



## Status Report for WPSA

FSD - Tokamak Exploitation Project Board | 14 March 2022

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# 1 – WP Organization

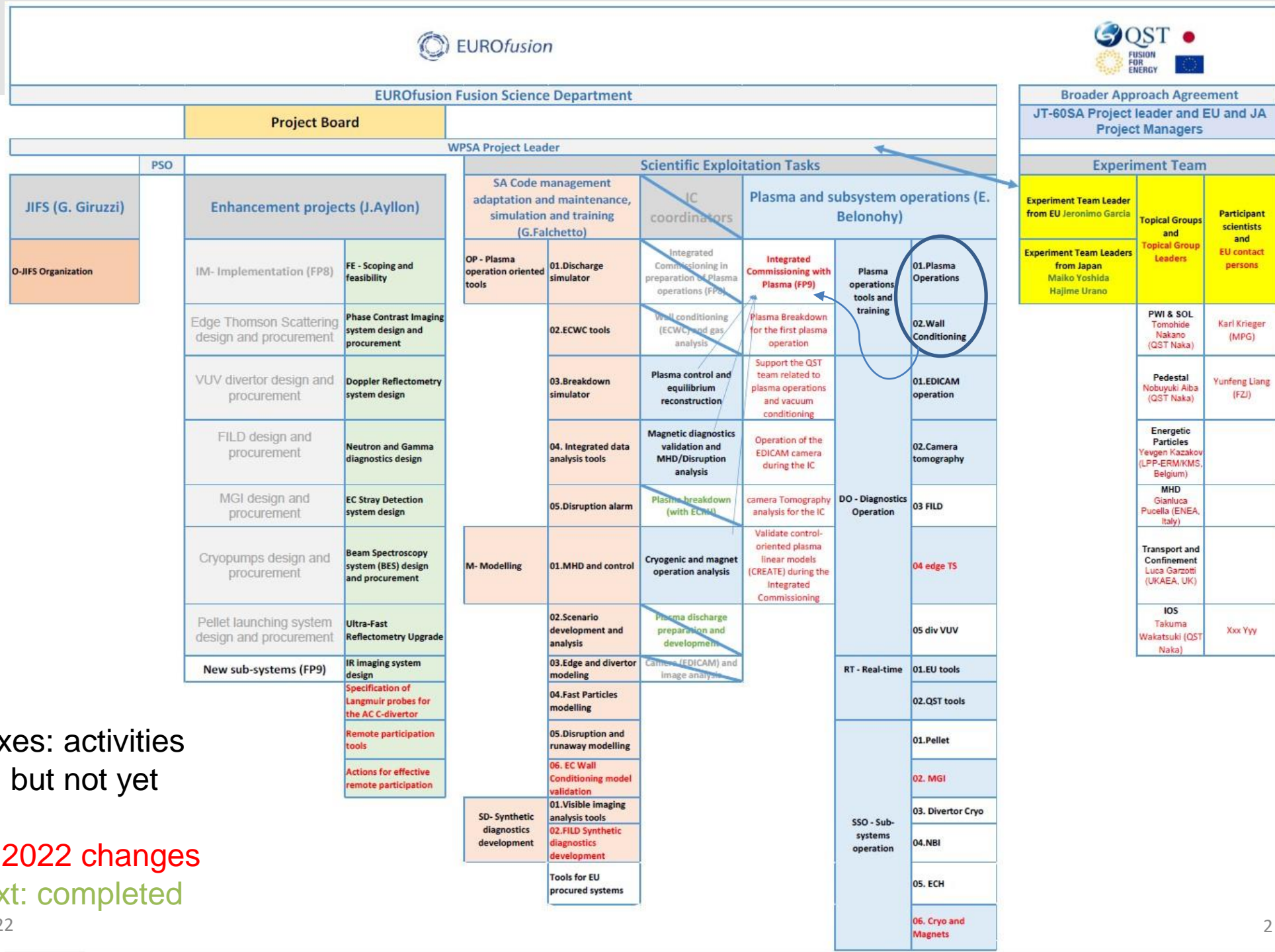
- Hybrid nature of WPSA
  - Runs partially as a project
  - Partially as a campaign

- Mixed Work programme FP8 & FP9 (until 2022)

- Substantial importance of interfaces (F4E, QST...)

- WPDIV, WPPWIE
- WPPrIO, WPTE
- WPAC

- white boxes: activities foreseen but not yet started
- red text: 2022 changes
- green text: completed





Task coordinator *E. Joffrin*

Team: *J-F Artaud, B. Faugeras; C. Boulbe; G. Giruzzi  
M. Iafrati, O. D'Arcangelo, M. Mattei, L. di Grazia*

*New version of Scenario 4-2  
computed with METIS FEEQS  
coupled simulation.*

Equilibrium evolution and time dependent quantities from the full-bore start to the end of the discharge (currents in the various Equilibrium Field and Central Solenoid coils, computed by FEEQS).

❖ **2021 strongly coupled CREATE-NL/METIS dynamic simulation achieved**

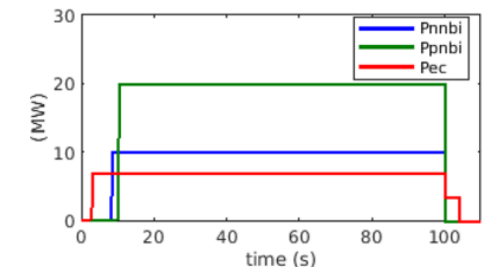
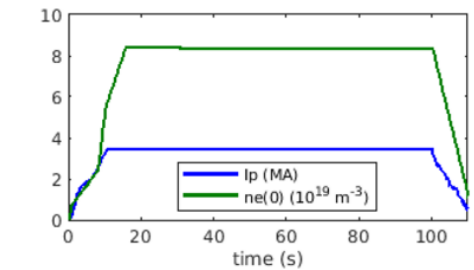
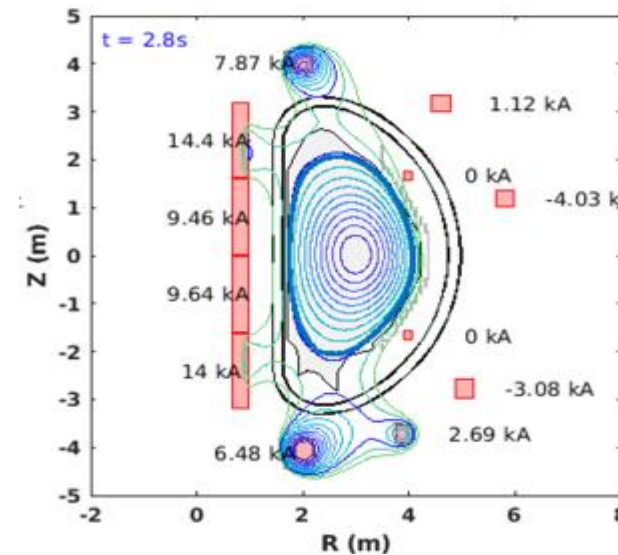
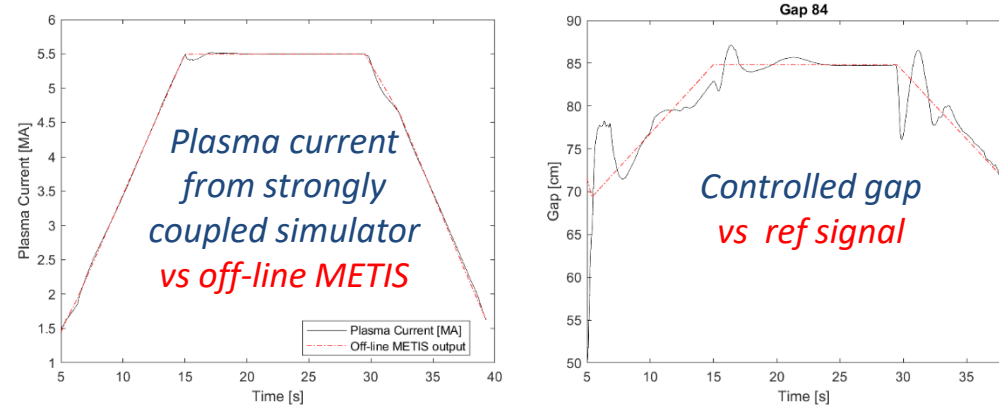
of an entire non-Ohmic JT-60SA Scenario in the diverted phase, using an ad hoc designed magnetic controller

❖ **2021:** Deployment of the light coupling discharge simulator METIS-CREATE with controllers

✓ METIS/NICE/FEEQS and EGENE installed on the EUROfusion Gateway cluster

✓ **Test cases available on the EF Gateway**

Scenario 2 dynamic evolution with additional power (NBI+ECRH) in the plateau : assessment of the feasibility with regards of various parameters



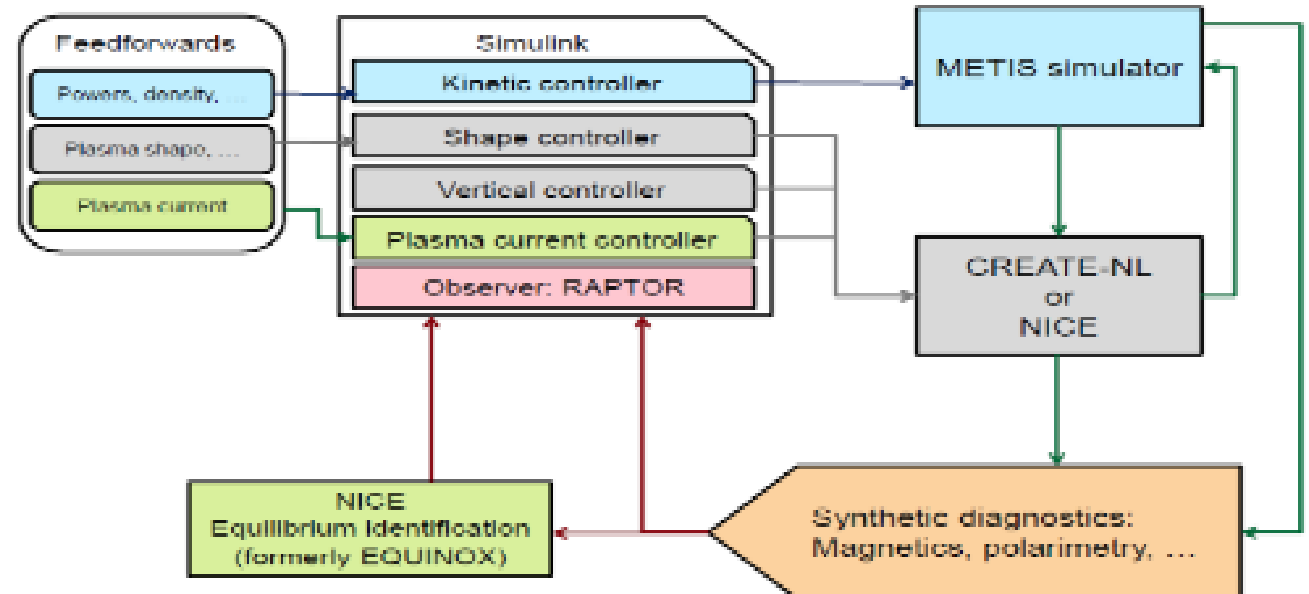
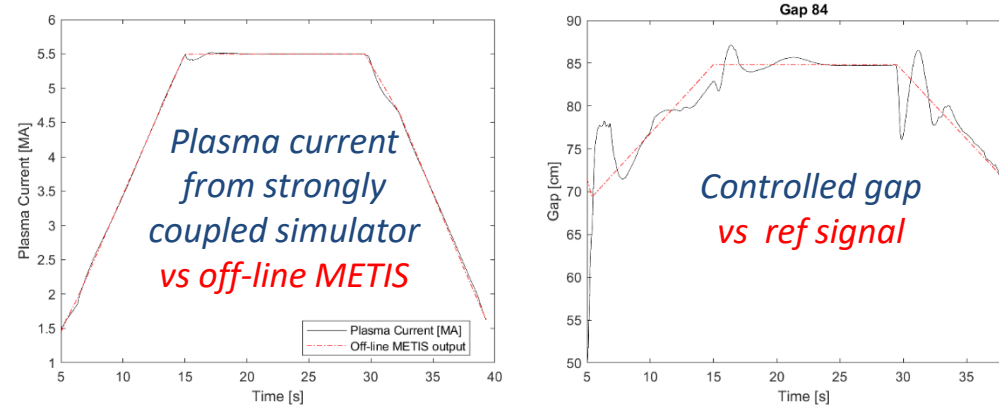


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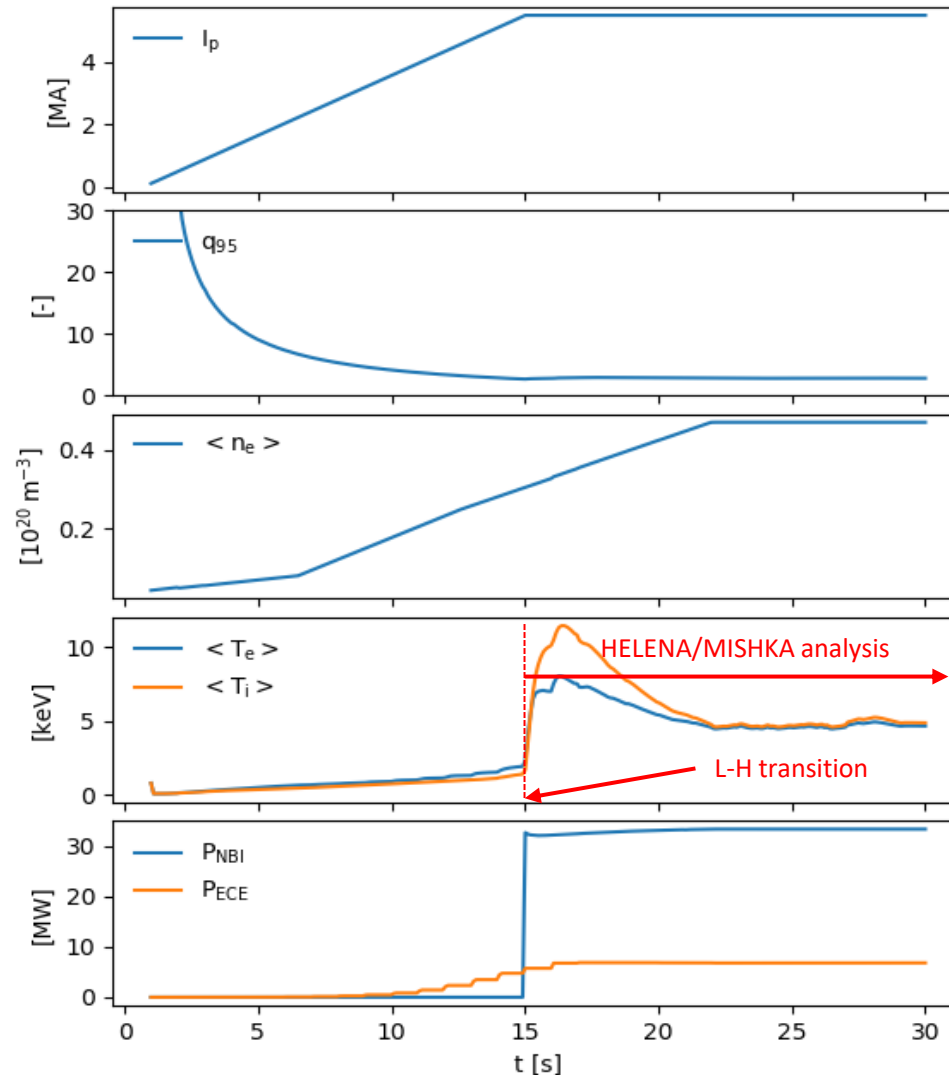
✓ New workflow light coupling METIS/NICE based on new Galerkin numerical method [*Heumann JCP2021*]

❖ **2022:** Deployment of the up-to-date discharge simulator coupling METIS-CREATE codes with controllers for simulating a JT-60SA discharge.



- Simulation for Scenario 2, based on [V. Ostuni et al 2021 Nucl. Fusion 61 026021](#)
  - Semipredictive:
    - current density and ion and electron temperatures predictive,
    - density prescribed
  - Equilibrium (ESCO), power deposition ECE (GRAY) and NBI (PENCIL) L-H transition (Martin scaling) calculated self-consistently.
  - Temperature pedestal height after L-H transition set by self consistent HELENA/MISHKA stability analysis.
- ❖ **2021:** Numerical integration of HCD schemes for ECRH in the IM transport codes (JINTRAC / ETS) tested
- ❖ **2022:** Assessment of ramp-up for Initial Phase Scenario 2 with first principles transport models with IM codes

*L. Garzotti, D. Taylor (UKAEA)*





#### **EDICAM (EK-CER)** – first EU diagnostic on JT-60SA

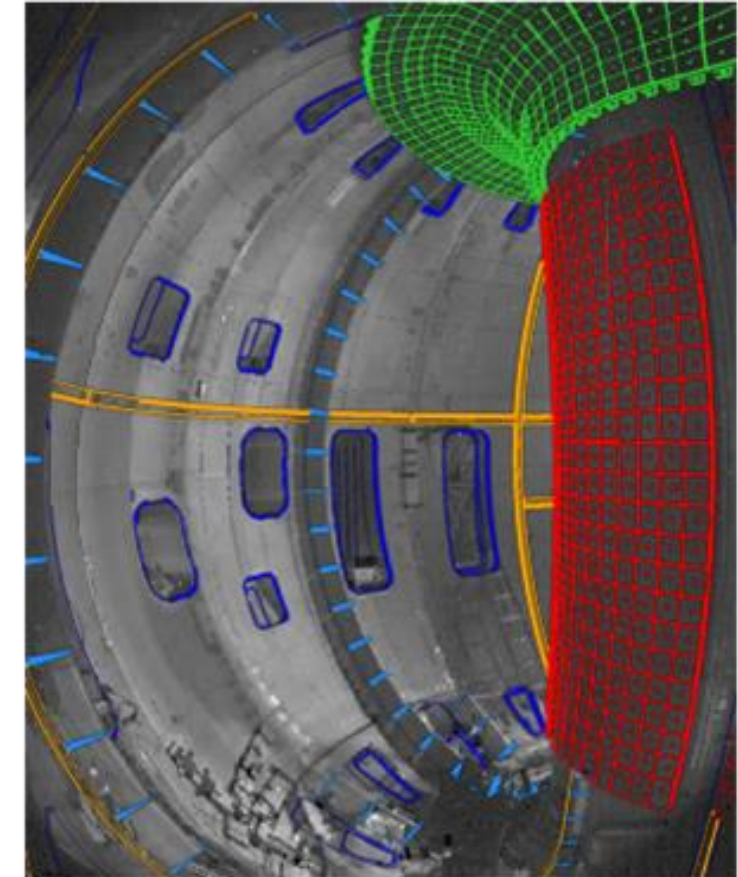
- Commissioning of the EDICAM camera completed without plasma remotely from Hungary

Status: Ready for first plasma

#### **Camera Tomography (IPP-CR)**

- Need identified to provide additional emissivity profile information for the modelling of ECWC discharges to complement the single interferometer line available in the integrated commissioning phase.
- TOMOTOK camera tomography python package (open source) updated and calibrated for EDICAM on JT-60SA
- Validated on different plasma conditions, specifically, on electron cyclotron experiments, including ECWC (TCV and COMPASS)
- Code installed and tested on the Naka Analysis Server
- Calibration tested by overlaying some PFC components over an image taken by the EDICAM camera

Status: Ready for analysis by local users on breakdown, ECWC, first plasma operation. RE measurements being explored



First EDICAM vacuum vessel image with the JT-60SA calibration of the TOMOTOK code  
(T. Szepesi & J. Cavalier)

# 2 – WP Main Objectives & Summary of Achievements 2021: Operations



## Vacuum conditioning (led by LPP-KLM-ERM + CEA, ENEA, UKAEA)

- Baking: 2 baking cycles without EU involvement
- GDC (Glow Discharge Cleaning): strong involvement from EU team, partially commissioned, ready for long GDC phase
- ECWC - Electron Cyclotron Wall Conditioning): strong EU involvement particularly providing ECWC modelling

### 1. Share European and Japanese experience:

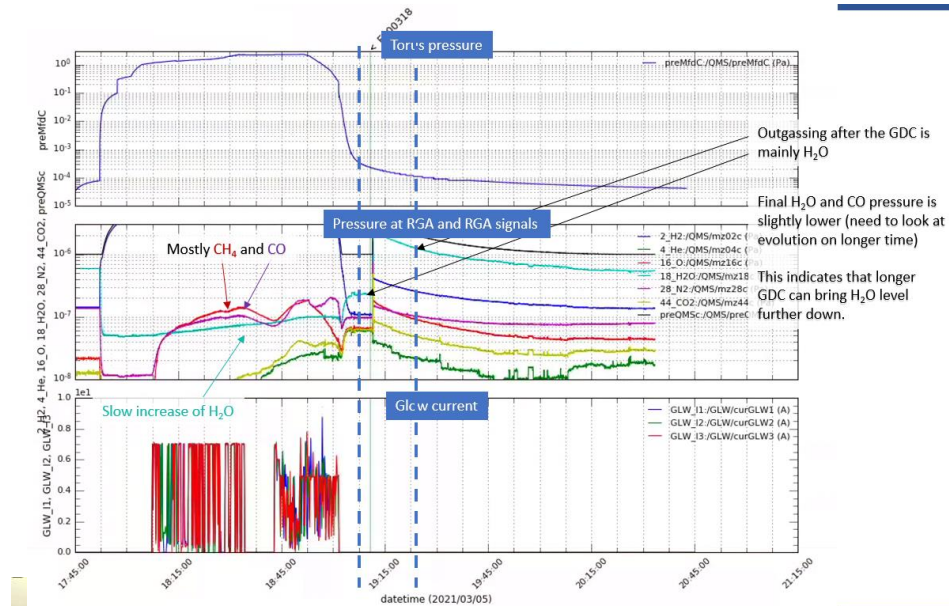
- Two workshop held sharing operational experience from JET, MAST-U, W7-X, WEST, FTU, JT-60U and KSTAR.

### 2. Joint elaboration of the JT-60SA vacuum conditioning strategy

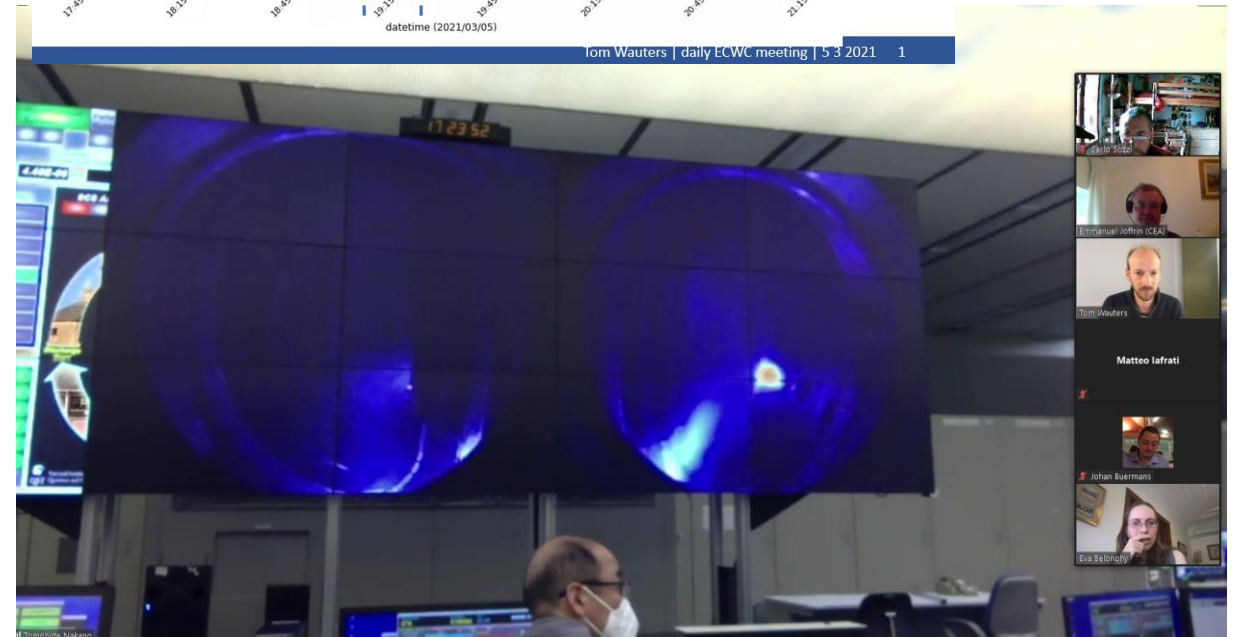
- Direct input into the vacuum conditioning strategy (baking, GDC, ECWC)
- ECWC modelling parameter scans to provide basis for ECWC experiment plan

### 3. Daily short control room meetings with the QST contact and Plasma Operation Chief (physics pilot)

- Daily control room meeting with European and QST team during the commissioning of the GDC system.
- Optimisation of the remote participation tools (Microsoft Teams, VPN data access) critical for future IC participation.
- **Status:** Ready for the next vacuum conditioning phase with clear plan. GDC ready for overnight conditioning.
- The joint work principles established for GDC commissioning are planned to be extended to the other IC topics in 2022.



Code Management and Operations



# 2 – WP Main Objectives & Summary of Achievements 2021: Enhancements



## NEUTRON & GAMMA DIAGNOSTICS (ENEA, ENEA-UniMib, VR, IPP-LM, UKAEA)

- Feasibility studies launched for different types of spectrometers, diamond detectors and dosimetry systems.
- Scientific cases preparation started for proposals support during evaluation and prioritization.
- MCNP studies currently being planned/discussed with QST/F4E for diagnostics development and N&G sensible components protection.

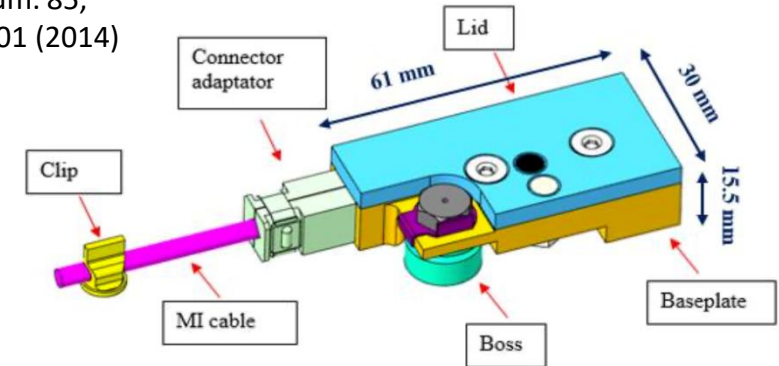
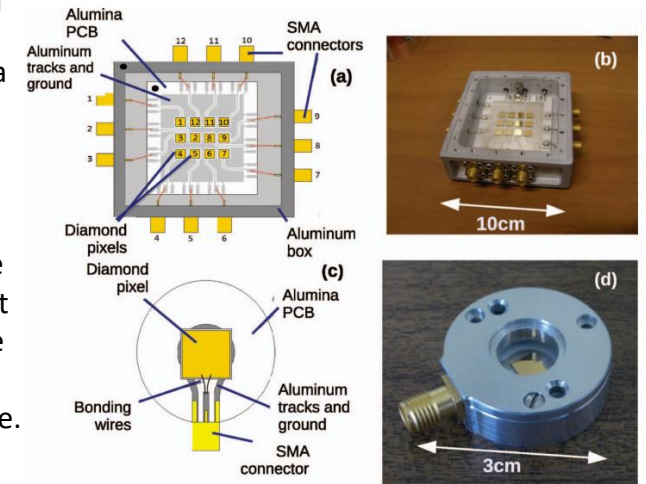
## EC STRAY DETECTION SYSTEM (ENEA)

- Adaptation of ITER EC stray sensor to JT-60SA under assessment: IO-F4E-EUROfusion-QST collaboration launched.
- Residual non-absorbed ECRF power fraction analyzed (GRAY, CATIA) as a function of ECRF frequency and plasma parameters.
- Integration study ongoing: initial port selection ready for discussion. Lab tests (CNR) started

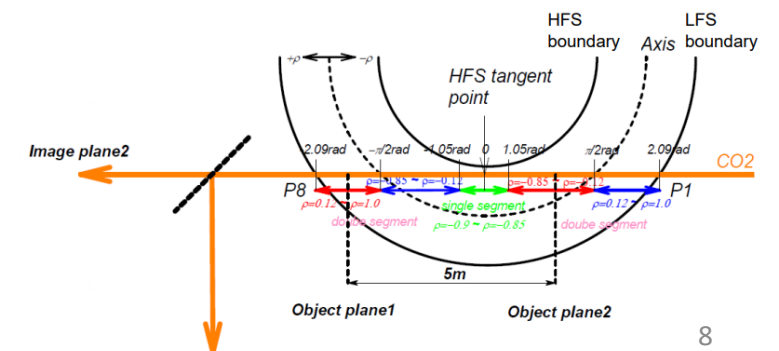
## PHASE CONTRAST IMAGING SYSTEM (EPFL)

- Final design phase started including adaptation of current design to new location requested by QST (will be finished in 2022).
- Using two imaging systems for two object planes LFS-HFS asymmetry can be measured
- Hardware cost sharing agreed with NIFS and first procurements started (from NIFS side).

layout (a) and picture (b) of a neutron spectrometer based on a 12 pixel diamond matrix. On the bottom, layout (c) and picture (d) of a single pixel prototype. Rev. Sci. Instrum. 85, 11E101 (2014)



ITER EC stray radiation sensor CAD model





## 2 – WP main issues and deviations/insufficient progress



- Deviations from the Annual Work Plan in the Operation area have been due in large part to the COVID outbreak, with a significant delay of the IC campaign and difficulties for Europeans to travel to Japan. This has been mitigated enhancing the remote support from the European labs.
- Moreover, IC was stopped by an incident in March 2021 and could not continue in the remaining months of the year. The programme is delayed to 2022, with consequent slowing down in the organization of the Experiment Team which is responsible for the organization of the scientific phase. This in turn resulted in a lack of on-site technical contact persons for some of the activities in WPSA related to Enhancement proposals and development of modelling tools.
- Other deviations causing delays for specific items in the work programme were:
  - TCPI (change in the layout of the Upper Stage of the JT-60SA Torus Hall and consequent requested change in the layout of the diagnostics)
  - Discharge simulator (delay in the software update of the EUROfusion Gateway platform)
  - Minor shortcomings due to technical difficulties or delay in the availability of input in some of the modelling activities will be tackled in the 2022 workprogramme.
  - Minor shortcomings caused by the impossibility of on-site work (EDICAM software)
  - Worthy to mention the lack of available expertise for ASCOT calculations which impact on several modelling activities.
  - Some of the JIFS tasks on hold because the date of the first edition cannot be yet defined (reasons: JT-60SA incident and related delay, COVID).
  - Unexpected and unavoidable absence of the PL in a critical period of the annual management cycle was effectively tackled with an interim leadership

## 2 – Status of Grant Milestones & Grant Deliverables (previous year)



GA Deliverable No.	Title	Due Date	Status	Details on Status (in case of delays or issues)
D02.01	Appointment of Experiment Leader from EU (after call issued end 2020)	30/04/2021	Completed	
D02.02	Report on the first phase of the Integrated Commissioning (before plasma operations). Results and return of experience, mainly for DTT	31/12/2021	Being Uploaded	The completion of the integrated commissioning is delayed. Deliverable dependent on external conditions to which the work package is constrained.
D02.03	Report on the initial organisation of the JT-60SA scientific exploitation	31/12/2021	Completed	

GA Milestone No.	Title	Due Date	Status	Details on Status (in case of delays or issues)
SA.M01	Participation in the Integrated Commissioning before plasma operations	30/04/2021	Completed	The completion integrated commissioning is delayed. Deliverable dependent on external conditions to which the work package is constrained.

### 3 – Risk & Mitigation Register: Current Status



Description of Risk	Severity [L/M/H]	Likely Hood [L/M/H]	Proposed Mitigation Action	Risk materialized?	Mitigating Measures applied?	Comments
Insufficient resources for enhancements	M	M	Resource levelling and reprioritization	n	n	Delay in the machine availability for the scientific programme has postponed the evenience of this risk.
Insufficient resources for preparation of simulation/analysis tools	M	M	Reprioritization, and exploit opportunities by interaction with appropriate TSVVs	y	n	<ul style="list-style-type: none"> <li>Up to now, marginal severity related to unavailability resources for ASCOT simulation. Being solved in 2023.</li> <li>TSVVs busy in development</li> <li>Possible lack of test users for the discharge simulator</li> </ul>
External boundary conditions impacting interaction with on-site operation	M	L	Define the way of interaction with F4E and QST. Assign dedicated resources on site	y	y	Change in H likelihood. Partially mitigated by remote participation. Change in H (or VH) severity
Delay in the machine availability for scientific use	M	M	Resource levelling and reprioritization	y	y	Change in H likelihood. Mitigated with resource levelling (postponing)



## Decisions on PCRs

PCR Number	PCR Title	PCR Status	Comments
1	<p><b>Langmuir Probes:</b> F4E/QST request expert support for probes development for actively cooled divertor phase.</p> <ul style="list-style-type: none"> <li>• Create one ENH task with one associated deliverable for 0.5 PM. (J. Gunn, CEA).</li> </ul>	[new / approved / rejected / implemented]	



## Decisions on PCRs

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2	<p><b>Remote access architecture:</b> focus on IC and Initial Research phases to grant EU researchers participation (tools, infrastructures, manuals,...).</p> <ul style="list-style-type: none"> <li>Split 2021 task into two tasks with one associated deliverable each (F. Imbeaux, CEA - G. de Tommasi, ENEA-CREATE).</li> </ul>	[new / approved / rejected / implemented]	<ul style="list-style-type: none"> <li>Impacts on the scope of SA.M.02: Start of the EU-REC project (Apr. 2022)</li> </ul>



## Decisions on PCRs

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3	<p><b>Re-organization of the EUF participation to IC:</b></p> <p>Extension in 2022 required a reshuffling to face with changes in HR and additional effort, and to pair with ET start of activities.</p> <ul style="list-style-type: none"> <li>• IC expected to continue in 2022 under the FP9 WPSA OP management</li> <li>• 3 topics will remain under the FP8 budget.</li> <li>• Some activity advancing under CM area</li> <li>• Some activity requiring external support (IO)</li> </ul>	[new / approved / rejected / implemented]	



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4	<p><b>First edition of JIFS postponed to 2023:</b></p> <p>Extension in 2022 of IC conflicts with first edition of the JT-60SA International Fusion School.</p> <p>Definitively moved to summer 2023.</p> <p>Establishment of the school organization. Program preparation, choice of lecturers and students, Web site, communication tools, documentation ongoing in 2022</p>	[new / approved / rejected / implemented]	



## Decisions on PCRs

PCR Number	PCR Title	PCR Status	Comments
5	Implementation of the role of EU Contact Person for the JT-60SA research Topics (SA.SE.EXP area)	[new / approved / rejected / implemented]	
6	Transfer of budget (3PMs) 2021 to 2022 for the SA.EU.ETL		
7	Transfer of budget (15kE) 2021 to 2022 for HW support for SA-EN.FE.04-T002 (EC stray detector)		
8	Transfer of budget (2PMs) 2021 to 2022 for SA-EN.FE.05-T002 (BES diagnostic proposal)		
9	Transfer of budget (2PMs) 2021 to 2022 for SA-SE.CM.OP.05-T002 (Disruption Mitigation Trigger) for delay in start of the activity		





## Decisions on PCRs

PCR Number	PCR Title	PCR Status	Comments
10	Transfer of budget (2 PMs) 2021 to 2022 for SA-SE.CM.OP.02-T001 (ECWC analysis tool validation) due to unavailability of data	[new / approved / rejected / implemented]	
11	Extension to 2022 (2PMs) of SA-SE.CM.M.05-T001 (Validation of Disruption Modelling tools) due to unavailability of data		
12	Increase of HR (3 PMs) for coordination of the OP activities in 2021 due to reshuffling of the IC organization		
13	Transfer of budget (4 PMs) from 2021 to 2002 for SA-SE.OP.PO.01.T001/T002 due to delay in machine operation		
14	Extension to 2022 and increase of budget (4 PMs) for SA-EN.FE.01-T002 (TPCI design) due to new QST request for upper stage layout.		
15	Start of task SA-SE.EX.AC.1-T001 (2 PMs, FILD synthetic diagnostics)		

# 4 – Project Change Requests & Other Items for Decision/Approval by PB



## Decisions on PCRs

PCR Number	PCR Title	PCR Status	Comments
16	Postpone SA.M.06 [Demonstration of stable operation at 5.5 MA plasma current in H-mode completed (participation)] from Dec 2023 to Dec. 2024 due to delay in scientific exploitation of JT-60SA	[new / approved / rejected / implemented]	
17	Postpone SA.M.07 [Demonstration of non-inductive scenario at $\beta_N \geq 3$ completed (participation) ] from Dec 2024 to Dec. 2025 due to delay in scientific exploitation of JT-60SA		
18	Postpone SA.D.02 [Report on the first phase of the Integrated Commissioning (before plasma operations). Results and return of experience, mainly for DTT] from Dec 2021 to Dec 2022.		Report being delivered for activity before first plasma. Plasma phase reported later (Dec 2022)
19	Postpone SA.D.04 [Documented plan of EU enhancement programme for BA Phase II–2025-2029] from May 2022 to Dec 2022 due to delay in the setting of the Exp. Team		
20	Postpone SA.D.05 [Delivery and final tests of EU-REC completed] from Jan 2023 to June 2023, due to delay in the start of the exp. Campaign.		



- Great added value from EEGs participating to the project
  - Extend this kind of participation to the WPs
  - Direct involvement in the WPs activity within a restricted topic very effective contribution and, **at the same time**, very valuable opportunity of training
- Great added value from the work of PSO
- Major (negative) impacts on the project come from external factors (pandemic, ubiquitous travel restrictions, technical incident outside the WP control, in a near future most probably from East Europe situation impacting on the procurement of Enhancements instrumentation,...)
  - All this indicate the need of increase the flexibility in planning/management. E.g. 2022 limit for FP8 funded projects - high to be impacted by the current situation



**End of PB-Presentation slides**