



Trace space reconstruction of pepperpot data

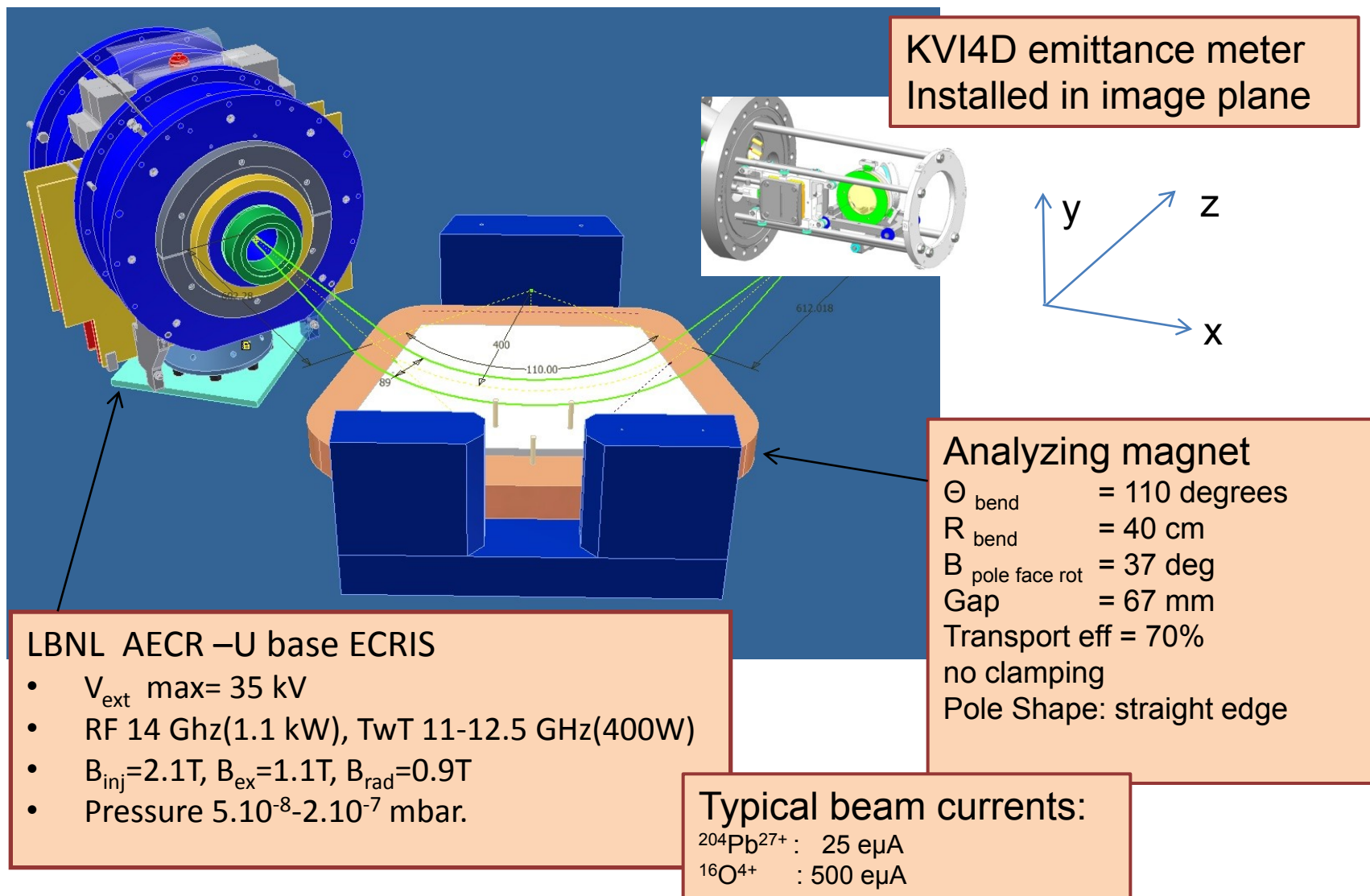
H.R. Kremers

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Content

- AECR source setup.
- KVI4D pepper pot emittance meter.
- Trace space measurement.
- Analysis (reconstruction)
- Results (projections)
- Conclusions.

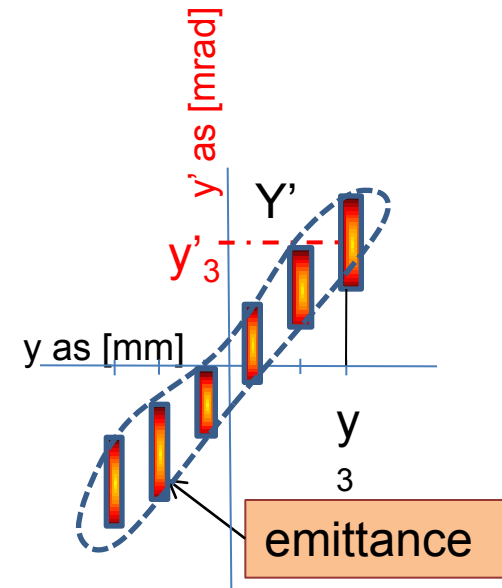
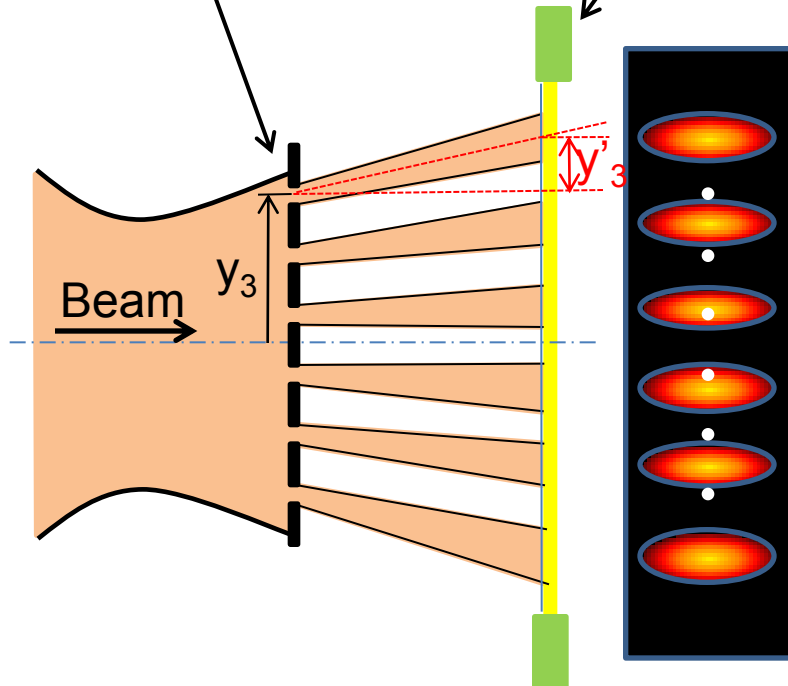
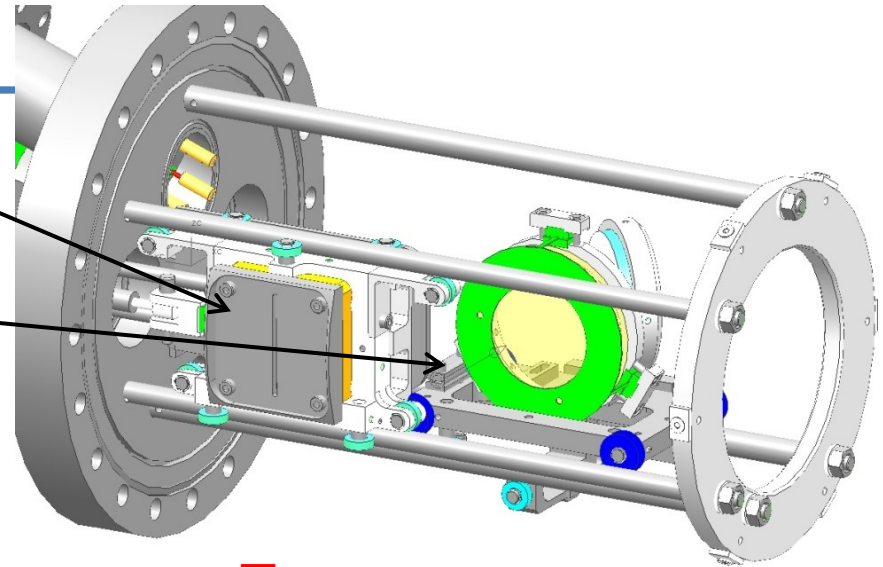
AECR ion source setup



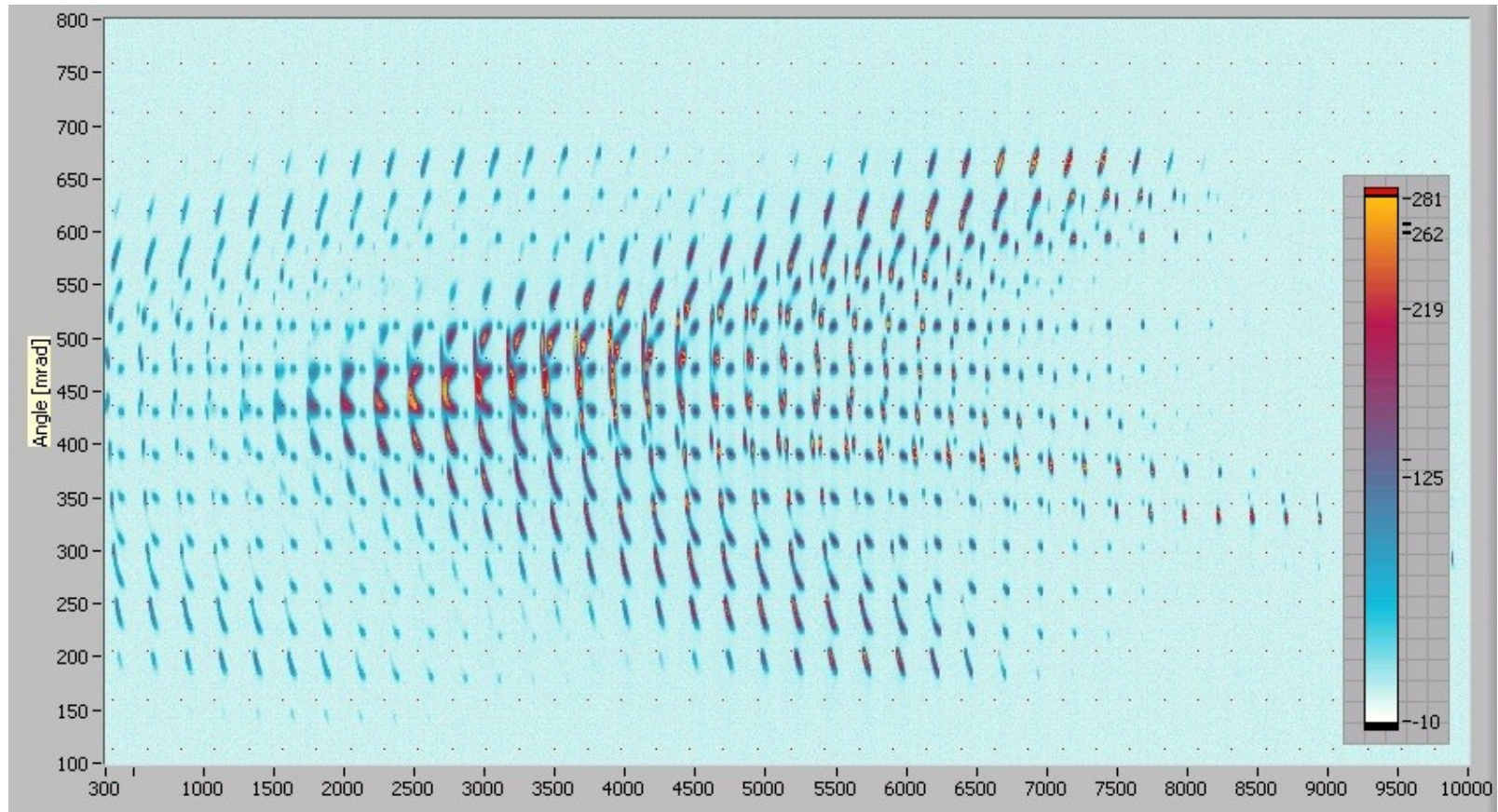
KVI4D pepper pot emittance meter

Pepper pot plate (array 20 x $\varnothing 20$ micron holes)

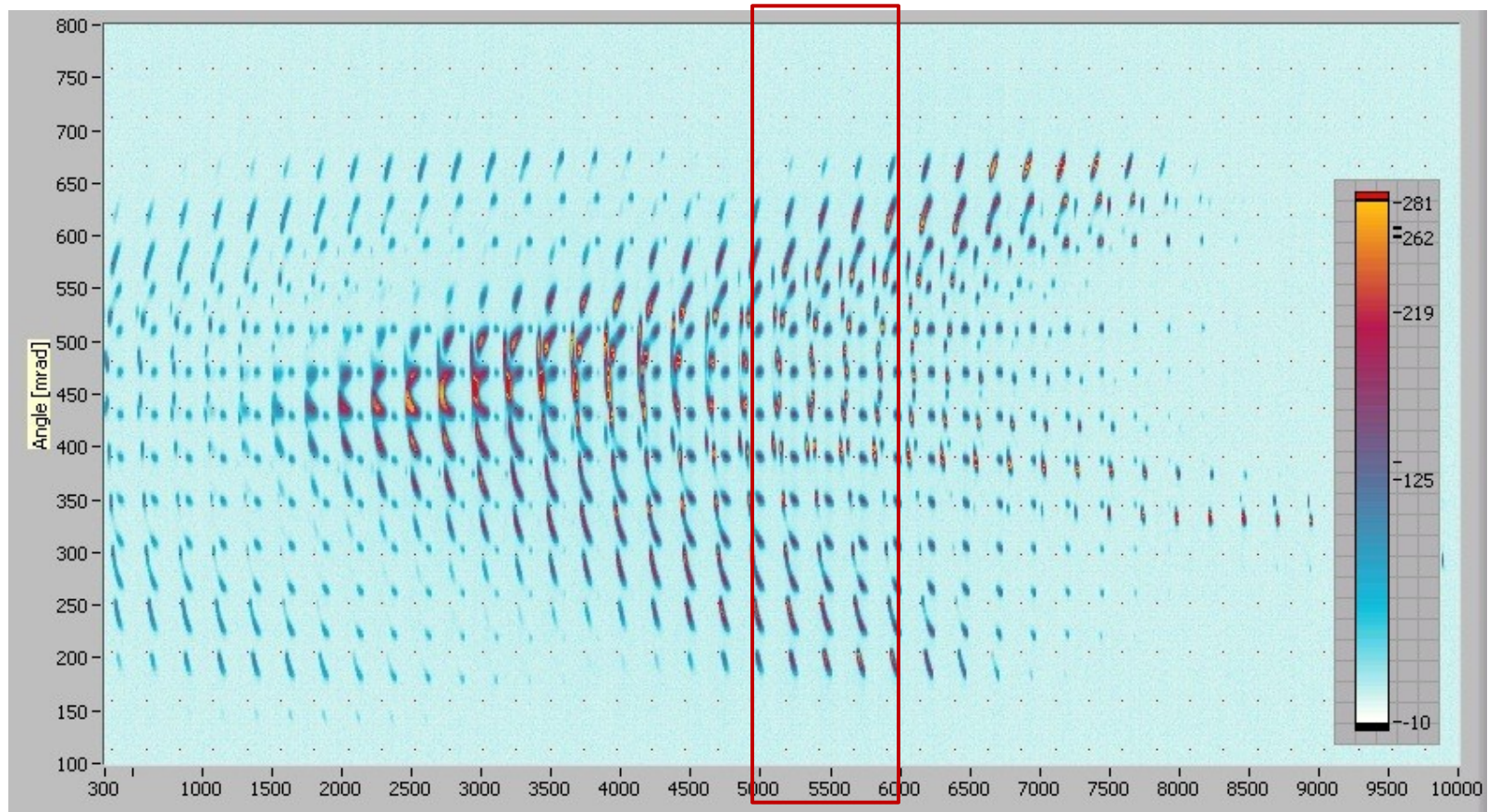
Multi channel plate detector



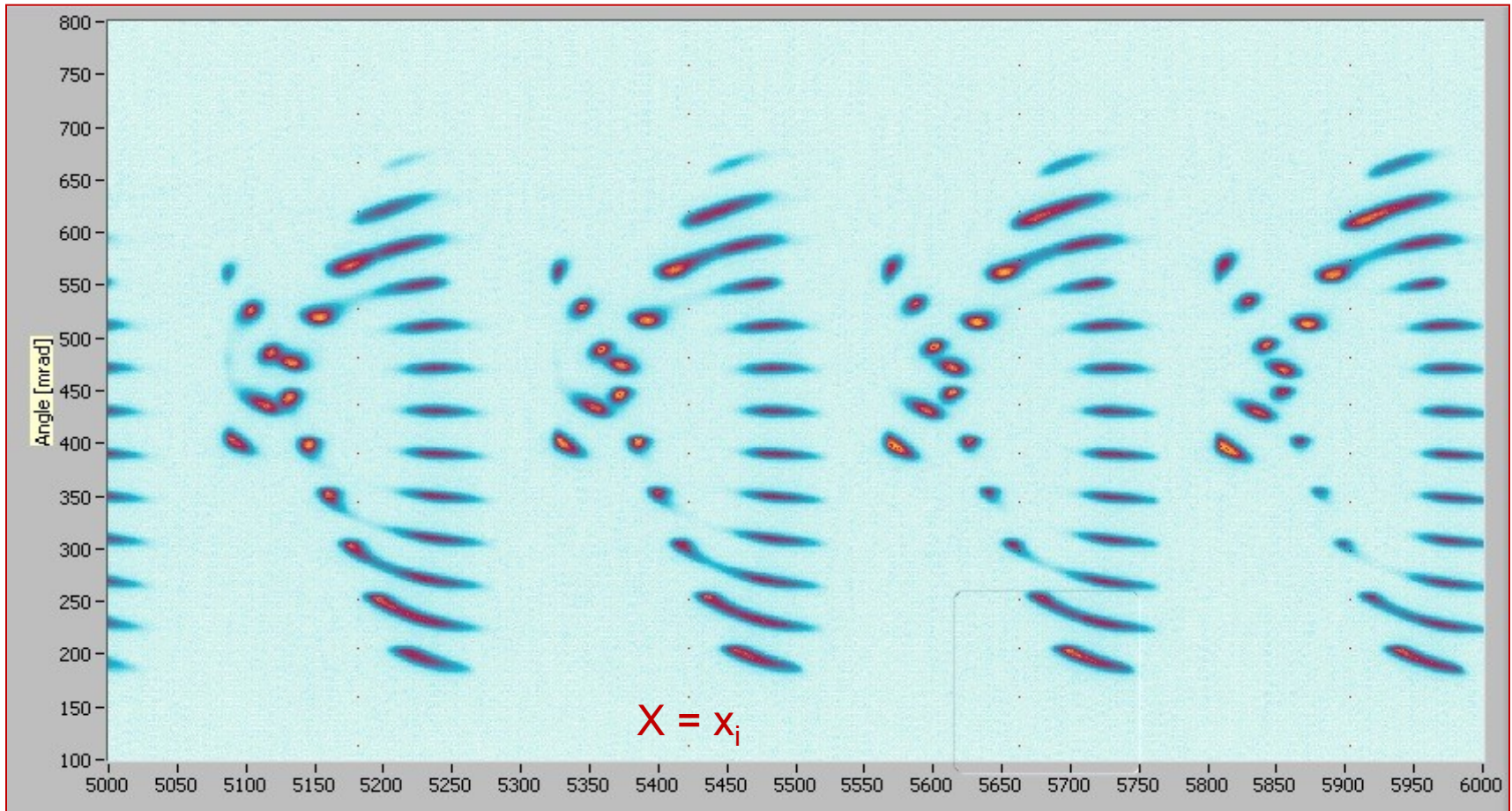
Trace space of a 21 keV He^{1+} beam



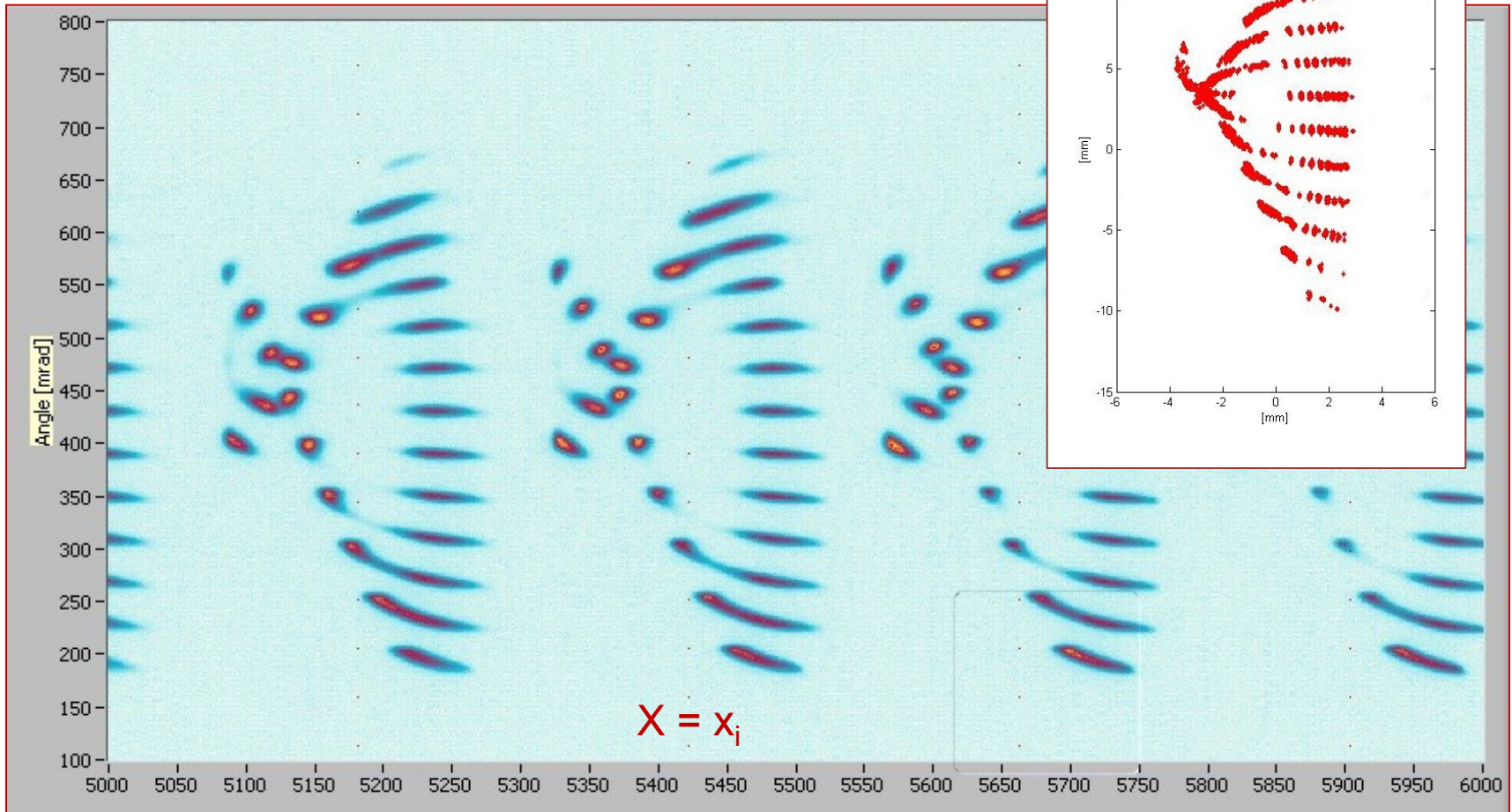
Trace space of a 21 keV He^{1+} beam



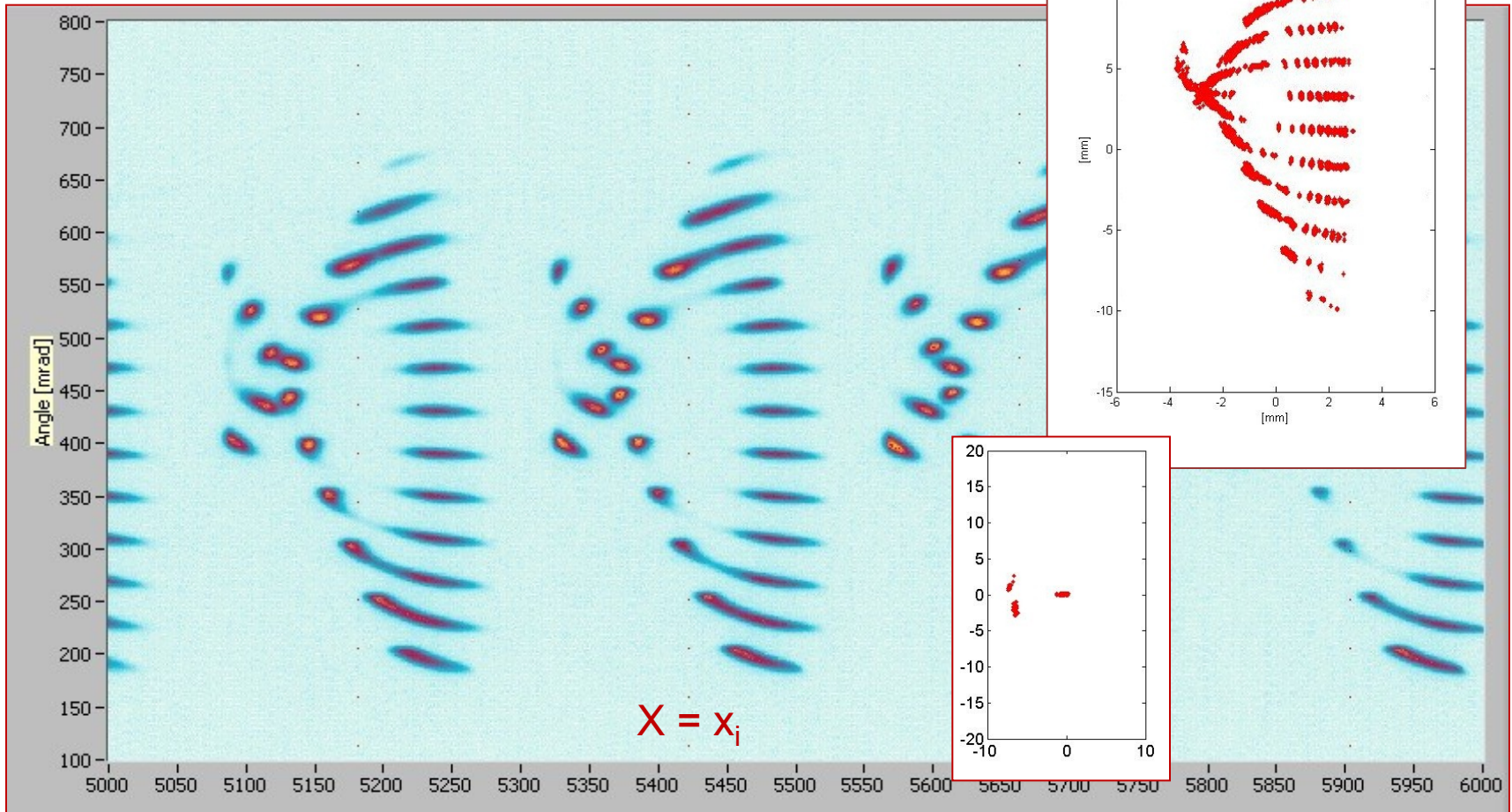
Response distribution of array of 20 holes on four positions in the beam



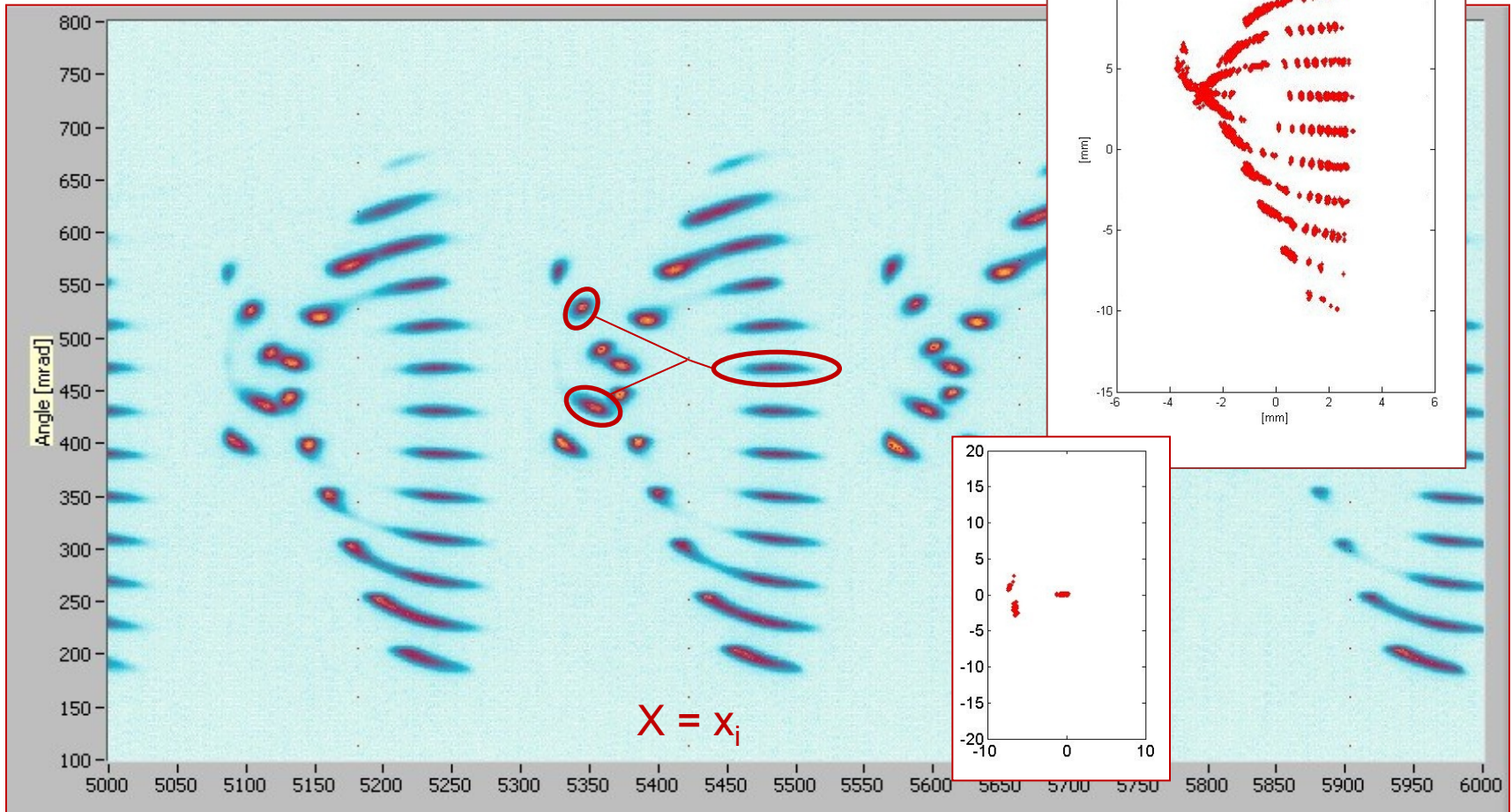
Response distribution of array of 20 holes on four positions in the beam



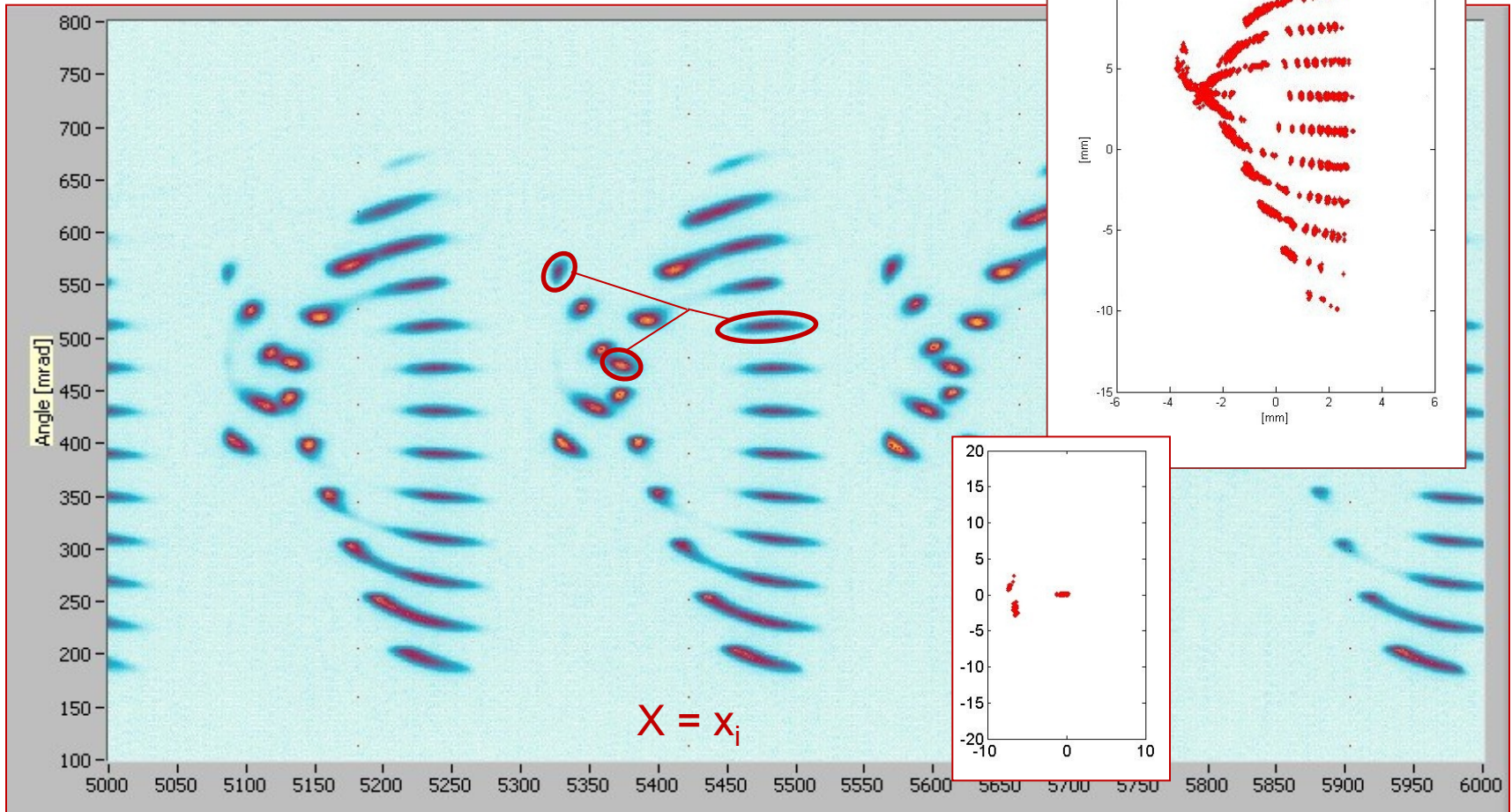
Response distribution of array of 20 holes on four positions in the beam



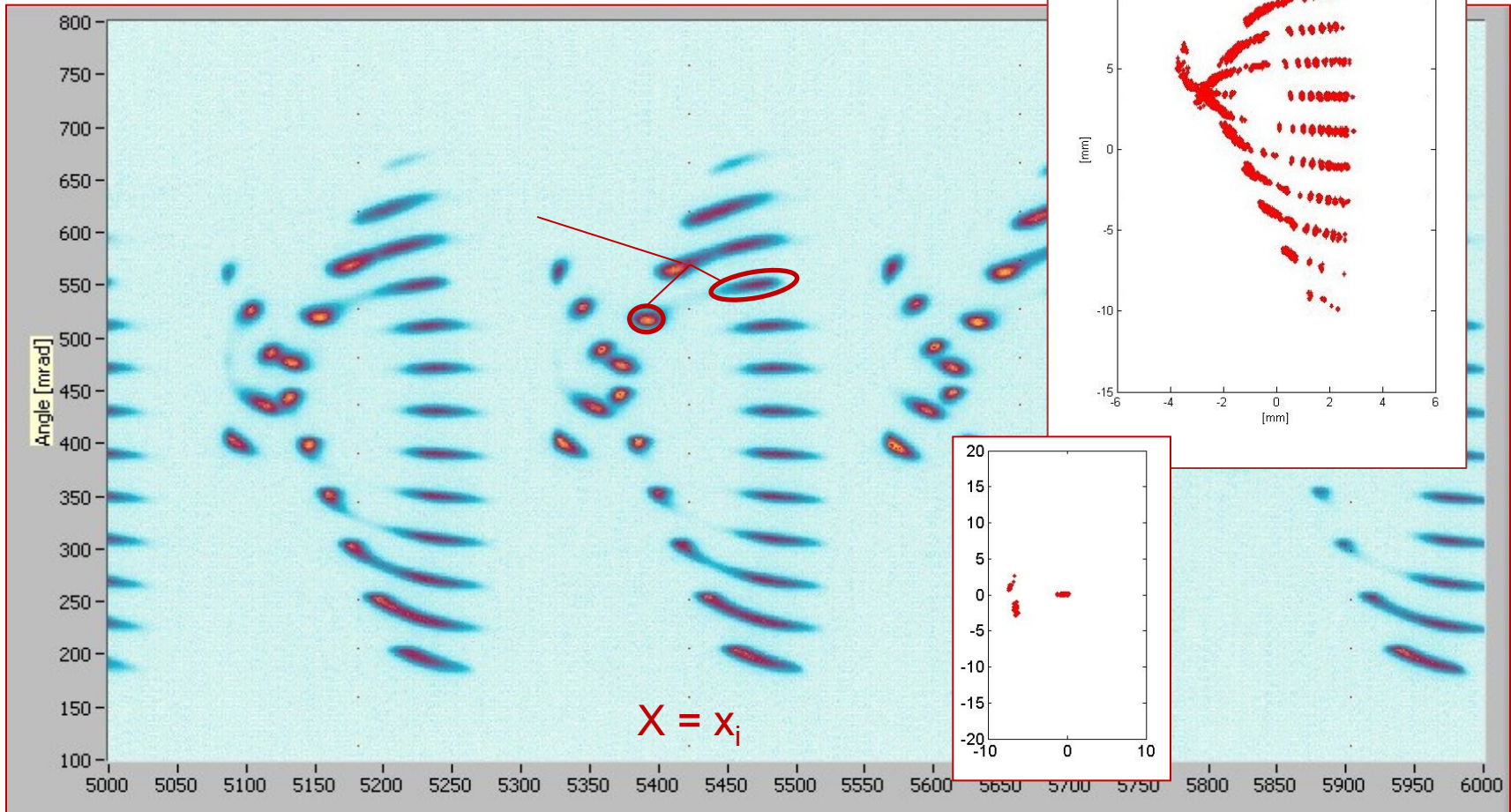
Response distribution of array of 20 holes on four positions in the beam



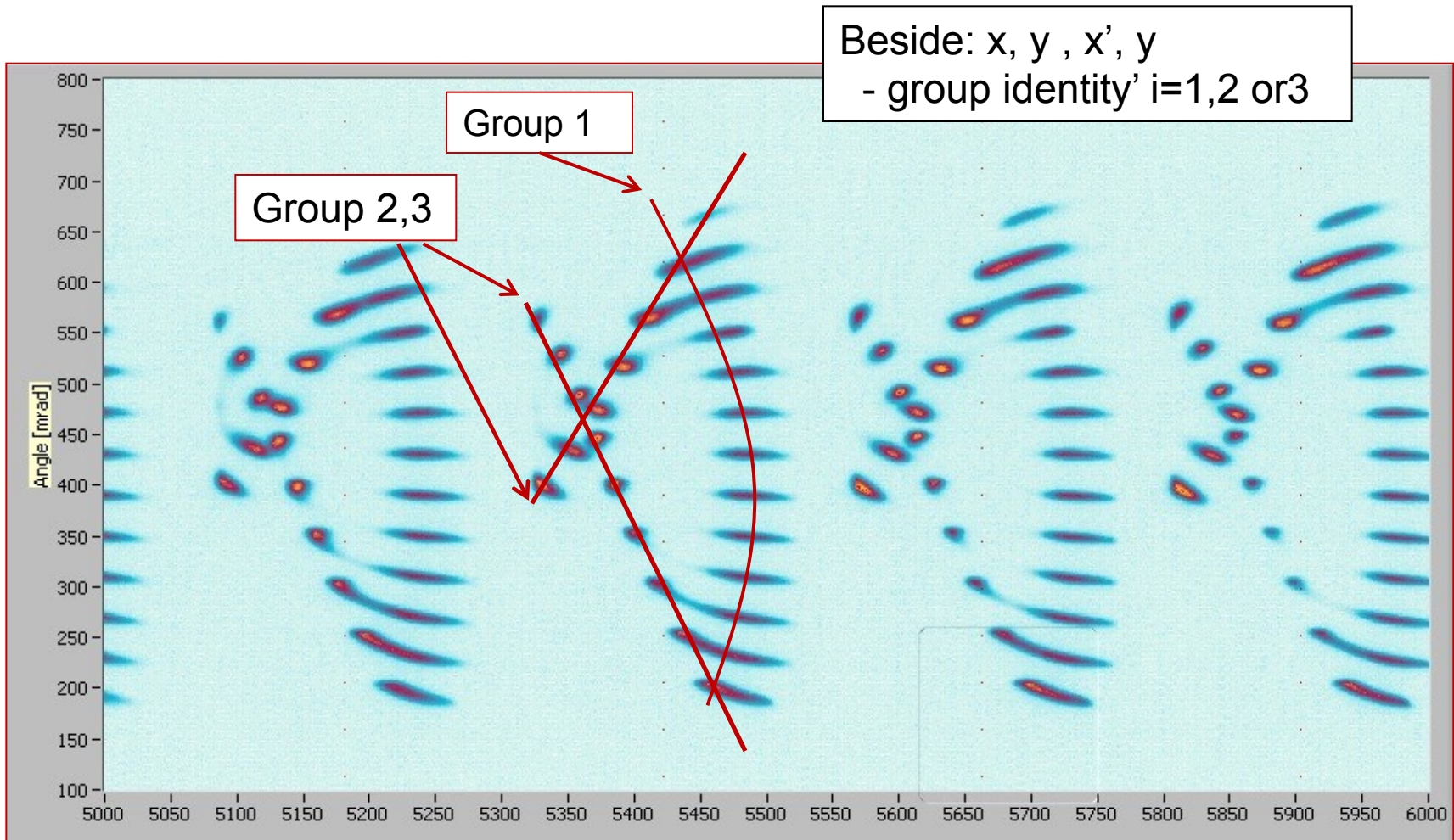
Response distribution of array of 20 holes on four positions in the beam



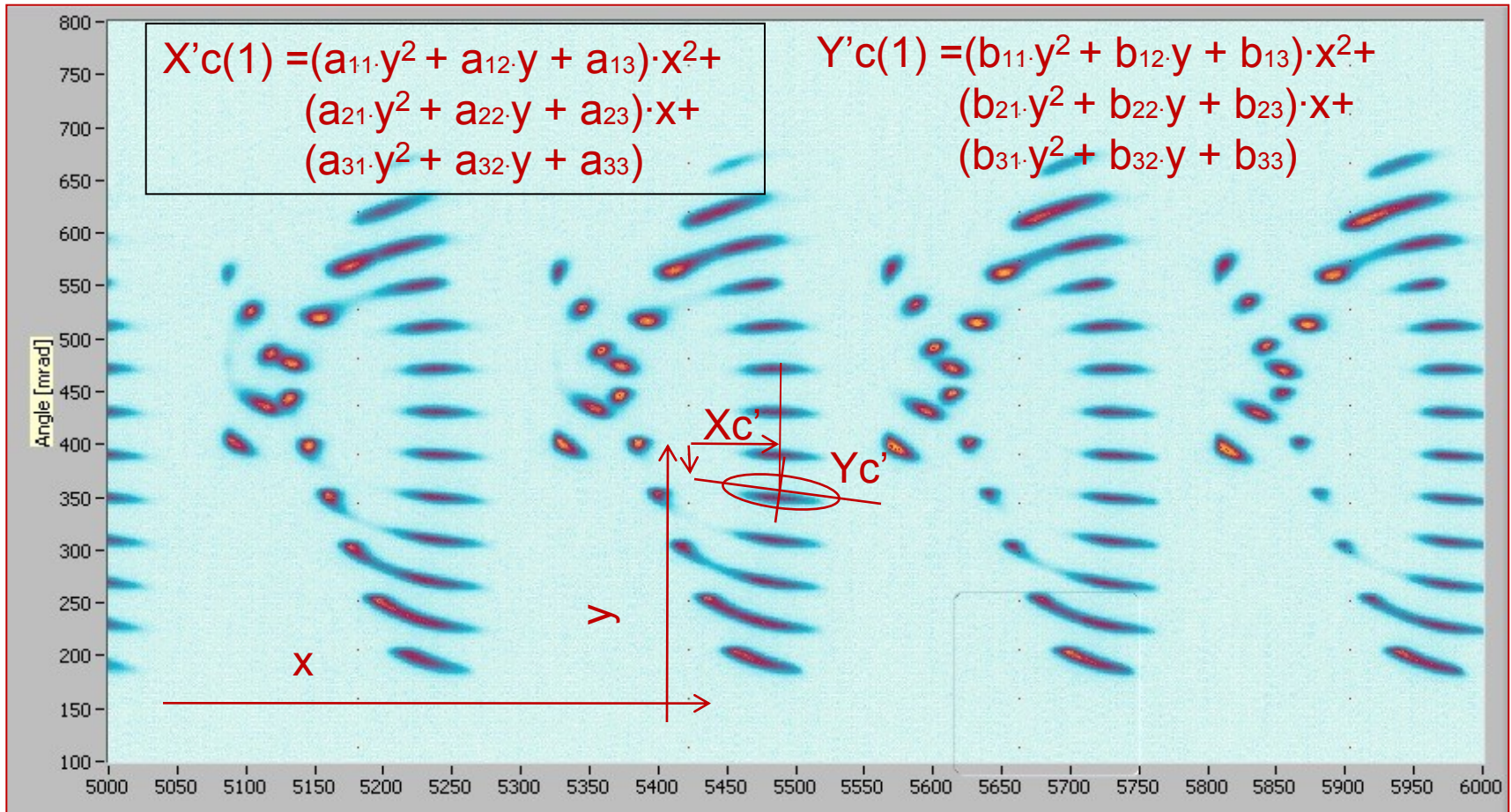
Response distribution of array of 20 holes on four positions in the beam



Overlap of response distributions



Data modeling.



The four dimensional dataset

$$P_i = \mathcal{D} [x, y, x', y']_i$$

- Dataset is unambiguous
 - Extra label (i) for group 1,2 or 3.
- Projections in the image plane as function of (i).
 - x-y projection known as viewing screen
 - x-x'projection used for a x-x'emittance
 - y-y'projection used for a y-y'emittance
 - x'-y'projection

Result of the model

x-y projection. (viewing screen projection)

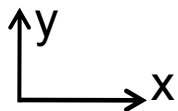
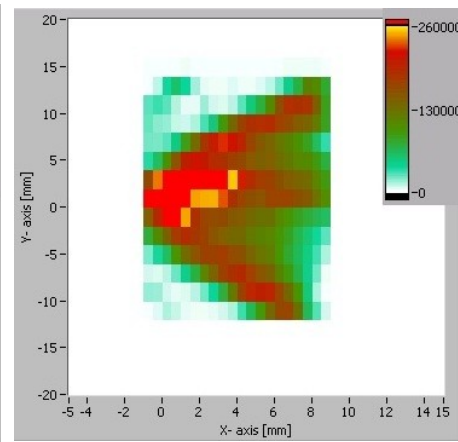
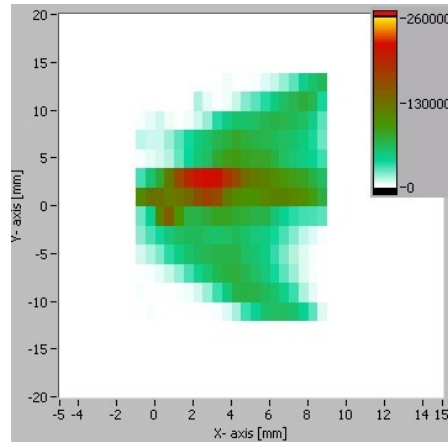
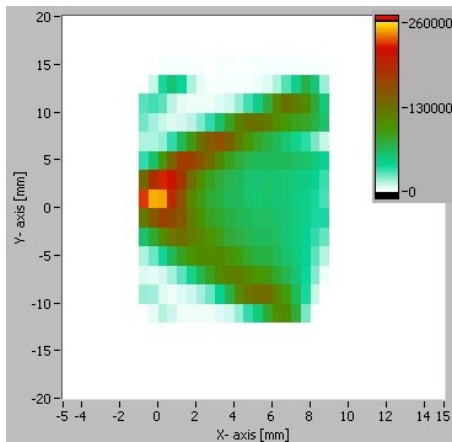
$$P(x, y)_{i=1} = \int_{y'=-0.0001}^{y'=0.0001} \int_{x'=-0.0001}^{x'=0.0001} \rho(x, y, x', y') dx' dy'$$

i=1

i=2,3

i=1,2 and 3

camera recording



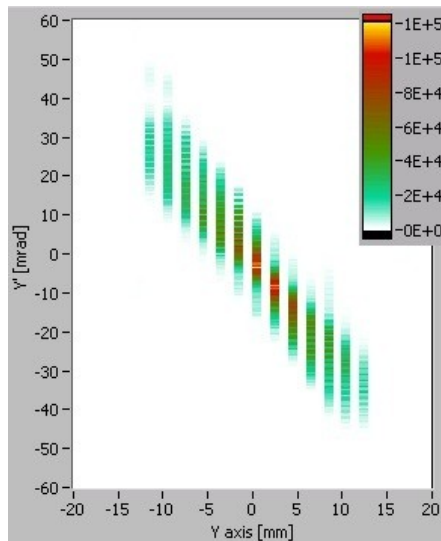
The emittances in the image plane

y-y' projection

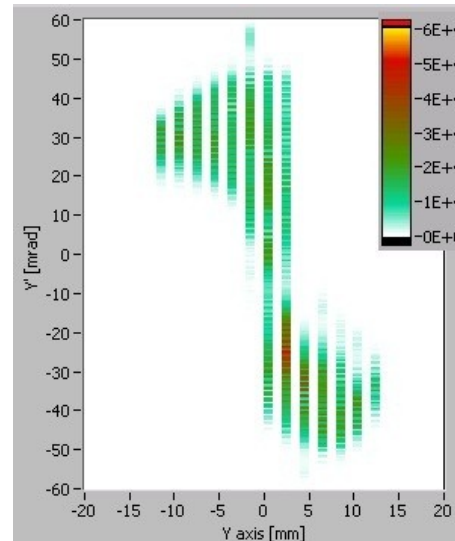
2 sigma 320 π mm mrad

$$P(y, y') = \int_{x=-2\text{mm}}^{x=2\text{mm}} \int_{x'=0\text{mrad}}^{x'=0\text{mrad}} \rho(x, y, x', y') dx dx'$$

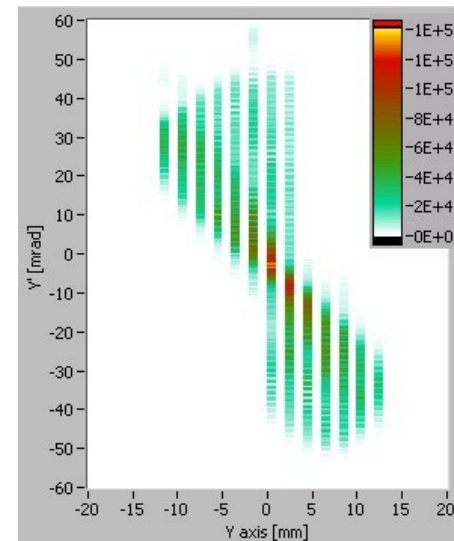
group 1



group 2,3



group 1,2,3

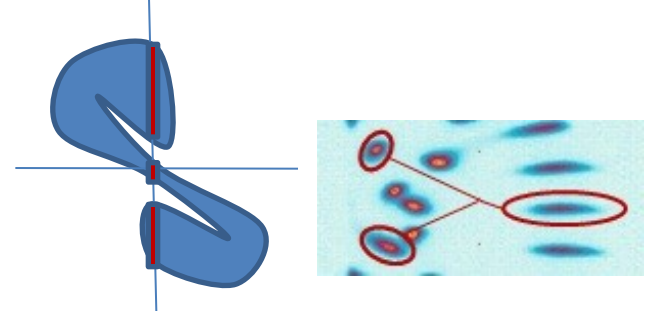


The emittances in the image plane

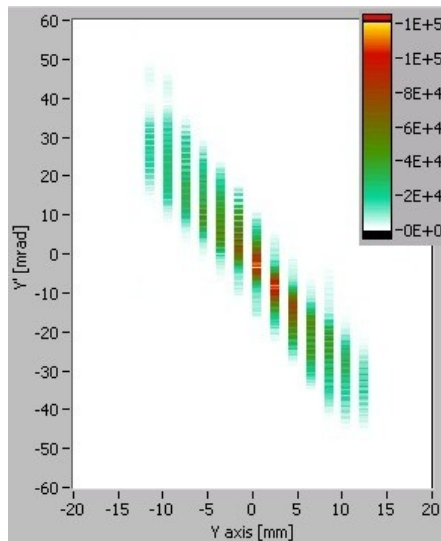
y-y' projection

$$P(y, y') = \int_{x=-2\text{mm}}^{x=2\text{mm}} \int_{x'=0\text{mrad}}^{x'=0\text{mrad}} \rho(x, y, x', y') dx dx'$$

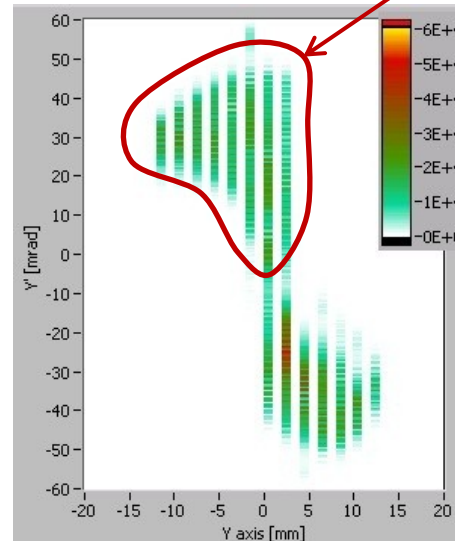
2 sigma 320 π mm mrad



group 1

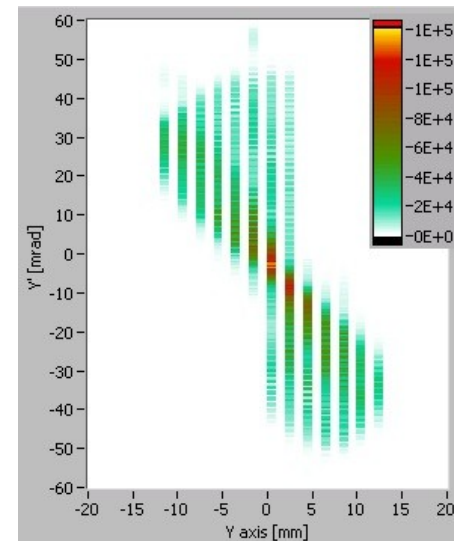


group 2,3



group2

group 1,2,3

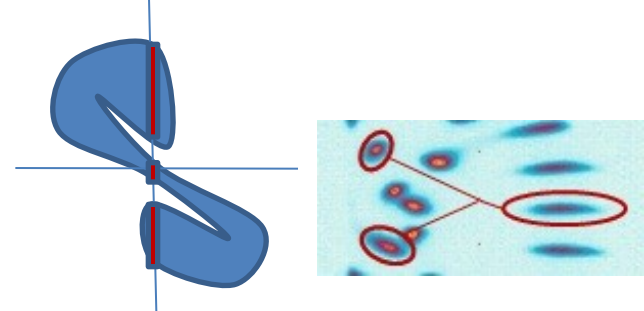


The emittances in the image plane

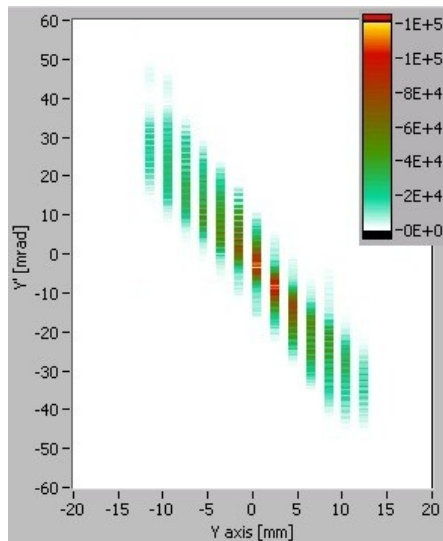
y-y' projection

$$P(y, y') = \int_{x=-2\text{mm}}^{x=2\text{mm}} \int_{x'=0\text{mrad}}^{x'=0\text{mrad}} \rho(x, y, x', y') dx dx'$$

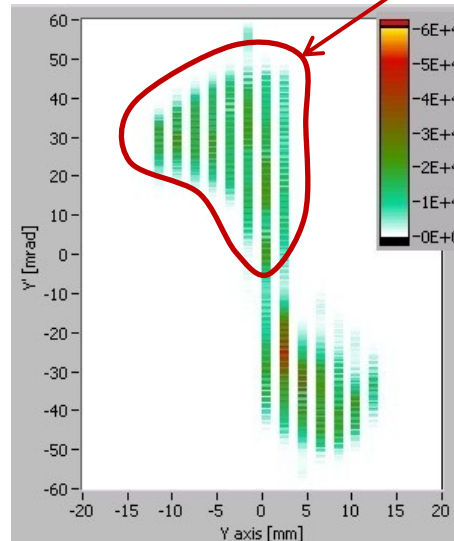
2 sigma 320 π mm mrad



group 1

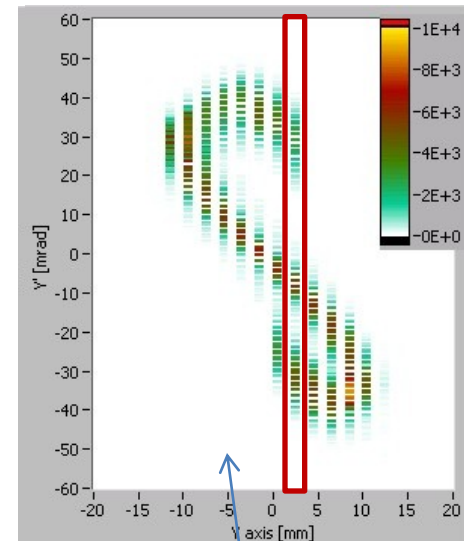


group 2,3



group2

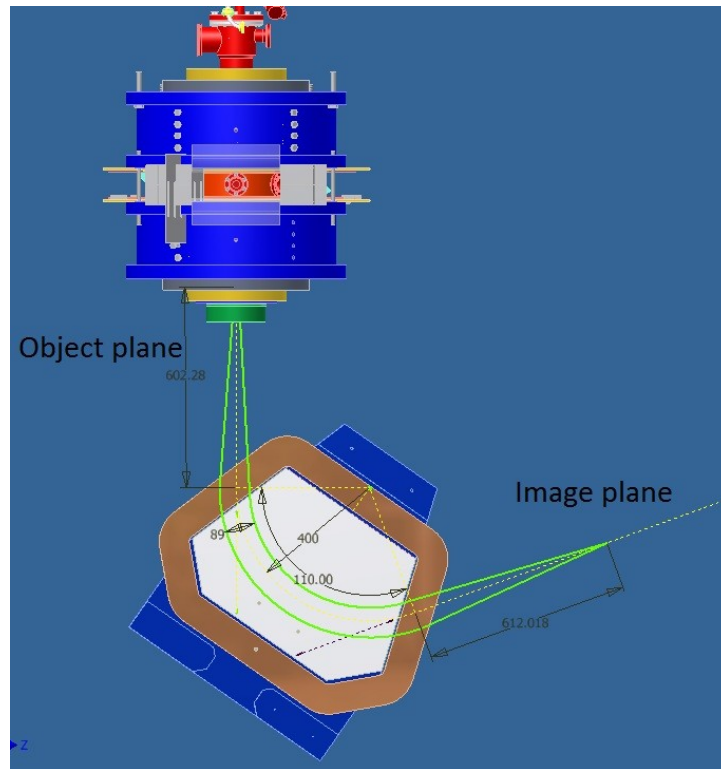
group 1,2,3



y-y' for only one x position: x=-10

Transformation to object plane in 2^{de} orde

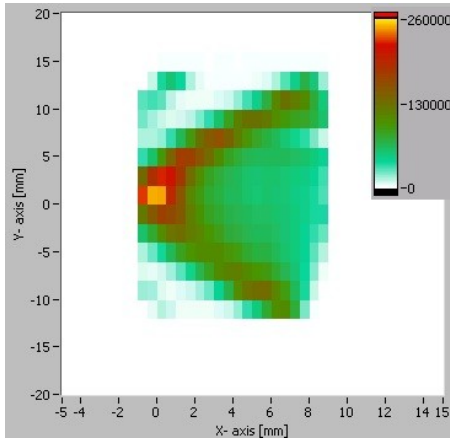
$$P_{i \text{ image plane}} = \rho \begin{bmatrix} x, x', y, y' \end{bmatrix}_{i \text{ image plane}}$$



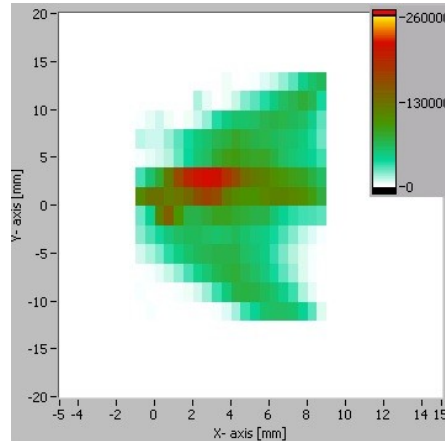
$$P_{im} = M^{2^{de}} \cdot P_{obj} \rightarrow P_{obj} = M^{2^{de}}^{-1} \cdot P_{im}$$

Transformation to entrance of M110 of x-y projections (viewing screen projections)

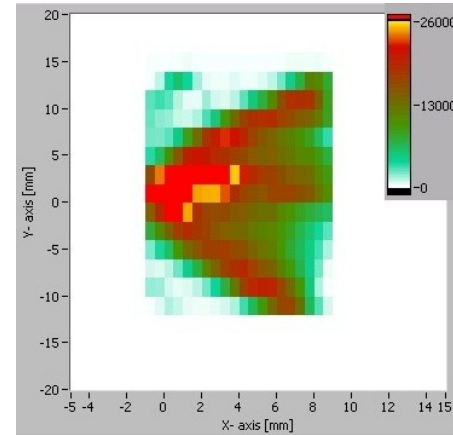
group 1



group 2,3



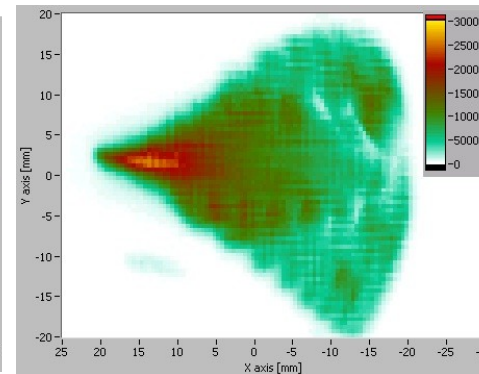
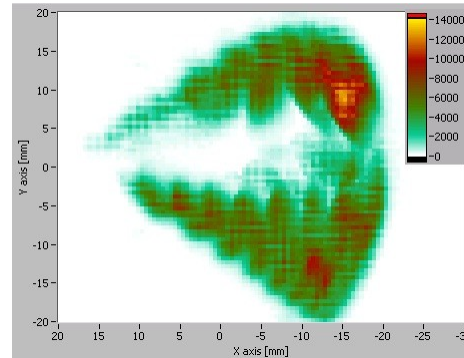
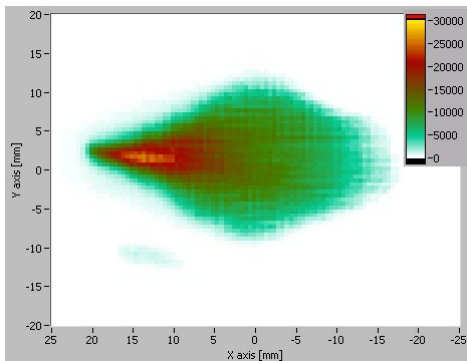
group 1,2,3



$$X_f = M \cdot X_o$$

$$X_o = M^{-1} \cdot X_f$$

In image plane



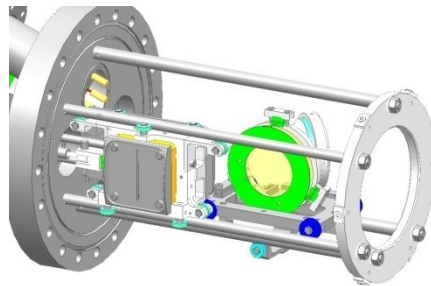
In object plane

Conclusions:

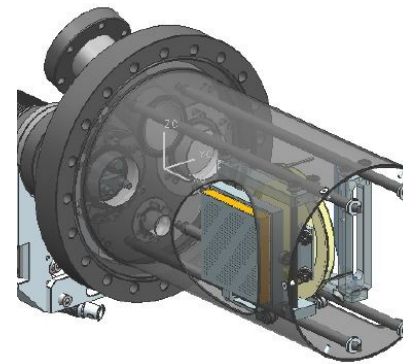
- Dipole induced second order aberration of the beam.
- Group 2,3 created by the dipole fringe field
- Three beams can emerge due to S-shape emittance in y - y' phase-space.
- These Trace-space patterns are not plasma related effects
- Plasma-related effects can be seen at the entrance of the analyzing magnet as a non homogeneous distribution.

Future outlook

- Installation of a new analyzing magnet
 - Compensation for the second order aberration
 - Gap increase with a factor of 2.
- New emittance meter KVI4D-advanced is in construction to operate at G.S.I. (ready feb2011)



KVI4D



KVI4D-ADV

KVI ion source group

- KVI Ion source group
 - Sytze Brandenburg
 - Hans Beijers
 - Vladimir Mironov
 - Suresh Saminathan
 - Jan Mulder
 - Rob Kremers

Thank you for your
attention