Pair backgrounds at the feedback BPM – ESA tests and simulations

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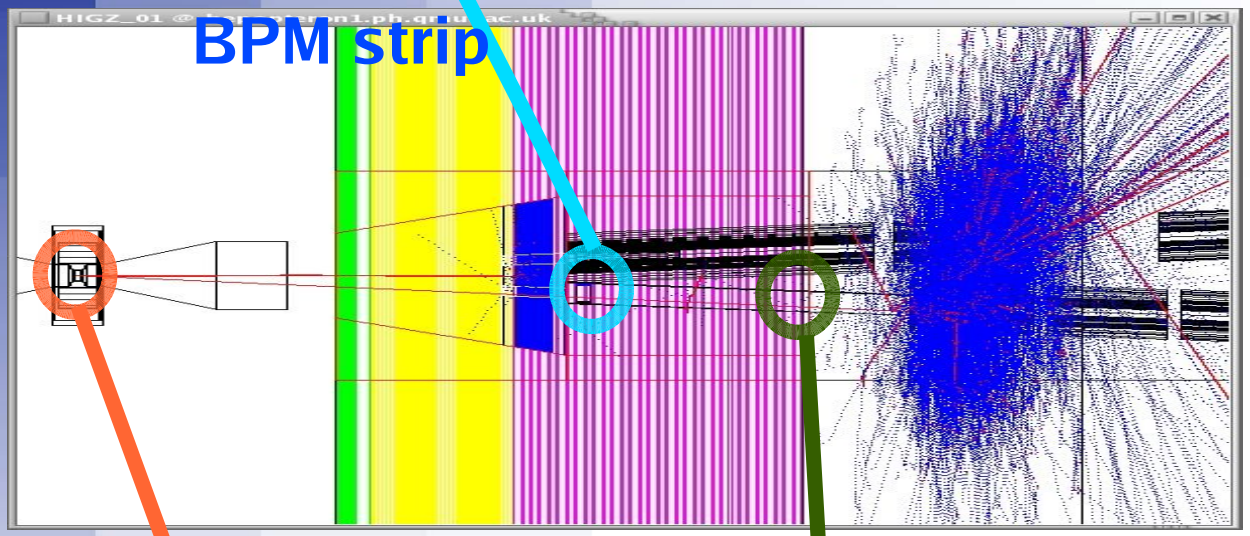
OUTLINE

- *Review ILC geant simulation*
- *Describe FONT@ESA experiment and GEANT model thereof*
- *Simulation of noise on BMP strips*
- *Describe changes for ESA run '07*

ILC simulation of BPM backgrounds

93,500 hits on each BPM strip

scheme 14



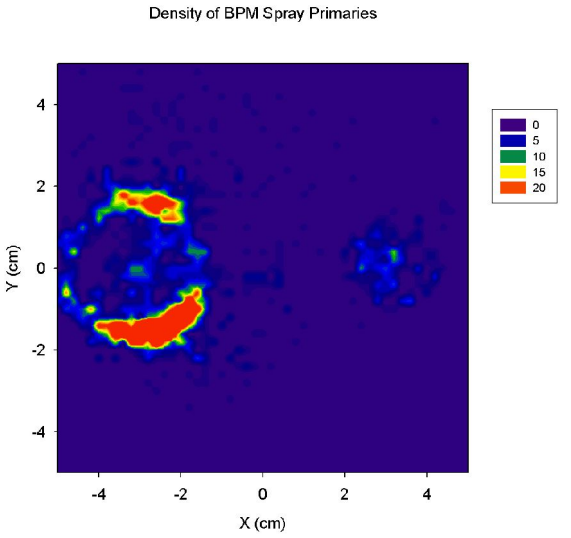
680,000 pairs from IP

2×10^{10} charges in spent beam

expected noise/signal ratio: 4.7×10^{-6}

origin of BPM hitting spray?

- x/y number density plots reveal spray from mask edge annulus around beampipe
- uneven annulus density due to solenoid field



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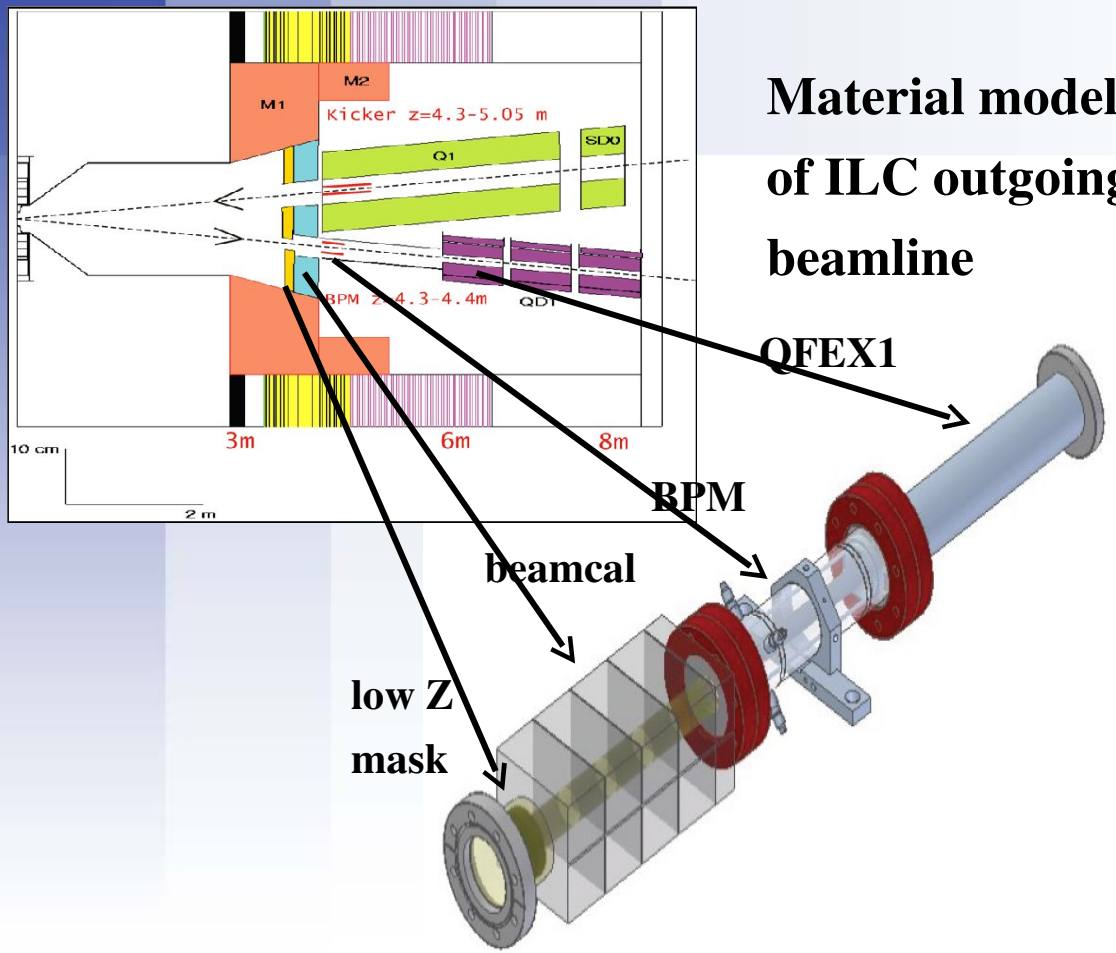
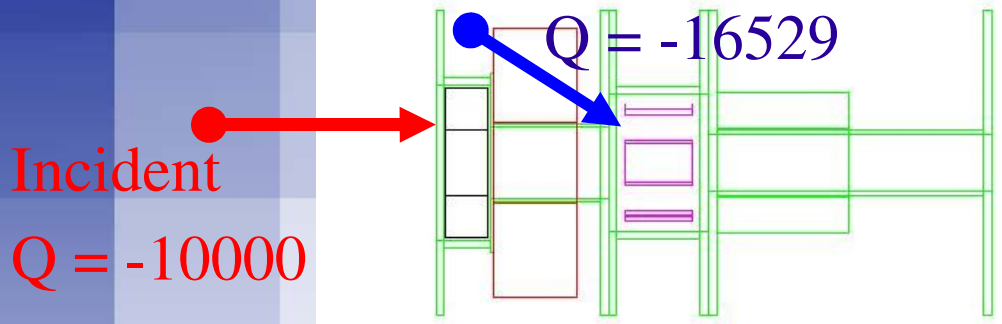


AIM:Recreate ILC-like background hits on BPM

- Pass 30 GeV main beam through Be radiator, select momentum bites and transport to A-line
- bunch charge 10^6 - 10^{10} obtained by varying transmission at slits
- run1, July06: x,y beam shift to impinge directly on lowZ mask and produce spray
- run2, March07: insert thin radiator upstream to produce halo of spray impinging on lowZ mask

ESA run1 July06

Net Q at upstream end of BPM strips



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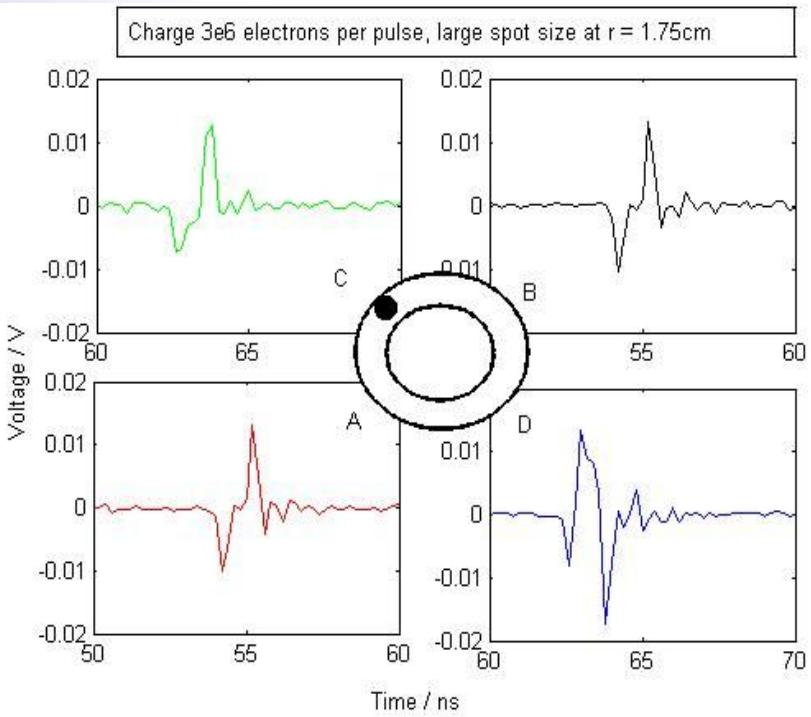
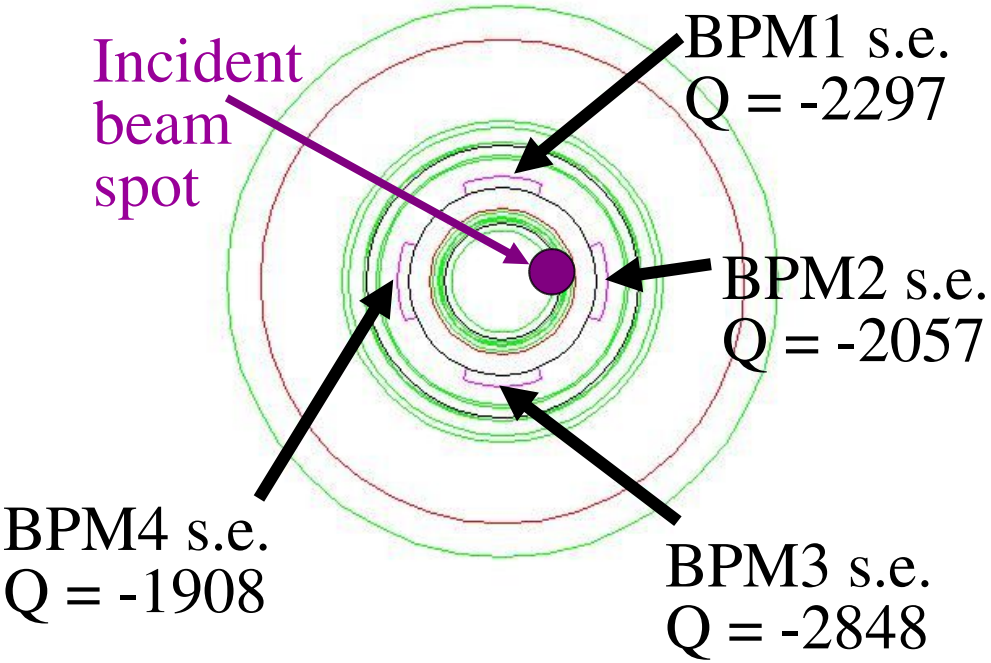


- 1mm spot size incident on low Z at (x,y)=(1.4,0)
- "Signal" obtained by counting net charge passing by strips
- "Noise" obtained by counting net charge in the secondary emission from the striplines
- Time response obtained from GEANT T.O.F. parameter



Components of the noise

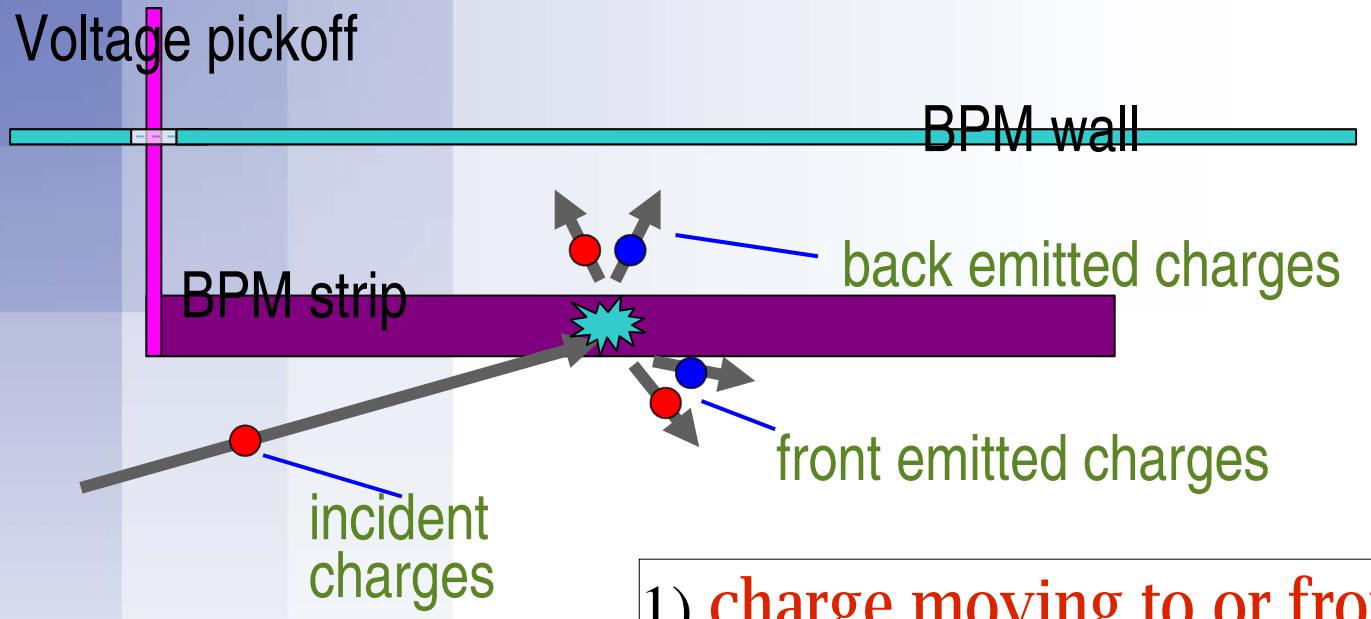


image charge components

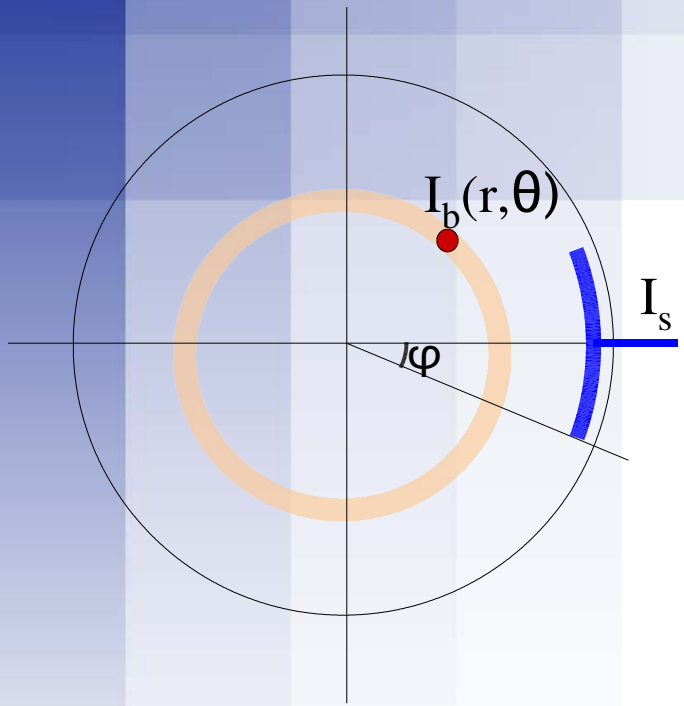
1) charge moving to or from strip surface – needs special treatment, see next slide

2) charge absorbed/emitted at front face – balanced by loss/addition of image charge

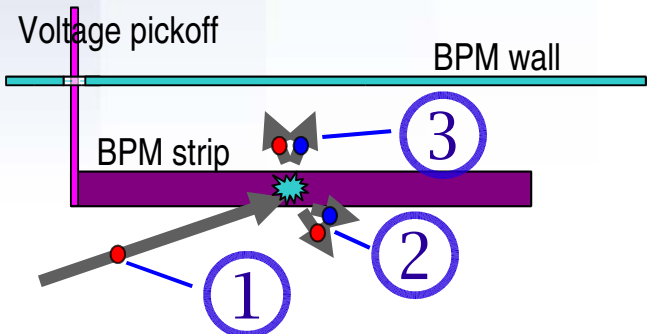
3) emitted charge from back face and reaching wall +1 for electron and -1 for positrons

Image charge signal due to pipe filling spray

$$I_s = \frac{-\phi}{2\pi} I_b \left[1 + \frac{4}{\phi} \sum_{n=1}^{\infty} \frac{1}{n} \left(\frac{r}{b}\right)^n \sin\left(\frac{n\phi}{2}\right) \cos(n\theta) \right]$$



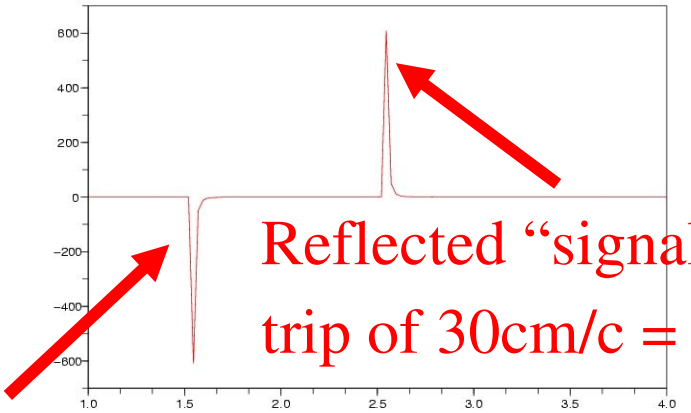
- assume by smmetry, density ρ is constant around annulus
- write I_b as ρdA and add contribution at θ+π for odd n, and θ+π/2 for even n
- total contribution from annulus is −φ/2π of the beam current in the annulus.... repeat for all r



SO noise components 1 and 2 can be neglected. ONLY COUNT COMPONENT 3

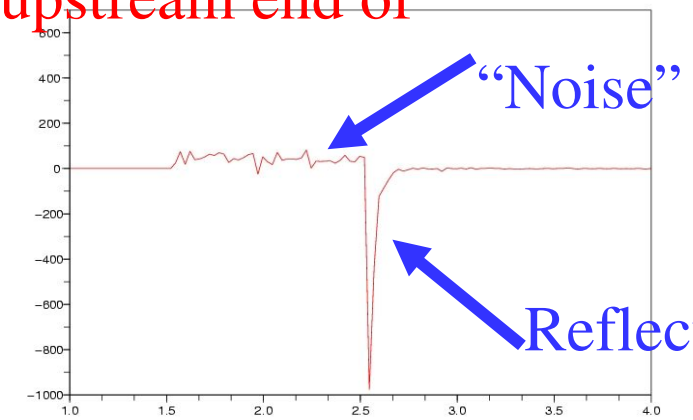
TOF histogram: ”raw” signal/noise

- **This is ”raw” because...**
- **we have to balance signal against noise by taking into account the fraction of the image charge on each strip**
- **reflected noise shows ”pile up”. This happens because most spray still travels close to c**



Reflected “signal” after round trip of 30cm/c = 1.0 ns

“signal” is almost a delta function at upstream end of BPM strips

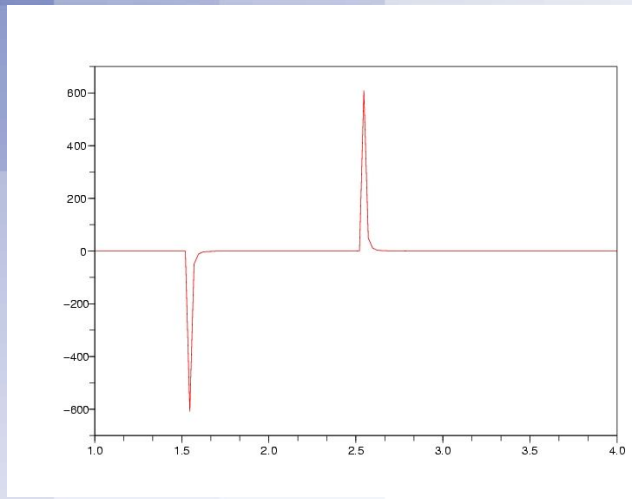


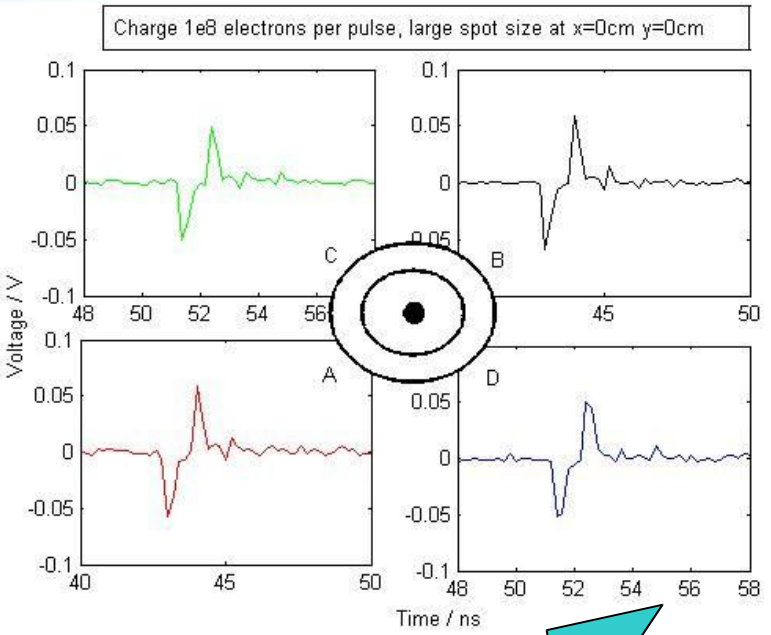
“Noise”

Reflected“Noise”

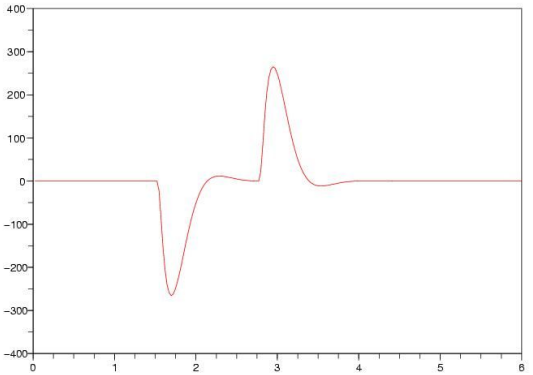
Convert raw histogram to real signal

start with ideal bipolar deltas



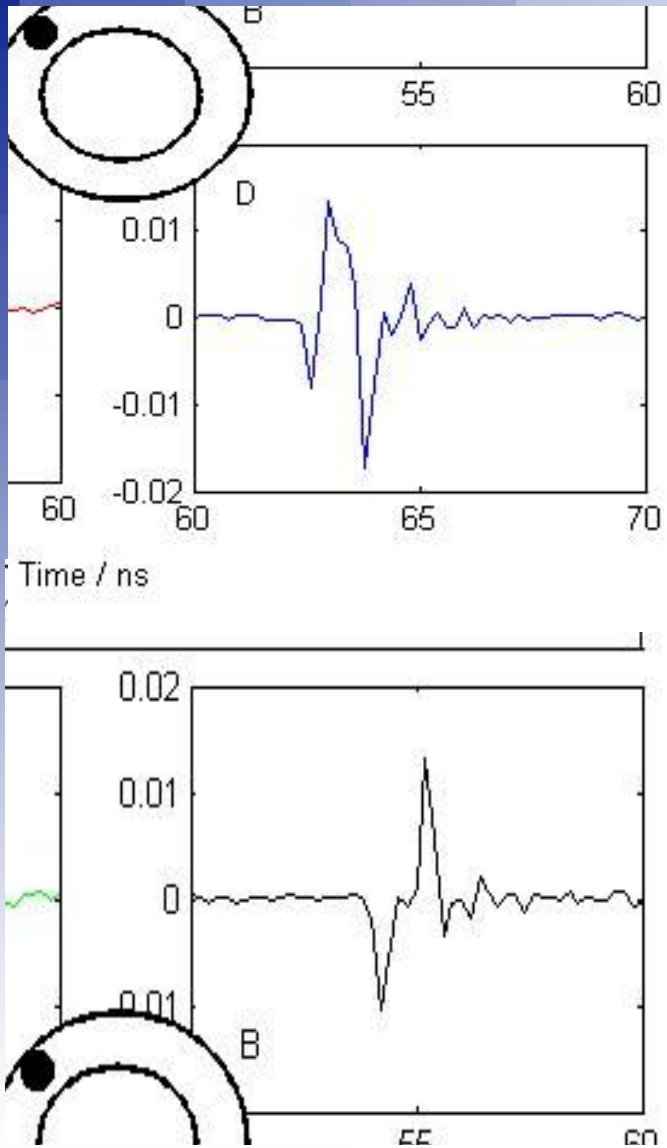


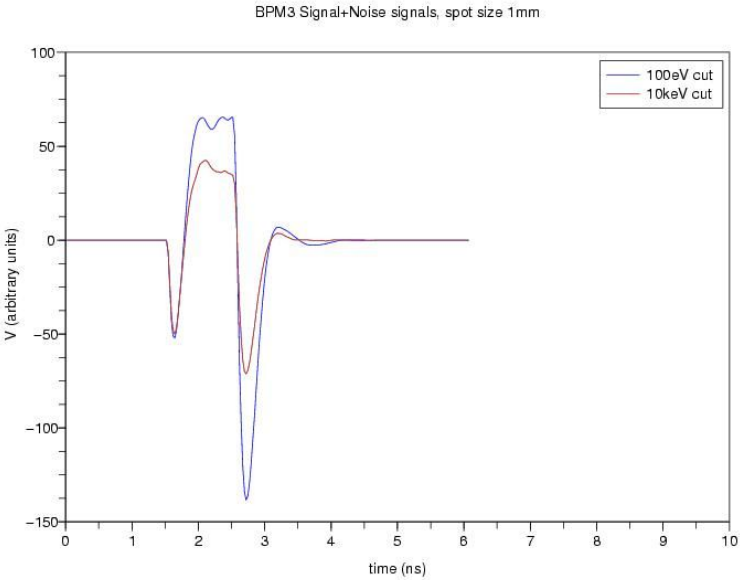
Broaden analytic signal pulse by passing through a 2nd order 1.2 GHz Butterworth Low pass filter

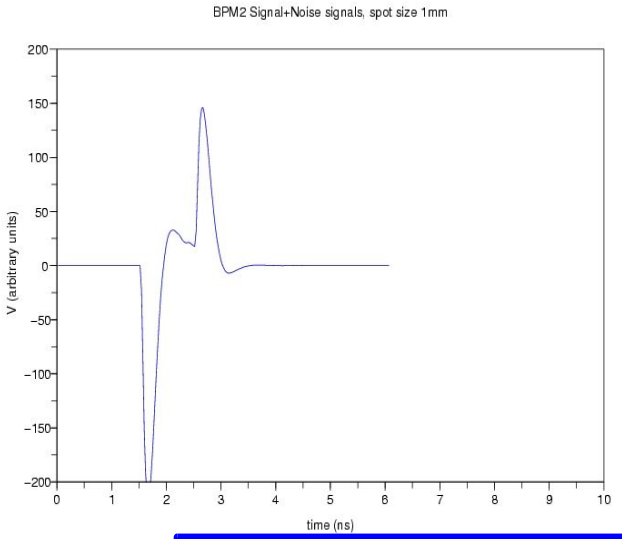


compare with data

Simulated signal+noise results







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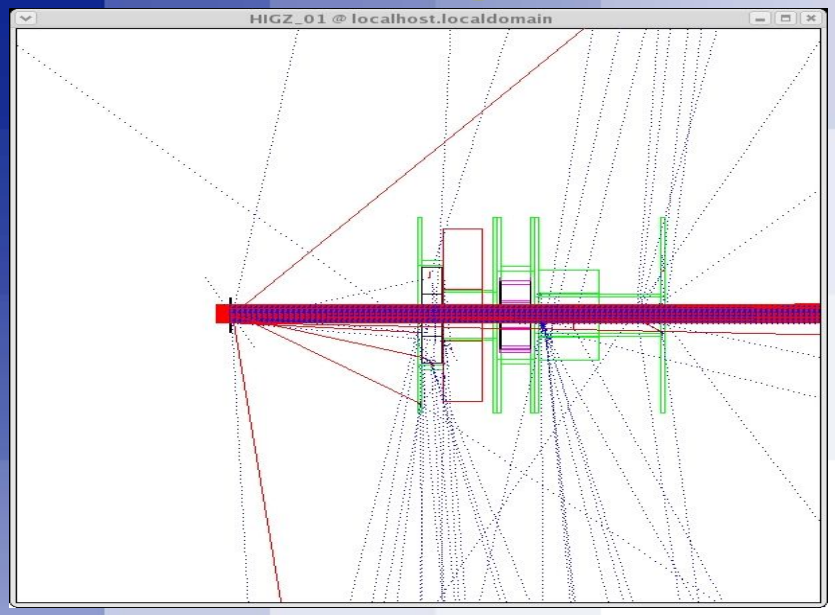
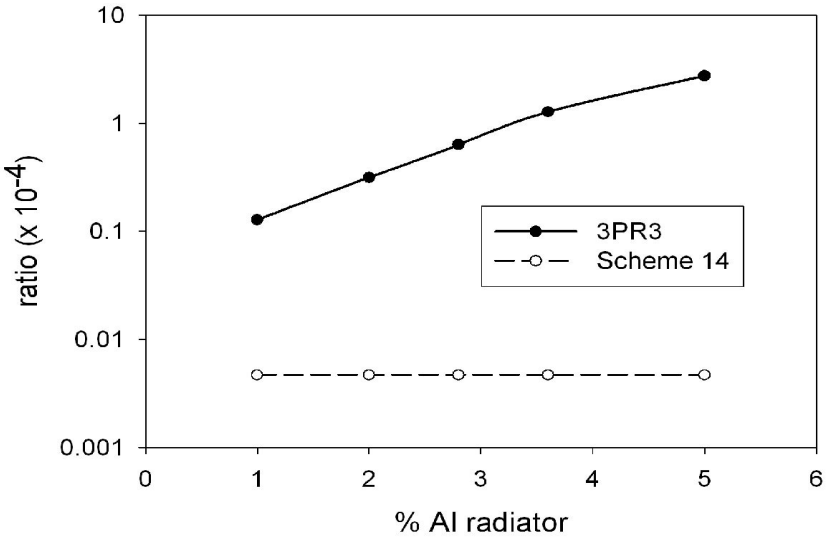
SIMULATION

FONT@ESA Mar07 simulations

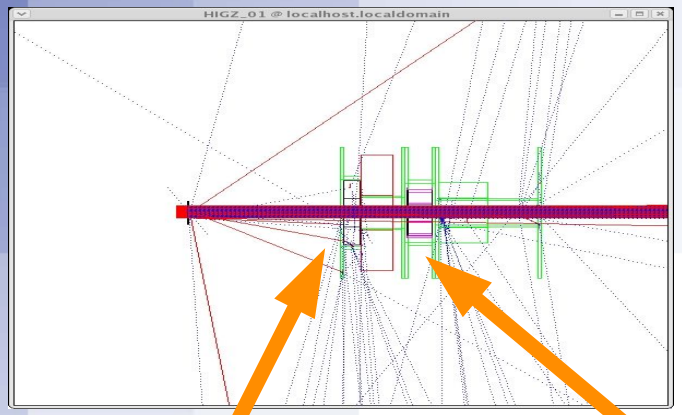


Ratio of BMP hits per strip to spent beam number, comparing scheme14 and ESA module with thin Al radiators

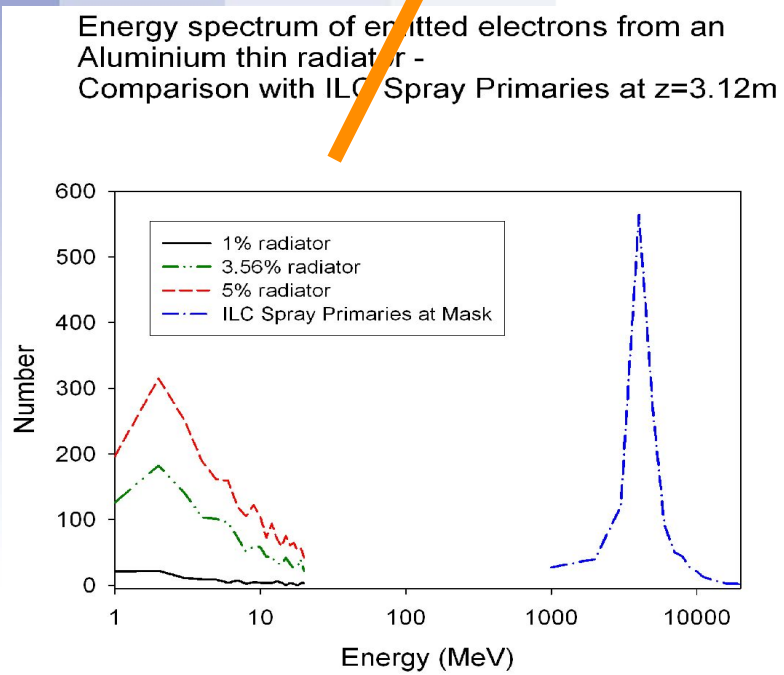


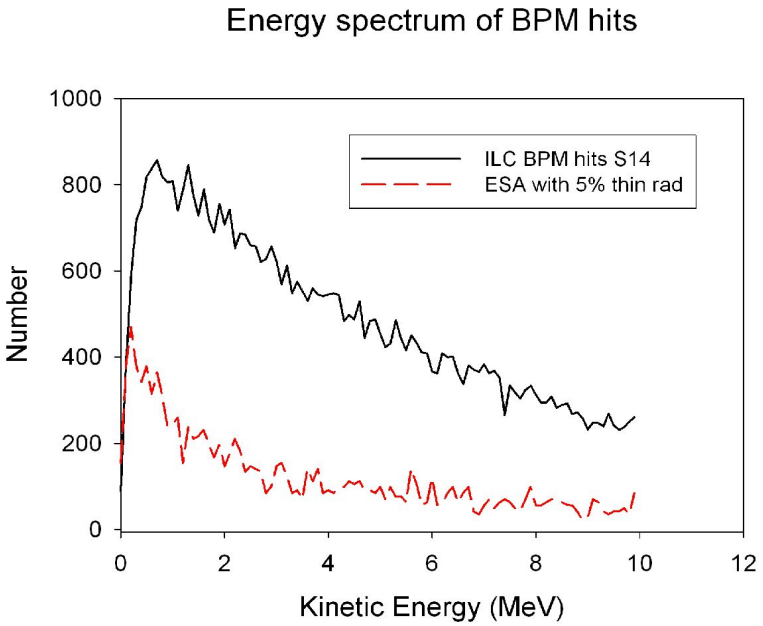
- previous run illuminated one spot on mask, ILC indicates annulus
- ILC expected noise/signal ~$5x10^{-6}$ but July06 run produced noise/signal ~$5x10^{-2}$
- pass 10^6 particles through ESA GEANT module containing thin radiator
- So..1% Al at 3PR3 (0.952m upstream of lowZ) gives an order of magnitude more noise/signal than ILC S14

FONT@ESA Mar07 – Energy spectra comparison



- ILC/ESA energy spectra at LowZ mask different, but..
- At BPM strips the spectra is similar





Summary

- **FONT@ESA run 1 – July06**
  - primary beam directed onto LowZ mask to produce pipe filling spray
  - signal/noise traces consistent with secondary emission
- **Simulation of data**
  - used GEANT TOF to obtain time dependence of secondary emission
  - developed analytic model to count secondaries emitted from ouside face of strips
  - initial success in simulating the data
- **Further data run at ESA in 2007**
  - insert thin radiator upstream of lowZ mask
  - attach FONT processor to gauge effect of noise on processed signal