A New Stripline BPM Design for the ILC IR Fast Feedback (?!)

– For discussion: A metal/ceramic brazed BPM pickup –

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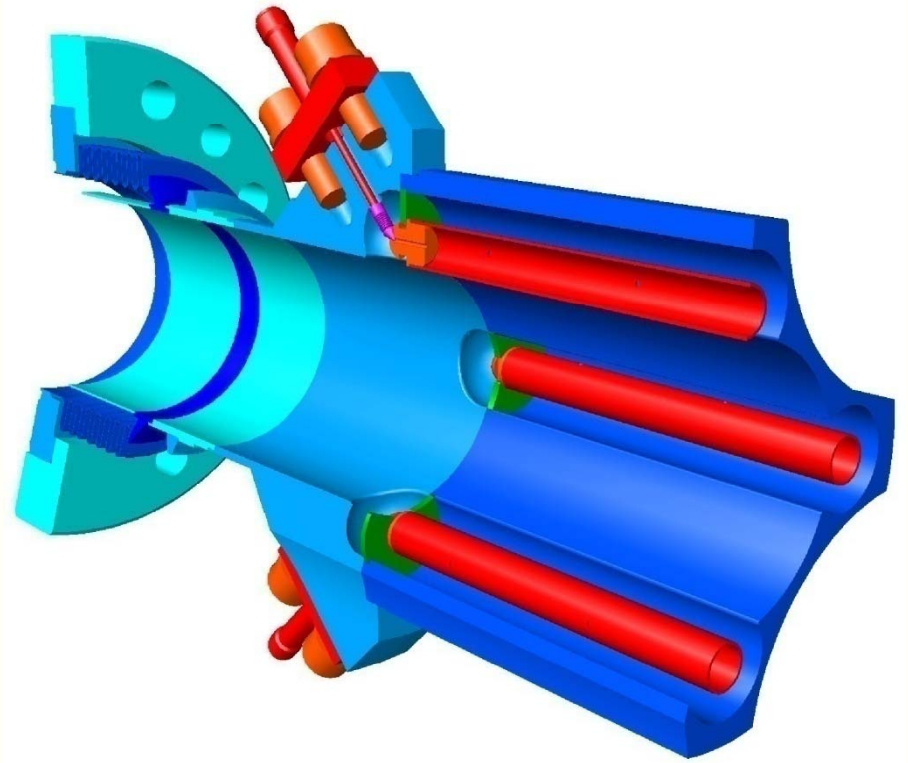
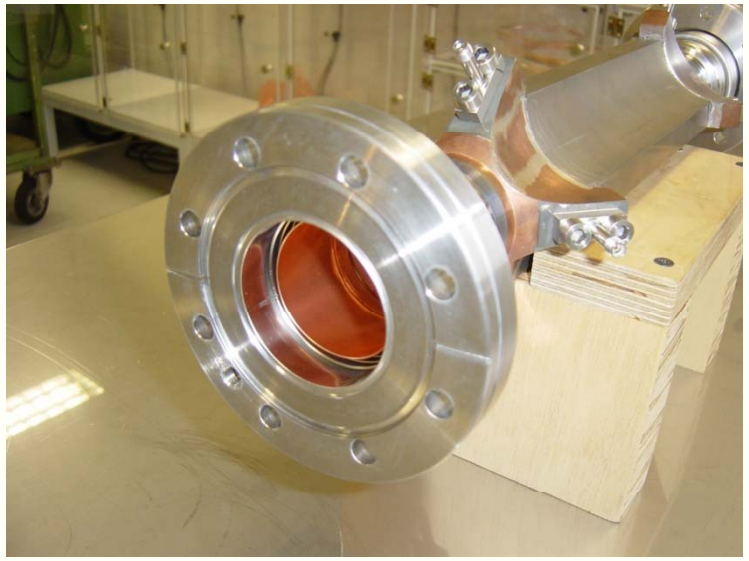
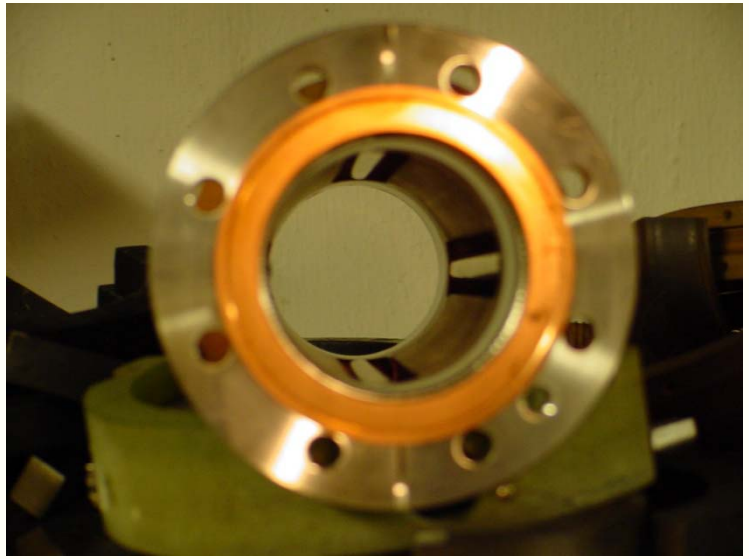
IR Feedback BPM Pickup

- **(Some) requirements for the IR feedback BPM pickup:**
  - Separate e^- and e^+ beam signals (in case of a single pipe for incoming and outgoing beams)
  - Sufficient bandwidth (for bunch-by-bunch signal processing)
  - Minimum real estate demands
  - Insensitive to background particles from the IP
- **Stripline BPM pickup detector:**
  - Directional coupler principle, supplies e^- and e^+ beam signals at separate output ports. Good RF performance.
  - Directivity restricted by the physical layout of the coupling line to UHV feedthrough output line transition.
  - Many mechanical/electrical issues, e.g. rigid construction (no microphonics), precise alignment (50 Ω match) of the electrodes, minimum VSWR through the ports!

FLASH/TTF Stripline BPM (DESY)

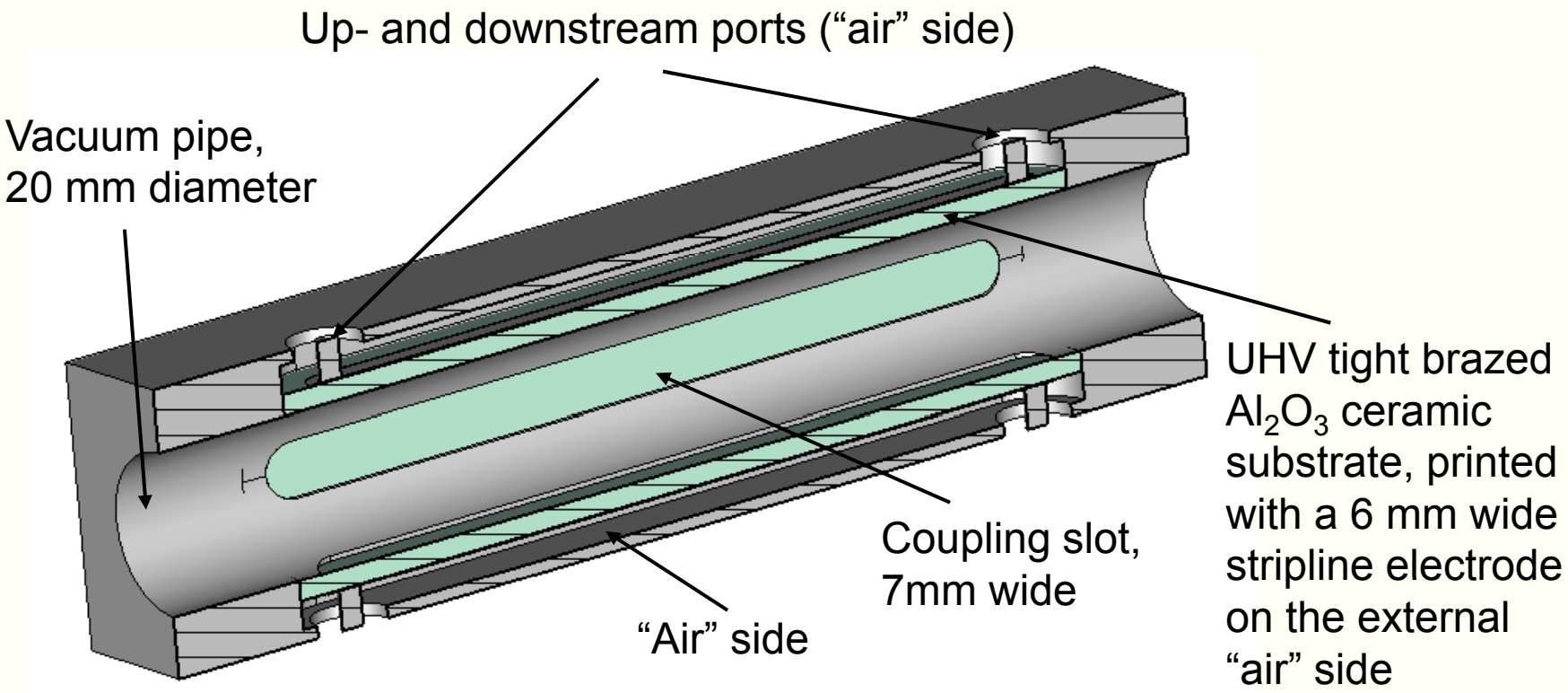






- **Complicated mechanics**
  - **Assembly, electrode alignment, feedthroughs, electrical contacts, brazing, VSWR optimization, etc.**

ILC IR Stripline BPM



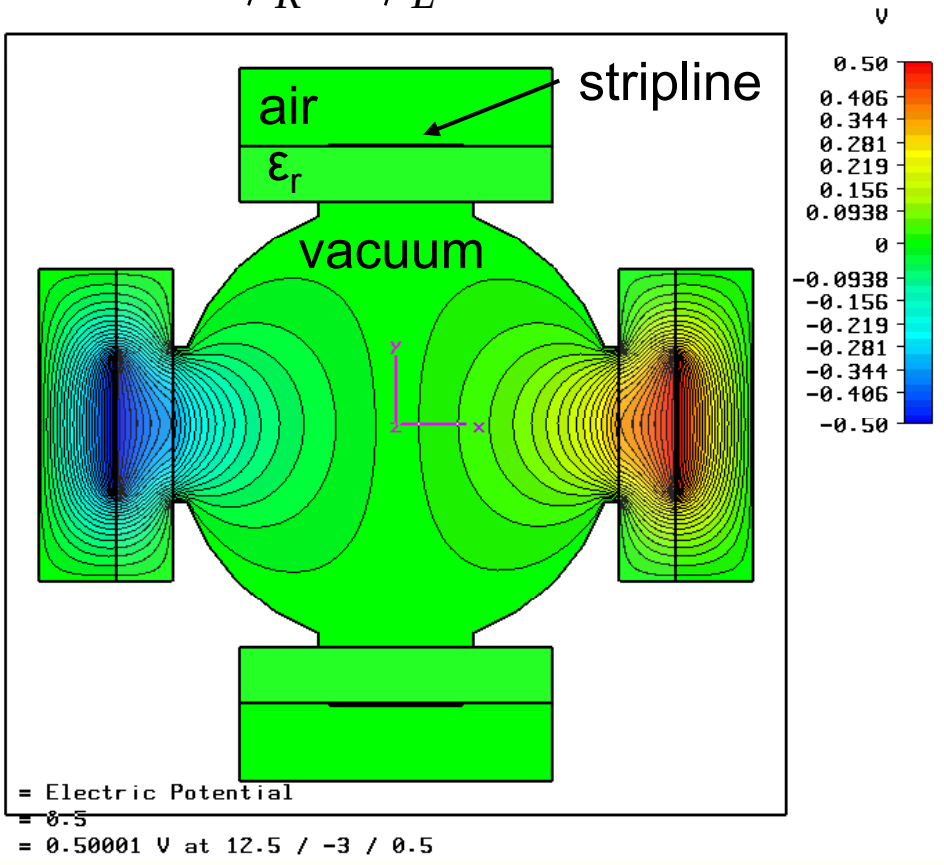
- **No UHV RF feedthroughs. Rigid construction.**
- **Flexible RF optimization in the transition area, no UHV!**
- **Extended electrical length, but needs termination!**

2D Simulation Results

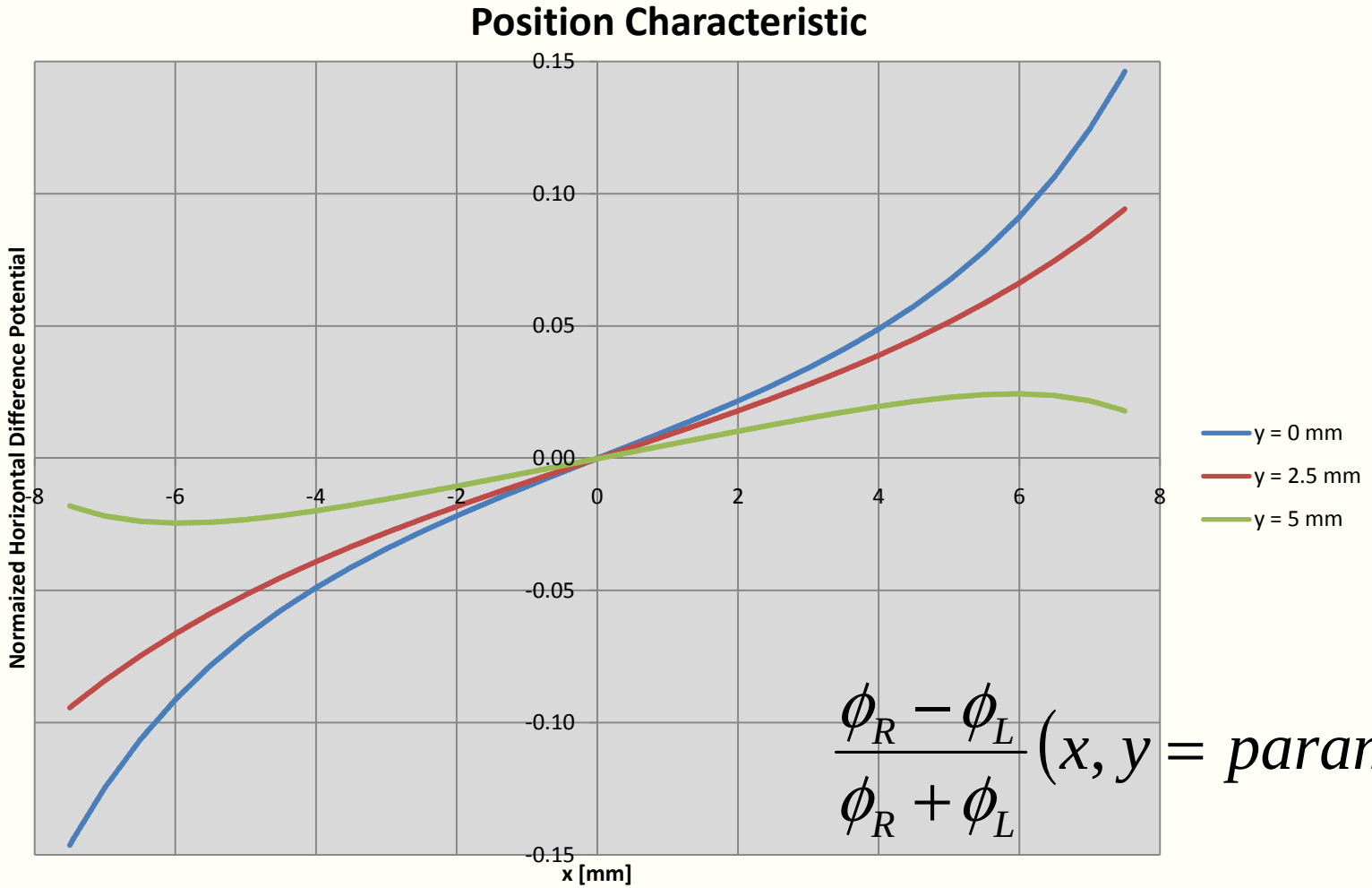
- **Stripline electrodes:**
  - 6 mm wide on 2.5 x 14 mm Al_2O_3 substrate (ε_r = 9.4)
  - Metallic cover at 3.5 mm distance
  - Characteristic impedance Z_0 = 50 Ω
  - Effective dielectric constant: ε_{eff} = 2.067
  - Beam-to-electrode coupling (centered beam): 5.34 % (7mm wide coupling slot)
  - Position sensitivity: 1.8 dB/mm

Normalized difference equipotentials

$$\frac{\phi_R - \phi_L}{\phi_R + \phi_L}(x, y)$$



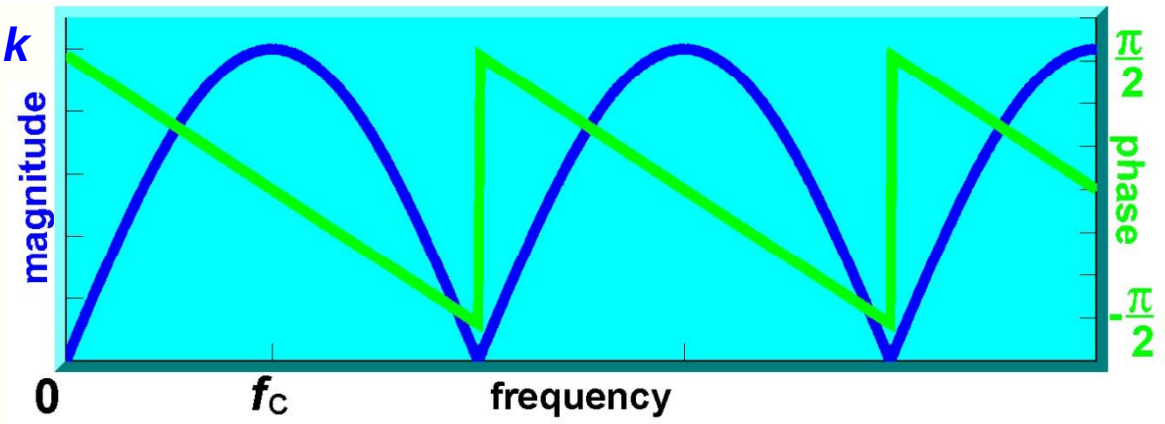
Δ/Σ Position Characteristic



$$\frac{\phi_R - \phi_L}{\phi_R + \phi_L}(x, y = param.)$$

Transfer Impedance

$$Z(\omega) = j\,k\,Z_0\,e^{-\frac{\omega l}{v_0}}\sin\left(-\frac{\omega l}{v_0}\right)$$



- ***k***: coupling coefficient (~5 %)
- Z_0 = 50 Ω
- ***l***: physical electrode length, e.g. 100 mm
- $v_0 = c_0/\sqrt{\varepsilon_{eff}} \approx 2.1\ 10^8$ m/s
  - Center frequencies at: $(2n\text{-}1)\ f_c \approx 530$ MHz
  - Bandwidth of the lobes: $f_{BW,3dB} \approx 530$ MHz

Preliminary Summary

- Conceptual design of a compact stripline BPM pickup.
- No UHV RF feedthroughs required.
- However, needs an UHV ceramic/metal brazing process!
- Requires broadband port termination, e.g. using diplexers based on 90^0-hybrids.
- Offers flexible optimization of the stripline to output port transition, not in vacuum!
- Possible next steps(???!!!):
  - Full 3D electromagnetic modeling and optimization.
  - Evaluate sensitivity to IP background. (WHO?)
  - Prototyping and RF characterization on the test bench.
  - UHV prototype, beam measurements?!