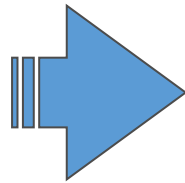
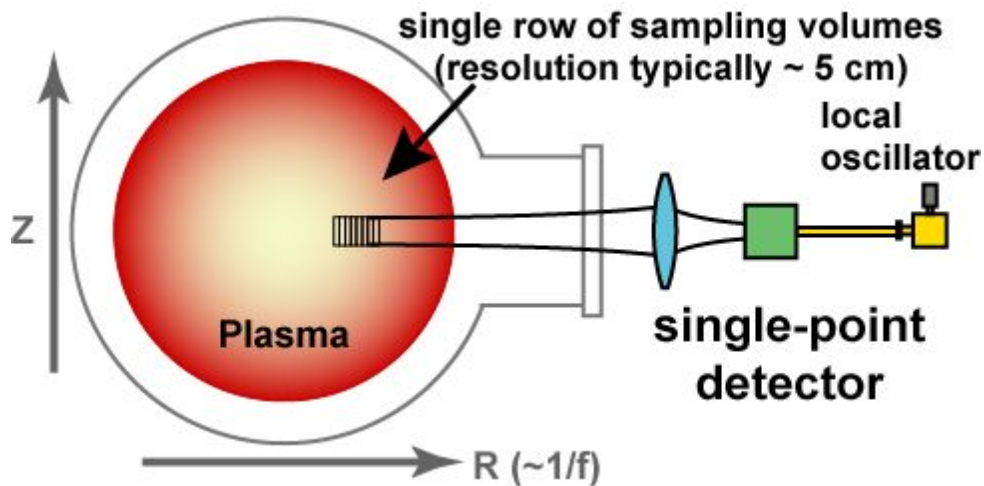
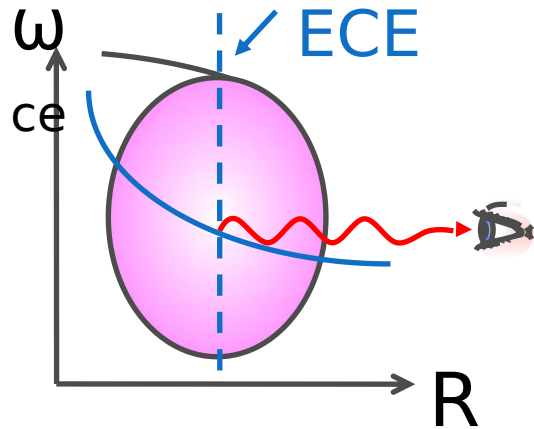


Methods of ECEI data analysis and difficulties

赵朕领

2015/11/6

Introduction to ECEI



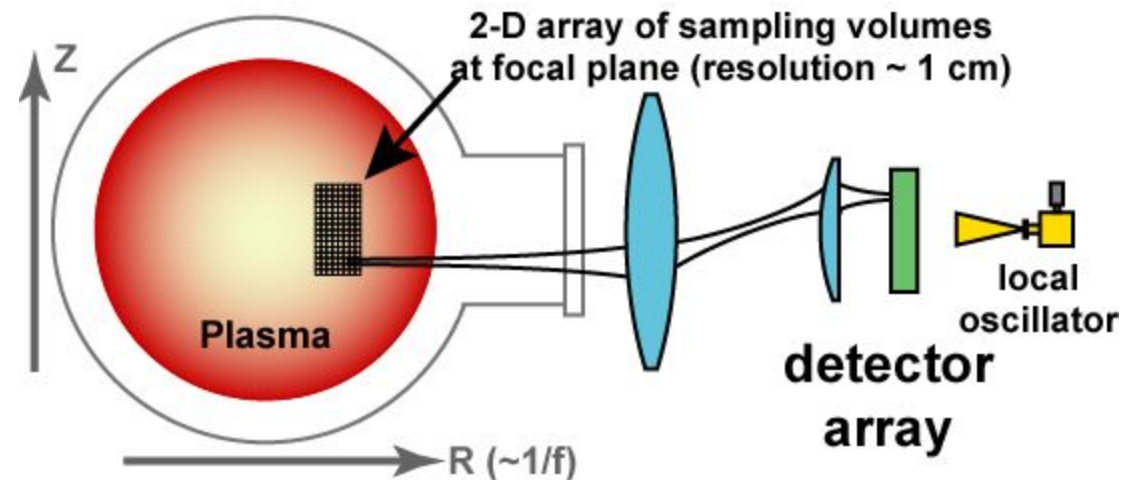
Advantages of ECEI

Optics and antenna array are employed for imaging

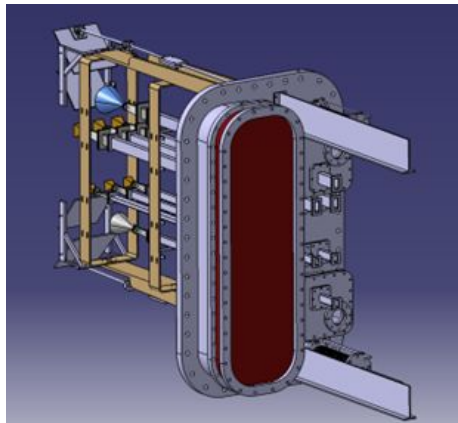
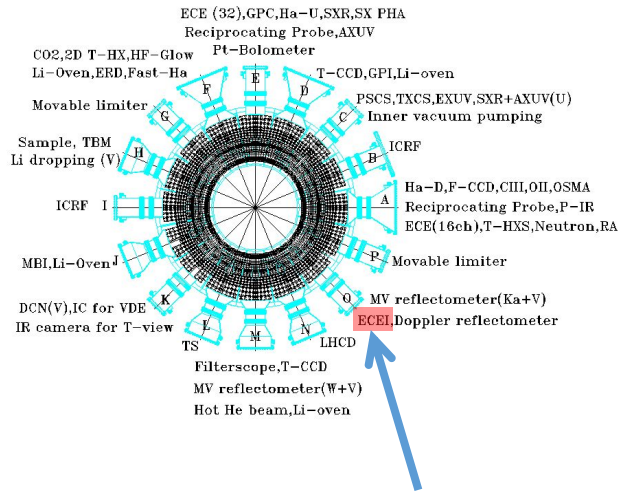
High poloidal spatial resolution

Visualization for MHD instability and turbulence

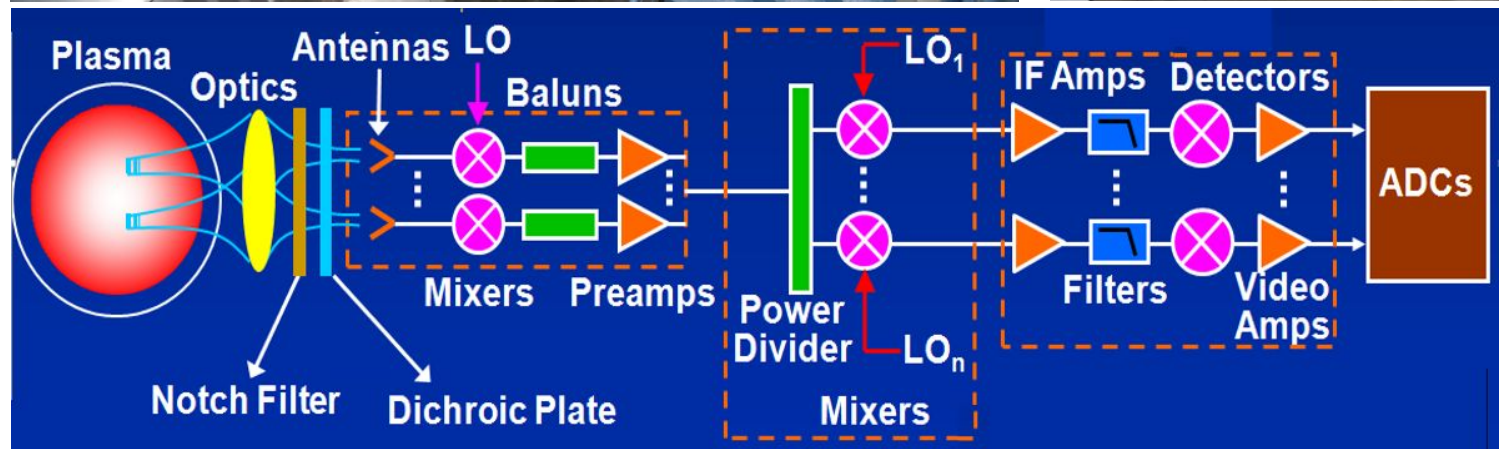
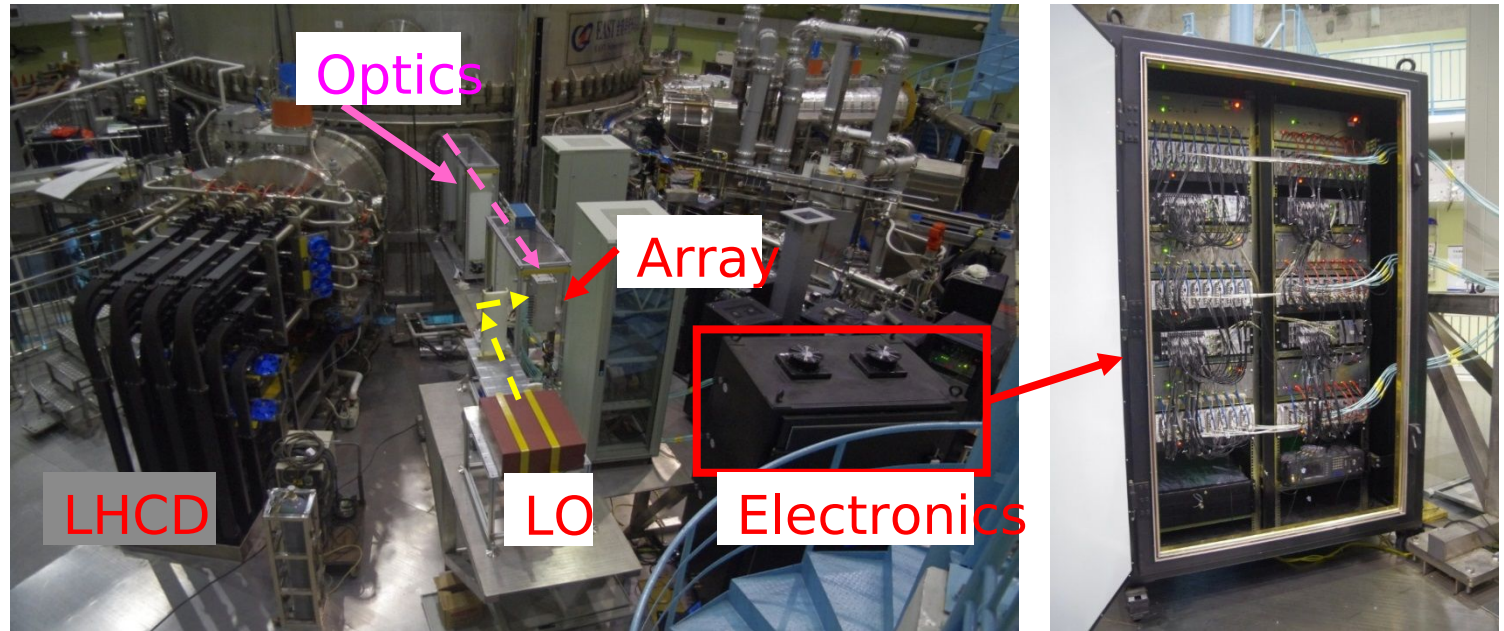
Optics and antenna array -> 2D imaging



24×16 ECEI system successfully installed on EAST in 2012



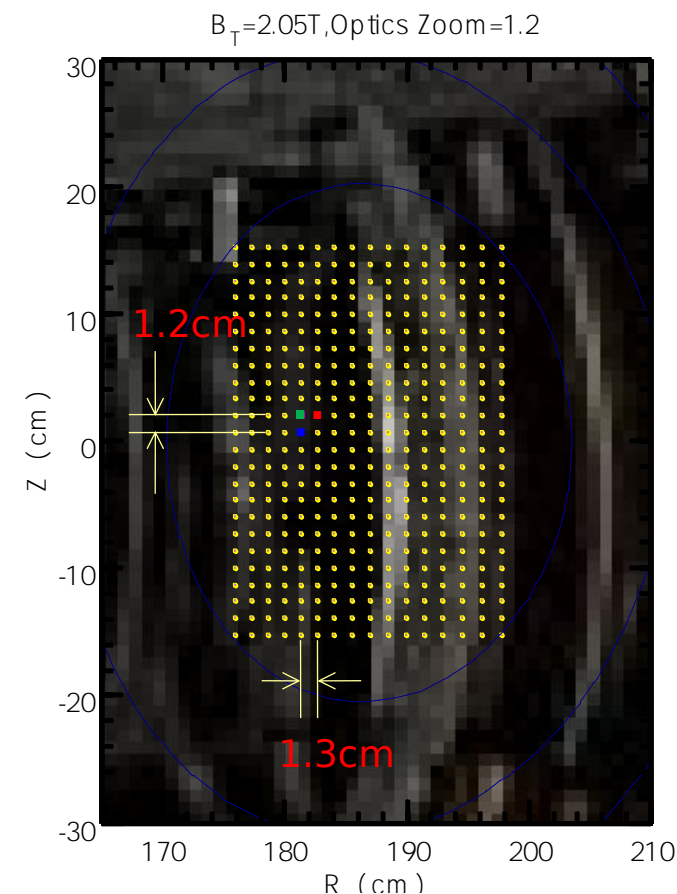
ECEI window



24×16 ECEI on EAST : parameters and unique features

Parameters

Spatial resolution	Poloidal	>1cm
	Radial	1~2.5cm
	Toroidal	>3cm
Imaging area	Poloidal	<70cm
	Radial	>15cm
Temporal resolution		~1us
Noise level of electronics		<-30dB
Sample rate		1M/s
Total channels (pixel)		384



384 channel ECE imaging
Cover the core of plasma

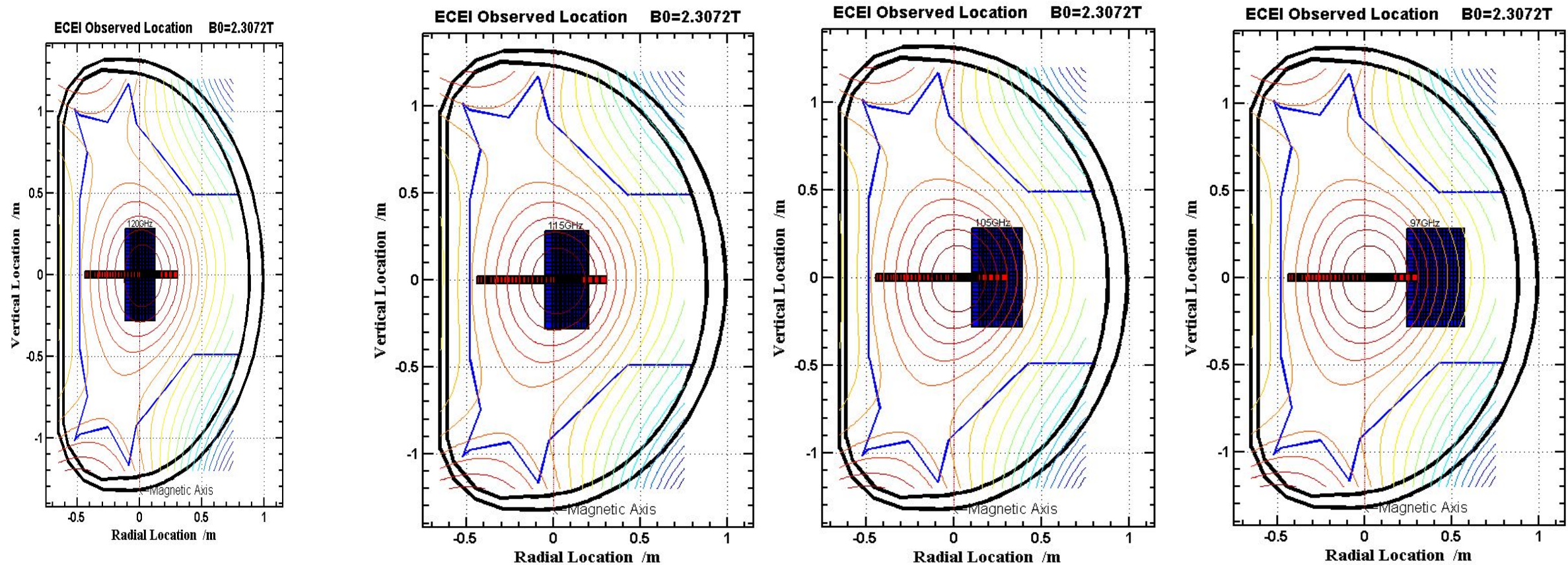
ECEI DATA TYPE

1. ECEI data is saved in binary system with 2 bit for each point.
2. Size of the data for each SHOT on EAST: $1\text{M/s} * 384 * 10\text{s} * 2\text{bit} = 7.6\text{G}$

```
function tmp=scan(shotdir,Time,FS,PRE)
fid=fopen(shotdir,'r');
if fid<0
    error(['Can''t open: ' shotdir,',please check your DIR of datastorage!!']);
end
if length(Time)<2||Time(1)>=Time(2)
    error('The TIME must be a timeslice,and Time must be Time(1)=<Time(2) ');
end
if ~exist('FS','var')
    FS=1e6;
end
if ~exist('PRE','var')
    PRE=0;
end
ind1=round(Time(1)*FS);
ind2=round((Time(2)-Time(1))*FS);
%-----
fseek(fid,(ind1+PRE)*2,'bof');
tmp=fread(fid, ind2, 'int16')/2^15;
fclose(fid);
```

MATLAB function to load
ECEI data

ECEI SETUP MOTIVATIONS



Sawtooth and Alfvén mode @ Core.

Tearing mode @ 2/1.

ELM @ edge.

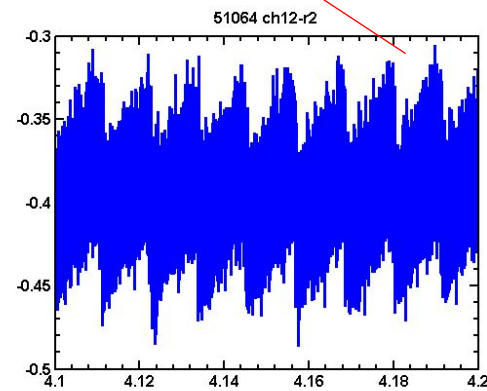
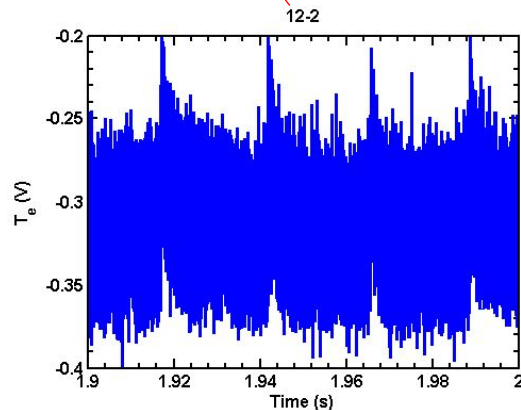
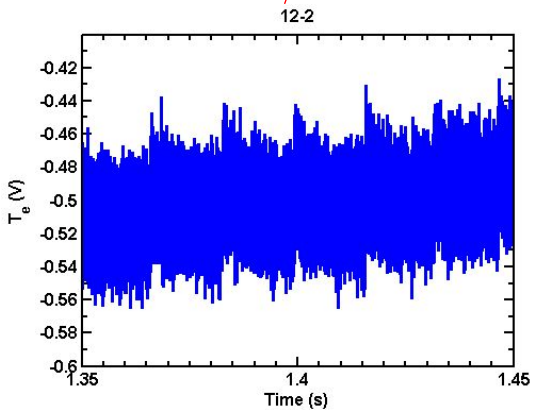
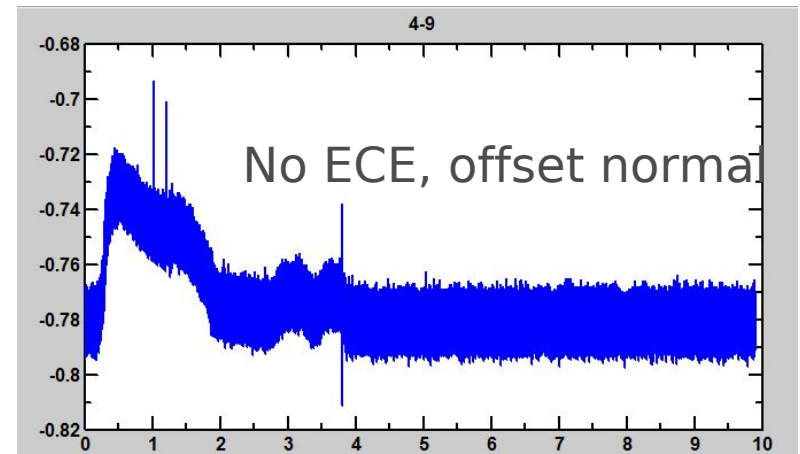
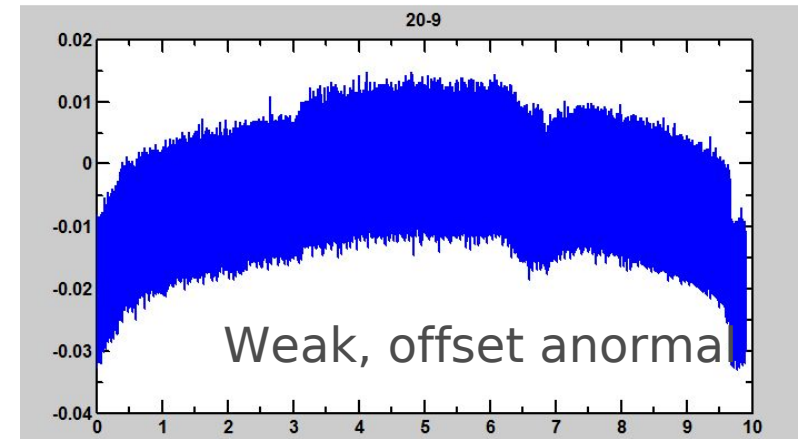
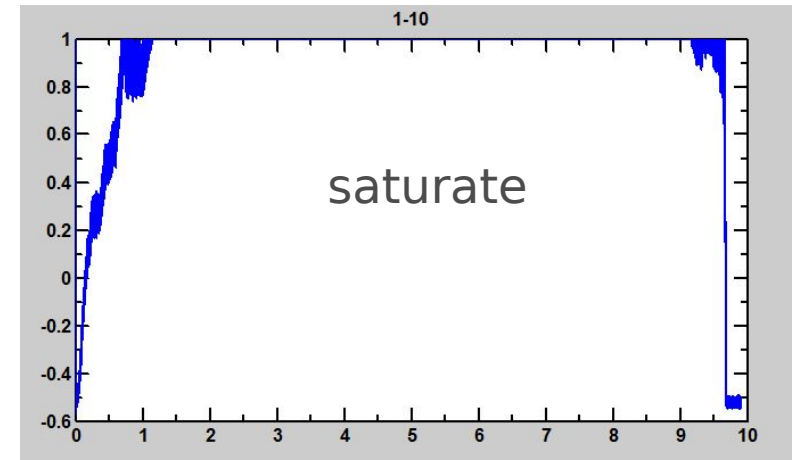
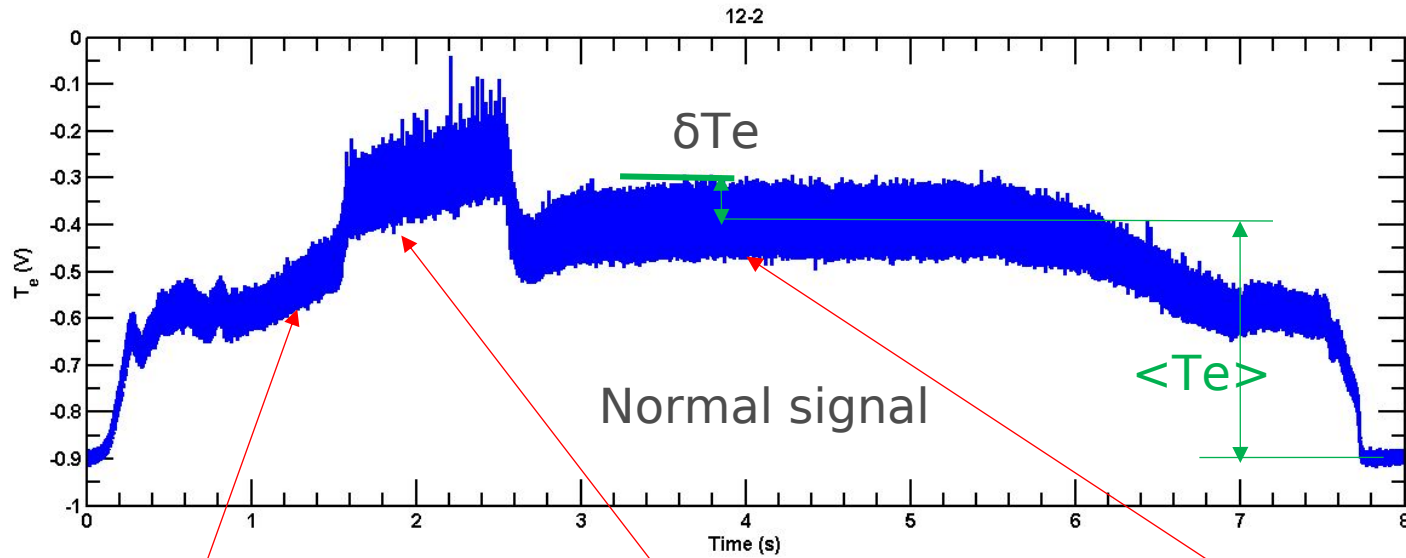
For different proposal, set the observed position of ECEI (Freq. of LO and optics) to study sawtooth, tearing mode, AE, ELM etc.

RAW DATA

Voltage range of DAQ system:
-1~1V

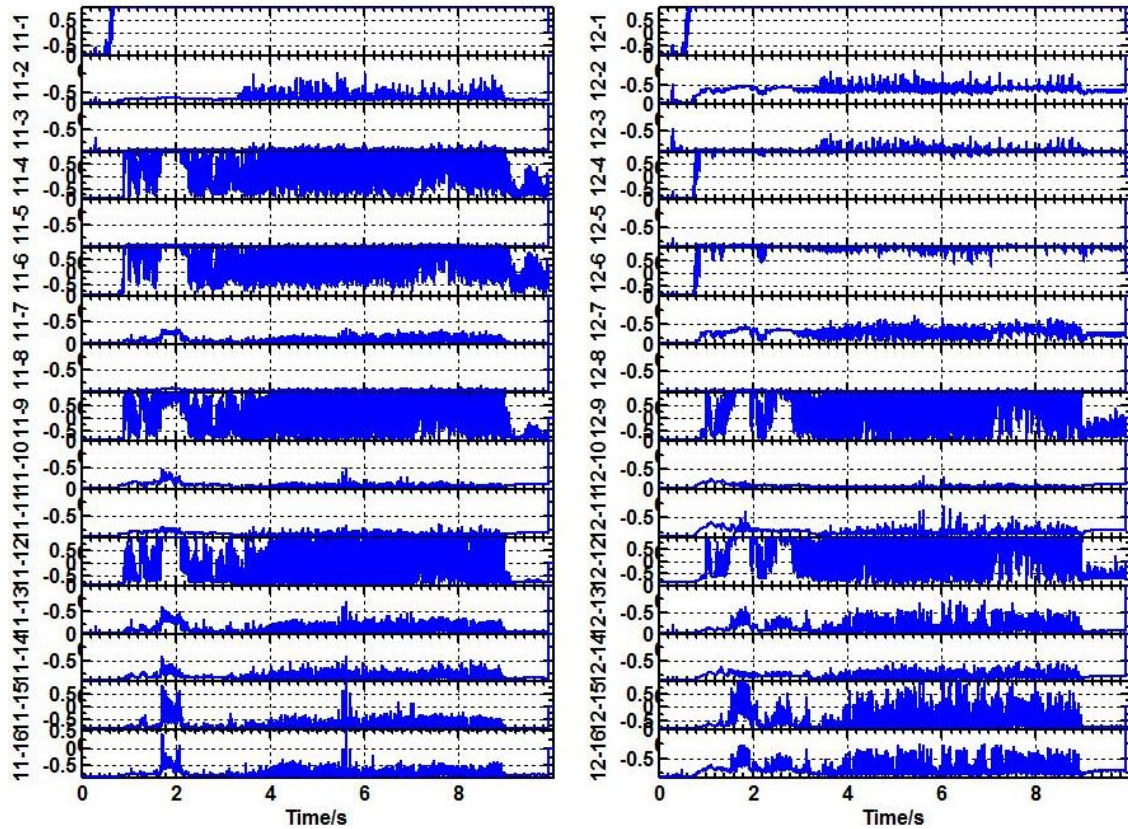
Temperature
fluctuation:

$$\frac{Te - \langle Te \rangle}{\langle Te \rangle}$$



NOISE FROM LHCD

SHOT 43238

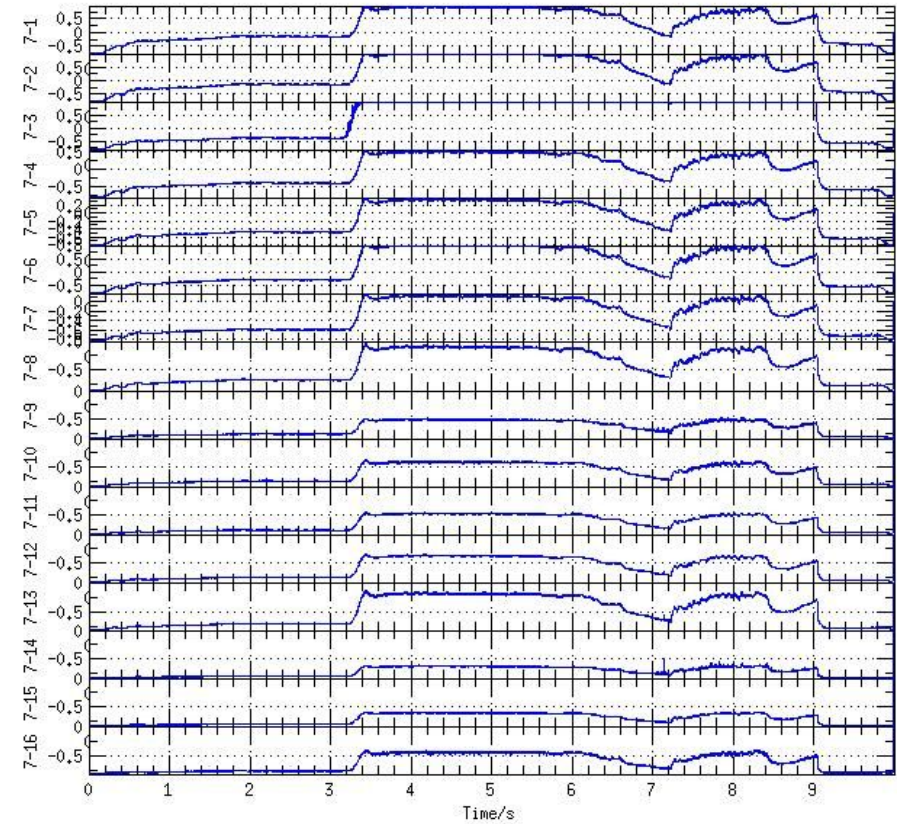


SHOT 43238

LHCD @2.45GHz 1.2 MW

For last campaign (2012), most of the 384 channels were polluted by LHCD

SHOT 49867



Normal ECEI
signals

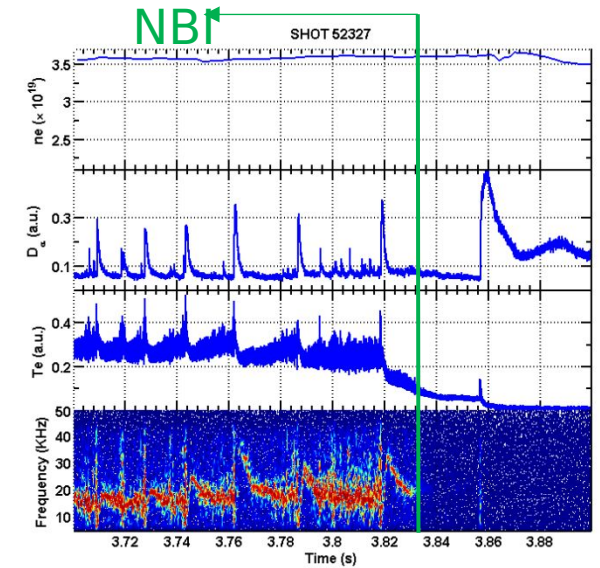
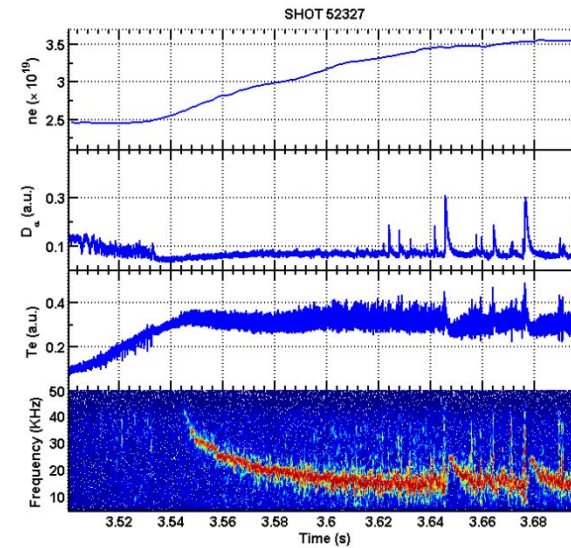
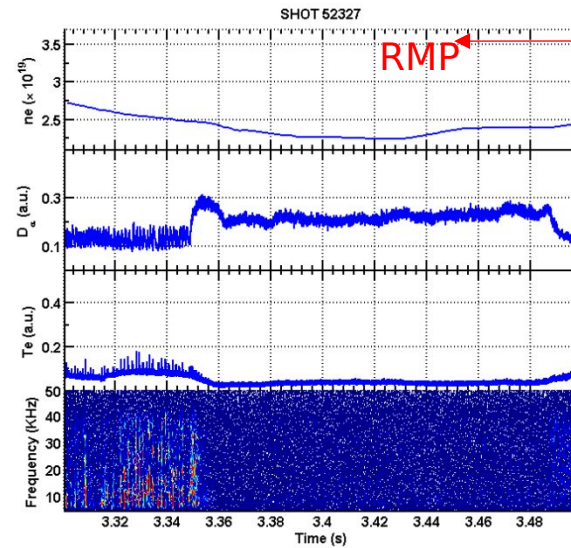
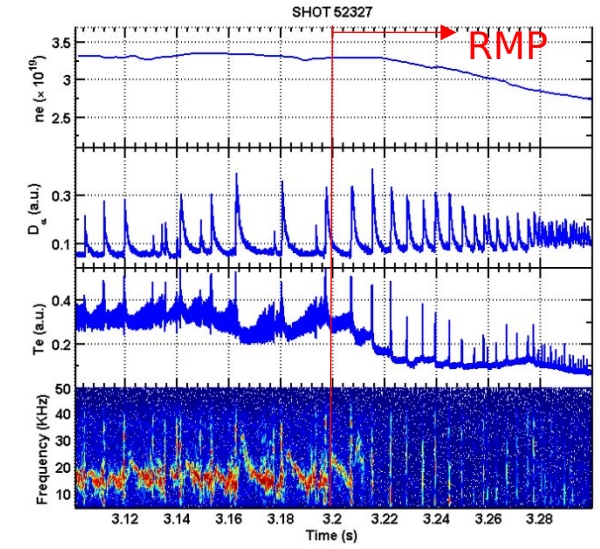
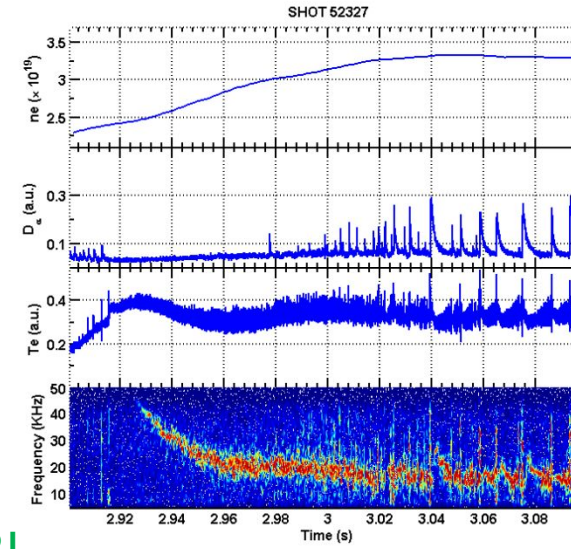
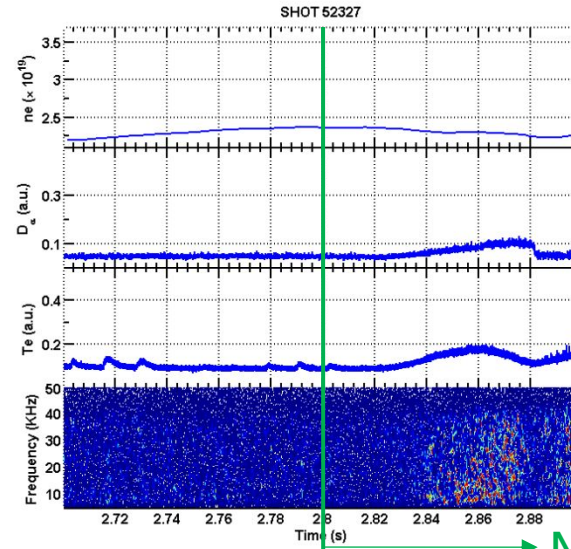
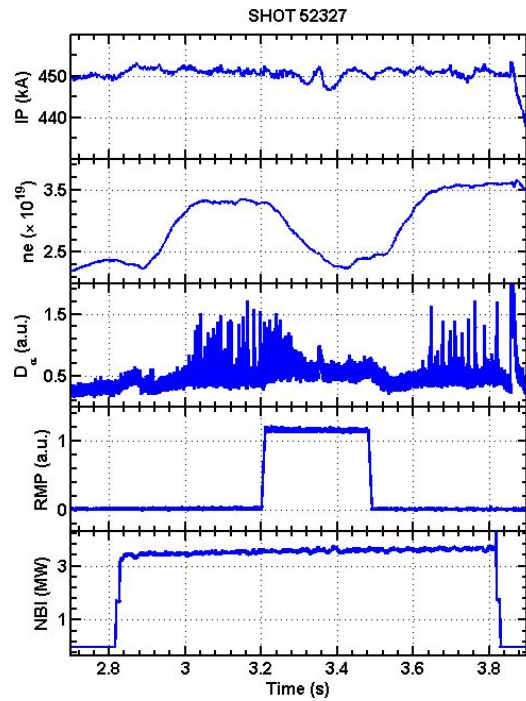
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1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	1	1	0	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
2	2	1	0	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	2	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-1

data statistics

2-saturate; 1-normal; 0-no signal; -1 -weak

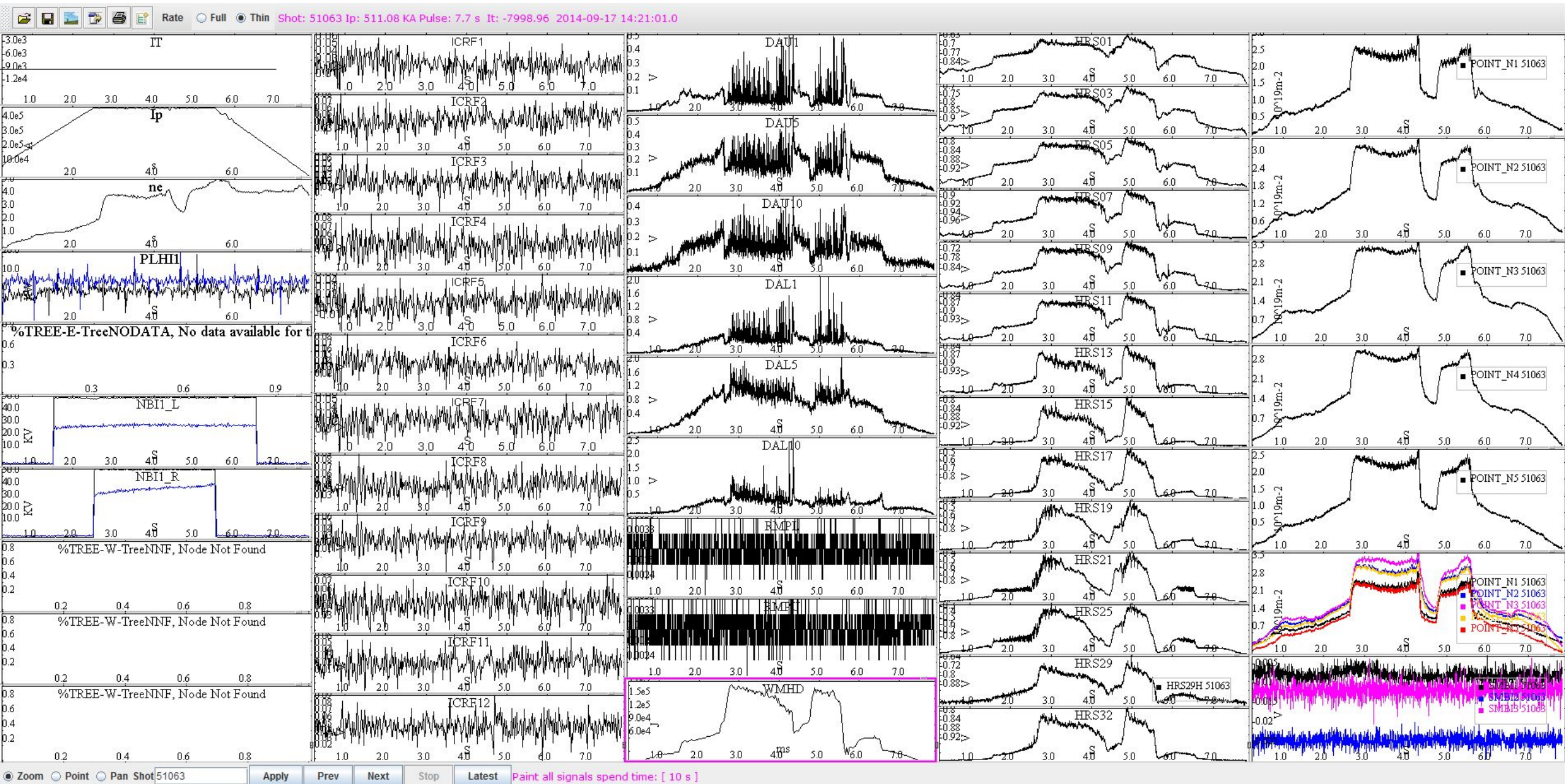
SEPECTRUM OF ECEI DATA

Plasma discharge parameters

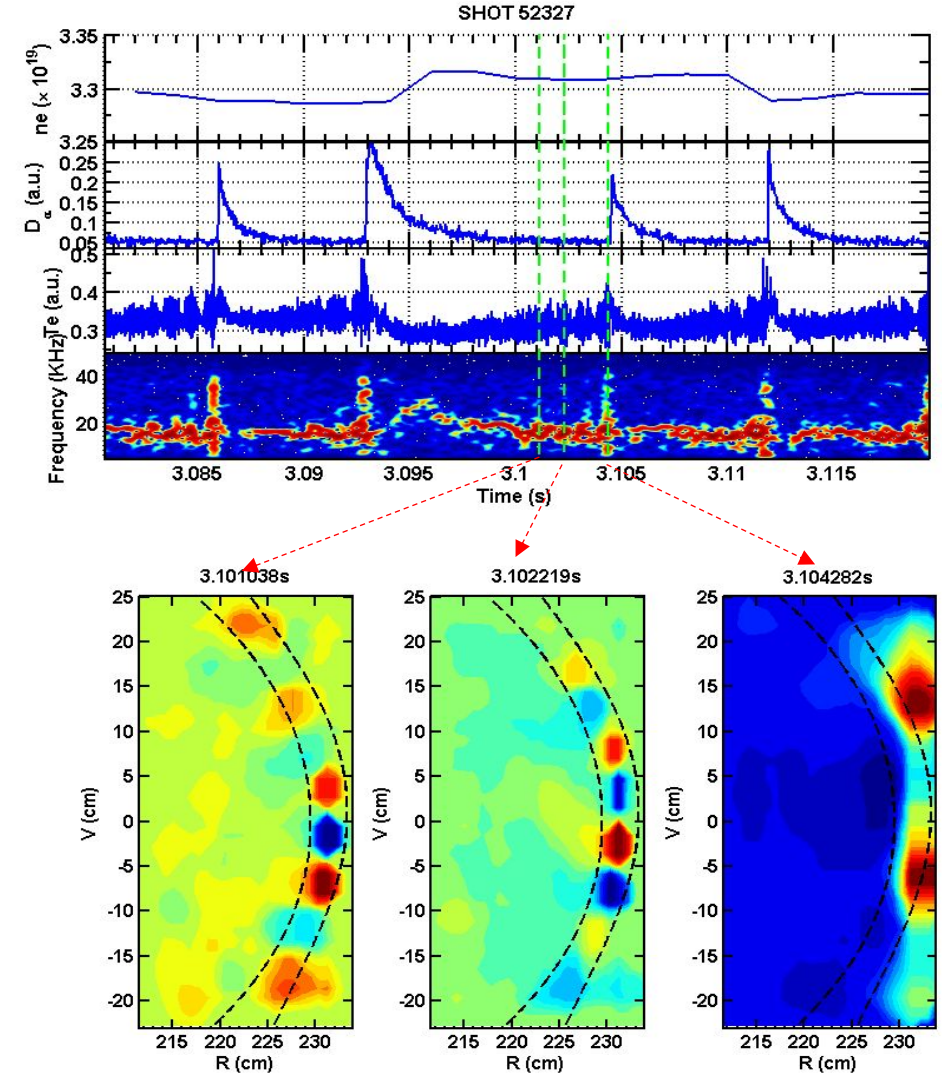
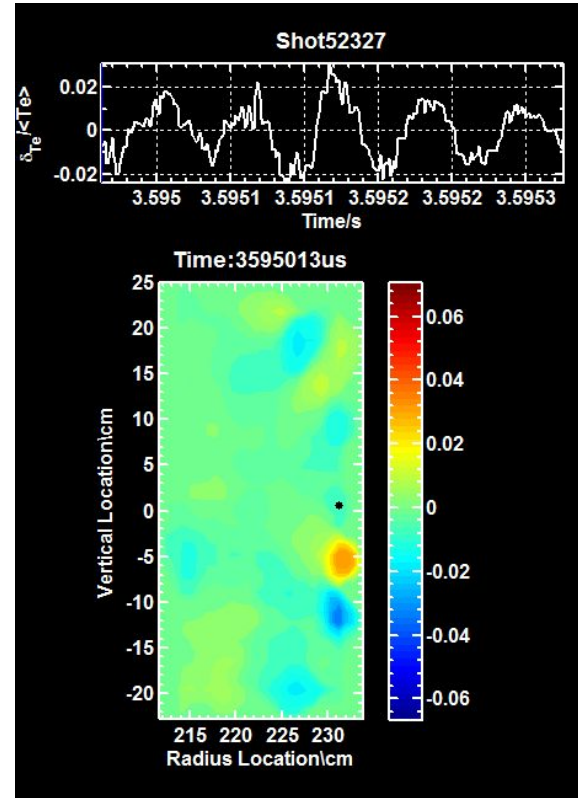
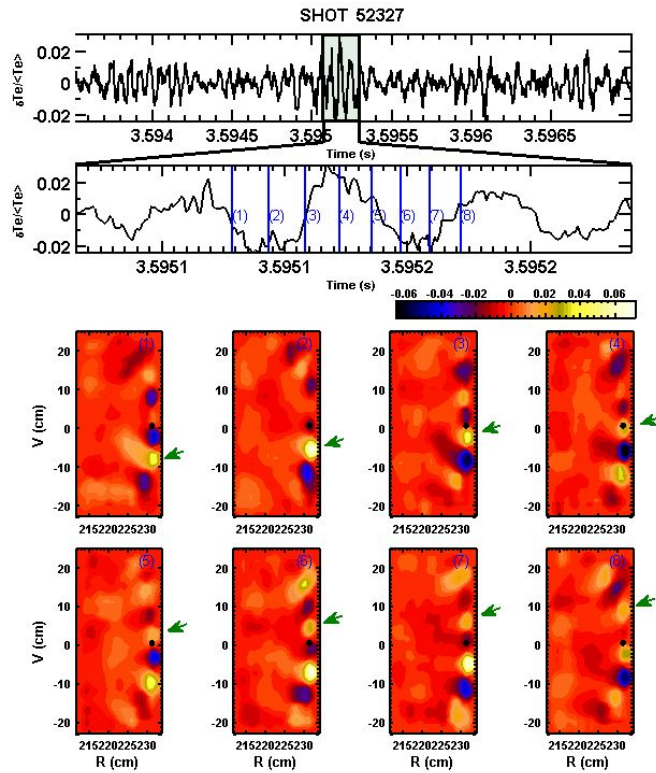


PLASMA DISCHARGE PARAMETERS

EAST webscope: mds.ipp.ac.cn



CHARACTERISTICS OF THE MODE



1. Mode rotation direction: electron diamagnetic
2. Mode structure: ballooning mode type
3. Mode number: $m \sim 30$, $q_{95} \sim 3-5$, $n \sim 6-10$
4. Behavior during ELM crash
5. Other characteristics ...

DIFFICULTIES OF DATA ANALYSIS

1. Too many channels (384) to be identify good or not.
(saturate, weak, NULL, polluted by LHCD ?)
2. Big data (7.6G) to analysis to recognize the physics
in the signal. (From spectrums, imaging, compared to
other signals)
3. Much research work should be done to understand the
physics.