Trace space reconstruction of pepperpot data

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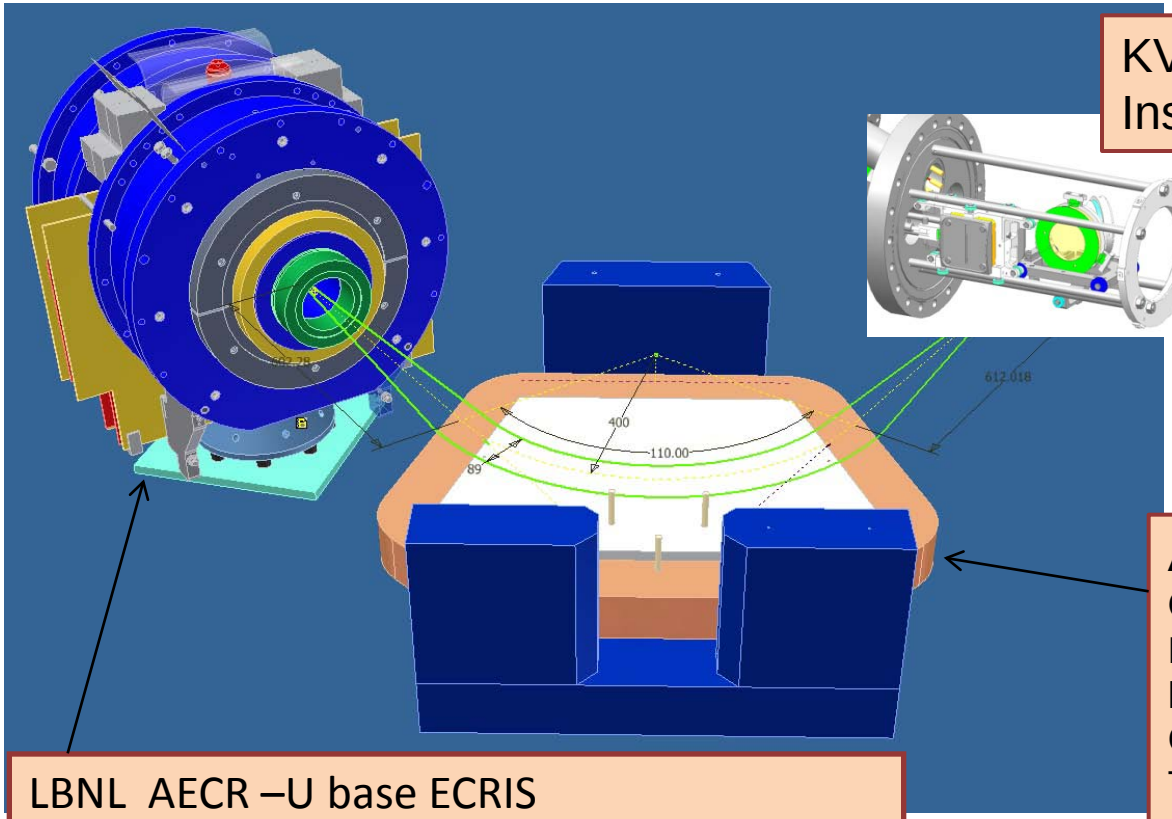
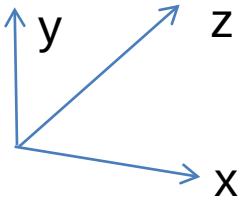
Content

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

AECR ion source setup



KVI4D emittance meter
Installed in image plane



LBNL AECR –U base ECRIS

- V_{ext} max= 35 kV
- RF 14 Ghz(1.1 kW), TwT 11-12.5 GHz(400W)
- B_{inj}=2.1T, B_{ex}=1.1T, B_{rad}=0.9T
- Pressure 5.10^{-8}-2.10^{-7} mbar.

Analyzing magnet

Θ_{bend} = 110 degrees
R_{bend} = 40 cm
$B_{pole\ face\ rot}$ = 37 deg
Gap = 67 mm
Transport eff = 70%
no clamping
Pole Shape: straight edge

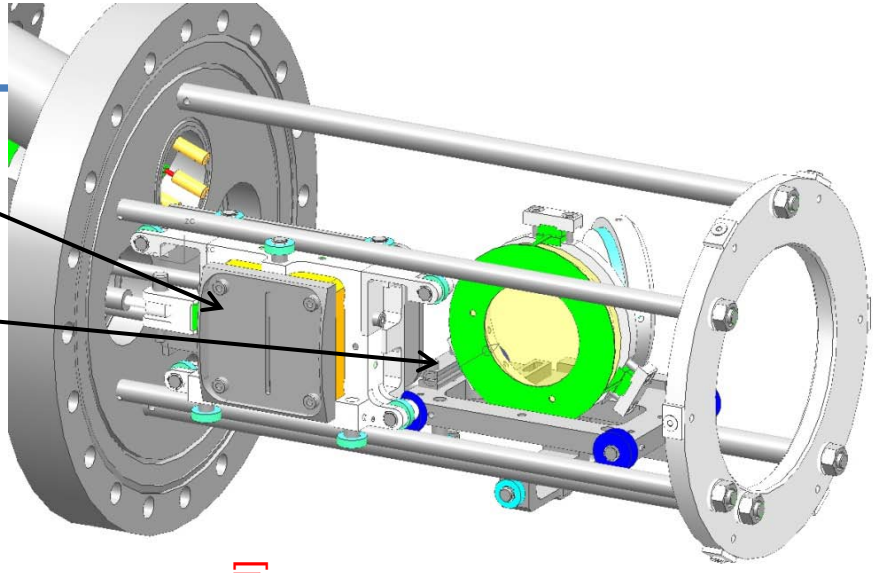
Typical beam currents:

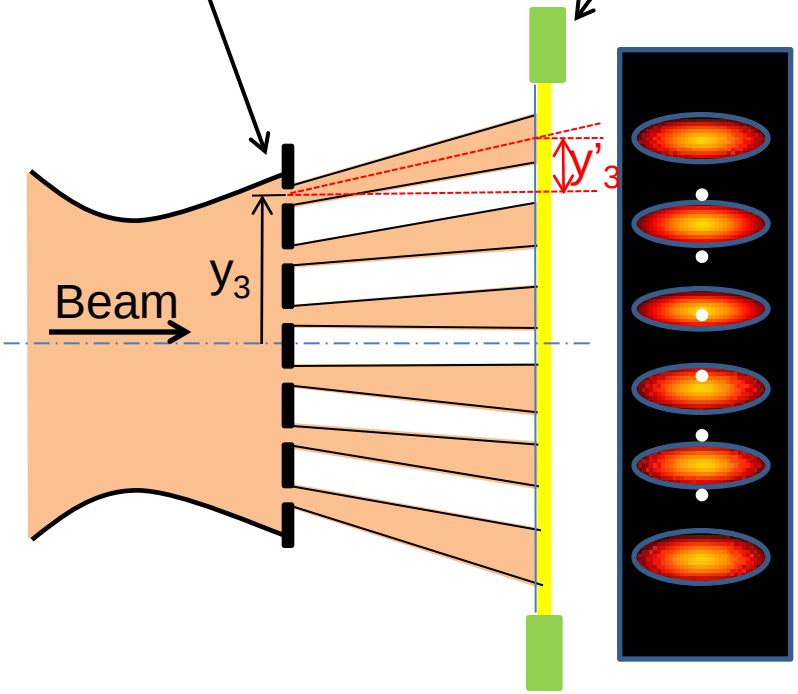
$^{204}Pb^{27+}$: 25 eμA
$^{16}O^{4+}$: 500 eμA

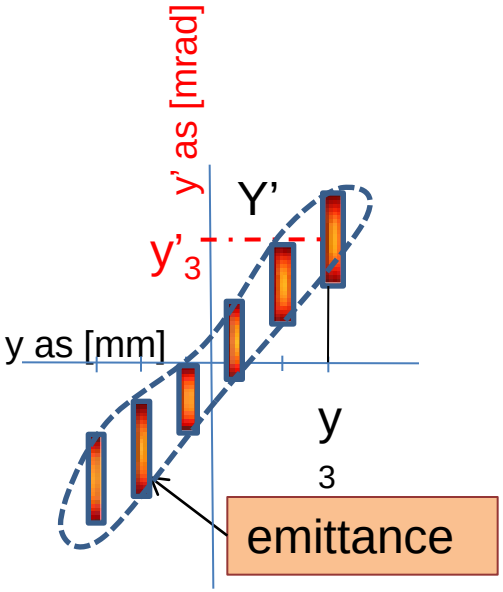
KVI4D pepper pot emittance meter

Pepper pot plate (array 20 x ø20 micron holes)

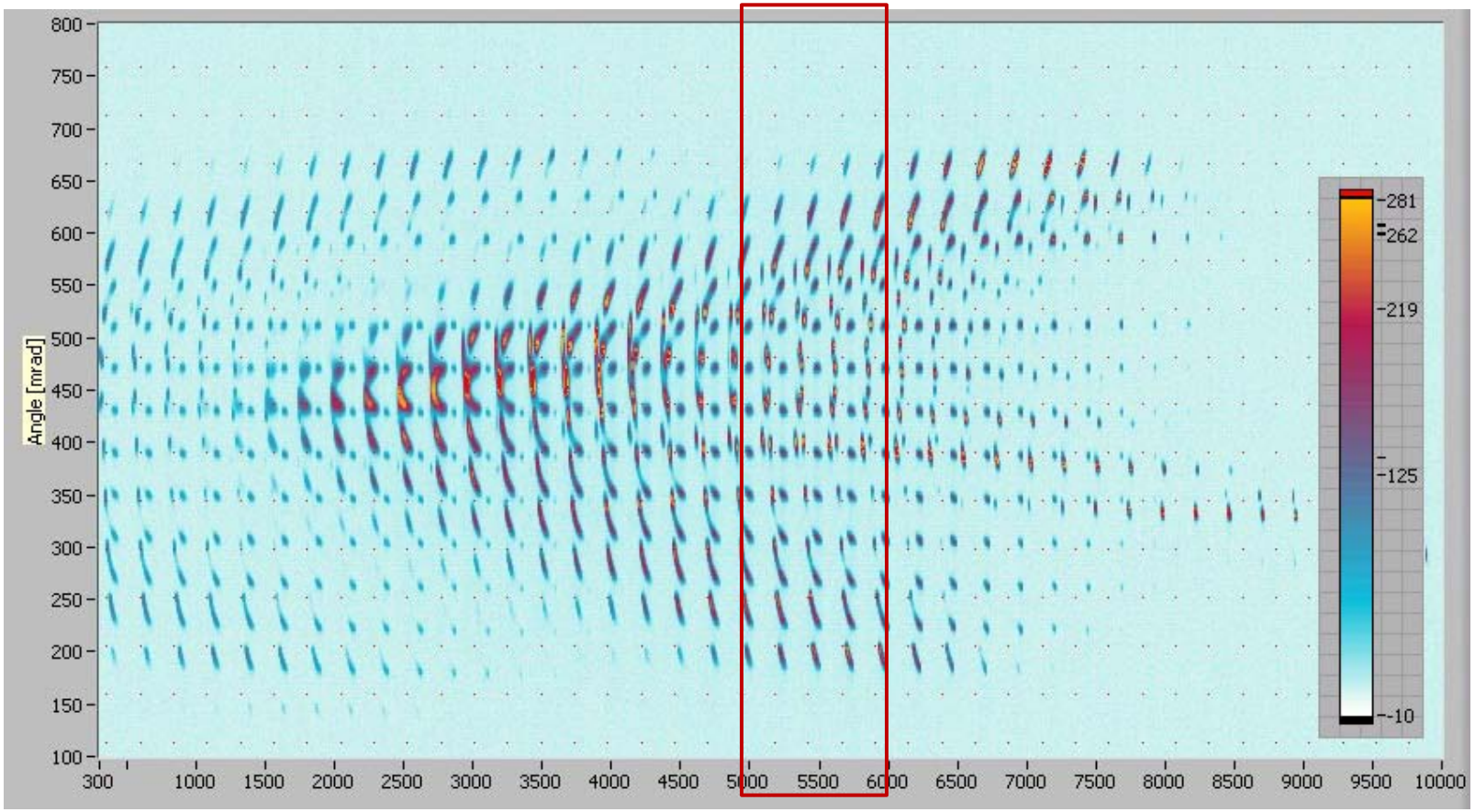
Multi channel plate detector





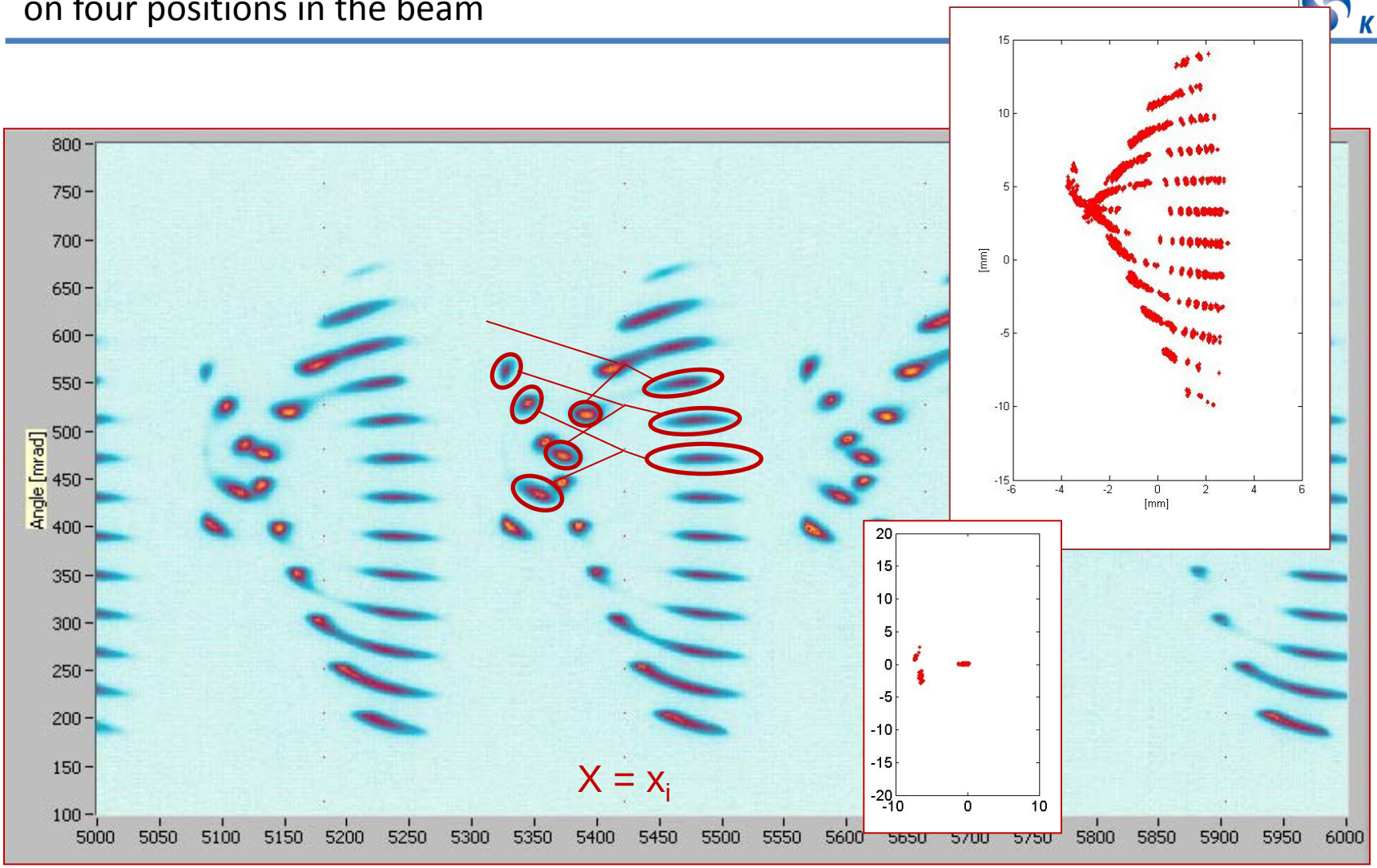


Trace space of a 21 keV He^{1+} beam

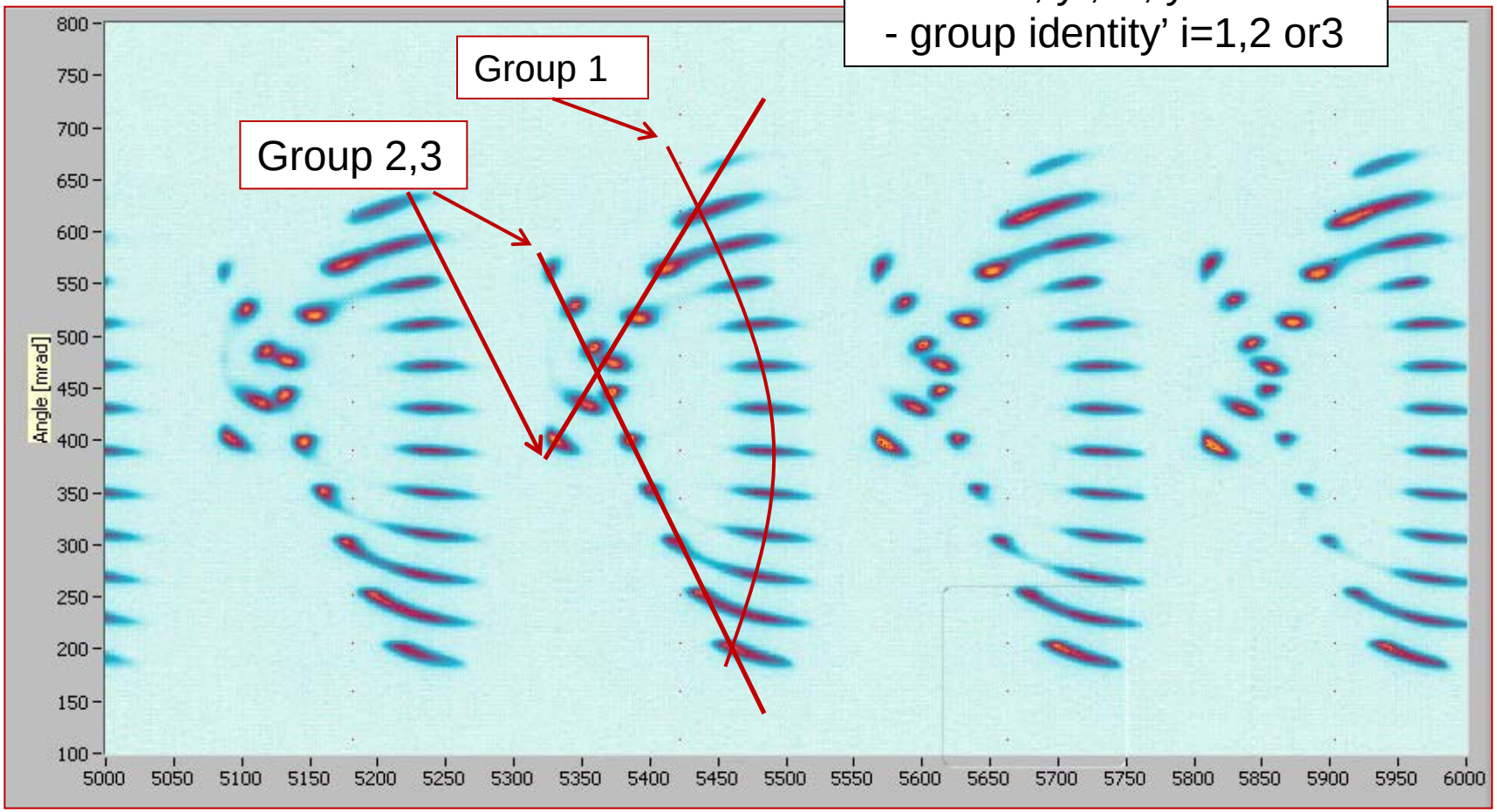


Response distribution of array of 20 holes

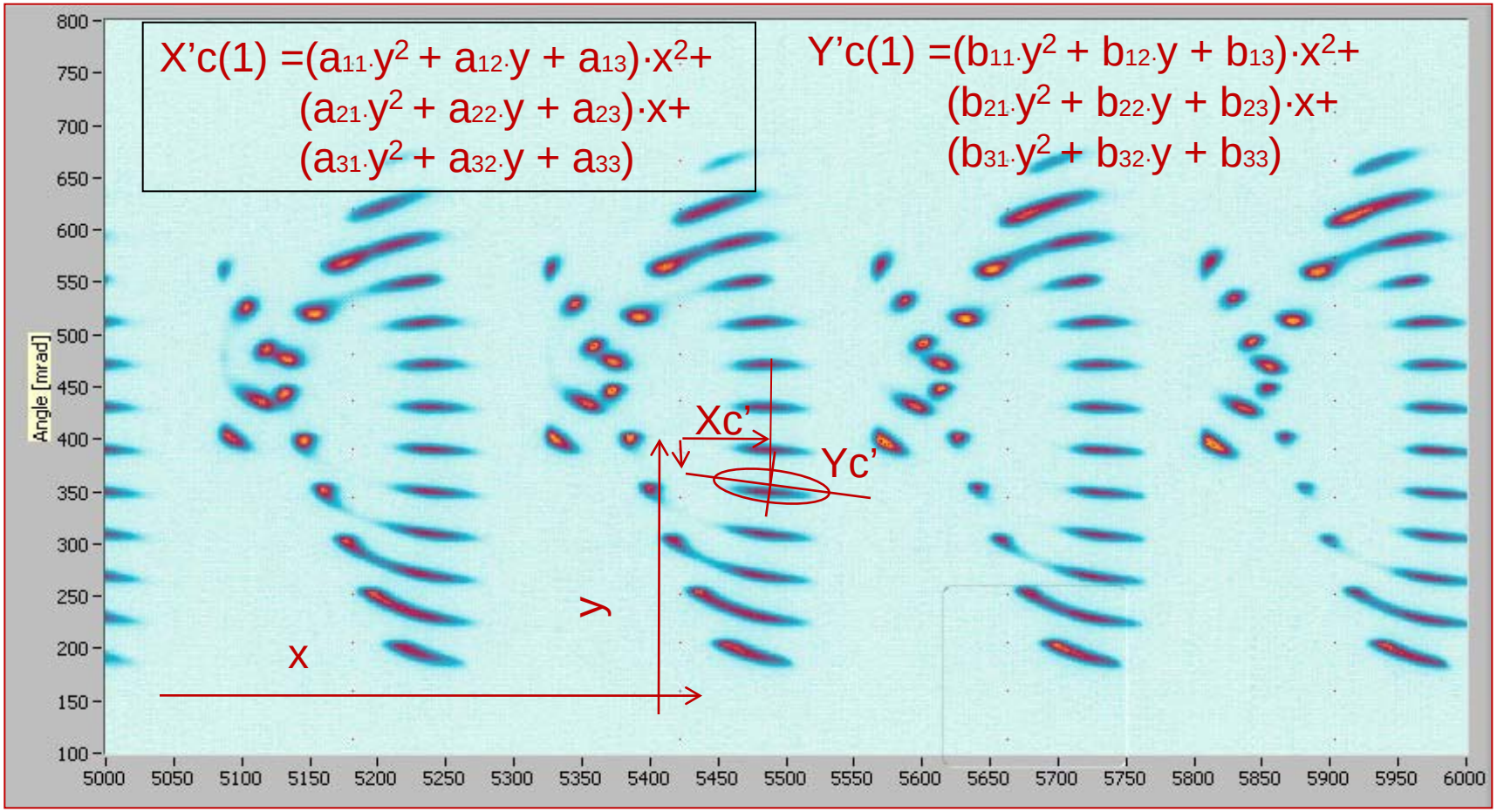
on four positions in the beam



Overlap of response distributions



Data modeling.



The four dimensional dataset

$$\mathrm{P}_i = \rho\left(x, y, x', y'\right)_i$$

- Dataset is unambiguous
  - Extra label (i) for group 1,2 or 3.

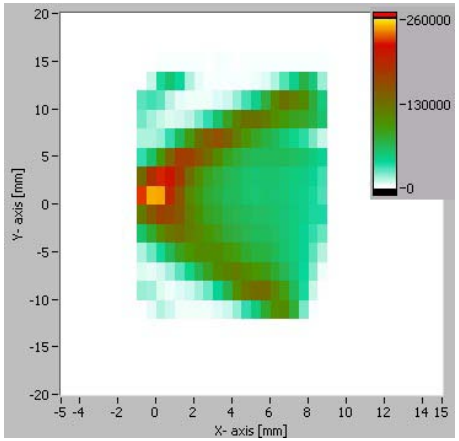
- Projections in the image plane as function of (i).
  x-y projection known as viewing screen
  x-x'projection used for a x-x'emittance
  y-y'projection used for a y-y'emittance
  x'-y'projection

Result of the model

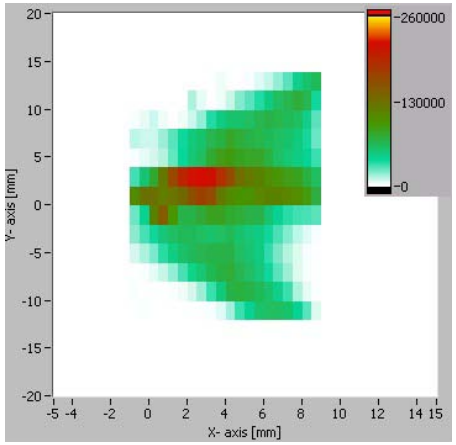
x-y projection. (viewing screen projection)

$$P(x,y)_{i=1} = \int_{y'=-20mrad}^{y'=+20mrad} \int_{x'=-60mrad}^{x'=+60mrad} \rho(x,y,x',y')_1 dx'\,dy'$$

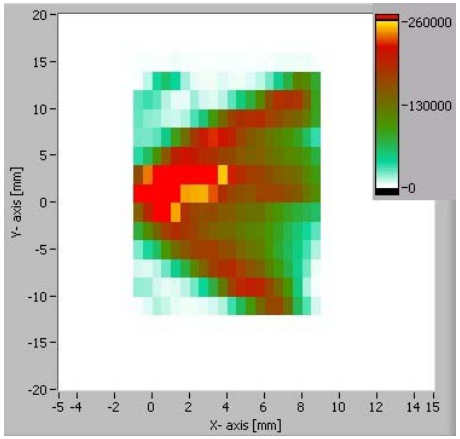
i =1



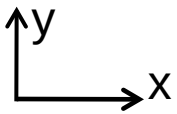
i=2,3



i=1,2 and 3



camera recording

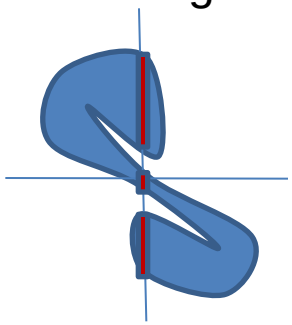


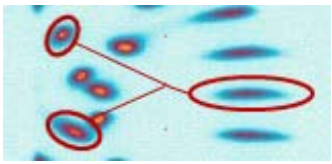
The emittances in the image plane

y-y’ projection

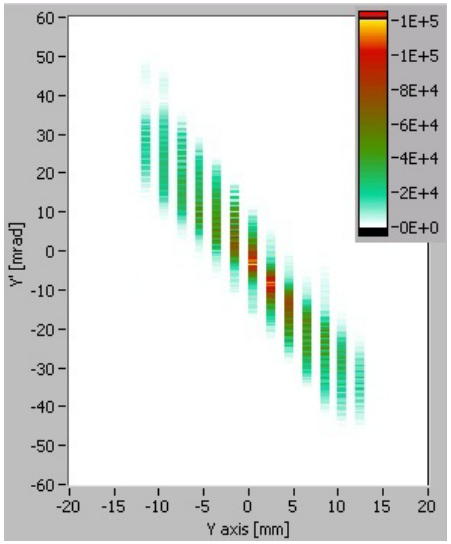
$$P_i(y,y') = \int_{x=-12mm\ x'=-60mrad}^{x=+12mm\ x'=+60mrad} \rho(x,y,x',y')_i dx dx'$$

2 sigma 320 π mm mrad



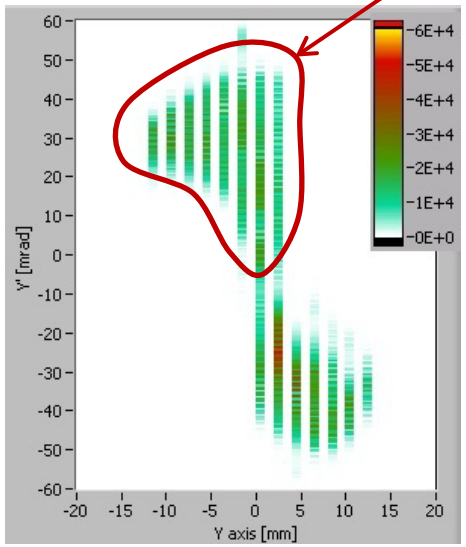


group 1

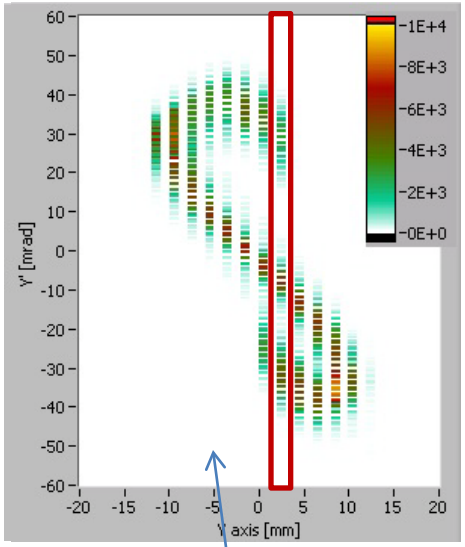


group 2,3

group2



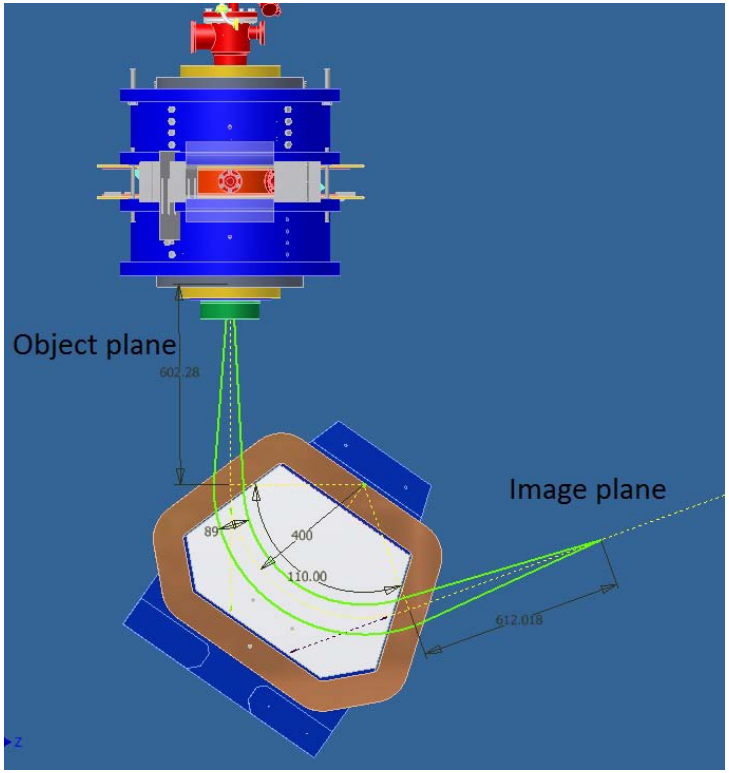
group 1,2,3



y-y’for only one x position: x=-10

Transformation to object plane in 2de orde

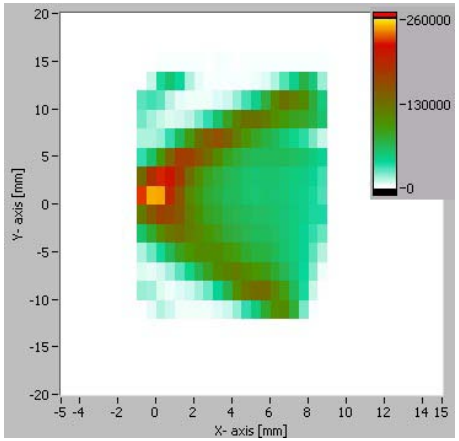
$$[P_i]_{image\cdot plane} = [\rho(x, x', y, y')_i]_{image\cdot plane}$$



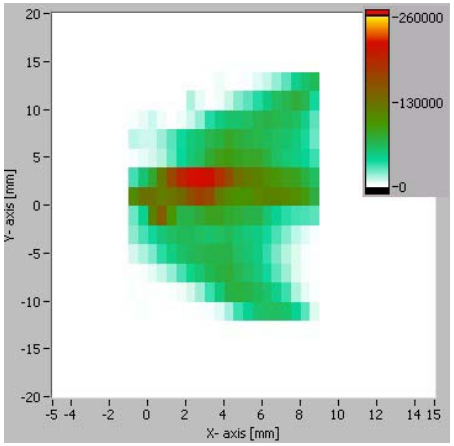
$$P_{im} = M^{2^{de}} \cdot P_{obj} \rightarrow P_{obj} = M^{2^{de}\ -1} \cdot P_{im}$$

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

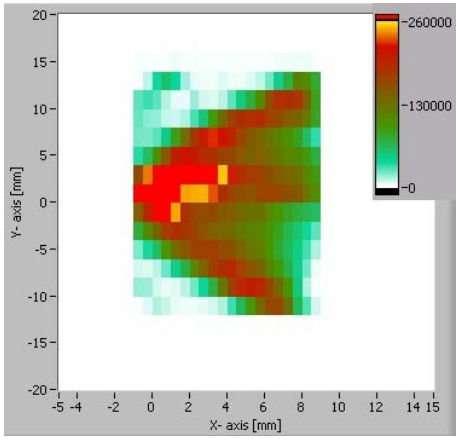
group 1



group 2,3



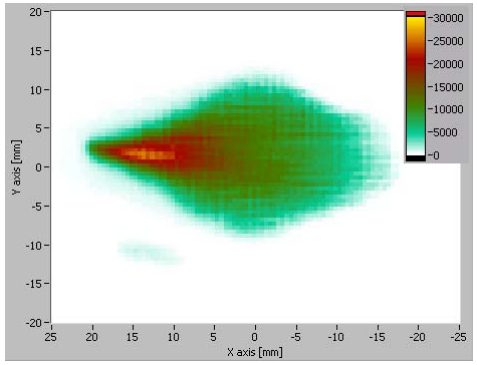
group 1,2,3

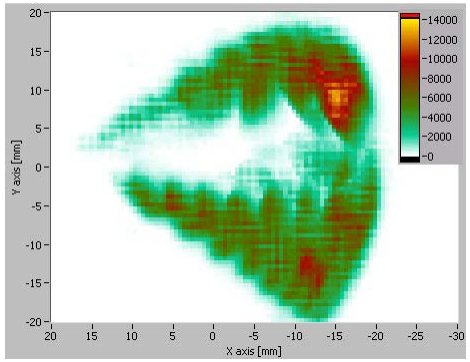


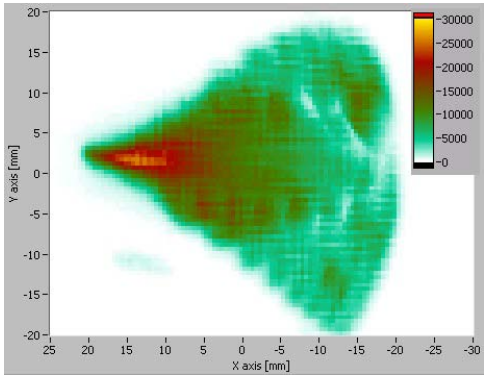
$X_f = M \cdot X_o$

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

In image plane







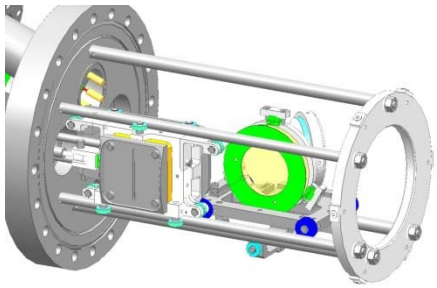
In object plane

Conclusions:

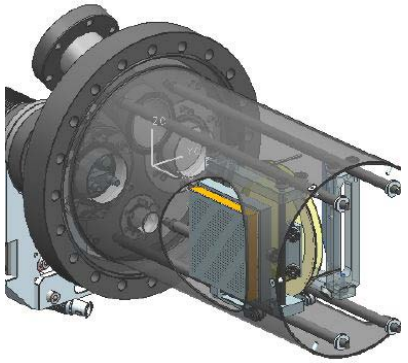
- Dipole induced second order aberration of the beam.
- Group 2,3 created by the dipole fringe field
- Three beams can emerge due to S-shape emittance in y-y’phase-space.
- These Trace-space patterns are not plasma related effects
- Plasma-related effects can be seen at the entrance of the analyzing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

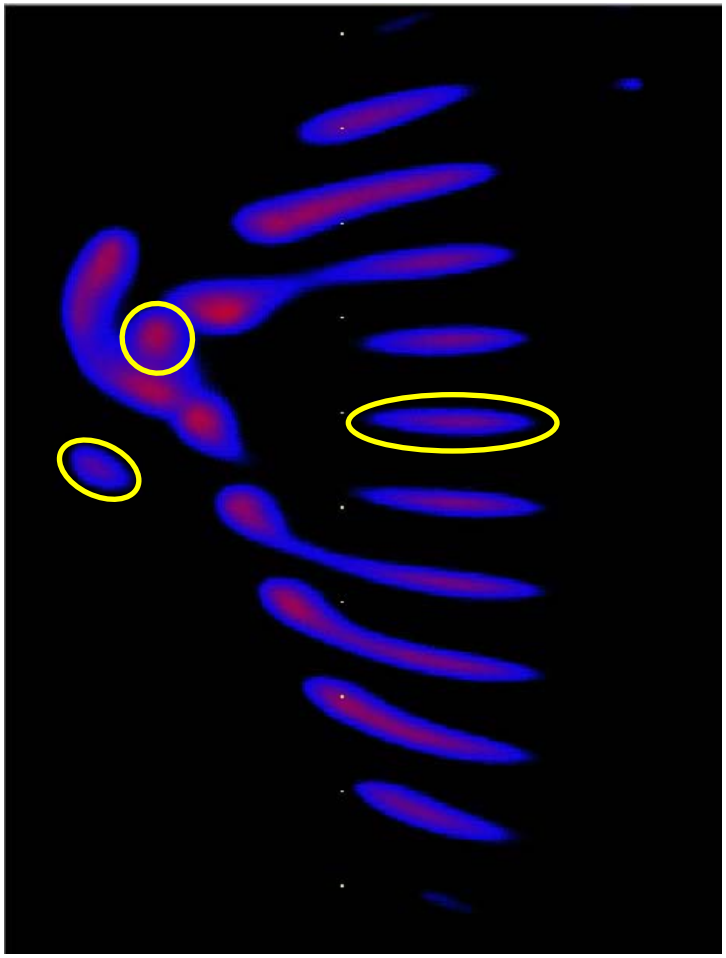


KVI4D-ADV

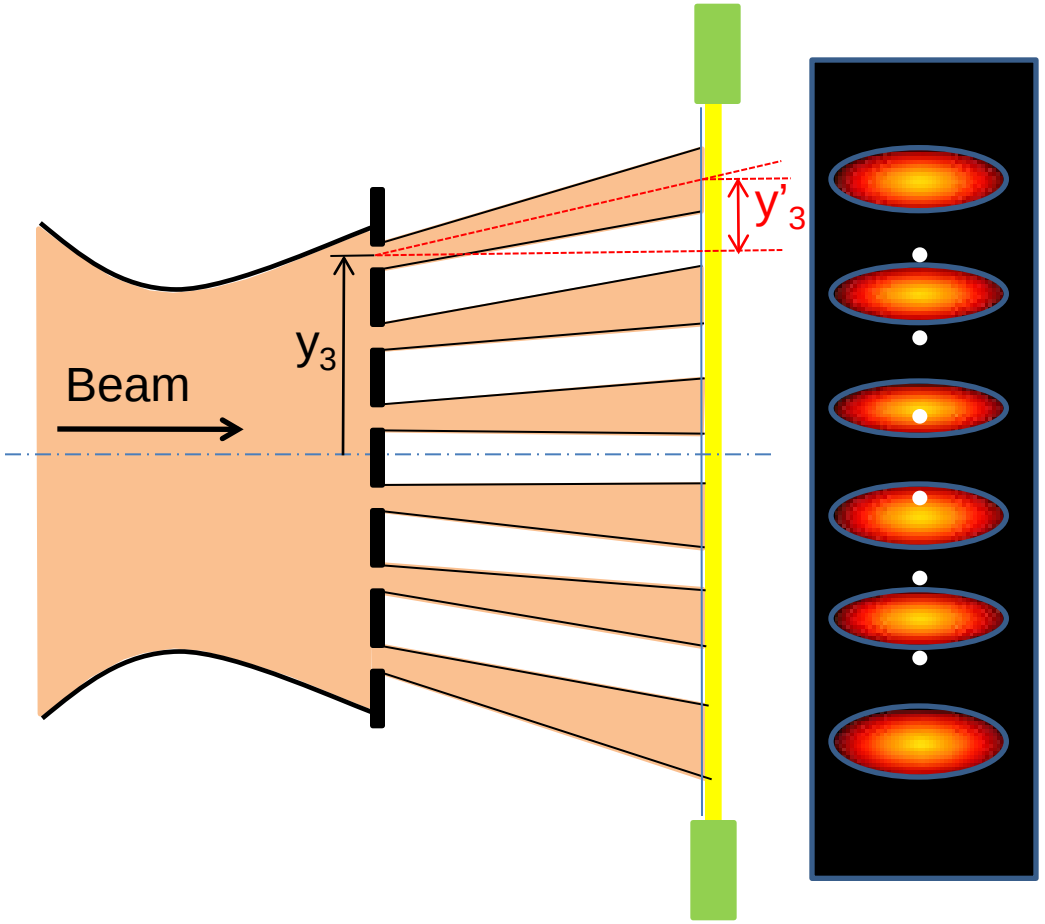
KVI ion source group

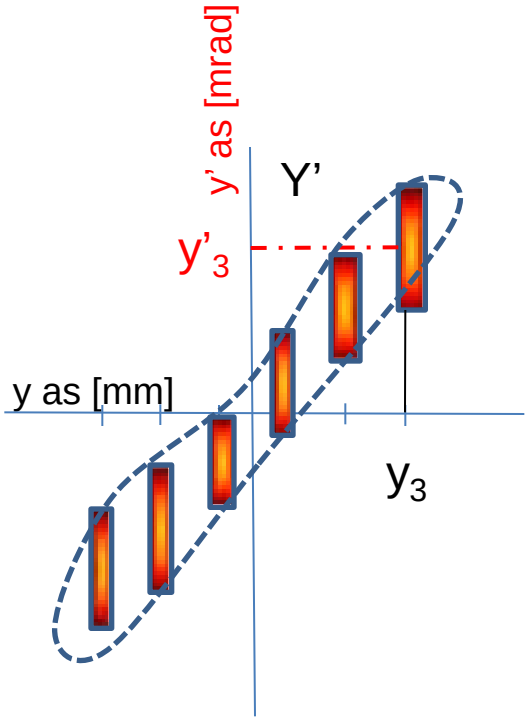
- KVI Ion source group
  - Sytze Brandenburg
  - Hans Beijers
  - Vladimir Mironov
  - Suresh Saminathan
  - Jan Mulder
  - Rob Kremers

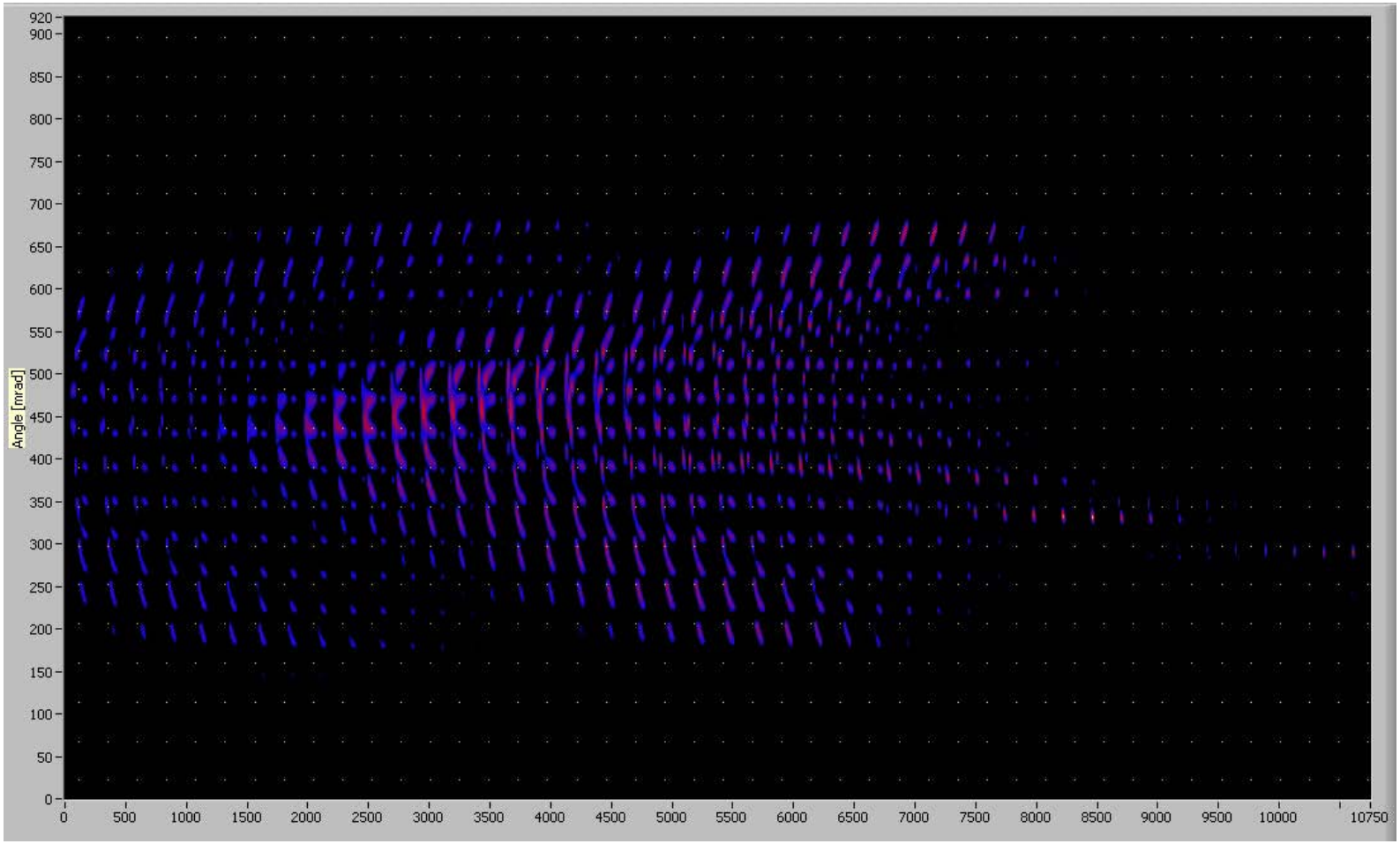
Thank you for your attention



Trace space






Angle [mrad]
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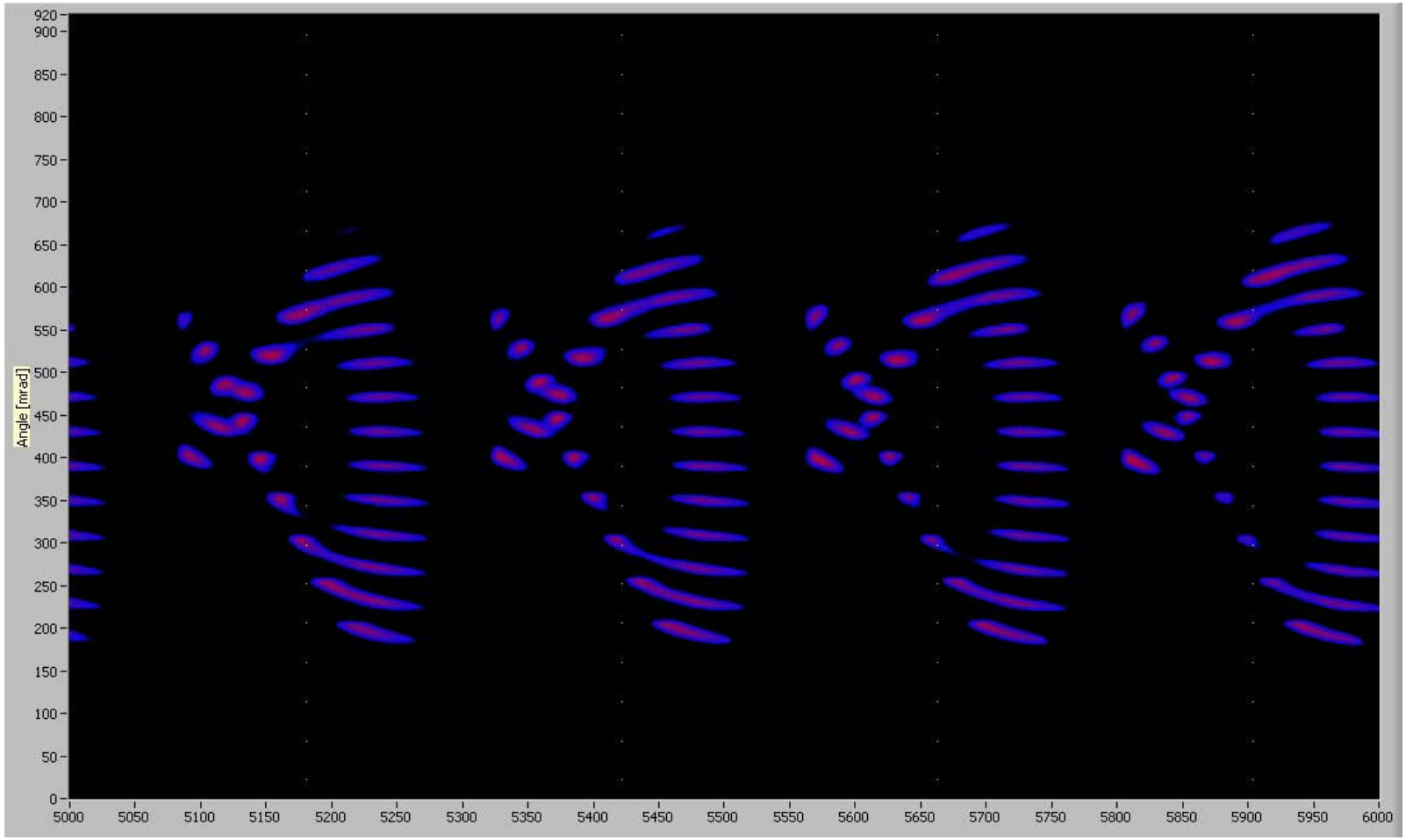
Angle [mrad]
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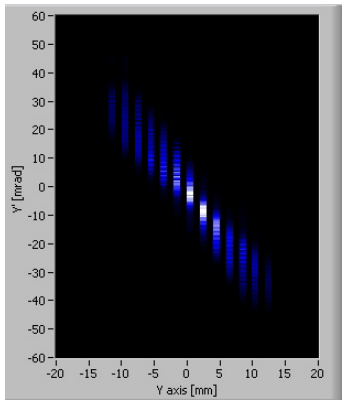
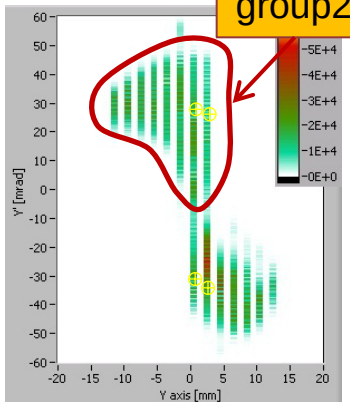
The emittances in the image plane

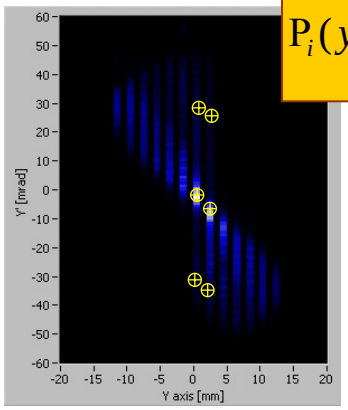
group 1



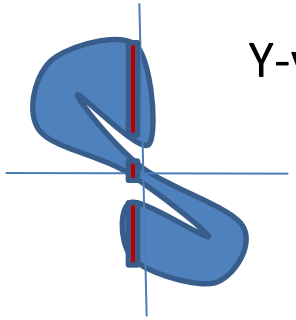
group 2,3



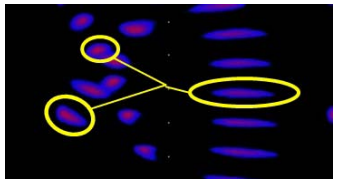
group 1,2,3

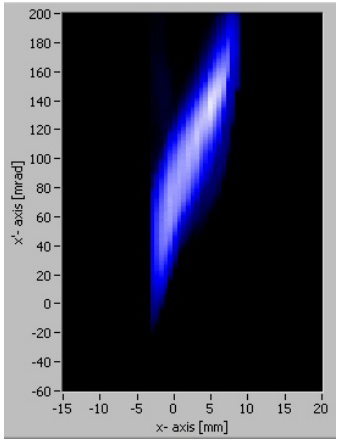


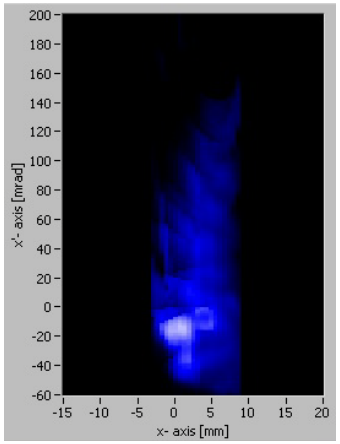
$$P_i(y,y') = \int_{x=-12mm\ x'=-60mrad}^{x=+12mm\ x'=+60mrad} \int \rho(x,x',y,y')_i dx dx'$$

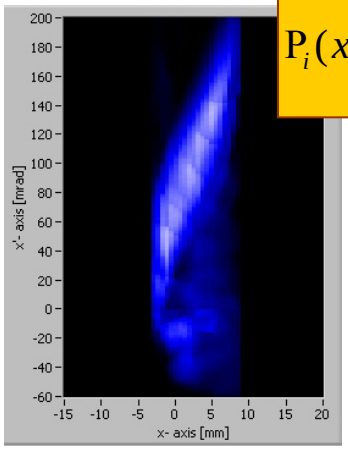


Y-y' projection's









$$P_i(x,x') = \int_{y=-20mm\ y'=-20mrad}^{y=+20mm\ y'=+20mrad} \int \rho(x,x',y,y')_i dy dy'$$

X-x' projection