Experimental Operation Instruction Manuals of EAST 2022

CATALOGUE

1 General information of EAST campaign 2022

This campaign will be from April 15 to July 15 as follow:
1) April 9-14, commissioning of EAST sub-systems: superconducting magnets, power supplies, plasma control, magnetic measurements calibration etc.
2) April 15-30 (2 weeks), commissioning of EAST machine: plasma setup (Ip=0.5MA，n_e=1.5-2.0x10^{19}/m^3,B_T=2.5T), mid-level heating and current drive power (5.0-6.0MW), self-consistency of plasma diagnostics；
3) May 1-28 (4 weeks), major EAST targets of this campaign (400s H-mode， 10MW inject power with 100s duration), investigating the following topics in long-pulse operation and to accomplish the national tasks in the national 13th Five-Year Plan : plasma control, equilibrium & stability, transport & confinement, H&CD, particle and heat exhaust, core-edge integration, energetic particles.
4) May 29-July 15 (7 weeks), physical experiment for proposals, covering ongoing fundings/projects, open proposals on cutting-edge topics. Proposals should focus on the key issues of ITER/CFETR.
* 2 weeks contingency included.

Plasma operation windows for this campaign:

I_p=0.3-0.8MA, B_T<3.0T, 3.0<q_{95}<9.0, 0.3<n_e/n_{GW}<0.8, USN/LSN/DN, 4.0MW<P_{heat}<10MW.

2 Physical research Content

2.1 Integrated scenario development and relevant key physics

Integrated scenario development and relevant key physics toward ITER and CFETR：
high betap scenario with high q_{min} and ITB, high betap scenario at ITER relevant heating sch eme, ITER baseline and hybrid related scenario， high ion temperature operation with synergy effect of NBI, ICRF and ECRH， advanced plasma control methods etc.

2.2 Plasma confinement and transport

For high-power, long-pulse plasma confinement and transport, study the momentum and p article transport under steady-state operating conditions, focusing on high-Z impurity beha vior under high-power heating, and explore internal transport barrier formation at high ion temperatures. Establish a dimensionless normalized parameter scaling database for studyin g the turbulence and transport characteristics under various operating conditions and the m ulti-scale interaction mechanism with multi-mode (such as NTM, AE, EP), and carry out long -pulse I-mode analysis.

2.3 MHD&3D physics

MHD instabilities and 3D physics studies in low torque, low q95 plasmas in support of ITER h igh Q operation: RMP ELM control, disruption physics and mitigation, Core MHD and its interaction with 3D field, frontier studies in 3D physics etc.

2.4 Pedestal and edge physics

Pedestal structure and small/No ELM regimes in supporting ITER and CFETR: parameter dependence and validation of pedestal structure (especially ne,sep/ne,ped, grad ne); extension of small/no ELM regimes towards low q_{95} (q_{95}~5→3) relevant to ITER high Q scenario; compatibility of high-performance pedestal with radiative divertor; impact of recycling particles on edge plasma behaviors in long-pulse high-performance operation; key physics in pedestal for high-performance high-density operation (especially with pellet injection), etc.

2.5 Divertor and Plasma-Wall Interaction

Plasma–wall interaction physics and its integrated control for long-pulse high-power operation: detachment control compatible with core plasma, tungsten source and edge transport, wall conditioning and its real-time control, particle exhaust and recycling, material erosion and migration during long pulse operation， with P_{inj} > 10 MW.

2.6 Energetic particle physics

Towards ITER and CFETR high performance plasma, EAST EP research program is focused on: EP velocity-space distribution with the synergistic effects of NBI and ICRF; the effect of non-axisymmetric magnetic fields on EP redistribution/loss with the impact on the first wall; investigation of destabilizing and controlling EP related modes; the interaction of EP with background instabilities (turbulence, sawtooth, neoclassical tearing modes, etc.)

3 Operating parameters and capabilities of each EAST system

3.1 Magnet and cryogenic system

- **TF coils：** 16 TF coils， which operating current is 14.3 kA, BT(0)<=3.5T；
- **central solenoid coils and PF coils:** Six central solenoid coils and six large poloidal field coils form the poloidal field magnet system. The maximum operating current of PF is 14.5 kA, and the maximum poloidal magnetic field intensity and magnetic field change rate can reach 4.5 T and 7 T/s separately.
- **Toroidal Field (TF) Power Supply:** The maximum output of each power supply set is 14.3 kA, and the stability and accuracy are better than 0.05%. The maximum current rise and fall capacity is 5 A / s, and the excitation and demagnetization time under normal operation mode is 2800 s. The fast demagnetization is started under fault conditions for 1800 s. The demagnetization time shall not be greater than 100s in case of lost superconduction.
- **Poloidal Field (PF) Power Supply:** PS1-PS6 and PS11/PS12 power supply with load voltage of 300 V, PS7/PS8 power supply with load voltage of 900 V, PS9/PS10 power supply with load voltage of 600 V. All power supplies are bipolar output, with a maximum current of 15 kA and power response time of 5 ms. Each set of power supplies is equipped with a set of plasma start-up auxiliary switching units, which provide the maximum 2400 V auxiliary voltage at the plasma start-up time. The duration is adjustable from 0 to 100 ms, and the synchronization time error of 12 sets of switches is not greater than 1.5 ms. In the plasma breakdown stage, the maximum current change rate is 20 kA/s, and in other stages, it is not greater than 4 kA/s.
- **Cryogenic system:** The cooling capacity of the helium refrigerator exceeds 2kW/4.5K+13kW/80K; it provides 4.5K supercritical helium for cooling, and the outlet temperature of the cooling PF and TF coil windings does not exceed 5.5K. The maximum total massflow of liquid helium that can be provided for cooling the built-in cryopump, NBI and the pellet injection does not exceed 13g/s.
- **Quench Detection System(QDS)：** Quench detection in the EAST magnet system is distributed as follows: 16 Toroidal Field coils (based on voltage detection, the voltage threshold in the range of 0.2- 0.25V and the holding time in the range of 0.9-1s), 14 Poloidal Field & Central Solenoid coils (based on voltage detection, the voltage

threshold in the range of 0.5- 0.65V and the holding time in the range of 0.9-1s), 1 pair TF High Temperature Superconducting Current Leads (HTSCL) and 12 pairs PF&CS HTSCL (based on voltage detection, the voltage threshold in the range of 1mV and the holding time in the range of 1-1.1s). The EAST QDS have the following capabilities including the insulation to ground (DC 10kV), the signal to noise ratio of 8, trigger the Fast Discharge (FD) within 10ms and has strong anti-electromagnetic interference ability.

3.2 Internal components and control coils

- ✧ **Upper and Lower W/Cu divertor：**the thermal load capacities are 10MW/m^2（steady state）and 20MW/m^2（transient）at the hit point；5MW/m^2（steady state）and 10MW/m^2（transient）at the non-hit point, plasma facing components(High field plates、passive plates and low field plates)：the thermal load capacities are 1MW/m^2（steady state）and 2MW/m^2（transient）in high field plate、passive plate and low field plat with TZM & SiC/C(5/16 of the high field Plates).
- ✧ **Guard Limiter（W/Cu）：**the max thermal load capacity of LHCD guard limiters is 10MW/m^2.
- ✧ **Fast Control Coils:** The quick control coil comprises upper and lower groups, which can be adjusted through external wiring to form two operation modes of positive and negative series.The maximum voltage on-load is 1000 V, and the maximum operating current is bipolar output 9000 A (100 ms) and 6000 A(long-term). The power supply can operate in voltage or current control mode, and the response time shall not be greater than 200us. The current change rate is 2 × 106 A/s.
- ✧ **RMP Coils：**There are eight sets of power supplies, with the maximum voltage on-load of 450 V and the maximum bipolar output current of 4000 A. The output frequency range is DC-1kHz, the current rise rate is 2 × 106 A / s, and the response time is not more than 500us. The power supply can operate in voltage or current control mode. RMP coil has multiple combination modes: positive series, n = 2 and 4; negative series, n = 1, 3; Additionally, climbing, platform, descent, and rotation current waveforms can be set.
- ✧ **Internal Lower Divertor Coils：**There is one set of power supply, with output voltage on-load of 600V, bipolar output. The maximum power output frequency is 100Hz. DC operation: the short pulse discharge is about 10 s, and the discharge interval between two shots is about 10 min. The current range is ± 30 kA and the current value can be continuously adjusted. It can overshoot to ± 30 kA, and the duration shall not exceed 0.1s. In a single discharge, the average value of the current effective value is ≤ 20 kA, and the current amplitude is allowed to exceed 20 kA in a short time (about 1-2s). The discharge time is about 100-400s, and the discharge interval between two shots is 0.5-2 h (depending on the discharge duration and engineering limitations). The current can be continuously adjusted with an adjustable range of ± 10 kA. In a single discharge, the average value of the current effective value is ≤ 8 kA, the current amplitude is allowed to exceed 8 kA in a short time (about 1-20s), and the current change rate is ≤ 1 × 106 A/s. AC operation: the waveform can be adjusted to triangular wave and sine wave; The maximum current is ± 30 kA, and the current amplitude can be continuously adjusted; current amplitude < 20 kA, frequency: 1-100 Hz, duration: 3-20 s; Current amplitude ≥ 20 kA, frequency5-10 Hz, duration: 1-2s; Within 50 Hz, the frequency can be continuously adjusted in steps of 1Hz. Zero drift: ± (100-200) A; Duration: 3-20 s; Accuracy: current amplitude ≤ 5 kA, within ± 100 A; Current amplitude ≥ 5 kA, within ±

2%.

3.3 Vacuum, fueling and wall conditioning

- **Pumping system:** 2 sets of inner cryo-pumps, pumping speed ~130m^3/s; 14 sets of external cryo-pumps, 4 sets of molecular pumps, the total pumping speed of hydrogen ~70m^3/s. It can meet the requirement that the ultimate vacuum pressure of the plasma discharge vacuum chamber is better than 5×10^{-6}Pa. The inner cryo-pump on/off needs to be contacted 1 day in advance.
- **Gas puffing:** It is used for fuel and impurity injection. D_2, He, H_2, Ar, Ne, etc. can be injected. Gas puffing for plasma charging: 3 sets of horizontal J window low field side; 1 set of upper O window high field side; 3 sets of upper O window divertor; 6 sets of lower divertor, 4 sets are located in the lower O window, 2 sets are located in the lower H window. Gas puffing flux: 0-3 Pa·m^3/s. Contact 1 day in advance.
- **Supersonic Molecular Beam Injection (SMBI):** used for fueling and impurity injection, can inject impurity gases such as Ar, Ne, He, etc. Mid-plane SMBI system: 2 sets are located in the horizontal C and J windows, respectively, and the number of particles injected by 1ms pulse under 6bar back pressure is (2-8) × 10^{18}; Divertor Fast Particle Injection system (DFPI): 2 sets of 4 injection positions are located near the horizontal and vertical strike points of the outer target plates of the D and O divertors respectively. Contact 1 day in advance.
- **Pellet Injection:** used for fueling and ELM control, please contact 1 day in advance. Low-frequency pellet injection system, the injection frequency is adjustable from 1-10Hz, the number of atoms in a single pellet is (1.03 ± 0.1) × 10^{20}, and the injection positions are the low-field side (LFS), high-field side (HFS) and the low-field side of the lower divertor (DLFS). High frequency pellet injection system, the injection frequency is 25Hz, currently in the engineering commissioning stage.
- **Baking:** The first wall has a baking capability of 200 degrees and currently operates at 150 degrees.
- **Glow Discharge Cleaning (GDC):** 4 sets of electrodes are located in the P-A, B-C, F-G, J-K windows, respectively, GDC pressure: 0.01 – 10 Pa, GDC current: (1-3) A×4.
- **Ion cyclone cleaning:** 2 sets of antennas are located in windows B and I respectively, corresponding to 2 sets of 50kW RF transmitters working independently through impedance adjuster, cleaning pressure: 10^{-3} – 10^{-1} Pa, total power: ~50kW.
- **Wall coating:** The lithium coating crucibles are located in the O/F/J windows, which can achieve 0-30g lithium coating each time; The boronization system is located in the horizontal J window, using $C_2B_{10}H_{12}$ material, can achieve 0-15g boron coating each time. The siliconization system is located in the horizontal J window, using SiD_4/He mixed gas injection, and the working pressure range is 0.01-0.5Pa. Contact 3 day in advance.
- **Impurity injection:** powder injection systems are located on the high and low field sides of the upper window of J, with R~1.94 m (Li)/ R~1.57 m (B), realizing the injection of lithium powder (~40 μm), boron powder (~100 μm), lithium balls, etc. (0.9 mm); injection speed ~10 m/s. Mid-plane lithium pellet injection system: located in the J horizontal window, pellet size 0.9/0.7 mm, injection speed 0-100 m/s. These systems are mainly used for ELM control and real-time wall conditioning experiments. Contact 7 days in advance.
- **Disruption mitigation:** MGI system, located in horizontal O and J windows, working voltage 0-3000V, pressure 0-30bar, system response time 0.15ms, can achieve 0-10^{23} particles injection. Contact 7 days in advance.

3.4 Plasma heating system

- **ICRH:** 5.0MW of ICRF system is available for the coming campaign. The ICRF system can be capable of operating at any frequency in the range of 25-70MHz.The ICRF power can be coupled to the plasma through two launchers located in I- and N- ports. The phasing of currents in the adjacent current straps can be adjusta ble from -180o to +180o .The heating scenarios is H minority heating or Helium-3 mino rity heating or second/third harmonic heating of D fast ions produced by NBI. ICRF pow er of a maximum 4.0MW were put into EAST experiments with two launchers since 202 1, and can achieve 4.0MW /10s or 2.0-3MW/400s long-pulse operation.
- **LHCD：** two CW LHCD systems working at the frequency of 2.45GHz（B-port） and 4.6GHz（E-port）, respectively. The normal parameters of LHCD system in this campaign：1MW@2.45GHz/2MW@4.6GHz w/o power feedback control； Power modulation frequency range 0-1kHz； Phase control range 0-360^o； Antenna displacement range -50mm-50mm.
- **ECRH：** 140GHz, 3 waveguide transmission lines，total available RF power / Pulse length is 1.3MW/100s~400s； antenna adjustment range： poloidal adjustment range: ∓5°～±25°； toroidal adjustment range: -10°～ +25°.
- **NBI：** There have two beam lines (both co-injection), which installed on port A (NBI-1) and port D (NBI-2). Each beam line have two ion sources. Four ion sources can be operated individually. The injected NB power for each ion source is around 0.4 MW to 1.2 MW with beam energy of 40 -65 keV. The beam duration is 0-10 seconds. The beam also can be modulated with frequency of 1-5 Hz, the duty ratio is around 50%.

3.5 Plasma control

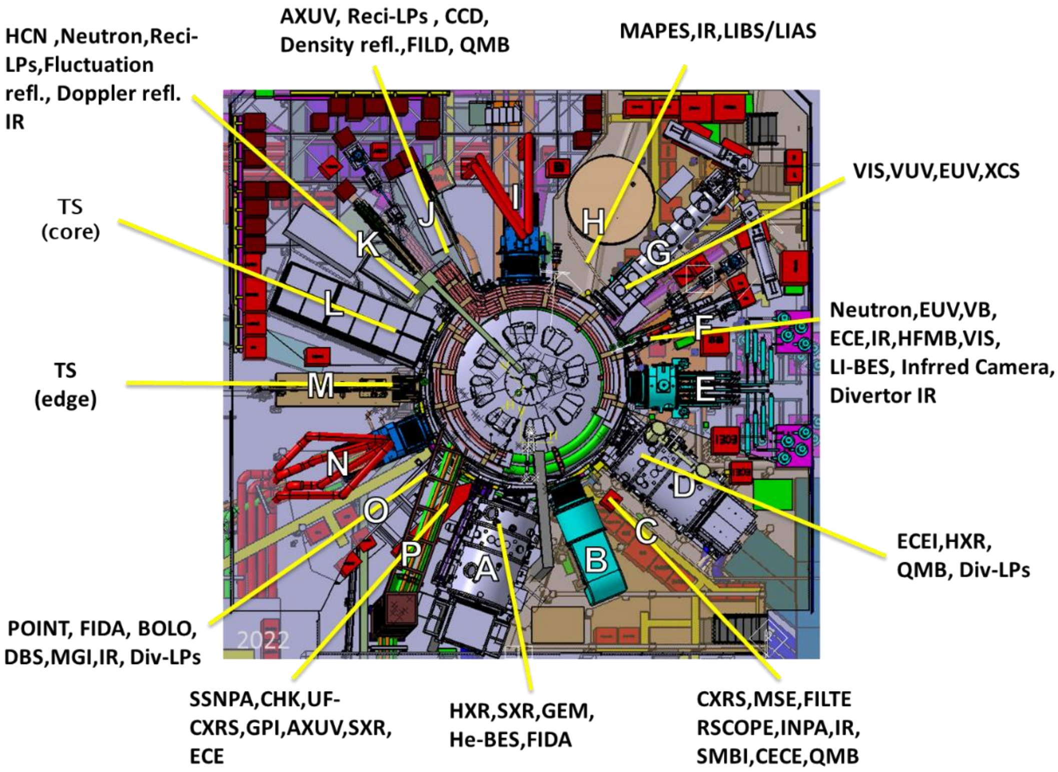
Plasma control system (PCS) provides plasma current, position, shape, density, loop voltage, radiation power, divertor detachment, profile control, etc. The main control performance is as follows:
1) the maximum controllable plasma vertical displacement is about 5 cm;
2) PCS provides multiple advanced shape control algorithms, such as low/upper single null shape, double null shape, quasi-snowflake shape, and the flux errors at control points is about 1 mwb/rad, while the control errors at the X points are less than 1 cm;
3) the real-time parallel reconstruction code PEFIT can provide plasma boundary and equilibrium information within 500 us in 129*129 grid resolution.
At present, the actuators controlled by PCS for real-time plasma feedback control are poloidal power supply, inner coil power supply, RMP power supply, lower divertor coil power supply, gas puffing system, LHW2.45 GHz system, LHW4.6GHz system, and two NBI sources.

3.6 MAPES

The Material and Plasma Evaluation System (MAPES) is located at the midplane outboard H port of EAST. A gate valve with a nominal diameter of 500 mm is used to connect the MAPES and the EAST main chamber. A sample with the weight less than 25 kg and the size smaller than 400 mm can be installed on MAPES and be transported to the position around the normal separatrix. Thermal couples and Langmuir probes can be embedded in samples for the recording of sample temperature and plasma parameters. Moreover, the MAPES is also equipped with sample water cooling and heating facilities as well as gas puffing component to provide flexible experimental conditions. The MAPES can be used for the study of material erosion, impurity migration, fuel retention, plasma cleaning, new material or component such as liquid Lithium loop system etc.

3.7 Diagnostic System

Layout of Diagnostic System on EAST.



List of diagnostic name and detailed system parameters

Diagnostic name	System function and parameters
Thomson scattering diagnostic（TS）	Provides electron temperature Te and electron density ne profiles (1)Core TS: Spatial resolution: 3cm Measurement Space: R=1.90m, Z: -15cm~+65cm Coverage: 0-0.95a Temporal resolution: 1-100Hz Accuracy: Te<10% and ne~ 15% (2)Edge TVTS （TEST）: Measurement Space: R:2240mm<R<2320mm Coverage: 0.8-1.1a Temporal resolution： 1-20Hz Accuracy: Te<10% and ne~ 15%

HCN interferometer	Measurement: line-integrated density Measurement position :R = 1820mm Temporal resolution: 100μs
CO2 dispersion interferometer	For high electron density measurement Vertical single channel measurement at R = 1730mm Temporal resolution: 50μs
Microwave solid source interferometer	Measurement: line-integrated density Vertical single channel measurement at R = 1910mm Temporal resolution: better than 2μs
POlarimeter-INTferometer (POINT)	Measurement: line-integrated density and farady rotation angle Measurement position: Z=42.5 cm, 34 cm, 25.5 cm, 17 cm, 8.5 cm, 0 cm, -8.5 cm, -17 cm, -25.5 cm, -34cm, -42.5cm Sampling frequency: 10MHz Temporal resolution: up to 1μs
Electron Cyclotron Emission diagnostic(ECE)	Provide electron temperature profile. Coverage: 56-channel heterodyne radiometer, cover the plasma radial region in the midplane. Frequency coverage: 97-167.1 GHz. (1 GHz separation when frequency is at 97-137GHz, 2 GHz separation when frequency is at 138-167 GHz) Sampling Frequency: 1 MHz Temporal resolution: up to 2.5 us. Spatial resolution: ~2 cm
X-ray imaging crystal spectrometer (XCS)	Ion temperature and toroidal rotation velocity Measurement Space: -540mm≤Z≤540mm, ρ~ 0-0.7 Range: 0.1keV<Ti<30 keV, 5 km/s≤V_t ≤4500 km/s Sampling Frequency: 100 Hz Temporal resolution: 10-100 ms Spatial resolution: 1~3 cm
Charge exchange recombination Spectroscopy (CXRS)	Ion temperature and toroidal rotation velocity profiles. Measurement Space: 12-channels cover the low filed side of the plasma (R=1.8-2.3m) Temporal resolution: 30~50ms Spatial resolution: 3~4cm Ion temperature: >100eV velocity: >3km/s

Fast frequency sweeping reflectometry	Electron density profile Measurement Space: generally coveringρ= 0.5-1.1 (depends on B_t&n_e). Frequency coverage: 33-110 GHZ Sampling frequency: 62.5 M/s Temporal resolution: 50µs
Motional Stark Effect Diagnostic (MSE)	Plasma current density profile Measurement Space: 10-channels, cover the low filed side (R=1.8~2.3m) Temporal resolution: 30~50ms Spatial resolution: 3~4cm Polarization direction measurement accuracy: 0.5°
AXUV diagnostics	Provide the total radiated power in bulk plasma and the profile of radiated power LOS arrangement: cover the whole poloidal section, 4 horizontal arrays with 64 channels, 2 vertical arrays with 40 channels and 1 divertor array with 16 channels Photon energy range: 7ev-6kev Spatial resolution: 3-4cm Temporal resolution: 0.01-0.1ms
Metal foil Bolometer	Provide the total radiated power in bulk plasma and the profile of radiated power LOS arrangement: cover the whole poloidal section, horizontal array with 44 channels and vertical array with 16 channels. Photo energy range: infrared – 10keV Spatial resolution: 3-6cm Temporal resolution is about 1-10ms
Divertor Langmuir probes (Div-LPs)	Provide the particle flux, electron temperature, density, heat flux in the divertor region Distributed on the inner and outer target plates of the upper and lower divertors Spatial resolution: about 12.5 mm Temporal resolution: 20 µs
Reciprocating probe diagnostic	SOL parameters, plasma density electron temperature, and floating potential Radial range: far SOL, 1-3 cm in front the radial location of the limiter Sampling Frequency: 1-2 MHz Temporal resolution: 1-2µs for fluctuations, 0.5 s for profiles

	Spatial resolution: 2mm
MWHCCD	Horizontal field of view（H）: -6°～39° Vertical field of view（V）: -32°～32° Relative Aperture: D/f=1:4 Spatial resolution: ≤5mm Temporal resolution: <10μs
DHCCD	Relative Aperture: D/f=1:4.8 Horizontal field of view（H）: -9.5°～9.5° Vertical field of view（V）: -7.0°～7.0° Horizontal observation direction（H）: 39.5° Vertical observation direction（V）: 75° Spatial resolution：<2mm Temporal resolution：<10μs
Filterscope diagnostics	Monitor the visible line emission of the work gas D and impurity. Include 3 arrays, each 13 channels for bottom and upper regions, 24channels for the middle region Wavelength coverage: D α / H α (656.1nm), O II(441.5nm), C III (465.0nm),Li I(670.8nm), W I(400.9nm), Mo I (386.4nm),D γ / H γ (433.9nm), D β/ H β (468.6nm), bremsstrahlung (538nm) Sampling Frequency: 50 kHz /250kHz Temporal resolution: 0-200KHz Spatial resolution: 2-2.5cm
Bremsstrahlung diagnostic	Measure the number of effective charges Central wavelength: 523.0nm Half height width: 2.0nm Temporal resolution: 20kHz Spatial resolution: 2.5cm
Visible spectrometer（OSMA）	Monitor the visible spectrum of the D and impurity emission and provide H/(H+D) Include: sct320 and sp2750 spectrometer Coverage: view the top and bottoms divertors region, each with 13 channels Sampling Frequency: several tens Hz Wavelength resolution: 0.004 nm (SP2750 at 2400 g/mm), 0.018 nm (SCT320 at 1800 g/mm) Spatial resolution: 2-2.4cm
EUV impurity diagnostics	Temporal evolution of impurity behavior and distribution. Study on high- resolution spectra, impurity transport (1) Fast-time-response EUV spectrometers (fast EUV):

	Impurity species: He-W (Z=2-74) Ionization stages: low-moderate-high Wavelength range: 5-500 Å Spectral resolution: 0.1@20 Å, 0.22@200 Å Temporal resolution: 5ms (2) Space-resolved EUV spectrometers (space-resolved EUV): Wavelength range: 5-520 Å (scanning) Temporal resolution: 15/50/200 ms Spatial resolution: 0.3/0.8 cm Viewing range: [-45 +45] / [-25 +25] cm
Soft X-ray & vacuum ultraviolet spectroscopic diagnostics	Measure the impurity spectra from core and edge plasma Space coverage: 20 channels, cover region Z=0-45cm. soft X-ray & extreme ultraviolet spectrometer: Wavelength range: 30-500Å Sampling Frequency: 5 Hz Spatial resolution: 4~5cm VUV spectrometer: Wavelength range: 500-3000Å. Sampling Frequency: 200Hz
VUV imaging diagnositics	Temporal resolution: 50μs Pixel resolution: 2mm.
Divertor tungsten source spectroscopy	Monitoring tungsten atom flux and Li I、CII、NeII、ArII spectral lines etc at divertor targets. Sampling Frequency: 30Hz-100Hz. Temporal resolution: 0.01s-0.03s. Spatial resolution: 13mm-25mm.
Divertor Laser-Induced breakdown spectroscopy	Qualitative results (depth and intensity) of Li, Mo, W, C etc Scanning region: inner-target, dome of upper W divertor and part of Mo first wall on HFS. Wavelength range: 200 – 980 nm. Spectra resolution： 0.01nm. Spatial resolution: 2mm (Polodial).
Ultra-Fast Charge eXchange Recombination Spectroscopy (UF-CXRS)	Provide fast evolutions of temperature and toroidal velocity of target impurity (Ne at present) near the pedestal. Measurement position: 2 channels at R=2235 and 2272 cm Sampling Frequency: 1 MHz Temporal resolution: >1 kHz (depend on the concentration of target impurity) Spatial resolution: (Spot size)1~2 cm

FIDA diagnostics	Monitor the Da spectrum of the fast neutral D from the NBI. Coverage: 16 view chords in Port O, 11 view chords in Port A, 8chords in top Port B. Sampling Frequency: 0-50Hz Wavelength resolution: 0.032nm. Spatial resolution: 5cm
Fast ion loss diagnostics	Energy range: 10kev-2mev. Sampling rate is 2MHz.
Soft X-ray image (SXR)	Provide SXR emission profile and MHD information. LOS arrangement: 2 horizontal arrays, each with 46 channels, and one vertical array with 30 channels. Time sampling rate: 100-200kHz Spatial resolution: ~2cm.
Soft X-ray energy spectrum diagnosis (PHA)	Measure the different line emission spectrum intensity of high-Z impurity and line-integrated electron temperature. LOS arrangement: cover the bottom poloidal section (-50cm≤Z≤ 6cm) Photon energy range: 1kev-30kev Temporal resolution: ≥20ms Spatial resolution: 5cm
Hard X-ray diagnosis (HXR)	Measure the intensity of the HXR emission and give fast electrons, LHW deposition information. LOS arrangement: 2 horizontal arrays, 40 channels in total Photon energy range: 20keV-200keV Temporal resolution: 1ms Spatial resolution: 3.5cm
Imaging of Neutral Particle Analyser (INPA)	Measure the distribution of energetic ions density along major radial direction; Photon energy range: 30-150keV Sampling Frequency: 1kHz of maximum Temporal resolution: ≤5ms Spatial resolution: 10cm
ssNPA diagnostics	Monitoring NBI neutral particle behavior. Coverage: 2 arrays, 16 channels each,one tangential viewing NBI beam and the other back viewing Spatial resolution: ~5cm System sampling rate: 100kHz
Runaway electron diagnostic	Measure the thick-target bremsstrahlung emission caused by runaway electrons Energy：0.5 MeV - 20 MeV

	Pulse Width：5μs - 20 ms Sampling Rate：200 kHz
Gamma ray diagnostics	Measurement gamma ray spectrometry to study fast ions and runaway electrons behavior Energy：0.3 MeV-10 MeV Max Countrate：1 MHz Temporal resolution：10ms Sampling Rate：14-bit 500 MS/s
Multi-spectral Infrared Camera	Synchrotron radiation from runaway electrons Measuring wavelength: 3μm to 4.9μm. Viewing Field: 26 ° from left and right, 21.3 ° from up to down. Temporal resolution: 10ms-10us (depending on the effective pixel used, with multispectral image measurement capability).
Neutron diagnostics	Provide neutron emission rate, neutron flux and neutron energy spectrum. (1) Neutron yield measurement Range: 10^{9}-10^{12} n/s (count mode), 10^{12}-10^{15} n/s (campbelling mode) Temporal resolution: 1-10ms (2) Neutron emission profile measurement Temporal resolution: 100ms Spatial resolution: 12cm
CO2 laser collective scattering	Provide Electron-scale turbulence and relative poloidal rotation velocity in multi-region of plasma core. Measurement range: 10 cm^{-1}<k<30 cm^{-1} Sampling Frequency: 4 MHz Temporal resolution: ≥1ms Spatial resolution: ≥10cm (depended on density and magnetic topology)
Poloidal correlation reflectometry	Electron density fluctuation Space coverage: generally covering ρ= 0.3-1.1 (depends on B_t&n_e). Sampling frequency: 2 MHz Spatial resolution: ~1 cm
Doppler reflectometer (DBS)	Provide the poloidal rotation velocity and the density fluctuation. Including eight-channel Doppler reflectometer and the two-channel poloidal correlation.

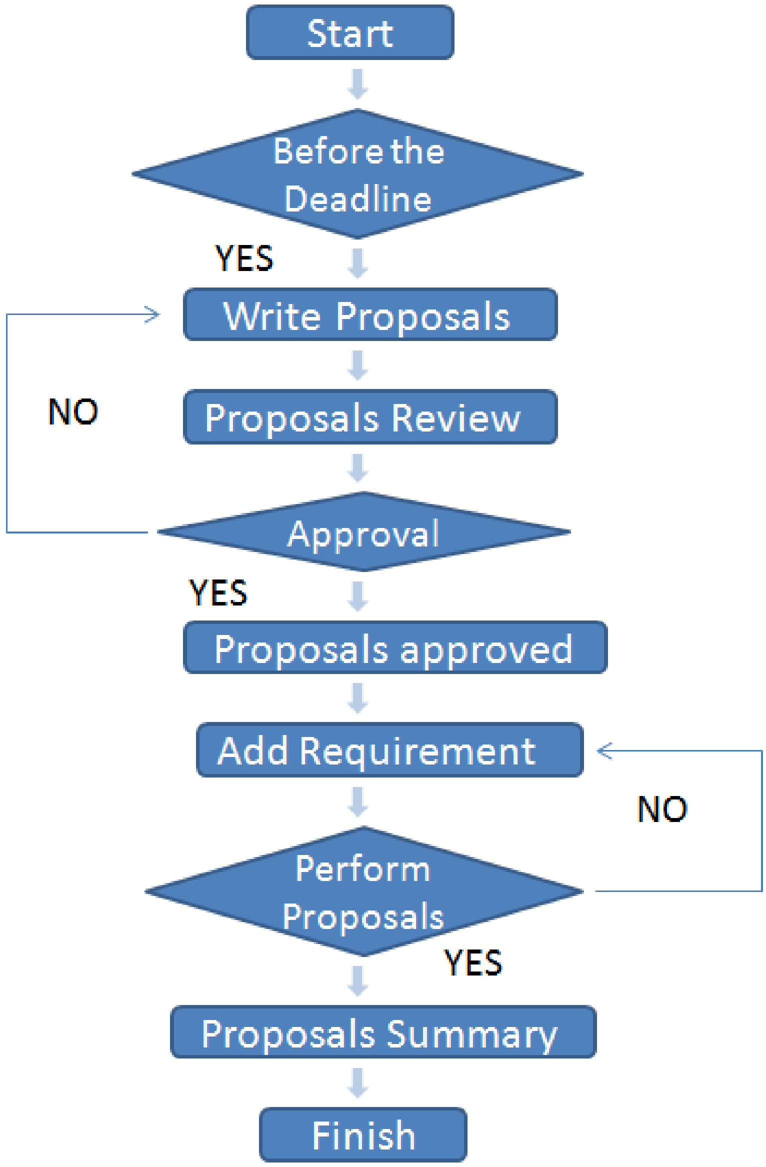
	Sampling Frequency: -5MHz-5MHz for Doppler shift 10 MHz for I/Q signals Temporal resolution: 0.1μs for I/Q signal 10ms for Doppler shift Wavenumber range: 4-20/cm Wavenumber resolution: better than 0.3
Single transmitter single receiver dual polarization density profile reflectometer system	Band range: 30-72 GHz Temporal resolution: 100ms The evolution information of boundary density distribution and plasma density zero is provided
CECE system	Provide a small range of electron temperature fluctuation. Space coverage: ρ= 0.5-0.9 Frequency coverage: 106-134 GHz
High precision heterodyne system	For precise positioning of magnetic island Frequency coverage of 120-125 GHz
384 channel electron cyclotron radiation imaging	Band range: 90-140 GHz. Number of tracks: 384 (24 * 16). Temporal resolution: 1 minute Provide two-dimensional temperature fluctuation information
96 channel microwave reflection imaging diagnositics	Band range: 75-105GHz. Number of tracks: 96 tracks (12 * 8) Temporal resolution: 1 minute Provide two-dimensional density fluctuation information
GEM diagnostic	Provide the SXR emission profile in plasma core. Photon energy range: 3keV-20keV Sampling Frequency: 100kHz Temporal resolution: 10μs
Helium beam emission spectroscopy (HeBES)	Provide electron temperature, density and electrostatic fluctuation profile in pedestal and SOL region. Te： 10 -250 eV ； ne： 2.0×10^{18} - 2.0×10^{19} m^{-3} Radial measuring range: $0.8<\rho_t<1.1$； Sampling rate: 1MHz Temporal resolution: ~0.1 s Spatial resolution: ~5 mm
Lithium beam emission spectroscopy (Li-BES)	Provide edge electron density profile and fluctuation. Spatial coverage: 1.2 < r/ a < 0.7 Spatial resolution: 0.6-2cm Beam energy: 30-50 keV Chopping frequency: 100-1000 Hz Sampling Frequency: APD 1MHz

	Density profile ~few milliseconds
Gas Puff Imaging (GPI)	Measure the 2D edge turbulence structure Objective plane: size 130×130 mm, from 2.189 m to 2.319 m in major radius direction and rom 0.2115 m to 0.3415 m in vertical direction. Temporal resolution: 500 kHz. Spatial resolution: 2 mm
Runaway electron diagnostic (Cherenkov)	For high time-resolved fast electronic direct measurement. Energy range 0.02-1 MeV Time response: 1 μ s Measure region: SOL region
Real time diagnosis and control of NTM Magnetic Island	Real time detection and location tracking of NTM / TM magnetic island provide support for active fracture control and physical research The positioning accuracy is 1 ~ 2 cm, the Temporal resolution is 10ms, and the control response is 50ms
Divertor coil system	Participate in the campaign according to the needs of physical experiment, operating with two configurations of AC and DC model, and monitoring the coil vibration, water temperature and other parameters. The maximum currnt is 28 kA for AC model and 20 kA for DC model
Neutron and γ Cumulative dose measurement	During the experiment, 40 groups of neutron gamma dosimeters in the peripheral environment (single time) and 14 groups of neutron gamma dosimeters in the experimental site (quarterly) were used to monitor the total radiation dose in each area
Remnant γ Radioactive and surface pollution survey	Detection device host, experimental hall and surrounding environment γ Radioactivity, α/β Surface dose rate
Neutron activation analysis	Analyze and detect the radionuclides produced by the operation of the main machine of the device
Radiation protection	Experimental research on radiation shielding materials and biological effects of fusion radiation, personal dose monitoring of professional personnel (45 persons per quarter, including device maintenance personnel), physical examination and internal training

Low energy neutral particle analyzer (LENPA)	Provide the energy spectrum of neutrals in the range of 20 to 3000 eV near the mid-plane Energy range: 20~3000 eV Sampling Frequency: ~1 GHz Temporal resolution: 104 μs.
Quartz crystal microbalance (QMB)	Monitoring the erosion and deposition of first wall samples in real time and obtaining the average erosion/deposition rate of first wall material during one discharge Mass range: 0-18 mg/cm^2; Sampling Frequency: 4 Hz; Time resolution: 0.1 s; Measurement accuracy: ±2ppm; Mass resoluton:1 ng/cm^2
Magnetics diagnostics	Rogowski Coil and FOCS are used to measure plasma current. Frequency response is 20KHz, error<1%. Pickup coils and flux loops are used to measure poloidal magnetic field and flux, and the signals are send to PCS for boundary reconstruction. Frequency response is 20KHz, error<1%. Diamagnetic loops are used to measure plasma energy and BETAP. Frequency response is 20KHz, error<10%. Flux loops can be used to measure loop voltage, error<10%. Mirnov coils and saddle coils are used to detect MHD and plasma disruption. Frequency response is 100KHz. Mirnov coils (High frequency response) are used to measure MHD for high frequency. Frequency response is 500KHz. Rogowski coils are used to measure HALO current when plasma disruption.

4 Proposals management

EAST users should submit proposals through the experimental proposal management system: http://east.ipp.ac.cn/. The selection and management process is as follows:



Proposals selection and management process

（1）Users should submit the proposals before deadline.

（2）EAST Physics Groups will firstly review and select the proposals, giving the numbers of proposals and experimental sessions needed for each Group.

（3）Division of EAST Physics and Experimental Operations will finally review all the proposals from each group, make final decisions for campaign schedules/sessions.

（4）One who submits the proposal (Proposer) should organize internal discussions and presents executable experimental plan for the proposal.

（5）Session leader will organize the experiment for the Proposers during each session.

（6）If a proposal is executed, Coordinators of EAST Physics Groups will confirm the proposals execution in the proposal system. Proposers will receive Emails by the system to the, to fill in the Proposal Summary and Satisfaction Questionnaire.

（7）Publications related to the proposal should be uploaded in the system.

5 Experimental data access

EAST Data information system provides the following functions including network communication, data storage, data service, integrated display and user management to meet the requirements of EAST continuous operation. The main specifications are listed below:

Core network bandwidth: 40Gbps, access bandwidth: 10Gbps;

Total storage capacity: 3000TB, max data access bandwidth: 10GBytes/s;

The data access services are listed below：

- Gate Cluster: user remote login;
- CS Cluster: experiment data calculation;
- WebScope: experiment data display;
- Eastviewer: EAST equilibrium data display (RTEFIT, PEFIT, off-line EFIT);
- EASTprofiles：plasma profile data display;
- LogBook: experiment log system;
- EngData: engineering data access;
- EASTVOD: camera and video data access.