# FONT@ESA IP feedback BPM electromagnetic background expt

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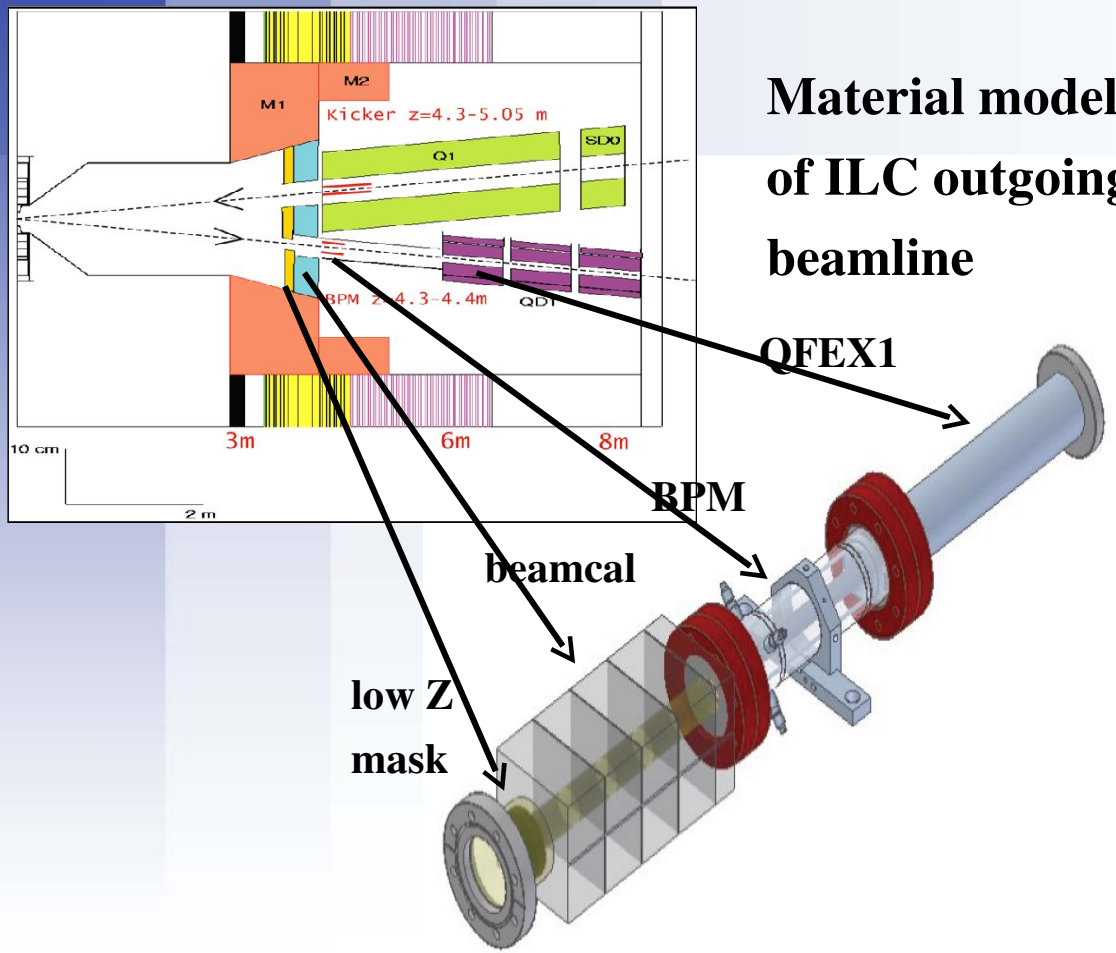
**OUTLINE**

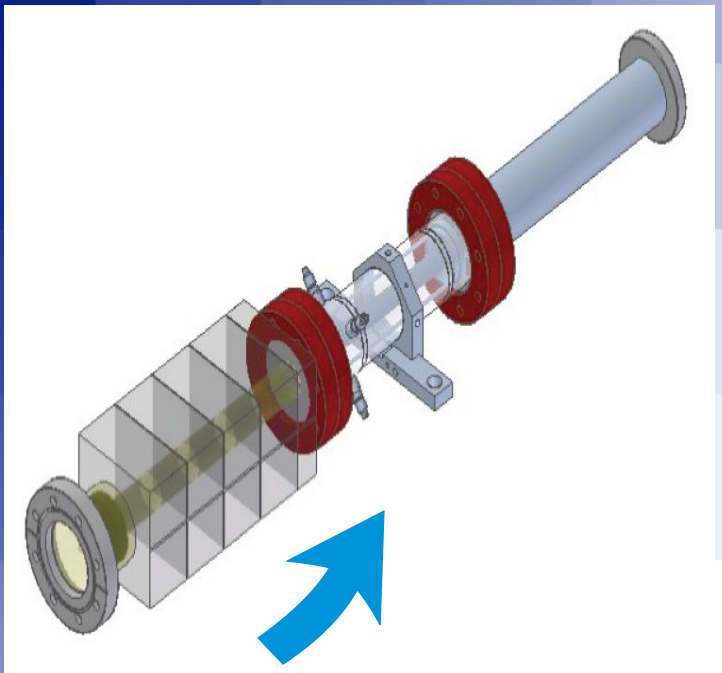
- *describe FONT@ESA experiment and explain aims*
- *present data from Jul06 and Mar07 runs - lowZ, thin radiator and FONT processor data*
- *Analysis of data and comparison with ILC conditions via simulation*

# FONT BPM experiment @ESA



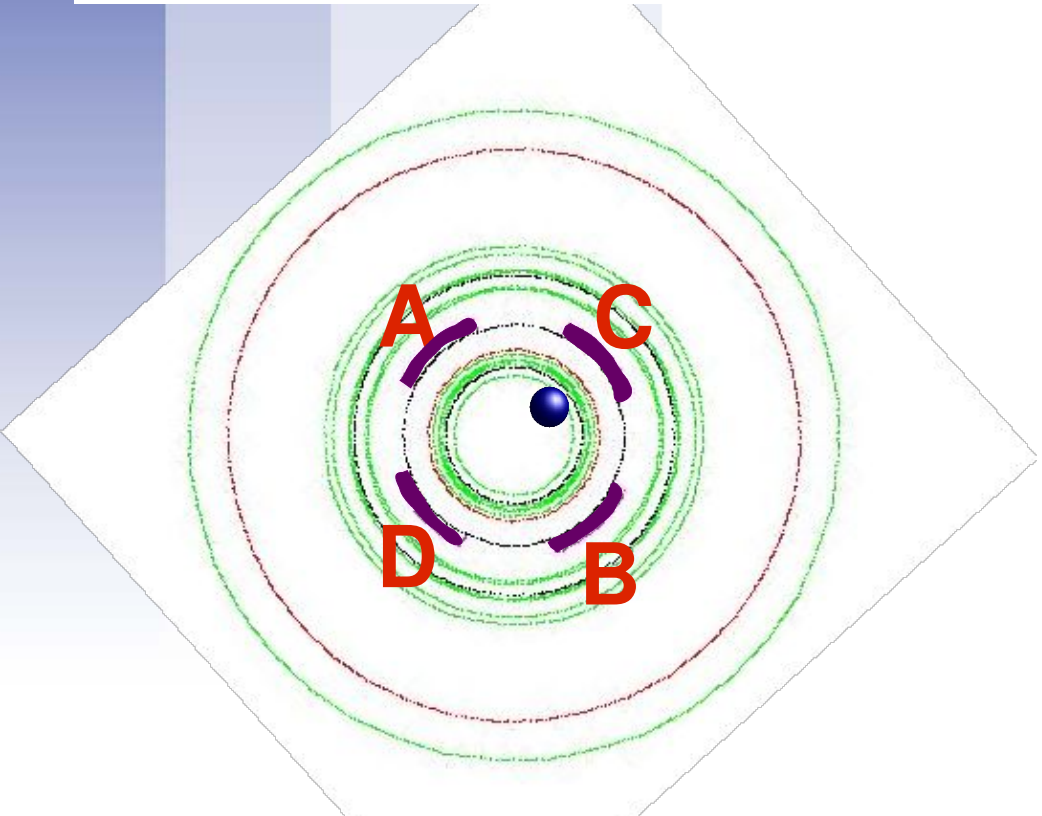

**AIM:Recreate ILC-like background hits on BPM**

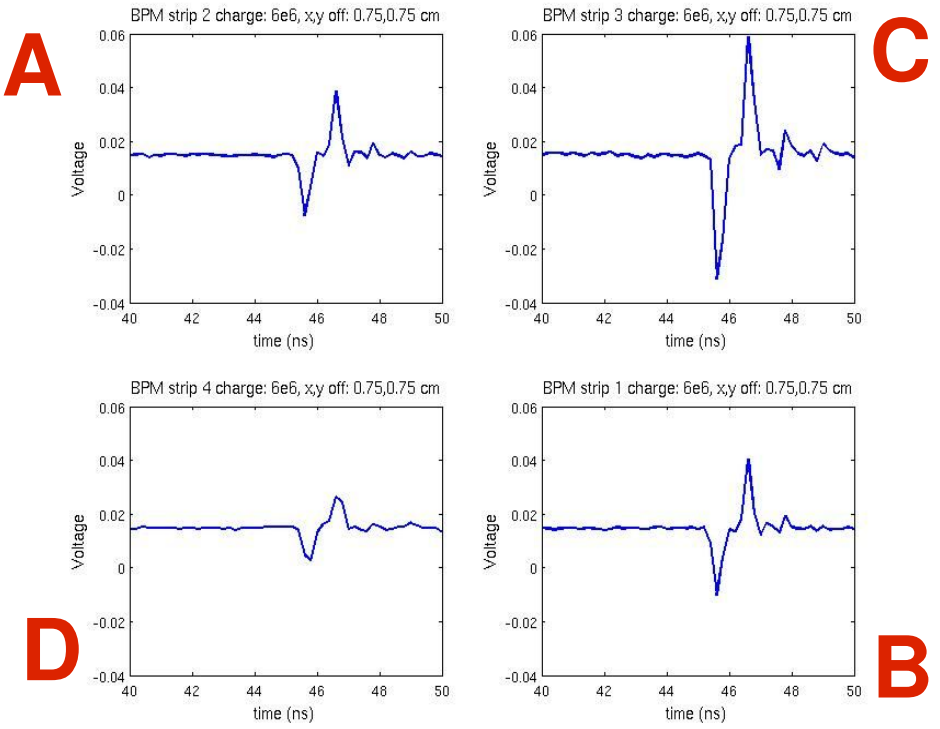
- Pass 30 GeV main beam through Be radiator, select momentum bites and transport to A-line
- bunch charge $10^6$ - $10^{10}$ obtained by varying transmission at slits
- **run1**, July06: x,y beam shift to impinge directly on lowZ mask and produce spray
- **run2**, March07: insert thin radiator upstream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



# Data I - beam offset r=1.06cm

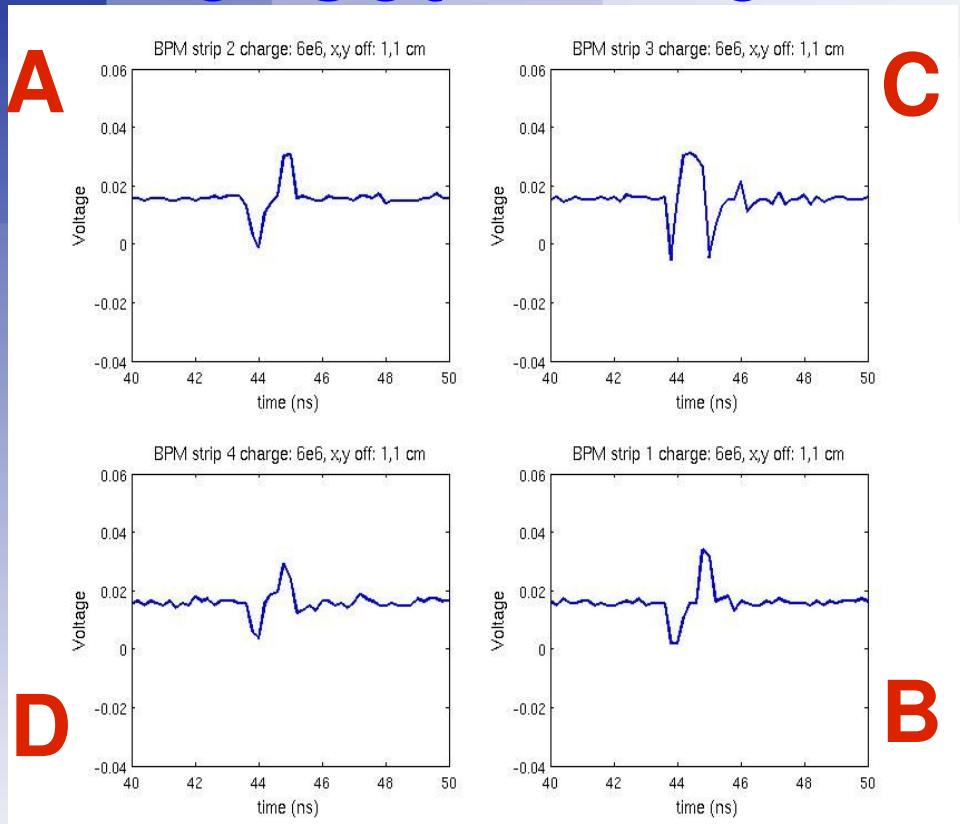
- offset towards upper right strip C
- stripline C shows enhanced signal
- stripline D shows diminished signal
- stripline A,B same

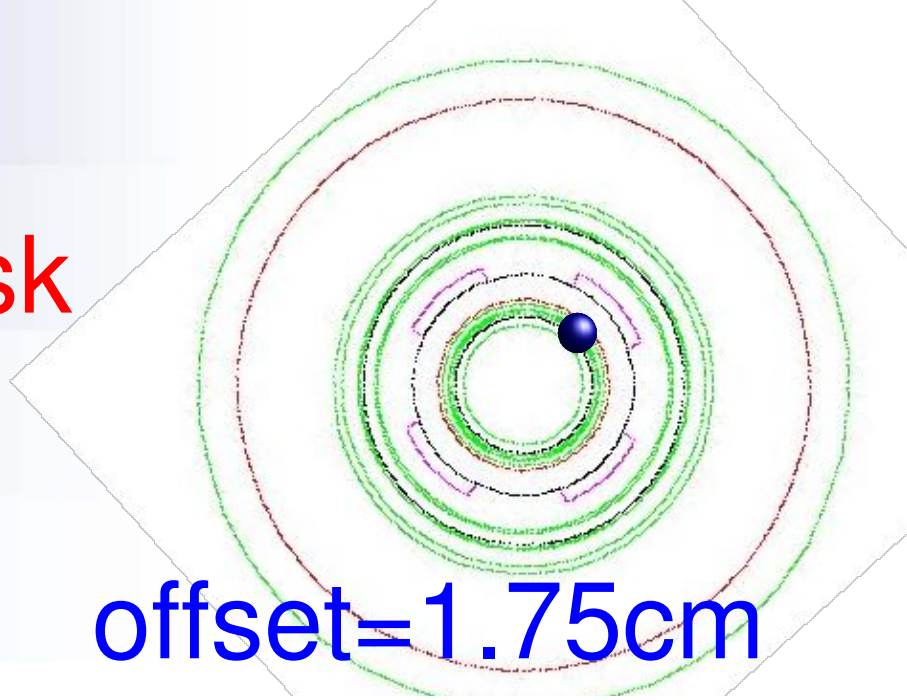


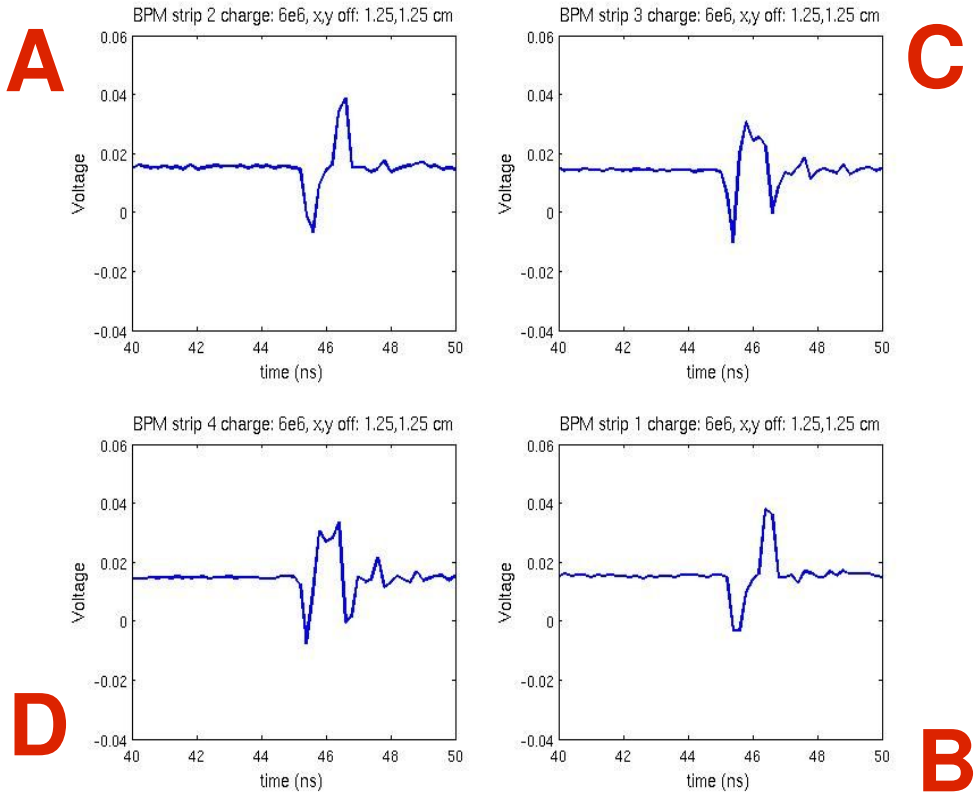
# DATA II - beam offset impinging on lowZ mask

## offset=1.41cm



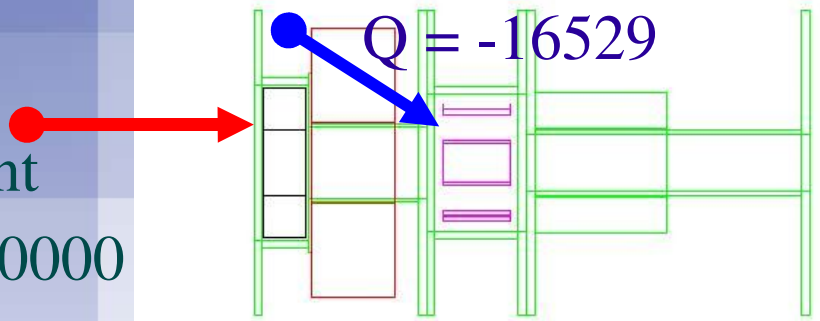
## offset=1.75cm

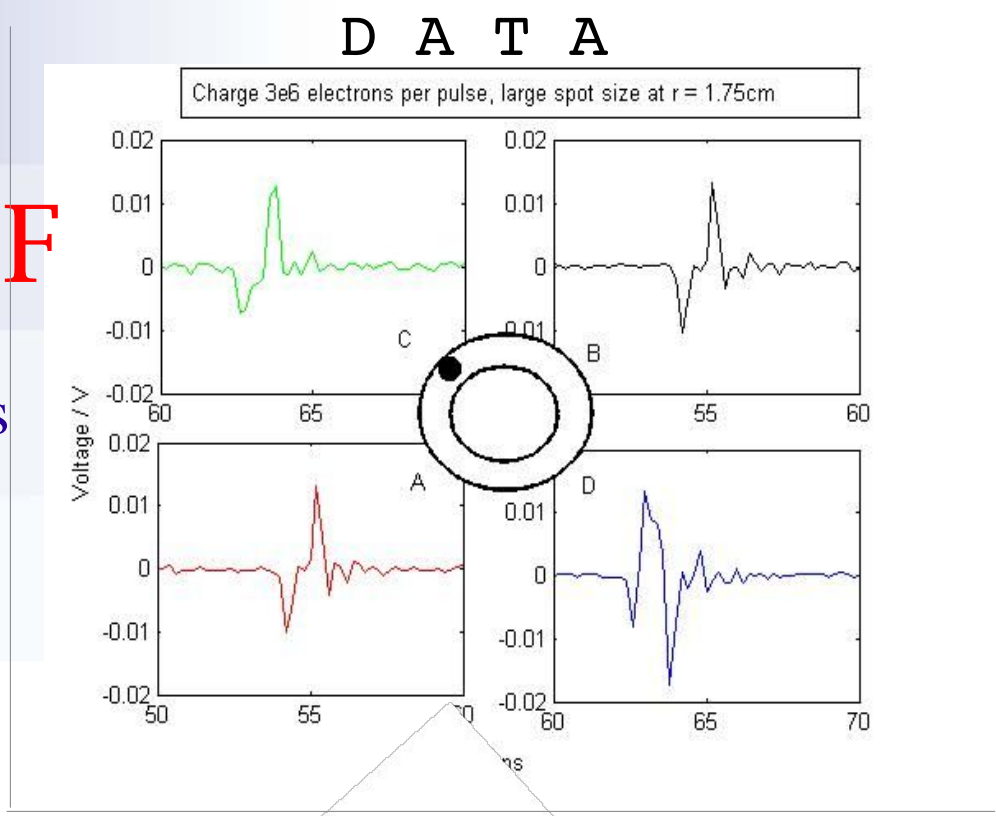



- 'noise' appears on furthest and nearest strips with fluctuating weights
- noise sensitive to offset

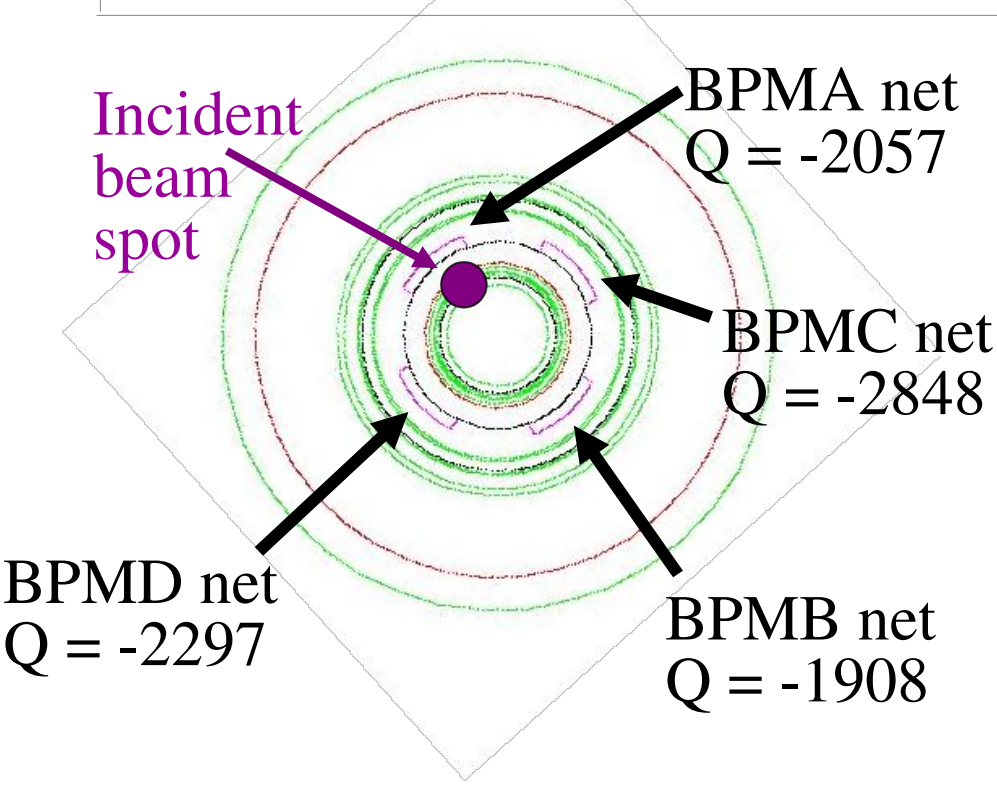
# Simulation I – Geant TOF

Net Q at upstream end of BPM strips

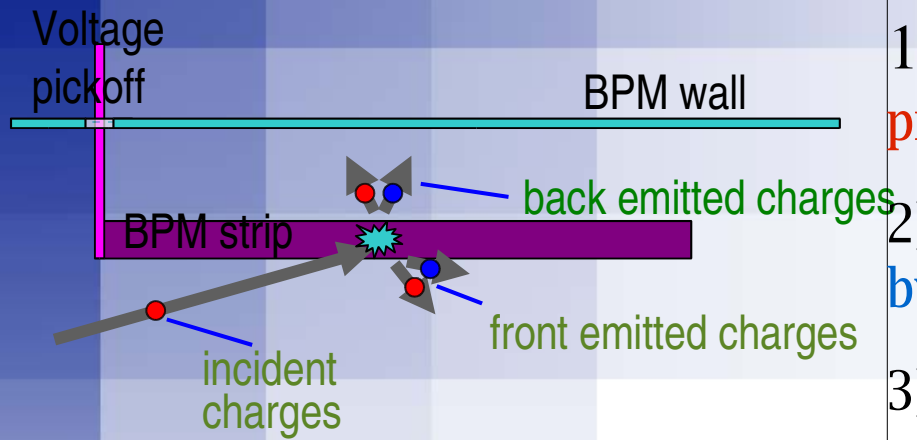



- 1mm spot size incident on low Z at (x,y)=(1.4,0)
- "Signal" obtained by counting net charge passing by strips
- "Noise" obtained by counting net charge in the secondary emission from the striplines
- Time response obtained from GEANT T.O.F. parameter



# Simulation II – signal & noise relative weights

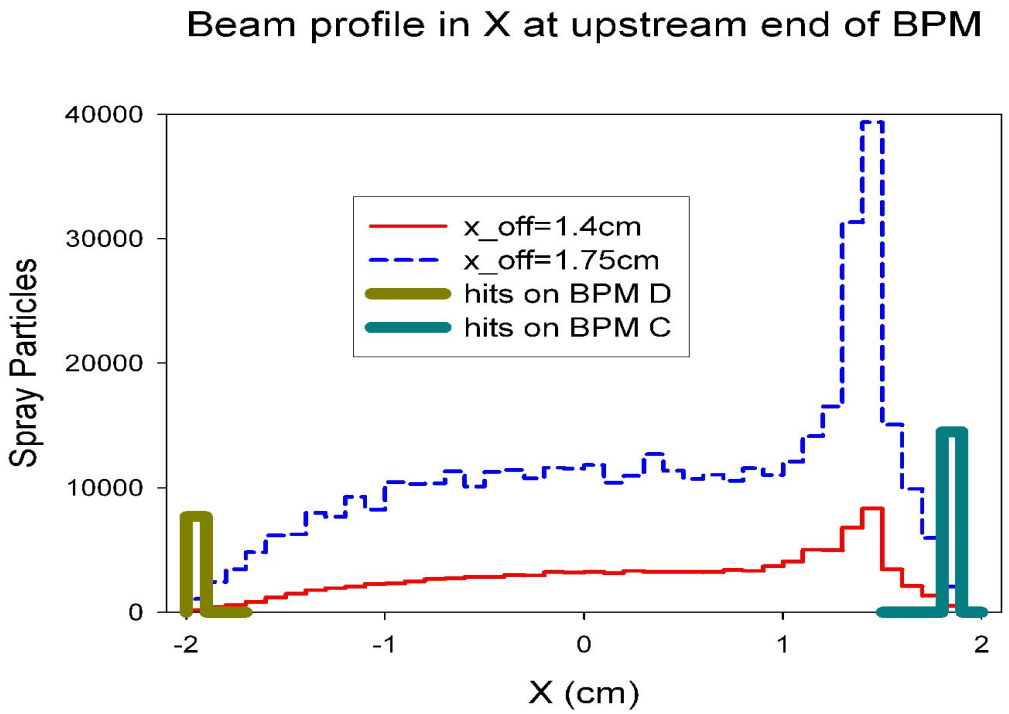



1) charge moving to or from strip surface contributes proportionally due to the angle of approach

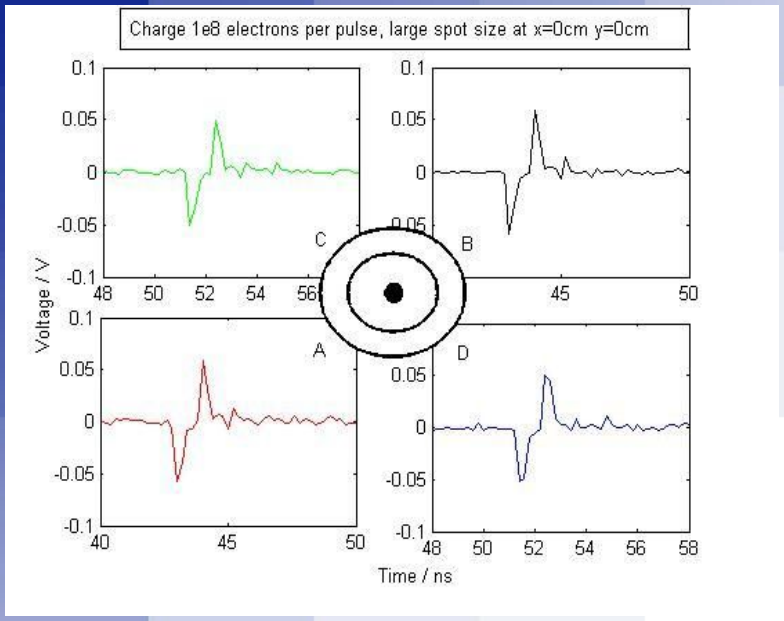
2) charge absorbed/emitted at front face – balanced by loss/addition of image charge

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

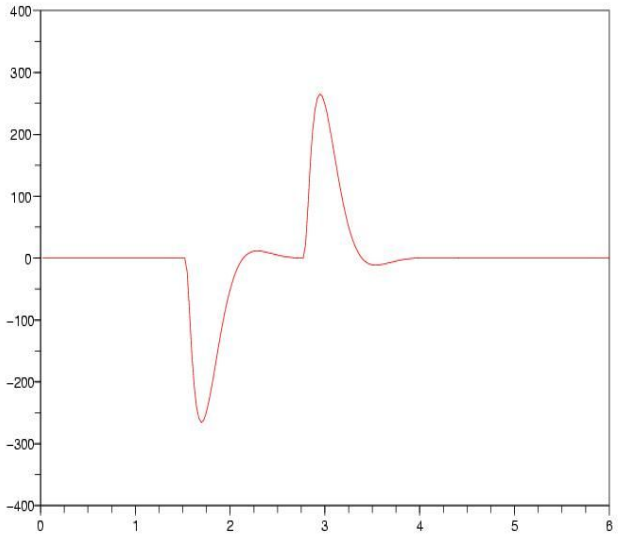
- beam impinging on LowZ smears out and peaks at ~x=1.5cm
- more spray hits on the BPM strip **nearest** the beam **but** beam signal is strongest on nearest strip
- in terms of 'signal/noise' these are countervailing factors

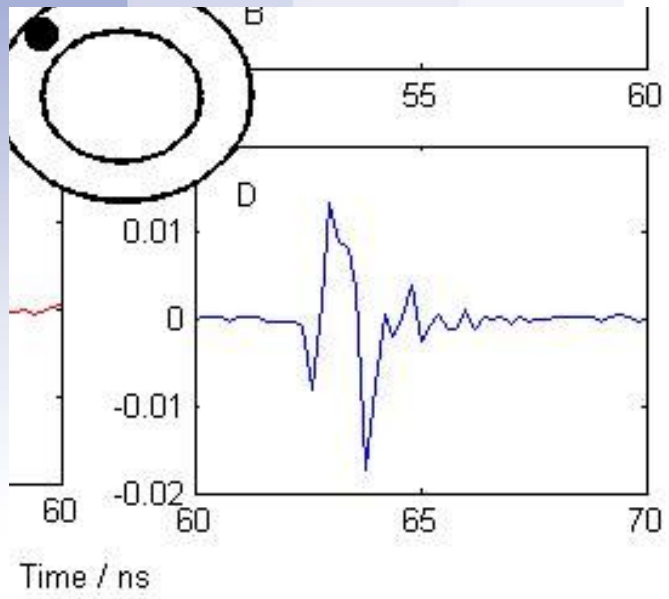


# Simulation III – comparison with data

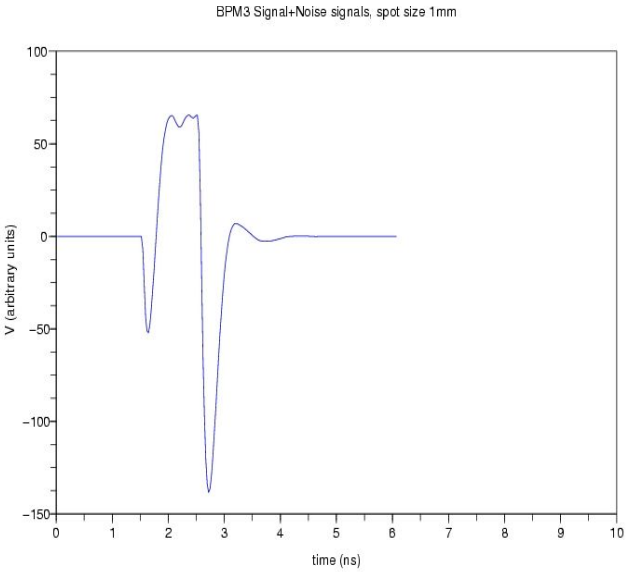



Broaden a simulated signal pulse by passing through a 2nd order 1.2 GHz Butterworth Low pass filter



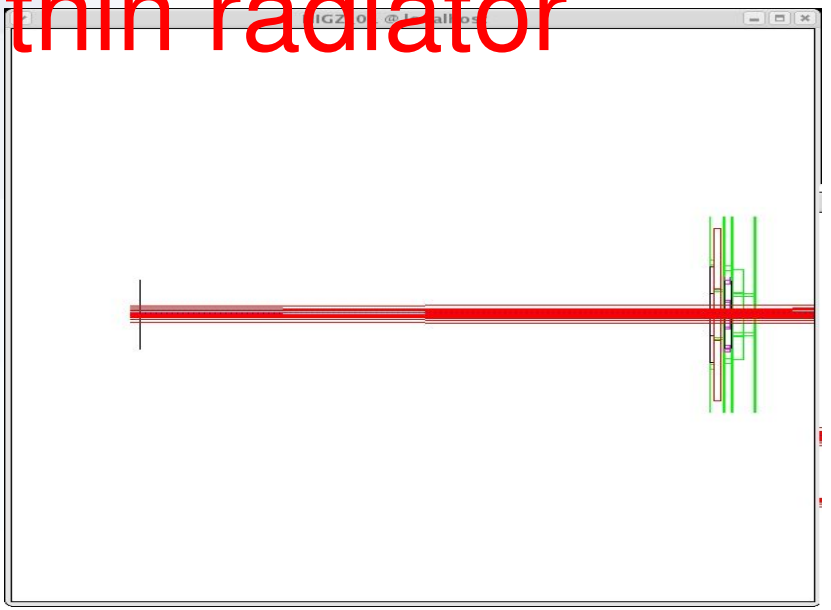



Apply scheme for adding the effect of stripline hits to produce 'noise'.
'Signal' is determined by beam charge and offset



# FONT@ESA Mar07 thin radiator

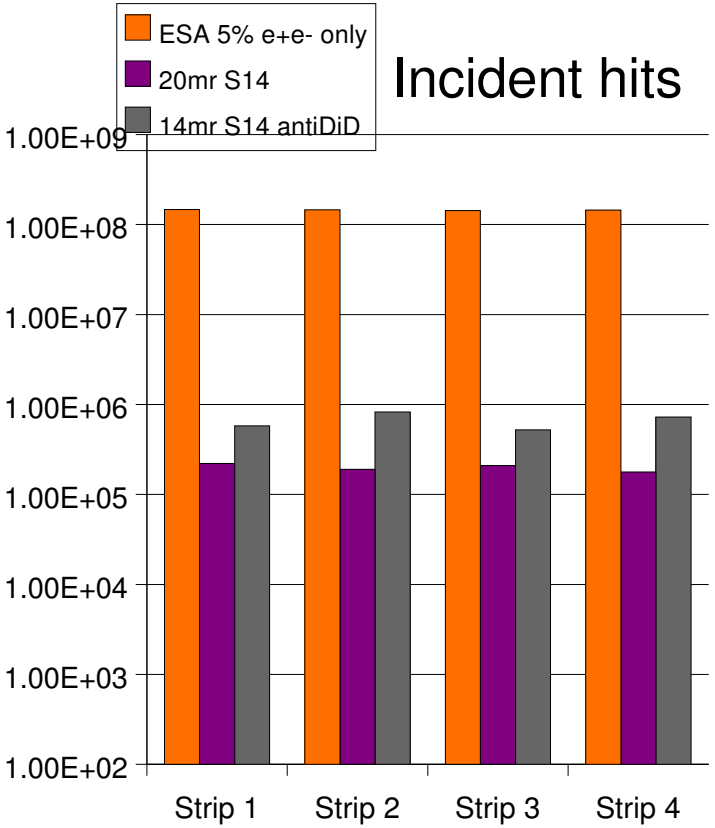
- Jul06 run illuminated one spot on mask, but ILC indicates spray originating from an annulus
- July06 run produced condition 4 orders of magnitude worse than can be expected at ILC, so.....



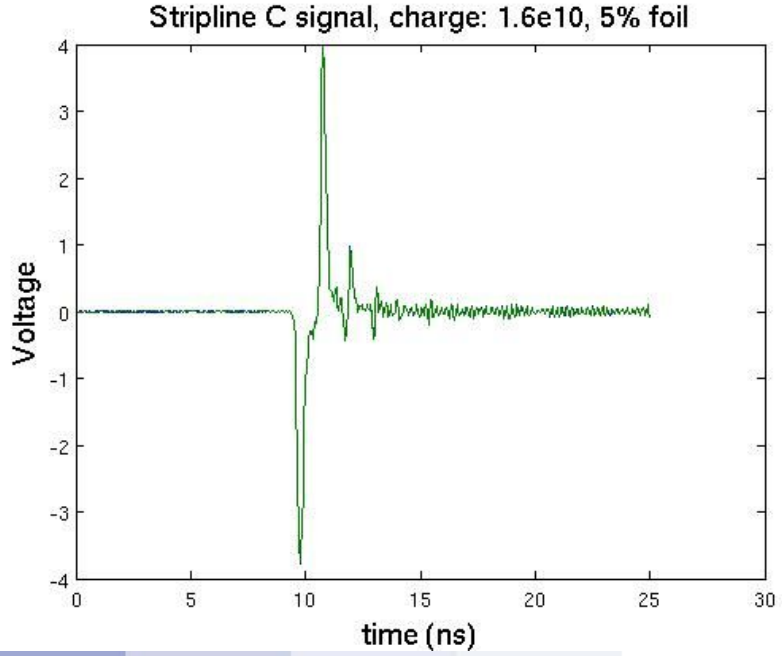
**INSERT THIN RADIATOR UPSTREAM**

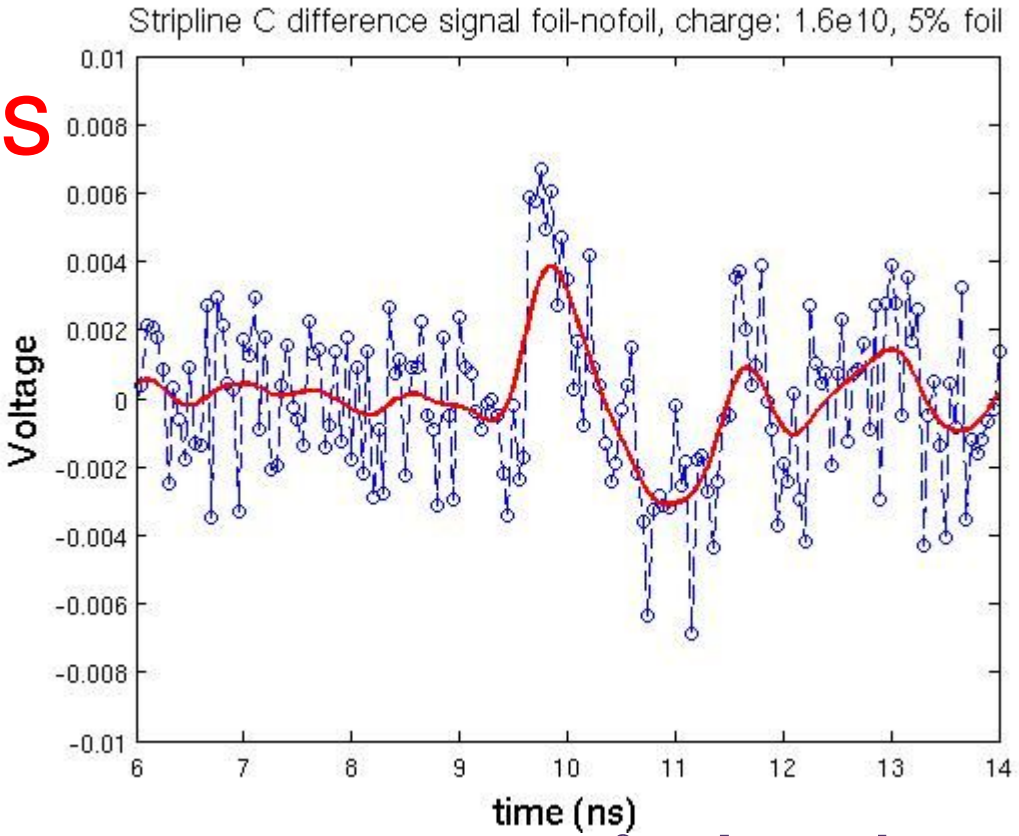
pass $10^6$ particles through ESA GEANT module containing thin radiator

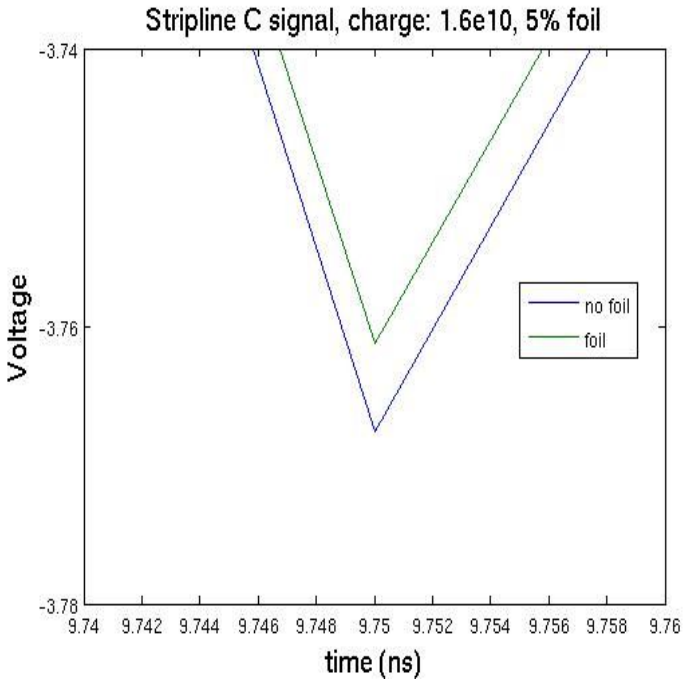
So..5% Al at 3PR2 (15.7m upstream of lowZ) gives a couple of orders of magnitude more strip hits than ILC S14

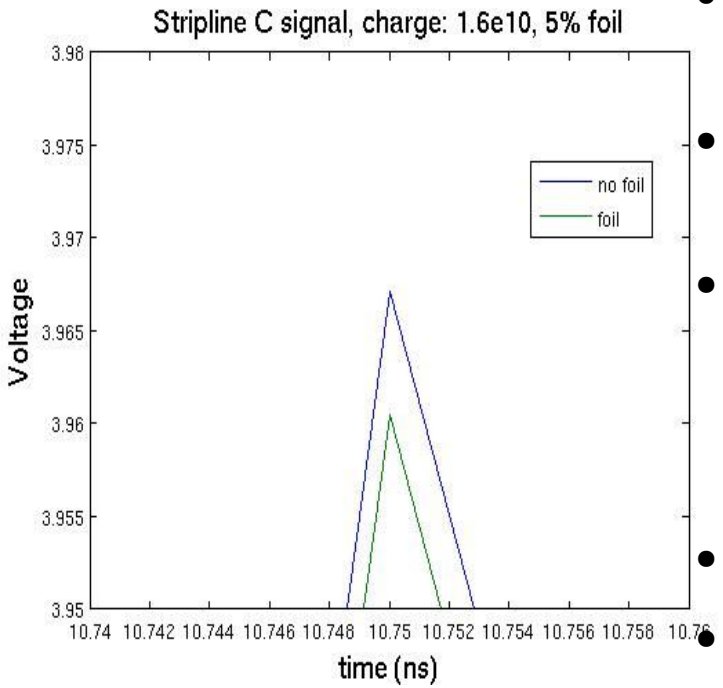


# raw stripline signals



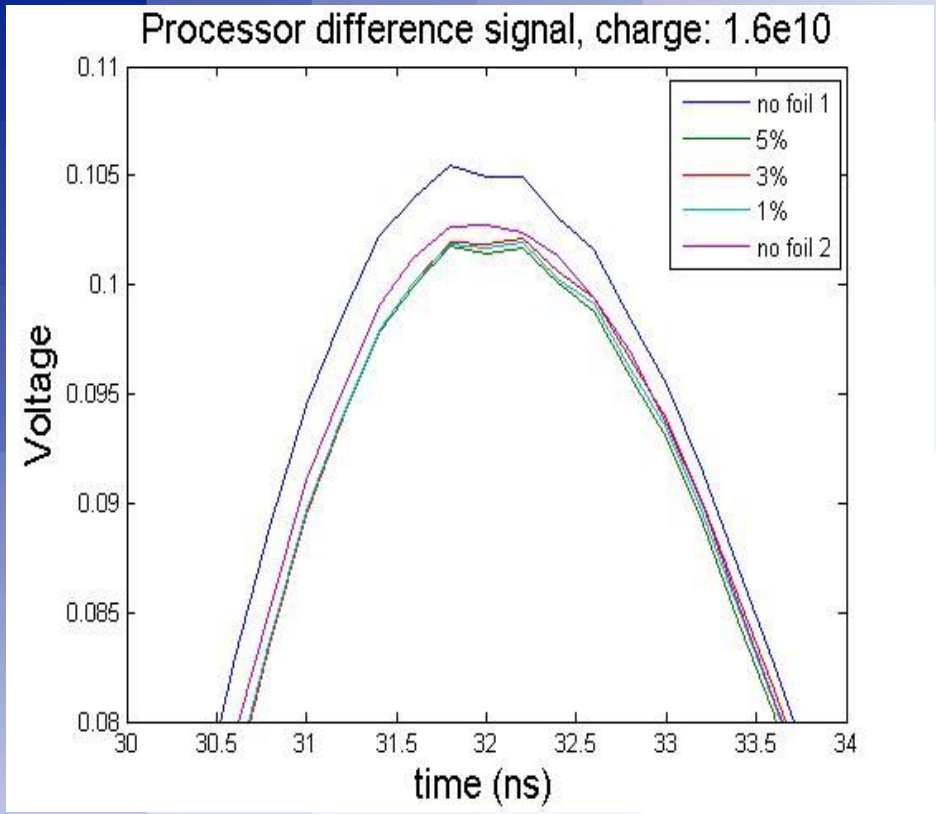




- fit spline and zero data to compare like and like
- closeup shows foil signal is smaller amplitude
- subtracting nonfoil from foil data gives a reverse bipolar double-EITHER noise signal OR drift
- data noise/signal~0.1%
- sim noise/signal~0.14%

# processor data – difference signal




- average 1000 bunches to remove jitter and view closeup of peak with smoothed spline
- The peaks are spread over ~2% variation, but the error (std deviation) for each is the same order, so...
- We cannot say whether the spread is due to drift, jitter or secondary emission – the experiment is not sensitive enough
- If we assumed worst case, what would be the effect on feedback?
- Will jitter/drift be so bad at the ILC?
- Can the experiment be made more sensitive for next ESA run?

**no foil 1 peak = 0.105 ± 0.002**

**5% foil peak = 0.102 ± 0.005**

**3% foil peak = 0.102 ± 0.002**

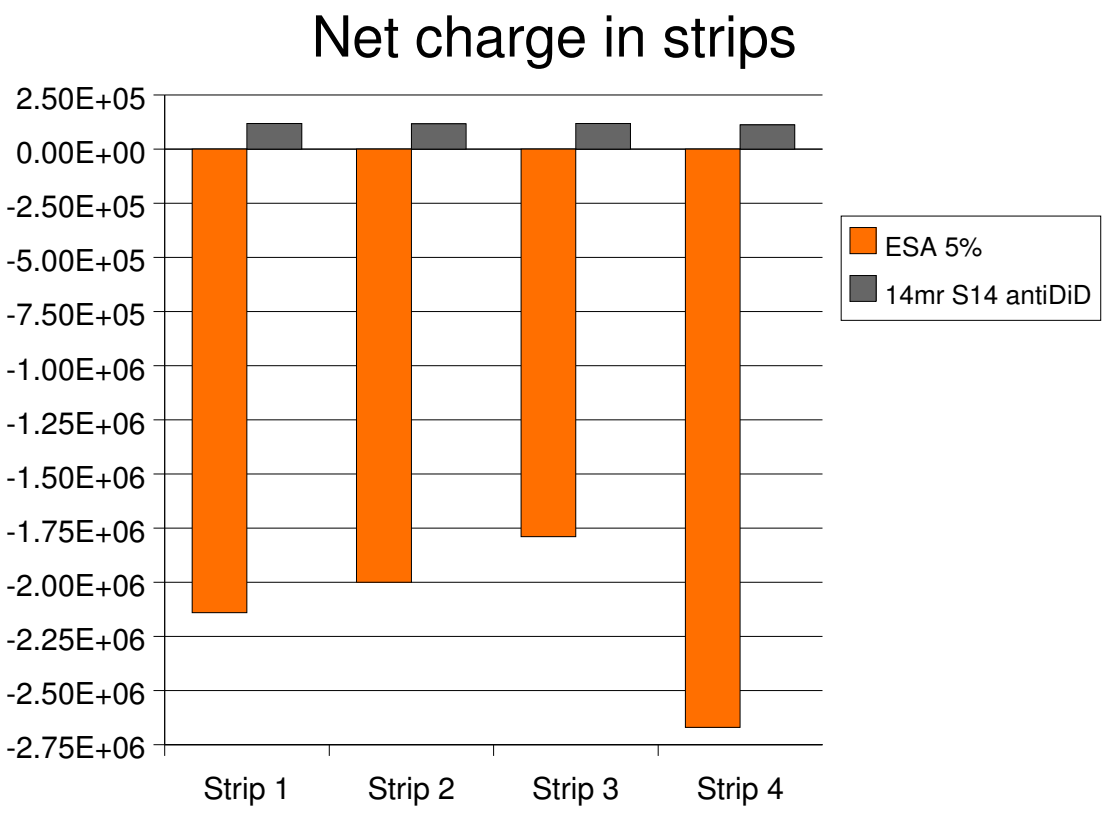
**1% foil peak = 0.102 ± 0.002**

**no foil 2 peak = 0.103 ± 0.002**

# Simulation IV – comparison with ILC worst case

- 'Noise' in stripline signals is given by net charge in strips proportional to the amount of beam charge seen by the stripline
- We know that the ESA striplines will receive 2 orders less hits, but what about net charge?

- ILC parameter set 14 ~700,000 pair particles
- ESA beam charge is $1.6 \times 10^{10}$ and we need to process a significant proportion
- ESA sim 0.01% of beam, ILC 10% of beam
- net charge for ESA experiment is ~1 order of magnitude greater than ILC worst case



# Summary

- **FONT@ESA Jul06 & Mar07 data**
  - **LowZ:** raw stripline signals as beam x_offset varies
  - **1,3,5% thin radiator:** raw stripline signals with beam on axis
  - **processor:** full set of processor data for all configurations
- **Data trends**
  - **LowZ offset in x:** noise appears in the strips closest and furtherest from the initial beam offset
  - **thin radiator:** Either position drift, jitter and/or noise from direct hits on BPM striplines of ~2% of the signal
- **Simulations**
  - used GEANT to obtain time dependence of secondary emission and relative weights of noise and signal – good match with signal shapes
  - ILC 14mrad geometry with high luminosity beam parameter would produce 10 times **less** noise due to hits on striplines than peoduced in the Mar07 ESA test
- **Conclusions**
  - maximum noise at the ILC feedback BPM striplines ~0.2% of signal – Probably outweighed by jitter
  - FONT@ESA experiment successfully concluded with positive message