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Fermilab studies of quality factor changes of a N doped cavity from vertical to dressed horizontal test

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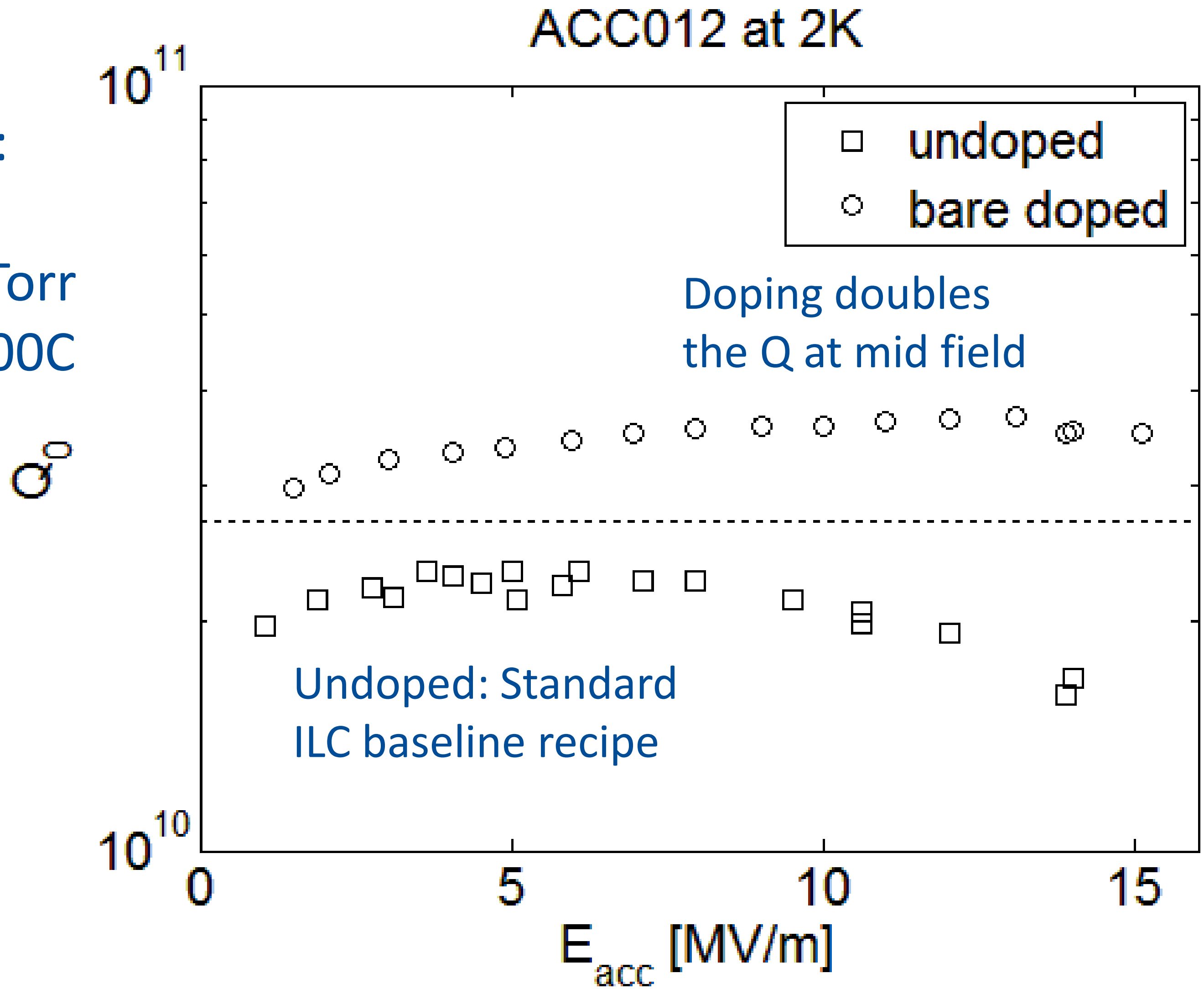
For the FNAL high-Q group

Bare cavity performance, N doping recipe

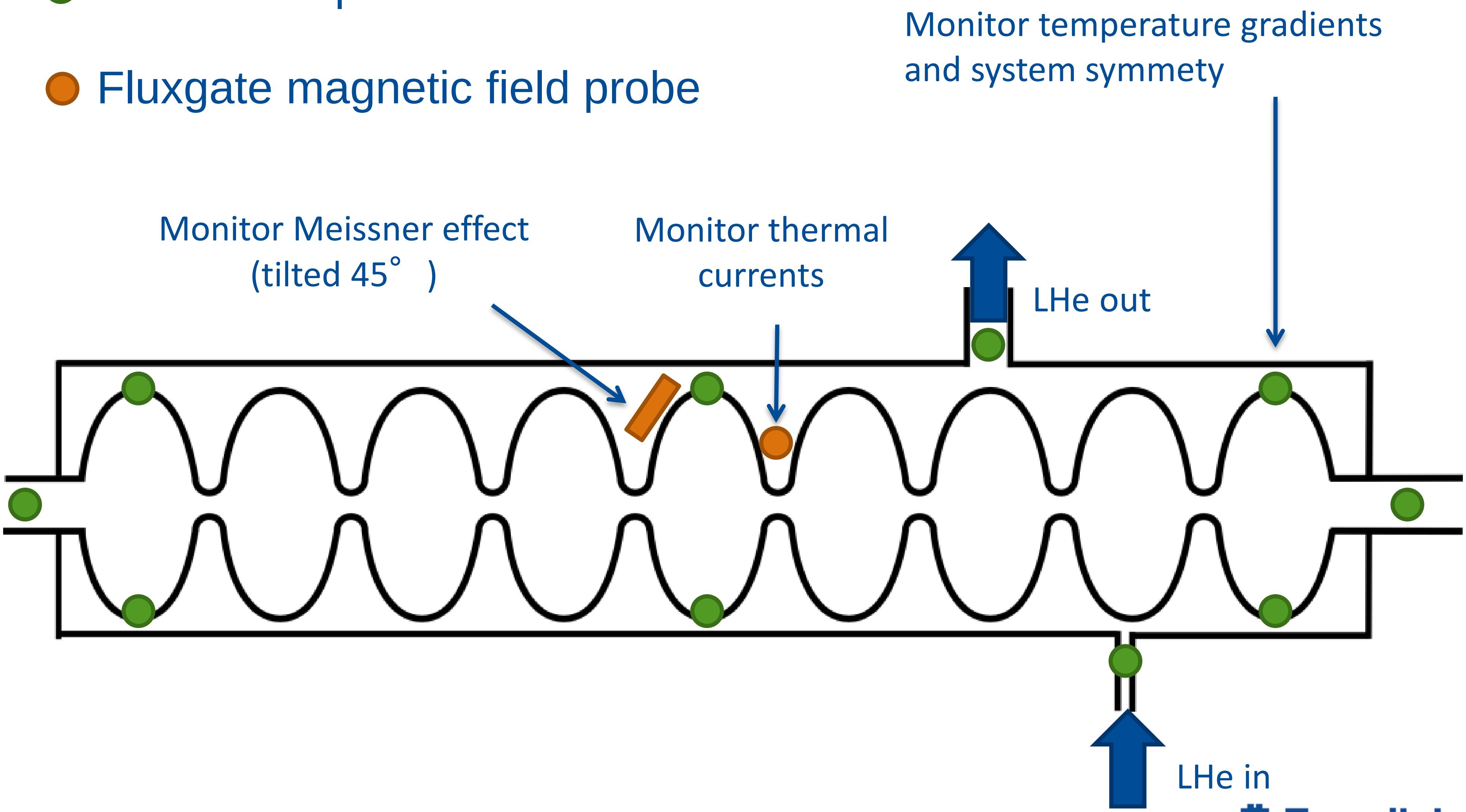
ACC012 treatment:

20 min N2 @25 mTorr
30 min anneal @800C
~18 microns EP



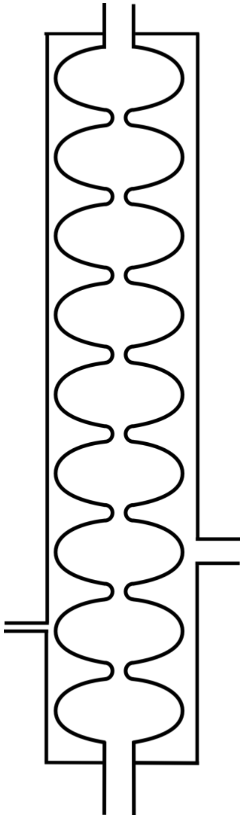
Cavity dressing and instrumentation

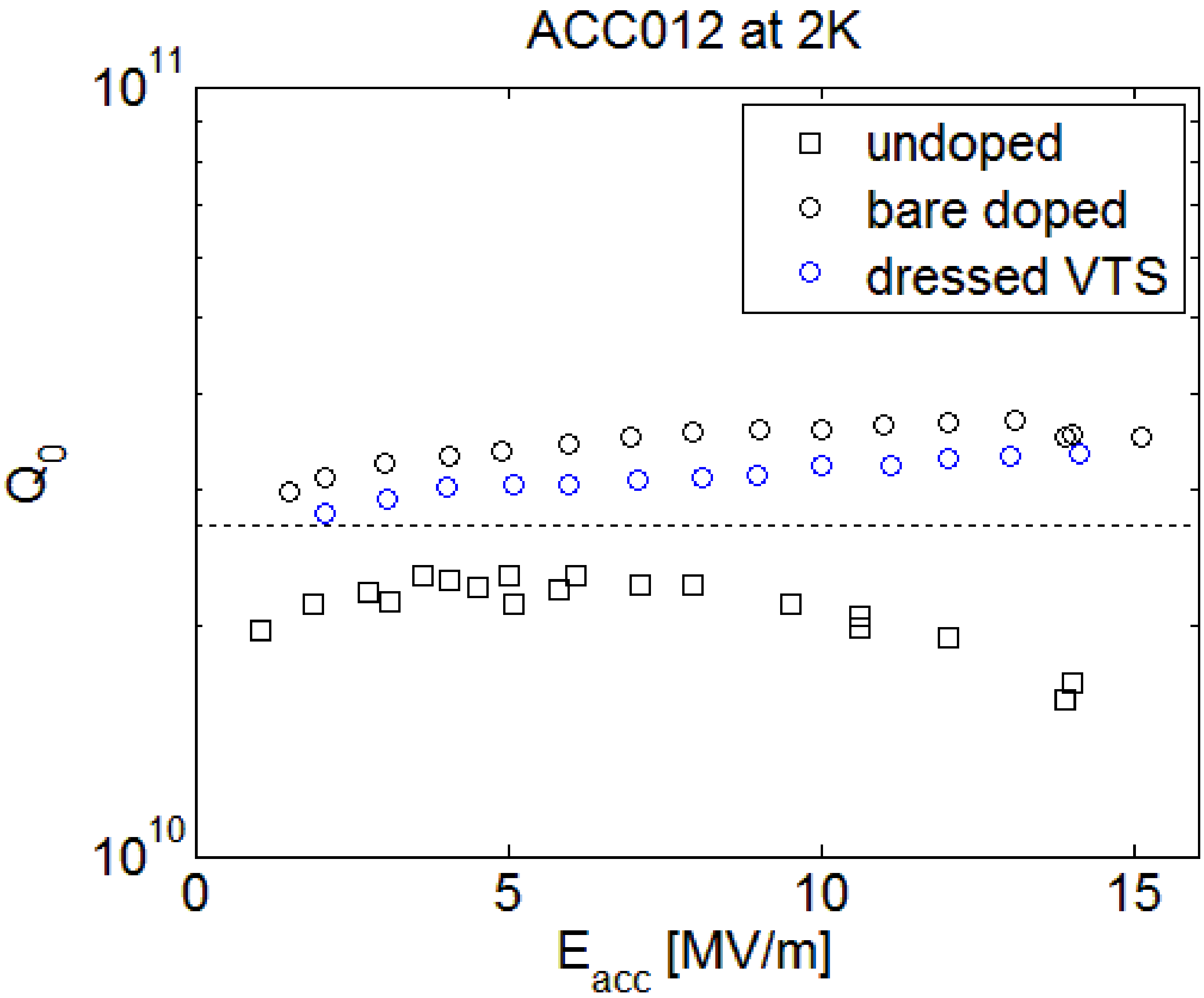
- Cernox temperature sensor
- Fluxgate magnetic field probe



Vertical test of dressed cavity

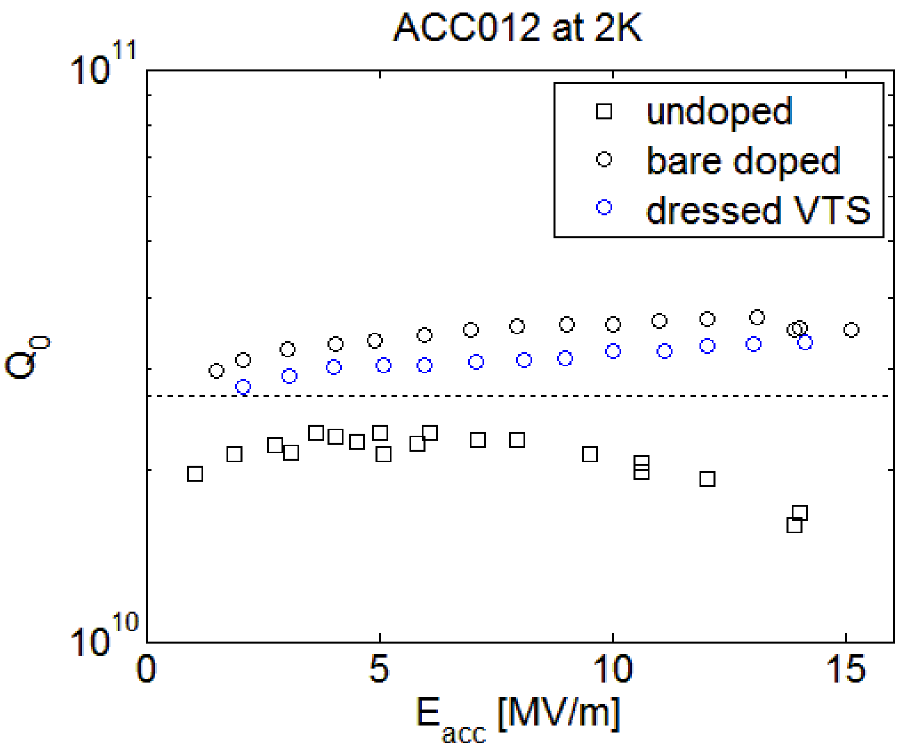
Dressing barely influences Q



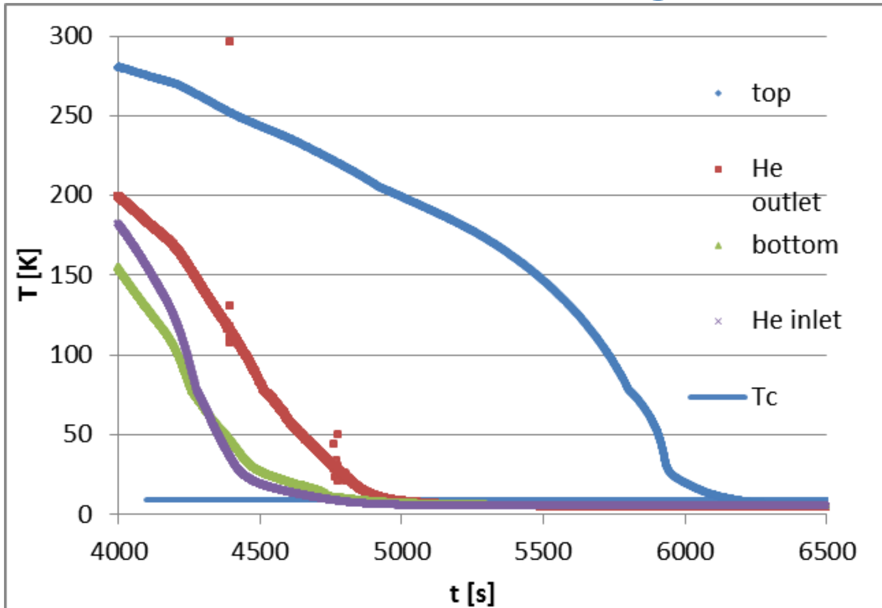


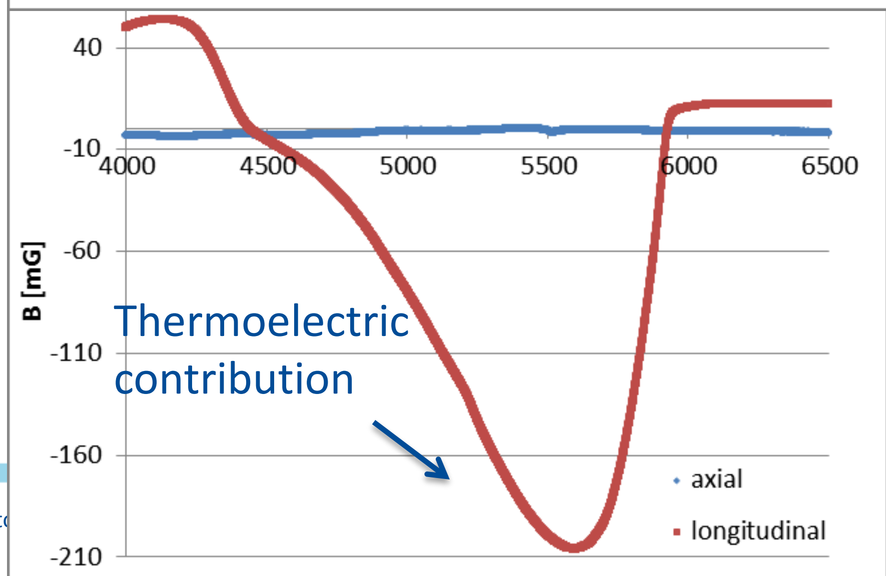
VTS test: Thermal currents

High thermal current induced field does not significantly degrade Q. Cernox sensors on Cells show symmetric cooling.

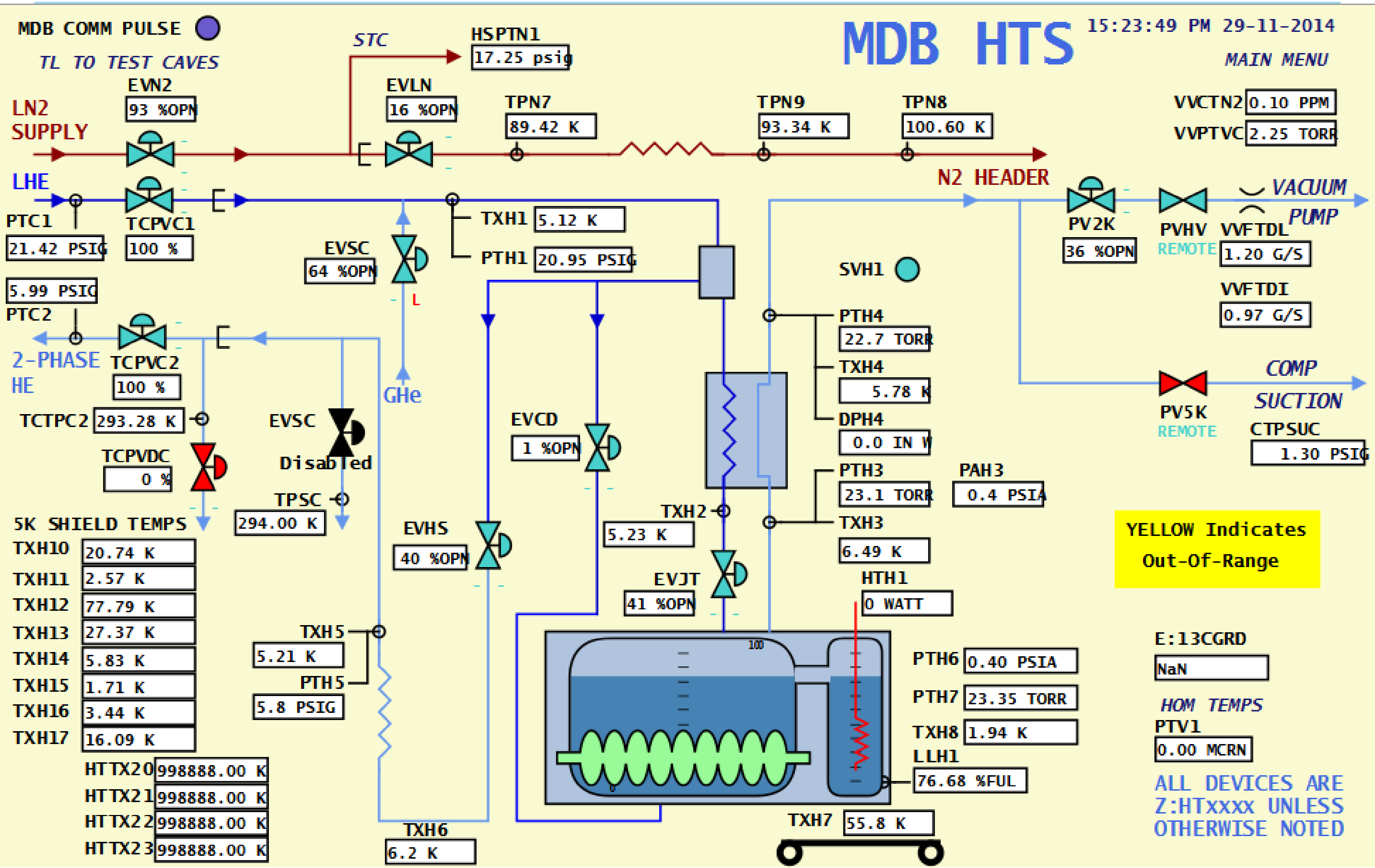


Sensors outside and fluxgates:

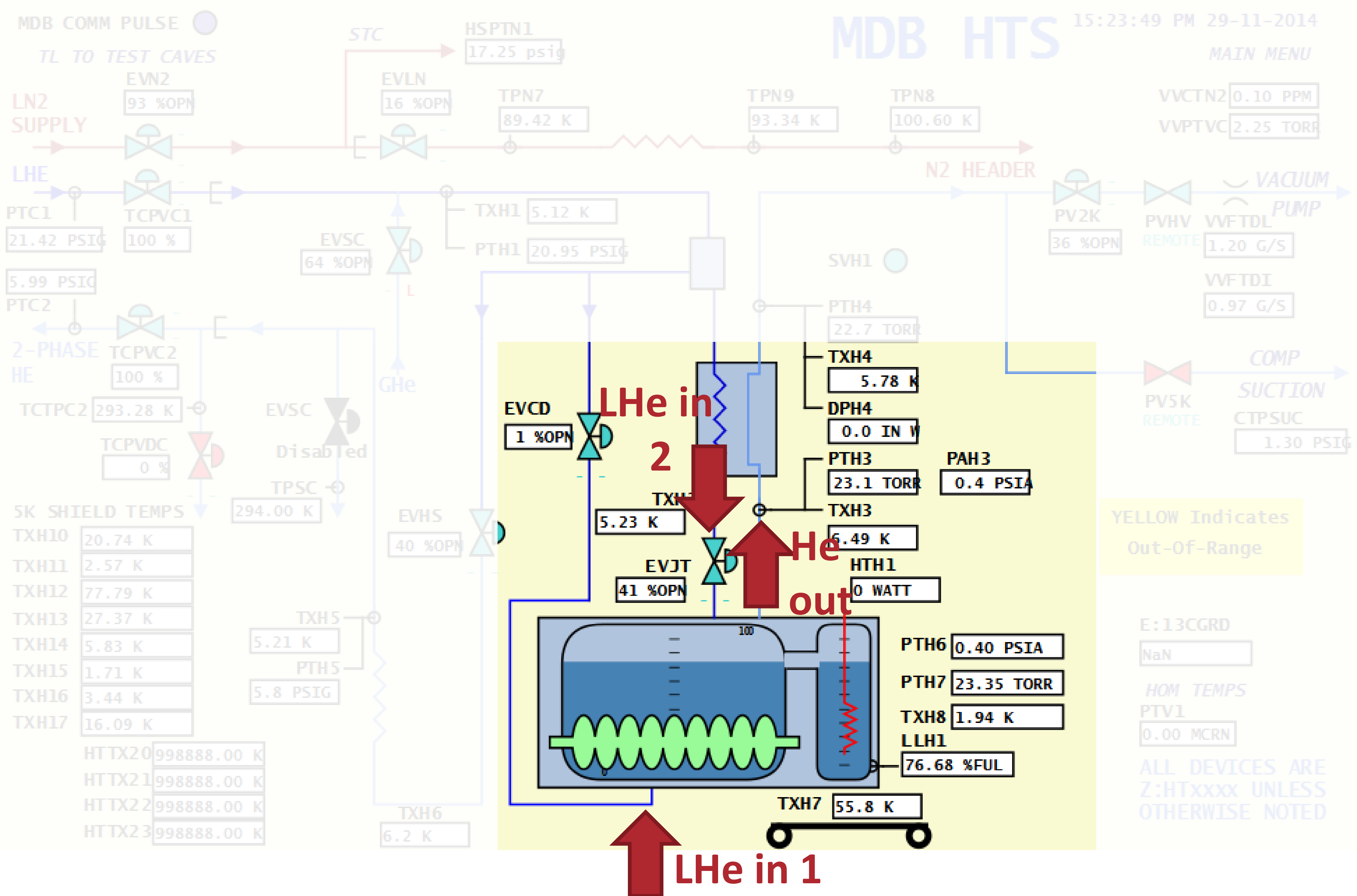




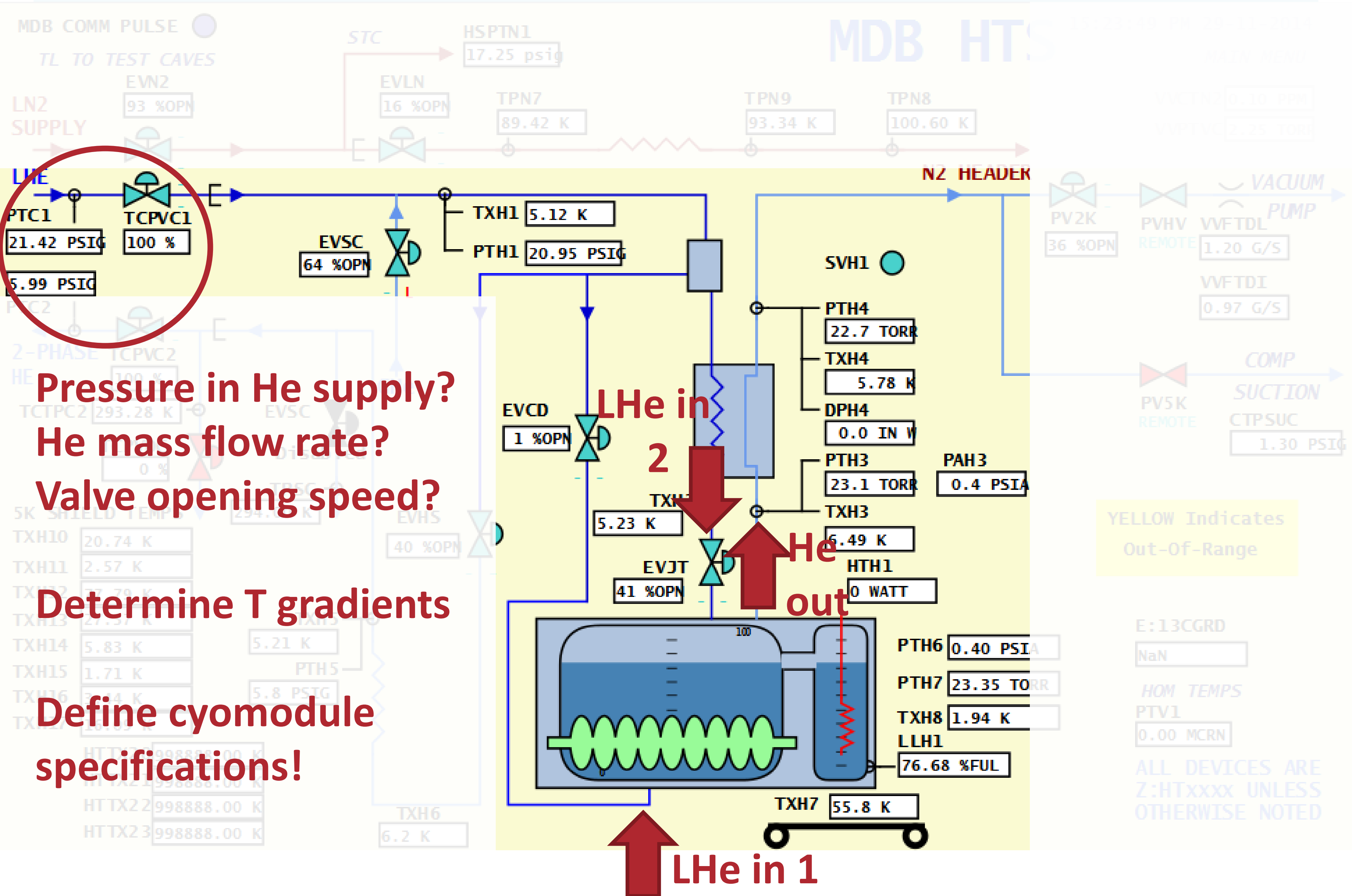
Horizontal test: Cryo setup



HTS test: Cryo setup



HTS test: Cryo setup



Pressure in He supply?

He mass flow rate?

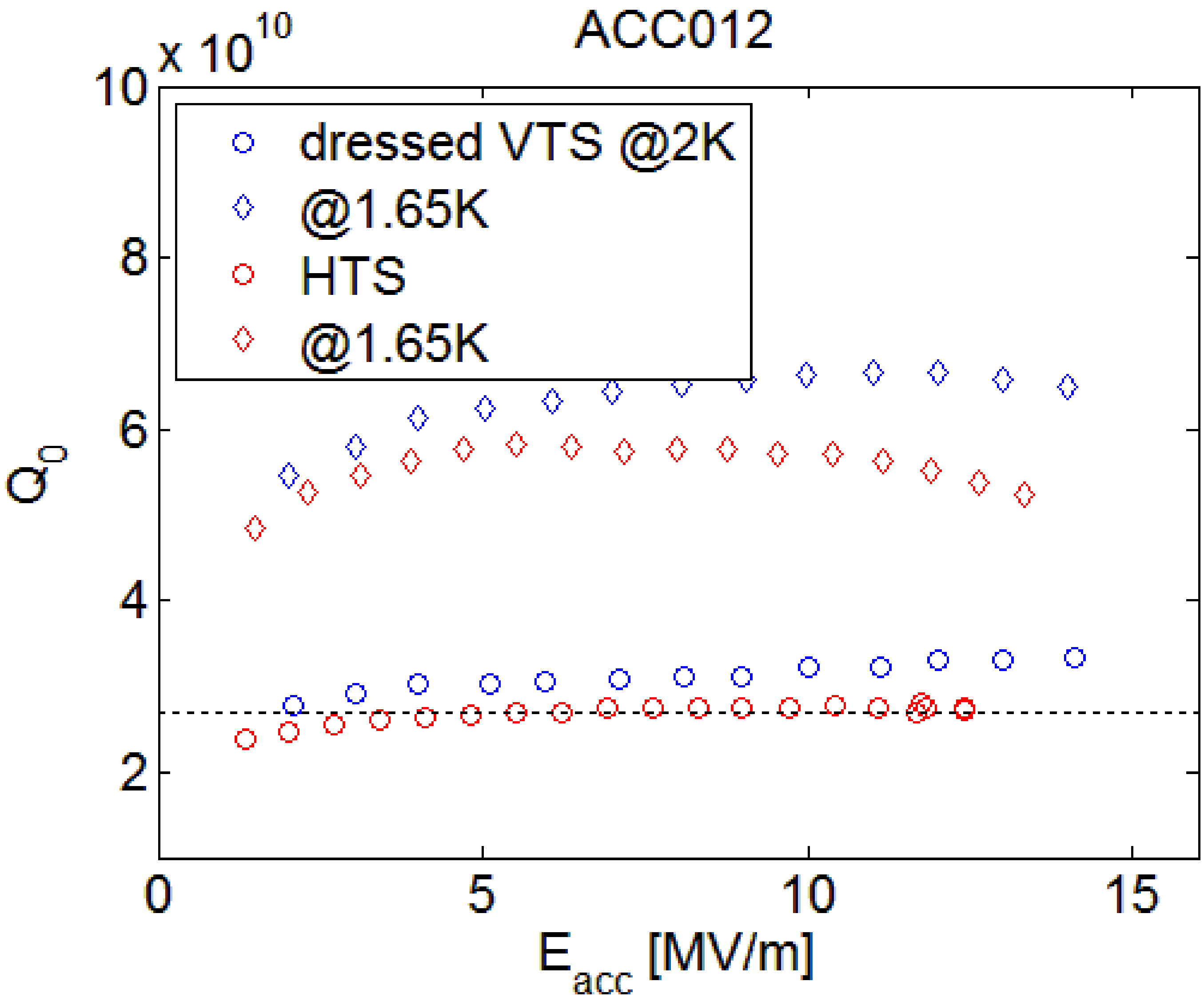
Valve opening speed?

Determine T gradients

Define cyomodule specifications!

HTS results

Difference in Surface resistance < 2nΩ @ 1.65K



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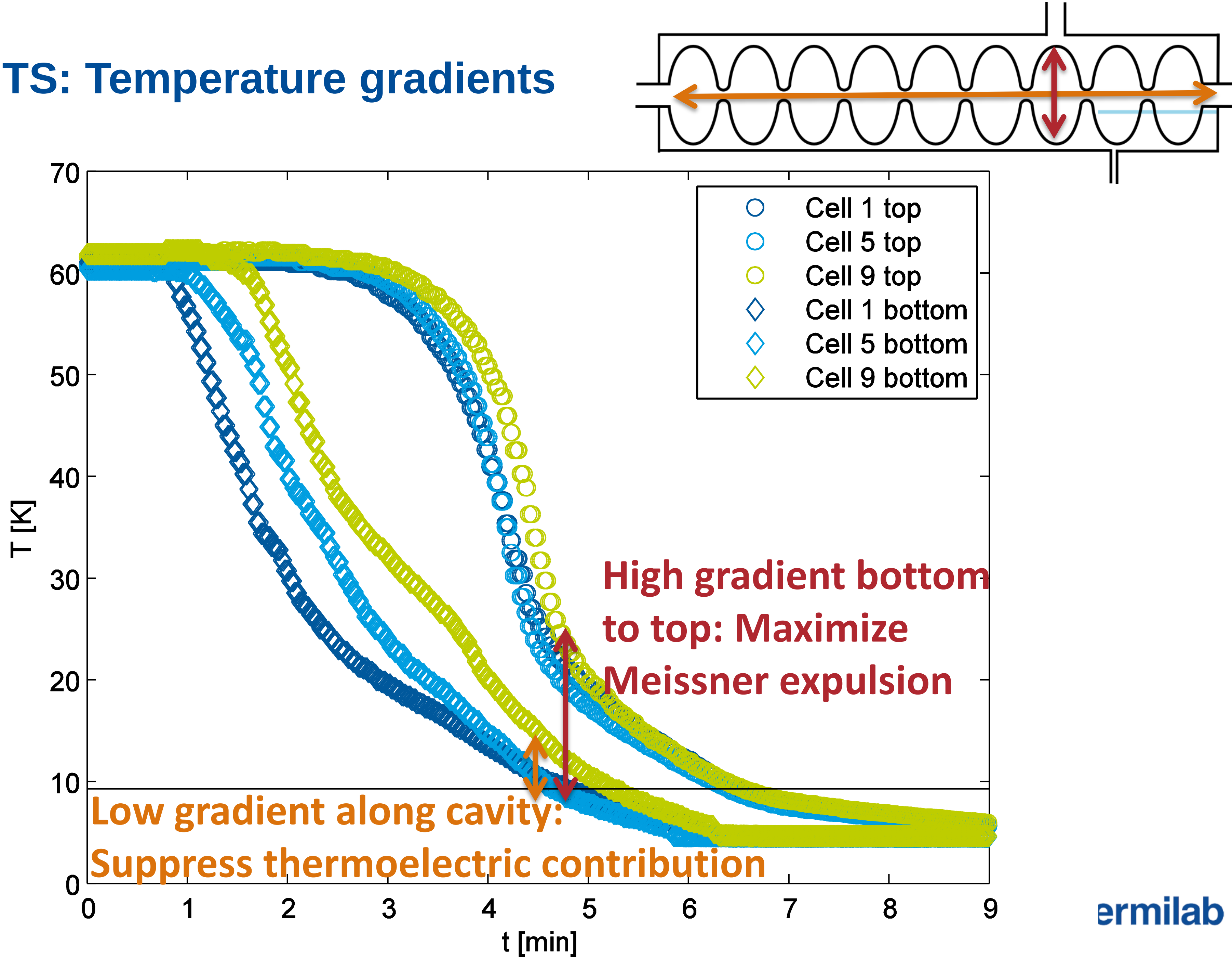
HTS: Temperature gradients



Comparison of all performed cooldowns

	VTS	HTS0	HTS1	HTS2
Starting T [K]	300	300	60	70
Gradients along cavity [K]	240	7	5	6
Gradients “bottom“ to “top“ (symmetry) [K]	0	35	12	45
Cooling rate [K/min]	2	10	5	6
Ambient field [mG]	5 + thermal	30	< 10	12

Pressure in He supply?

He flow rate?

maximum ΔT taken when first sensors in cavity transition

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Pressure in He supply			9psig	16psig

He flow rate?

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Conclusion, next steps and goals

- Successful demonstration of high-Q cavity operation starting with bare 9 cell all the way to HTS
- LCLS-II specs met (Q-wise)
- High spatial gradients and good flux expulsion are achievable without degradation due to thermal currents
- He inlet pressure and He mass flow define gradients on the cavity
- Further studies on those parameters important for CM design
- Design of He vessel influences gradients hence future studies will address other geometries

Acknowledgements

- Studies funded by DOE-BES via the High-Q FNAL work for LCLS-II
- Thanks to the FNAL processing and testing group, CM assembly group, TD and AD cryo groups and in particular to Chuck Grimm for the incredibly fast turnaround (despite many difficulties)
- Thanks to Rich Stanek, Slava Yakovlev and Hasan Padamsee for endorsing making the High-Q work a high priority at FNAL

Relevant references

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