International Review Meeting on C-ADS Accelerator Physics Design
Beijing, 2011.9.19-20

Physics design on Injector-2 RFQ

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On behalf of
ADS-RFQII Team

Contents

Overview

ADS-LINAC Design

High power CW Proton LINAC

With highest reliability and efficiency

ADS-RFQ+MEBT Design Issue：

- Adiabatic bunching and necessary acceleration（to SC. structures）
- Crucial part for controlling emittance growth
- Crucial part for controlling beam loss（least beam loss at SC. structures）
- For most of the direct power dissipation

Key scientific and technologic points for ADS-RFQ：

- Beam dynamics：adiabaticity，beam halo，power optimization（distribution and voltage），reducing difficulties at fabrication and operation
- Electromagnetic： power optimization （shunt impedance），field distribution，dipole mode
- Structure：structure realization、machining precision、**Brazing**，leakage，deformation/thermo-mechanical stability
- Cooling system
- General：thermo-mechanical/electromagnetic stability，control of total errors

→ RFQ model cavities

Roadmap

- Phase I (2011.1-2011.9)

  Independent designs by LBNL (to be reviewed) and IMP (model cavity started)

→RFQ model cavities

- Phase II (2011.9-2013)

  Intensive collaboration on the final RFQ

  LBNL design: Baseline design after review

  IMP design: R&D + Backup

Results for this review: IMP design for RFQII

RFQII Main Parameters (IMP design)

Frequency (MHz)	162.5
Injection energy (keV)	35
Output energy (MeV)	2.1
Pulsed beam current (mA)	15
Beam duty factor	100%
Inter-vane voltage V (kV)	68
Beam transmission	89%
Average bore radius r_0 (mm)	5.23
Vane tip curvature (mm)	4.184
ρ / r_0	0.8
Maximum surface field (MV/m)	16.8 (1.23Kilp.)
Cavity power dissipation (kW)	30kW*5
Total power (kW)	180
Max. copper power/Area (W/cm^2) at undercut	2.33
Max. copper power/Area (W/cm^2) at vane-side	1.01
Input norm. rms emittance(x,y,z)(π mm.mrad)	0.25/0.25/0
Output norm. rms emittance(x/y/z) (π mm.mrad/ π keV.ns)	0.25/0.25/0.8
Vane length (cm)	478.56
Accelerator length (cm)	498.56

Double-waist output

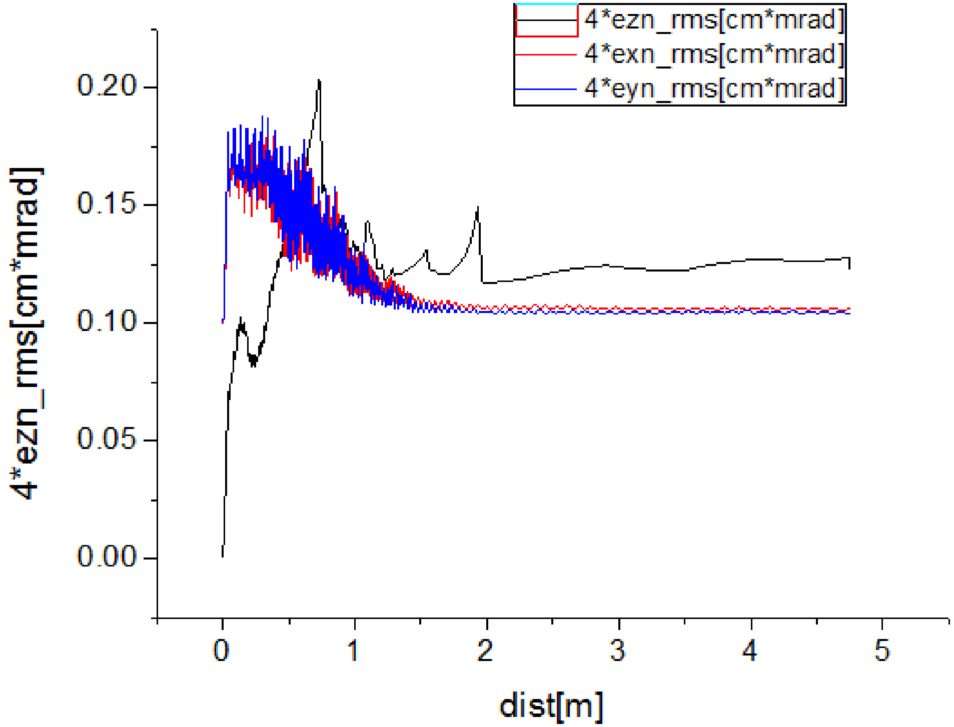
Upstream Matching and Emittance Evolution

I=15 mA

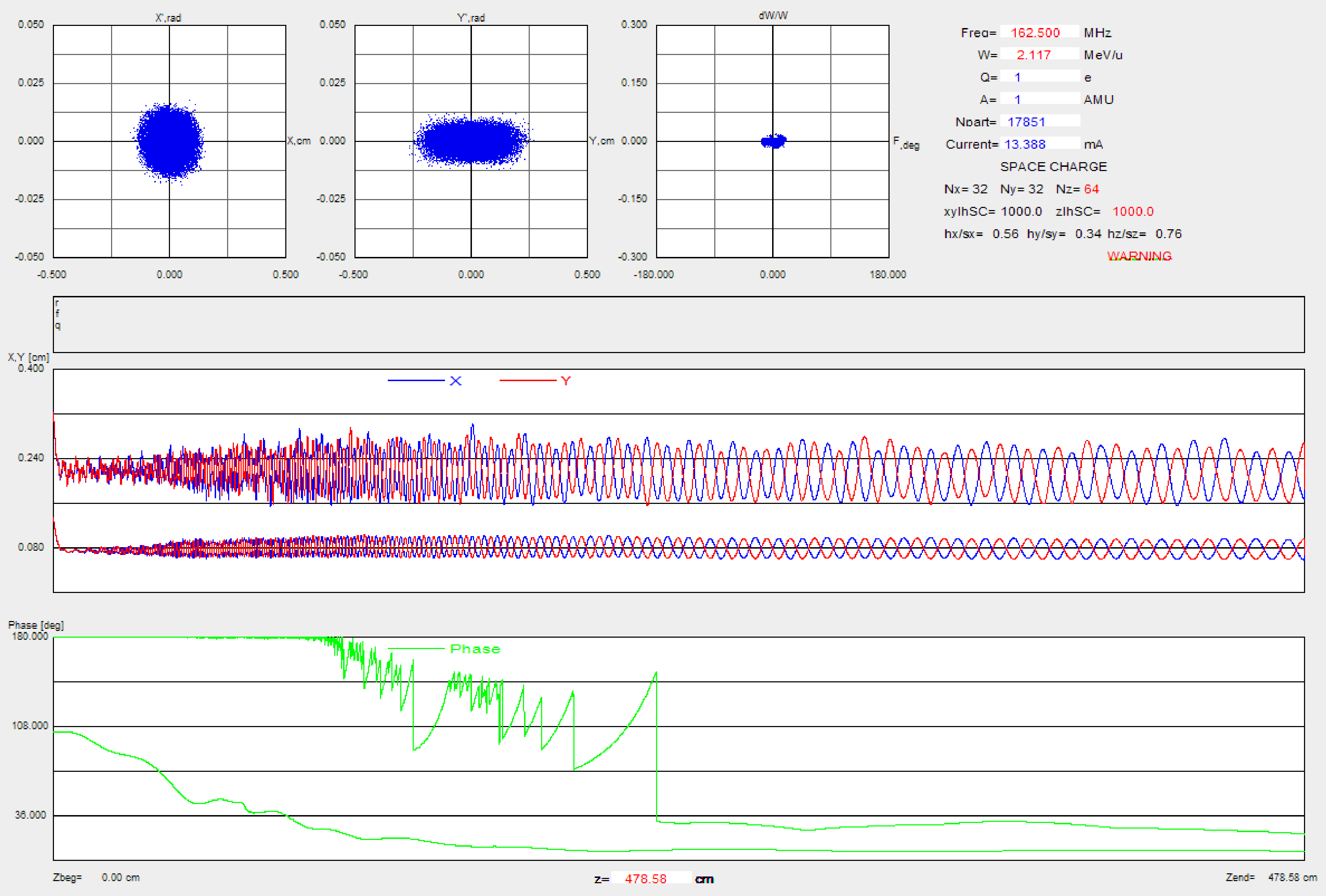
Phase space	α	β (cm/mrad)	(π .cm.mrad)
Horizontal	1.57390	6.22	0.025
Vertical	1.57390	6.22	0.025

I=0

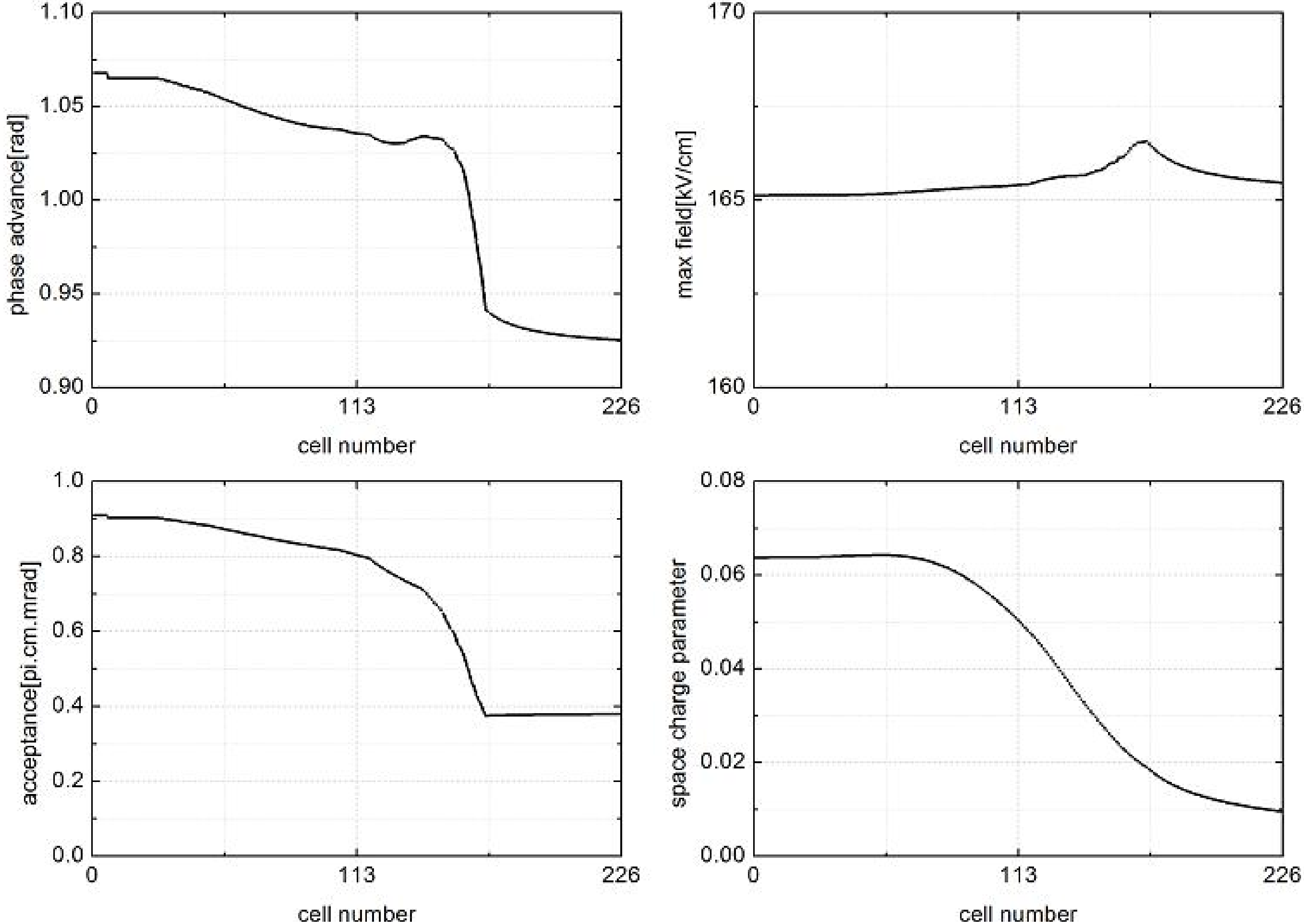
Phase space	α	β (cm/mrad)	(π .cm.mrad)
Horizontal	1.33599	5.57	0.025
Vertical	1.33599	5.57	0.025



RFQII Dynamic Design： 35keV-2.1MeV



RFQII Lattice Parameters



RFQII Dynamic Studies

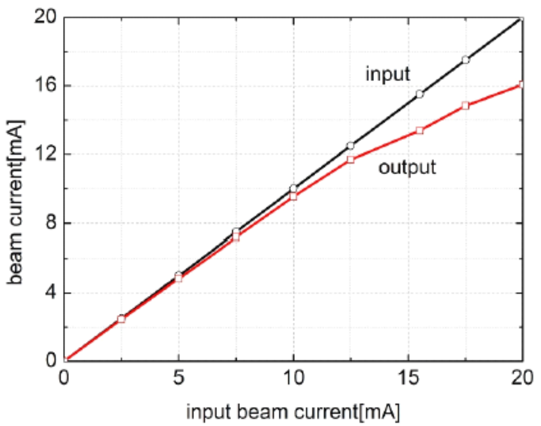


Fig.2 The input beam current VS the output beam current.

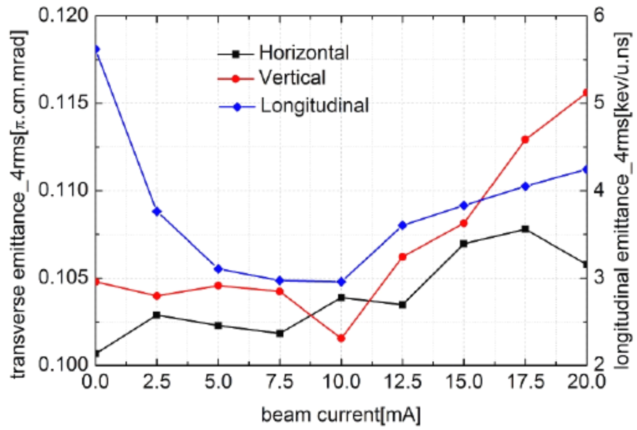


Fig.3 The output beam emittance VS the input beam current.

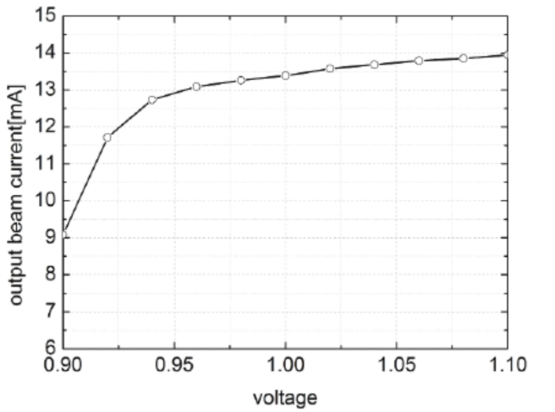


Fig.4 The output beam current VS the inter-vane voltage.

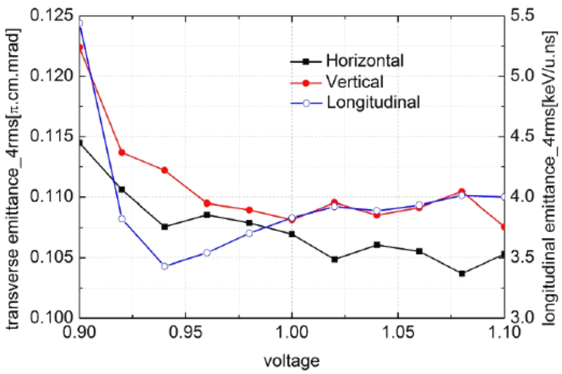


Fig.5 The output beam emittance VS the inter-vane voltage.

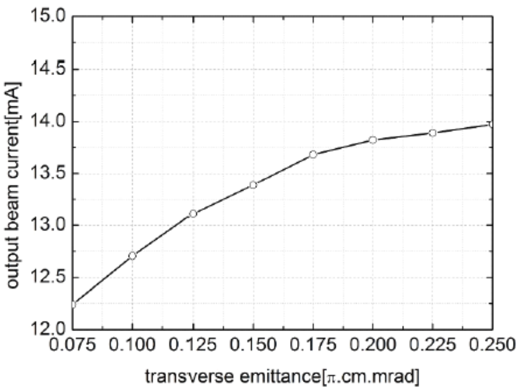


Fig.7 The output beam current for the different beam emittance.

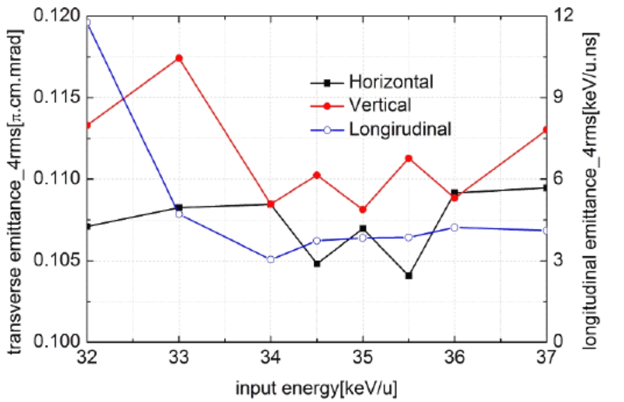
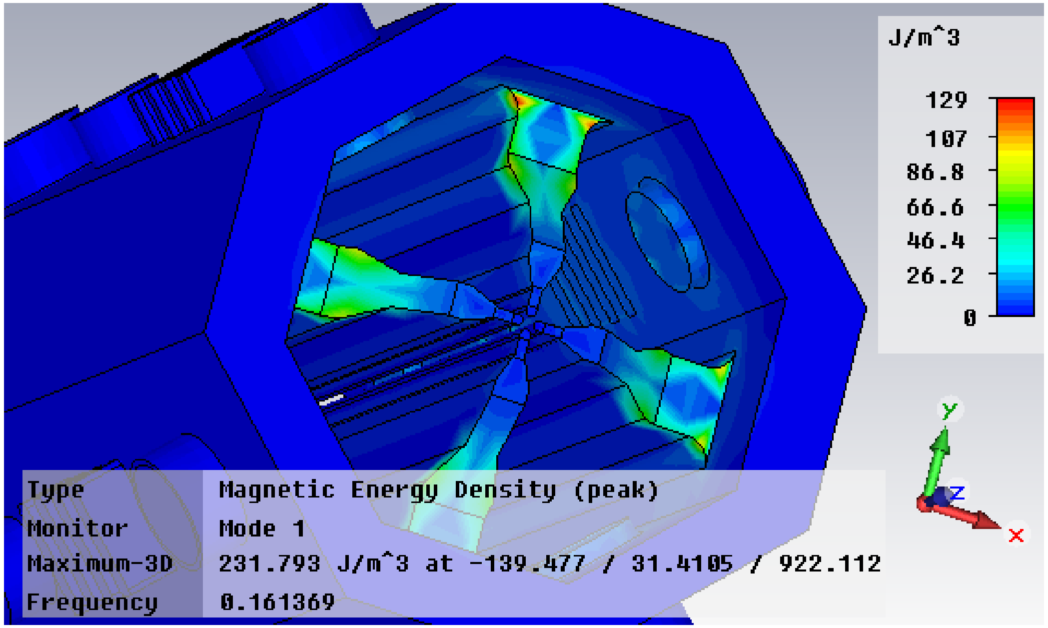
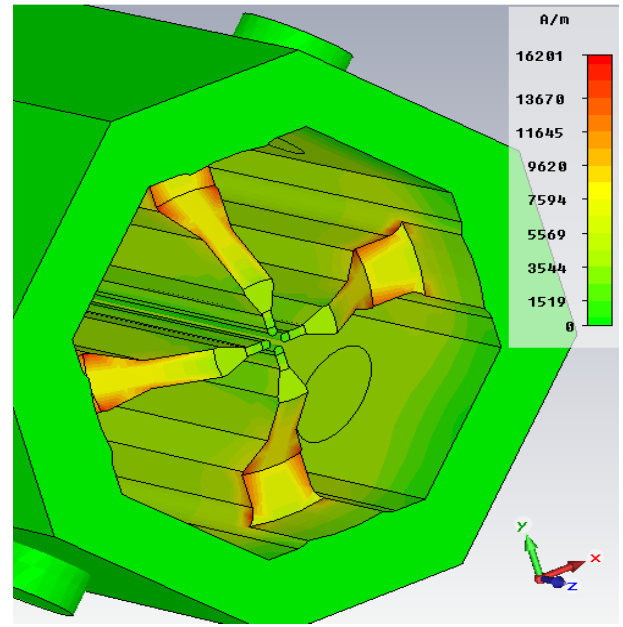


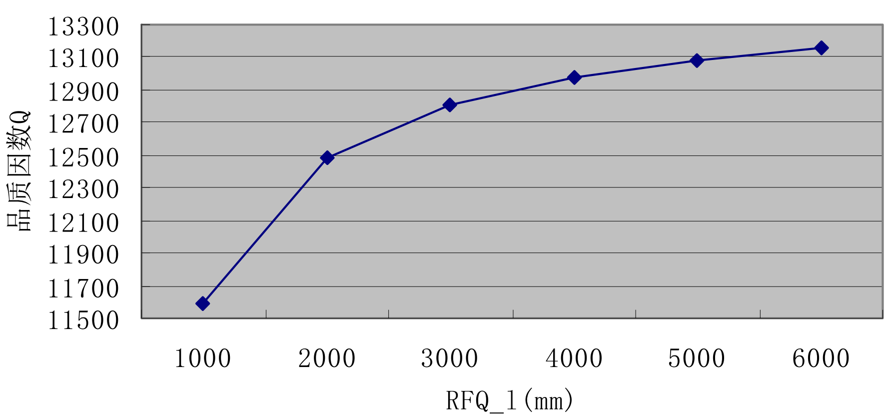
Fig.9 The beam emittance outputs for the different input energies.

RFQII EM Design

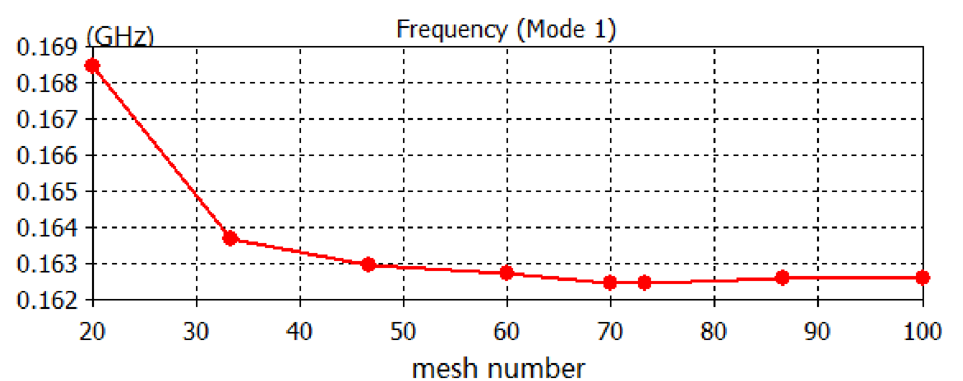




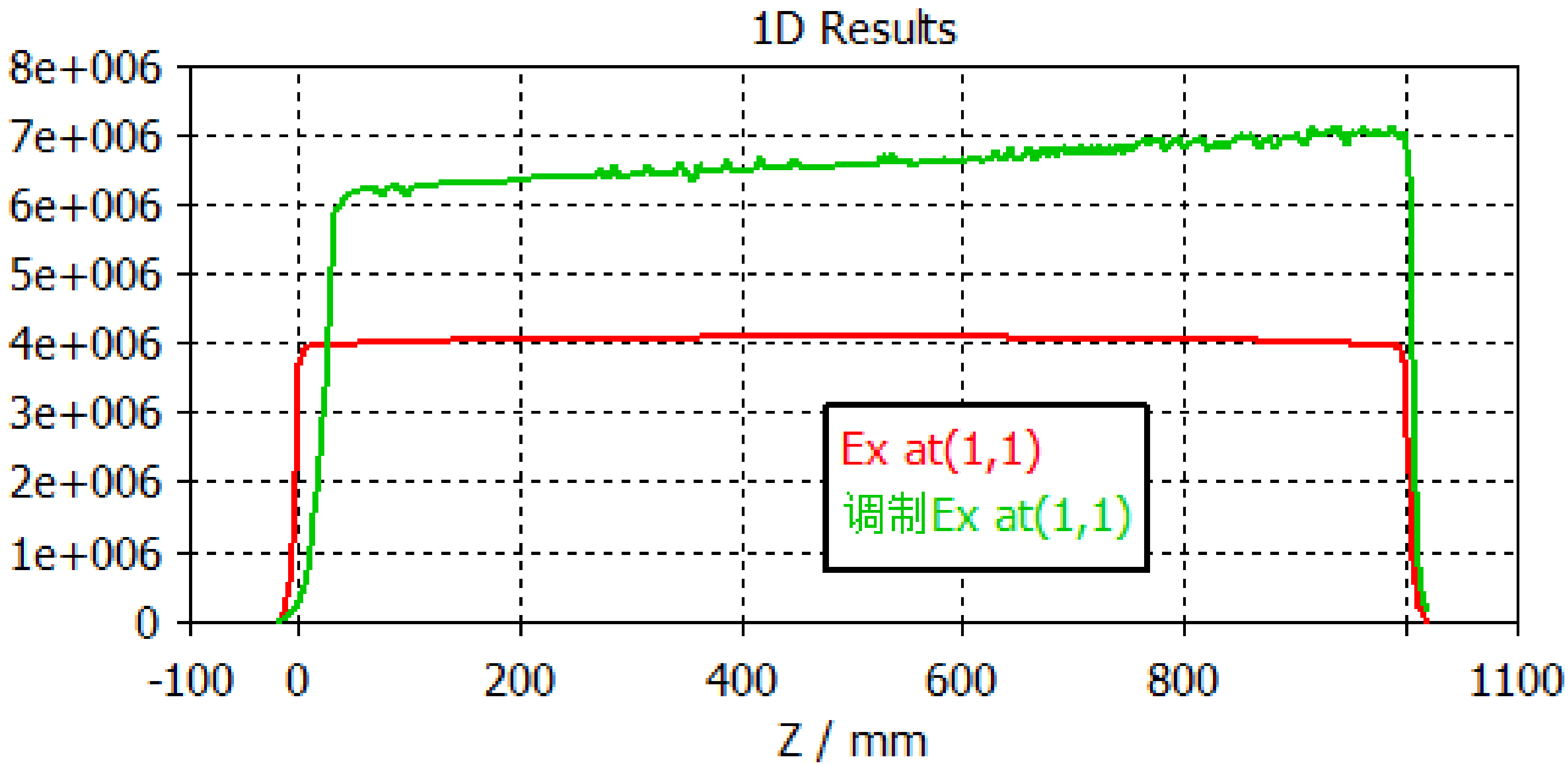
Q value vs. RFQ length



Mesh analysis for 1m model

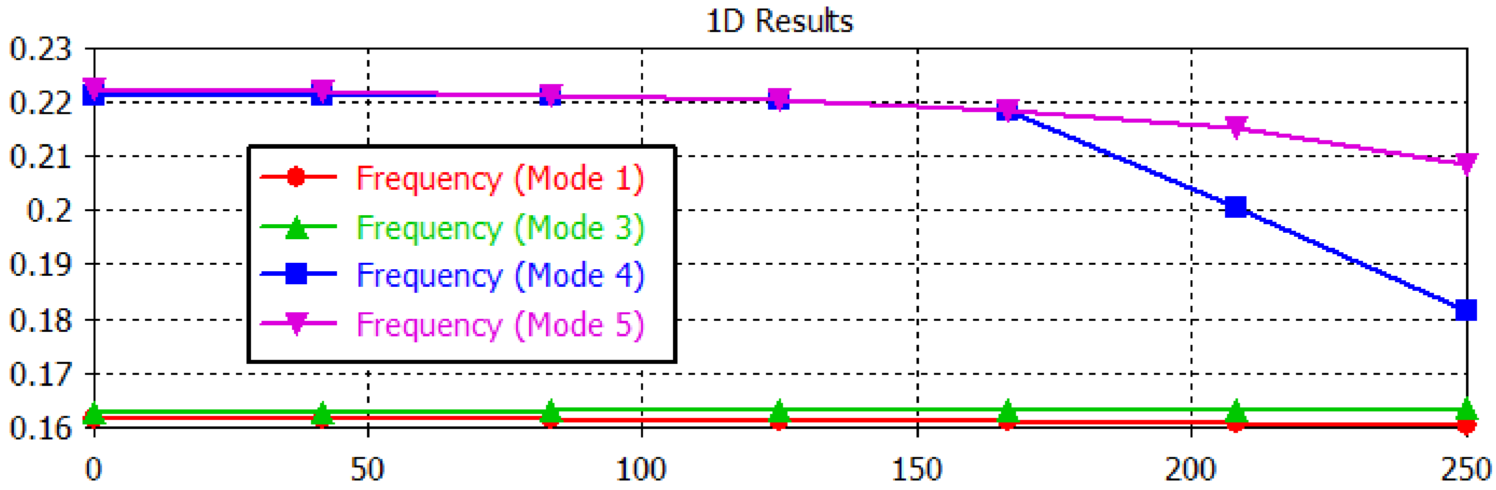


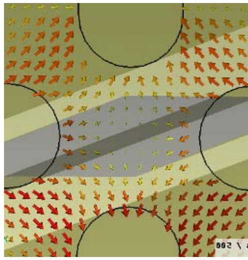
RFQII Field Flatness: Modulation vs. Undercut



Undercut at Exit: 90mm → 80mm

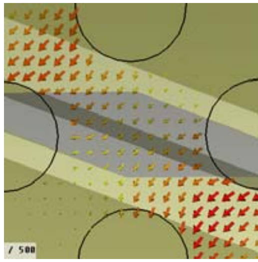
RFQII Dipole Mode: Stabilization Rods (5-m Cavity)

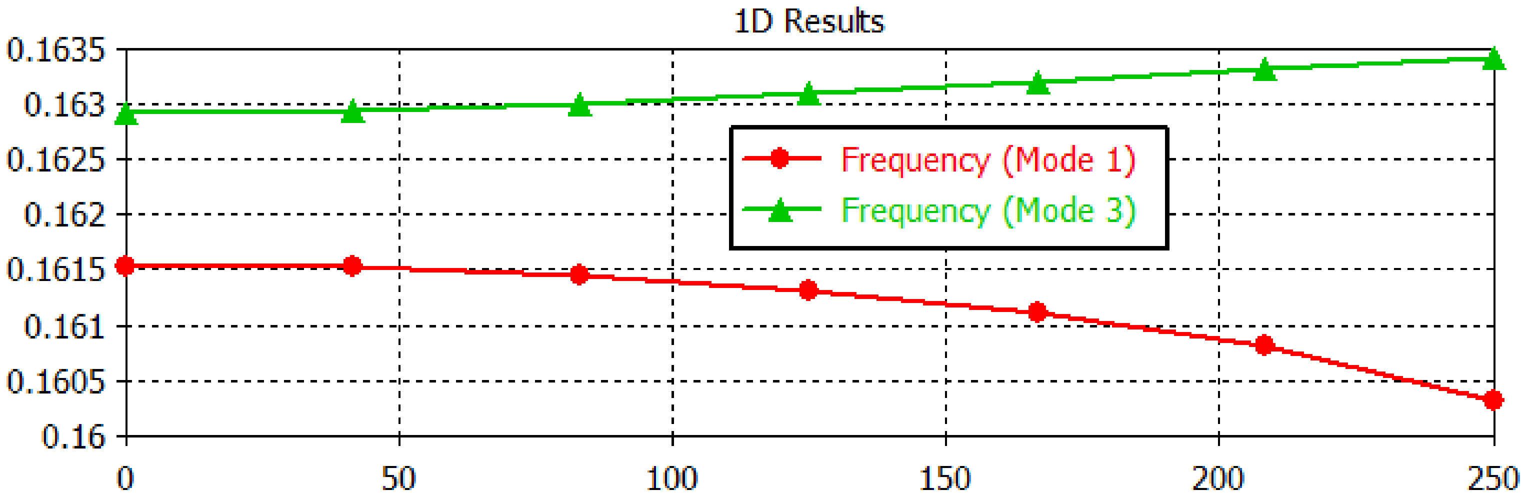




Rod Depth(mm)

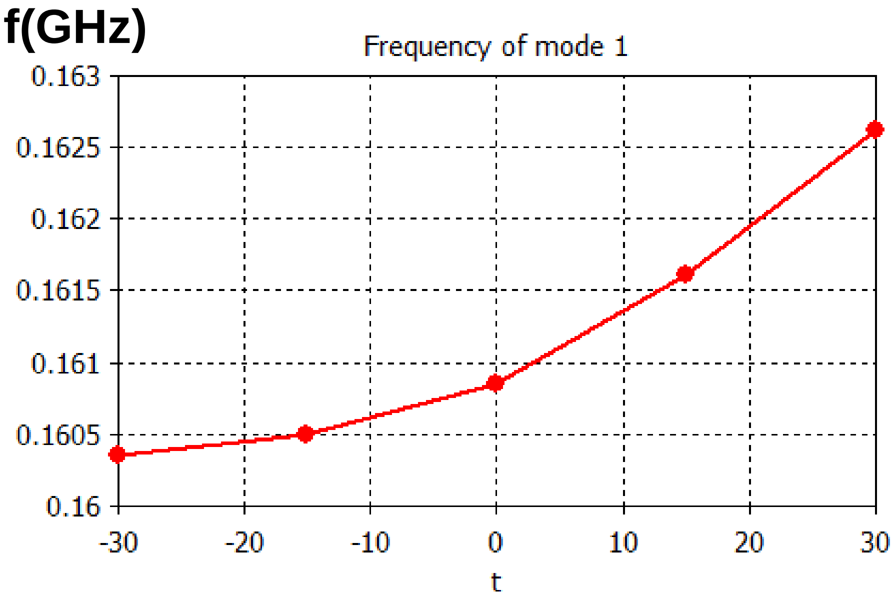
f(GHz)

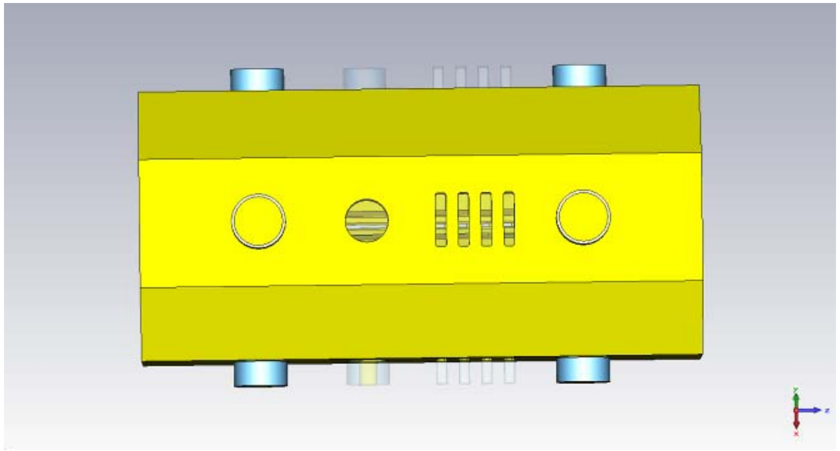




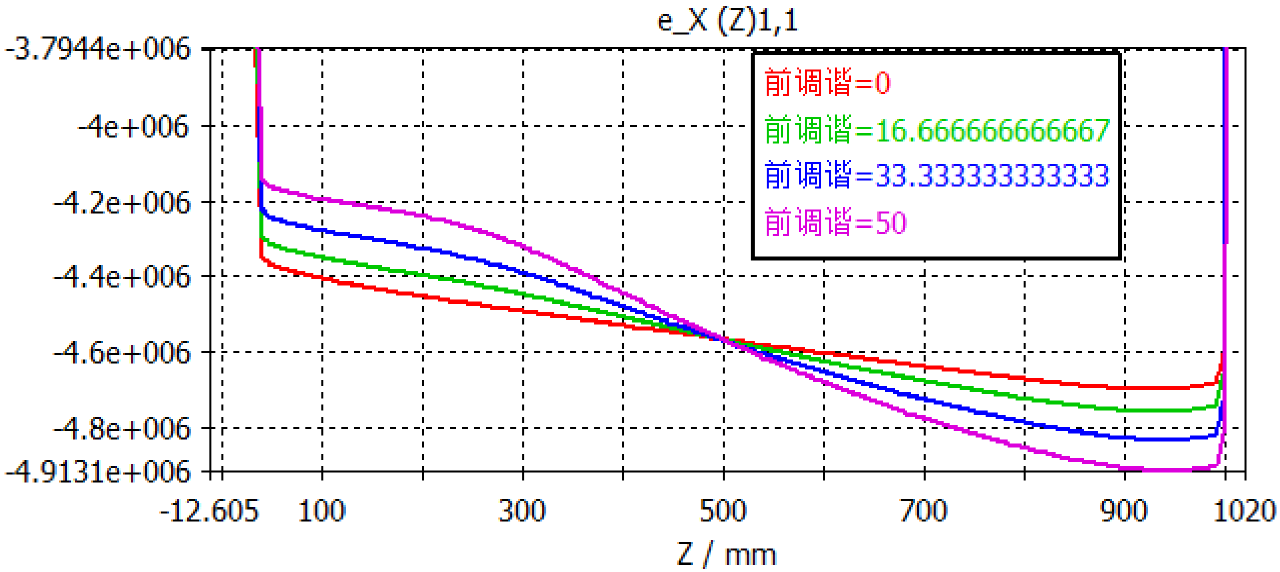
RFQII Tuner Studies (1-m Module)

Freq. vs. Tuner Depth

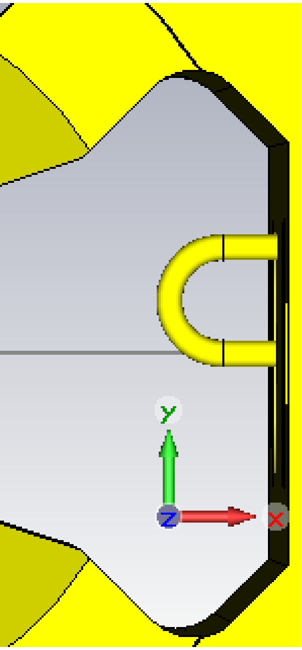


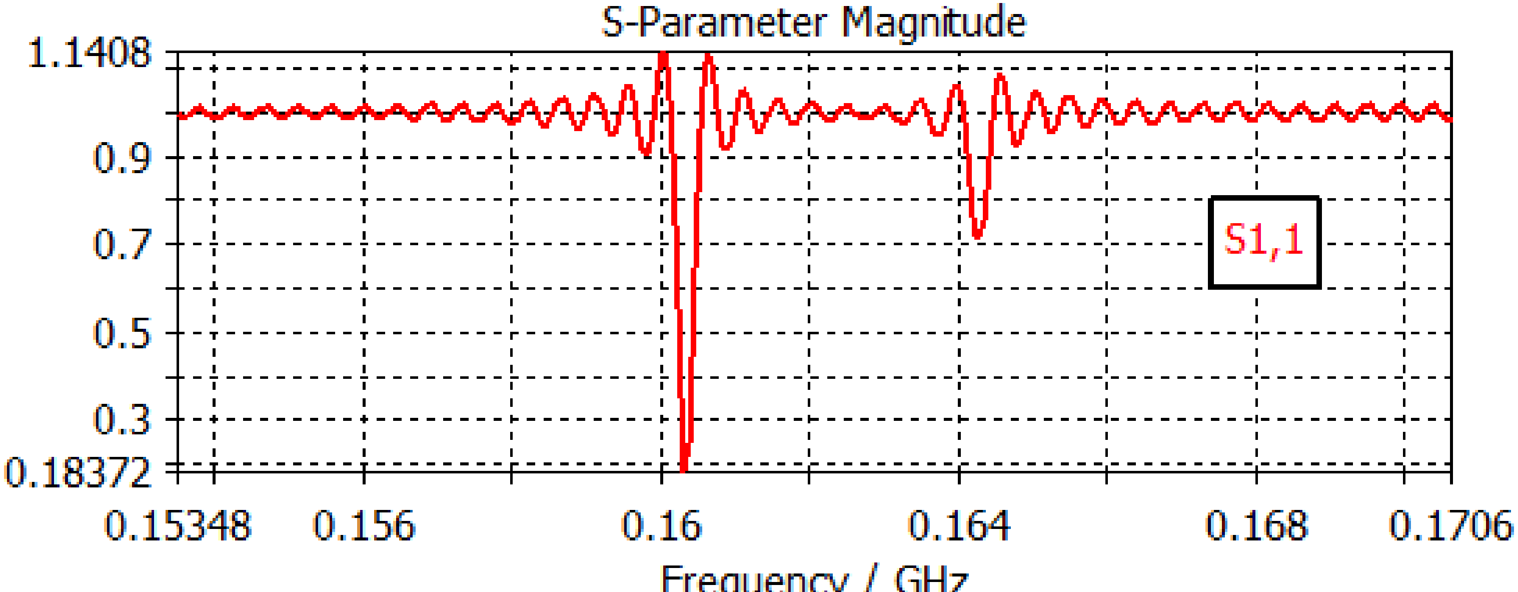


Field flatness vs. Tuner Depth, with RM section

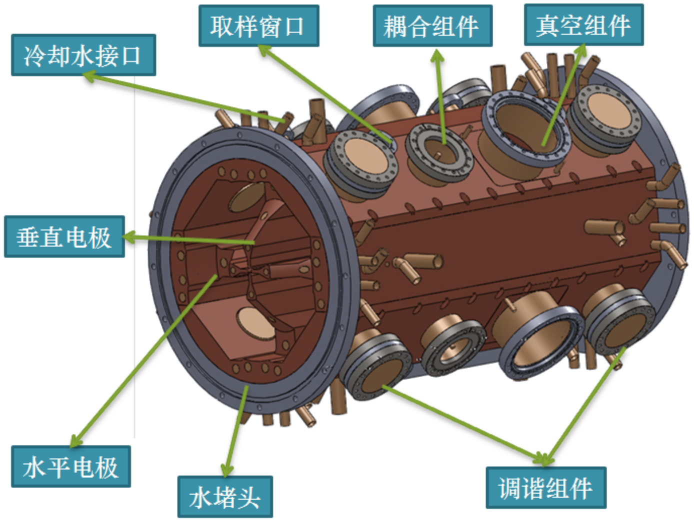


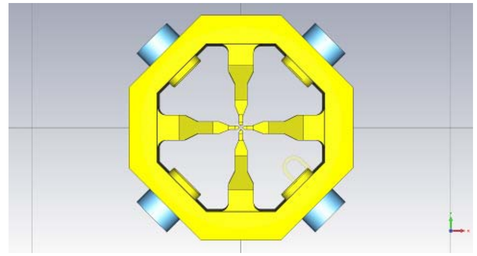
RFQII Coupling Design

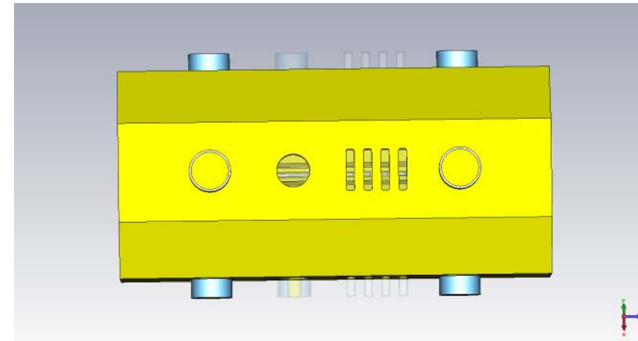


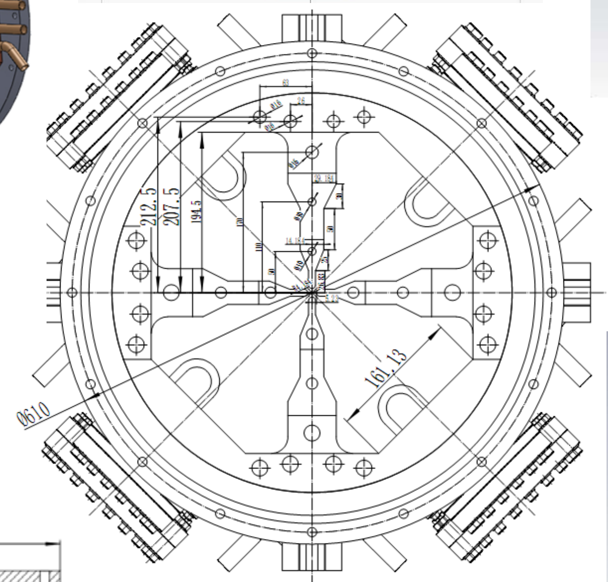


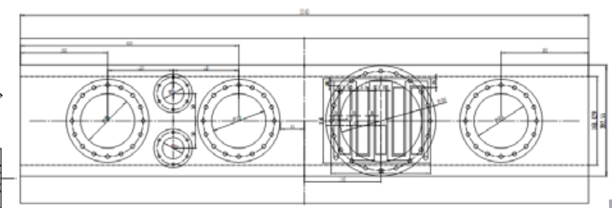
RFQII Structure Design

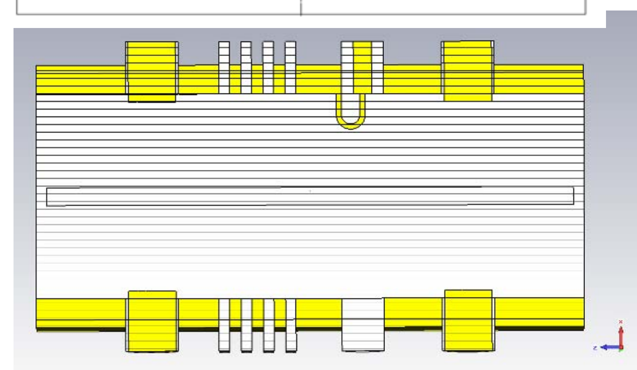


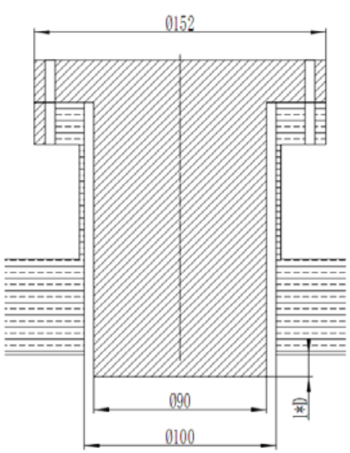


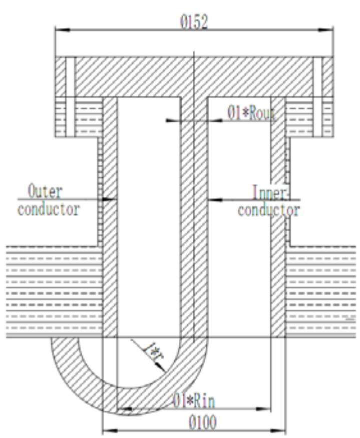


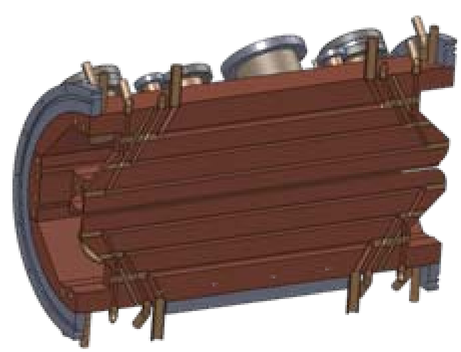


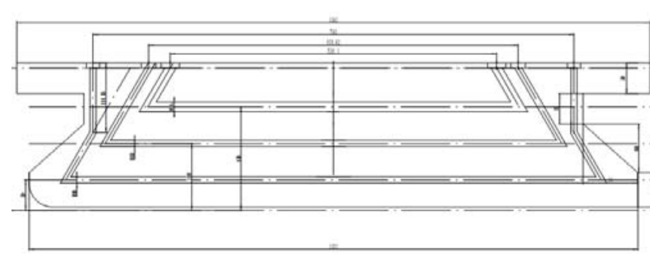






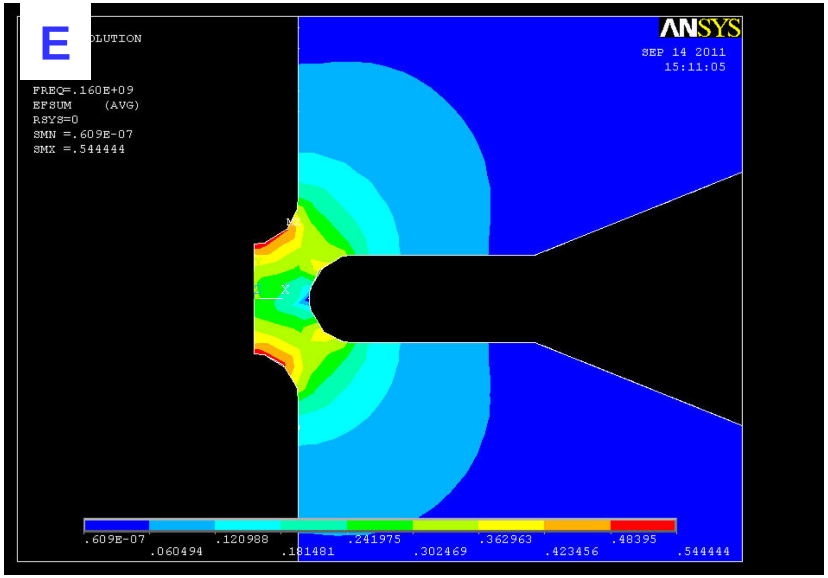


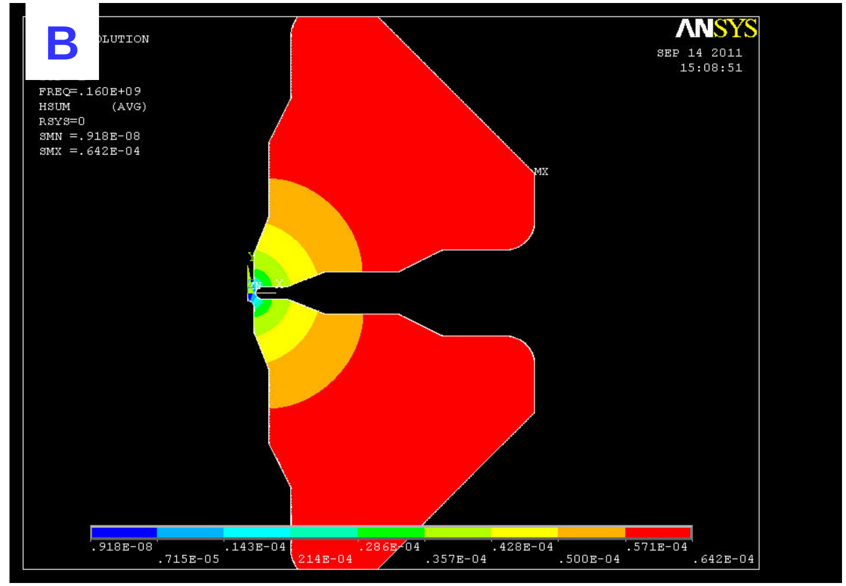


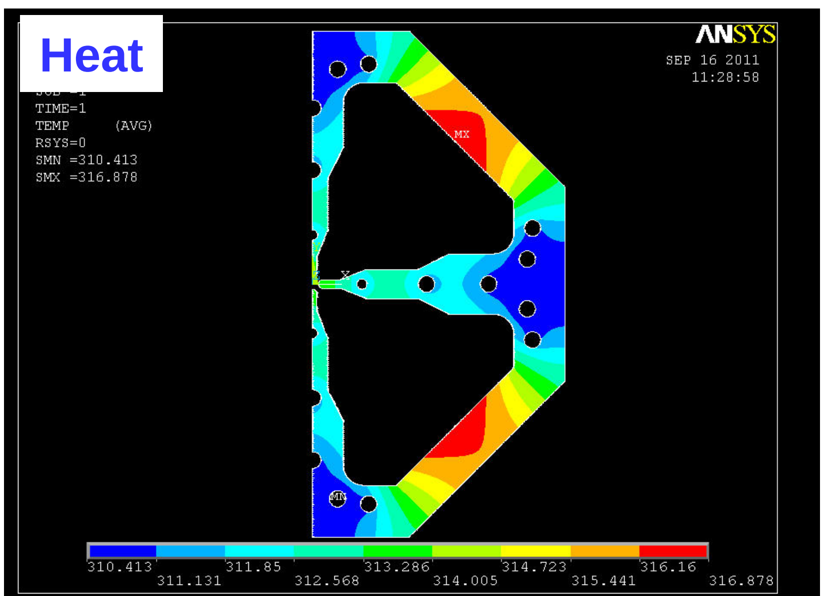


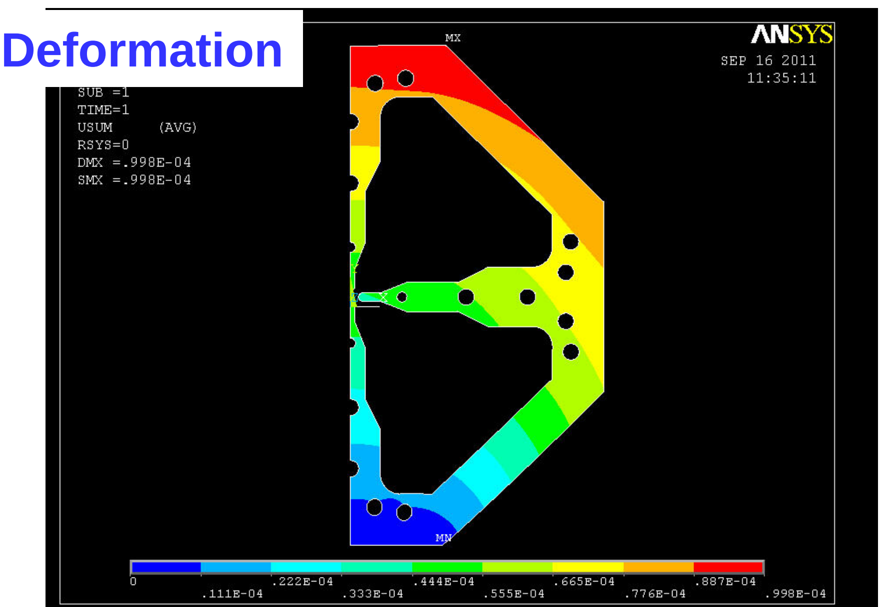
C-ADS RFQII Thermal Analysis

preliminary results









C-ADS RFQII Thermal Analysis

reference settings

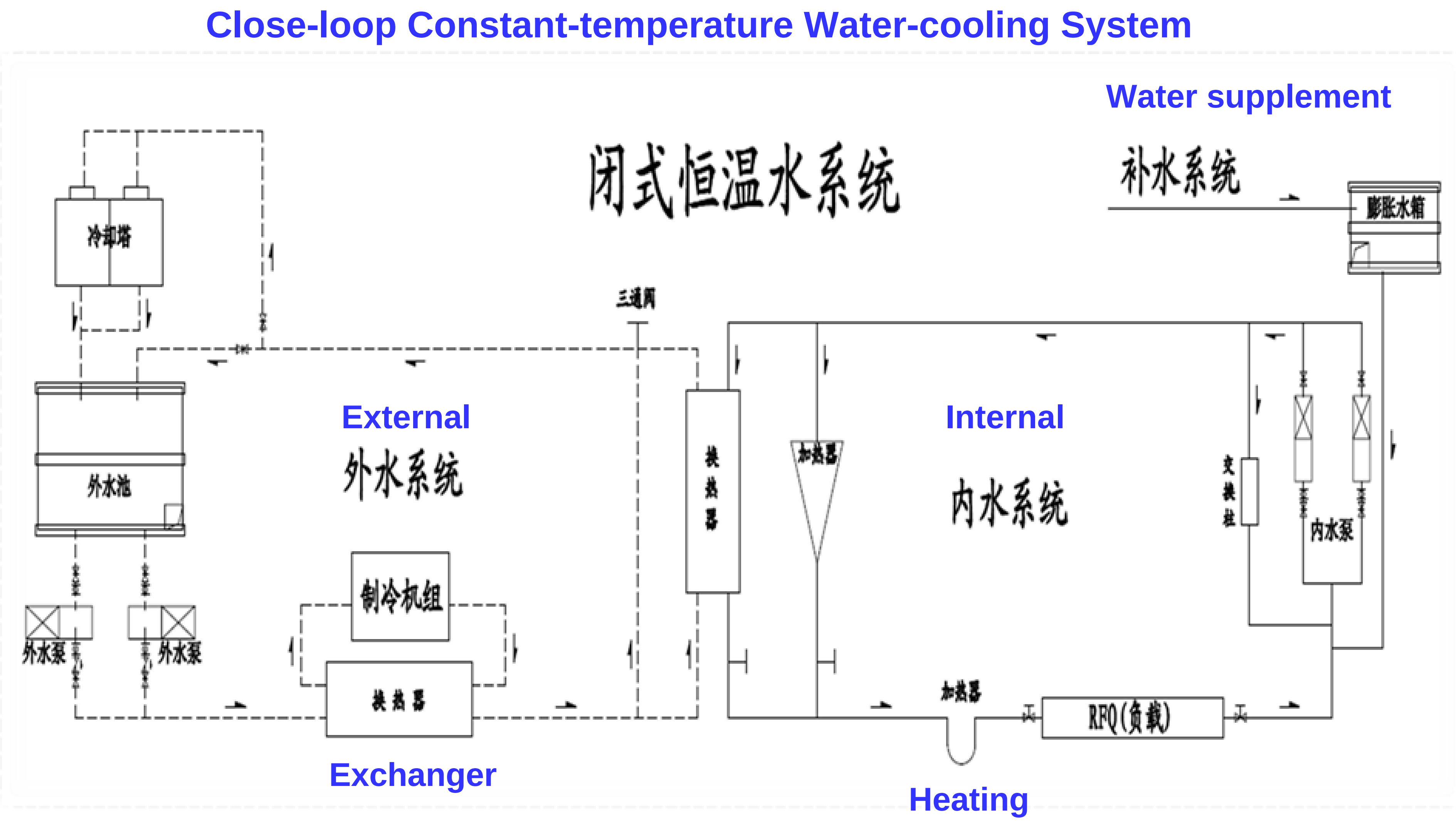
Reference temperature: 25^{0}C

Operation temperature: ~36^{0}C

Temperature increase: 1.5^{0}C

Speed of cooling water: 1.5m/s

C-ADS RFQII Cooling System



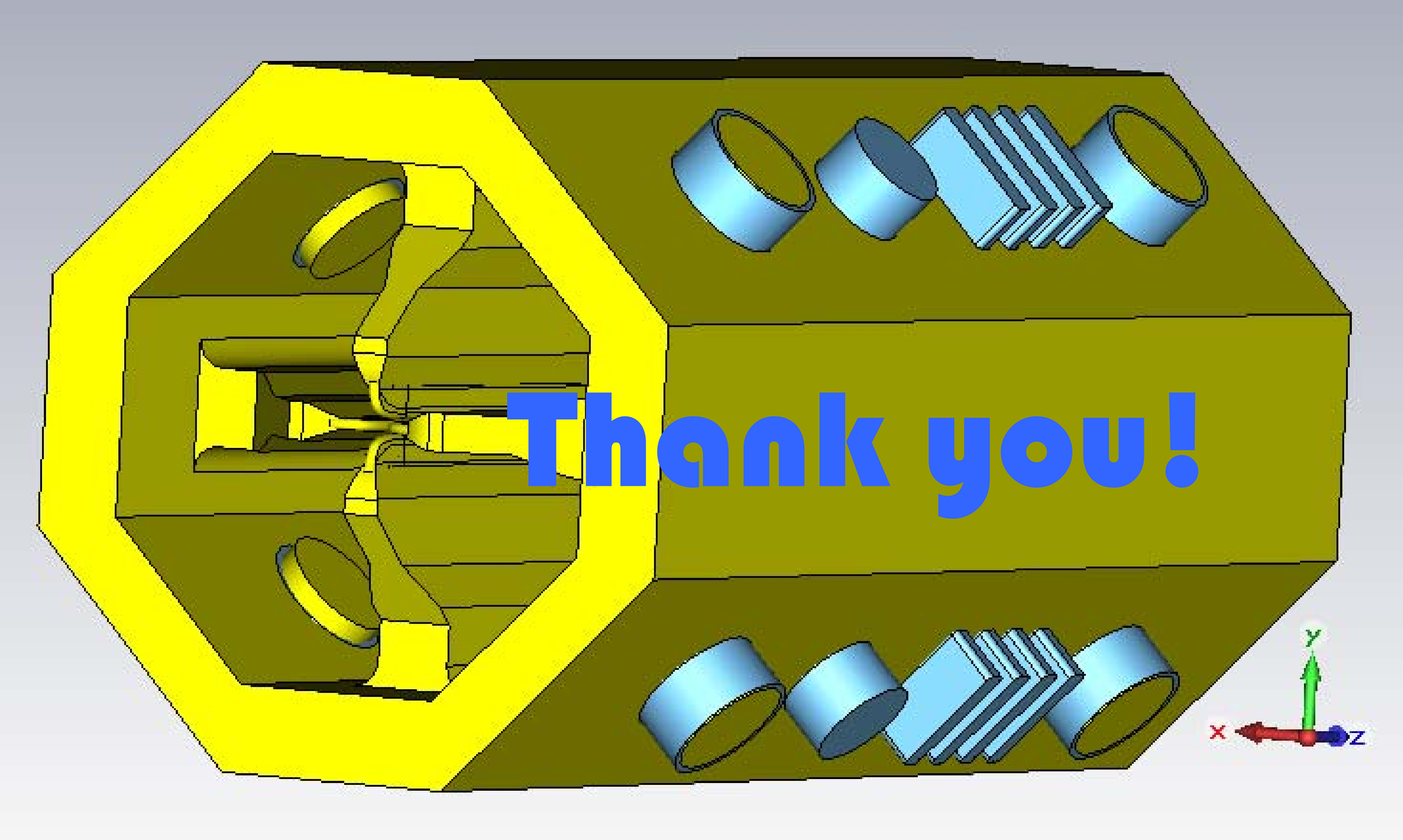
ADS-RFQII Summary

Physics design of IMP version: ready

A model cavity being fabricated based on IMP design

Next step:

Accomplish the final design based on LBNL design


Thank you!
y
x
z