Particle transport simulations for the MEBT Laserdiagnostic Status

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FETS meeting at RAL

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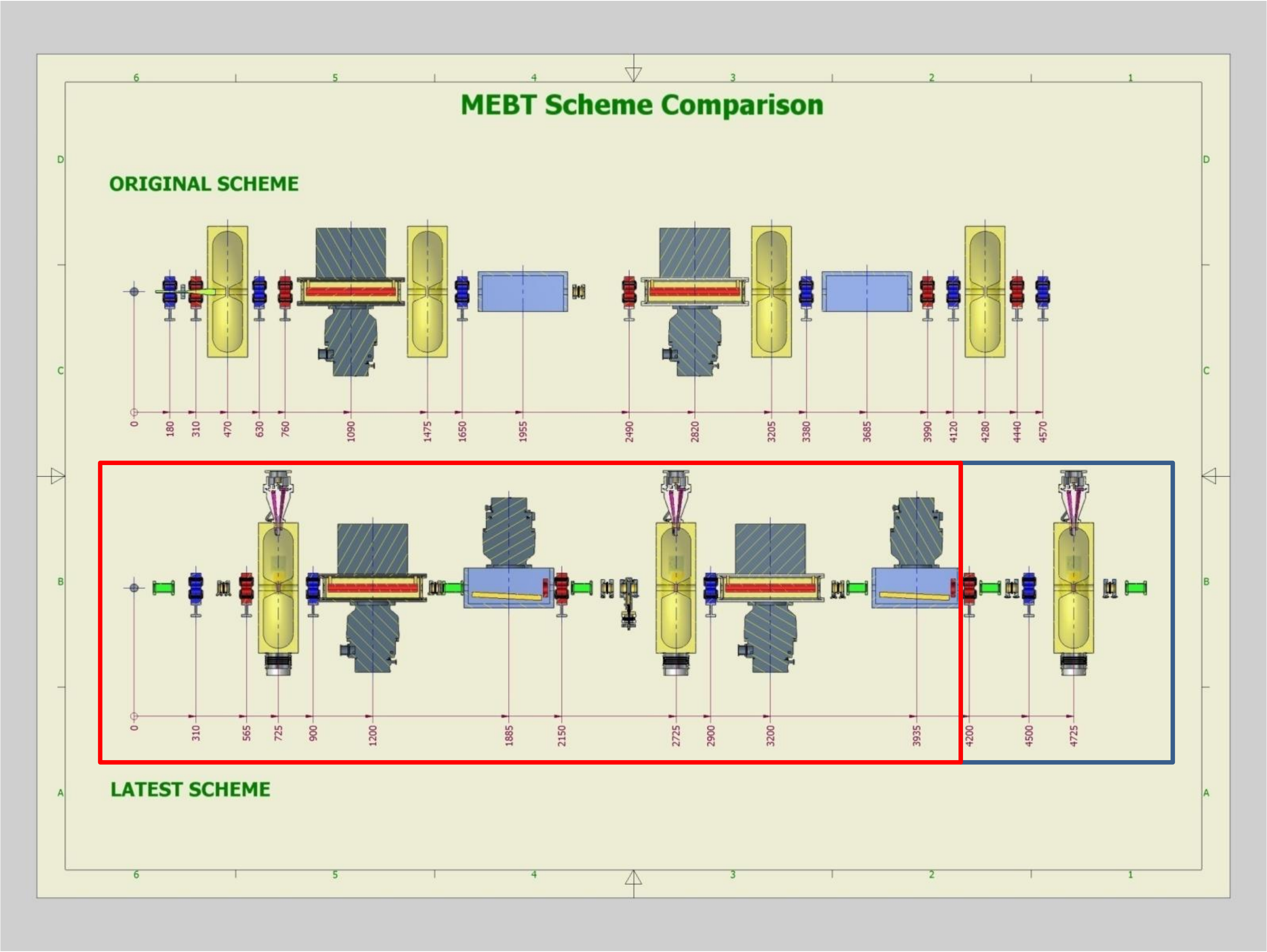
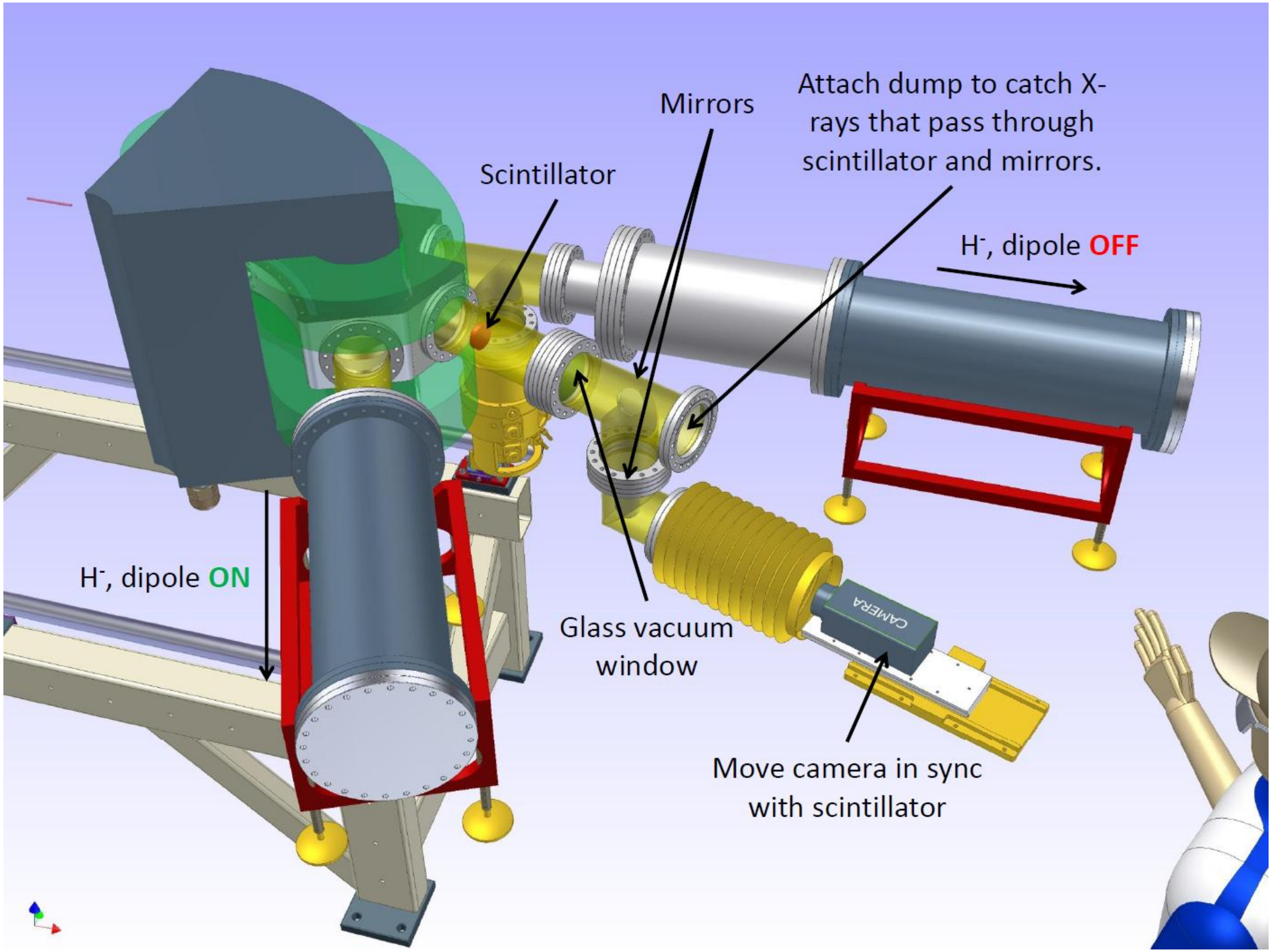
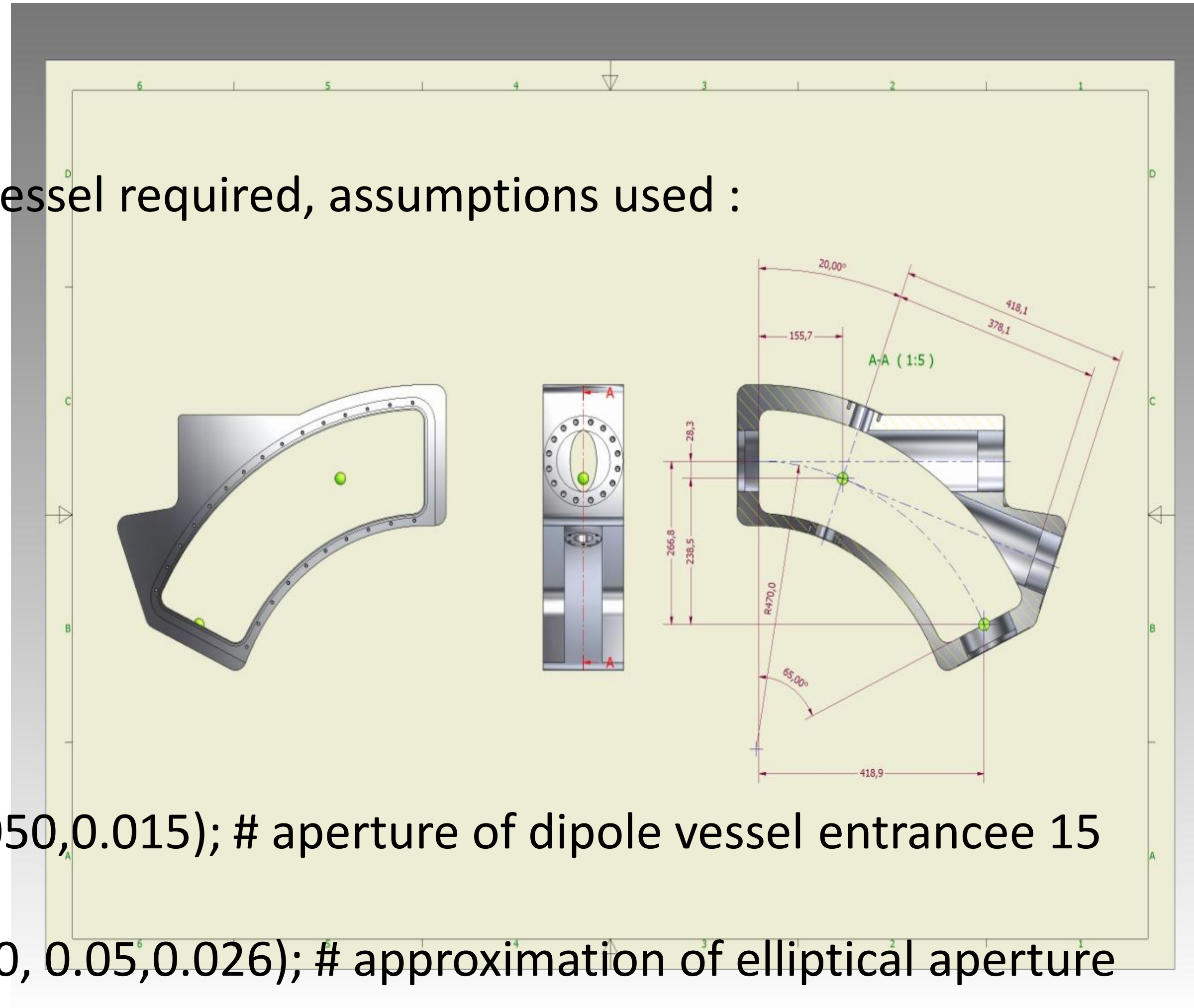
MEBT transport simulation stopped at 4.13 m to allow to produce input file for particle transport in following section.



Details of the setup before introducing further QP.



Detailed parameter list of vessel required



Detailed parameter list of vessel required, assumptions used :

Z= 5 m (input phase)

Bending radius = 0.47 m

Bending angle = 65 degree

Laser angle = 20 degree

rmax ("wcs","z",5.0075, 0.050,0.015); # aperture of dipole vessel entrancee 15 mm thick CF 100 flange
xymax("wcs","z",5.028, 0.10, 0.05,0.026); # approximation of elliptical aperture 26 mm long......

Simulation method

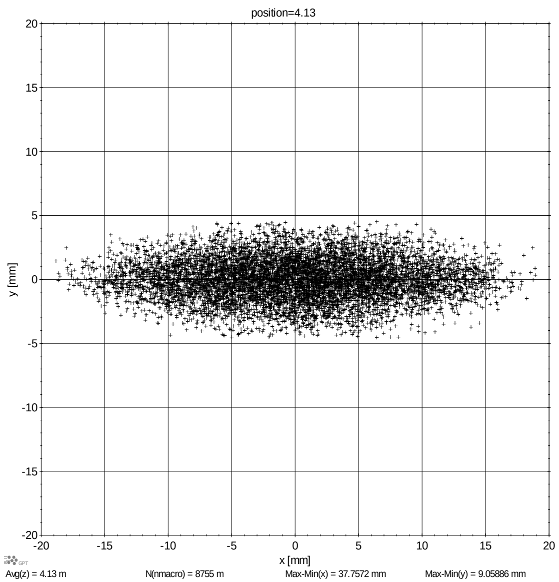
First stage:
Run of MEBT lattice (2) including the latest fieldmap (as 14th May) to 4.13 m.

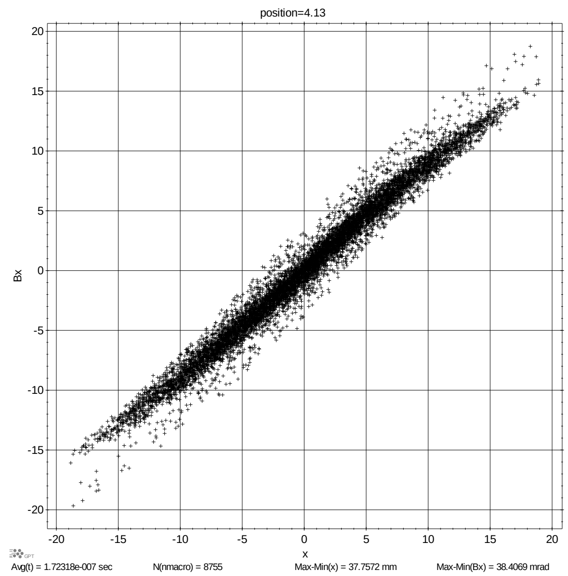
The second stage is using three simulation runs producing :
The output distributions in straight forward direction when the dipole is off (1).
The output distributions behind the dipolevessel in the 60 degree output direction (2).
The output distribution at the laserinteraction point used as input for the third stage (3).

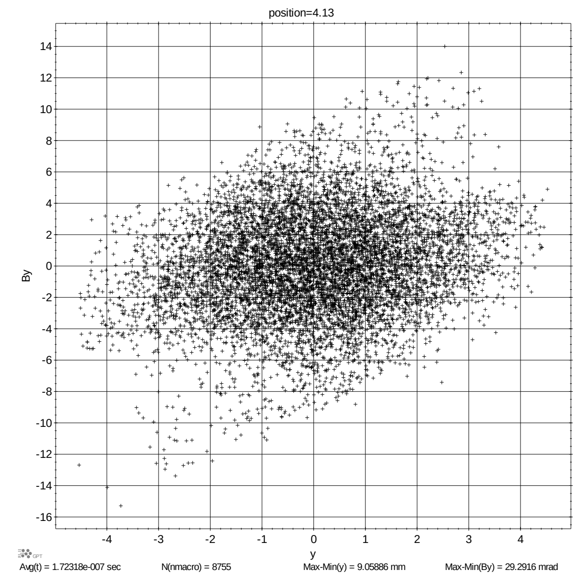
The third stage
Is using a variable number of simulations to produce the output in the direction of the laser detector port. This simulation can use the full beam or by introduction of an slit aperture an sequence of beamlets similar to the ones produced by the laser.

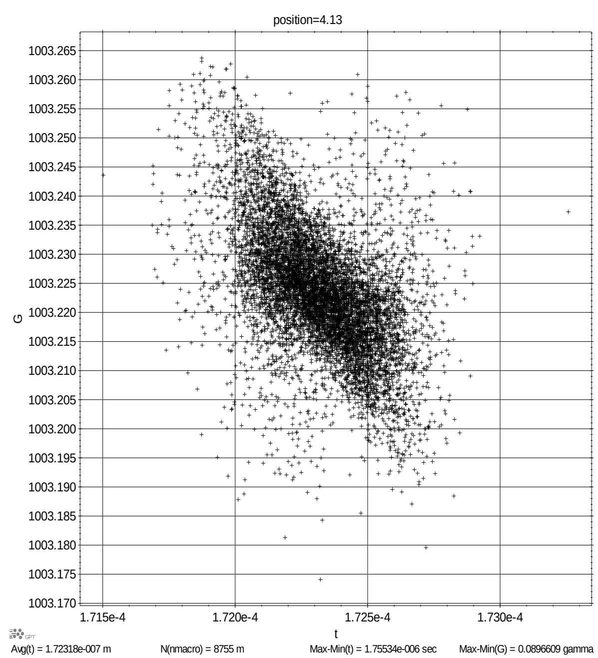
Should be later upgraded to us a laser profile rather than a slit function.

Input distribution at 4.13 m (from RFQ end flange)

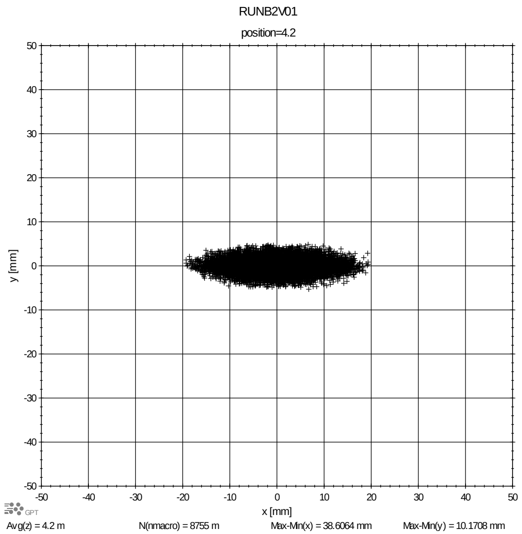


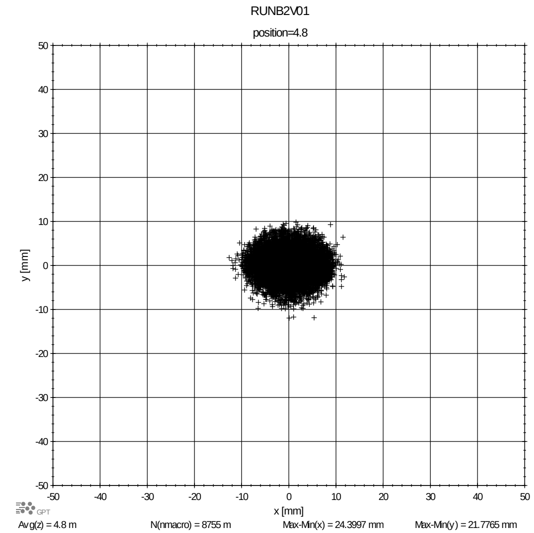


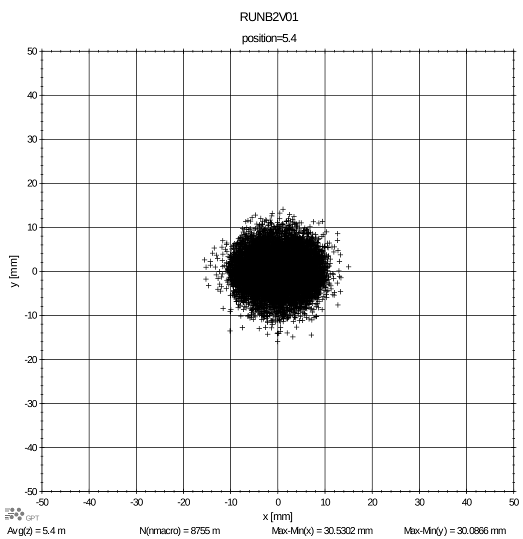


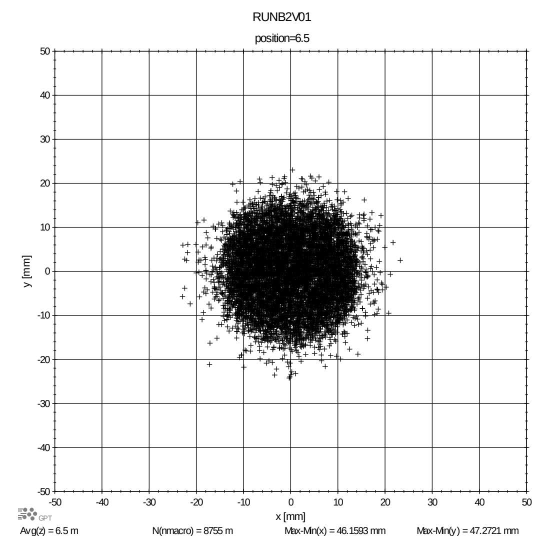


Calculation using fieldmaps – dipole off – Q7 =-7 ; Q8=6

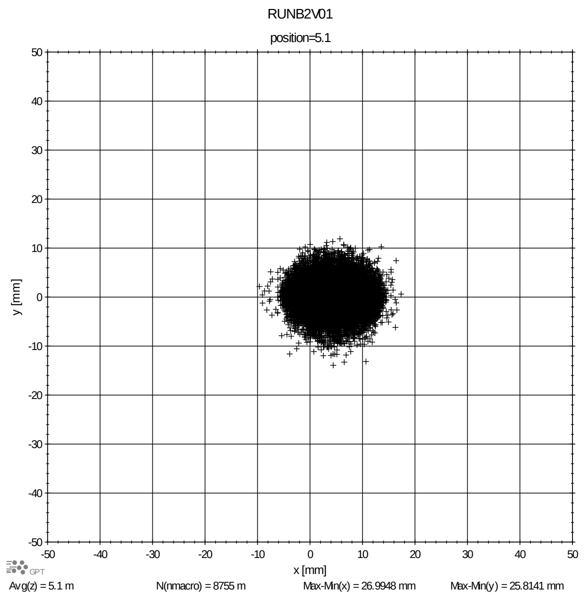


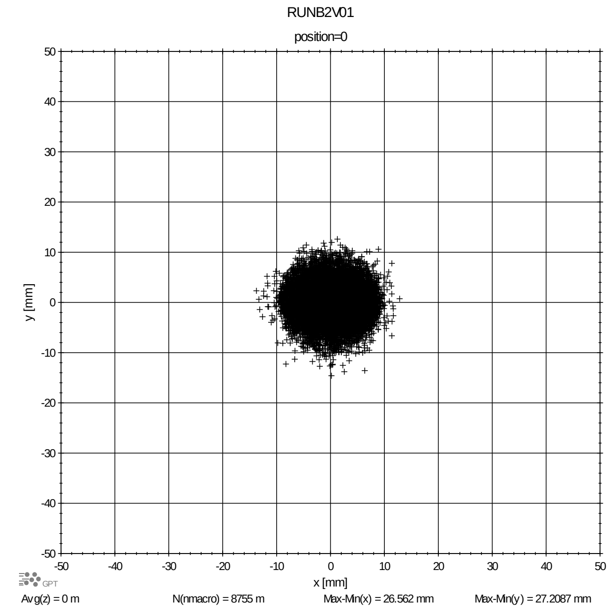


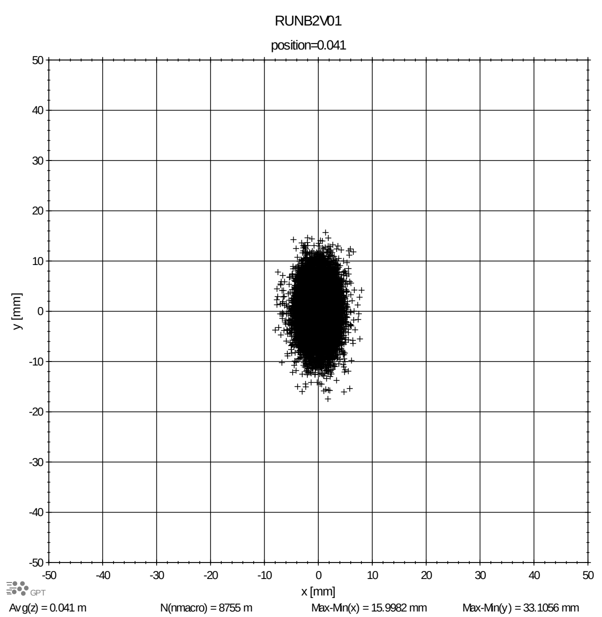


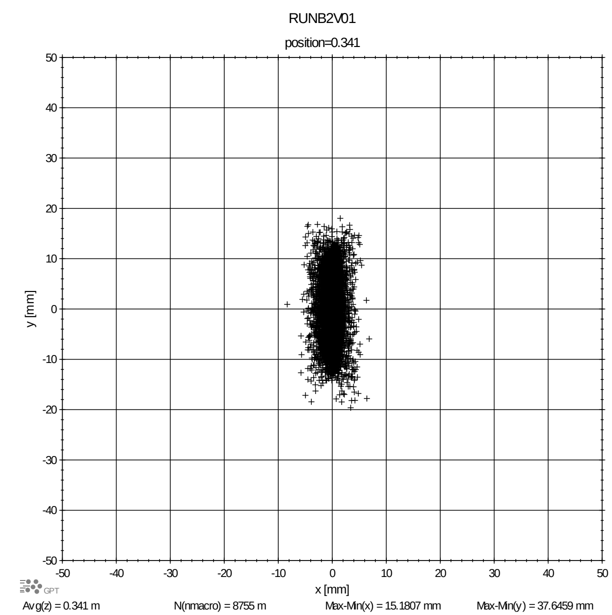


Calculation using fieldmaps – dipole on – Q7 =-7 ; Q8=6

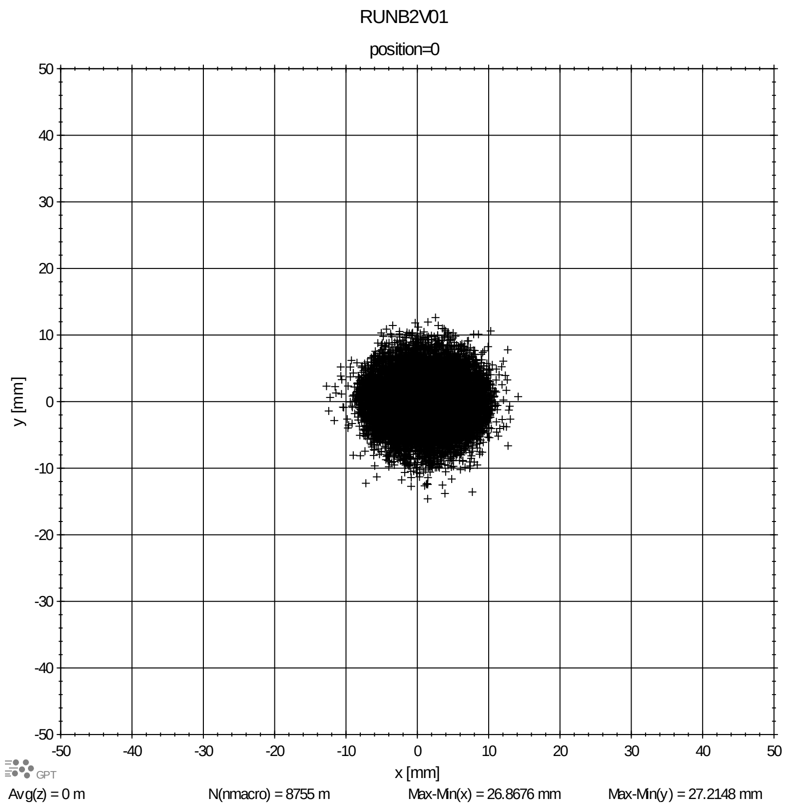


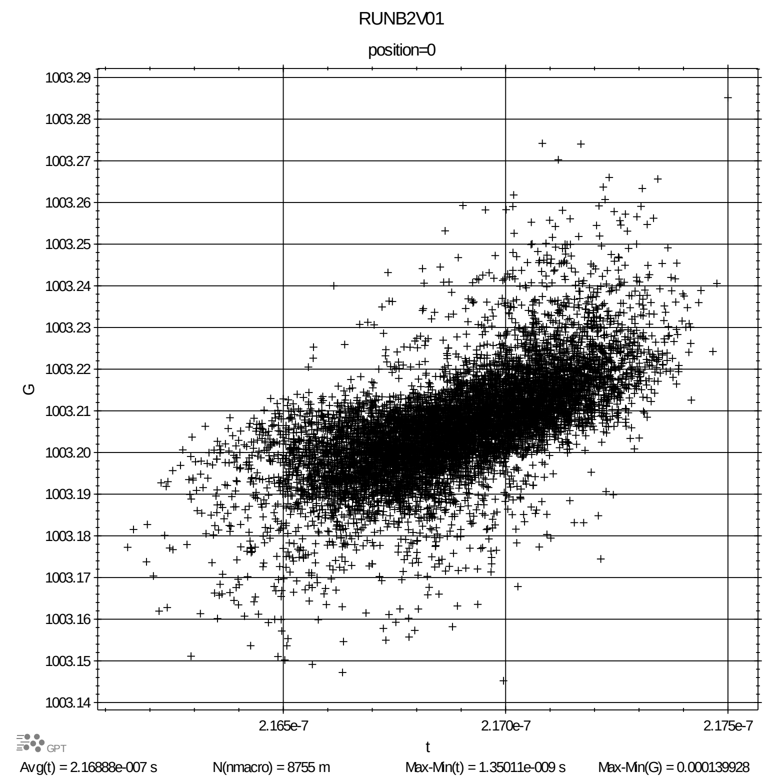




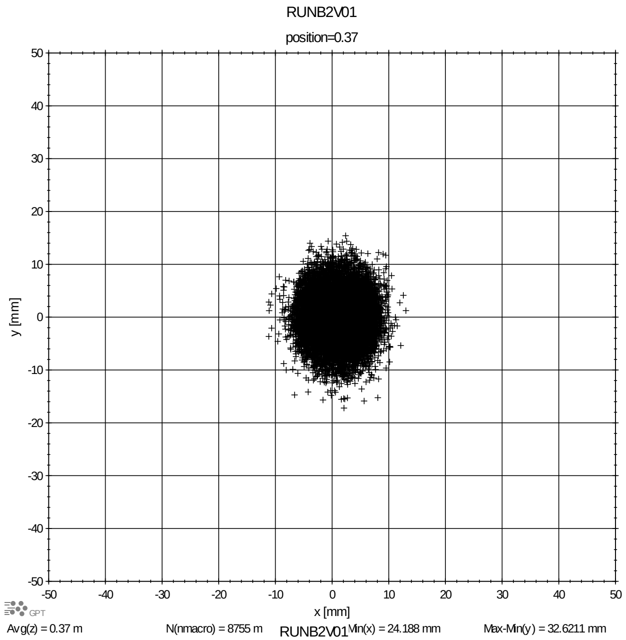


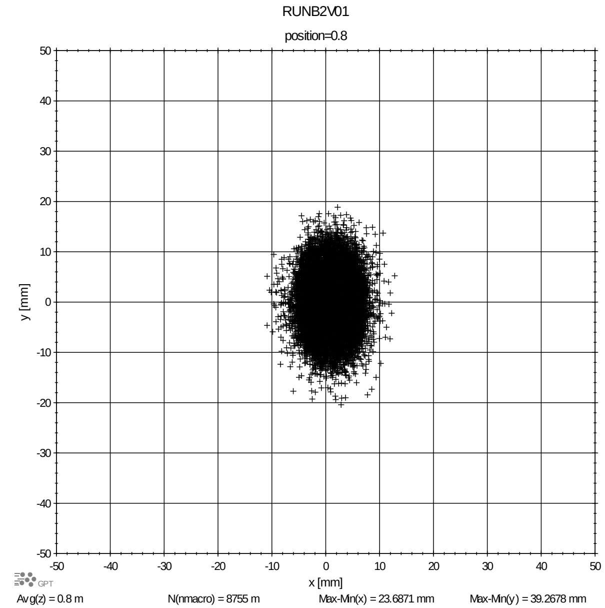
Distribution at laser interaction – dipole on
Bfac7=-7; # Q7
map3D_B("wcs", "z", 4.200,"MEBTquadFieldmap14MayScott.gdf“
Bfac8=6; # Q8;
map3D_B("wcs", "z", 4.500,"MEBTquadFieldmap14MayScott.gdf"

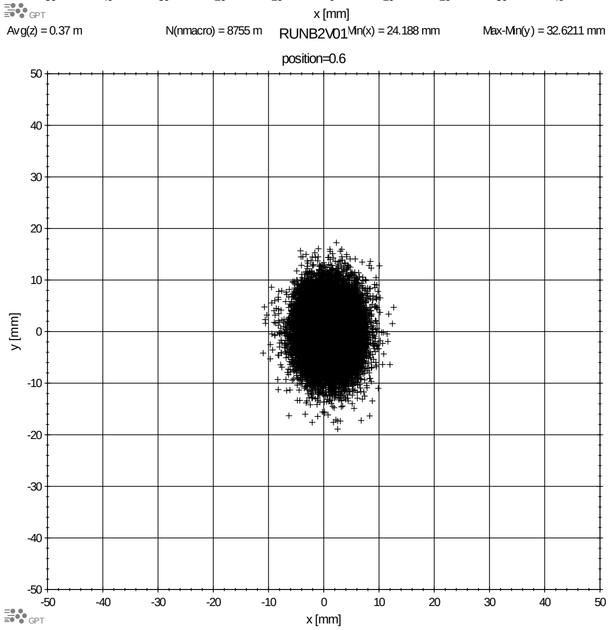


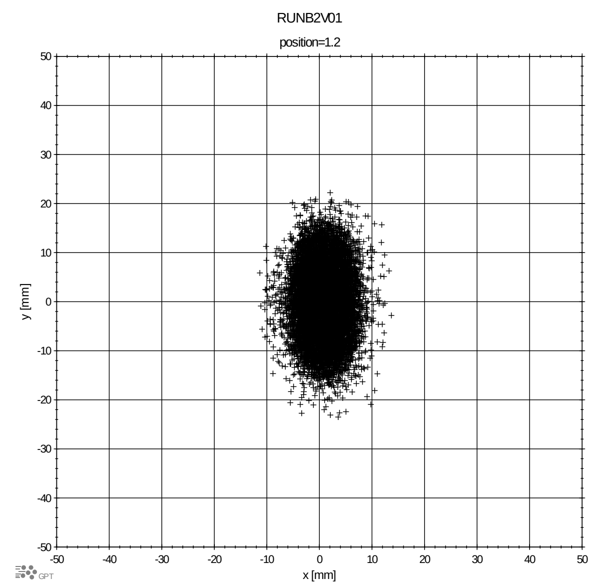


Further drift after “laser sheath interaction” = all particles Q7 =-7 ; Q8=6

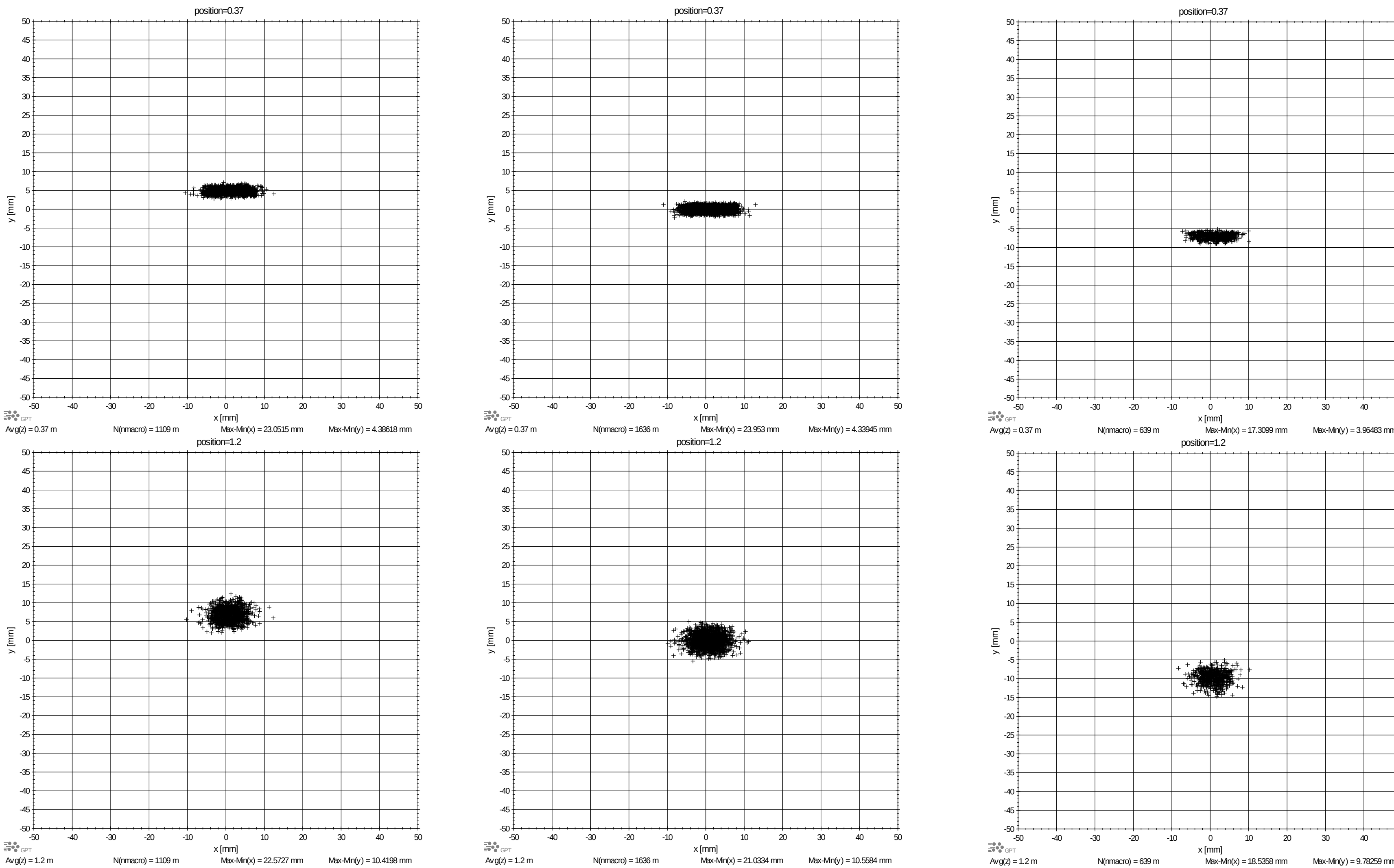






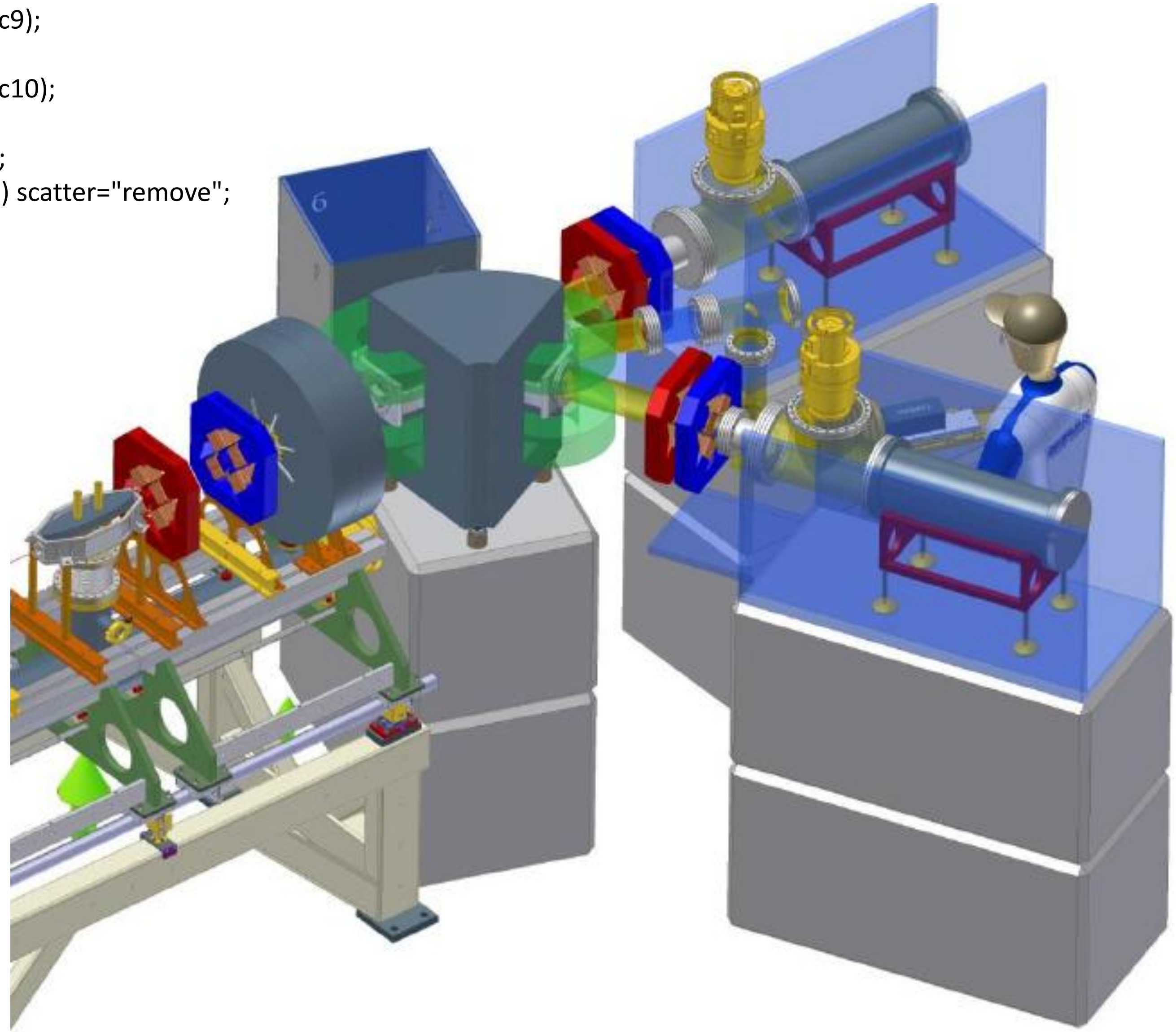


Further drift after “laser wire interaction”, y= +4 / 0 / -6 mm , Q7 =-7 ; Q8=6

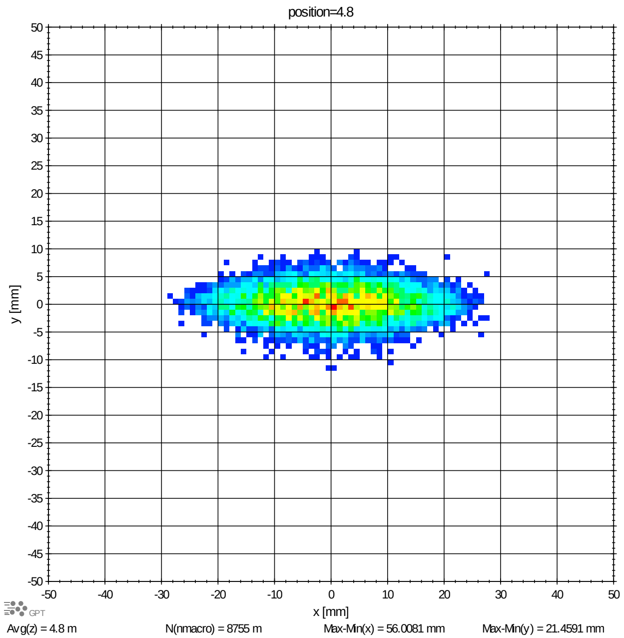


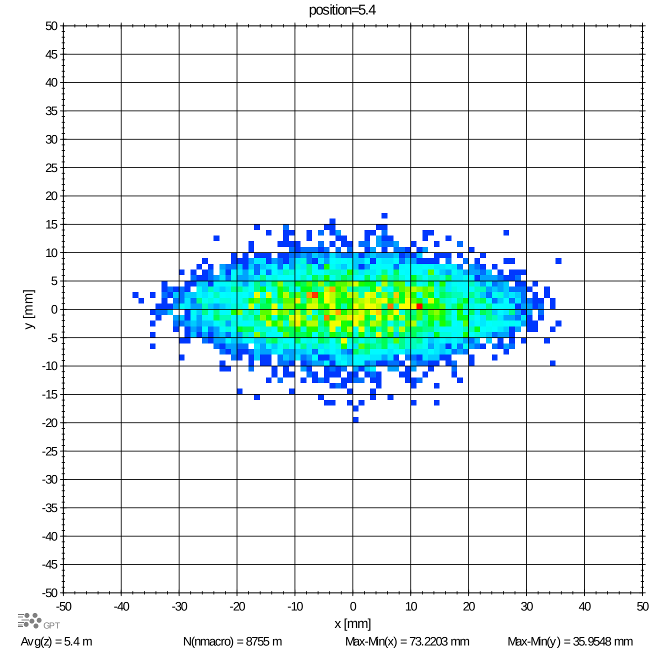
Lattice 3 : including QP in front and behind dipole (40 mm bore radius) and beam dumps

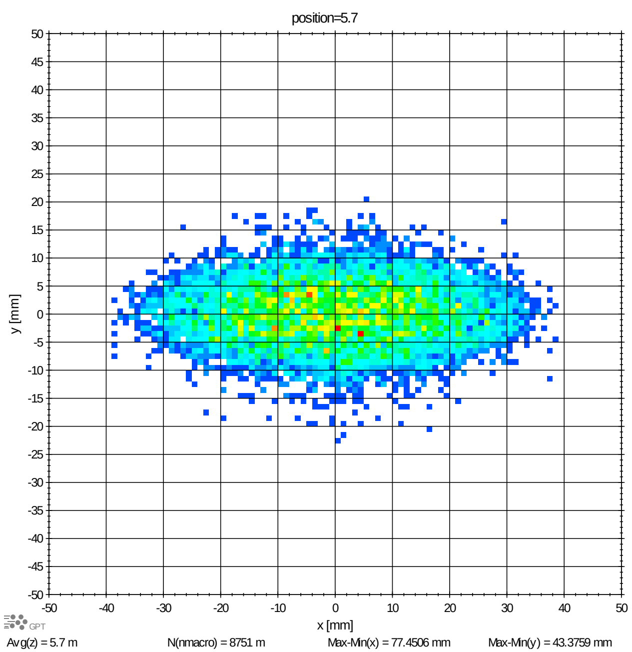
```
rmax ("wcs","z",6.25, 0.04,1.5); # beam line behind dipole - straight beam - 40 mm radius from 5.5 to 7.5 m.
Bfac9=1.25; # Q9
quadrupole("wcs", "z", 6.000,0.15,Bfac9);
Bfac10=-1.25; # Q10;
quadrupole("wcs", "z", 6.500,0.15,Bfac10);
#beam dump
forwardscatter("wcs", "I","remove",0);
scattercone("wcs", "I", 7.0,0.075,8.0,0) scatter="remove";
```

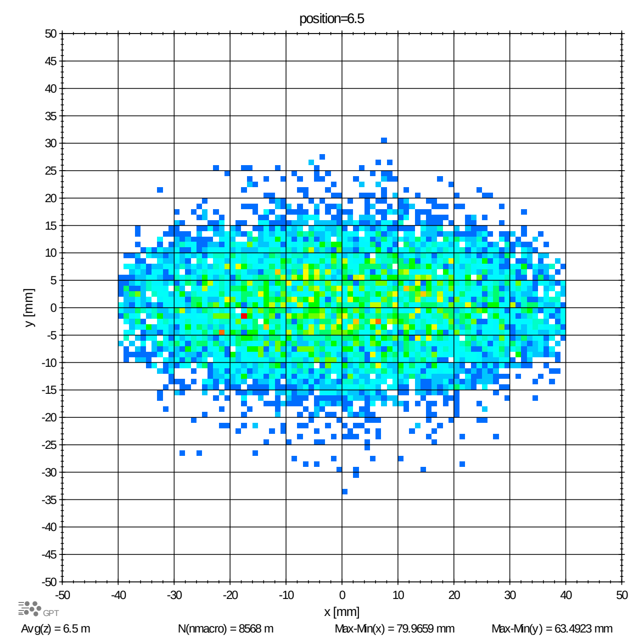


Lattice3 – drift only – sector magnet off – nearly fail safe operation



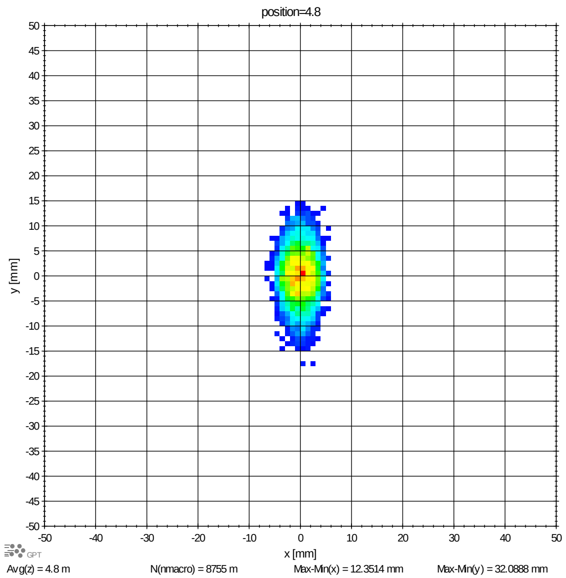


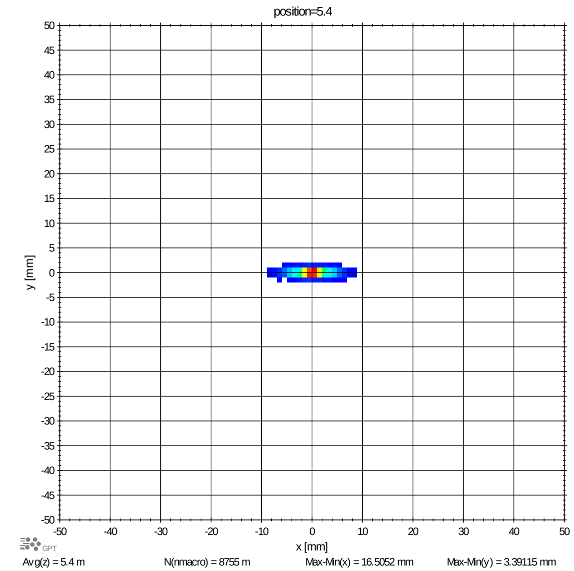


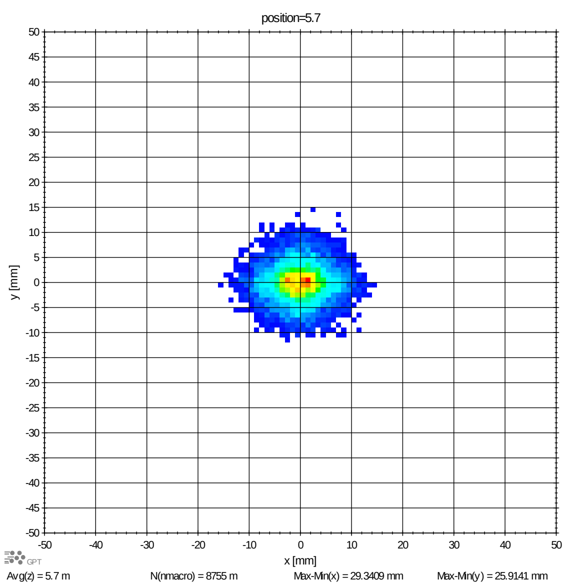


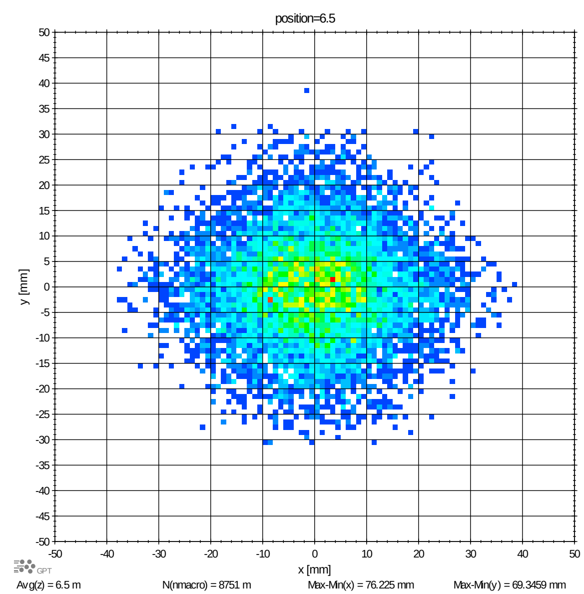
Lattice3 - sector magnet off

Bfac7=-3.5; # Q7
quadrupole("wcs", "z", 4.25,0.15,Bfac7);
Bfac8=6; # Q8;
quadrupole("wcs", "z", 4.900,0.15,Bfac8);



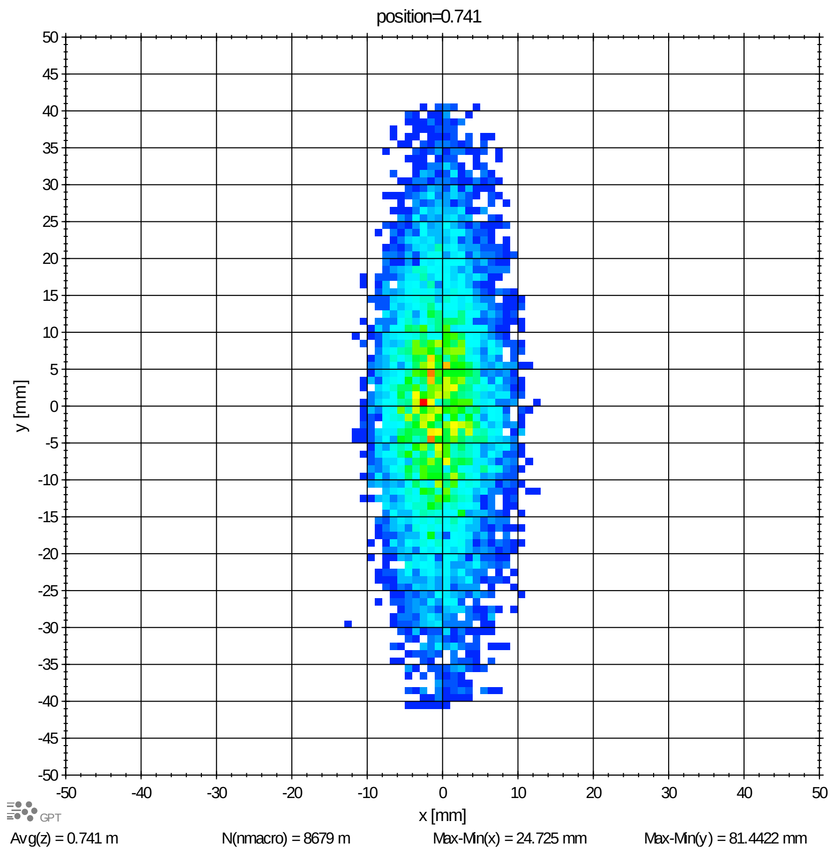


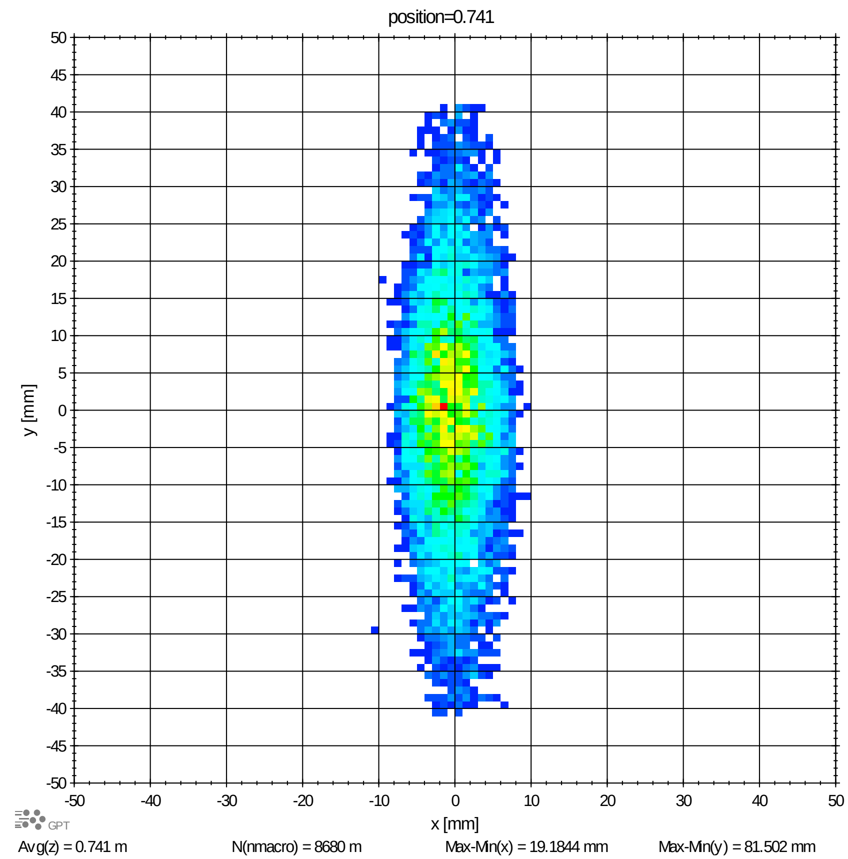




With and without edge focussing – Lattice3

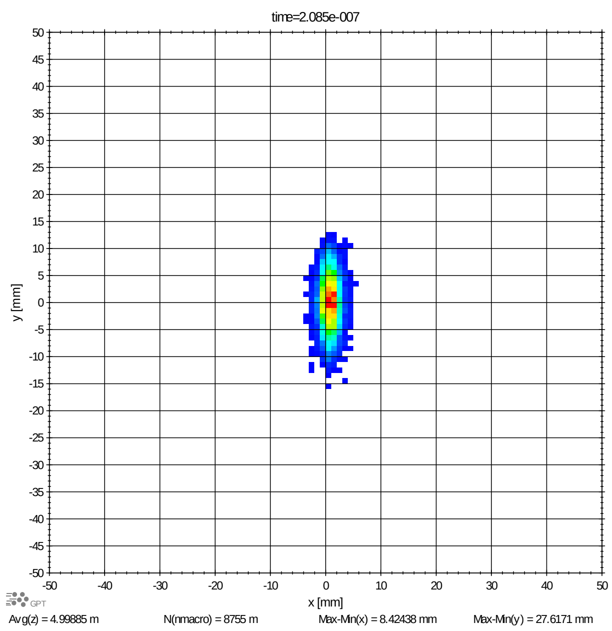
```
Bfac7=-3.5; # Q7
quadrupole("wcs", "z", 4.25,0.15,Bfac7);
Bfac8=6; # Q8;
quadrupole("wcs", "z", 4.900,0.15,Bfac8);
sectormagnet("wcs","Dipoleout", Rbend,Bbend,0.35,0.35,0,0,0)
```

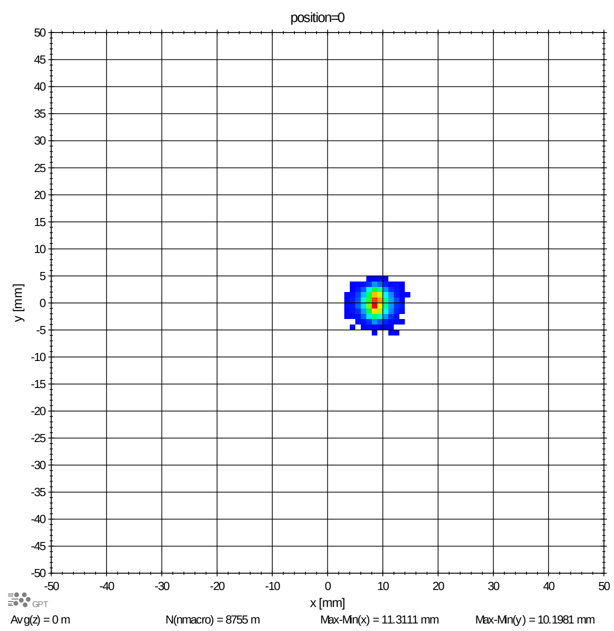


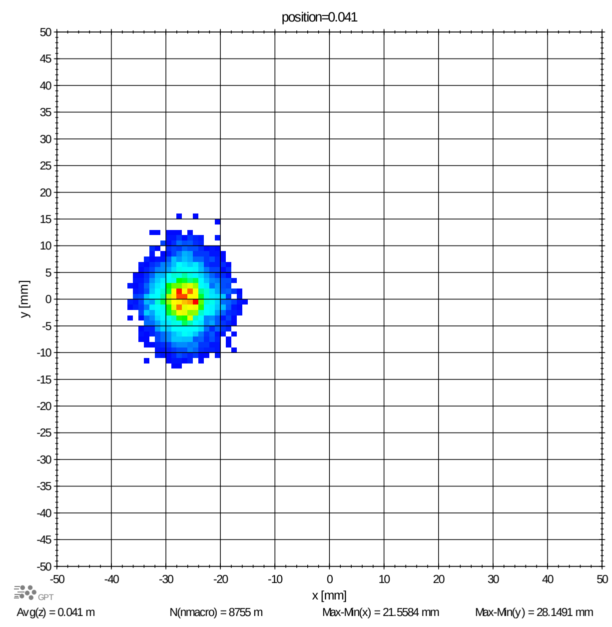


With fringe fields – Lattice3

Bfac7=-3.5; # Q7
quadrupole("wcs", "z", 4.25,0.15,Bfac7);
Bfac8=6; # Q8;
quadrupole("wcs", "z", 4.900,0.15,Bfac8);
sectormagnet("wcs","Dipoleout", Rbend,Bbend*0.8,0.35,0.35,0.04,50,0) – rather moderate





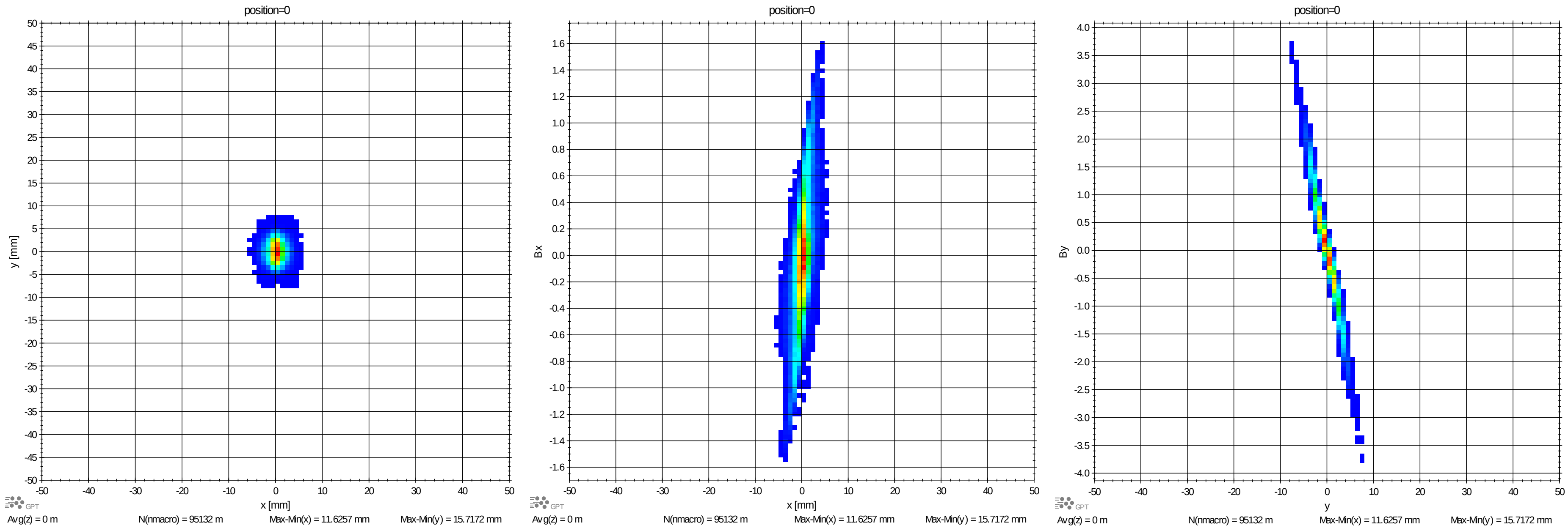


Lattice3 – no edge , no fringe – beam at interaction point

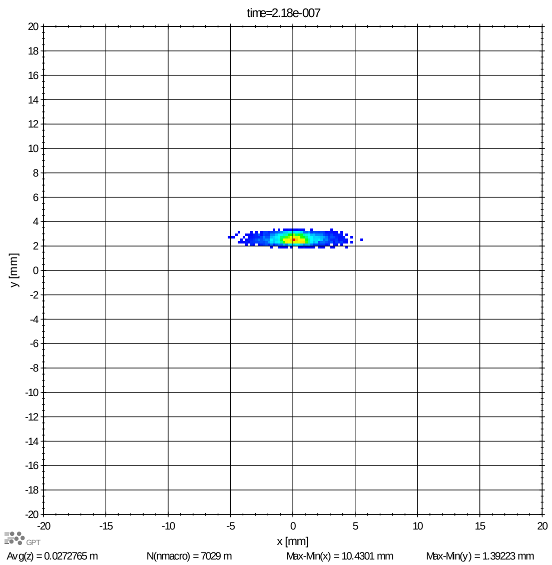
Bfac7=-3.5; # Q7

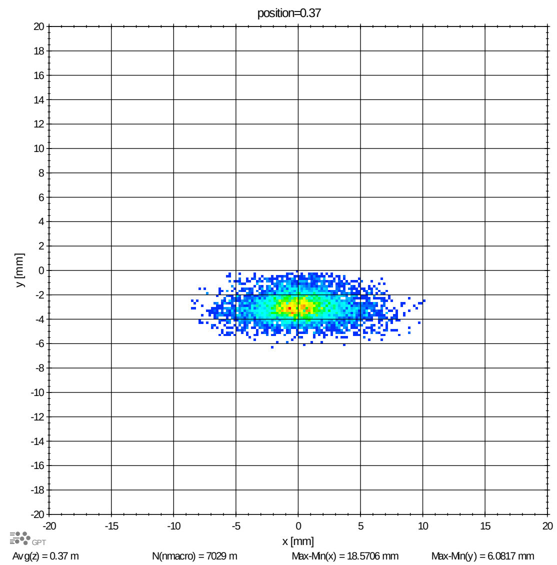
quadrupole("wcs", "z", 4.25,0.15,Bfac7);

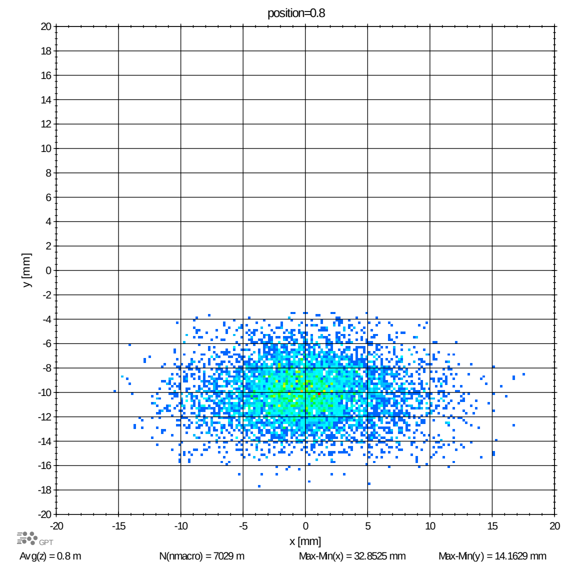
Bfac8=6; # Q8;

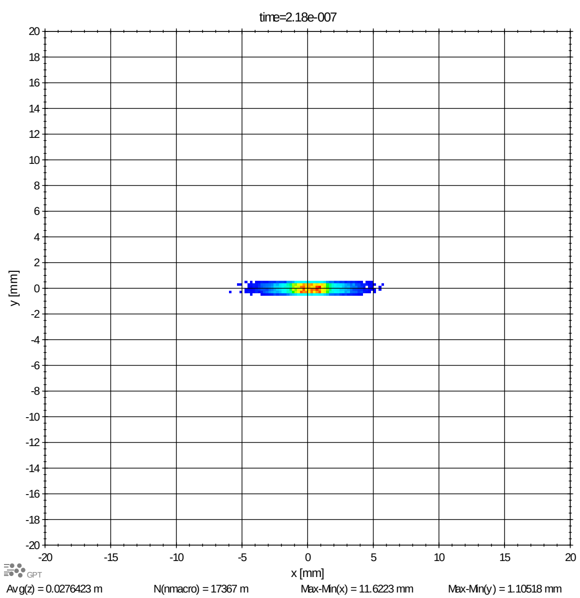


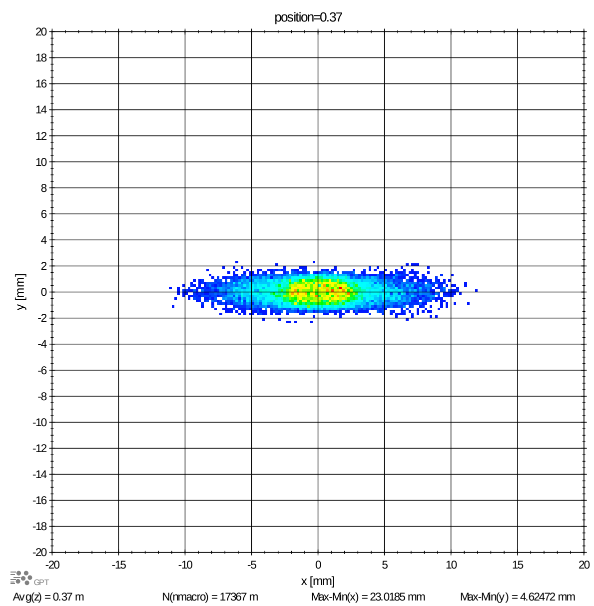
Further drift after “laser wire interaction”, y= +3 / 0 mm

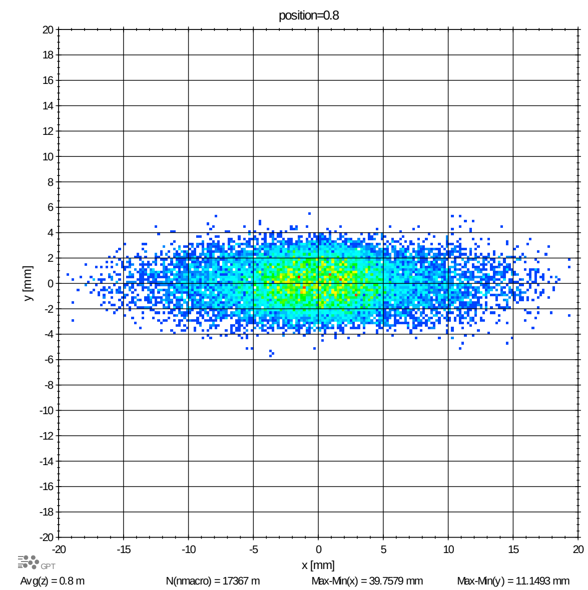








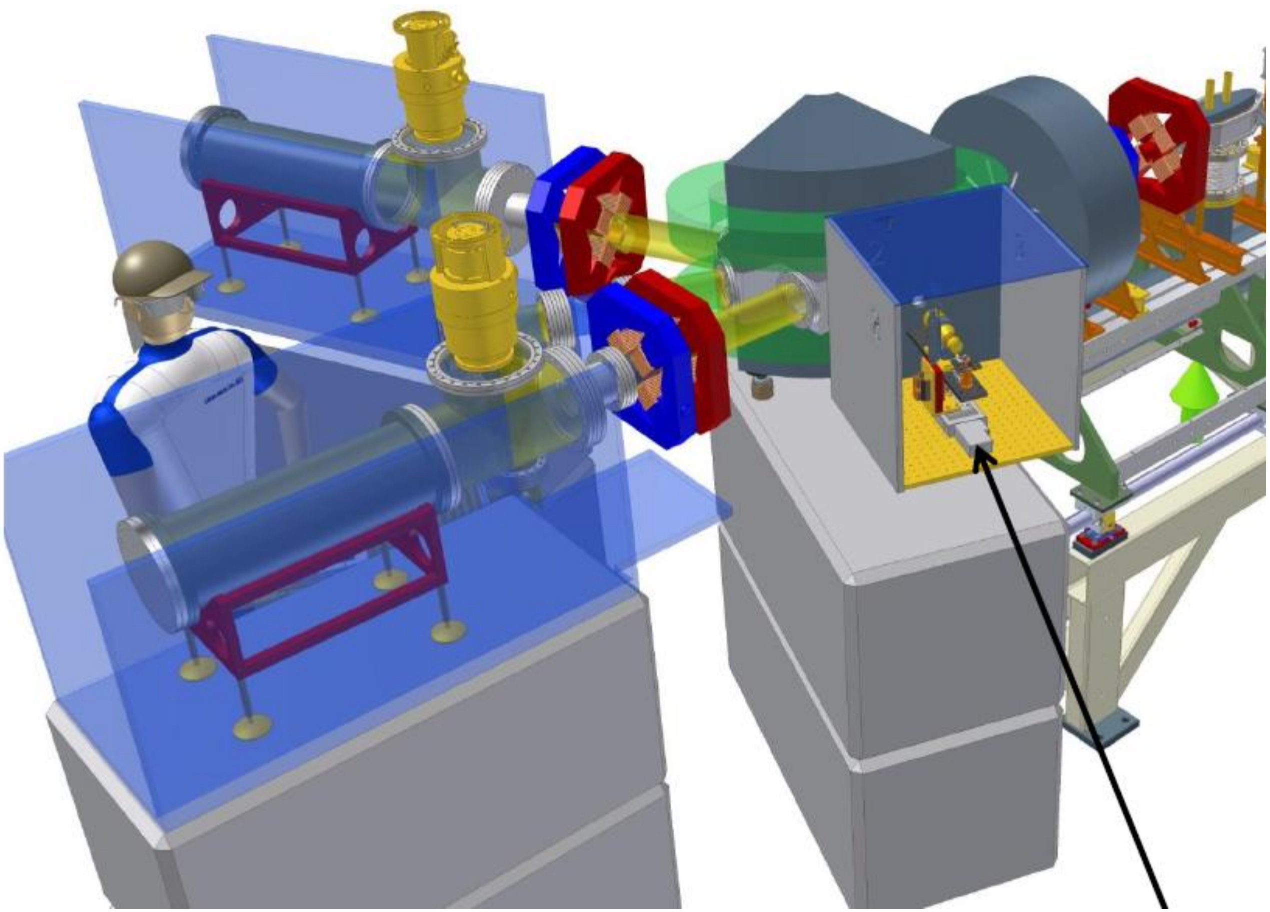




Lattice3

Output beam of MEBT 2 does not allow a beam of > 20 mm radius in Y
Even without cavity. Cavity in front of dipole not required and seriously reduces acceptance. Do larger QP make sense ?

Space constrains behind the dipole severely reduce flexibility to locate QP.



Summary

A framework of simulations has been setup in GPT using the output of MEBT simulations together with a realistic description of the laser diagnostic setup to perform first simulations of beam transport in the laser diagnostic vessel to the detector. While those simulations can only be a first step they already show some performance values and should also kickstart a feedback loop between experimental design and engineering design that need to be mostly finalized towards autumn 2013.

We urgently require fieldmap for dipole to investigate the fringe field effects, have to discuss edge focussing.

Next steps

- continuation of investigations.... best would be with two independent codes.
Fast feedback with engineering on requested geometry changes, include other lattice,
include all other boundary conditions (further beampipes etc.) where relevant
- change QP positions and settings to allow for highest phase space sampling.
- Investigate power distribution on beam dumps

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- investigate optimum for laser size and stepping in y
- investigate for best range on long movement of detector
- investigate influence of - dipole fringe fields, real field distribution (fieldmap)
- investigate influence of weak focussing / edge focussing.

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- determine neutralisation degree, calculate particle numbers, calculate scintillator output, calculate signal in camera => define optical beam path from scintillator to camera.

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Should be enough for 2-3 peer reviewed publications (as indicated)....

......we need to decide soon who is doing what....