The effect of EM backgrounds on an IP feedback system at ILC

Christine Clarke

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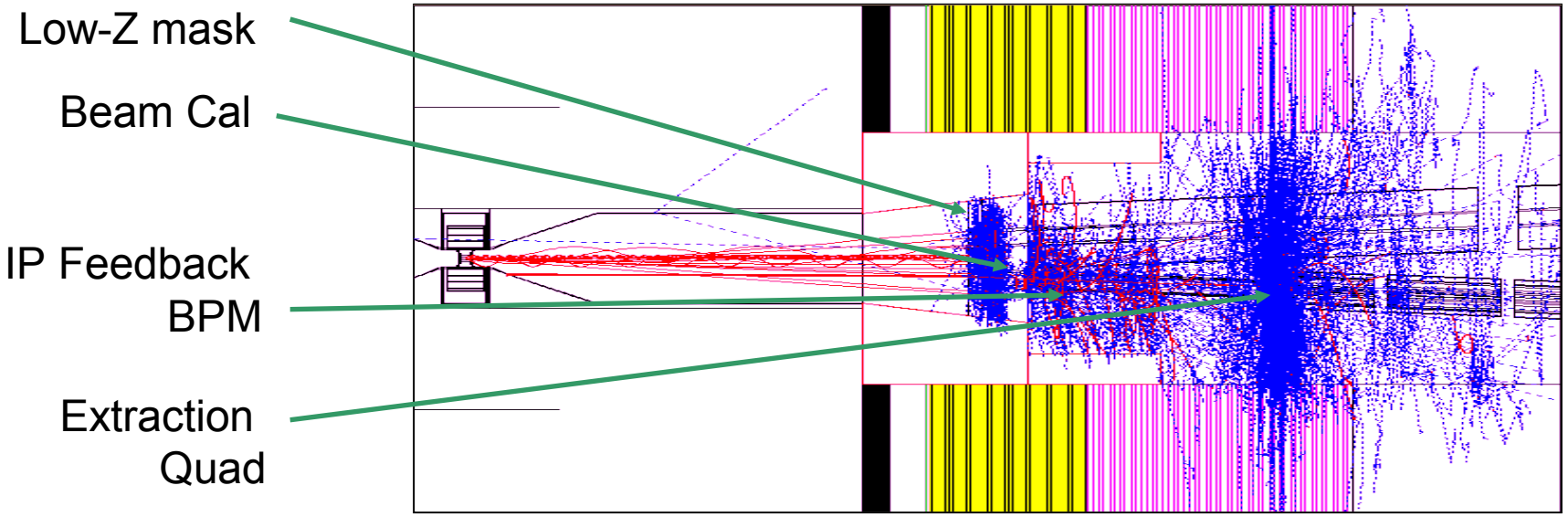
IOP HEPP Lancaster

Oxford (P. Burrows, C. Perry, G. Christian, T. Hartin, H. Dabiri Khah, C. Clarke, C. Swinson, B. Constance)
Daresbury (A. Kalinin)
SLAC (Mike Woods, Ray Arnold, Steve Smith, Steve Molloy, Glen White)
KEK

The ILC Interaction Region (IR)

- The IP feedback stripline BPM sits between the Beam Calorimeter and the first extraction line quad.
- This area has lots of low energy particles due to interaction of e+e- pairs (from beam-beam interaction) with IR material.
- GEANT simulation (Tony Hartin, Oxford): > 10^5 $e^+ e^- \gamma$ hits per stripline.



FONT background tests: Module

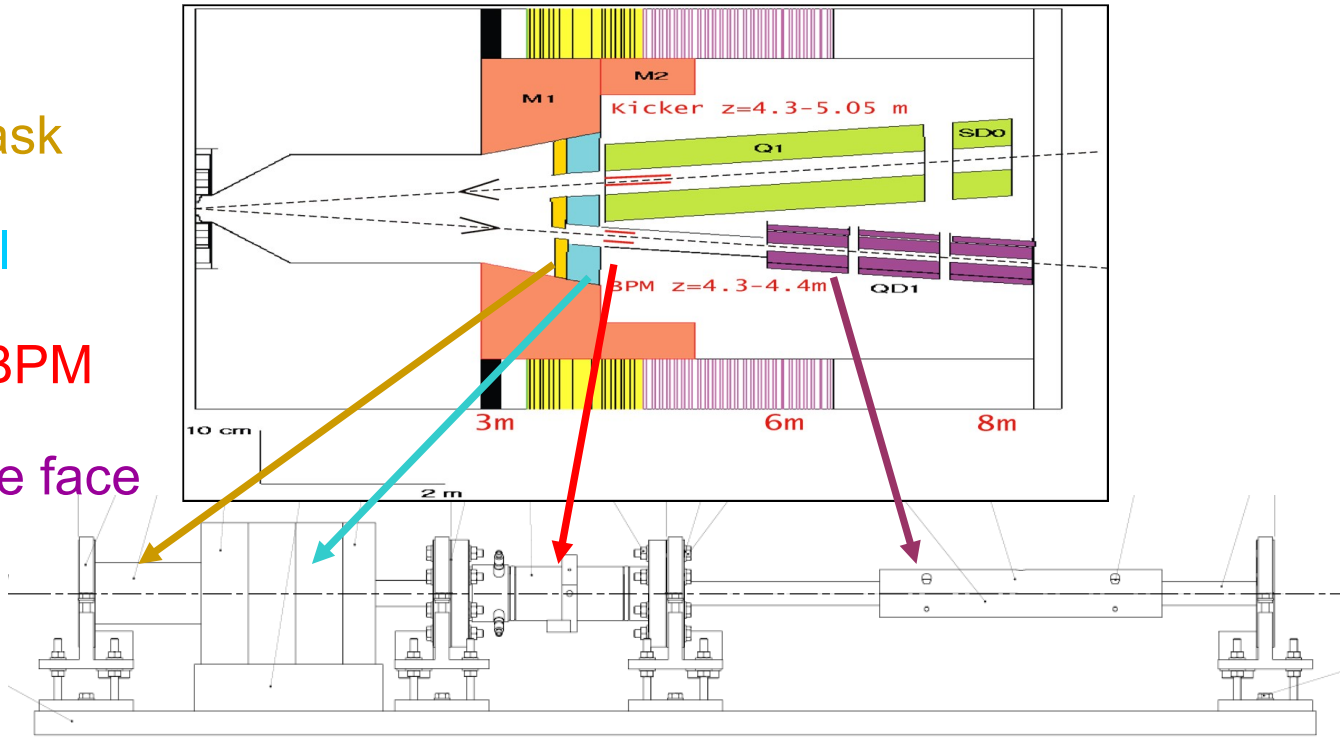
- Recreate the environment that the BPM sits in (i.e. the Interaction Region (IR)
  - Match radiation lengths and inner radii of components
- Energy distribution of impacting charges depends on the IR material).
- Constructed at Daresbury.

Low Z Mask

Beam Cal

Stripline BPM

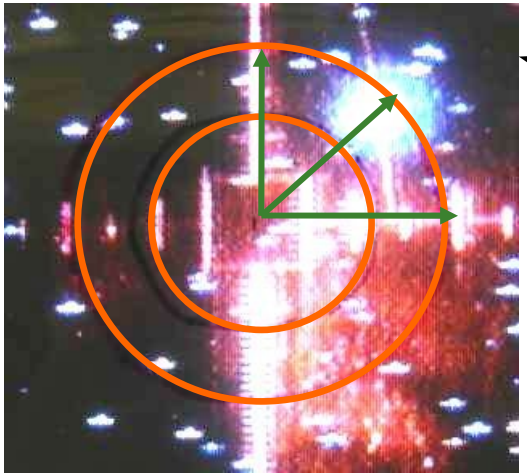
Quad Pole face



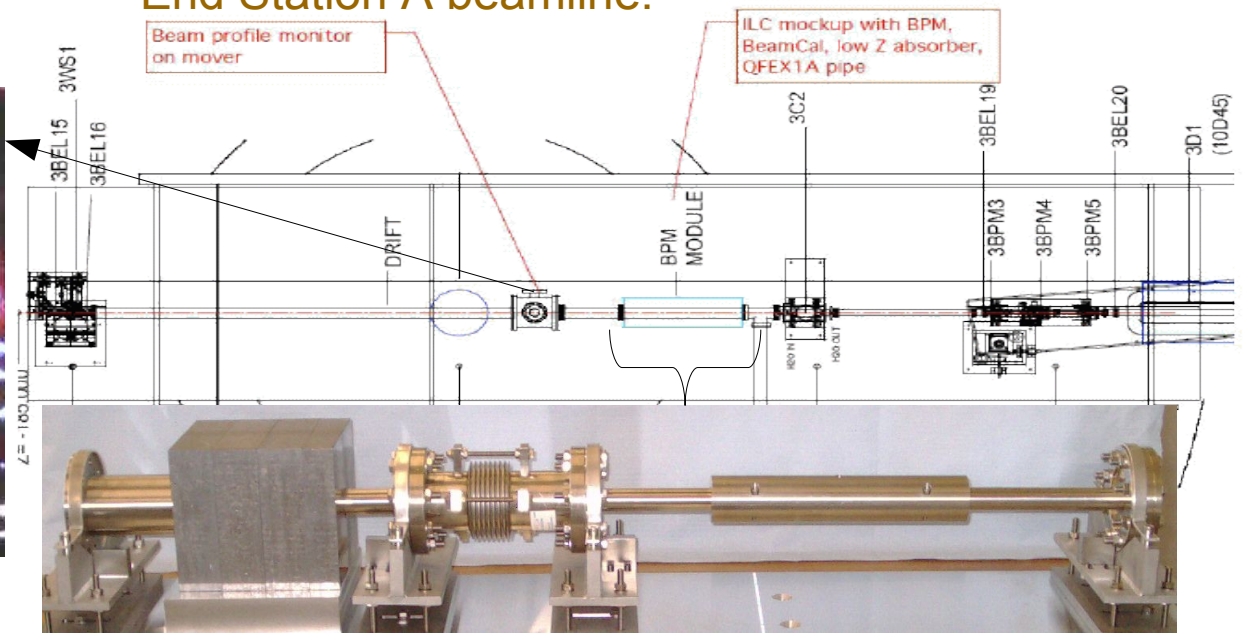
FONT at ESA: Method A

- Ran tests at End Station A (ESA) at SLAC.
- Scanned the electron beam across the front face of the module.
- CCD camera and upstream scintillator to aid positioning beam spot on the front face of the module.
- A Low Flux Toroid monitored beam charge down to 10^6 electrons.
- Ran at 28.5 GeV, ~10^7 electrons beam charge. Produced ~15000 times more hits per stripline than worst case ILC.

CCD camera image:



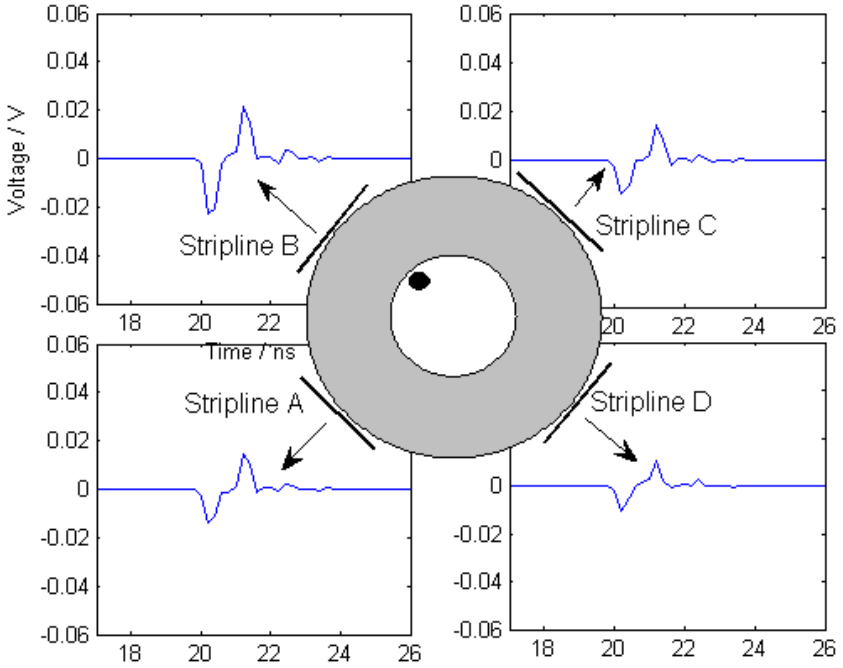
End Station A beamline:



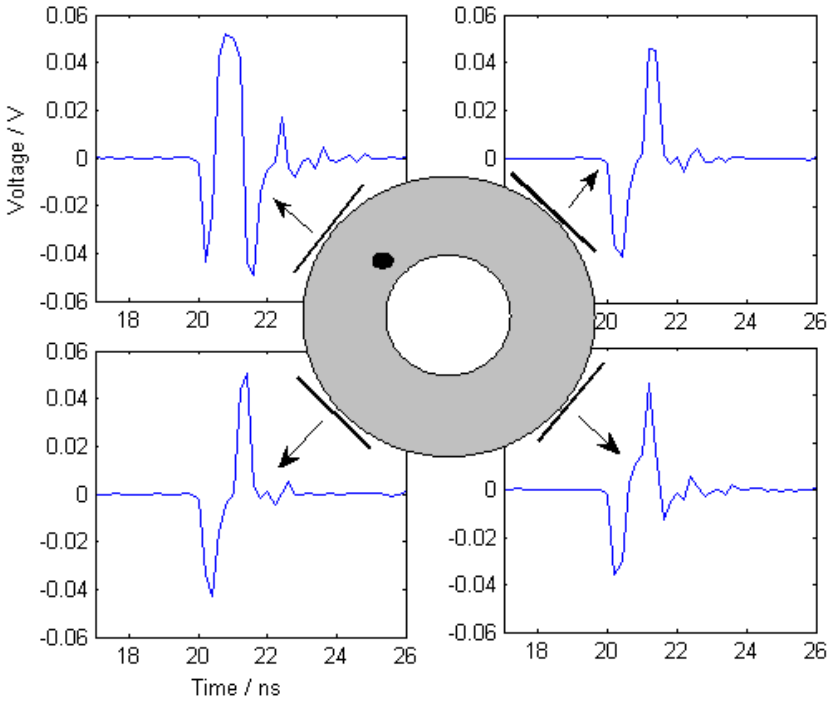
FONT at ESA: Method A Results

- Signals with the beam on the Low Z mask were different from BPM stripline signal- suggestive of secondary emission.

Signals from four striplines with the beam going clear through the beam pipe



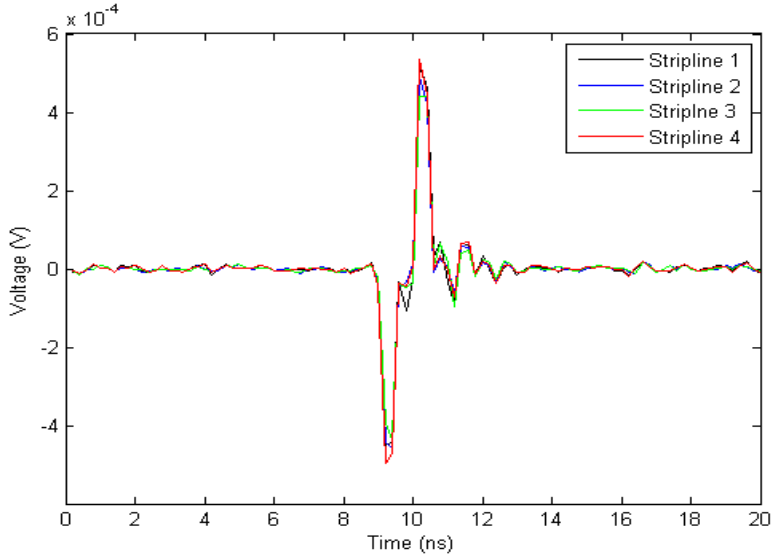
Signals from four striplines with the beam hitting the "low-Z mask"



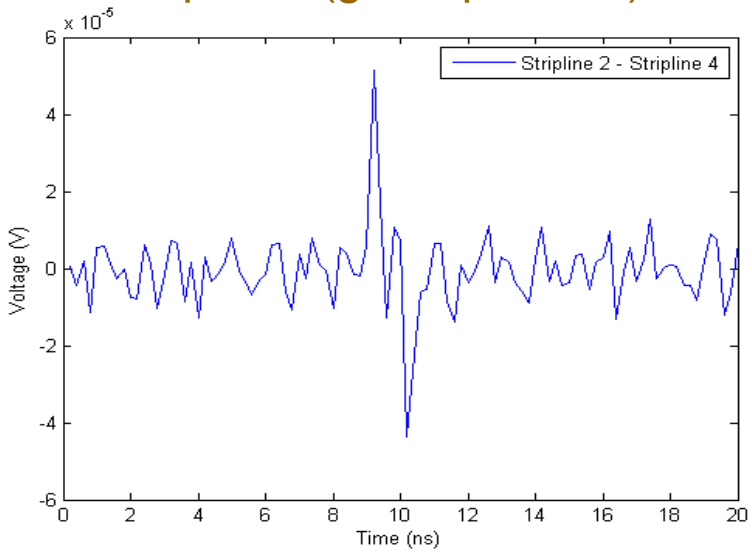
From ESA to ILC – Method A

- ESA- illuminated small spots
- ILC- whole front face of low-Z mask and the aperture are illuminated.
- A weighted superposition of ESA spots and the addition of stripline signals ≈ ILC?
- Predicted signal at ILC due to pairs corresponds to 6 nm error.

Prediction for 4 ILC striplines (based on Method A results)



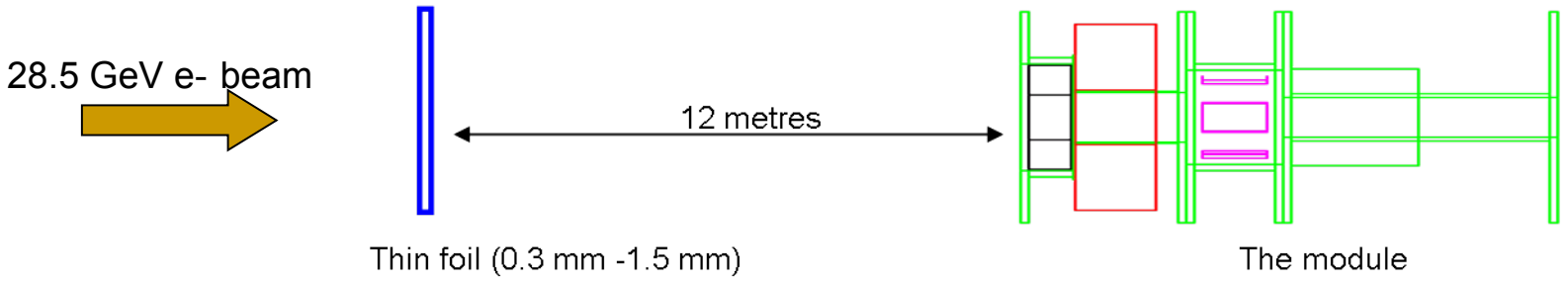
Difference of top and bottom striplines (gives position)



FONT at ESA: Method B

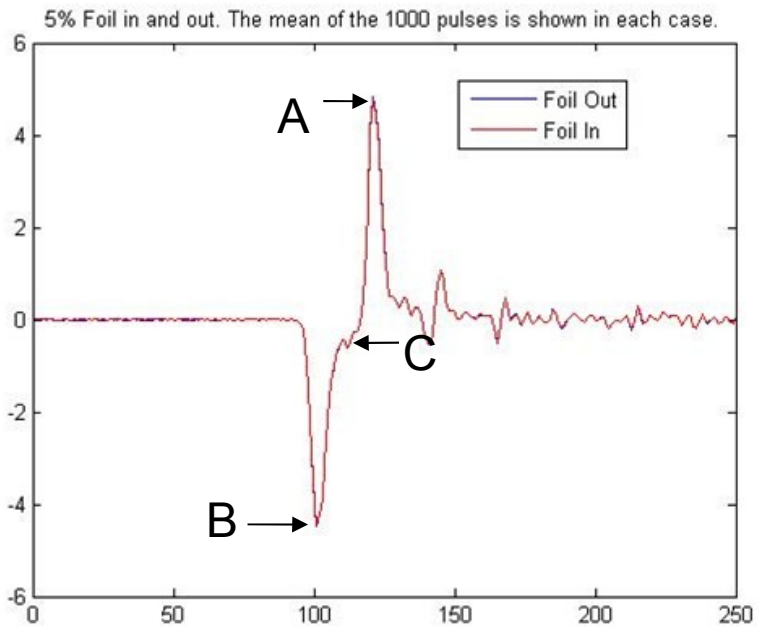
- Second method delivers both electrons and positrons as a halo around the main electron beam using thin radiators just upstream of module.
- 3 aluminium foils used, 1%, 3%, 5% X_0.
- Recorded 1000 stripline signals without foils, 1000 stripline signals with foils.

  Is there a difference between the stripline signals with and without backgrounds?
- With 5% X_0 foil in, Produced ~1000 times more hits per stripline than worst case ILC.



FONT at ESA: Method B Results

- No change with foil in and foil out.
  - Statistical errors on parameters (d and z) greater than the difference between the foils in and out.
  - Statistical error at ESA represents 8.5 um uncertainty.
  - Backgrounds at ESA 990 times worse than ILC.



→ < 8.6 nm position error.

d = (A+B)/(A-B)

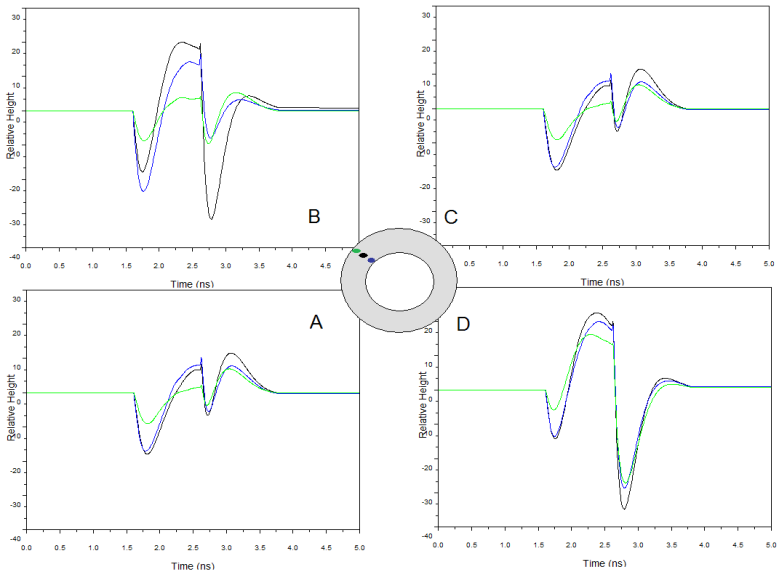
z = C/(A-B)

	Mean(d)	error	Mean(z)	error
No foil	0.0364	4e-4	-0.0326	2e-4
5 % foil	0.0363	4e-4	-0.0325	2e-4

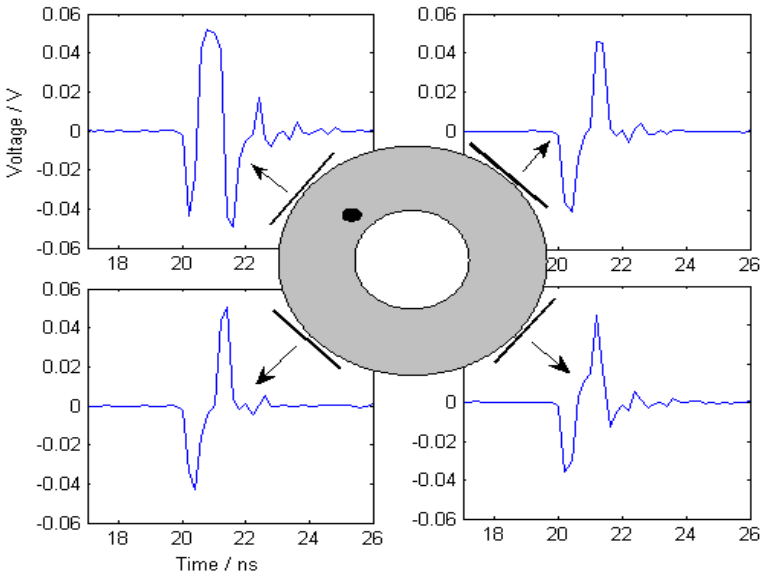
FONT at ESA: MethodA Simulations

- Simulating these results in GEANT has had some success.
  - Normal stripline response + Impacting hits + Secondary emission
  - Binned time of flight of particle + signal in stripline
  - Passed result through filter (cables + scope input bandwidth).

GEANT-based Simulation of stripline signals from beam on mask



Method A data with the beam on the mask

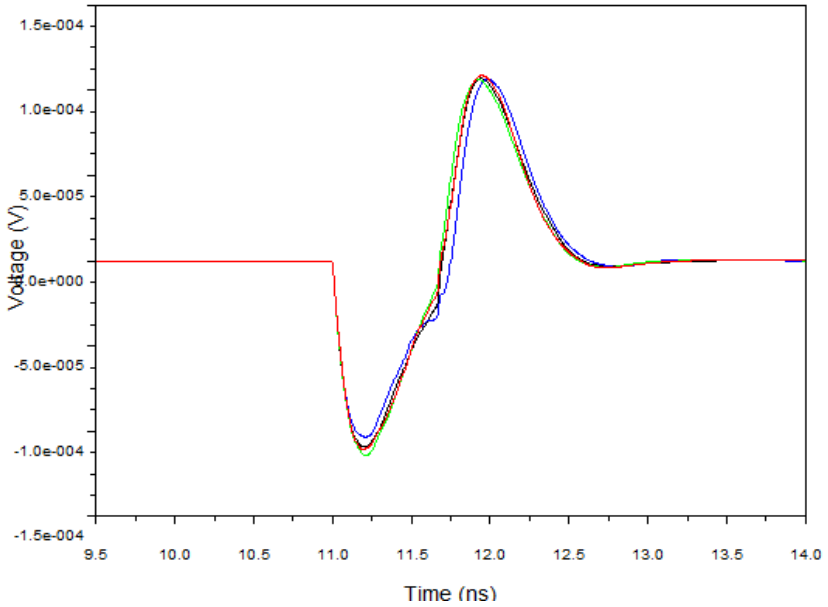


ILC Simulations

- Ran same simulation for ILC
  - Beam-Beam pairs were used as input to a GEANT3 simulation of IR.
  - ESA Method A results were used to calibrate the simulated ILC signals to voltage and position error.
- Position error without taking difference signal = 13 nm
- Taking difference of top and bottom strips

→ ~1 nm

GEANT-based simulation of ILC stripline signals from the beam-beam pair backgrounds



FONT: Summary

- IP Feedback BPM sits in a region where high backgrounds are present due to pairs from the beam-beam interaction.
- Created backgrounds and recorded the stripline signals.
  - Stripline signal shows secondary emission when in backgrounds.
  - Some success in understanding the exact form just using GEANT3.
  - **Signal is not large enough to cause problems with micron-level position measurement at the ILC**.
- General
  - Ability to simulate IR backgrounds and their signals.