MSE on ITER and JET Experience

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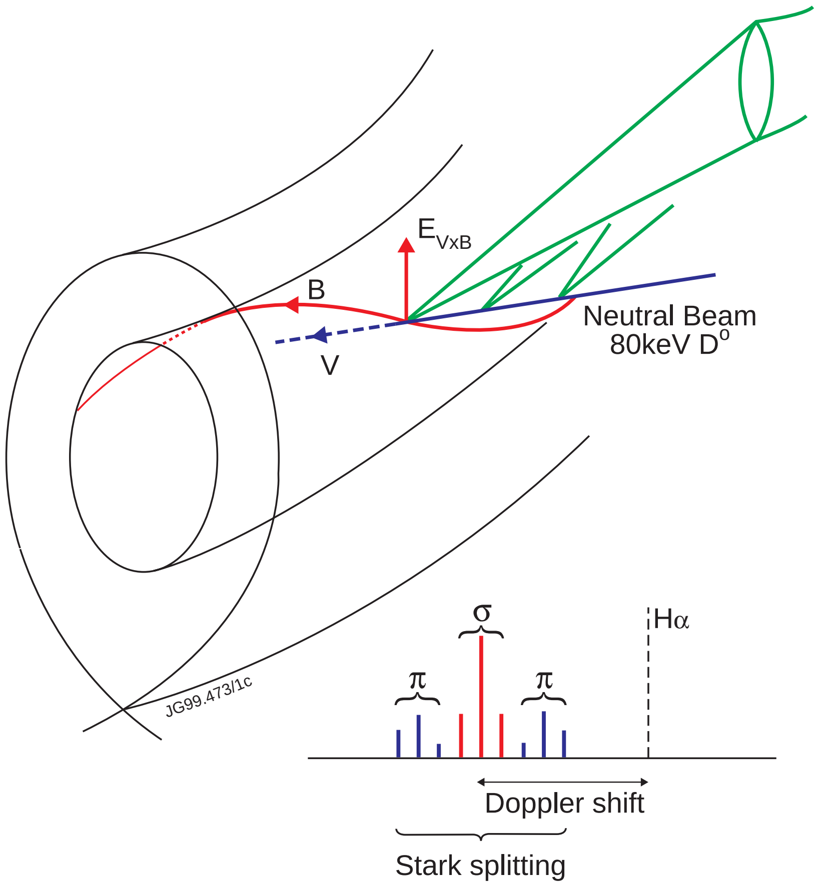
Outline

- MSE Diagnostic concept
- ITER Beam parameters
- MSE Diagnostic geometry
- Potential concerns
- JET Experience

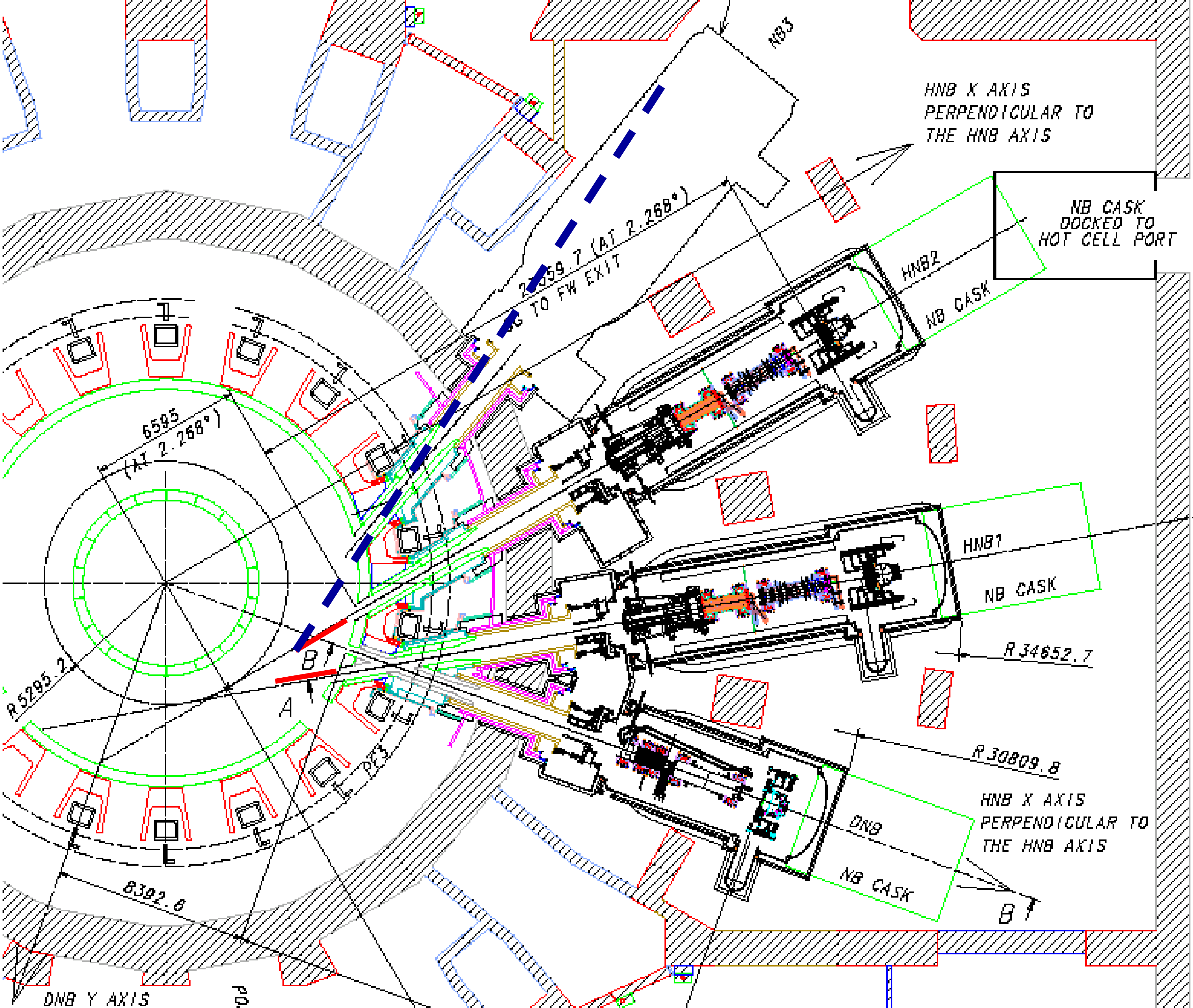
MSE Diagnostic concept

MSE Measurements-HNB



- Deuterium atoms in the neutral heating beams are excited by collisions, emit H-alpha radiation
- Plasma magnetic field is Lorenz transformed to an electric field in the frame of the emitting atoms
- Stark splitting and polarisation of the radiation by this E-field
- Polarisation projected onto detection optics - yields information on the magnetic pitch angle

ITER Beam parameters



NB3
HNB X AXIS
PERPENDICULAR TO
THE HNB AXIS
NB CASK
DOCKED TO
HOT CELL PORT
HNB2
NB CASK
(AT 2.268°)
TO FW EXIT
6585
(AT 2.268°)
HNB1
NB CASK
A
R 34652.7
B
A
R 5295.2
R 30809.8
HNB X AXIS
PERPENDICULAR TO
THE HNB AXIS
DNB
NB CASK
B
8392.6
DNB Y AXIS

Beam Parameters

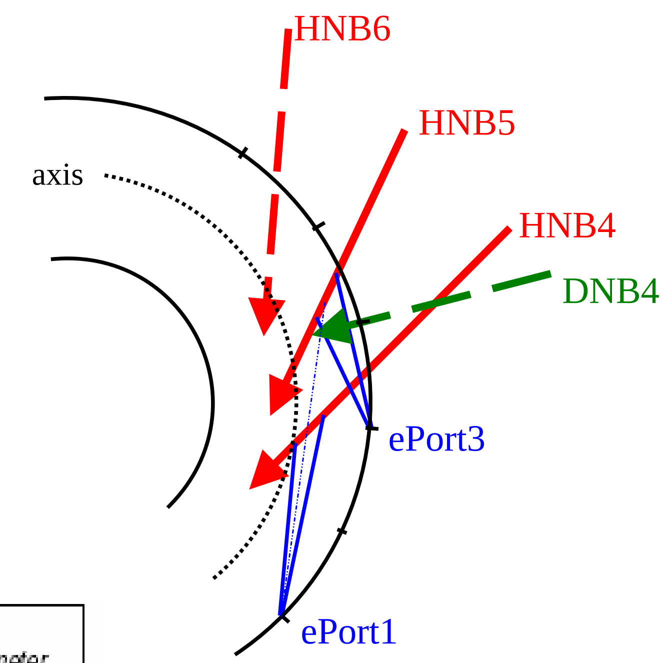
- Heating Beams
- Tangential
- 400-1000 KeV D beams
- Negative ion source
  - no half/third energy components
  - No He doping

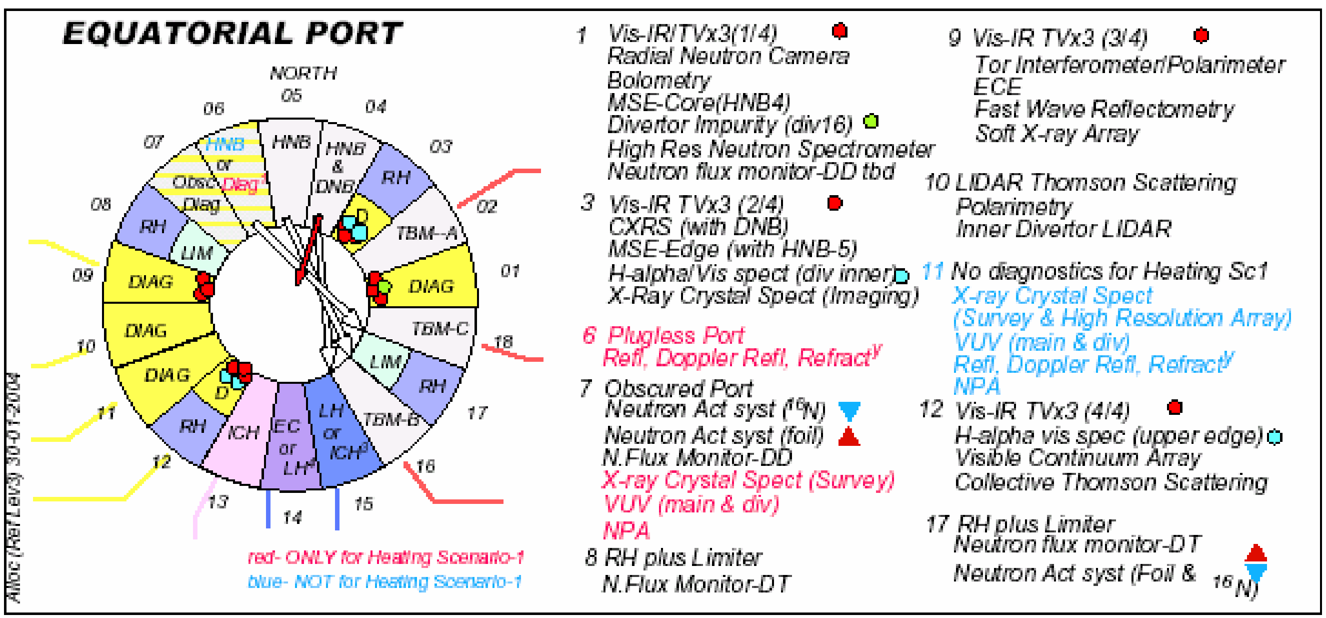
- Diagnostic beam
- Radial
- Similar parameters to heating beams
- Modulated
  - ~5 secs on in 20s

MSE Diagnostic Geometry

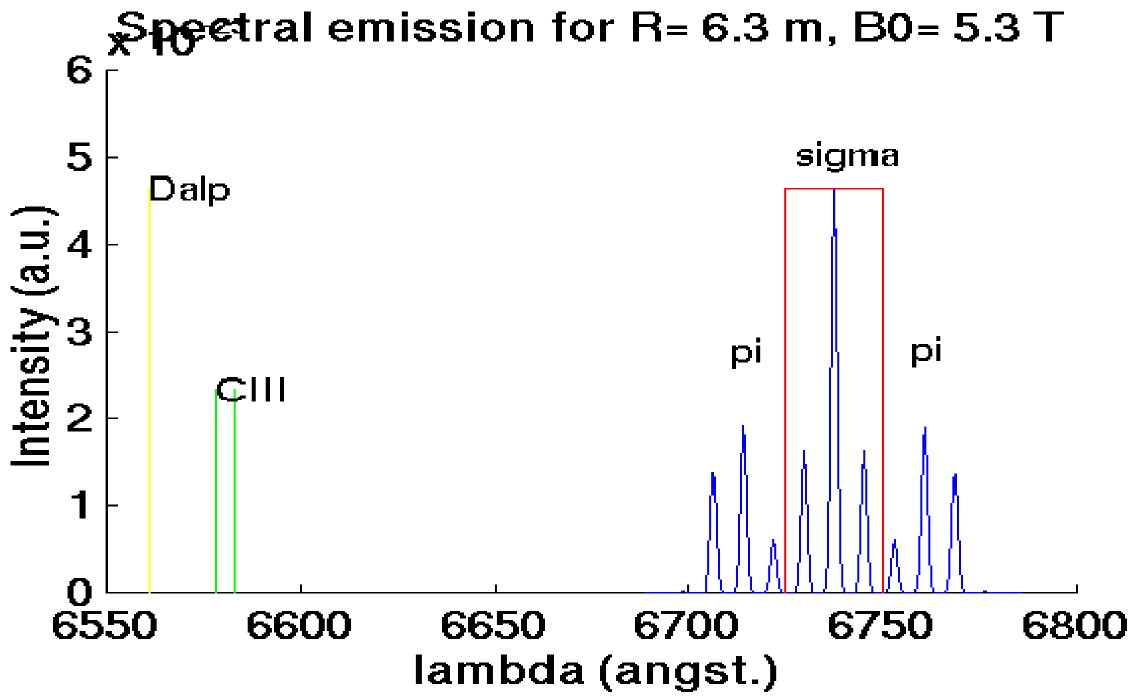
Midplane Ports (HNB)

- Optimum MSE port is not available
  - obscured by beam structures
- Diagnostic port 16 exchanged for port 1 to give overall MSE coverage.





MSE Spectrum from HNB



- High Doppler shift, only one beam component
- High Stark shift (clear separation of σ and π).
- But high level of Bremsstrahlung.

HNB Light Collection System

- Four mirrors at least are necessary with a W-shape of the light path to have a good neutron shielding.
- But incidence angles on mirrors are large (~45°) (modification of initial polarisation)
- Add 2 mirrors to reduce incidence angles ?

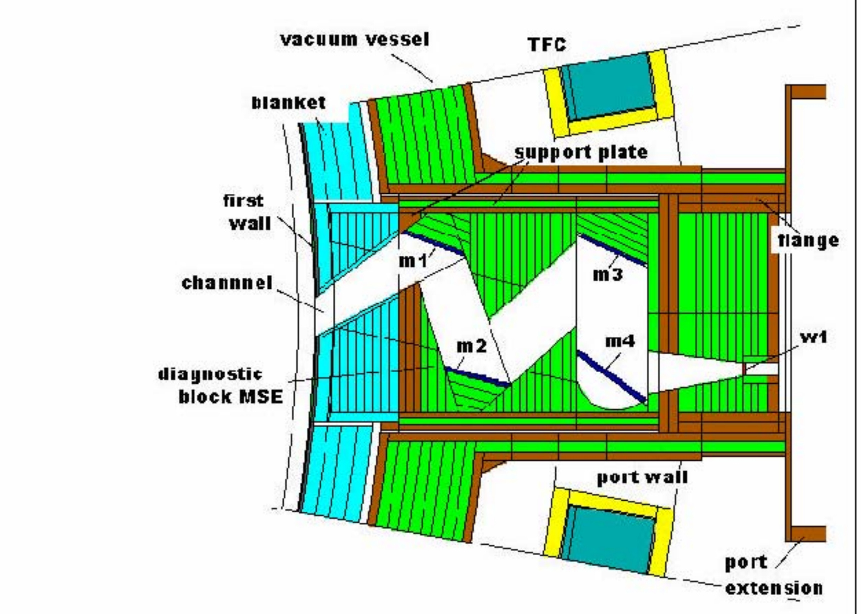
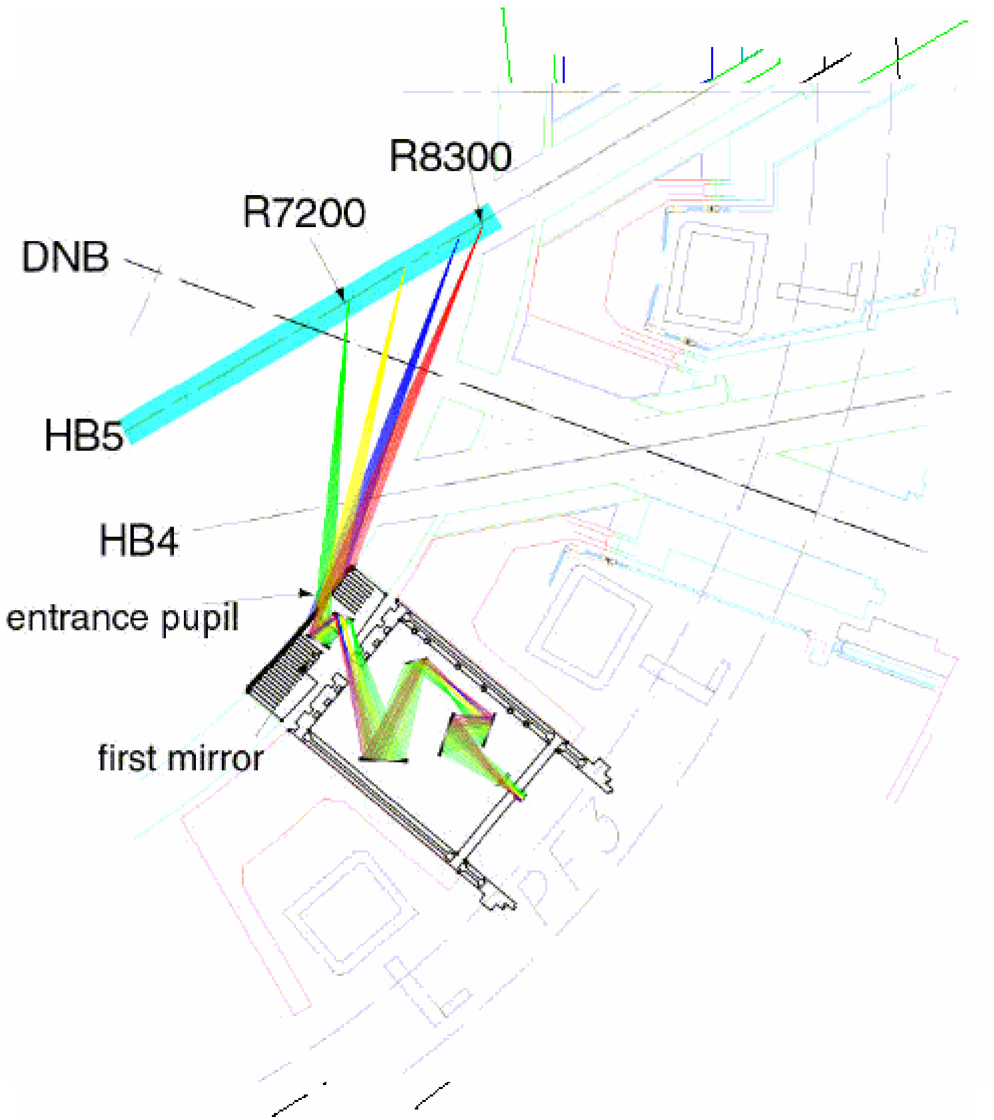


Fig.6 Horizontal cross-section Z=120cmof FEAT central port with MSE diagnostic system

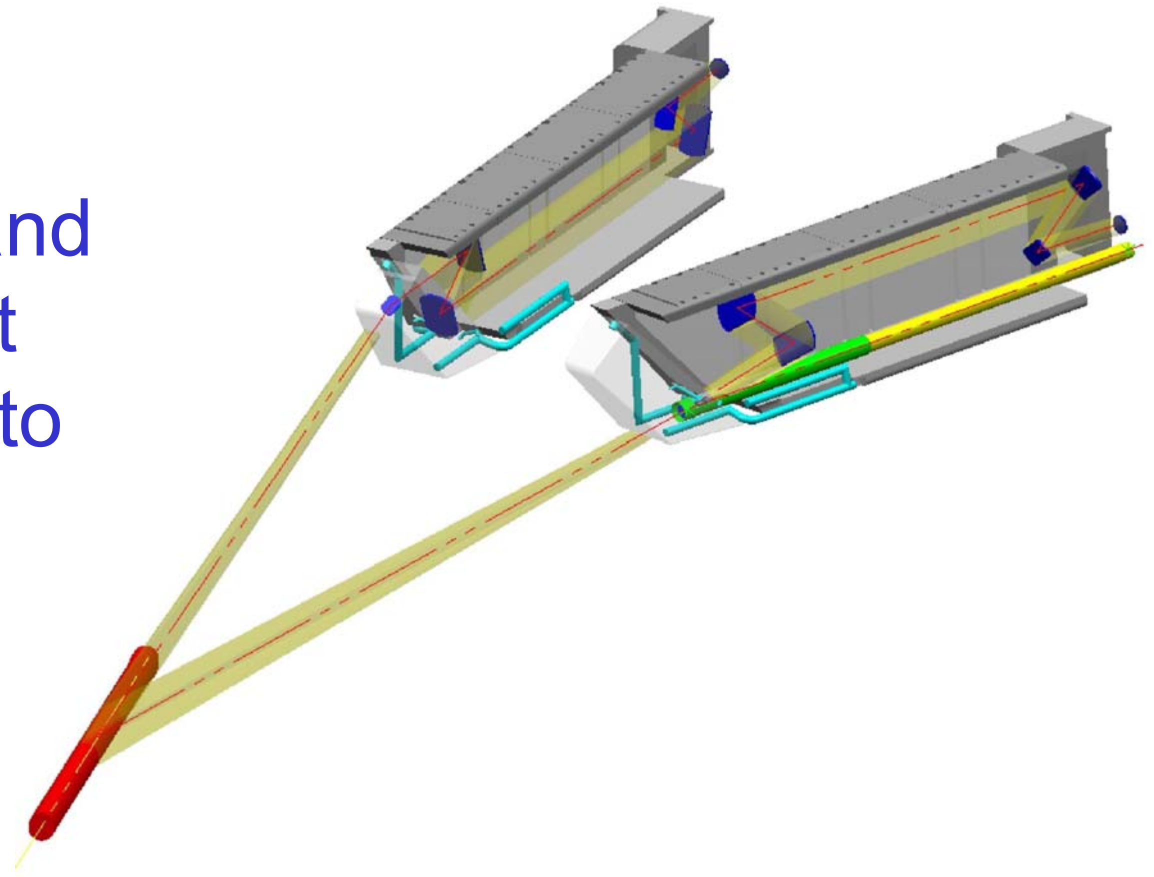
Optical system for equatorial port 3



- Design of a light collection system in equatorial port 3.
- Vertically positioned to avoid HNB4 and DNB.
- Ray tracing to obtain the positioning of the mirrors.

MSE Ratiometry on DNB

- View of DNB from above at 45°
- Intensity ratio of σ and π-lines is dependent on angle from LOS to E-field.



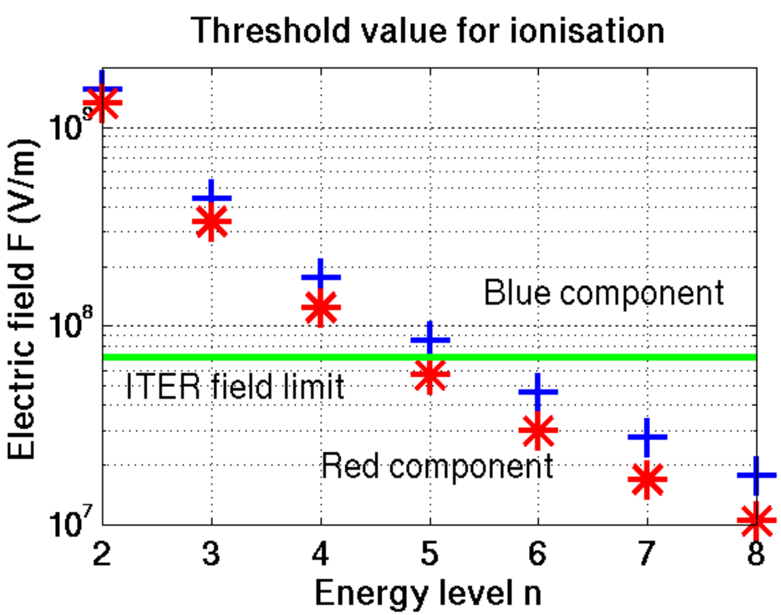
- Potential benefit of CXRS viewing optics.

Potential Concerns

Feasibility of MSE at high Lorentz electric field

Both methods can be applied on ITER Heating Beams (Ph. Lotte)

- Polarimetry: no mixing of the polarised lines
- Quadratic term must be added to deduce $E_L(B_{tot})$:
  $\Delta\lambda = a.E_L + b.E_L^{\ 2}$ (6% correction)



Lines quenching:

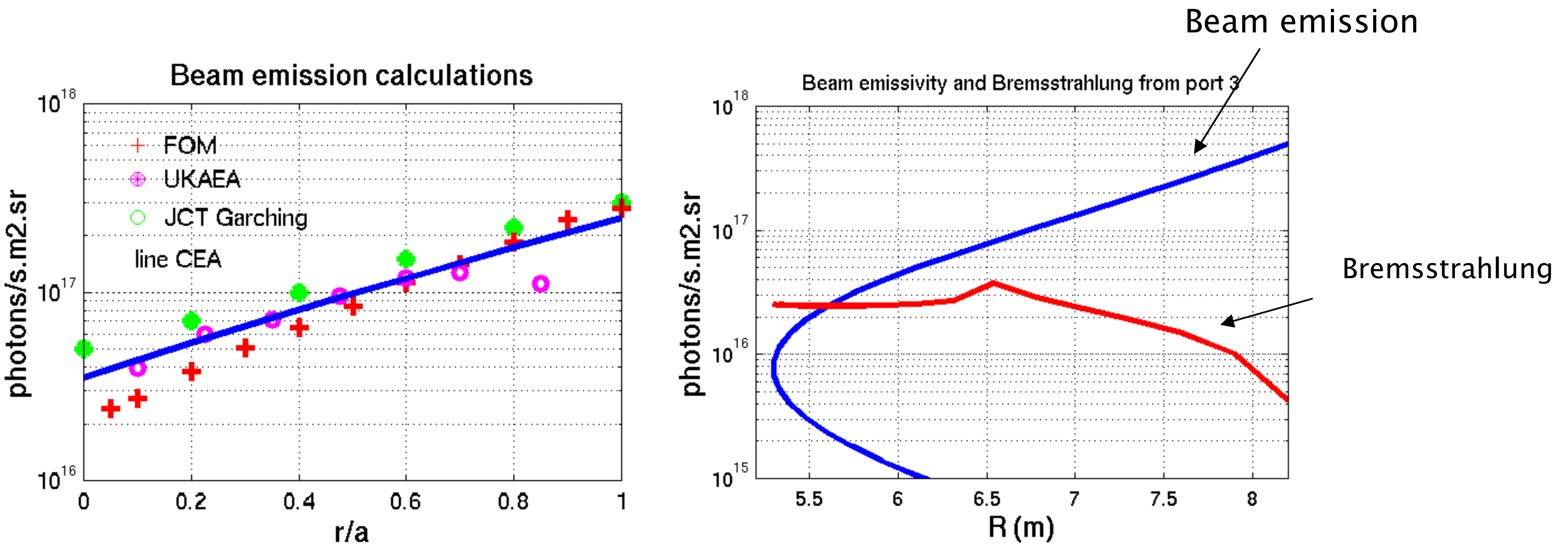
No attenuation of $D\alpha$ line expected

But slight attenuation of neutral beam possible due to ionisation of excited levels n > 6 ?

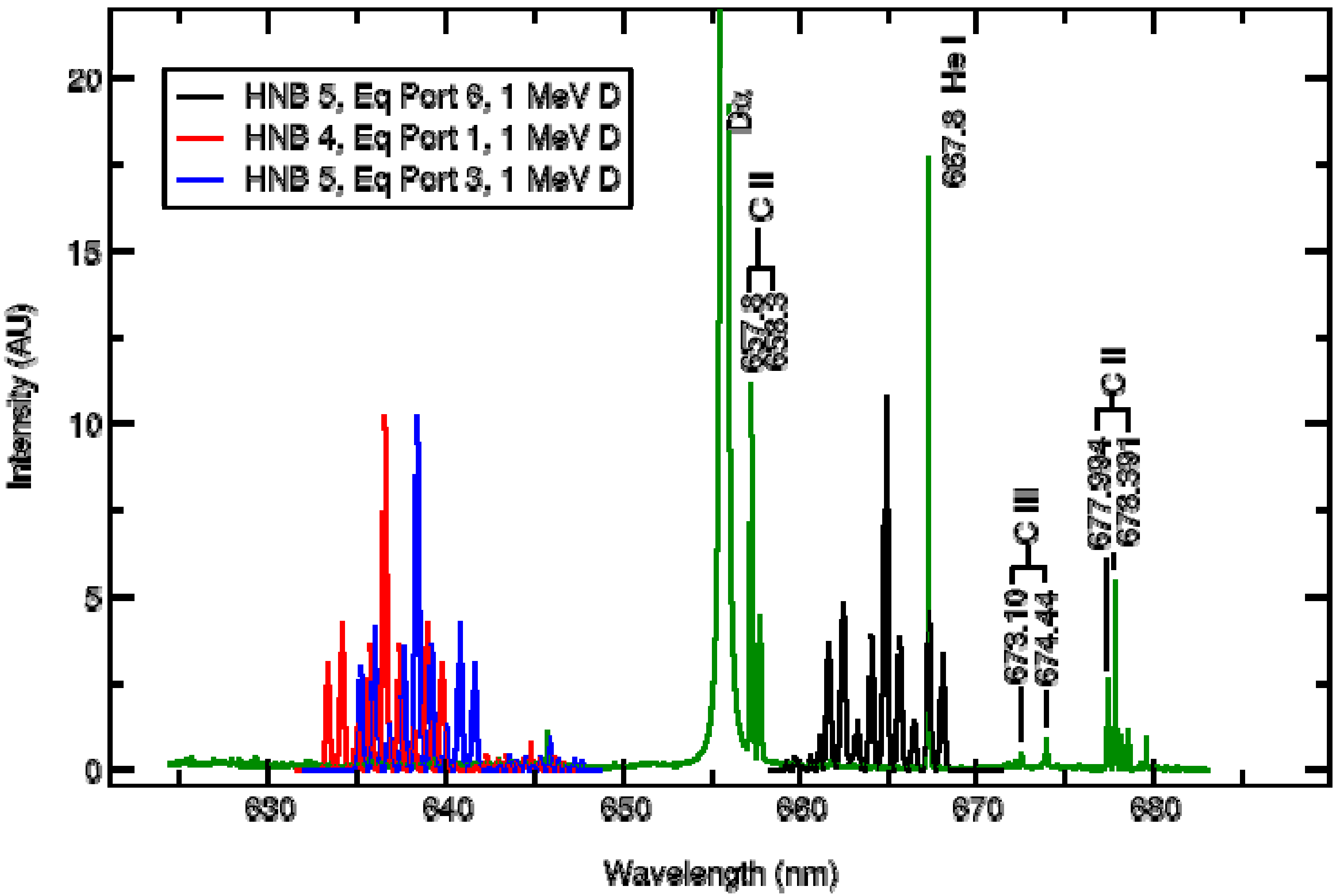
Beam emission, time resolution

Bremsstrahlung evaluation and SNR comparison with existing machines show that a time resolution of 20 ms can be envisaged.

Assumes all background light is unpolarised….

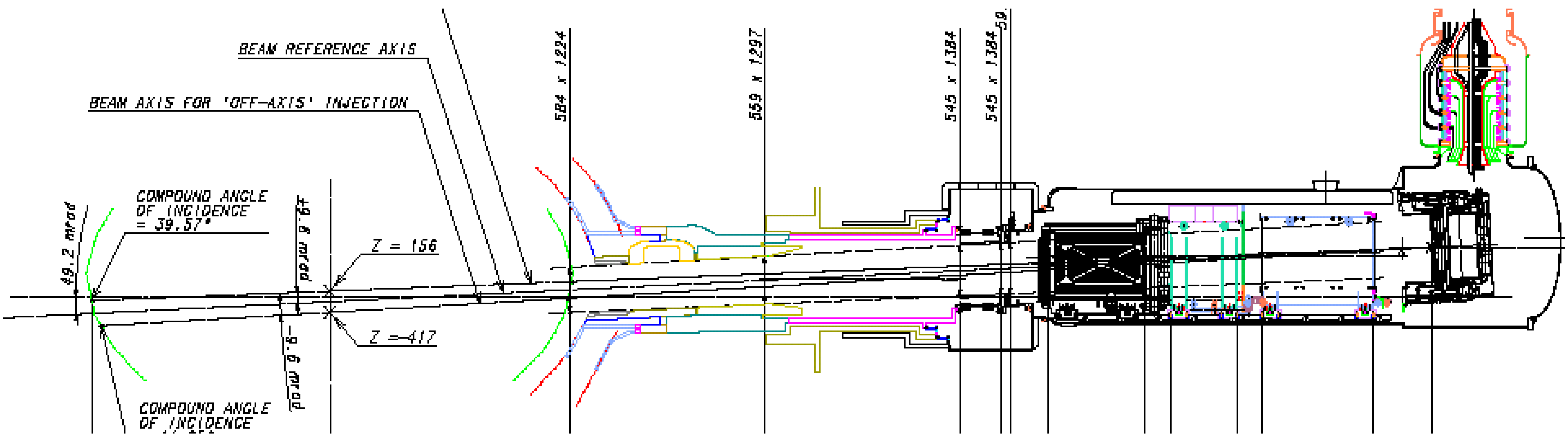


JET observations (with C, Be and He) show spectral region is clean

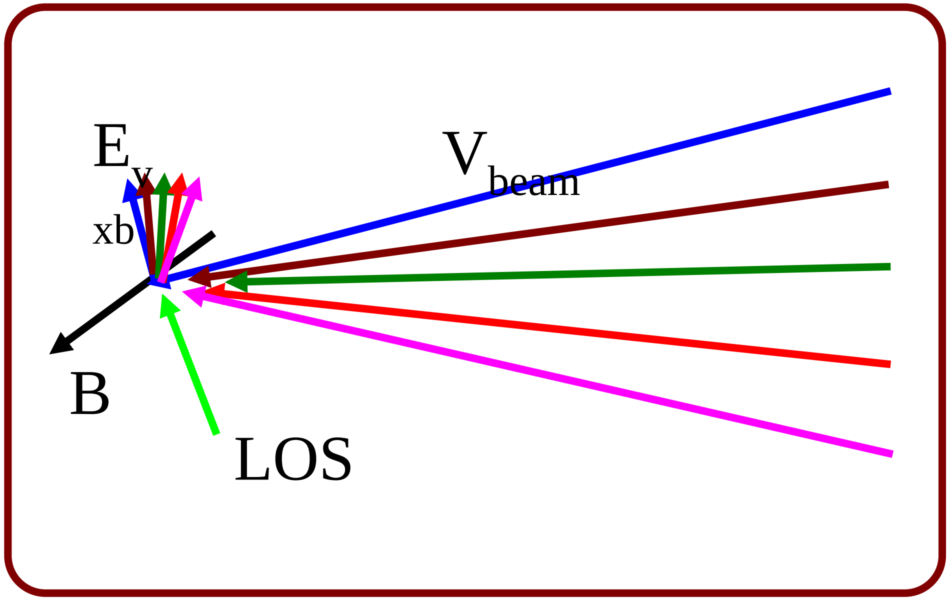


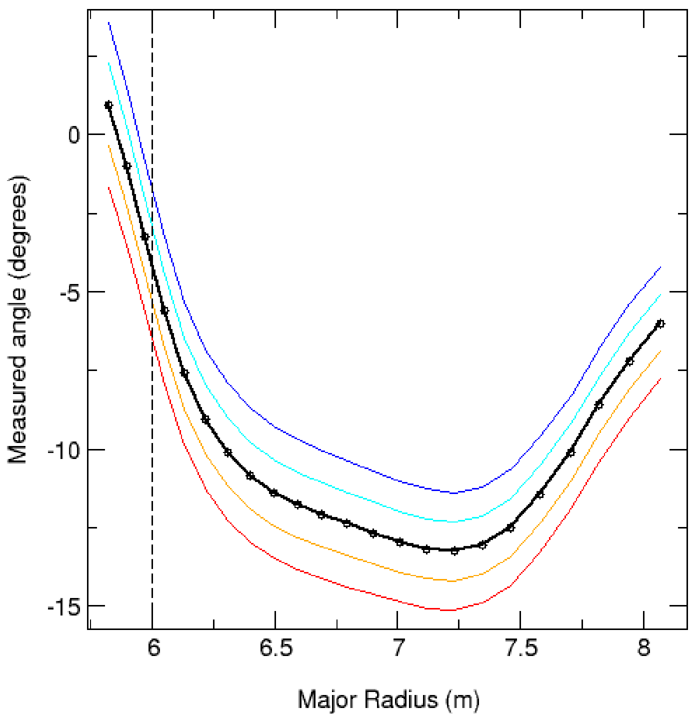
Multiple segments to the negative ion beams

- Negative ion beam sources have relatively low power density so sources have to be extended
- Beams composed of 4 vertical segments, spread of tilt angles 2.9 degrees. Gives about 3.5 degrees spread in the polarisation angles.
  - we are highly dependent on the beam geometries being stable, power balance between segments etc
  - If the segments could be individually switched (they can't) we would have an excellent in-situ calibration technique.

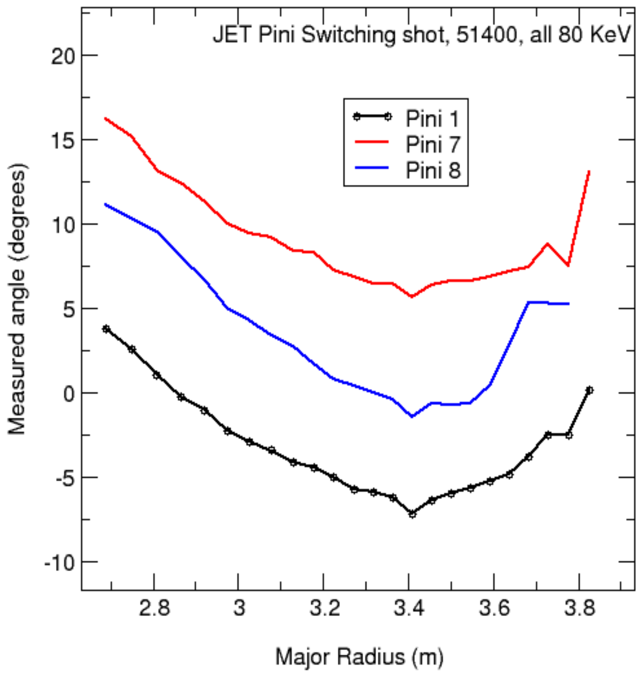


Beam Segment Contributions to Total – weighted sum



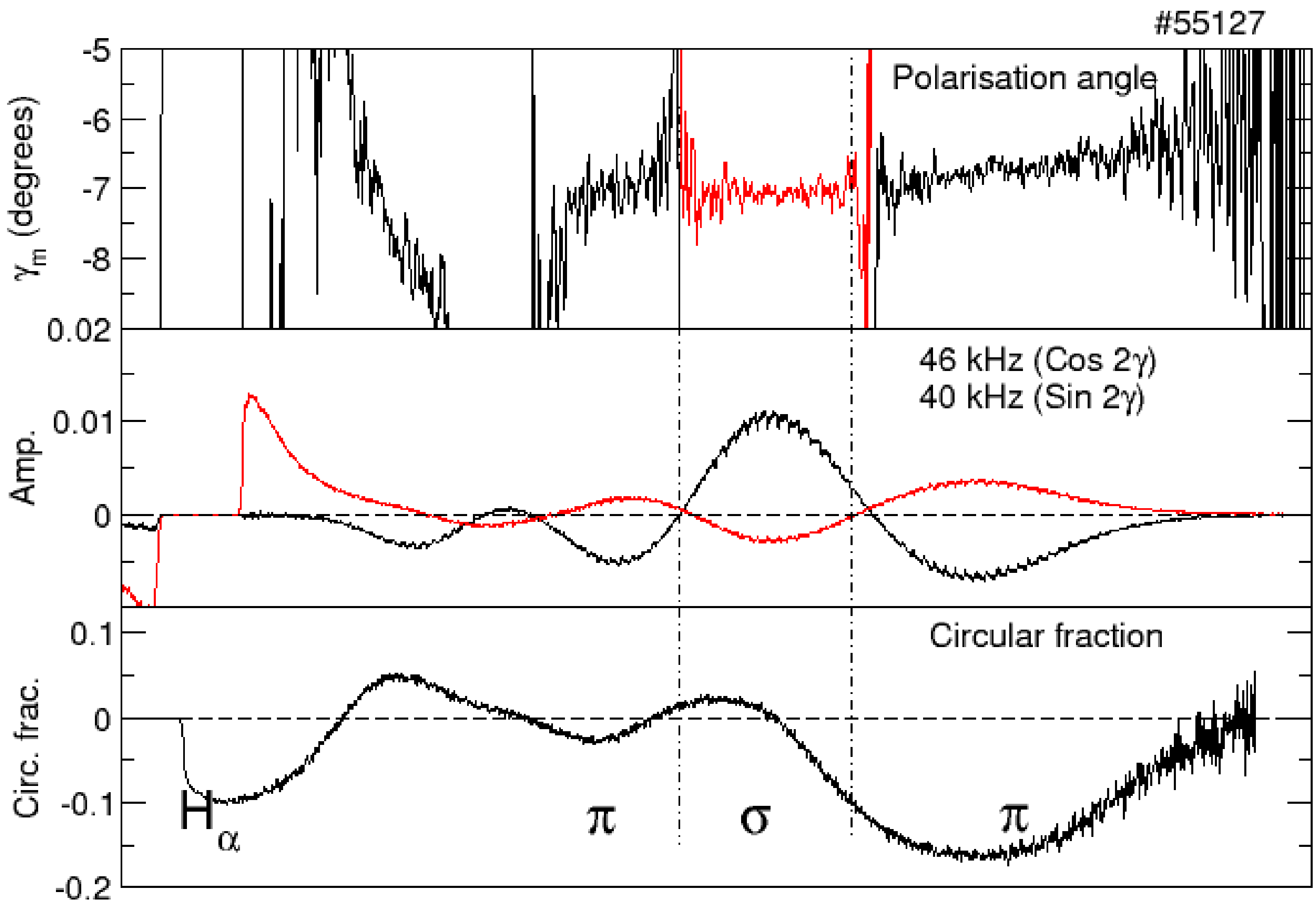


Contributions from the separate ion source segments differ by 3-4°



- Problem is as on JET before PINI 1 voltage upgrade (although the angular difference is less).
- Necessitated 'switching' shots to measure relative contributions, even then a major source of error

Circular components in Stark Spectrum from Atomic Physics ?



Important to record ω1 as well as 2ω1 and 2ω2