

Cryomodule design changes for ICD-2

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Outline



- **TESLA & ICD-2**
- **ICD-2 Cryomodule Design Questions**
- **Heat Rejection**
- **Pressure Drop**
- **Shields**
- **Conclusion**

TESLA and ICD-2

		TESLA	ICD-2
Duty factor	[%]	1	100
E_{acc}	[MV/m]	23.4	16
Q_0	[-]	1.0E+10	2.2E+10
Operating Temp	[K]	2.0	1.8
Beam Current	[μA]	9	1
Dynamic Load	[W/cavity]	< 1	~22
Cryo Unit Length	[m]	~ 2,500	~ 150

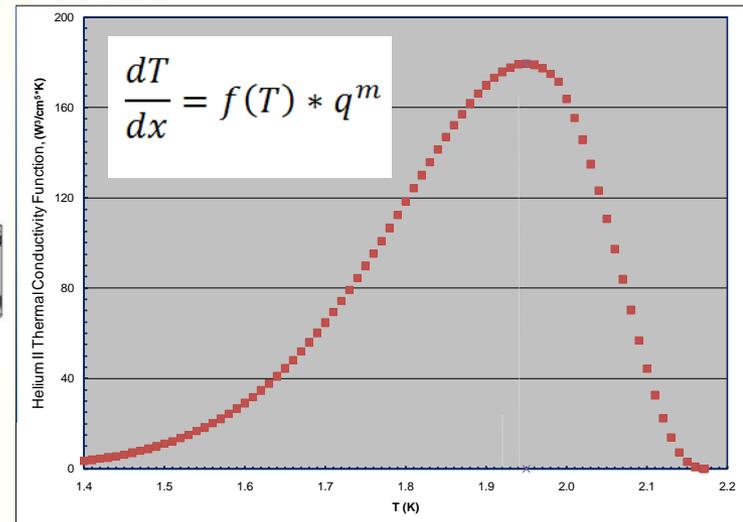
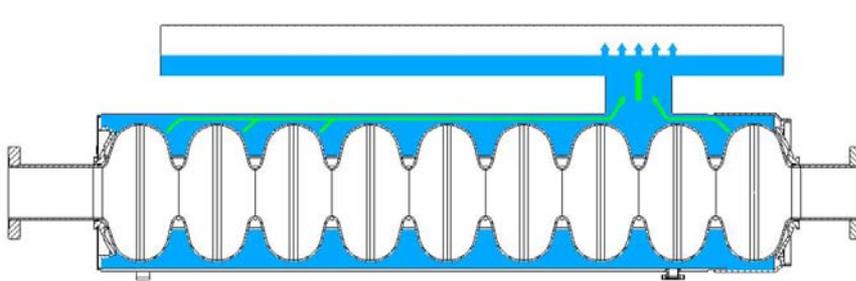
ICD-2 Cryomodule Design Questions



- **Can current helium vessel design and associated piping accommodate high heat load requirements of the ICD-2?**
- **What is an impact of shorter Cryo string on thermal shields and associated pipe sizes?**
- **... ?**

Heat Rejection

- Compared to TESLA, ICD-2 dynamic heat load has increased by a factor of ~ 30
- Heat rejection must be by superfluid conduction ($T < T_{\text{sat}}$). Boiling will cause microphonics
- Must not exceed peak heat flux



Pressure Drop

- **Increased flow rate due to higher heat load affects “Chimney”, 2 phase pipe and Helium Gas Return Pipe (GRP)**
- **“Chimney” diameter affects thermal conductivity path. “Chimney” diameter needs to be increased**
- **2 phase pipe needs to be increased to maintain stratified smooth flow regime**
- **GRP was sized for 2.5 km TESLA strings and appears to be OK for the ICD-2 layout**

Shields



- **5/8 K and 40/80K shields function as**
 - **Thermal radiation shield**
 - **Thermal intercept for supports, input coupler, HOM coupler, HOM absorber, leads, etc.**
- **5/8 K shield intercepts ~ 2 W of thermal radiation heat load per module that otherwise would be absorbed by 2 K circuit. For the ICD-2, total heat load per module is ~ 180 W**
- **Short Cryo Unit size relaxes shield operating temperature and pressure requirements. It also opens opportunity to reduce shield pipe sizes**

Conclusion

- **ICD -2 operating parameters warrant review and modification of the CM's 2 K circuit**
- **Potential modifications include but not limited to increase of the helium vessel, the “chimney” and the 2 phase pipe**
- **Economic benefits of the 5K thermal radiation shield need to be evaluated**
- **Shields operating temperature, pressure and associated pipe sizes should be optimized within ICD-2 operational and safety constraints**