KSTAR Diagnostics Data User Guide

14 Aug 2025

Before read this guide…

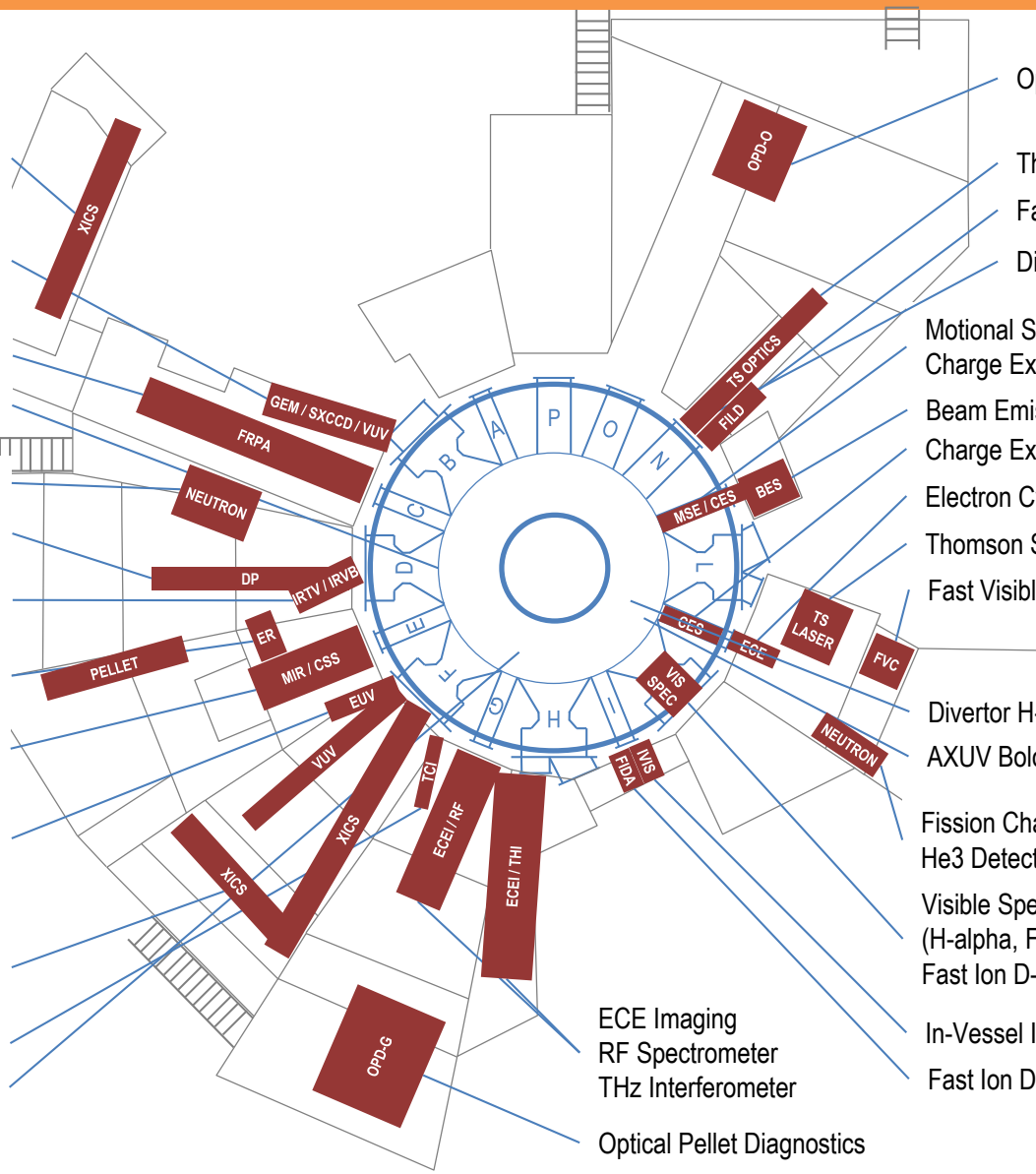
- Diagnostics data uploaded on KSTAR MDS+ should be used for the preliminary analysis only. Some of data are automatically uploaded by data acquisition systems without final confirmation from person in charge.

- Please consult to the contact person in this guide for the detail information on the diagnostics and for the in-depth analysis.

- Before a publication using KSTAR experimental results, all data included on the publication MUST be confirmed by person in charge.

Contents

KSTAR Diagnostics



X ray Imaging Crystal Spectroscopy (Radial)

GEM X ray pinhole camera
Soft X ray CCD camera
Vacuum UV Telescope

Fast Reciprocating Probe Array

Edge Probe Array

Scintillation Neutron Detector

Deposition Probe

Tangential IR TV
IR Video Bolometer

Edge Reflectometer

Microwave Imaging Reflectometer
Collective Scattering System

Extreme UV Spectroscopy
Vacuum UV Spectroscopy

X ray Imaging Crystal Spectroscopy (Tangential)

Two Color Interferometer

Dispersion Interferometer

Optical Pellet Diagnostics

Thomson Scattering Optics

Fast Ion Loss Detector

Divertor IR TV

Motional Stark Effect Diagnostics
Charge Exchange Spectroscopy (Toroidal)

Beam Emission Spectroscopy
Charge Exchange Spectroscopy (Poloidal)

Electron Cyclotron Emission Radiometer

Thomson Scattering Laser

Fast Visible Camera

Divertor H-alpha

AXUV Bolometer

Fission Chamber
He3 Detector

Visible Spectrometry
(H-alpha, Filterscope, Bremsstrahlung Array)
Fast Ion D-Alpha

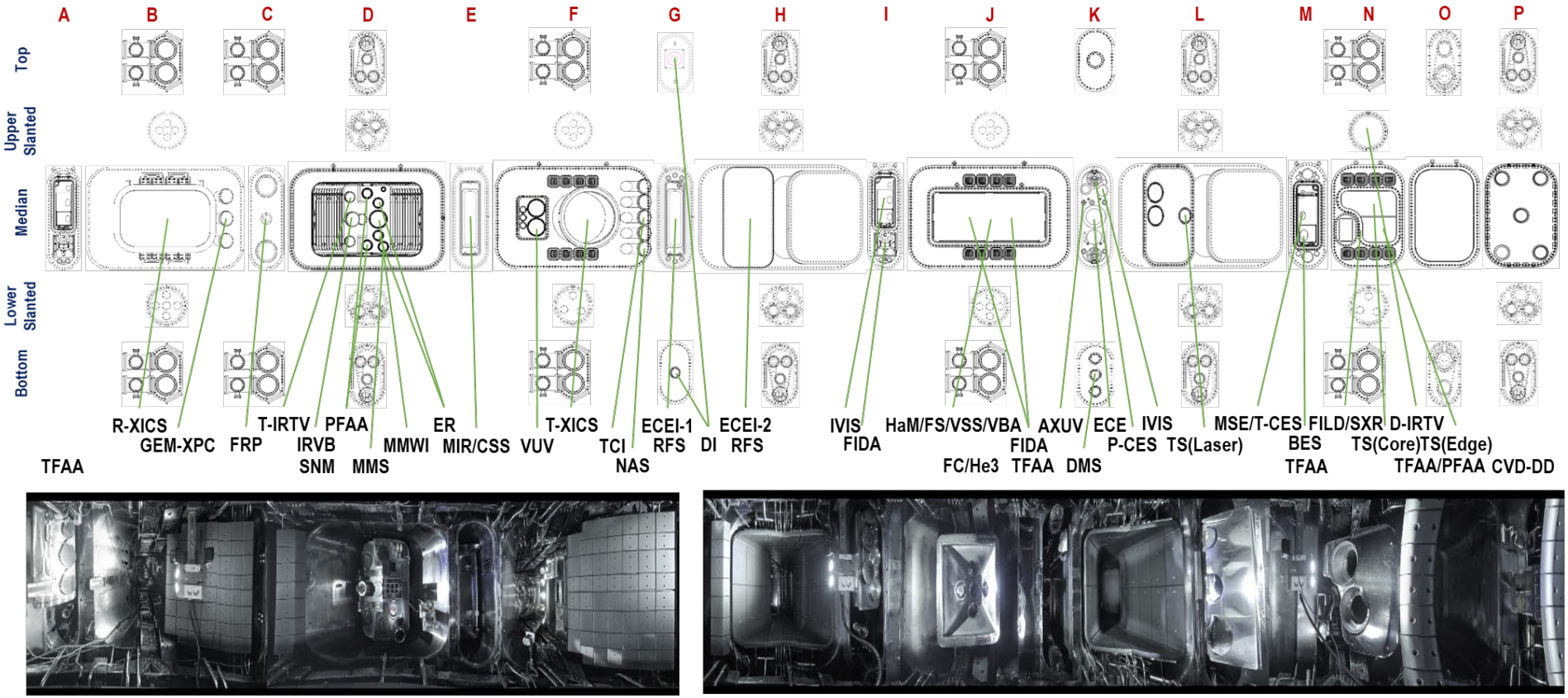
In-Vessel Inspection System

Fast Ion D-Alpha

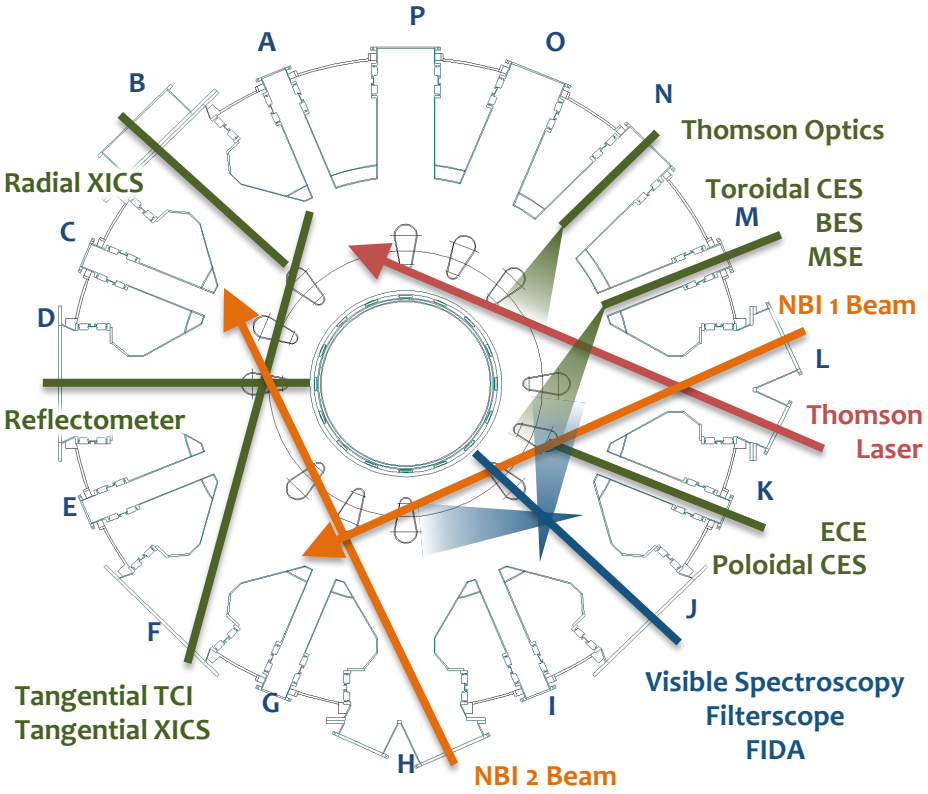
ECE Imaging
RF Spectrometer
THz Interferometer

Optical Pellet Diagnostics

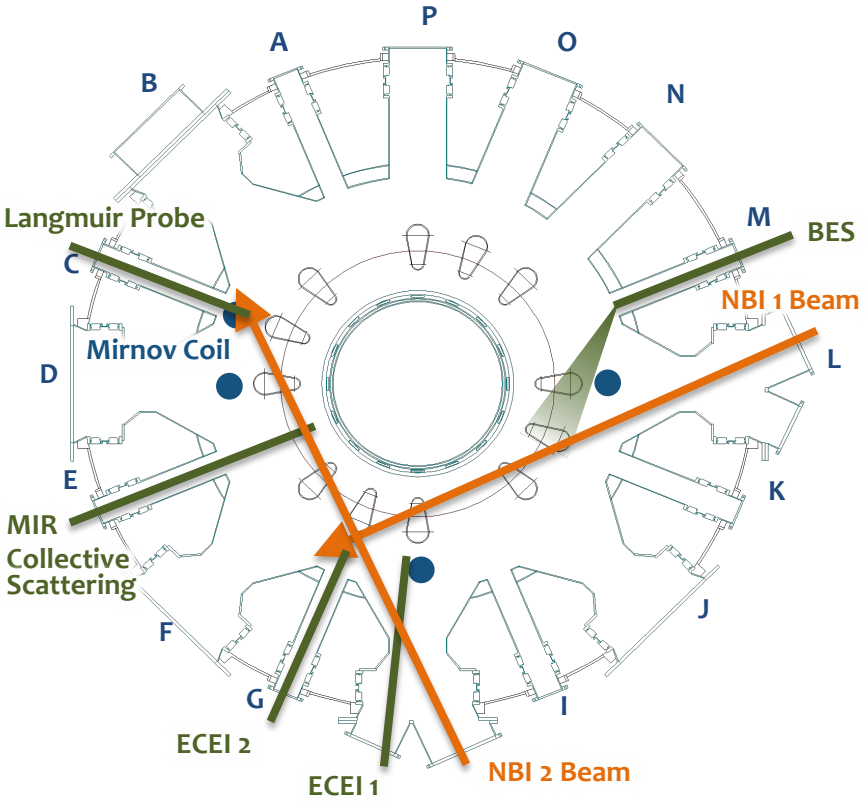
Diagnostics Port Allocation



Diagnostics Layouts : Toroidal

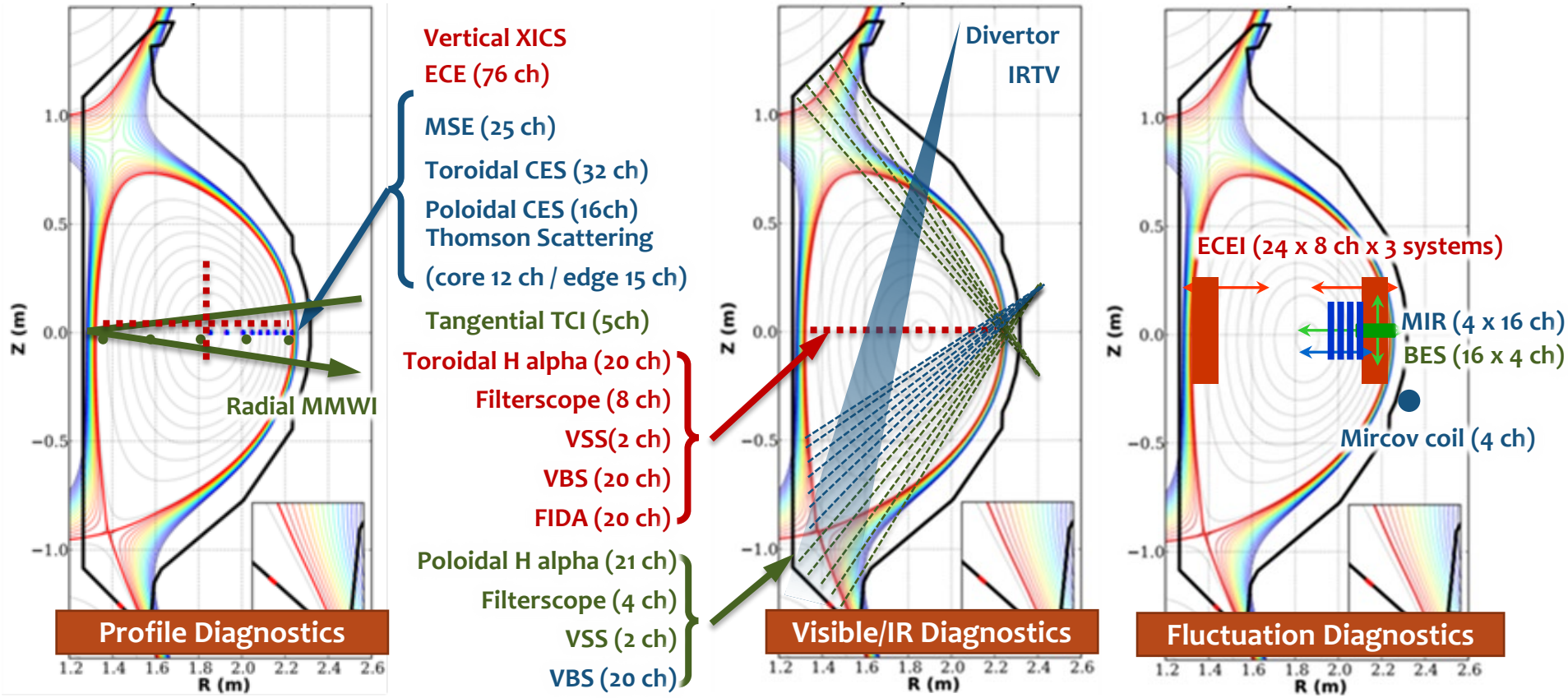


Profile Diagnostics



Fluctuation Diagnostics

Diagnostics Layouts : Poloidal

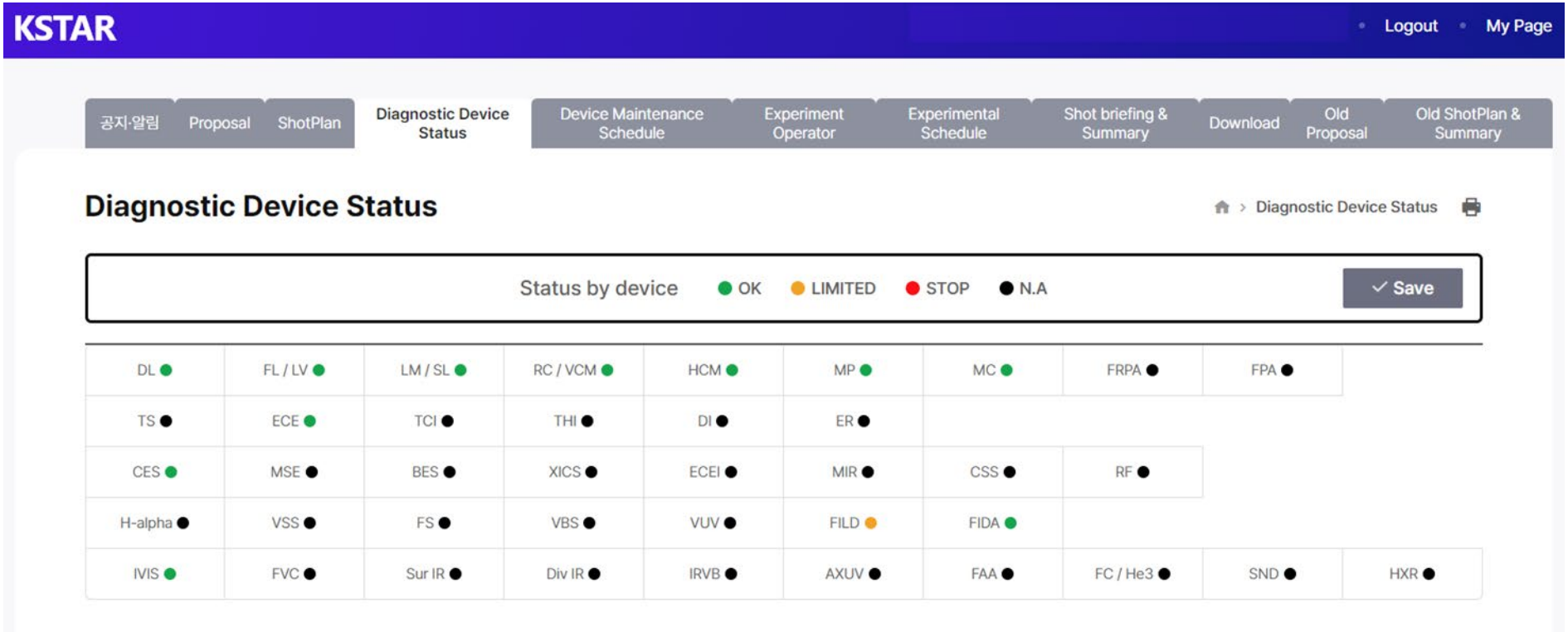


Diagnostics Device Status WebPage

- Daily Status of KSTAR Diagnostics can be checked on the following KSTAR website.

  https://kstar.kfe.re.kr/diagnostics?mid=a12000000000

  * sign up required. contact H.M. Wi (hanmin@kfe.re.kr)

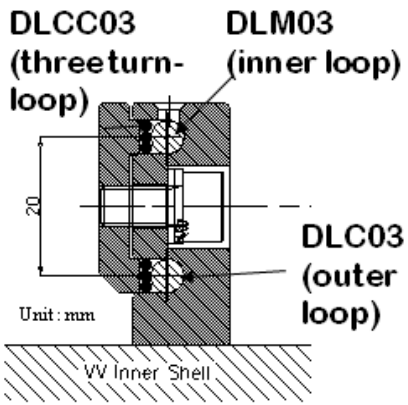


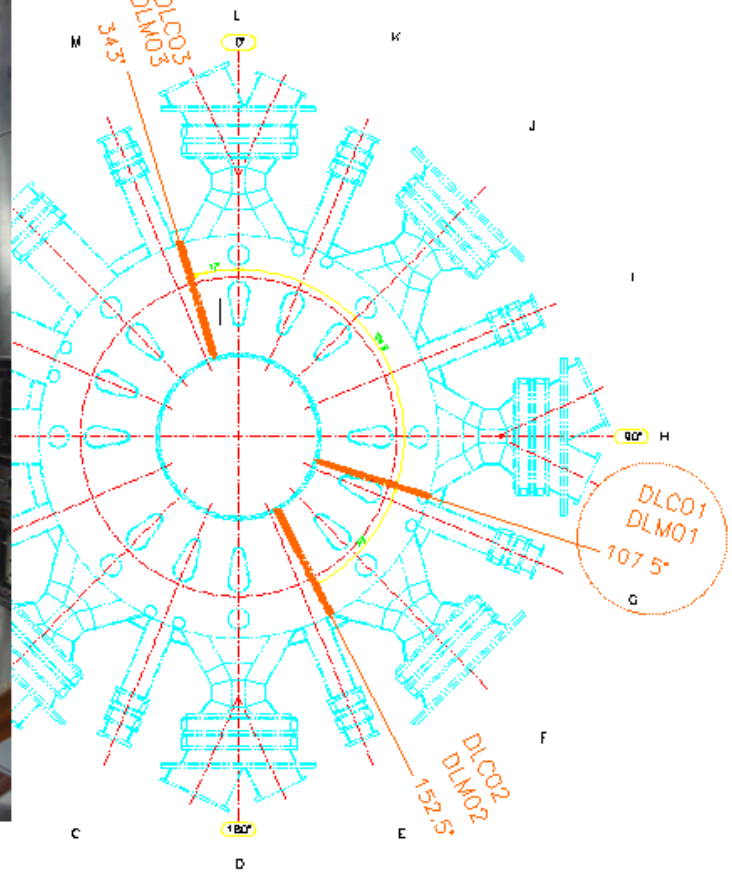
Magnetic Diagnostics - DL

Full Name	Diamagnetic Loop
Contact	J. G. Bak (jgbak@kfe.re.kr) , H. S. Kim (kimhs@kfe.re.kr)
Measuring properties	diamagnetic flux (Φ_d), poloidal beta (β_p), stored energy (W_{tot})
Port assignment	loop (E, G, M), feedthrough (B, F, J, N)
Channel information	3 loops
Time resolution	20 kHz
Spatial Resolution	-
Availability	routinely available

Magnetic Diagnostics - DL

Channels Layout





Magnetic Diagnostics - DL

Name	Sampling	Unit	Description
\DLM01,\DLM02,\DLM03	20 kHz	V	raw data
\DLC01,\DLCC02,\DLCC03	20 kHz	V	raw data
\DMF_DLM03	20 kHz	Wb	diamagnetic flux
\BETAP_DLM03	20 kHz		poloidal beta
\WTOT_DLM03	20 kHz	kJ	stored energy
\BETAP_kappa			poloidal beta via RTEFIT
\WTOT_kappa			stored energy via RTEFIT

Notes

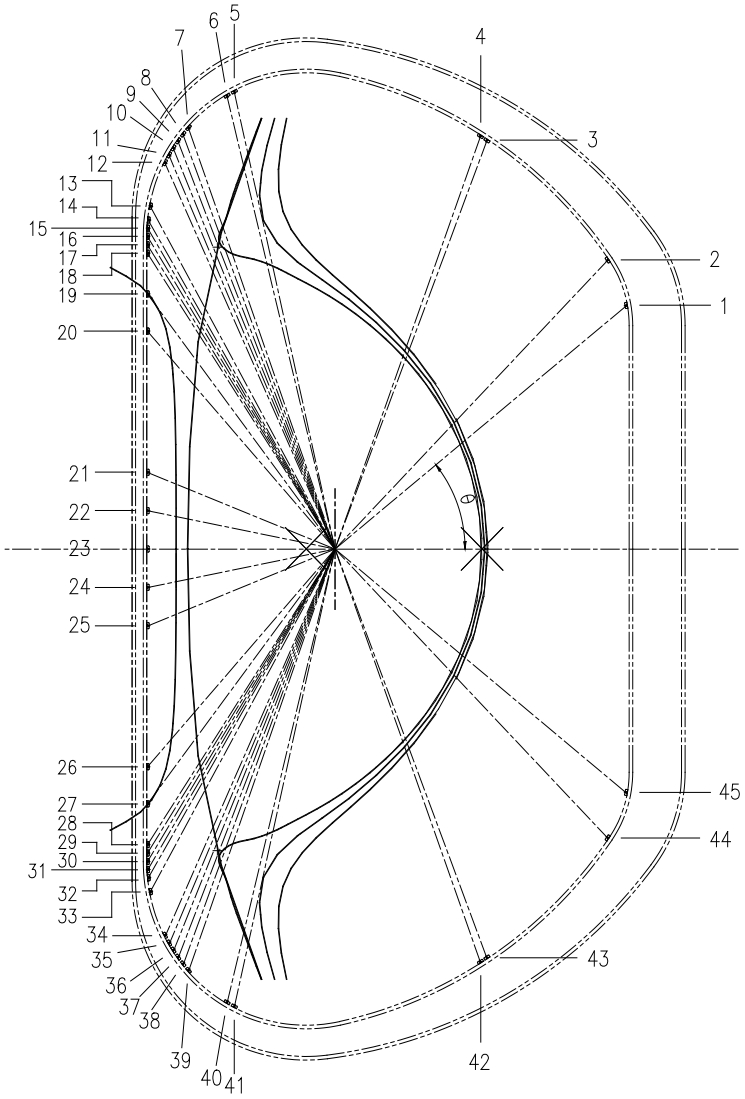
- \BETAP_kappa and \WTOT_kappa are evaluated by using both DL measurements and kappa from the EFITRT1 code.

Magnetic Diagnostics – FL / LV

Full Name	Flux loop / Loop voltage
Contact	J. G. Bak (jgbak@kfe.re.kr) , H. S. Kim (kimhs@kfe.re.kr)
Measuring properties	poloidal flux (Φ_{pol}), loop voltage (V_l)
Port assignment	feedthrough (B, F, J, N)
Channel information	45 loops
Time resolution	20 kHz
Spatial Resolution	-
Availability	routinely available

Magnetic Diagnostics - FL / LV

Channels Layout



Magnetic Diagnostics - FL / LV

Name	Sampling	Unit	Description
\FL01 … \FL45	20 kHz	Wb	poloidal flux
\LV01, \LV12, \LV23, \LV34, \LV45	20 kHz	V	loop voltage

Notes

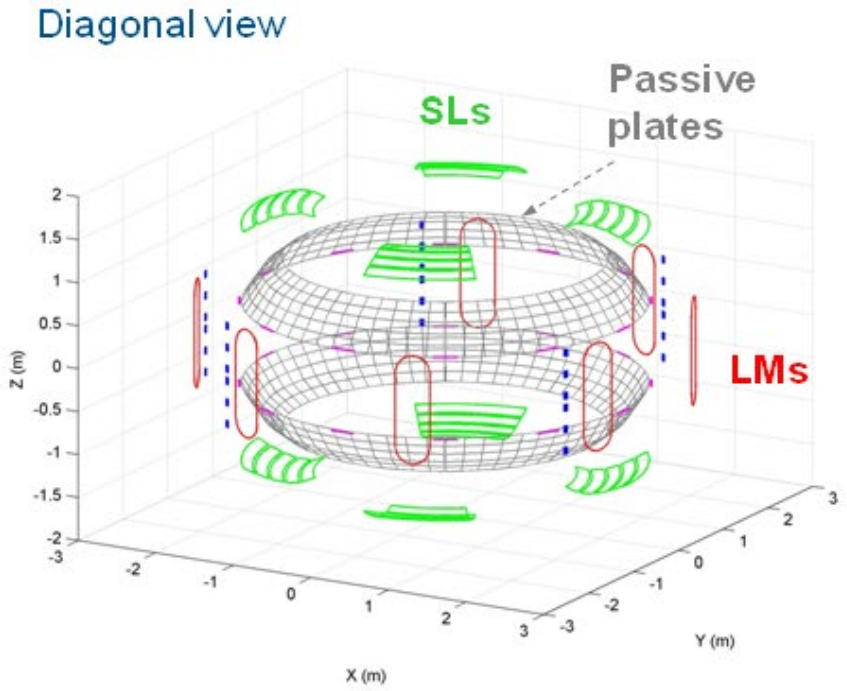
•

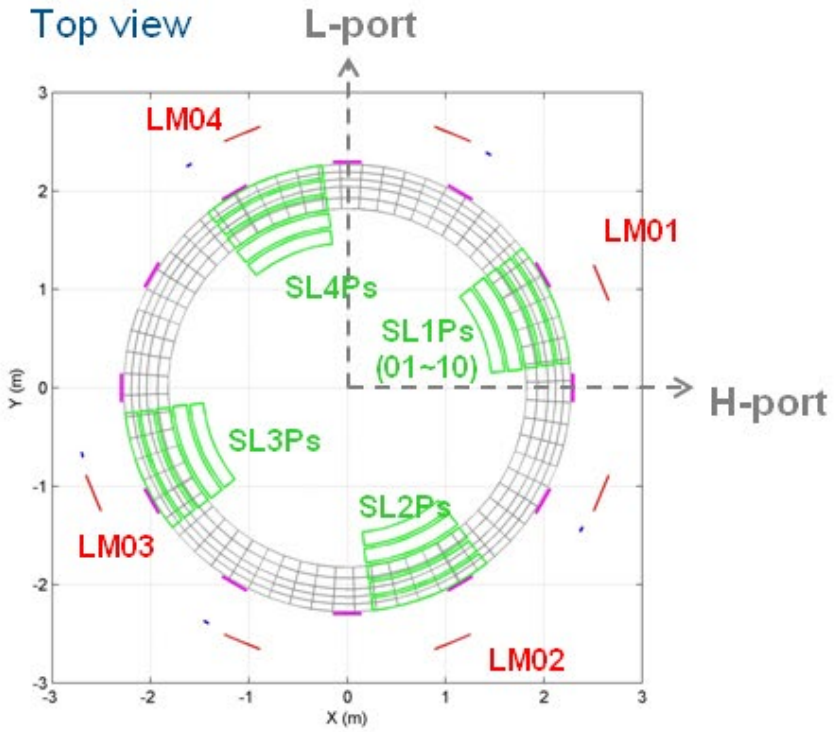
Magnetic Diagnostics – LM / SL

Full Name	Locked Mode coils / Saddle loop
Contact	J. G. Bak (jgbak@kfe.re.kr) , H. S. Kim (kimhs@kfe.re.kr)
Measuring properties	LM : local radial magnetic field (Φ_r) SL : local vertical magnetic field (Φ_v)
Port assignment	feedthrough (B, F, J, N)
Channel information	LM : 4 coils SL : 40 loops
Time resolution	20 kHz
Spatial Resolution	-
Availability	routinely available

Magnetic Diagnostics - LM / SL

Channels Layout





Magnetic Diagnostics - LM / SL

MDS+ Node Information

Name	Sampling	Unit	Description
\LM01 … \LM04	20 kHz	Wb	Local radial magnetic flux at midplane.
\SL1P01 … \SL1P10	20 kHz	Wb	Local vertical magnetic flux at the toroidal angle of 67.5 Degs.
\SL2P01 … \SL2P10	20 kHz	Wb	Local vertical magnetic flux at the toroidal angle of 157.5 Degs.
\SL3P01 … \SL3P10	20 kHz	Wb	Local vertical magnetic flux at the toroidal angle of 247.5 Degs.
\SL4P01 … \SL4P10	20 kHz	Wb	Local vertical magnetic flux at the toroidal angle of 337.5 Degs.

Notes

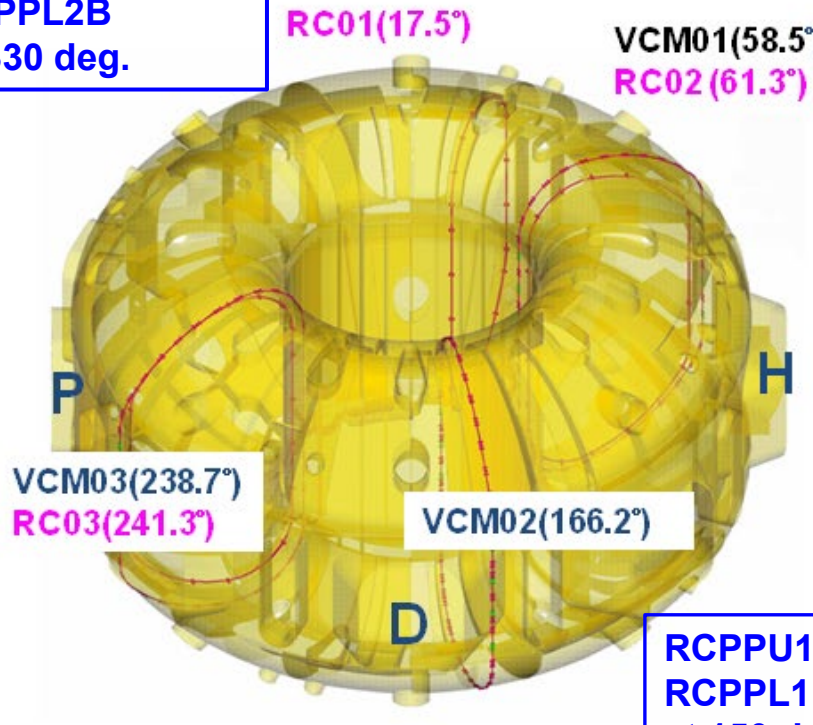
- Local radial magnetic field can be obtained as Br = □ r / ALM where ALM is effective area of LM (ALM= 0.4603 m2).

Magnetic Diagnostics – RC / VCM

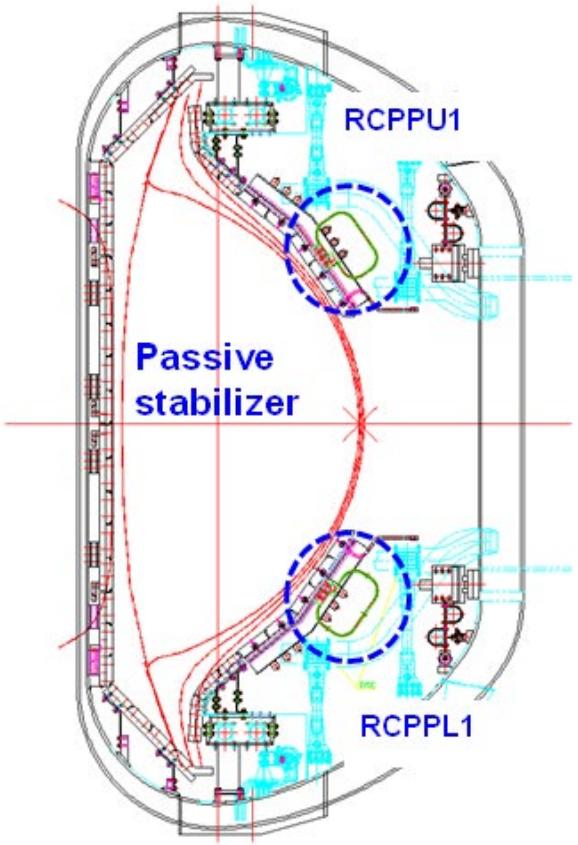
Full Name	Rogowski Coil, Vessel Current Monitor
Contact	J. G. Bak (jgbak@kfe.re.kr) , H. S. Kim (kimhs@kfe.re.kr)
Measuring properties	RC : plasma current (I_p), eddy current at passive stabilizer (I_{eddy}) VCM : total current (I_{tot})
Port assignment	feedthrough (B, F, J, N, Cb)
Channel information	RC : 3 coils, VCM : 3 loops
Time resolution	20 kHz
Spatial Resolution	-
Availability	routinely available

Magnetic Diagnostics - RC / VCM

RCPPU2(2B) &
RCPPL2B
at 330 deg.



RCPPU1 &
RCPPL1
at 150 deg.



Poloidal cross-section at the
location of the E-port

Magnetic Diagnostics - RC / VCM

Name	Sampling	Unit	Description
\RC03	20 kHz	A	Plasma current
\VCM03	20 kHz	A	Total toroidal current
\RCPPU1, \RCPPU2:FOO, \RCPPU2B:FOO	20 kHz	A	Toroidal eddy current at backplate for upper passive stabilizer
\RCPPL1, \RCPPL2B:FOO	20 kHz	A	Toroidal eddy current at backplate for lower passive stabilizer
\RC02,\RC01	20kHz	A	Plasma current
\VCM02, \VCM01	20kHz	A	Total toroidal current

Notes

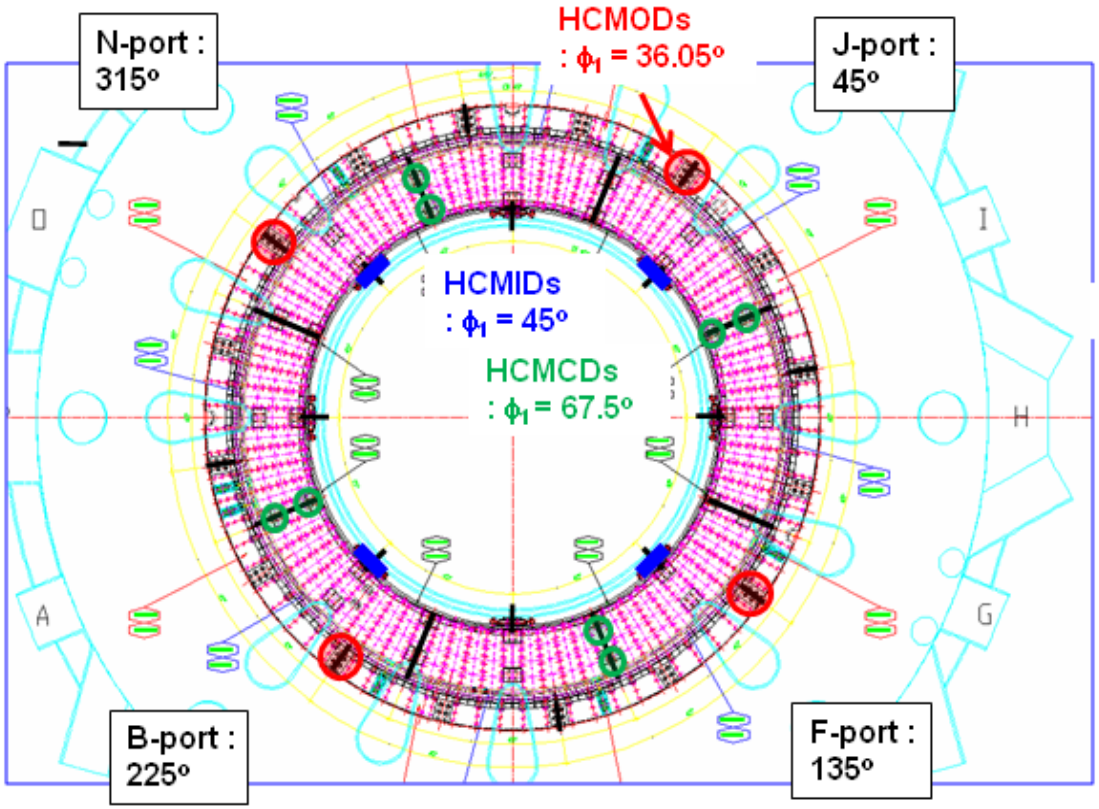
- \VCM03 means total current, plasma current plus current induced at vacuum vessel during a plasma discharge. The vessel current Iv can be obtained as Iv = Itot - Ip
- Three RCs and VCMs were installed at different toroidal locations (see figure). Now All of RC and VCM can provide data at the MDSplus. \RCPPU2,\RCPPU2B,\RCPPL2B are available as raw data

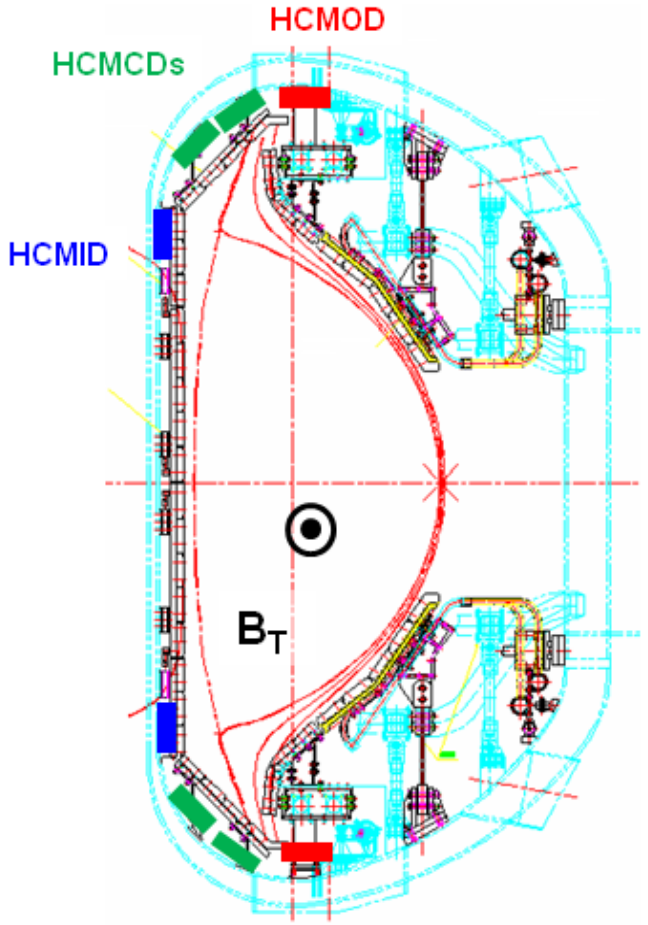
Magnetic Diagnostics – HCM

Full Name	Halo current monitor
Contact	J. G. Bak (jgbak@kfe.re.kr) , H. S. Kim (kimhs@kfe.re.kr)
Measuring properties	halo current (I_h)
Port assignment	feedthrough (B, F, J, N)
Channel information	48 coils
Time resolution	20 kHz
Spatial Resolution	-
Availability	routinely available

Magnetic Diagnostics - HCM

Channels Layout





Magnetic Diagnostics - HCM

MDS+ Node Information

Name	Sampling	Unit	Description
\HCMIL01 ~ \HCMIL08 (UPPER) \HCMIL09 ~ \HCMIL16 (LOWER)	20 kHz	A	Halo currents through the supporting structures of back-plates for inboard limiters
\HCMID01 ~ \HCMID04 (UPPER) \HCMID05 ~ \HCMID08 (LOWER)	20 kHz	A	Halo currents through the supporting structures of back-plates for inboard divertors
\HCMCD01 ~ \HCMCD08 (UPPER) \HCMCD09 ~ \HCMCD16 (LOWER)	20 kHz	A	Halo currents through the supporting structures of back-plates for central divertors
\HCMOD01 ~ \HCMOD04 (UPPER) \HCMOD05 ~ \HCMOD08 (LOWER)	20 kHz	A	Halo currents through the supporting structures of back-plates for outboard divertors

Notes

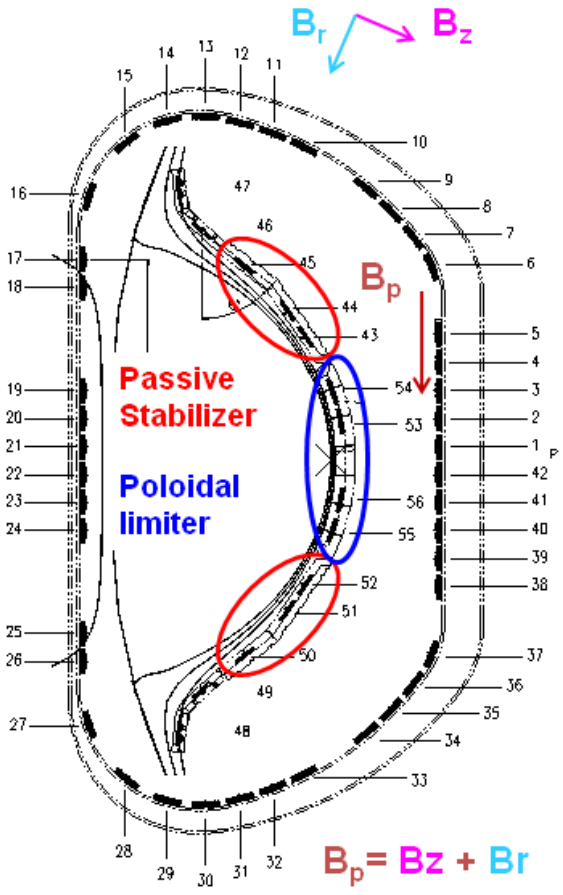
- Please an e-mail to the contact person if you want to see the HCM data.

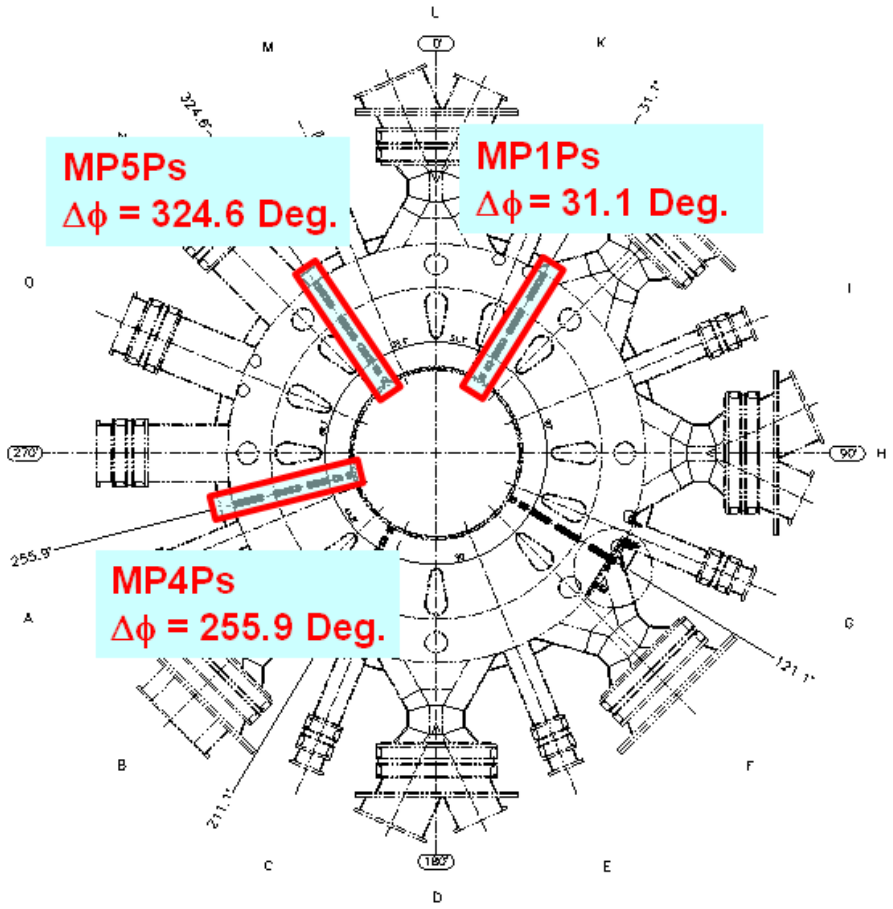
Magnetic Diagnostics – MP

Full Name	Magnetic field probe
Contact	J. G. Bak (jgbak@kfe.re.kr) , H. S. Kim (kimhs@kfe.re.kr)
Measuring properties	tangential and normal components of local poloidal field (B_z, B_r)
Port assignment	feedthrough (B, F, J, N)
Channel information	3 arrays
Time resolution	20 kHz
Spatial Resolution	-
Availability	routinely available

Magnetic Diagnostics - MP

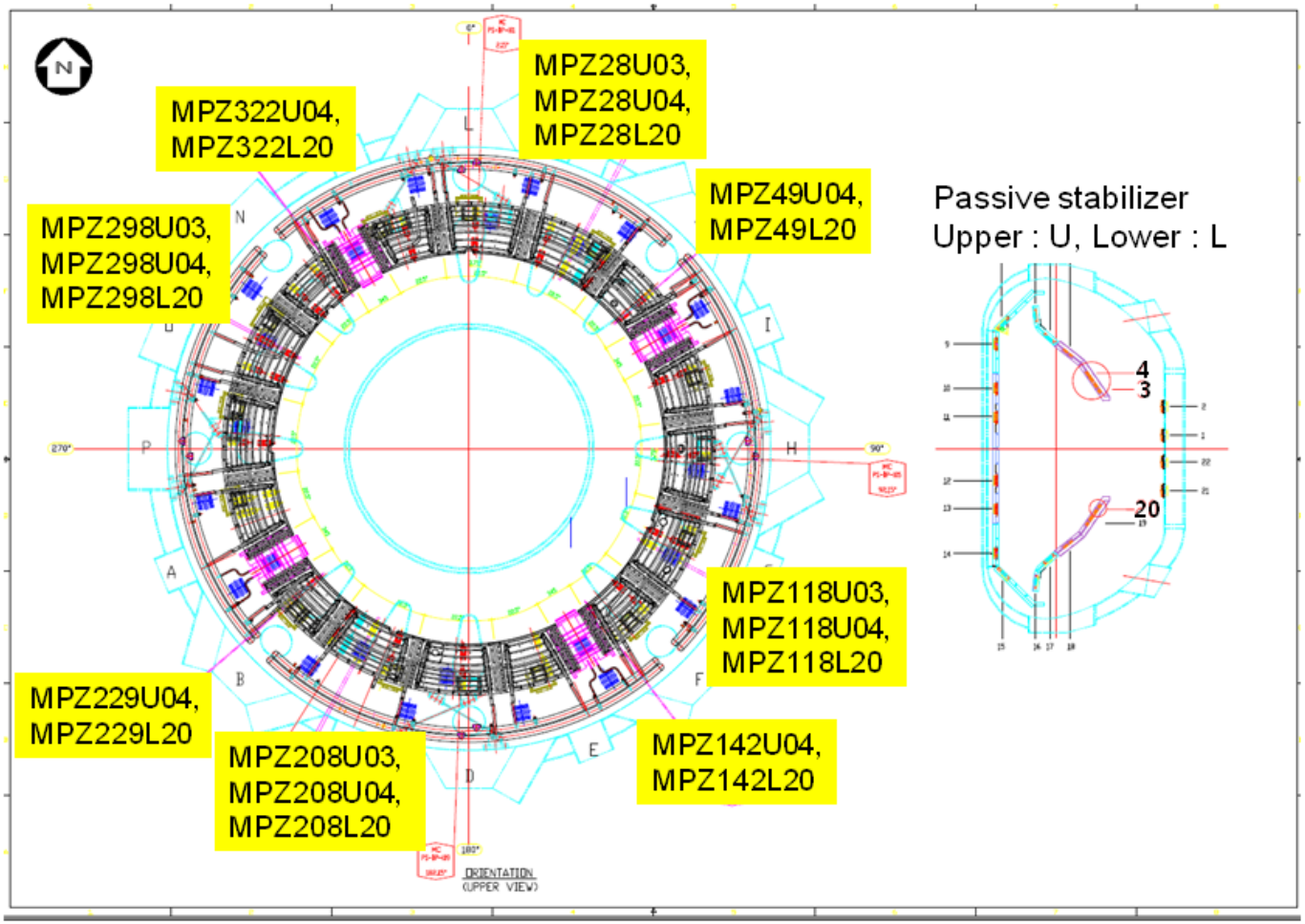
Channels Layout





Magnetic Diagnostics - MP

Channels Layout



Magnetic Diagnostics - MP

Name	Sampling	Unit	Description
\MP4P01Z … \MP4P42Z	20 kHz	T	Tangential component of local poloidal field at the toroidal angle of 255.9 deg. The MPs were mounted at the wall of vacuum vessel
\MP4P01R … \MP4P42R	20 kHz	T	Normal component of local poloidal field at the toroidal angle of 255.9 deg. The MPs were mounted at the wall of vacuum vessel
\PLMP01Z … \PLMP04Z	20 kHz	T	Tangential component of local poloidal field at the toroidal angle of 324 deg. The MPs were mounted at the poloidal limiter
\MP4P43Z … \MP4P45Z \MP4P50Z … \MP4P52Z	20 kHz	T	Tangential component of local poloidal field at the toroidal angle of 255.9 deg. The MPs were mounted at the passive stabilizer.
\MP1P01Z … \MP1P42Z	20 kHz	T	Tangential component of local poloidal field at the toroidal angle of 31.1 deg. The MPs were mounted at the wall of vacuum vessel
\MP1P01R … \MP1P42R	20 kHz	T	Normal component of local poloidal field at the toroidal angle of 31.1 deg. The MPs were mounted at the wall of vacuum vessel

Magnetic Diagnostics - MP

MDS+ Node Information

Name	Sampling	Unit	Description
\MPZ028U03 \MPZ028U04 \MPZ028L20	20 kHz	T	at the toroidal angle of 28 deg. (passive stabilizer)
\MPZ049U04 \MPZ049L20	20 kHz	T	at the toroidal angle of 49 deg.
\MPZ118U03 \MPZ118U04 \MPZ118L20	20 kHz	T	at the toroidal angle of 118 deg. (passive stabilizer)
\MPZ142U04 \MPZ142L20	20 kHz	T	at the toroidal angle of 142 deg. (passive stabilizer)
\MPZ208U03 \MPZ208U04 \MPZ208L20	20 kHz	T	at the toroidal angle of 208 deg. (passive stabilizer)

Magnetic Diagnostics - MP

Name	Sampling	Unit	Description
\MPZ229U04 \MPZ229L20	20 kHz	T	at the toroidal angle of 229 deg. (passive stabilizer)
\MPZ298U03 \MPZ298U04 \MPZ298L20	20 kHz	T	at the toroidal angle of 298 deg. (passive stabilizer)
\MPZ322U04 \MPZ322L20	20 kHz	T	at the toroidal angle of 322 deg. (passive stabilizer)

Notes

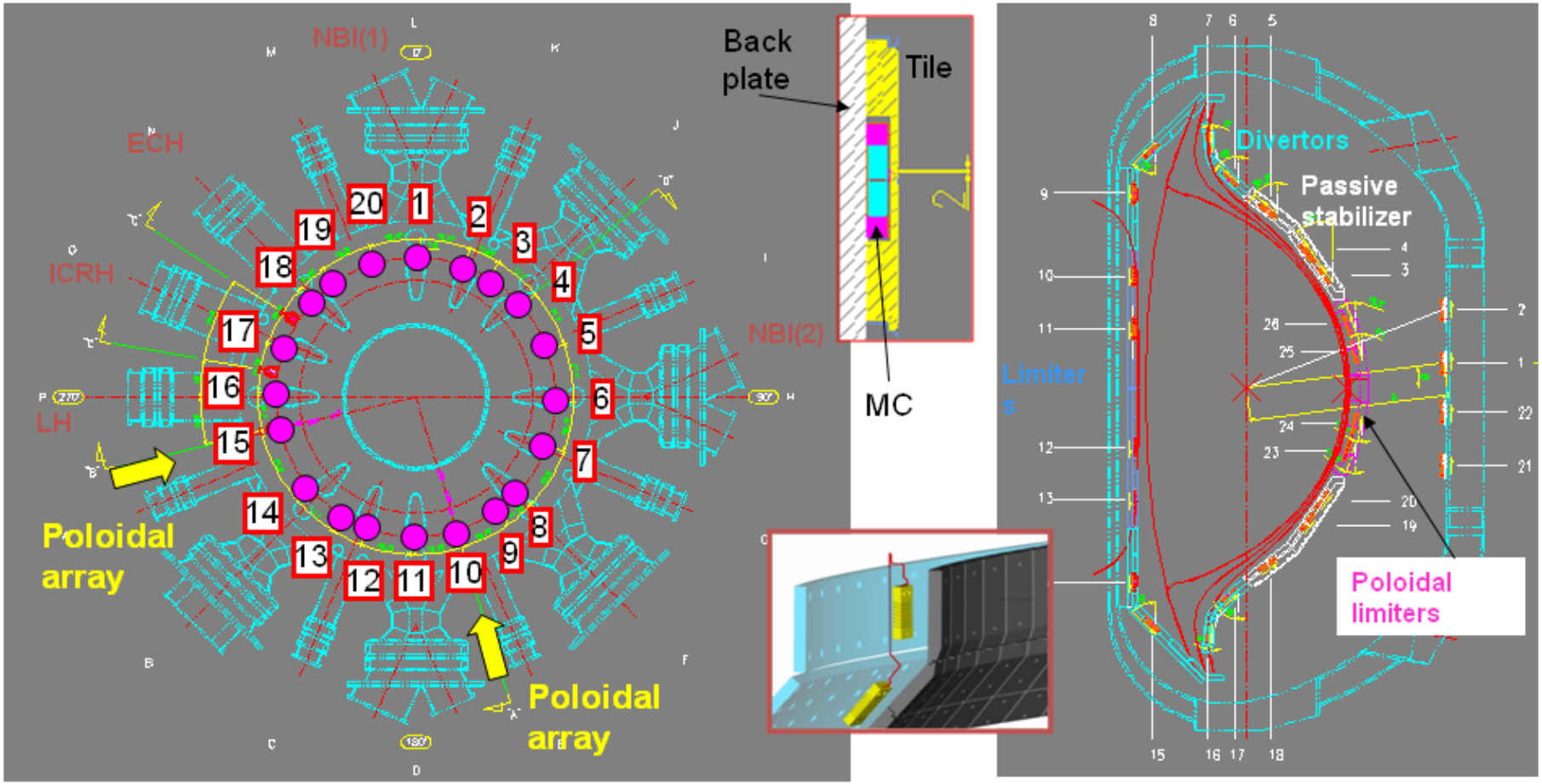
- Several data from \MP5P01Z to \MP5P42Z provide integrated tangential components of local poloidal fields at the toroidal angle of 324.6 Degs.
- Several data from \MP5P06R to \MP5P16R and from \MP5P27R to \MP5P37R provide integrated normal components of local poloidal fields at the toroidal angle of 324.6 Degs.

Magnetic Diagnostics – MC

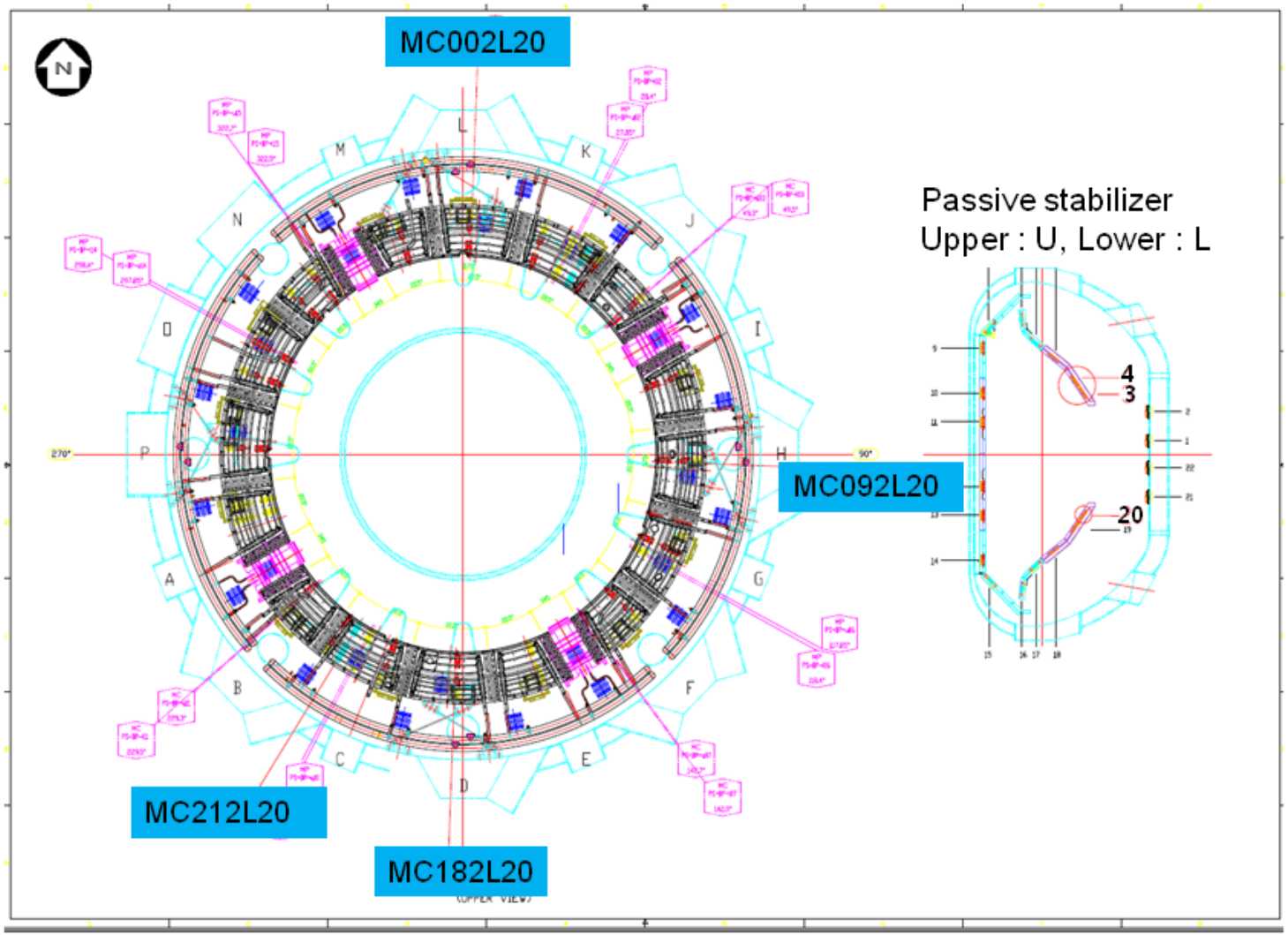
Full Name	Mirnov Coil
Contact	J. G. Bak (jgbak@kfe.re.kr) , H. S. Kim (kimhs@kfe.re.kr)
Measuring properties	time derivative of tangential component of poloidal magnetic field, magnetic fluctuation (dB_z/dt)
Port assignment	feedthrough (B, F, J, N)
Channel information	toroidal array (20 ch), poloidal array (22 ch)
Time resolution	2MHz (default)
Spatial Resolution	-
Availability	routinely available

Magnetic Diagnostics - MC

Channels Layout



Magnetic Diagnostics - MC



Magnetic Diagnostics - MC

MDS+ Node Information

Name	Sampling	Unit	Description
\MC1T02 ~ \MC1T08 \MC1T10 ~ \MC1T16 \MC1T19	2 MHz (default)	T/s	Magnetic fluctuation (time derivative of tangential component of poloidal magnetic field) for evaluation of toroidal mode number of the MHD (toroidal array)
\MC1P01 ~ \MC1P06 \MC1P08, \MC1P10~\MC1P13, \MC1P15 ~ \MC1P17, MC1P20~\MC1P22	2 MHz (default)	T/s	Magnetic fluctuation for evaluation of poloidal mode number of the MHD (poloidal array)
\MC2P10, \MC2P11	2 MHz (default)	T/s	Magnetic fluctuation for evaluation of poloidal mode number of the MHD
\PCMCTL01 \PCMCTL02 \PCMCTL05 \PCMCTL09	100 kHz	T/s	Magnetic fluctuation for NTM control (toroidal angle : 2, 92,182,212 degs)

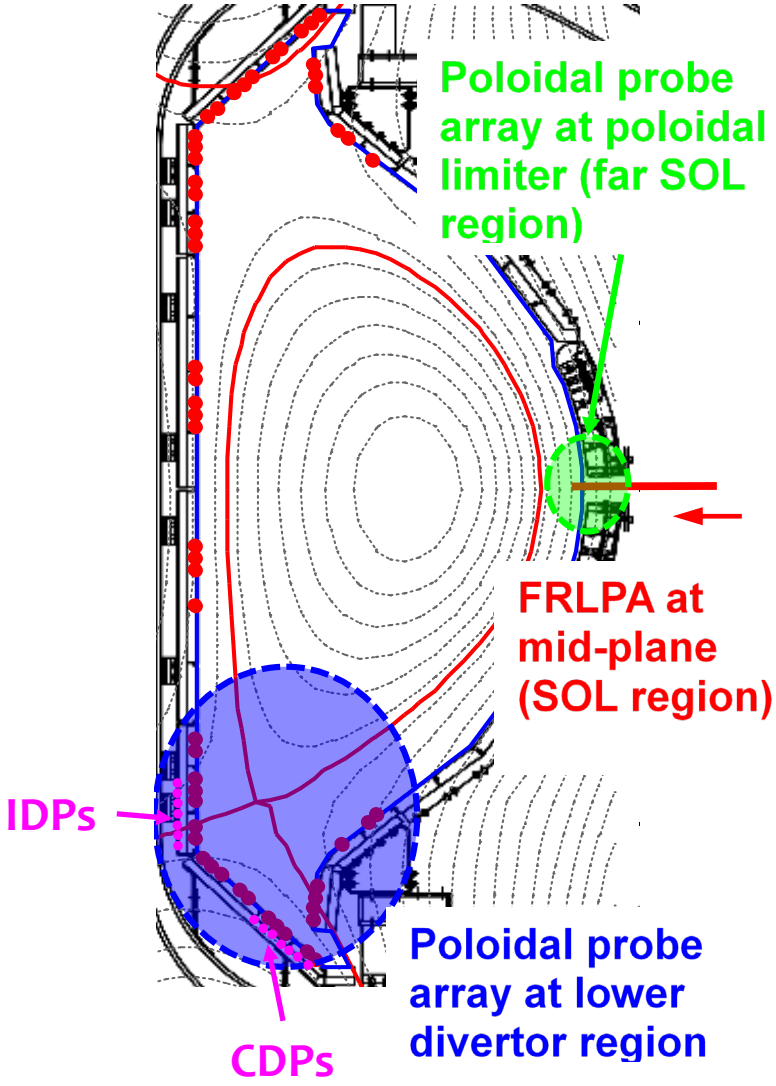
Notes

- In order to get "\MC1T10", please use " \MC1P03"
- Signal whose polarity should be corrected by just multiplying "-1"
  : MC1T12~16,19 (toroidal array), MC1P01~04,06,10,11,15,17, MC2P11 (poloidal array)

Electric Probe Diagnostics - FRPA / ELPA

Full Name	Fast reciprocating Langmuir Probe Assembly Edge Langmuir Probe Array Inner Divertor Probe / Central Divertor Probe
Contact	J. G. Bak (jgbak@kfe.re.kr), H. S. Kim (kimhs@kfe.re.kr), S. H. Son (ssho609@kfe.re.kr)
Measuring properties	FRPA : ion saturation current (I_{is}), plasma & floating potential (V_p, V_f) at SOL ELPA : ion saturation current (I_{is}) at divertor region IDP/ CDP : ion saturation current (I_{is}) at divertor region
Port assignment	C (FRPA / ELPA), N (IDP / CDP)
Channel information	FRPA : 5 ch ELPA : 57 ch, IDP : 13 ch, CDP : 13 ch
Time resolution	100 kHz (default), 1 MHz (maximum on request)
Spatial Resolution	-
Availability	on request

Electric Probe Diagnostics - FRPA / ELPA



Note :

- Only EP40- Ep63 (in the lower divertor region at the Bay C) are available
- In addition, IDP01- IDP13, and CDP01-CDP13 are available in the lower divertor region at the Bay N.
- FRPA data for only certain shots before the campaign of 2019 are available.
- ELPA data (EP#s, IDP#s, CDP#s) before the campaign of 2023 are provided.
- Please ask the contact person for further information of the FRPA and ELPA data

Electric Probe Diagnostics - FRPA / ELPA

MDS+ Node Information

Name	Sampling	Unit	Description
\FRPA01:FOO : \FRPA05:FOO	100 kHz	V	Raw data of ion saturation currents, floating and plasma potentials in the scrape-off-layer(SOL) region
\EP07:FOO : \EP63:FOO	100 kHz	V	Raw data of ion saturation currents at the divertor region
\IDP01:FOO : \IDP13:FOO \CDP01:FOO : \CDP13:FOO	100KHz	V	Raw data of ion saturation currents at the in and out divertor target region (N port) Distance between probe tips (in poloidal direction): 3 cm

Notes

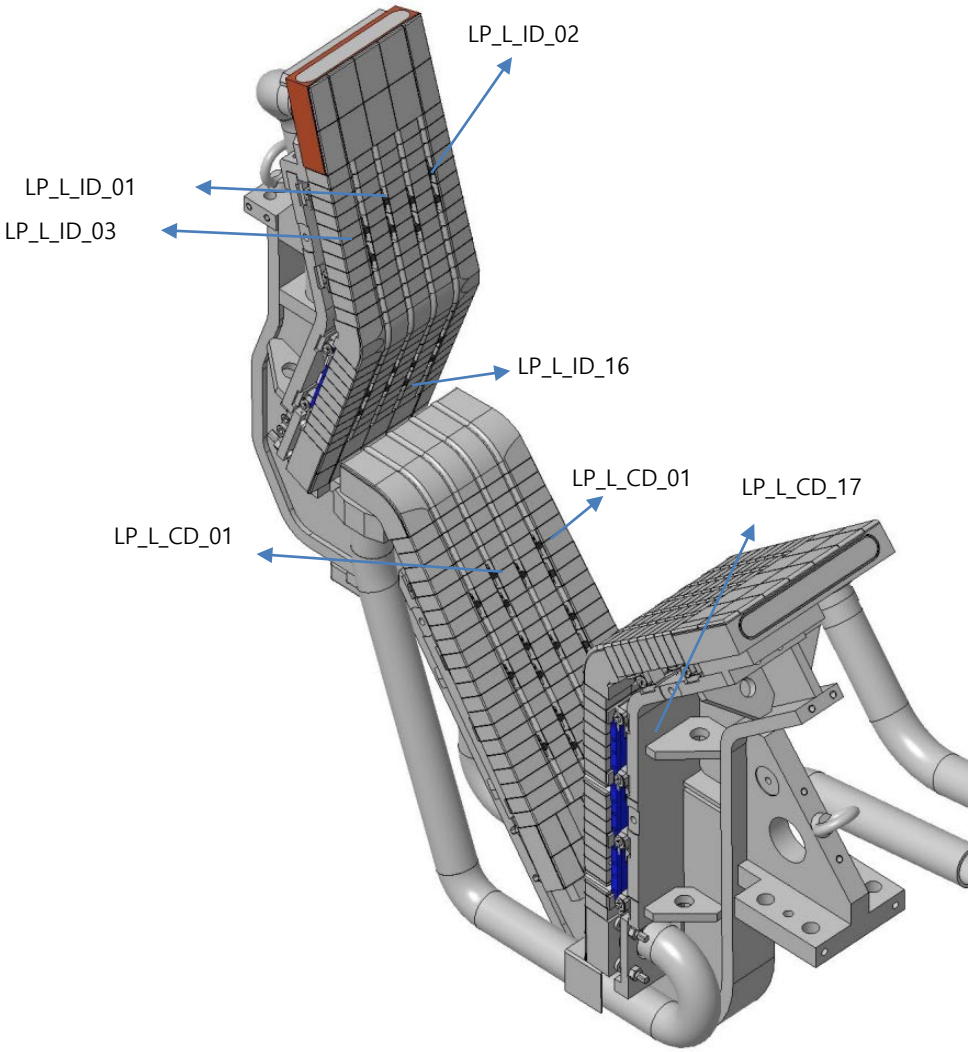
- FRPA : Data analysis on the raw data should be required for the evaluation of radial profiles of plasma density, electron temperature and Mach number.
- ELPA : Data analysis on the raw data should be required for the evaluation of radial profiles of heat/particle flux

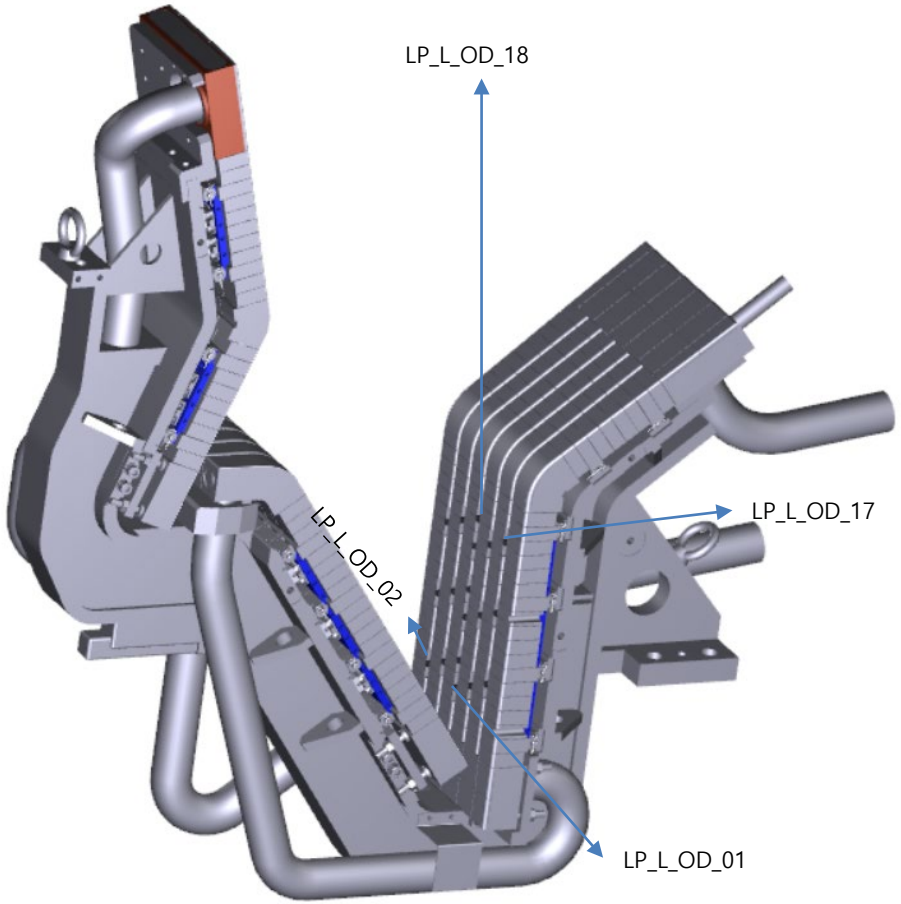
Electric Probe Diagnostics – TCD LP

Full Name	Tungsten cassette divertor Langmuir Probe Inner Divertor Probe / Central Divertor Probe/ Outer Divertor Prone
Contact	Eunnam Bang(bang14@kfe.re.kr), J. G. Bak (jgbak@kfe.re.kr), H. S. Kim (kimhs@kfe.re.kr)
Measuring properties	Ion saturation current (I_{is}), plasma & floating potential (V_p, V_f) at SOL
Port assignment	D, L
Channel information	D port: 54ch, L port : 54ea (ID: 16ch, CD: 18ch, OD: 18ch)
Time resolution	200 kHz (default)
Spatial Resolution	25~28mm
Availability	routinely available

Electric Probe Diagnostics – TCD LP

Channels Layout





Electric Probe Diagnostics – TCD LP

Name	Sampling	Unit	Description
\LP_D_ID_01 ~ \LP_D_ID_16:foo \LP_D_CD_01 ~ \LP_D_CD_18:foo \LP_D_OD_01 ~ \LP_D_OD_18:foo	200 kHz (default)	V	Raw data of ion saturation currents floating (main) and plasma potentials in the scrape-off-layer(Isat) region (changeable) Distance between probe tips: 2.5 ~2.8cm
\LP_L_ID_01 ~ \LP_L_ID_16:foo \LP_L_CD_01 ~ \LP_L_CD_18:foo \LP_L_OD_01 ~ \LP_L_OD_18:foo	200 kHz (default)	V	Raw data of ion saturation currents floating and plasma potentials in the scrape-off-layer(SOL, main) region (changeable) Distance between probe: 2.5 ~ 2.8cm

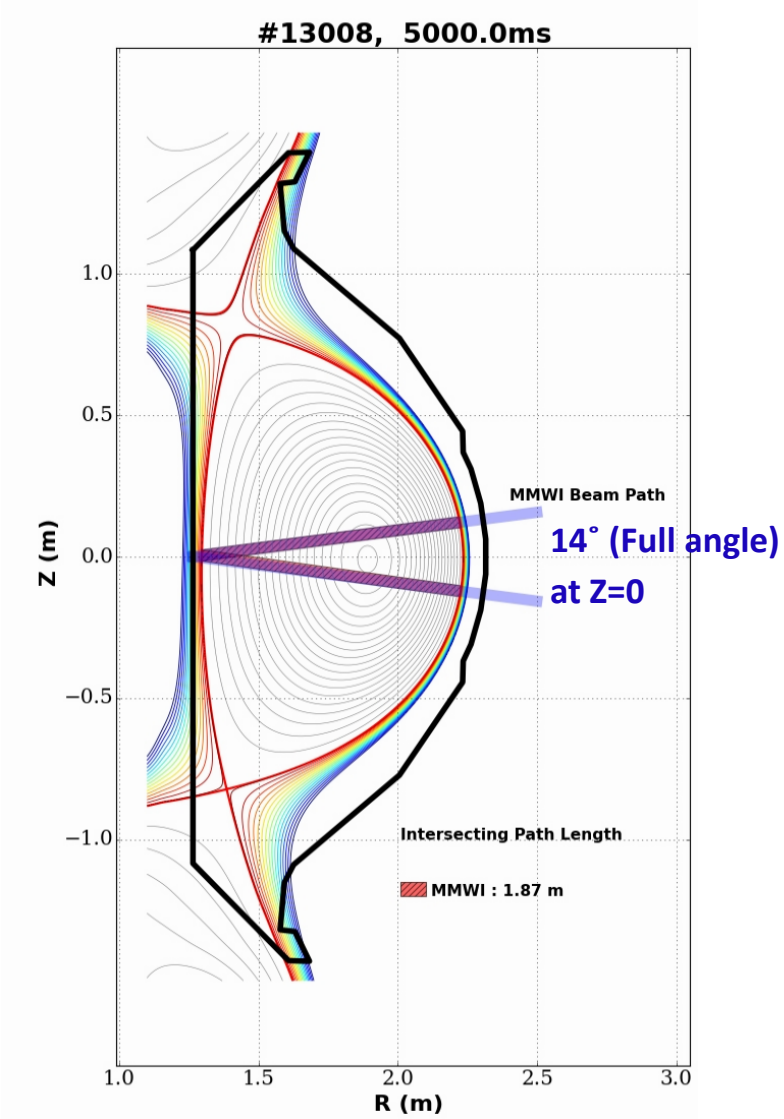
* There is a possibility of changing the channel for V sweeping as needed.

Interferometer – THI

Full Name	Tera-Hertz Interferometer (THI, former MMWI)
Contact	Y. U. Nam (yunam@kfe.re.kr), Dong-jae Lee (djlee124@kfe.re.kr)
Measuring properties	line-integrated electron density (n_{el})
Port assignment	D -> H (planned)
Channel information	Horizontal 1 ch on midplane (Z=0.0 m with 14° full angle)
Time resolution	100 kHz
Spatial Resolution	-
Availability	Data available only for MMWI

Interferometer - THI

Channels Layout



Interferometer - THI

Name	Sampling	Unit	Description
\ne_intero1	100 kHz	10^{19} m^{-2}	Double-path line-integrated electron density at Z=0

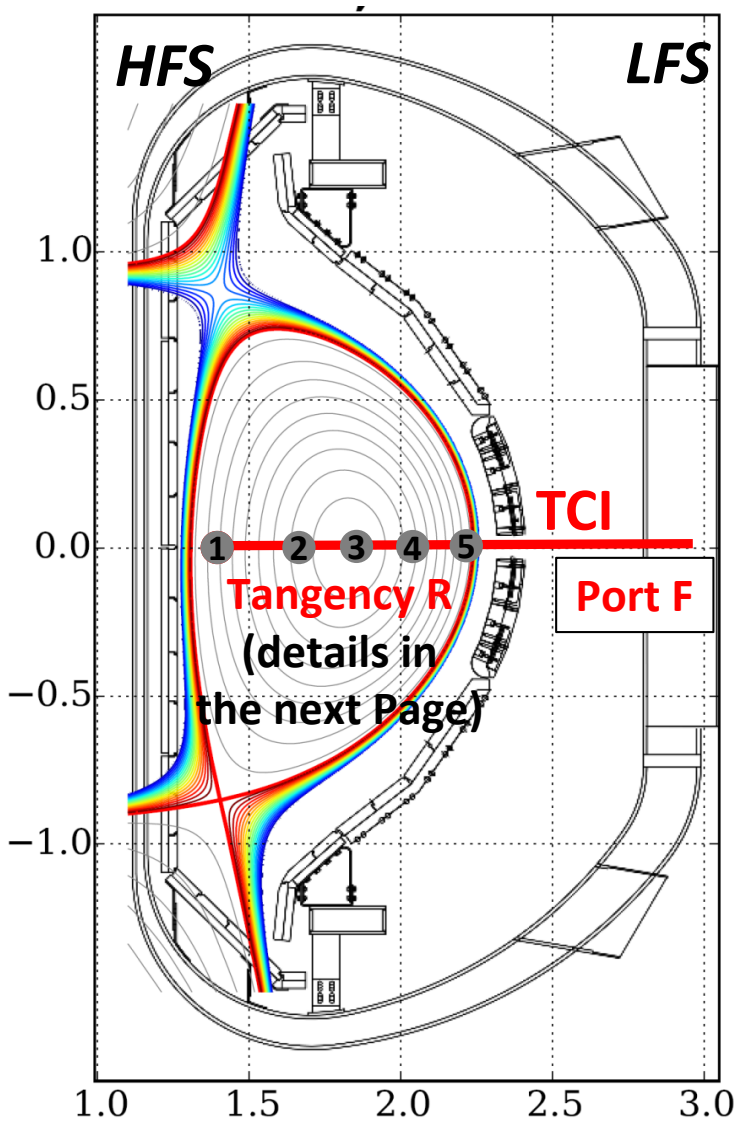
Notes

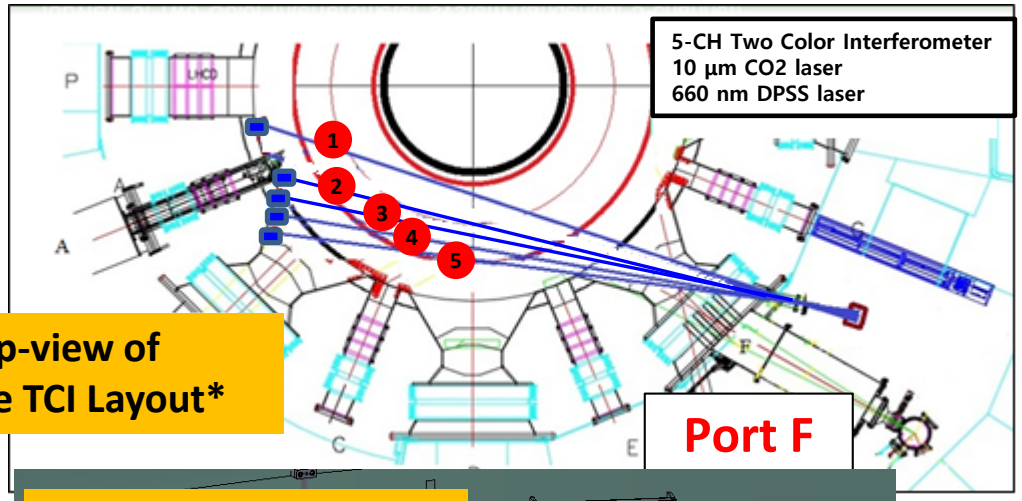
- The main EM-wave source has been changed from millimeter-wave to tera-hertz wave.
- But the point name is kept same.
- Line-density is integrated for double-path. So dividing by 2 will be necessary for the single-path line-integration.
- For line-average density calculation, dividing by 1.9 will be more appropriate in case of the typical diverted plasmas.
- Be careful for dividing by 2 or 1.9 whichever, especially when the vertical position of the plasma column is biased usually known as vertical displacement.
- During disruption, nel may not follow the abrupt density drop so final density may not fall down to 0.

Interferometer - TCI

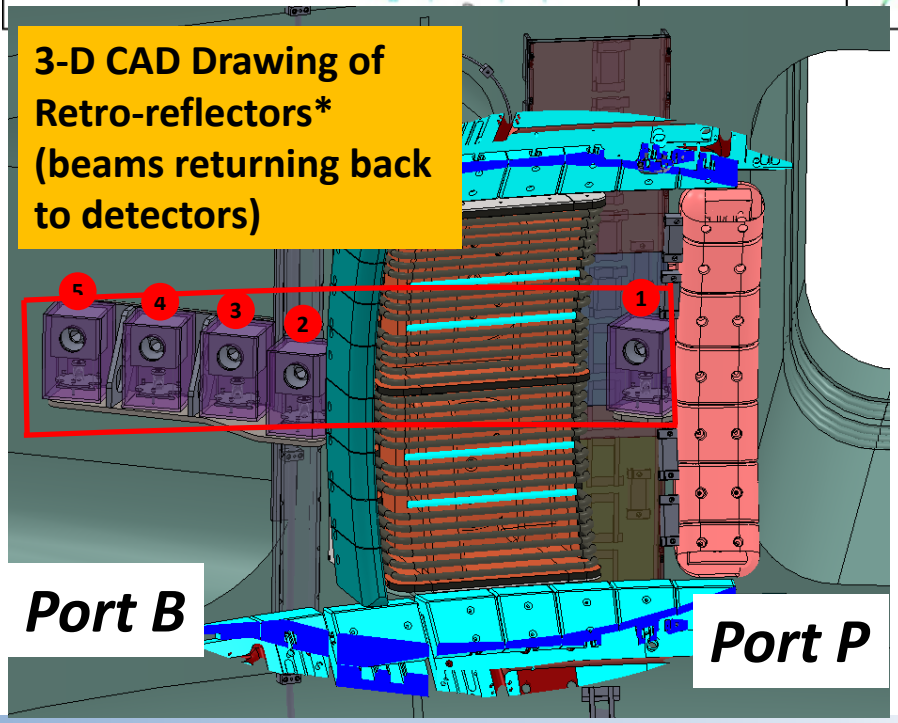
Full Name	Two-Color Interferometer
Contact	K.C. Lee(kclee@kfe.re.kr), J. W. Juhn(jwjuhn@kfe.re.kr) , J. H. Kim (jhwakim@kfe.re.kr), Y. S. Kim (ablesun@kfe.re.kr)
Measuring properties	Tangentially line-averaged electron densities (n_{el}) in different tangency radii (up to 5 chords)
Port assignment	Tangential Fm
Channel information	2017 : 1 2018 : 1, 2, 5 2019 : 1, 2, 3, 4 2020 : 1, 2, 3, 4, 5
Time resolution (Sampling Rate)	>100 kHz (typ. 313 or 625 kHz of raw data are available in 2019. If needs these raw data, please consult jwjuhn@kfe.re.kr)
Spatial Resolution	N/A
Availability	2018. 8. 27~

Interferometer - TCI





Top-view of the TCI Layout*



Interferometer - TCI

Name	Sampling Rate	Unit	Tangency R (m)	Path Length (m)	Description
\ne_tci01	>100 kHz (typ. 313 or 625 kHz of raw data are available since 2019)	10^{19} m^{-3}	**1.34**	**7.23**	All are LINE-averaged density. See the notes below. Path lengths here count double-path for round-trip beam path.
\ne_tci02			**1.78**	**5.51**	
\ne_tci03			**1.91**	**4.76**	#03, 04 channels are added in 2019. CH #04 started after #22958
\ne_tci04			**2.04**	**3.80**	
\ne_tci05			**2.16**	**2.52**	#5 channel is available since 2020.

Notes

- In principle, TCI is also double-path line-integrated measurement like MMWI and FIR. However, the path-length is already divided for each cord in the MDS+ data based on the typical numbers given above. Do not confuse other interferometer data that are line-integrated. If line-integrated densities are necessary, use the path lengths given above for each cord.
- In general, tangentially line-averaged data of CH #01 are accurate within at most 10% of discrepancy from the radial interferometer MMWI depending on the position of the plasmas.
- CH#04 started after #22958 while CH#05 started from yr 2020.
- Slow drift were suppressed after #22970. A few of drift cases still exist after #22970 depending on the status of the optical reference channel (temporarily stored using the node of CH #05. Since 2020 optical reference data is stored on #00).
- Tangency R remains the same since 2019
- Tangency R was calculated with the typical R of LCFS as 2.25 m. For the special cases, the path length should be changed w.r.t. the actual R of LCFS.
- Slow drift, fringe jumps and phase jumps may exist for your shots.
- Therefore, before use TCI data , **consult June-Woo Juhn (jwjuhn@kfe.re.kr)**

Interferometer - TCI

Name	Default	Usage
TCI_DAQ_TIME_AFTER_DISRUPT	3 (30 for ECWC*)	TCI operation time after IP min fault time set on TCI Host PC #1 and #2.
TCI2_DAQ_TIME_AFTER_DISRUPT	3 (30 for ECWC*)	

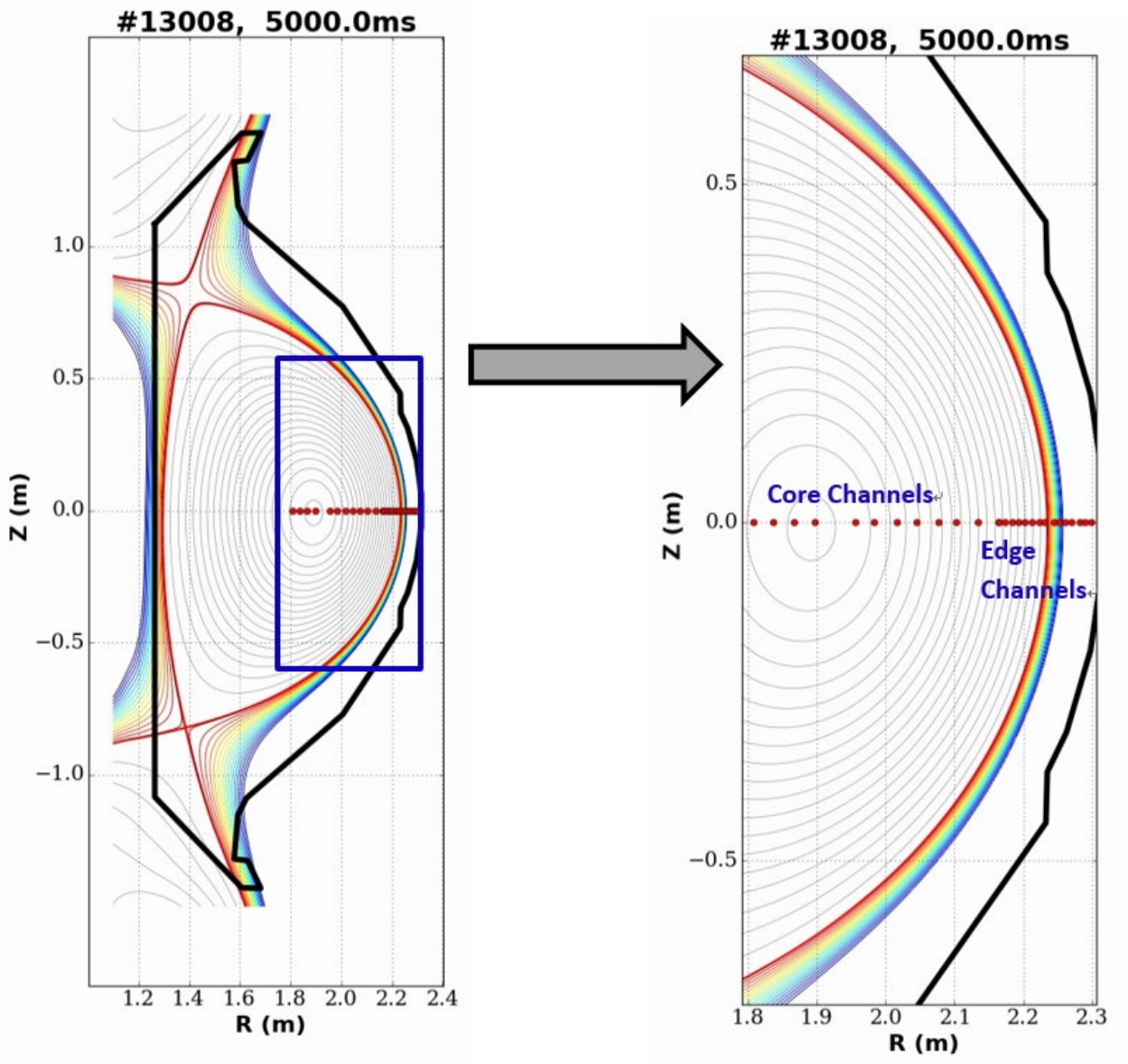
*Manually adjusted for ECWC

Thomson Scattering

Full Name	Thomson Scattering
Contact	J. H. Lee (jhlee@kfe.re.kr), H. J. Kim (jinkim1146@kfe.re.kr), G. H. Park(ghpark@kfe.re.kr), J. H. Kim (jhwakim@kfe.re.kr), Y. G. Kim (ykim@kfe.re.kr)
Measuring properties	electron temperature (Te), electron density (ne)
Port assignment	laser input (L), collection optics (N)
Channel information	core (14 points), edge (15points)
Time resolution	20Hz, **50 Hz(main)** : depends on the laser condition
Spatial Resolution	~ <20 mm (core), < 5 mm (edge)
Availability	Available by request

Thomson Scattering

Channels Layout



Thomson Scattering

Name	Sampling	Unit	Description
\TS_CORE1:CORE1_TE … \TS_CORE14:CORE14_TE	50 Hz	eV	Te at core with 14 channels
\TS_EDGE1:EDGE1_TE … \TS_EDGE15:EDGE15_TE	50 Hz	eV	Te at edge with 15 channels
\TS_CORE1:CORE1_NE … \TS_CORE14:CORE14_NE	50 Hz	m^{-3}	ne at core with 14 channels
\TS_EDGE1:EDGE1_NE … \TS_EDGE15:EDGE15_NE	50 Hz	m^{-3}	ne at edge with 15 channels
\TS_CORE1:CORE1_POS … \TS_CORE14:CORE14_POS	50 Hz	m^{-3}	radial channel position at core : see next page
\TS_EDGE1:EDGE1_POS … \TS_EDGE15:EDGE15_POS	50 Hz	m^{-3}	radial channel position at edge : see next page

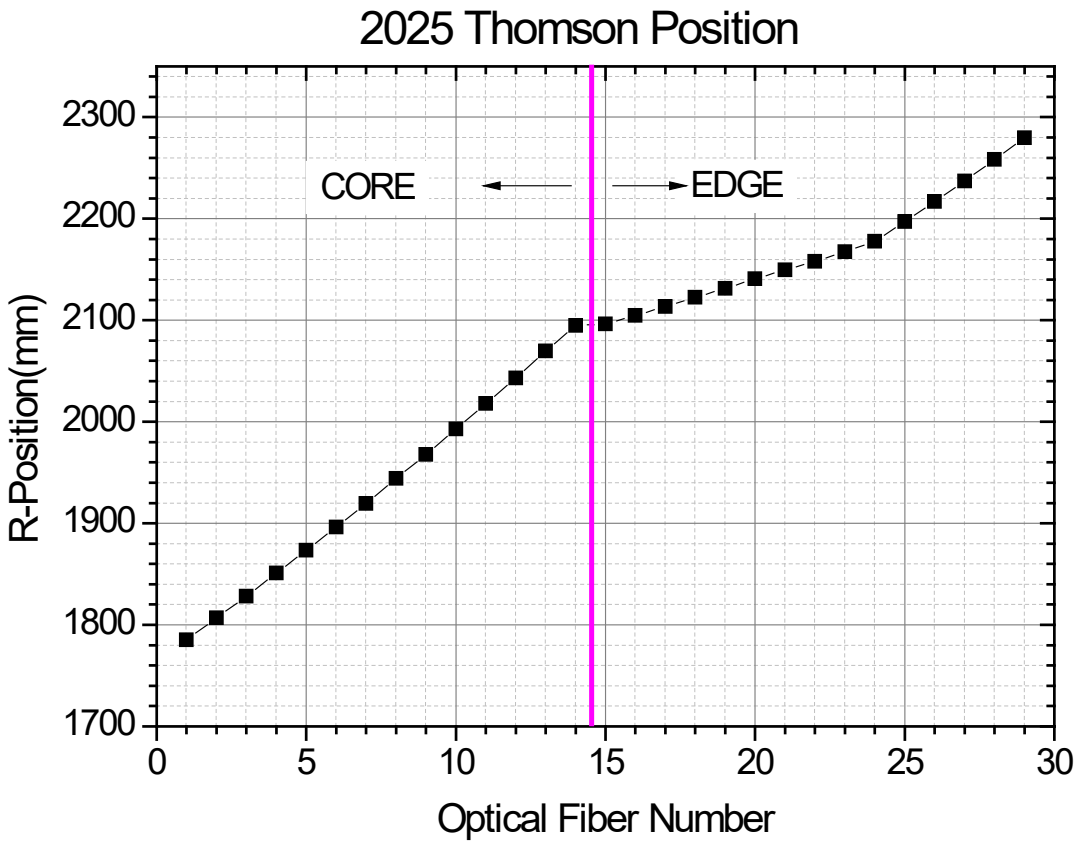
Notes

•

Thomson scattering

Position information

1	1785.20091
2	1806.74887
3	1828.24475
4	1850.83171
5	1873.30334
6	1896.23067
7	1919.59738
8	1944.03634
9	1967.58604
10	1992.84772
11	2017.82838
12	2043.17369
13	2069.5695
14	2094.90512
15	2096.3218
16	2104.84179
17	2113.39556
18	2122.6998
19	2131.32267
20	2140.70081
21	2149.39104
22	2158.11299
23	2167.59713
24	2177.85142
25	2197.00482
26	2217.04247
27	2237.22651
28	2258.30854
29	2279.53952

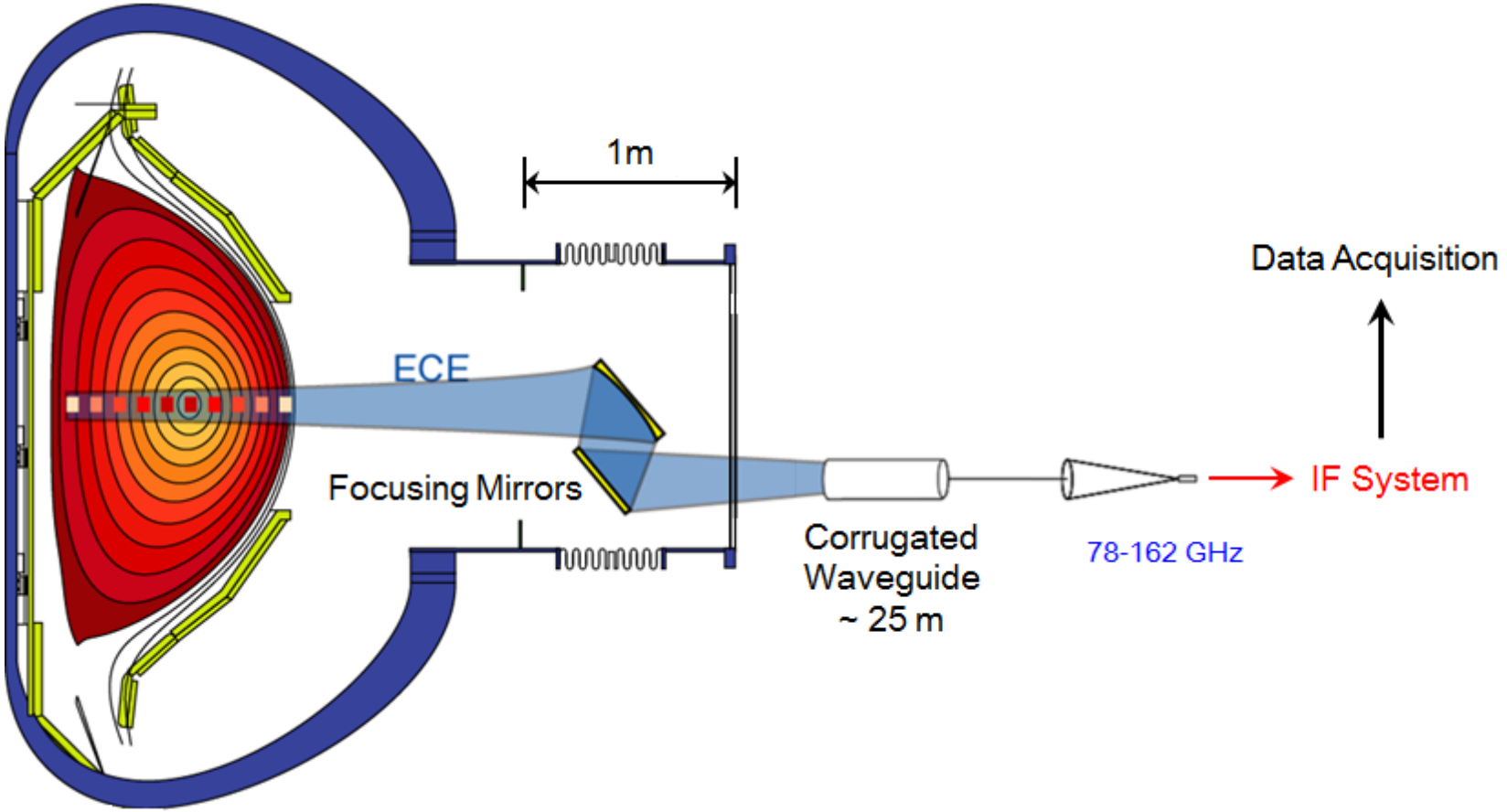


ECE Radiometer

Full Name	Electron Cyclotron Emission Radiometer
Contact	K. D. Lee (kdlee@kfe.re.kr)
Measuring properties	electron temperature (T_e)
Port assignment	K
Channel information	76 ch (horizontal, midplane)
Measuring position	full radial profile (depending on B_T)
Time resolution	500 kHz (default), 2 MHz (maximum)
Spatial Resolution	~ 1 cm
Availability	routinely available

ECE Radiometer

Channels Layout



ECE Radiometer

Name		Sampling	Unit	Description
\ECE01 … \ECE76		500 kHz	eV	electron temperature (T_e)
Subnodes	:FOO	500 kHz	V	raw data
	:FREQ		GHz	ECE frequency
	:RPOS2ND		m	radial position for ECE 2nd harmonics
	:RPOS3RD		m	radial position for ECE 3rd harmonics
\ECE_I_TF			kA	TF current value for calculating radial position
\ECE_R2ND			m	76ch radial positions for ECE 2nd harmonics
\ECE_CENT				central ECE channel
\ECE_CPOS			m	central ECE radial position

Notes

- Since 2016, 76 channels have been available and full radial profiles are available from B_T=1.8T to 2.5T.
- ECE27 has no calibration factor due to the 140 GHz notch filter and also ECE72 has no calibration factor due to the 105 GHz notch filter.
- ECE01, 02, 03, 28, 48, 49, 52, and ECE59 have no calibration factor due to the poor detector sensitivity.
- Information of radial positions based on the 2nd harmonic channels is listed on the next two pages. The harmonic overlap channels (yellow color numbers) are not recommended to be used.

ECE Radiometer

Position Information

ECE position (latest version, 2020.07.07)

CH	f [GHz]	B=1.5 T	B=1.6 T	B=1.7 T	B=1.8 T	B=1.9 T	B=2.0 T	B=2.1 T	B=2.2 T	B=2.3 T	B=2.4 T	B=2.5 T	B=2.6 T	B=2.7 T	B=2.8 T	B=2.9 T	B=3.0 T
Core		ECE54	ECE59	ECE63	ECE67	ECE73	ECE03	ECE08	ECE13	ECE18	ECE24	ECE26	ECE32	ECE37	ECE42	ECE48	(ECE48)
ECE01	110	1.369	1.461	1.552	1.643	1.734	1.826	1.917	2.008	2.100	2.191	2.282					
ECE02	111	1.357	1.447	1.538	1.628	1.719	1.809	1.900	1.990	2.081	2.171	2.262					
ECE03	112	1.345	1.435	1.524	1.614	1.704	**1.793**	1.883	1.972	2.062	2.152	2.241					
ECE04	113	1.333	1.422	1.511	1.600	1.688	1.777	1.866	1.955	2.044	2.133	2.222	2.310				
ECE05	114	1.321	1.409	1.497	1.586	1.674	1.762	1.850	1.938	2.026	2.114	2.202	2.290				
ECE06	115	1.310	1.397	1.484	1.572	1.659	1.746	1.834	1.921	2.008	2.096	2.183	2.270				
ECE07	116	1.299	1.385	1.472	1.558	1.645	1.731	1.818	1.904	1.991	2.078	2.164	2.251				
ECE08	117	1.287	1.373	1.459	1.545	1.631	1.717	**1.802**	1.888	1.974	2.060	2.146	2.231				
ECE09	118	1.276	1.362	1.447	1.532	1.617	1.702	1.787	1.872	1.957	2.042	2.127	2.213	2.298			
ECE10	119	1.266	1.350	1.435	1.519	1.603	1.688	1.772	1.856	1.941	2.025	2.110	2.194	2.278			
ECE11	120		1.339	1.423	1.506	1.590	1.674	1.757	1.841	1.925	2.008	2.092	2.176	2.259			
ECE12	121		1.328	1.411	1.494	1.577	1.660	1.743	1.826	1.909	1.992	2.075	2.158	2.241			
ECE13	123		1.306	1.388	1.470	1.551	1.633	1.714	**1.796**	1.878	1.959	2.041	2.123	2.204	2.286		
ECE14	124		1.296	1.377	1.458	1.539	1.620	1.701	1.782	1.863	1.944	2.025	2.106	2.187	2.267		
ECE15	125		1.285	1.366	1.446	1.526	1.607	1.687	1.767	1.848	1.928	2.008	2.089	2.169	2.249		
ECE16	126		1.275	1.355	1.435	1.514	1.594	1.674	1.753	1.833	1.913	1.992	2.072	2.152	2.231	2.311	
ECE17	127		1.265	1.344	1.423	1.502	1.581	1.660	1.740	1.819	1.898	1.977	2.056	2.135	2.214	2.293	
ECE18	128			1.334	1.412	1.491	1.569	1.647	1.726	**1.804**	1.883	1.961	2.040	2.118	2.197	2.275	
ECE19	129			1.323	1.401	1.479	1.557	1.635	1.713	1.790	1.868	1.946	2.024	2.102	2.18	2.257	
ECE20	130			1.313	1.390	1.468	1.545	1.622	1.699	1.777	1.854	1.931	2.008	2.086	2.163	2.24	
ECE21	131			1.303	1.380	1.456	1.533	1.610	1.686	1.763	1.840	1.916	1.993	2.070	2.146	2.223	2.300
ECE22	132			1.293	1.369	1.445	1.521	1.598	1.674	1.750	1.826	1.902	1.978	2.054	2.13	2.206	2.282
ECE23	133			1.284	1.359	1.435	1.510	1.586	1.661	1.737	1.812	1.888	1.963	2.039	2.114	2.19	2.265
ECE24	134			1.274	1.349	1.424	1.499	1.574	1.649	1.724	**1.799**	1.873	1.948	2.023	2.098	2.173	2.248
ECE25	138				1.310	1.383	1.455	1.528	1.601	1.674	1.746	1.819	1.892	1.965	2.037	2.11	2.183
ECE26	139				1.300	1.373	1.445	1.517	1.589	1.662	1.734	**1.806**	1.878	1.951	2.023	2.095	2.167
ECE27	140				1.291	1.363	1.435	1.506	1.578	1.650	1.721	1.793	1.865	1.937	2.008	2.08	2.152
ECE28	141				1.282	1.353	1.424	1.496	1.567	1.638	1.709	1.780	1.852	1.923	1.994	2.065	2.137
ECE29	142				1.273	1.344	1.414	1.485	1.556	1.626	1.697	1.768	1.839	1.909	1.98	2.051	2.121
ECE30	143				1.264	1.334	1.404	1.475	1.545	1.615	1.685	1.756	1.826	1.896	1.966	2.036	2.107
ECE31	144					1.325	1.395	1.464	1.534	1.604	1.674	1.743	1.813	1.883	1.953	2.022	2.092
ECE32	145					1.316	1.385	1.454	1.524	1.593	1.662	1.731	**1.801**	1.870	1.939	2.008	2.078
ECE33	146					1.307	1.376	1.444	1.513	1.582	1.651	1.719	1.788	1.857	1.926	1.995	2.063
ECE34	147					1.298	1.366	1.435	1.503	1.571	1.639	1.708	1.776	1.844	1.913	1.981	2.049
ECE35	148					1.289	1.357	1.425	1.493	1.561	1.628	1.696	1.764	1.832	1.9	1.968	2.035
ECE36	149					1.280	1.348	1.415	1.483	1.550	1.617	1.685	1.752	1.820	1.887	1.954	2.022
ECE37	151					1.264	1.330	1.397	1.463	1.530	1.596	1.663	1.729	**1.796**	1.862	1.929	1.995
ECE38	152						1.321	1.387	1.453	1.519	1.586	1.652	1.718	1.784	1.85	1.916	1.982

ECE Radiometer

Position Information

ECE position (latest version, 2020.07.07)

CH	f [GHz]	B=1.5 T	B=1.6 T	B=1.7 T	B=1.8 T	B=1.9 T	B=2.0 T	B=2.1 T	B=2.2 T	B=2.3 T	B=2.4 T	B=2.5 T	B=2.6 T	B=2.7 T	B=2.8 T	B=2.9 T	B=3.0 T
Core		ECE54	ECE59	ECE63	ECE67	ECE73	ECE03	ECE08	ECE13	ECE18	ECE24	ECE26	ECE32	ECE37	ECE42	ECE48	(ECE48)
ECE39	153						1.313	1.378	1.444	1.510	1.575	1.641	1.706	1.772	1.838	1.903	1.969
ECE40	154						1.304	1.369	1.435	1.500	1.565	1.630	1.695	1.761	1.826	1.891	1.956
ECE41	155						1.296	1.360	1.425	1.490	1.555	1.620	1.684	1.749	1.814	1.879	1.944
ECE42	156						1.287	1.352	1.416	1.481	1.545	1.609	1.674	1.738	**1.802**	1.867	1.931
ECE43	157						1.279	1.343	1.407	1.471	1.535	1.599	1.663	1.727	1.791	1.855	1.919
ECE44	158						1.271	1.335	1.398	1.462	1.525	1.589	1.652	1.716	1.78	1.843	1.907
ECE45	159						1.263	1.326	1.389	1.453	1.516	1.579	1.642	1.705	1.768	1.832	1.895
ECE46	160							1.318	1.381	1.444	1.506	1.569	1.632	1.695	1.757	1.82	1.883
ECE47	161							1.310	1.372	1.435	1.497	1.559	1.622	1.684	1.746	1.809	1.871
ECE48	162							1.302	1.364	1.426	1.488	1.550	1.612	1.674	1.736	**1.798**	1.860
ECE49	78	1.931	2.060	2.189													
ECE50	79	1.907	2.034	2.161	2.288												
ECE51	81	1.860	1.984	2.108	2.231												
ECE52	82	1.837	1.959	2.082	2.204												
ECE53	83	1.815	1.936	2.057	2.178	2.299											
ECE54	84	**1.793**	1.913	2.032	2.152	2.271											
ECE55	85	1.772	1.890	2.008	2.126	2.245											
ECE56	86	1.751	1.868	1.985	2.102	2.219											
ECE57	87	1.731	1.847	1.962	2.078	2.193	2.308										
ECE58	88	1.712	1.826	1.940	2.054	2.168	2.282										
ECE59	89	1.692	**1.805**	1.918	2.031	2.144	2.257										
ECE60	90	1.674	1.785	1.897	2.008	2.120	2.231										
ECE61	91	1.655	1.766	1.876	1.986	2.097	2.207										
ECE62	92	1.637	1.746	1.856	1.965	2.074	2.183	2.292									
ECE63	96	1.569	1.674	**1.778**	1.883	1.987	2.092	2.197	2.301								
ECE64	97	1.553	1.656	1.760	1.863	1.967	2.070	2.174	2.278								
ECE65	98	1.537	1.639	1.742	1.844	1.947	2.049	2.152	2.254								
ECE66	99	1.521	1.623	1.724	1.826	1.927	2.029	2.130	2.231								
ECE67	100	1.506	1.607	1.707	**1.808**	1.908	2.008	2.109	2.209	2.310							
ECE68	101	1.491	1.591	1.690	1.790	1.889	1.988	2.088	2.187	2.287							
ECE69	102	1.477	1.575	1.674	1.772	1.871	1.969	2.067	2.166	2.264							
ECE70	103	1.462	1.560	1.657	1.755	1.852	1.950	2.047	2.145	2.242							
ECE71	104	1.448	1.545	1.641	1.738	1.835	1.931	2.028	2.124	2.221							
ECE72	105	1.435	1.530	1.626	1.721	1.817	1.913	2.008	2.104	2.200	2.295						
ECE73	106	1.421	1.516	1.610	1.705	**1.800**	1.895	1.989	2.084	2.179	2.274						
ECE74	107	1.408	1.502	1.595	1.689	1.783	1.877	1.971	2.065	2.159	2.252						
ECE75	109	1.382	1.474	1.566	1.658	1.750	1.843	1.935	2.027	2.119	2.211	2.303					
ECE76	110	1.369	1.461	1.552	1.643	1.734	1.826	1.917	2.008	2.100	2.191	2.282					

R [m]
2nd Harmonic
Harmonic overlap
Core

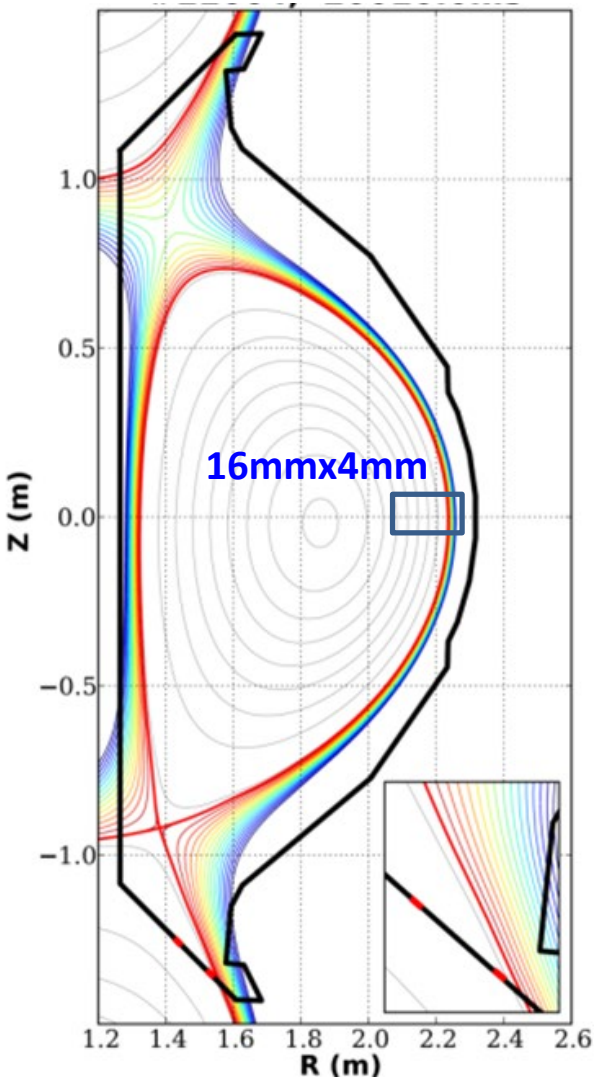
ECE##
Notch
Bad

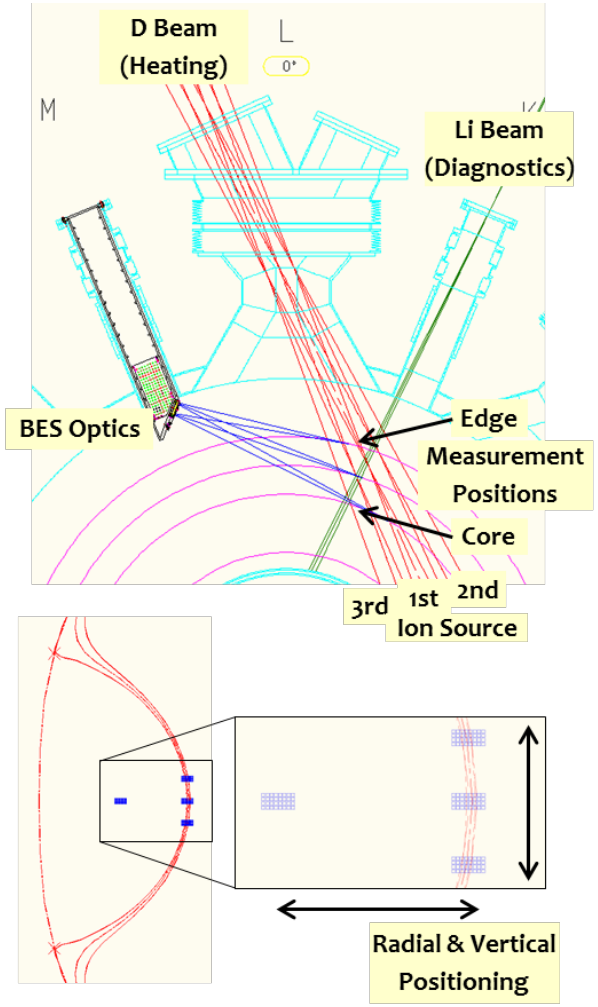
BES

Full Name	Beam Emission Spectroscopy
Contact	Y. U. Nam (yunam@kfe.re.kr), Jaewook Kim (ijwkim@kfe.re.kr)
Measuring properties	electron density (n_e, relative)
Port assignment	M (collection optics), K (measuring position)
Channel information	16 x 4 channels (16 x 4 cm)
Measuring position	adjustable (radial position, array angle, default at edge midplane)
Time resolution	2MHz
Spatial Resolution	1 cm
Availability	NBI needed

BES

Channels Layout





BES

Name		Sampling	Unit	Description
\BES_0101 : \BES_0416		200kHz	V	\BES+[vertical channel number:01-04] + [radial channel number:01-16] = (:FOO x :CAL)
Subnodes	:FOO	200kHz	V	200kHz down-sampled data (photodiode intensity)
	:CAL			calibration factor (for relative cal. btw channels)
	:RPOS		mm	radial channel position
	:VPOS		mm	vertical channel position

Notes

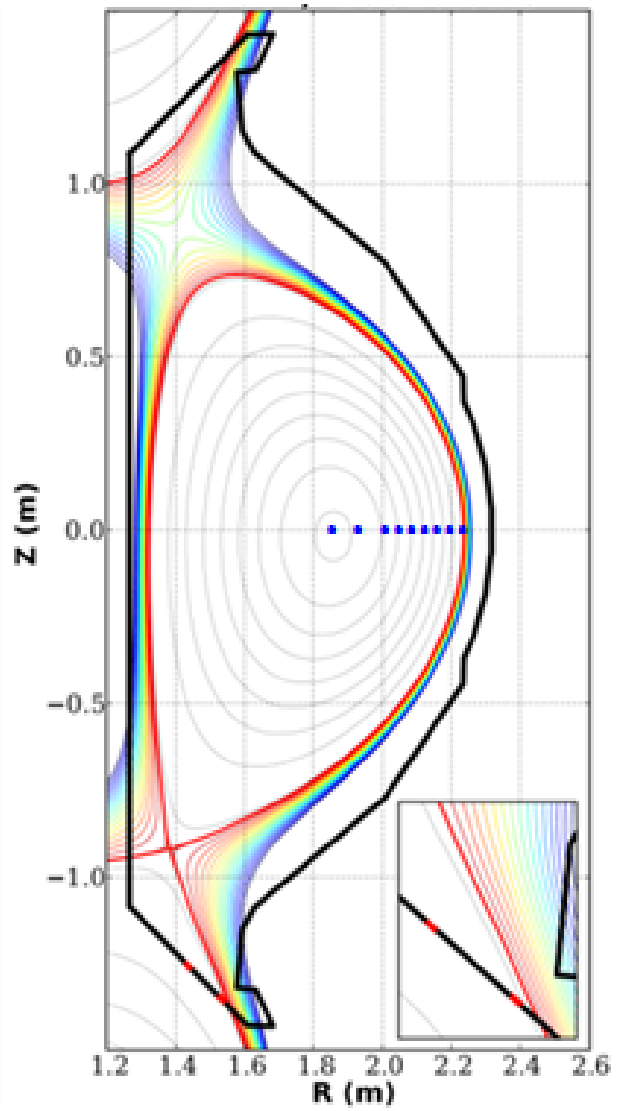
- Measurements position can be varied shot-by-shot.
- When the calibration factor is not available, please refer data at \BES_0101:FOO
- If 2MHz raw data is required, please consult with contact persons.
- Measured voltage is mainly proportional to the local electron density with background subtraction. Effect of the electron temperature is under 5% in typical condition. The background signal level can be obtained during NBI turn-off.
- Measured signal can be directly interpreted as the local electron density in case of edge measurements with heating beam. In other case, such as core measurements or lithium diagnostics beam measurements, a reconstruction analysis is required to obtain the electron density.

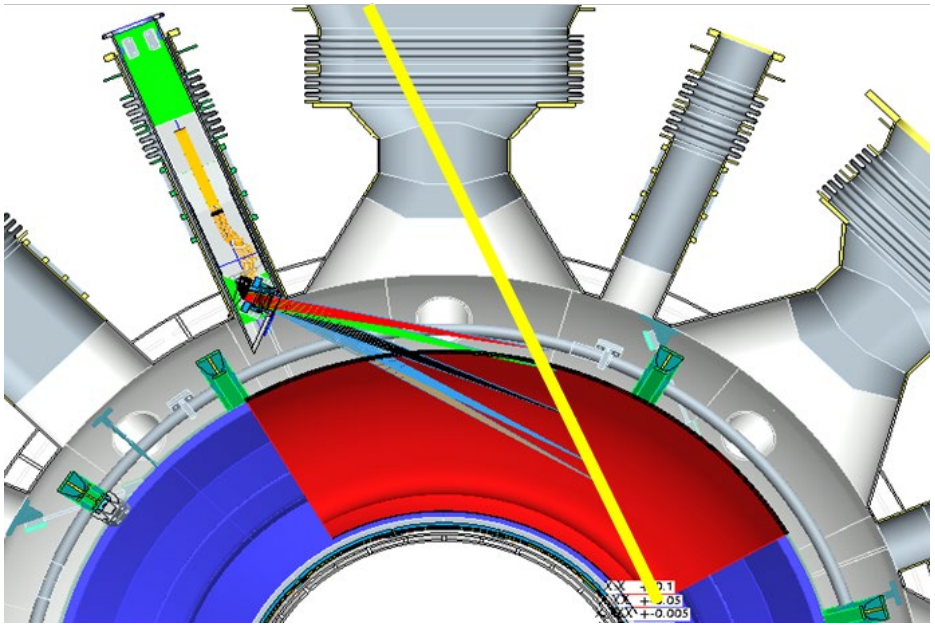
CES

Full Name	Charge Exchange Spectroscopy
Contact	W. H. Ko (whko@kfe.re.kr), J. K. Lee (jklee@kfe.re.kr)
Measuring properties	ion temperature (T_i), toroidal/poloidal rotation velocity (V_t, V_p)
Port assignment	M (toroidal optics), K (poloidal optics), K (measuring position)
Channel information	32 ch (toroidal), 16 ch (poloidal)
Time resolution	100 Hz (10 ms)
Spatial Resolution	5 mm (edge), 20-30 mm (core)
Availability	NBI modulation needed (1 or 2 Hz with 99% duty)

CES

Channels Layout





CES

Name		Sampling	Unit	Description
\CES_TI01 … \CES_TI32		100 Hz	eV	ion temperature from toroidal CES (in M port)
\CES_VT01 … \CES_VT32		100 Hz	km/s	toroidal rotation from toroidal CES (in M port)
\CES_RT01 … \CES_RT32			mm	major radius of toroidal CES (in M port)
\CES_TP01 … \CES_TP16		100 Hz	eV	ion temperature from poloidal CES (in K port)
\CES_VP01 … \CES_VP16		100 Hz	km/s	poloidal rotation from poloidal CES (in K port)
\CES_RP01 … \CES_RP16			mm	major radius of poloidal CES (in M port)
Subnodes	:FOO			raw data
	:ERR_BAR			error bar

Notes

- **It is neccesary to be checked by the person in charge of CES before using it because Ti and Vt data is automatically calculated and uploaded in MDSplus.**
- If you need T_i and V_t or V_p, you should have NBI modulation with a few Hz because CES need the background signal obtained during NBI turn-off.
- There are toroidal and poloidal rotation velocities which have unit km/s. If Rotation divided by major radius or effective radius, the value is angular velocity and the unit is [kω/s].

CES

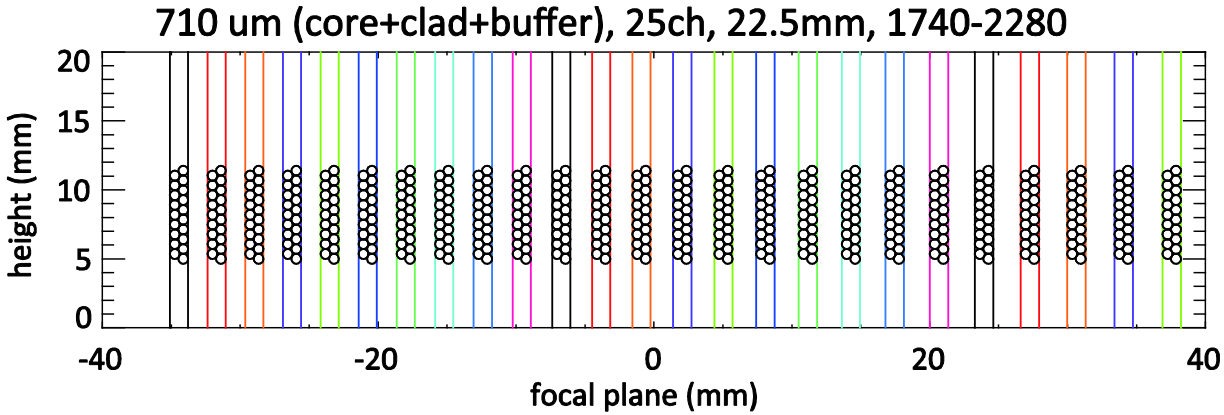
Toroidal CES node

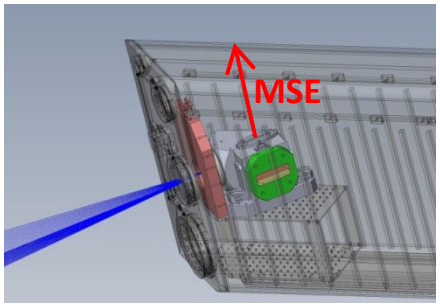
T_i [eV]	T_i error bar [eV]	V_T [km/s]	V_T error bar [km/s]	R [mm]	R [mm]						
					2011	2012	2013 2014	2015	#13522~ #27382	2021	2022~
CES_TI01	CES_TI01:err_bar	CES_VT01	CES_VT01:err_bar	CES_RT01	**1795**	**1800**	**1795**	1801	1801	**1800**	**1794**
CES_TI02	CES_TI02:err_bar	CES_VT02	CES_VT02:err_bar	CES_RT02	**1800**	1850	1850	1822	1822	**1823**	**1819**
CES_TI03	CES_TI03:err_bar	CES_VT03	CES_VT03:err_bar	CES_RT03	1850	1900	1900	1843	1843	**1853**	**1849**
CES_TI04	CES_TI04:err_bar	CES_VT04	CES_VT04:err_bar	CES_RT04	1900	1950	1950	1874	1874	**1884**	**1879**
CES_TI05	CES_TI05:err_bar	CES_VT05	CES_VT05:err_bar	CES_RT05	1950	2000	2000	1895	1895	**1914**	**1910**
CES_TI06	CES_TI06:err_bar	CES_VT06	CES_VT06:err_bar	CES_RT06	2000	2050	2050	1945	1945	1945	**1939**
CES_TI07	CES_TI07:err_bar	CES_VT07	CES_VT07:err_bar	CES_RT07	2050	2100	2100	1995	1995	**1985**	**1979**
CES_TI08	CES_TI08:err_bar	CES_VT08	CES_VT08:err_bar	CES_RT08	2100	**2150**	2150	2016	2016	**2013**	**2009**
CES_TI09	CES_TI09:err_bar	CES_VT09	CES_VT09:err_bar	CES_RT09	**2140**	2170	2170	2047	2047	**2043**	**2038**
CES_TI10	CES_TI10:err_bar	CES_VT10	CES_VT10:err_bar	CES_RT10	**2160**	2180	2180	2078	2078	**2073**	**2069**
CES_TI11	CES_TI11:err_bar	CES_VT11	CES_VT11:err_bar	CES_RT11	2170	2190	2190	2099	2099	**2094**	**2089**
CES_TI12	CES_TI12:err_bar	CES_VT12	CES_VT12:err_bar	CES_RT12	2180	2200	2200	2125	2125	**2122**	**2119**
CES_TI13	CES_TI13:err_bar	CES_VT13	CES_VT13:err_bar	CES_RT13	2190	2205	2205	2150	2150	**2147**	**2144**
CES_TI14	CES_TI14:err_bar	CES_VT14	CES_VT14:err_bar	CES_RT14	2200	2210	2210	2171	2171	2171	**2168**
CES_TI15	CES_TI15:err_bar	CES_VT15	CES_VT15:err_bar	CES_RT15	2205	2215	2215	2192	**2187**	2187	**2183**
CES_TI16	CES_TI16:err_bar	CES_VT16	CES_VT16:err_bar	CES_RT16	2210	2220	2220	2203	**2192**	2192	2187
CES_TI17	CES_TI17:err_bar	CES_VT17	CES_VT17:err_bar	CES_RT17	2215	2225	2225	2213	**2198**	2198	2192
CES_TI18	CES_TI18:err_bar	CES_VT18	CES_VT18:err_bar	CES_RT18	2220	2230	2230	2223	**2203**	2203	2198
CES_TI19	CES_TI19:err_bar	CES_VT19	CES_VT19:err_bar	CES_RT19	2225	2235	2235	2228	**2208**	2208	2203
CES_TI20	CES_TI20:err_bar	CES_VT20	CES_VT20:err_bar	CES_RT20	2230	2240	2240	2233	**2213**	2213	2208
CES_TI21	CES_TI21:err_bar	CES_VT21	CES_VT21:err_bar	CES_RT21	2235	2245	2245	2238	**2218**	2218	2213
CES_TI22	CES_TI22:err_bar	CES_VT22	CES_VT22:err_bar	CES_RT22	2240	2250	2250	2243	**2223**	2223	2218
CES_TI23	CES_TI23:err_bar	CES_VT23	CES_VT23:err_bar	CES_RT23	2245	2255	2255	2248	**2228**	2228	2223
CES_TI24	CES_TI24:err_bar	CES_VT24	CES_VT24:err_bar	CES_RT24	2250	2260	2260	2253	**2233**	2233	2228
CES_TI25	CES_TI25:err_bar	CES_VT25	CES_VT25:err_bar	CES_RT25	2255	2265	2265	2259	**2238**	2238	2233
CES_TI26	CES_TI26:err_bar	CES_VT26	CES_VT26:err_bar	CES_RT26	**2265**	2270	2270	2264	**2243**	2243	2238
CES_TI27	CES_TI27:err_bar	CES_VT27	CES_VT27:err_bar	CES_RT27	**2275**	2275	2275	2269	**2248**	2248	2243
CES_TI28	CES_TI28:err_bar	CES_VT28	CES_VT28:err_bar	CES_RT28	2280	2280	2280	2273	**2253**	2253	2248
CES_TI29	CES_TI29:err_bar	CES_VT29	CES_VT29:err_bar	CES_RT29	2285	2285	2285	2280	**2259**	2259	2253
CES_TI30	CES_TI30:err_bar	CES_VT30	CES_VT30:err_bar	CES_RT30	2290	2290	2290	2286	**2264**	2264	2259
CES_TI31	CES_TI31:err_bar	CES_VT31	CES_VT31:err_bar	CES_RT31	2295	2295	2295	2291	**2269**	2269	2264
CES_TI32	CES_TI32:err_bar	CES_VT32	CES_VT32:err_bar	CES_RT32	2300	2300	2300	2296	**2273**	2273	2269

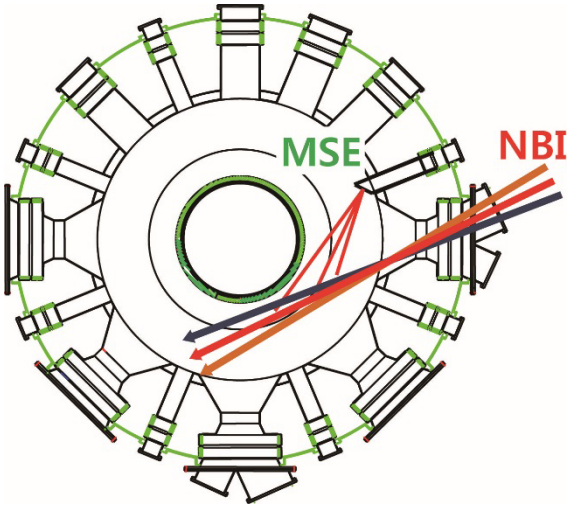
MSE

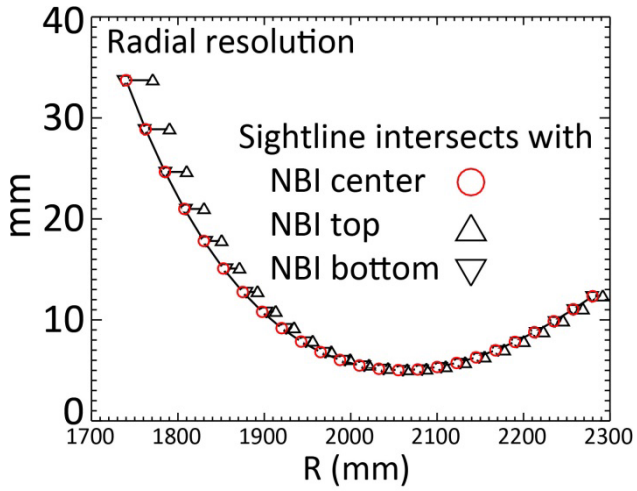
Full Name	Motional Stark effect diagnostic system
Contact	J. Ko (jinseok@kfe.re.kr) , J. Ko (juyoung05@kfe.re.kr), J. Chung (jinil@kfe.re.kr)
Measuring properties	Magnetic pitch angle (J and q profiles when combined with EFIT)
Port assignment	M port – middle window
Channel information	25 spatial channels
Time resolution	100 Hz
Spatial Resolution	1 – 3 cm
Availability	Available by request

MSE


710 um (core+clad+buffer), 25ch, 22.5mm, 1740-2280
height (mm)
20
15
10
5
0
-40
-20
0
20
40
focal plane (mm)


MSE


MSE
NBI


Radial resolution
Sightline intersects with
NBI center
NBI top
NBI bottom
mm
40
30
20
10
0
1700
1800
1900
2000
2100
2200
2300
R (mm)

MSE

Name		Data Type	Unit	Description
\spectro::top.mse.pmse.pmse_efit001				
Subnodes	:aa1gam … :aa7gam	# of channels		'a' coefficients
	:rrrgam			
	:zzzgam			
	:pmse_ver	scalar		mse analysis version number
	:pmse_ic	string		invessel calibration flag name
	:pmse_fc	string		faraday calibration flag name
	:pmse_ge	string		geometry flag name
	:pmse_bc	string		bandpass filter calibration flag name
	:pmse_avg_dt	scalar		integration time

MSE

Name		Data Type	Unit	Description
\spectro::top.mse.pmse.pmse_efit001.tgamma				
Subnodes	:tgamma01 : :tgamma25	# of time points		'tgamma' for efit mse snap file for channel 1 - 25
\spectro::top.mse.pmse.pmse_efit001.sgamma				
Subnodes	:sgamma01 : :sgamma25	# of time points		‘sgamma' for efit mse snap file for channel 1 -25

Notes

- When NBI1-a/b/c sources are injected, the recommended NBI energy combination for good MSE measurements is 100/80/90 keV. See Ko (Rev. Sci. Instrum., In press).
- Although we need to experimentally confirm, the injection of NBI2 is expected to have no effect on MSE measurements.

MSE

MDS+ Node Information for direct q and j profiles

Current density (j)

Node name	Node name	Notes
\pmse_jv01	\pmse_je01	j value & error at r/a = 0 [MA/m^2]
\pmse_jv02	\pmse_je02	…
…	…	…
\pmse_jv20	\pmse_je20	j value & error at r/a = 0.98 [MA/m^2] (Constrained to zero)

Safety factor (q)

Node name	Node name	Notes
\pmse_qv01	\pmse_qe01	q value & error at r/a = 0 (a.k.a q0)
\pmse_qv02	\pmse_qe02	…
…	…	…
\pmse_qv20	\pmse_qe20	q value & error at r/a = 0.98 (Constrained to q95 from rtEFIT)

Normalized minor radius = (Rmajor – Rmagx) / (Redge – Rmagx)

where Rmagx is the major radius at the magnetic axis inferred from the MSE pitch angle profile (zero-crossing).

Node name	Notes
\pmse_av01	1st normalized minor radius (r/a = 0)
\pmse_av02	2nd normalized minor radius
…	…
\pmse_av20	Last normalized minor radius (r/a = 0.98)

Others (q0, Rmagx)

Node name	Notes
\pmse_magxv	Magnetic axis inferred from MSE pitch angle [m]
\pmse_magxe	Its error [m]
\pmse_q0v	q0
\pmse_q0e	Its error

Ref for direct q & j

C. C. Petty et al, 'Analysis of current drive using MSE polarimetry without equilibrium reconstruction', Nucl. Fusion 42 (2002) 1124-1133

MSE

Name	Value	Usage
CCS_SHOT_NUMBER	Shot number	MSE filter setup for Bt and NBI1 energy before shot. Final settings at PASS_SHOT_COUNTDOWN = 20.
PASS_SHOT_COUNTDOWN	Time left before shot start [sec]	
CCS_ITF_MEASURED	Current in TF coil [A]	
NB1_P1G1_RTN_VOLT	NB1A energy [keV]	
NB1_P2G1_RTN_VCMD	NB1B energy [keV]	
NB1_P3G1_RTN_VCMD	NB1C energy [keV]	

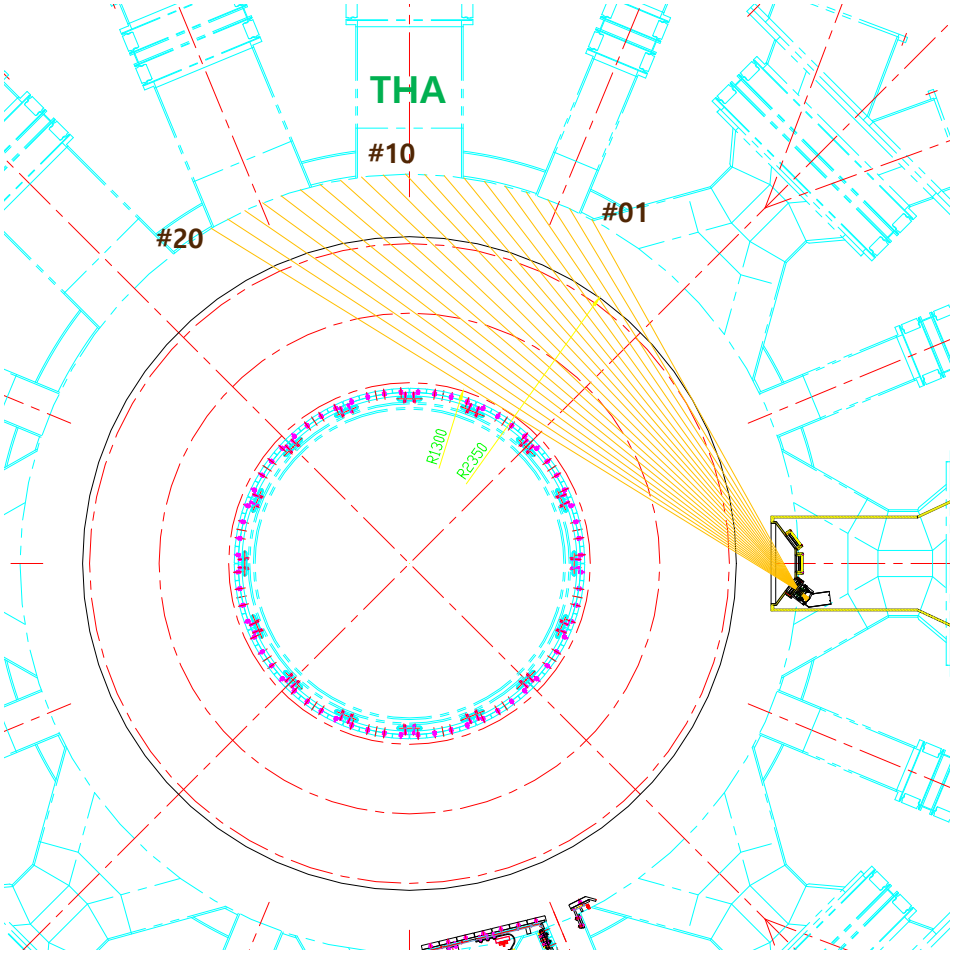
Visible Spectroscopy – H alpha

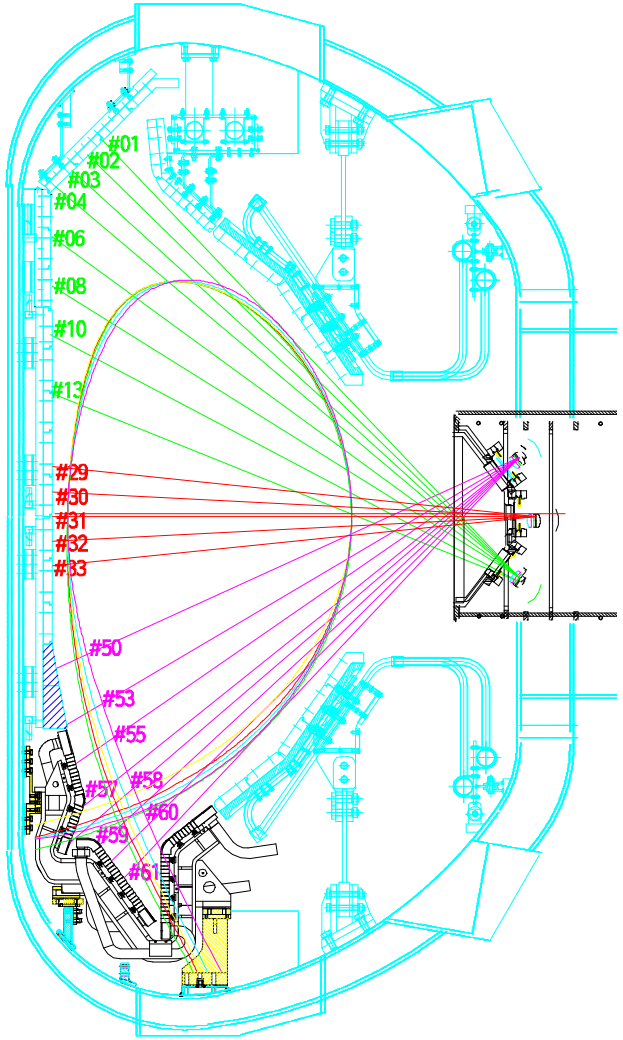
Full Name	Hα monitoring system
Contact	J. Jang (jjh4368@kfe.re.kr), D.C. Seo (dcseo@kfe.re.kr)
Measuring properties	H alpha emission intensity
Port assignment	J
Channel information	Horizontal 20 ch on midplane, Poloidal 21 ch
Time resolution	20 kHz (default), ~ 500kHz (maximum on request)
Spatial Resolution	-
Availability	routinely available

Notes

- In 2024, 61 poloidal channels were upgraded, 21 channels are in use.

Visible Spectroscopy - H alpha





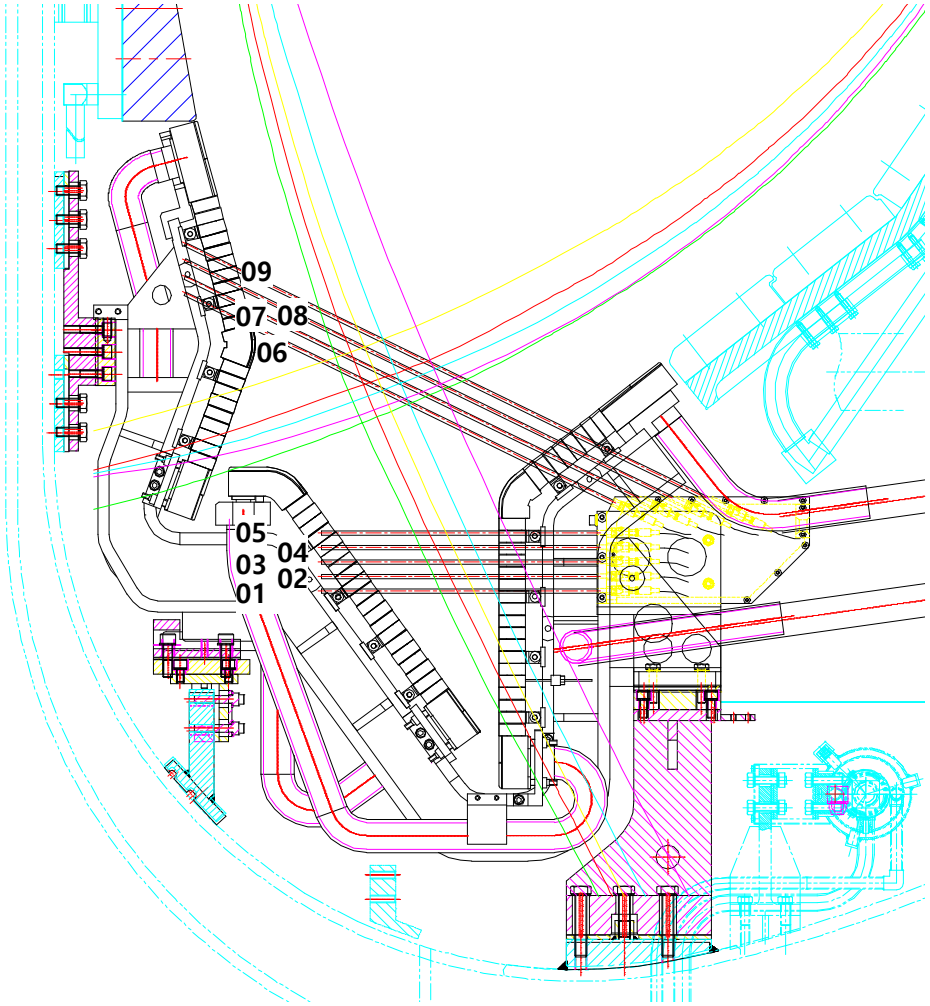
Visible Spectroscopy - H alpha

Name		Sampling	Unit	Description
\TOR_HA01 : \TOR_HA20		20 kHz	photon flux (ph/m²/nm/sr/s)	Toroidal channels for H alpha emission photon flux
\POL_HA01 : \POL_HA61				Poloidal channels for H alpha emission photon flux
Subnodes	:FOO		V	raw data

Visible Spectroscopy – Divertor H alpha

Full Name	Divertor Hα monitoring system
Contact	D.C. Seo (dcseo@kfe.re.kr), J. Jang (jjh4368@kfe.re.kr)
Measuring properties	H alpha emission intensity in divertor
Port assignment	K
Channel information	divertor 9 ch
Time resolution	20 kHz (default), ~ 500kHz (maximum on request)
Spatial Resolution	-
Availability	routinely available

Visible Spectroscopy – Divertor H alpha



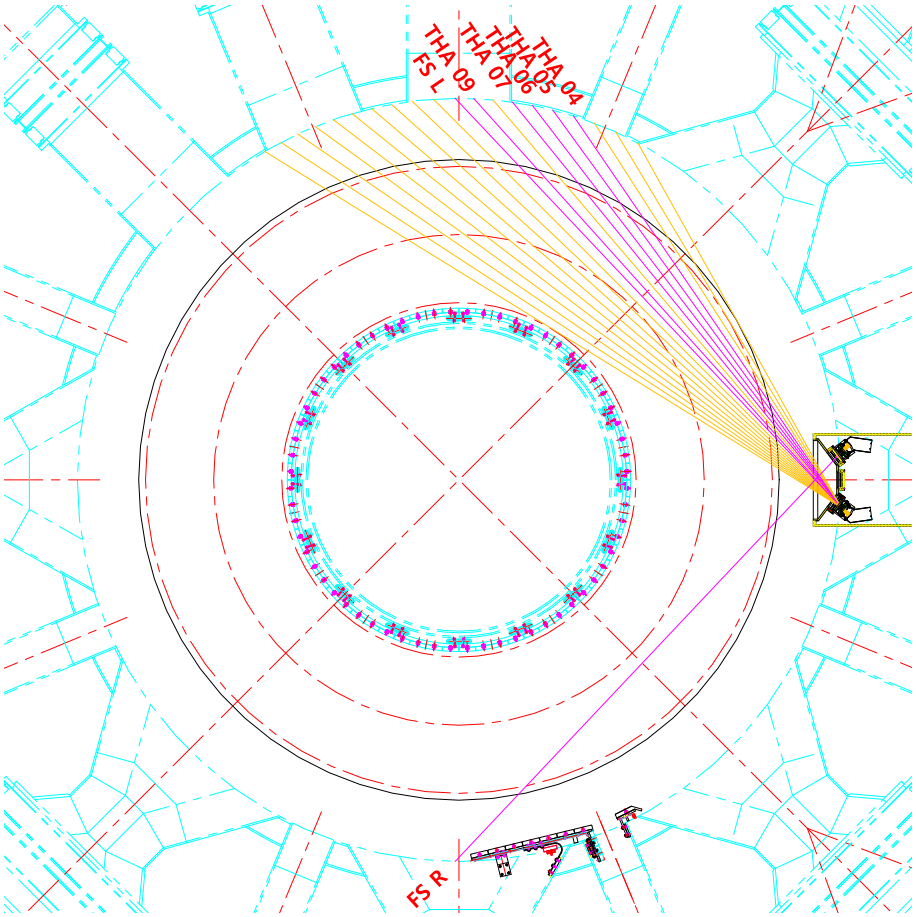
Visible Spectroscopy – Divertor H alpha

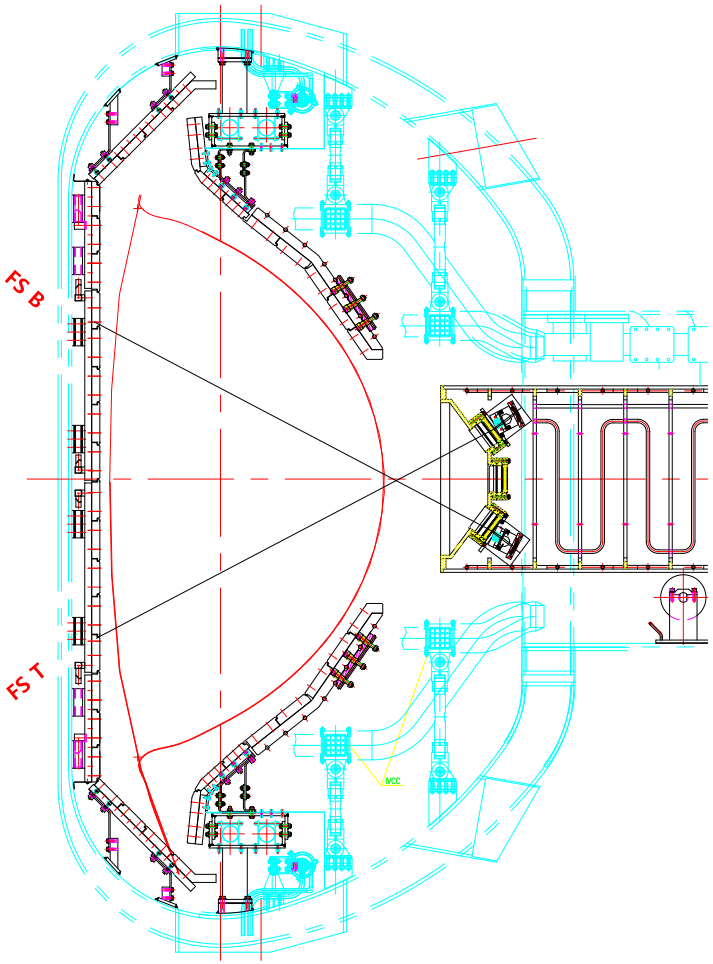
Name		Sampling	Unit	Description
\DIV_KHA01 : \DIV_KHA09		20 kHz	photon flux (ph/m²/nm/sr/s)	Divertor channels for H alpha emission photon flux
Subnodes	:FOO		V	raw data

Visible Spectroscopy - FS

Full Name	Filterscope
Contact	D.C. Seo (dcseo@kfe.re.kr), J. Jang (jjh4368@kfe.re.kr)
Measuring properties	Impurities intensity
Port assignment	J
Channel information	Horizontal 8 ch on midplane, 4 ch in poloidal direction
Time resolution	20 kHz (default)
Spatial Resolution	-
Availability	In commissioning

Visible Spectroscopy - FS





Visible Spectroscopy - FS

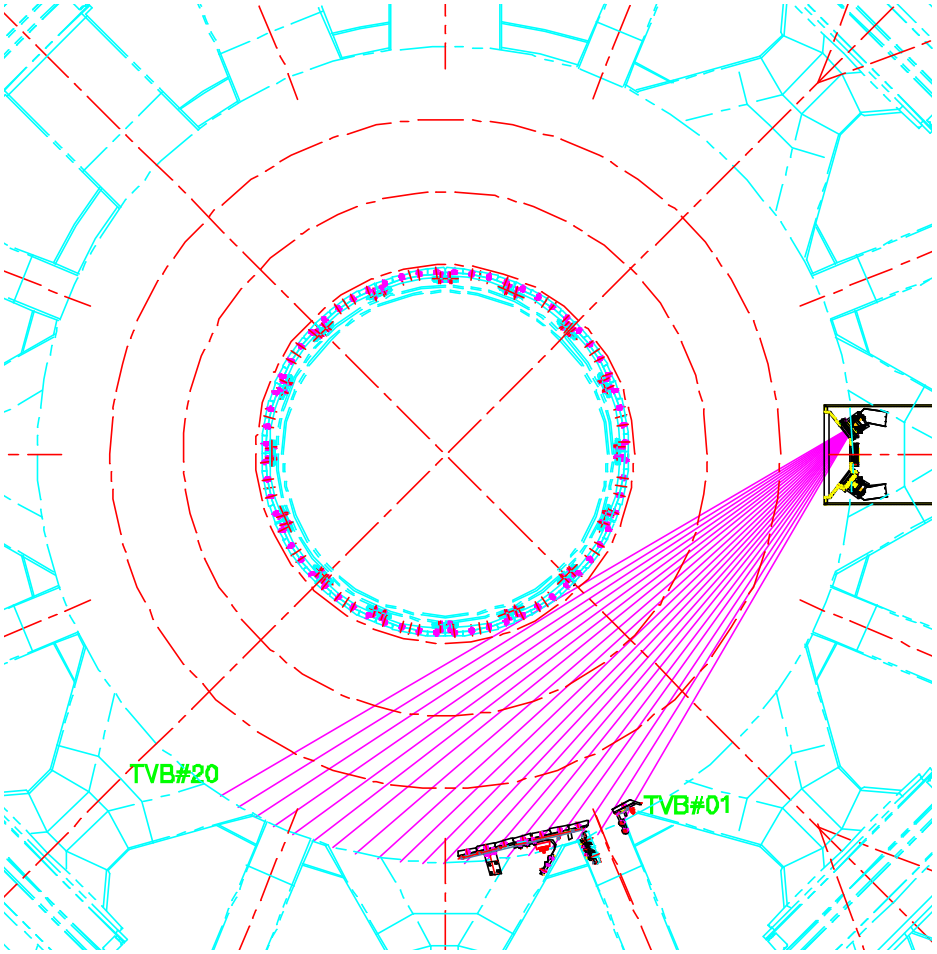
Name	Sampling	Unit	Description
\TUBE01	20 kHz	photon flux ($ph/m^2/nm/sr/s$)	O(II), toroidal direction (FS_L)
\TUBE02			H alpha, toroidal direction (FS_R)
\TUBE03			VB4*, toroidal direction (THA 07)
\TUBE04			C(III), poloidal direction for lower divertor (FS_T)
\TUBE05			C(III), poloidal direction for upper divertor (FS_B)
\TUBE06			He(II), poloidal direction for lower divertor (FS_T)
\TUBE07			H alpha, poloidal direction for lower divertor (FS_T)
\TUBE08			VB1, toroidal direction (THA 04)
\TUBE09			VB2, toroidal direction (THA 05)
\TUBE10			VB3, toroidal direction (THA 06)
\TUBE11			H alpha, toroidal direction (FS_L)
\TUBE12			VB5, toroidal direction (THA 09)

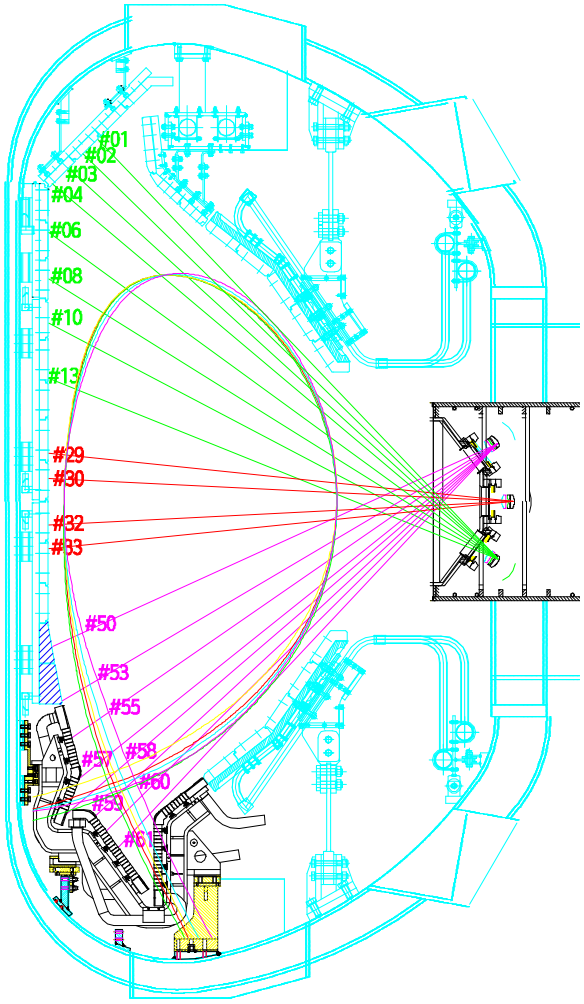
* Visible Bremsstrahlung

Visible Spectroscopy - VBS

Full Name	Visible Bremsstrahlung System
Contact	J. Jang (jjh4368@kfe.re.kr), D.C. Seo (dcseo@kfe.re.kr)
Measuring properties	effective Z number (Z_{eff}, impurities)
Port assignment	J
Channel information	Horizontal 20 ch on midplane, poloidal 20 ch
Time resolution	20 kHz (default), ~ 500kHz (maximum on request)
Spatial Resolution	-
Availability	routinely available

Visible Spectroscopy - VBS





Visible Spectroscopy - VBS

Name	Sampling	Unit	Description
\TOR_VB01 : \TOR_VB20	20 kHz	V	toroidal channels
\POL_VB01 : \POL_VB61	20 kHz	V	poloidal channels

Notes

- In 2020, toroidal channel #07 and #08 have been changed to He I (467nm) and Ne I (640 nm) filters, which are used for SPI experiments.
- In 2021, toroidal channel #07 and #08 returned to VBS
- In 2024, 10 toroidal channels were added.
- In 2024, 61 poloidal channels were upgraded, 20 channels are in use.
- Please consult Juhyeok Jang (jjh4368@kfe.re.kr) for Z_{eff} calculation.

- Since Shot#35216 (12 Nov 2024), the followings are for CIII and WI monitoring:

  CIII (464.7 nm) → -\POL_VB59:foo
  WI (400.9 nm) → -\POL_VB60:foo

Visible Spectroscopy - VSS (I)

Full Name	Visible Survey Spectrometer (AVANTES)
Contact	D.C. Seo (dcseo@kfe.re.kr), J. Jang (jjh4368@kfe.re.kr)
Measuring properties	A variety of impurities species in visible range
Port assignment	J
Channel information	Horizontal 1 ch on midplane (same LoS with THA#13)
Time resolution	~50Hz
Spatial Resolution	-
Availability	Routinely available

Notes

- Not available on MDS+, please consult to contact person.
- This system is operated using Toroidal H-alpha #13 channel. Please check VSS(IV) section for the channels layout.

Visible Spectroscopy - VSS (II)

Full Name	Visible Survey Spectrometer (Princeton Instruments, PI)
Contact	J. Jang (jjh4368@kfe.re.kr), D.C. Seo (dcseo@kfe.re.kr)
Measuring properties	A variety of impurities species in visible range
Port assignment	J
Channel information	poloidal 1 ch (same LoS with PVB#56, PHA#56)
Time resolution	100Hz
Spatial Resolution	-
Availability	Routinely available

Notes

- Not available on MDS+, please consult to contact person.
- This system is operated using Poloidal VB #56 channel. Please check VSS(IV) section for the channels layout.

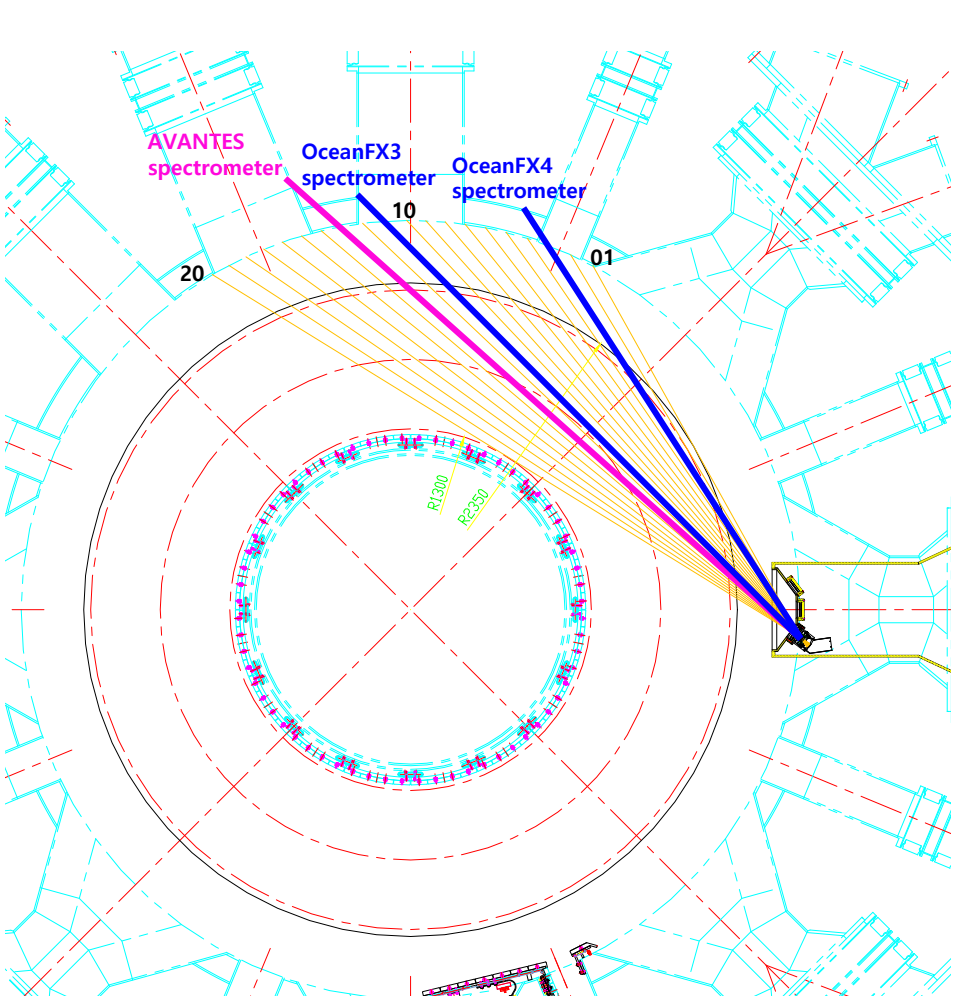
Visible Spectroscopy - VSS (III)

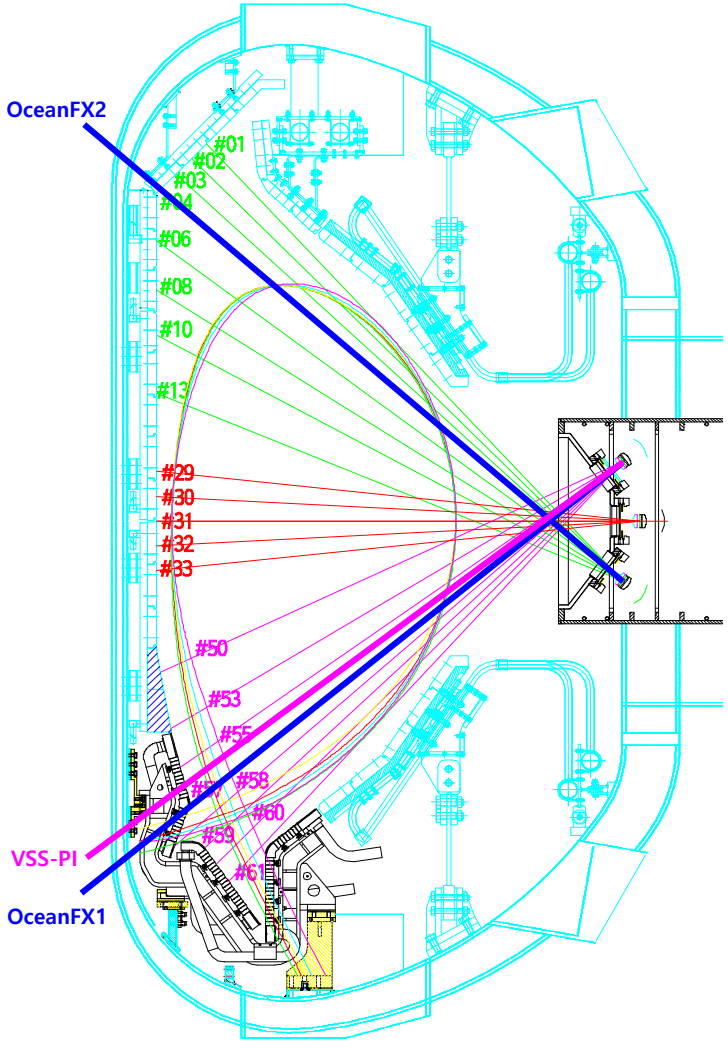
Full Name	Visible Survey Spectrometer (OceanFX)
Contact	D.C. Seo (dcseo@kfe.re.kr), J. Jang (jjh4368@kfe.re.kr)
Measuring properties	A variety of impurities species in visible range
Port assignment	J
Channel information	Horizontal 2 ch on midplane, poloidal 2 ch
Time resolution	500Hz
Spatial Resolution	-
Availability	Routinely available

Notes

- Not available on MDS+, please consult to contact person.
- This system is operated using toroidal H-alpha #3, #11 and poloidal H-alpha #4, #57 channels. Please check VSS(IV) section for the channels layout.

Visible Spectroscopy - VSS (IV)



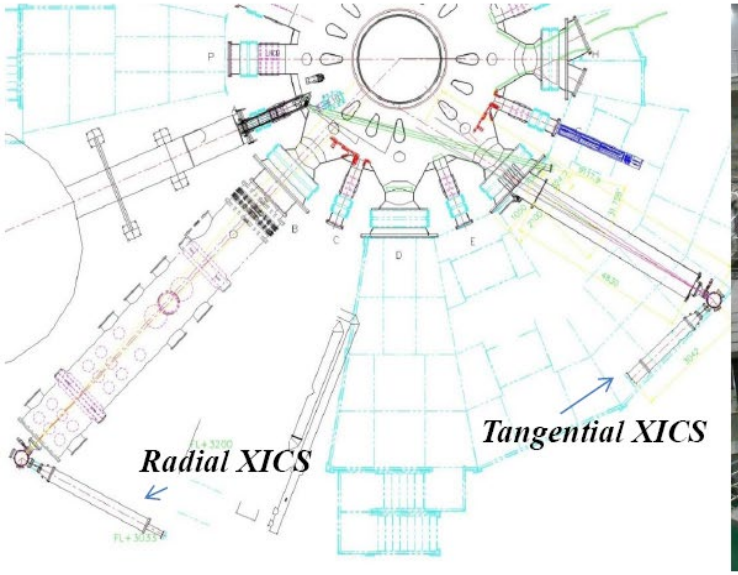


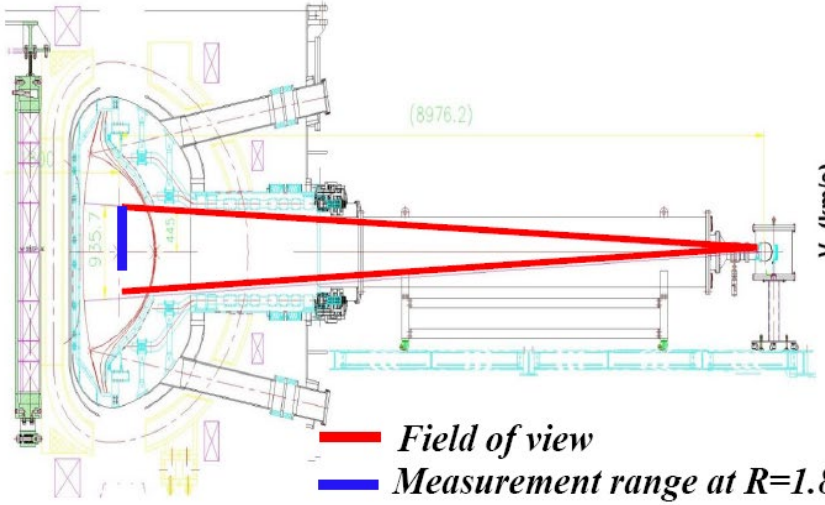
XICS

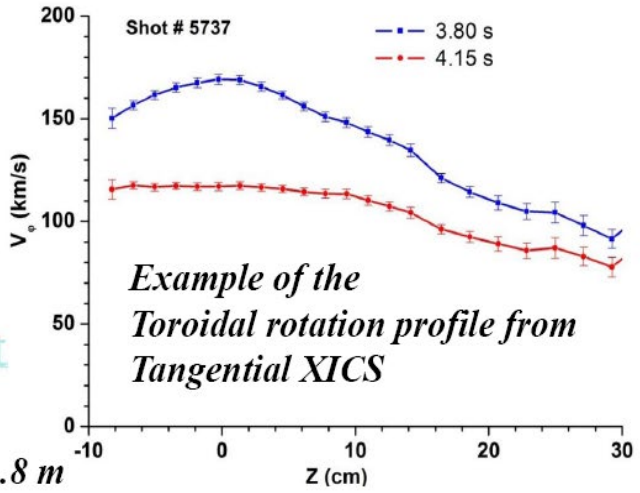
Full Name	X-ray Imaging Crystal Spectrometer
Contact	S. G. Lee (sglee@kfe.re.kr)
Measuring properties	toroidal rotation velocity (V_φ), ion temperature(T_i), electron temperature (T_e)
Port assignment	B (radial), F (tangential)
Channel information	Vertical profile in the core region at (R=1.8m , -0.1 m < Z<+0.3 m)
Time resolution	2 – 10 ms depending on the photon count rate
Spatial Resolution	< 2 cm depending on the photon count rate
Availability	Argon puffing required

XICS

Channels Layout







XICS

Name	Sampling	Unit	Description
\TXCS_VR053		km/s	Toroidal rotation at R = 1.8 m, Z = 0 m
\TXCS_TI053		keV	Ion temperature at R = 1.8 m, Z = 0 m
\TXCS_TE053		keV	Electron temperature at R = 1.8 m, Z = 0 m

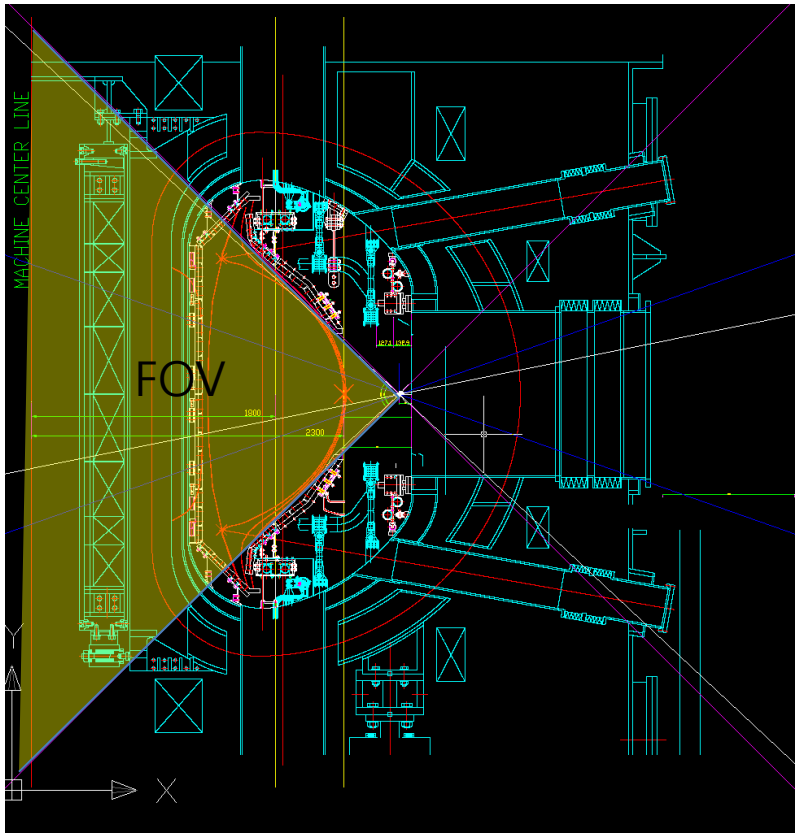
Notes

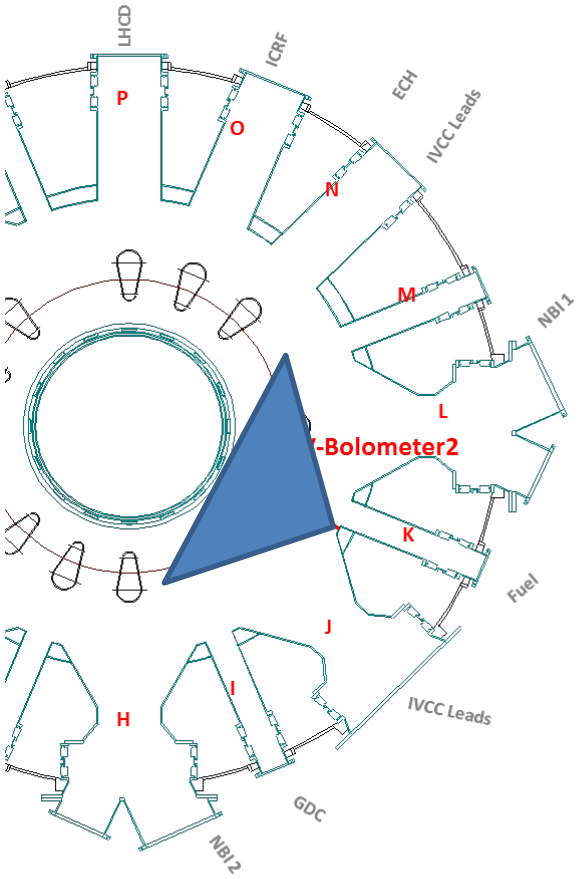
- The radial and tangential XICS systems have been installed as shown above layout. The main diagnostic is the tangential XICS system since it can provide the toroidal rotation, ion and electron temperatures simultaneously. Whereas the radial XICS system can provide the poloidal rotation, ion and electron temperatures simultaneously.
- Although XICS system can provide core profile measurement, one core location at R=1.8 m and Z=0 m from the tangential XICS system is routinely uploaded in the MDS+ server due to the detector limitation. The core profile measurements from both the radial and tangential XICS systems will be uploaded when the proper detector systems are ready.
- The measurement wavelength range of Ar XVII (helium-like) is from the resonance line w, 1s2 1S0-1s2p 1P1 at 3.9494 Å, to the forbidden line z, 1s2 1s0-1s2p 3S1, at 3.9944 Å.
- A proper argon gas puffing (or multiple puffing for long-pulse discharges) is required for the XICS operation.

AXUV bolometer

Full Name	Absolute eXtreme Ultra-Violet photodiode bolometer
Contact	S. Oh (stoh@kfe.re.kr)
Measuring properties	Radiation Power (P_{rad})
Port assignment	J-K (feedthrough K)
Channel information	1 single channel
Time resolution	100.0 μs
Spatial Resolution	
Availability	routinely available

AXUV bolometer





AXUV bolometer

Notes

- Data are sensor signals [V] representing relative radiation power values
- The absolute radiation power cannot be derived due to the sensitivity changes of the AXUV sensors during campaign.

After-Shot Data

Name	Sampling	Unit	Description
\ax3_bolo02:FOO		V	MDS+ node name Photodiode signal [V] for the total radiation power, at the toroidal location between J-Port and K-Port.

- basic sampling rate is 10 KHz. (max. 1 MHz)

Real-Time Data

RFM map :

category	HEX address	0	4	8	C	no. of bytes
IRVB-> PCS	0x3110100	id	AXUV_BOLO01 (float, V)	AXUV_BOLO02 (float, V)	AXUV_BOLO03 (float, V)	16

Main sensor

- basic sampling rate is 1 KHz. (max. 2 kHz)

Filtered AXUV Array (FAA)

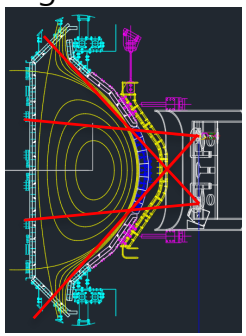
Full Name	Filtered AXUV Array
Contact	Jayhyun Kim (jayhyunkim@kfe.re.kr), Jae-Wook Kim (ijwkim@kfe.re.kr)
Measuring properties	Plasma radiation (during disruption)
Port assignment	D, O
Channel information	Bare AXUV, Al filter, Multilayer filter, Blind channel
Time resolution	10 μs
Spatial Resolution	6 cm (for PFAA)
Availability	routinely available

Filtered AXUV Array (FAA)

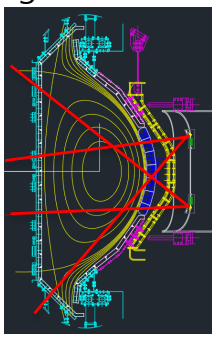
Poloidal Filtered AXUV Array (PFAA)

✓ Radiation distribution on each poloidal plane (tomography)

D-port
Poloidal viewing angle 54°



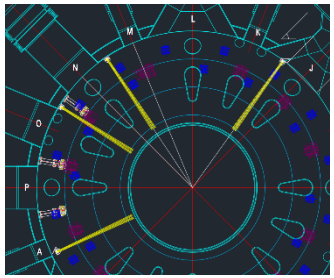
O-port
Poloidal viewing angle 41°



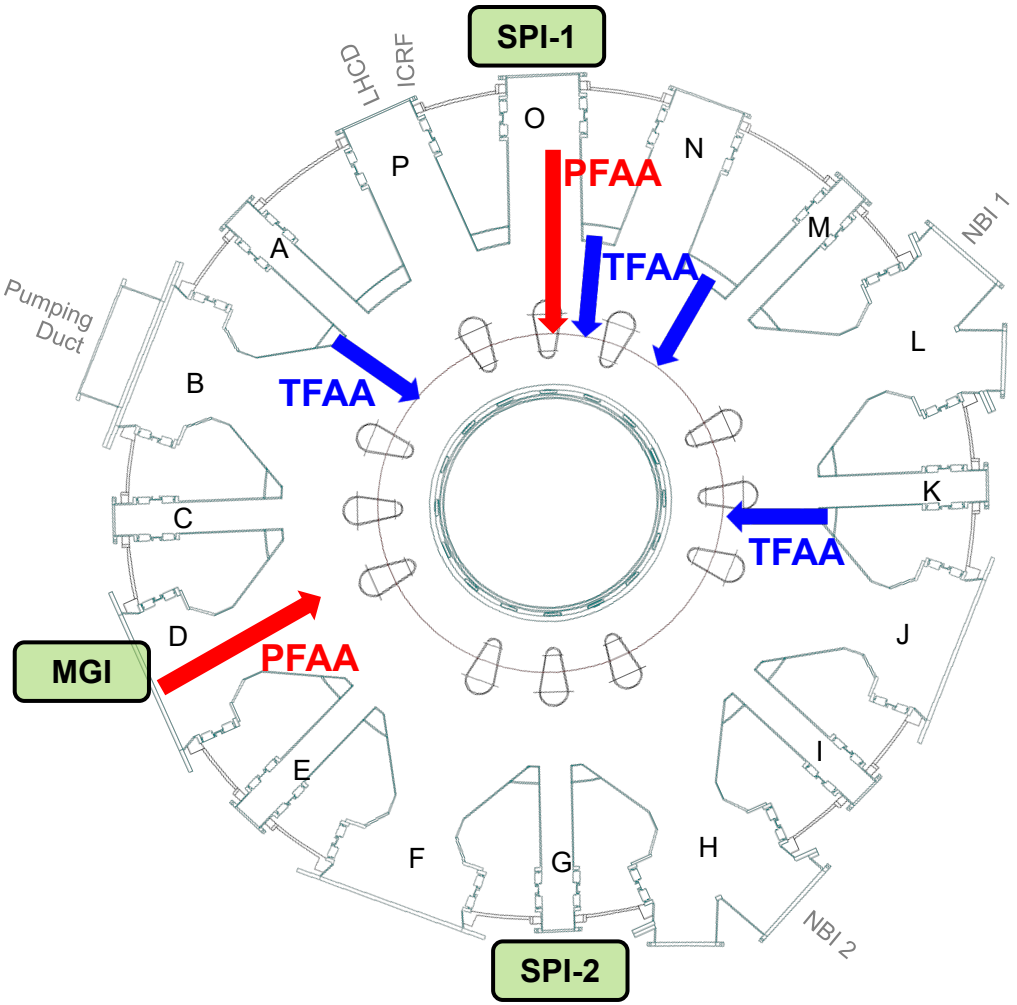
Toroidal Filtered AXUV Array (TFAA)

✓ Radiation power on different toroidal location

Top View



Side View
Poloidal viewing angle 79°



Filtered AXUV Array (FAA)

Name	Sampling	Unit	Description
\PFAA_DU001 … \PFAA_DU060	100 kHz	V	Plasma radiation signal from upper PFAA at D port
\PFAA_DL001 … \PFAA_DL060	100 kHz	V	Plasma radiation signal from lower PFAA at D port
\PFAA_OU001 … \PFAA_OU060	100 kHz	V	Plasma radiation signal from upper PFAA at O port
\PFAA_OL001 … \PFAA_OL060	100 kHz	V	Plasma radiation signal from lower PFAA at O port
\TFAA_001 … \TFAA_016	100 kHz	V	Plasma radiation signal from TFAAs

Notes

- This node provides the raw voltage signal which is integrated through the line of sight. To assess exact radiated power, please contact Juhyeok Jang (jjh4368@kfe.re.kr)

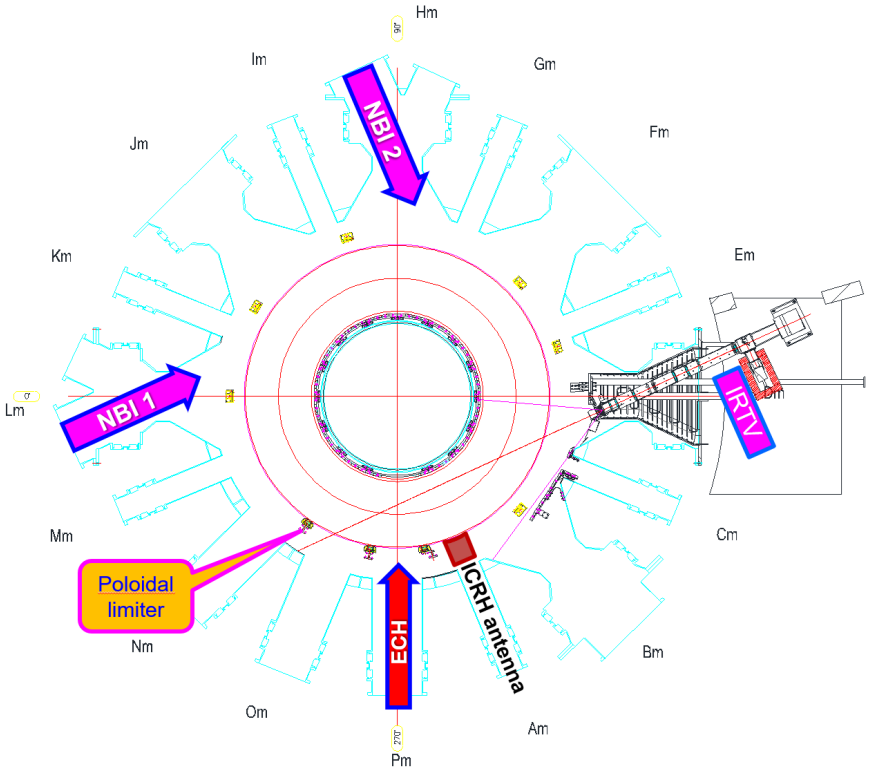
IRTV - Tangential

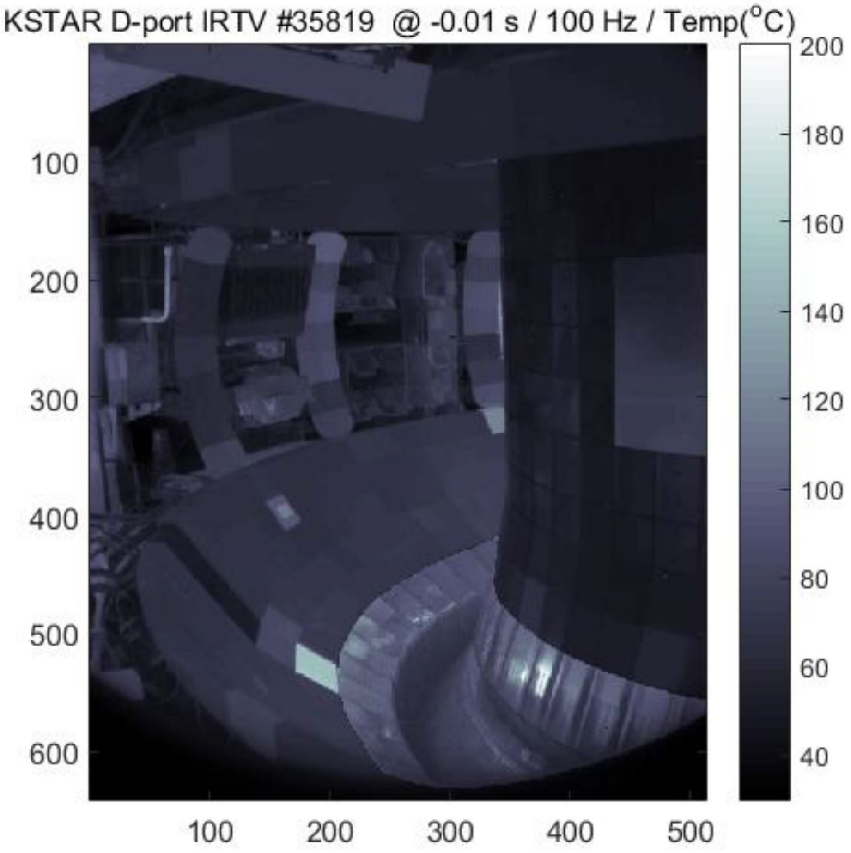
Full Name	Tangential Infrared TV
Contact	H. H. Lee (jdfm@kfe.re.kr)
Measuring properties	Surface temperature of fist wall(T), heat flux(q_{tan})
Port assignment	D middle port
Channel information	2D image (640x512)
Time resolution	100 Hz ~ 36 kHz (depends on window size)
Spatial Resolution	3 ~ 8 mm/pixel
Availability	routinely available

Notes

- MDS+ node not assigned yet but data can be provided by request.
- Video clip of the measurement result is available on KDIS (KSTAR Data Integration System) server

IRTV - Tangential





IRVB - Tangential

Full Name	Infra-Red Video Bolometer
Contact	S. Oh (stoh@kfe.re.kr)
Measuring properties	Radiation Profile
Port assignment	D middle port
Channel information	2D image (640x512, raw data)
Time resolution	100 Hz (integration time : 1 msec)
Availability	routinely available

Notes

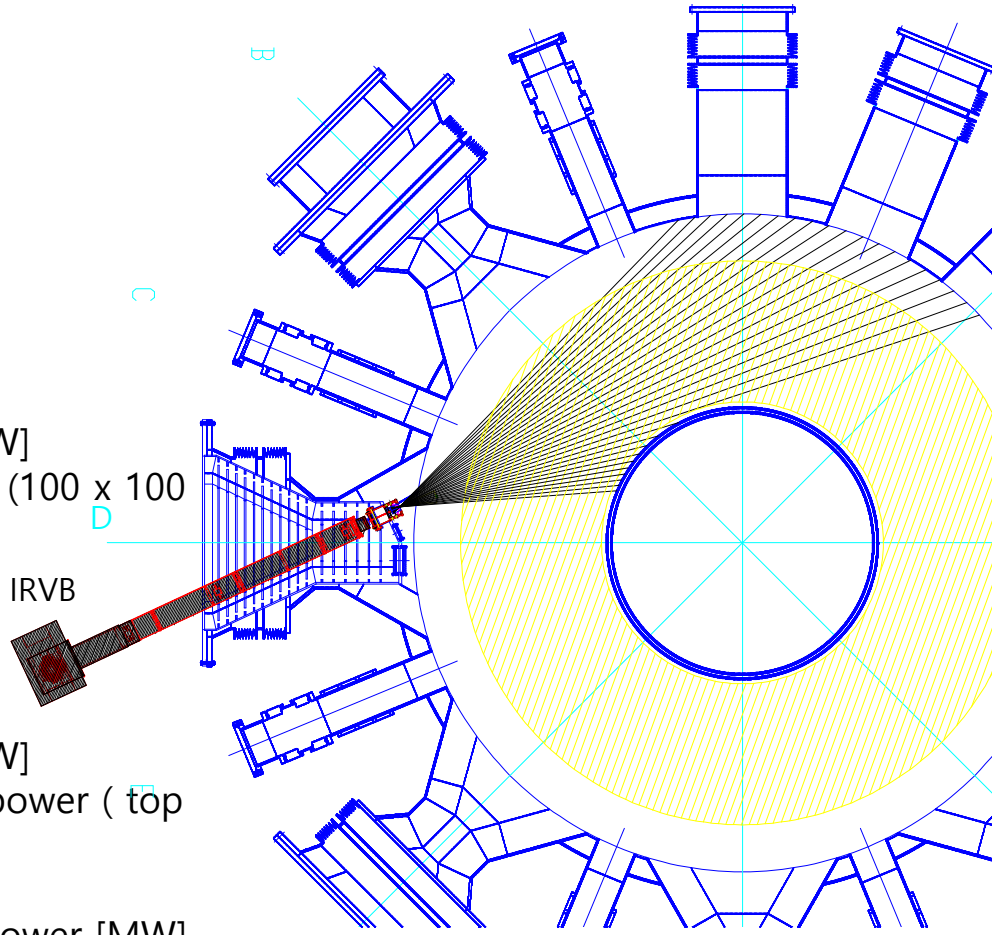
- RFM is available after Jan 8th 2024.
- DDS is available after 2024 campaign.

IRVB - Tangential

Infra-red imaging video bolometer (IRVB)

- Main Bolometer System
  >> absolute Value can be serviced.

- Data :
  - ➢ After-shot
    - ➢ Data rate : 100 Hz
    - ➢ Data contents:
      - total radiation power [MW]
      - 2D reconstructed Profiles (100 x 100 resolutions)
  - ➢ Streaming
    - Data rate: ~ 25 Hz
    - RFM :
      - ✓ total radiation power [MW]
      - ✓ Sampled Grid Radiation power (top 90% value)
    - DDS :
      - ✓ absolute total radiation power [MW]
      - ✓ 2D radiation profile (100 x 100 resolutions)



IRVB - Tangential

DATA Service

[After-shot]

- **MDS+**
  - Data type : total radiation power (No profile data)
  - Addr. : expName= "IMAGE", nodeName="\IRVB1_PRAD"

- **WebServer**
  - Data type : data plot, **2D profile data**, total radiation power
  - Visualization: movie file
  - Addr. : 172.17.112.125

- **KDIS**
  - Data type : plot data (movie file)

[Streaming (Real-Time)]

- **RFM**
  - Data : total radiation power, max power of sampled grid (No profile data)
  - Addr. : 0x3110000 ~

- **DDS**
  - Data: **2D profile data**, total radiation power
  - Addr. : topicName = "IRVB_RT_Recon" on network (172.17.112.XXX)

IRVB - Tangential

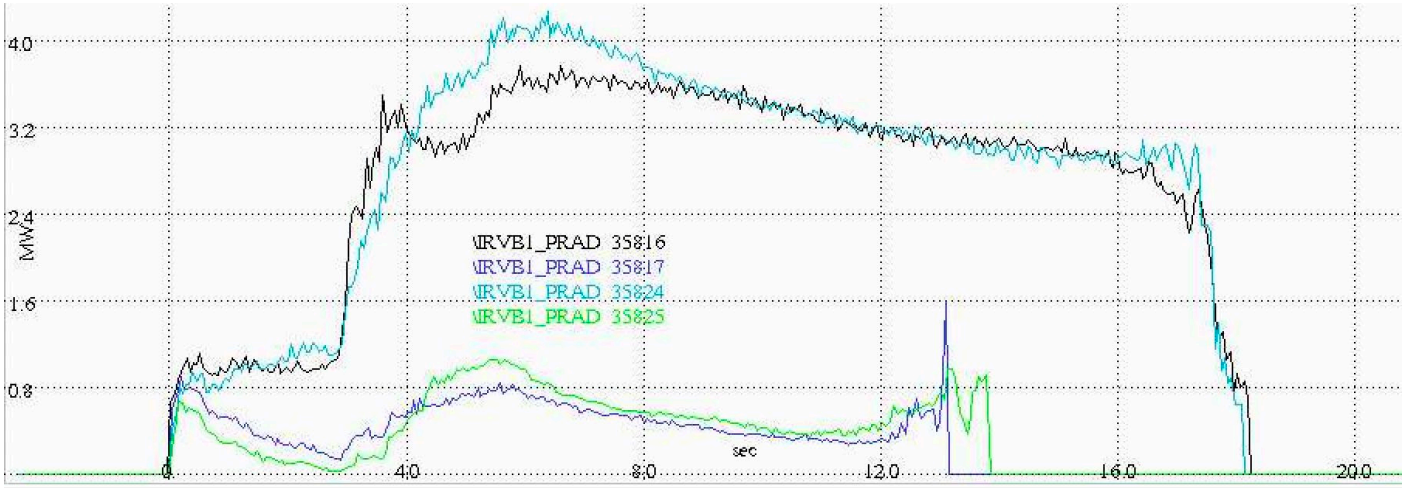
- **After-shot data service**

1. MDSplus

Data service:
total radiation power [MW]

Addr. :
expName= "IMAGE"
nodeName="\IRVB1_PRAD"
Description = "total radiation power [MW]"

Notice : plot using Jscope



IRVB - Tangential

- **After-shot data service**

2. Website

Data service:

- visualization (movie file)
- 2d profile [MW] (res.: 100 x 100)
- total radiation power [MW]

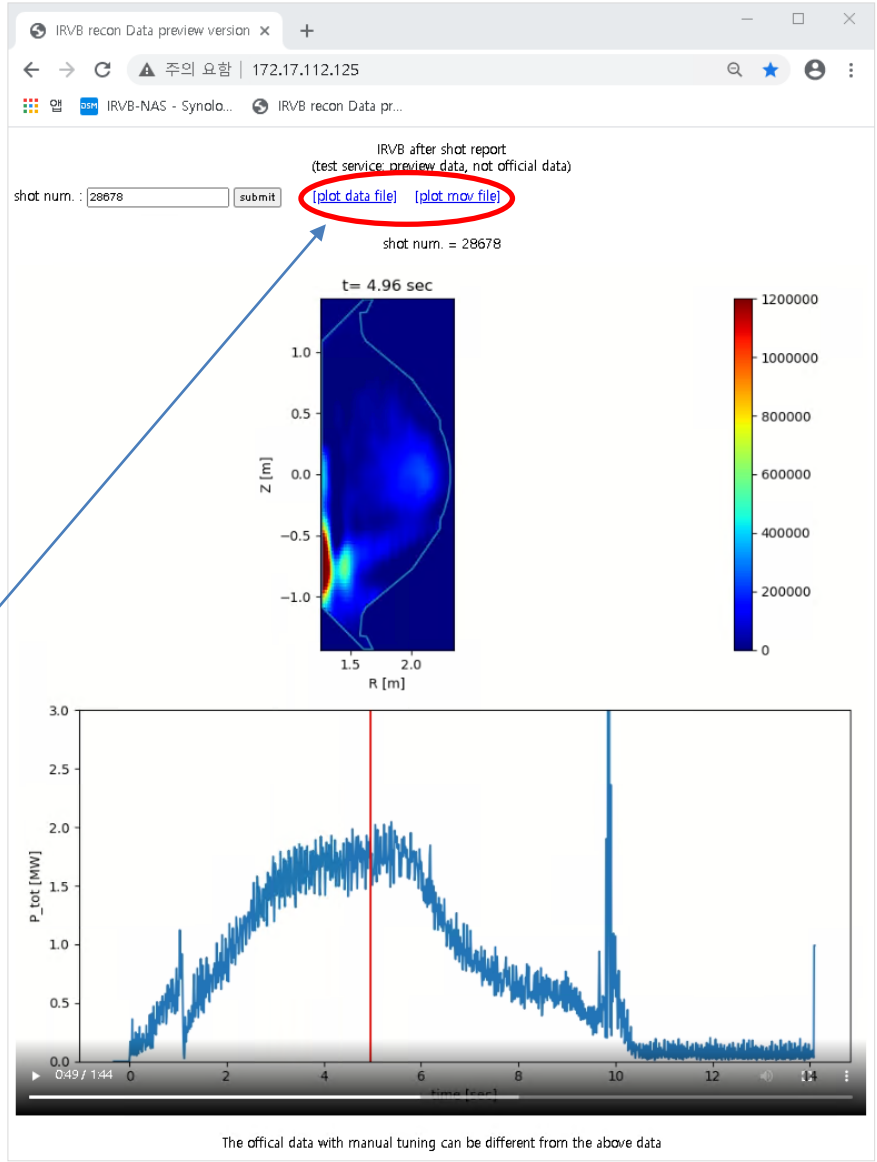
Addr. :

- http://172.17.112.125
- Accessible in KSTAR Exp. Network

Notice:

Data files can be downloaded from the website

If you have trouble in accessing the web-site, contact KSTAR network/computer team.



IRVB - Tangential

- **Streaming (Real-Time) Data service**

1. RFM

Data service:

- total radiation power [MW]
- Max power of each Grid (no full 2d profile)

Update Rate:

- ≤ 25 Hz

Addr. :

category	HEX address	0	4	8	C	no. of bytes
IRVB-> PCS	0x3110000	time_sec	timestamp_sec	total radiation_MW	fault_code	16
	0x3110010	p_MW[0]	p_MW[1]	p_MW[2]	p_MW[3]	32
	0x3110020	p_MW[4]	p_MW[5]	p_MW[6]	p_MW[7]	48
	0x3110030	p_MW[8]	p_MW[9]	p_MW[10]	p_MW[11]	64
	0x3110040	p_MW[12]	p_MW[13]	p_MW[14]	p_MW[15]	80
	0x3110050	p_MW[16]	p_MW[17]	p_MW[18]	p_MW[19]	96
	0x3110060	p_MW[20]	p_MW[21]	p_MW[22]	p_MW[23]	112
	0x3110070	p_MW[24]	p_MW[25]	p_MW[26]	p_MW[27]	128
	0x3110080	p_MW[28]	p_MW[29]	dummy	dummy	144
	0x3110090	dummy	dummy	dummy	dummy	160

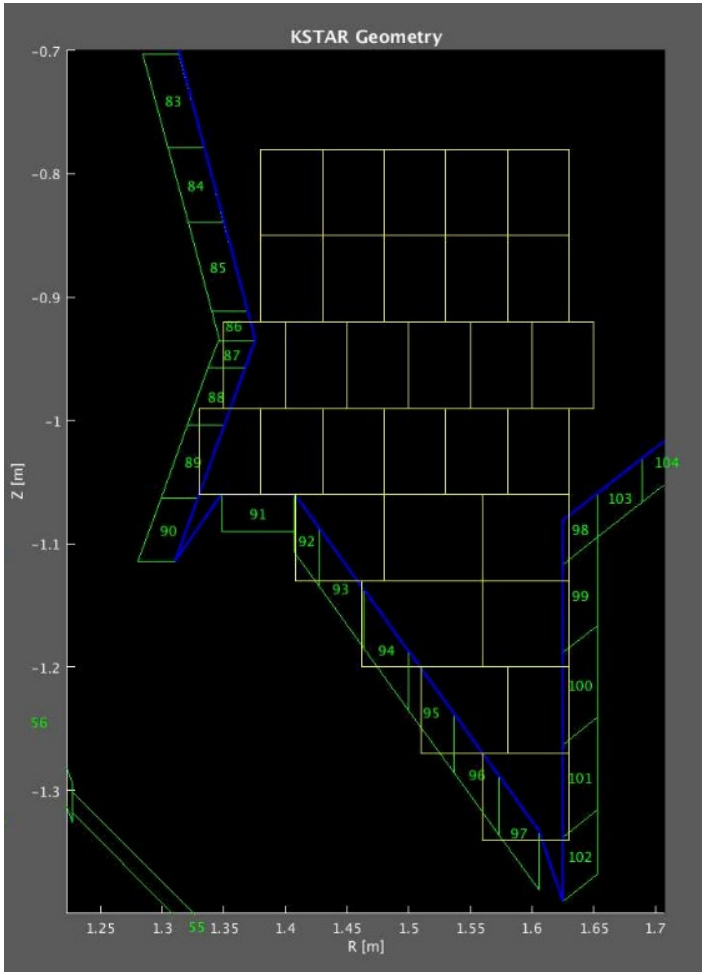
Data type : all float

IRVB - Tangential

- **Streaming (Real-Time) Data service**

1. RFM

Grid coordinates:



	R0 [m]	Z0 [m]	dr	dz
p_MW[0]	1.408	-1.13	0.072	0.07
p_MW[1]	1.48	-1.13	0.08	0.07
p_MW[2]	1.56	-1.13	0.07	0.07
p_MW[3]	1.462	-1.2	0.098	0.07
p_MW[4]	1.56	-1.2	0.07	0.07
p_MW[5]	1.51	-1.27	0.07	0.07
p_MW[6]	1.58	-1.27	0.05	0.07
p_MW[7]	1.56	-1.34	0.07	0.07
p_MW[8]	1.33	-1.06	0.05	0.07
p_MW[9]	1.38	-1.06	0.05	0.07
p_MW[10]	1.43	-1.06	0.05	0.07
p_MW[11]	1.48	-1.06	0.05	0.07
p_MW[12]	1.53	-1.06	0.05	0.07
p_MW[13]	1.58	-1.06	0.05	0.07
p_MW[14]	1.35	-0.99	0.05	0.07
p_MW[15]	1.4	-0.99	0.05	0.07
p_MW[16]	1.45	-0.99	0.05	0.07
p_MW[17]	1.5	-0.99	0.05	0.07
p_MW[18]	1.55	-0.99	0.05	0.07
p_MW[19]	1.6	-0.99	0.05	0.07
p_MW[20]	1.38	-0.92	0.05	0.07
p_MW[21]	1.43	-0.92	0.05	0.07
p_MW[22]	1.48	-0.92	0.05	0.07
p_MW[23]	1.53	-0.92	0.05	0.07
p_MW[24]	1.58	-0.92	0.05	0.07
p_MW[25]	1.38	-0.85	0.05	0.07
p_MW[26]	1.43	-0.85	0.05	0.07
p_MW[27]	1.48	-0.85	0.05	0.07
p_MW[28]	1.53	-0.85	0.05	0.07
p_MW[29]	1.58	-0.85	0.05	0.07

IRVB - Tangential

- **Streaming (Real-Time) Data service**

2. DDS

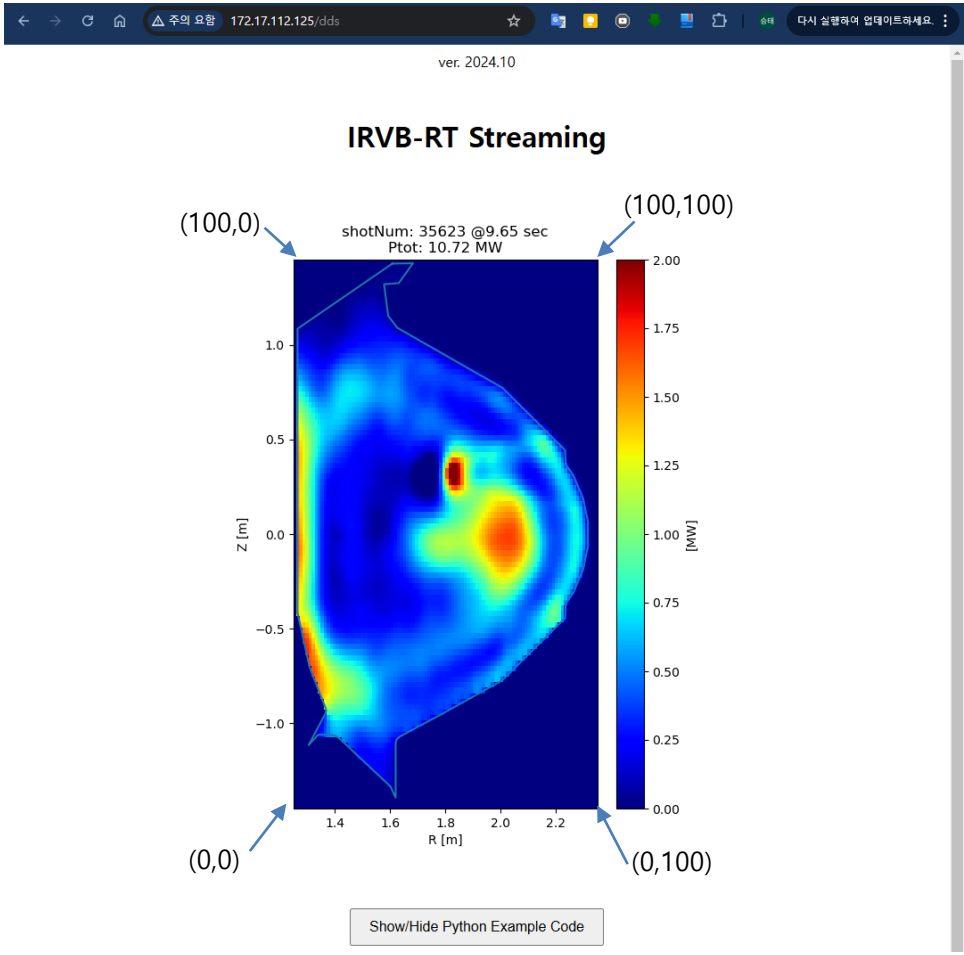
Data service:
- visualization
- 2D profile [MW] (res.: 100 x 100)
- total radiation power [MW]

Update Rate:
- ≤ 25 Hz

Addr. :
- DDS data:
  Networks: 172.17.112.x
  Topic name: "IRVB_RT_Recon"

- DDS visualization:
  http://172.17.112.125/dds

Notice:
If you have trouble in accessing the web-site, contact KSTAR network/computer team.



IRVB - Tangential

- **Streaming (Real-Time) Data service**

2. DDS

Code Example:

```
global Nr, Nz
Nr=100
Nz=100


from dataclasses import dataclass
from cyclonedds.idl import IdlStruct
from cyclonedds.topic import Topic

from cyclonedds.domain import DomainParticipant
from cyclonedds.sub import Subscriber
from cyclonedds.sub import DataReader

from cyclonedds.util import duration
import numpy as np


@dataclass
class Message(IdlStruct):
    shotNum: int
    time: float
    recon1D_MW: array[float,10000]
    totRadPrad_MW: float

participant = DomainParticipant()
topic = Topic(participant, "IRVB_RT_Recon", Message)
subscriber = Subscriber(participant)
reader = DataReader(subscriber, topic)

for msg in reader.take_iter(timeout = duration(weeks=20)):
    print("I got shotNum:", msg.shotNum)
    print("I got time:", msg.time)
    print("I got recon1D_MW:", msg.recon1D_MW)
    print("I got totRadPrad_MW:", msg.totRadPrad_MW)

    recon2D_MW = np.reshape(msg.recon1D_MW,(Nr, Nz))
```

This code is a Python example for receiving IRVB-RT streaming data, specifically the entire IRVB 100x100 2D recon profile data, in real-time (streaming). CycloneDDS package must be installed, and the access is only possible in KSTAR experiment network.

Code is available on http://172.17.112.125/dds

IRTV - Divertor

Full Name	Divertor Infrared TV
Contact	H. H. Lee (jdfm@kfe.re.kr)
Measuring properties	divertor surface temperature (T_{div}), divertor heat flux (q_{div})
Port assignment	F middle port
Channel information	2D image (640 x 512)
Time resolution	150 Hz – 35 kHz (depending on the viewing size)
Spatial Resolution	~ 1.2 mm/pixel
Availability	To be updated

Notes

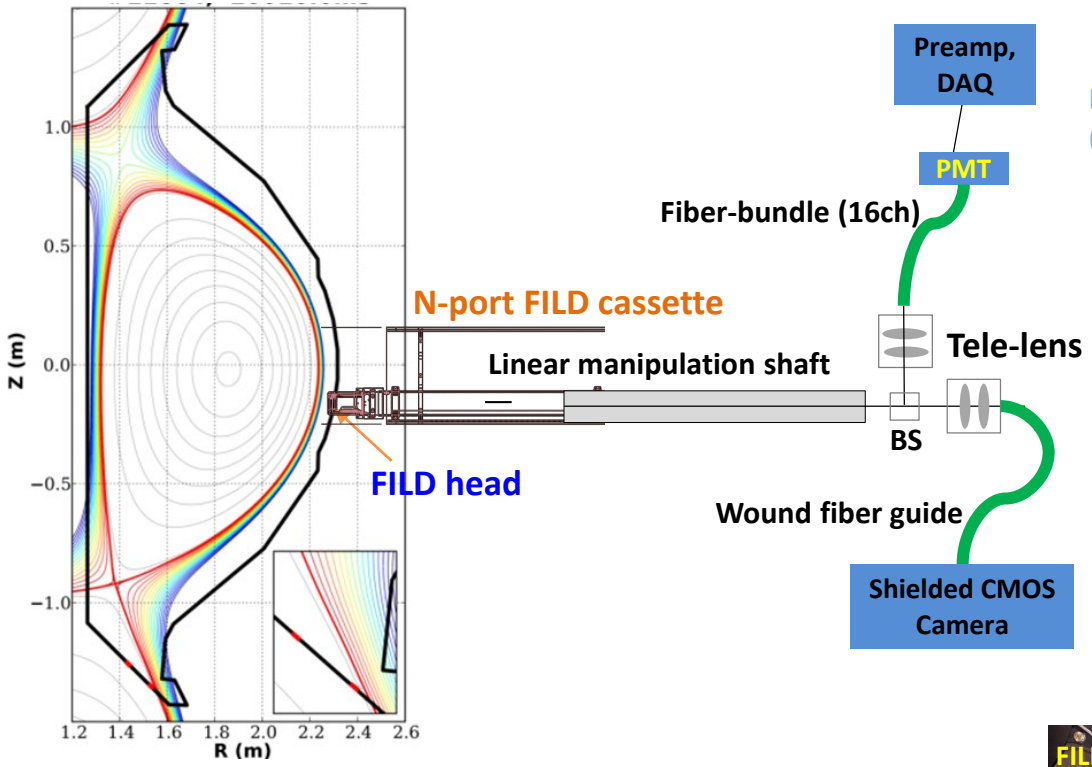
- MDS+ node not assigned yet but data can be provided by request.
- Divertor heat flux profile is estimated from the time history of the surface temperature. It takes some time to obtain the result. The divertor heat flux data is also provided by request.

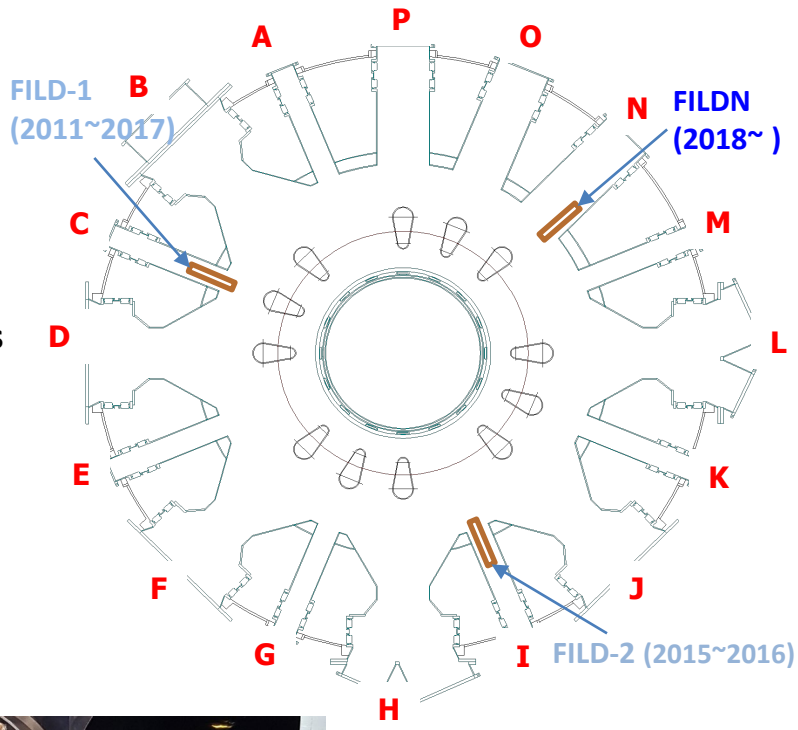
FILD

Full Name	Fast-Ion Loss Detector
Contact	Junghee Kim (kimju@kfe.re.kr)
Measuring properties	• Local deposition power of the lost fast-ions • Phase-space of lost fast-ions: Detectable range is (40 – 500 keV) of energy and (5° – 87°) of pitch-angle.
Port assignment	C (FILD-1, 2011-2017), I (FILD-2, 2015 - 2016), N (FILDN, 2018 -)
Channel information	3 x 3 (virtual segments from 2D scintillator image → PMT or APD array)
Time resolution	60 - 5000 fps (CMOS), 2MS/s (PMT)
Resolution	2 – 5 keV in energy, 2.0° – 4.0° in pitch-angle
Availability	Only on request

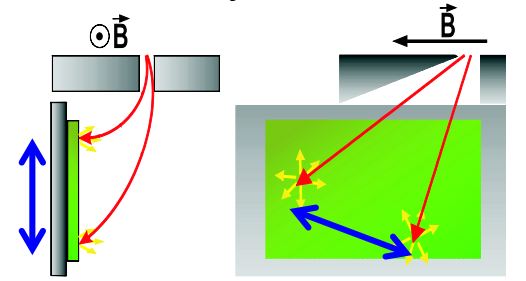
* deduced from the Larmor radius and the pitch-angle mapped onto the FILD scintillator plane
* pitch-angle = $\arccos(v_{\parallel}/v)$
* Scintillator material: TG-Green or ZnS:Ag (2011, since 2019)

FILD





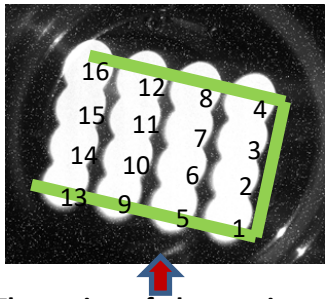
Scintillator-based fast-ion loss detector



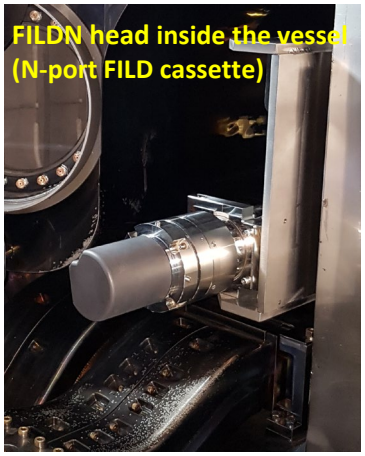
Energy: 30 – 500 keV

Pitch-angle: 5° – 87°

Figure courtesy of M. Garcia-Munoz



The region of observation on the scintillator, corresponding to the PMT channels



Notes

- FILD-1 system has been removed from the C-port, and refurbished at the N-port (2018).
- APDCAM channels for the FILD-2 has not been uploaded to the MDSplus.

FILD

Name	System	Sampling	Unit	Description
\FIL1_INT:FOO or \FIL1_INT	FILD-1 CCD	125 - 250 fps (640 X 480)	a.u.	Time-dependent intensity record over whole scintillator plane (2011 - 2017)
\FILDN_INT	N-port FILD CCD	0.12 – 2 kfps (1024 X 1024)	a.u.	Time-dependent intensity record over whole scintillator plane, Photron Mini AX50: Max. 170 kfps /w 128x16 pixels (in 2018)
\FIL2_INT:FOO or \FIL2_INT	FILD-2 CCD	125 - 250 fps	a.u.	Time-dependent intensity record over whole scintillator plane
\FIL1_PMT01:FOO … \FIL1_PMT16:FOO	FILD-1 PMT	0.1 - 2 MHz	V	Raw data of PMT signal for each segment are a of the scintillator plane (2011 - 2017) (2017 campaign: only\FIL1_PMT05:FOO is available.)
\FILDN_PMT01:FOO … \FILDN_PMT16:FOO	N-port FILD PMT	0.1 - 2 MHz	V	Raw data of PMT signal for each segment are a of the scintillator plane (in 2018)
\FIL1_PMT01 … \FIL1_PMT16	FILD-1 PMT	10 kHz	V	Down-sampling + smoothing (not available since 2015)

Notes

- Currently, uploading data to the MDS+ nodes is stopped temporarily. Post-processed data will be provided by the request.
- From 2018 campaign, N-port FILD system is operated. → \FILDN_INT, \FILDN_PMTXX:FOO are available instead of FILD-1 nodes.
- Energy and pitch-angle map is calculated separately on request, based on the magnetic equilibrium (3-D magnetic pitch at the FILD head) information.
- MDS node names of the FILD signals in 2011 or 2012 campaigns are different with the current one. Try '\FIL_INT' or \FIL_INT:FOO' first for the 2011 & 2012 campaign data. If an error is encountered to acquire the MDS signal, please ask the contact persons

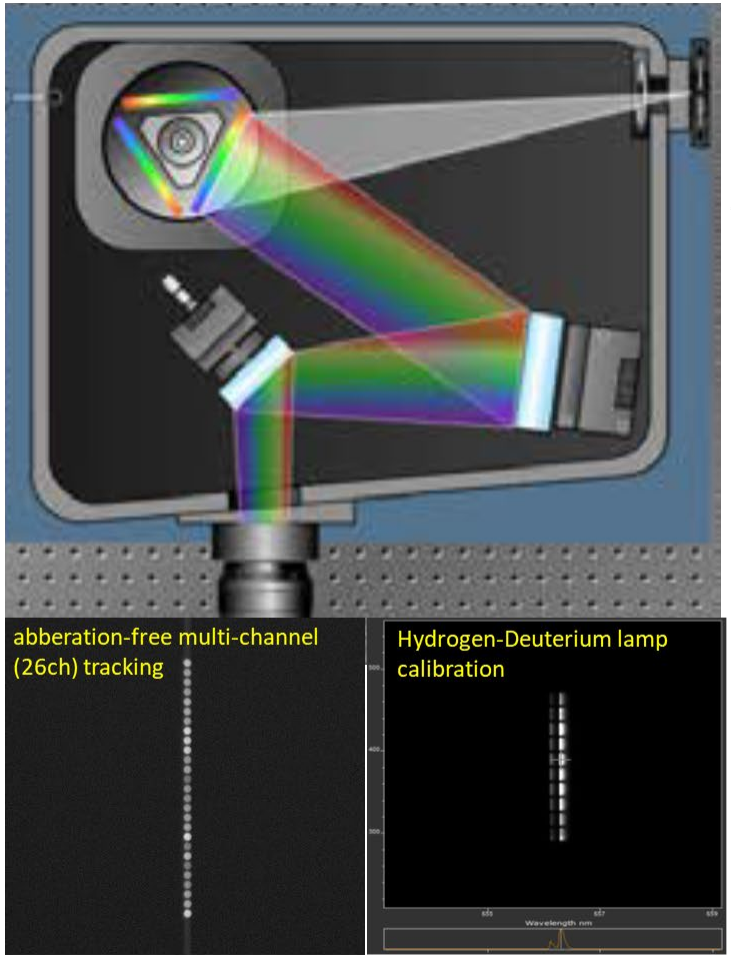
FIDA

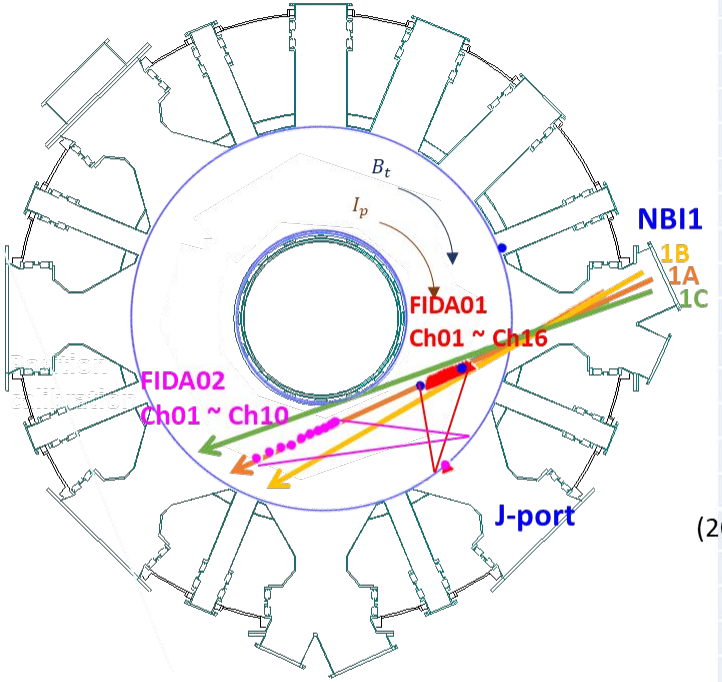
Full Name	Fast-Ion Dα Spectroscopy
Contact	Junghee Kim (kimju@kfe.re.kr), Minuk Choi (muchoi@kfe.re.kr)
Measuring properties	• Fast-ion Dα intensity (∝ fast-ion density) profile • Phase-space (Distribution of energy and pitch-angle) of confined fast-ions
Port assignment	J (tangential-view, 2019 -), J (oblique-view, 2025 -)
Channel information	2 arrays, 26 ch (FIDA01[bue-shift]: 18-19ch, FIDA02[red-shift]: 7-8ch)
Time resolution	10 msec
Resolution	Spatial: 2 – 5 cm
Availability	routinely available

* **Fast-ion phase-space** and **density profile** can be deduced by FIDASIM calculations combined with NUBEAM/TRANSP modelling on request.
* In 2015 campaign, D spectra have been acquired by sharing MSE optics. In 2018, dedicated FIDA optics are installed at J-port (optical module #3 and #5).
* J-port Module #3: Blue-shifted FIDA (NB-1), J-port Module #5: Red-shifted FIDA (NB-1 or NB-2)
* Beam-modulation is essential. (minimum beam-off duration: 10msec (20 msec recommended))
* FIDA intensity profile data for the specific fast-ion energy band (e.g. 60 – 70 keV) will be acquired by *OMFIT-FIDA* module (HDF5 format).

FIDA

Schmidt-Czerny-Turner Spectrograph (2021 ~)





FIDA array line-of-sights (two mid-plane tangential)
FIDA01: blue-shifted, FIDA02: red-shifted

(2019) FIDA01

CH	R [cm]
1	224.71
2	220.28
3	217.00
4	213.11
5	209.52
6	206.69
7	203.90
8	201.03
9	198.79
10	196.32
11	193.75
12	191.28
13	189.32
14	186.93
15	184.93
16	182.92

(2019) FIDA02

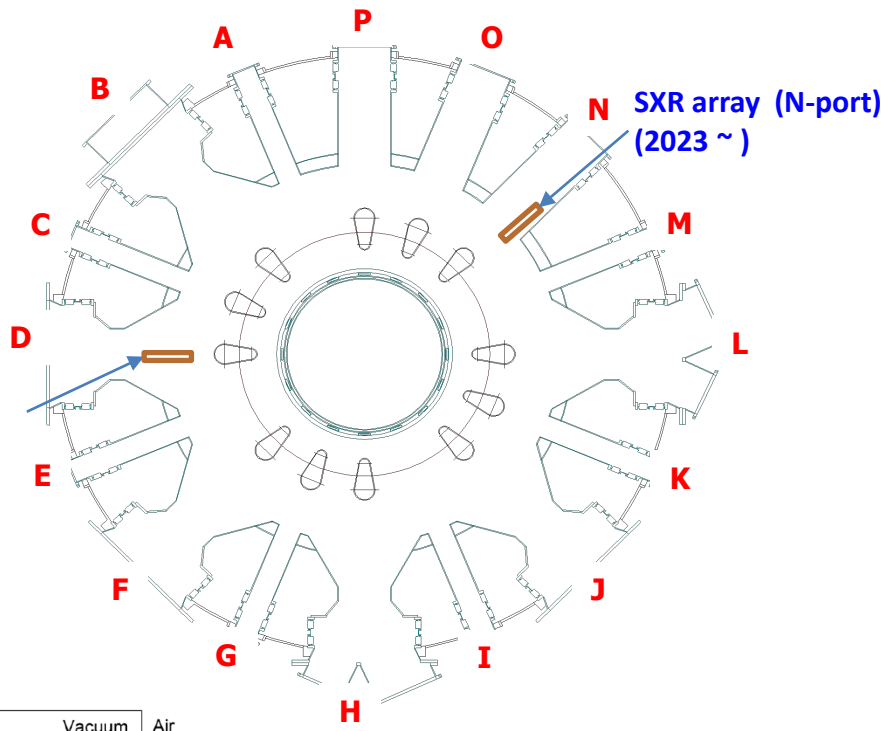
CH	R [cm]
1	227.56
2	211.87
3	199.34
4	189.03
5	179.17
6	171.61
7	165.68
8	161.07
9	157.35
10	154.5

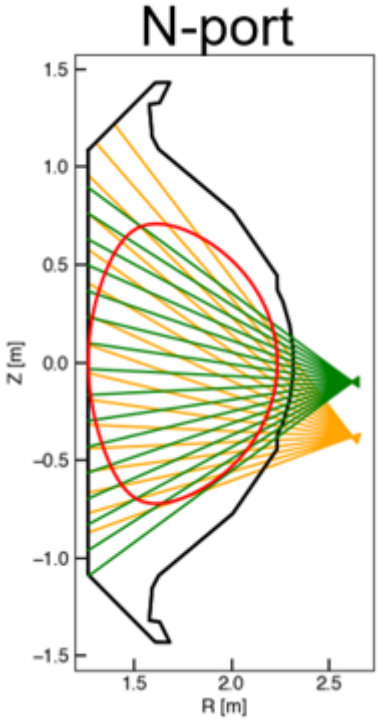
SXR array

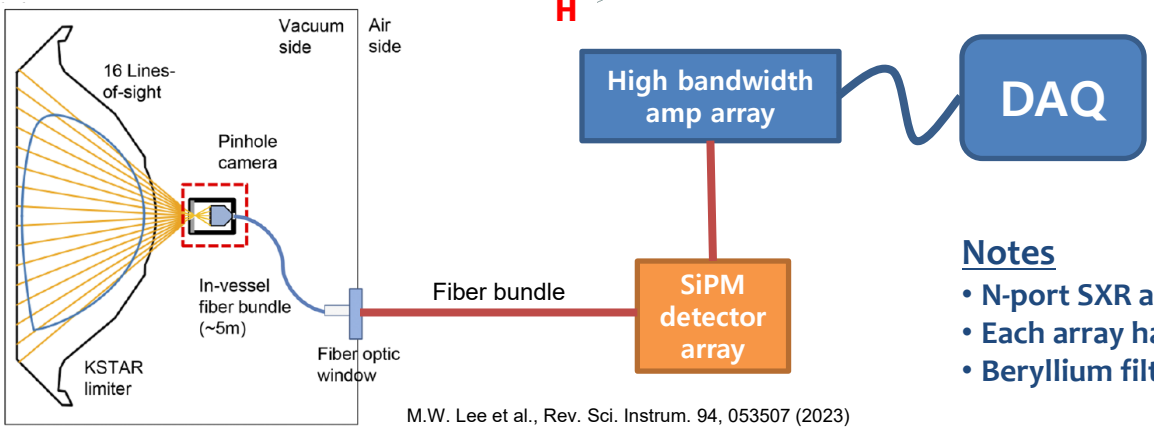
Full Name	Soft x-ray array
Contact	Junghee Kim (kimju@kfe.re.kr)
Measuring properties	• X-ray emission profile • Electron temperature/fluctuation profile • MHD mode activities • High-Z impurity contents
Port assignment	N (2023 -), N & D (2025 -)
Channel information	2 – 3 ch (2023 – Dec 2024), 16 – 64 ch (Jan 2025 –)
Time resolution	1 μsec (1MS/s/ch)
Resolution	Spatial: 1 – 3 cm
Availability	routinely available (after Jan 2024)

* KSTAR SXR array diagnostic system is based on the x-ray scintillation (YAG:Ce). (a.k.a. Optical SXR)
* Nominal data type of the SXR array: HDF5
* Data analysis tool will be provided in the OMFIT platform (*OMFIT-SXR* module) after Jan 2025.
* Tomography reconstruction service will be provided in 2025 ~ .

SXR array







M.W. Lee et al., Rev. Sci. Instrum. 94, 053507 (2023)

Notes

- N-port SXR array: 16ch × 2 (2 arrays)
- Each array has a double layer (two-filter T_e measurement).
- Beryllium filter thickness in each array: 50 μm & 10 μm

Fusion Neutron Diagnostics

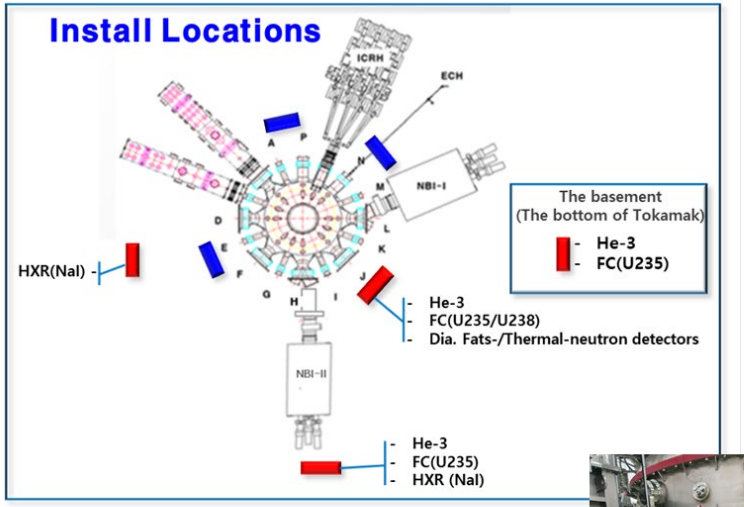
Full Name	Fusion Neutron Diagnostics
Contact	Youngseok Lee (yslee@kfe.re.kr)
Measuring properties	- Time-resolved Neutron emission rate • Micro-Fission chambers (U-235/U-238) • Micro-He3 counters • Diamond-based Thermal/Fast neutron detectors - D-D/D-T Fusion neutron Energy • Diamond-based neutron spectrometers
Port assignment	Near J-port
Channel information	Measurements at three locations (J, Lower vessel(basement), Entrance upper side) around the KSTAR tokamak
Time resolution	100 μsec~100 msec (typical 1~10 msec.)
Resolution	-
Availability	routinely available (after Jan 2024)

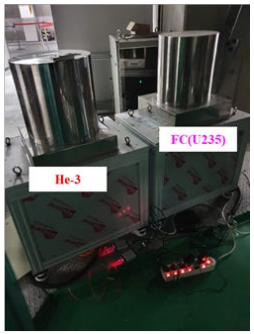
Fusion Neutron Diagnostics

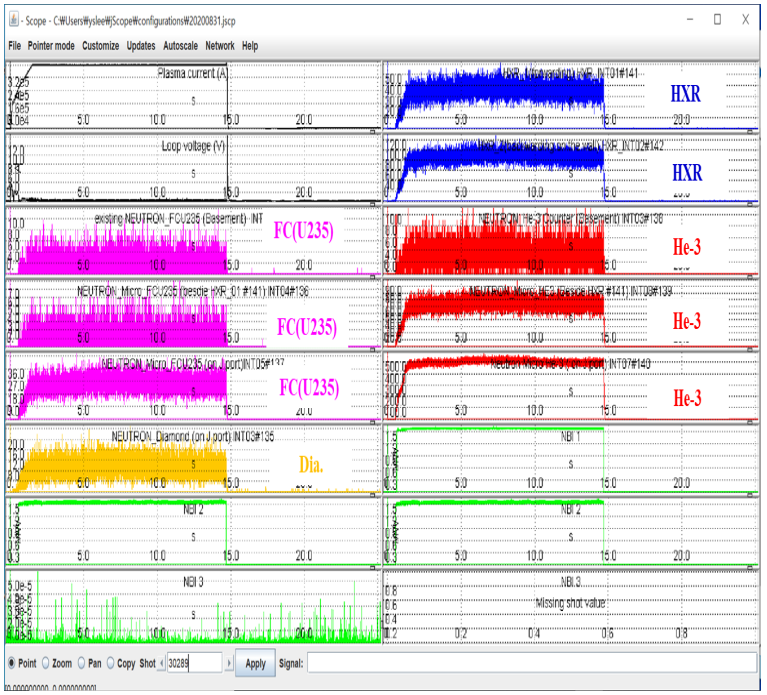
Name	System	Sampling	Unit	Description
\NTRN_INT01	Fission	100MHz	n/ms	**Lower vessel (basement Level D2)**
\NTRN_INT06	He-3	100MHz	n/ms	**Lower vessel (basement Level D2)**
\NTRN_INT05	Fission	100MHz	n/ms	**Near J-port**
\NTRN_INT08	He-3	100MHz	n/ms	**Near J-port**
\NTRN_INT04	Fission	100MHz	n/ms	**Entrance upper side**
\NTRN_INT07	He-3	100MHz	n/ms	**Entrance upper side**
\NTRN_INT03	Diamond-based detector	100MHz	n/ms	**Near J-port**

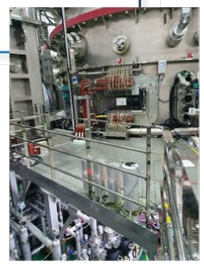
Fusion Neutron Diagnostics

Measurements at three locations around the KSTAR tokamak









HXR Monitor

Full Name	Hard X-ray monitor
Contact	Youngseok Lee (yslee@kfe.re.kr)
Measuring properties	Thick target bremsstrahlung emission (Hard X-ray) & Energy spectra
Port assignment	on either side of the KSTAR tokamak
Channel information	2 system (forward & backward)
Time resolution	100 μsec~100 msec (typical 1~10 msec.)
Spatial Resolution	-
Availability	routinely available

Notes

*** Because of its data size, the HXR energy spectrum is saved only local PC.**

HXR Monitor

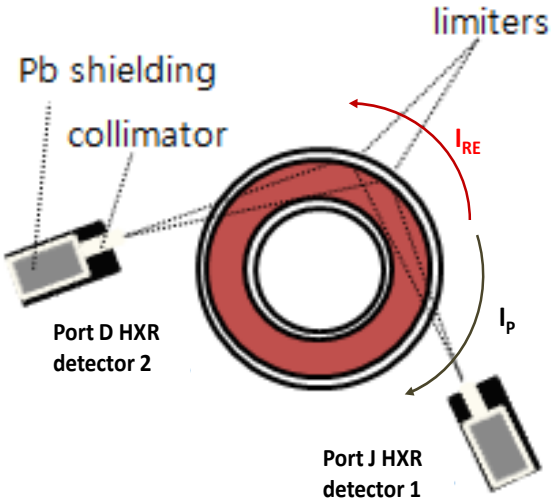
Name	Sampling	Unit	Description
\HXR_INT01			Backward HXR emission
\HXR_INT02			Forward HXR emission

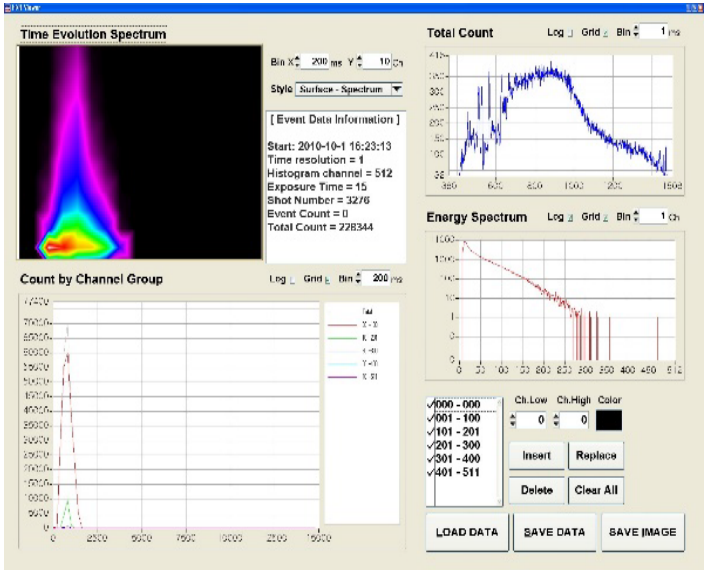
Notes

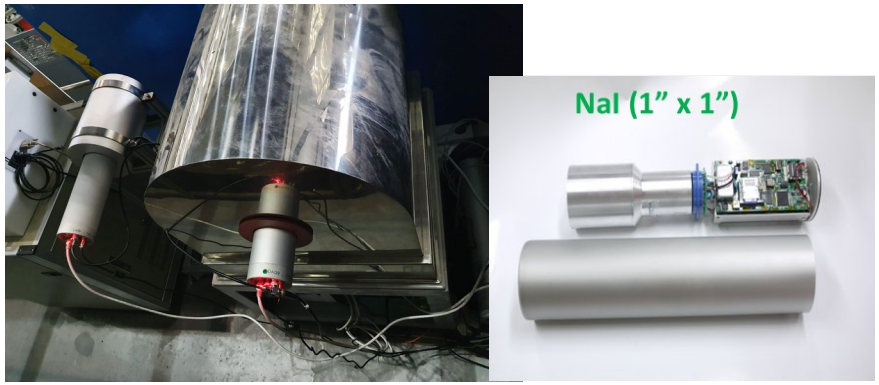
- Measured HXR signals mean that runaway electrons collided with limiters.
- Measured HXR signals include the effects of neutron. Therefore, good care is needed when NBI is used.

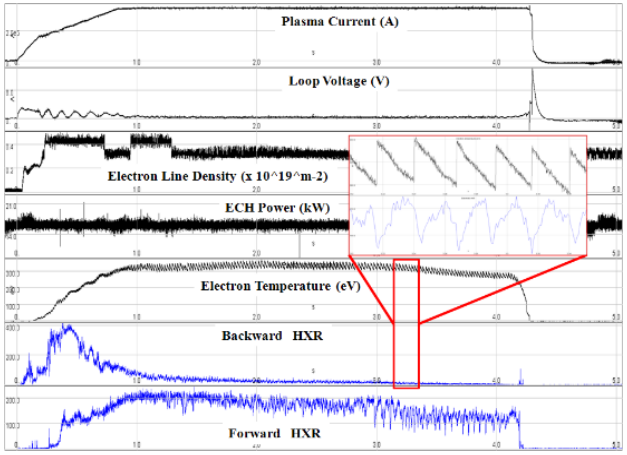
HXR Monitor

Channels Layout









ECEI

Full Name	Electron Cyclotron Emission Imaging (ECEI) system
Contact	J. Lee (jaehyun@kfe.re.kr), G.S. Yun (gunsu@postech.ac.kr)
Measuring properties	Electron temperature fluctuation ($\delta T_e/\langle T_e \rangle$)
Port assignment	G (1st ECEI: dual array), H (2nd ECEI: single array)
Channel information	24 (vertical) X 8 (radial) = 192 channels for 1 detector (ECEI consists of 3 detectors)
Measurement range	From the inboard edge to the outboard edge by changing (1) Bt, (2) LO frequencies from 78 to 103 GHz, and (3) flexible optical system
Time resolution	0.5, 1, or 2 (typical) us
Spatial Resolution	1 X 1 ~ 2 X 2 cm^2
Availability	On request (need Bt for the system setup prior to experiment)

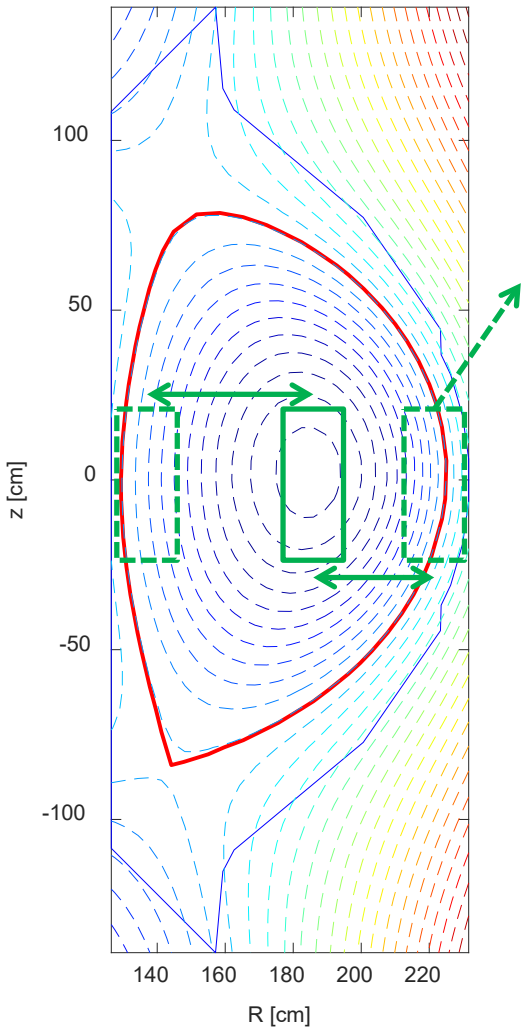
Notes

- Although MDS+ node is not assigned, ECEI data can be accessed via the iKSTAR server after experiments or delivered on your request (typical data size is ~4GB for one shot).
- For simple analysis, please use 'fluctana' software package on the iKSTAR server. Detailed image processing and spectra/statistics analysis take some time.

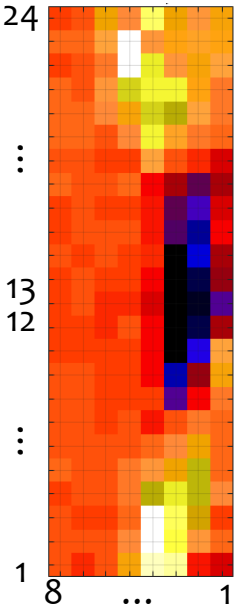
ECEI

Channels Layout

View position
(Poloidal cross section)



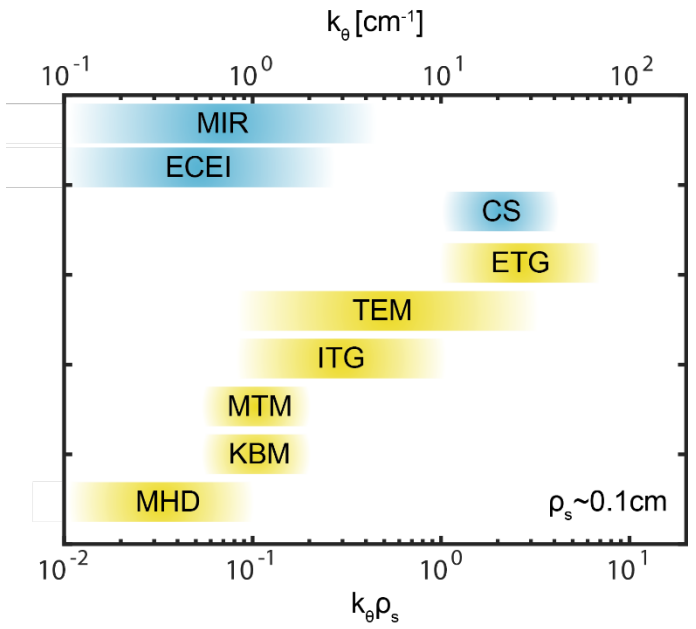
ECE image
Vertical ch. (1~24)



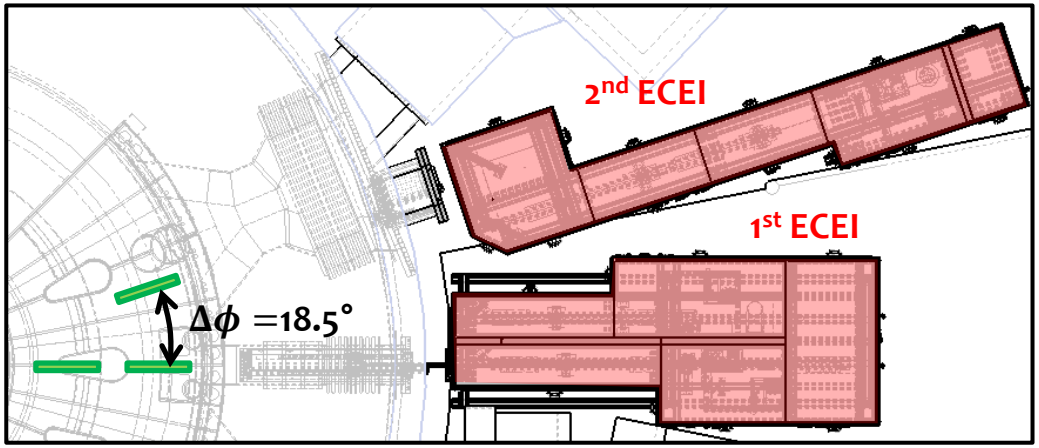
Radial ch. (1~8)

Measurable wave number limits (2018)

k_r<0.78 cm^{-1}
k_θ<1.9 cm^{-1}



View position
(Top view)

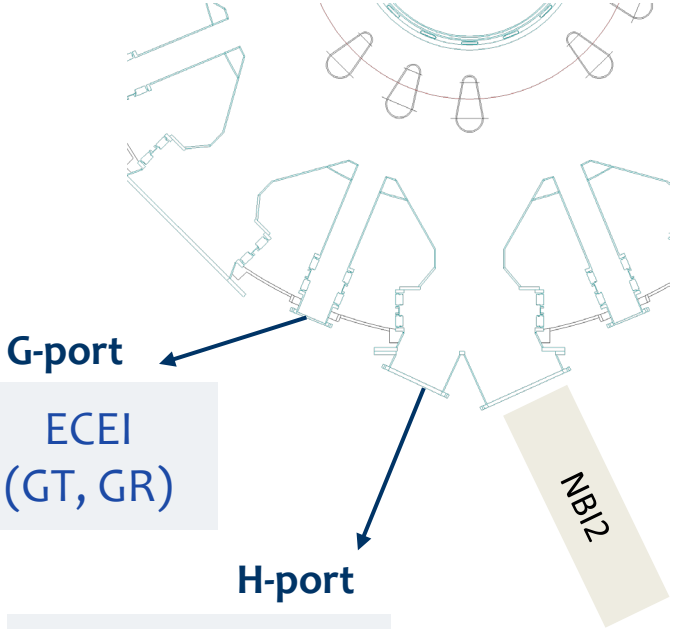


RF spectrometer

Full Name	Radio-frequency (RF) spectrometer
Contact	G.S. Yun (gunsu@postech.ac.kr), D.-K. Kim (dkwonkim@kfe.re.kr)
Measuring properties	Intensity of RF emission captured by spiral antennas
Port assignment	H (Large spiral antenna)
Channel information	Filter-bank system - Center freq (in MHz): 40,60,100,150,200,250,300,400,500,600,700,800. Bandwidth is 10% of center frequency.
Time resolution	1 MHz (filter-bank spectrometer), Up to 16GHz (fast digitizer)
Spatial Resolution	-
Availability	Filter-bank: Routinely available* Fast digitizer: On request*

*From 2024 campaign, raw signal from spiral antenna can be temporarily accessed with MDS+ nodes of ECEI: ECEI_GR2301-08:FOO and ECEI_GR2401-08:FOO.
*Fast digitizer: acquisition available up to 1.6s per shot (0.2 s per segment × 8 segments). As the sampling rate is high, the raw data may not be provided due to high file capacity; only the spectrograms may be provided.

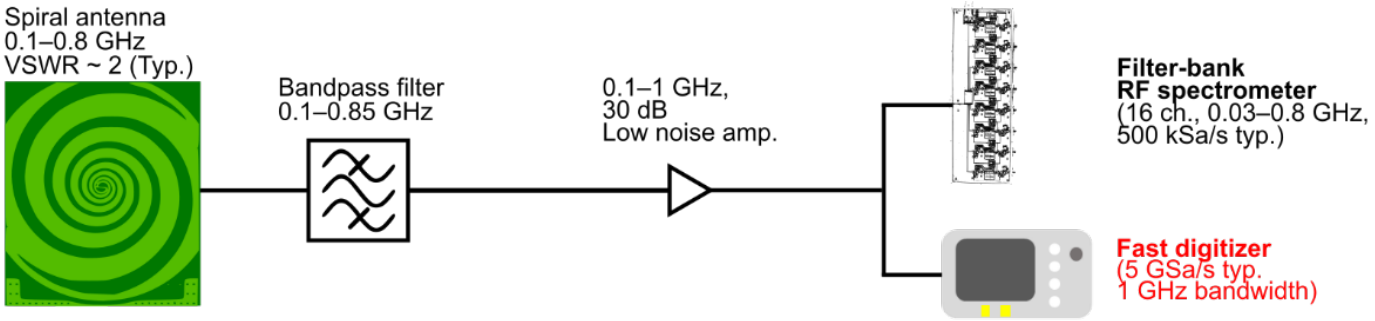
RF spectrometer



Two types of acquisition:

- **Filter-bank:** overall RF activities during the entire discharge duration.
- **Fast digitizer:** high-resolution (16 Gsa/s) information for fast events such as ELM crash. (1.6 s acquisition per shot)

Spiral antenna:



MIR

Full Name	Microwave Imaging Reflectometer
Contact	Woochang Lee (wclee@kfe.re.kr), Dong-jae Lee (djlee124@kfe.re.kr)
Measuring properties	Electron density fluctuations with poloidal wavenumber up to 3 cm^{-1} Poloidal rotation velocities of fluctuations Poloidal (and radial) correlation length of fluctuations
Port assignment	E-port from 2018 (G-port until 2017)
Channel information	4 x 16 (radial and poloidal)
Measurement range	Measurement radii can be positioned from the core to the outer edge by changing (1) Bt or (2) ne or (3) probing frequencies from 78 to 96 GHz.
Time resolution	Typically 1 μs (at 1 MS/s for 30 second acquisition) Minimally 0.5 μs (at 2 MS/s for 15 second acquisition)
Spatial Resolution	Radial: 1 to 10 cm (primarily depending on electron density profile) Poloidal: 0.6-0.9 cm (poloidal spot size ~ 0.9 cm)
Availability	On request (need Bt and ne for system setup prior to the experiment)

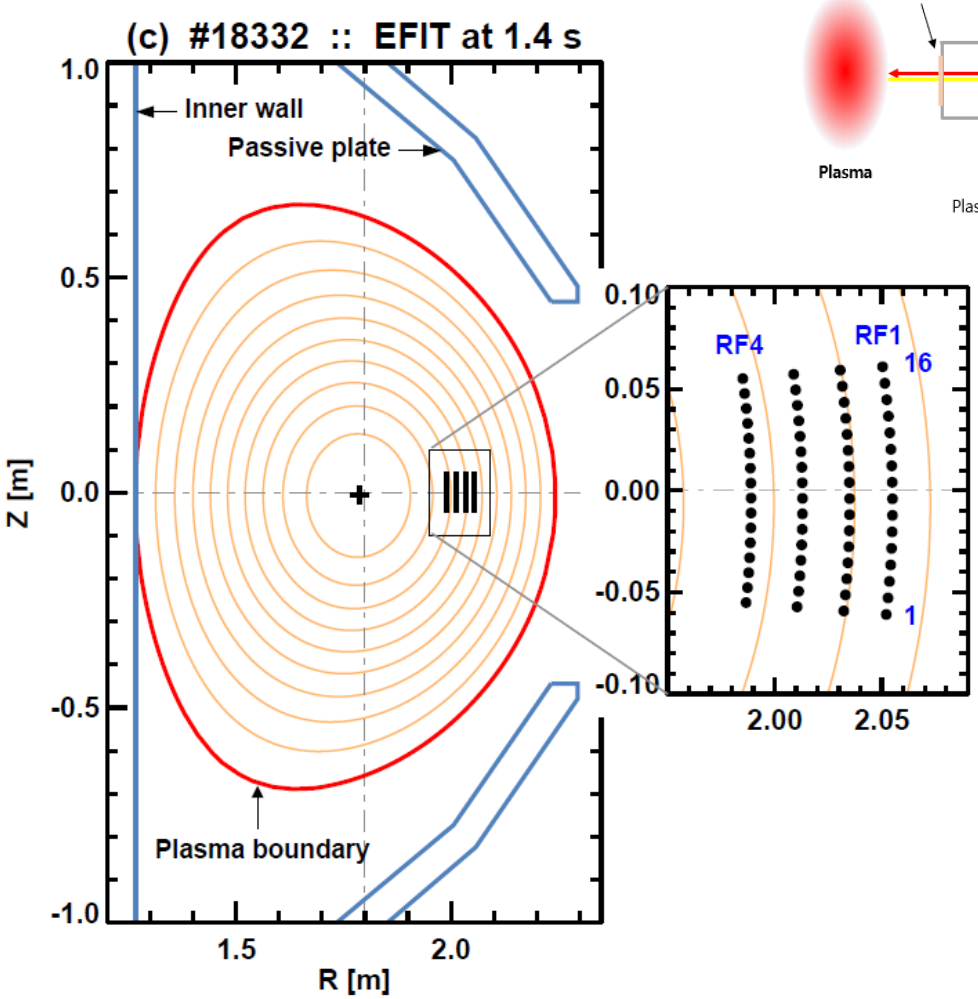
Notes

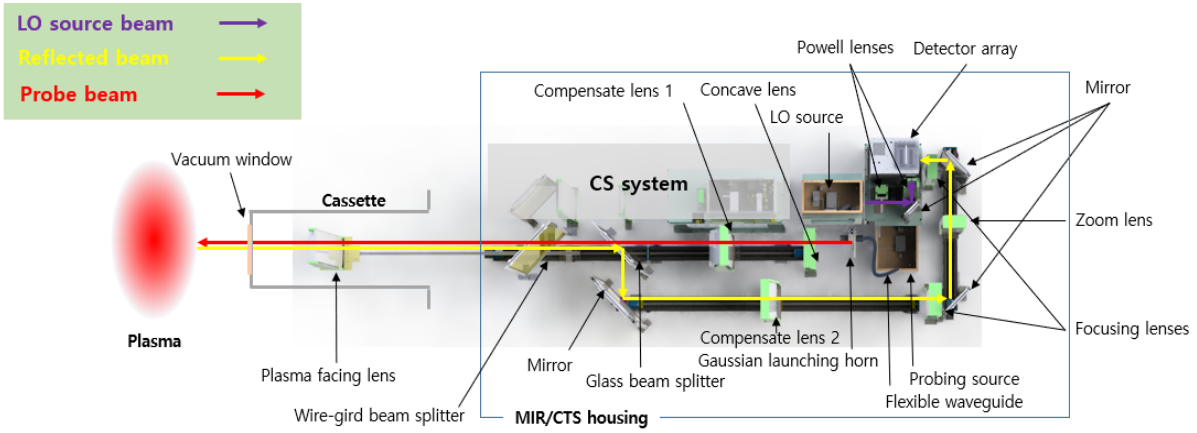
- MDS+ node is not assigned but MIR data can be delivered on your request.
- This complicated system is featured by (1) tunable 4 frequency X-mode probe beams, (2) 16-channel detector array, (3) heterodyne detection system (providing I/Q signals), and (4) imaging optical system.

MIR

Channels Layout

Example of locations of the MIR channels





MIR

Name	Sampling	Unit	Description
\MIR_I01_01 … \MIR_I01_16	1 MHz		In-phase signal of radial channel 1, vertical channel 1~16
\MIR_Q01_01 … \MIR_Q01_16	1 MHz		Quadrature signal of of radial channel 1, vertical channel 1~16
\MIR_I02_01 … \MIR_I02_16	1 MHz		In-phase signal of radial channel 2, vertical channel 1~16
\MIR_Q02_01 …. \MIR_Q02_16	1 MHz		Quadrature signal of of radial channel 2, vertical channel 1~16
\MIR_I03_01 …	1 MHz		…
\MIR_Q03_01 …	1 MHz		…
\MIR_I04_01 … \MIR_I04_16	1 MHz		In-phase signal of radial channel 4, vertical channel 1~16
\MIR_Q04_01 … \MIR_Q04_16	1 MHz		Quadrature signal of of radial channel 4, vertical channel 1~16

Notes

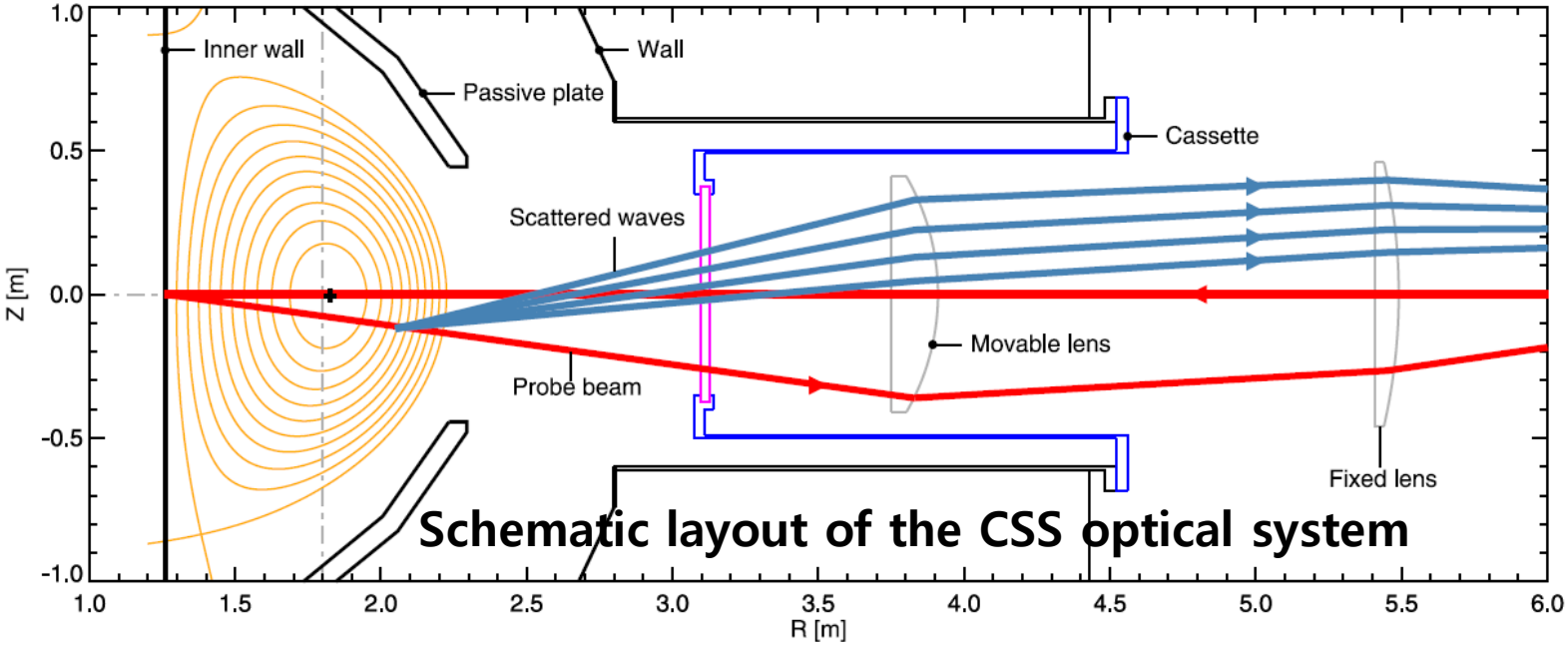
- When you make frequency spectra with MIR data, please keep in mind that the MIR signal of each channel consists of the real (in-phase signal) and imaginary (quadrature signal) components. So, you have to make the frequency spectra of complex signals.

CSS

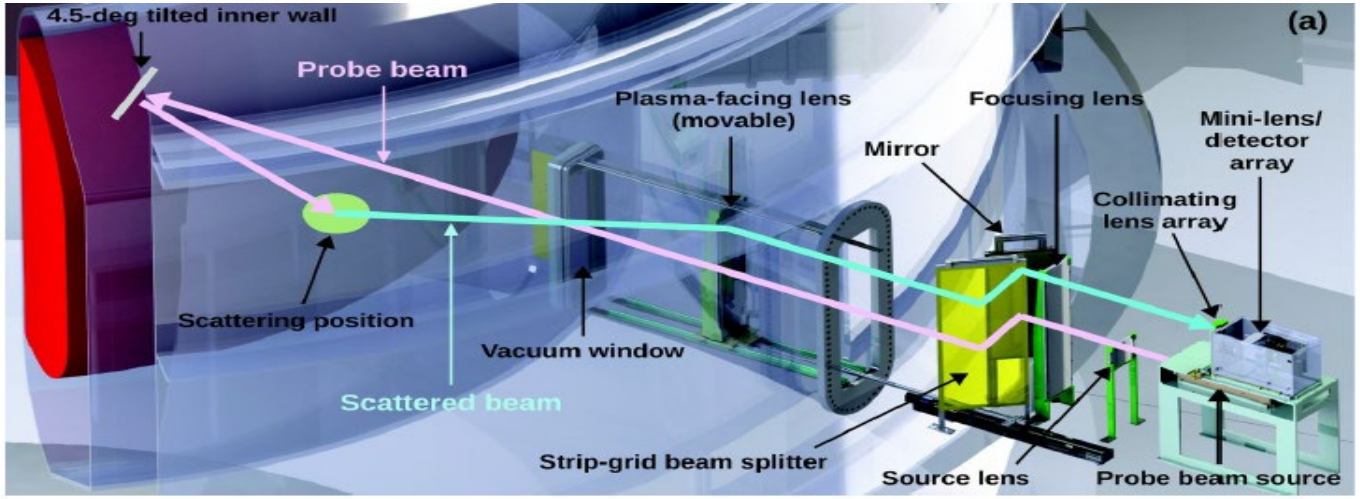
Full Name	Collective Scattering System
Contact	Woochang Lee (wclee@kfe.re.kr), Dong-jae Lee (djlee124@kfe.re.kr)
Measuring properties	Electron density fluctuations with four discrete poloidal wavenumbers from 14 to 26 cm^{-1}
Port assignment	E-port
Channel information	4 poloidal wavenumber channels
Measurement range	Measurement radii can be positioned from the core to the outer edge
Time resolution	Typically 0.1 μs (at 10 MS/s for up to 17 seconds)
Spatial Resolution	Radial spot size: ~10 cm Poloidal spot size: ~2.3 cm
Availability	On request (need Bt and ne for system setup prior to the experiment)

CSS

Channels Layout



Schematic layout of the CSS optical system



CSS

Name	Sampling	Unit	Description
\CSS_I01	10 MHz		In-phase signal of channel 1
\CSS_Q01	10 MHz		Quadrature signal of channel 1
\CSS_I02	10 MHz		In-phase signal of channel 2
\CSS_Q02	10 MHz		Quadrature signal of channel 2
\CSS_I03	10 MHz		In-phase signal of channel 3
\CSS_Q03	10 MHz		Quadrature signal of channel 3
\CSS_I04	10 MHz		In-phase signal of channel 4
\CSS_Q04	10 MHz		Quadrature signal of channel 4

Notes

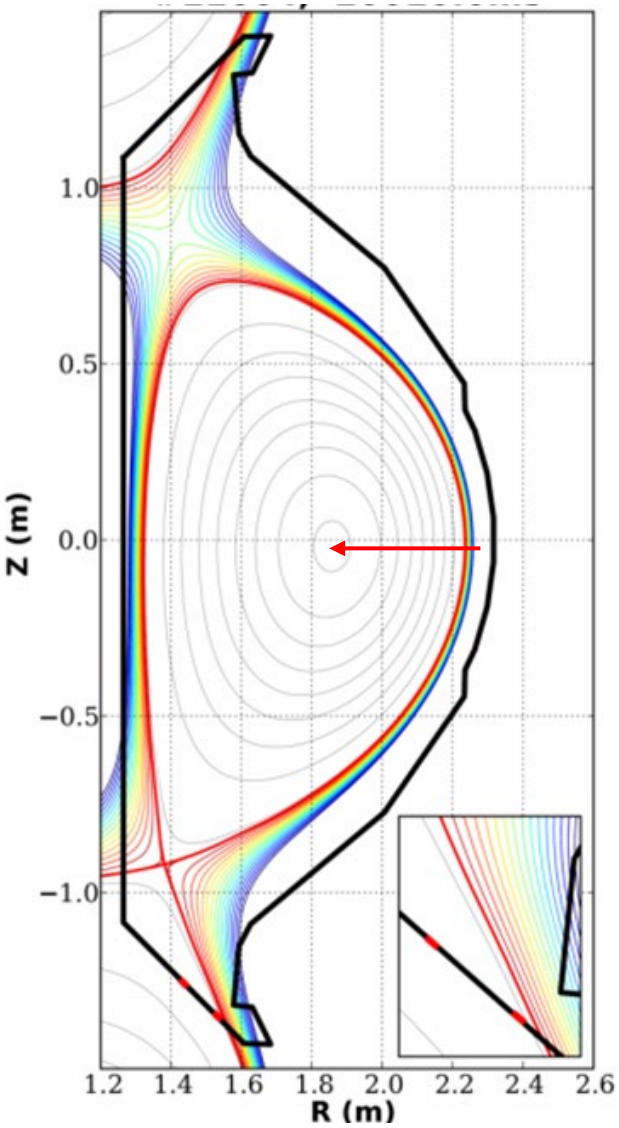
- When you make frequency spectra with CSS data, please keep in mind that the CSS signal of each channel consists of the real (in-phase signal) and imaginary (quadrature signal) components. So, you have to make the frequency spectra of complex signals.

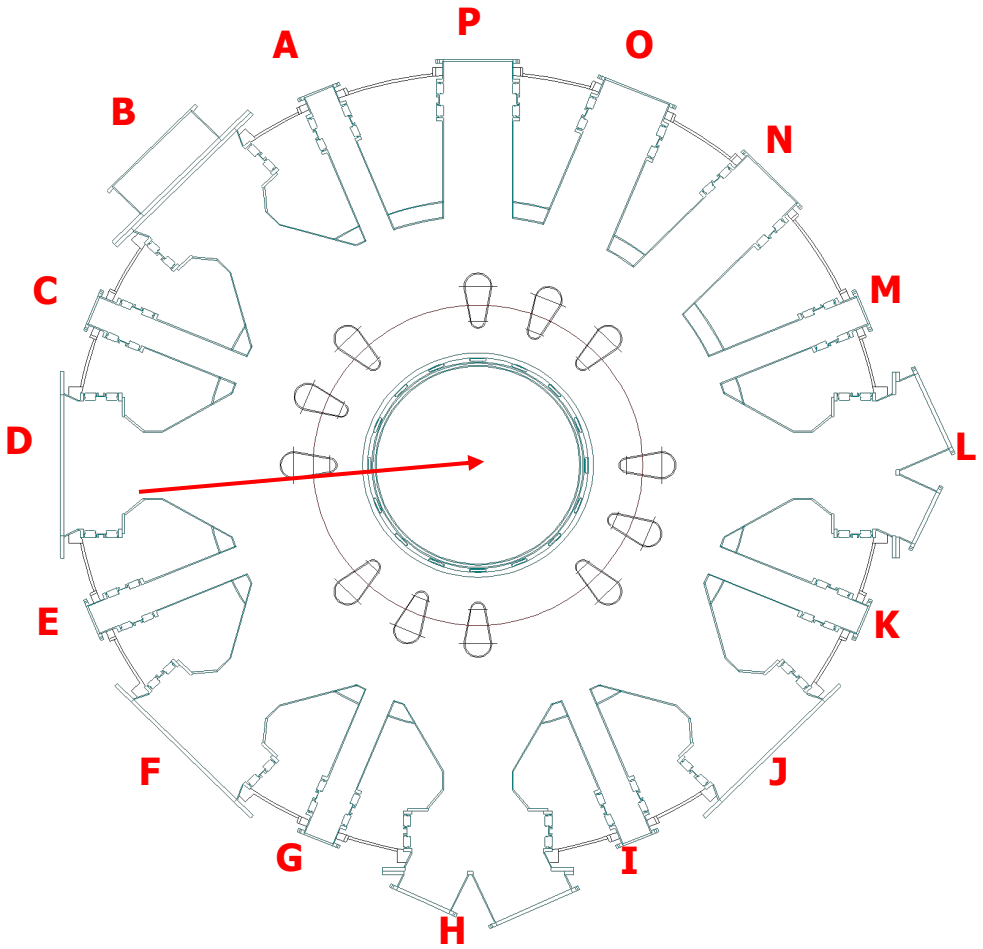
Edge reflectometer

Full Name	Edge reflectometer
Contact	Seong-Heon Seo (shseo@kfe.re.kr)
Measuring properties	Plasma density profile
Port assignment	D
Channel information	Q (30-50 GHz), V (50-75 GHz), W (75-110 GHz)
Time resolution	50 μs for **Trigger** mode, 20 ms for **Continuous** mode
Spatial Resolution	1 mm
Operation Mode	1. Continuous : 20 ms time resolution for the whole discharge time
	2. Trigger : 50 μs time resolution for the 8 segments of 100 ms
	Normally operated in the continuous mode. Operated in the trigger mode with request of 8 triggering times before shot

Edge reflectometer

Channels Layout





Edge reflectometer

Name	Sampling	Unit	Description
\r_ref		m	Radial position 2D array [radius, time index]
\ne_ref		m^{-3}	Density 2D array[density, time index]

Example

- Read data from 1 s to 1.02 s

```
IDL> s = mdsvalue('SetTimeContext($,$)', 1.0, 1.02)
IDL> t = mdsvalue('dim_of(₩r_ref)')
IDL> r = mdsvalue('₩r_ref')
IDL> n = mdsvalue('₩ne_ref')
```

- Plot density profile at 1.001 s, that is 1000 μs (= 20 x 50 μs) after the first data

```
IDL> iplot, r[*,21], n[*,21]
```

note

- Processed data until 9 Nov. 2017

11499-11503, 11506-11510 , 19340

Edge reflectometer

- IDL routines for 3D plots

IDL> y = kstar_read2(19340, 4.09, 4.11)
IDL> plot_density, y, 19340, /D3, STEP=2, NRANGE=2.5, VERTEX=1.9

Options
/D3 : 3D line plot
/SURFACE : 3D surface plot
/CONTOUR : contour plot
STEP = the interval for plotting (defaults = 1, too slow)
NRANGE = the maximum value for z-axis (10^{19} m^{-3})
VERTEX = the scale factor for the color table of 'BLUE/GREEN/RED/YELLOW ' (10^{19} m^{-3})
1.9 scales as <0 is BLUE, 1.9x10^{19} m^{-3} is YELLOW>