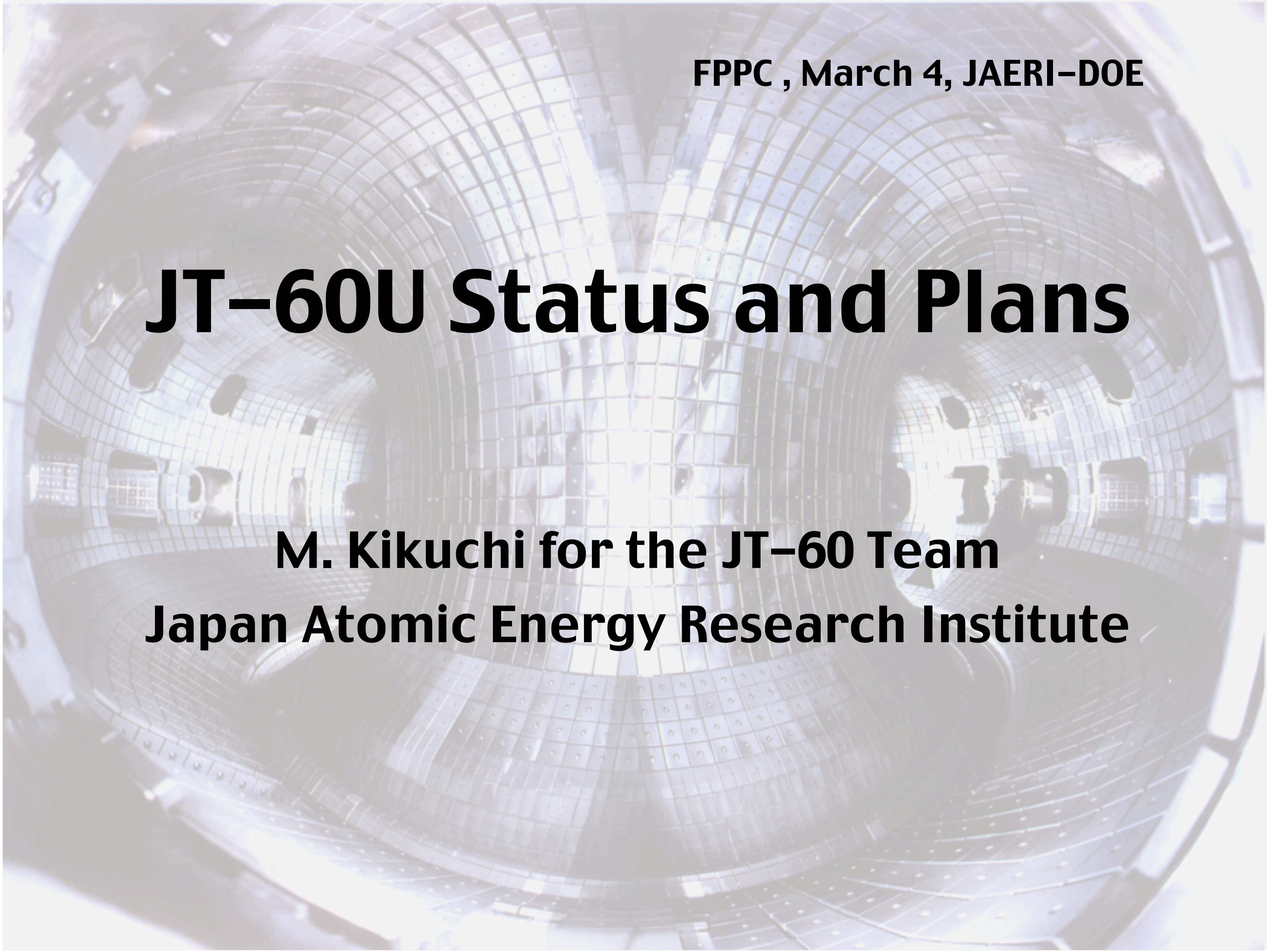


FPPC , March 4, JAERI-DOE

JT-60U Status and Plans

M. Kikuchi for the JT-60 Team
Japan Atomic Energy Research Institute

1. Unification of JAERI and JNC

JAERI (Japan atomic Energy Research Institute) and JNC (Japan Nuclear Fuel Cycle-Development Institute) will be unified to form a new entity in Mid 2005. Present staff and budget of two institutes as of 2003 are as follows.

JAERI employs ~2,200 staff
budget ~ 94 billion Yen.

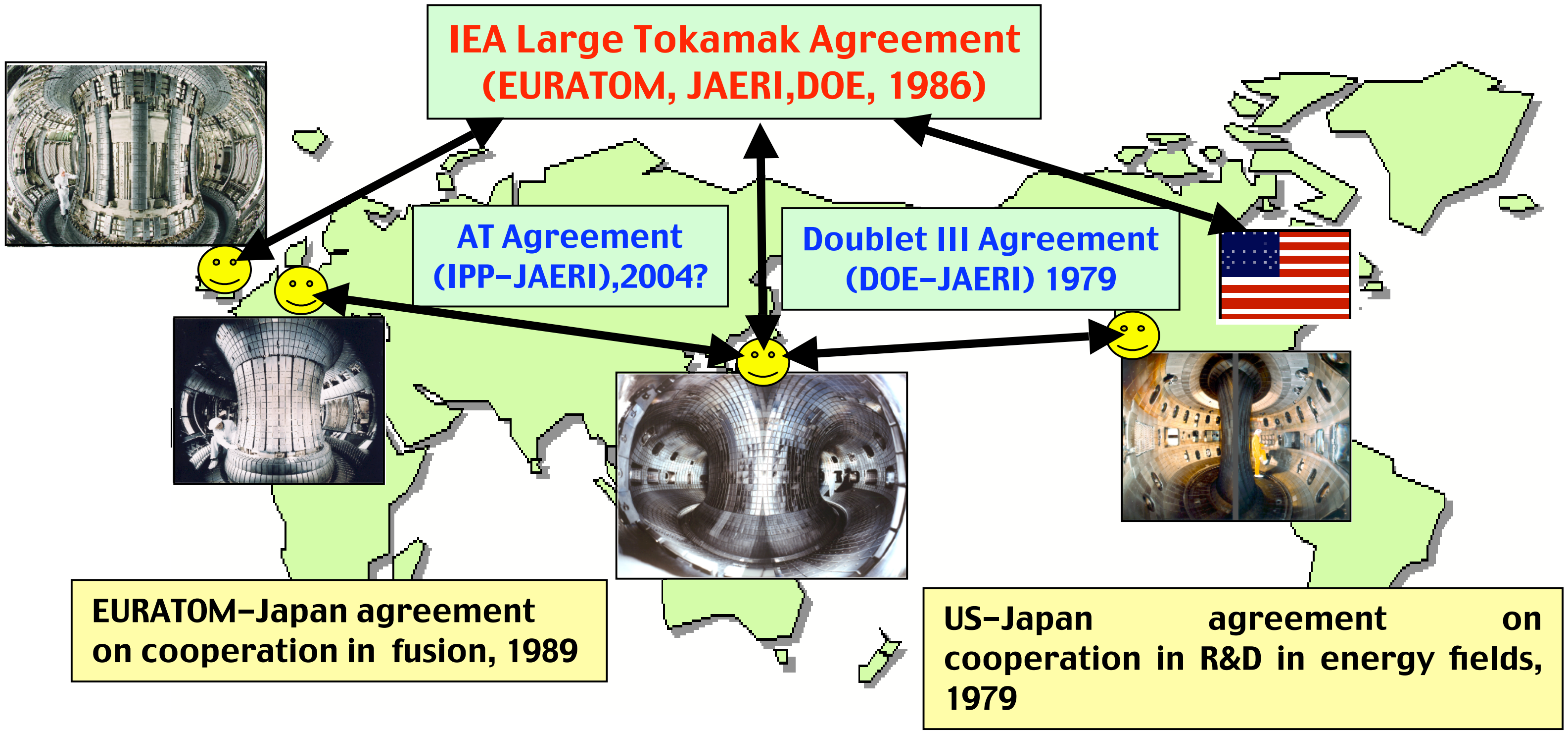
JNC employs ~2,300 staff
budget ~ 130 billion Yen.

President of JAERI T. Okazaki from JAERI HP

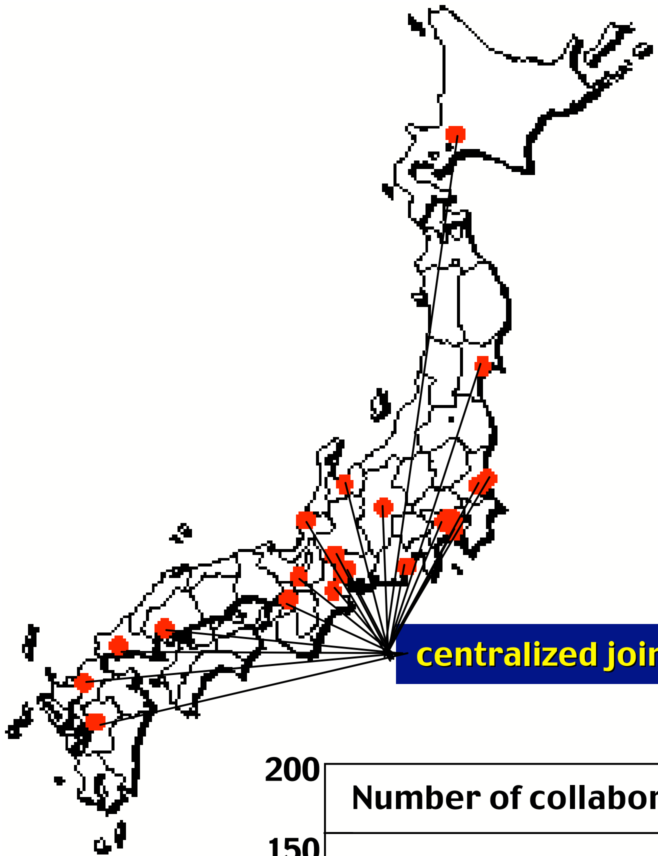
Procedures for personal assignment

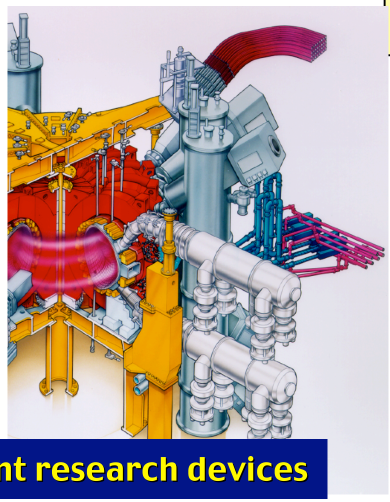
ITPA Joint experiments

US to JT-60U : LT IA Appendix A2 signed by E. Oktay and Visitor
EU to JT-60U : LT IA Appendix A2 signed by M. Watkins and Visitor
JT-60U to US : Personal assignment agreement (US-J) is required except PPPL and GA.
JT-60U to EU : Personal assignment agreement (EU-J) is required except JET.

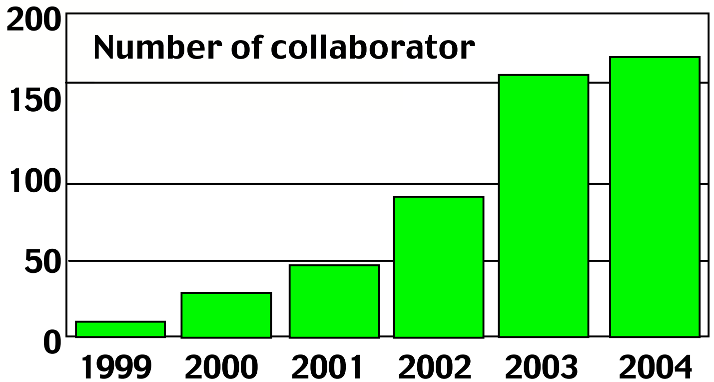


National research collaboration





centralized joint research devices



Research Theme structure for 2003-2004

- Director of Department of Fusion Plasma Res.
- Theme Leaders; (T. Fujita), S. Ide, H. Ta
  - Task
    - Extension of Discharge Duration (S. Ide)
    - Development of advanced tokamak(N. Sakamoto)
    - Confinement improvement at high density (H. Takenaga)
    - AMTEX (K. Tsuzuki)
  - Subject
    - Core Plasma (T. Takizuka)
    - H-mode Physics/ Pedestal (Prof. K. Toi(NIFS))
    - Modeling of ITB (Prof. A. Fukuyama(Kyoto U))
    - Current Hole (T. Fujita)
    - MHD/Energetic Particle / Disruption, (M. Takechi)
    - Current Drive (Prof. K. Hanada(Kyushu U))
    - Divertor/SOL (N.Asakura)
    - Advanced Fueling (H. Ogawa)
    - Innovative operation (Prof. Y. Takase(U. of Tokyo))
    - Plasma Material Interaction (Prof. T. Tanabe(Nagoya U))

3. Organization of Fusion Research in JAERI

Board of Executive Directors
- President : T. Okazaki
- Vice President : S. Tanak, O. Tanaka
- Executive Director : S. Matsuda

Office of Planning
Director : S. Okada
General Manager : S. Ishida

NAKA FUSION RESEARCH ESTABLISHMENT
Director General : M. Seki

Office of ITER Project Promotion
Director : Y. Okumura

- **DEPARTMENT OF FUSION PLASMA RESEARCH**
  Director : H. Ninomiya
  Deputy director : M. Kikuchi
  - Tokamak Program Division — General Manager.: Y. Miura
  - Plasma Analysis Division — G. M.: T. Ozeki
  - Large Tokamak Experiment and Diagnostics Division — G.M. : Y. Kamada
  - Plasma Theory Laboratory — Head : Y. Kishimoto*
  - Experimental Plasma Physics Laboratory — Head : Y. Kusama
  - Reactor System Laboratory — Head : K. Tobita

  *: Kyoto U.

- **DEPARTMENT OF FUSION FACILITIES**
  Director : M. Kuriyama
  Deputy director : N. Hosogane
  - JT-60 Administration Div. — G. M. : Y. Terakado
  - JT-60 Facilities Div. 1 — G. M. : K. Kurihara
  - JT-60 Facilities Div. 2 — G. M. : N. Miya
  - RF Facilities Div. — G. M. : T. Fujii
  - NBI Facilities Div. — G. M. : T. Yamamoto
  - JFT-2M Facilities Div. — G. M. : T. Yamamoto

- **DEPARTMENT OF FUSION ENGINEERING RESEARCH**
  Director : S. Seki
  Deputy director : H. Takatsu
  - Blanket Engineering Lab. — Head : M. Akiba
  - Superconducting Magnet Laboratory — Head : K. Okuno
  - Plasma Heating Lab. — Head : K. Sakamoto
  - Tritium Engineering Lab. — Head : M. Nishi
  - Office of Fusion Material Research Promotion — Head : M. Sugimoto
  - Fusion Neutronics Laboratory — Head : T. Nishitani

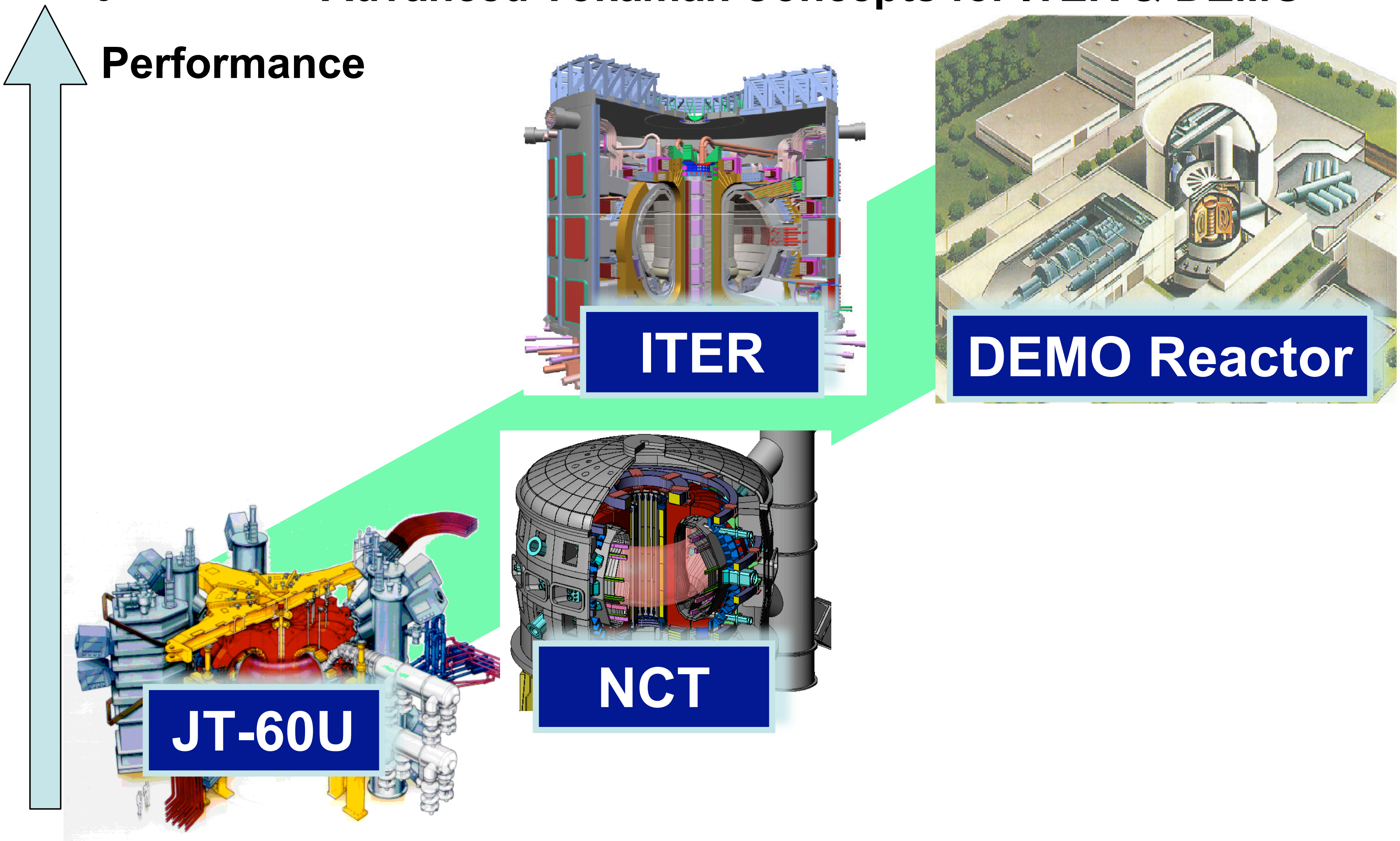
- **DEPARTMENT OF ITER Project**
  Director : T. Tsunematsu
  Deputy director : R. Yoshino
  - Project Management Div. — Head : M. Mori
  - International Coordination Div. — Head : T. Ando
  - Tokamak Device Div. — Head : K. Shibanuma
  - Plant System Div. — Head : T. Shoji
  - Safety Design Div. — Head : E. Tada

- **DEPARTMENT OF ADM.SERVICES**
  Director : I. Kikuchi
  Deputy director : H. Kobayashi
  - Administrative Service Div.
  - Accounts Div.
  - Utilities and Maintenance Div.
  - Safety Div.

Introduction

JT-60U Objectives

- ITER Physics R&D
- Advanced Tokamak Concepts for ITER & DEMO

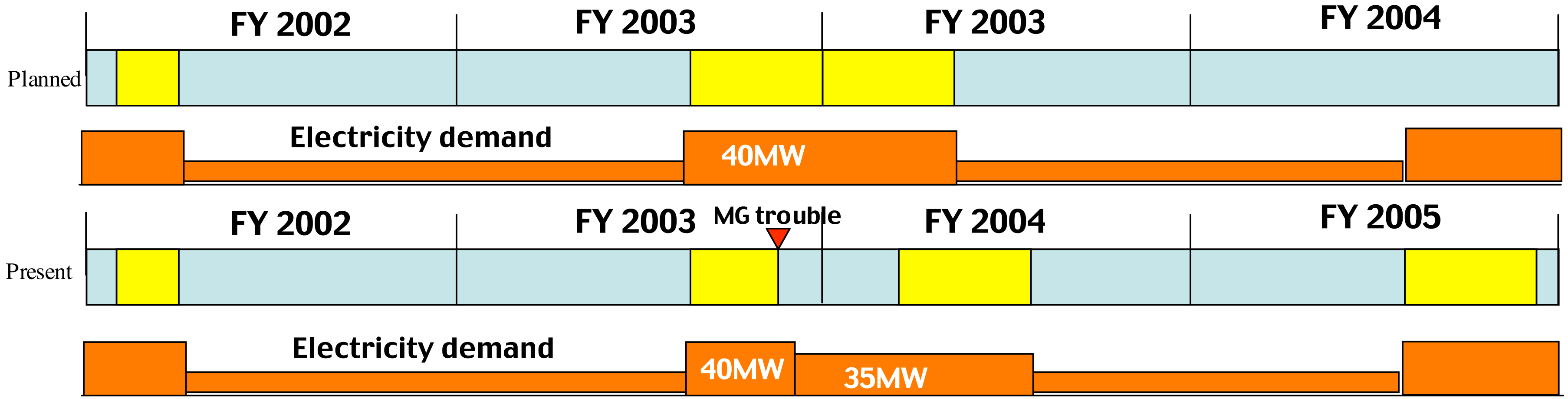


4. Status of JT-60U

Recent trends of operation cycles

FY2000 : 9 cycles two shifts 18 weeks of experiment
FY2001 : 6 cycles two shifts 12 weeks of experiment
FY2002 : 2 cycles two shifts 04 weeks of experiment
FY2003 : 2 cycles one shift 08 weeks of experiment
MG trouble in Feb. 2004 3 EX weeks cancelled.
FY2004 : 2 cycles one shift 08 weeks of experiment 65s
with reduced Bt capability
FY2005 : 2 cycles one shift 08 weeks of experiment 65s

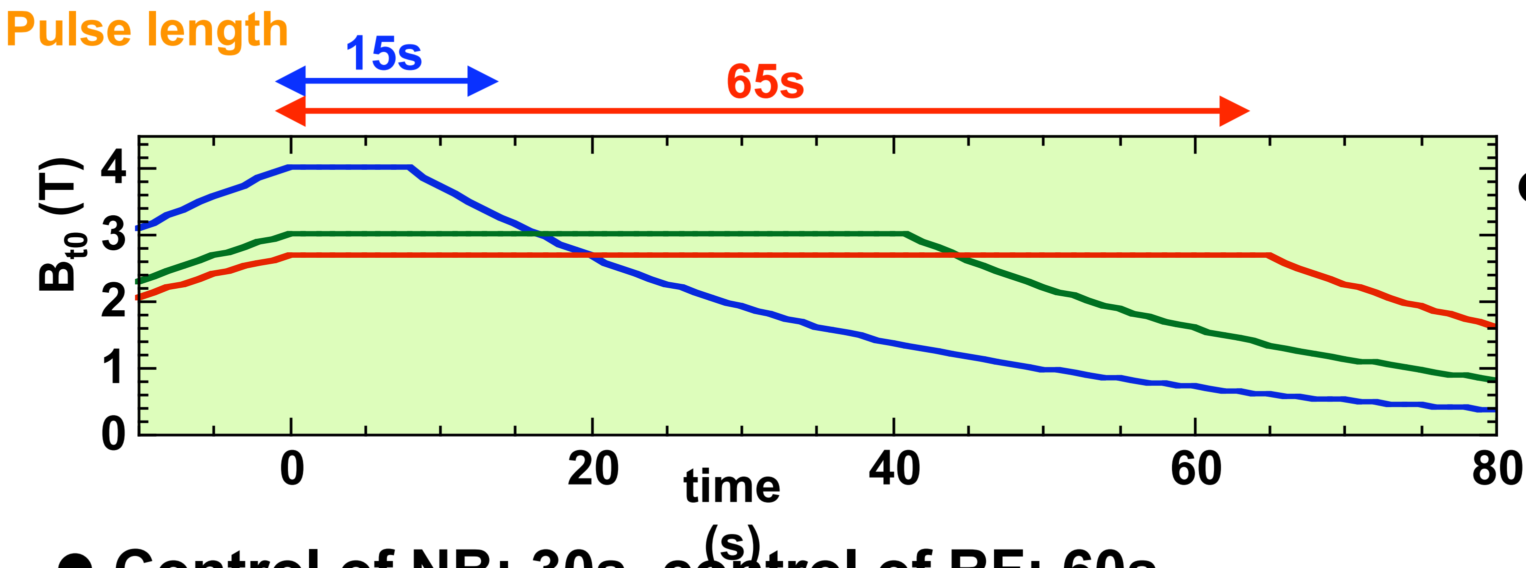
Research plans are based on two year frame.



1. Modification for long pulse discharge

Max. pulse length of a discharge : 15s ⇨ 65s.

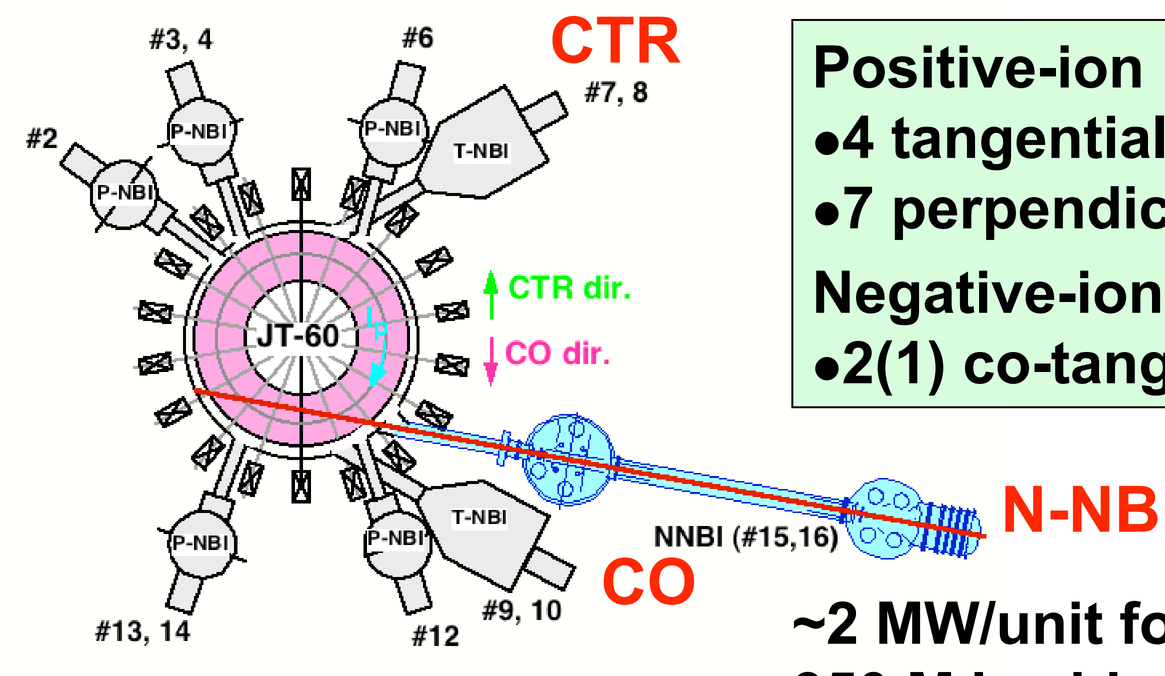
Modification on control systems in operation, Heating/CD and diagnostics, but not on major hardware.



- B_{t0} flat top 4Tx8s ⇨ ~2.7Tx65s

- Control of NB: 30s, control of RF: 60s.
- PFC temperature is not actively cooled; carbon tiles (CFC for divertor), a small number of W tiles, and RF antennas.
- Vessel temperature is kept 150-300 degC; mostly 150 degC in 2003-04 campaign.

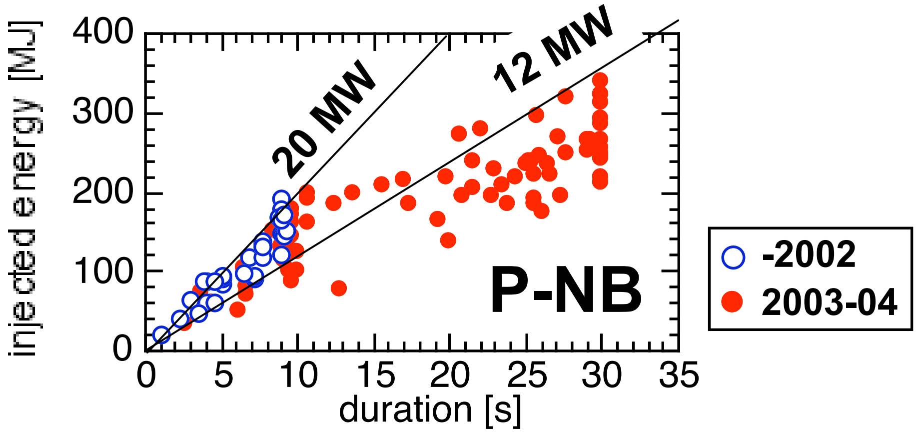
Improvement in NB systems (P-NB, N-NB)

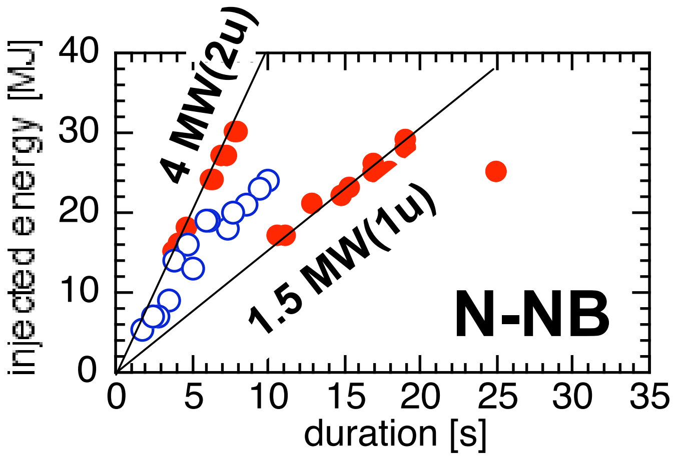


Positive-ion NB (P-NB)(~85keV)
- **4 tangential (2 co + 2 ctr): 30 s**
- **7 perpendicular: 10s(6u),15 s(1u)**

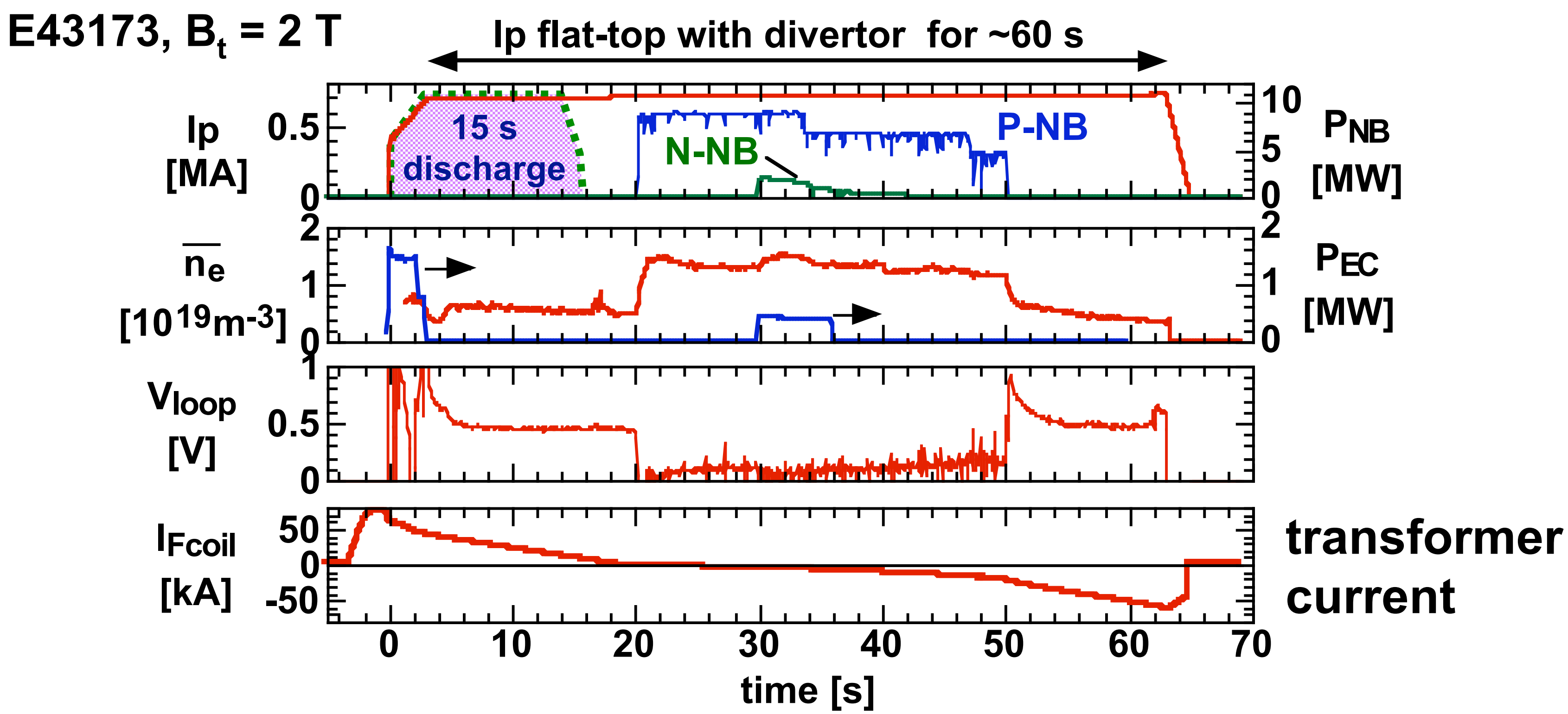
Negative-ion NB (N-NB)(~360keV)
- **2(1) co-tangential: 10 s (30s)**

~2 MW/unit for long pulse operation.
350 MJ achieved with P-NB + N-NB



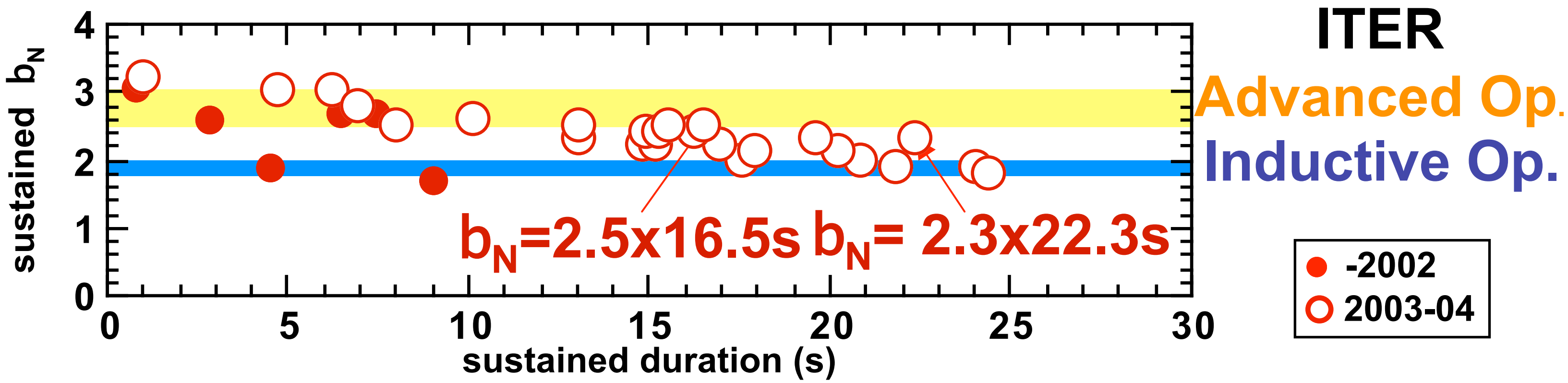


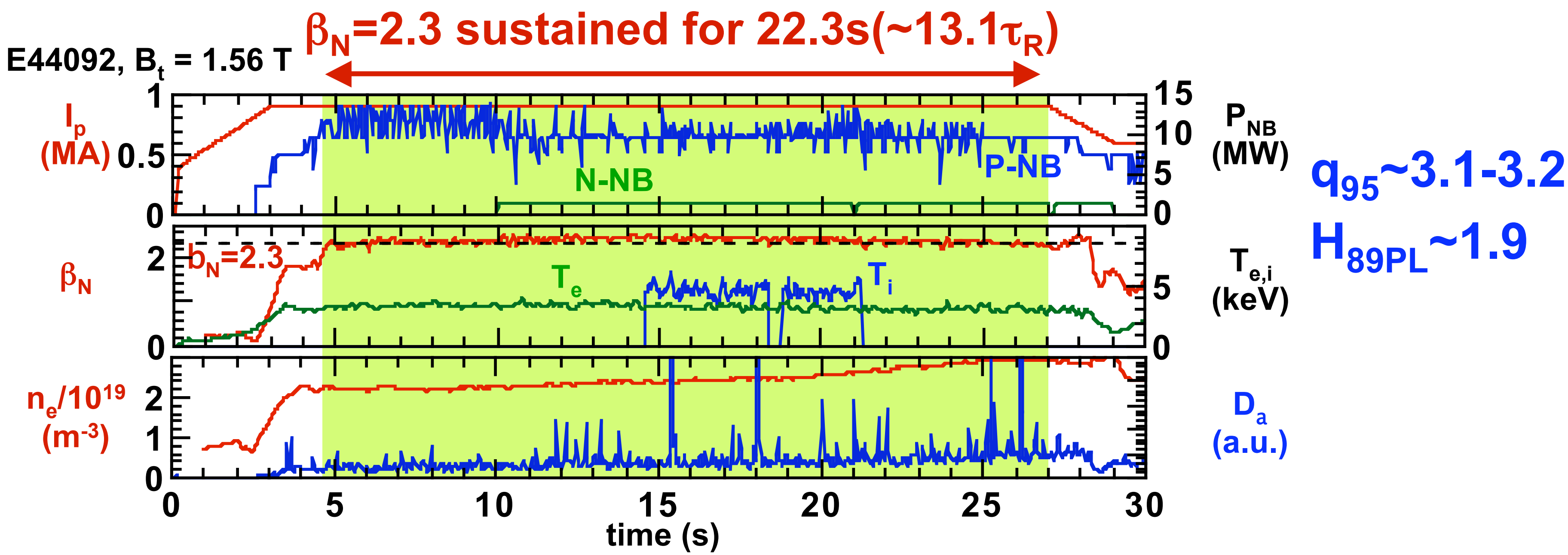
65 s discharge has been achieved



- Flux swing of transformer saved by NB+EC heating and EC breakdown assist.
- Long pulse LHCD will result in higher I_p.
- For 30 s, 1.4 MA ELMy H-mode was maintained.

Long sustainment of high β_N in extended pulse operation

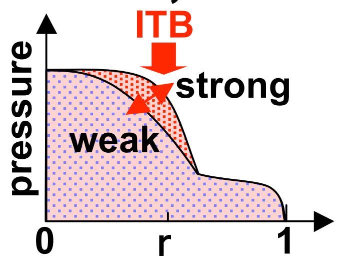


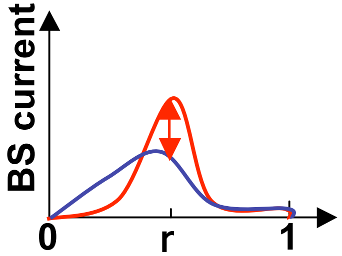


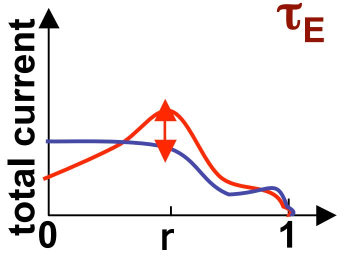
$\tau_R \equiv m_0 \langle\sigma_{NC}\rangle a^2/12$ D.R. Mikkelsen, Phys. Fluids B 1 (1989) 333.

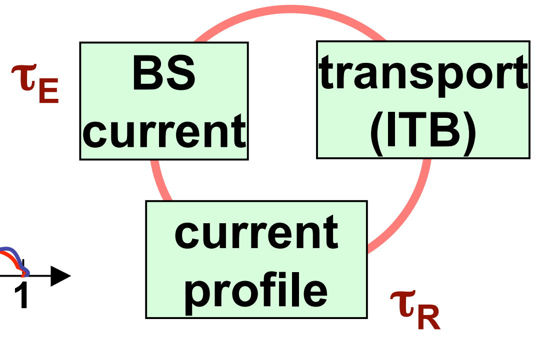
Long sustainment of high f_{BS}

- **Strong linkage of $j_{BS}(r)$, $j_{total}(r)$ and transport in high f_{BS} plasmas,**

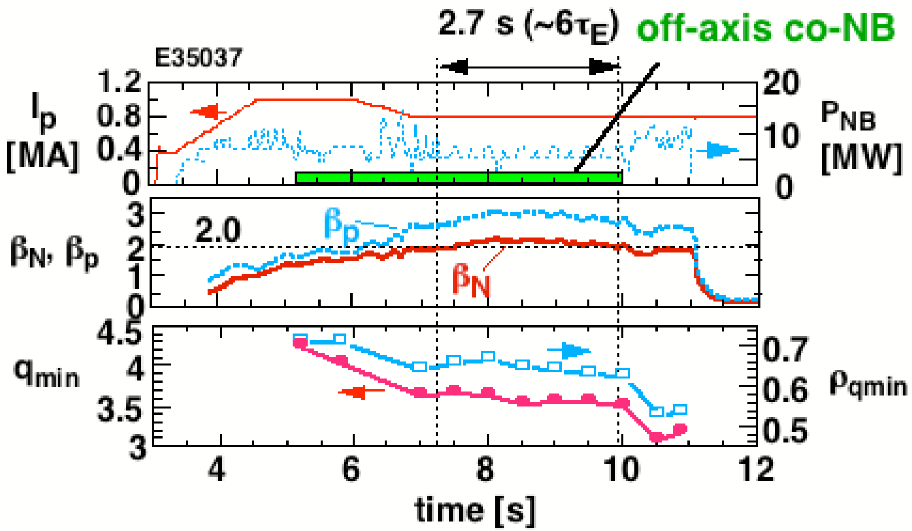


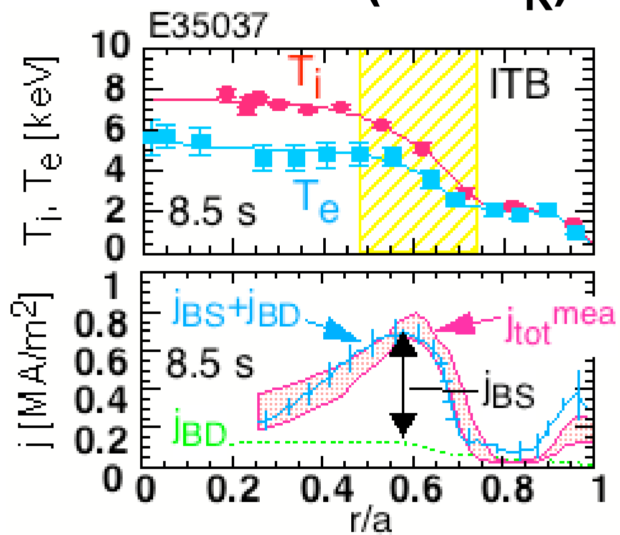






- **Previously, f_{BS}~80% was maintained for 2.7 s (~0.6τ_R)**





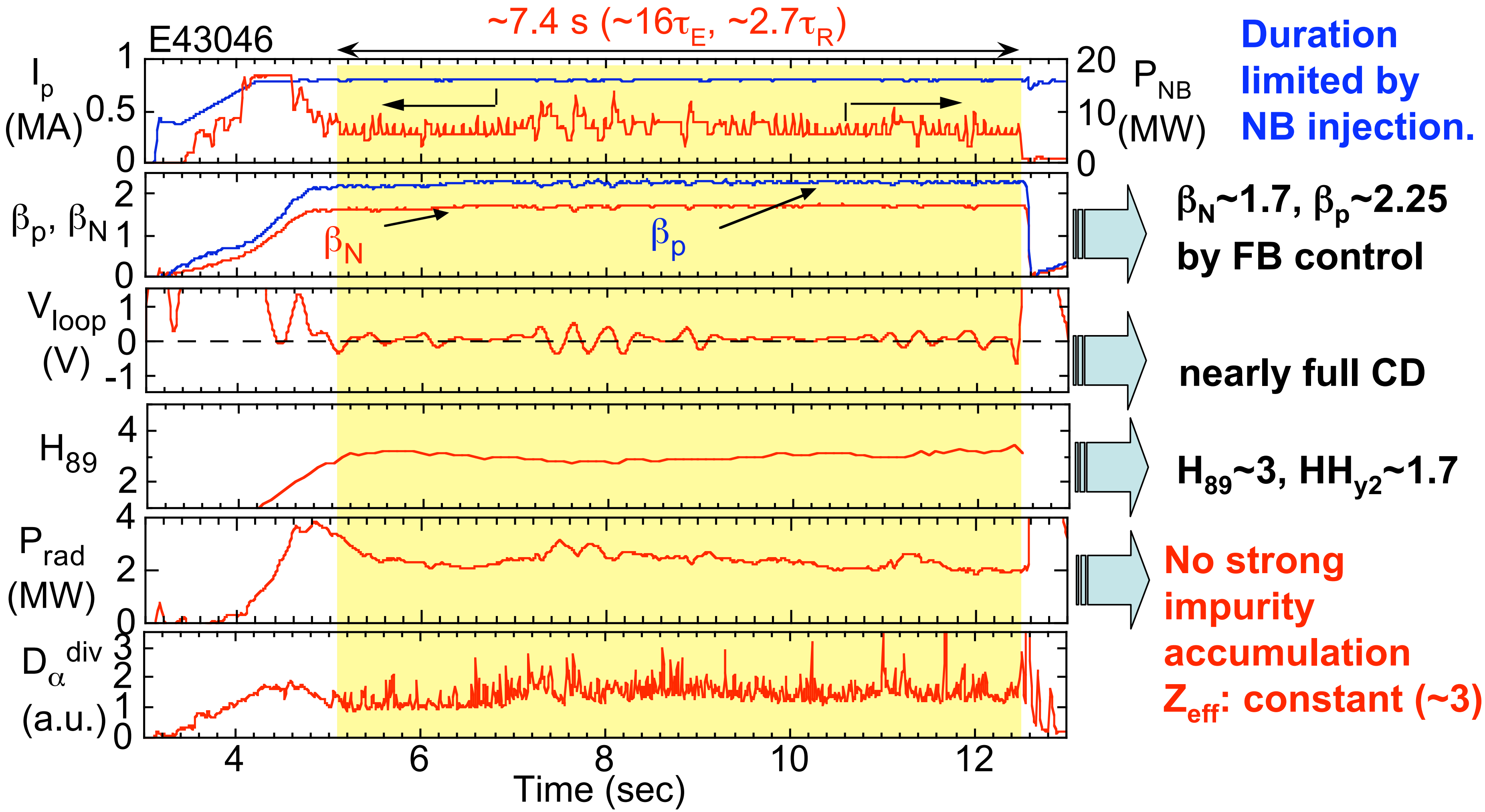
- **Control must be demonstrated in longer sustainment (>>τ_R).**

When ITB (c) changes=> p and j_{BS} changes in τ_E. But j_{tot} changes in τ_R.

β_p~2.25, HH_{y2}~1.7 sustained for ~7.4s (~2.7τ_R) under nearly full CD in RS plasma

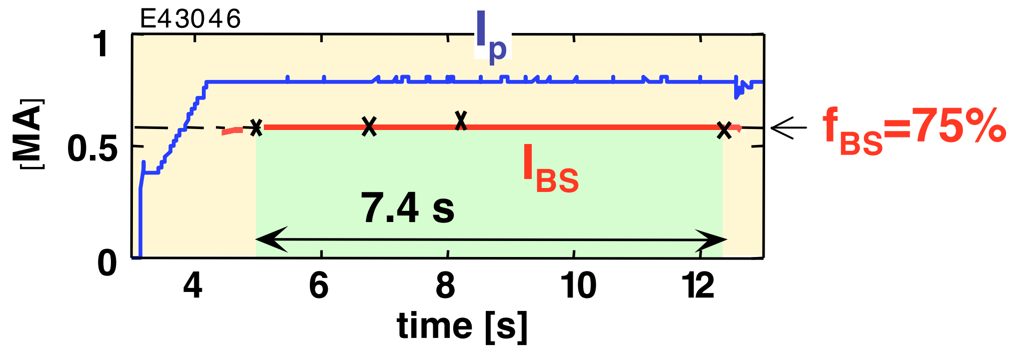
Reversed shear ELMy H-mode (3.4T, 0.8MA, q_{95}~8.6, δ~0.42)

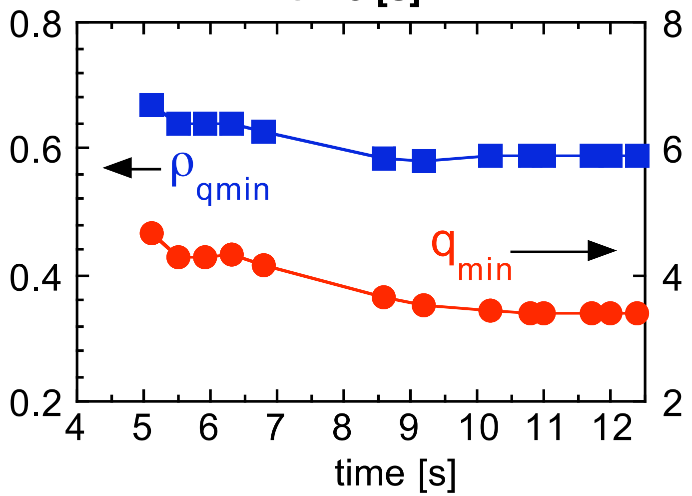
Non-inductive CD: Bootstrap dominant & P_{NB}^{inj}(co)=3.2MW

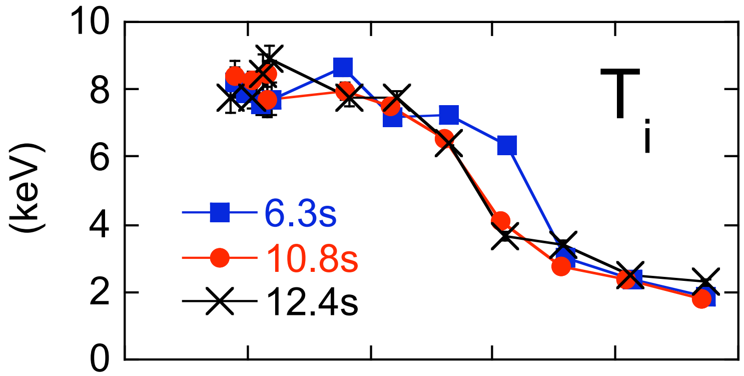


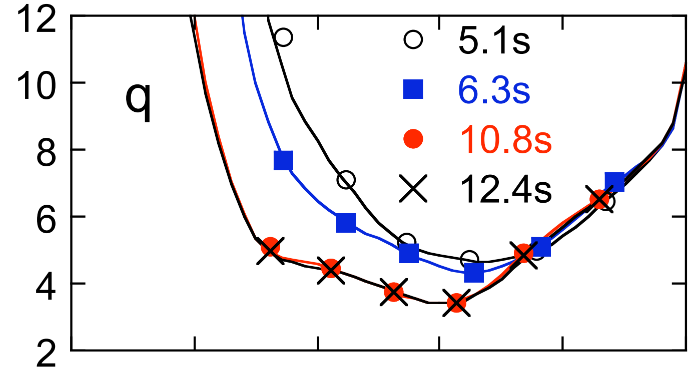
f_{BS}~75% sustained for ~7.4s (~2.7τ_R)

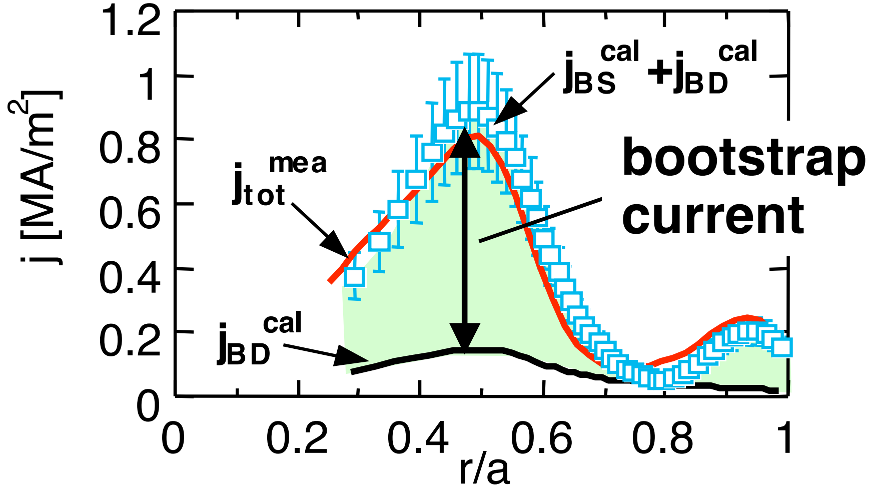
- BS current peaked at the ITB.
- f_{BS}~75%, f_{BD}~20%, f_{CD}~95%
- well-aligned BS current
- j(r) and p(r) reached stationary conditions.





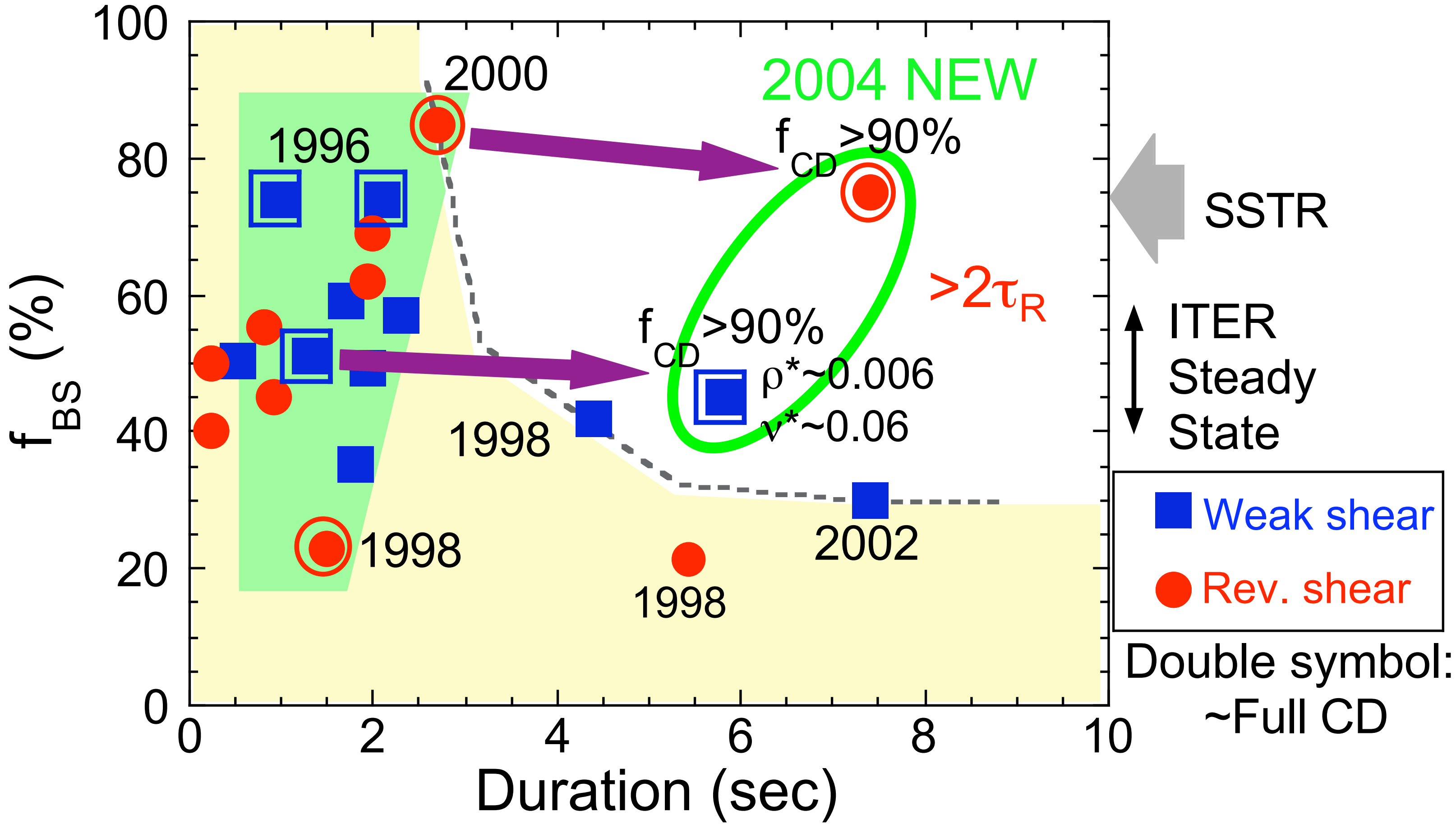




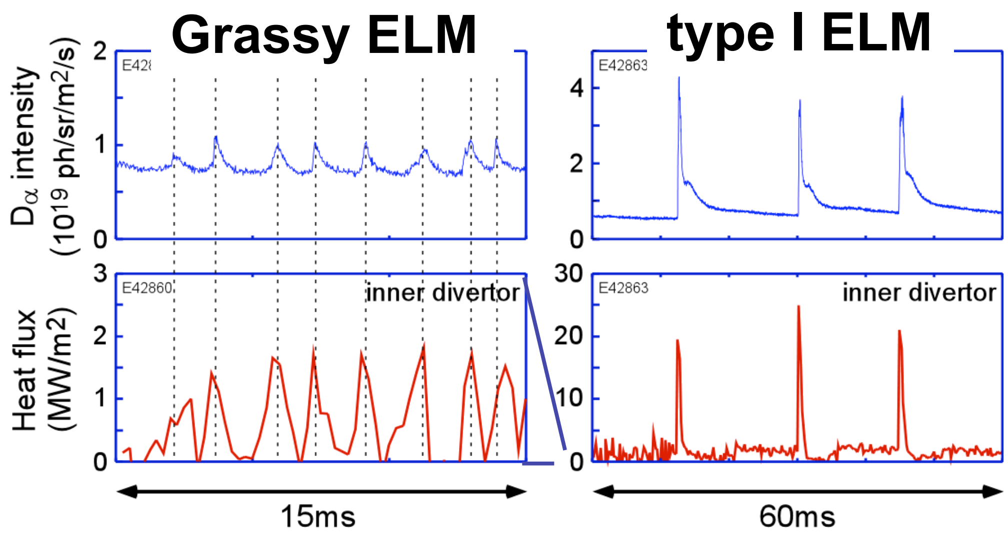


Long sustainment of nearly full CD plasmas

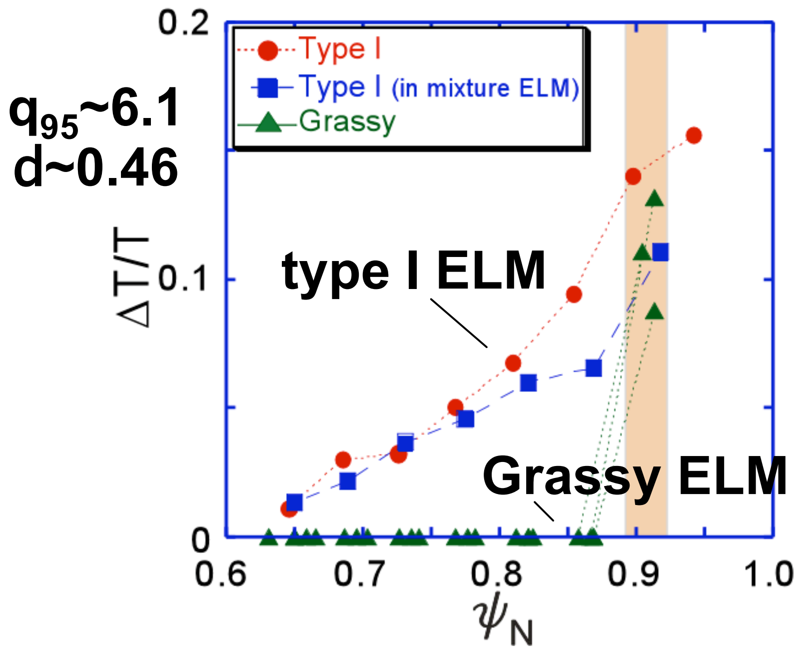
- Achieved region of ~ full CD with large f_{BS} has been significantly extended.
- j(r) approached stationary conditions.
- Controllability of j(r) and p(r) must be studied in a long time scale.

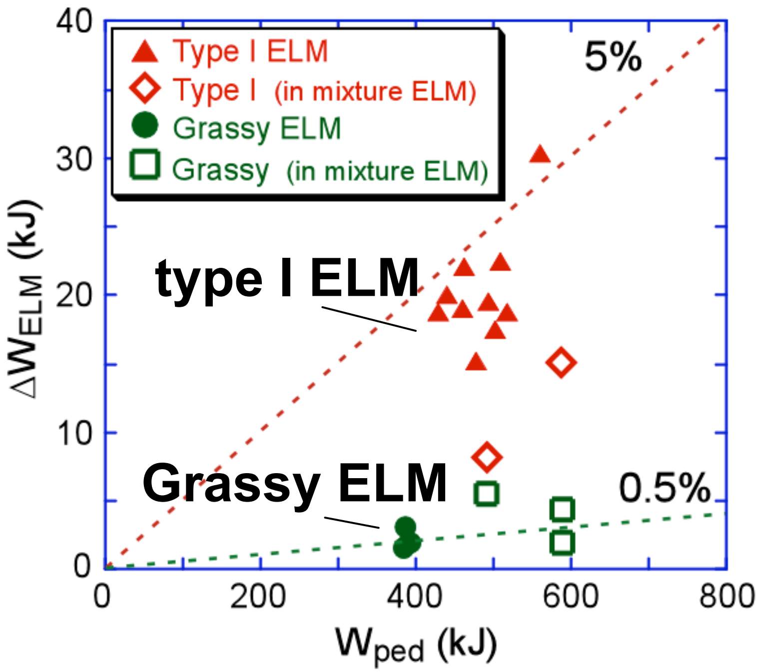


Divertor heat load is reduced by a factor of 10 during grassy ELM than during type I ELM



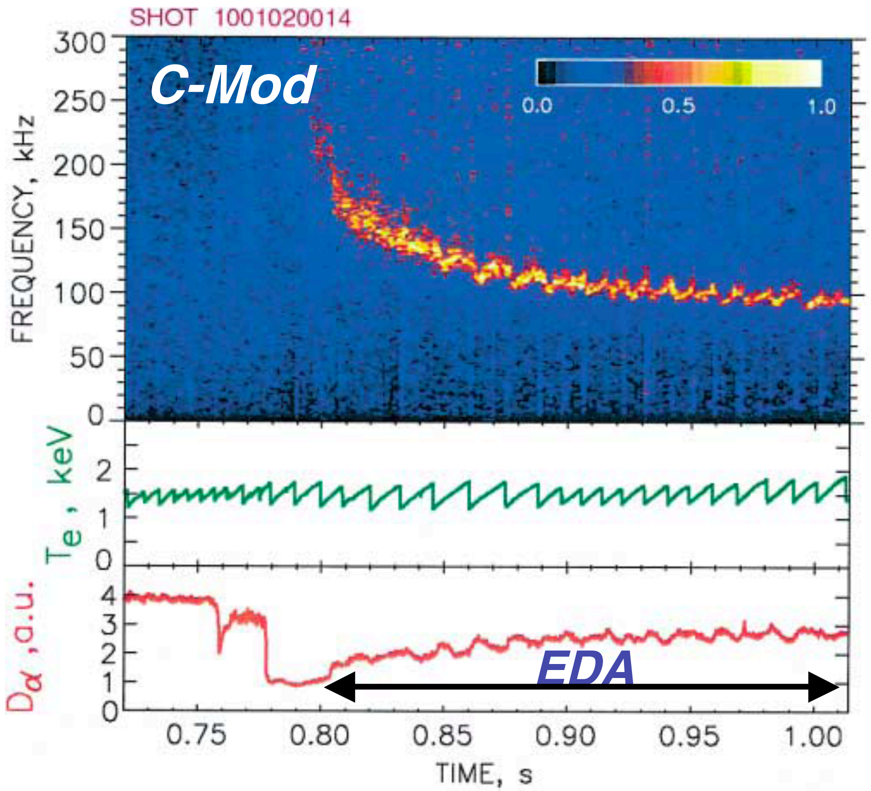
- ●ΔW_{ELM} is reduced by a factor of 10 during grassy ELM.
- ●Narrower radial extent.
- ●Low n_e* region (n_e* ≤0.15).

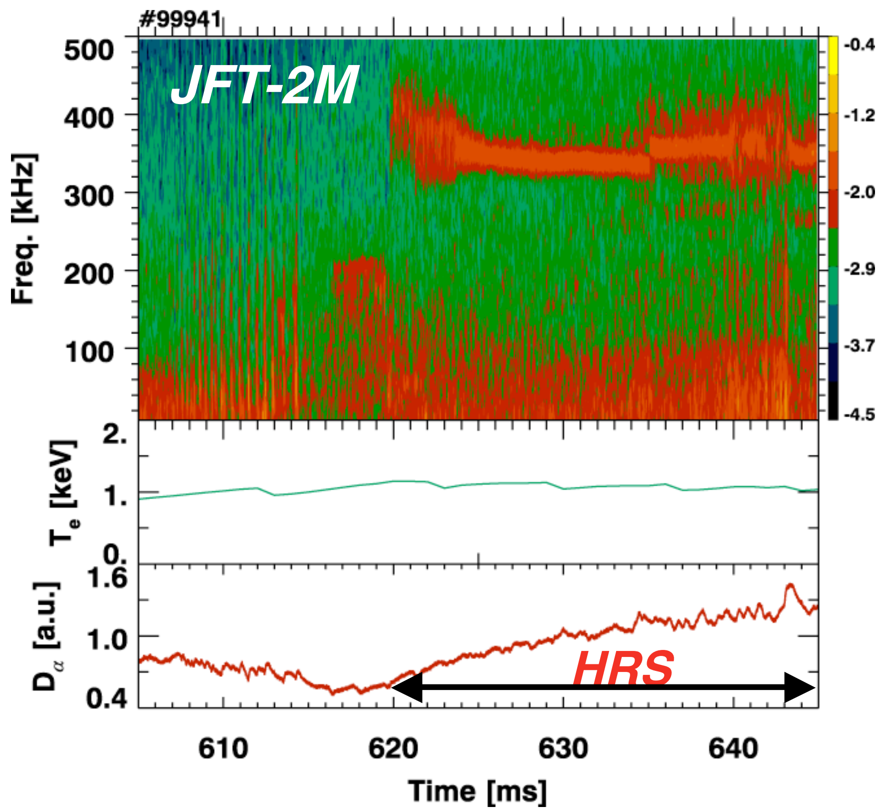




Inter-machine comparison between C-Mod EDA and JFT-2M HRS regimes

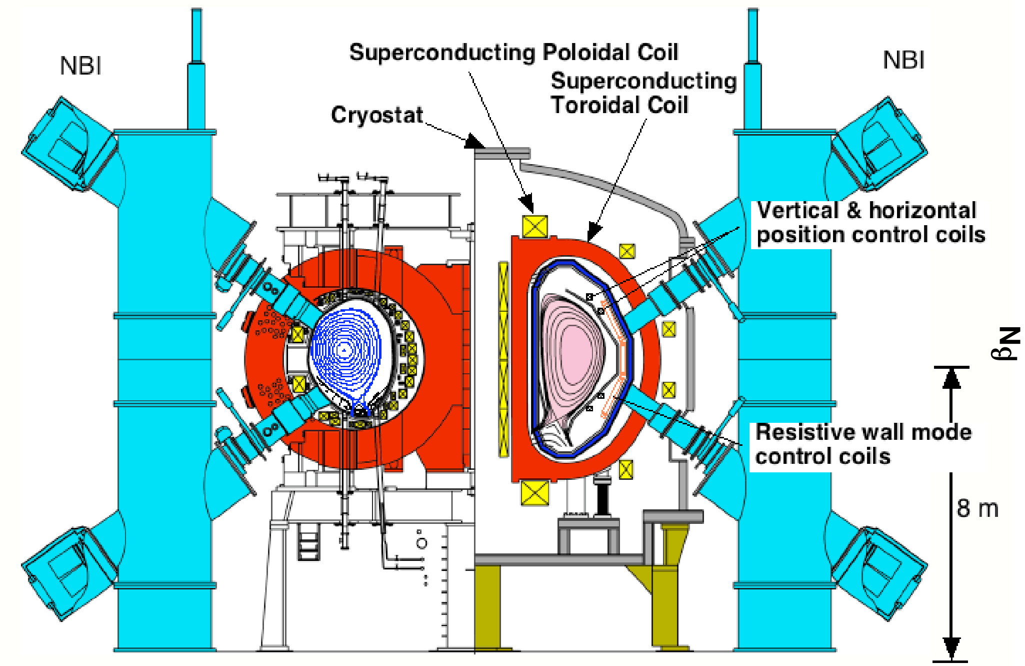
JFT-2M has found a "High Recycling Steady" (HRS) H-mode
These features are qualitatively similar to C-Mod EDA regime
ITPA Inter-machine collaboration was proposed (*PEP-12*).
<u>Questions</u>: ***Is this the same regime as EDA? If so, how do access conditions and fluctuations scale and compare?***

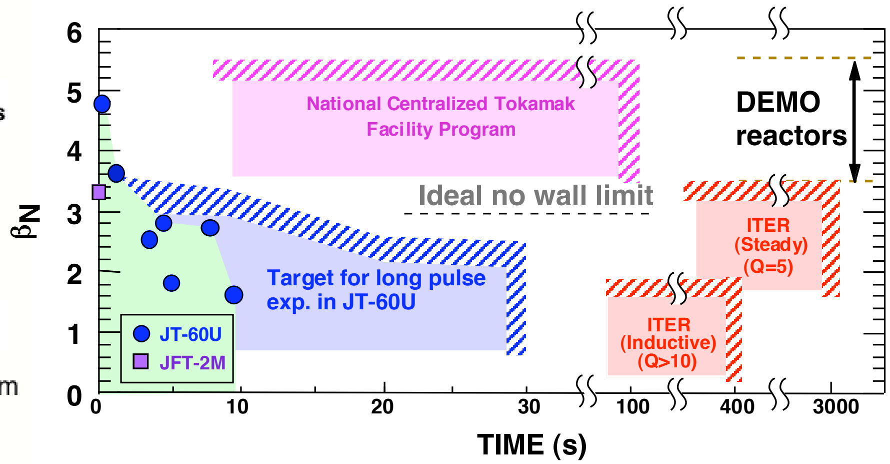




National Centralized Tokamak Program

- **Objectives:** to realize **high-beta steady-state operation** with the use of reduced radio-activation **ferritic steel** in a **collision-less regime**.
- **Planning :** For further progress in the high beta steady state research, the modification of JT-60 is regarded as "**National centralized tokamak facility program**". Detailed design work is ongoing in collaboration with universities, institutes and industries in Japan.





Summary

- **Long pulse operation is successfully performed.**
  - 65 second discharge
  - 30 second H-mode
  - 24 second sustainment of β_N~1.9
- **Region of sustained high beta has been extended.**
  - Stationary RS ELMy H-mode plasma with f_{BS}~75% has been sustained for 7.4s under near full CD
- **NCT is being promoted.**
  - DOE-JAERI technical planning of tokamak experiments(WS)
- **US-Japan cooperation is always productive.**
  - C-MOD/JT-60U joint experiments