CRYOGEN LOCA MODELLING USING MELCOR

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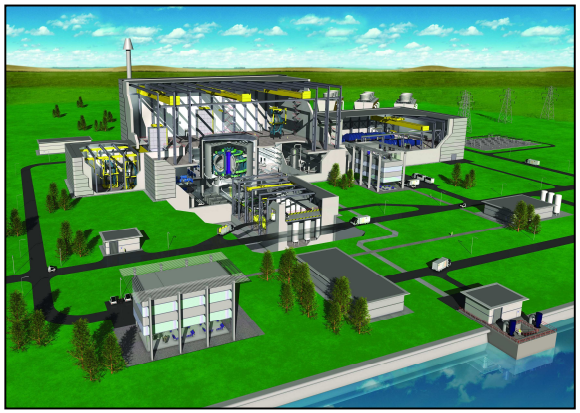
Culham Centre for Fusion Energy

Operate & Maintain JET

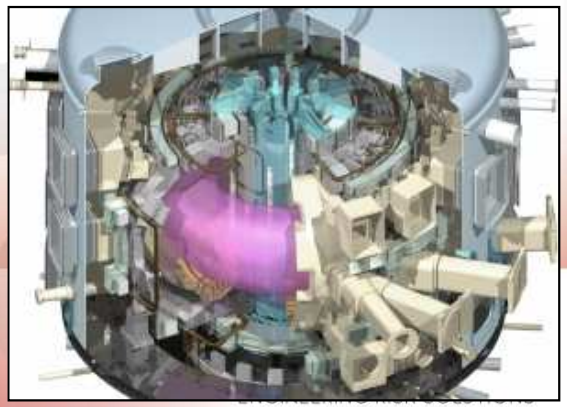


Lead and work on DEMO work packages

Fusion Research

Provide expertise for ITER and design ITER components

Design, construct, operate & maintain MAST



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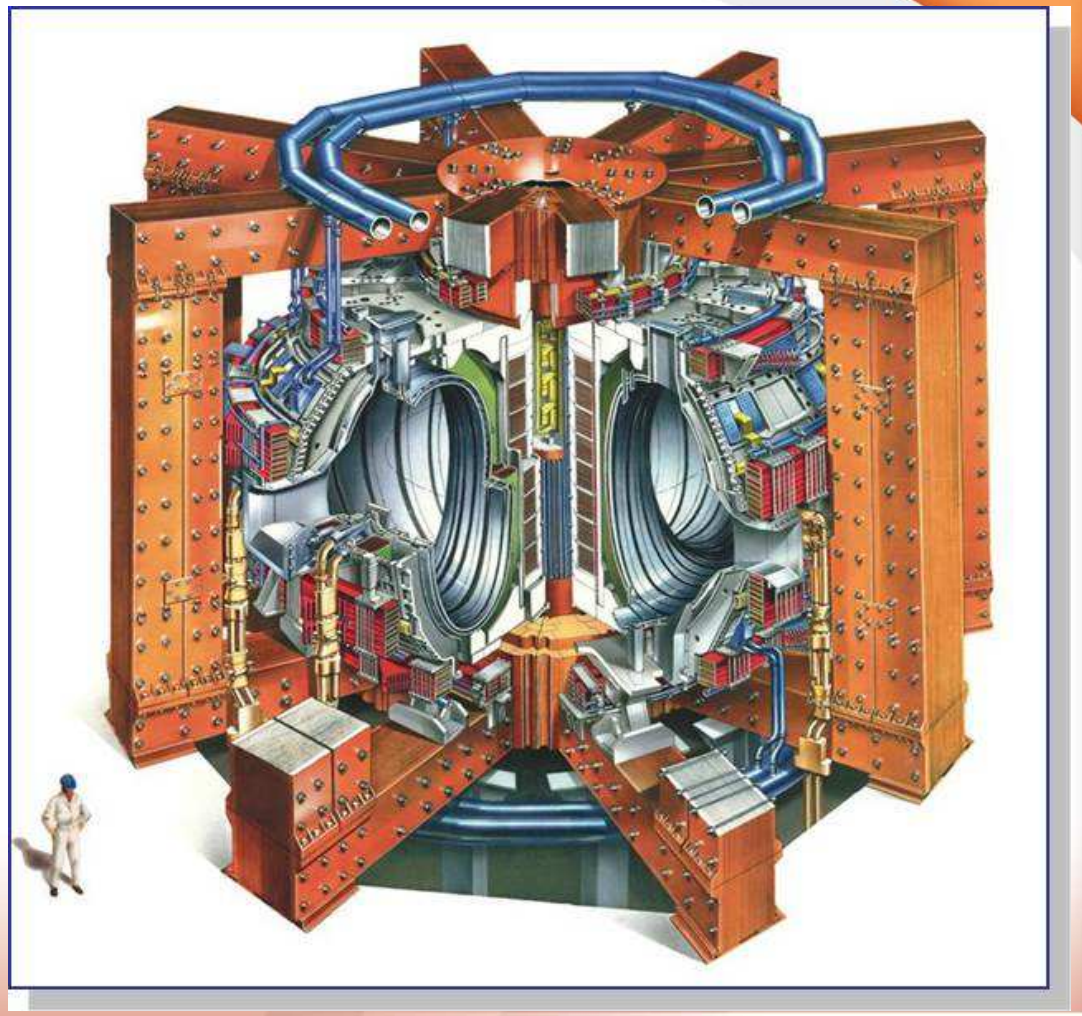
JET Facility

- Largest operating Fusion reactor in the world
- Only reactor to be able to run with Deuterium-Tritium fuel
- Holds world record for Fusion Energy (16MW)



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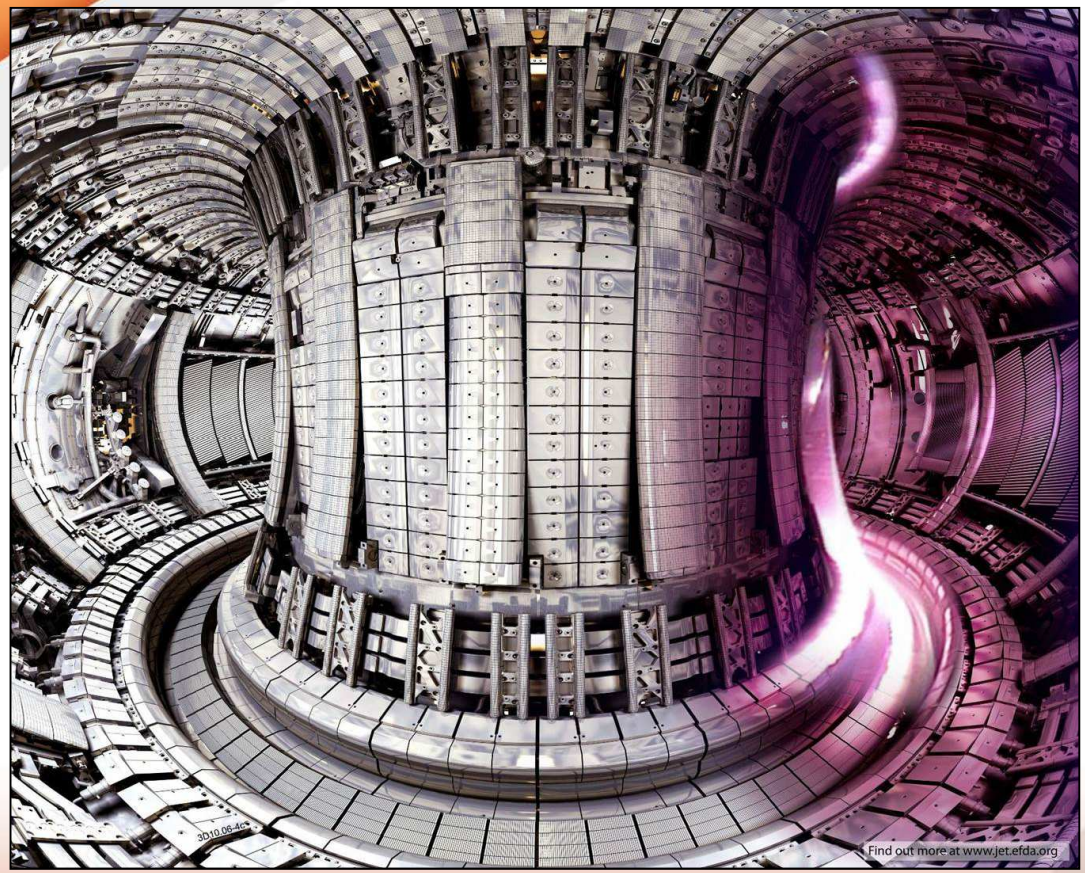
JET Facility



- Plasma temperature 150,000,000 degrees
- 60s pulses
- Up to 45 pulses per day

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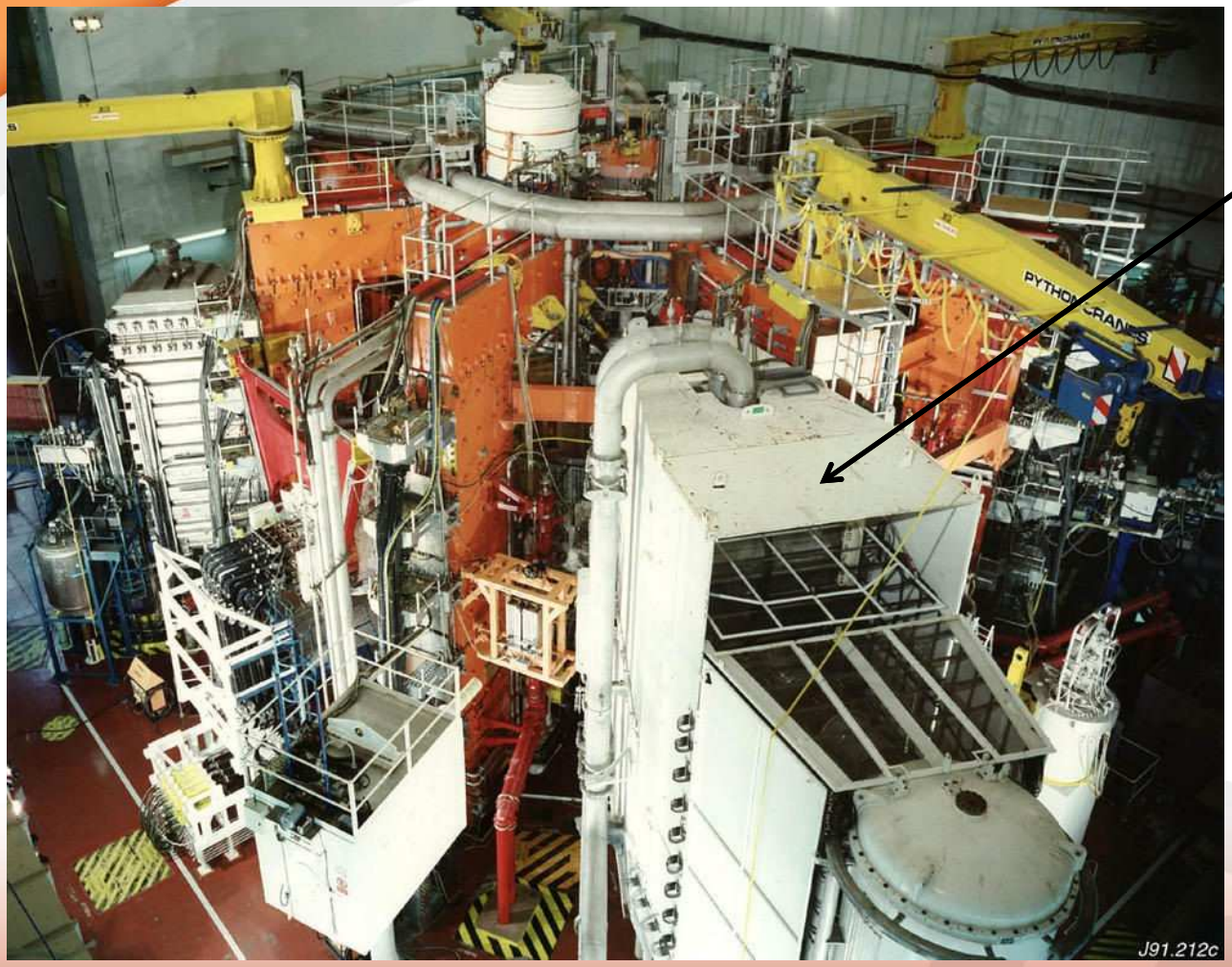
JET Facility



Neutral Beam Injector Box (NIB)

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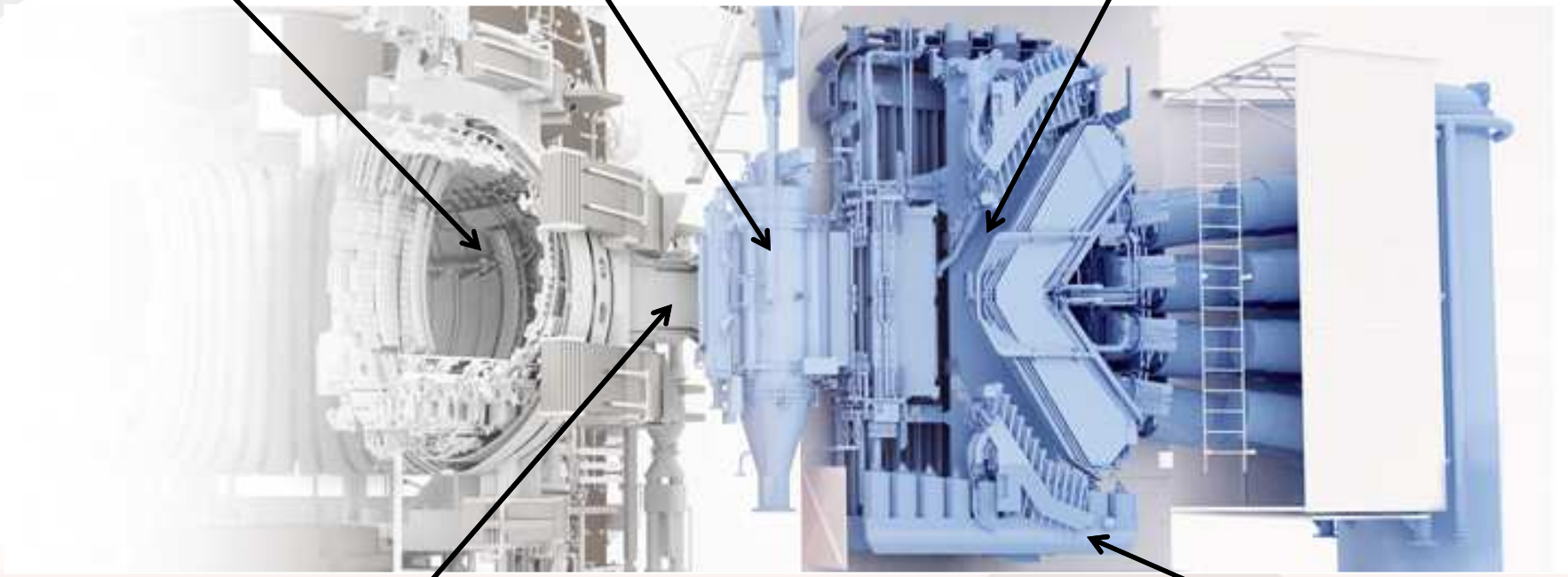
JET Main Components



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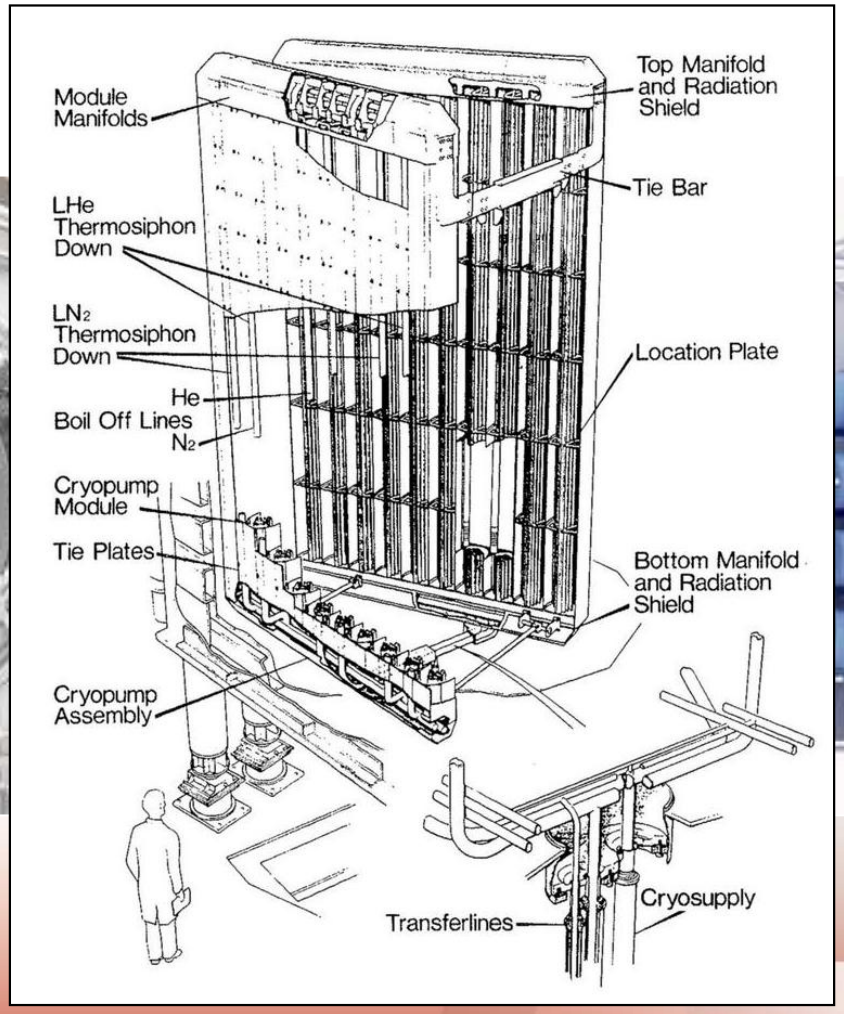
JET Main Components

NIB Cryopanels



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Fusion MELCOR

- First modification of MELCOR for use in Fusion installations made with MELCOR 1.8.2 by B. Merrill
- Variety of main fluids introduced for the needs of the fusion installations
- Fusion MELCOR 1.8.2 validated against tests and other codes. Published in 2000 by INEEL
- Next set of modifications to MELCOR 1.8.2 for ITER applications were published in 2007

Fusion MELCOR 1.8.5

- Existing changes were transferred to MELCOR 1.8.5 (no official publication available) and compiled for Windows
- Latest changes were made for the needs of JET cryo-LOCA model in 2014
- Only 64-bit Linux version supported with fluid properties for water, helium and nitrogen as main fluid

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First JET MELCOR model

- First JET model was developed in 2012 by Sebastien Grange
- Developed for modelling helium and nitrogen LOCA inside the Neutral Injection Box
- Includes a detailed model of the cryo-cooling panels

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Limitations of the initial JET model

- Conservative initial conditions
- Nitrogen flashing modelled using control functions
- No nitrogen freezing

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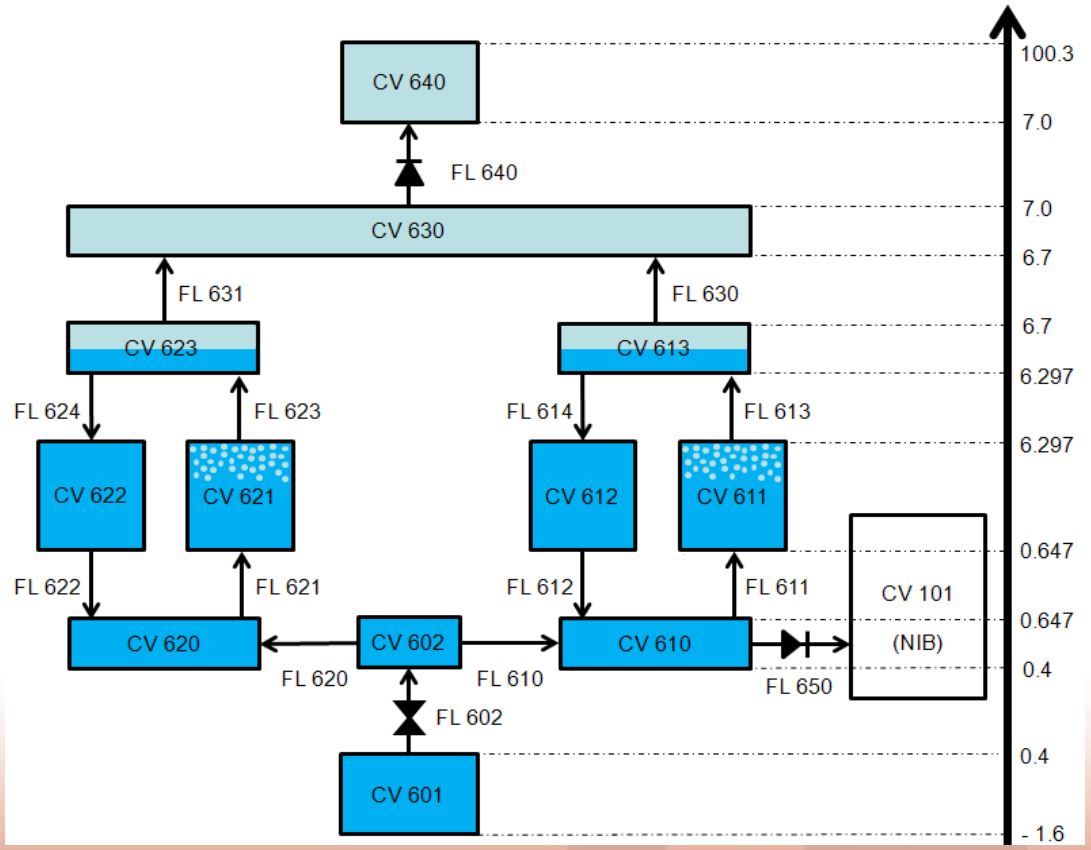
Cryo-cooling panel nodalization



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Model improvements

- More realistic initial conditions (required additional MELCOR modifications)
- Additional cryo-panel (HS only, no active cooling)
- Nitrogen freezing model
- Active flow path connecting the Torus and the NIB (RHVV)
- Detailed automatic control model

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Effect of the improvements on the results

- Lower pressure peak in the NIB
- Slower pressure rise inside the NIB during nitrogen LOCA
- RHVV can be closed during the calculation
- The amount of frozen nitrogen during the accident can be calculated as HS film mass / thickness

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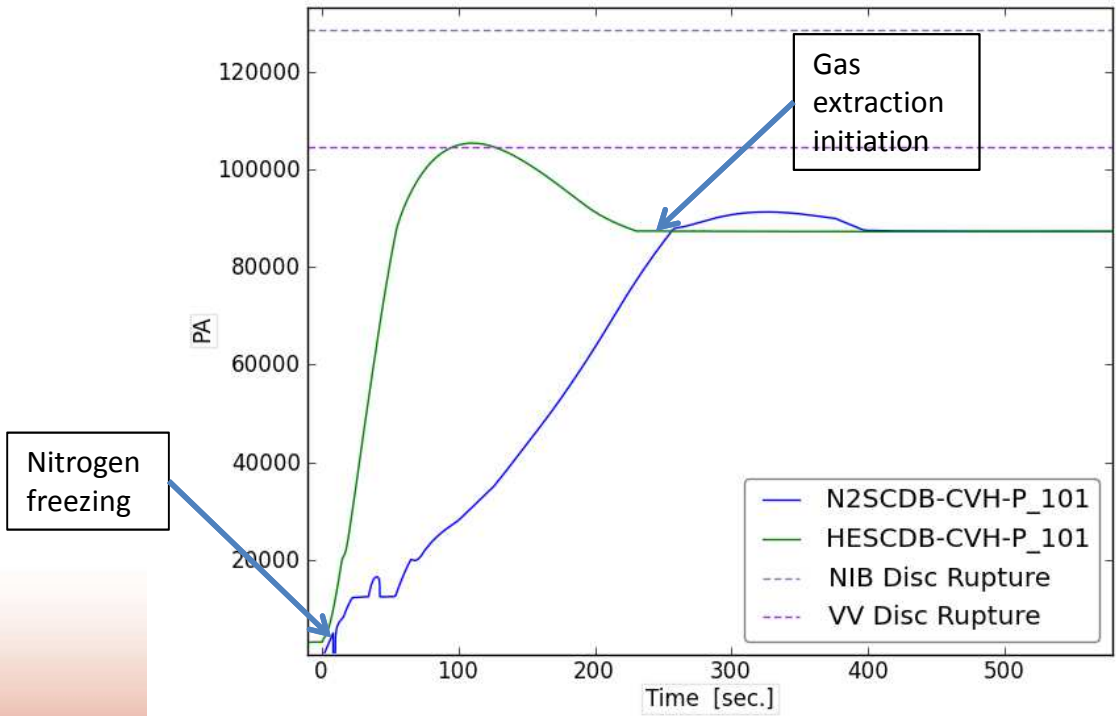
Helium and Nitrogen LOCA Pressure Profile



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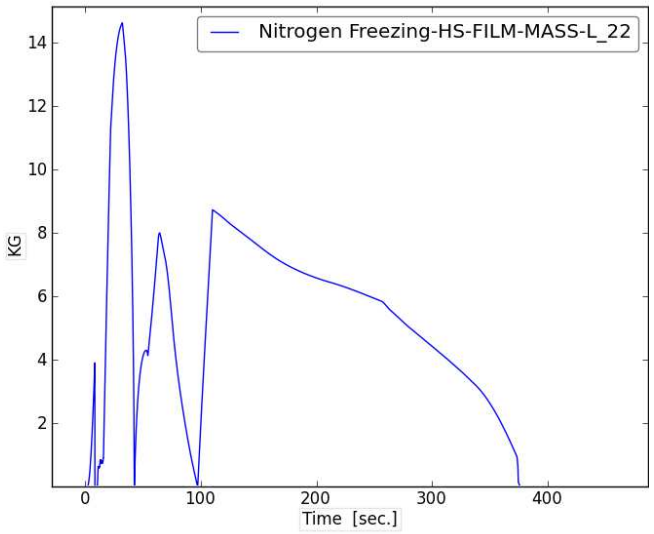
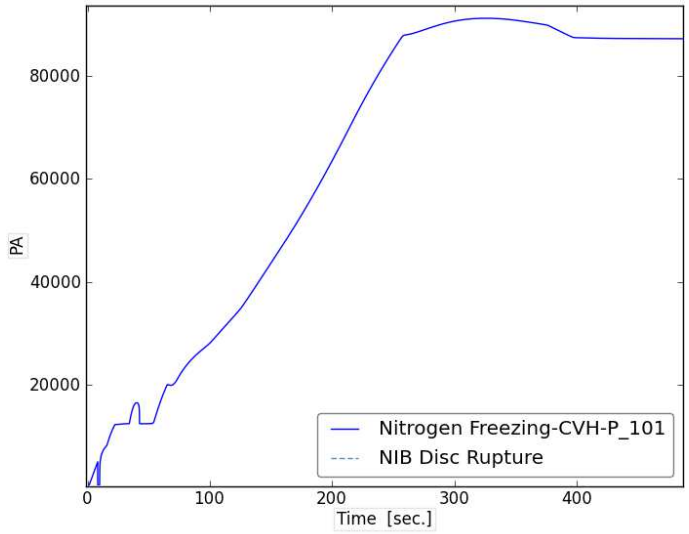
Frozen Nitrogen on the Cryo-Panel Surface



Frozen N_2 mass



N_2 LOCA pressure profile

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Questions?

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Thank you for your attention

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