Considerations of diagnostic requirements of CFETR

Qingwei YANG （杨青巍）

SouthWestern Institute of Physics (SWIP)

University of Science and Technology of China (USTC)

May 30 – Jun. 1, 2012, USTC Hefei

Mission of CFETR

- Address the nuclear S&T for a reactor
- Test material and components
- Demonstrate the T self-sufficiency, TBR > 1.2
- Power: 50 – 400 MW, duty time: 0.3 – 0.5

Scientific issues

- ✓ Burning plasma
- ✓ Predictable high performance

Engineering issues

- ✓ T self-cycle
- ✓ SSO or long pulse
- ✓ Material
- ✓ Components

Limitation of diagnostic

- Long time measurement – SSO or Long pulse
- Surviving from radiation – high fusion power
- Limited diagnostic ports – blanket for T cycle
- Reliability and easy maintenance
- Simplified
- High resolutions – physics issue

Operational diagnostics

purpose	measurement	Nominated diag.
Plasma control	Ip, Vl, config., W_E, beta, VDE	Magnetic measurement. Is coils OK? Or others
	Ne	TS? MW? interfero?
	Te	TS? ECE?
	Ti	Gamma-ray spectr. in DT
	Zeff	Optical?
	n_T/n_D	
	D_α, T_α	Optical?
MHD instability contr.	NTM, ELM, AEs, RWM	Coils, MW refl.
	Halo current	coils
Tritium	T retention	
	…	

Diagnostics for physics issue

measurement	Nominate diag.
NTM, ELM, AEs, RWM	Coils, MW refl.
Ne(r)	TS, MW, interferometer,
Te(r)	TS, ECE
Ti(r)	CXRS, X-ray spectrum
Zeff(r)	Continuum spectrum, CXRS
J(r)	MSE, polarimetry
Fast ions profile	CTS, NPA
Momentum	CXRS
Plasma emission	Bolometer
T retention	
ITER like	Need more diagnostic port – affects TBR

Fusion products

purpose	measurement	Nominated diag.
Fusion products	Neutron energy spectrum	Liquid Scintillantor, Diamond, FOT
	Neutron profiles	Neutron camera
	Radiation, activation	
	alpha particle profile and loss alpha particle	NPA, CTS, Faraday cup
	Helium density profile	CXRS?
	gamma ray profile and spectrum	
Fusion power	Neutron flux	Fission chamber
	Dose	
	…	

First wall, divertor and components

purpose	measurement	Nominated diag.
Machine protection	Heat deposition profile (divertor)	IR camera? Thermocouple?
	First wall temperature	IR camera? Thermocouple?
	Erosion of first wall	
	Damage	In-situ monitor
	dose	

Blanket diagnostics

purpose	measurement	Nominated diag.
Blanket	Neutron flux and gamma-ray profiles	
	Neutron and gamma-ray energy spectrum	
	Activation	
Component monitor	Temperature profile heat load Erosion Damage …	

Big challenge of diagnostics

- **Much current used diagnostics:**
  - ✓ Is difficult to survive from radiation.
  - ✓ Is too complicated
  - ✓ Is hard to measure long pulse discharge
  - ✓ Occupies so many ports
- **Need to look for the new diagnostic method** – for example, the diagnostic database need to established.
- **New diagnostics development:** for new studies in material/component damaging, blanket, …

Thank you for your attention