Design of the Palmer Pickup for Stochastic Pre-Cooling of Hot Rare Isotopes at the Collector Ring for FAIR at GSI

Duncan Barker, COOL'15, Newport News, VA, USA, 2015
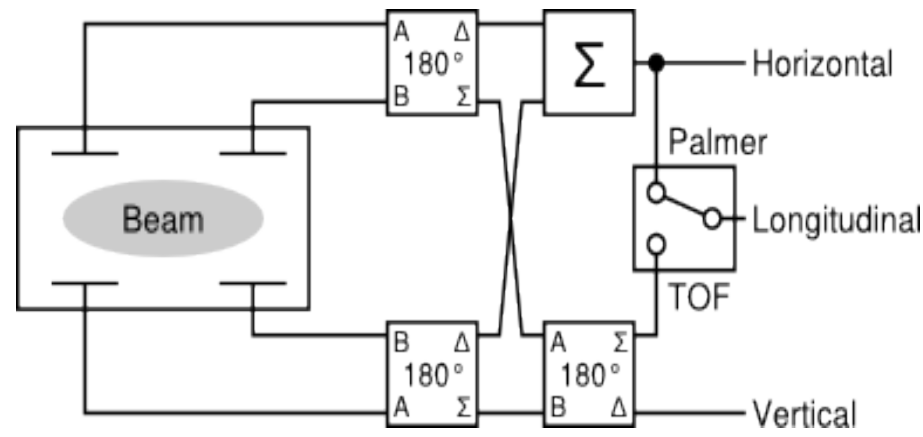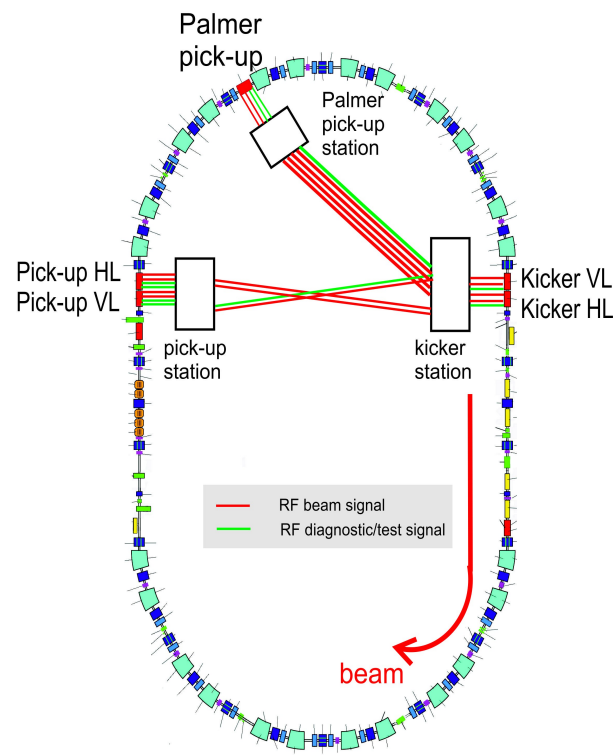
Introduction

- Palmer cooling and Faltin rails at the CR
- Simulation Design Methods
- Problems, Solutions and Results
- Conclusions

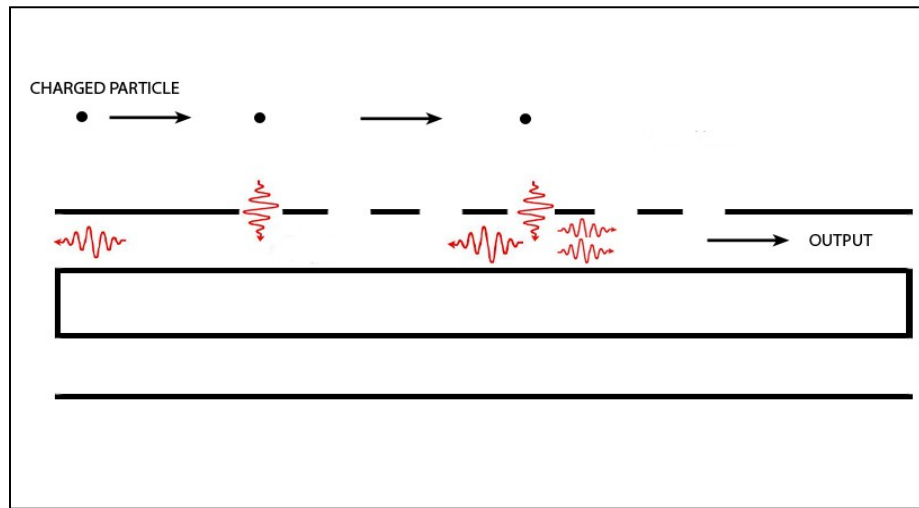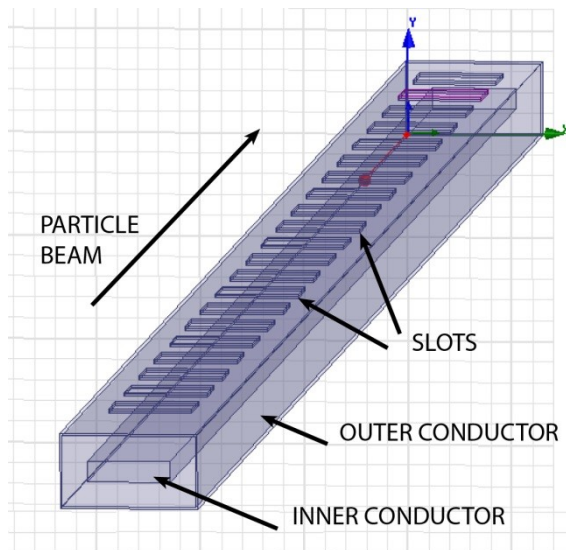Duncan Barker, COOL'15, Newport News, VA, USA, 2015

Palmer Cooling at the CR

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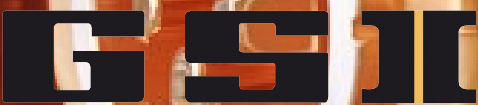## The Faltin Rail

L. Faltin, Nucl. Instr. and Meth. 148, p.449-455, (1977).

- $V_{phase} = V_{particle}$
- RIBS $0.83c = 2.49e8$ ms^{-1}

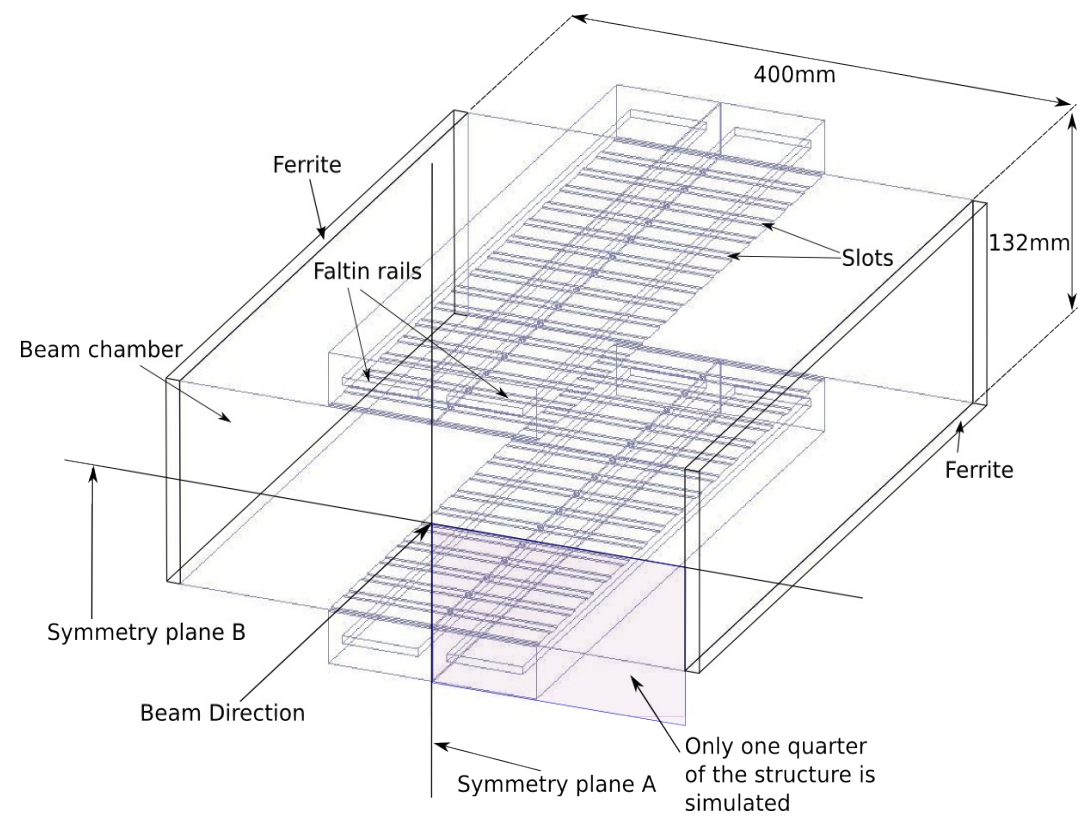Duncan Barker, COOL'15, Newport News, VA, USA, 2015

Palmer Pickup Tank

- Strong pickup signal from the beam
- Need a linear phase
- 1-2GHz.

$$Z_k(f) = \frac{V_{accel}^2}{P_k} \quad Z_{pu}(f) = \frac{P_{pu}}{I_b^2}$$

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Palmer Pickup Tank

- Simulations are done with HFSS

- The pickup can be simulated as Pickup or as a Kicker - Reciprocity
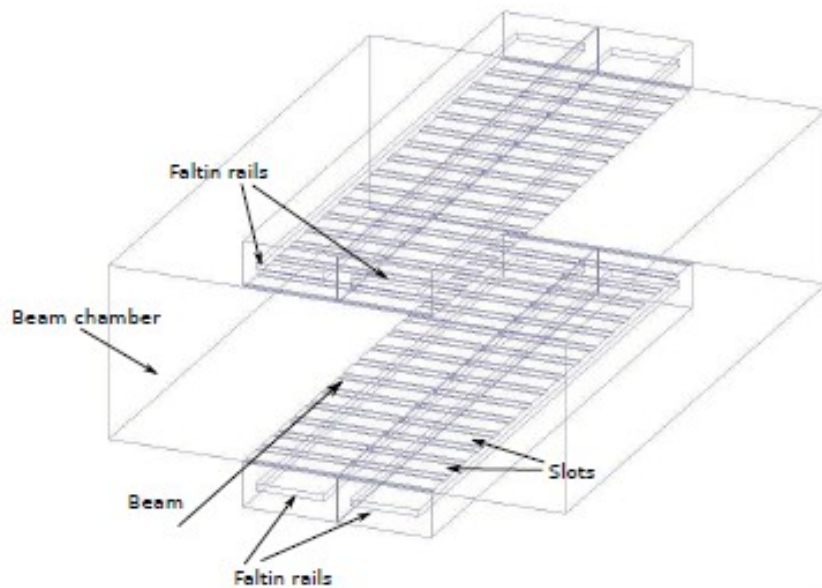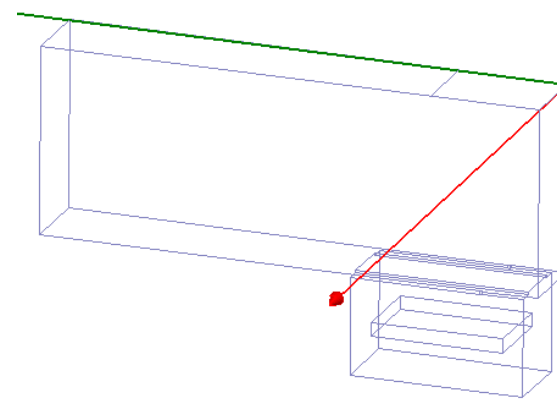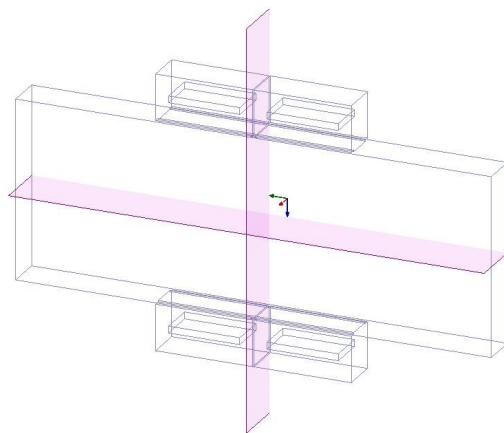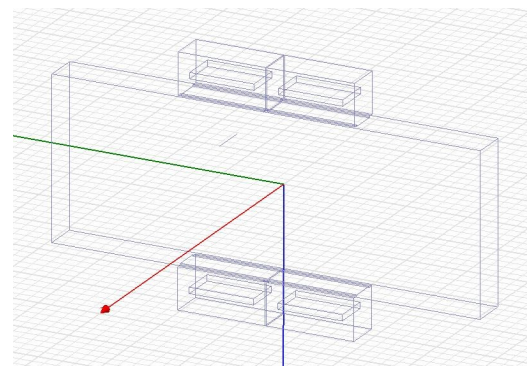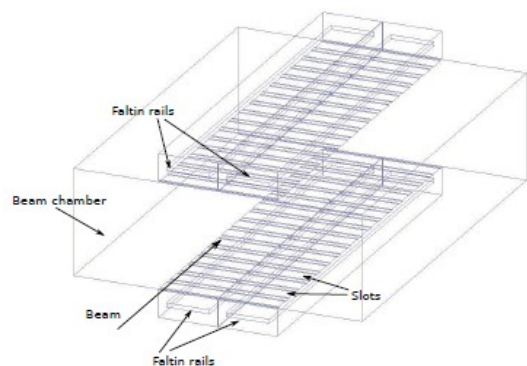

- HFSS – Eigenmode, Drivenmode and Foil method

- Eigenmode – simulation as a kicker

- Drivenmode – simulation as a kicker

- Foil Method – simulation as a pickup

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Cell Method – Eigenmode (kicker)

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Cell Method – Eigenmode (kicker)
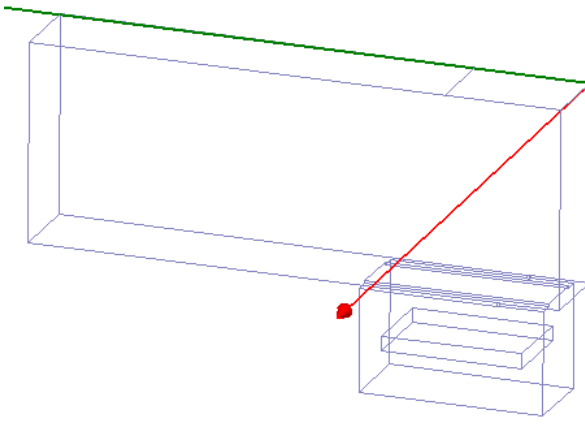
$$Z_{pu} = \frac{P_{pu}}{I_b^2} \qquad Z_k = \frac{V_{accel}^2}{P_k}$$

$$sa = \int_{polyline} Re\left(E_z\left[\cos(\frac{\omega z}{v_p}) + i\sin(\frac{\omega z}{v_p})\right]\right)$$

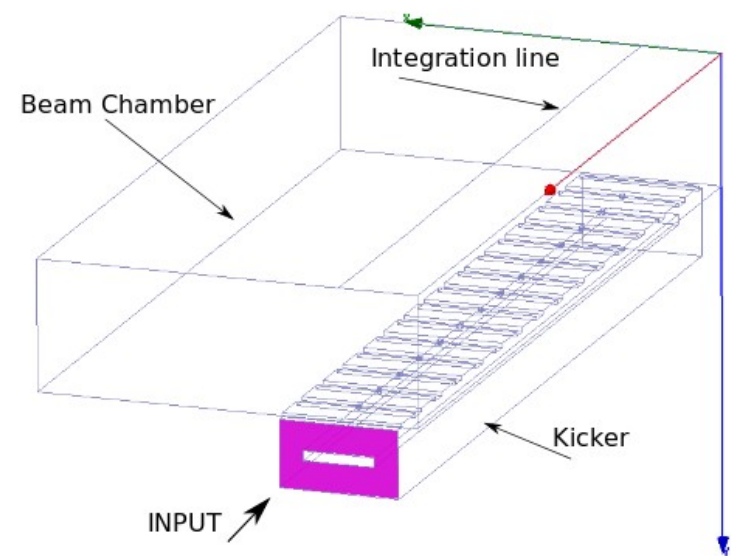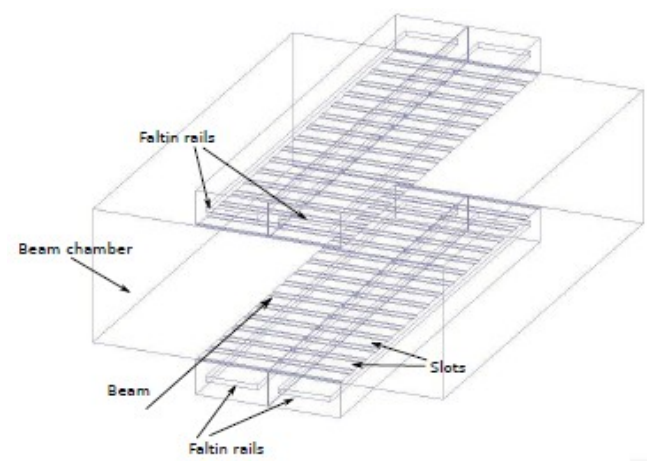$$ima = \int_{polyline} Im\left(E_z\left[\cos(\frac{\omega z}{v_p}) + i\sin(\frac{\omega z}{v_p})\right]\right)$$

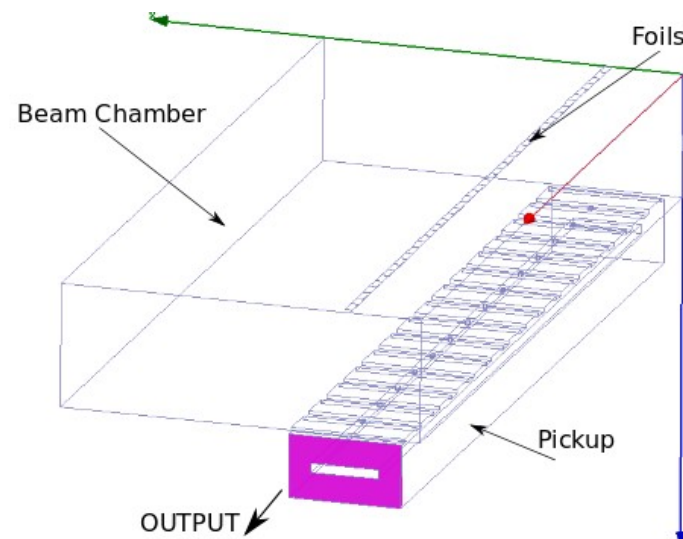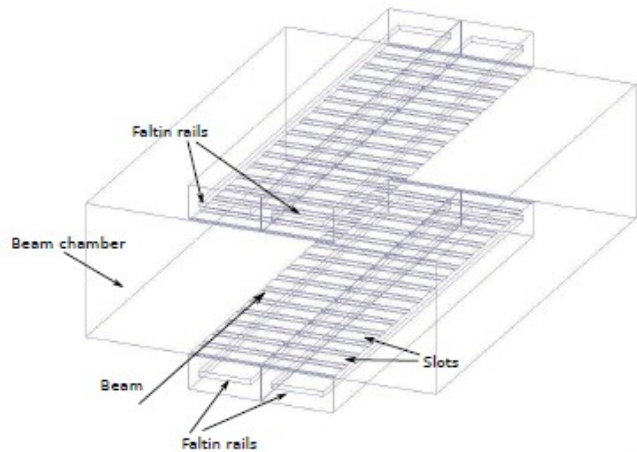$$\frac{r}{Q} = \frac{((sa)^2 + (ima)^2)}{2\omega W}$$

$$Z_k(n,h) = \left(\frac{R}{Q}\right)_h m\omega_h T_h F_{\phi slip}^2$$

$$Z_{pu}(n,h) = \frac{1}{4}\left(\frac{R}{Q}\right)_h m\omega_h T_h F_{\phi slip}^2$$

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Driven Mode - (kicker)

$$sa = \int_{polyline} Re\left(E_z\left[cos(\frac{\omega z}{v_p}) + isin(\frac{\omega z}{v_p})\right]\right)$$

$$ima = \int_{polyline} Im\left(E_z\left[cos(\frac{\omega z}{v_p}) + isin(\frac{\omega z}{v_p})\right]\right)$$

$$Z_k = \frac{V_{accel}^2}{P_k}$$

$$Z_{pu}(f) = \frac{V_{accel}^2}{32}$$

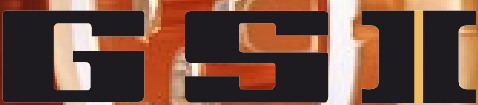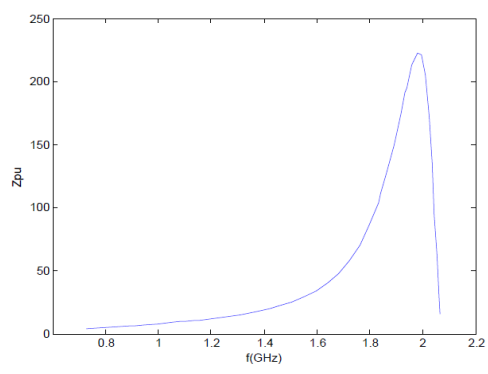Duncan Barker, COOL'15, Newport News, VA, USA, 2015

Foil Method (Pickup)

$$Z_{pu} = \frac{P_{pu}}{I_b^2}$$

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Cell Method – Results
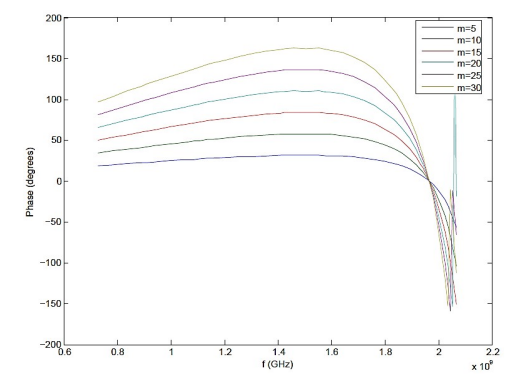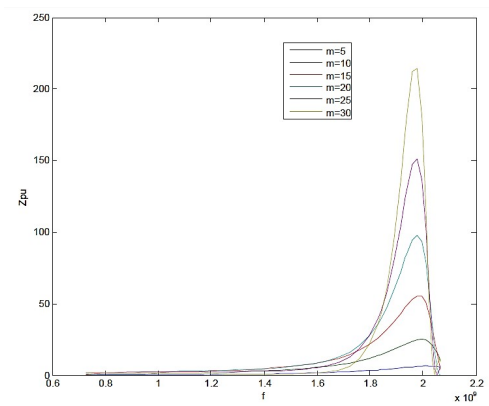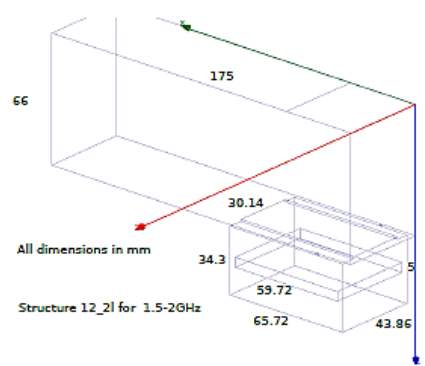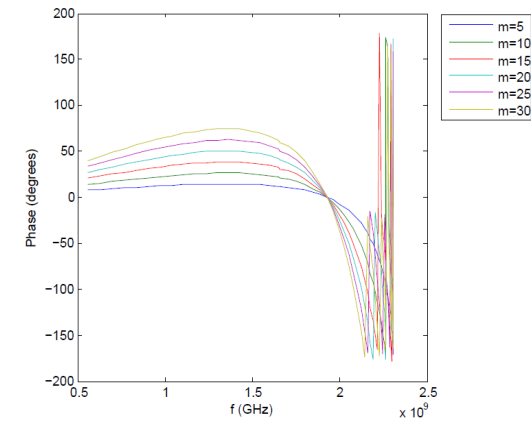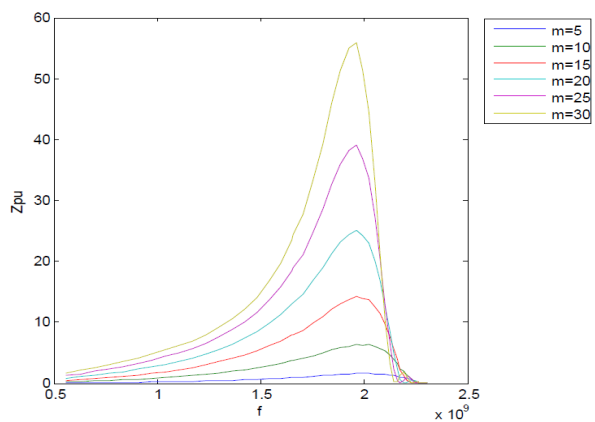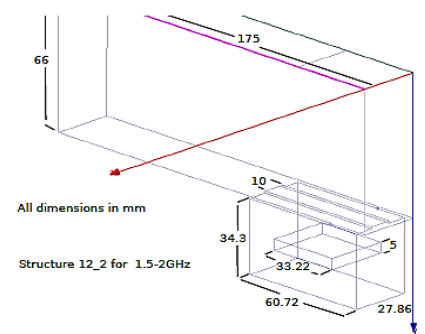
Duncan Barker, COOL'15, Newport News, VA, USA, 2015
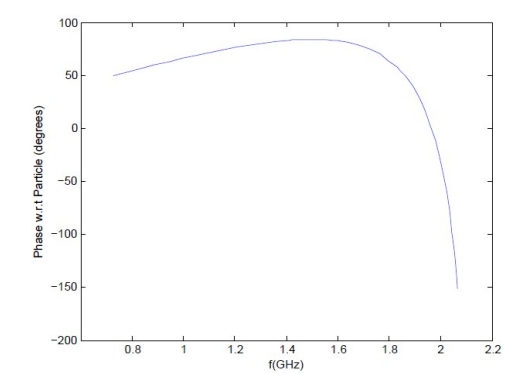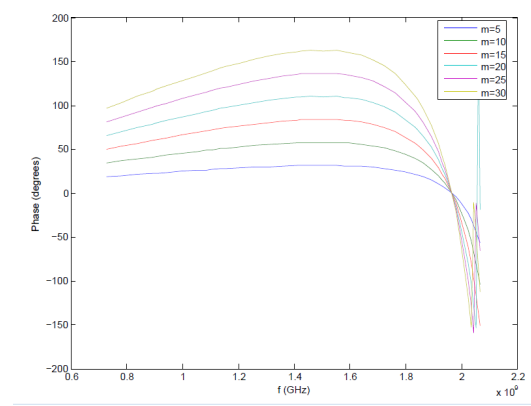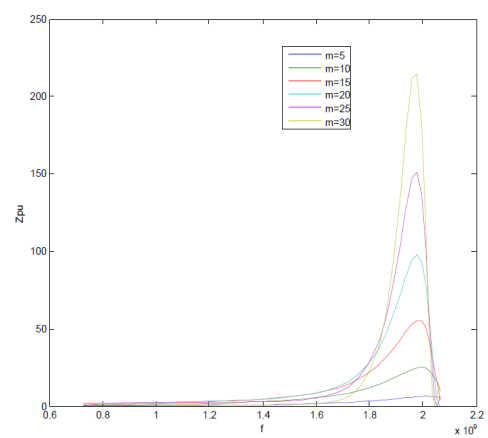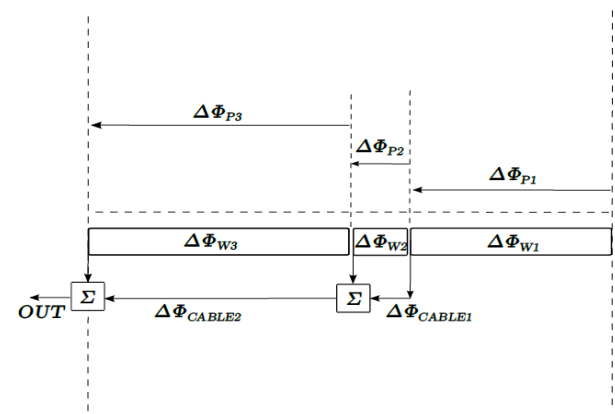
Cell Method – Combining Rails

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Cell Method – Combining Rails

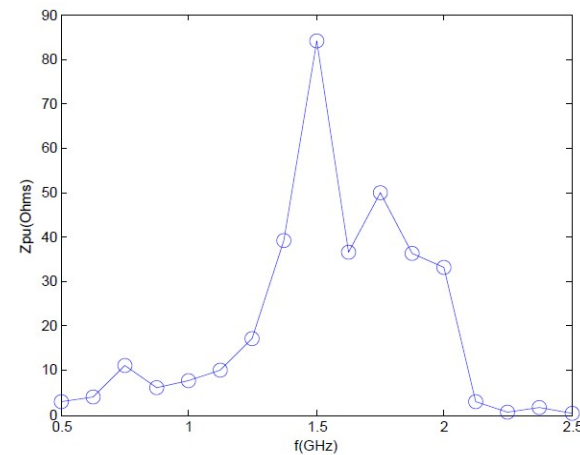- 3 separate rails of the same structure with number of cells [20 12 7]. Structure 12_2
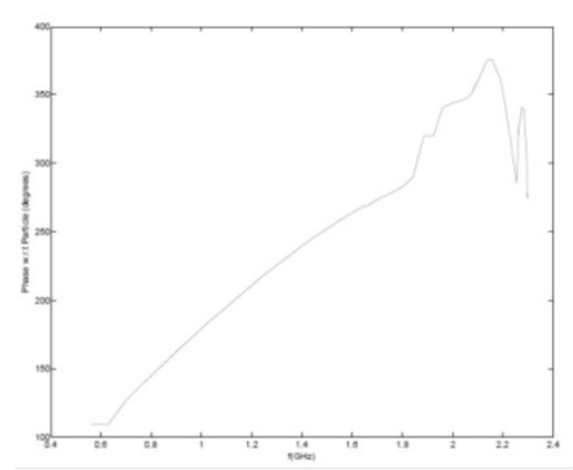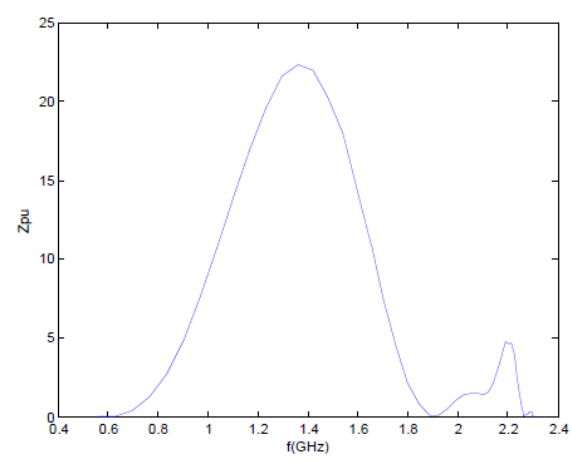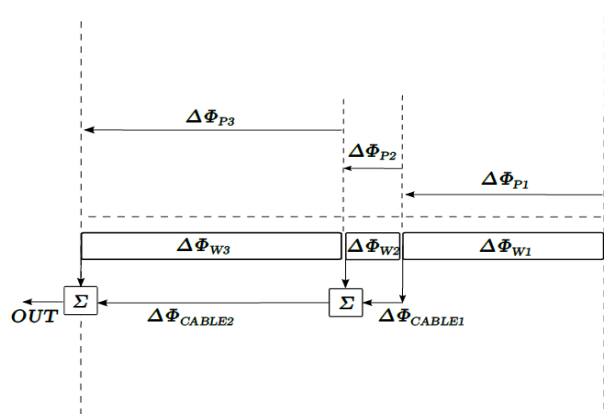
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Foil Method – Combining Rails
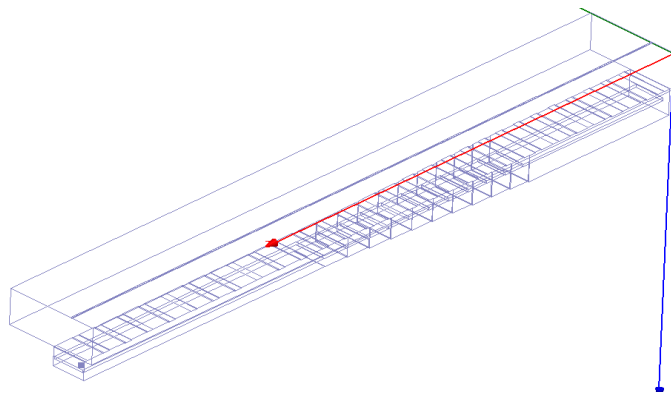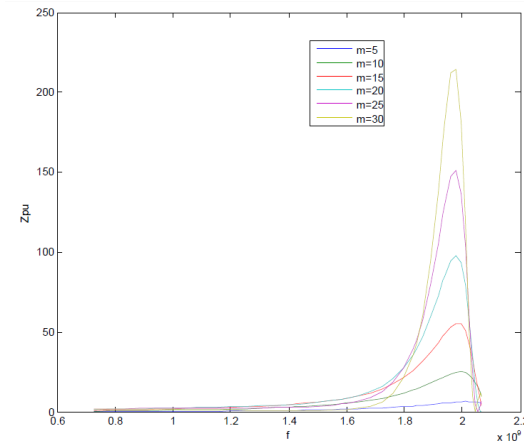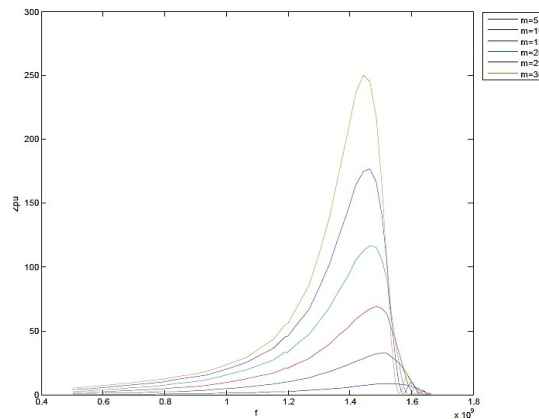
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Matching Pieces
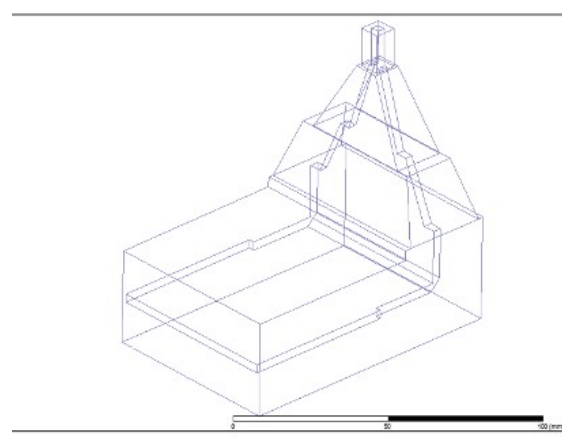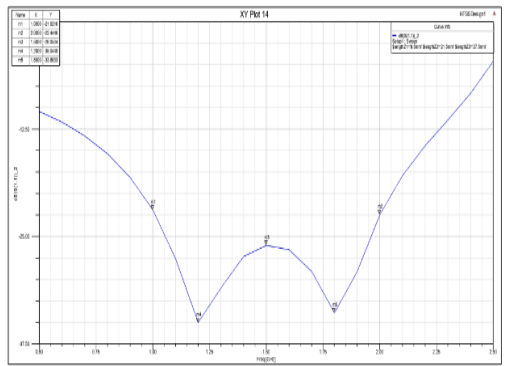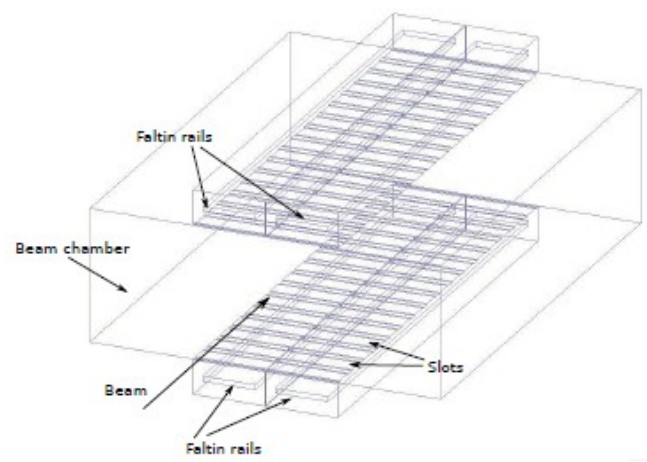
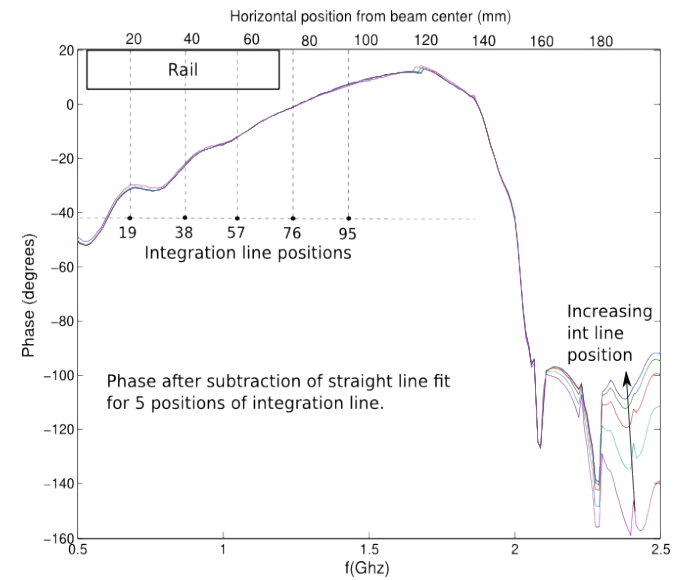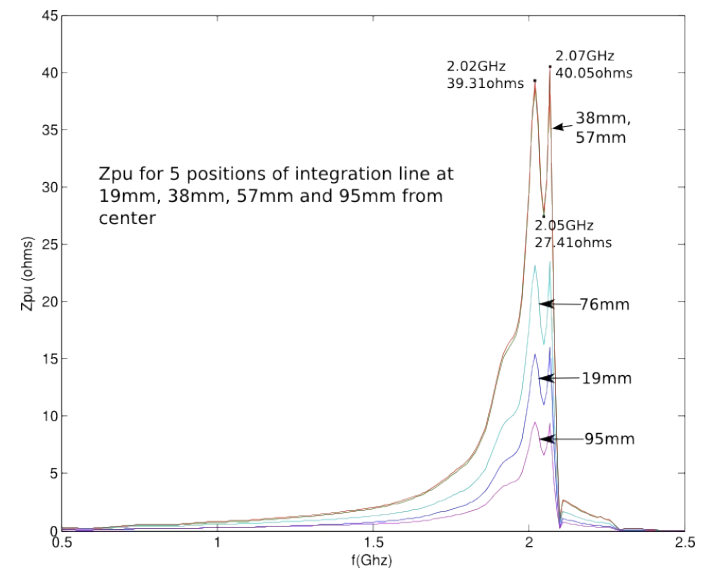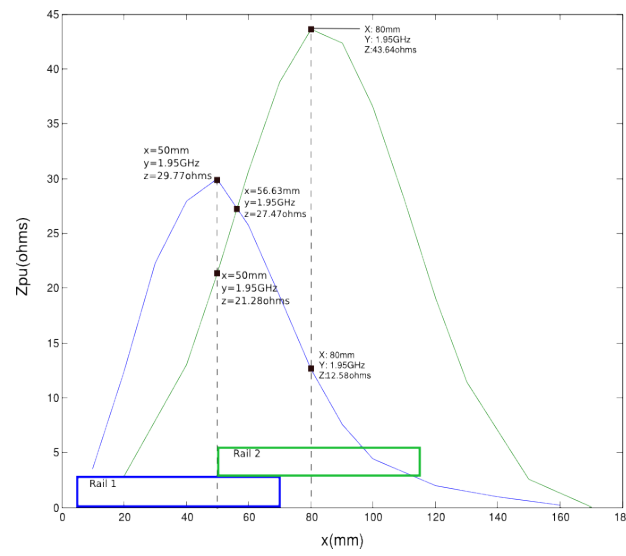

- 3 stage, rectangular coax, tapered quarter wavelength transformer

- 29ohm to 50ohm

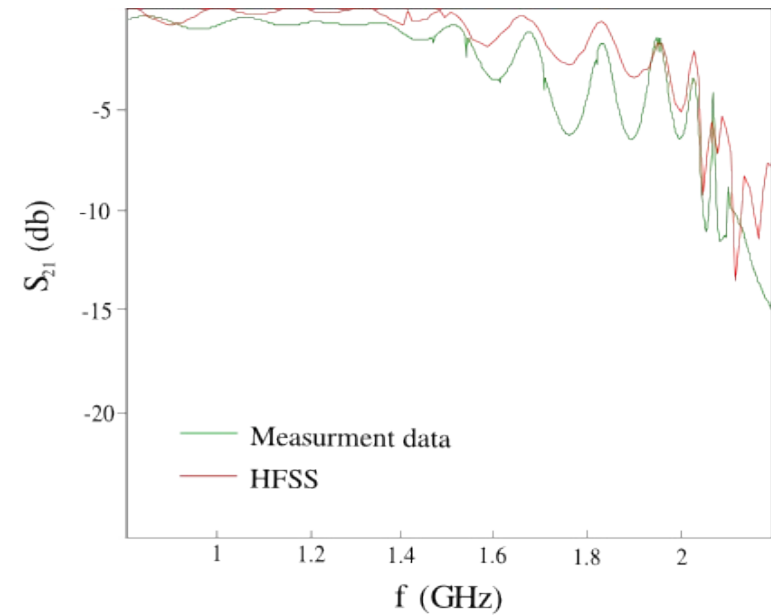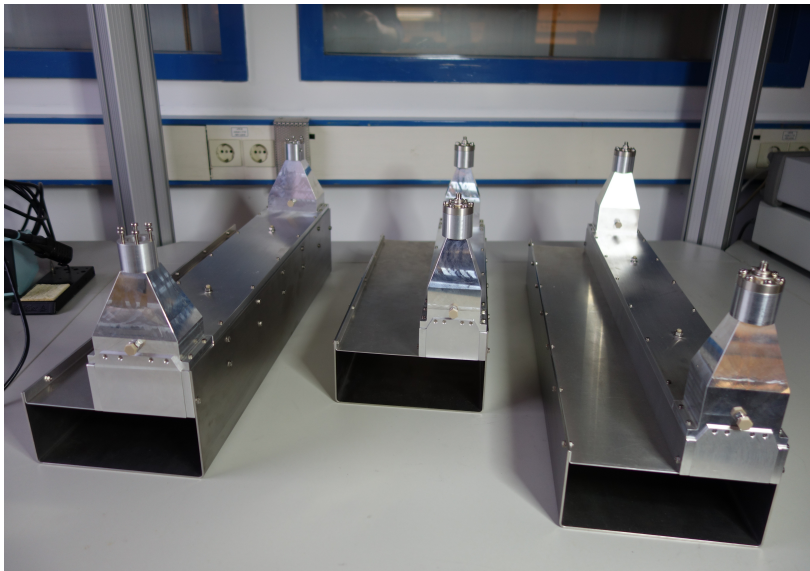Duncan Barker, COOL'15, Newport News, VA, USA, 2015

Horizontal Particle Position

Duncan Barker, COOL'15, Newport News, VA, USA, 2015

Prototypes

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Final Design
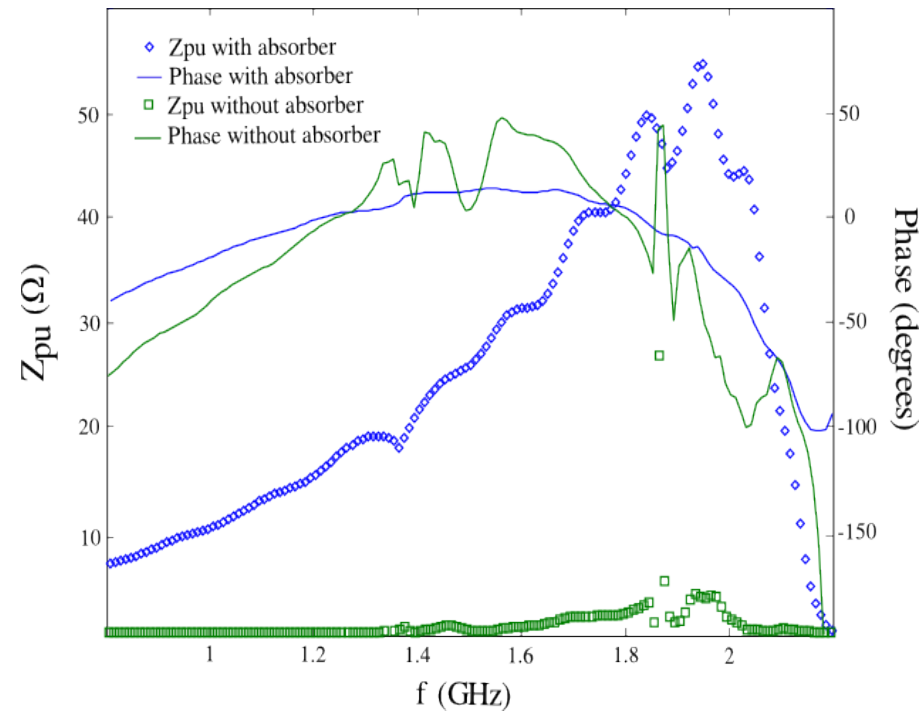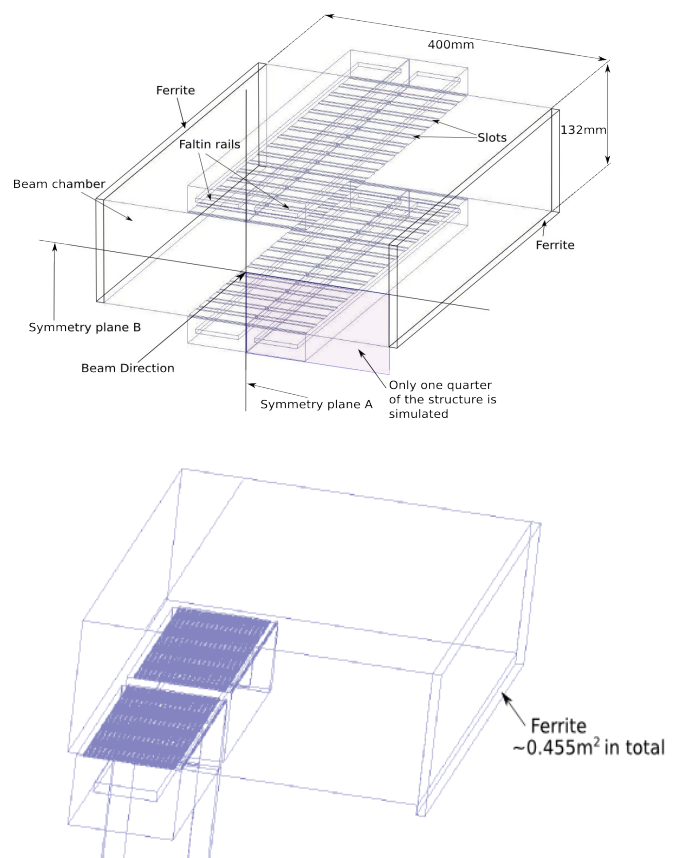
- Two rails of 49 cells each
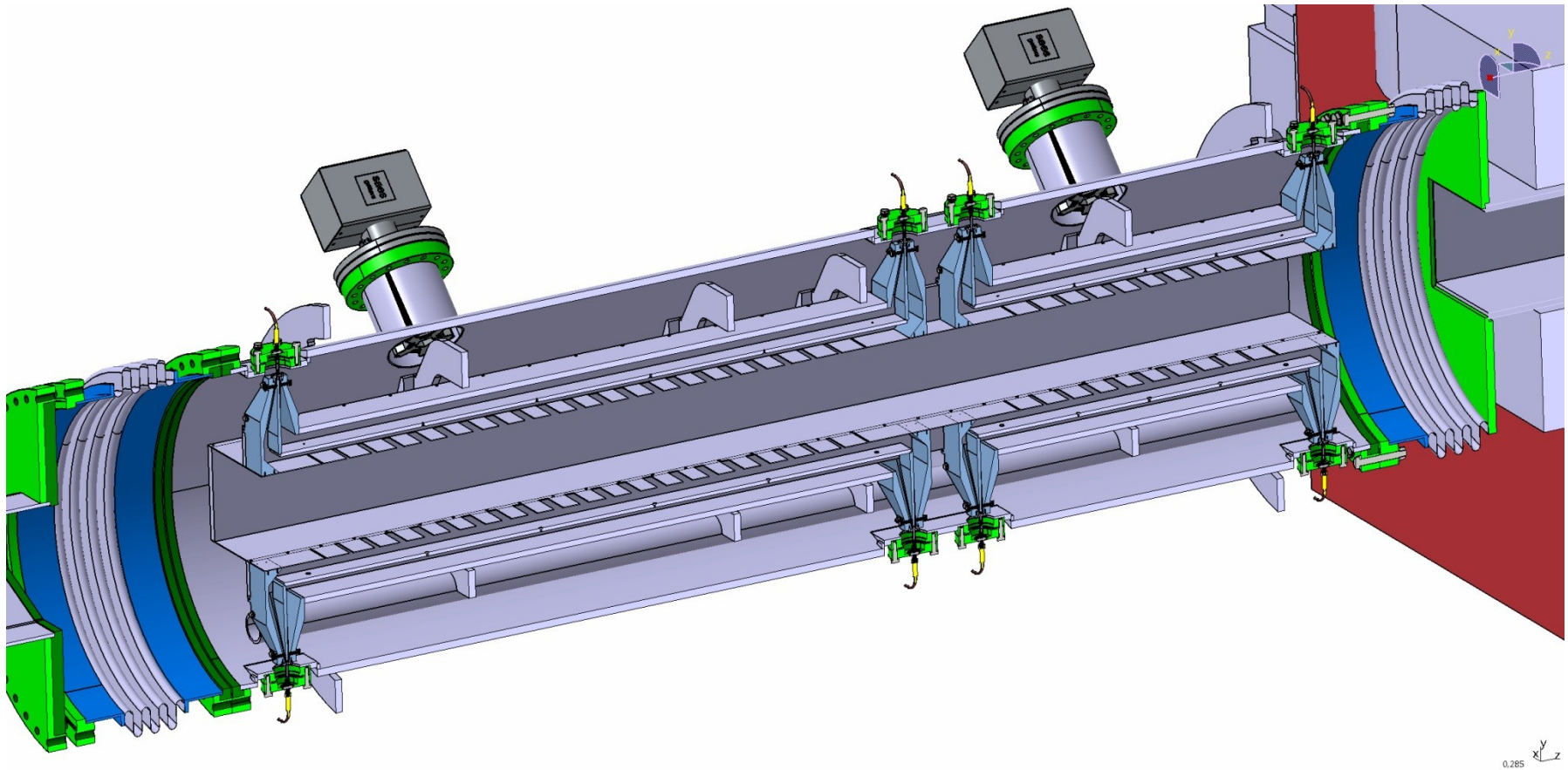
Duncan Barker, COOL'15, Newport News, VA, USA, 2015

Tank design

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Conclusion

- Three design methods using HFSS have been shown
- Benefits of combining several rails
- Matching piece design
- Prototypes and simulation check
- Final design and the need for damping material

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