Recent advances in materials research for nuclear fusion

Dr. Pete Pappano

Chair, Implementing Agreement for a Programme of Research and Development of Fusion Materials

IEA Fusion Power Co-ordinating Committee (FPCC)

ADVANCING MATERIALS RESEARCH FOR POWER GENERATION

28 January 2015, 14h00 – 18h00

The IEA Fusion Materials Implementing Agreement (IA-FM)

- Has been a forum for international collaboration in the field of fusion materials beyond the immediate needs of ITER.
- In areas such as the divertor, where high temperature materials are still under development, the two activities have often merged.
- Through its more flexible organization, the IEA fusion materials implementing agreement has attracted a broad community of researchers and scientific establishments allowing it to make significant progress.
- Today, several IA-FM initiatives have reached maturity and have been taken up by ITER, TBM and DEMO.
- The best examples are reduced activation ferritic / martensitic steels (for TBM and DEMO) and IFMIF.
- Since ITER will be the leading activity in the world fusion program moving forward there is growing interest in expanding IA-FM activities to consider the materials needs of that project and test facilities such as IFMIF-EVEDA under BA.

Update on activities in fusion materials research: USA

- The US DOE Fusion Materials program is focused on adding experimental capabilities that can better replicate prototypic burning plasma conditions for more realistic fusion materials testing.
- Current fission reactors are used to study structural materials response to irradiation, but fission neutrons are about 14 times less energetic than fusion neutrons.
- Therefore, fission irradiations can achieve high levels of displacement per atom (dpa), but NOT the helium/hydrogen generation that will occur in fusion neutron irradiations.
- One option to address this problem, in advance of IFMIF, would be spallation neutron irradiation of materials.
- FES is investigating the possibility of adding a harness to the Spallation Neutron Source (SNS) at the Oak Ridge National Laboratory (ORNL), but no decision to proceed has been made.

Update on activities in fusion materials research: USA

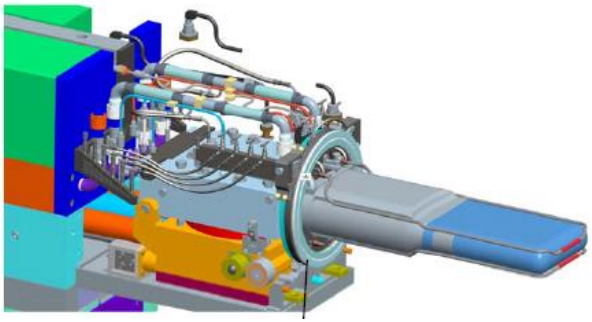
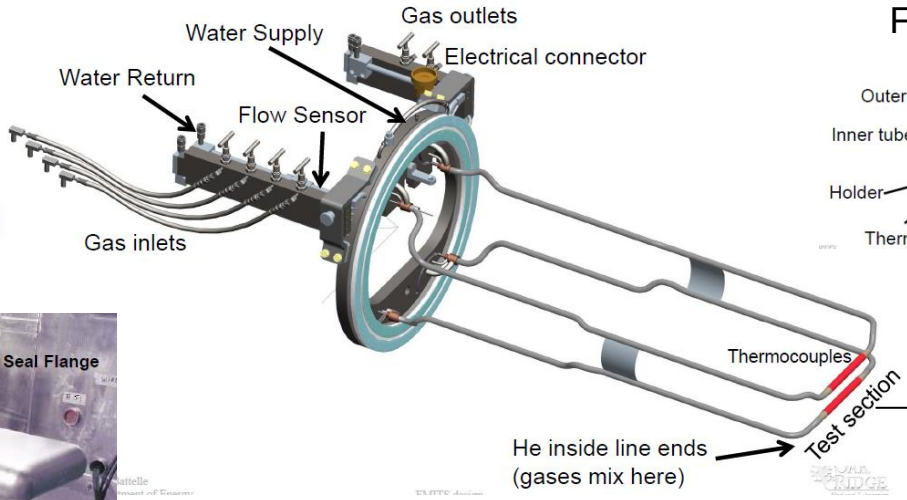
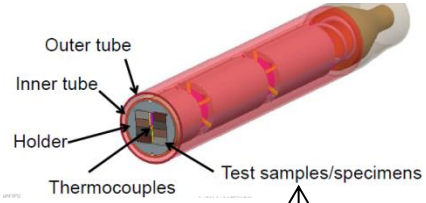


Image of existing SNS Hg target



FMITS sample tube



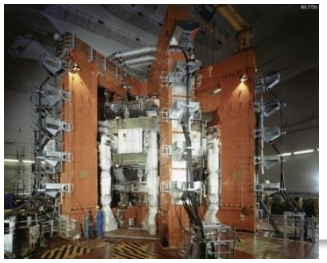
The Fusion Materials Irradiation Test Station (FMITS) concept for the SNS

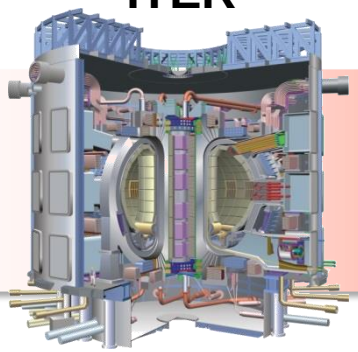
Update on activities in fusion materials research: USA

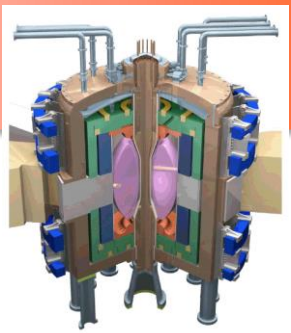
- Another concept being investigated by FES is upgrading an existing linear plasma source such that an ITER-like plasma is achieved and divertor lifetimes can be tested.
- Divertor plasma conditions cannot be reached in today's tokamaks or plasma generators.
- The impact of these conditions on divertor lifetime and plasma performance is not known.
- The impact on the plasma of eroded and re-deposited material, and the altered surface morphology and chemistry of the divertor material (tungsten) is not fully known due to geometry of current linear devices.

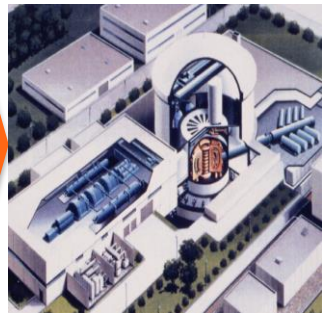
Update on activities in fusion materials research: USA

JET | **ITER** | **FNSF** | **Fusion Reactor**









50 x divertor ion fluxes

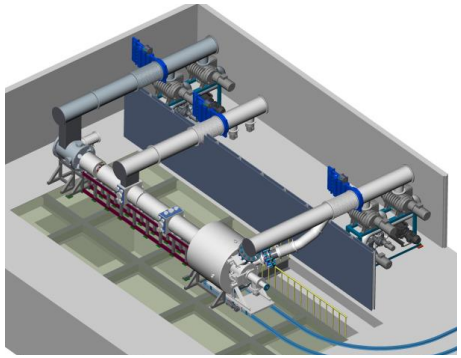
5000 x divertor ion fluence

10^6 x neutron fluence (1dpa)

up to 5 x ion fluence

up to 100 x neutron fluence (150dpa)

Material Plasma Exposure eXperiment (**MPEX**)



Materials need to be developed and tested under fusion prototypic conditions