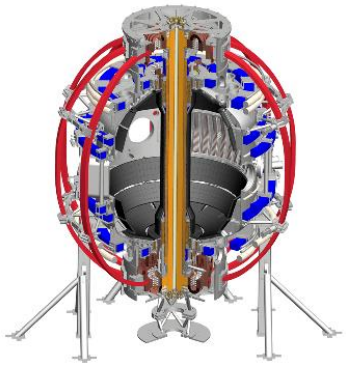
U.S. DEPARTMENT OF ENERGY | Office of Science

NSTX-U

HL-2A and EAST collaboration opportunities

T&T TSG meeting
Feb. 15, 2017

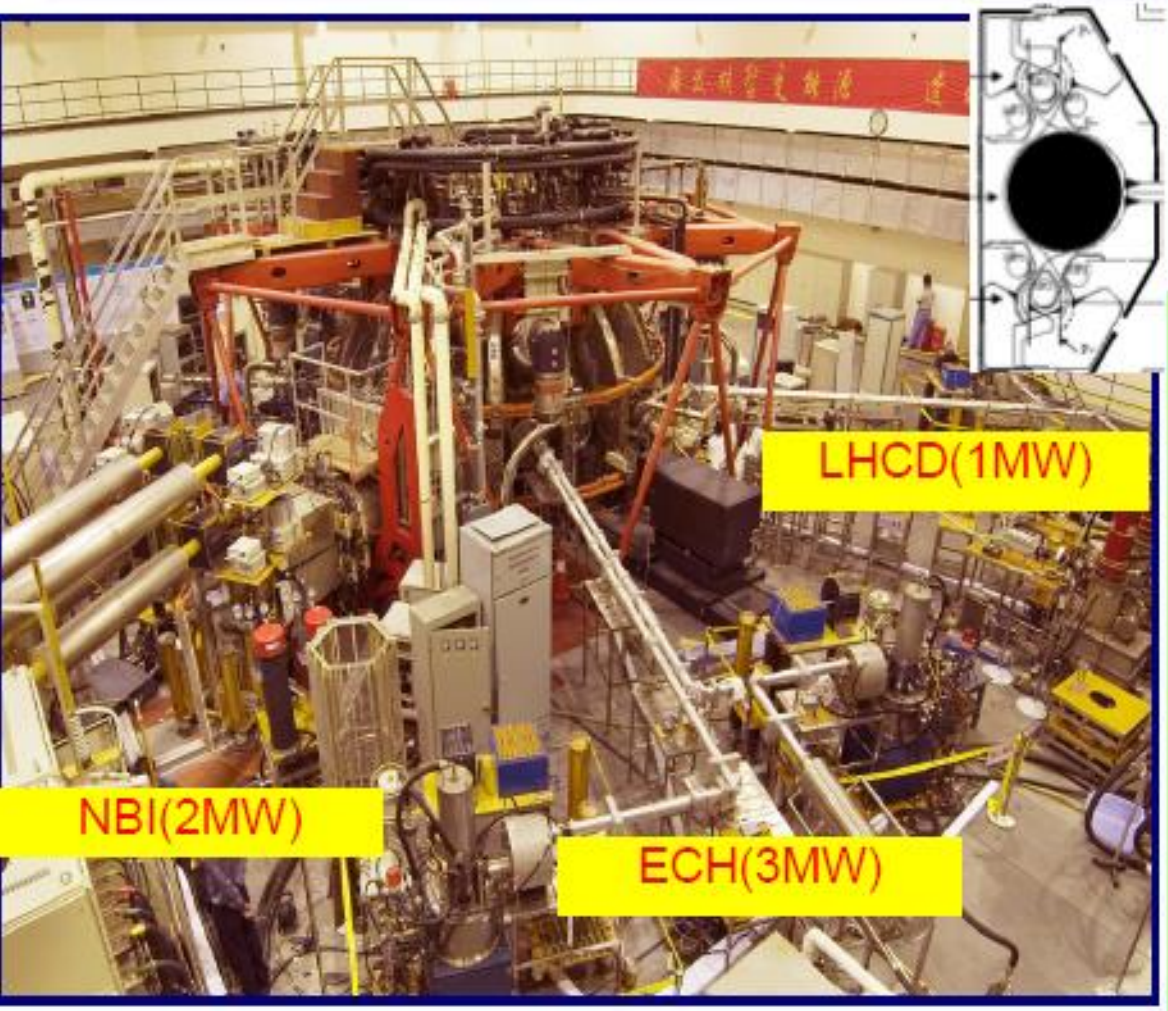
PPPL



HL-2A 2017 campaign schedule and special considerations for NSTX-U team

- Rough plan is to start operation in March 2017 and to finish the run in June 2017
- Internal experimental proposal review is going now
  - NSTX-U team is exempted from this review
  - Still need to work with task force leaders in proposal preparation process
- Run time is guaranteed for NSTX-U team (with reasonable XPs) and no preset runtime allocation limit

Present status of HL-2A tokamak (2017)



- HL-2A tokamak:
  - R/a=1.65m/0.4m
  - Ip=150-300kA, B_T=1.3-2T
  - ne=1-4e19 m^{-3},T_e=1-3 keV
- Heating and fuelling
  - ECRH: 2-3MW (coupled power), 500Hz modulation,68GHz
  - NBI: 1-2MW, 40keV
  - LHCD: 1MW, 3.7GHz
  - Pellet: repetitive
  - SMBI: 0.2-3MPa, 100Hz modulation
- RMP (n=1)
- More than 30 diagnostics have been developed

Diagnostics for transport study

HL-2A

- The transport study, i.e. electron heat transport, particle transport, impurity transport, and momentum transport, have been carried out on HL-2A.
- Perturbative techniques: gaspuffing, SMBI(H,D2,He,…), pellet, LBO(Al,Fe,W,Ti,30Hz), M-ECRH/ECCD (500Hz), NBI(4 pulse), …

•Te profile Measurement

- 32 Channel ECE (32ch/3cm/10us)

•Ne profile measurement

- 4 Channel HCN laser Interferometer
- Reflectometer,33-110G($6\times10^{19}m^{-3}$,20us）

•Ti profile Measurement

- CXRS（for Ti(r) 1.5cm,10ms,32ch）

•Multi-Channel Detector arrays

- Soft X-Ray System: 5arrays 100chs
- Bolometer system：4arrays 48chs
- Ha measurement： 2arrays 92chs

•Plasma rotation

- CXRS （for Vt(r), .5cm,10ms, 32ch）
- Doppler （for Vp(r), >20 ch, 2 ms）
- Probe array (edge velocity)

•Impurity

- EUVSpectroscopy(3nm-40nm,6ms/2mm)

Diagnostic systems for fluctuation measurements on HL-2A

Parameters	Diagnostics	channel	Spatial	Temporal	Reliability	error	
Plasma image	Visible CCD camera	1	Entire	9 ms	>90%	--	
	Fast visible CCD camera	1	-	100 ns		--	
Te	Multi-channel ECE/ECEI	16/384	2.5/1 cm	1/10 μs	>70%	a.u.	73-97G
ne	MW interferometers	4		1 μs			
	Doppler reflectometers	24	1cm	1-5ms			17-60GHz
MHD	Mirnov coils	2 sets	m<17, n<4	50 kHz	100%	2 %	
	Soft-x-array	20*5	3 cm	10 μs	>90%	5%	
Edge parameters (ne,Te, EXB,…)	Movable electrostatic probe	2	1 mm	1 μs	~50%	30%	
	Fast reciprocating probe	1	1 mm	1 μs	~70%	30%	
Divertor parameters	Movable electrostatic probe	2	1 mm	1 μs	>50%	30%	
	Target plate probe	7*4	1 cm	1 μs	100%	30%	
	Microwave interferometer	1	--	10 μs	<30%	5%	
Target plate temp.	IR camera	1	1 mm	1 μs	>70%	1%	
Edge turbulence	Electrostatic plate	3	1 mm	1 μs	>50%	30%	
Plasma rotation	doppler reflectometer	4	1 cm	1-20 ms	~50%	10%	

Newly developed diagnostics

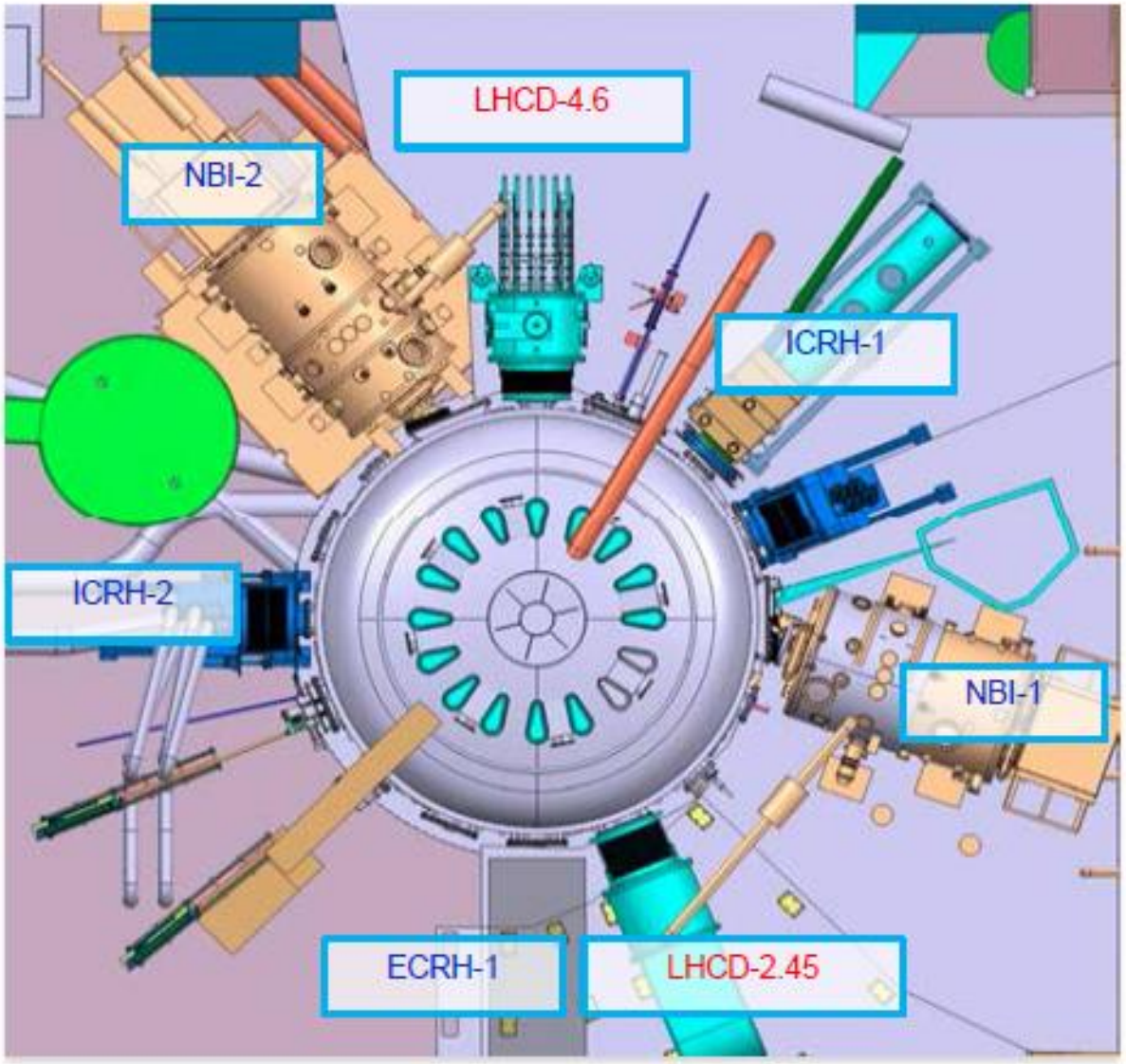
Diagnostics	parameters	
CO2 interferometer	Line-averaged density, 1ch, 1us (for density feedback)	2016
BES	Density fluctuation, based on NBI	2017
CTS	High K turbulence, ETG	2017
Scintillator fiber array	Fast ion loss, 20keV-200keV, 12ch (working on calibration issue)	2016
imaging-FIDA	Fast ions, 10ms, (need to improve signal)	2016
PCI	Density fluctuation	2017
Wide zoom IR camera	Whole vacuum chamber	2016
He-GPI	2D density fluctuation	2017
CIS	Impurity(Carbon) rotation (CIII, SOL, divertor, high spatial resolution)	2017

EAST opportunities

EAST schedule for next year has been disclosed

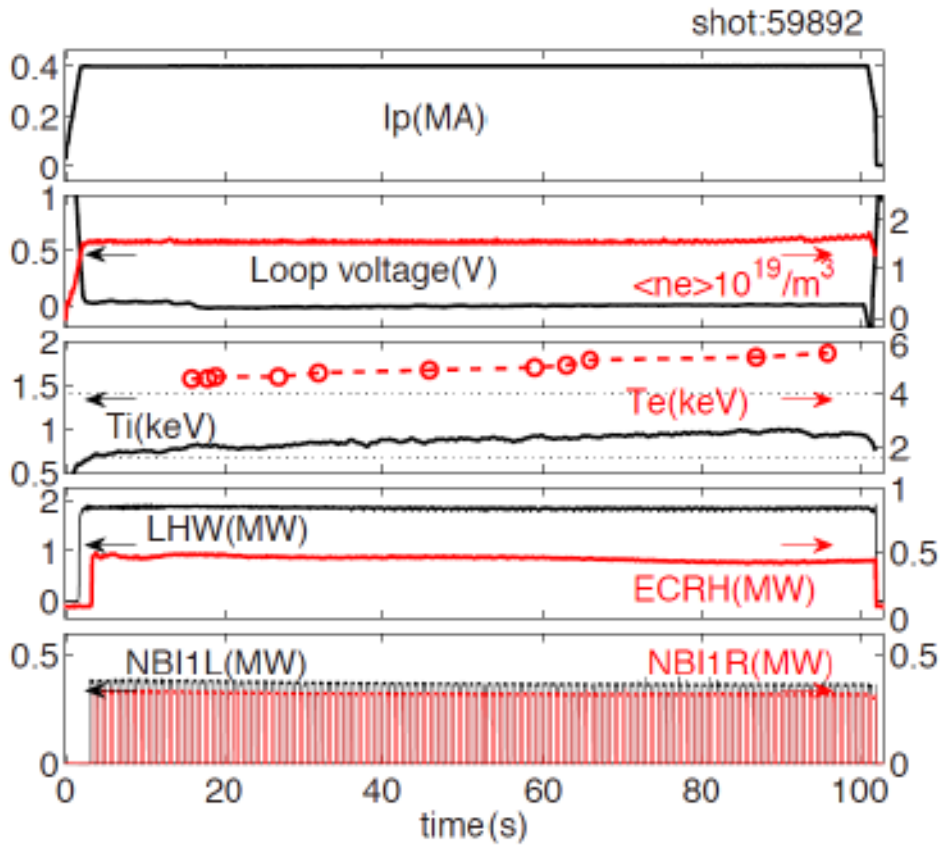
- EAST experiments stopped end of Dec. 2016
  - Shut down for Chinese New Year for 2 weeks on 1/20/17
  - An experiment planning meeting is scheduled for March 13-14, 2017, similar to the first one in Jan. 2016
- Restart operations in Spring, 2017 with no changes
  - 2 month run in May and June
  - Opportunities for follow-on lithium experiments
  - Lower divertor has damage – cannot put much power on it
- Shut down summer 2017 to install W lower divertor
  - Start-up ~ early 2018 with all metal walls
  - Plan for a controlled lithium introduction after assessing uncoated tungsten performance

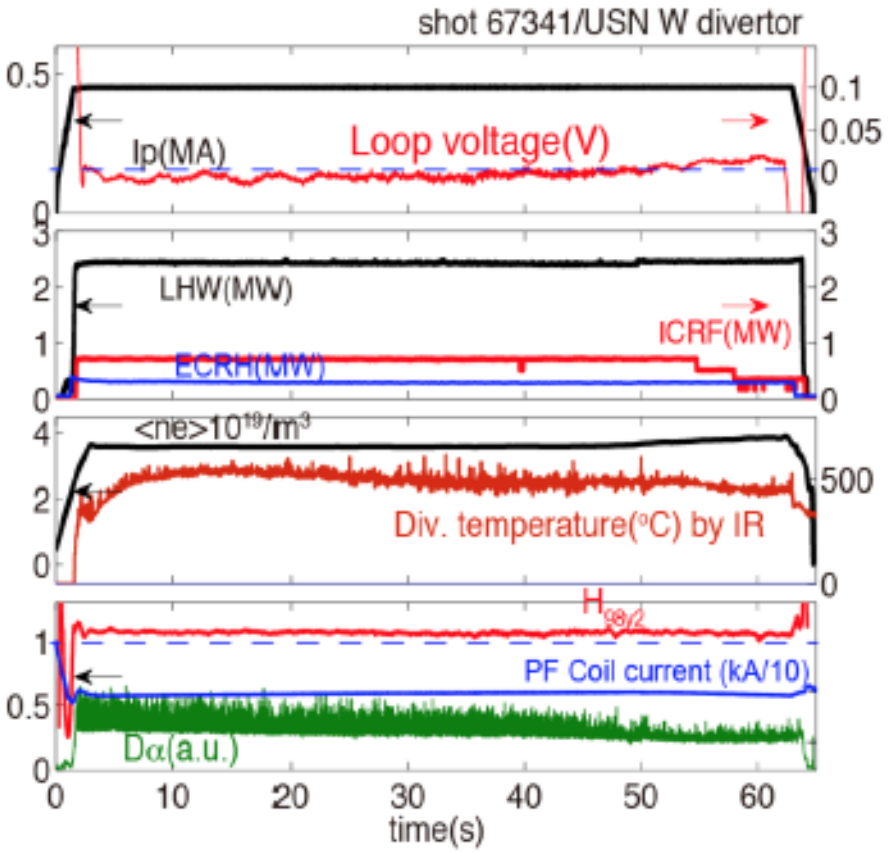
Current EAST heating capabilities



- LHCD-4.6 GHz < 3 MW (typical 2 MW)
- LHCD-2.5 GHz < 2 MW (typical 0,8 MW)
- NBI-1 (co) < 3 MW
- NBI-2 (ctr) < 3 MW
- ECRH < 0.5 MW (typical 0.4 MW)
- ICRH < 2 MW (coupling efficiency ~ 25%)

Long pulse steady-state operation on EAST





100s high electron temperature (Te > 4.5keV) operation

Minute-scale steady-state H-mode (H_{98}>1.1) operation