31st SYMPOSIUM ON FUSION TECHNOLOGY

DETERMINATION OF A PRE-HEATING SEQUENCE FOR THE DONES TARGET ASSEMBLY

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https://join.skype.com/kicfMVPP5FJe

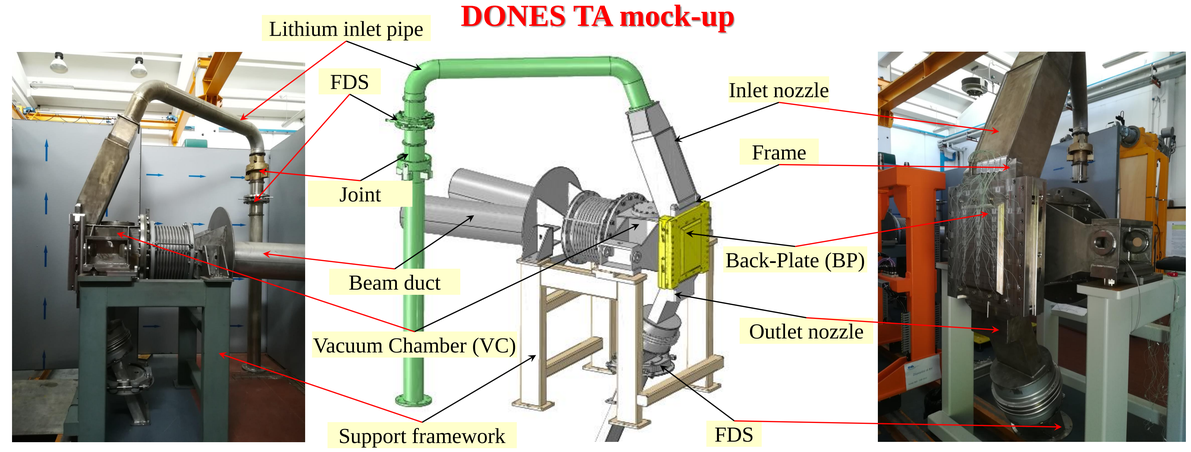
ABSTRACT

Within the activities promoted by the EUROfusion consortium in support of the design and construction of the DEMO Oriented NEutron Source (DONES), a mock-up of its Target Assembly (TA), based on the configuration with a "bayonet" Back-Plate (BP) and available at ENEA Brasimone labs, is being adopted for the performance of experimental activities aiming at the validation of specific aspects of the target design.

Despite the "integrated"-TA concept is the current reference, experimental tests concerning the execution of TA pre-heating phase are not significantly affected by the TA concept and are still representative even though conducted on the TA-bayonet concept. Indeed, the main objective of the pre-heating phase is to raise the TA temperature up to a value close to that of the lithium flow in nominal condition (250°C). In particular, one of the main concerns is to keep the BP at a temperature higher than 200 °C to avoid possible local lithium freezing.

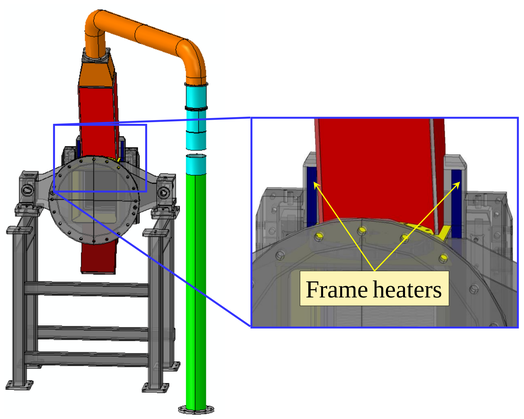
In order to support the afore-mentioned tests, a numerical research campaign has been launched by ENEA Brasimone in collaboration with the University of Palermo with the goal of determining an optimal design of the electrical heaters, both in term of temperature set-points and geometrical layout. To this purpose, several configurations have been assessed following a theoretical-computational approach based on the Finite Element Method (FEM) and adopting a qualified commercial FEM code. In a first phase, different electric heater layouts were assessed by means of steady state thermal analyses. Once the most promising scenario was selected, a detailed thermal transient analysis was carried out. An iterative procedure, based on the analysis of the maximum temperature achieved within the mock-up most critical components, was followed in order to determine the duty cycle of the electric heaters. The obtained numerical results are herewith reported and critically discussed.

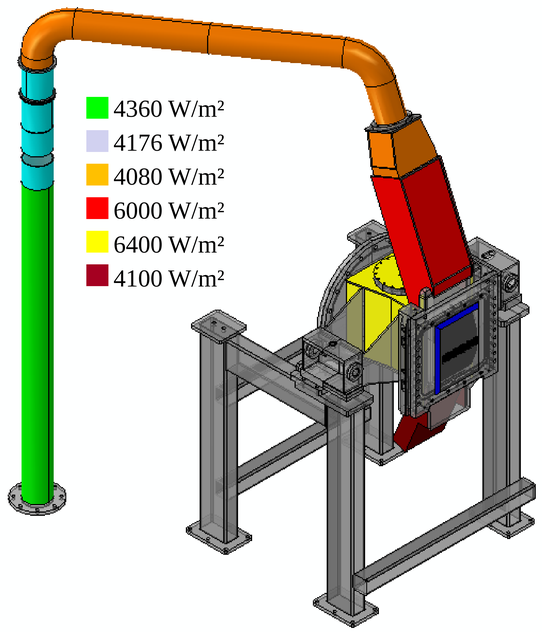
DONES TA mock-up



LOADS &BOUNDARY CONDITIONS

- Electrical heaters*
- Heat transfer between BP and High Flux Test Module (HFTM)
- Convective cooling with air at 10 °C (h=10 W/(m²°C)
- Thermal contact between structures
- Internal and external irradiation with an emissivity value of 0.3





*In steady-state analyses the electrical heater effect has been reproduced setting the heated surface at the set-point temperature, while in transient analyses the actual heat flux value has been adopted.

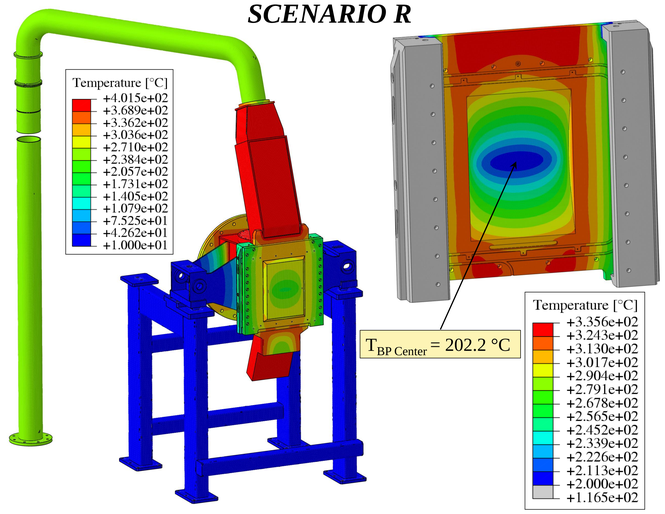
ANALYSIS & RESULTS

Scenario	A	B	C	D	E	F	G	H
Component	Set-point [°C]							
Inlet pipe	250	250	250	250	250	250	250	250
Inlet Nozzle	250	250	250	250	250	250	400	400
Vacuum Chamber	250	250	250	250	250	250	400	400
Outlet Nozzle	250	250	250	250	250	250	400	400
Frame	N/A	250	400	400	400	400	400	400
BP	N/A	N/A	N/A	N/A	250	400	400	N/A
HFTM	10	10	10	100	100	100	100	100
Scenario	**I**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**
Inlet pipe	250	250	250	250	250	250	250	250
Inlet Nozzle	250	400	250	400	250	400	400	400
Vacuum Chamber	250	400	250	400	250	400	400	400
Outlet Nozzle	250	400	250	400	250	400	400	400
Frame	400	400	N/A	N/A	N/A	N/A	400	N/A
BP	400	400	400	400	400	400	N/A	N/A
HFTM	10	10	100	100	10	10	10	10

Scenario	A	B	C	D	E	F	G	H
T_{min} Li channel [°C]	116.8	122.6	144.2	185.7	180.9	226.2	269.5	251.7
Scenario	**I**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**
T_{min} Li channel [°C]	192.0	238.6	223.2	268.6	188.8	237.6	215.9	202.2

Steady state results are reported in this poster
Complete and detailed results will be available in the paper

SCENARIO R



CONCLUSIONS

Results obtained from the steady state campaign of analyses have shown that it is possible to heat the lithium channel up to a temperature higher than 200 °C without the adoption of electric heaters onto BP and/or frame surfaces, as well as with the HFTM at the room temperature of 10 °C. An experimental adopting the *Scenario R* for the electrical heaters will be performed.

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