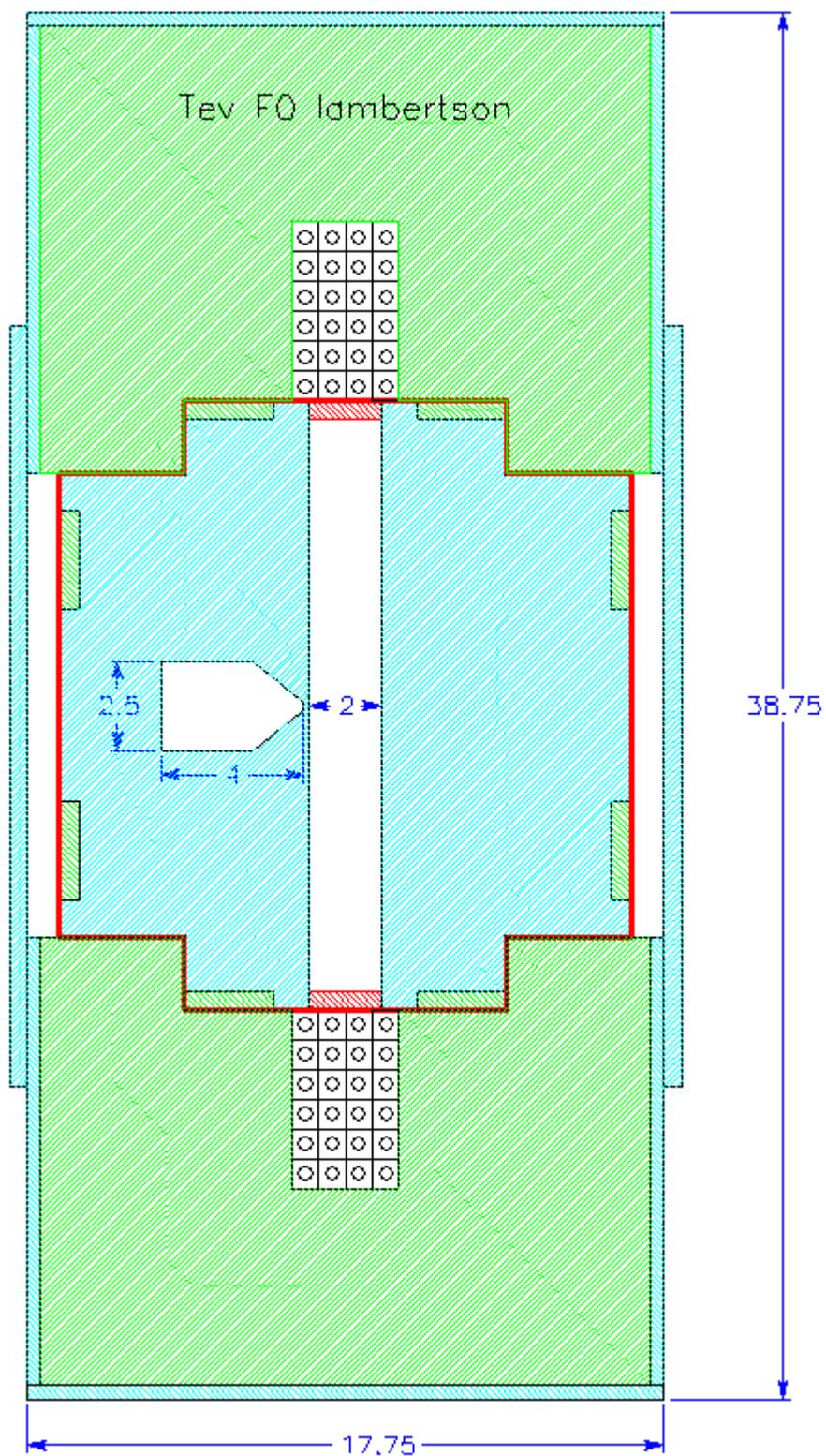


# Measured F0 Lambertson Beam Impedance

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## How to measure impedance

Better results are obtained by estimating the transverse impedance from a longitudinal impedance measurement.

Longitudinal impedance is derived from the attenuation ( $S_{21}$ ) measured through the device. The attenuation is normalized to the attenuation measured through a 3" stainless beam pipe. This corrects for termination errors and for losses associated with the wire itself.

The real impedance is discussed here. (the real and imaginary parts of the impedance are equal)

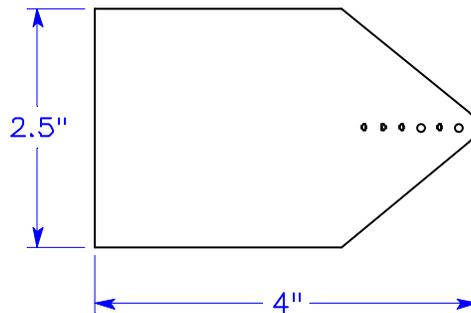
$$Z_L = -2Z_0 \ln S_{21} = 2 Z_0 \frac{S_{21}[db]}{20 \log(e)} \quad \text{for distributed impedance}$$

$$\frac{Z}{n} = Z_L \frac{\omega_0}{\omega} \quad \omega_0 = 2\pi \text{ rotation frequency}$$

For a round pipe of radius  $b$ :

$$\begin{aligned} Z_T &\approx \frac{2c}{\omega b^2} Z_L \\ &= \frac{2c}{\omega_0 b^2} \frac{Z_L}{n} \end{aligned}$$

For these measurements, the distance between the wall and the wire was used for  $b$ .

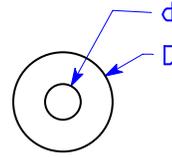


The impedance was measured at 6 positions in the F0 lambertson: 5, 10, 15, 20, 25, and 30mm from the nose.

## What is Zo?

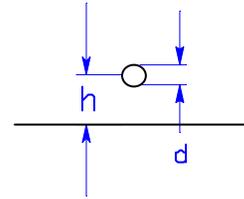
**coaxial line:** (let  $D=2$  x distance from surface)

$$Z_o = \frac{1}{2\pi} \sqrt{\frac{\mu}{\epsilon}} \ln \frac{D}{d} = 60 \ln \frac{D}{d}$$



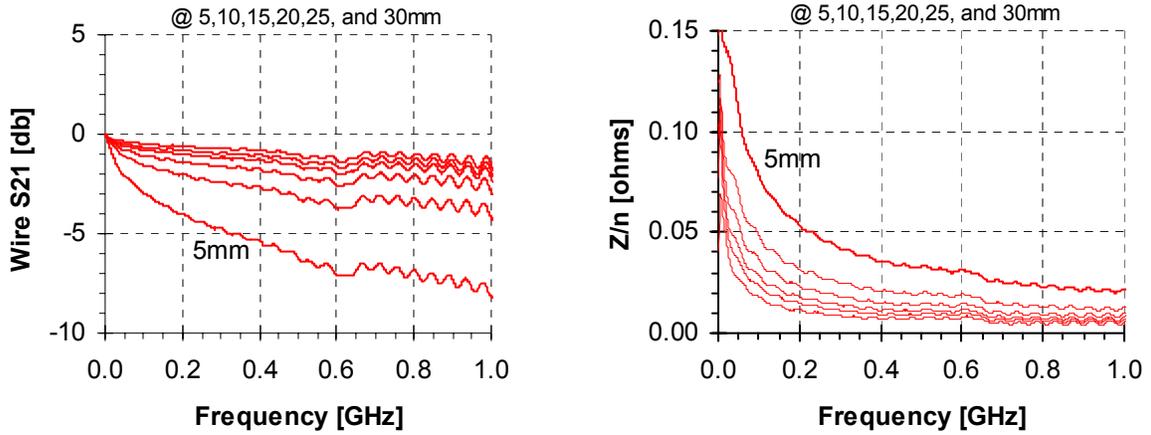
**single plate line:**

$$Z_o = \frac{1}{2\pi} \sqrt{\frac{\mu}{\epsilon}} \ln \frac{4h}{d} = 60 \ln \frac{4h}{d}$$

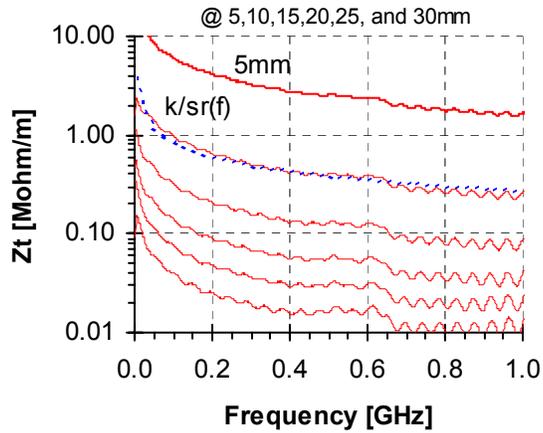


b mm	coaxial ohms	wire/plane ohms	used ohms	
30	328	369	328	coaxial
25	317	359	326	estimate
20	304	345	324	average
15	286	328	307	average
10	262	304	283	average
5	220	262	241	average

F0 lambertston impedance (**for one lambertston**)

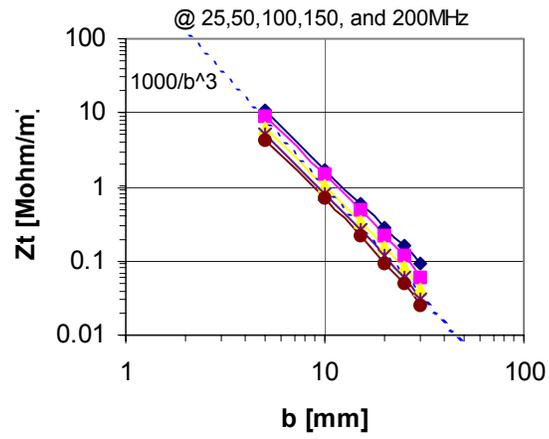


Measured attenuation and longitudinal impedance of one Tevatron F0 lambertston with the wire 5, 10, 15, 20, 25, and 30mm from the septa.



Transverse impedance for one lambertston estimated from the longitudinal measurement with the wire at 5, 10, 15, 20, 25, and 30mm from the nose. A dotted trace indicates one over square root of frequency dependence.

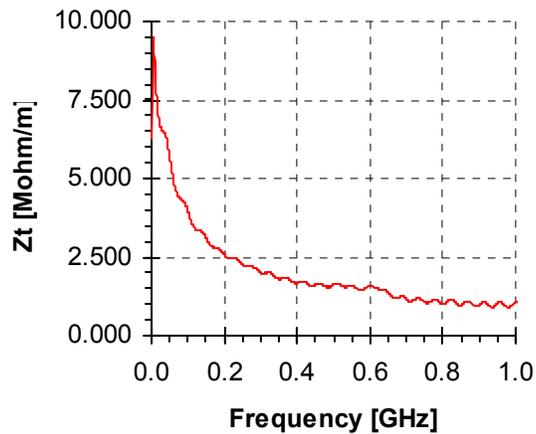
### Effect of beam position



Horizontal and Vertical impedance for one lambertson at 6 different positions and 4 frequencies. .

### Conclusions:

- Transverse impedance scales like one over the square root of frequency and one over the distance to the surface cubed.
- All four Tev F0 lambertsons have  $24\text{M}\Omega/\text{m}$  at  $100\text{MHz}$  with beam  $5\text{mm}$  from the surface
  - Doubling the distance would reduce this to  $3\text{M}\Omega/\text{m}$
- 24 Tev Separators have  $2.4\text{M}\Omega/\text{m}$  in a limited frequency range around  $25\text{MHz}$ .
  - This could be eliminated by changing the  $50\Omega$  series resistor to  $500\Omega$ .



Transverse impedance at  $10\text{mm}$  from the nose for all 4 lambertsons.