WPSA Enhancements Area progress meeting, online, 23 October 2026

# Report on LEI support to neutronics activities 2026

## Deliverable SA-EN.FE.11-T004-D003

Task SA-EN.FE.11-T004: 2026 Support WPSA and F4E in neutronics assessments for systems and enhancements radiation shielding

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Deliverable owner: Dr. Gediminas Stankunas, LEI, 1.0 PM in 2026

**Agenda**

1. Progress and main achievements
2. Gaps and open issues

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# The D003 report is final: it delivers items 1 and 2, the review of the existing models and the analysis of previous work.

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## 1 Progress and main achievements

**Item 1**

Review and assessment of the existing neutronics geometry models

**Delivered in D003**

**Item 2**

Analysis of previous work and studies

**Delivered in D003**

**Item 3**

Technical discussions and coordination with F4E and WPSA partners

**For the 2027 planning**

**Item 4**

General support to ongoing neutronics activities within WPSA

**For the 2027 planning**

**Item 5**

Further development or refinement of models and approaches

**For the 2027 planning**

**5**

EUROfusion IDM reports reviewed in full

**339**

literature records, 254 confirmed against Crossref, 24 rated core

**263**

further Scopus records screened by title and abstract, 62 added

**19**

models and model outputs in the inventory

Source: Report Introduction, Tables 1 and 5, sections Material reviewed and method and LEI activity in 2026

# The review lists 19 models and model outputs, most in three generations, and none has yet been shared with LEI.

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## 1 Progress and main achievements

| 1 Design models, 2006 to 2011 | 2 QST study models, 2019 to 2025 | 3 F4E assembled model and submodels |
|---|---|---|
| **M1** 2006 TF heating sector model | **M7** 2019 TF feeder duct, PHITS | **M11** 2024 to 2026 Assembled model |
| **M2** 2007 1D and 2D shielding models | **M8** 2020 NEMP collimator, MCNP6.2 | **M12** 2026 Common stage, GEOUNED |
| **M3** 2007 CDR sector model, MCNP-4C2 | **M10** 2022 to 2025 Monitor calibration | **M13** 2025 P10 spectrum, F4E model |
| **M4** 2009 ENEA TF model, MCNP5 | | **M14** 2023 to 2026 VUV submodel |
| **M5** 2011 PHITS device, building models | | **M15** 2024 TSS trolley CAD |

**Other models and outputs in the inventory**

| | | |
|---|---|---|
| **M6** JT-60U model, 2011 to 2015 | **M9** Kyushu torus, 2021 | **M16** Diagnostic models, 2024 to 2026 |
| **M17** Irradiation spectra, 2021 to 2022 | **M18** QST model run by ENEA, 2022 | **M19** Possible UKAEA TCWS models |

**None of the 19 has yet been shared with LEI. The assessment rests on the published and IDM descriptions.**

Source: Report Table 5. Generations as in the Conclusions of the report.

# Only the VUV and common stage submodels document lost particle and volume checks, and no model is compared with JT-60SA data.

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## 1 Progress and main achievements

| | JAEA design models<br>2006 to 2011 | ENEA runs<br>M4 of 2009, M18 of 2022 | QST study models<br>2019 to 2025 | F4E assembled model<br>Gitronics, MCNP6.2 | F4E and IPPLM submodels<br>VUV, common stage, TSS | Possible UKAEA TCWS models<br>D004 |
|---|---|---|---|---|---|---|
| 1 Extent | Partly | M4 Yes; M18 Partly | Partly | Partly | Yes | No |
| 2 Origin of geometry | Partly | Partly | No | Partly | Yes | No |
| 3 Materials and densities | Partly | Partly | Partly | No | Partly | No |
| 4 Source term and normalisation | Partly | Partly | Partly | Partly | n/a | No |
| 5 Nuclear data | Partly | Yes | Partly | Partly | Partly | No |
| 6 Lost particle and volume checks | No | Partly [a] | No | Partly [b] | VUV, stage Yes; TSS Partly | No |
| 7 Version control | No | No | No | Partly | Partly | No |
| 8 Benchmark against measurements | No | No | No | No | No | No |

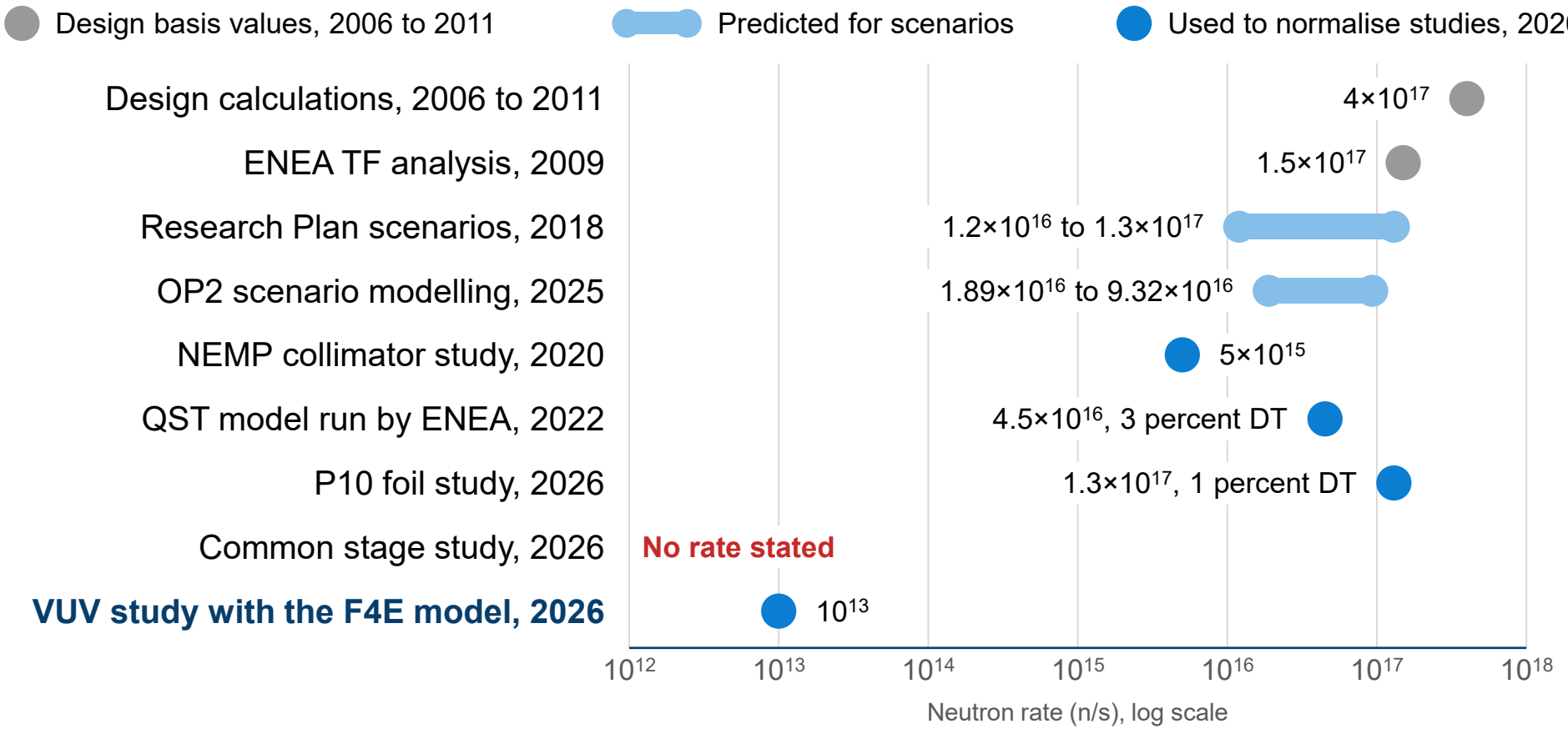
Yes: documented  Partly: partly documented  No: not documented in the material reviewed  n/a: not applicable

a Lost particle test for M18, no volume check. b 49 lost particles in $10^9$ histories with a source of 15 m radius, and $2.53\times10^{-7}$ with no radius stated. Source: Report Table 6

# The source term is not consistent: normalisation rates range from $10^{13}$ to $4\times10^{17}$ n/s and the DT fraction from 1 to 3 percent.

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1 Progress and main achievements




**First deuterium limit**

**$3.2\times10^{19}$ or $4\times10^{19}$**

neutrons per year, both in the Research Plan

**DT fraction assumed**

**1 to 3 percent**

JT-60U measured
0.3 to 2.0 percent

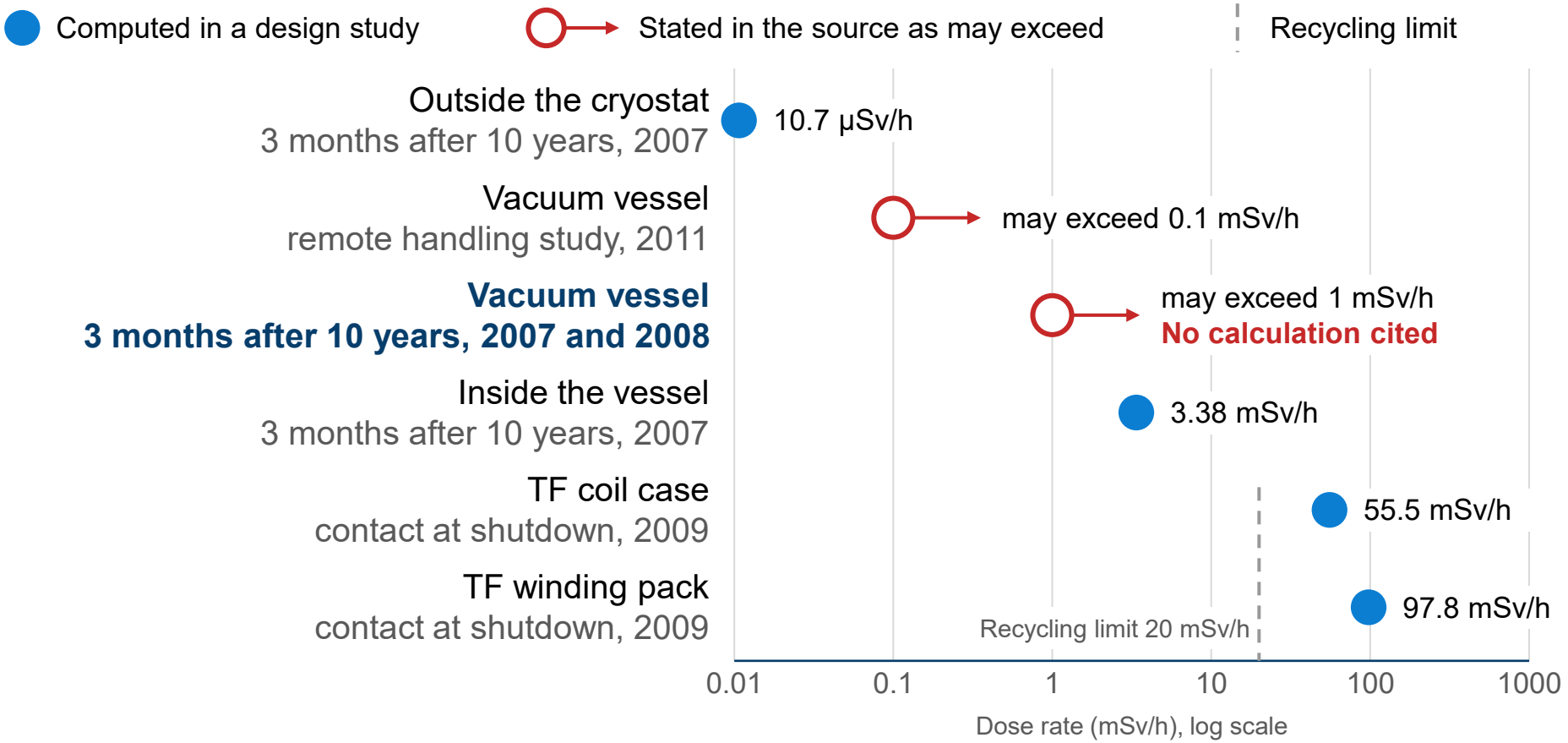
**D002 and D004 results may be normalised in different ways.**

Source: Report Tables 2, 4 and 5, section Operation phases and neutron source term

# Shutdown dose rates exist only as design values of 2007 to 2011, and the papers giving the 1 mSv/h figure cite no calculation.

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1 Progress and main achievements




**Design budgets**
**$1.5\times10^{21}$ or $4\times10^{21}$**
neutrons per year at most

**Staged limits start at**
**$3.2\times10^{19}$ or $4\times10^{19}$**
neutrons per year

**No estimate found for the OP2 limits or for ME2**

Source: Report Tables 2 and 9 and section Activation, shutdown dose rate and remote handling

# Gaps in the models: the F4E model is described in parts, few checks are documented and no model is validated against JT-60SA data.

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## 2 Gaps and open issues

| Gap in the material reviewed | Consequence for the project | What would close it |
|---|---|---|
| **F4E assembled model described only in parts** | No model version is named for the outputs used by D001 and D002 | Released model with its content, materials and source described |
| **Published results name no version tag** | Results of different partners may come from different models | Version tags and release records cited with each result |
| **Geometry checks documented for few models** | Undetected errors would pass into all D001 to D004 results | Void tests with a stated source radius and volume checks on each model |
| **No benchmark against JT-60SA data** | No model is validated, and OP2 data are the first chance | OP2 measurements and D002 foils, with model versions and irradiation histories |
| **Design changes not traced in models** | A model may represent a superseded design | CAD of the machine as built, with ME1 components and ports |
| **Material data not documented** | Activation and dose rates depend on impurities | Material certificates, borated water and concrete specifications |
| **Japanese and European model lines not compared** | Results for the same position may disagree | A QST model and the F4E model compared at the same positions |

Source: Report Sections 2.5.5, 2.6 and 2.9 with Tables 10 and 12

# Gaps in the physics basis: no agreed source term, and no current study of shutdown dose rate, hall dose or water and air activation.

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## 2 Gaps and open issues

| Gap in the material reviewed | Consequence for the project | What would close it |
|---|---|---|
| **Source term not consistent** | D002 and D004 results may be normalised in different ways | Agreed reference scenarios for OP2 and OP3, with the approved annual limits |
| **No current shutdown dose rate study, no calculation cited for 1 mSv/h** | No documented dose basis for planning ME2 or for access inside the vessel | Study with the current model, materials and OP2 history, before ME2 |
| **No current torus hall or duct streaming maps** | No dose maps of the torus hall for electronics and diagnostics | Torus hall and building geometry with penetrations |
| **No water or air activation study found** | Activation of borated water, cooling water and hall air not assessed | Activation study with the water and concrete specifications |
| **Photoneutron and beamline sources not modelled, DT fraction assumed** | Monitor and foil predictions incomplete, beamline activation not assessed | Models that include these sources, and a documented choice of DT fraction |
| **Diagnostic integration models pending** | Shielding and response of the pending diagnostics assessed only in part | Pending diagnostic models, and tabulated spectra and errors at the irradiation ends |

Status: the D003 report is final. The comments of this meeting will be included before the IDM upload. Plans for 2027 and the inputs needed will follow at the 2027 task planning stage.

Source: Report Sections 2.6, 2.8 and 2.9 with Tables 10 and 12

# Thank you!




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