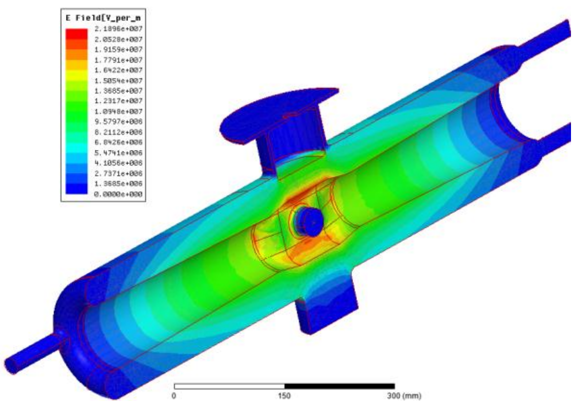
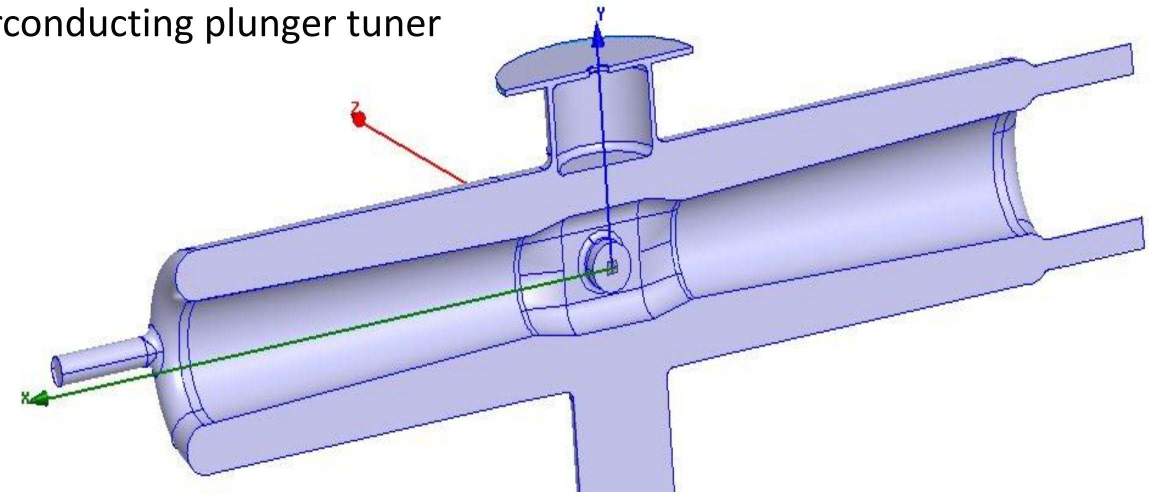
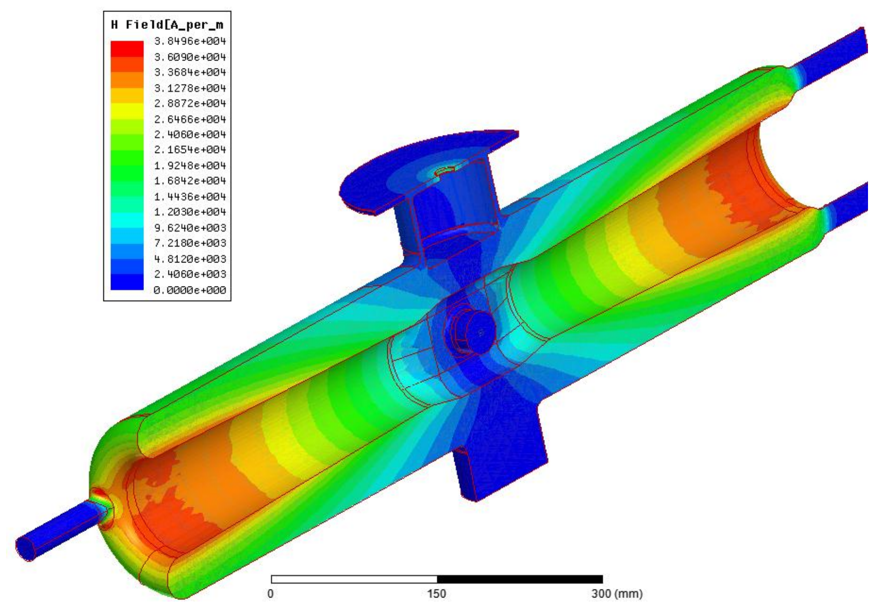
IFMIF HWRs issues

Original cavity design includes a superconducting plunger tuner





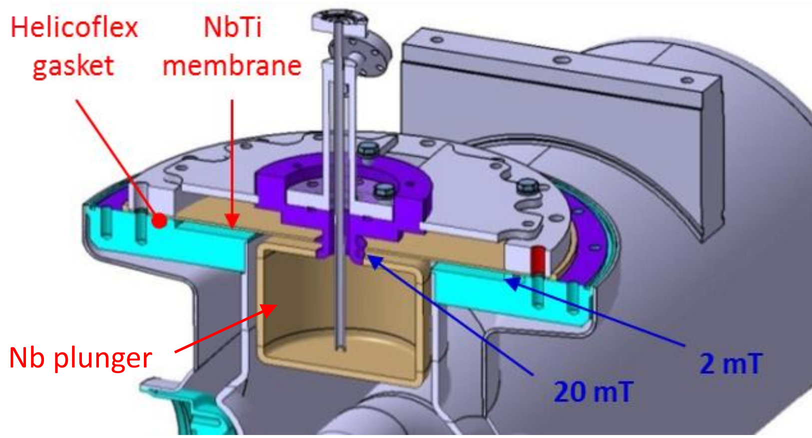
Parameter	Value	Unit
Frequency	175.366	MHz
Maximum r/Q	150	Ohm
Optimum beta	0.11	
Design beta	0.094	
r/Q @ design beta	140	Ohm
Epk/Eacc	4.8	
Bpk/Eacc	11	mT/(MV/m)



A0 coaxial plunger (part of the original design) design rationale is

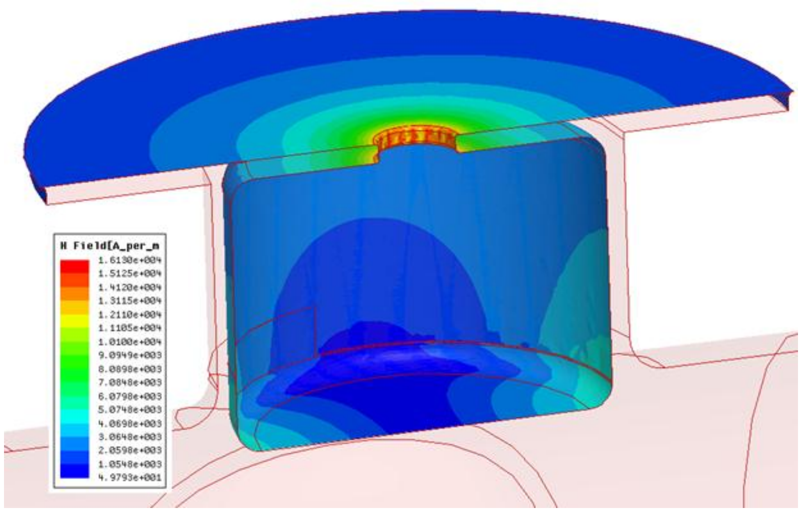
- Maximise stroke using a large diameter membrane and small central connection to the SC plunger
- Reduce multipactor probability of occurrence in the membrane region by adjusting the plunger diameter

A0 plunger design



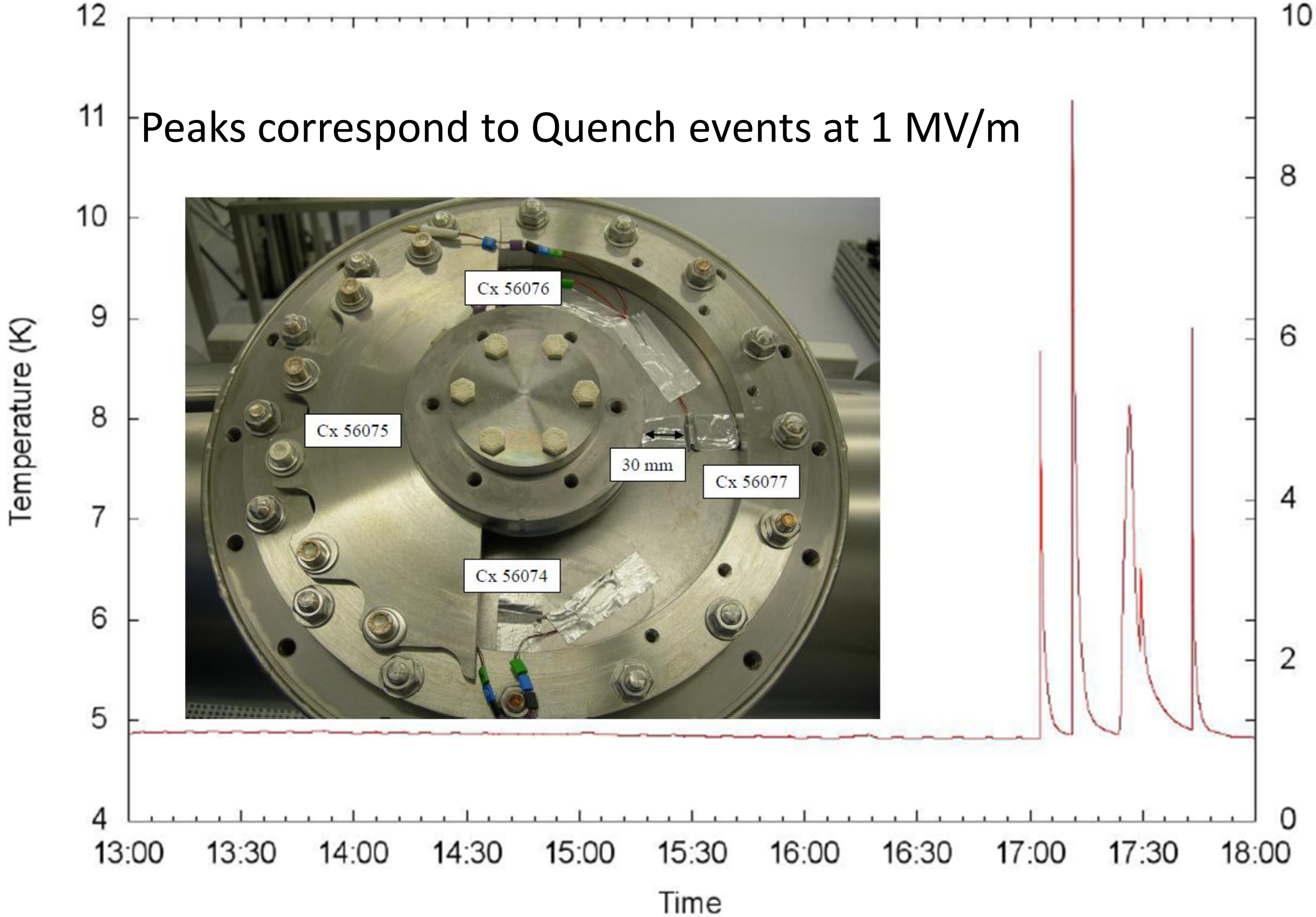
Drawbacks (other than those common to any plunger):

- large peak magnetic field at the « neck »
- Difficult to manufacture : neck region contains two NbTi/Nb welds in a recessed area
- The plunger has to be directly cooled by liquid He, therefore is a pressure vessel



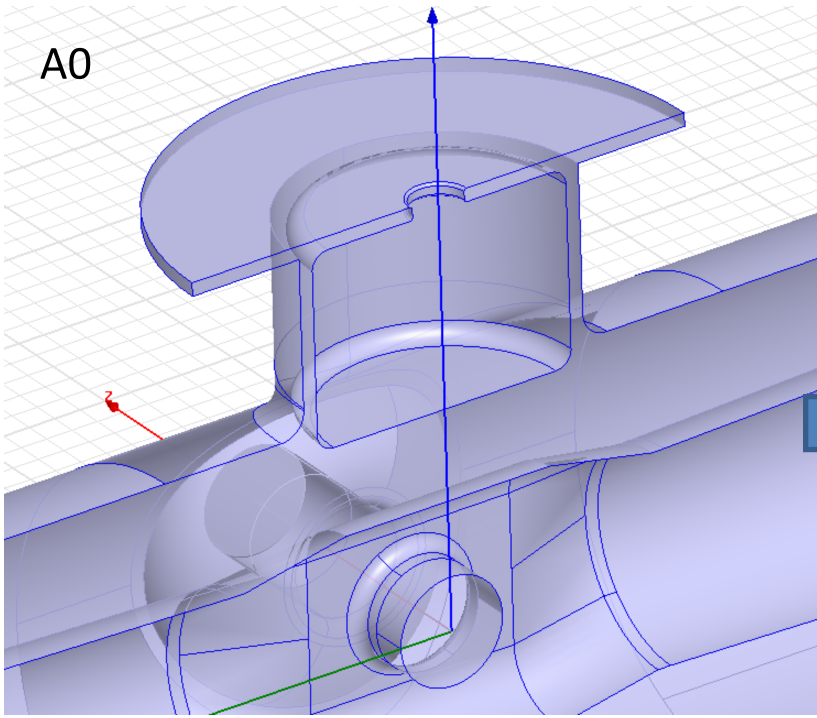
Early Test results

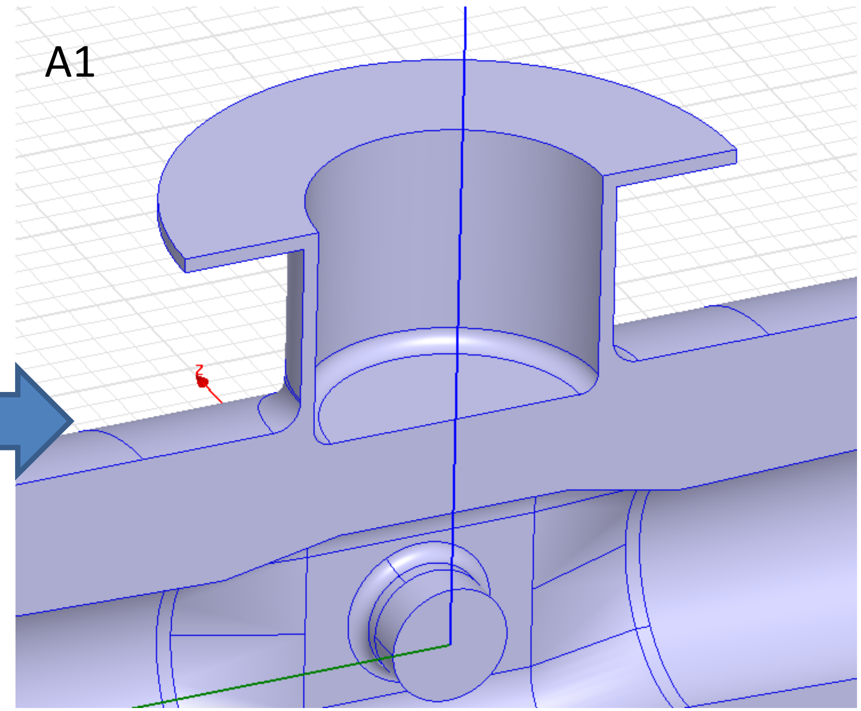
- The plunger geometry is effective to suppress low field MP plaguing previous tests done with a the port closed with a blank Nb flange
- The limitation at Eacc=1 MV/m and low Qo can be caused by several factors but Tc is exceeded in the membrane during quench : the plunger is involved



Further testing

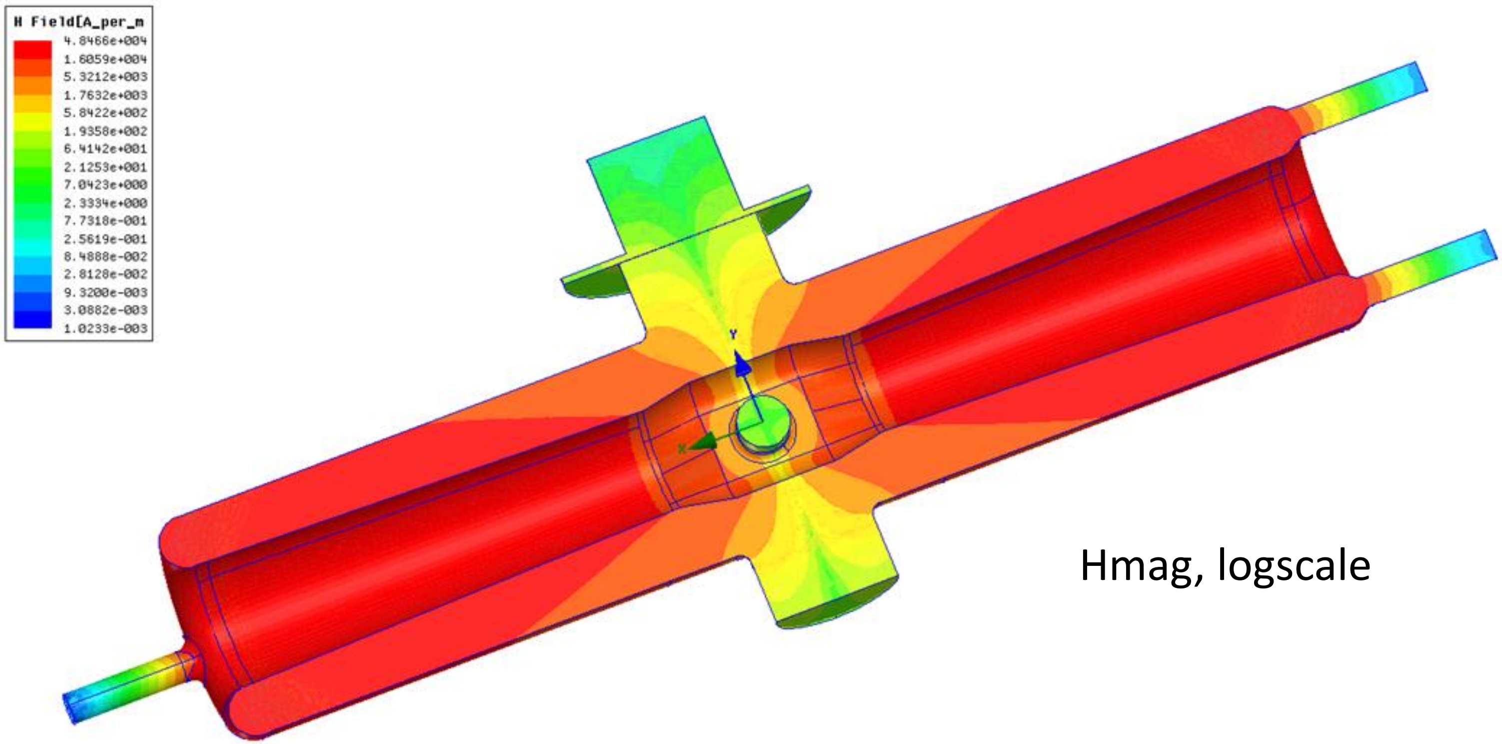
- The NbTi plunger was replaced by a simple Nb plunger
- The Helicoflex gasket was replaced by indium and Quench field was pushed to 2.5 MV/m.





Changing the plunger material from NbTi to Nb prevented heat build-up or low field quench but did not improve Qo. A test at 2.3K (indium seal in SC state) improves the low field Qo but does not improve the Quench field.

Why invert the plunger?

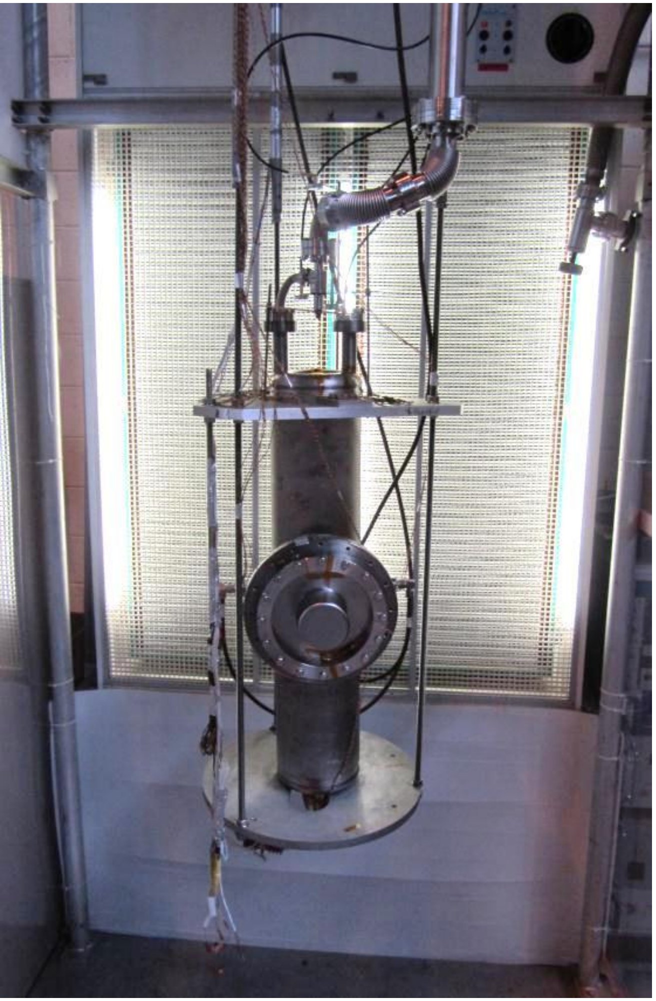


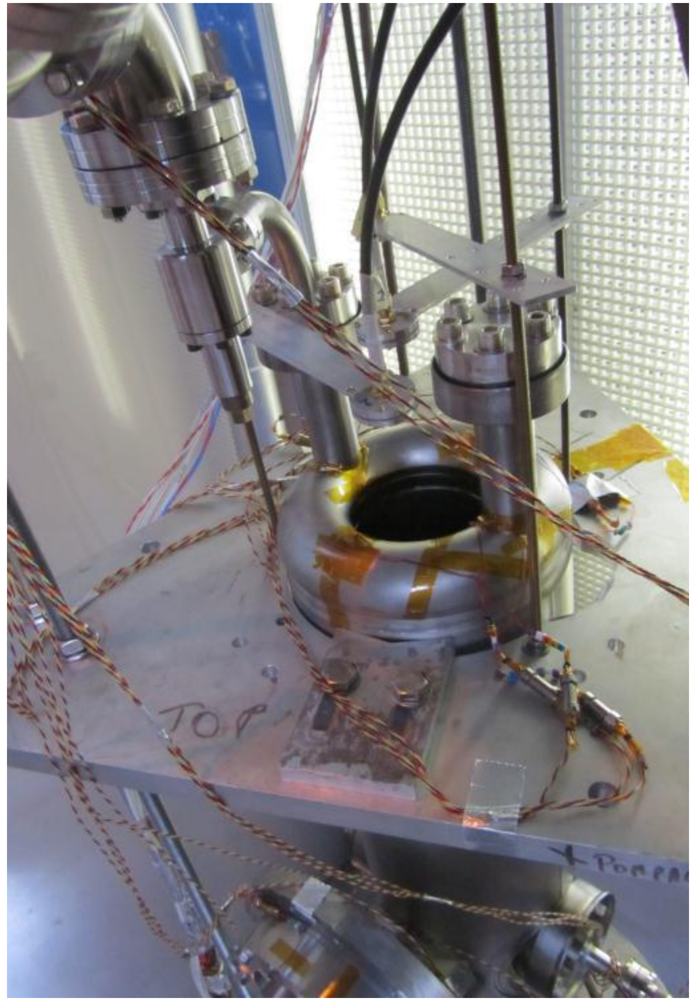
Hmag, logscale

determine if the cavity limitation come from the main cavity body or the tuner flange

- H is reduced by a factor of 25 on the NbTi tuner flange with respect to the current situation.
- Very similar to the first tests with the Nb plate closing the tuner flange plagued with MP and leaks, but with a different geometry. More similar to the test setup on the coupler port
- No new parts to manufacture, only 1 groove machining is necessary

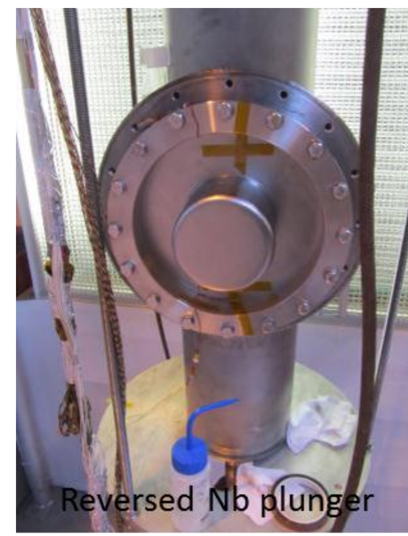
Test of P01 with inverted plunger



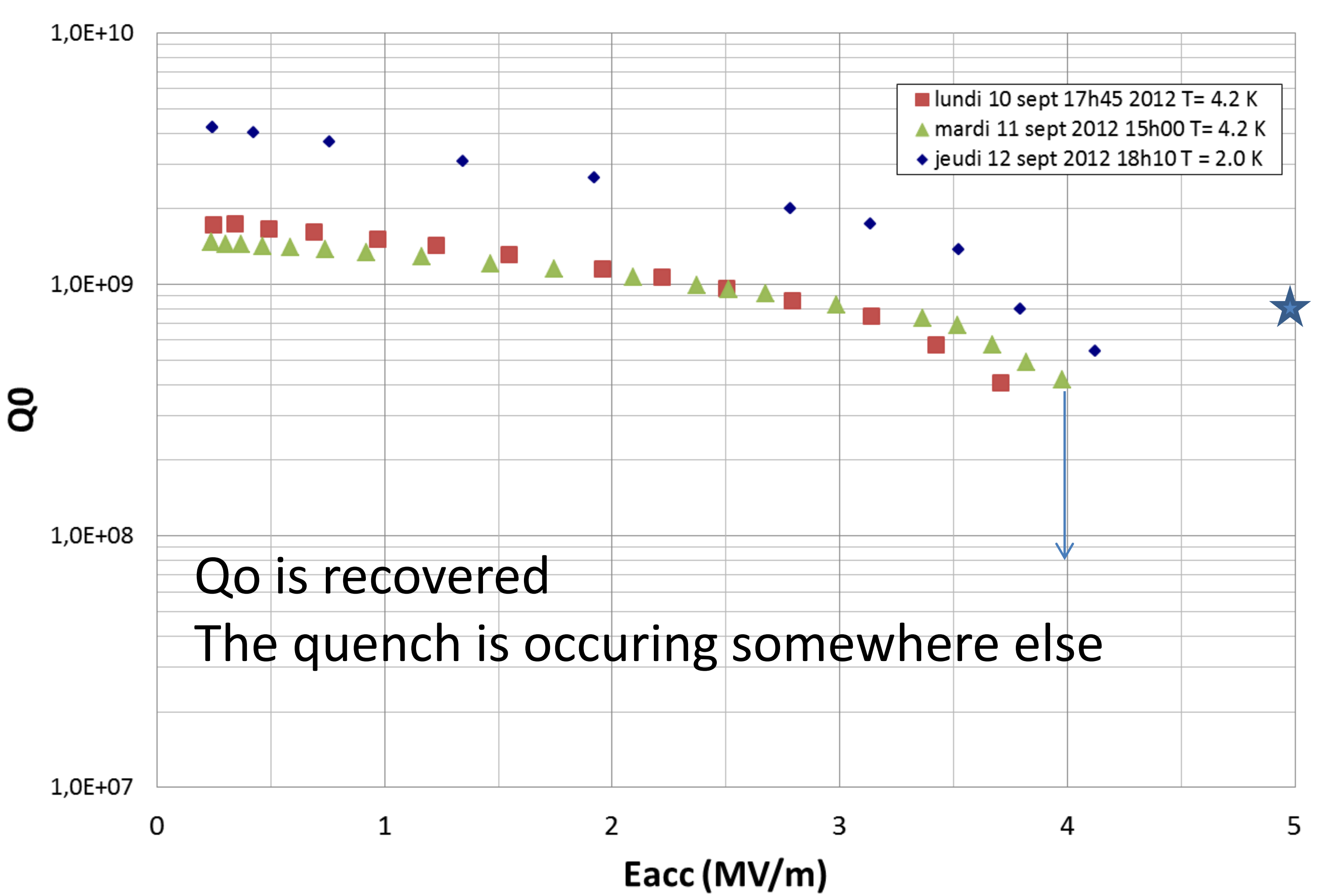


18 CERNOX T-sensors on critical areas:

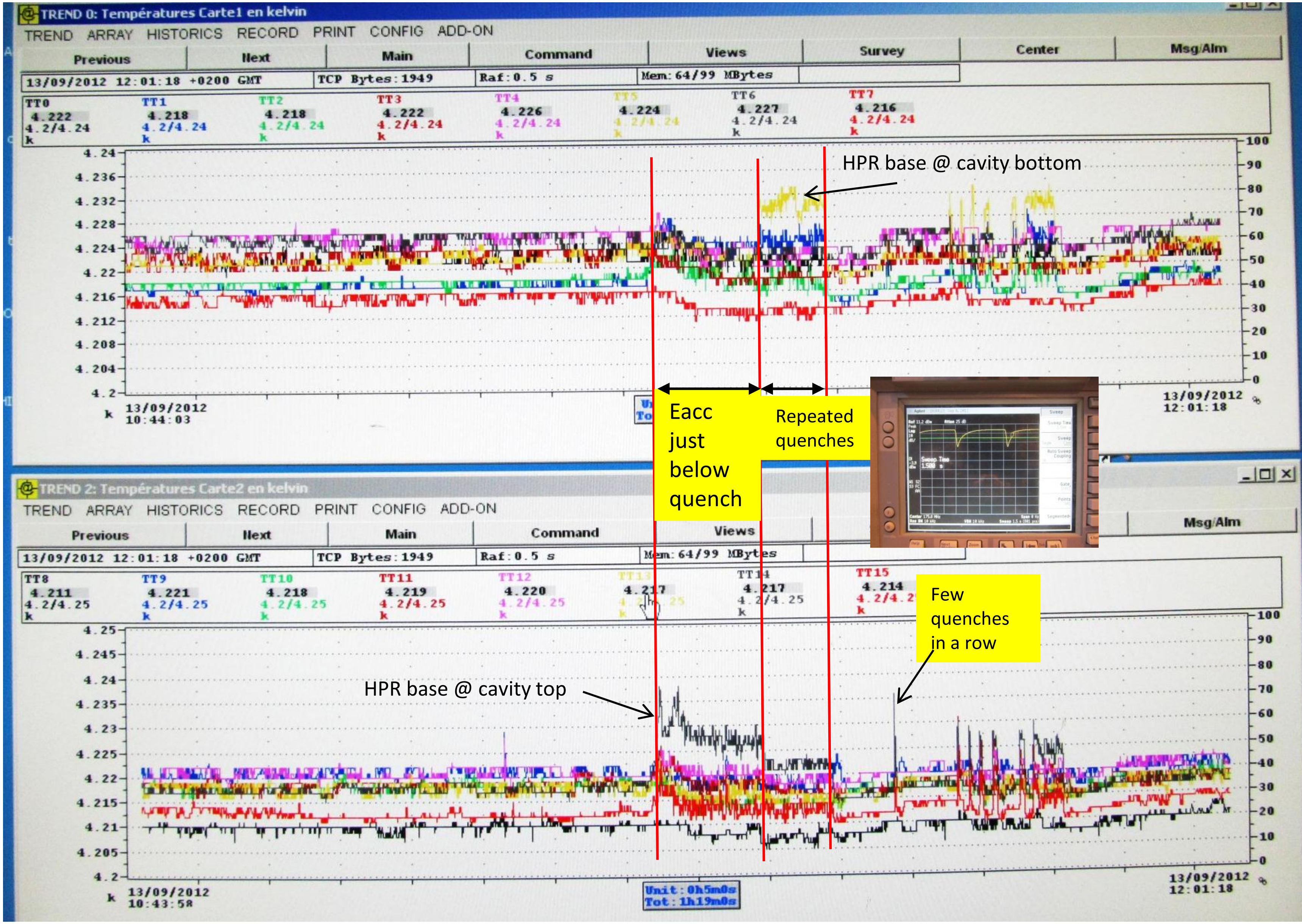
- HPR ports base
- Torus
- Inner conductor welds
- Plunger and coupler ports next to NbTi flange connection



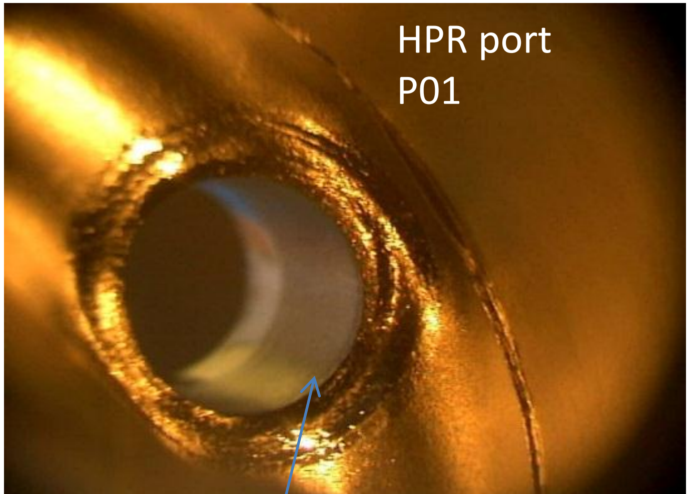
Test of P01 with inverted plunger



Quench at the HPR base

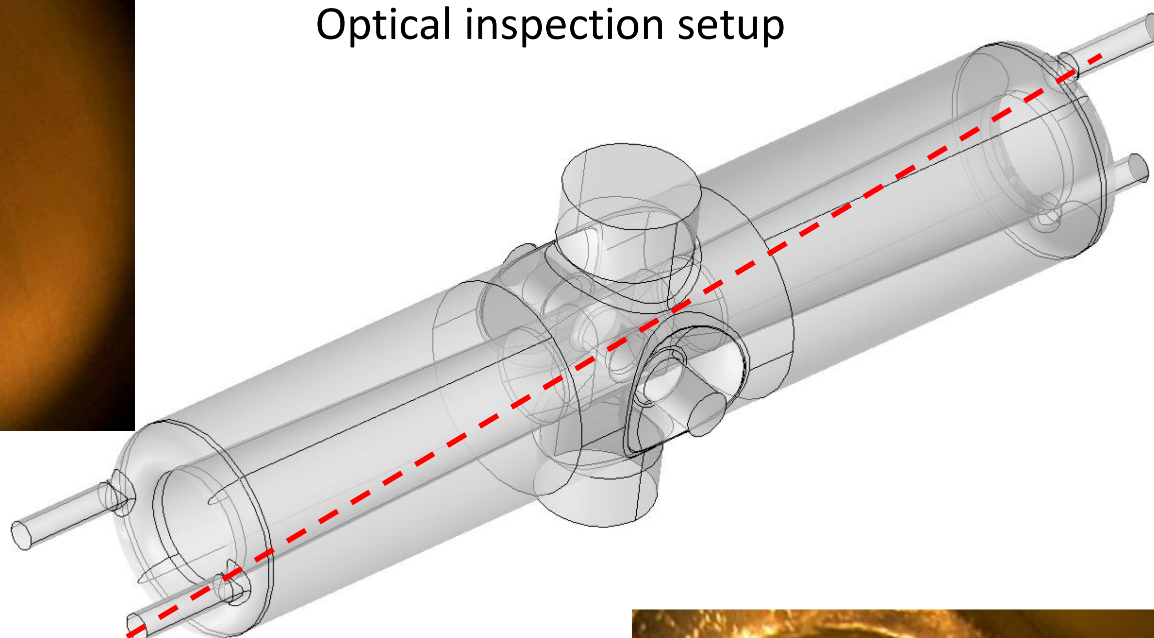


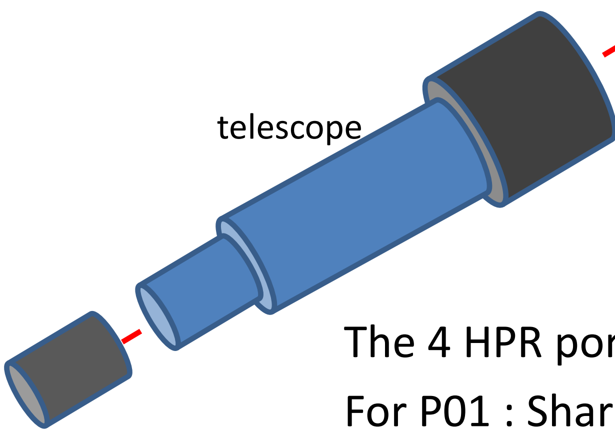
Geometry of HPR to torus weld area



Sharp inner edge

Optical inspection setup

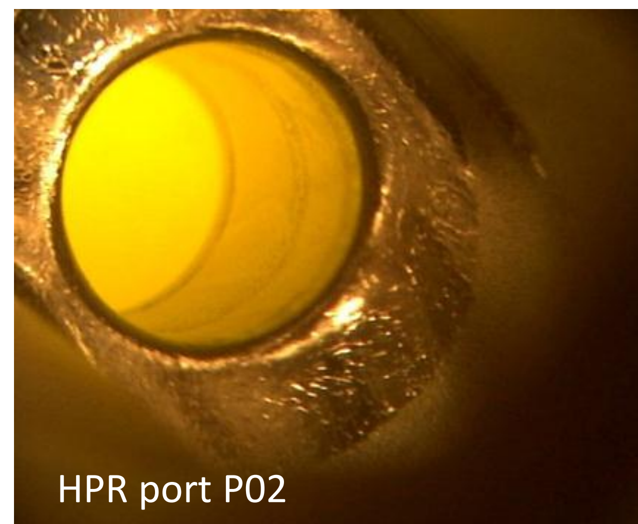




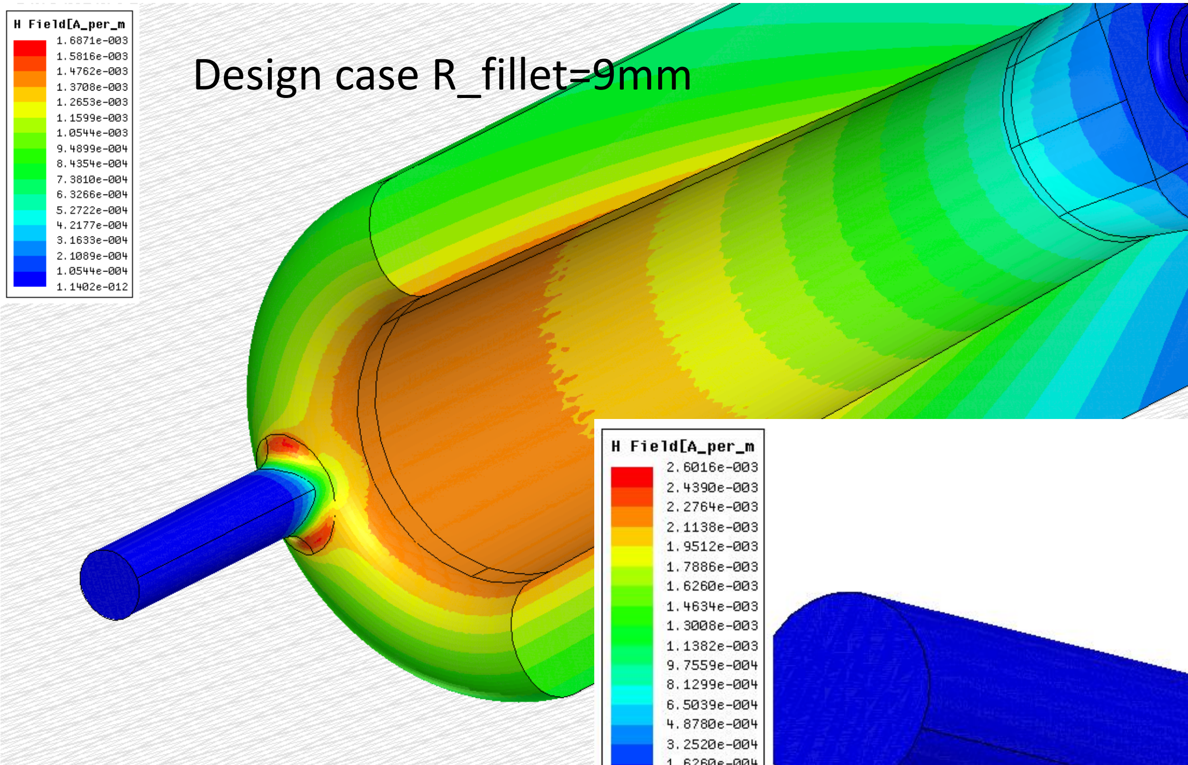
The 4 HPR ports are similar in apearance:

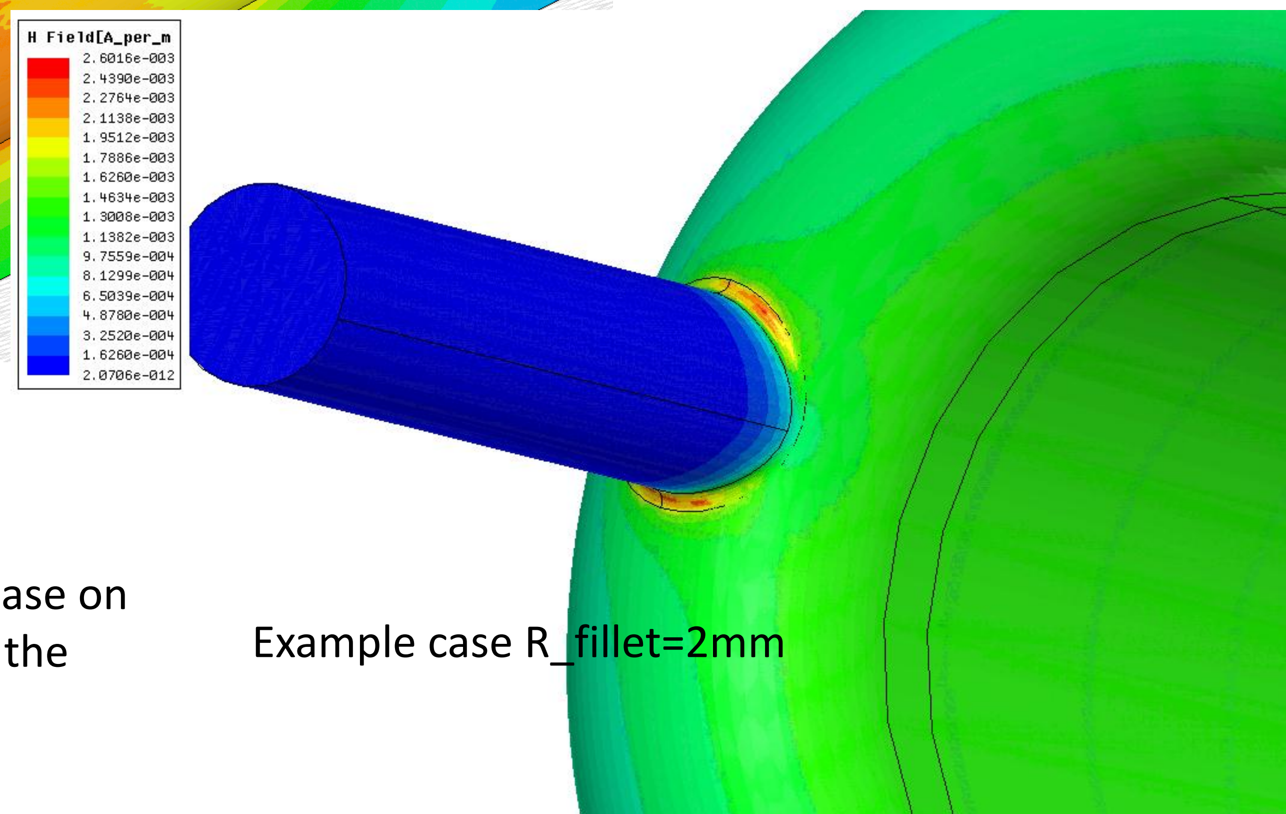
For P01 : Sharp edges + steps at the weld

For P02: fillet of ~2mm



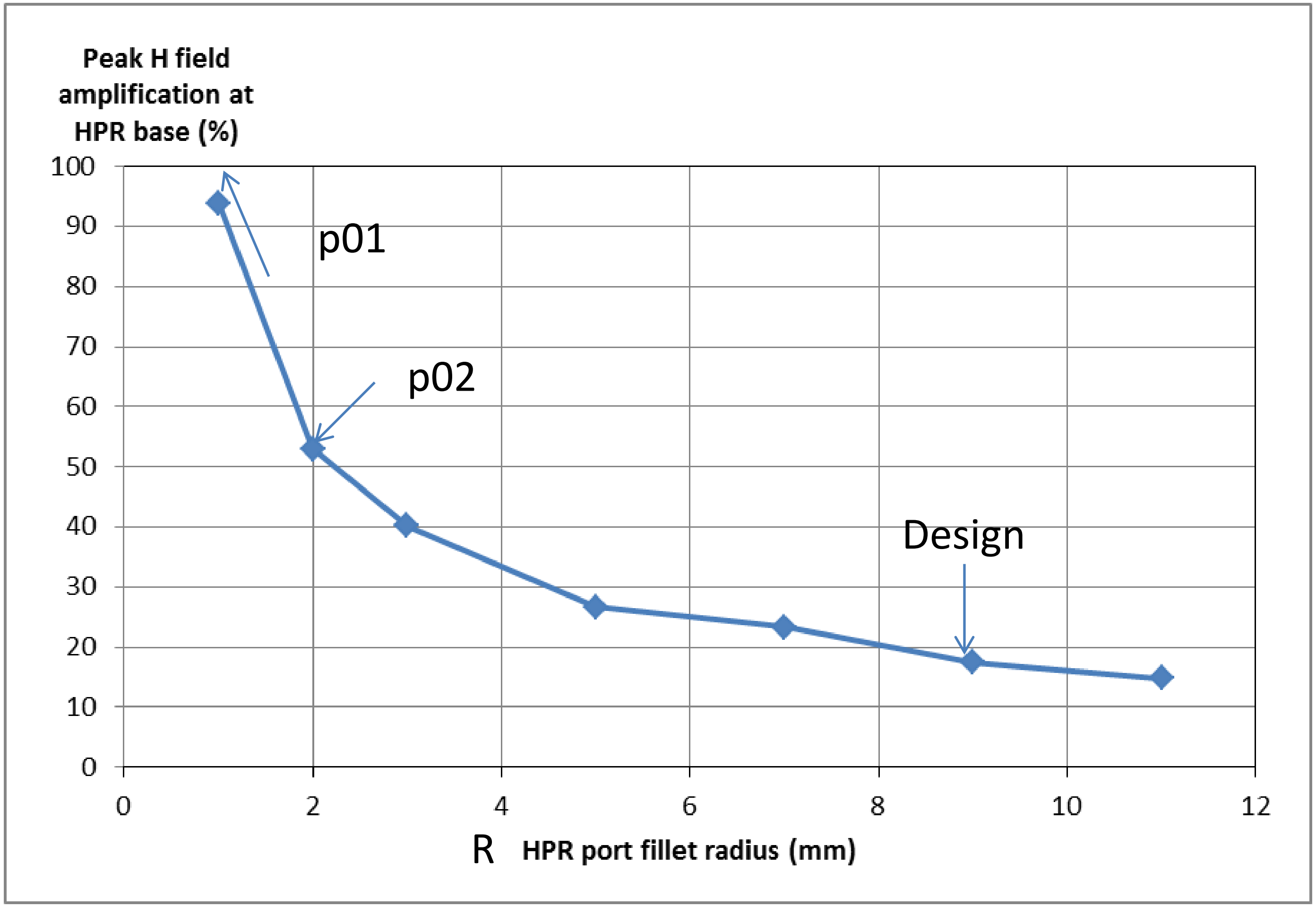
H-field distribution





H enhancement at the HPR base on prototypes is higher than for the design case.

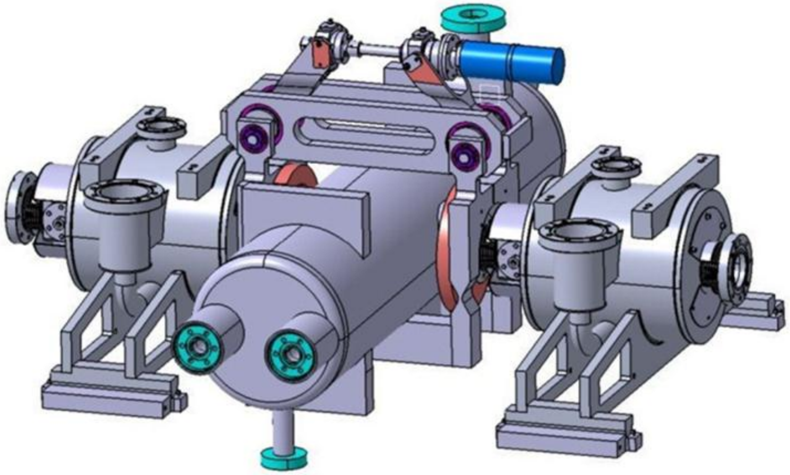
Sharp edges effect



An additional COMSOL simulation show that the amplification of H reaches 450% with R=0.1mm !

Conclusion

- The NbTi flange issue was masking the sharp edge issue for P01
- Current test of P02 will bring more data on the HWR design and associated manufacturing constraints (HPR ports)



- For future IFMIF HWRs a compression tuner will be used with a dis-engagement system
- Compression tuning has induced a re-desing of the cavity (Nb thickness, He tank, new interface between the cavity and tuner, more constraints from the pressure vessel code requirements adding up to the difficulty of having an assymetrical deformation dur to the large power coupler port)
- The plunger tuner is still a possible solution for any HWR if an all-Nb configuration is used at the tuner port, but has yet to be demontrated in a test