# Beam dynamics simulation study with core + halo beam distribution for emittance measurement

- Simulation results with uniform distribution input
- Simulation results with Core+halo beam distribution
- conclusions

Quantang Zhao, Carlos Hernandez-Garcia & Mikhail Krasilnikov

PITZ physics Seminar

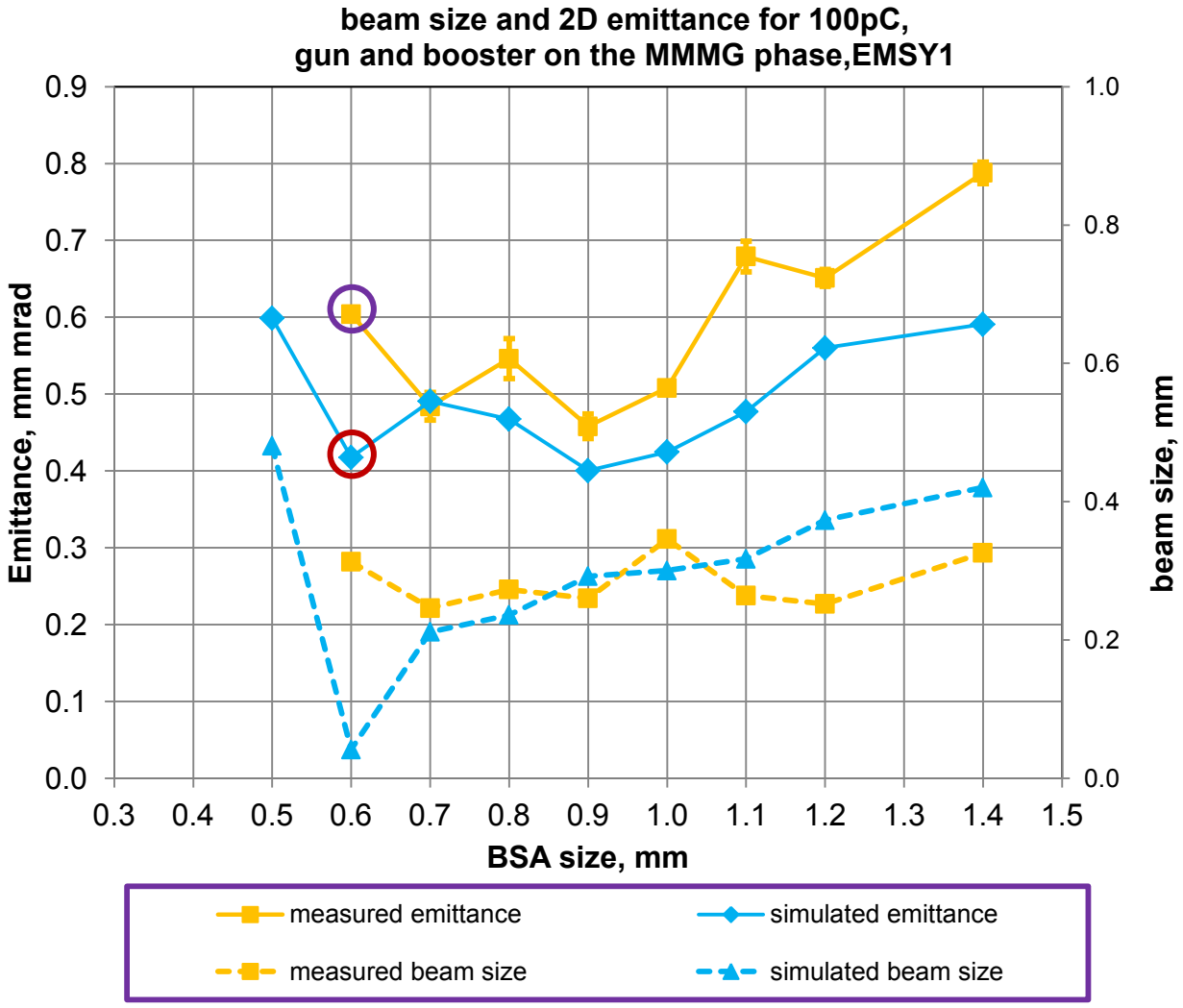
Zeuthen, 07.05.2015

HELMHOLTZ ASSOCIATION

DESY

# Simulation results with uniform beam distribution( 100 pC)

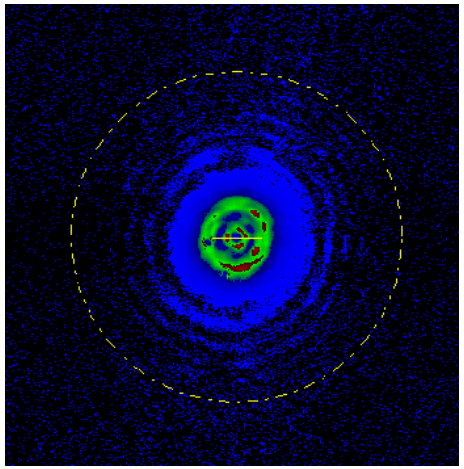
> At each laser beam size, take the solenoid scan for minimum emittance

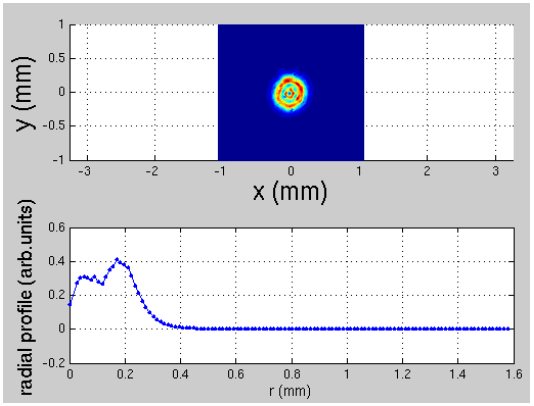



- For BSA>=0.8 mm, the minimum emittance effected by laser beam size from simulation are consistent with measurement
- for BSA =0.6mm, 0.7mm, simulation result is quite different from measurement. (?)

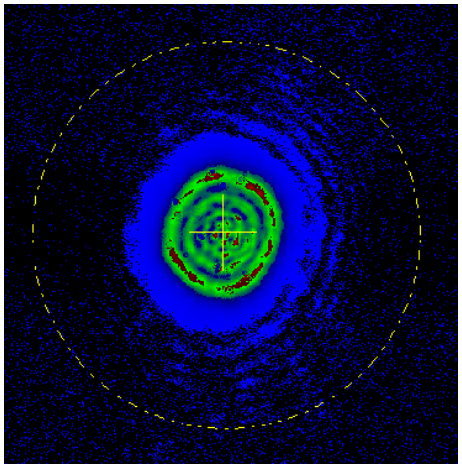
# Laser beam size on VC2 (for 100 pC)

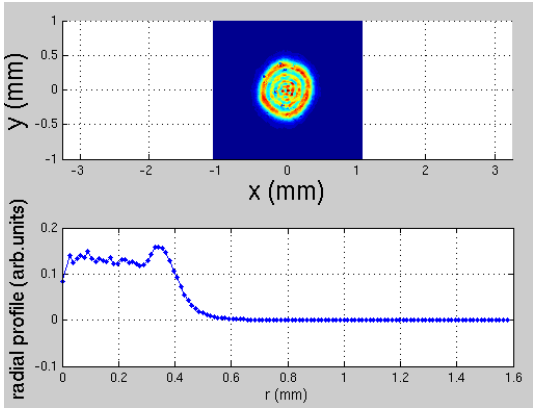
BSA 0.6 mm



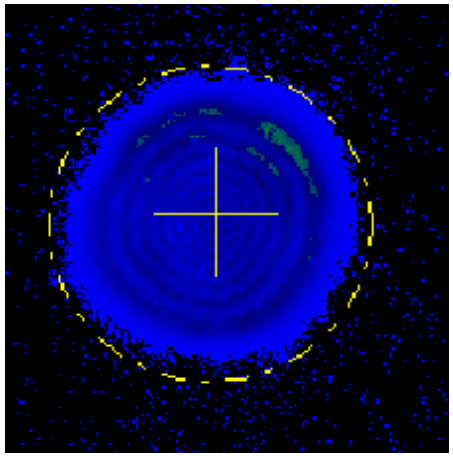


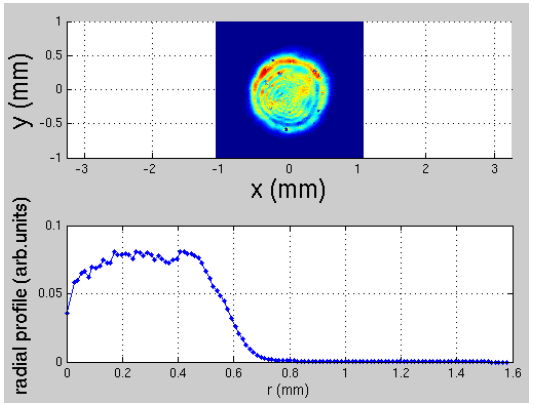

BSA 0.9 mm





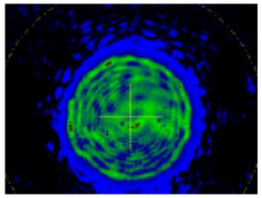

BSA1.2mm



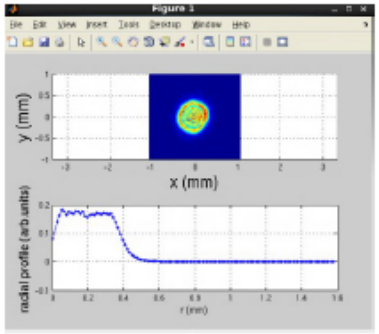


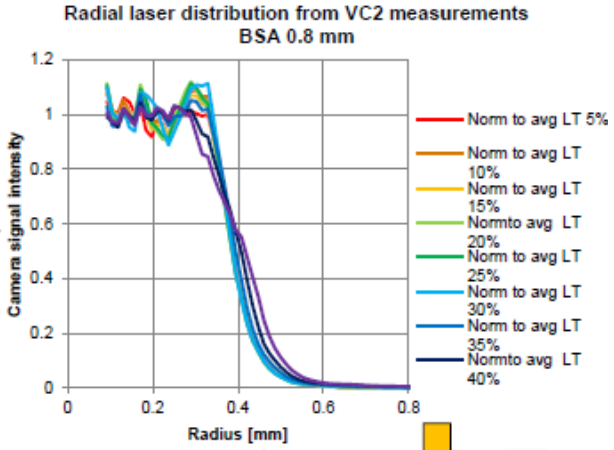
# The process for add halo to input beam distribution to ASTRA (from Carlos Hernandez-Garcia & Mikhail Krasilnikov ,14.04.2015 PPS Seminar )

VC2 data image capture

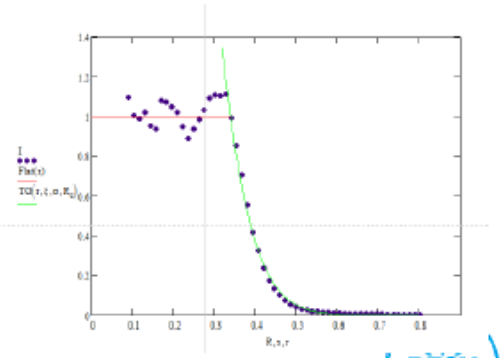


VC2 data reproduced in MatLab

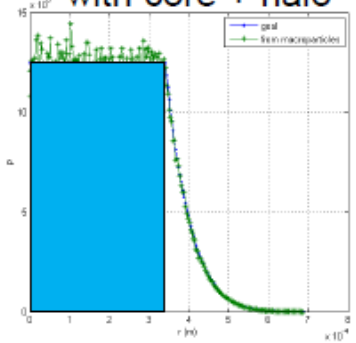


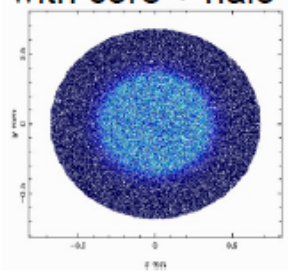

Curve fit to match laser distribution



MatLab-generated input distribution for ASTRA with core + halo



Input distribution shown by postpro with core + halo



To ASTRA

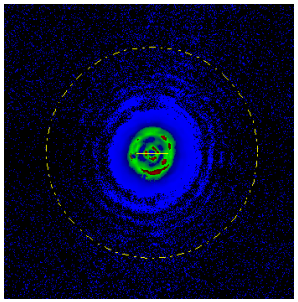
# Uniform and core+halo beam distribution for ASTRA input (for 100 pC)

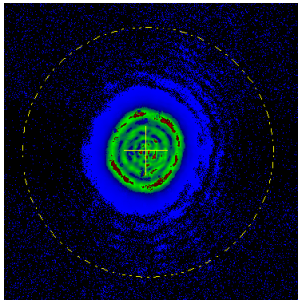
BSA = 0.6 mm

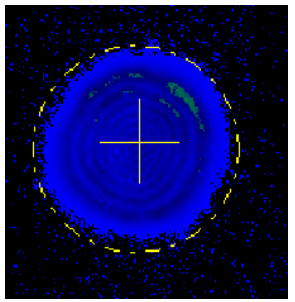
BSA = 0.9 mm

BSA = 1.2 mm

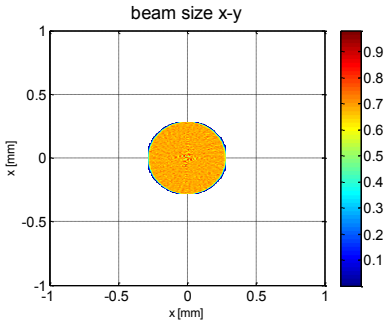
On VC2

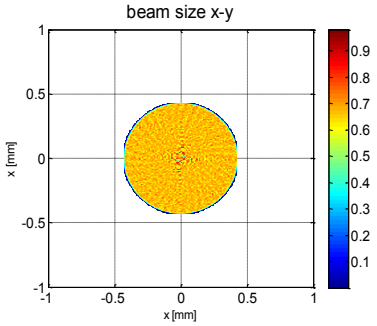


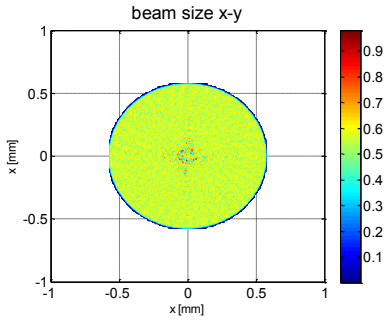




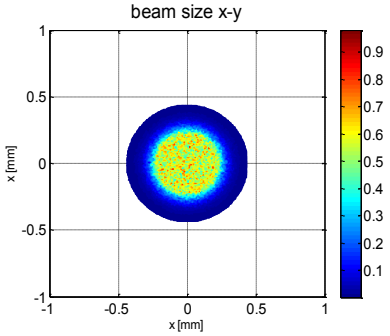
uniform

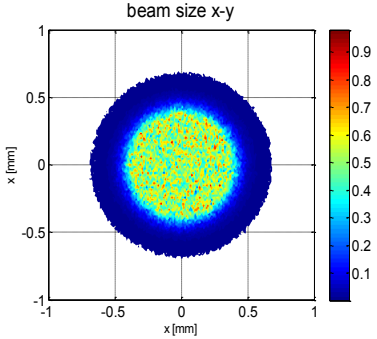


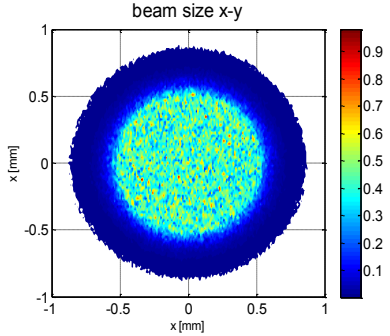



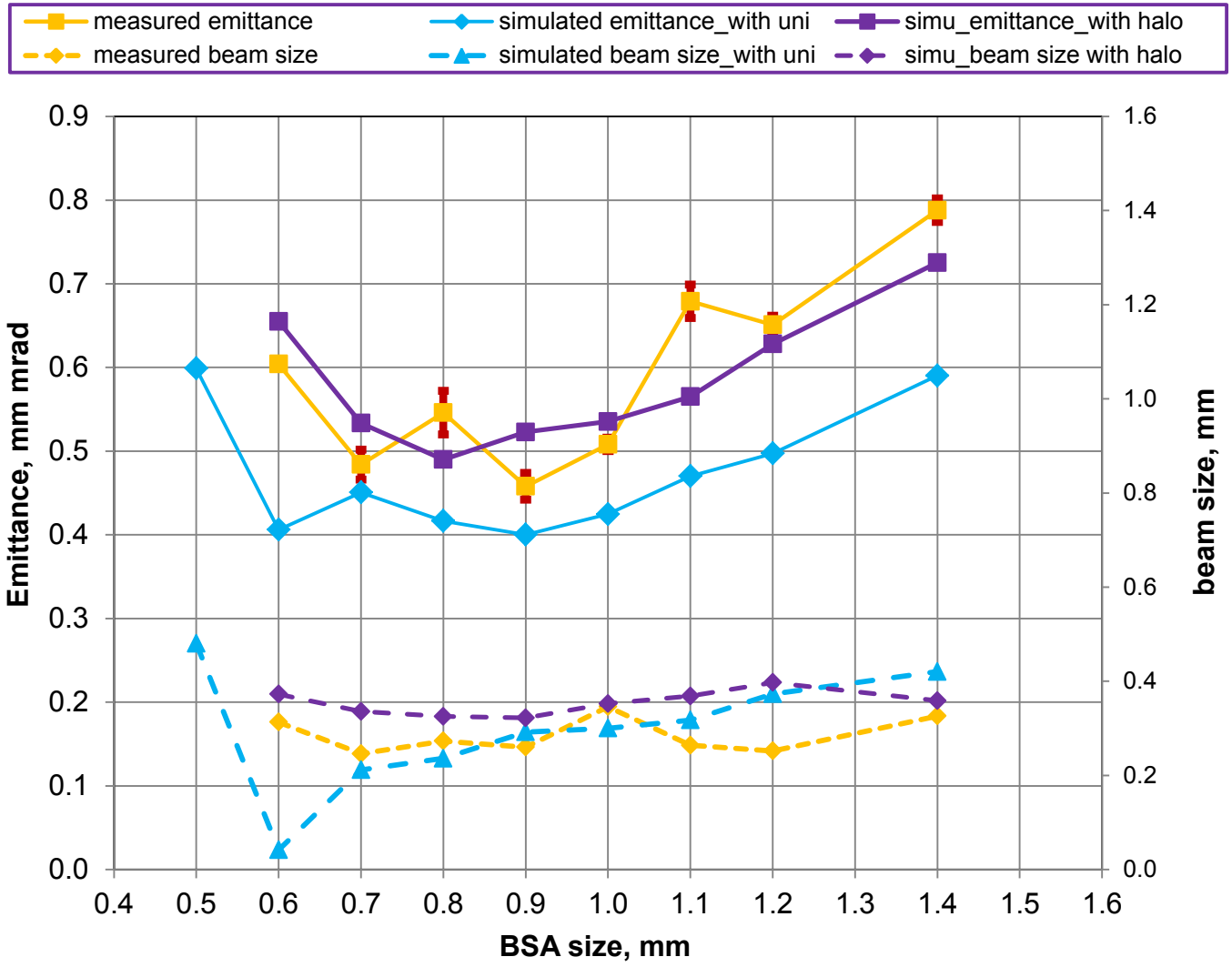

Core+halo



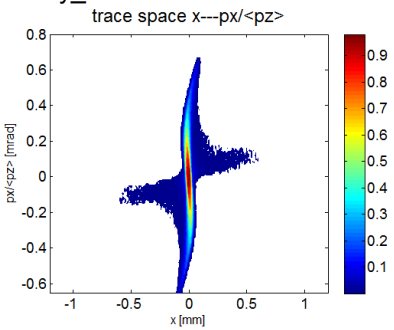
# Results for 100 pC

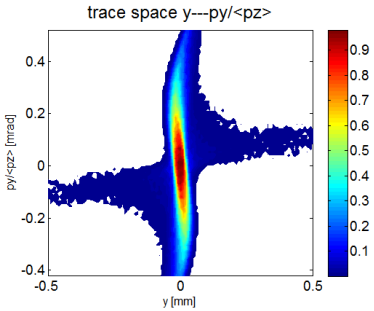


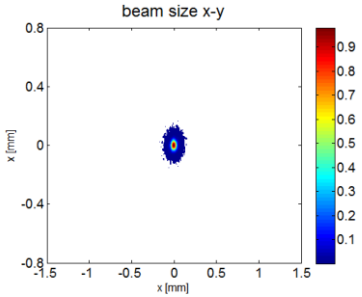
# Phase space compared for BSA = 0.6 mm, 100pC

## simulated trace space Uniform distribution

Exy_sim=0.407 mm mrad



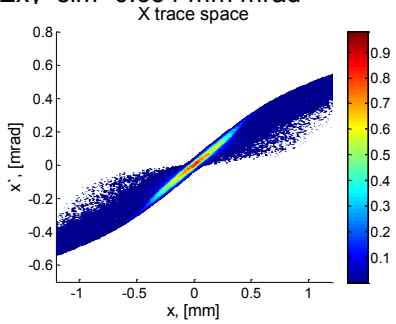



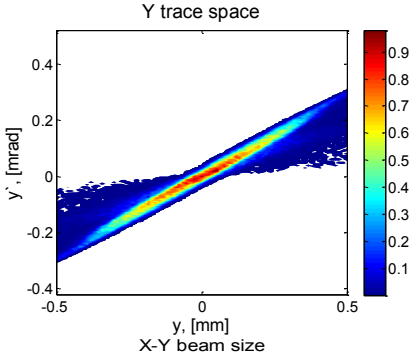



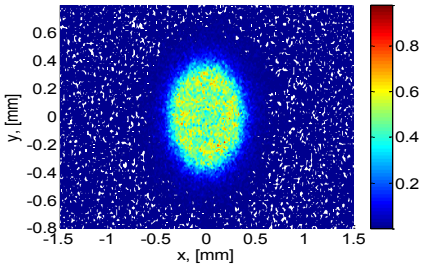

beam size at EMSY1
Xrms= 0. 043mm, yrms=0. 043mm

## simulated trace space with halo

Exy sim=0.654 mm mrad



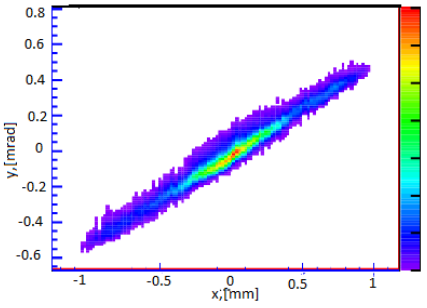



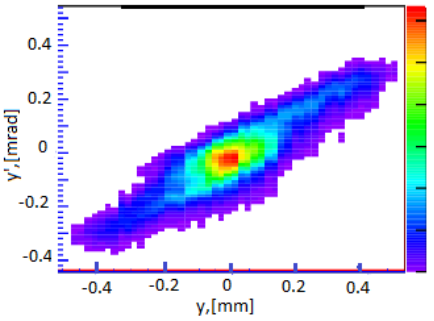



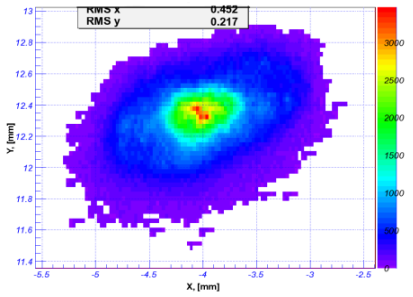

beam size at EMSY1
Xrms= 0.372 mm, yrms=0.372 mm

## Measured trace space

Measurement: Exy_sta= 0.604 mm mrad



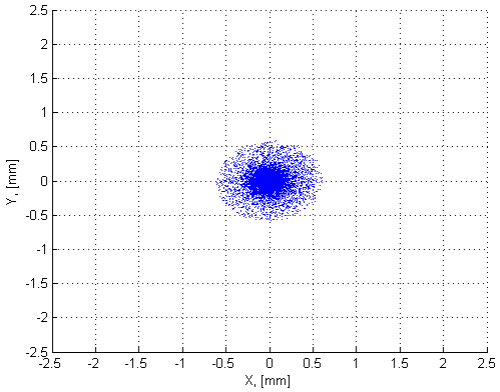



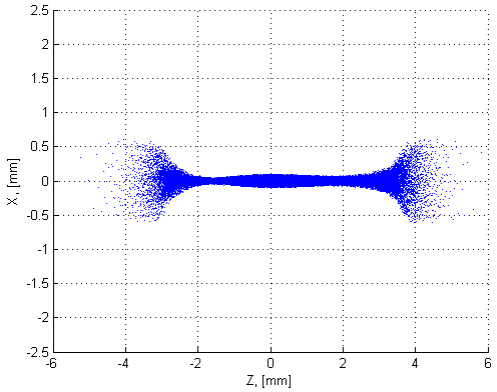



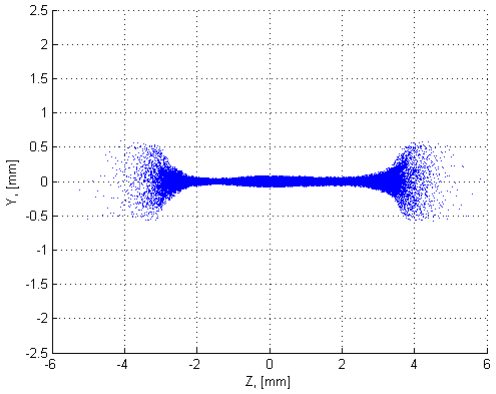

Measurement beam size at EMSY1
Xrms=140mm,Yrms= 0.162 mm

# Particle distribution for BSA = 0.6 mm, 100pC

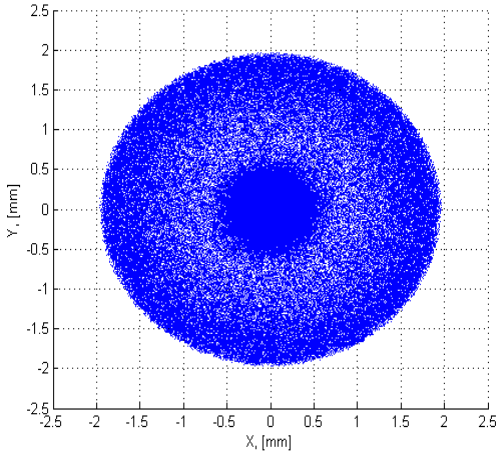
simulated with uniform distribution

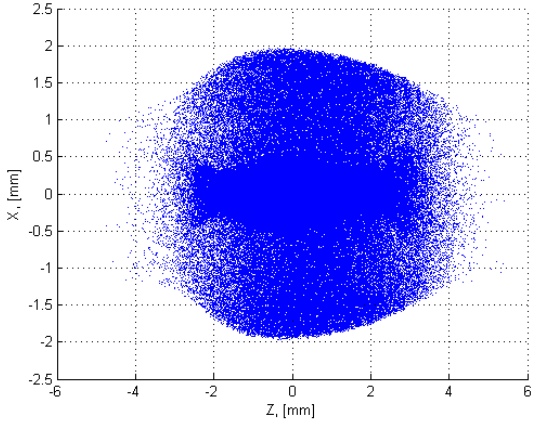


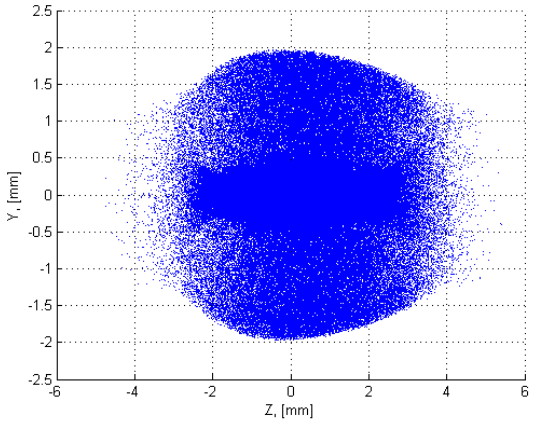




simulated with core+halo distribution



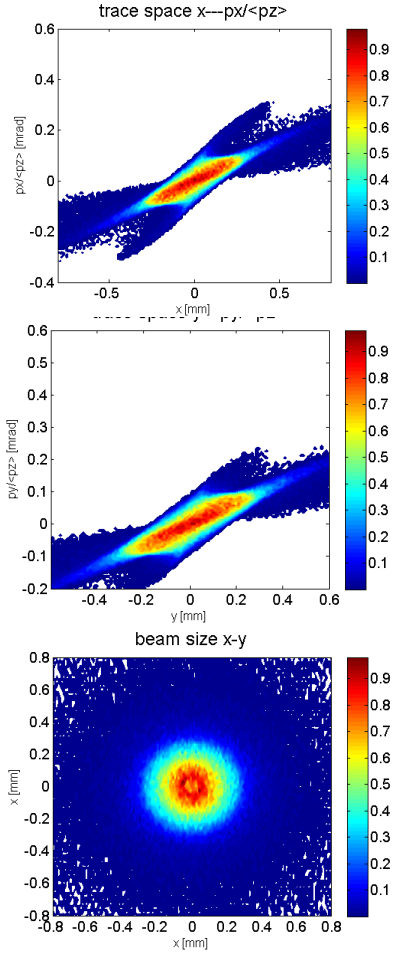



# Phase space compared for BSA = 0.9 mm, 100pC

## simulated phase space Uniform distribution

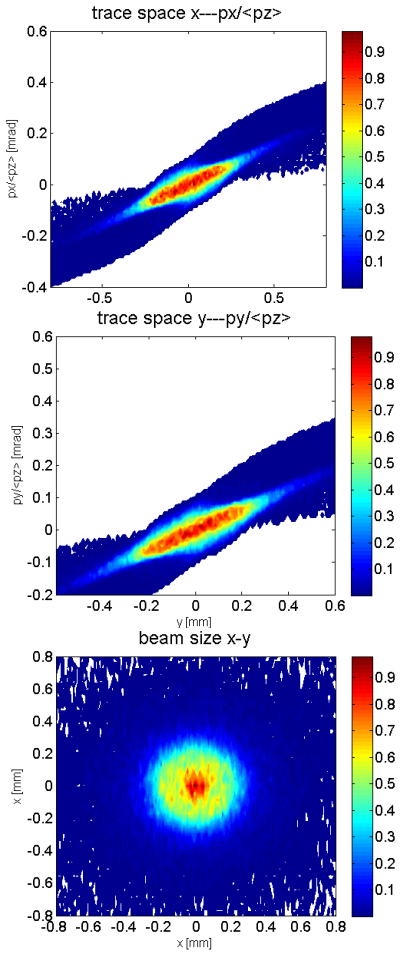
Simulation: Exy_sim=0.402 mmmrad




beam size at EMSY1
Xrms= 0.269 mm, yrms=0.259 mm

## simulated phase space with core+halo

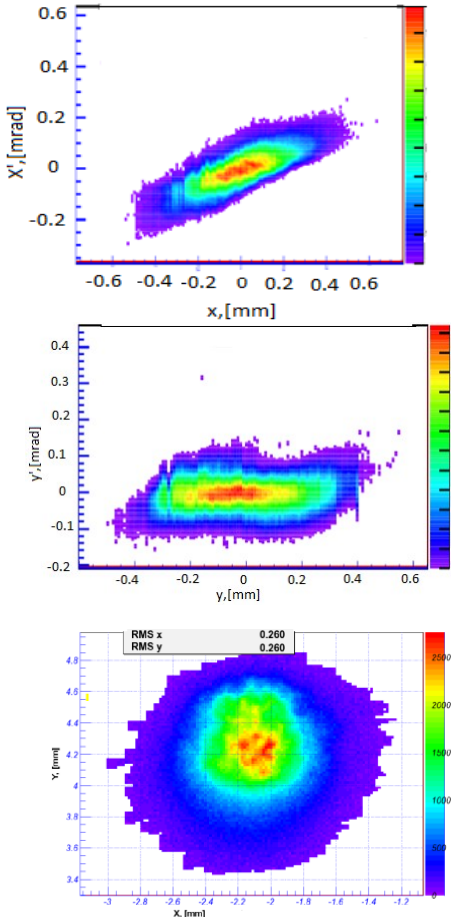
Simulation: Exy_sim= 0.522mmmrad




beam size at EMSY1
Xrms= 0.322mm, yrms=0.321 mm

## Measured phase space

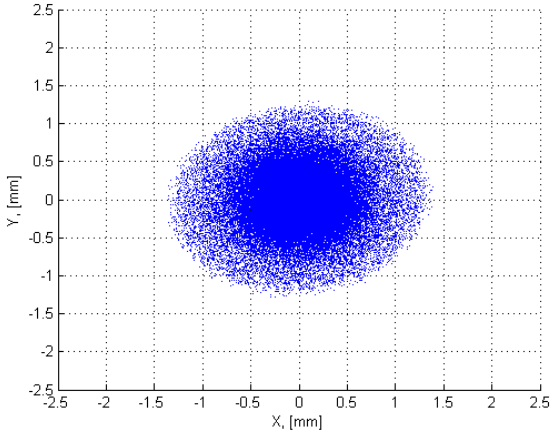
Measurement: Exy_sta=0.458 mmmrad

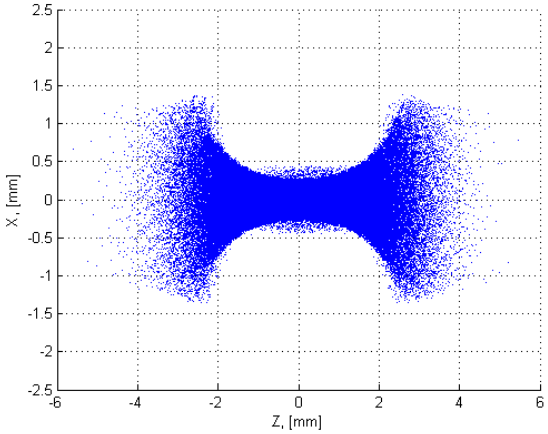


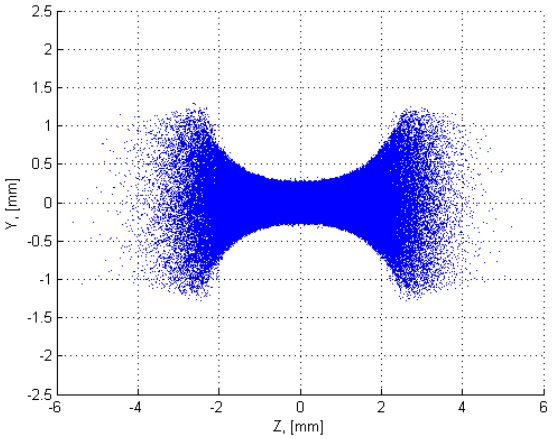

Measurement beam size at EMSY1,Xrms=yrms=0.26 mm

# Particle distribution for BSA = 0.9 mm, 100pC

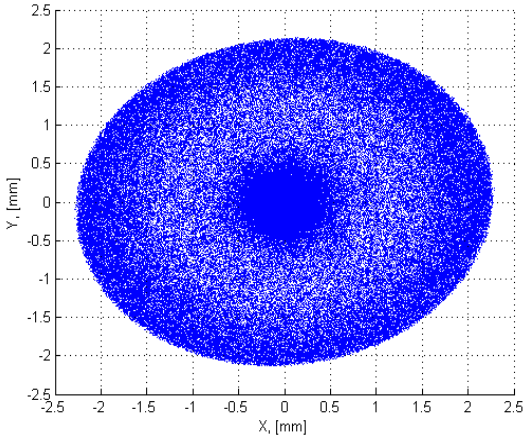
## simulated with uniform distribution

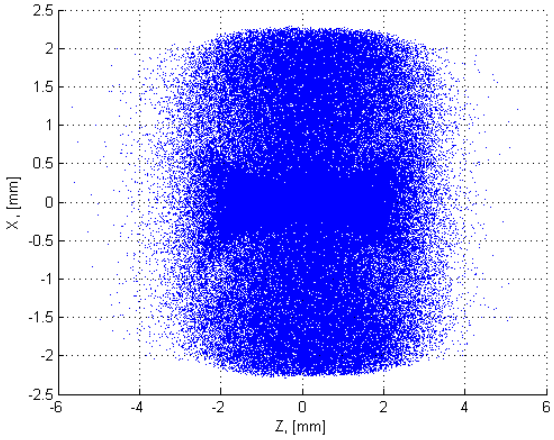


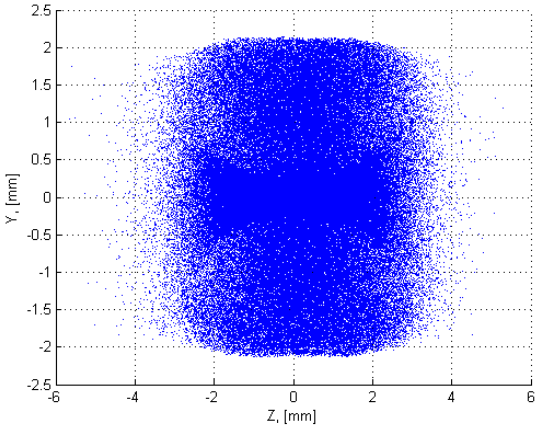



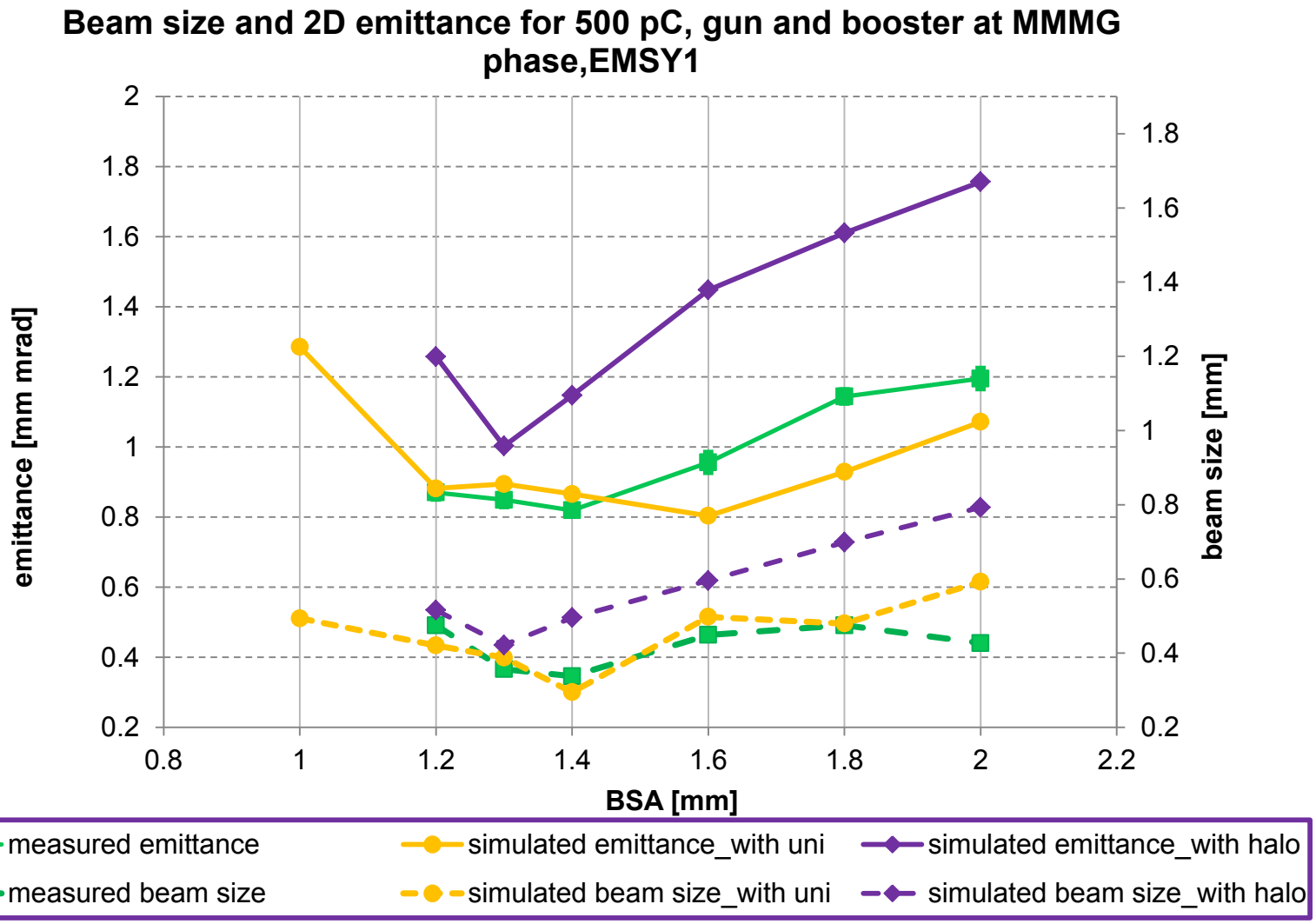

## simulated with core+halo distribution



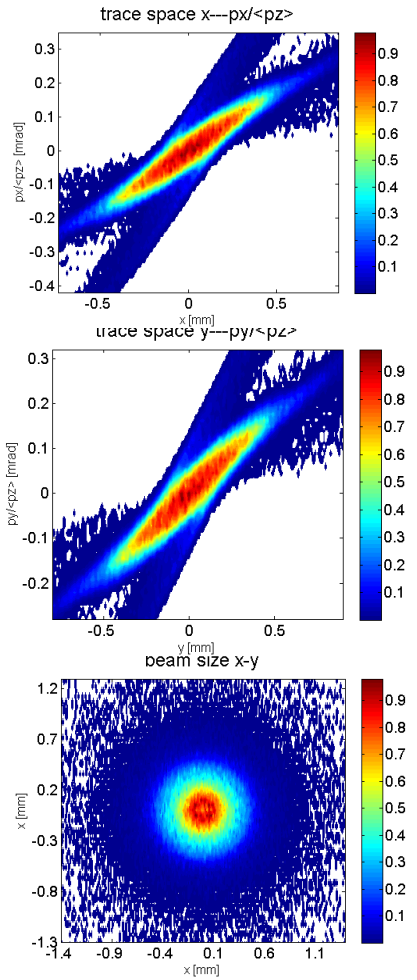
# Results for 500 pC



# Phase space compared for BSA = 1.4 mm, 500pC

## simulated phase space Uniform distribution

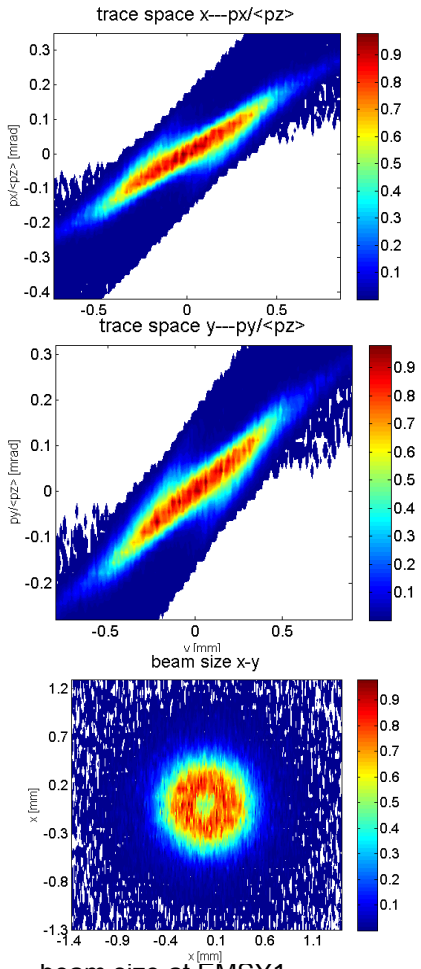
Simulation: Exy_sim=0.893mm mrad




beam size at EMSY1
Xrms= 0.355mm, yrms= 0.355mm

## simulated phase space with core+halo

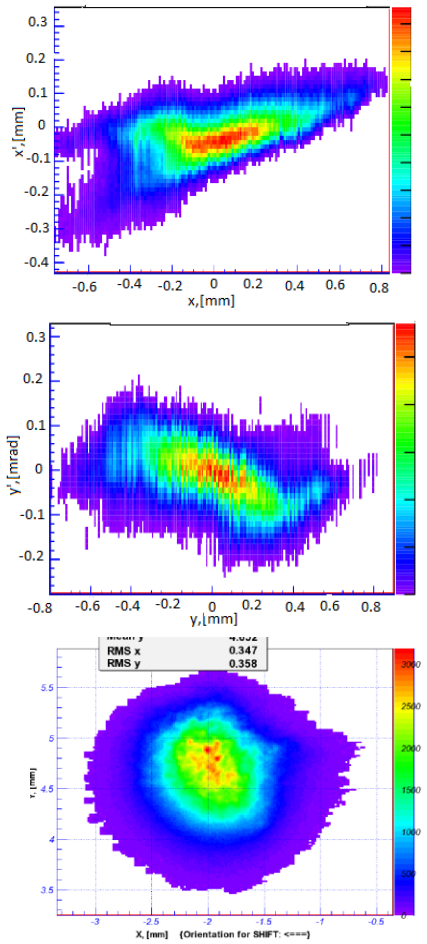
Simulation: Exy_sim= 1.14mmmrad




beam size at EMSY1
Xrms=0.495mm, yrms=0.495mm

## Measured phase space

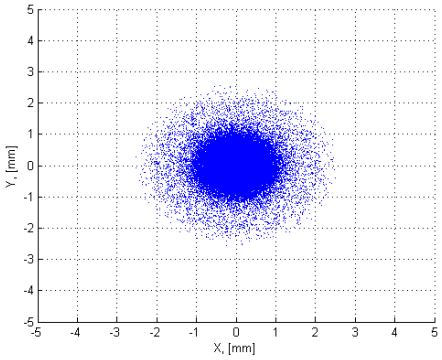
Measurement: Exy_sta=0.819mmmrad

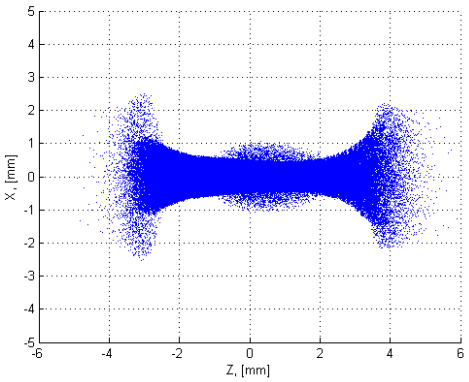


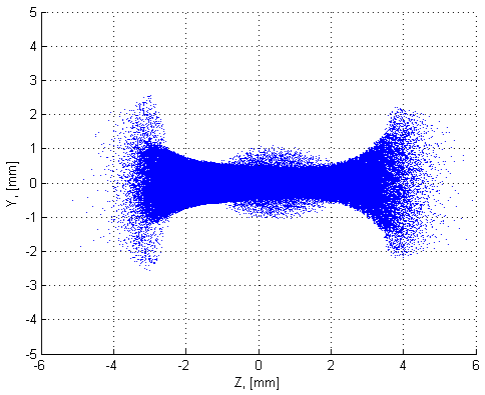

Measurement beam size at EMSY1
Xrms=0.347mm yrms=0.358mm

# Particle distribution for BSA = 1.4 mm, 500pC

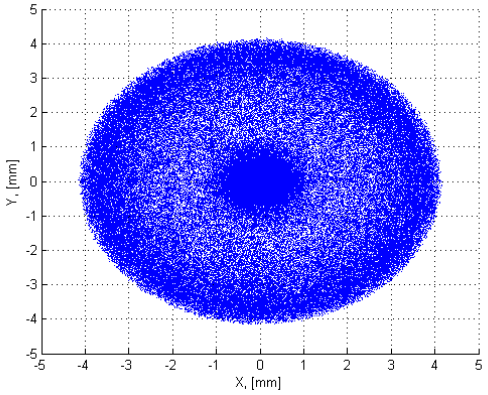
simulated with uniform distribution

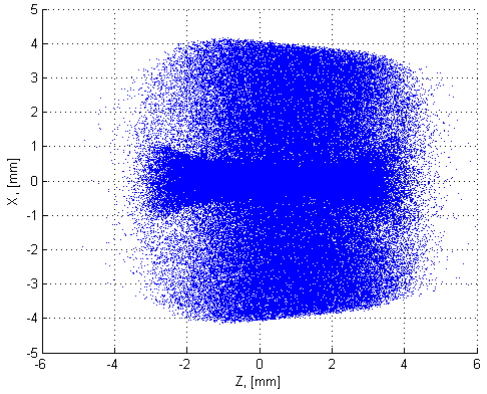


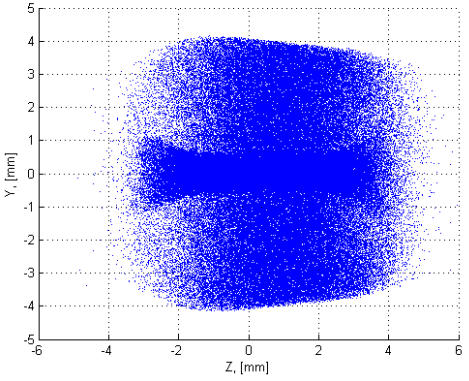




simulated with core+ halo distribution



# conclusions

- For low charge 100 pC, the simulated emittance results with core+halo input distribution are more closer to the measured results than with uniform input distribution simulation, especially for small BSA.
- For large charge 500 pC, the simulated emittance results with core+halo beam distribution are much larger than measured and with uniform distribution simulation results.
- Compared with uniform beam distribution simulation, the halo makes the beam particle distribution large.

?charge ratio of halo to core seems too large, put too much charge in halo area for large bunch charge.

- The simulation for 1 nC will be taken after the emittance measurement.