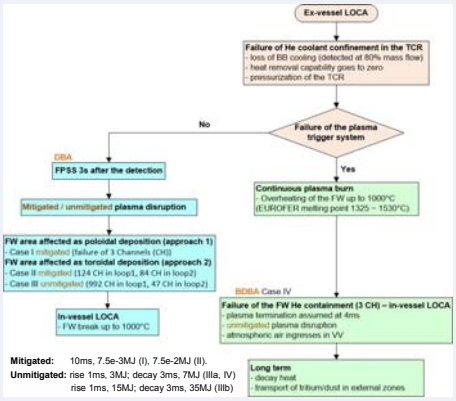
Karlsruhe Institute of Technology
EUROfusion
Institute of Neutron Physics and Reactor Technology (INR)
P.O. Box 3640 D-76021 Karlsruhe, Germany

P1.224

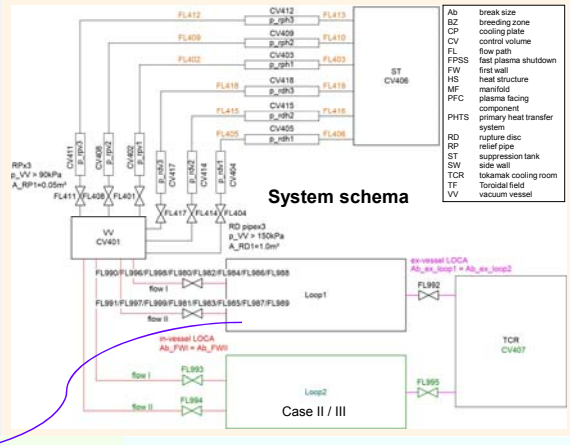
Preliminary accident analysis of ex-vessel LOCA for the European DEMO HCPB blanket concept

Xue Zhou Jin

Evolution scheme of the ex-vessel LOCA



Modelling using MELCOR1.8.6 for fusion

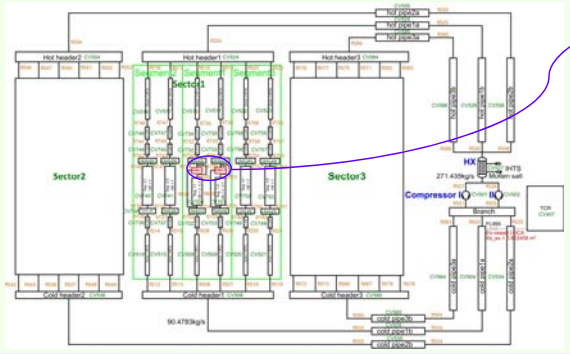


Reference design

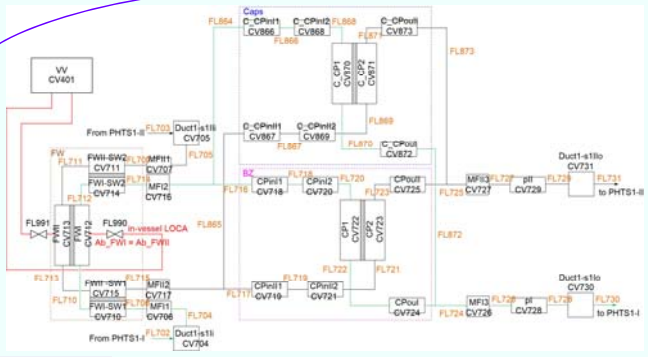
- **DEMO baseline 2015 (18TF)**
- **HCPB2016 vs. HCPB2015V3**
  - **Double-caps at top and bottom: 42 cooling channels / CP, cross section 5mmx5mm**
  - **BZ: 42 cooling channels / CP , cross section 5mmx3mm, 60CPs**
- **PHTS for HCPB2015V3: inlet piping through the lower ports**
- **Parameters for the VV, ST and TCR:**

Item	V [m³]	T [°C]	p [kPa]
VV	2502	300	0.1
ST_1 (dry)	50000	30	4.5
ST_2 (wet, air/water)	49900 / 100	30	4.5
1xRP (3x)	2.0	30	4.5
1xRD (3x)	40.0	30	4.5
TCR	60700	30	98.0

Loop1



OB4



CaseIVd

- **Source terms**
  - o W-dust: 25kg & 5kg at disruption
  - o Tritium: 351 ~ 2450g in PFC, 106.76g in BMs, 0.64g/loop.
- **Results at t_{end} (volume & HS)**
  - o Dust: 29.9644kg in the VV, 4.78744e-3kg in the ST, not in the TCR.
  - o Tritium: 2.4477kg in the VV, 5.1358e-4kg in the ST, 1.6135e-2kg in the TCR.

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

Scenarios & time evolution in transient

Sequence		Time (s)							
Scenarios		I	II	IIIa	IIIb	IVa	IVb	IVc	IVd
FW failure size (m²)		0.01	1.0	5.0		0.01			
ST		ST_2				ST_1	ST_2	ST_1	
VV cooling		steady			controlled	steady	steady	controlled	steady
Emissivity		0.25			0.8	0.25			
He		NCG				WF	NCG	WF	
ex-vessel LOCA		0.0 (DEGB with 0.622408 m²)							
Detection of He blowdown (t_{sig})		0.0215	0.0217	0.0217	0.0219	0.0211	0.0215	0.0212	0.0212
FPSS (t_{sd_f})		3.0215	3.0217	3.0217	3.0219	-			
Compressor shutdown (t_{sd_c})						3.0211	3.0215	3.0212	3.0212
End of plasma disruption		3.0315	3.0317	3.0257	3.0259	-			
In-vessel LOCA (t_{fail})		16315.676	16160.924	16058.430	16869.387	133.6691	133.6554	133.7611	133.6711
End of plasma disruption		-				133.6731	133.6594	133.7651	133.6751
Open RP (t_{RP})		22540.832	16224.662	16058.430	16883.934	5352.6753	5346.8013	7562.5713	5352.7192
Open RD (t_{RD})		no							
Tritium / dust	VV	-							133.6731
	ST	-							5352.731
	TCR	-							0.0026 / -

Conclusion

- **He inventory of two loops of 3.1696e3kg has impact on the pressurization of the TCR, the VV and the ST. A pressure peak in the TCR of 1.64465e5 Pa is 25.81% higher than it from one loop.**
- **In-vessel LOCA at ~134s due to the BDBA; it is postponed to ~4.46h in the DBA.**
- **Remove the excessive power in the VV during the in-vessel LOCA, T_{VV} can retain at T_{OB_in}, and the in-vessel LOCA is delayed.**
- **The VV pressure increased to the system equilibrium level is less than p_{VV_RD}, thus the RD is closed all the time.**
- **Temperature can be reduced effectively in the wet ST.**
- **For the small break size, the most dust and tritium stay in the VV. Dust is not transported to the TCR.**
- **Next steps: detailed VV model for effective heat removal; in-vessel LOCA for large failure size in two loops; and source terms transport for the max. releases.**

Transient