

Status of the WEST Joint Team

**Presented by:
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**West Governing Board #7
7 May 2021**

Objectives of the WEST JT

- The 'Joint Team for ITER Divertor test in WEST' has been created in May 2019 to establish and implement a work program ensuring the best use of Divertor units (*WEST elements*) in the WEST platform, for the interest of IO.

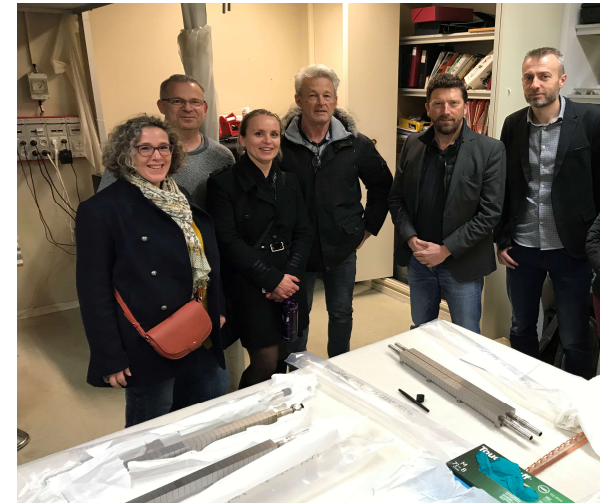
Ref. CEA: CJ 2018-259/S34061



LGA-2018-A-40



SPECIFIC AGREEMENT
ON ASSESSMENT OF ITER-LIKE DIVERTOR PLASMA FACING UNITS IN WEST



- Activities to be coordinated include:
 - the **procurement** of the elements by F4E
 - the **specifications** of the procedures and experiments to be executed
 - the **execution of the experiments**
 - their **analysis and reporting**

F. Escourbiac appointed as WEST Joint Team Leader in place of G. De Temmerman in November 2020

ACTIVE TEAM: > 10 Progress and Technical meetings held since KoM in July 2019

Status WEST elements manufacturing (1/4)

4 EU companies involved:

- **Research Instruments (RI, Germany)**
- **Atmostat (ATM, France)**
- **Ansaldo Nucleare (ANN, Italy)**
- **CNIM (France)**

Status WEST elements manufacturing (2/4)

▪ Research Instruments

5 WEST elements manufactured and delivered to CEA in December 2019:

- Pre-characterization at CEA are being performed (Visual and Dimensional, Hot He leak test, Pressure Drop, confocal microscopy, Emissivity, W and CuCrZr Hardness, SATIR & HHF tests)

→ Objective: 5 elements to be tested during C6 Operations

▪ Atmosat

5 WEST elements in manufacturing:

- 1 element accepted with HIPing defects detected by ultrasonic examination out of the high heat flux areas,
- 2 elements rejected due to HIPing defects,
- On-going activities: NCRs root cause analysis, optimization of HIPing process

→ Objective: 5 elements to be delivered by Sept. 2021 (for C7 operations)

Status WEST elements manufacturing (3/4)

▪ Ansaldo Nucleare

5 WEST elements in manufacturing:

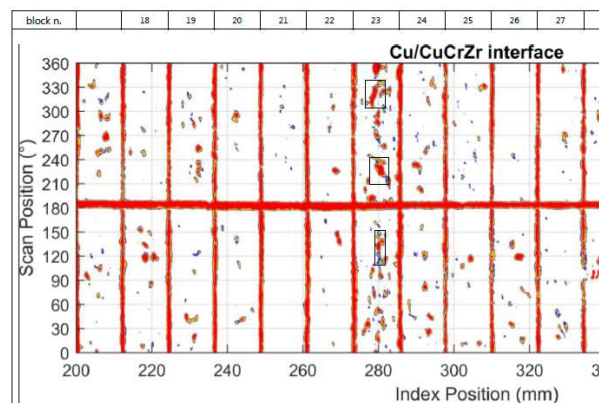
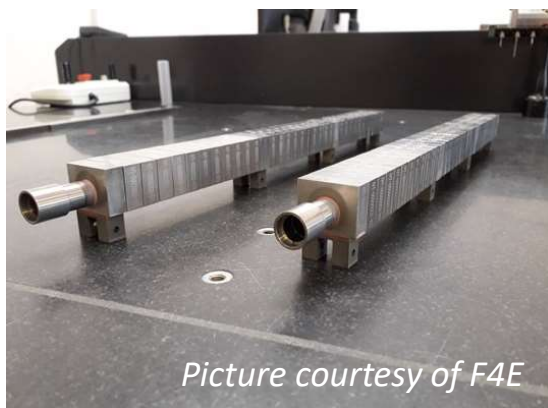
- 1 element was Hot Radial Pressed in April, EDM trials on-going

▪ CNIM

5 WEST elements in manufacturing:

- Elements #1, #2 and #3 accepted
- Elements #4 and #5 with Non conformities of CuCrZr/Cu brazing defects will be further characterized with SATIR and HADES before decision of mounting in WEST to be taken
- On-going activities: NCRs root cause analysis, optimization of brazing process

→ Objective: 10 elements to be delivered by June 2021 (for C7 operations)

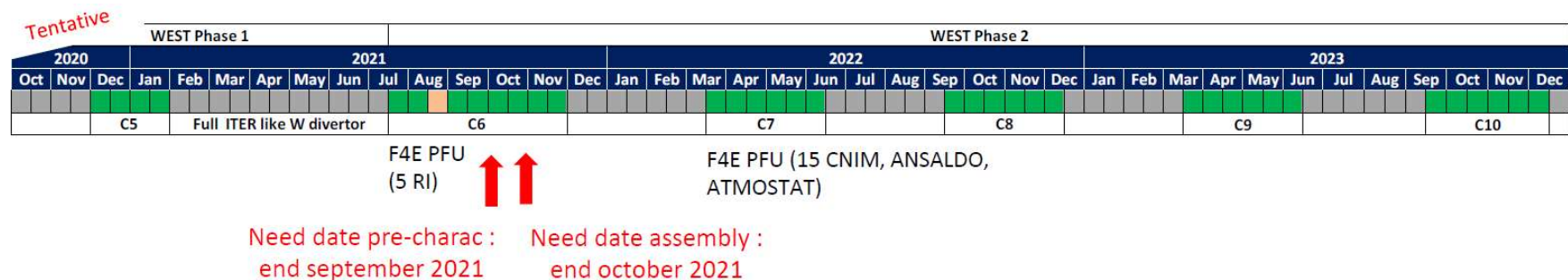


Example of Ultrasonic Inspection report (CNIMC-scan)

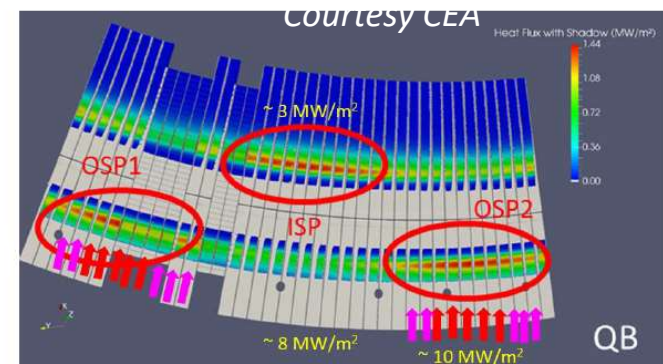
Status WEST elements manufacturing (4/4)

- **Summary:**

- 5 F4E WEST elements (RI) being installed for C6 (summer 2021)
- 15 F4E WEST elements will be delivered later in 2021 with the objective of installation for C7 Operations in spring 2022
- Any delivery after end September 2021 means WEST elements will be installed for C8 (autumn 2022)



- ▶ Planning for 2022 under consolidation : we will keep you updated
- ▶ Plan : 5 RI assembled in C6, remaining 15 PFU for C7 on Q1B sector
- ▶ Proposal : use Q1B only (good IR resolution, all PFU analyzed with same camera), minimize sector handling
- ▶ Put 10 PFU around each max OSP (within ~20 % max heat load)
- ▶ Reminder : PFU are paired (1-2, 3-4 etc)
- ▶ Standard procedure foreseen : alignment within ITER specs (< 0.3 mm)
(metrology performed on assembled sector)



Status pre-characterization plan (1/2)

- Additional Tungsten monoblocks (MB) were provided by each supplier for extended pre-characterization tests:
 - Already provided to CEA: 2 RI MBs (AT&M) + 2 CNIM MBs (AT&M) + 2 ATM MBs (AT&M - already purchased with small double chamfer)
 - Still to be procured: 2 ANN MBs (ALMT)



CNIM W-MBs provided to CEA

- **Foreseen pre-characterization tests – *under discussion*:**
 - Surface morphology (front and back)
 - Characterization of the grain structure
 - Mechanical properties from tensile tests
 - Recrystallization tests
 - Hardness tests
 - ..

AT&M: Chinese Company, Advanced Technology & Materials (1998)

ALMT: Japanese company historically from Sumimoto group (1930's)

Status of pre-characterization plan (2/2)

- **Meeting in July 2020 with several labs in Europe**
 - Labs: FzJ, SCK-CEN (Mol Univ.), Mines Nancy, IUSTI Marseille, IPP Garching
 - Characterization capabilities within the labs were reviewed: a large range of available techniques were identified in adequation with the Joint Team wish list
 - **Action (on hold till G. De Temmerman left IO):** To organize dedicated meeting to discuss sample cutting and initial tests

- **Also, funding of analyses is an issue to be solved**
 - Ongoing discussions with Eurofusion to see how this could be integrated through their program
 - Some labs ready to start some analyses on their own budget for scientific interest
 - Similar issue to be foreseen for the post-mortem analyses

Conclusion

- An active 'Joint Team for ITER Divertor test in WEST' focussed on the WEST elements manufacturing coordination
- Expected positive outcome, in addition with previous findings in particular on Tungsten micro cracks development and optical hot spot : the possibility to test elements to anticipate the Non Conformities during the ITER manufacturing series – well in the spirit of the Joint Team
- A pre-characterization plan still to be defined and implemented to ensure an efficient post-mortem analysis

Back-up

CNIM - WEST elements

Lot 2 – WEST element status



All elements with defects with different extension

NCR-OMF.567.02-015 - Brazing defect WEST n°3

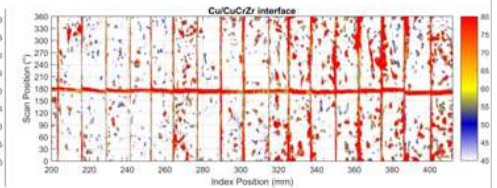
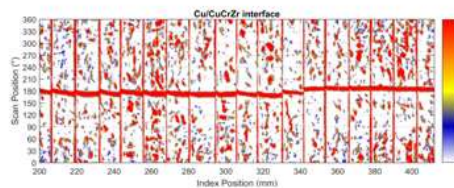
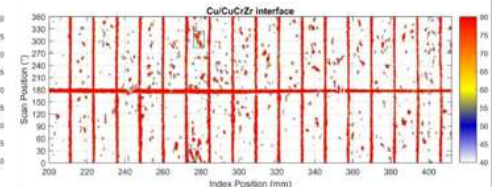
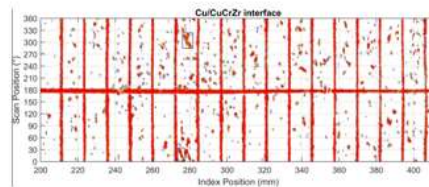
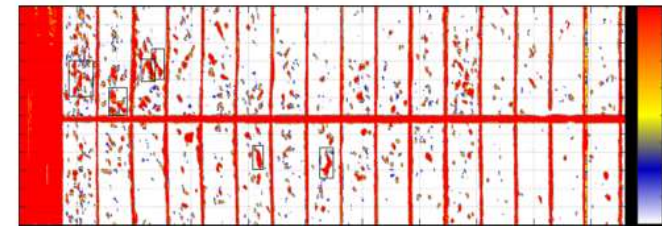
- Preliminary root cause analysis pointed to tighten lateral fixation screws generated friction and shear resistance during brazing
- Root cause under analysis points now to outgassing of the tool during brazing
- Accepted as-is by CEA

Draft NCR [4S3DTQ] - Brazing defect WEST n°1, n°2, n°4, n°5

- Same root cause analysis as the other NCR
- But extend of defects in #1 and #2 less than the others
- To be submitted for acceptance by CEA

Next steps

- Confirm interest of accepting to use defective elements in WEST
- Close the NCRs
- Wire cutting and dimensional control
- Twisted tape insertion
- Orbital welding and NDT
- FAT



Courtesy F4E

Status WEST JT coordination activities

- **Regular meetings:**

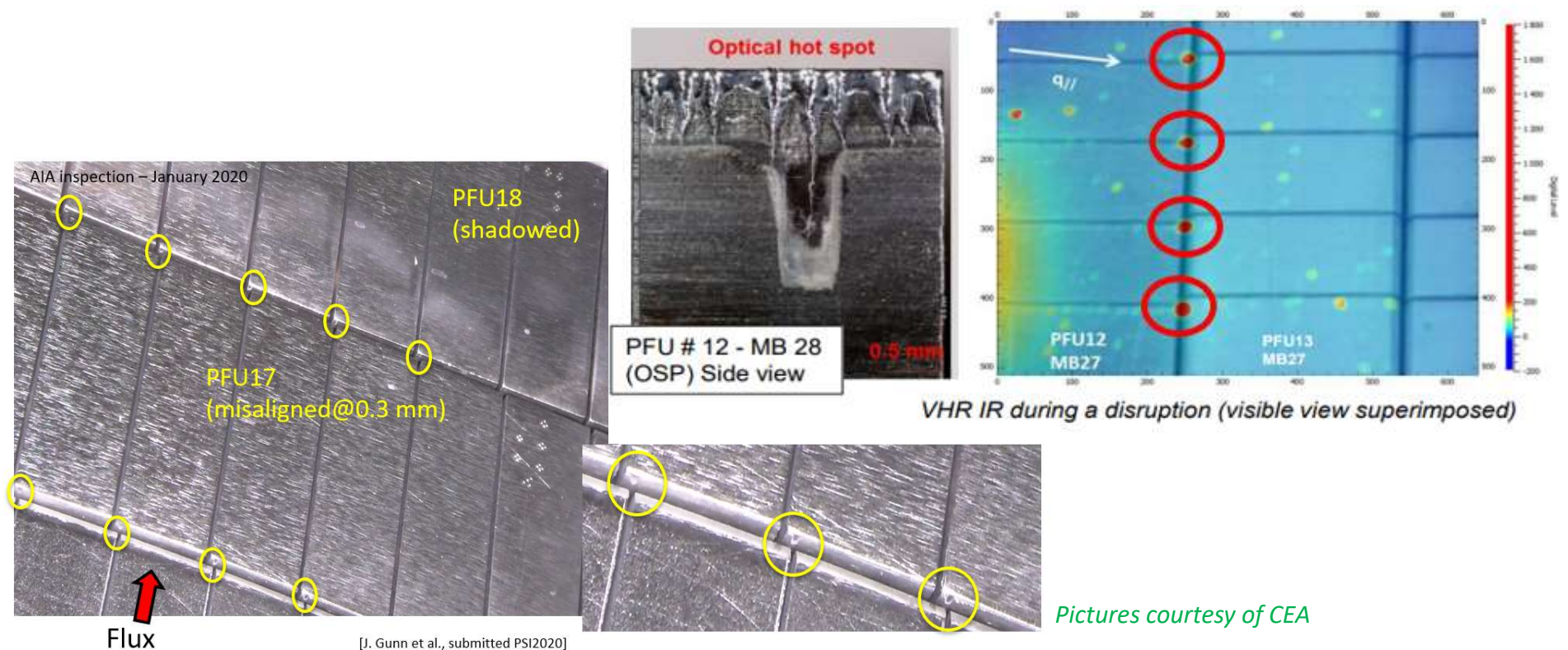
- Kick-Off Meeting held on 31 July 2019 - see [KoM 20190731](#)
- Progress Meetings (PMs) – see [Progress Meetings](#):
 - 07 Oct. 2019 (PM#1), 22 Nov. 2019 (PM#2), 24 Jan. 2020 (PM#3), 30 April 2020 (PM#4), 17 June 2020 (PM#5), 03 Sept. 2020 (PM#6), 24 Nov. 2020 (PM#7), 8+15 Feb. 2021 (PM#8 & tech. meeting), 15 April 2021 (PM#9), **03 May 2021 (tech. meeting decision CNM Elements-NCRs UT)**
- IO participation to WEST Experimental meeting – 22-24 March 2021
- IO follow-up of CEA WEST PFMC rehearsal (April 2021)

- **Main topics under discussion / actions:**

- **Pre-characterization tests & Post-mortem analysis of the WEST elements**
- **ITER-relevant experimental proposal for WEST campaigns**
- **Follow-up WEST elements manufacturing by F4E suppliers, Decision on non-conformities**
- **Technical discussions of interest for ITER: Fretting & Corrosion, Cracks formation and propagation, Evolution of UT defects under in-situ plasma conditions, (Test of Operational Instrumentation, Langmuir probes)**

Visit WEST Sector – July 2020

- Regular visits and meetings with CEA → dismantled WEST Sector in July 2020
- Observation of Optical Hot Spot (OHS) and edge damages on newly installed PFUs
→ **Confirming the model prediction for ITER !**



Timeline

- May 2019** ➤ Creation WEST Joint Team ⇔ Signature IO-CEA Specific Agreement
(by IO DG & CEA Head of Fundamental Research Direction)
- July 2019** ➤ Endorsement of the WEST Joint Team ToR and Members list by the
IO-CEA Coordination-Committee (CC)
[ITER D YUDUB6 - WEST Joint Team - Terms of Reference](#)
- Nov. 2019** ➤ WEST Joint Team Work Program established and submitted to the IO-
CEA CC [ITER D YJNFDM - WEST Joint Team – Work Program](#)
- January 2020** ➤ Signature of IO Change Notices on IVT PA (F4E WEST elements
formally included into PA)
[Procurement of WEST Elements within the scope of the IVT PA - 1.7.P2B.EU.01 - Annex B](#)
[Procurement of WEST Elements within the scope of the IVT PA - 1.7.P2B.EU.01 - PA Main Text](#)
- 2019-2020- ..** ➤ F4E WEST elements manufacturing / procurement on-going (*see status given next slides*)

WEST JT Members and experts

- WEST Joint Team is constituted of IO and CEA representatives + ITER and/or WEST partners

[ITER D YJNES4 - WEST Joint Team - List of Joint Team members and experts - Appointment of IO and CEA Technical Correspondents](#)

2. The WEST Joint Team is constituted of:

- Joint Team Leader:

- Gregory De Temmerman (IO/Science Division);

F. Escourbiac appointed as WEST Joint Team Leader in Nov. 2020 in place of G. De Temmerman

- Joint Team members:

- For IO: Frederic Escourbiac (IO/Divertor Section), Alain Durocher (IO/Divertor Section), Sophie Carpentier-Chouchana (IO/Divertor Section);
- For F4E: Bruno Riccardi (F4E/In-Vessel Components) and Pierre Gavila (F4E/In-Vessel Components);
- For the CEA: Emmanuelle Tsitrone (CEA/IRFM) and Marc Missirlian (CEA/IRFM);

- Joint Team additional experts (involved in a consultative role, if required for the best completion of the activities):

- Satoshi Suzuki (JADA/QST) is involved as expert;
- Other staff from IO, CEA or partners will be involved as experts in the future, notably to define analysis and experiments to be performed, and analyze all available data.

New JADA expert to be nominated when necessary