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TRANSversal Actions for Tritium

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General context: tritium in fusion and in fission



- **Fusion (ITER):**
 - 3-4 kg of tritium on site,
 - Large recirculation:
 - Due to low efficiency, 3,5 kg/d of tritium **throughput** (350 kg/d in DEMO) (complex and large tritium plant)
 - ➔ Need of control/treat tritium gaseous releases
 - ➔ Need of water detritiation plant
 - ➔ Tritiated waste management
- **Fission (GEN II (CANDU), GEN IV (ASTRID))**
 - CANDU :
 - Tritium production: 250 g/MWe/an
 - Tritium release: mainly HTO (trapped in water)
 - ➔ Need of water detritiation plant + tritiated waste management
 - ASTRID :
 - Tritium production higher than PWR (less than CANDU)
 - Tritium release: mainly as HT form
 - ➔ Need of control/treat gaseous releases + tritiated waste management

common open issues between both communities



- Assess technologies to **minimise tritium permeation at source**
- Assess technologies to **capture and store tritium** from treatment of metallic waste and liquid and gaseous effluents

Also to include:

- (i) An assessment of the tritium inventory using **state-of-the-art modelling tools**
- (ii) **Refinement of the knowledge** on outgassing, radiotoxicity, radioecology, radiobiology, dosimetry and metrology of tritium,
- (iii) Engineering solutions for **detritiation techniques and waste management**
- (iv) Tritium permeation control

TRANSAT general objectives (some obvious constraints)



Proposals will only be retained if:

- They clearly demonstrate substantial benefit for both fission and fusion,
- They include actors from both communities
- They complement the existing research efforts in both domains
- International cooperation is encouraged and will be considered during the evaluation.



- **Development of barrier against tritium permeation (control of tritium releases):**
 - Fission: GEN IV(ASTRID)
 - Fusion (ITER/DEMO) : Tritium Breeding Module (TBM)/plasma facing components
 - **Action: development and test of permeation barriers**
- **Treatment of operational tritiated gases (control of tritium releases):**
 - Fusion : plasma or TBM operation / Fission : Astrid
 - Today in fission, no treatment considered due to low tritium gaseous production
 - However, tritium gas production much higher in GEN IV.
 - **Actions**
 - **Review of the operational gaseous tritium releases**
 - **Review of the different treatments considered**
 - **Tests of some relevant solutions**



- **Modelling of the tritium migration in plant/processes (prediction of tritium releases) :**
 - KUTIM : fission (GEN IV ASTRID) / ECOSIMPRO : fusion (ITER, DEMO)
 - **Action: Benchmark of the fusion code with the fission on Astrid predictions**



- **Development of accurate tritium measurements in LLW (waste management):**
 - The quantity of purely tritiated waste will increase in the following years due to:
 - Fusion reactors operation
 - The increase of the gaseous tritium releases in GEN IV and their treatment
 - Need of accurate tritium measurement in tritiated waste (LLW)
- **Action:**
 - **Development of different diagnostics :**
 - **Autoradiography (Fission → Fusion)**
 - **LIBS (Fusion → Fission)**
 - **NRA/IBA (Fusion → Fission)**



- **Tritium inventory measurement in soft waste (waste management).**
 - Today : the tritium inventory in a container evaluated statistically
 - Need of a global method
 - **Actions : Study and development of the technique**
 - **Correlation between tritium inventory and tritium release rate**
 - **Correlation between tritium inventory and tritium inventory in washing liquid**
 - ...
 - **Depending on the results: proposal of the measurement methodology**
- **Development of a safe container for tritium waste storage (waste management)**
 - Need of the development of a container for tritium waste disposal in geological facility
 - With an almost perfect control of tritium release.
 - **Action:**
 - **Select materials, test the permeability (low temperature)**
 - **Propose a solution**



- **Behavior in the environment and toxicity of tritiated particles produced during tritium plant dismantling**
- Particles studied: SS and cement
- **Actions:**
 - **Production of such particles in the dismantling process at a laboratory scale, characterization of the particles, tritiation**
 - **Radio-ecology of these particles:**
 - **Modelling of the transport of the particles in the atmosphere and their deposition on grass**
 - **Biodegradation,**
 - **Radio-toxicology**
 - **Dosimetry**

(Unique activity worldwide)



- **TRANSAT built through a strong interaction with fusion/fission experts (a success!)**
- **Common actions of interest assayed and supported**
- **TRANSAT focused on:**
 - **Management, production and detection of tritium,**
 - **Control of tritium gas releases,**
 - **Tritium inventory measurement and modelling,**
 - **Tritiated waste management,**
 - **Impact of tritiated products (mainly dust) on environment and human health**
- **TRANSAT major objective: train people on tritium main open issues**
 - ➔ **TRANSAT tritium school.**



FIRST TRITIUM SCHOOL

Ljubljana, Slovenia
25-28 March 2019

ABSTRACT DEADLINE
30 September 2018

TOPICS COVERED
(tritium in fusion and fission):

- Tritium management
- Tritium detection
- Tritium migration
- Tritium inventory and control
- Tritium waste
- Radiotoxicity / Ecotoxicity
- Epidemiology of Tritium
- Tritium dosimetry

ORGANISING COMMITTEE
Christian Grisolia, France
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Ion Cristescu, Germany
Carlos Moreno, Spain
Véronique Malard, France
Dave Coombs, UK
Sabina Markelj, Slovenia
Robert Vale, UK



The Tritium School is organised by the TRANSAT project (TRANSversal Actions for Tritium). As part of the H2020 Euratom programme, TRANSAT was set up to contribute to research and innovation on cross-cutting activities required to improve knowledge on tritium management in fission and fusion facilities.

TRANSAT aims to answer the main following challenges:

- tritium release mitigation strategies
- improvement of waste management
- knowledge refinement in the field of radiotoxicity, radiobiology and dosimetry

The school will comprise two days of lectures followed by talks and a poster session. Both experimentalists and theoreticians are strongly encouraged to participate.

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TALKS & GUEST SPEAKERS

Tritium management

- **Tritium management in DEMO Breeding Blanket** – Ion Cristescu, KIT
- **Different detection techniques for Tritium inventory** – Pascal Fichet, CEA

Tritium migration

- **Tritium migration in Breeding Blankets in fusion technology** – Carlos Moreno, CIEMAT

Tritium waste

- **Tritiated waste research programme** – Robert Vale, UKAEA
- **UK approach to tritiated waste processing and disposal** – Dave Coombs, UKAEA
- **H-3 Advanced Technology Centre** – Damian Brennan, UKAEA
- **French Strategy for Solid Tritiated Waste Management** – Karine Liger, CEA

Tritium inventory and control

- **Reducing releases from tritium facilities** – Walter Shmayda, University of Rochester
- **Hydrogen isotope retention and transport in neutron-irradiated Tungsten** – Yuji Hatano, Toyama University
- **Modelling of tritium inventory in plasma facing component in fusion devices** – Klaus Schmid, Max Planck Institute
- **Tritiated Dust in Tokamak** – Christian Grisolia, CEA



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TALKS & GUEST SPEAKERS (CONTINUED)

Radiotoxicity/ecotoxicity

- **Overview of Tritium effects** – Laurence Lebaron-Jacobs, CEA
- **Ecotoxicity of Tritium** – Awadhesh Jha, UOP
- **Biokinetics of low levels of tritium as HTO or OBT and its genotoxicity relative to gamma-radiation in a laboratory mouse model** – Dmitry Klokov, Canadian Nuclear Laboratories

Epidemiology of Tritium

- **Epidemiology of Tritium** – Richard Wakeford, UK

Tritium dosimetry

- **Dosimetry of Tritium in humans and non-humans biota** – François Paquet, IRSN



- 1. As for the preparation of TRANSAT, need for regular interaction between experts from both communities (positive point)**
 - ✓ Strengthen the links between both communities
 - ✓ Exchange useful information
 - ✓ Define common R&D requirement
 - ✓ Undertake common R&D
 - Appointment of a EU joint working group of permanent experts (?)
 - Regular call from the EU dedicated to cross-cutting activities

- 2. For the fusion community, from the conception of a reactor:**
 - ✓ Strengthen the interaction with fission experts and with nuclear industry on all the nuclear aspects:
 - ✓ Safety
 - ✓ Nuclear engineering
 - ✓ Nuclear operation and maintenance
 - ✓ ...
 - Integration to the EU joint working group of nuclear industry representatives



TRANSAT PROJECT TRANSversal Actions for Tritium

transat-h2020.eu/