-----Original Message-----  
From: Mohamed Abdou <[abdou@fusion.ucla.edu](mailto:abdou@fusion.ucla.edu)>  
To: carolfow <[carolfow@aol.com](mailto:carolfow@aol.com)>  
Sent: Thu, Mar 15, 2018 5:35 pm  
Subject: RE: question from Ken

Hi Ken,

Just saw this. So here is a quick response to a question that we answered fully in stdies over the past 30 years.

A plasma-based neutron source is needed to simulate VOLUMETRIC (“bulk”) heating in blanket.  (This was one of the  reasons we called it initially Volumetric Neutron Source before we called it FNSF) This was the main point of my slide Number 7 of my presentation to the NAS Committee at GA.

The topic has been studies for > 30 years and is documented in many papers. See for example, my Blanket Challenges paper in 2015. Also in many presentations on my website.

Briefly:

A.  Simulating nuclear **bulk heating in a large volume with gradients**is Necessary to:

1.    Simulate the temperature and temperature gradients

\*      Most phenomena are temperature dependent

\*     Gradients play a key role, e.g. :

–    temperature gradient, stress gradient, differential swelling impact on behavior of component, failure modes

2.   Observe key phenomena (and “discover” new phenomena)

–    E.g. nuclear heating and magnetic fields with gradients result in complex mixed convection with Buoyancy forces playing a key role in MHD heat, mass, and momentum transfer

–    for liquid surface divertor the gradient in the normal field has large impact on fluid flow behavior

B.  Simulating nuclear **volumetric heating ( magnitude and gradient) in a large volume requires a neutron field  - can be achieved ONLY in DT-plasma-based facility**

–    not possible in laboratory

–    not possible with accelerator-based neutron sources

–    not possible in fission reactors ( very limited testing volume, wrong spectrum, wrong gradient)

Fission reactors have extremely small volume for testing , typically ~ 5 cm in dimeter. You cannot fit a liquid metal section in that space. We also cannot put magnet in fission reactor to simulate the MHD  mixed convection as I explained in my presentation.

Also the very soft spectrum in fission reactors means mean free path of n in Li is ~ 1 mm. So neutrons from outside the test cell will be absorbed mostly in the outer layer and also results in the wrong direction of gradients.

The World fusion program already used fission reactors to simulate a small sub cell of solid breeders to study “ tritium release ‘(but not TBR) , but we could not study thermoechanics and other technical issues because they require  other loading conditions not possible to simulate in a fission reactor

Also, The only way to show that Tritium Self Sufficiency can be achieved is in DT plasma – based facility  (and I presented this to the NAS committee)

We are not talking here about Qualifying Components or 14 MeV neutrons. There are stages for FNST/blanket development (see my slides 28 and 29 in my presentation to NAS committee). We are talking now about scientific feasibility and Engineering Feasibility Stages. True component Qualification will come in the 3rd stage Engineering Development.

I urge my colleagues in fusion to avoid the use of common terms like “component qualification” and “ material qualification”.  Such qualification will happen only in the true fusion nuclear environment , e.g. in VNS/FNSF. It cannot happen in fission reactors or accelerator-based neutron sources.

Best Regards

Mohamed

**From:** [carolfow@aol.com](mailto:carolfow@aol.com) [[mailto:carolfow@aol.com](mailto:carolfow@aol.com?)]   
**Sent:** Thursday, March 15, 2018 8:15 AM  
**To:** [abdou@fusion.ucla.edu](mailto:abdou@fusion.ucla.edu)  
**Subject:** question from Ken

Hi Mohamed -- I am being challenged re need for a neutron source NOW. Comes down to whether 14 MeV neutrons are really needed to qualify components for something like ITER DT phase; or pilot plant etc. Why not DC fission to replicate thermal gradients etc?

Ken Fowler

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