

Session Introduction

Disruption Mitigation by Shattered Pellet Injection (SPI)

by
N.W. Eidietis (GA)

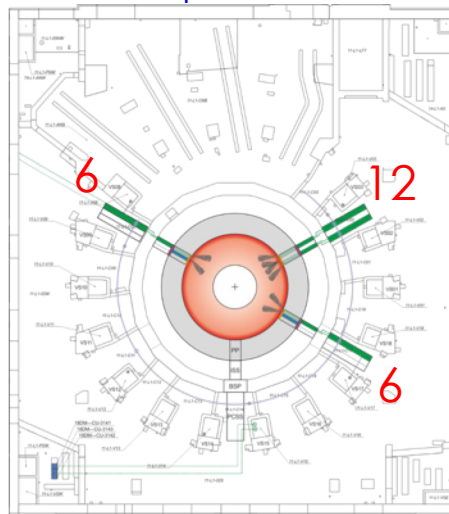
Presented at the
(Virtual)
**IAEA Technical Meeting on Plasma Disruptions
and their Mitigation**

July 22, 2020

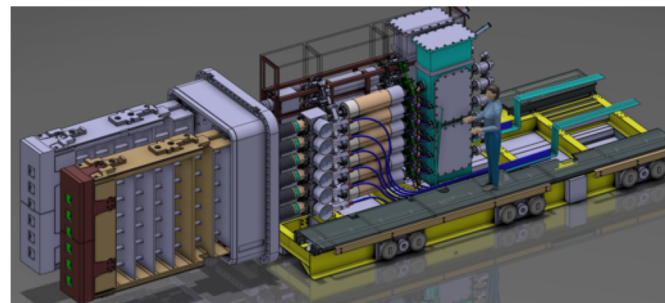
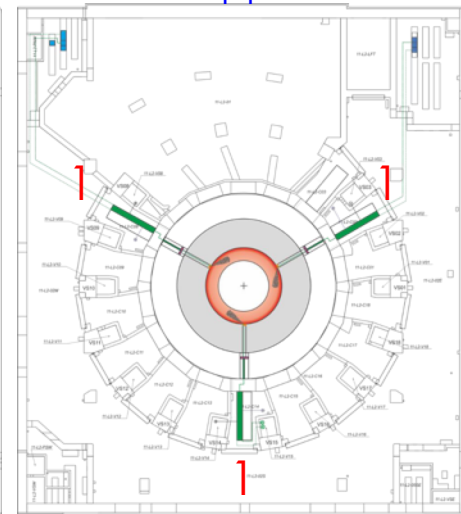
SPI chosen as baseline ITER disruption mitigation system (DMS) tech... **but many questions remain**

- Clear advantages of SPI in ITER environment led selection over other mature tech (MGI)
- ITER planning significant SPI installation to provide some overhead for uncertainties in operation

ITER Equatorial SPI



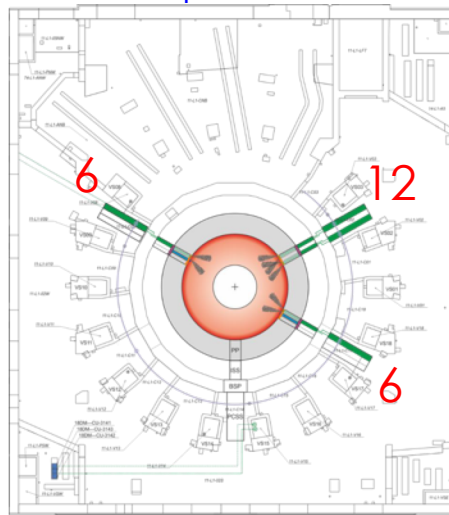
ITER Upper SPI



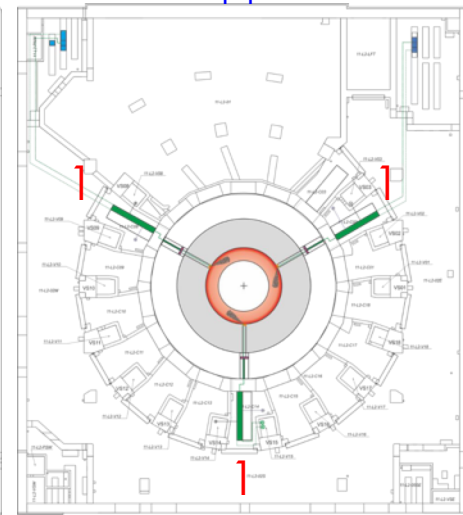
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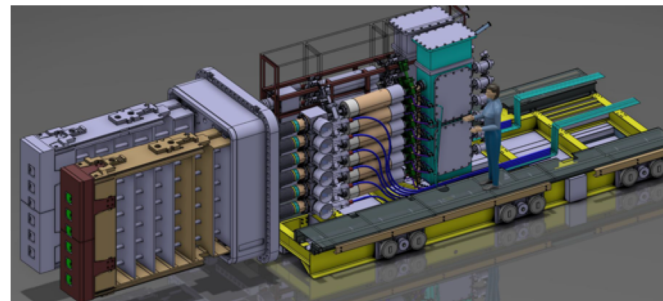


ITER Upper SPI



Goals of This Session:

1. Determine where state of science has resolved uncertainties in SPI operation
2. Create action plans to retire remaining



ITER DMS design driven by pessimistic (& very uncertain) outlook for runaway electron (RE) mitigation

- 1. Adequate dissipation of existing RE plateau appears impossible due to linking of VDE motion & dissipation [Konovalov IAEA 2016, Aleynikov ITPA Oct 2017] & low particle assimilation into RE plateau [Hollmann APS 2018, Hollmann APS 2018, Shiraki NF 2018, Reux NF 2015, Hollmann NF 2013]**
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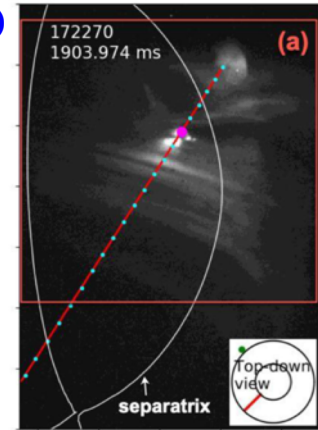
Key Questions

1. Is our RE understanding sufficient to predict conditions for avoidance?
2. Can many SPI be superimposed to provide necessary D2 for RE avoidance?
3. Are there other paths for dissipative RE mitigation besides avoidance?
4. Are above compatible with effective thermal quench (TQ) mitigation (radiation fraction, symmetry) & current quench (CQ) mitigation (eddy & halo currents)?

Recent explosion in SPI research has vastly expanded international capability to address these questions

- **Pre-2019:** A decade of only D3D...

D3D

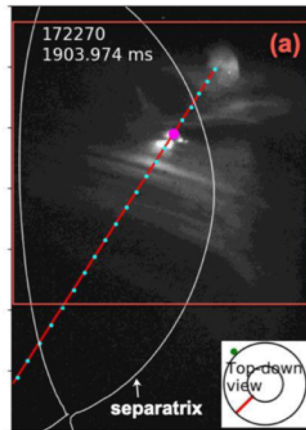


Raman NF 2020

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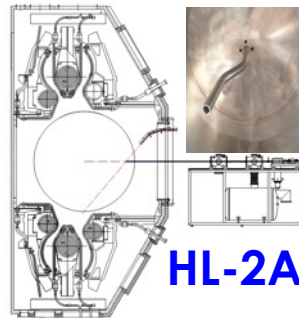
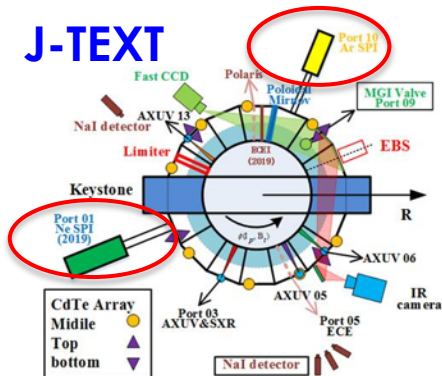
D3D



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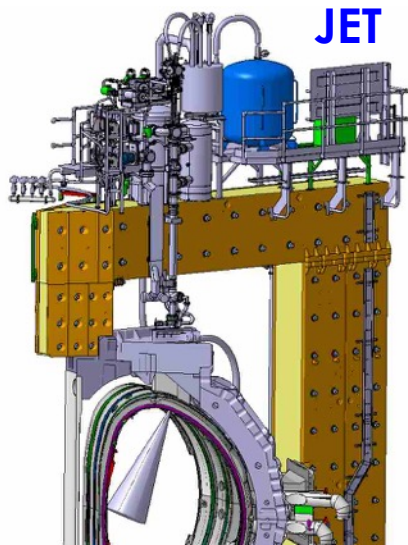
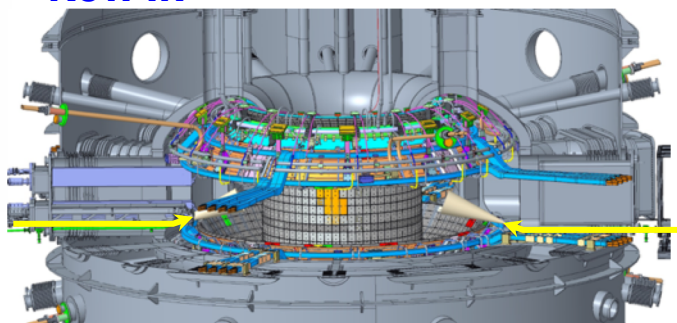
- 2019-20

J-TEXT



HL-2A

KSTAR



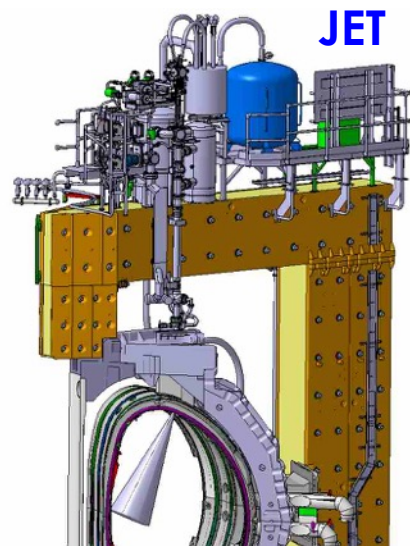
JET

2021: AUG

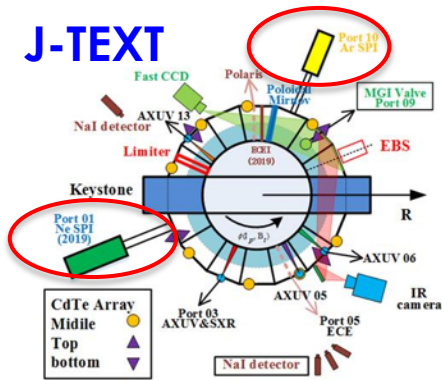
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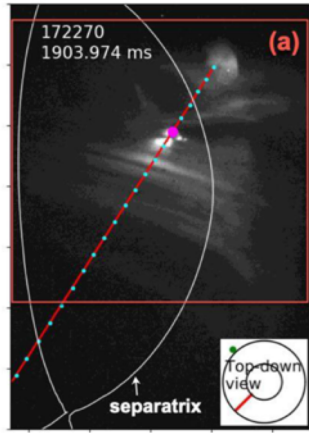


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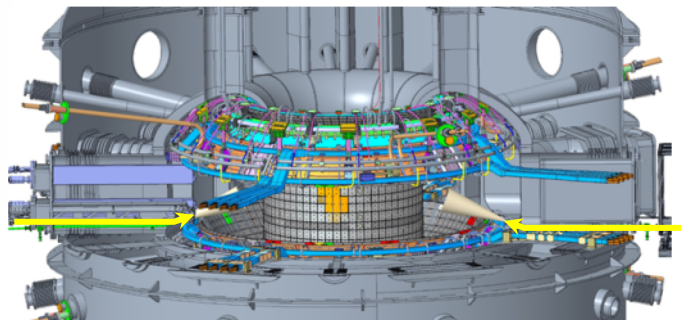
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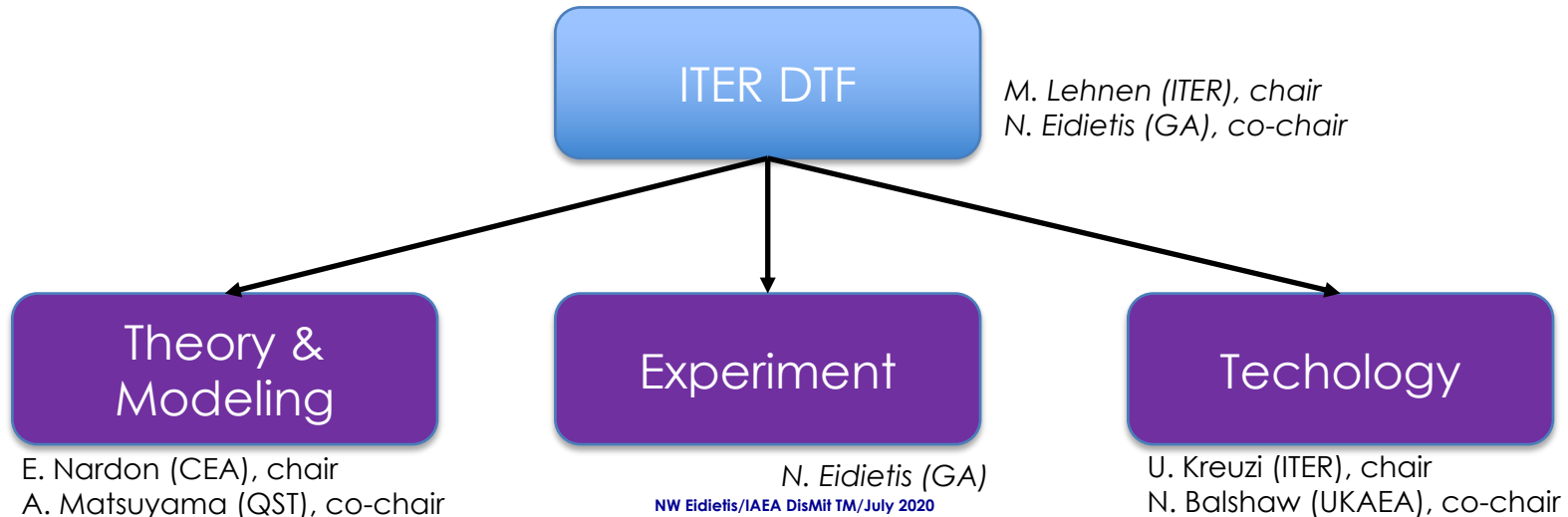
JOREK, NIMROD, M3D-C1
Modeling of ITER/JET/KSTAR/D3D
SPI Scenarios

Basic SPI ablation modeling

+ massive RE modeling effort

New organizing structures have grown to guide & collate this rapidly expanding SPI research

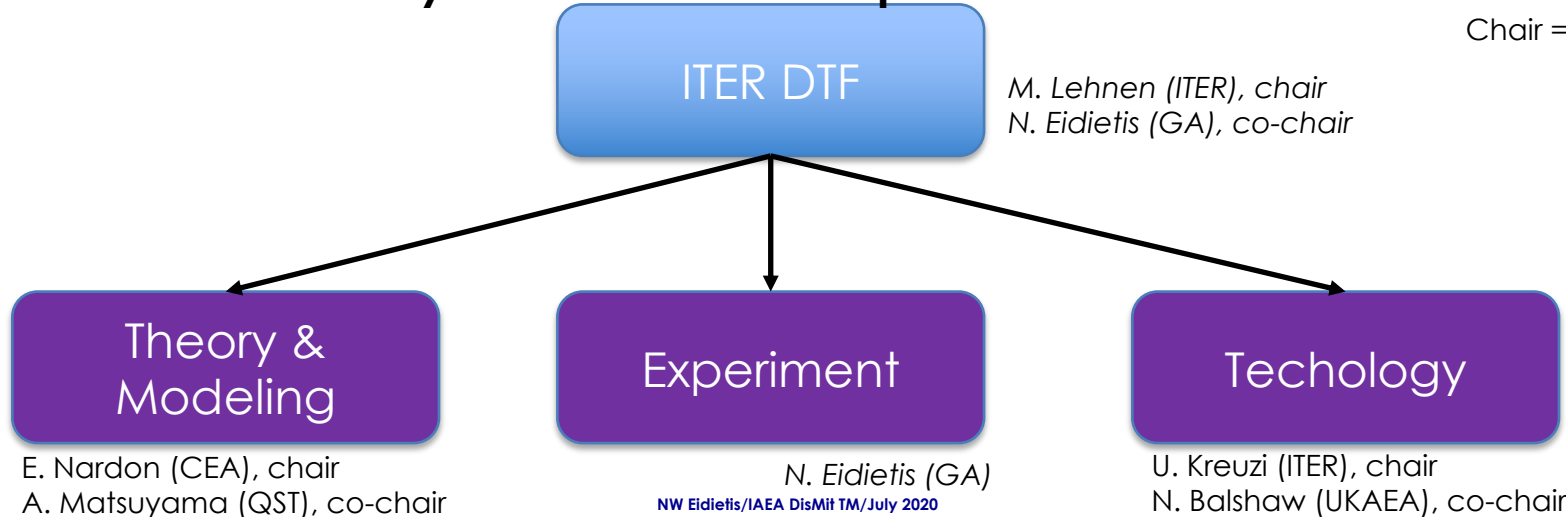
- **ITER DTF** formed to fund & coordinate targeted near-term SPI research to retire risk in ITER DMS design prior to 2022 FDR
 1. Technology development & testing
 2. Injectors & diagnostics for experiments
 3. Targeted modeling tasks



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- **ITPA MDC-24 “SPI Physics Validation”** to provide umbrella for data sharing

Chair = N. Eidielis



A wide variety of presentations have been organized to collate & discuss the state of SPI science

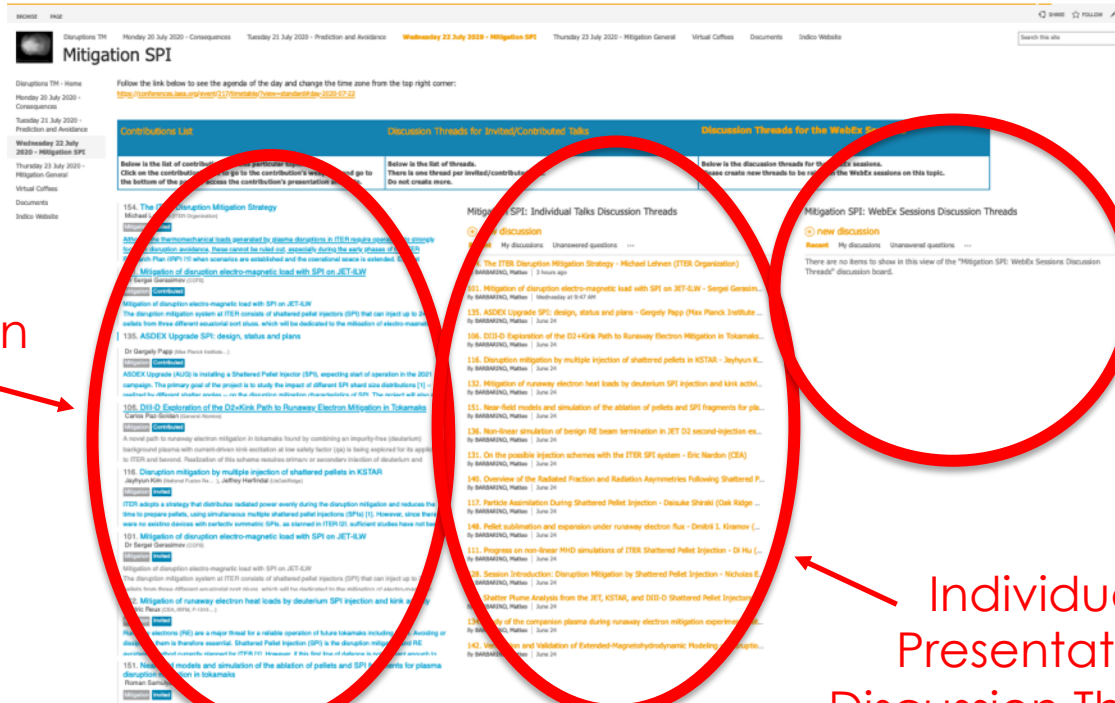
Invited Presentations

On the possible injection schemes with the ITER SPI system	E. Nardon (CEA)
Prospects for runaway electron avoidance with massive material injection in tokamak disruptions	T. Fülöp (Chalmers U.)
Progress on non-linear MHD simulations of ITER Shattered Pellet Injection	D. Hu (Beihang U.)
Disruption mitigation by multiple injection of shattered pellets in KSTAR	J. Kim (NFRI)
Mitigation of runaway electron heat loads by deuterium SPI injection and kink activity	C. Reux (CEA)
Overview of the Radiated Fraction and Radiation Asymmetries Following Shattered Pellet Injection	R. Sweeney (MIT)
Verification and Validation of Extended-Magnetohydrodynamic Modeling of Disruption Mitigation	B. Lyons (GA)
Near-field models and simulation of the ablation of pellets and SPI fragments for plasma disruption mitigation in tokamaks	R. Samulyak (Stony Brook U.)
Particle Assimilation During Shattered Pellet Injection	D. Shiraki (ORNL)

+ numerous contributions

But this remote session will only succeed with your **active participation BEFORE the conference**

- Discussion board for presentation & session is [here](#)
 - Includes list of ALL SPI session contributions



Presentation List

Session Discussion Threads
(add your own, or participate in existing)

Individual Presentation Discussion Threads

THANK YOU FOR PARTICIPATING!

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