Crab Cavity Tests

R. Calaga, HiLumi Meeting, Nov 13, 2013

Summary:

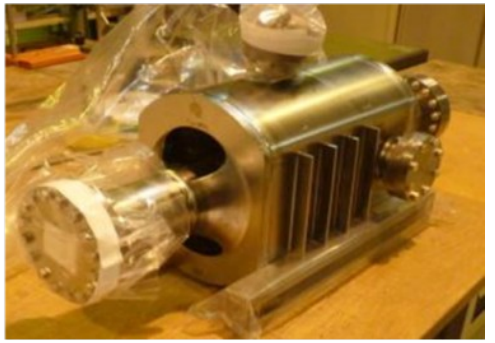
All 3 prototype cavities built by Niowave Inc. in bulk Niobium

Surface treatment and first tests completed

1 very good result, 2 moderate results and retreating to recover performance

BNL-DQW

ODU RF Dipole



UK-4Rod

4-Rod Cavity Treatment

Two tests (Nov 2012 & Sep 2013)

Procedure	**Specs**	**Comment**
1^{st} BCP	150 μm	Vertical/Rotated
H_2 Degassing	T~650^0 C	>24 hrs, P=3.5×10^{-7} mbar
RF Measure	Qext ~ 1×10^8, 1×10^{11}	Fr=399.5 MHz, Q0=5000
HP Rinsing	TOC=30ppb ρ ~16MΩcm	Limited wand height
RF Testing	1.3 MV → 3 MV	Vacuum leak, P=10^{-5} mbar

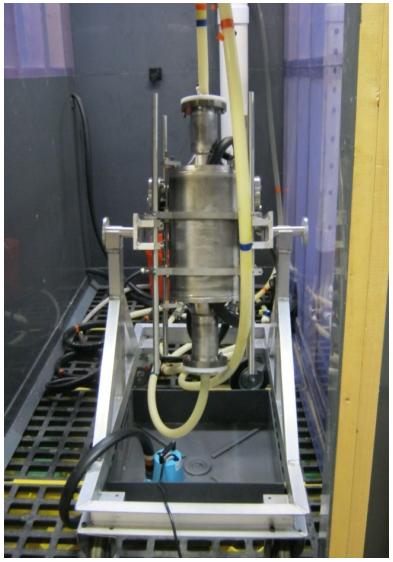
[†]Light BCP of ~20mm performed post 1^{st} testing

4Rod Cavity Treatment-Testing

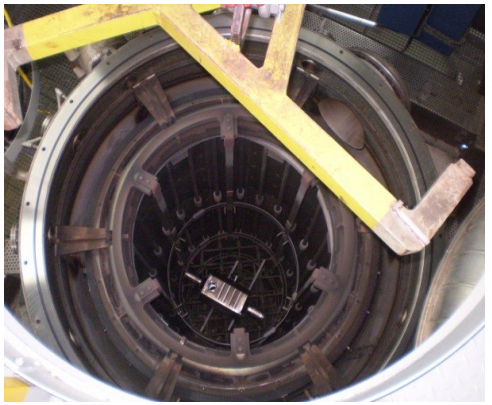
(Ack: BE-RF, TE-VSC, EN-MME)

Surface Treatment

Niowave



H_2 Degassing, CERN



600^0C, 48 hrs

High Press Rinsing

CERN

RF Measurements

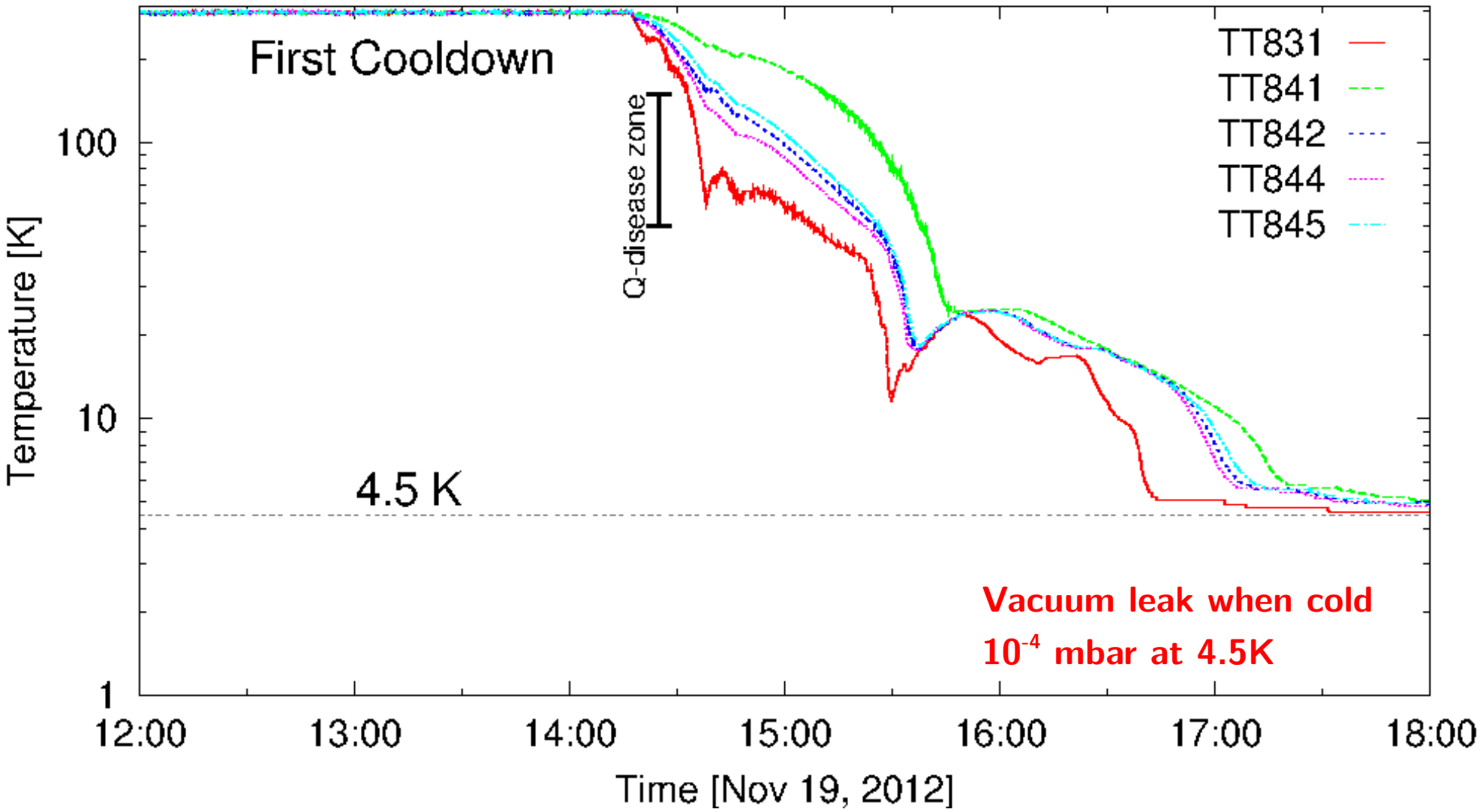
CERN

1st test performed Nov 2012

2nd test in Aug-Sep 2013

1st Cool-down

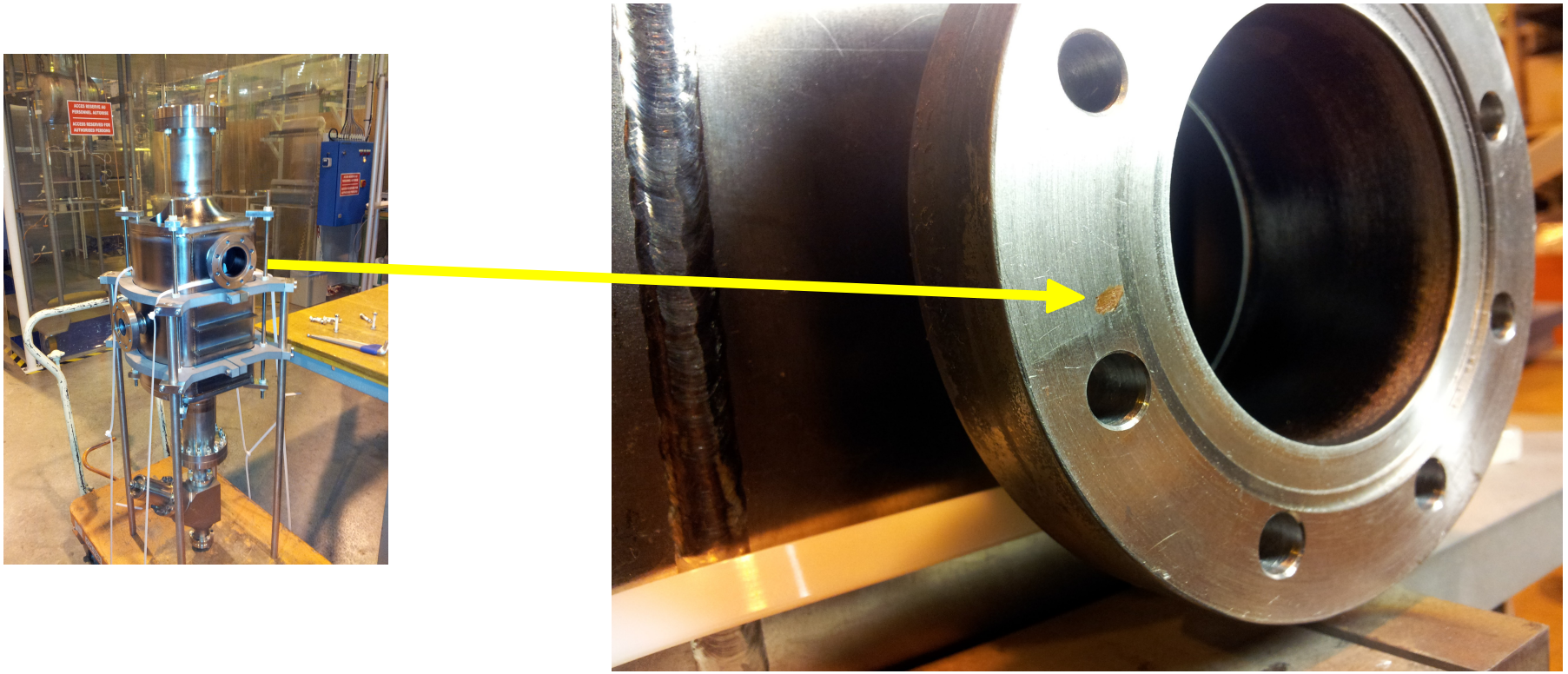
Q-disease zone (150-50K) → Approx ½ hr



Note: TTxxx are different temp gauges

Leak Check & Repair

Leak test with LN2 & Helium gas



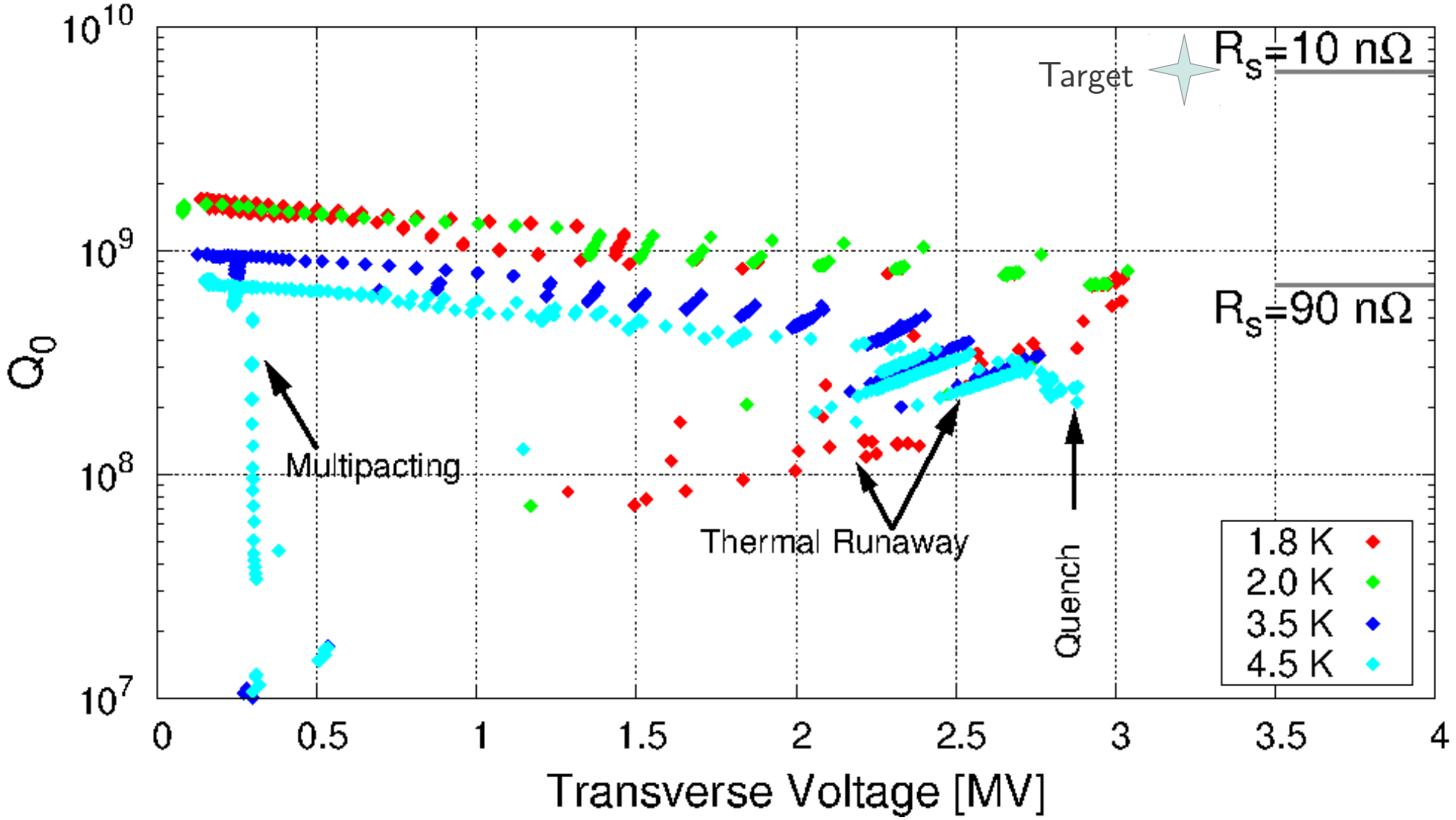
All NbTi flanges with irregular knife edges repaired

Final light chemistry of 20mm + HP rinsing

2nd RF tests in Sep 2013 → Vacuum leak persists but better ~10^{-7} mbar

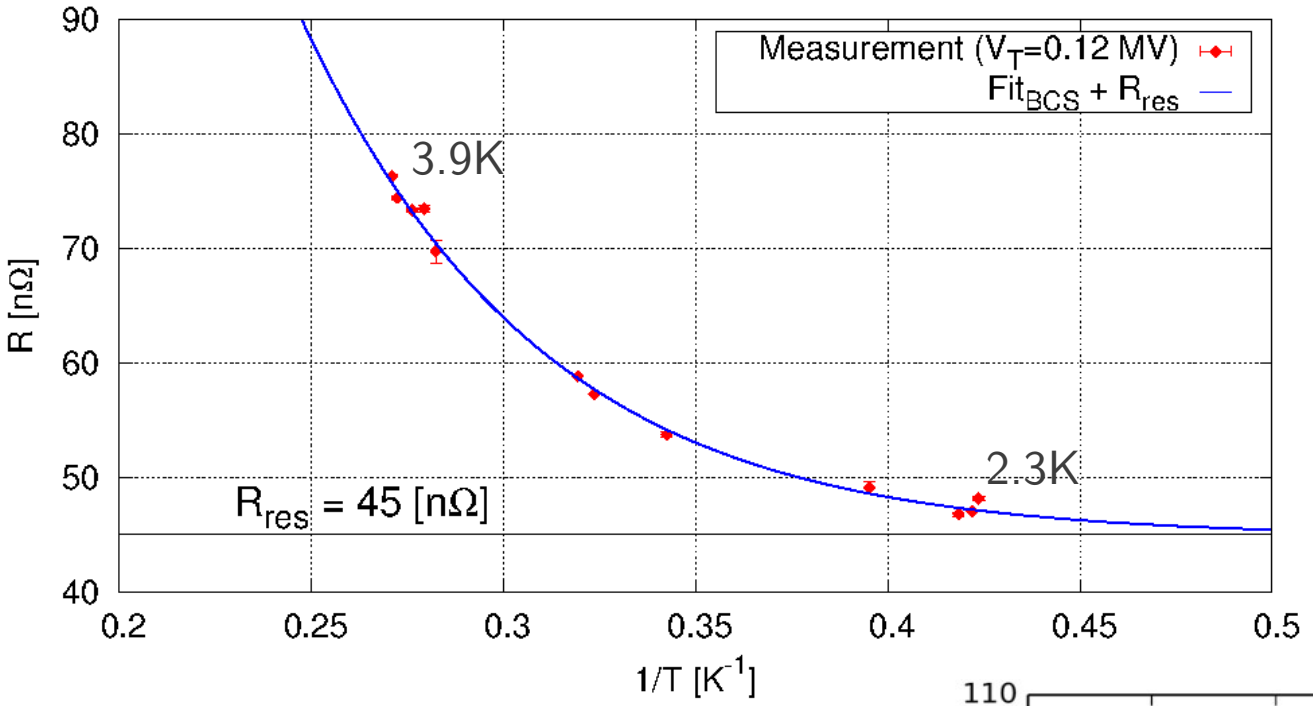
4Rod Cavity Qvs.$V_{\perp}$

Ack: BE-RF-SRF/PM



4Rod: R vs.T Curve

Ack: BE-RF-SRF/PM

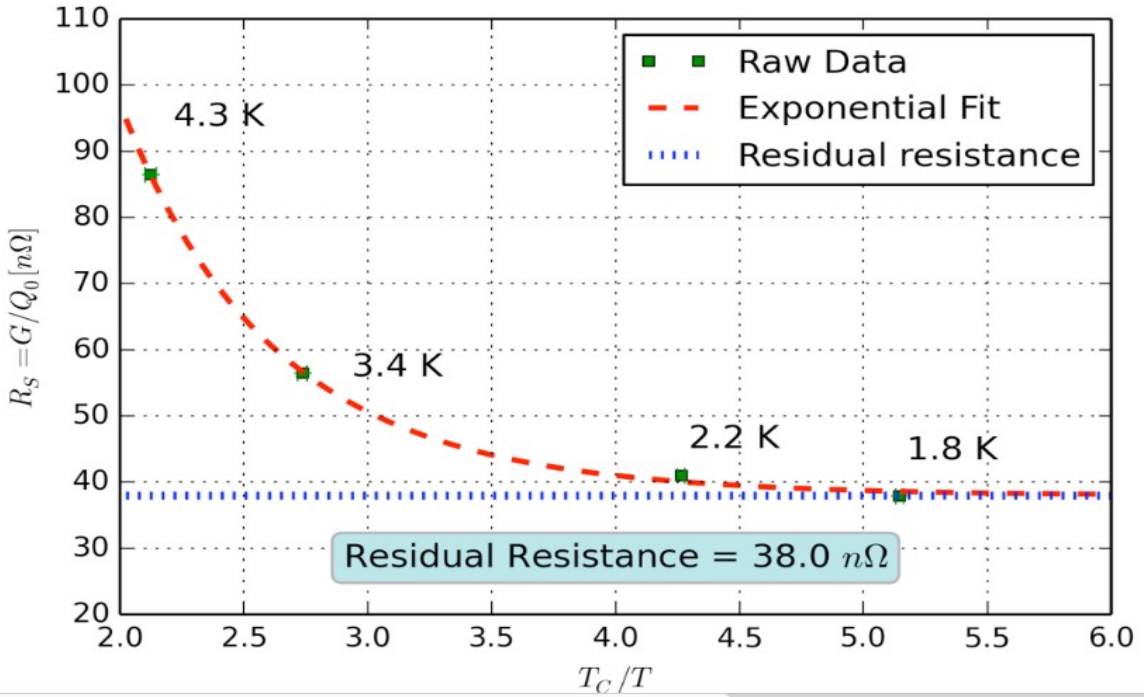


Calibration at 4.5K

Calibration at 2K

(Courtesy A. Macpherson

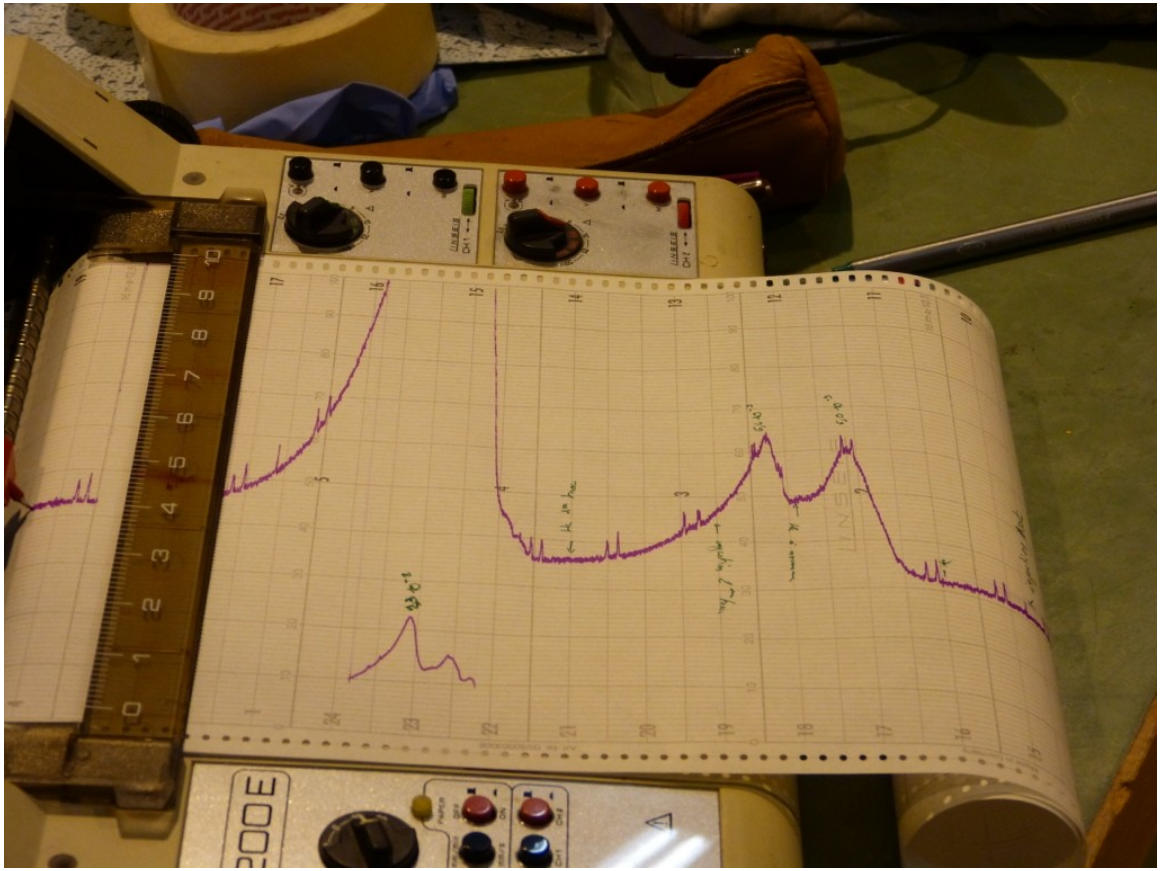
Target is 10 nΩ



Leak Tests of Rods

Apart from the NbTi flanges,

the rods themselves are porous!

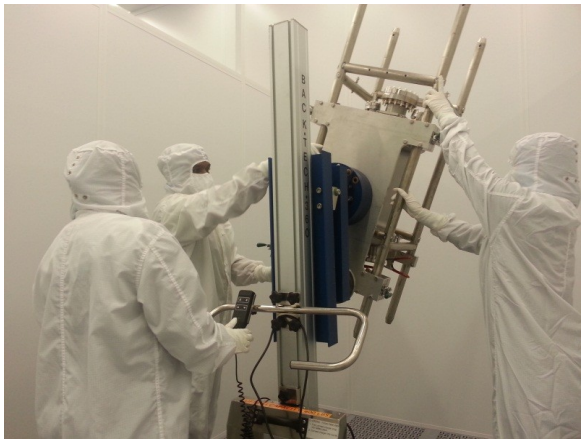


ODU RF-Dipole

Courtesy: ODU-Jlab

BCP, JLab

High Press Rinsing, JLab



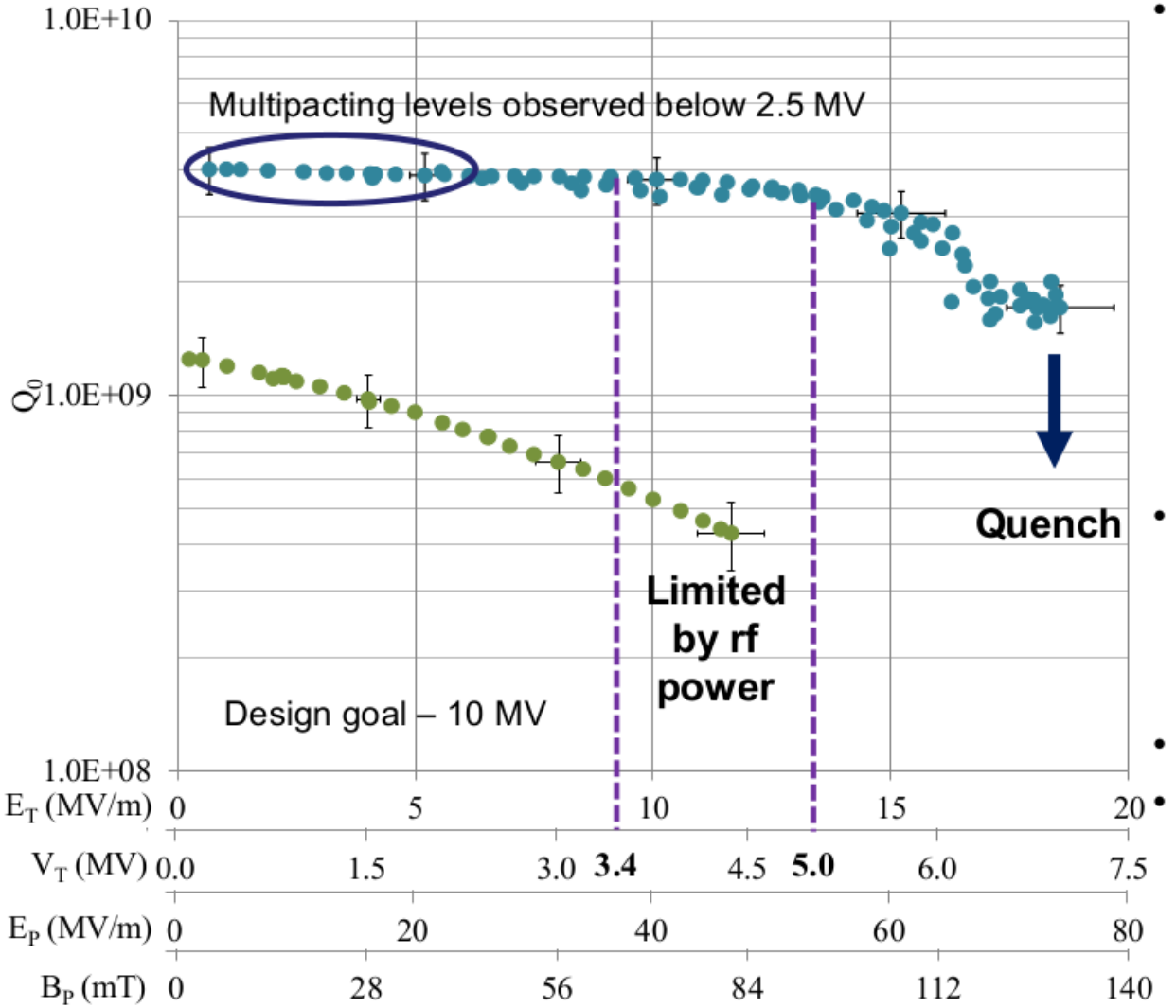
RF Measurements, JLab

Treatment & testing at JLab

- Bulk BCP ~85 μm
- Baking @ 600 ^{0} C for 10 hours
- Light BCP ~10 μm
- High Pressure Rinse ~3 passes
- Testing at 4K and 2K

ODU RF-Dipole

Courtesy: ODU-Jlab



Achieved fields:

V_T = 7.0 MV !!

E_p=75MV/m, B_p=131mT

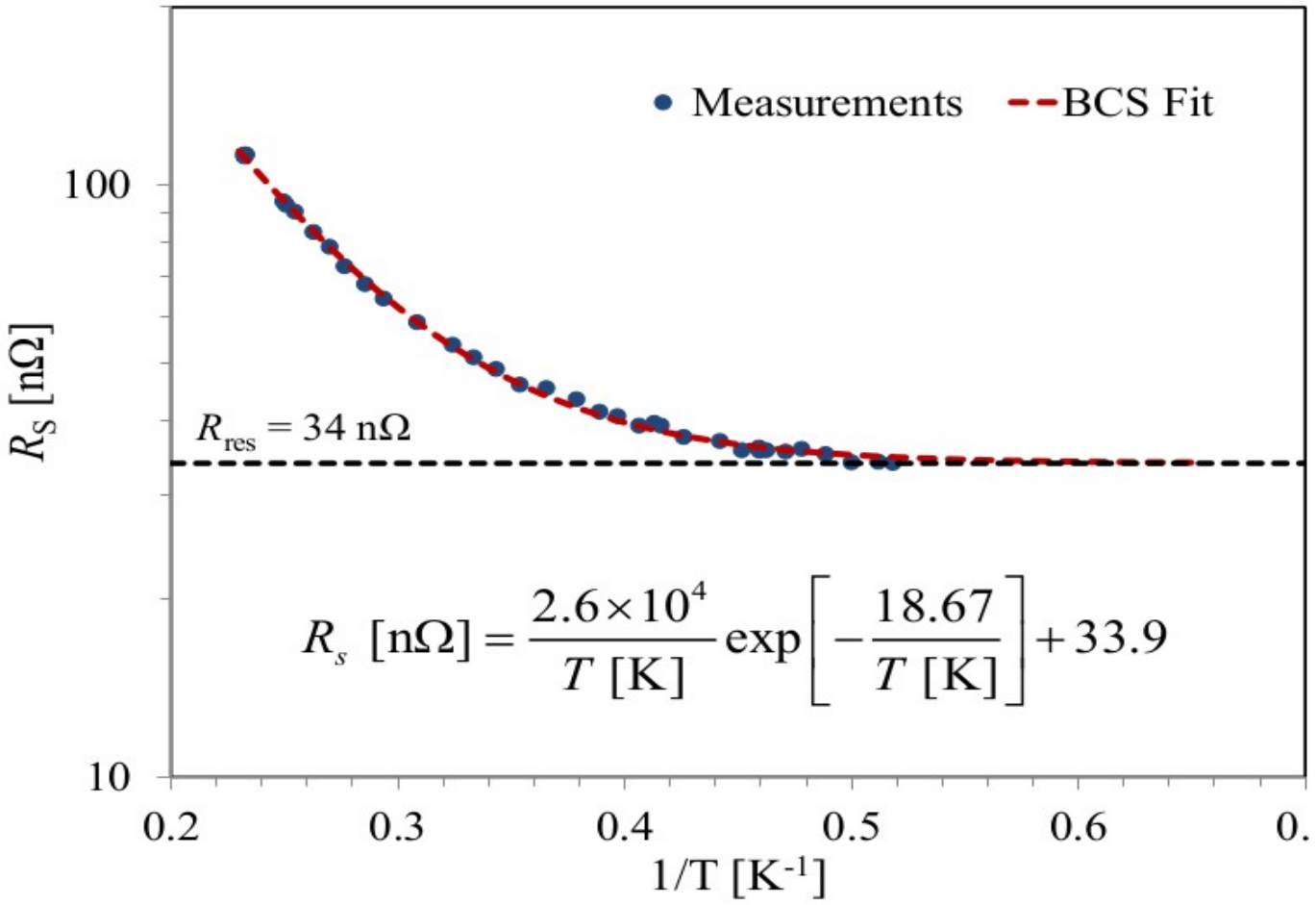
Achieved Q_0 = 4.0x10^9 (35nΩ)

Low field multipacting easily processed did not reoccur

The slight higher residual resistance either due to acid contamination or stainless steel flanges

RF Dipole: R vs.T Curve

Ack: ODU-JLab



Target is 10 nΩ

Calculated Q_0 from SS flanges $3.7\times10^9 \rightarrow$ 37 nΩ

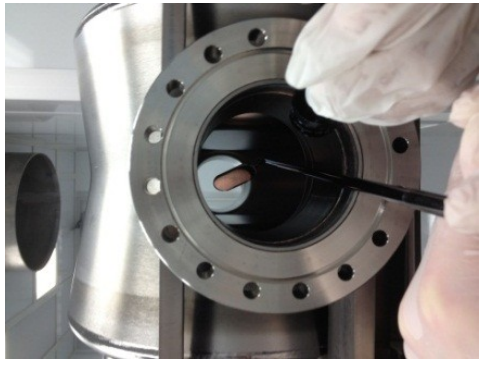
(R_{BCS} @2K = 2 nΩ)

Future tests pending funding, perhaps use Nb coated SS flanges

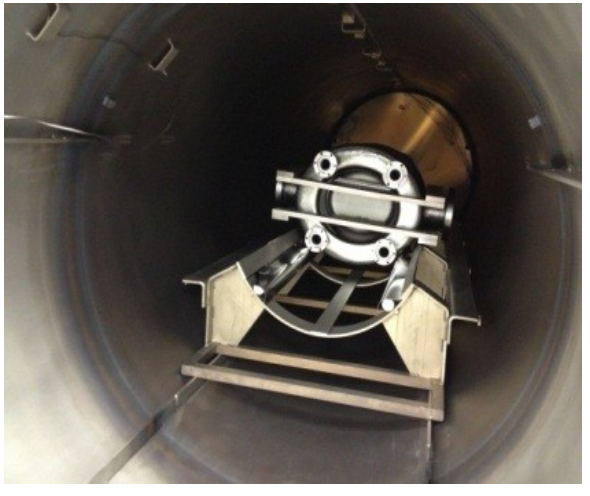
BNL, Double Quarter Wave

Courtesy: BNL

150 µm BCP @Niowave



Baking @600 ^{0} C, 10 hrs, BNL



1st test with poor results due to improper HPR

2nd Treatment at Argonne

- Light BCP 40 μm
- 2 rounds of HPR due to contamination
- Next test on Nov 19, 2013

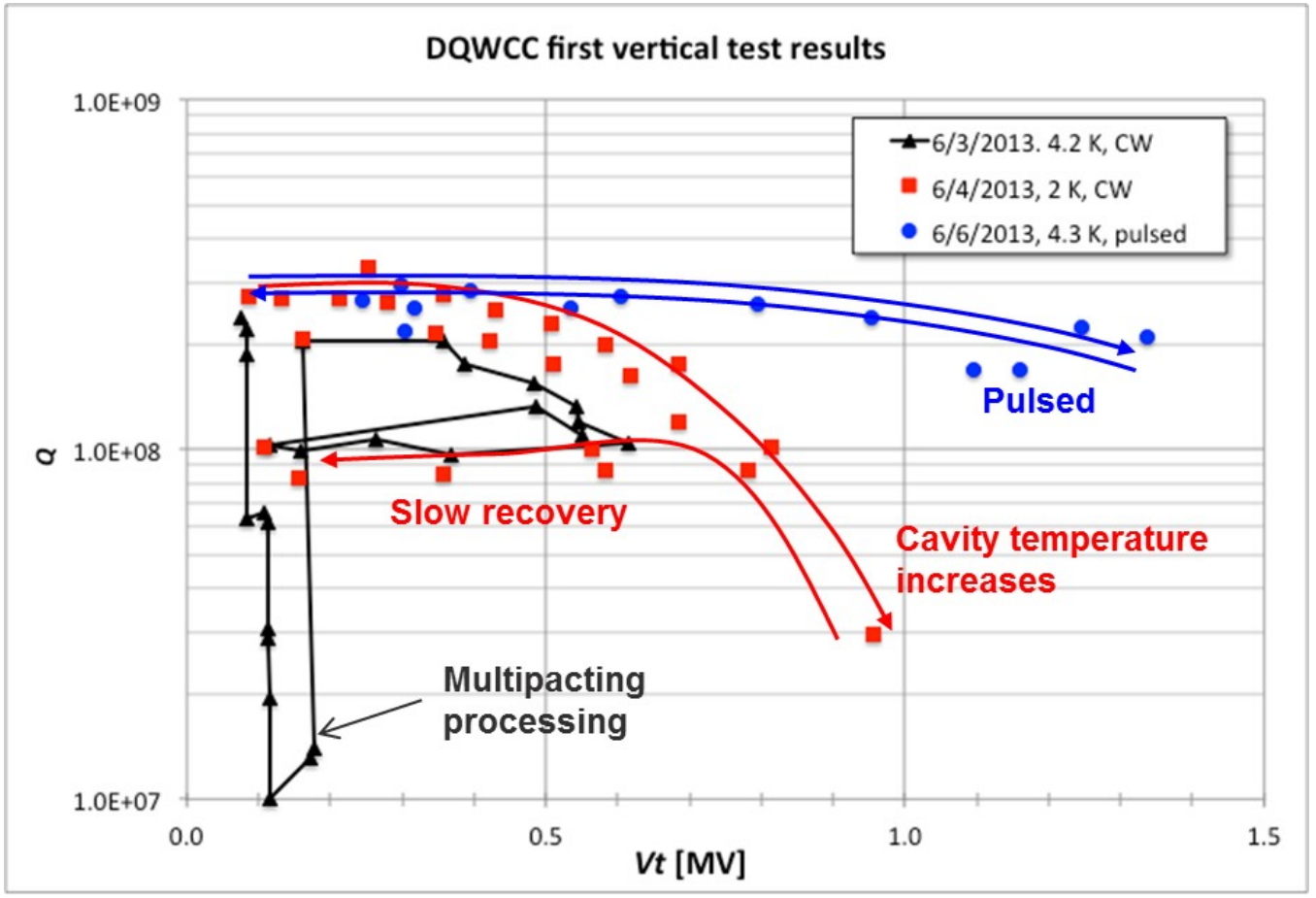
DQW 1st Test

Courtesy: BNL,

Q is low, ~3×10^8 (independent on the temp, expected 8.5x10^9)

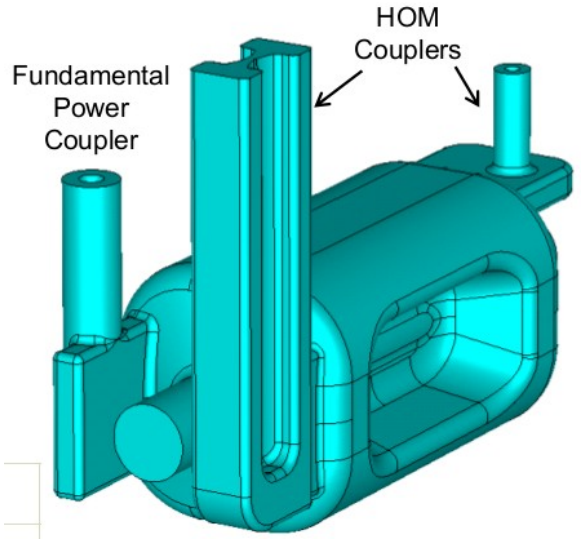
No Q-disease or not due to SS flanges

CW mode 0.96 MV (thermal load), pulsed mode reached 1.34 MV (200 W amplifier)

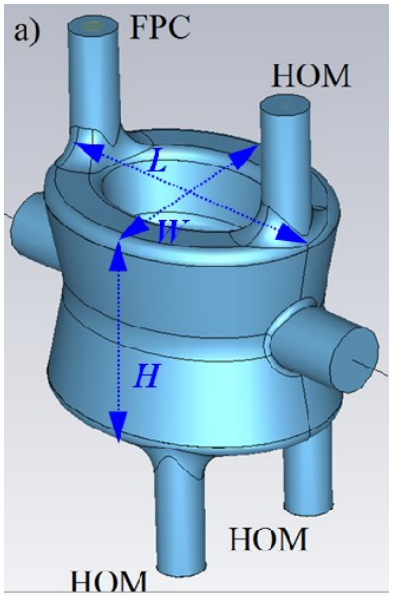


Low field multipacting (~0.1 MV) easily conditioned

Latest Cavity Designs

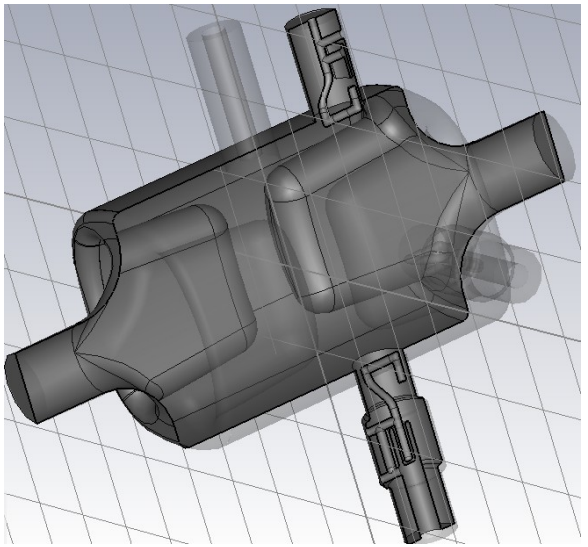


Waveguide or
waveguide-coax couplers



Coaxial couplers with
hook-type antenna

Coaxial couplers with
different antenna types



Towards a beam line
ready cavity design

Two Comments

On paper, the RF performance should be equivalent

But practice showed that SRF is highly dependent on treatment

The SPS "dressed" cavities are (maybe) more complex than initial prototypes, we expect more than one cavity to reach target performance by early 2015.