UKAEA Fusion Working with Europe

Edge CXRS Ion Temperature and Rotation Velocity Measurements on JET

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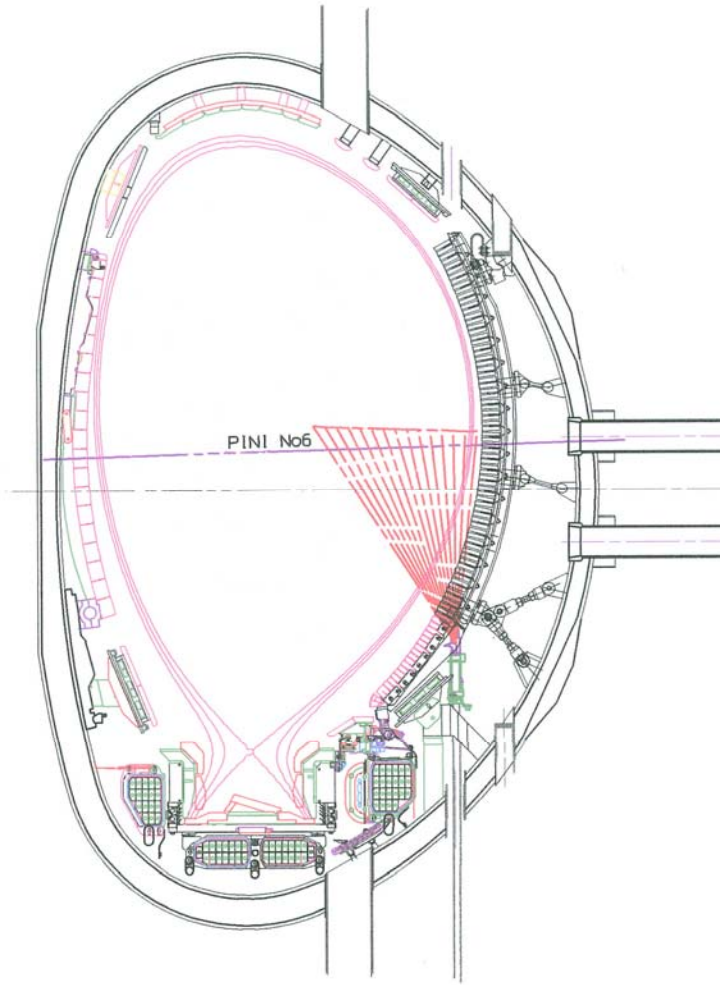
Outline

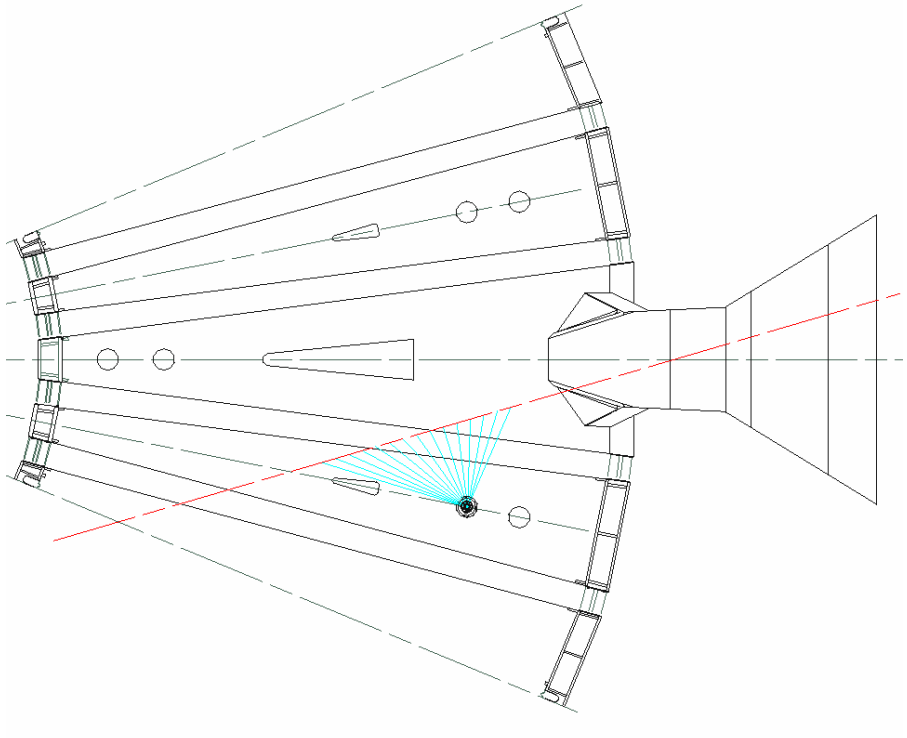
1. Overview of diagnostic set-up
2. What limits the spatial resolution?
3. What limits the time resolution?
4. Typical errors
5. Future work

Overview of JET-EP Edge CXRS Set-up - core view

Octant 8 - poloidal view

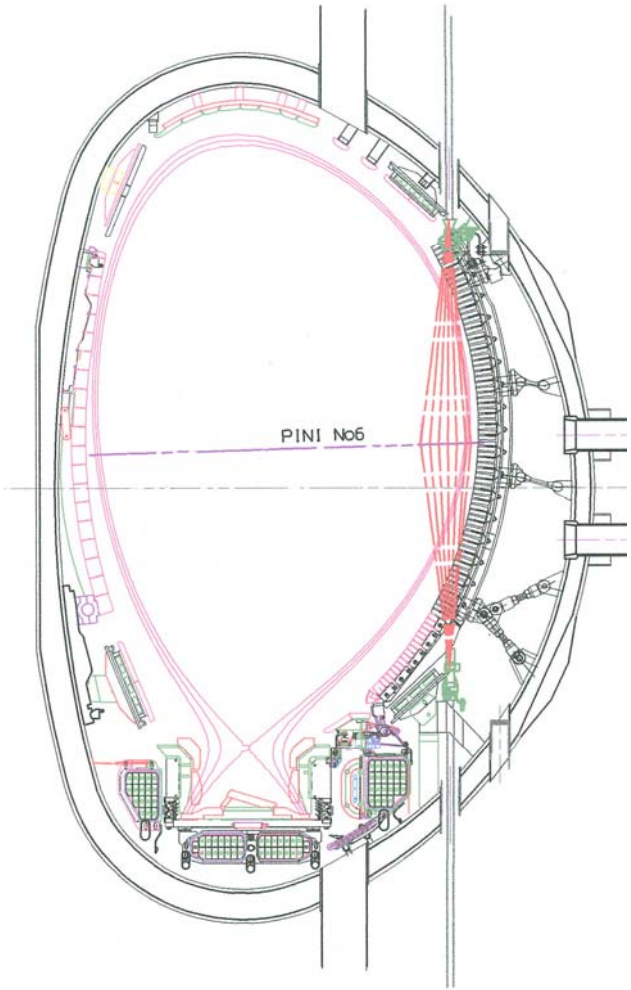


Octant 8 - plan view

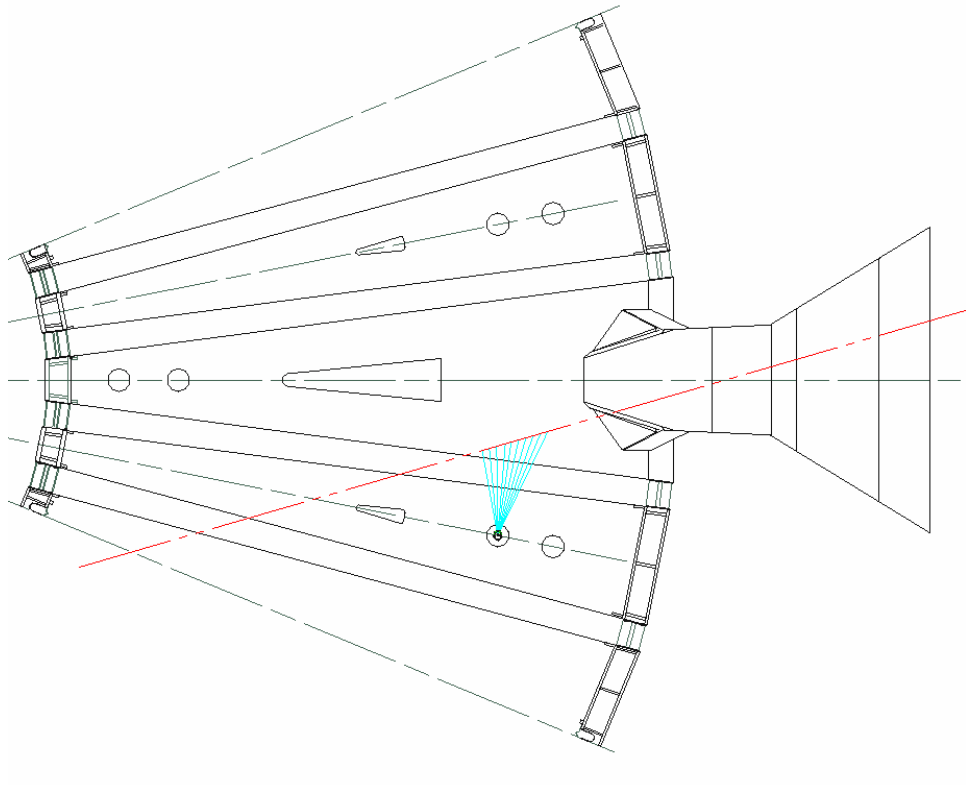


Overview of JET-EP Edge CXRS Set-up - edge view

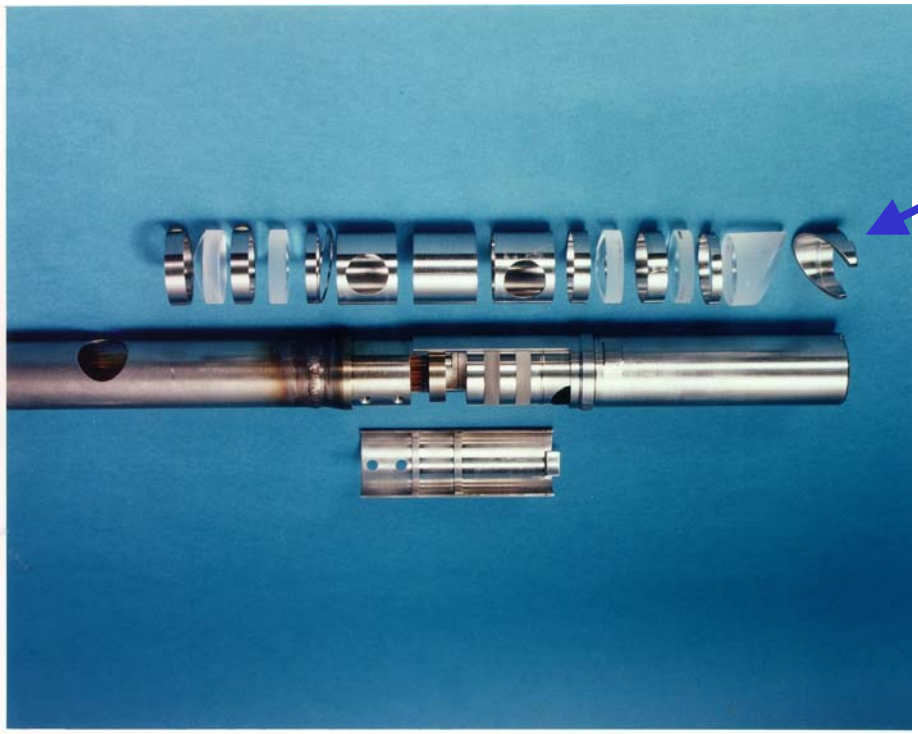
Octant 4 - poloidal view



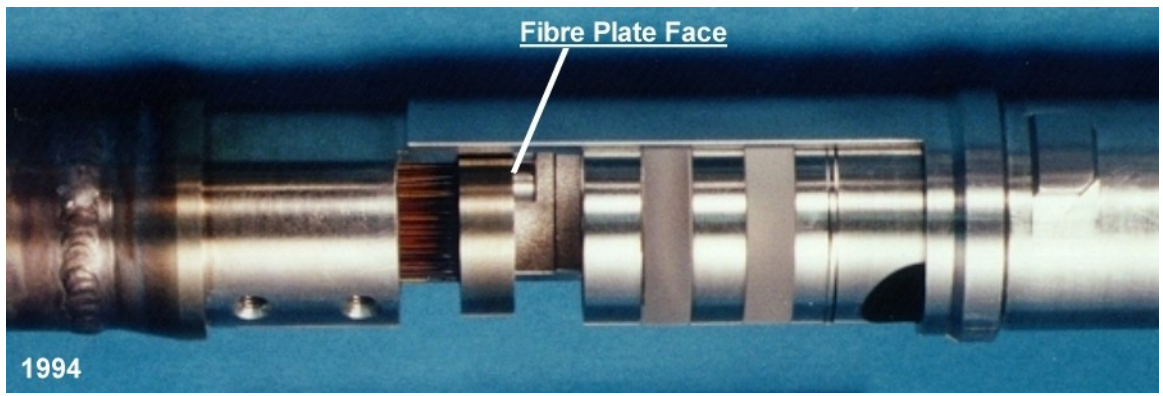
Octant 4 - plan view



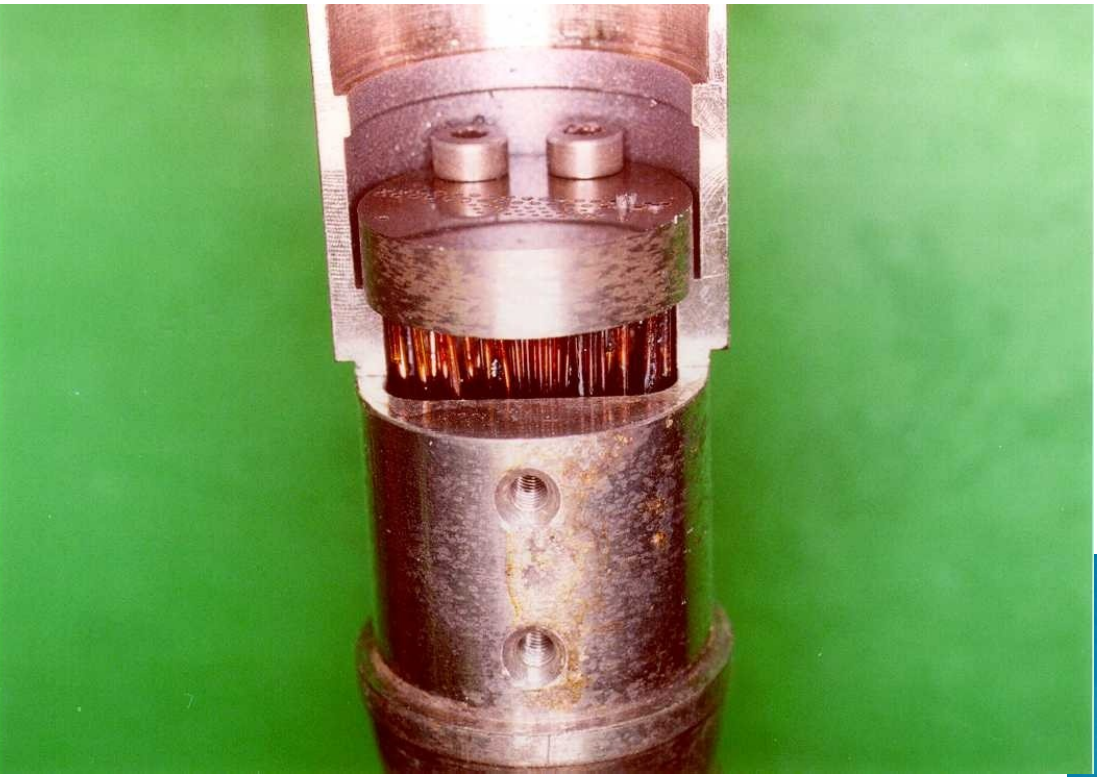
Periscope Fibre Plate and Optics



Set of collection optics to focus light on to fibre plate

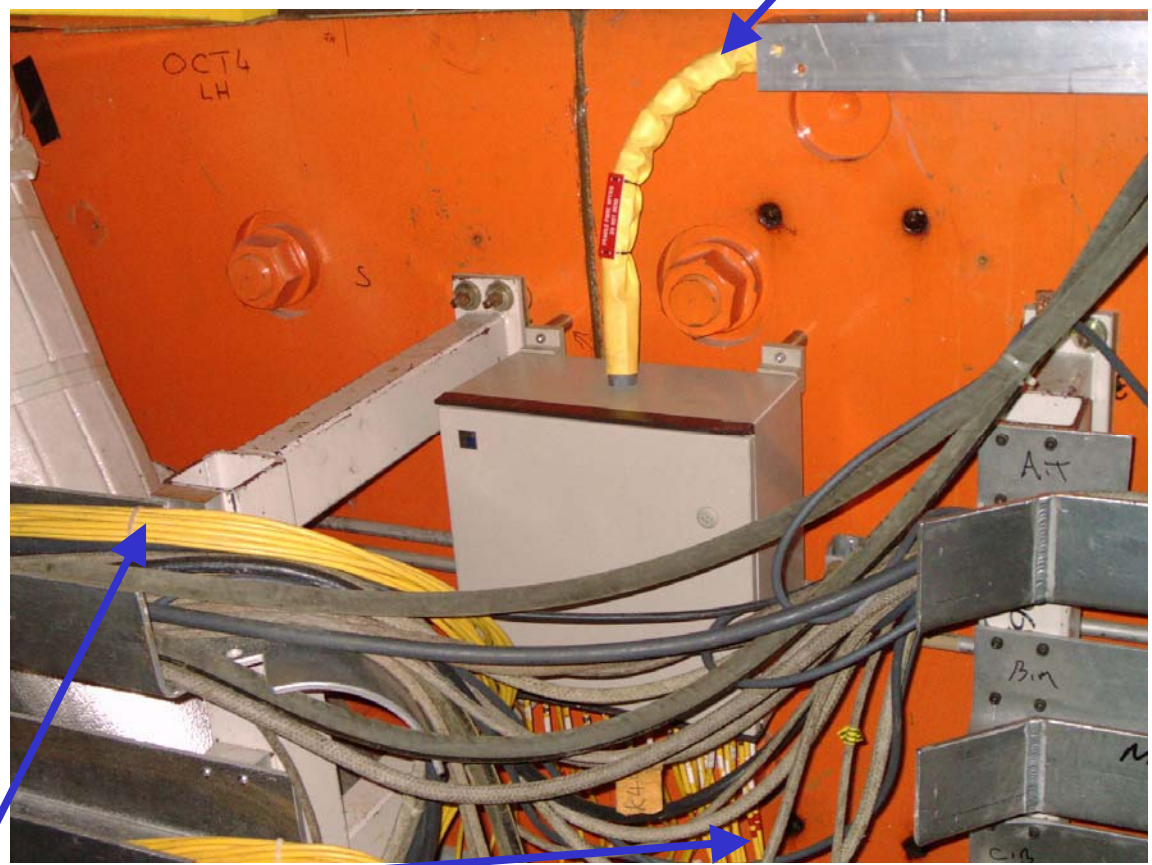


Periscope Fibre Plate and Optics



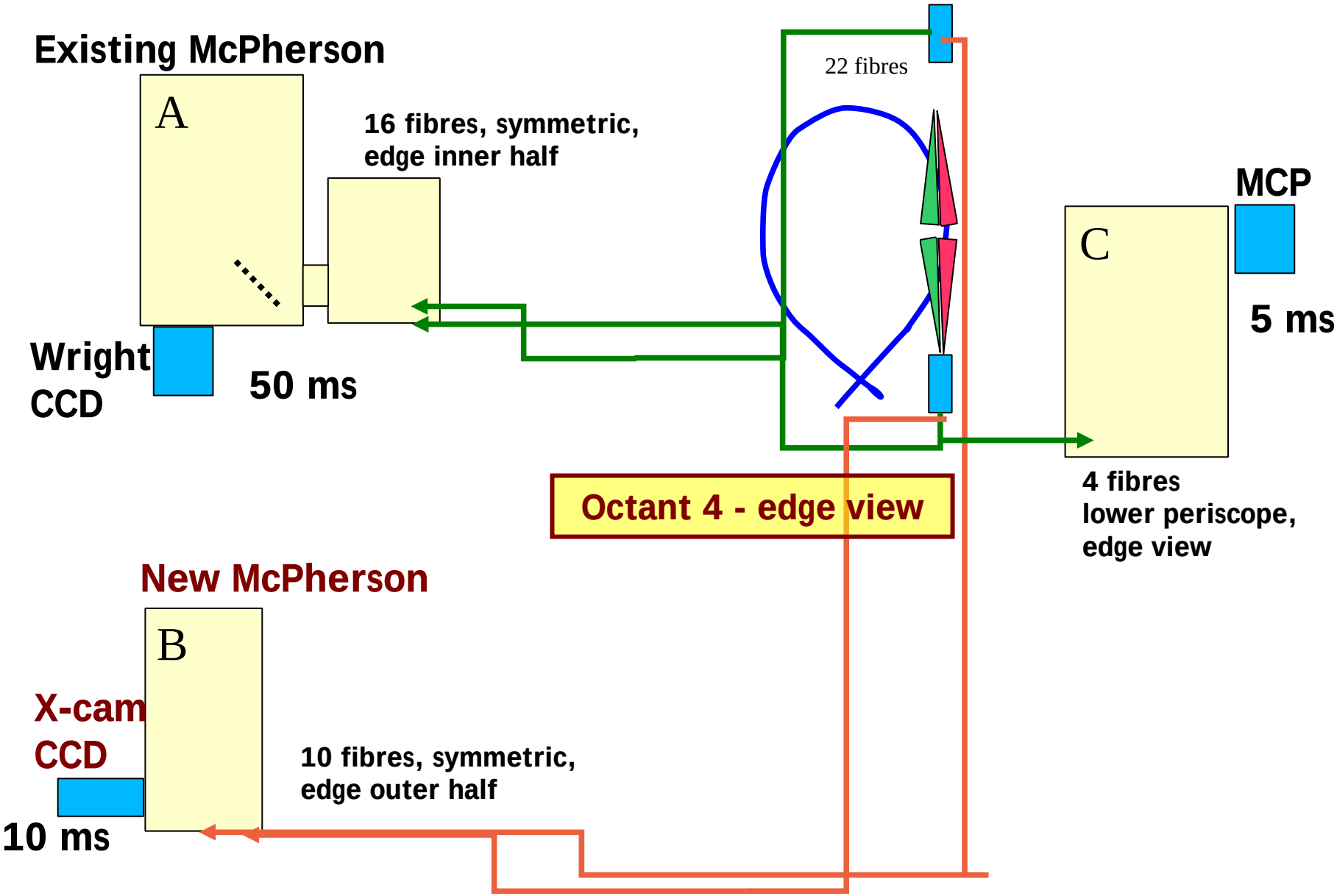
Octant 4 Lower Fibre Junction Box

Periscope fibres



Transmission fibres to diagnostic hall

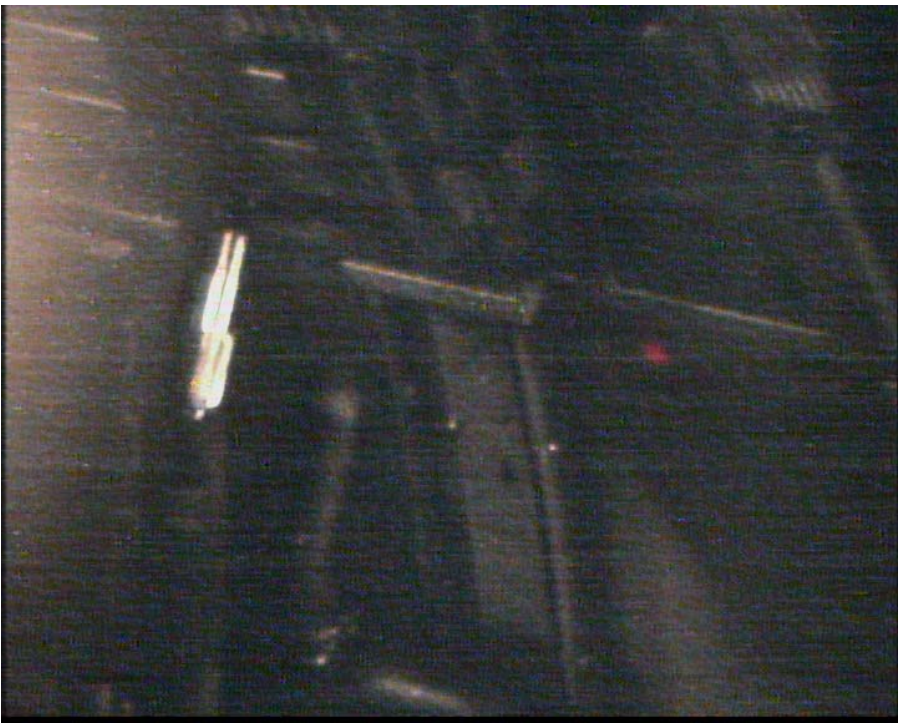
Spectrometers and Detectors



Periscope aligned using JET's In Vessel Inspection System (IVIS)

Laser light along two Octant 4, lower periscope fibres

Fibre 5



Fibre 9

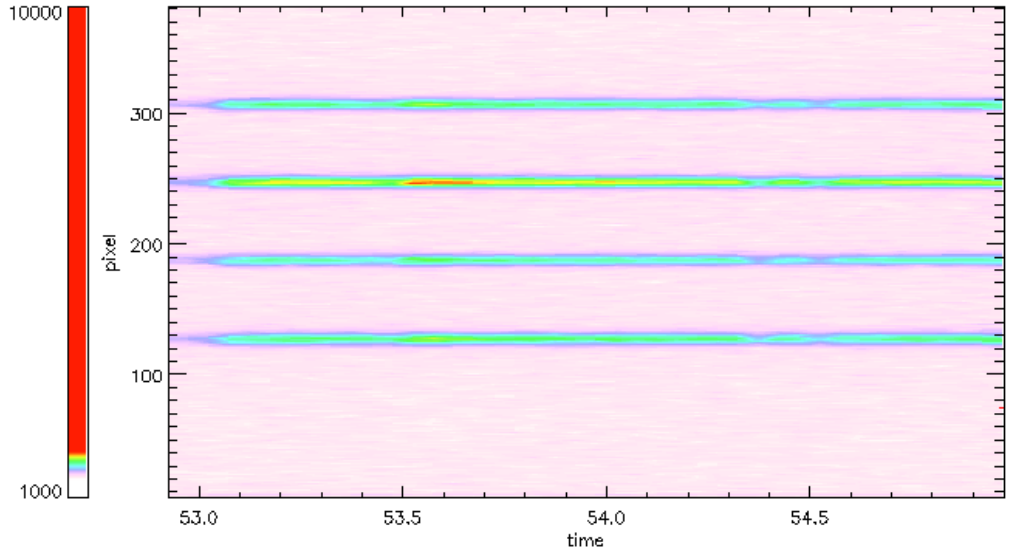
What limits the spatial resolution?

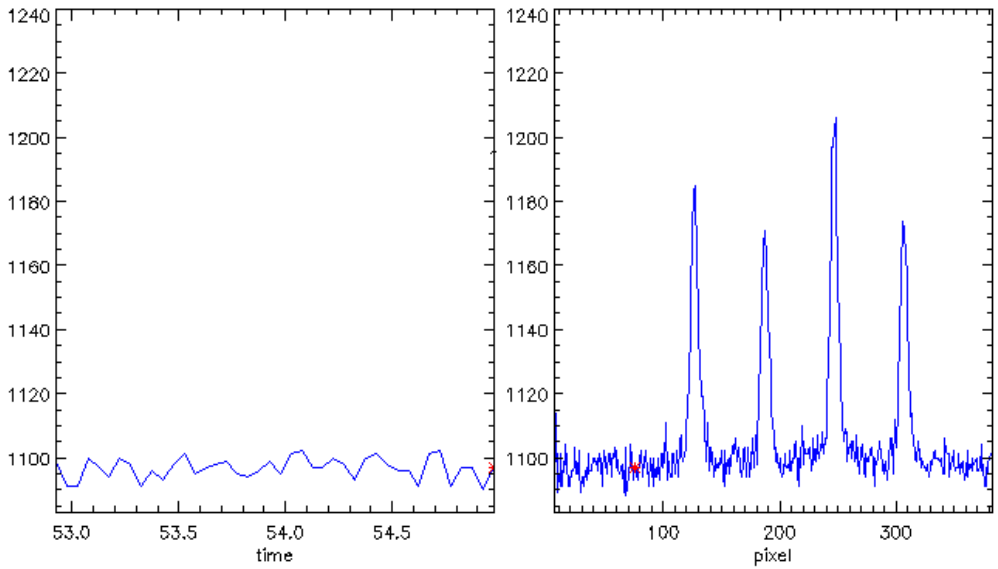
- Optical fibre diameter of 0.6 mm + 0.23 mm aluminium cladding
- Fibres centres spaced at 0.83 mm intervals in fibre plate
- Periscope optics fill the f/2.5 of the fibres.
- Line of sight diameter is therefore set by the port-hole diameter (9 cm), which in turn limits the lens diameter.
- This fixes the magnification of the fibres at the beam intersection
- Diameter of edge viewing lines of sight is 7.8 mm at the intersection with the NBI
- Total of 22 cm coverage in the plasma at beam intersection
- The space resolution of the system is further degraded to as much as 40 mm as each viewing line crosses a range of flux surfaces as it intersects with the neutral beam volume.

What limits the time resolution?

- Three detectors are used:
  - KS7A - 16 fibres, 8 radial positions, 50 ms, T_i, v_θ, v_ϕ
  - KS7B - 12 fibres, 6 radial positions, 10 ms, T_i, v_θ, v_ϕ
  - KS7C - 4 fibres, 4 radial positions, 5 ms - T_i only
- For the CCD camera (KS7A and KS7B) the time resolution is limited by the frame transfer rate
- Too fast leads to smearing
- It is possible to operate the MCP with a minimum of 1 ms exposure time (512 spectra). However, photon flux below 5 ms is too low for the edge system
- Edge system time resolution is therefore limited by photon flux

Example spectra - KS7A



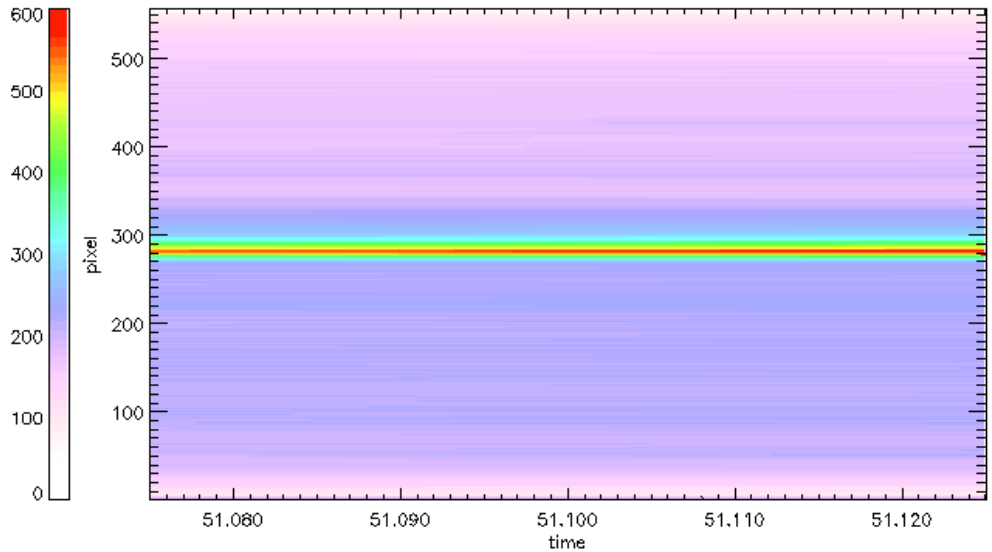


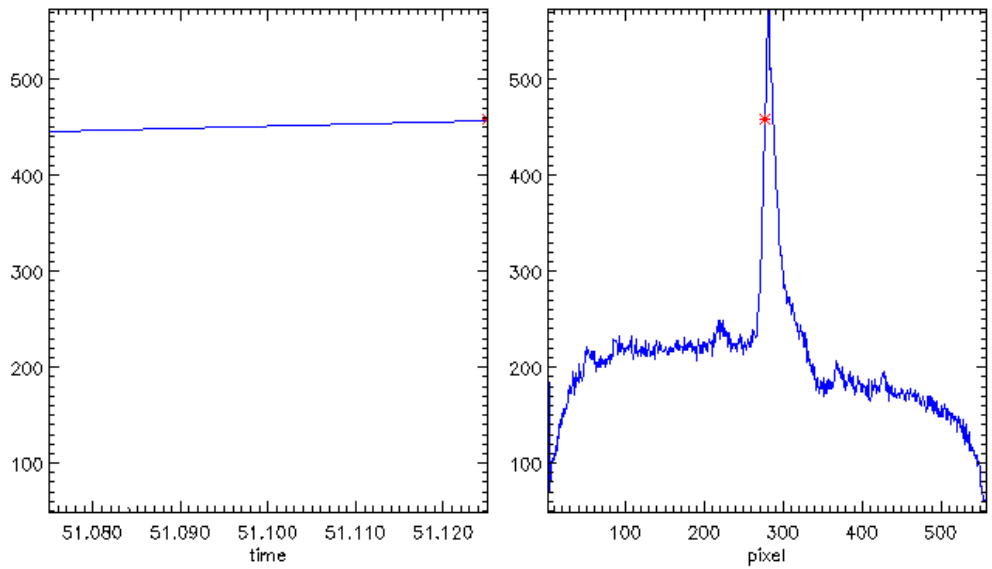
#65340

λ = 529.1 nm

4 spectra/track

Example spectra - KS7B



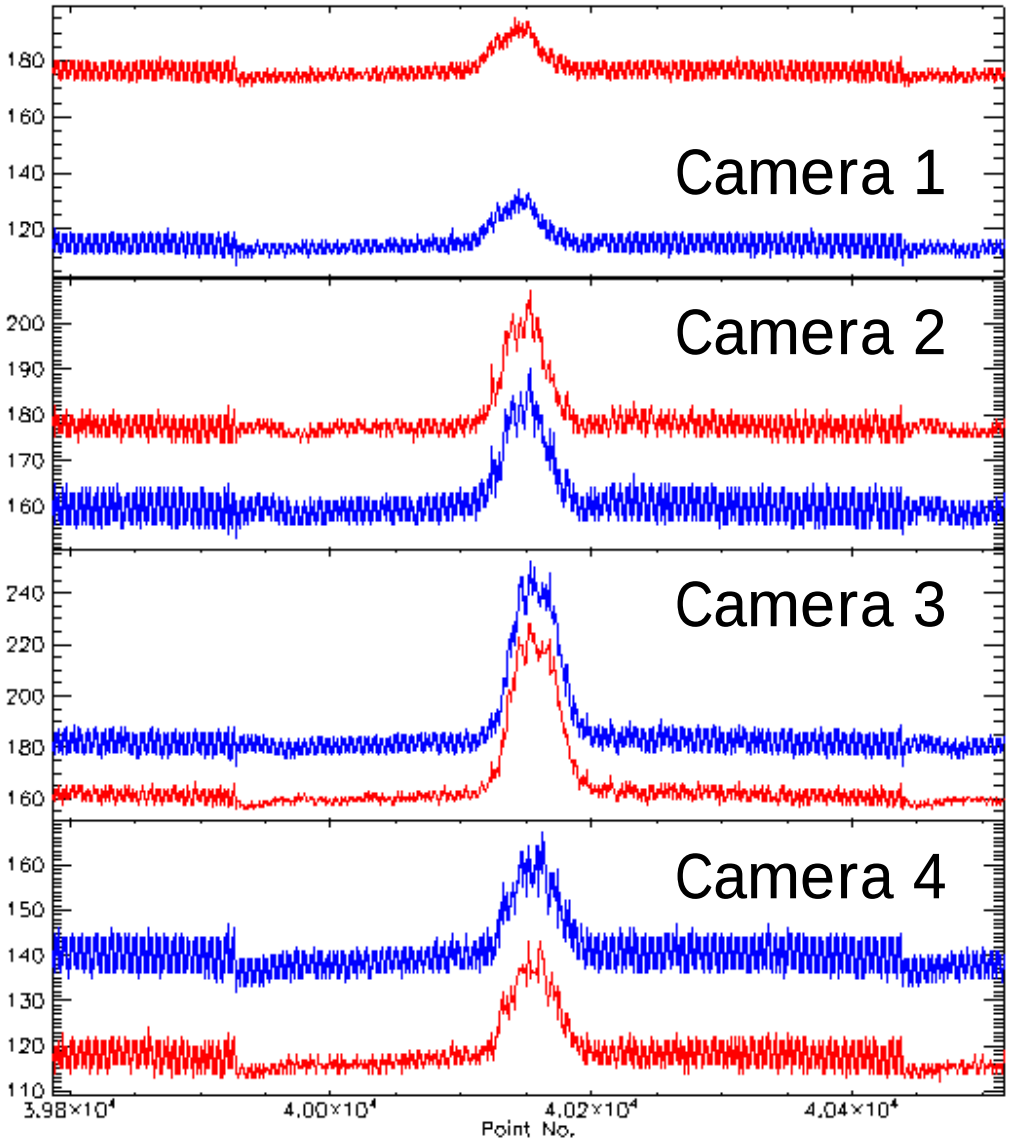


#65340

λ = 529.1 nm

1 spectra/track

Example spectra - KS7C



#65604

λ = 529.1 nm

1 spectra/track

Example T_i profiles with typical error bars

- Errors in fitting Gaussian(s) to the spectra are propagated to measurements
- Noisy spectra - low photon flux and measurements have larger error bars
- Radial resolution shown by horizontal error bars