合同サブクラスタ会合
2012. 7.24
筑波大学

JT-60SA Research Plan Toward v3.1 - Divertor, SOL and PWI -

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JT-60SA
Advanced Superconducting Tokamak
BA-Satellite Tokamak Program

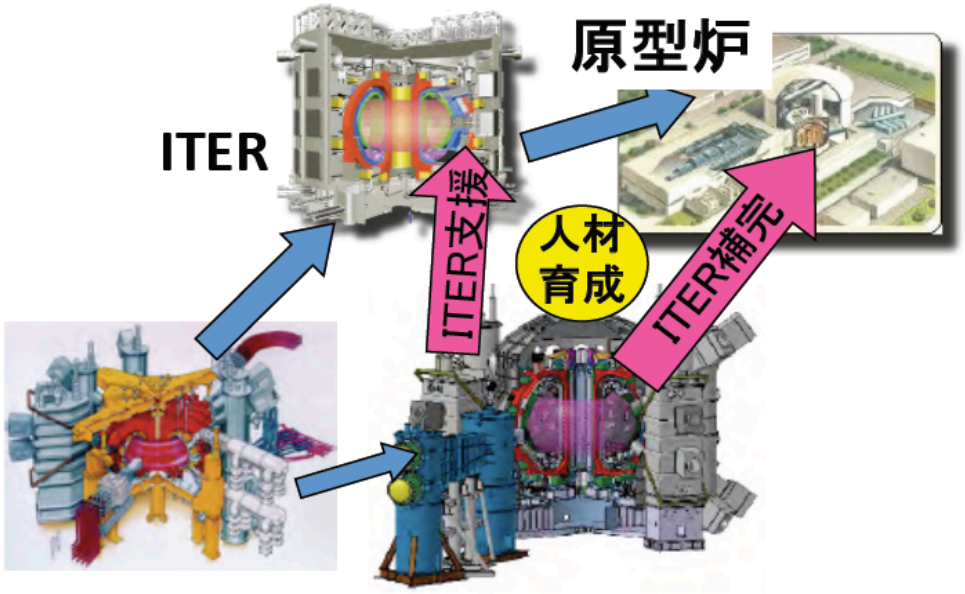
JT-60SA(super advanced) 計画

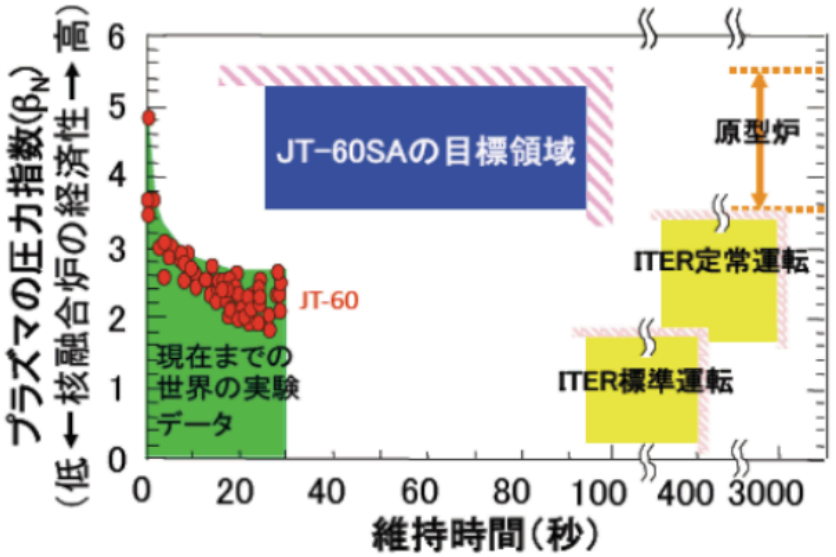
幅広いアプローチ活動におけるサテライトトカマク計画と トカマク国内重点化装置計画の合同計画=> 核融合炉の早期実現

○ITERの技術目標達成のための支援研究
　臨界条件クラスのプラズマを長時間（100秒程度）維持する高性能プラズマ実験を行い、その成果をITERへ反映させる。

○原型炉に向けたITERの補完研究
　原型炉で必要となる高出力密度を可能とする高圧力プラズマを100秒程度維持し、原型炉の運転手法を確立する。

我が国唯一の大型トカマク装置、世界の実験装置の中で、ITERに対して最も大きな支援を行なう能力を有するとともに、ITERでは実施が難しい高圧力プラズマ定常化研究開発を実現できる世界で唯一の装置。欧州が大規模予算で貢献するわが国初の実験装置。ITER・原型炉開発を主導する人材を育成する。==>この研究計画を国内コミュニティ（若手中心）に共同企画





JT-60SA Research Plan v3.0

JT-60SA Advanced Superconducting Tokamak
BA-Satellite Tokamak Program

Contents

分野	検討代表者 JAEA	検討代表者 大学等
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輸送と閉じ込め	吉田麻衣子	田中　謙治（NIFS）
高エネルギー粒子挙動	篠原　孝司	長壁　正樹（NIFS）
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Chapter 8. Divertor, SOL and PWI

8-1. Integration of high-confinement core plasmas with highly-radiative divertor plasmas for steady-state operation
8-2. Detached divertor study
8-3. Radiative divertor study
8-4. Particle and power balance study
8-5. Impurity generation and transport
8-6. Wall conditioning
8-7. Material probe
8-8. Post-mortem tile analysis
8-9. Metal divertor and first wall

Structure of the research plan

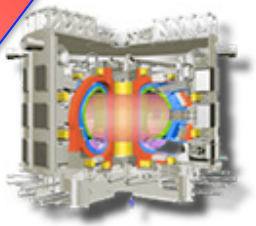
Peak Heat flux / PCF

5 MW/m² / W

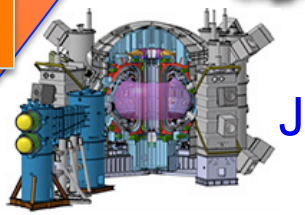
10 MW/m² / W

15 MW/m² / C

DEMO



ITER



JT-60SA

Mission:

8-1.Long-pulse high-β, high-density and high-radiative plasma

Elements:

Integrate

High β

Core/Ped

8-2 Divertor detachment
- V-shaped corner
- …

8-3 Radiative divertor
- Ar/Ne seed
- …

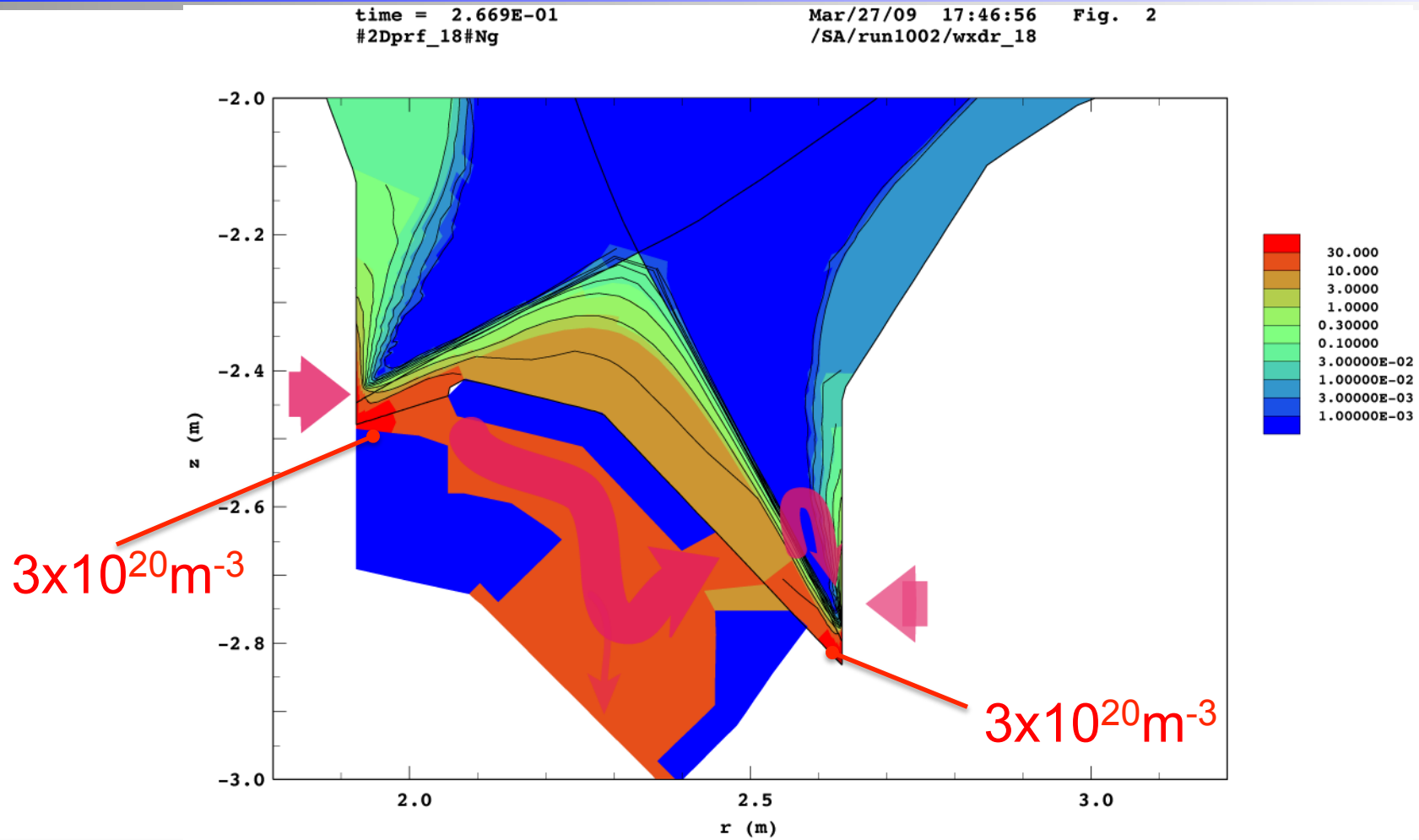
8-4.Fueling / exhaustl
- Pellet
- Ajustable Pump
- …

8-5. Impurity
- C/W transport
- …

8-6. Wall conditioning
- Inter-shot cleaning
- …

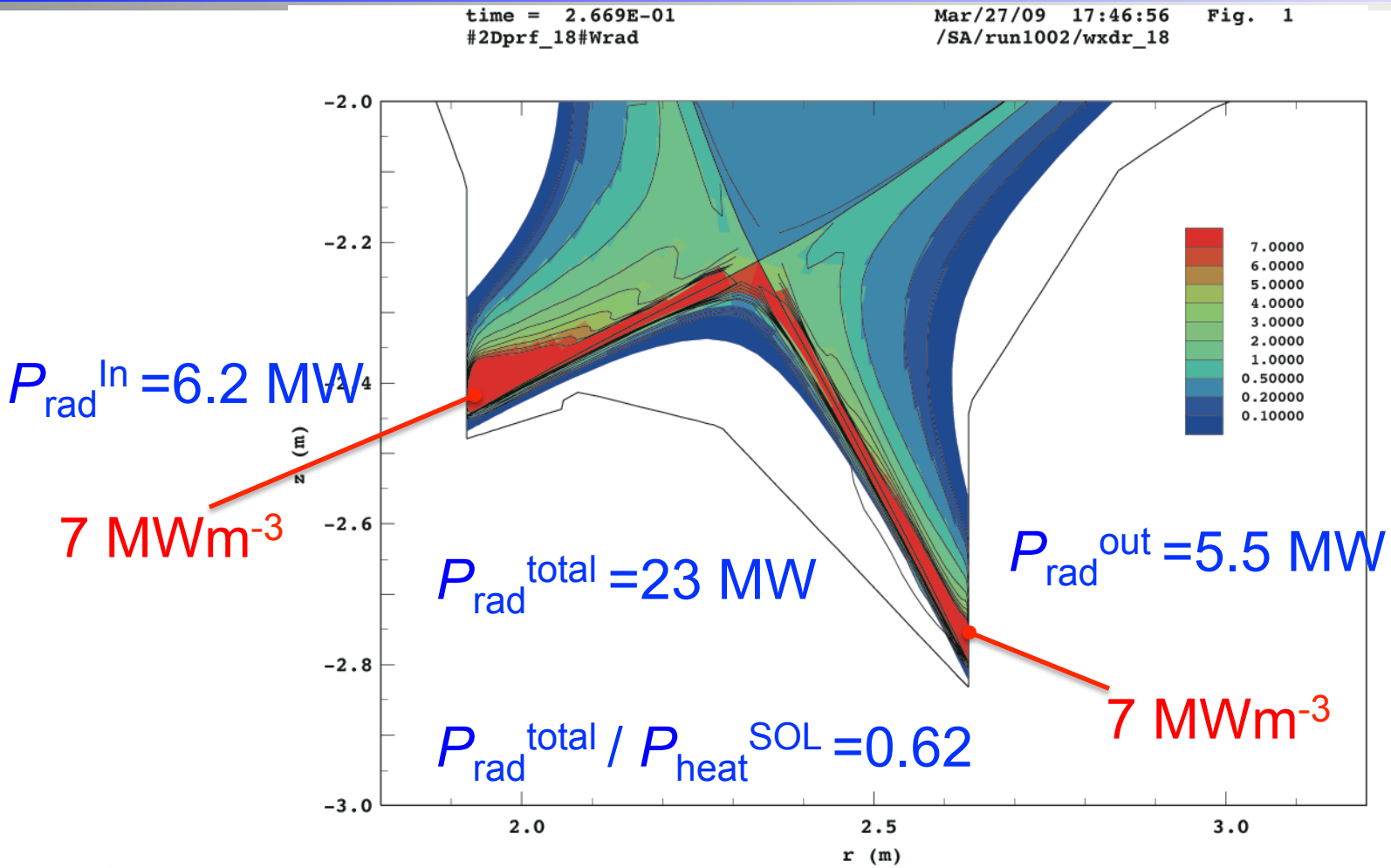
8-7~9. PWI
- Retention
- Erosion
- Deposition
- …

High neutral compression predicted in the V-shaped corners



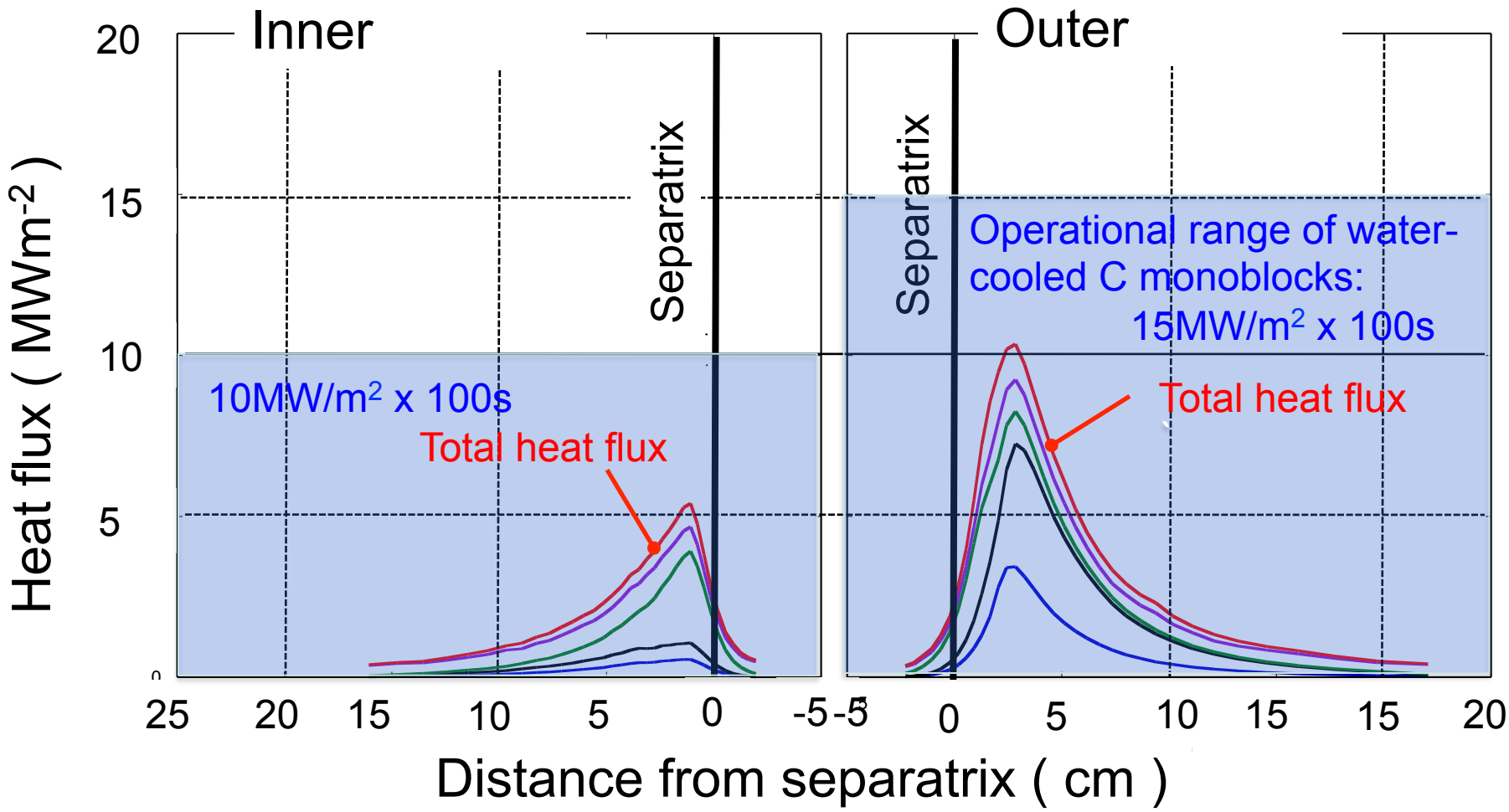
High neutral density in the V-shaped corner is predicted by SOLDOR simulation for the case with I_p of 5.5 MA, P_{heat} of 41 MW, Γ_{gas} of 1.5x10^{22}/s and S_{pump} of 50 m^3/s.

60% radiation in the divertor predicted



High radiation in both inner and outer divertors is predicted

Heat flux lower than 10 MW/m^2 predicted

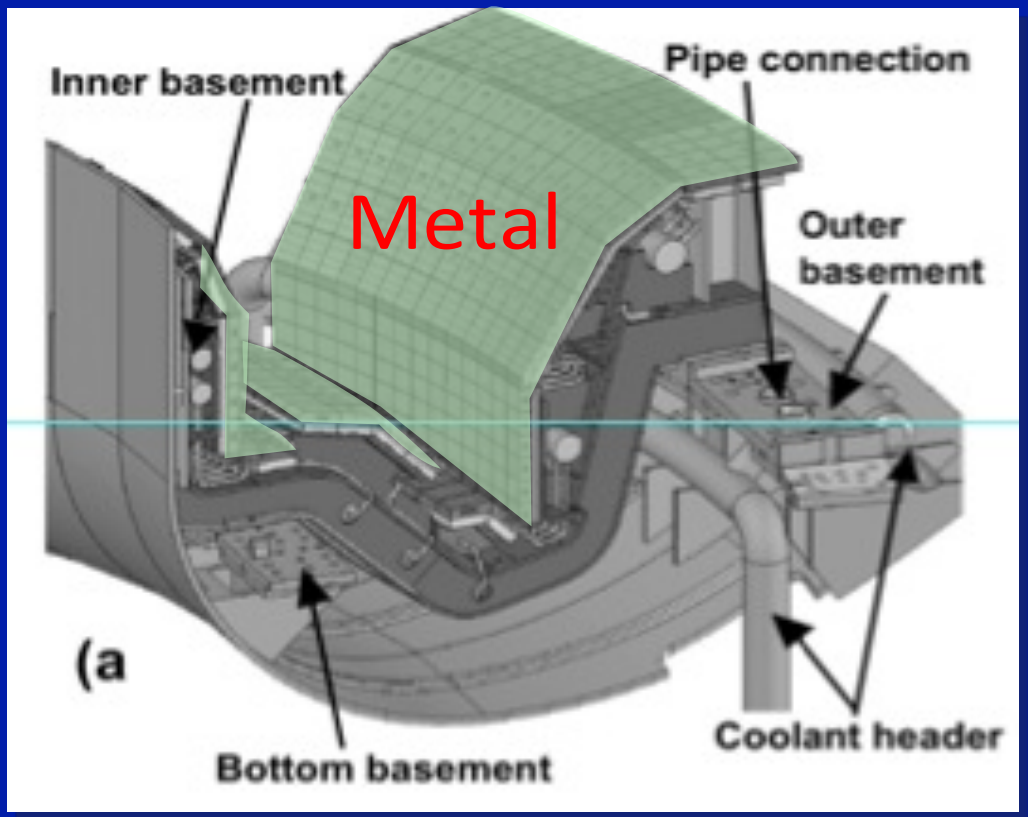


Detachment in both inner and outer divertors is predicted

⇒ Highly radiative divertor operation with detachment is essential in the SA full performance discharges.

リサーチプランVer.3.0への改訂

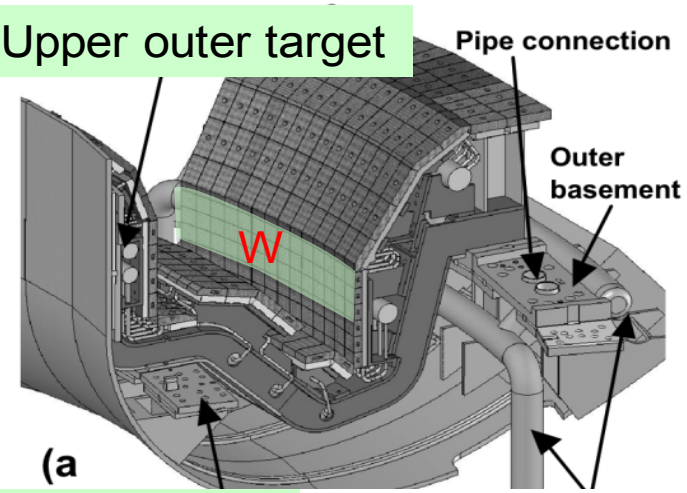
In support of ITER and DEMO, low heat flux regime (10 MW/m^2 for ITER and 5 MW/m^2 for DEMO) will be explored with the PFCs fully covered with metal, after achieving the integrated long-pulse high-b operation with the carbon monoblock divertor.

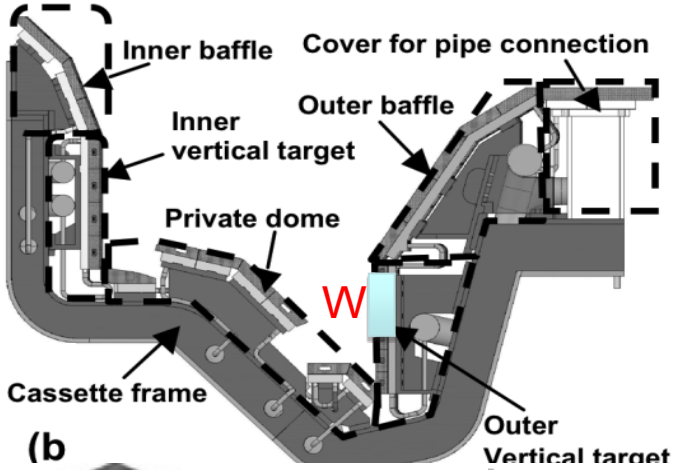


Possible plan, toward full coverage

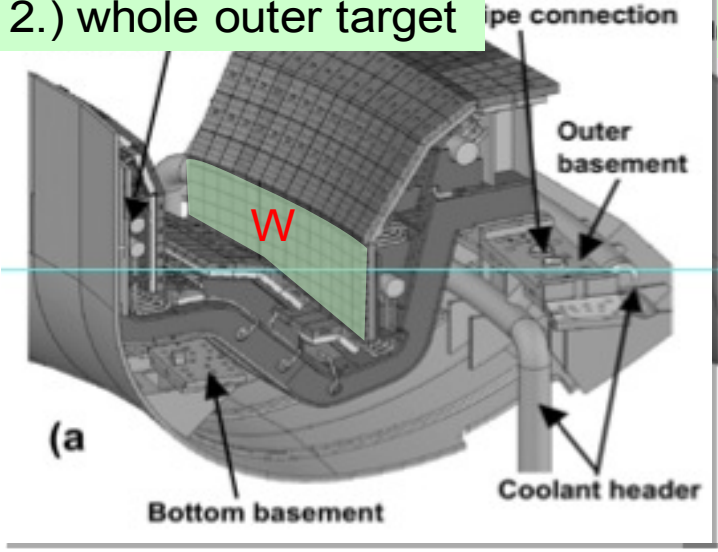
- Phased increase of coverage:

1.) Upper outer target

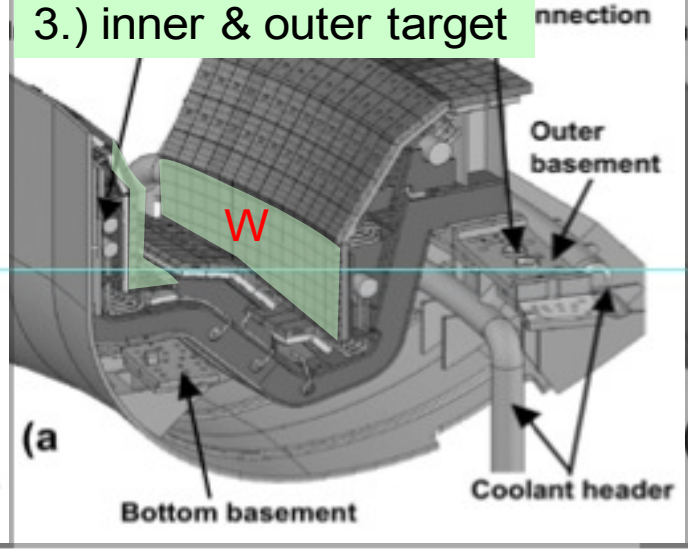




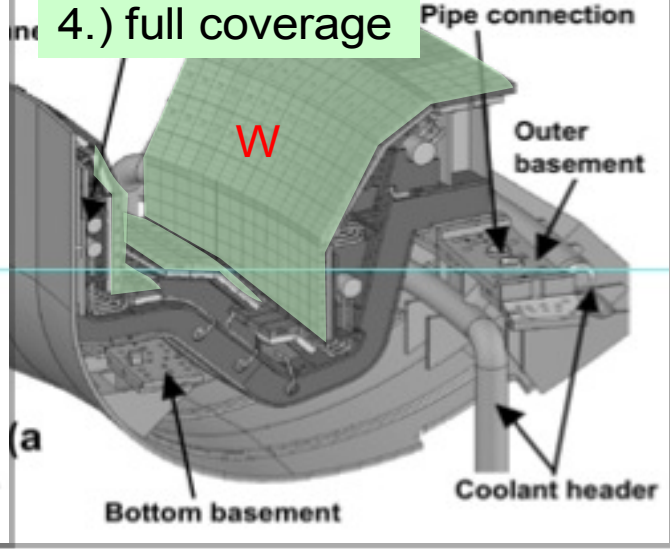
2.) whole outer target



3.) inner & outer target



4.) full coverage



Optional plans of changeover of PFCs to metal ones

Table 8-2 Optional plans of the changeover of plasma-facing components to metal ones

Phase		Duration	Access	Divertor	Heating	Optional Plan #1	Optional Plan #2	Original Plan
						Metal coverage of PFCs		
Initial Research Phase	I	1-2y	Man	Bolted CFC + Mono block	23 MW	1. Upper outer	1.Upper outer Achievement of High β	1.Upper outer Achievement of High β
	II	2-3y	Man		33 MW			
Integrated Research Phase	I	2-3y	Man	Mono block	37 MW	2. Whole outer, or 3. In & out		
	II	>2y	RH			4. Full coverage	4. Full coverage (2&3 skipped)	
Extended Research Phase		>5y	RH		41 MW			Phased increase 2->3->4
Remarks						High β on W PFC. Carbon contamination	Earliest, Compatible with high β	Too late Carbon Contamination

Optimistically, PFC change over takes 0.5 y by human hands, or 1.5 y by remote handing.

Aims in 2012~

●~2011

- The base of the JT-60SA research plan was completed. (ver 3.0)

●2012~

- Progress specific estimations for developing the JT-60SA research plan using EU-JA codes and experimental results in present machines.

  That is “Study on JT-60SA”; code validation/verification, operation/ experimental regimes, heating, diagnostics, analysis method ,etc.

  => These activities will contribute to ITER and DEMO as well as SA.

- Continue to propose a new or revised research items.
- Generate many papers/talks in 2012 such as EPS, IAEA, EC17, Toki and JSPF.
- A minor change of the SARP will be made as necessary (=>ver 3.1).

Schedule for 2012

TV meeting

	EU	JA
April	EU TROs' meeting	
May 7-10	EC-17 (1 paper)	
June 4-8	EFDA meeting	
June 5	EU-JA TROs' 2012 kick-off meeting (remote)	
July 2-6	EPS meeting (4 papers), satellite meeting	
July 31		An introductory report on SARP (~20 pages) for Journal of JSPF
Aug.		
Sep.		
Oct. 8-13	IAEA conference (3 papers)	
Nov.19-22	Toki conference (** papers)	
Nov. 27-30		JSPF annual meeting (** papers)
TBD	2nd RCM at Naka	
Jan.~Feb.	Finalization of the SARP v3.1 (draft at end-Jan. -> review -> publication at end-Feb.)	
Feb.~Mar.		4th JA-TROs' meeting

Updating Plan for Chap.8 (DSOLPWI) in 2012-13

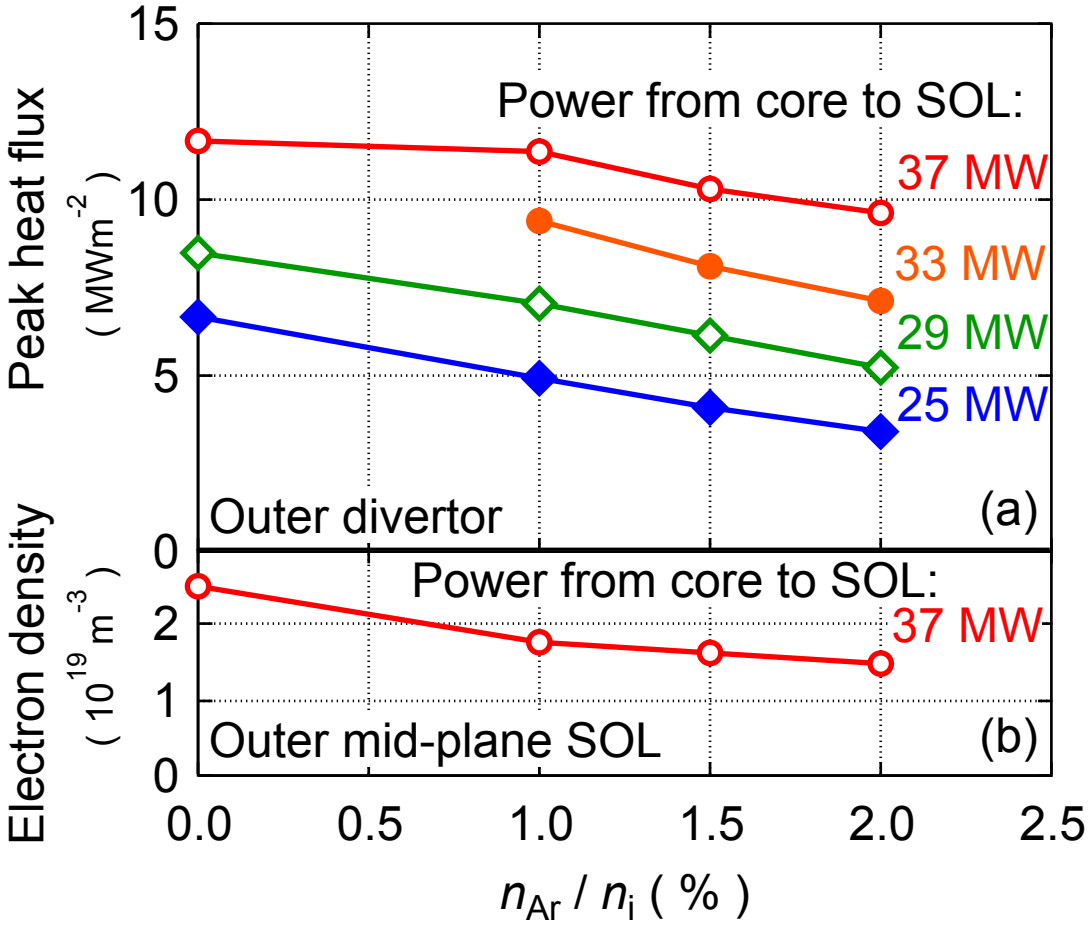
TV meeting

- **Scenario development in a metal wall**

Present evaluation is only for C-wall

⇒ n_{Ar}/n_i is scanned with n_C/n_i at 2% .

Plan: similar evaluation in a metal wall



- **Detailed evaluation of activation**

Man accessibility is uncertain after Integrated Research Phase I, where Present C->Metal changeover is planned.

Plan: update neutron fluence evaluation based on the current research plan.

<u>Long term plan(possibly for v.4):</u>

- **Comparison of pumping efficiency between EU and JA code**

The divertor and cryopanel geometry will be provided to EU.

- **Parameter survey with cooling rate validated by IMPMC**

Present cooling rate based on colonal model will be compared with that calculated with IMPMC in JT-60SA conditions.

Plans for 2012 JT-60SA related activities in EU

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M. Beurskens[b)], T. Bolzonella[c)], D. Borba[d)], C. Day[e)], E. Joffrin[a)],
P. Lauber[f)], R. Neu[f)], F. Orsitto[g)] , M. Romanelli[b)], C. Sozzi[h)]

JT-60SA EU Research Unit

[a)] CEA/Cadarache, [b)] CCFE/Culham, [c)] Consorzio RFX/Padova, [d)] EFDA/Garching,
[e)] KIT/Karlsruhe, [f)] IPP/Garching, [g)] ENEA/Frascati, [h)] IFP/Milano

2012 EFDA Workprogramme: table of resources

Tasks	manpower (ppy)	travel
coordination	0.2	1 EU + 1 JA-EU coord. meeting
follow-up of Research Plan revision (TROs)	1	1 EU + 1 JA-EU coord. meeting
modelling	2	1-2 months in Japan
working group on JT-60SA data system, analysis & validation tools	1	1 EU + 1 JA-EU meeting
experiments and data analysis on EU machines in support of JT-60SA	1	for participation in experiments
evaluation / optimization of ECRH launcher	0.5	
assessment of selected diagnostic systems	0.5	
assessment of JT-60SA divertor pumping system	0.5	
Total	**6.7**	*to be evaluated*

EFDA Workprogramme 2012 : specific subjects

- Evaluation / optimization of **ECRH launcher** performances
  - extensive beam-tracing for the present launcher configuration
  - comparison with physics requirements. Sensitivity studies
  - performance optimization analysis
- Assessment of selected **diagnostic** systems
  - current profile measurement diagnostics
    (MSE, polarimetry, integration of equilibrium reconstruction)
  - Thomson scattering system
- Assessment of JT-60SA **divertor pumping** system
  - use of state-of-the-art EU codes for the divertor pumping system design
  - possible optimization

EFDA Workprogramme 2012 : coordination structure

- Overall **coordination** and **follow-up** of Research Plan revision, managed by the same structure (Coordinator + TROs)
  - the JT-60SA EU Research Unit becomes a permanent EFDA structure
  - follow-up of RP revision: background work consisting in corrections, improvements, extensions of the Research Plan
  - coordination of collaboration activities connected with the physics and operation of JT-60SA
  - activity supervised by the ITER Physics Department of EFDA

- Changes in the EU Research Unit with respect to 2011:
  - Chap. 8 (Divertor): M. Wischmeier replaces R. Neu

JT-60SAリサーチプラン

JT-60SAリサーチプランは、JT-60SAを用いてどのような研究を進めていくかについての研究計画をまとめた書類です。

運転領域開発、MHD安定性と制御、輸送と閉じ込め、高エネルギー粒子挙動、ペデスタル及び周辺プラズマ、ダイバータ・プラズマ壁相互作用、核融合炉工学、理論モデル・シミュレーションコードに関する８つの研究領域について、　JT-60SAの実験研究を担う若手研究者を中心に企画・提案したものです。

JT-60SAリサーチプラン Ver.3.0

ダウンロードはここをクリック
(pdf 9.5MB)

このJT-60SAリサーチプランの検討活動の目的は、国内及び日欧の研究者で幅広く議論を行い、JT-60SAにおける研究計画を成熟させて行くこと、また、核融合原型炉に向けて、ITER及びJT-60SAを包含する総合的な研究計画を検討することで、国内の核融合研究の一層の活発化に貢献することです。

検討体制

日本では、核融合エネルギーフォーラムのプラズマ物理クラスター, 炉工学クラスター, 社会と核融合クラスターの各サブクラスターにおいて、検討代表者が取り纏め役となって検討を進めています。また、核融合ネットワークでも意見を集めています。 欧州では、F4Eとの協力の下、　EFDAにおいて検討代表者が取り纏め役となって検討を進めています。