Electromagnetic Background Tests for the Interaction Point Feedback System

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Outline

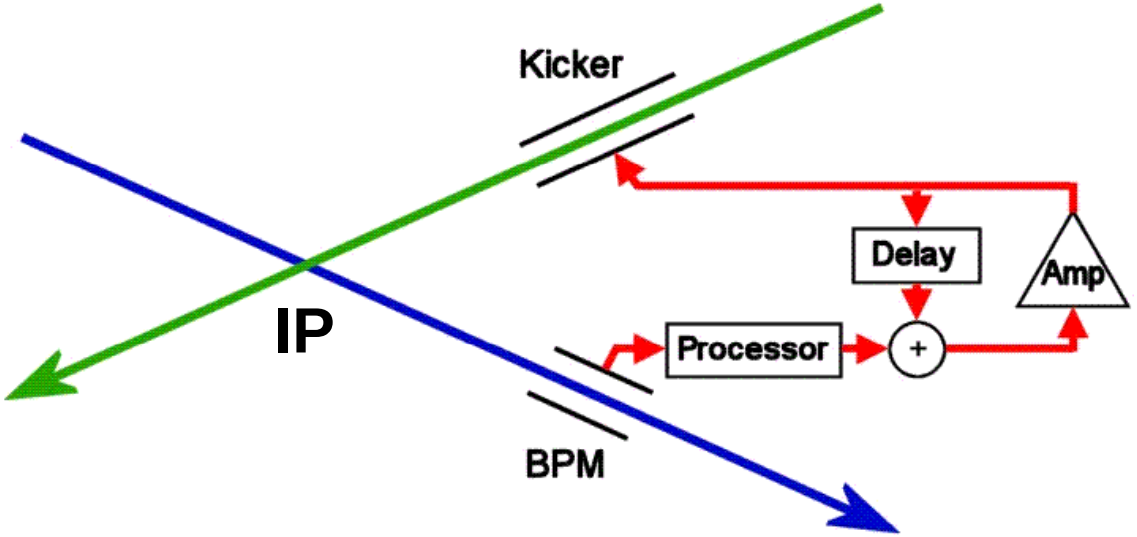
- Introduction
- ILC interaction point intra-train feedback system
- Beam-beam interaction and EM backgrounds
- T488 experiment at SLAC Endstation A
- Conclusions

Intra-train feedback system - concept

Last line of defence against relative beam misalignment

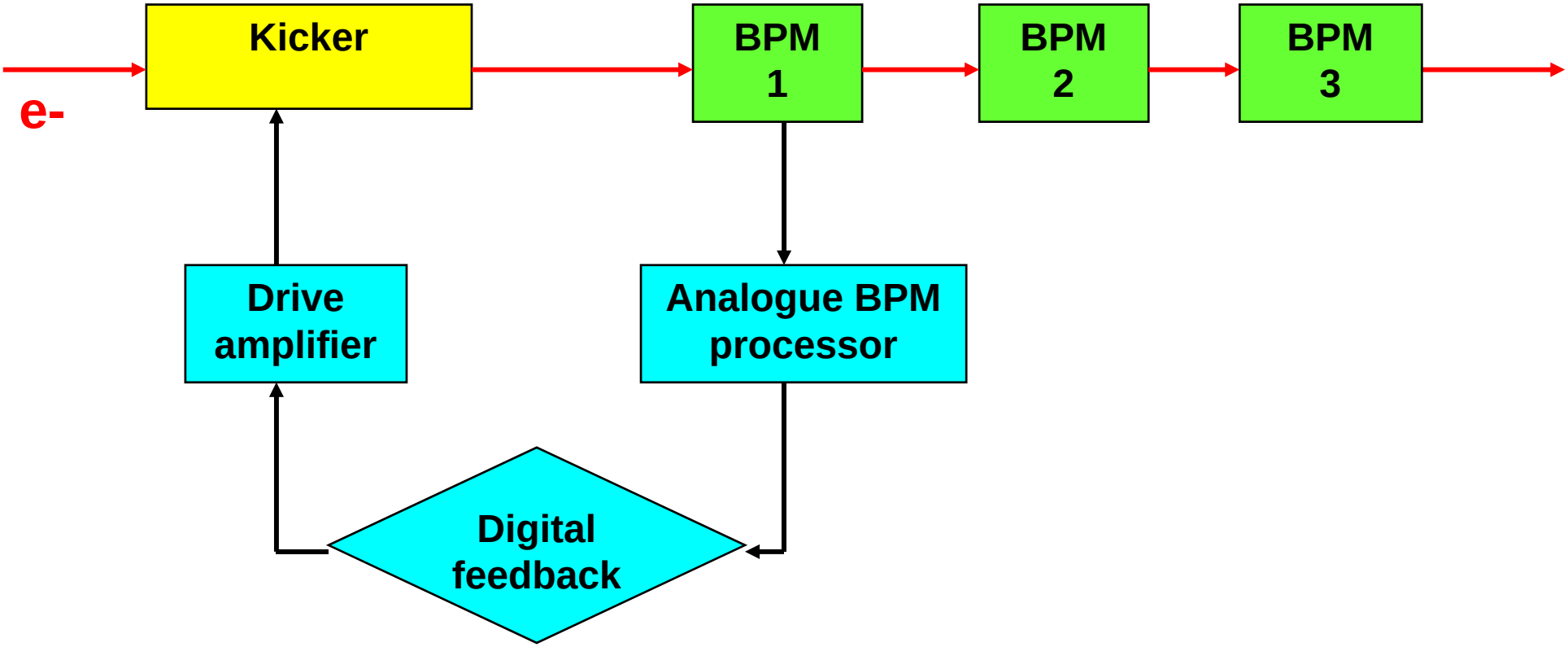
Measure vertical position of outgoing beam and hence beam-beam kick angle

Use fast amplifier and kicker to correct vertical position of incoming beam

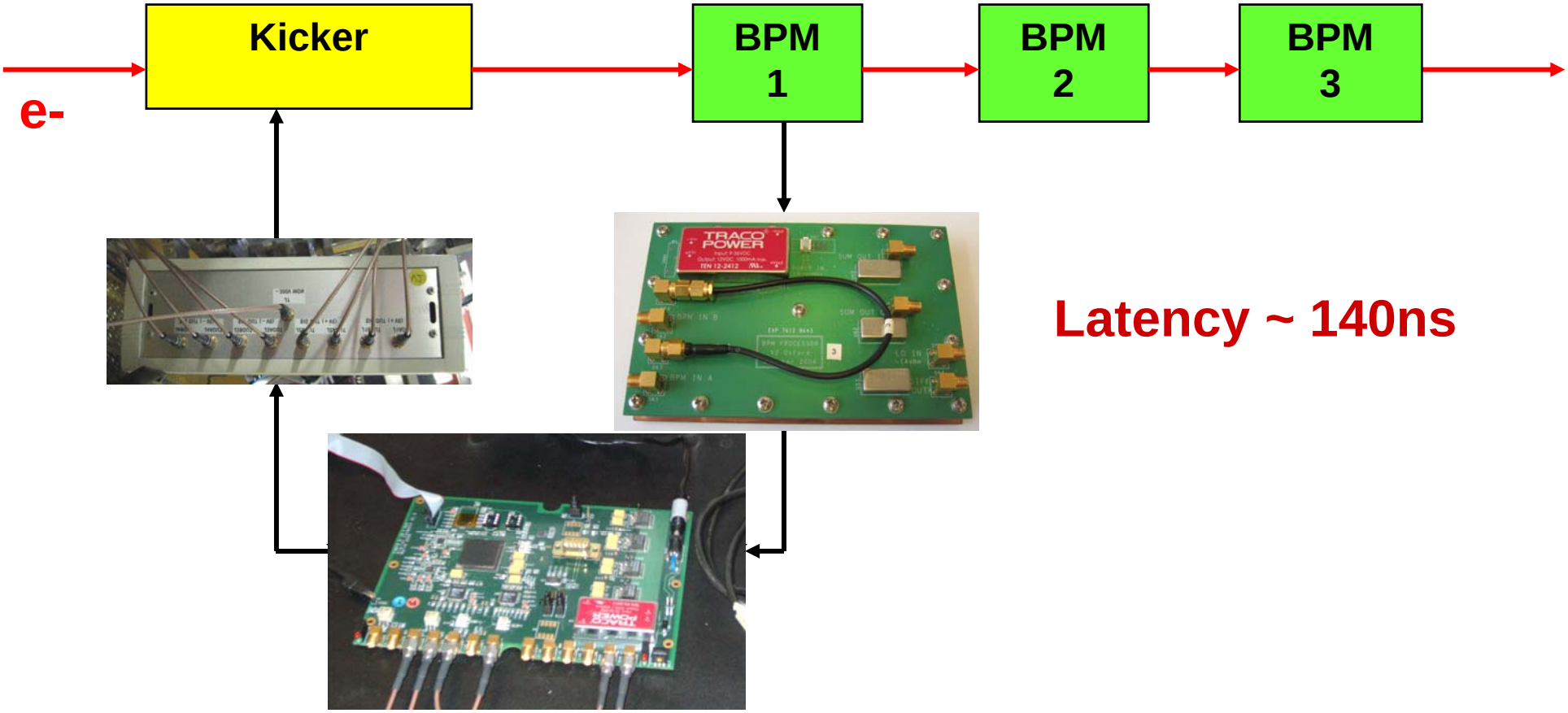


FONT:
Feedback On Nanosecond Timescales

FONT4 prototype at KEK/ATF

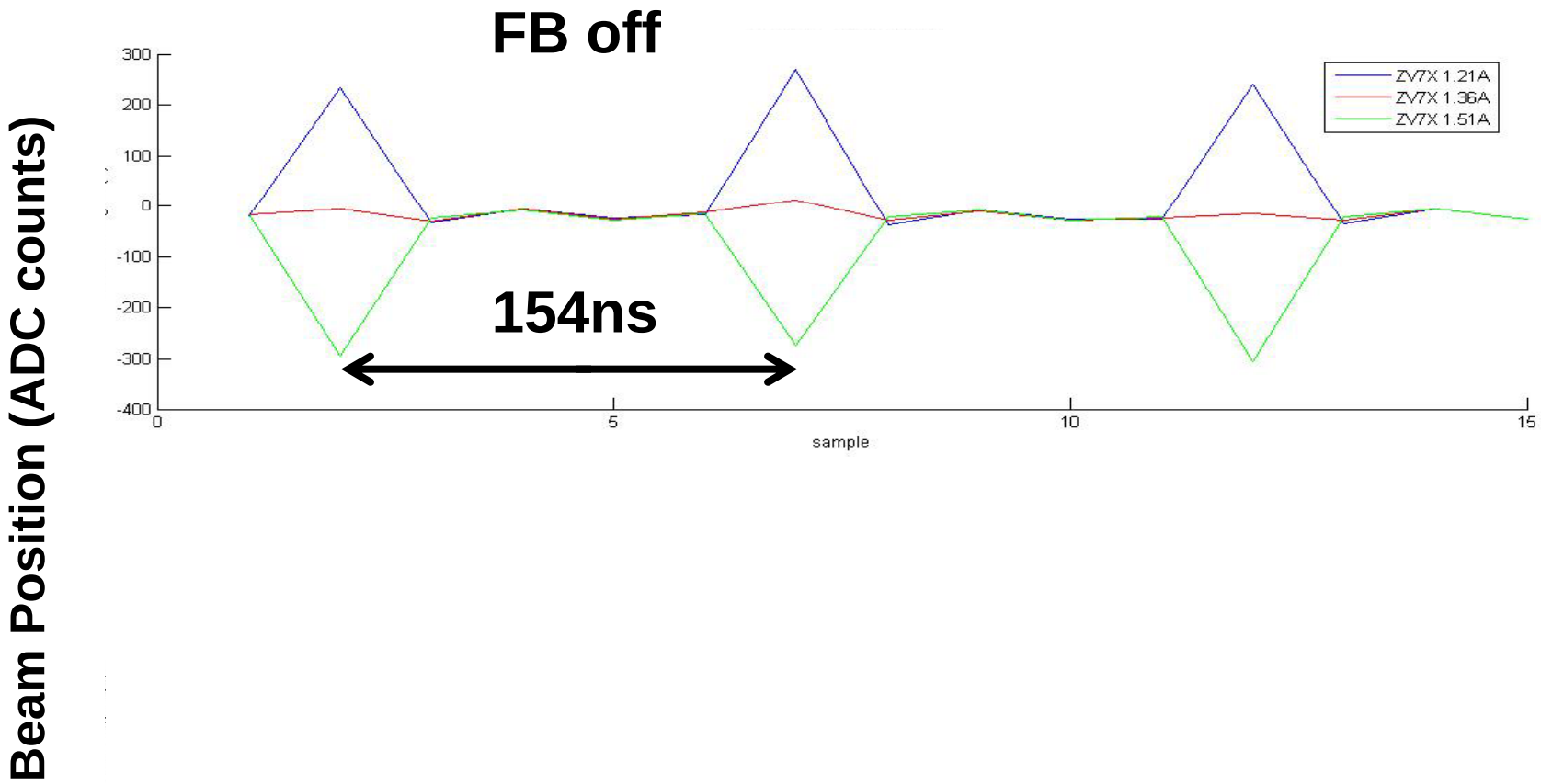


FONT4 prototype at KEK/ATF



Latency ~ 140ns

Reminder of FB performance



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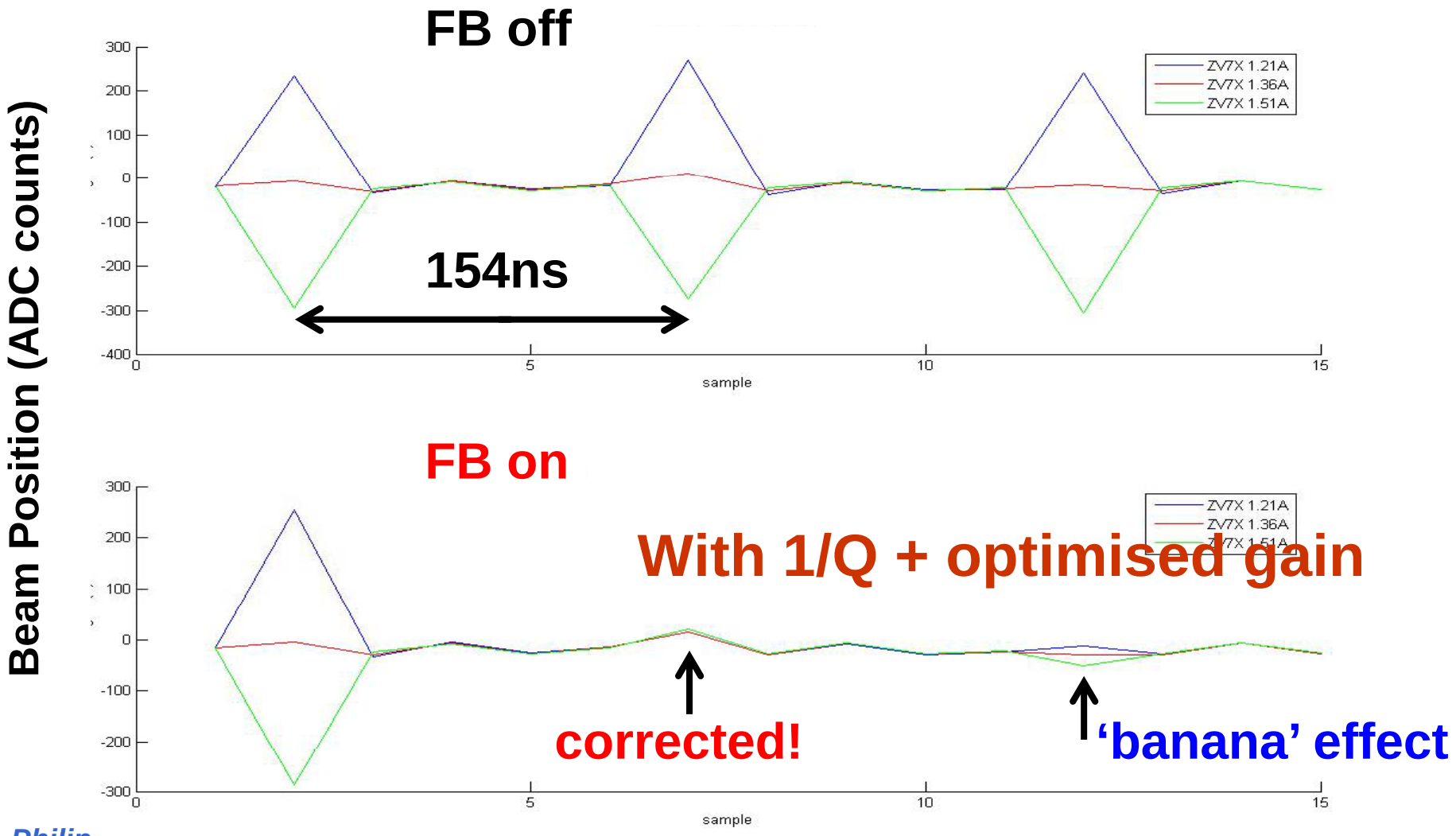
Reminder of FB performance



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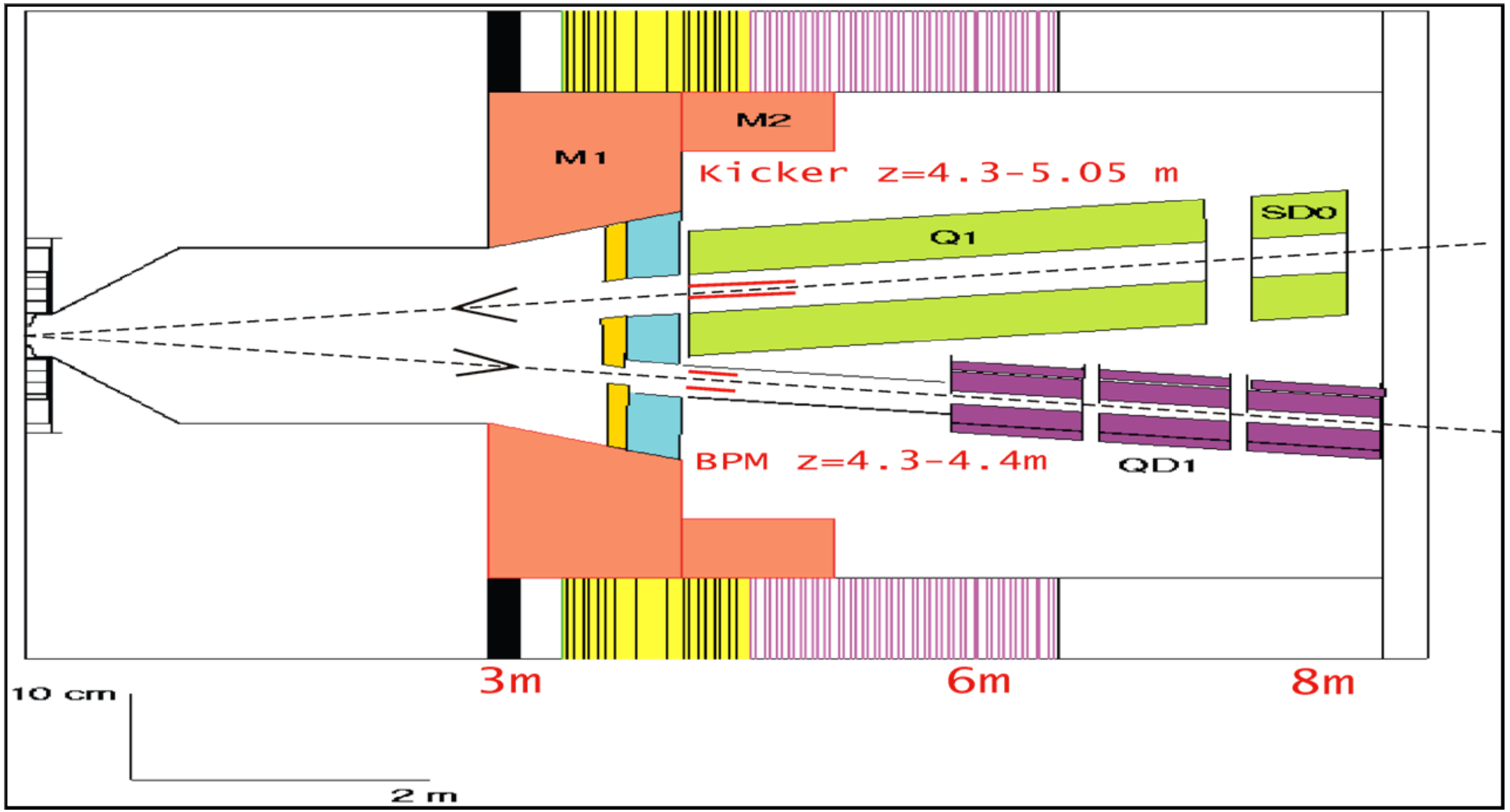
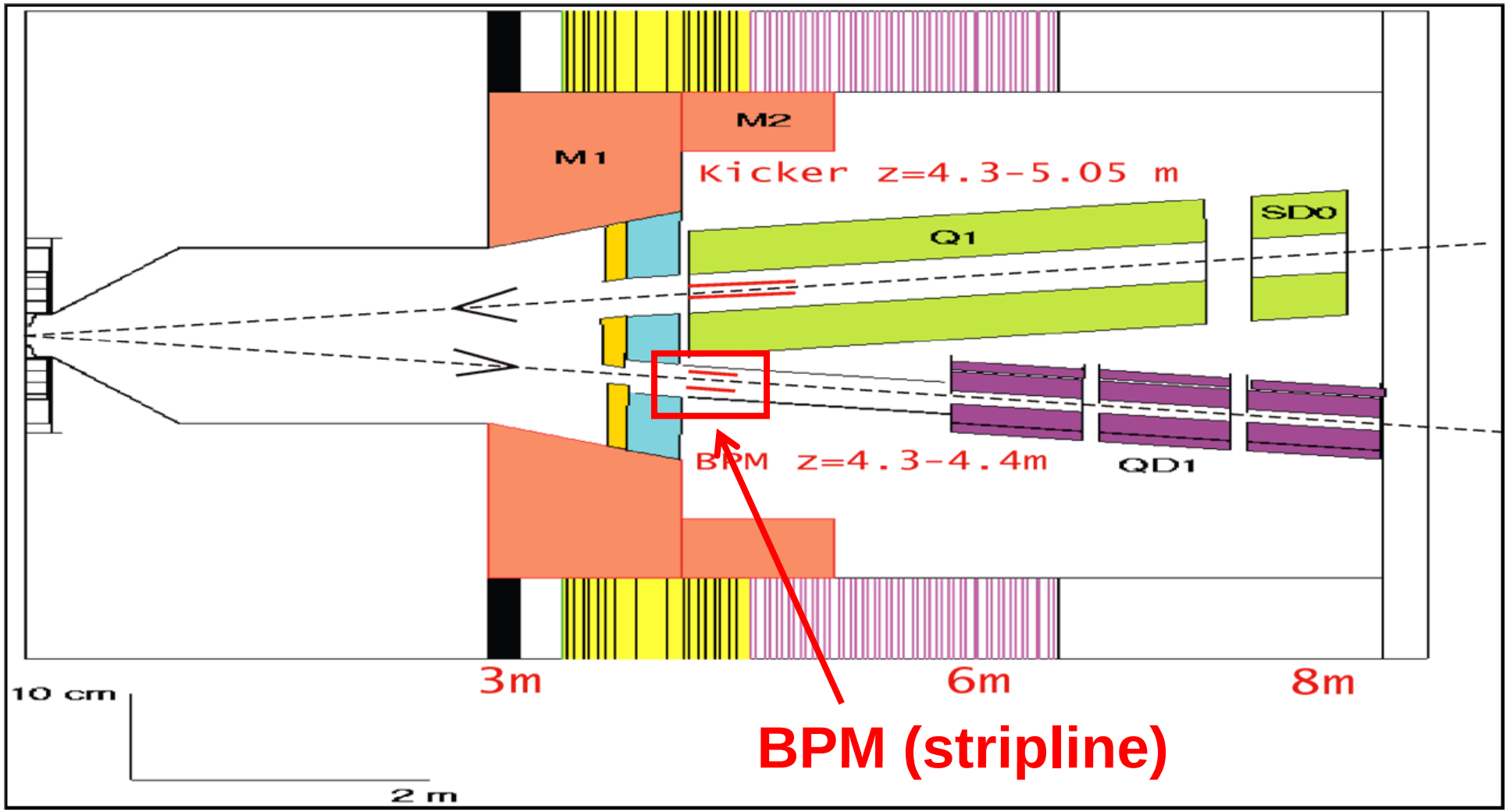
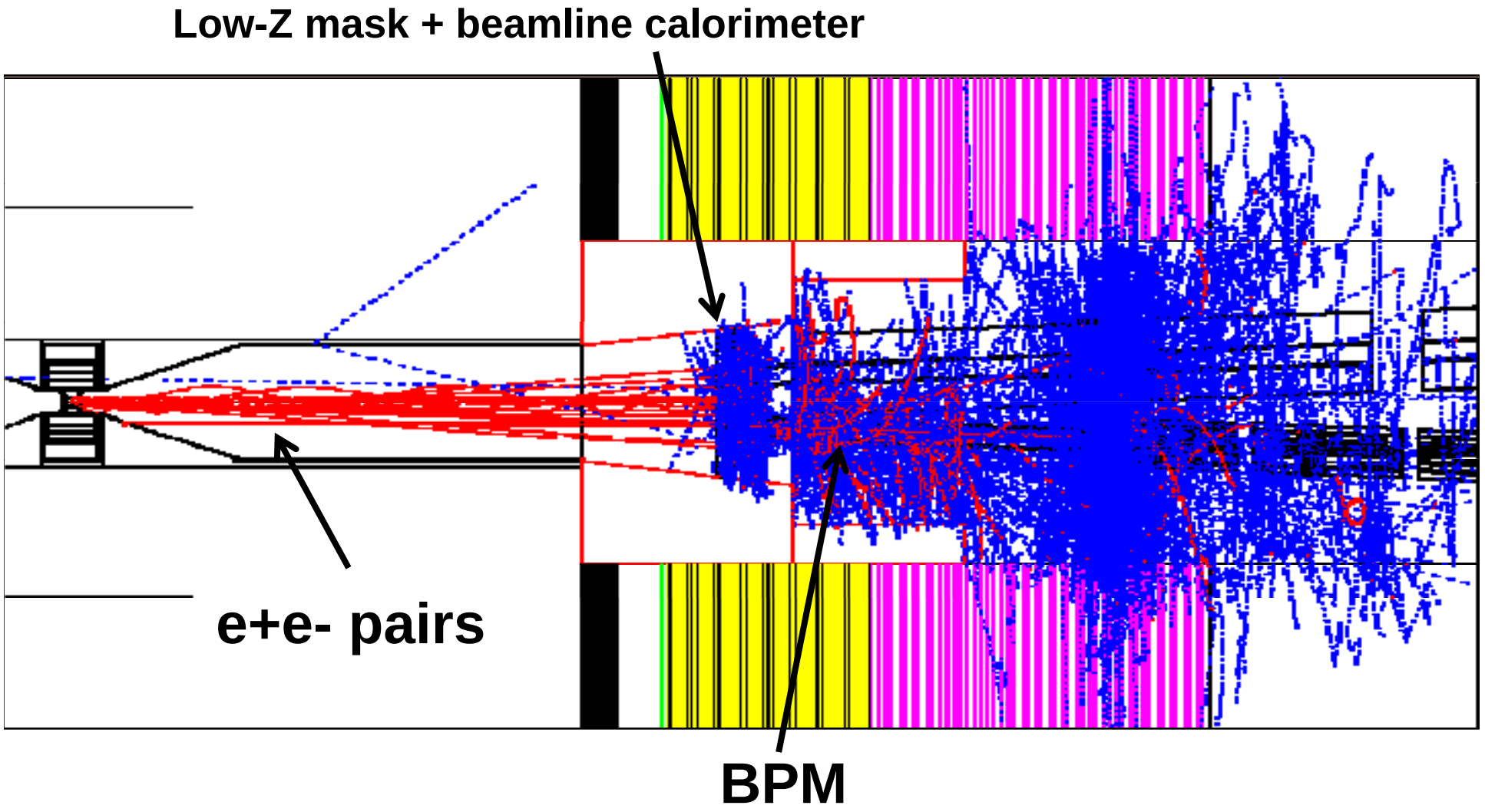
ILC interaction region (schematic)



Nominal IP feedback BPM location



Pair-induced EM backgrounds



Backgrounds due to e+e- pairs

Beam Parameters Scheme	Number of Pair Particles	Average Energy (GeV)	BPM hits
Scheme 1	195652	10.8	5141
Scheme 2	164370	10.6289	4497
Scheme 3	121966	10.8947	3057
Scheme 4	49720	12.3421	1074
Scheme 5	124273	9.58301	2321
Scheme 6	272218	10.6636	9686
Scheme 7	320352	10.9809	12314
Scheme 8	193166	11.2826	5127
Scheme 9	237749	11.5317	8758
Scheme 10	192976	11.3083	6399
Scheme 11	85218	12.8034	2623
Scheme 12	247683	10.1212	9287
Scheme 13	500457	13.8549	25016
Scheme 14	678811	15.5845	80443

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Parameter space for 500 GeV ILC

Parameter space for 1 TeV ILC

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Primaries per bunch crossing: 50 – 700k

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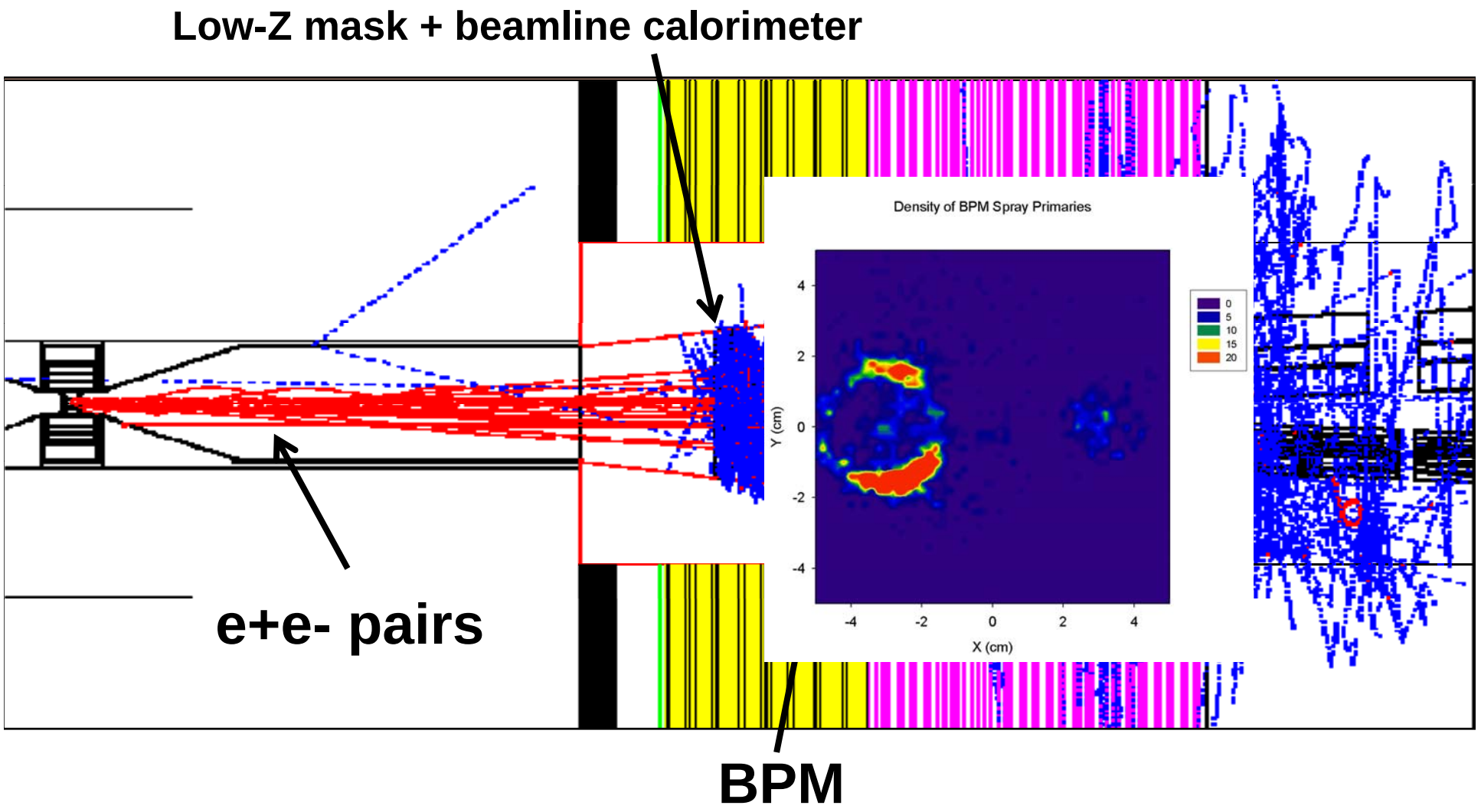
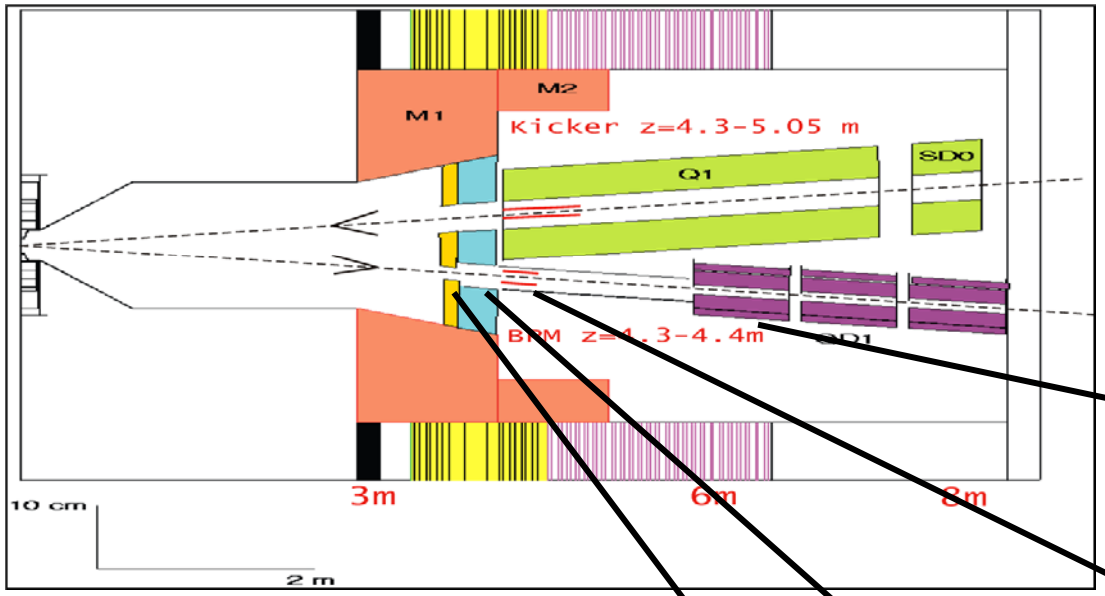
BPM hits per bunch crossing: 1 – 80k

Pair-induced EM backgrounds



FONT Test Module for ESA



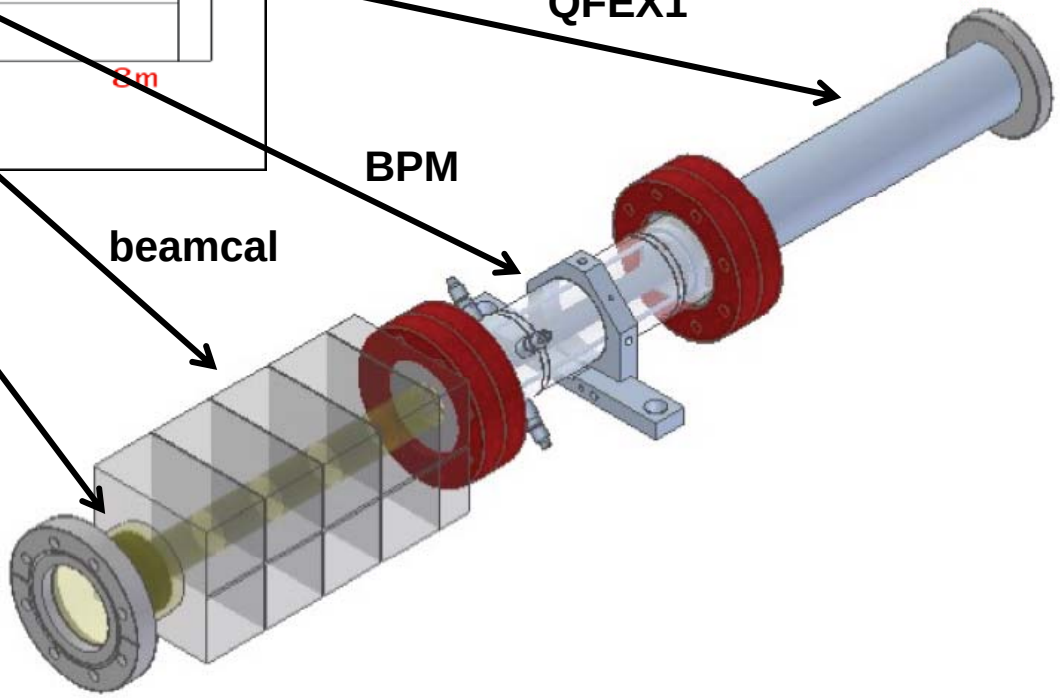
Material model of ILC outgoing beamline

QFEX1

BPM

beamcal

low Z mask



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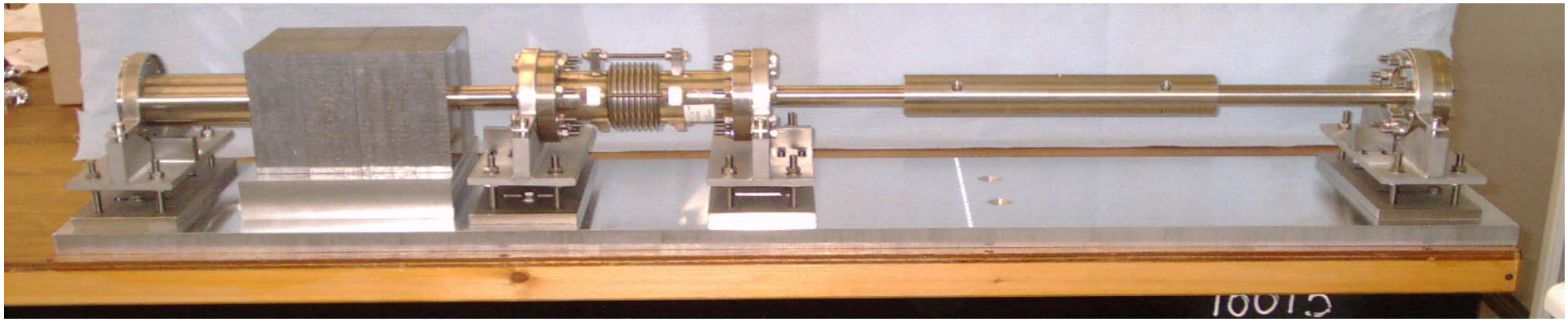
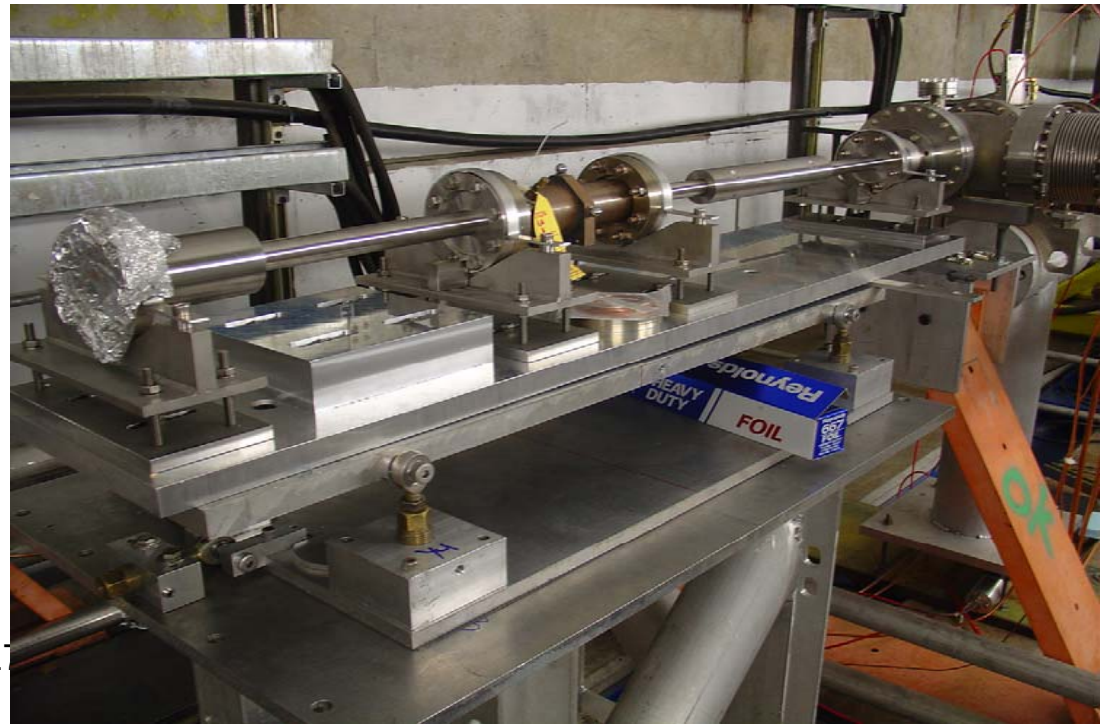
FONT Test Module (T-488)



Installation at ESA

Beam →



Overview of T-488 Experiment

- **Used 28.5 GeV SLAC beam to simulate ILC EM background environment:**
- **Mode 1:**

  Large beam ~ 1mm diameter, 106 < Q < 10**8**

  Beam steered onto front of FONT module
- **Mode 2:**

  Beam passed through upstream thin radiator

  Main beam + halo that strikes module

Overview of T-488 Experiment

- **Used 28.5 GeV SLAC beam to simulate ILC EM background environment:**
- **Mode 1:**

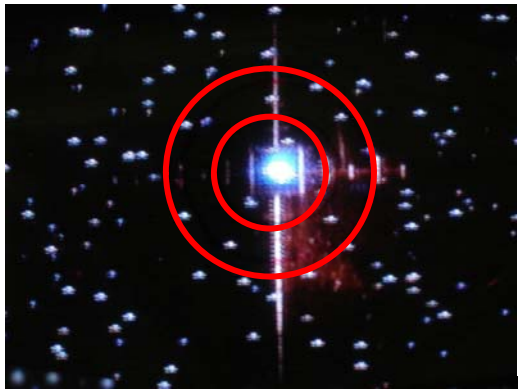
  Lose primary beam signal in BPM

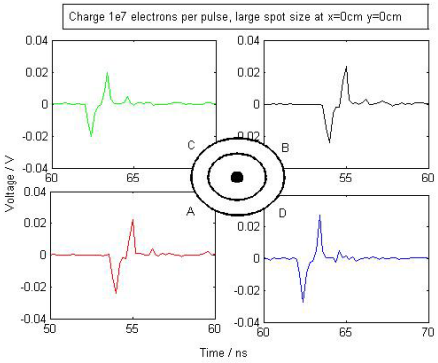
  Vary noise signal at BPM by varying Q
- **Mode 2:**

  Still get primary beam signal in BPM

  Tune noise signal at BPM by varying X0

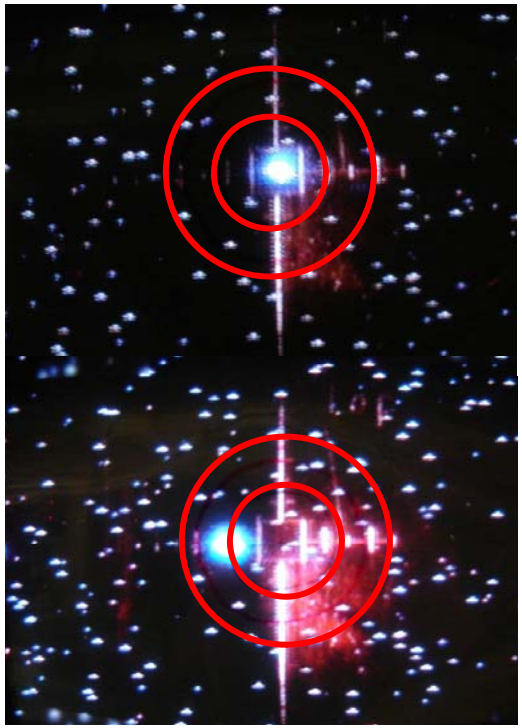
Studied impact on stripline BPM signals

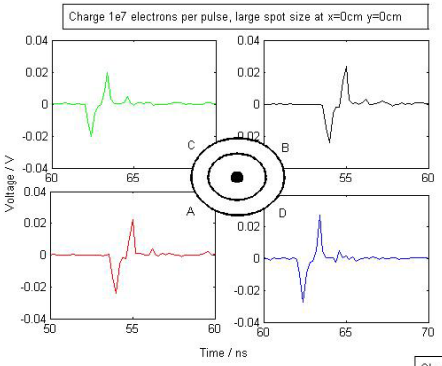




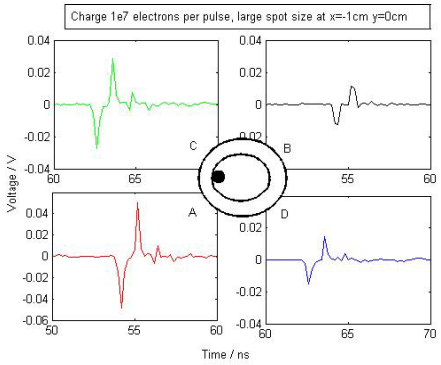
Mode 1:
beam scan across module: stripline BPM signals

107 beam**

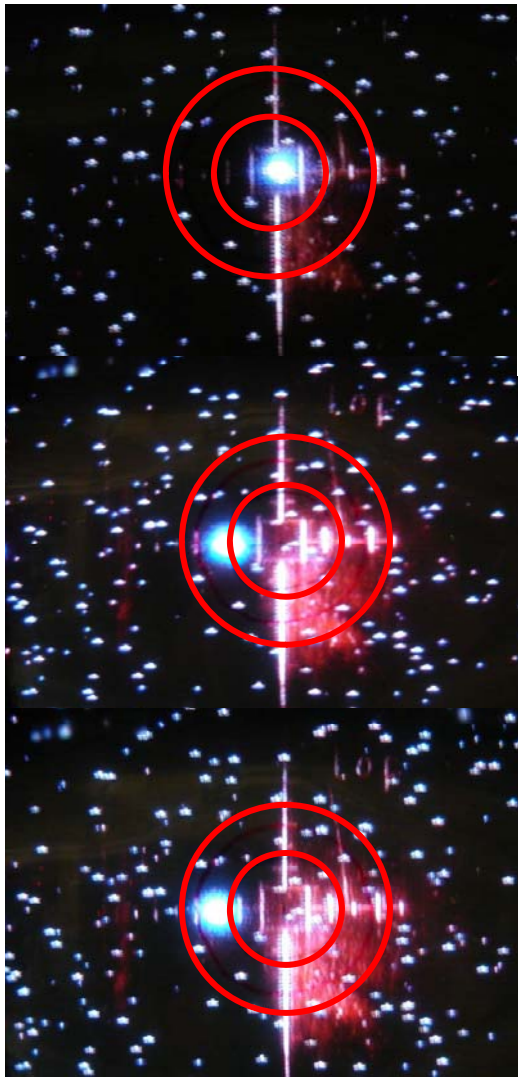


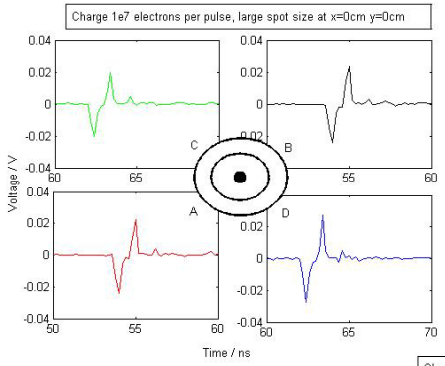


Mode 1: beam scan across module: stripline BPM signals



107 beam**





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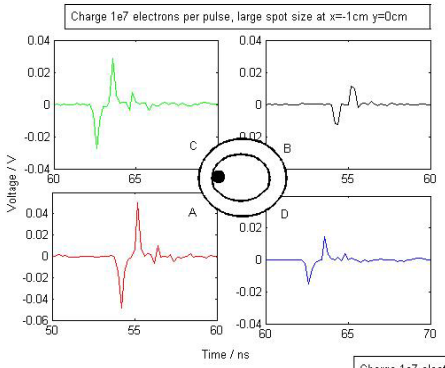
beam scan across module:
stripline BPM signals



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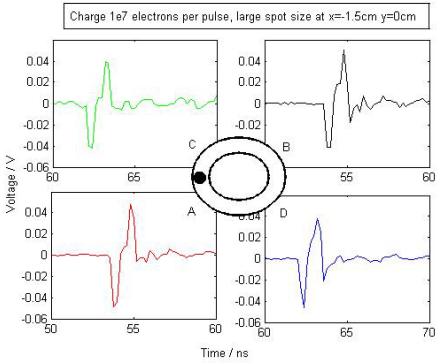

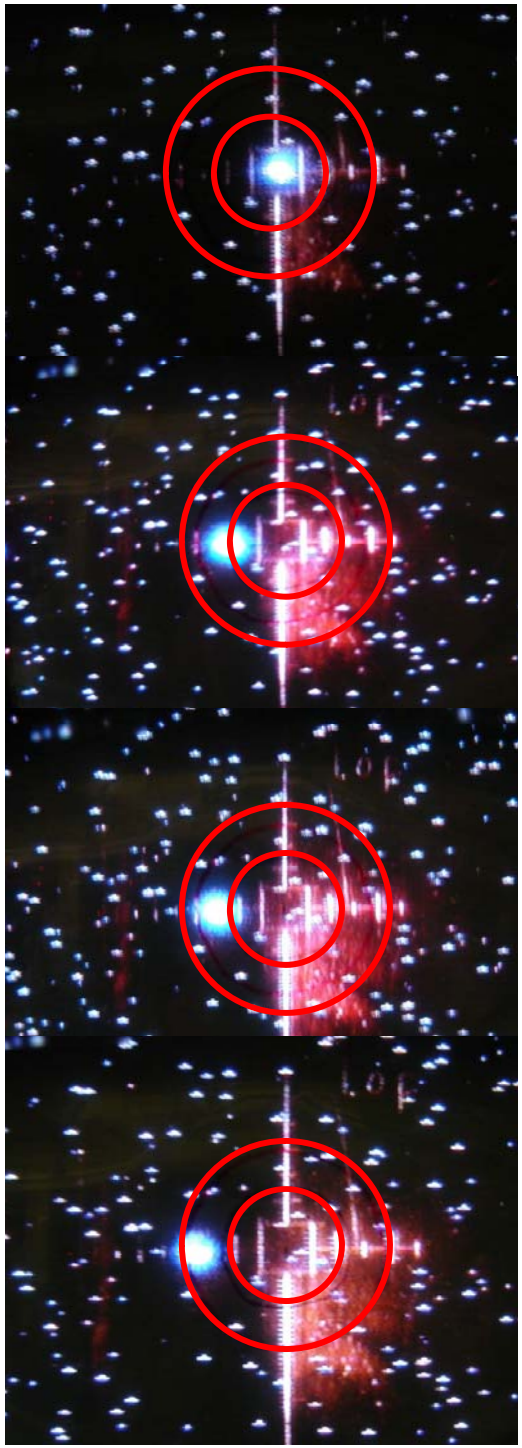

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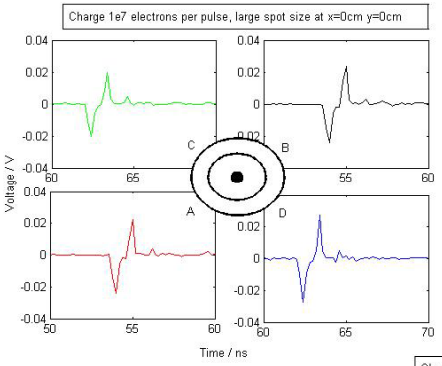
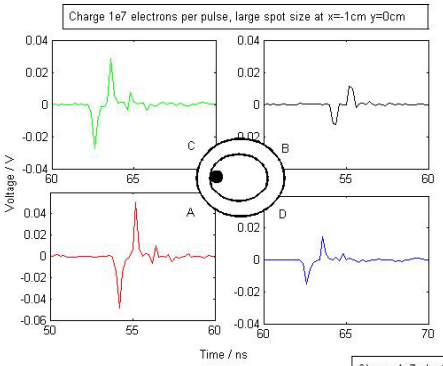
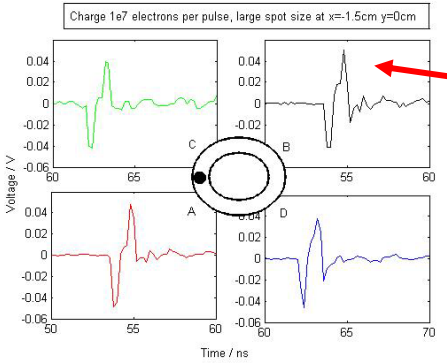
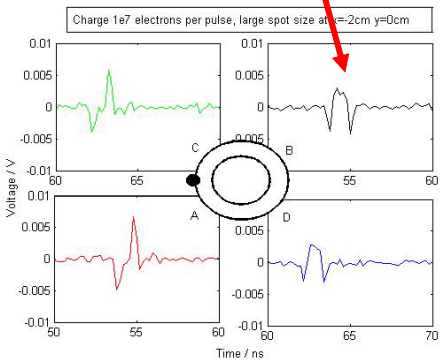




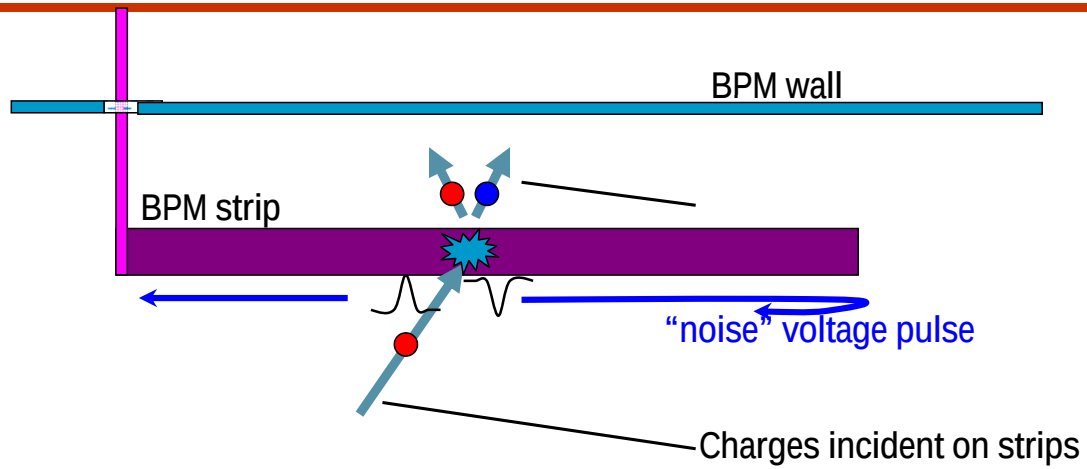
107 beam**



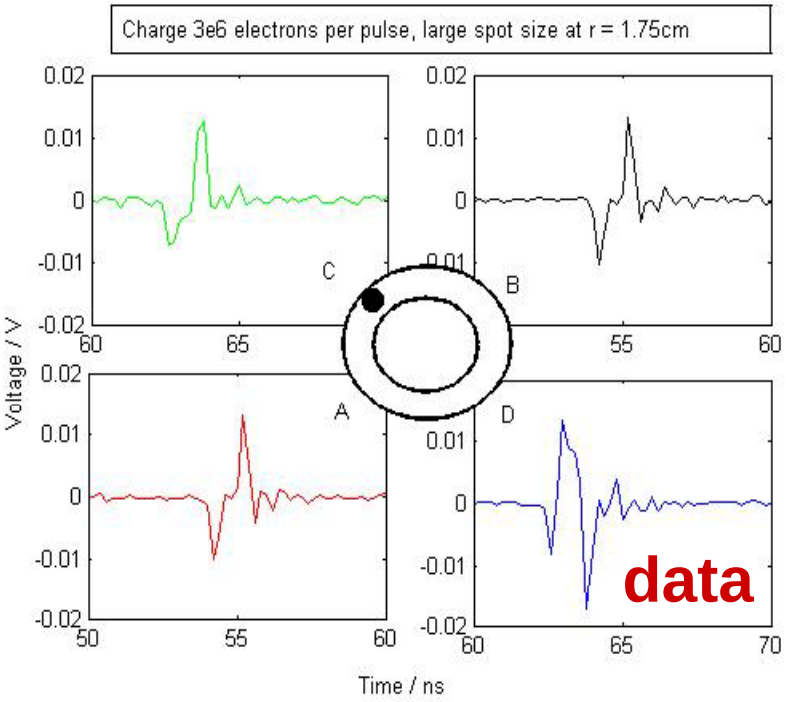
Noticeable degradation of signals

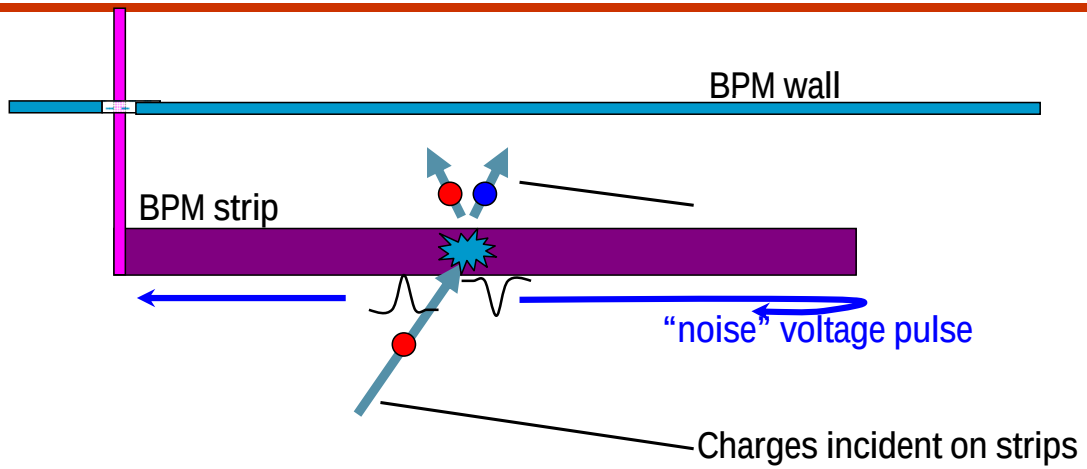


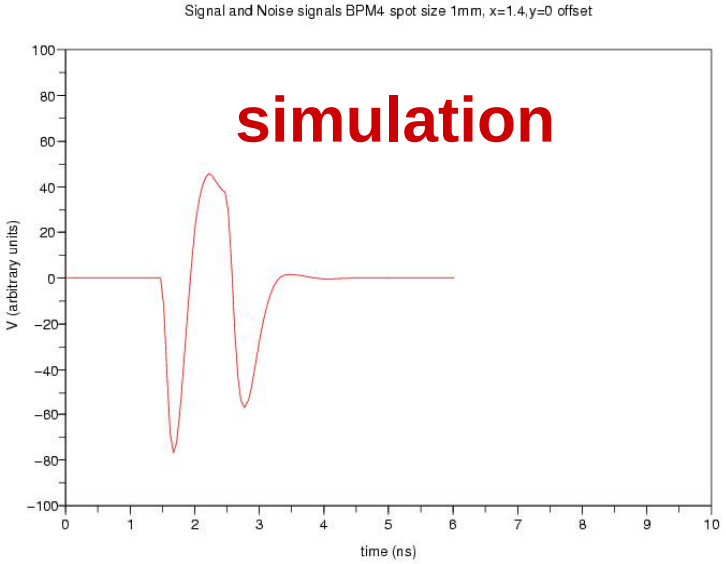
Modelling of noise on BPM strips



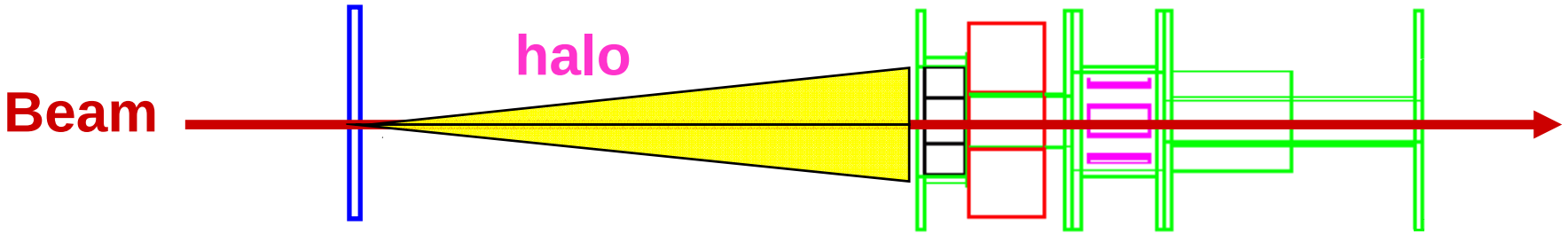
Modelling of noise on BPM strips



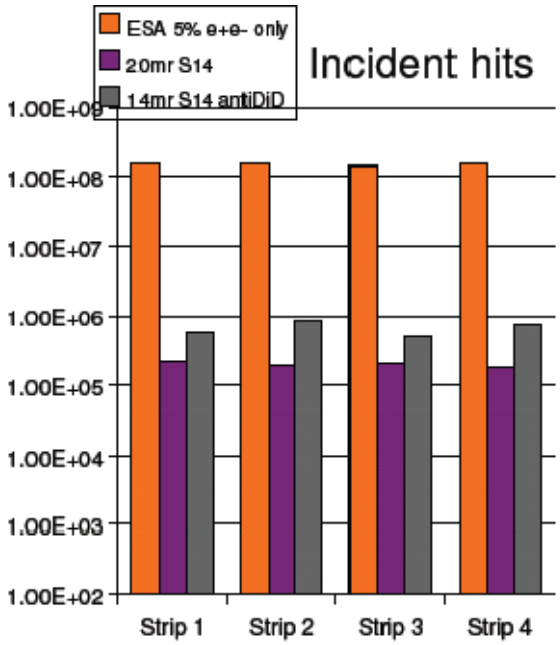




Mode 2: primary beam + halo

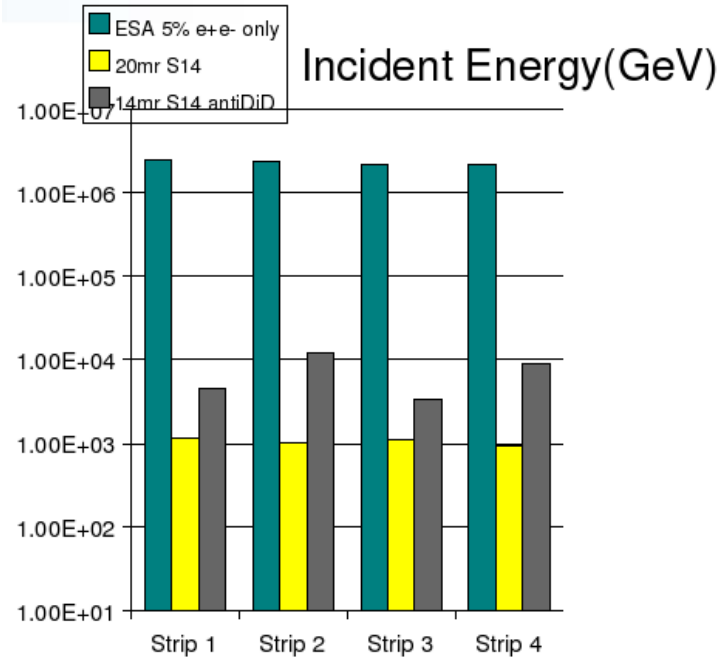


Scaling from ESA to ILC:

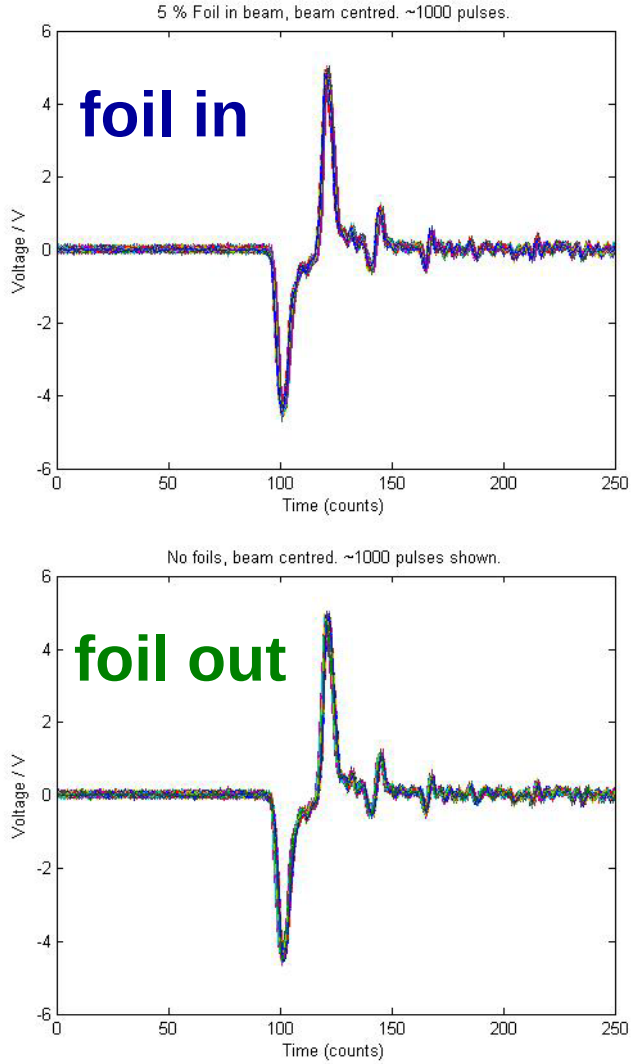


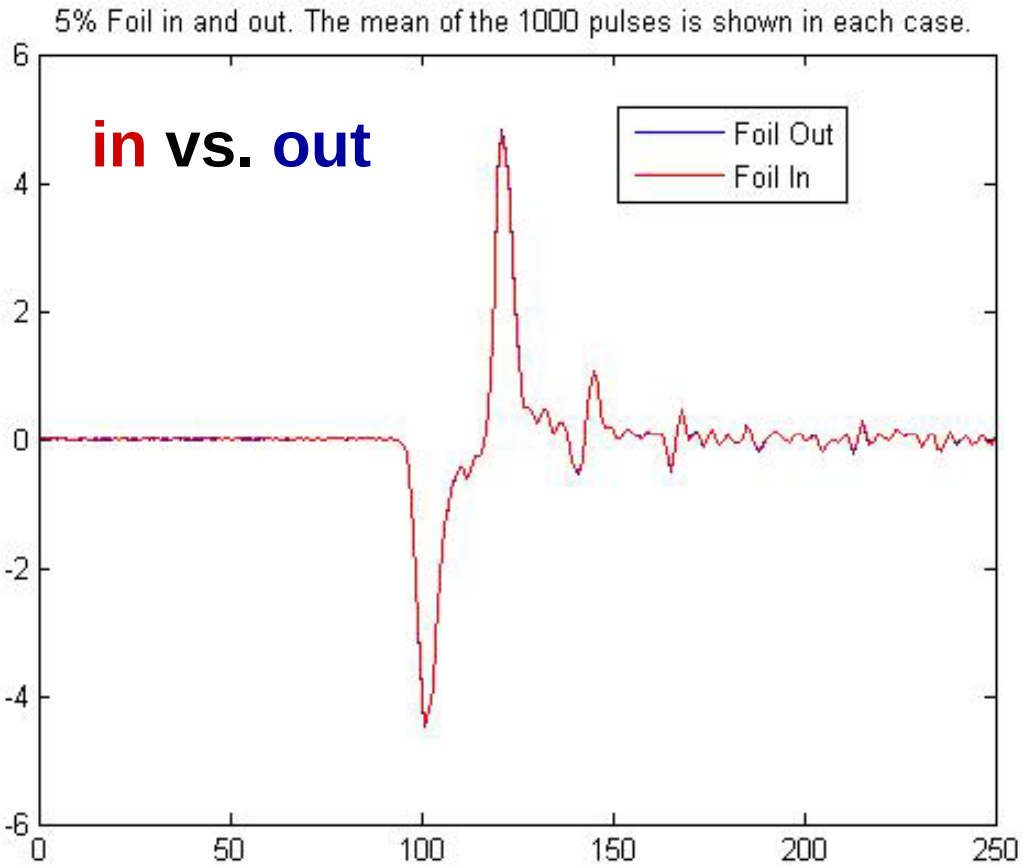
ESA

ILC



Mode 2: results: worst case: 5% foil





Peak voltages foil in vs foil out

Foil thickness	Foil IN		Foil OUT	
	Mean / V	std / V	Mean / V	std / V
5%	3.99	0.09	4.00	0.09
3%	4.00	0.08		
1%	3.99	0.09	4.01	0.09

See no effect within statistics (1000 pulses)

< 10 micron effect in position at ESA

< 100 nm at ILC

c.f. FB BPM resolution needed ~ few microns

Summary + conclusions

- **EM backgrounds were source of concern for operation of a feedback BPM in ILC interaction region**
- **Built a material model of ILC extraction line**
- **Used SLAC/ESA 28.5 GeV beam to simulate ILC EM bgds**
- **Developed simple BPM noise model; reproduces data**
- **Under background conditions c. 1000 x worse than ILC we saw no degradation of BPM operation**

< 100nm degradation in resolution at ILC

-> current design of IP FB system looks robust