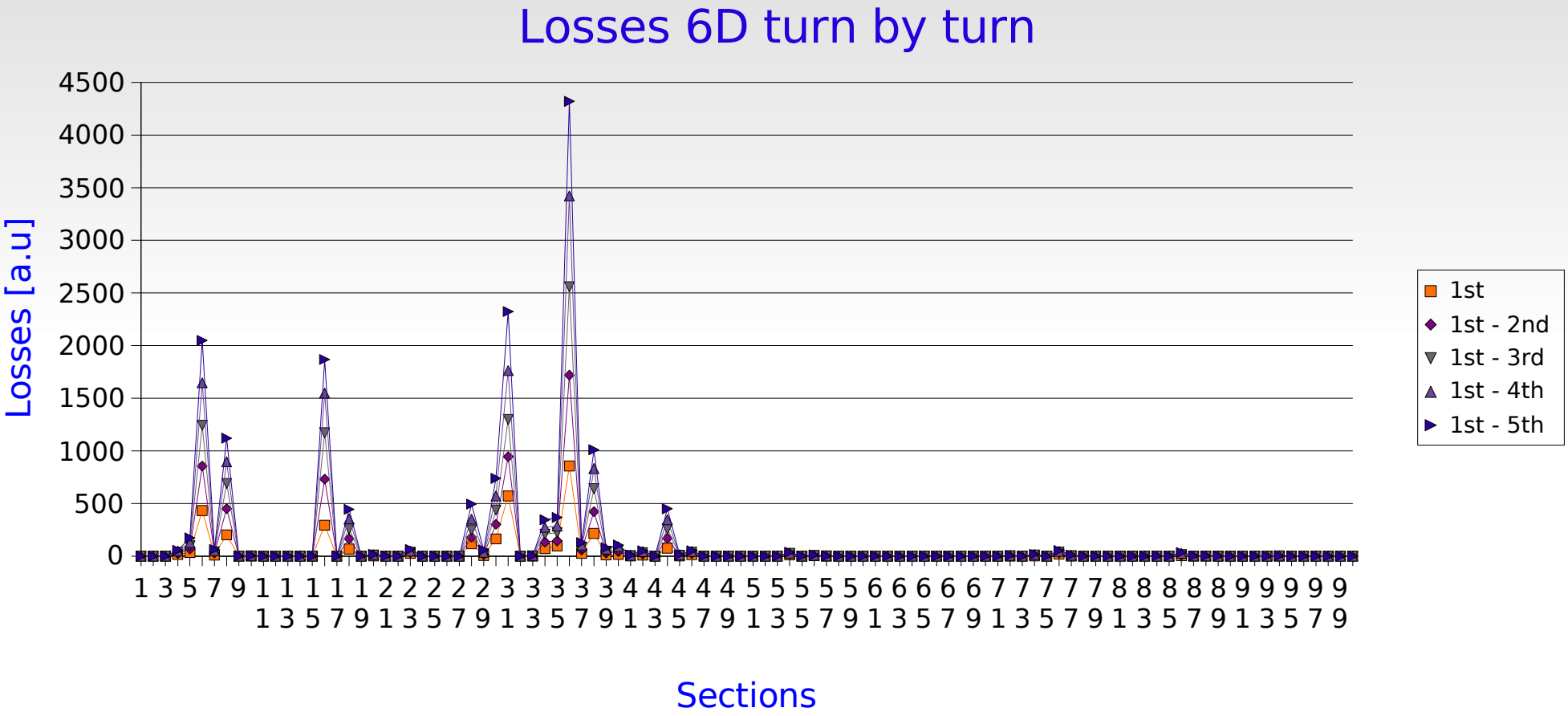


New Simulations & Results

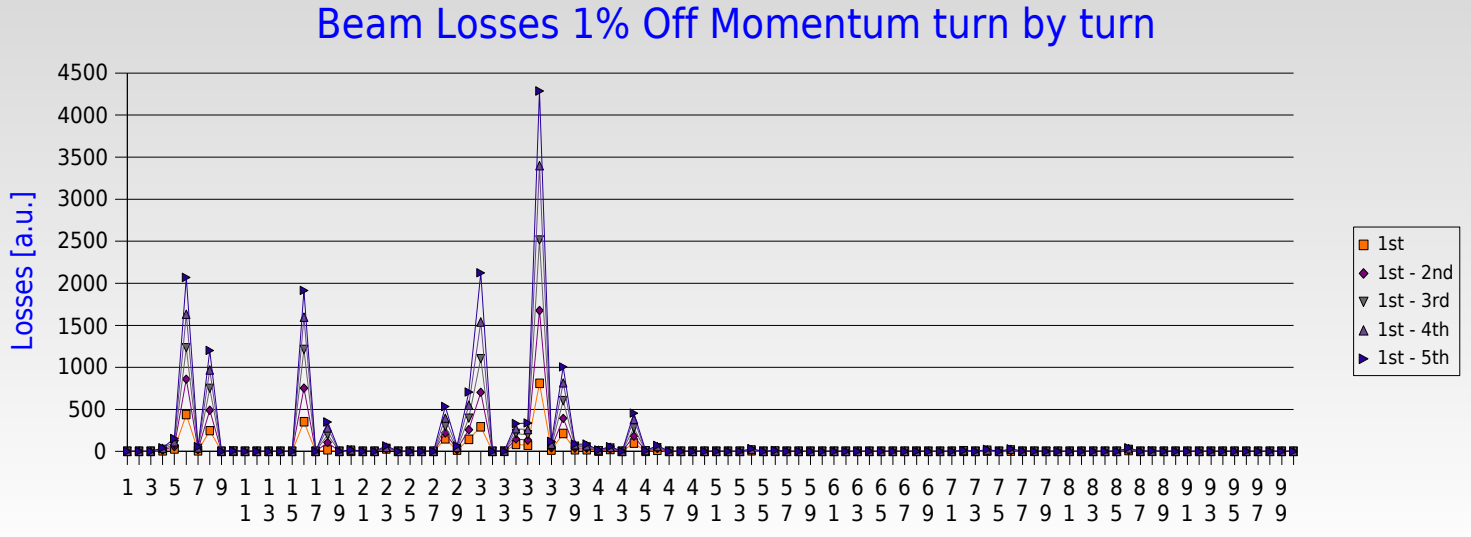
- *Next simulations include:*
  - *Different optics for each turn in CT Extraction.*
  - *Septum element.*
  - *Aperture model with no restriction in Septum location.*
  - *Tracking of all particles*

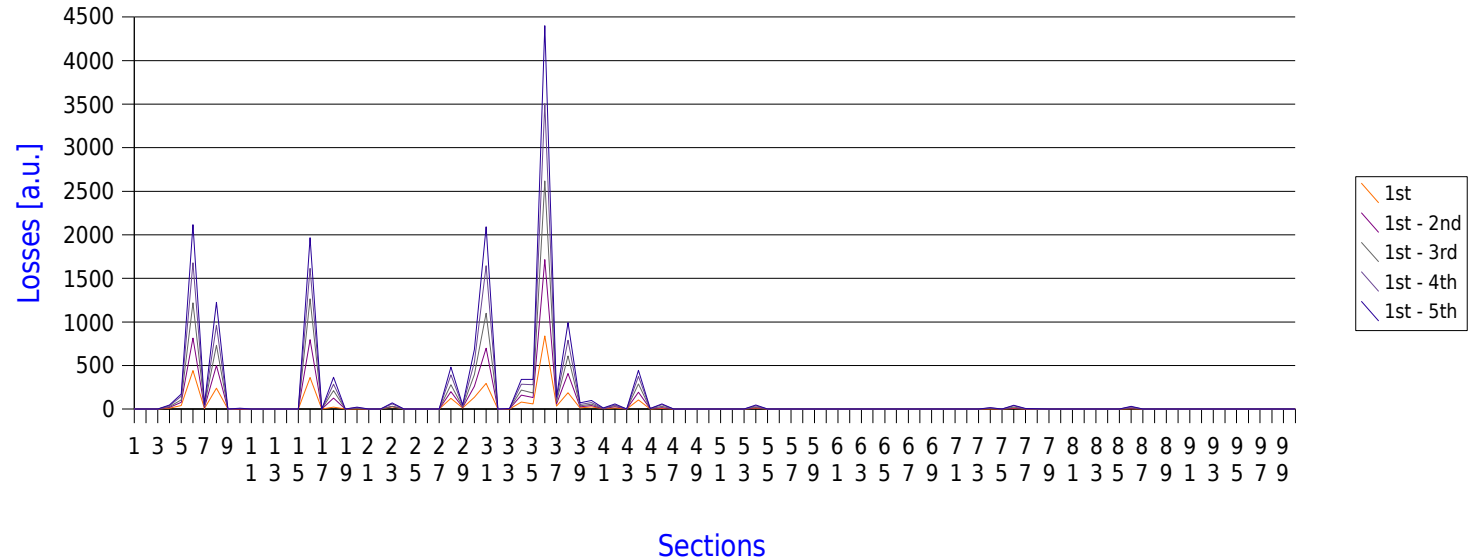


New Simulations & Results



New Simulations & Results





New Simulations & Results

- *New simulations show great improvement from the quantitative point of view. Losses in the septum are comparable with losses in other locations.*
- *New configuration with slim septum allows particle balance the ratio of losses along the ring.*
- *Still losses in SS9 do not appear.*
- *Results show good agreement with Simone's studies (APC meetings 06/10/2006 & 08/12/2006) and measurements.*

Considerations

Main consideration to be taken into account in the simulations.

- *K2 simulates only scattering processes (angle deflection, energy loss), but never the particle shower may produced. Others codes should be used for that purpose.*
- *Beam Loss Monitors measure mainly secondary particles at certain locations.*
- *Values for Pole Face Windings should be checked.*
- *The closed orbit used for tracking is an ideal and not the measured one.*

Future steps

- *Replace the actual halo generator with a proper beam generator (Gaussian distribution).*
  - *Include the aperture comparison inside the code to reduce computation time.*
- *Modification of the Multiple Coulomb Scattering step calculation algorithm in order to include the edges of both sides of the septum.*
- *Check the misalignments of the vacuum chamber in loss locations (With the help of the Survey group).*
- *Shower simulation is certain loss locations.*