Motional Stark Effect Imaging on ASDEX Upgrade:

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Oct 2014 Analysis

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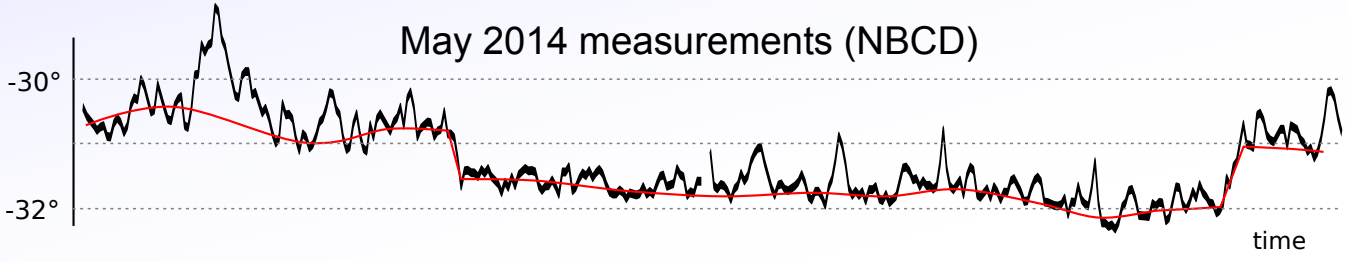
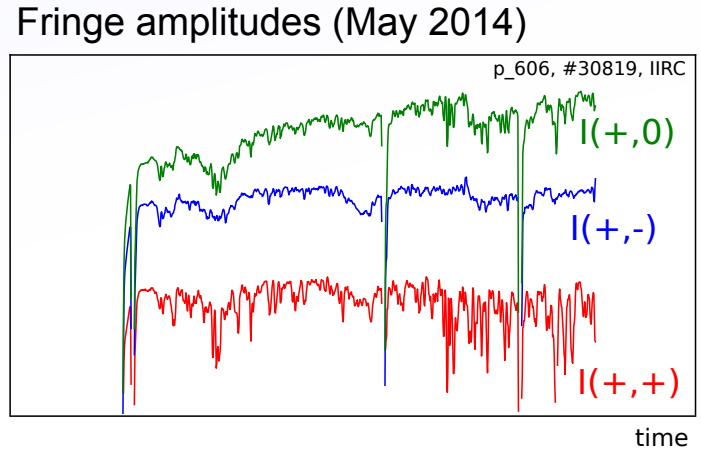
Vibrations

Many shots in May experiments showed sharp changes in measured polarisation angle due to unbalanced reduction in all contrasts - guessed this was vibrations of the camera blurring the fringes.

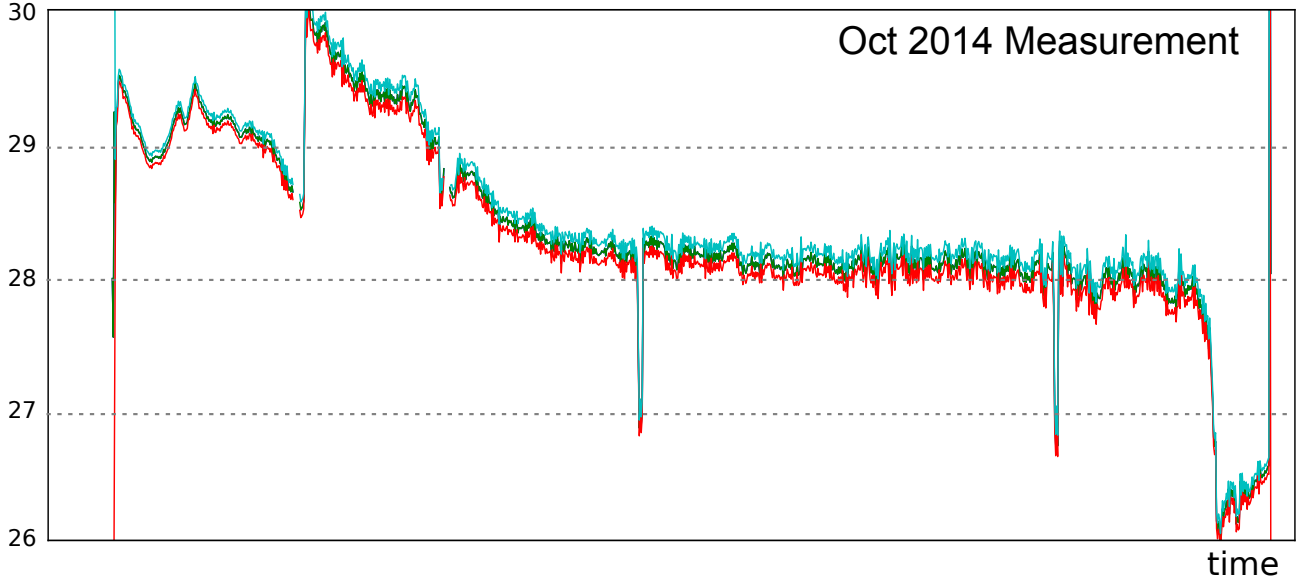




Improved camera and lens mounting and tested for vibration effect in Greifswald this summer.
Stable in the lab to < 0.05° despite severe external 'perturbations' to the diagnostic frame.

No severe fringe blurring seen in the October measurements.

The underlying image still moves significantly, but this should only effect our positioning (±1cm at the beam)



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Polarisation Angle --> Pitch

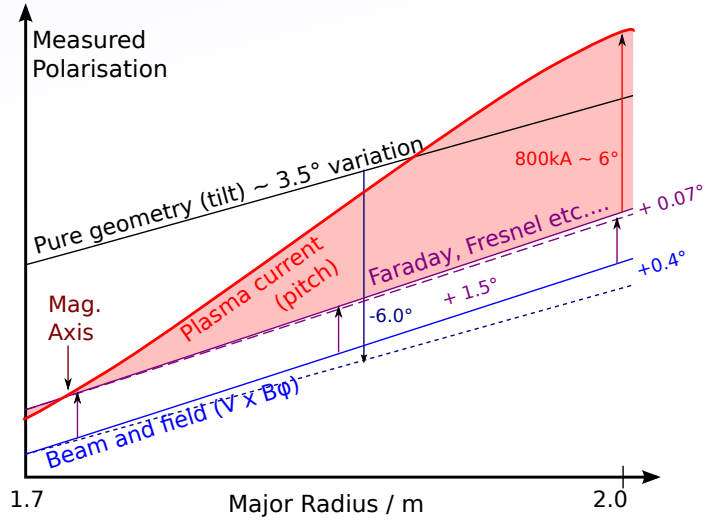
Measured θ is directly related to pitch (Bz/Bφ), but lots of things effect both the real and theoretical relationship:

0) Offset

- Diagnostic geometry
- Mirror position
- Vessel movements
- Plate temperatures
- Beam geometry
- Faraday rotation
- ....

Should not be required, if the edge field is known (and Er).

(with the new system, we need to make sure we see nearer the edge)



1) Linear in (R,Z)

- View geometry
- Beam geometry
- Mirror angle
- ...

The linear change needs calibrating. In vessel calibration not possible for prototype system so currently trying to calculate it from Equilibrium. This requires knowing Ip and **Axis position.**

2+) Non-linear in (R,Z)

- Intrinsic contrast
  (Crystal plate deformations)

2nd+ order instrument effects need eliminating or calibrating where possible!

Current setup suffers from crystal plate deformations (manufacturing).
Ordered better crystals to solve this but they did not arrive in time for this campaign.

Effect depends on light cone so we need illumination as if from the beam (in-vessel work)

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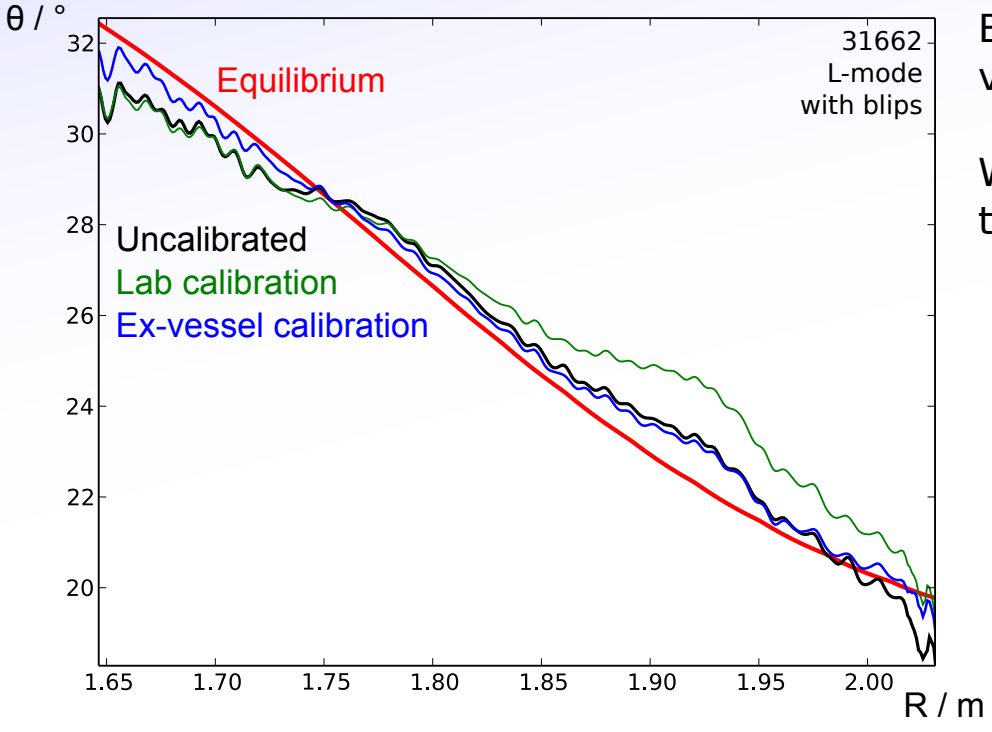
Polarisation Angle --> Pitch

We added some beam blips during an L-mode shot (piggyback).
The 5 blips recorded exactly the same (within noise), so we should have a simple, stable, and hopefully well-identified Equilibrium)



Big changes in dθ/dR indicate unphysical current profile variations - there is definitely a non-linear response.

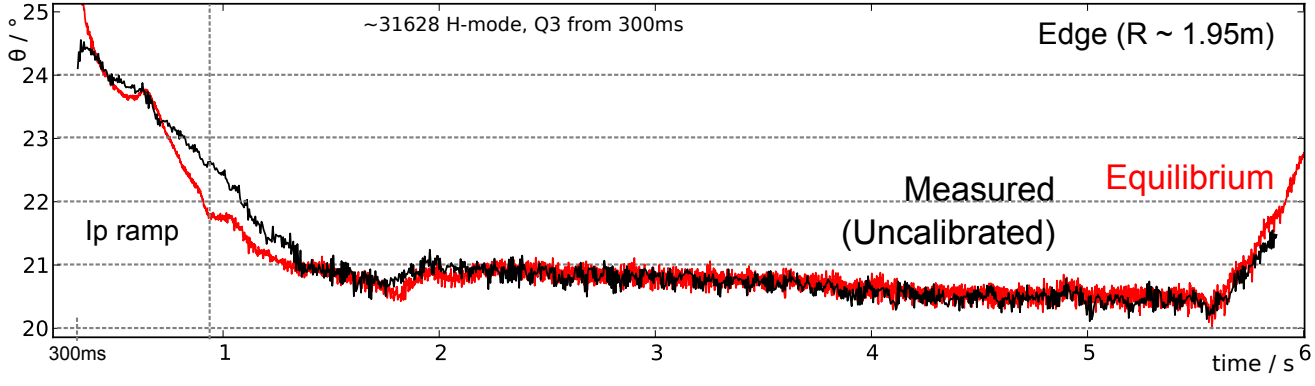
We have several different calibrations which will be tested to see if they can make this data make sense:

1. Calibration sphere (HGW lab) -
   Seems to be worse

2. MSE ex-vessel (partial vessel optics) -
   Much better, but not complete.

3. Online calibration (NBI light + polariser) -
   Not yet processed.

Fortunately, the deviation does appear to be stable within each pulse:



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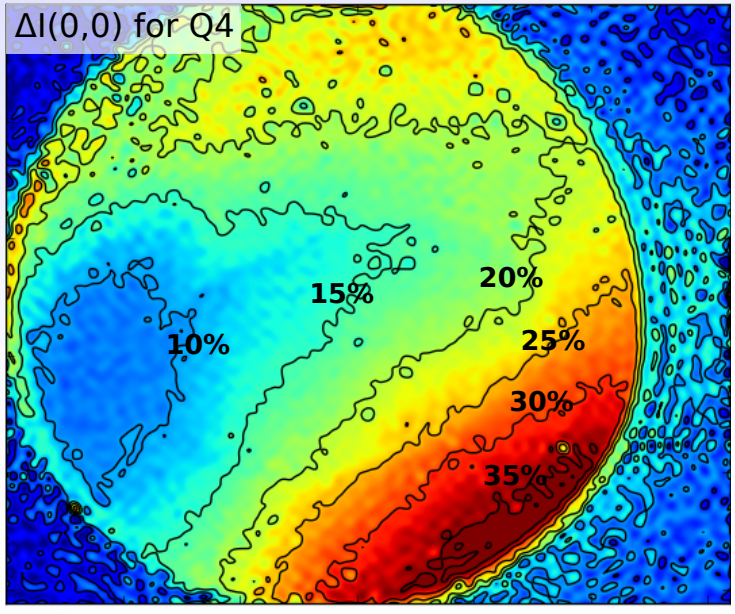
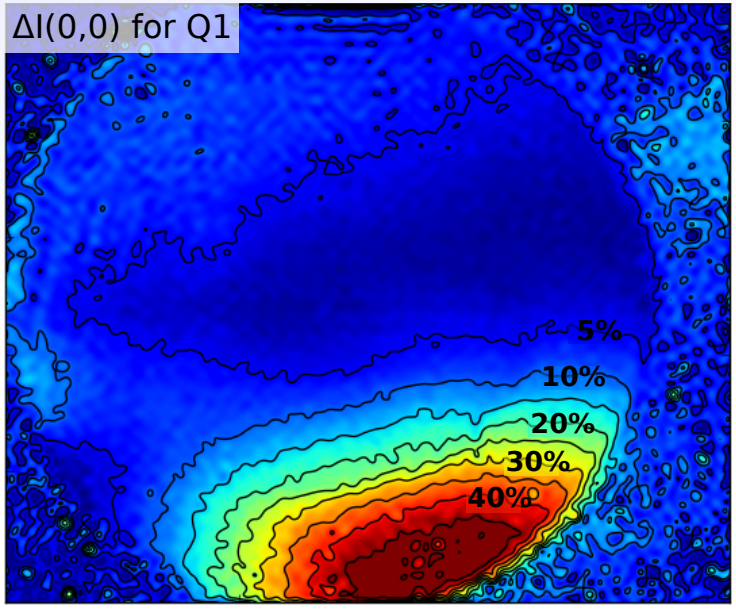
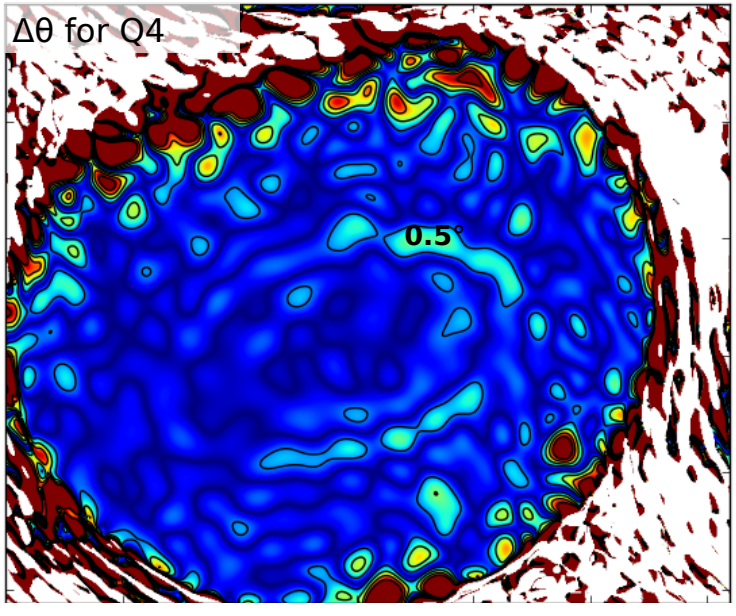
p_707
Q1: f_154 - f_151
Q4: f_197 - f_193

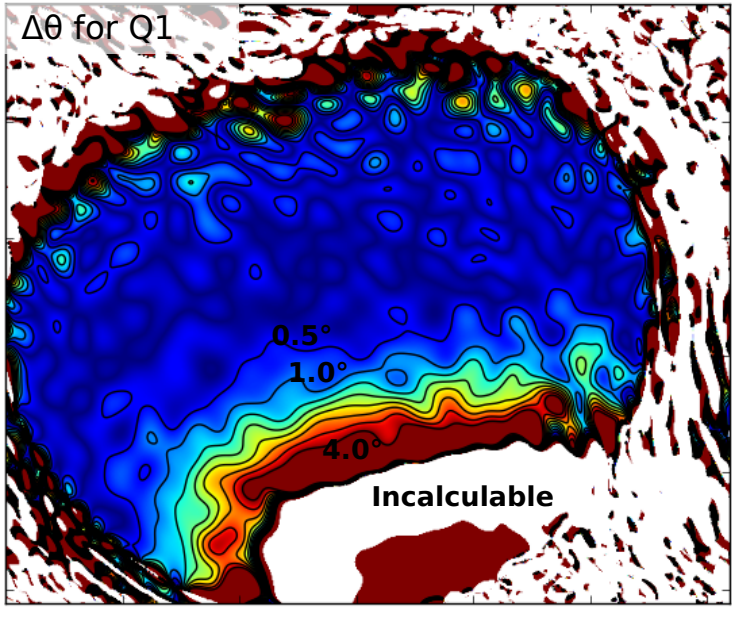
Multi-beam

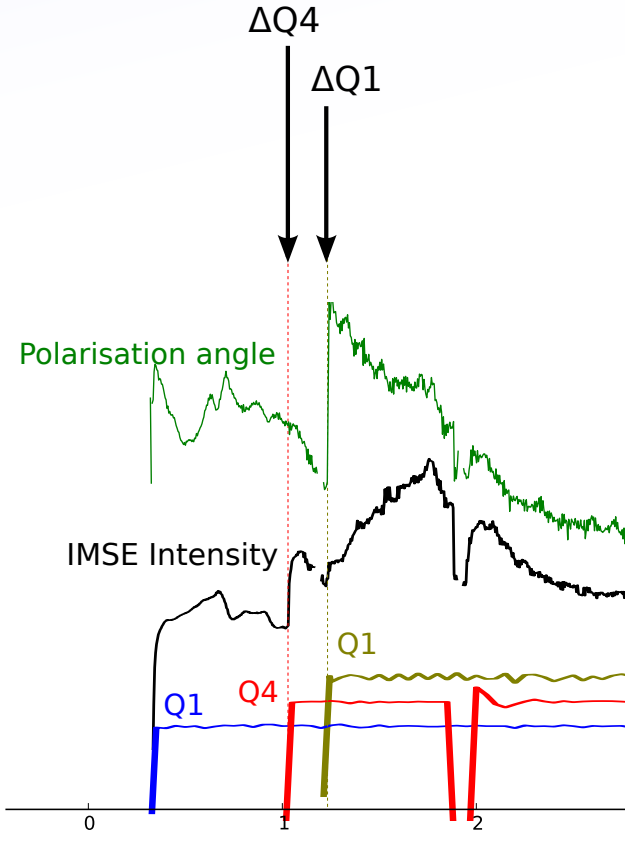
Also began examining the effect of mixed beams. Surprisingly Q4 has a stronger intensity effect but weaker effect on the angle than Q1.











So, we can probably do basic equilibrium analysis with Q1 active, and also with Q4 in certain areas of the image. At the very least the dynamics will still be valid.

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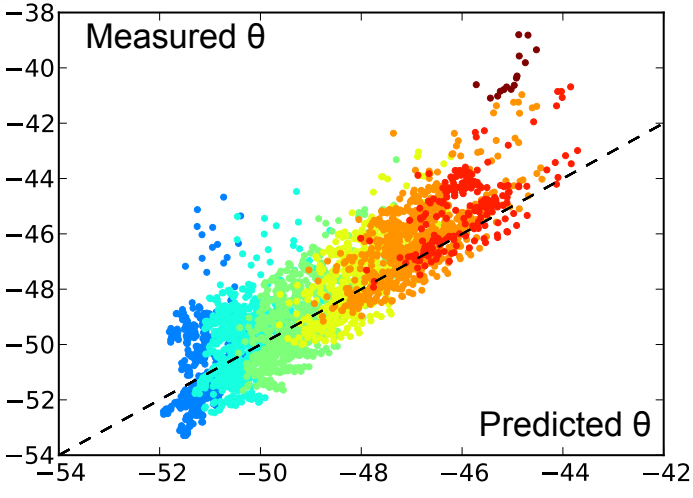
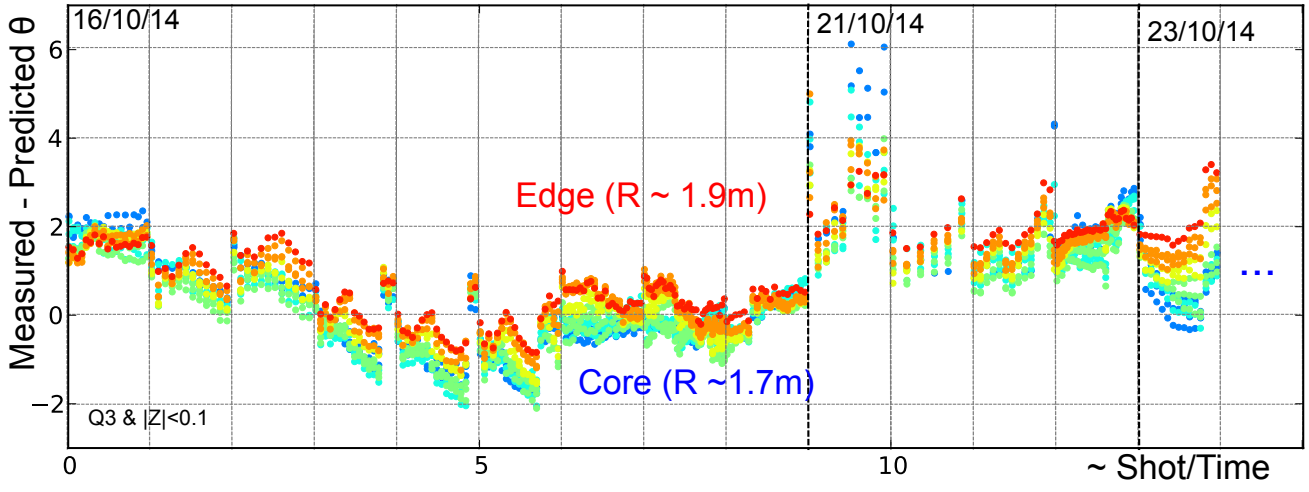
Other:

- Optimised filters to dramatically improve core signal.
- Fixed more magnetic shielding issues.
- Fixed various camera configuration and trigger problems.
  Now have full time integration on globally shuttered mode (10ms integration)
- Made various measurements to help identify background issues with MSE (A. Bock)
- Significant progress on permenant IMSE optical and mechnical design.

- 46 pulses of good plasma (Deuterium).
  - Didn't modify the system for duration.
  - Calibrations checks run every day throughout.
  - Maybe can extract a valid calibration.
  - Monitor stability and drifts of IMSE system and MSE optics.

Preliminary: Looks like there may be a some slow (~hours) drift.





The Permenant IMSE will have an automatic intershot ex-vessel (and hopefully in-vessel) reference calibration.