Status of reflectometry and phase-contrast imaging on Alcator C-Mod

Nils P. Basse

MIT Plasma Science and Fusion Center

<u>Reflectometry:</u> Y. Lin, G. J. Kramer, J. H. Irby, R. Nazikian

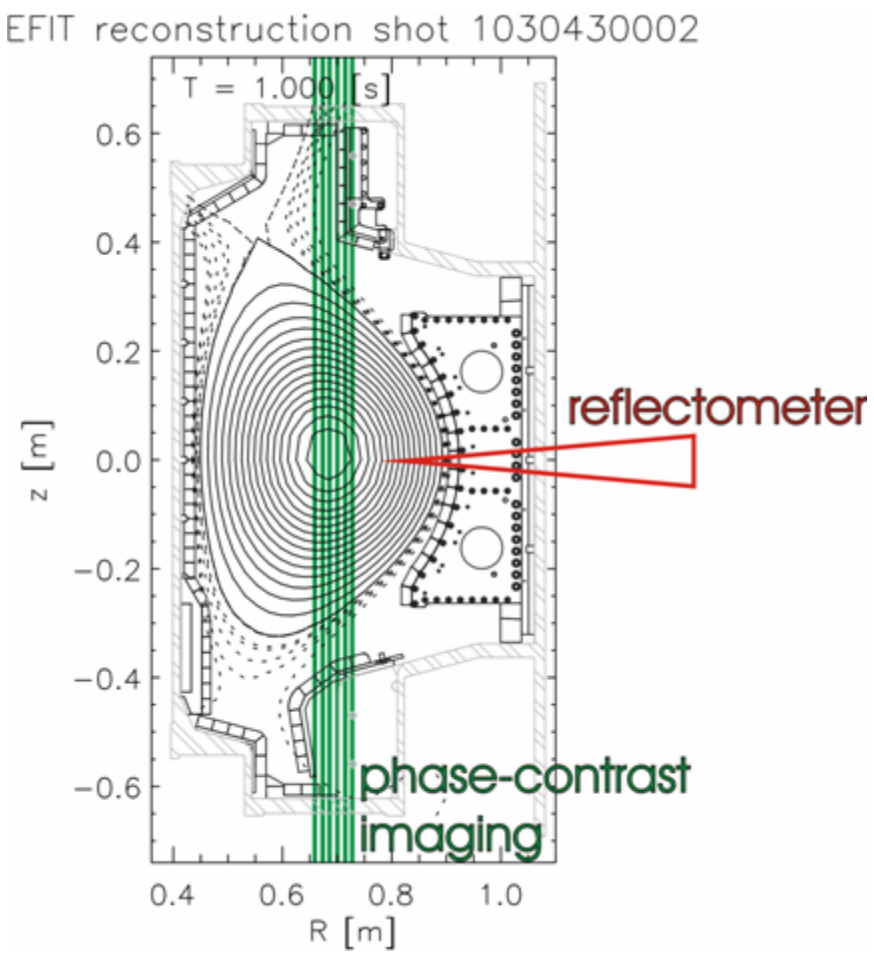
<u>PCI:</u> L. Lin, S. J. Wukitch, M. Porkolab, J. H. Irby, Y. Lin (A. Mazurenko, T.M. Jennings)

Dave Bellofatto, Willy Burke, Ed Fitzgerald, Bill Parkin, Dave Terry, Tom Toland etc.

<u>Outline:</u>

- **Sequence of events**
- **Status of reflectometry**
- **Status of PCI**
- **Plans**

Sequence of events



My main task: Data acquisition and control for the lower hybrid current drive system.

- March: Discussed diagnostics with Earl (polarimetry, probes, reflectometry), Ian (cameras, reflectometry) and Miklos (PCI).

  Conclusion: Work on reflectometry.

1. Early April: Started on reflectometry.
2. Mid April: Started on PCI.
3. 28th of May: First reflectometry measurements.
4. 10th of June: First PCI measurements.

Status of reflectometry

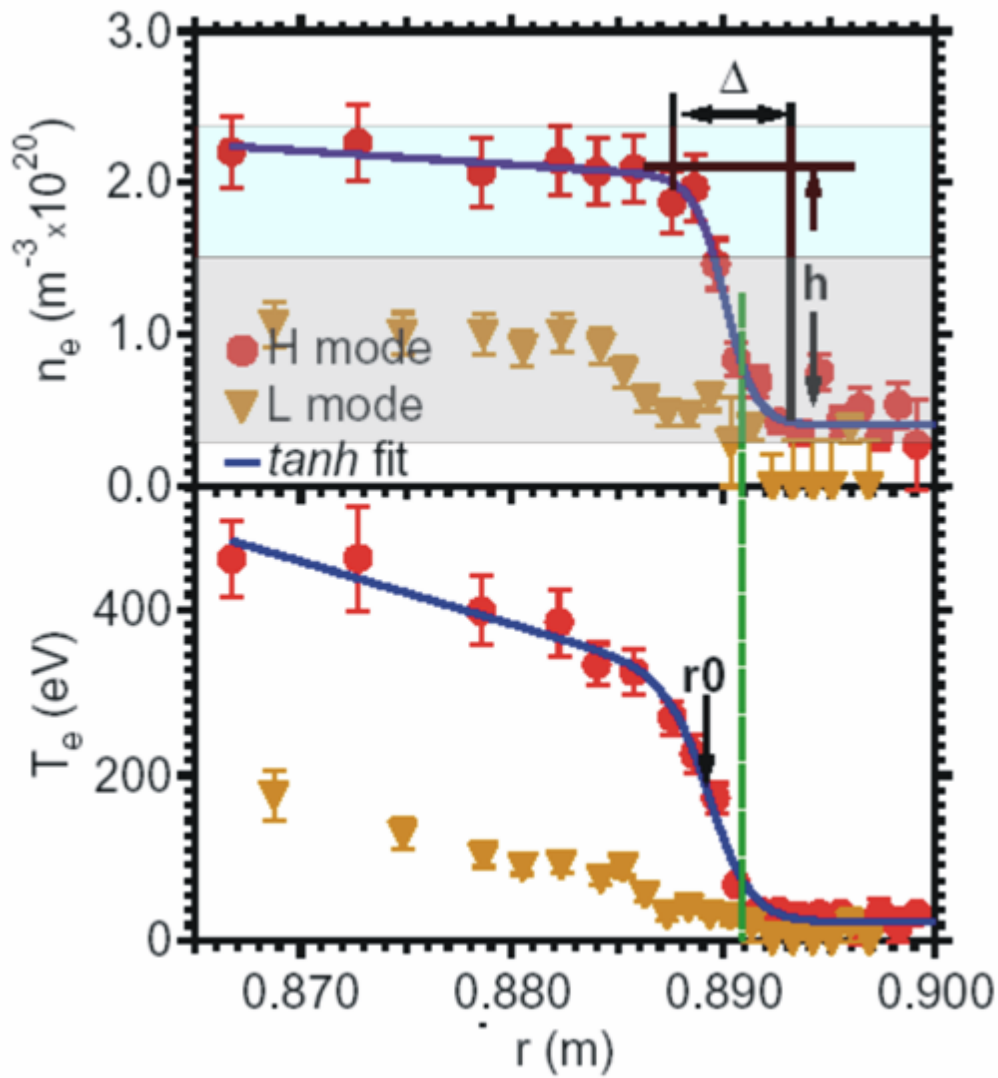
Alcator C-Mod

MIT system:

Frequencies
50, 60, 75, 88 and 110 GHz, corresponding to cutoff densities 0.31, 0.45, 0.69, 0.96 and 1.50 × 10^{20} m^{-3}. This density range is shown as a grey semi-transparent rectangle in the figure of typical L- and H-mode density profiles.

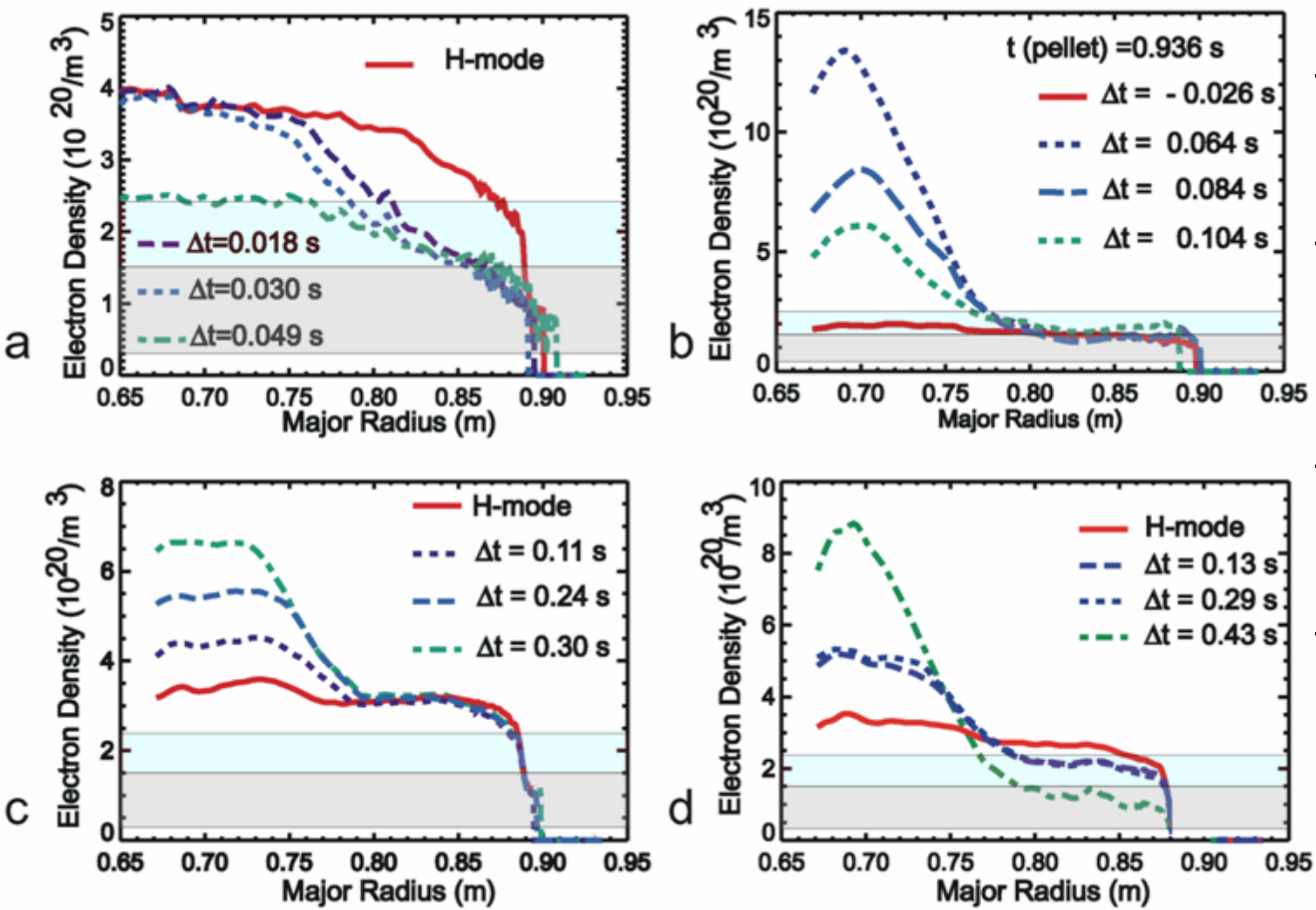
PPPL system:

Frequencies 132 and 140 GHz, corresponding to cutoff densities 2.2 and 2.4 × 10^{20} m^{-3}. This density range is shown as a blue semi-transparent rectangle.



D. A. Mossessian et al., APS Orlando (2002)

Status of reflectometry



a: Enhanced neutron (EN) mode.
b: Pellet enhanced performance (PEP) mode.
c: Off-axis ICRF internal transport barrier (ITB).
d: Peaked density Ohmic H-mode.

C. L. Fiore et al., Phys. Plasmas 8, 2023 (2001)

Status of reflectometry

Alcator C-Mod

Status of the reflectometry channels:

1. 50 GHz: Good
2. 60 GHz: No signal when connected to torus. Weak signal when directly connected.
3. 75 GHz: Weak
4. 88 GHz (LSB, USB, difference): Good
5. 110 GHz: No signal when connected to torus. Weak signal when directly connected.
6. 132 GHz: Good
7. 140 GHz: Weak

Presently, the following channels are digitized by two Aurora 14's: 50 GHz, 88 GHz, 132 GHz and 140 GHz. See the file /home/basse/reflectometry/basse/refl_freq.txt for day-to-day variations in the setup.

Status of reflectometry

Alcator C-Mod

Short-term plan:

1. Visit by Gerrit Kramer (PPPL) from Monday the 23rd of June to Wednesday the 25th of June (maintenance week). Purpose:
   - Tune system.
   - Make diagrams.
   - Search for the cause of the 140 GHz problem.
2. Digitizer range.

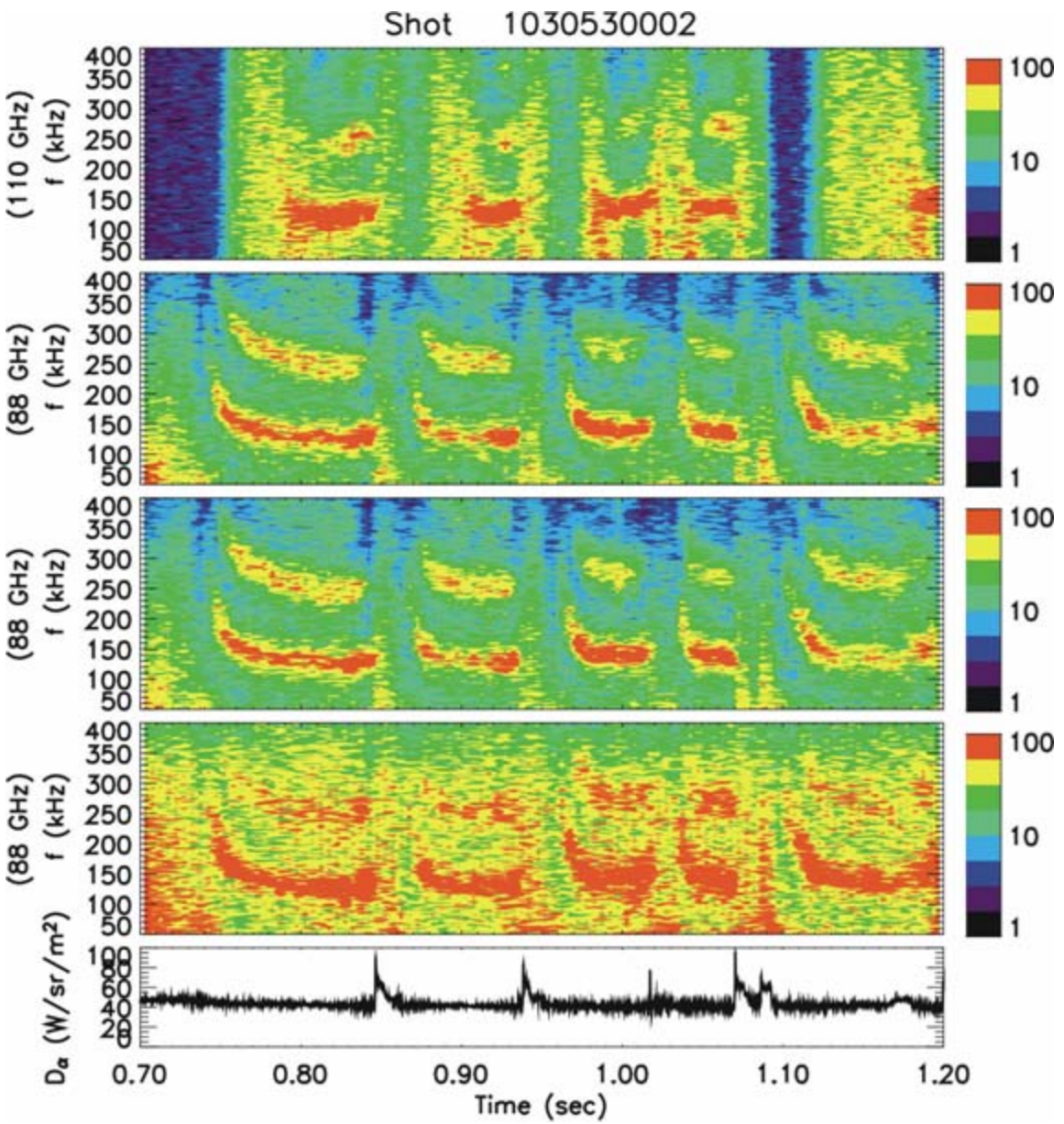
Status of reflectometry

Alcator C-Mod

Long-term plan:

1. High frequency upgrade: [June 2003]
   Two additional channels, 132 and 140 GHz.
2. Sideband upgrade: [autumn 2003]
   Modification of the system to remove amplitude modulation. It is in principle a simple operation, but will take time to implement.
3. Data acquisition upgrade: [2004]
   - Currently using CAMAC Aurora 14 digitizers (12 bit, 1 MHz, can acquire 0.5 seconds).
   - CAMAC equipment being discontinued. We will be switching to compact PCI (cPCI).

Status of reflectometry



Status of PCI

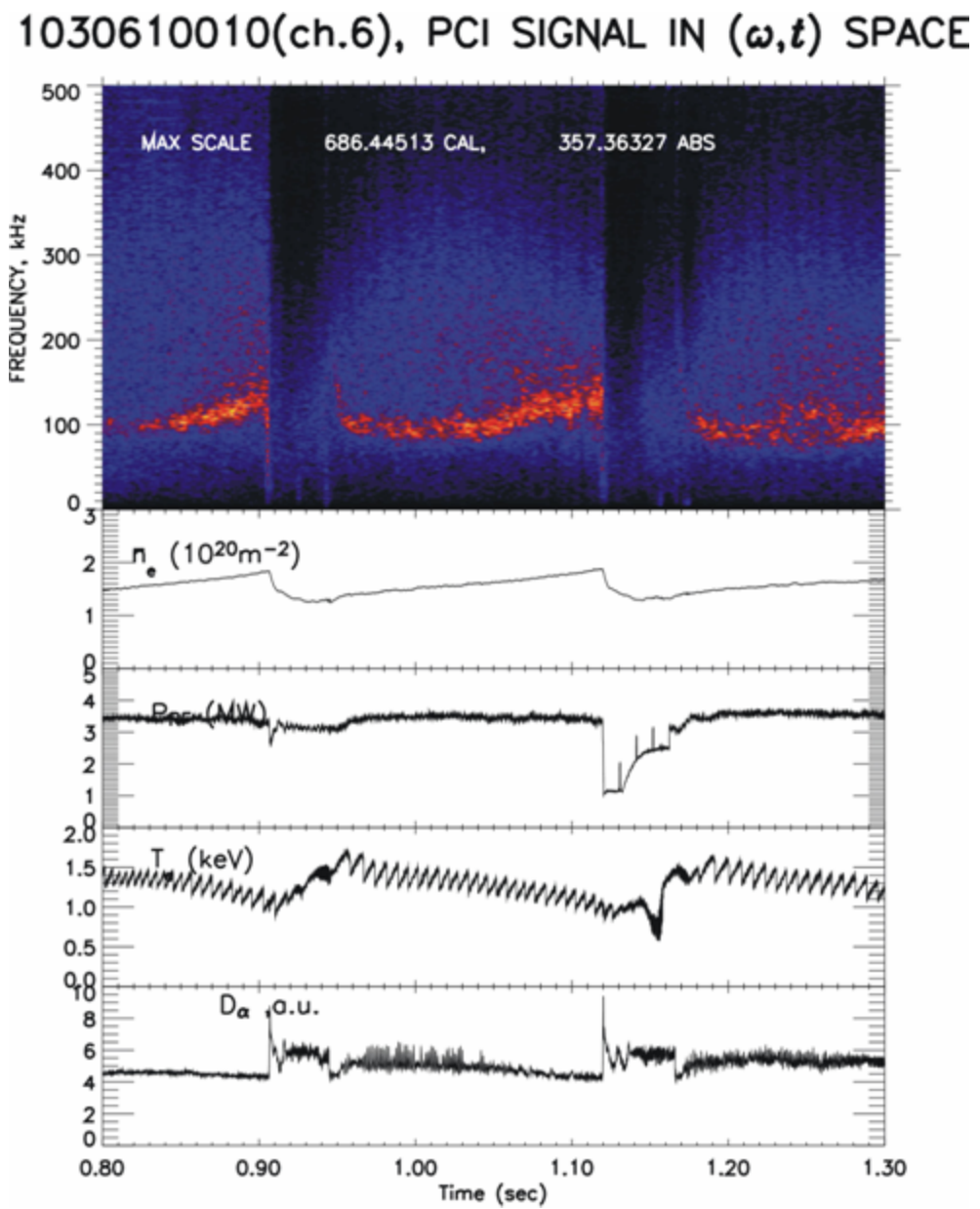
Alcator C-Mod

Several components had to be fixed:

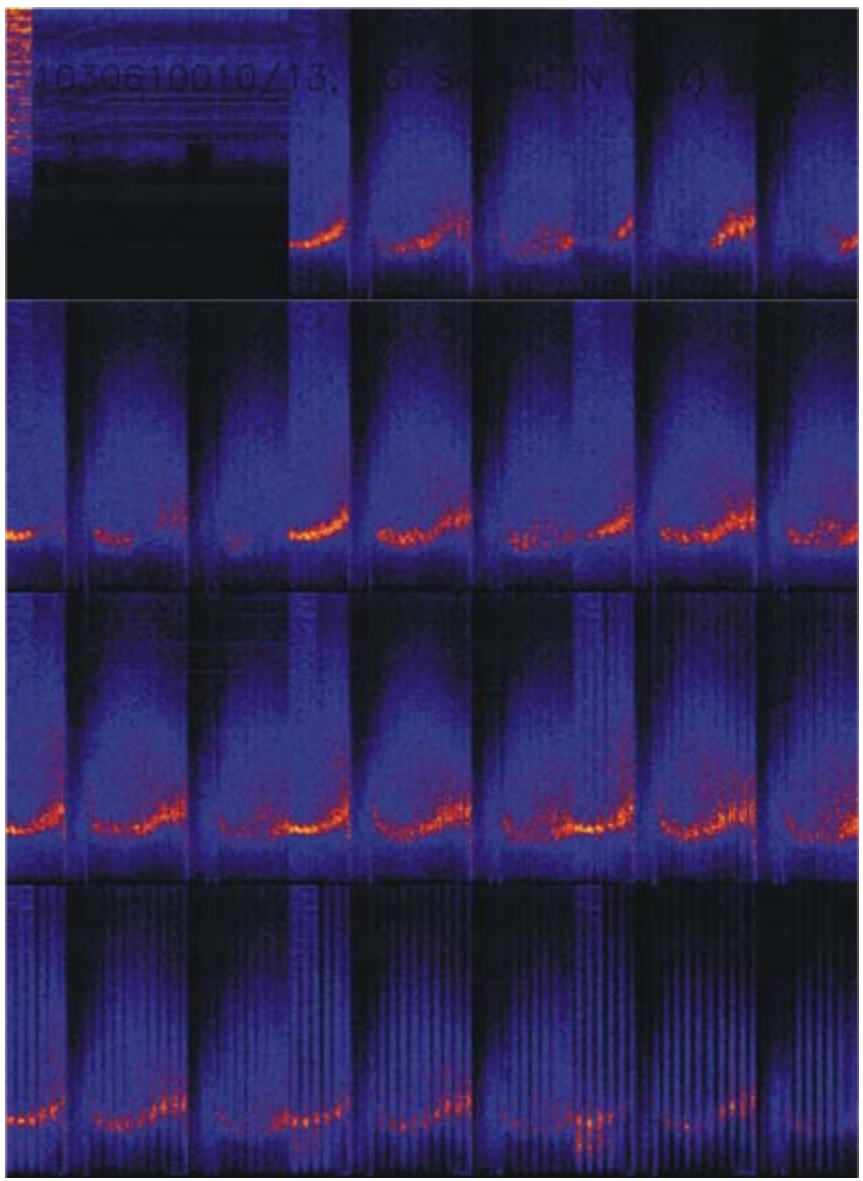
- The preamp power supply consisted of two boards lying on the optical table. It has been replaced by a new power supply box with a fuse, on/off switch and status diodes.
- The cable between the power supply and the preamps was defect and has been repaired.
- The loudspeaker box had bad solderings and was repaired.
- The vacuum in the LN2 cooled detector was broken. It has now been pumped. The ZnSe window in front of the detector array was cracked and had to be replaced.
- The PC where PLC programs are installed for remote control of the PCI system had a defect monitor which has been replaced.
- Bad AC distribution outlet box.

Remaining problem: A large variation of the laser/AOM power, mainly during run days. Probable causes: The cooling water becomes too hot, the laser beam moves around. Alternative causes: DNB, SF6 from RF in E-port, vibrations, thermal effects.

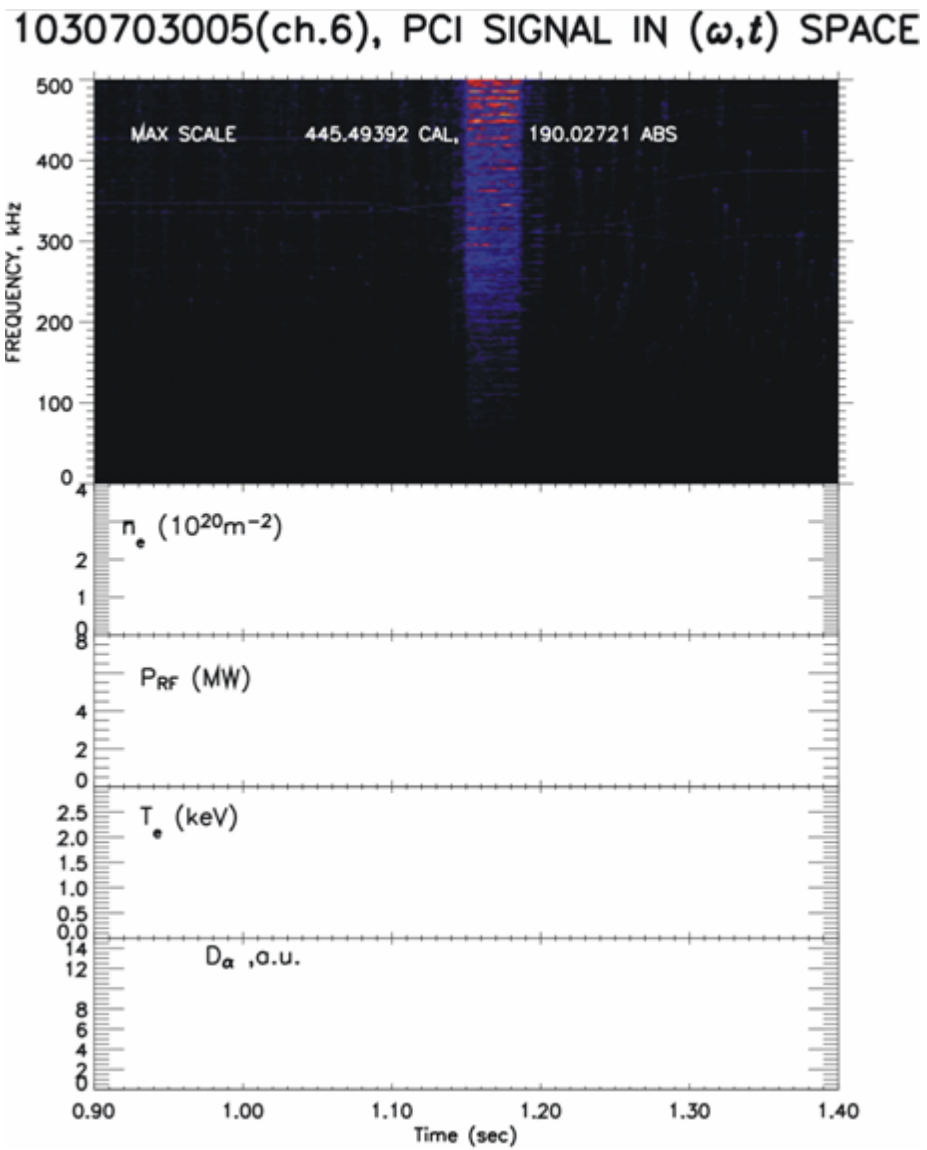
Status of PCI

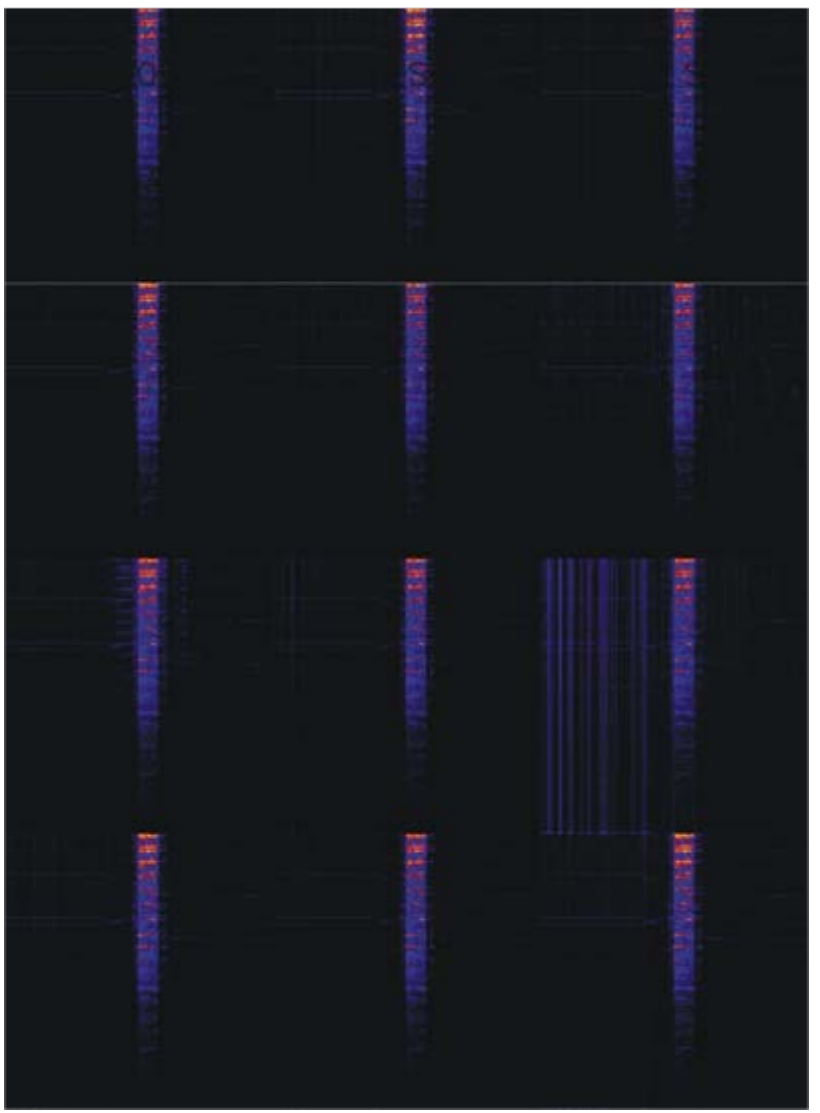


Status of PCI

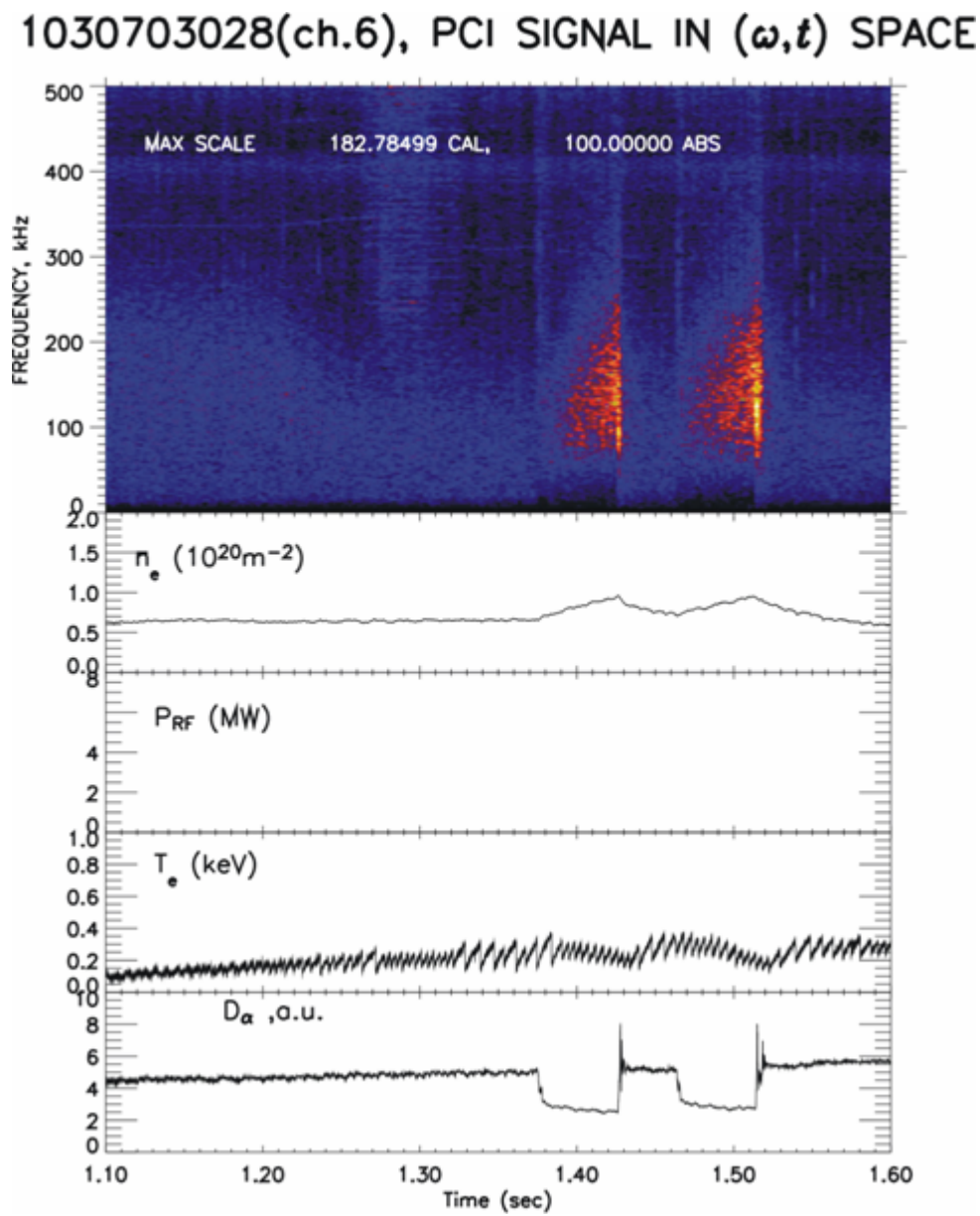


Status of PCI





Status of PCI



Status of PCI

Alcator C-Mod

Short-term plan:

1. Two preamp prototype boards to be tested and sampled at 3 MHz.
2. New preamps (build 32 fast pre-amps).
3. Data acquisition (fast cPCI boards have been ordered, ETA August).

Long-term plan:

1. Spatial localization.
2. Large wavenumbers.

Plans

- Separate characterization of reflectometry and PCI fluctuations.
  [Develop new software.]
- Study broadband fluctuations, not only the QC-mode.
- Correlations between reflectometry, PCI and magnetic fluctuations.
- Extend correlations to include BES, ECE etc..
  Matt Sampsell is currently adding reflectometry/PCI data to his correlation code.
- Comparative PCI studies between DIII-D and C-Mod.
- Universality of laser scattering measurements: Tokamak (C-Mod), stellarator (W7-AS), reversed field pinch (RFX).