Transform again - with FARO Measurements

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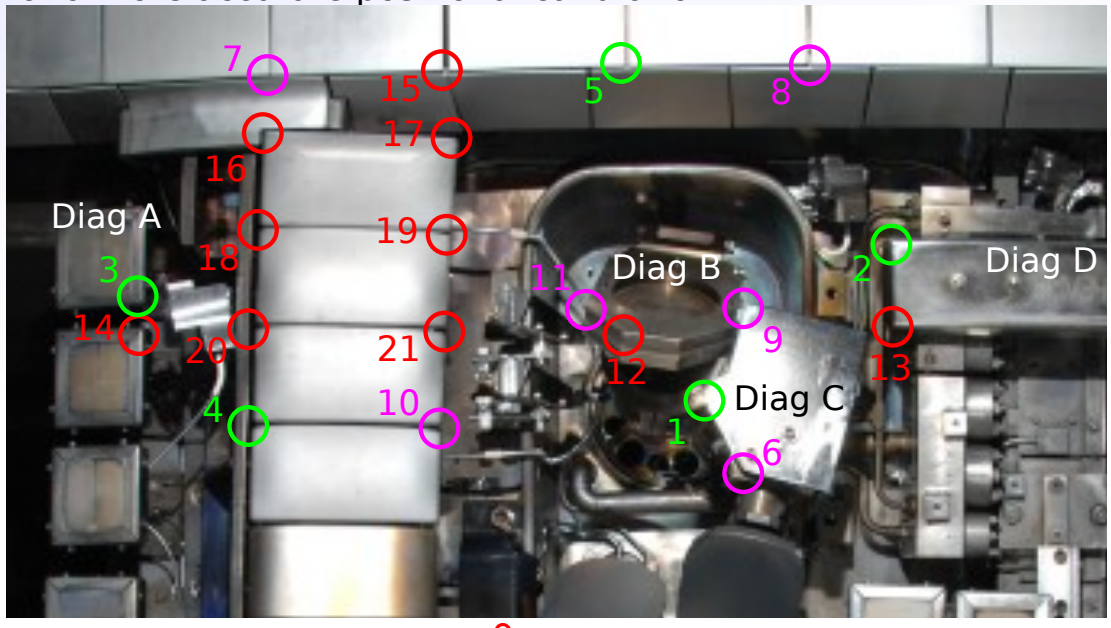
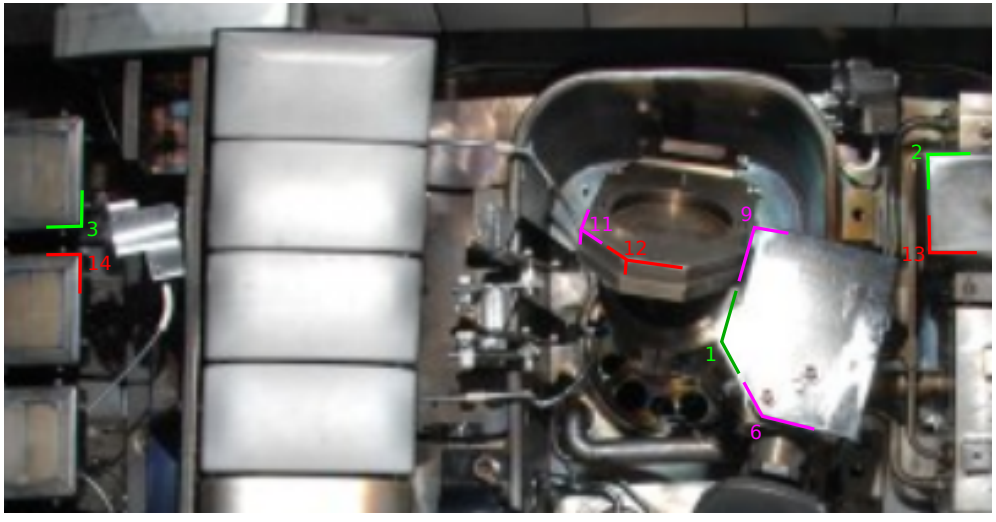
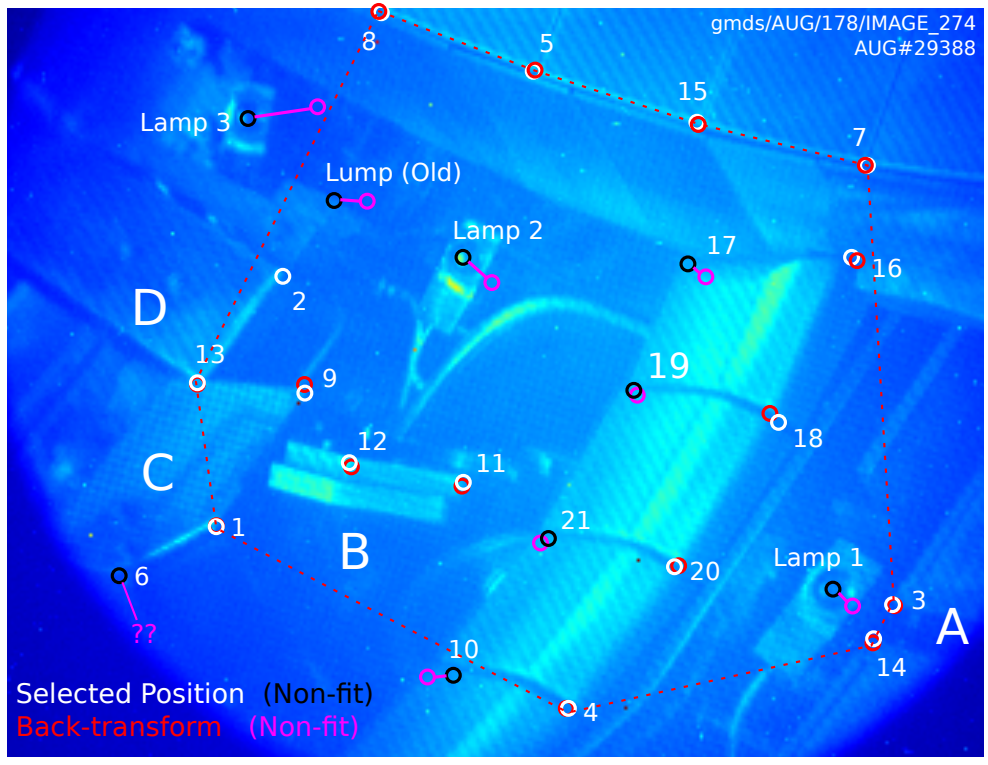
22 points in view were measured with the AUG FARO system for a more accurate positional calibration:

Description	No	x (North)	y (West)	z (Height)
diag A 1 BR	3	-2.02395	-0.94976	0.36006
diag A 2 TR	14	-2.02934	-0.95250	0.33870
diag B BL	12	-2.17777	-0.45567	0.30648
diag B L	11	-2.20498	-0.50535	0.34890
diag C B	6	-2.22262	-0.37674	0.23418 (Bad)
diag C BL	1	-2.22190	-0.37650	0.23436
diag C TL	9	-2.23276	-0.33111	0.34981
diag D BL	13	-2.30556	-0.18300	0.33352
diag D TL	2	-2.28035	-0.18153	0.42710
limiter 1 TL	16	-1.98941	-0.78018	0.51199
limiter 1 TR	17	-2.08211	-0.60271	0.50816
limiter 2 TL	18	-2.01561	-0.79503	0.41549
limiter 2 TR	19	-2.11711	-0.62289	0.41647
limiter 3 TL	20	-2.04149	-0.81012	0.31860
limiter 3 TR	21	-2.14380	-0.63845	0.31795
limiter 4 TL	4	-2.05810	-0.82039	0.21945
limiter 4 TR	10	-2.15611	-0.65006	0.21679
psl tiles 1	7	-1.95947	-0.75727	0.55107
psl tiles 2	15	-2.01799	-0.59125	0.54913
psl tiles 3	5	-2.06204	-0.42207	0.54682
psl tiles 4	8	-2.09171	-0.24937	0.54397



Positional calibration is now very good
(assuming the FARO measurements are good)





Dropbox/work/faro-points.ods; java:imseProc.proc.transform

Ray tracing fit - Mirror box hole

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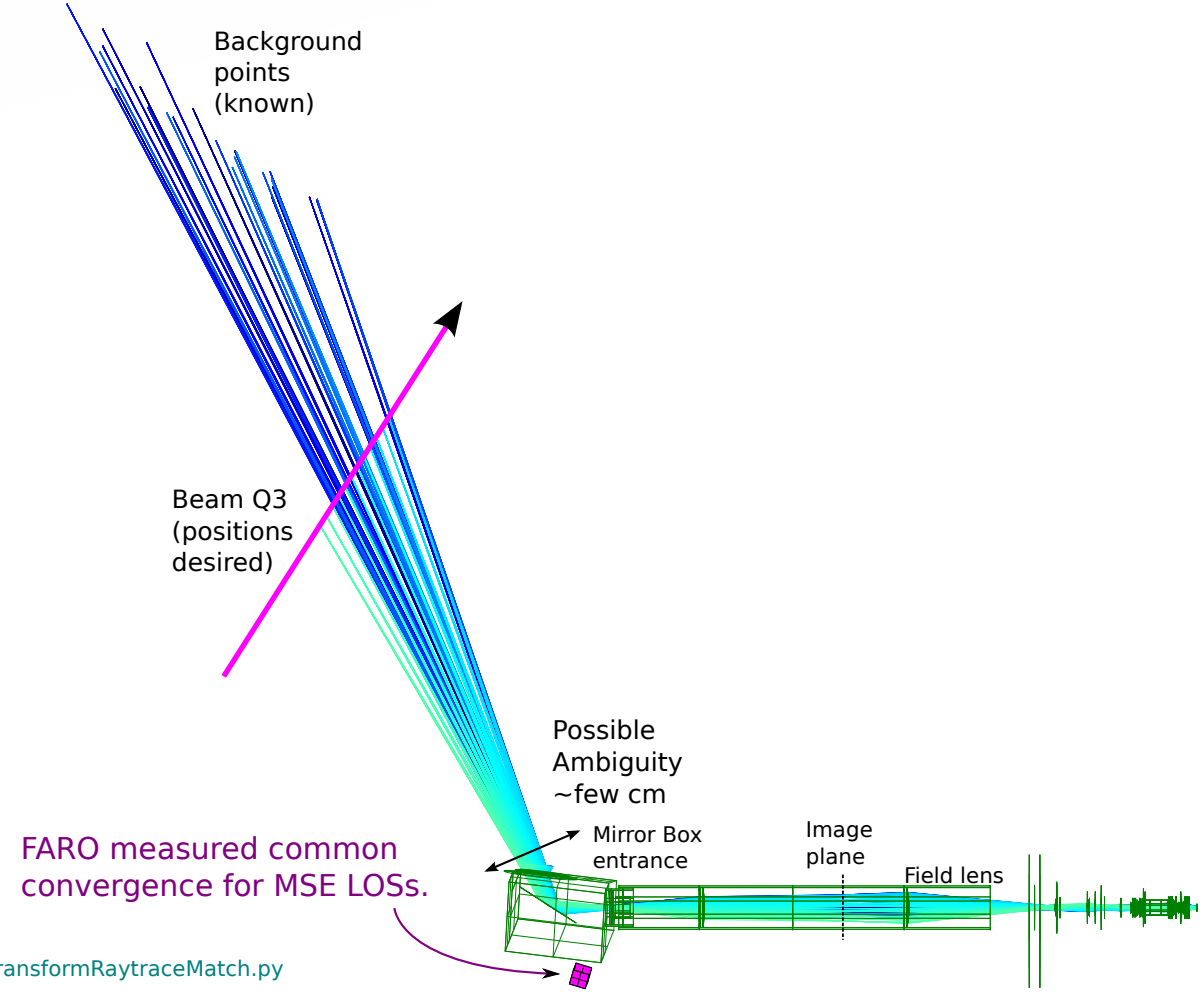
Next, we need to fiddle with ray tracing model to fit the new transform.

By firing rays backwards from the CCD and then measuring the closest approach to the 3D source point, the ray tracer is fast enough to optimise against to automatically find the CCD position and mirror tilt.

Unfortunately, it is possible to move the mirror position, and still fit the ray tracing to the transform by changing the CCD position and/or the mirror tilt. The spread of points give some, but not a lot, of information about the effective view origin.

In principle, this could change the observed beam positions against the background.



minerva-optics-imse/seed.minerva.apps.imse/TransformMatch.java; /work/sci/ipp/scrap/transformRaytraceMatch.py

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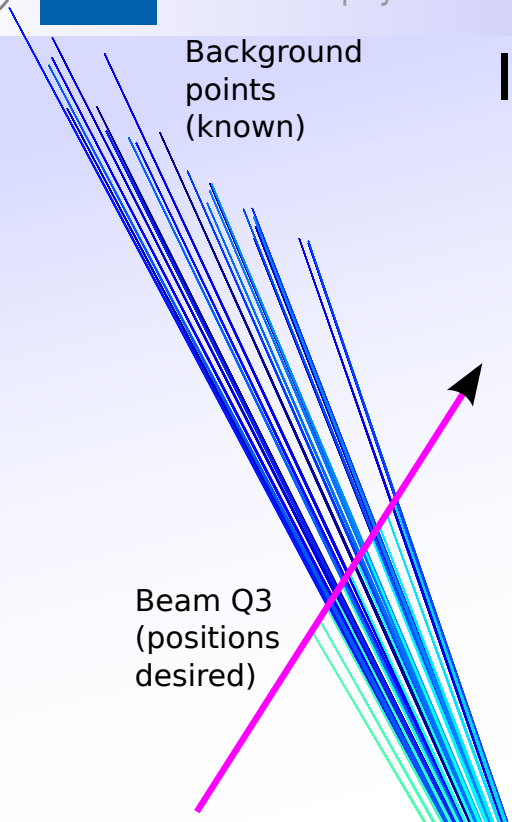
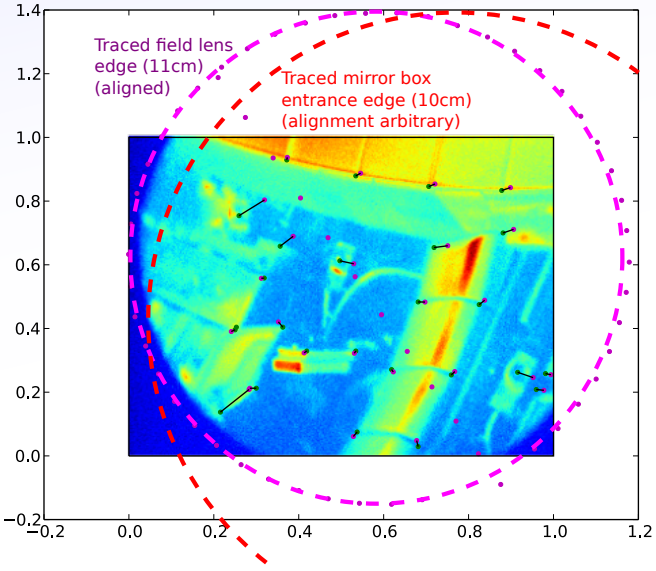
Image Hard Edge

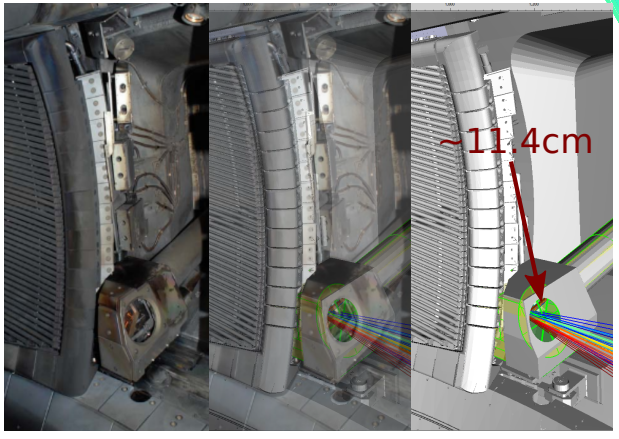


The recorded images have a circular hard edge to the view. I don't actually know for certain what this is.

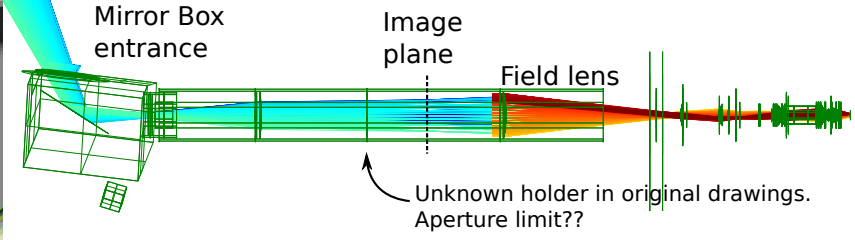
One option is the entrace to the mirror box but it would have to be smaller (~80mm) than the CAD says it is (>110mm, corroborated by photos).

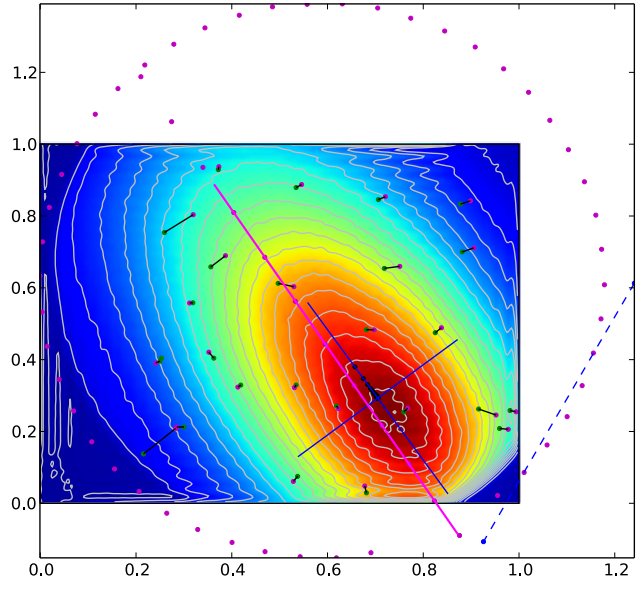
The more likely source is a slightly smaller (~105mm) field lens than CAD says (116mm) or another limiting aperture near the image plane in the optics tube.





Mirror box projection match to photo:
Entrance hole looks same size as CAD (> 10cm)





Since this is is after the mirror, the CCD position can be found by lining the ray tracing of that circle up with the image hard edge. The mirror is then moved to re-fit the background image (which doesn't move the aperture circle).

Dropbox/work/faro-points.ods; java:imseProc.proc.transform

Transform Ray-Trace fit.

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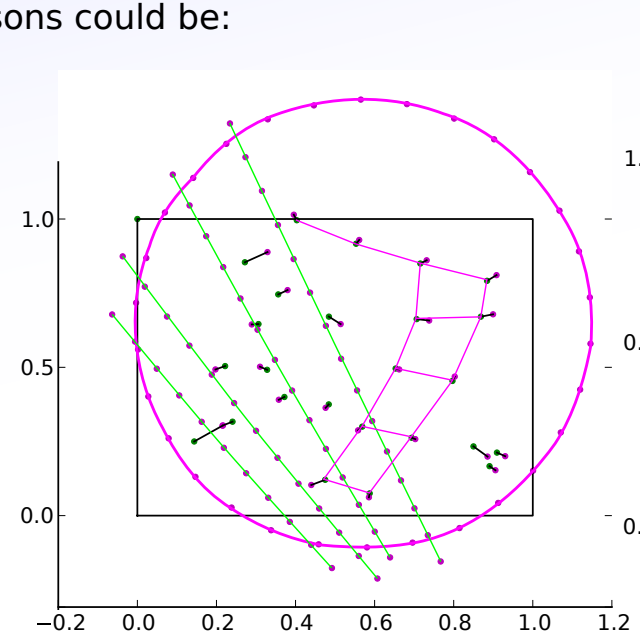
The mirror shift and angle is now fit to minimise the closest approach of the back-traced ray from the image position (on the CCD).

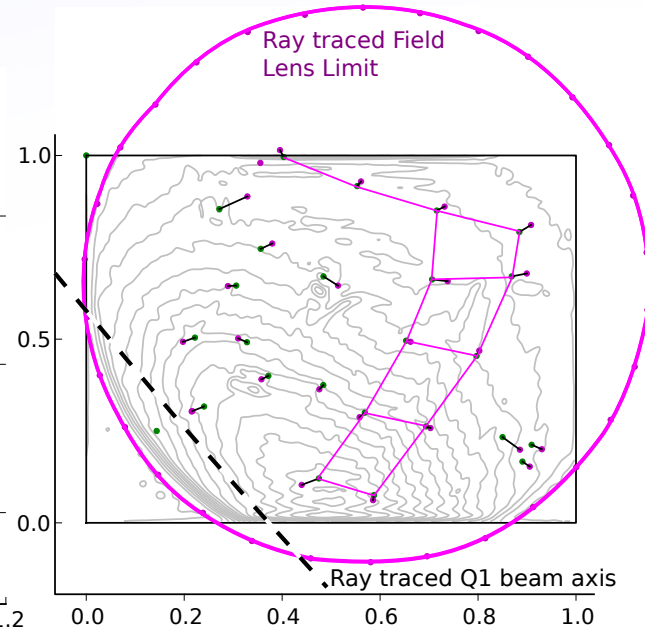
The IMSE pulse in Jan had all 4 beams independently. The intensity images from these don't seem to match the ray-traced beam axis. Reasons could be:

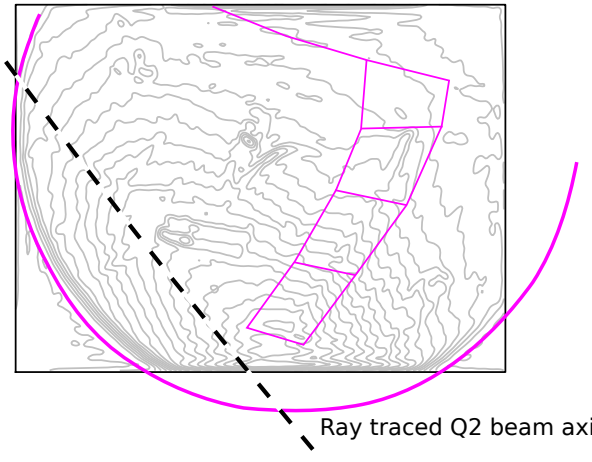
1) The view position is still wrong.
It would appear to need to move several cm, which would mean the view would not see through the mirror box hole. This seems to not be possible.

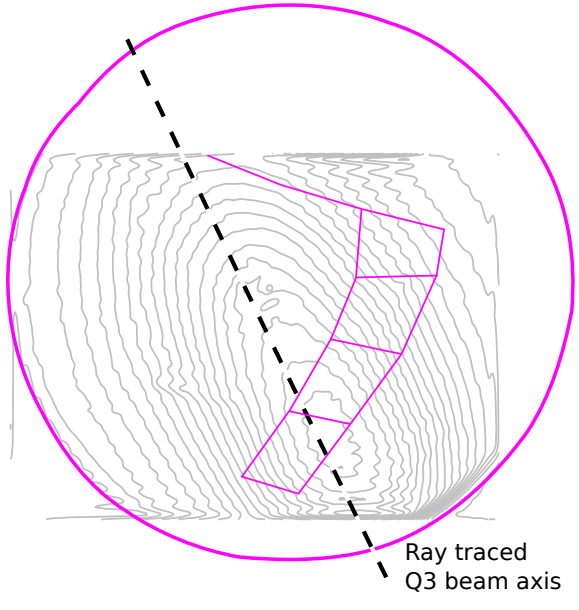
2) The beam intensity centre is not at the beam axis in the view. This could possibly happen due to the geometry, LOS integration and the beam attenuation.

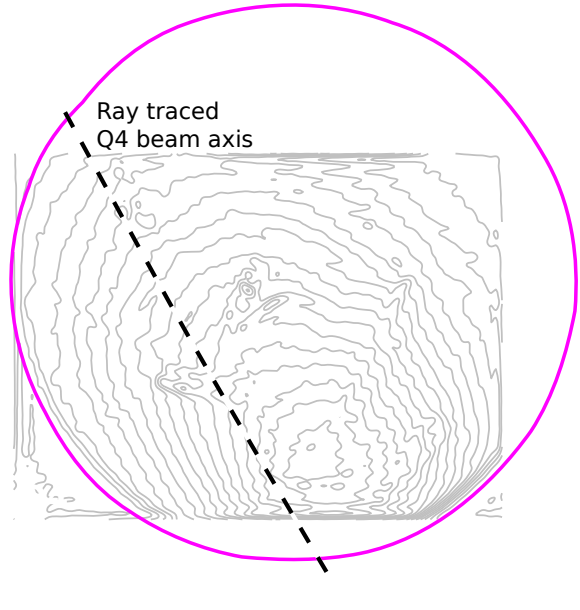
3) Vignetting causes an intensity fall-off that shifts the observed intensity maximum. This seems most likely effect for Q1 and Q2, but unlikely for Q4 since Q3 agrees and is in the same region of the image.











Vignetting; Beam addition

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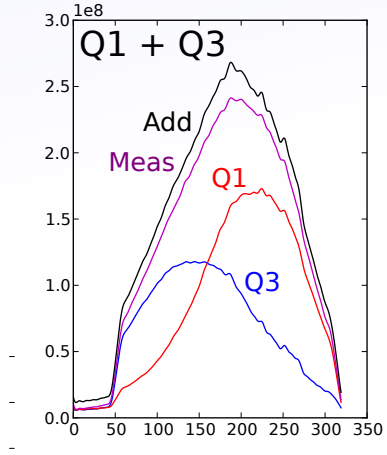
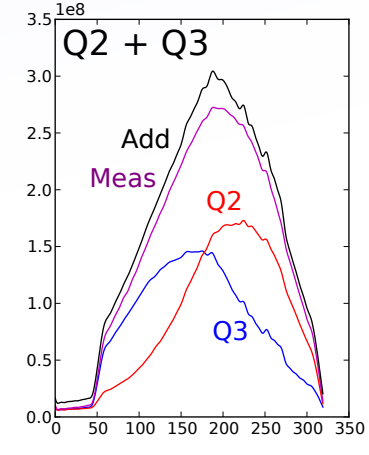
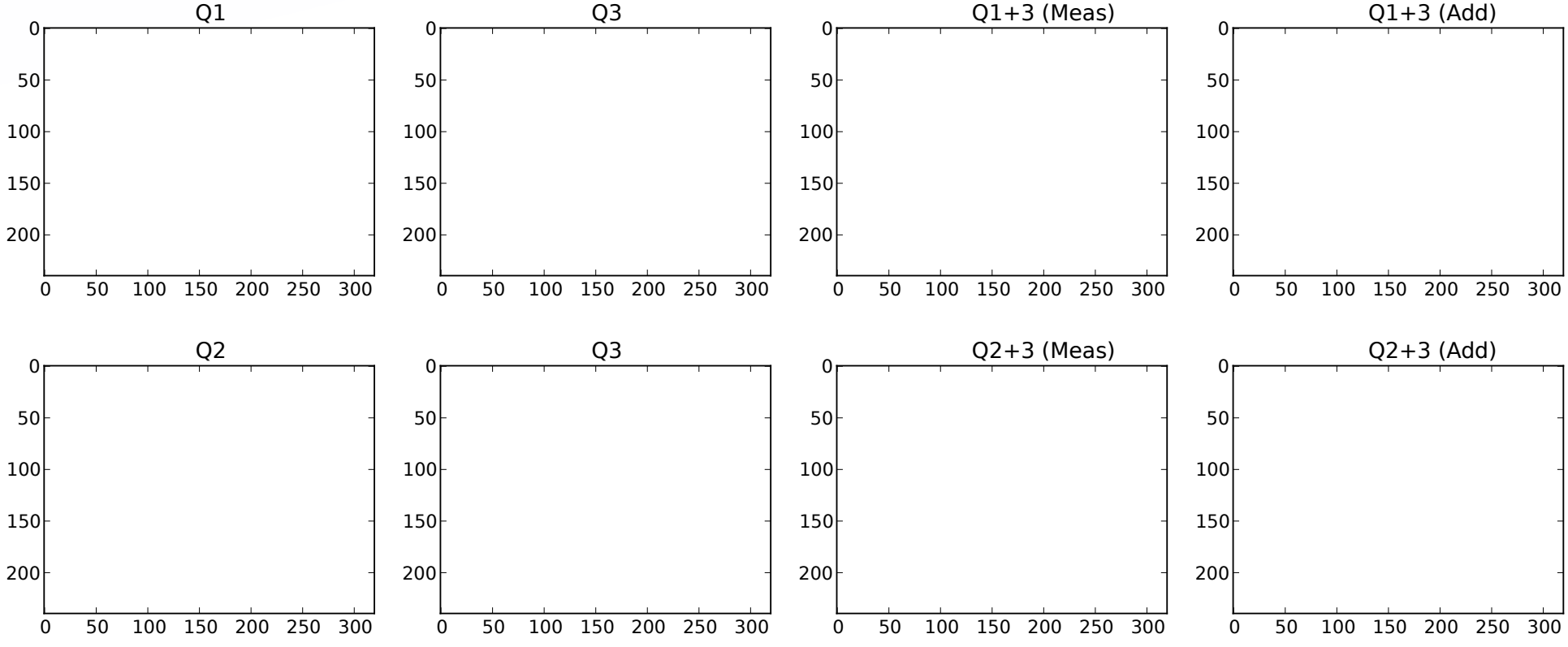
The Jan2013 data (as in previous slide) had the Omega filter, which shifts rapidly with AOI. This is probably the dominant contribution to the vignetting. Unfortunately, it will be different for the different beams. This would need to be true to explain why Q3 is near it's prediction but Q4 isn't. The filter vignetting effect on Q4 is expected to be very bad, since Q4 has much less Doppler shift at the same image position than Q3.

The Apr2013 data should have much less filter-based vignetting, as the filter edge is sharper, and shifts less with AOI.
Unfortunately, the April data doesn't have Q1,2 or 4 on alone.
However, the beam intensities ((0,0) component) should add, so we can subtract the power off as they are brought in together.

We can check that is true back on the January data:
Well... roughly. The beam intensity changes quite a bit due to the plasma changes. It's probably good enough for the beam line locations.







Beam Subtraction

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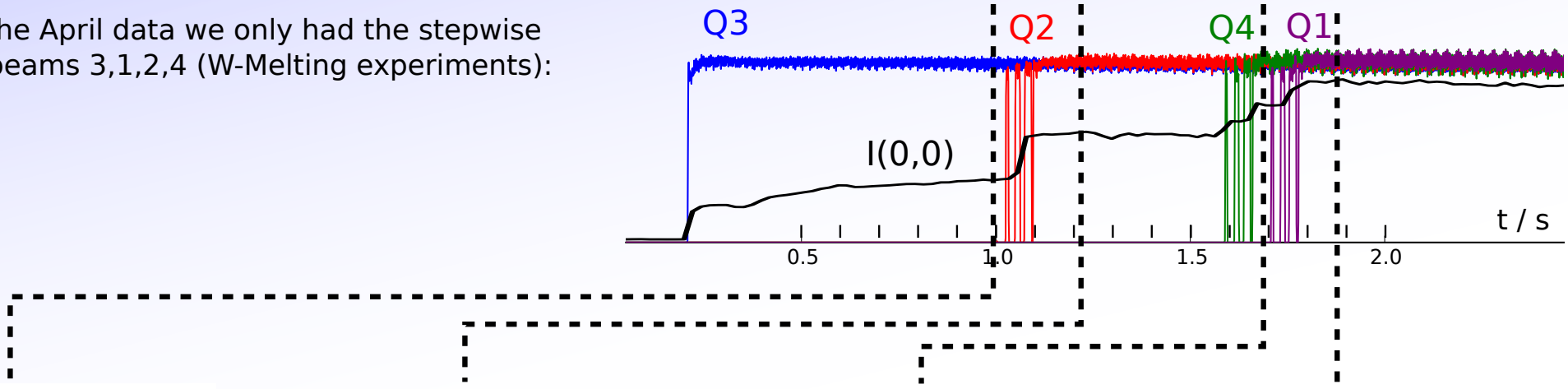
So, now for the April data we only had the stepwise inclusion of beams 3,1,2,4 (W-Melting experiments):



Ray Trace Match (Beam Subtracted)

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Can we now get a better ray trace match with the April data??

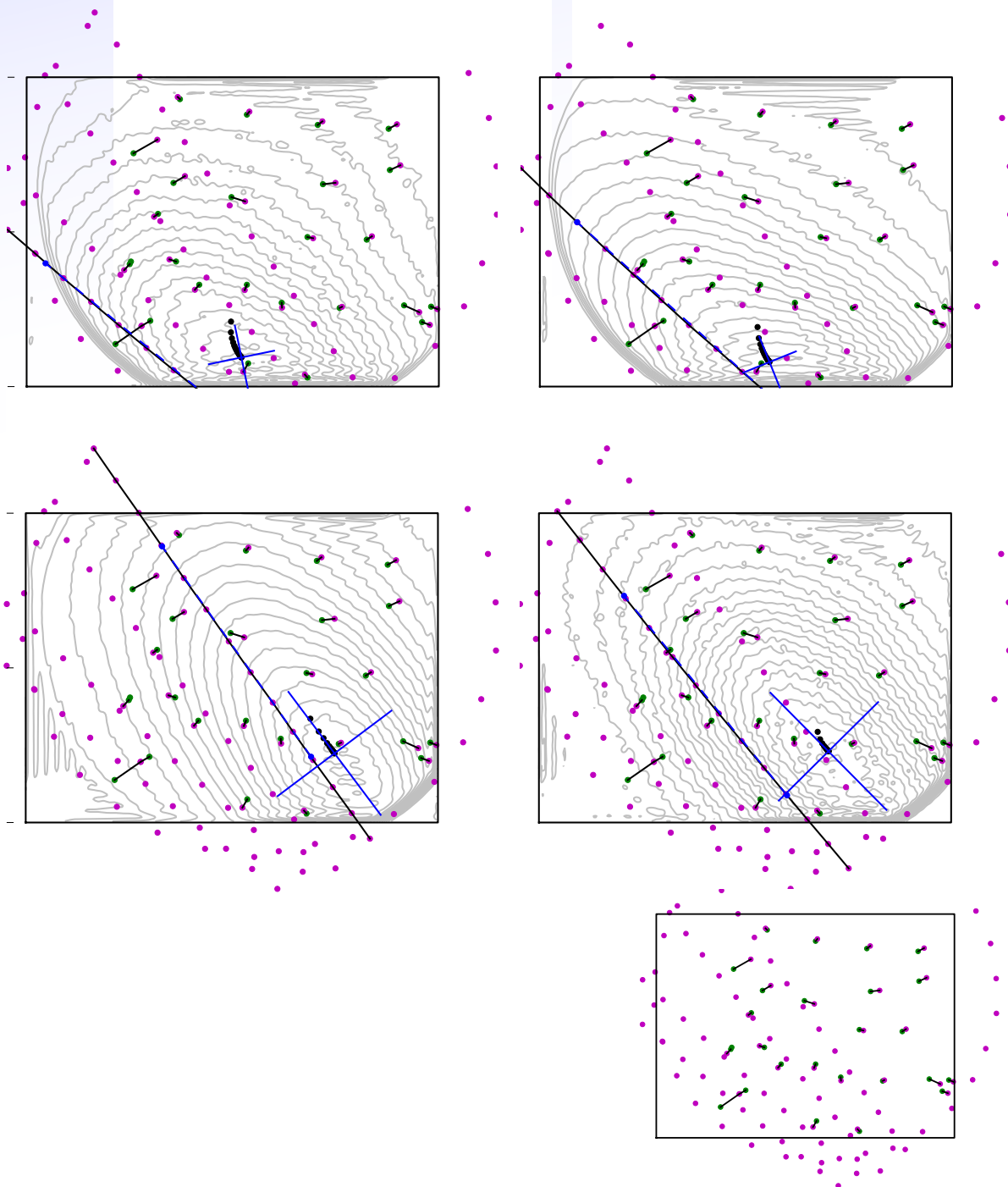
.. bascially, No.

It is possible to get close by shifting the mirror backwards by abuot 10cm (downwards by a few) but, aside from being a large deviation from the MSE FARO convergence measurement, it doesn't see past the mirror box hole, which would have to be lower by ~3cm at least.

Shifting the CCD back to it's origin (ignoring the image hard edge fit) doesn't change it much either.

So, is the beam geometry wrong?

1) Last check: Find smoe points that appear on the image behind the observed beam axis and back-trace them via several points along the beam axis (because we can't be sure about our R positioning) and see where the mirror box would have to be in the torus to see it like that.2) Find out exactly where them FARO mirror position and normal came from.



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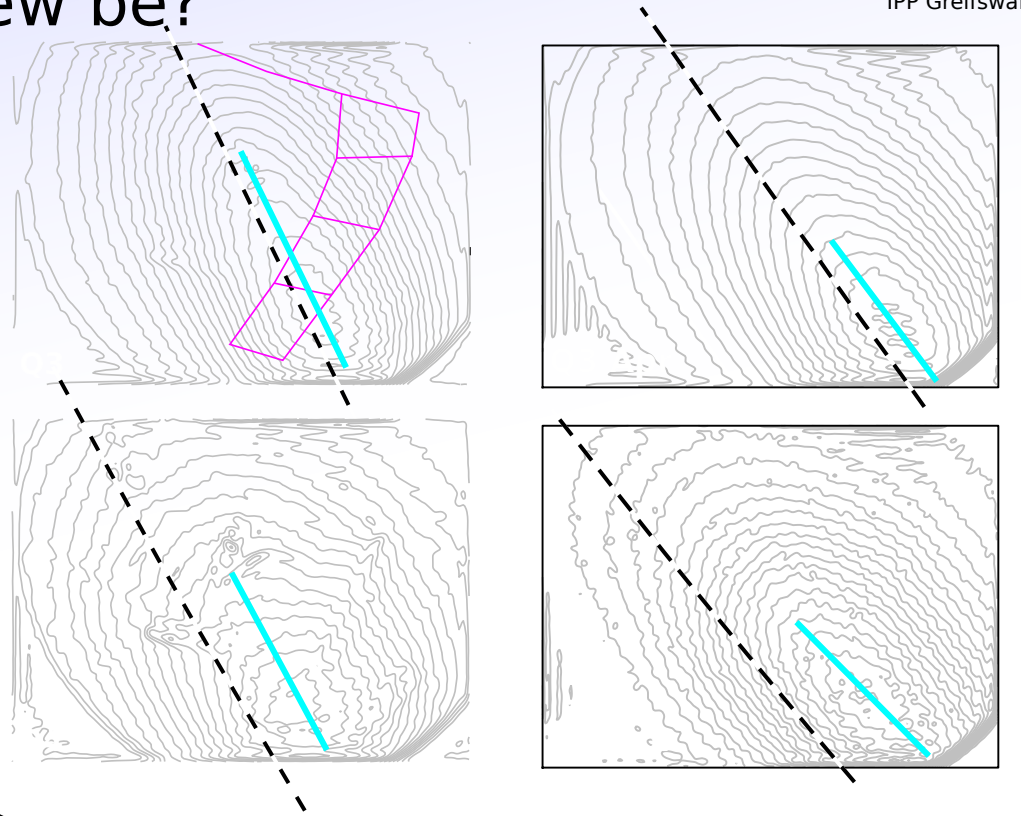
Where should view be?

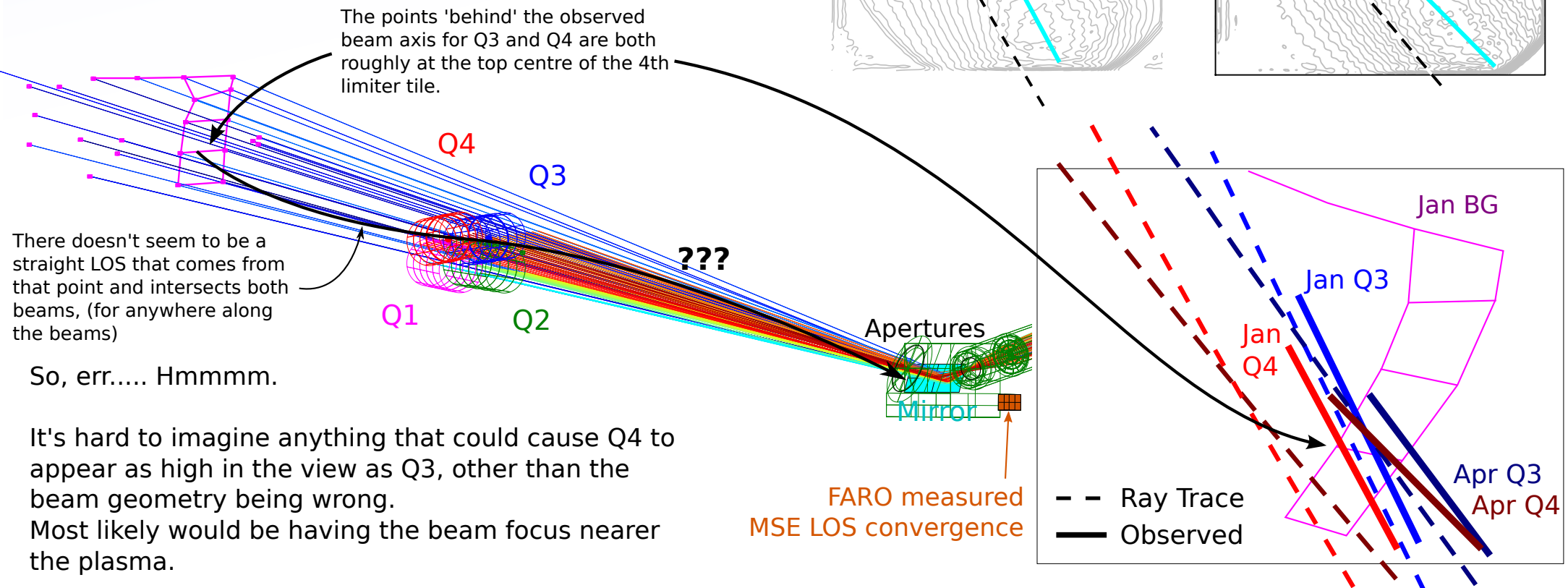
There is an extra clue in the Q3/Q4 comparison.

1) Both beams are near the centre of the view so should not be heavily effected by the vigneeting. The vignetting changed a lot between Jan and Apr, so would expect position to shift if it were that, but it doesn't.

2) In both Jan and April data, observed axis of Q3 and Q4 are almost together but ray tracing says they should be separated.

According to the geometry we have, that shouldn't be possible:





So, err..... Hmmmm.

It's hard to imagine anything that could cause Q4 to appear as high in the view as Q3, other than the beam geometry being wrong.
Most likely would be having the beam focus nearer the plasma.

Lamps

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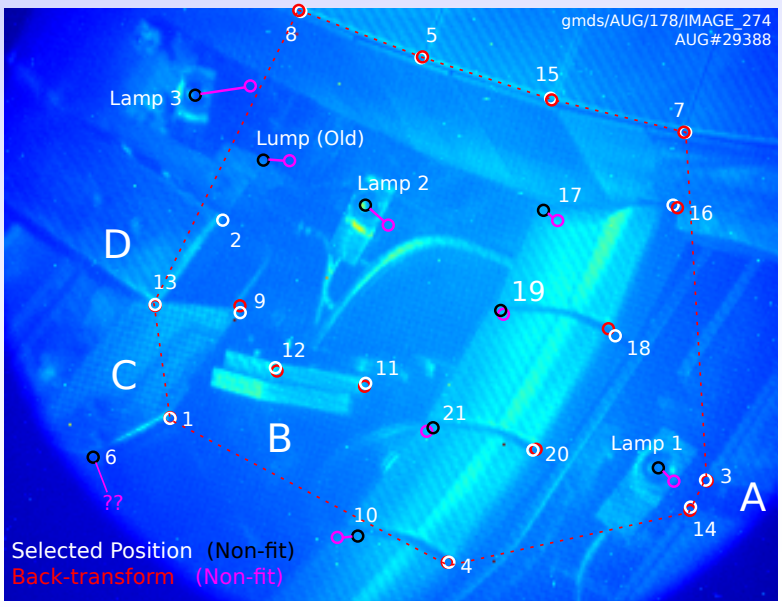

Lamps are now definitely out, need to reaquire their 3D positions.

I didn't ask for their positions.

...

Maybe we'll get them in November.

Image Transform 2

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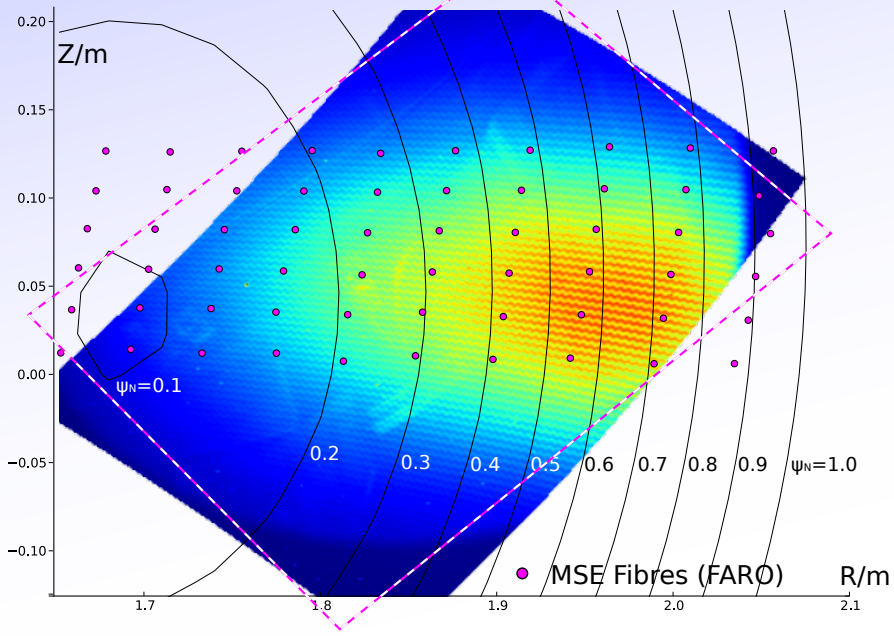
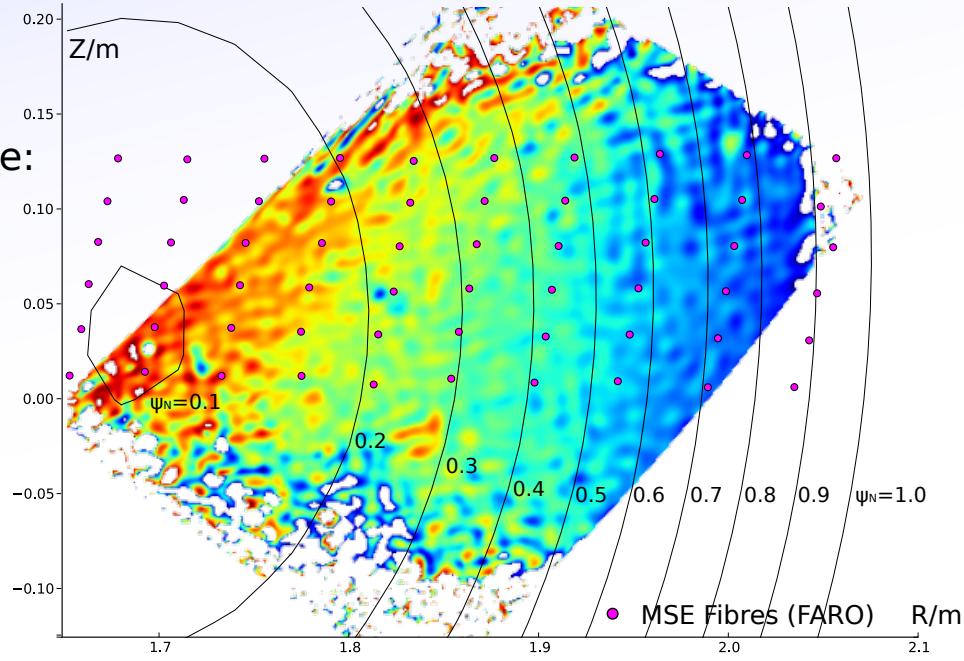
gmds/AUG/29317

With MSE beam (source 3) and flux surfaces:



Transformed polaristion angle looks like:



*April2013: Rotated and moved camera to get better view of core and edge.

Ideally would rotate camera ~22° clockwise, but can only get 10° due to physical restrictions.