Progresses on China ADS Superconducting Cavities

Peng Sha

IHEP, CAS

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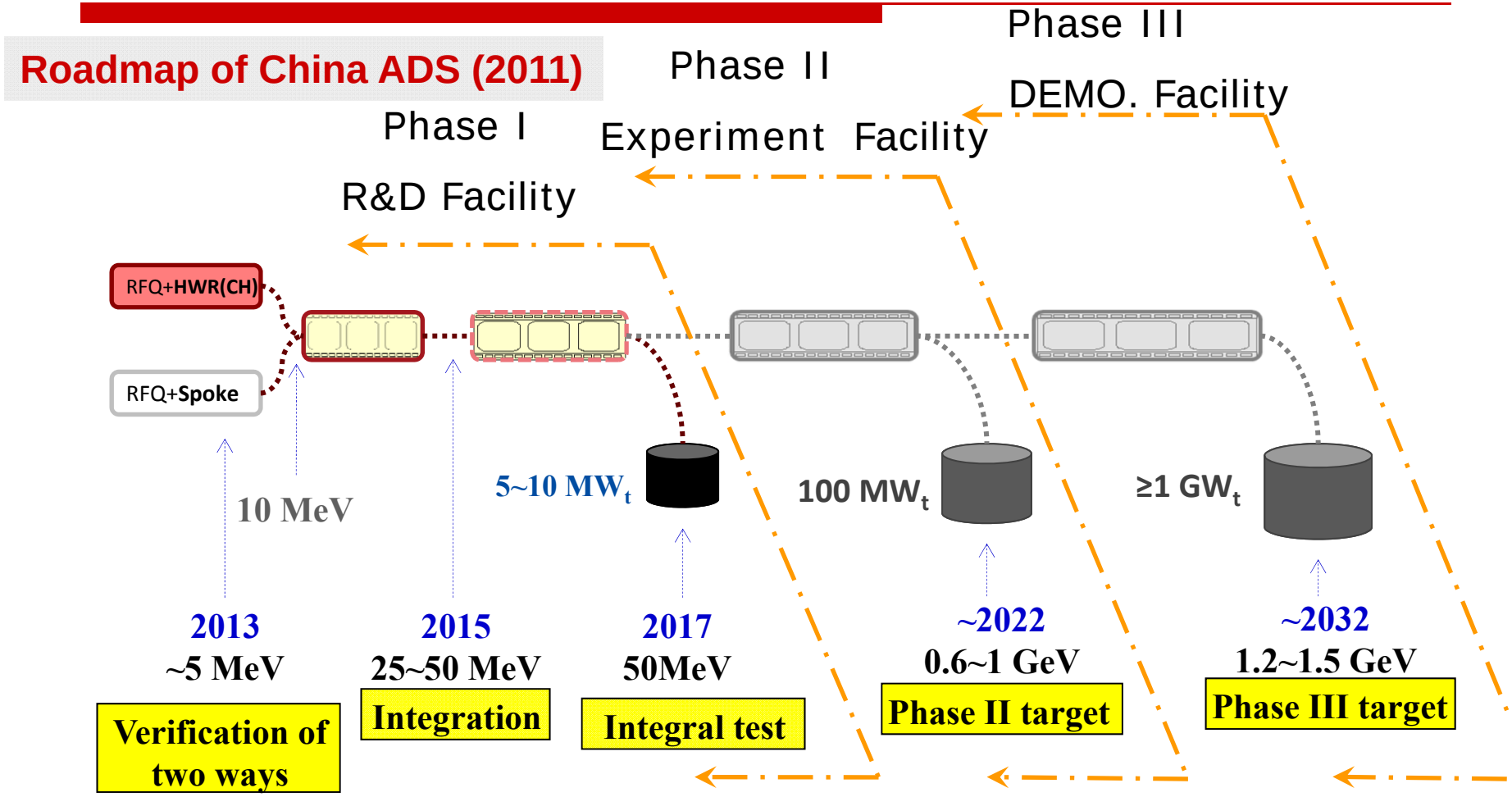
Outline

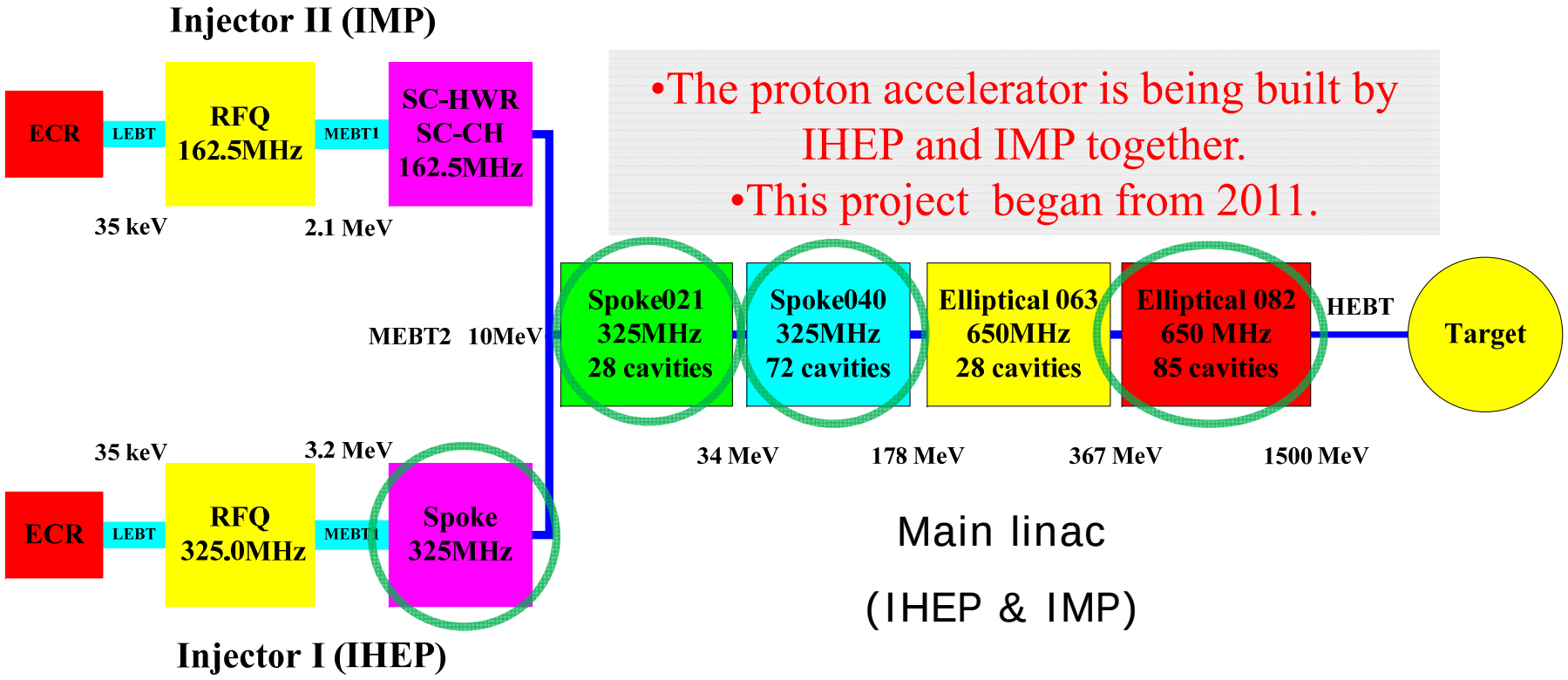
1. Introduction
2. Spoke012 cavity
3. Spoke021 cavity
4. Spoke040 cavity
5. 650MHz β=0.82 5-cell cavity
6. High power input couplers
7. Summary

1. Introduction

Roadmap of China ADS (2011)



Layout of ADS Accelerator



- The proton accelerator is being built by IHEP and IMP together.
- This project began from 2011.

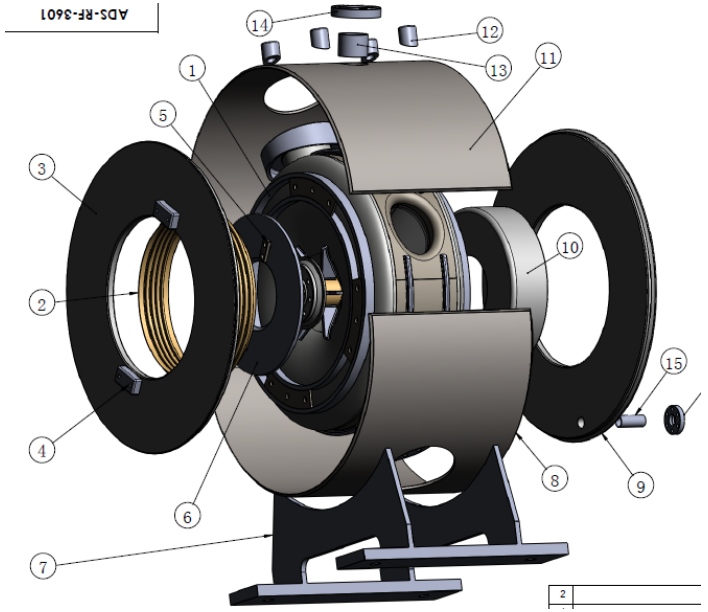
Parameters of ADS SC Cavities

Cavity type	Spoke012	Spoke021	Spoke040	Elliptical063	Elliptical082
Geometry β	0.12	0.21	0.40	0.63	0.82
Apertures (mm)	35	40	50	90	100
E_{peak}/E_{acc}	4.54	3.88	3.30	2.60	2.12
B_{peak}/E_{acc} (mT/(MV/m))	6.37	8.13	8.34	4.73	4.05
G(Ω)	61	87	104	193	236
R/Q(Ω)	142	206	244	304	515

2. Spoke012 Cavity

Parameter	Q_0(4.2K)	Q_0(2K)	E_{acc}	Loaded BW	df/dp (jacketed)
Value	5e8	3e9	7 MV/m	460 Hz	40 Hz/torr

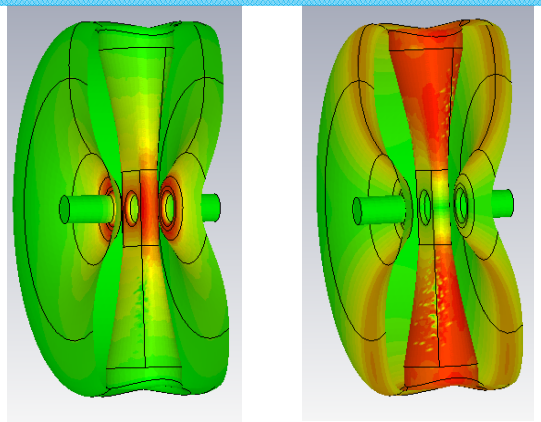
Two Prototypes

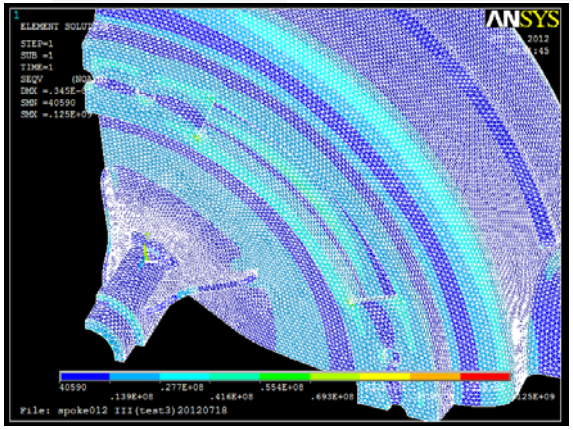


Cavity + Helium Vessel

Cavity Design

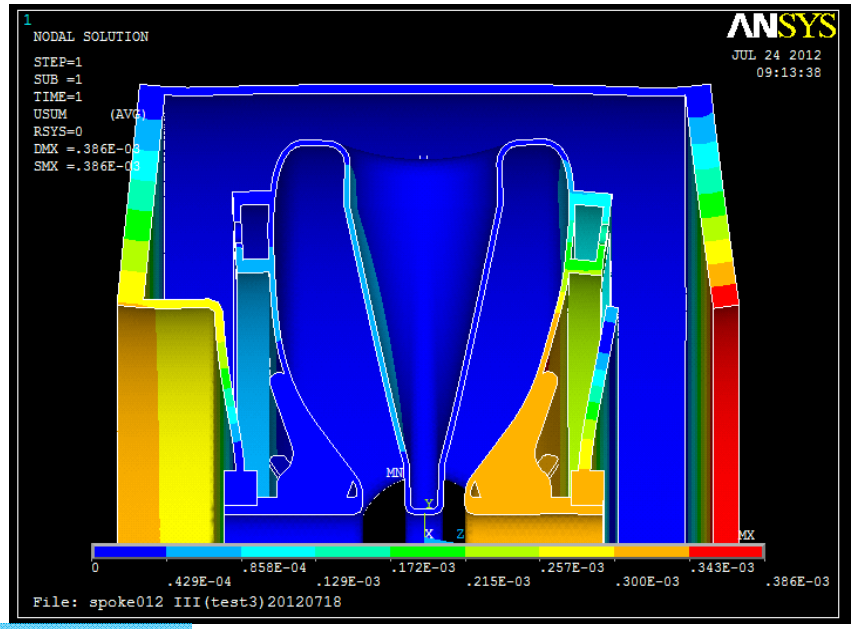
Electric and magnetic field





Stress under one atm & 300kg tuning force

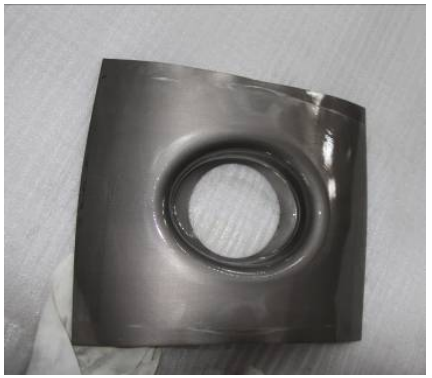
Deformation under one atm & 300kg tuning force



Fabrication (1)

Spoke (before EBW)

Coupler arc



Spoke arc

Endwall

Spoke

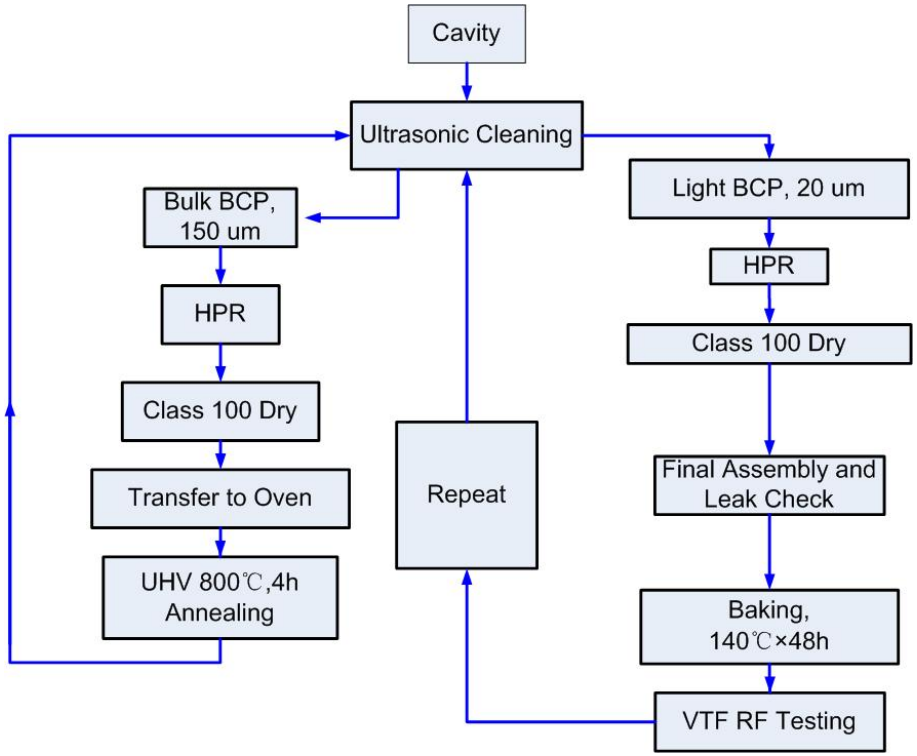
Fabrication (2)

Circle of cavity

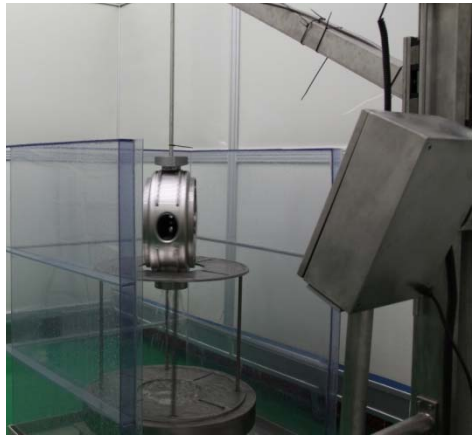
Cavity

Trimming

Post processing



BCP

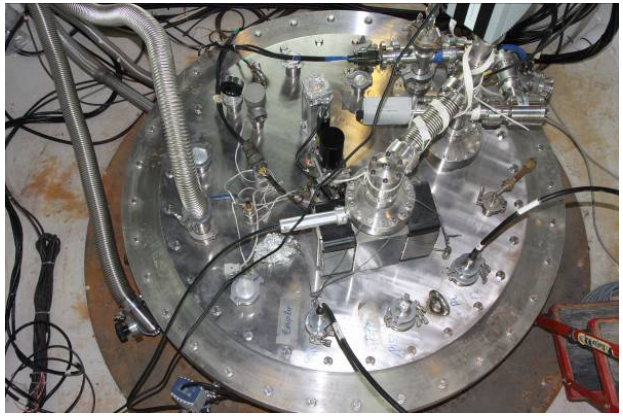


HPR

Vertical test

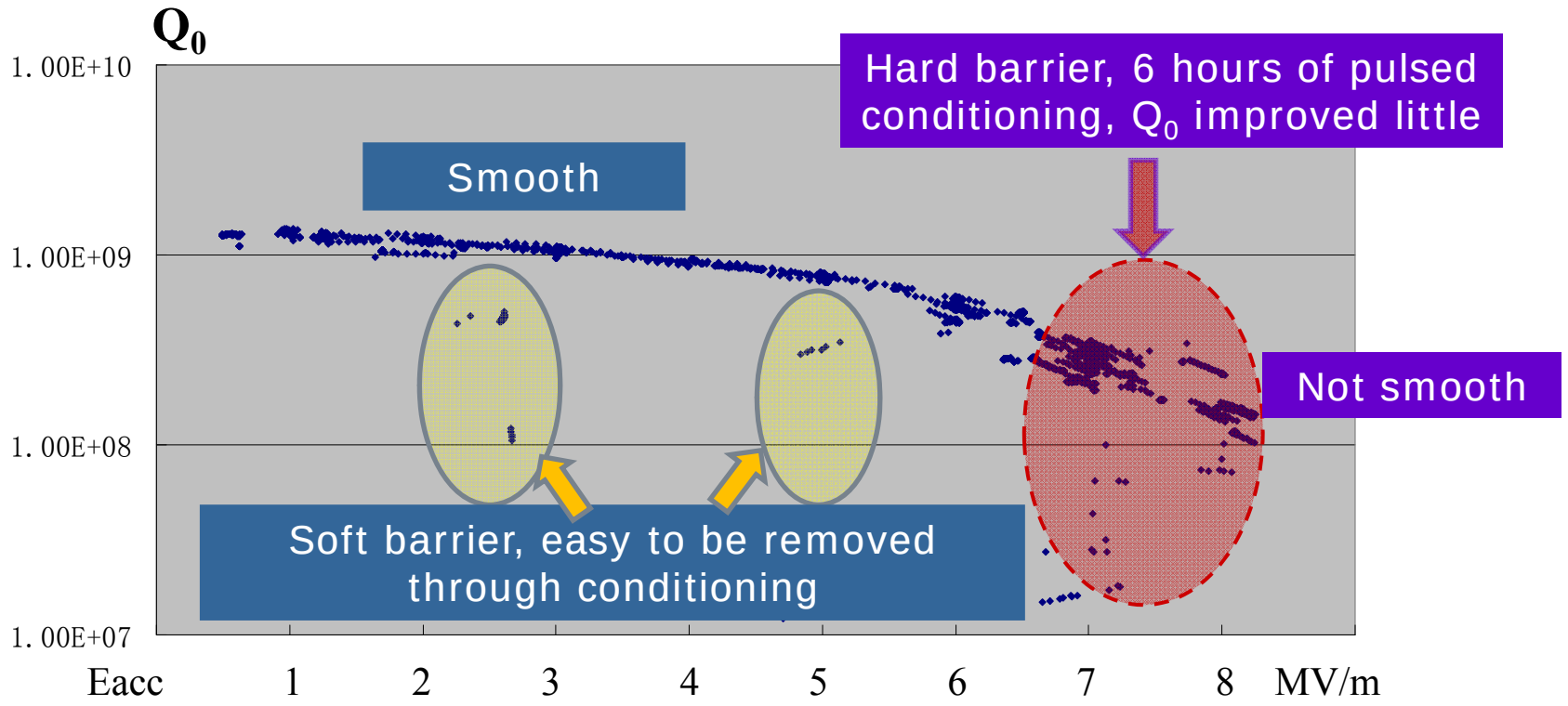
Hanging cavity

LLRF of test

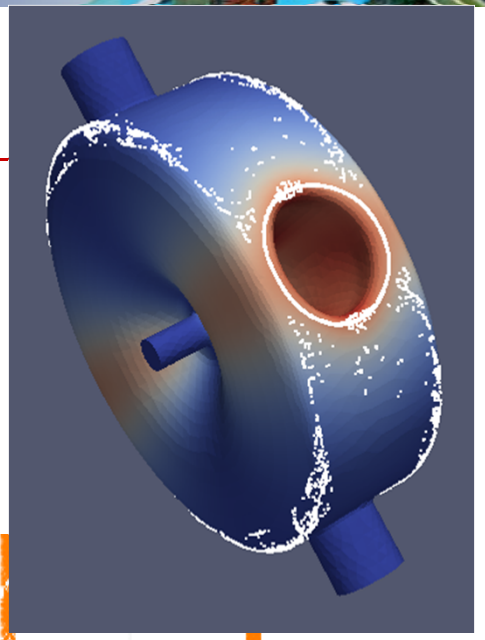


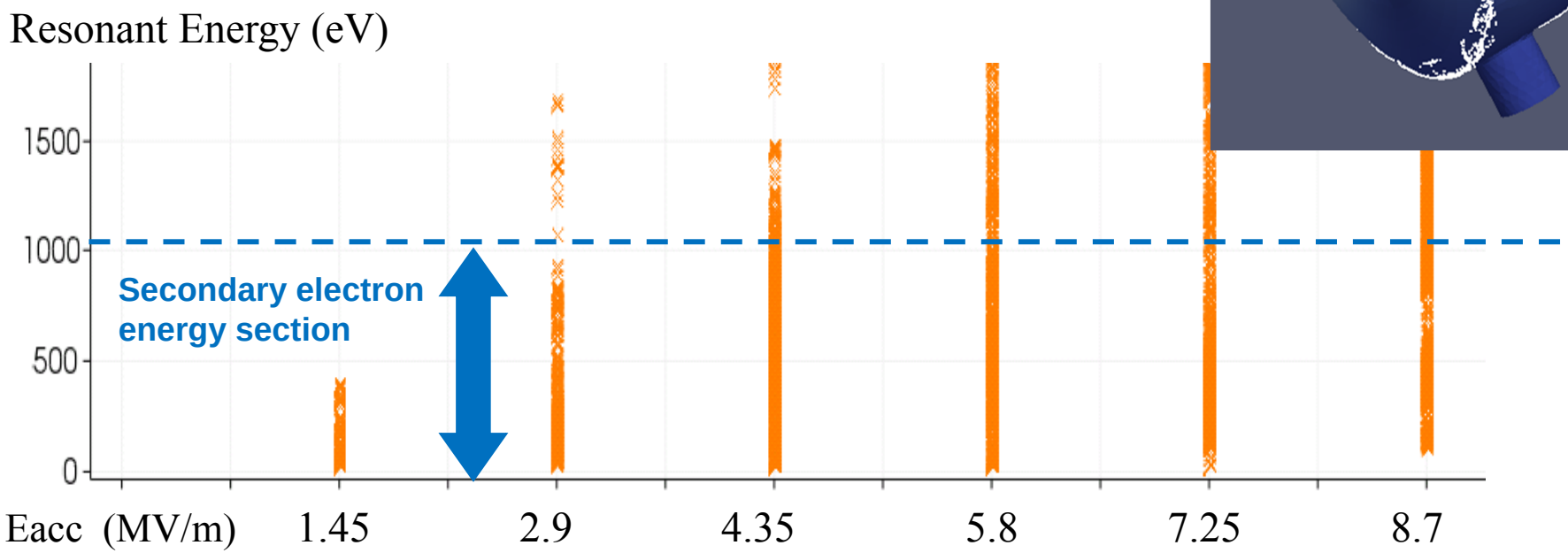
Top of the dewar in the test

Multipacting during the test

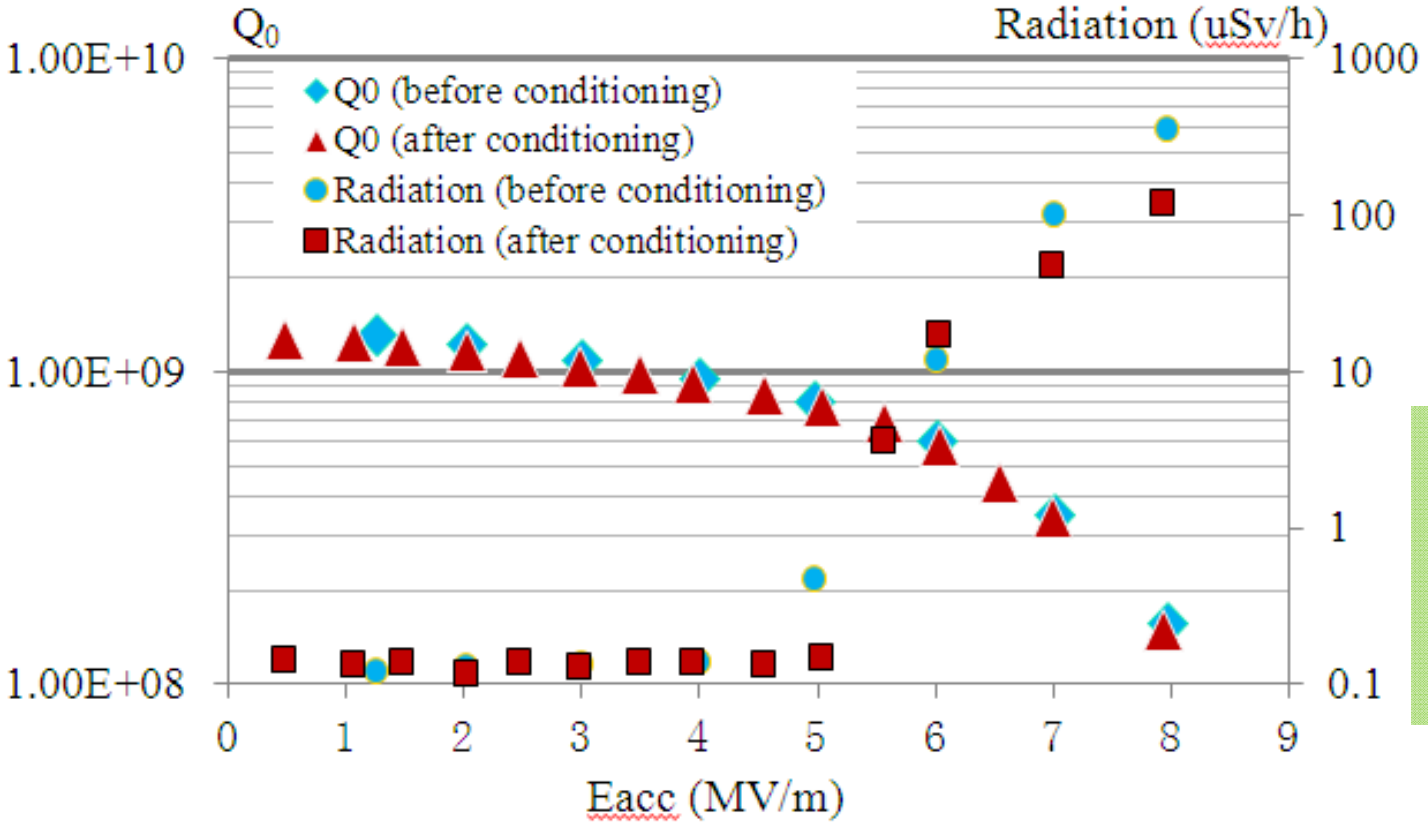


Multipacting simulation by Omega3P





Test results



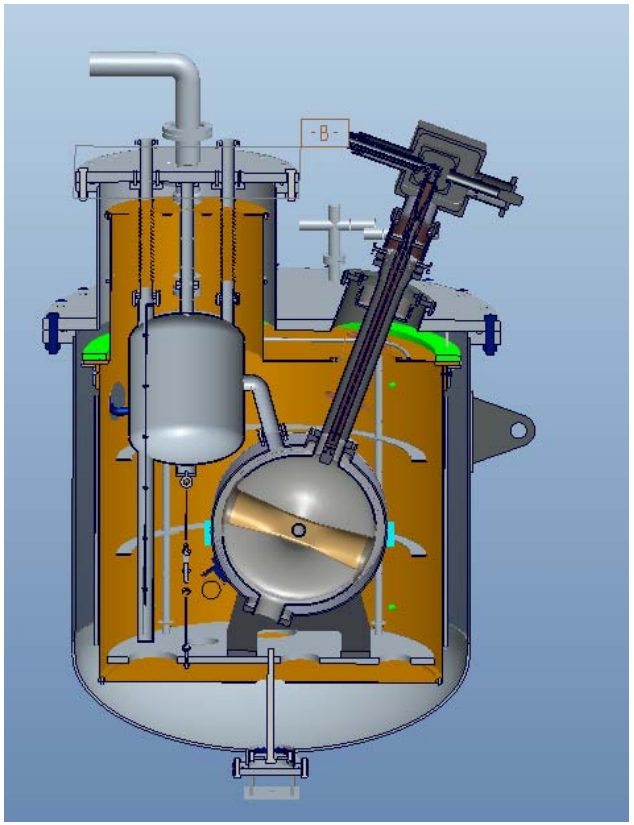
At 4.2K, Q_0=5.8x10^8@ E_{acc}=6MV/m.

More efforts need to increase the Q value of the cavity.

Things to do in near future

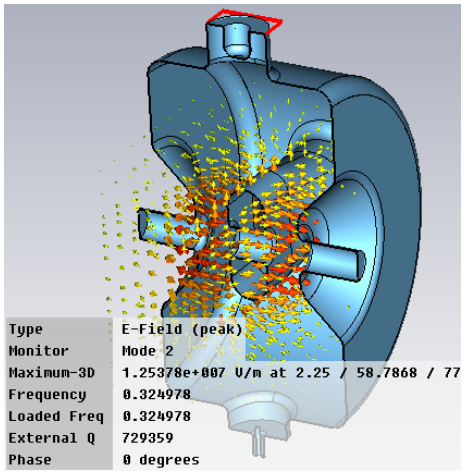
- More Spoke012 cavities.
- 4.2K horizontal test (Autumn 2013).

Components under machining



Cryostat for horizontal test

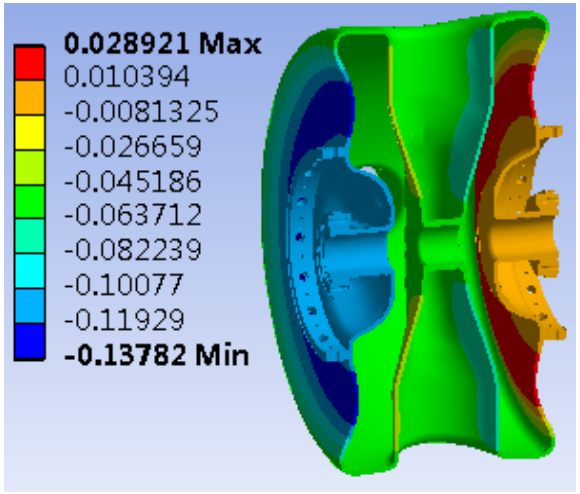
3. Spoke021 cavity

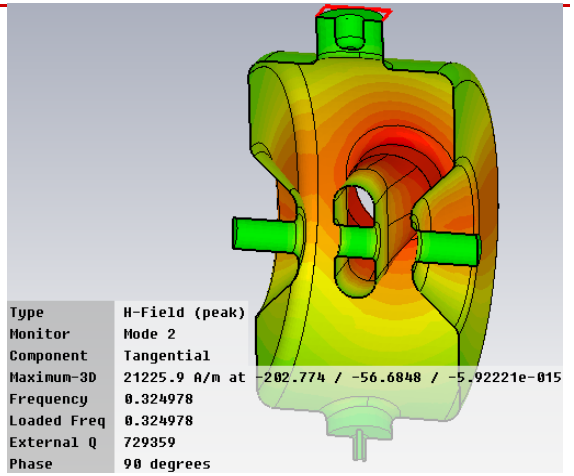


- Design Object:
  Eacc=8MV/m,
  Q_0>5E8 (4.2K),
  Q_0>5E9 (2K).

Electric field

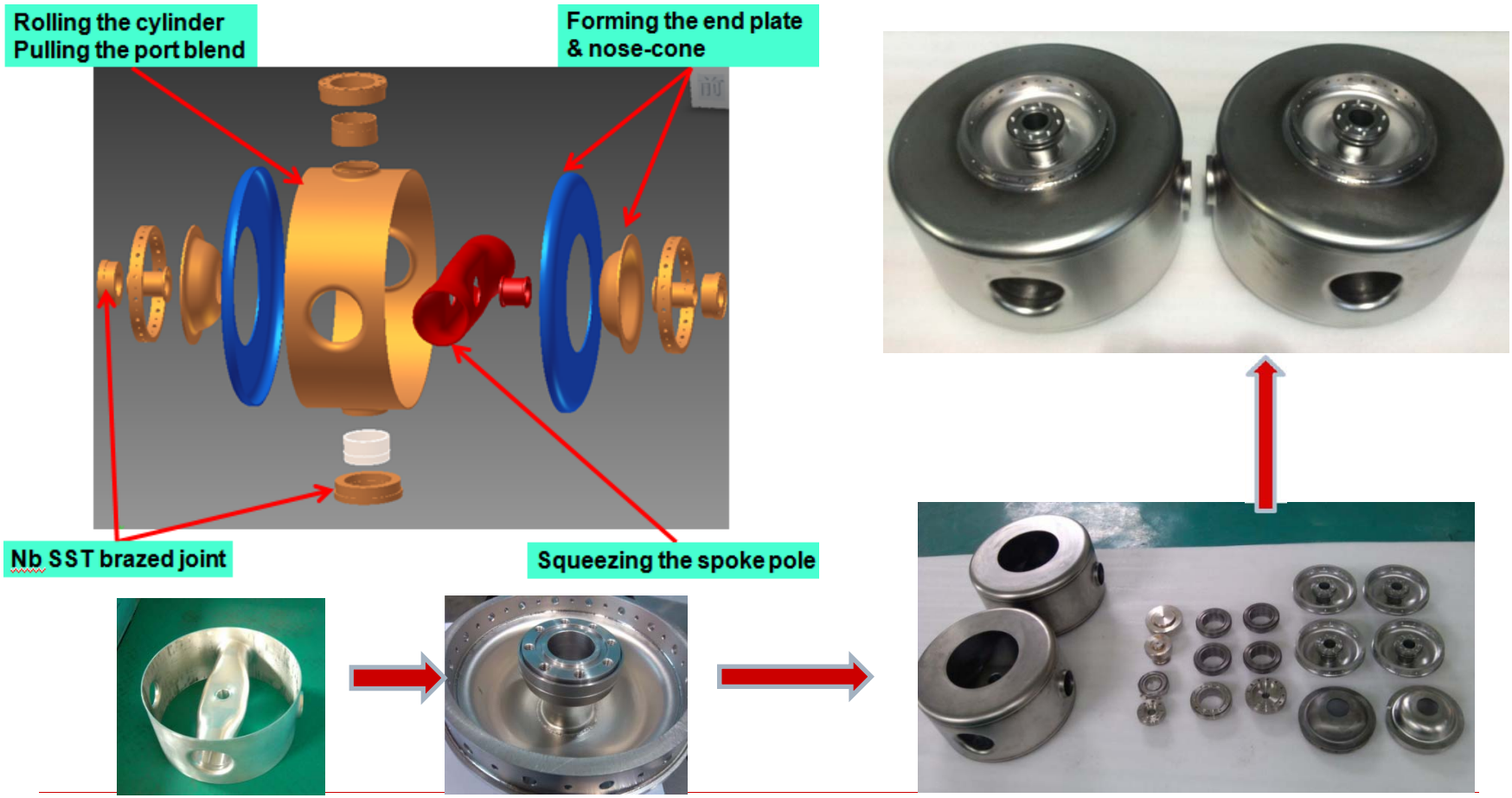
Magnetic field





Deformation
Under 1 atm & 800kg
tuning force

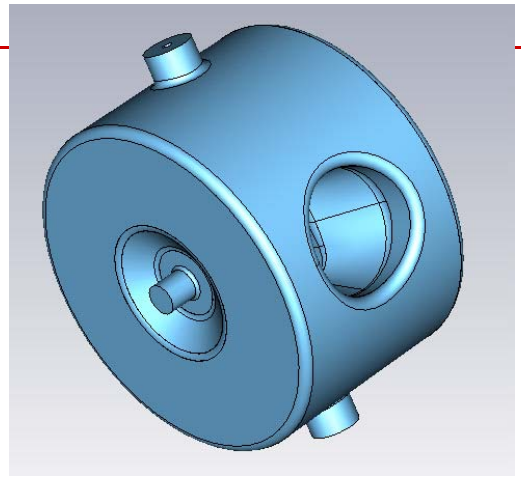
Fabrication



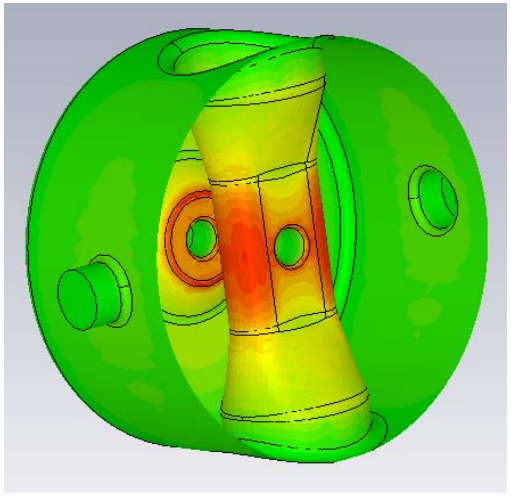
Next to do

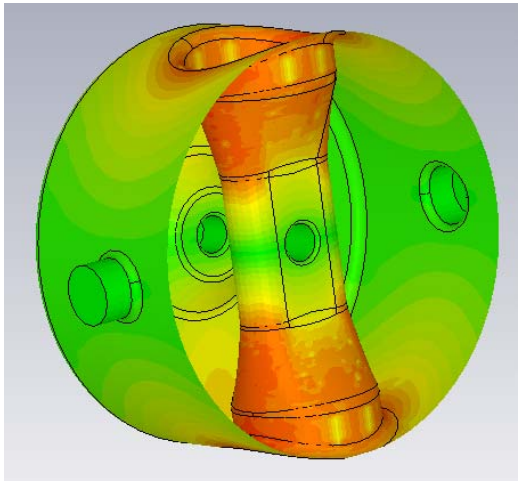
- Surface treatment (Manual polishing, BCP, Annealing, HPR,) (June~July, 2013)
- Baking and Vertical test (end of July, 2013)
- Horizontal test (middle of 2014)

4. Spoke040 cavity



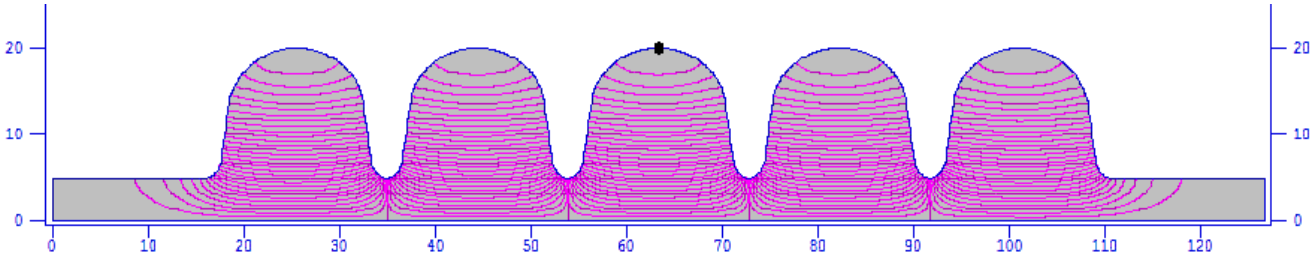
- Design Object： Q_0>5E9 (2K), Q_0>5E8 (4.2K) @ Eacc=7.7MV/m.
- The RF design has been finished.
- The mechanical design is under optimization.
- Experience of Spoke012 should be used.

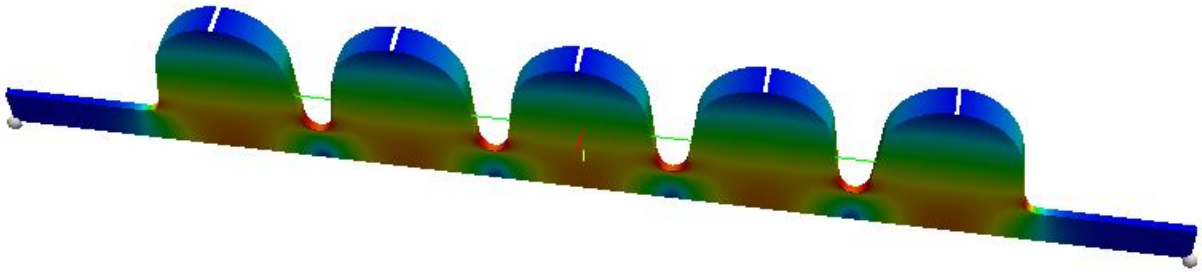




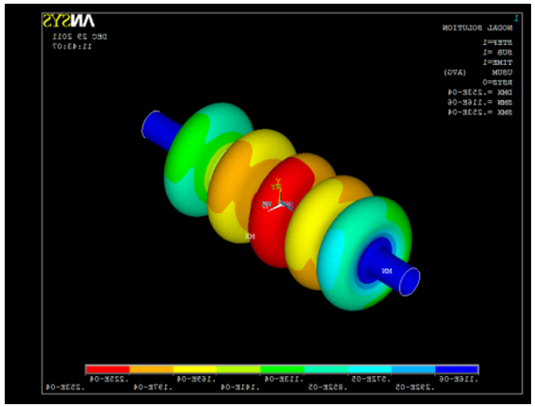
5. 650MHz β=0.82 5-cell cavity

- Design Object (2K)： Eacc=15MV/m ， Q_0>3E9.

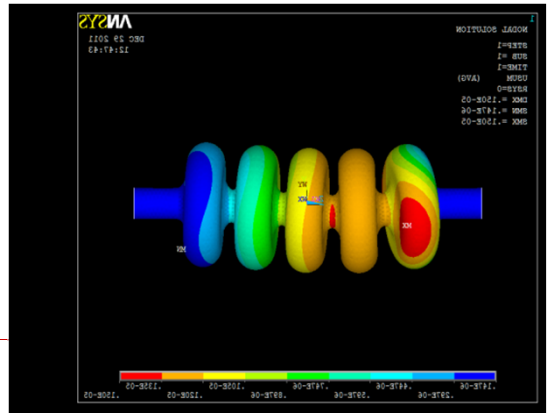




With stiffening ring r=8.52 cm:
K_L=-0.327Hz/(MV/m)^2



Without stiffening ring:
K_L=-1.04Hz/(MV/m)^2

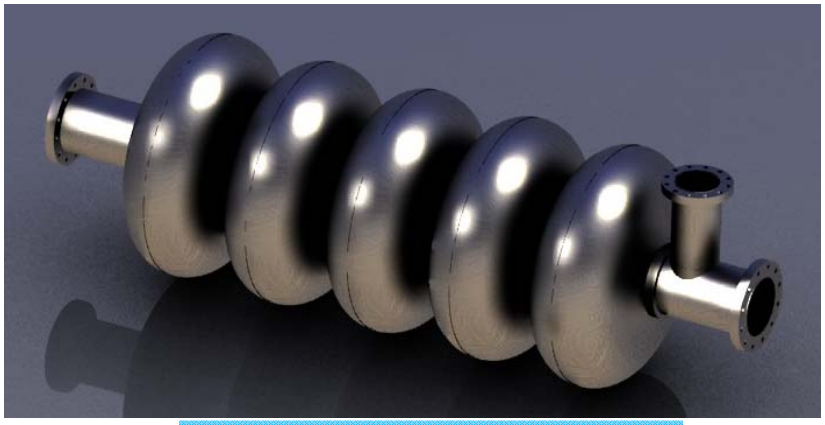


Fabrication

- Finish cavity dies.
- Finish half-cell deep drawing.
- Finish fabrication and welding procedure design.
- Finish half-cell BCP and frequency measurement.
- Finish main parts EB welding of the cavity.

It's planned to do the vertical test late 2013.

Dumbbell in cleanroom



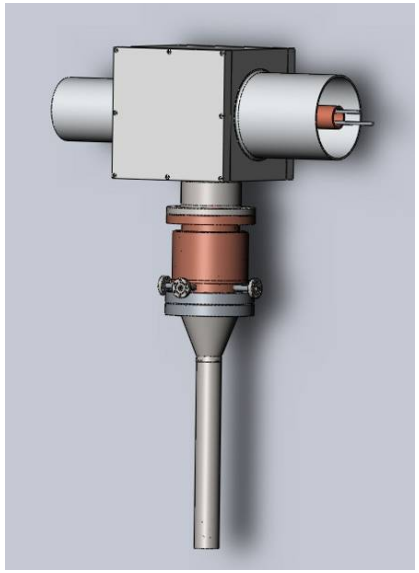
Cavity design sketch

6. High power input couplers

- Two kinds of couplers are under fabrication.
  - Two prototype couplers for HWR cavity (developed by IMP) had been tested up to 20kW with CW RF power in July 2012.
  - Two prototype couplers for Spoke cavity have been tested up to 10kW with CW RF power in Jan. 2013.

Cavity type	Frequency (MHz)	Power (kW)	Qext	Connecting type
HWR（IMP）	162.5	15,CW,TW	~7.0E5	Coaxial waveguide, YX50-105-1
SPOKE	325	10,CW,TW	~7.0E5	Coaxial waveguide, $3\frac{1}{8}$",50Ω

Coupler for HWR cavity



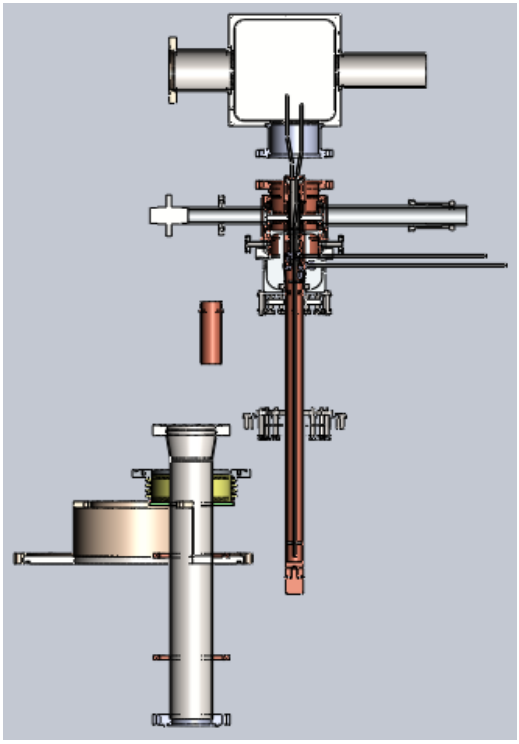
3D mechanical model

Prototype coupler fabricated

High power test stand

Maximum tested power:20 kW, CW

Coupler for Spoke cavity



3D mechanical model

High power test stand

Maximum tested power:10 kW, CW

7. Summary

- During the last 2 years, progress has been achieved for the ADS SC cavities in IHEP.
- In the future, much more efforts should be paid to the ADS SC cavities.
- Broad and deep collaboration over the world are expected.

Thanks for your attention!