

# FNAL PXIE BPM Option

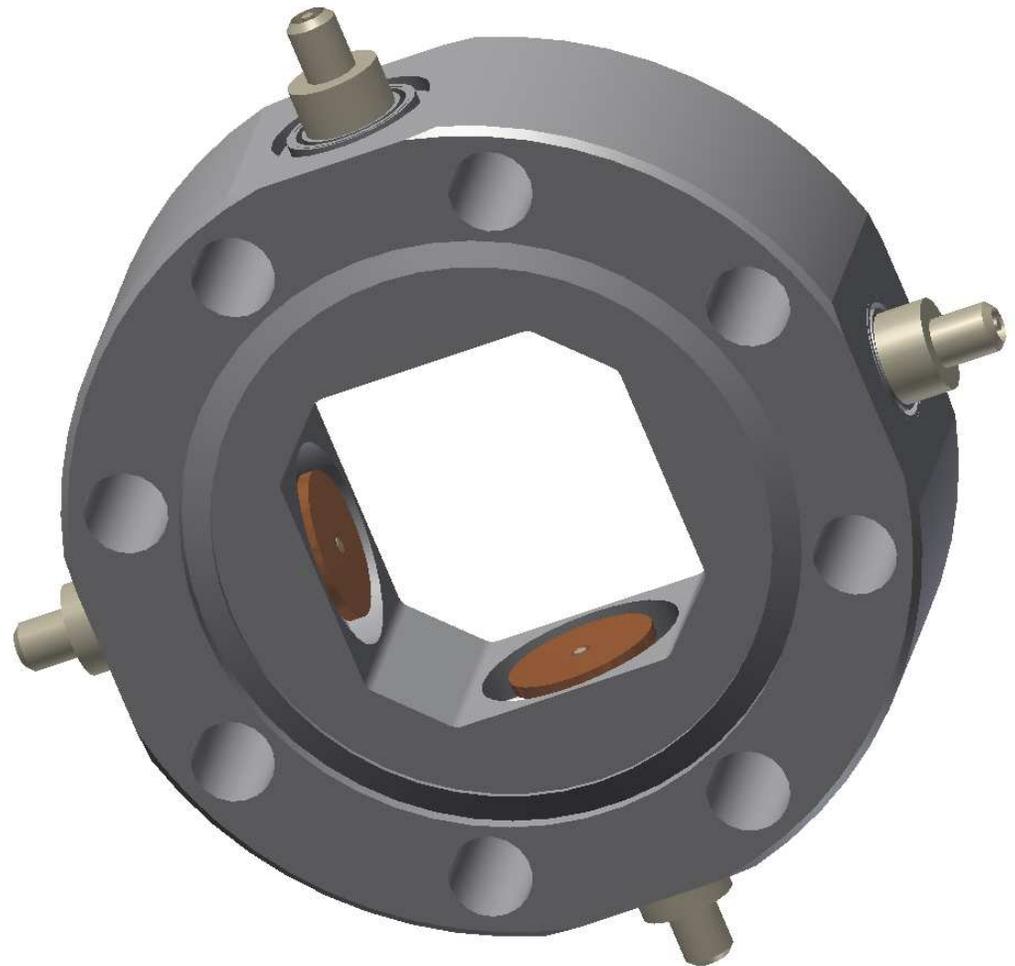
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## BPM Design

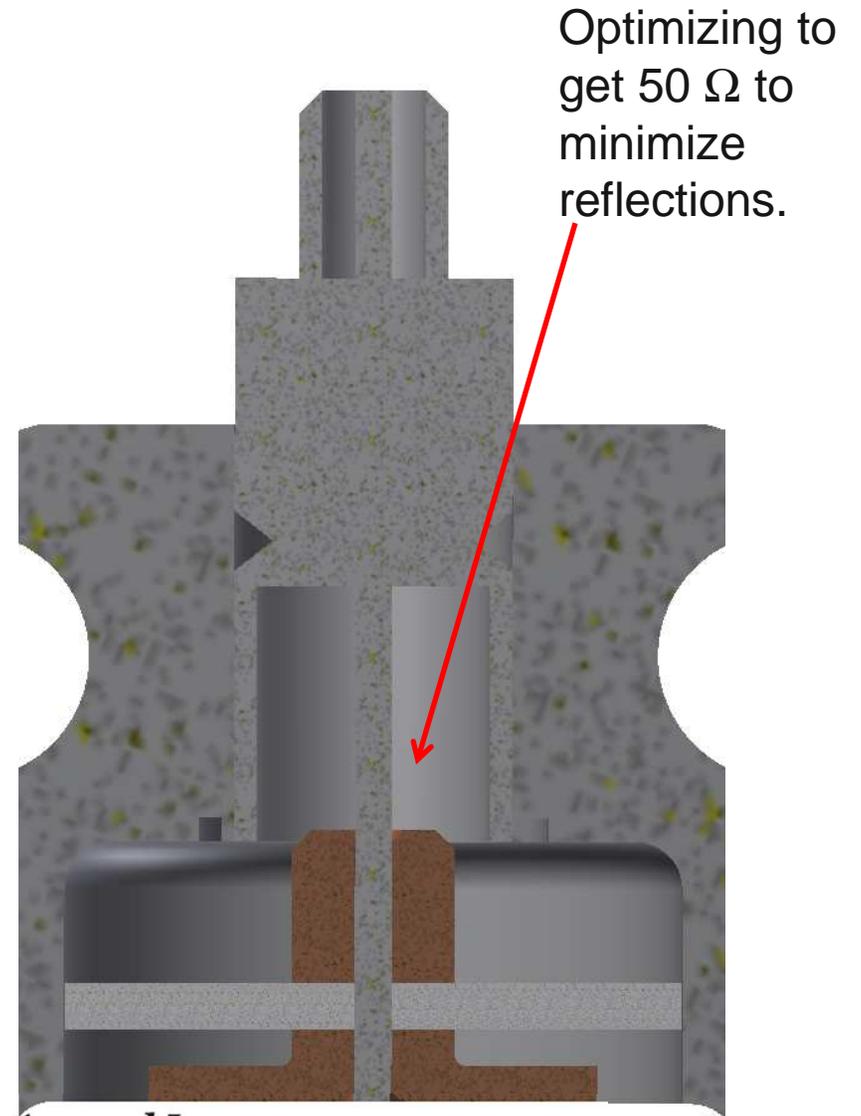
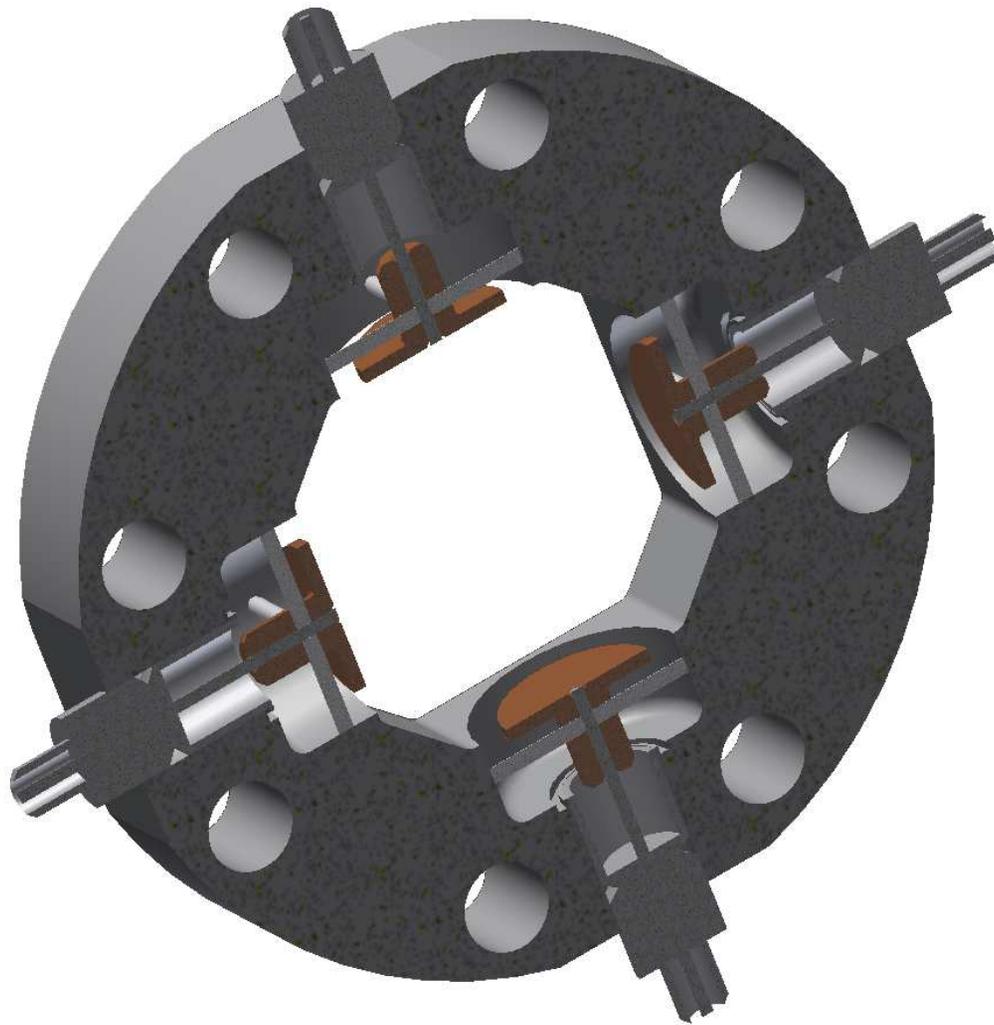
- Couple to the beam with a an induced voltage of .
- Cleanable.
- Minimal cost.
  - ~\$4,000 per unit
- Compact.
- Position measurement
  - Possibly measure phase
  - Will build prototype and install in ATLAS to test.
- Do not need BPMs right now
  - Need in ~1 year for cryomodule



Electrodes ~0.65" dia, aperture ~ 36mm, OD ~ 3.4".



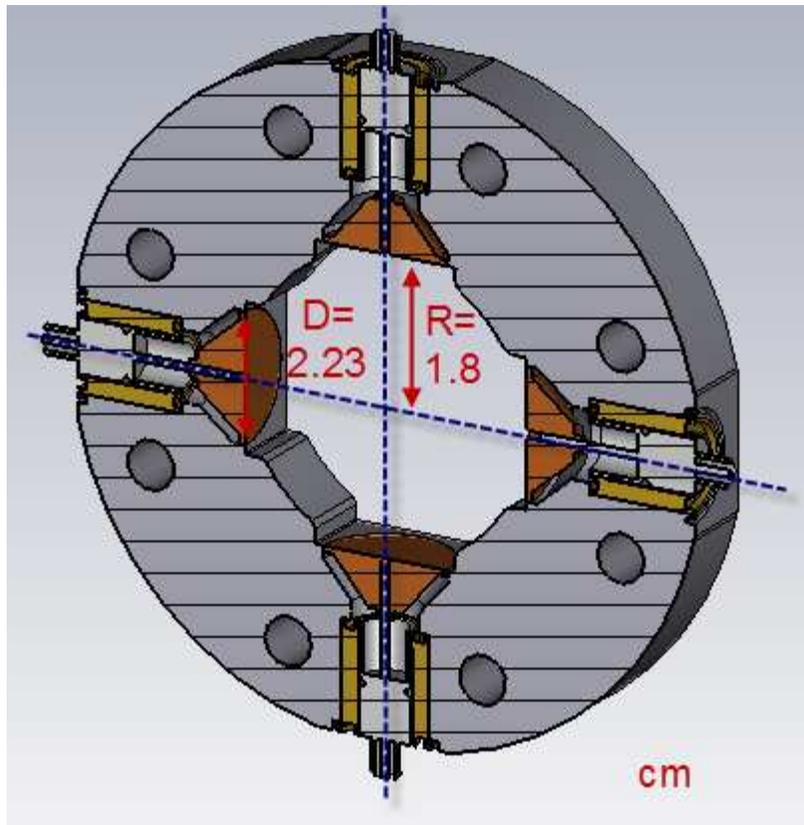
# BPM Button Electrode



$$V_{signal} = R * \frac{A}{2\pi a} * \frac{1}{\beta c} * \frac{dI_{beam}}{dt}$$



# BPM Design



Parameter	Value
F, MHz	162.5
I, mA	4
W, MeV	10

# Electrode response signal

- According to [1] the button-electrode response to a single Gaussian beam bunch containing N particles is:
  - $q = I \cdot T = I/f = 24.6 \text{ pC}$
  - $C = 10.4 \text{ pF}$  (from EM-studio)  $\longrightarrow$
  - $\sigma = 2 \text{ deg} \cdot T / 360 \text{ deg} = 34 \text{ ps}$
  - $\beta = 0.145$
- $V_{\text{peak}} = 2.2 \text{ V}$   
(for 4mA)
- $V_{\text{peak}} = 0.55 \text{ V}$   
(for 1mA)

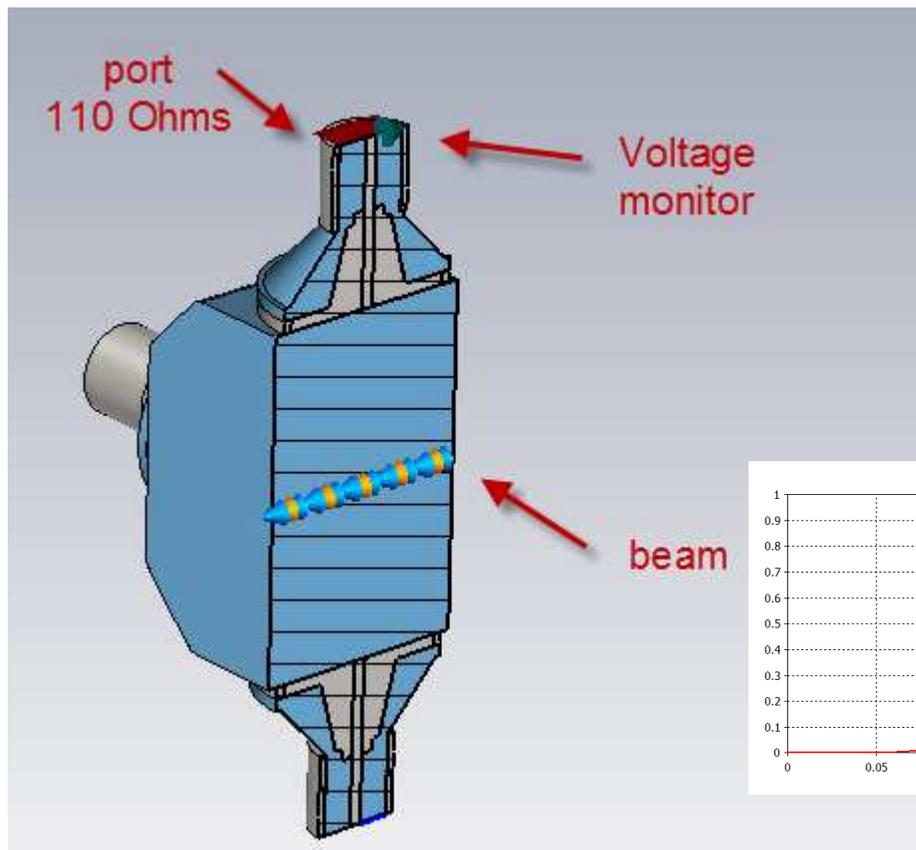
[1] Stephen R. Smith "Beam Position Monitor Engineering", SLAC

$$V_{\text{signal}} = R * \frac{A}{2\pi a} * \frac{1}{\beta c} * \frac{dI_{\text{beam}}}{dt}$$

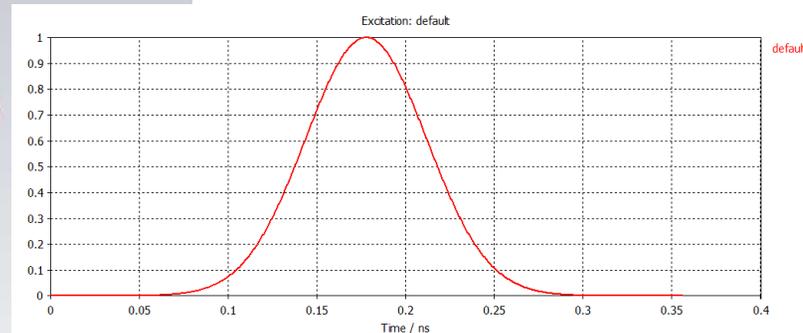


# Particle Studio Simulations

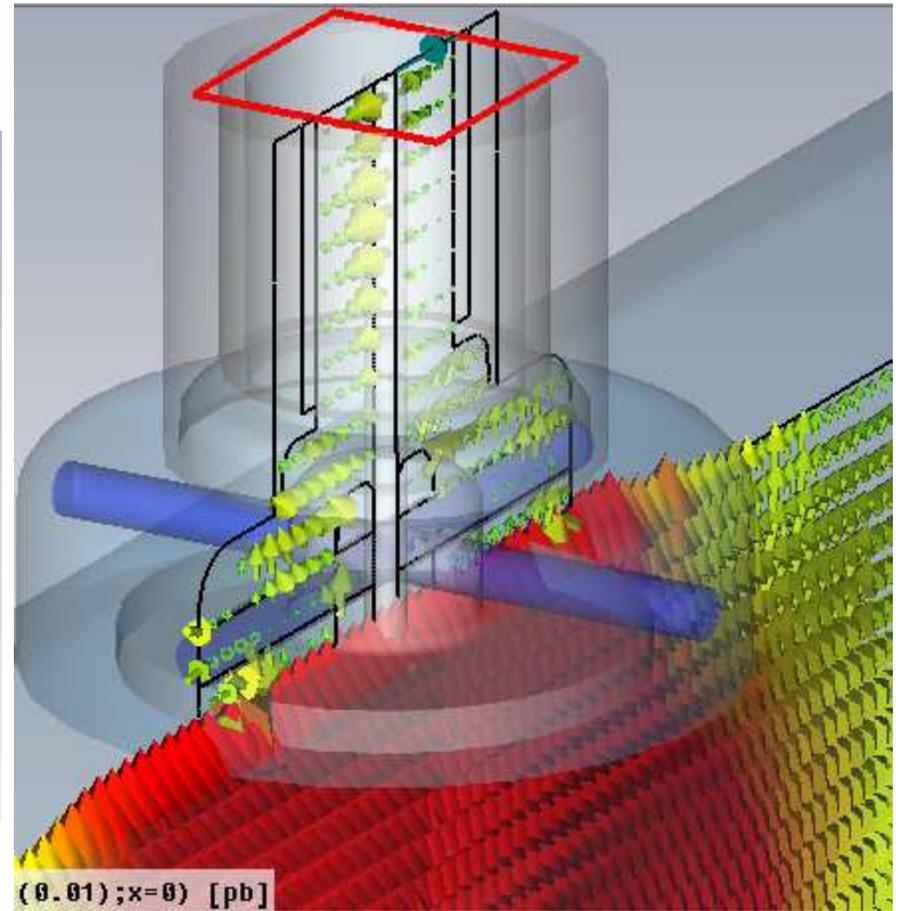
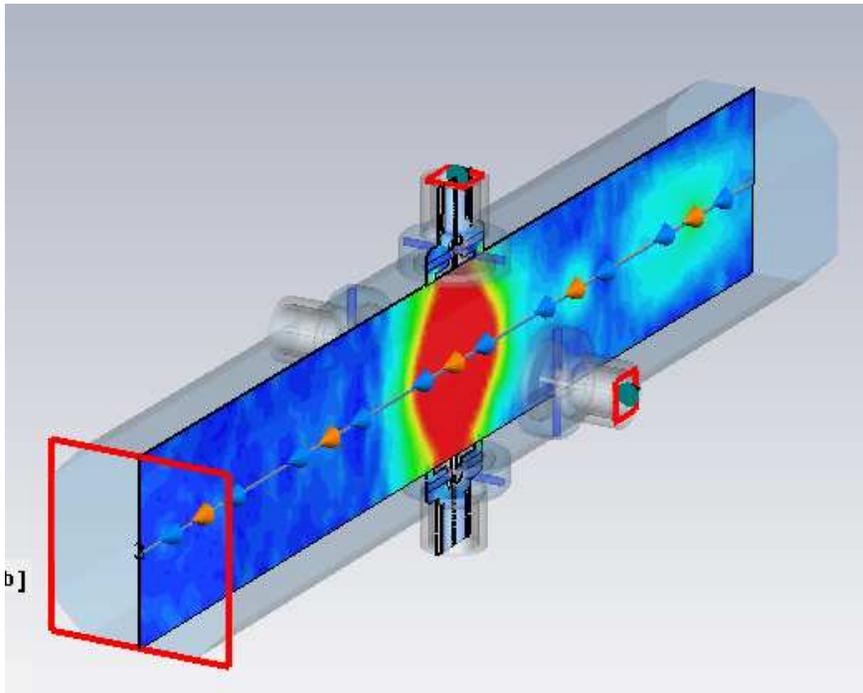
- Using Wakefield Solver
- W-solver is a T-solver with Gaussian beam excitation



Beam Parameter	Value
Sigma, cm	0.149
Q, pC	24.6
beta	0.145

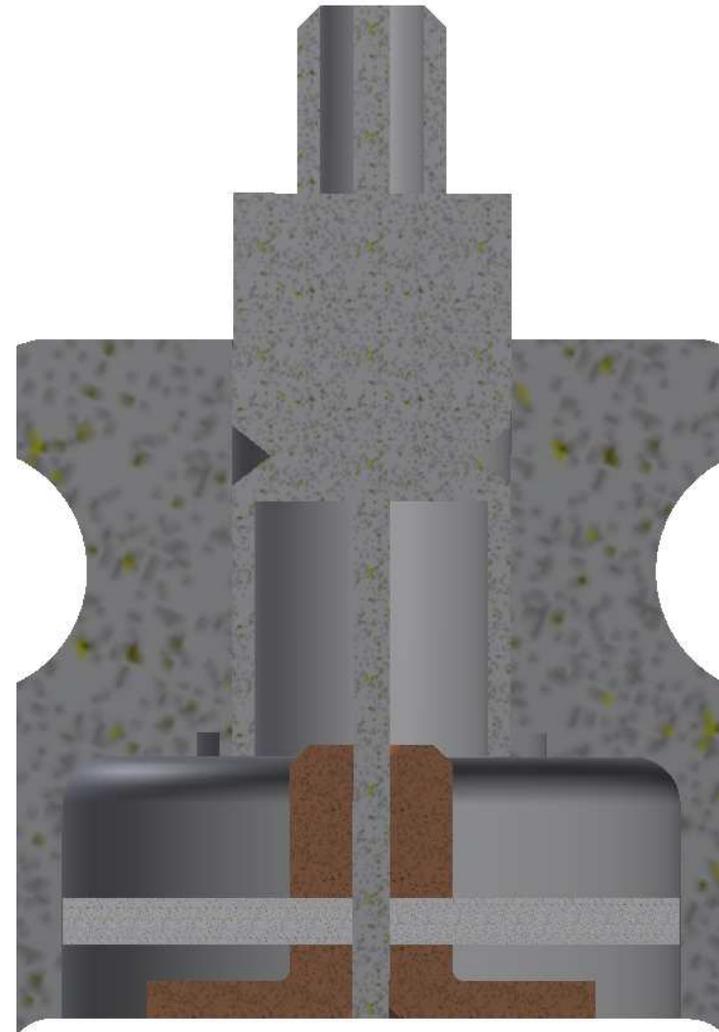


# Electric Fields



## BPM Cleaning

- The BPM will be located next to the SRF cavities in the cryomodule.
- The BPM must be cleaned such that it will not contaminate the SRF cavities, degrading their performance.
  - Ultrasonic clean in a 1-2% liquinox & deionized water solution @ 120°F.
  - High pressure water rinsing with DI water.
  - Mechanical structure of the BPM must be strong enough to survive these operations.



# BPM Fabrication Cost

## Prototype Cost

Item	Quantity	Cost Per Unit (USD)	Total Cost (USD)
3.375" CF Flange	1	\$65.00	\$65.00
50 $\Omega$ SMA Connector	4	\$85.00-\$345.00	\$1,380.00
Electrode	4	\$200.00	\$800.00
CF EDM	1	\$2,200.00	\$2,200.00
Welding	2	\$600.00	\$600.00
Sapphire Rods	4	\$65.00	\$260.00
Total			\$5,305.00



# BPM Fabrication Cost

## Cost To Fabricate 8 Units

Item	Quantity	Cost Per Unit (USD)	Total Cost (USD)
3.375" OD SS Rod	8"	\$200.00	\$200.00
50 $\Omega$ SMA Connector	32	\$85.00-\$345.00	\$11,040.00
Electrode	32	\$200.00	\$6,400.00
CF EDM	8	\$500.00	\$4,000.00
Welding	8	\$600.00	\$4,800.00
Sapphire Rods	32	\$65.00	\$2,080.00
Total			\$28,520.00



# Summary

- Almost ready to fabricate prototype BPM which will be tested with beam at ATLAS to evaluate performance.
  - Need to finish electromagnetic simulations
  - Need to procure parts
- The proposed design is cleanable and robust enough to survive the rigorous cleaning of SRF cryomodule beam-line components.
- The proposed design poses a minimal cost burden on the project.

