Propagate beam halo

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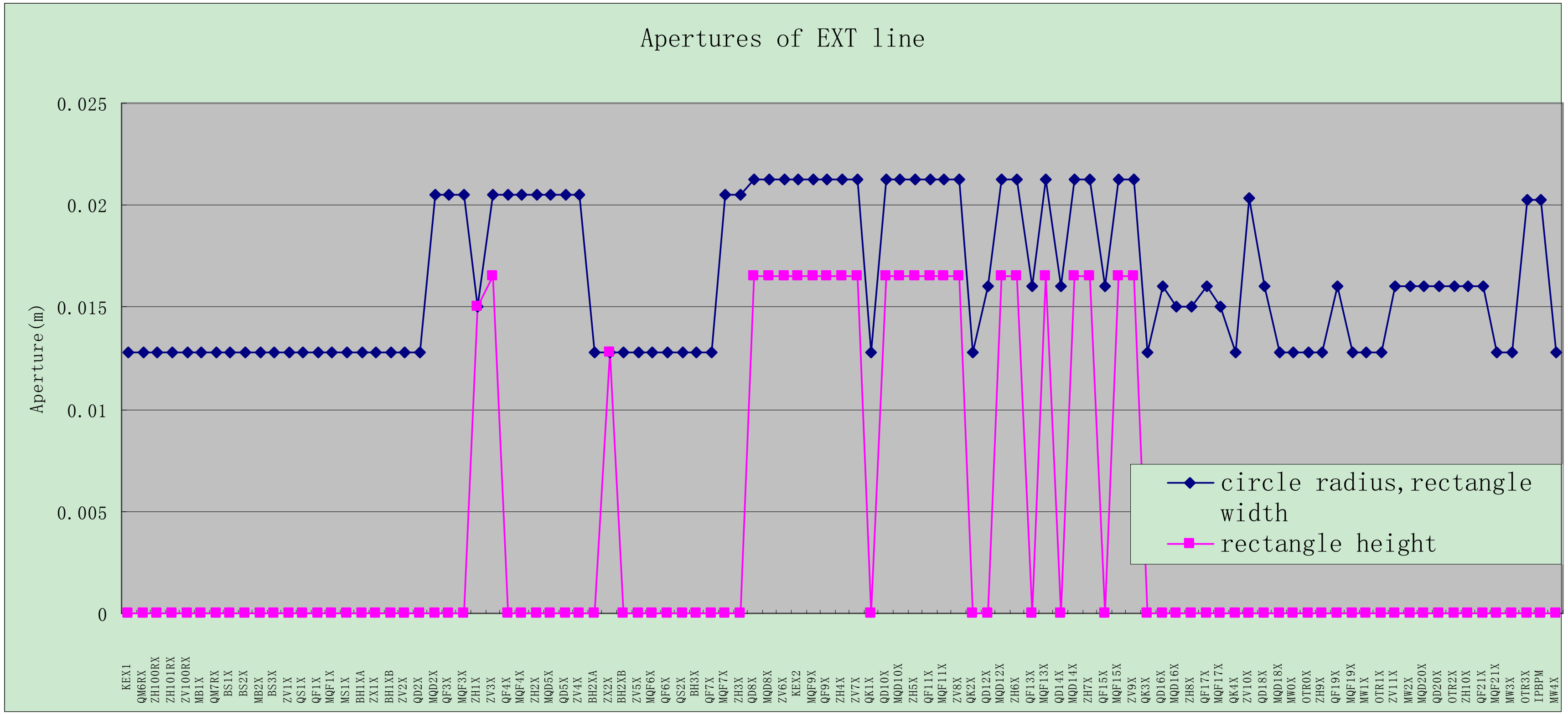
Motivation

- Beam halo is a major issue for IR backgrounds at many colliders, also an important problem at ATF2.
- Halo propagation along ATF2 with realistic apertures, a difficult task to get reliable results, but at least some dependancies can be looked at…
- It will be useful both to understand backgrounds in the BSM, to understand future aperture requirements for any upgrades (e.g. ultralow beta new FD quads…)and also for the planned halo / Compton recoil measurement program.

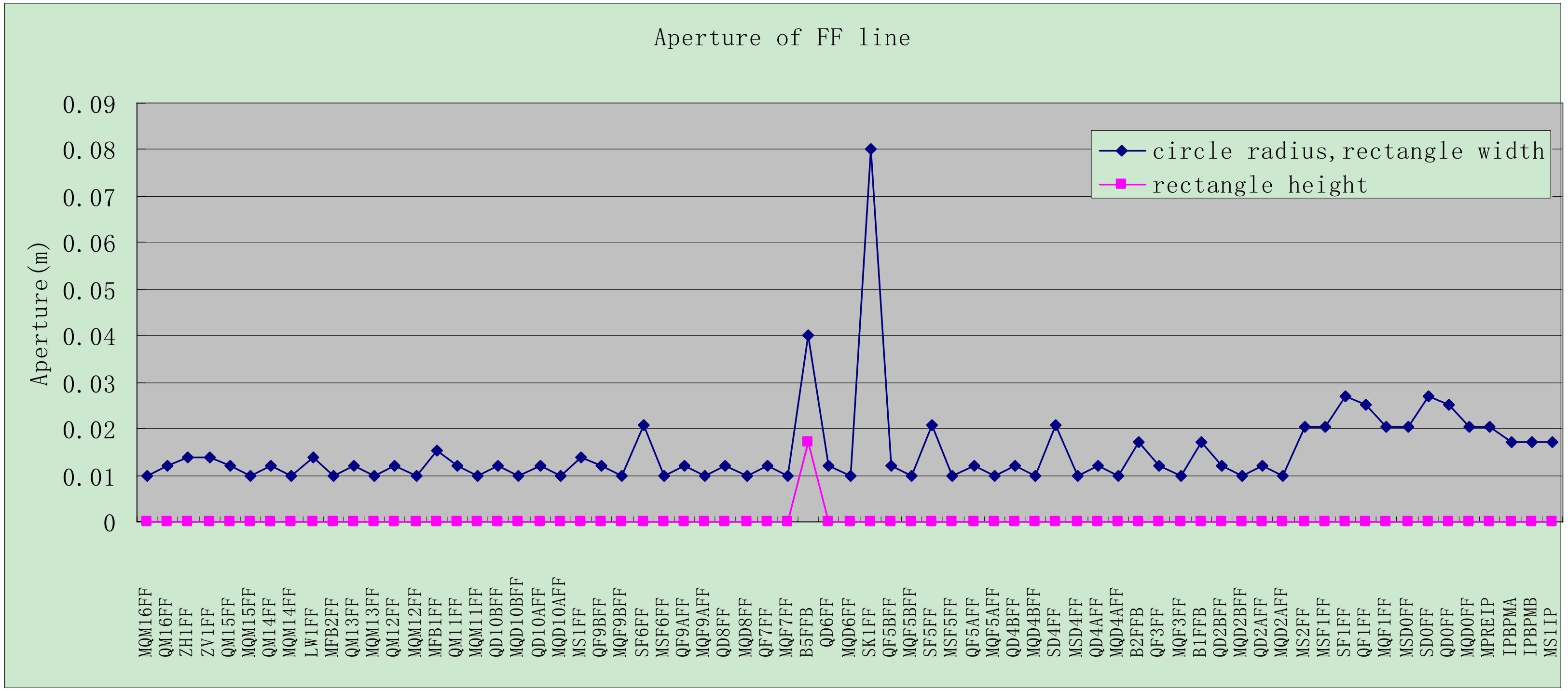
Outline

- Measured apertures of magnets, BPMs, beam pipes….along ATF2 beam line
- Halo generator
- Halo particles transmitted at the tightest C-band BPMs
- Non-linear optics influence on the increasing number of halo particles input
- Transmitted halo particles distribution just before the last BPM, influence of the compton recoil electrons measurement
- Conclusions and prospects

Apertures at ATF2 beam line (EXT)



Apertures at ATF2 beam line (FF)



- The tightest apertures are C-band BPMs attached to each quad and sextupole in the FFS, with only 0.01m radius, while in the FD it is wider S-band BPMs, and maybe the source of the background today…

Halo generator

- Same x, y positions as beam particles at the IP, but with different x’ and y’ angles*

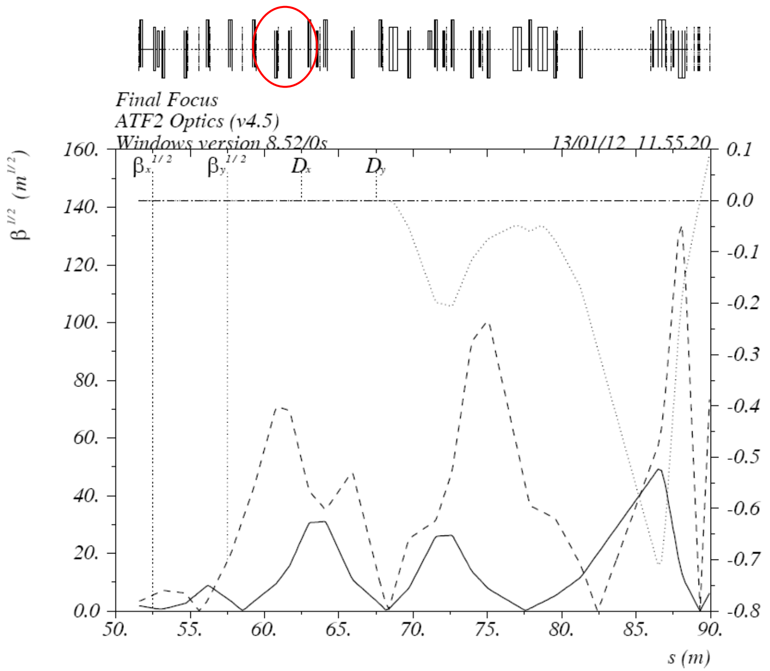
$$\rho_{h1} = 2.2 \times 10^{9} \times x^{-3.5}$$ (horizontal and vertical until 6 σ)

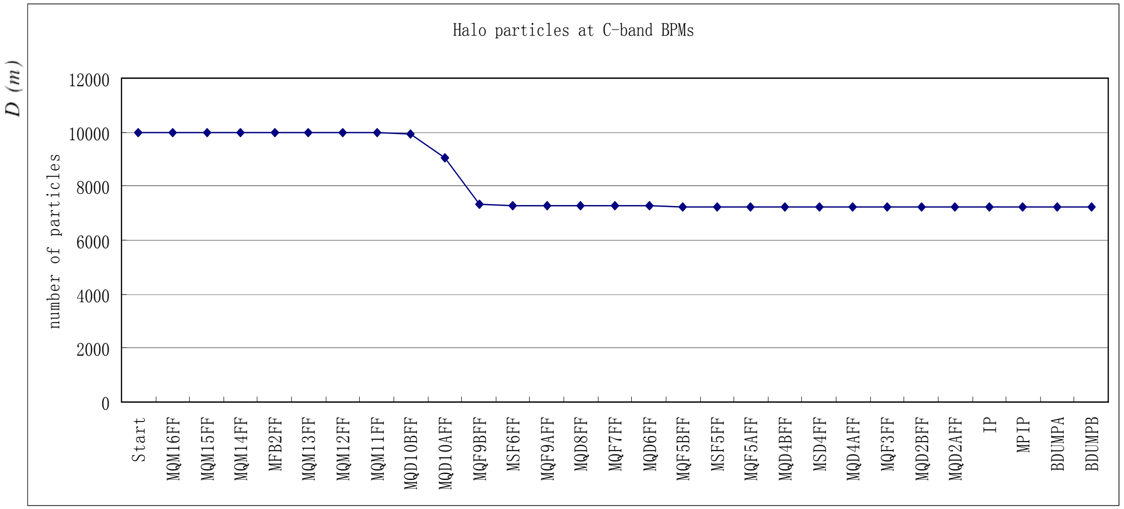
$$\rho_{h2} = 3.7 \times 10^{8} \times x^{-2.5}$$ (vertical outside 6 σ)

- the results are obtained for BX2.5BY1 optics
- The initial halo from the DR is assumed to be the same with the core beam.

* From T.Suehara, Design of a nanometer beam size monitor for ATF2

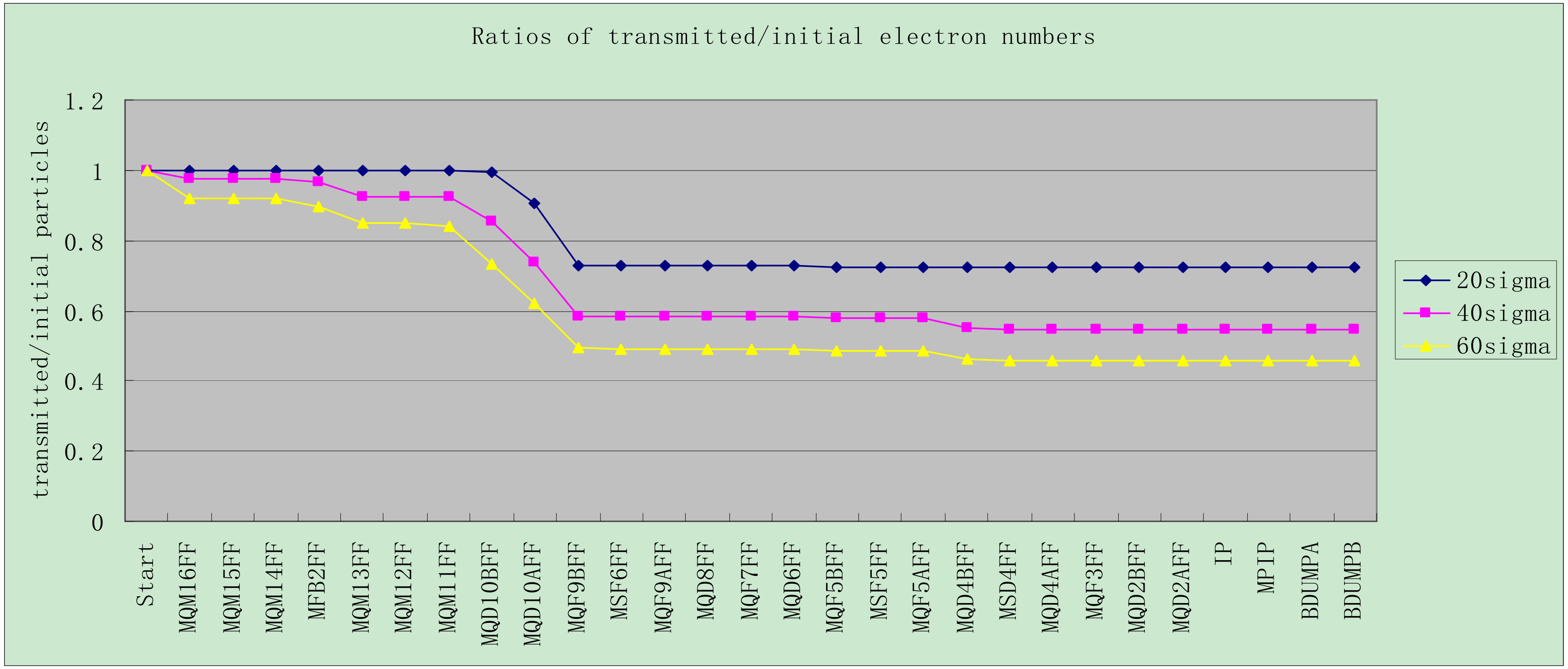
Halo particles at C-band BPMs





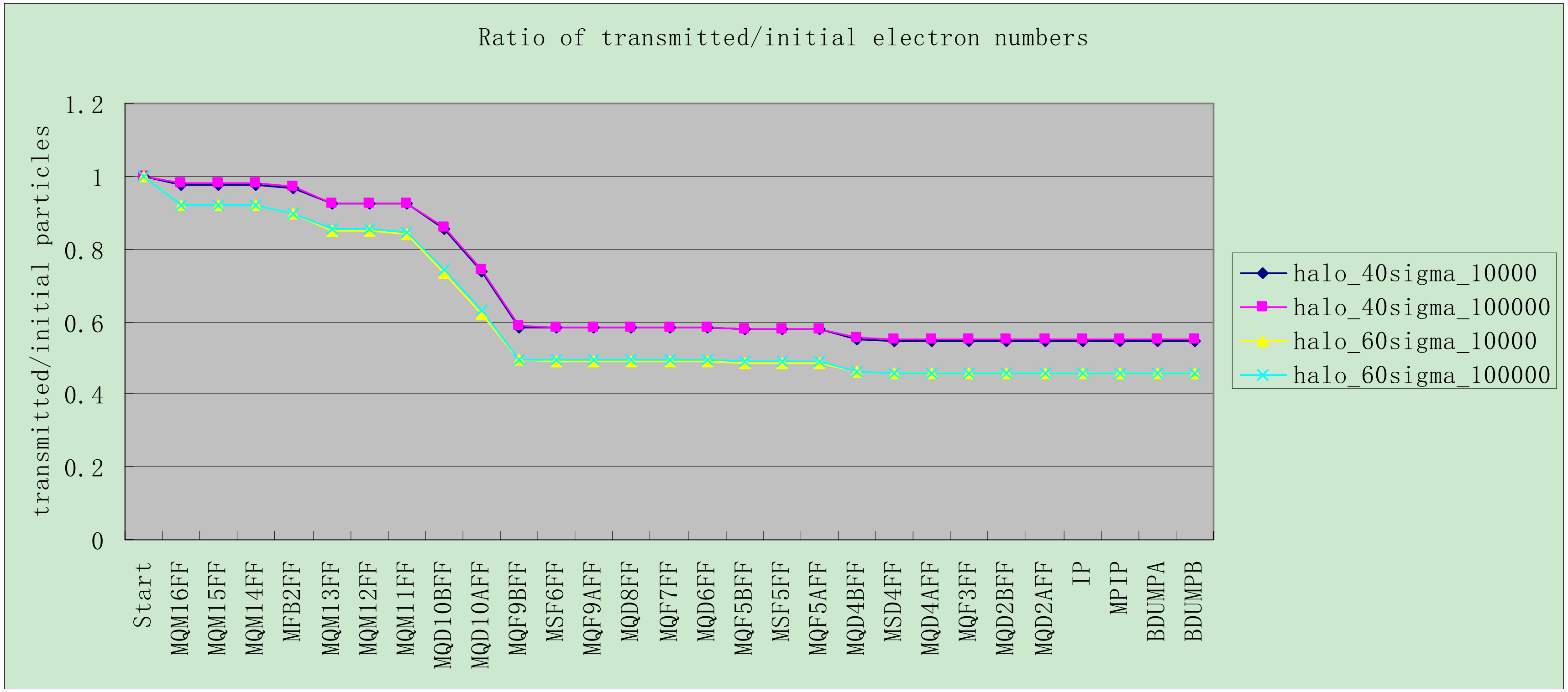
- Nominal optics BX2.5BY1 which optimized by Glen is used.
- The halo losses concentrated on the first two C-band BPMs where β_x and β_y have peaks.

Ratio of transmitted/initial halo particles



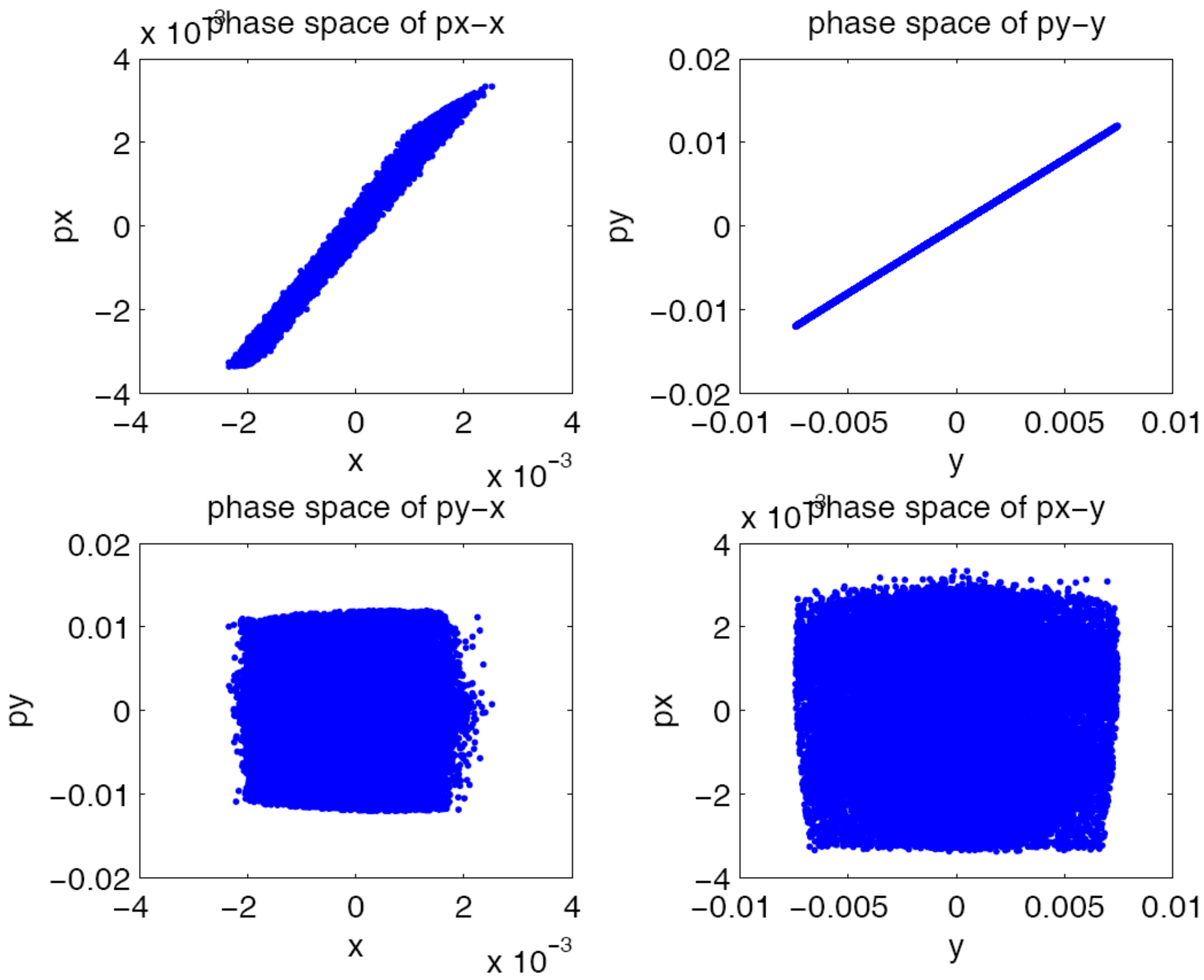
- The differences in transmission are because of the initial losses upstream at large β functions (two main ones at MQD10 and MQF9 and also other neighbouring apertures).

Non-linear optics influence

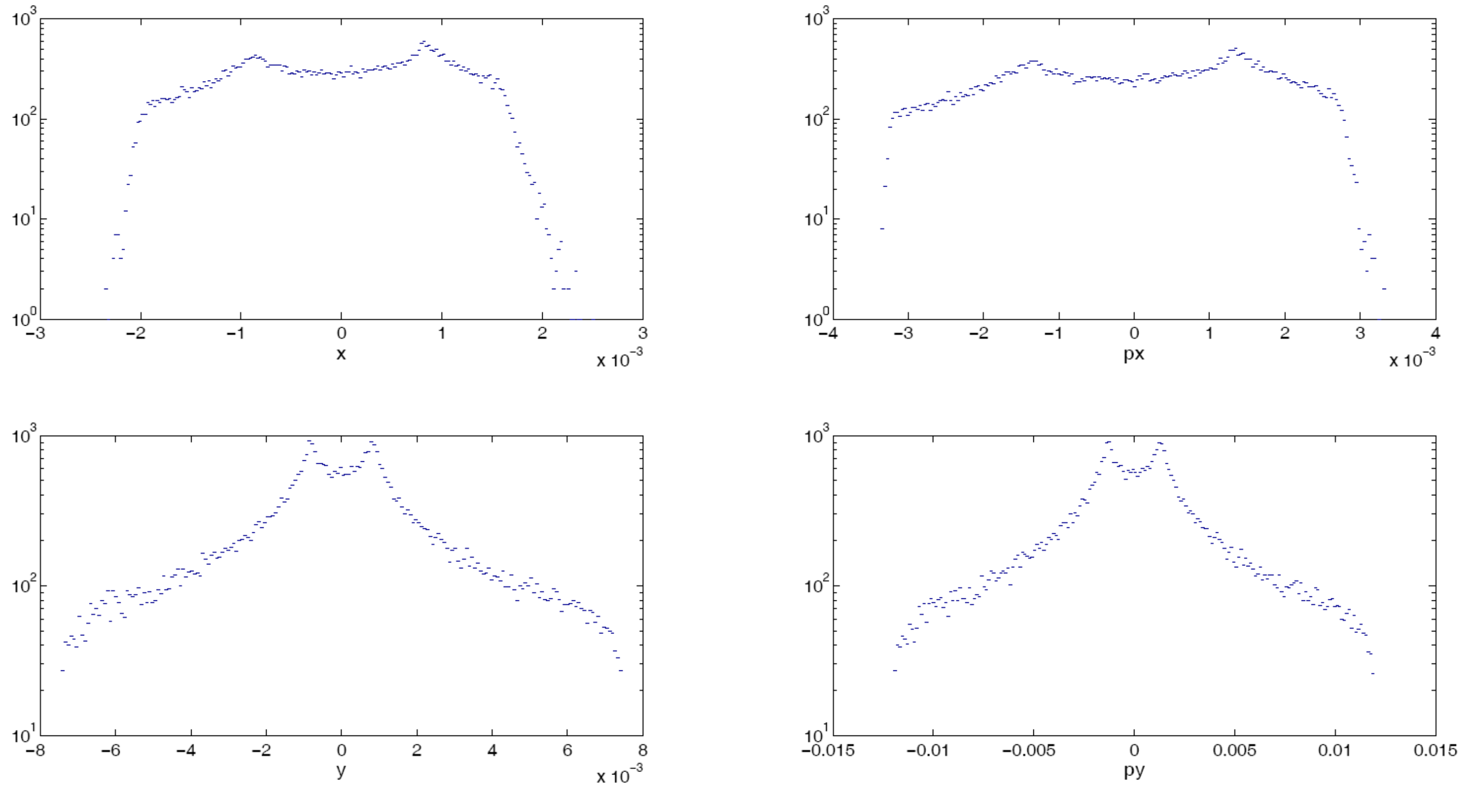


- It seems quite similar of 10000 and 100000 particles with different sigma input halo particles for the ratio of transmitted/initial electron numbers.
- Non-linear optics has little effect.

Phase-space at MPIP with 60 σ 100000 halo particles input



Halo distribution @ MPIP



- Compton recoil electrons generated when the BSM laser collides with the beam are just beyond that edge and are about 1000 times less numerous.
- x edge (about 2mm) is sharp, and could be easy to detect.

Conclusions

- The tightest apertures are C-band BPMs attached to each quad and sextupole in the FFS, with only 0.01m radius, and maybe the source of the background today
- The halo losses concentrated on the first two C-band BPMs where β_x and β_y have peaks.
- Non-linear optics has little effect on the different sigma input halo particles for the ratio of transmitted/initial electron numbers.
- Halo distribution at last BPM has quite sharp edge and is good for the compton recoil electrons measurement.

Prospects

- Different optics could be tried.
- Comparison study with Chao's study of halo distribution edge (stays at ~ 2cm).
- Initial energy spread could be increased to check the non-linear optics influence
- The expected halo about 10^7, increasing the particles~
- Uncertainty field quality for halo far from axis…
- Halo regeneration at C-band BPMs, a GEANT4 study needed…