FastSim studies: a status update

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Outline

- Different L0 solutions in FastSim
- Effects of worsening of L1, L2, L3 intrinsic hit resolution
- Present status of QED bkg in FastSim
- Comparison between FastSim and FullSim geometries and impact on bkg rates
- Next steps

L_0 solutions: striplets vs Hybrid pixels

Hybrid Pixel

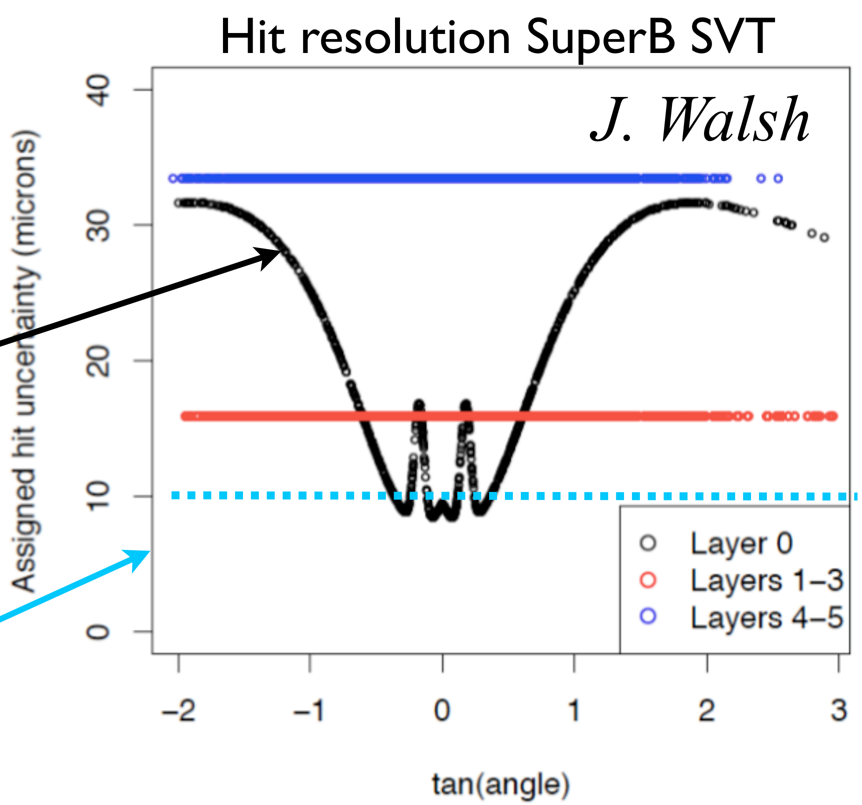
- material= 1.08% X_0
- digital readout
- average radius = 1.60 cm
- hit res ~ <14 μm> (ad hoc model)
- efficiency = 95%

Digital
50μmx50μm

Striplets

- material= 0.4% X_0
- analog readout
- average radius = 1.60 cm
- hit res ~ 8 μm (core gaussian)
- efficiency = 90%

Analog
50μm pitch



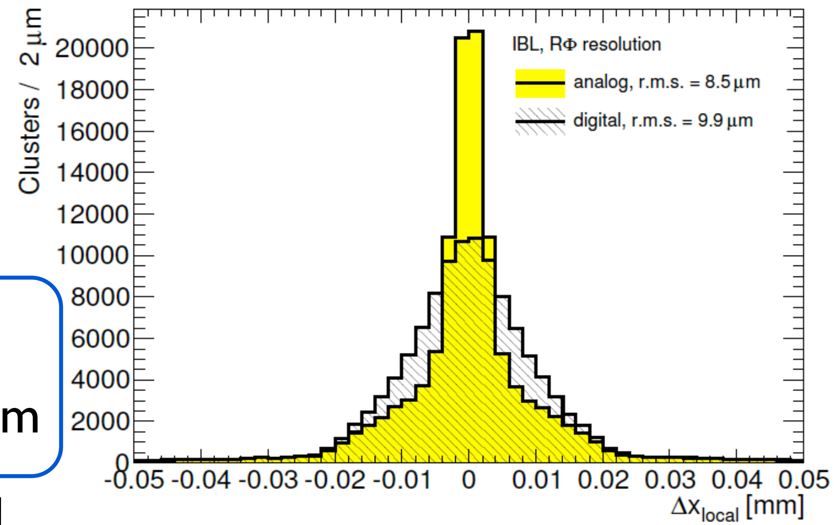
Hybrid pixels with Atlas FE-I4 chip

Hybrid Pixel with FE-I4

- material= 1.08% X_0
- “analog” readout with 8 bit ToT
- average radius = 1.60 cm
- pitch 50 μm x 250 μm in (r-phi,z)
- hit res ~ <8.5 μm> r-phi
- hit res ~ <47 μm> z
- efficiency = 99.9%

Analog
50μmx250μm

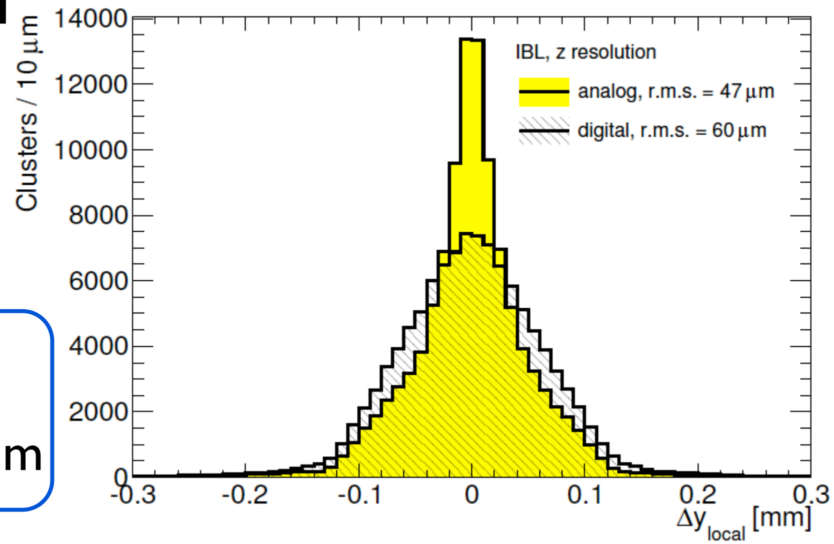
CERN-LHCC-2010-013
ATLAS TDR 19



Hybrid Pixel with FE-I4 rotated

- material= 1.08% X_0
- “analog” readout with 8 bit ToT
- average radius = 1.60 cm
- pitch 250 μm x 50 μm in (r-phi,z)
- hit res ~ <47 μm> r-phi
- hit res ~ <8.5 μm> z
- efficiency = 99.9%

Analog
250μmx50μm



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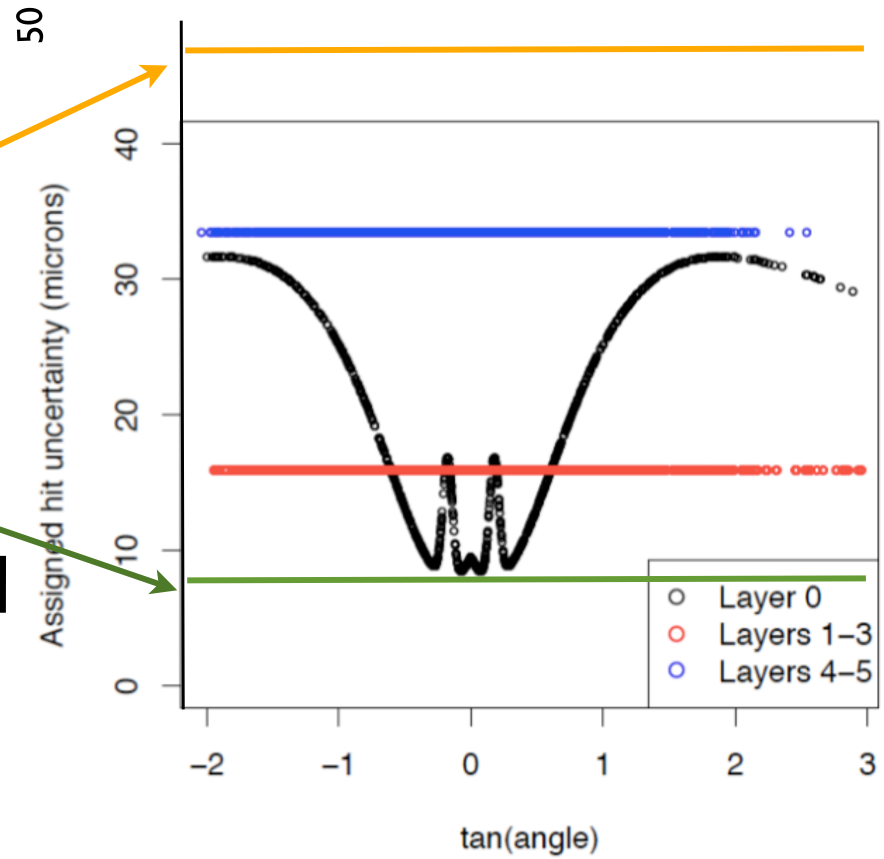
Hit resolution SuperB SVT



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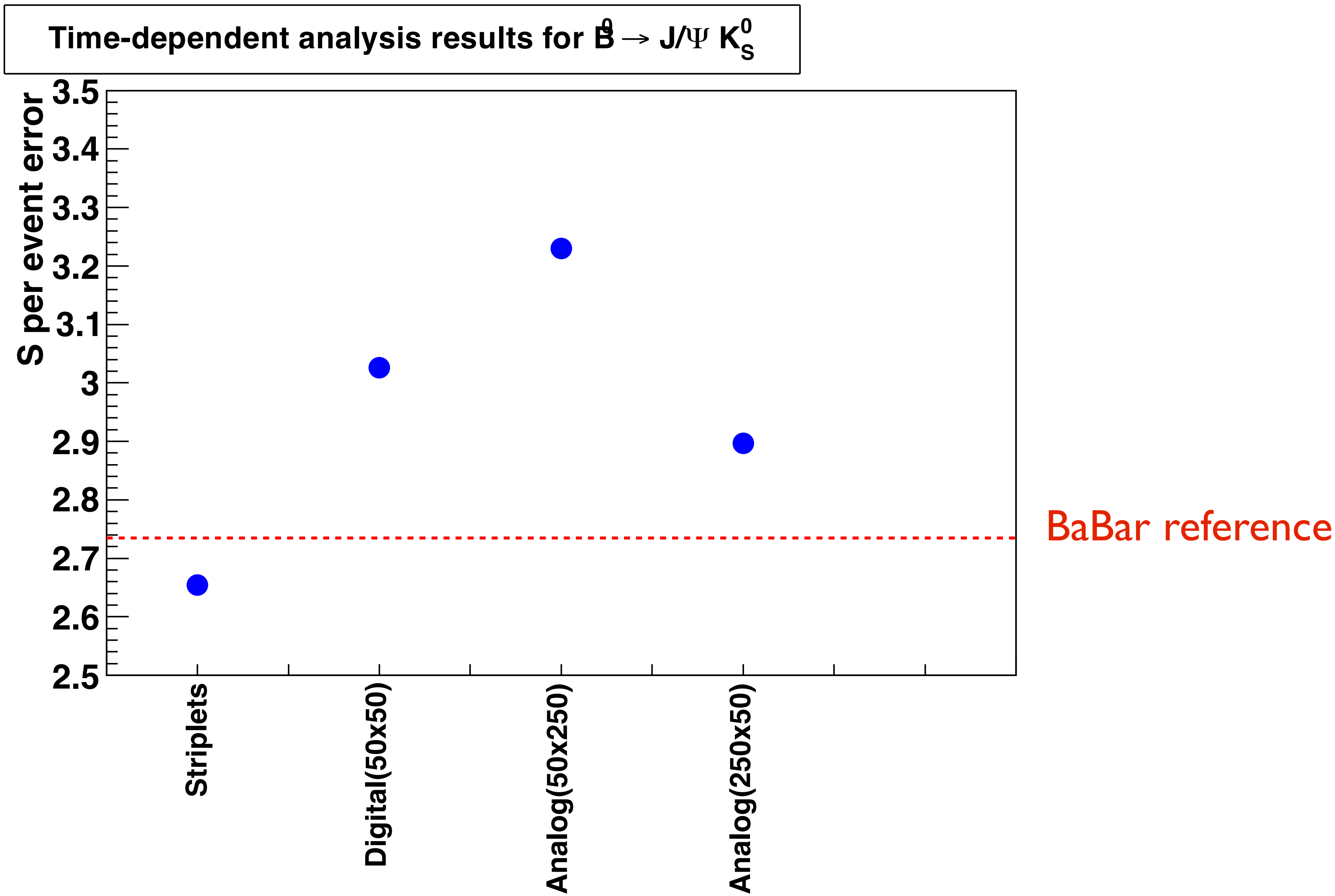
S per event error



Effect of worsening L1, L2, L3 hit resolution

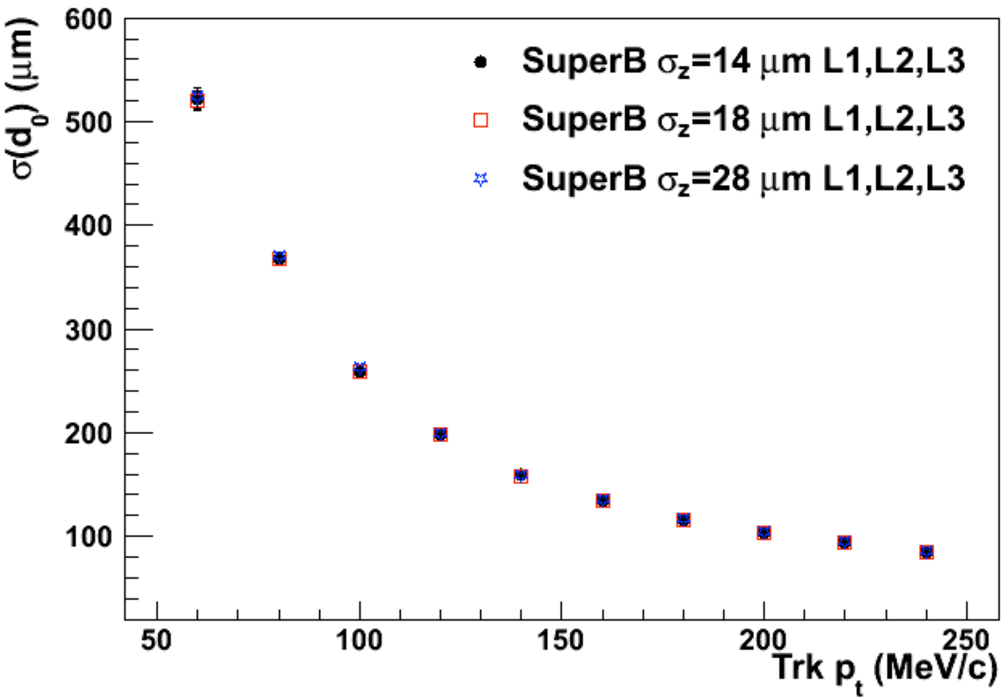
- Study the effect on track parameters vs intrinsic hit resolution in L1, L2, L3;
- L0 striplet solution is in place in the simulation.

Event generation

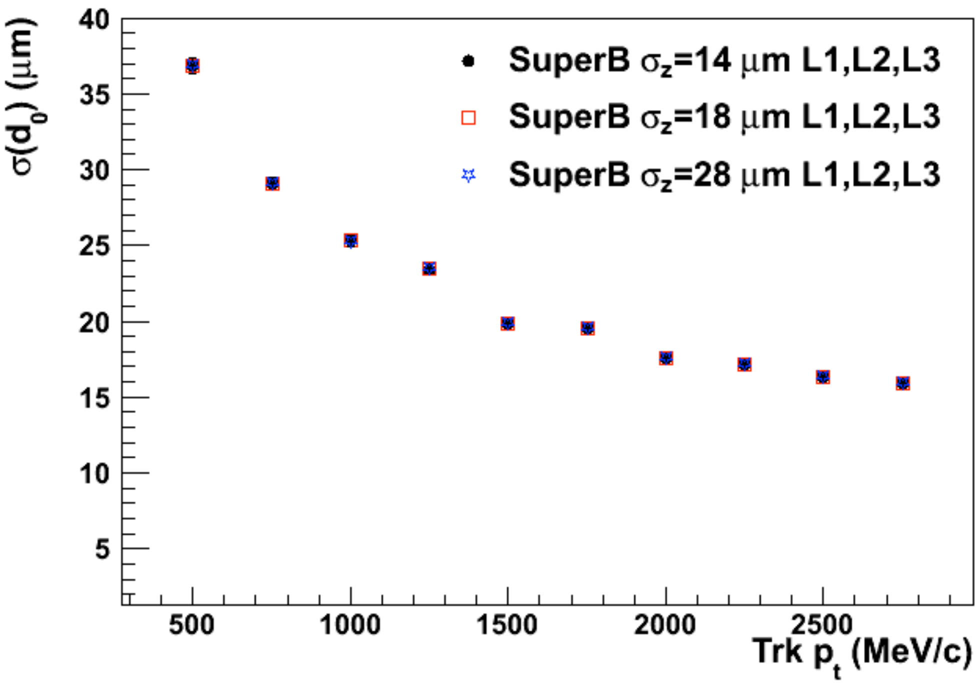
- Single track events:
  - pion tracks (no decays in flight);
  - $pT \in [0,3]$ GeV/c (uniform);
  - $|\cos(\vartheta)|<0.7$ (uniform).

d_0 resolution

“Low” pT



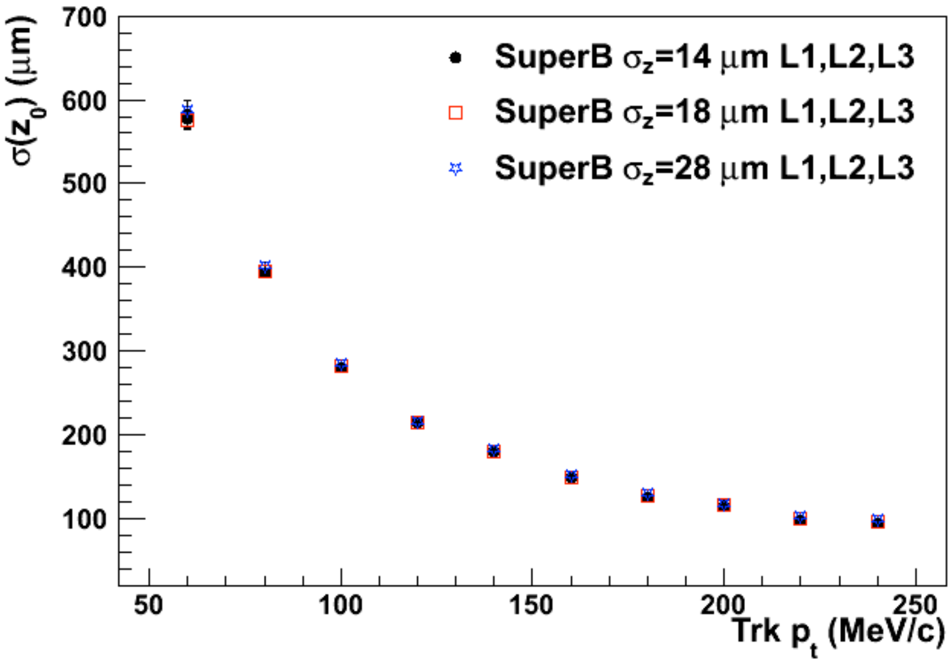
“High” pT



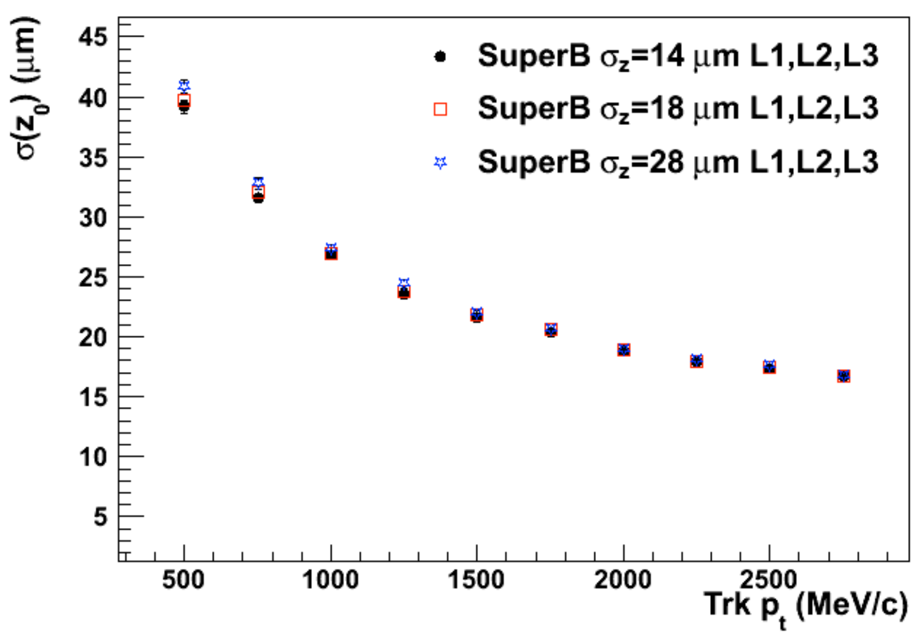
No relevant effects on d_0 resolution

z_0 resolution

“Low” pT



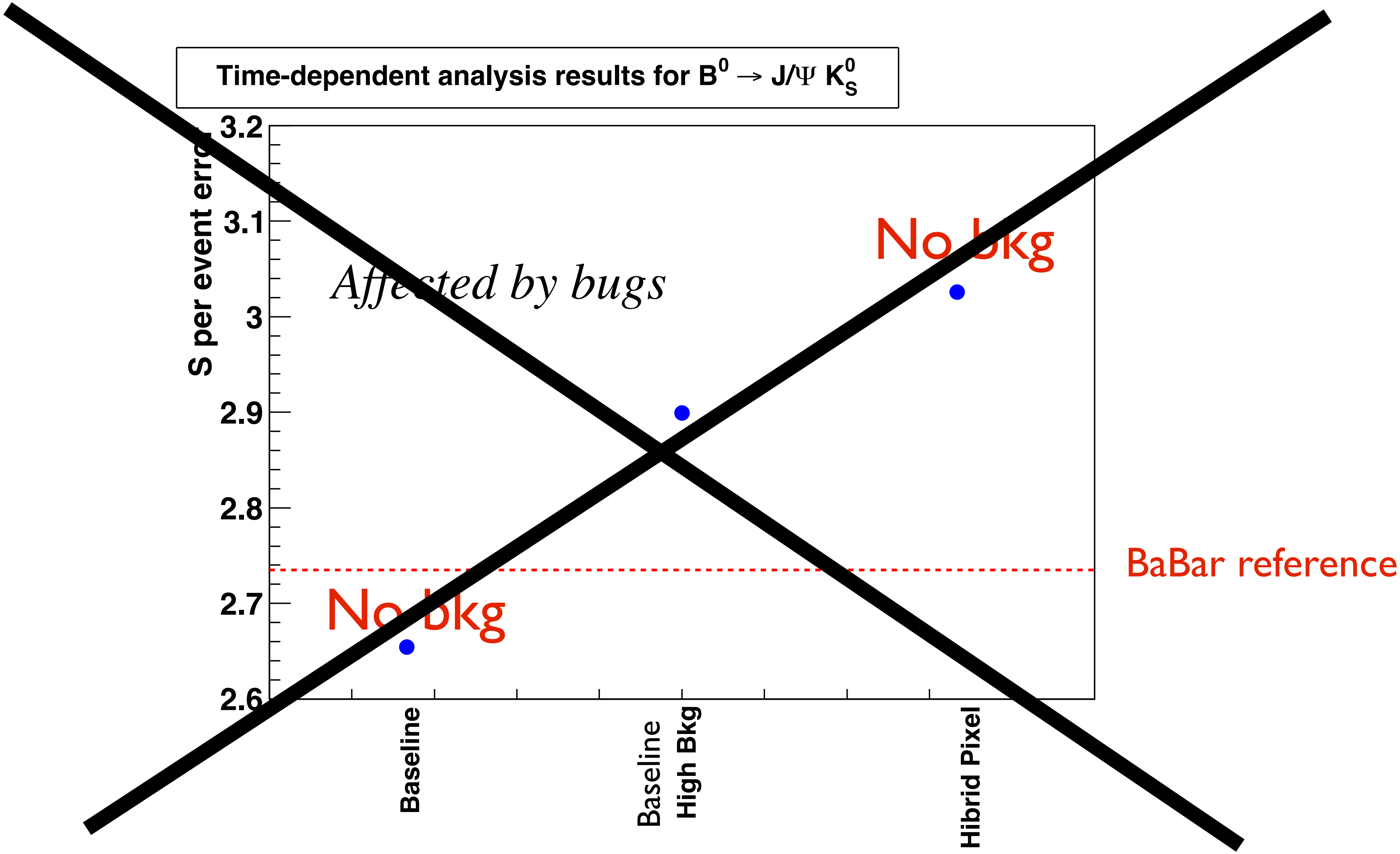
“High” pT



No relevant effects on z_0 resolution

QED bkg status in FastSim

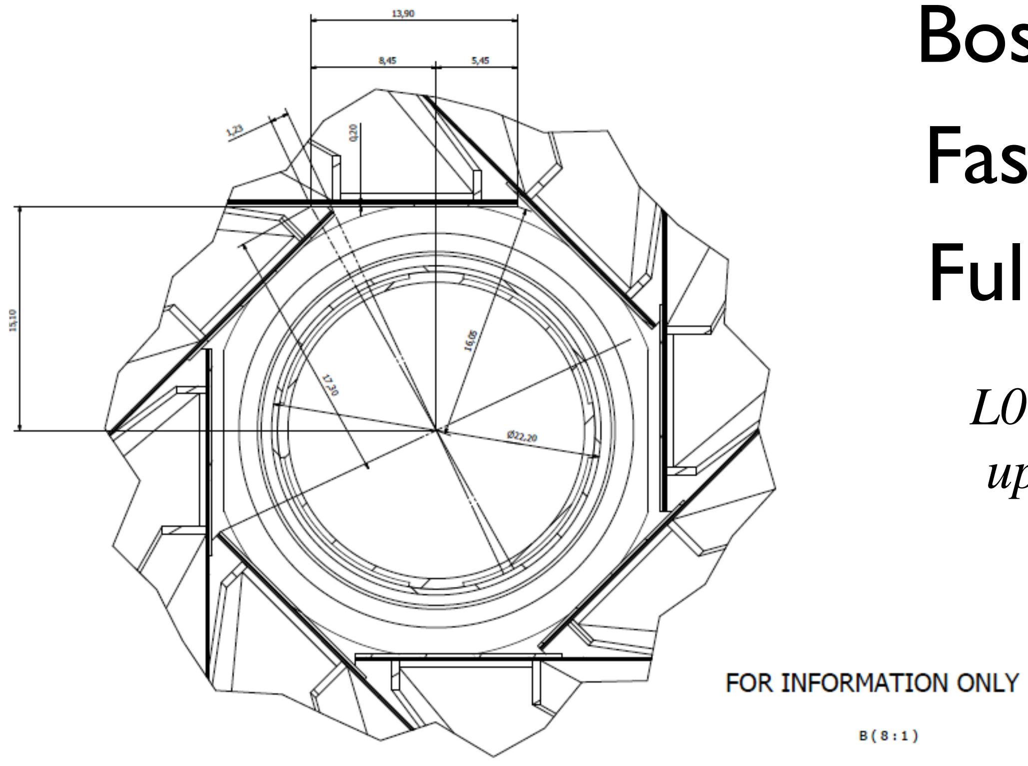
- Cross section for QED Pairs in FastSim was found to be about 10 times higher wrt to the nominal value.
- Average number of events per bunch crossing was 36 instead of 3.5.
- Another bug was found. A TParticle was produced for each hit in the SVT sensors instead for the first hit only. Very long tails in the distribution of number of particles per bunch crossing.
- Alejandro Perez has worked very hard and fixed it. He is still working for understanding discrepancies between FastSim and FullSim bkg rates. Almost a factor 3 difference.
- For the time being there is no evidence that the error is in FastSim or in FullSum (or in both simulations). Still under investigation.



These results should be considered as not reliable for the reasons explained in the previous slide

Geometries for striplet detectors

Courtesy of Filippo Bosi



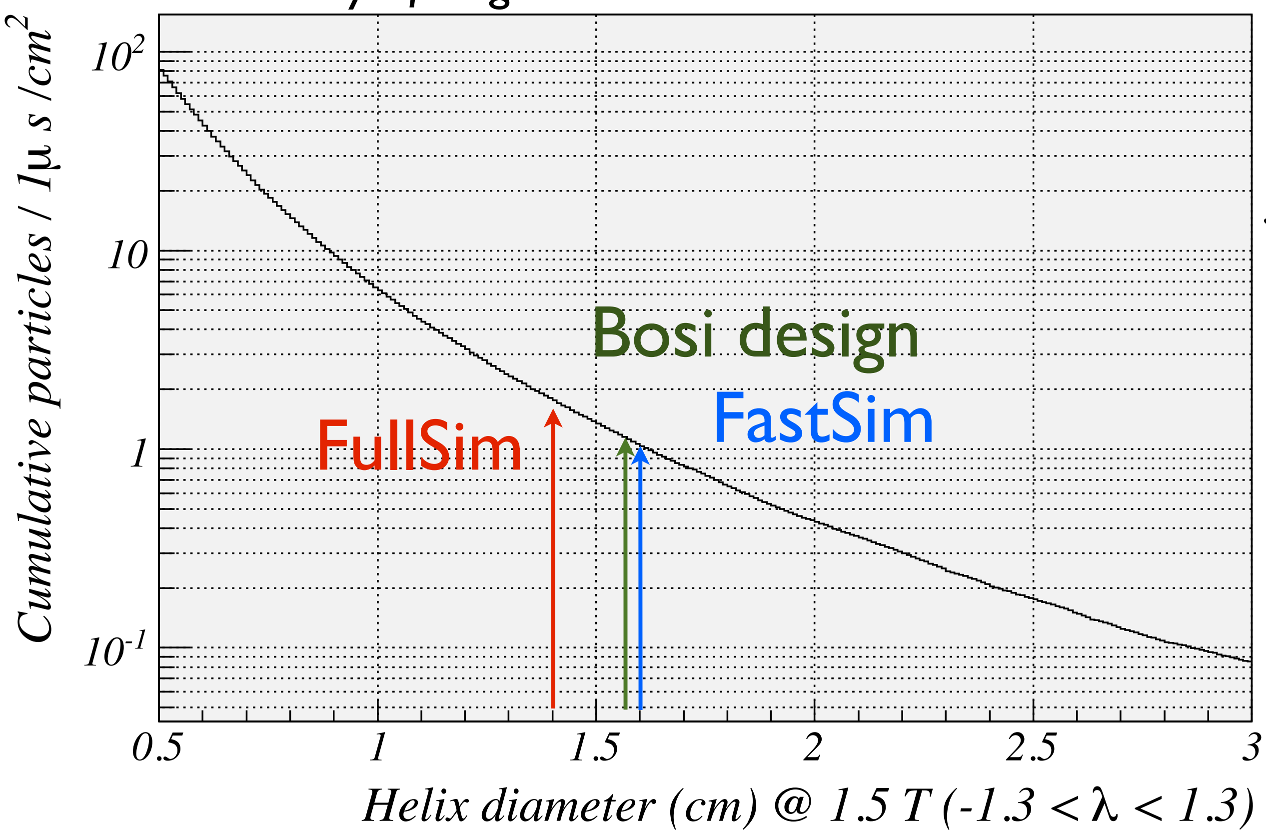
Dimensioni sensore 0.2 x 13.9 x 104 mm

	Average radius
Bosi design	15.64 mm
FastSim	16.00 mm
FullSim	14.02 mm

L0 parameters in simulations need to be updated according to new Bosi design.

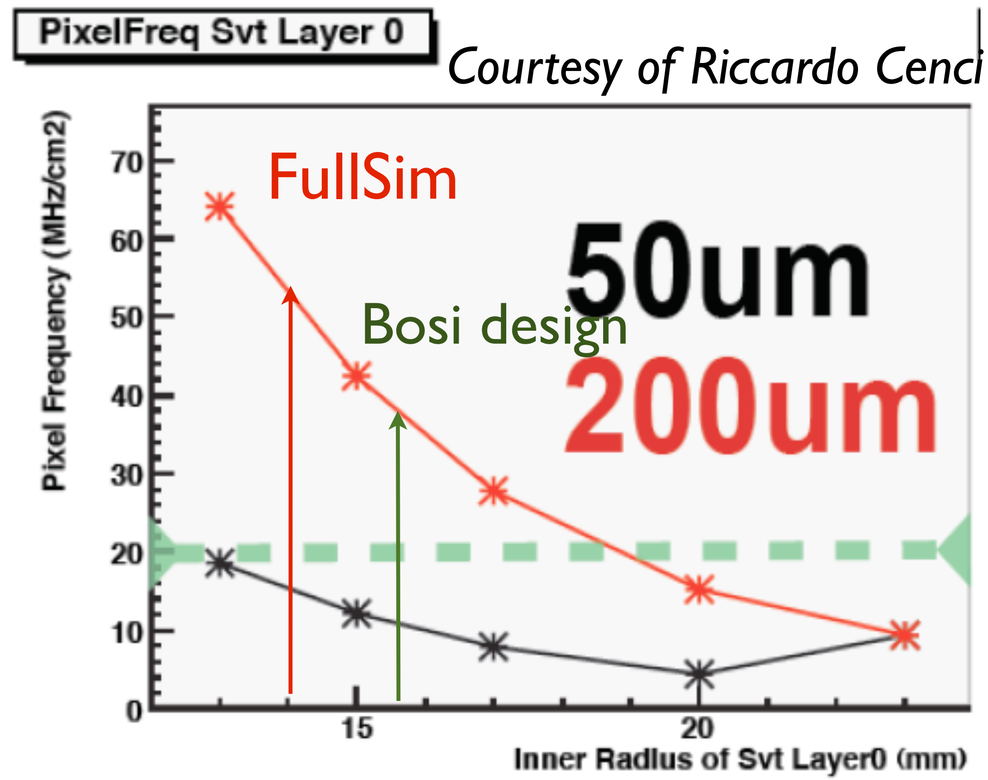
QED Pairs Bkg rates vs L0 radius

Courtesy of Eugenio Paoloni



Bkg rates evaluated with FullSim for striplets are overestimated so far. Should be evaluated with new Bosi geometry.

Tentative extrapolation for QED bkg rates in L0



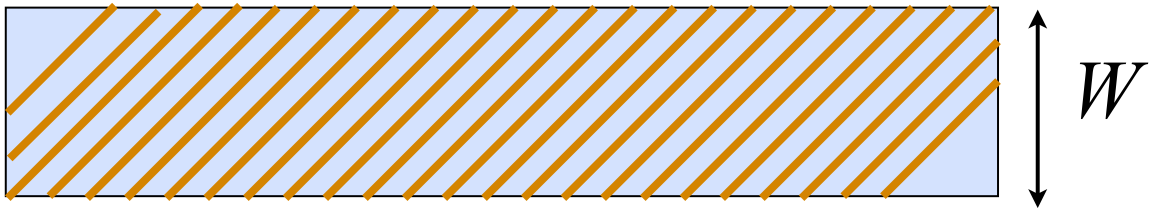
Rate at 14.0 mm ~ 52 MHz/cm^2
Rate at 15.6 mm ~ 38 MHz/cm^2

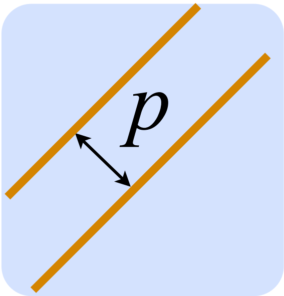
Correction factor ~ 38/52=0.7

QED pairs bkg rates with correction applied

Track Rate 4.52MHz/cm^2*0.70=3.16 MHz/cm^2
Strip Rate 24.3MHz/cm^2*0.70=17.0 MHz/cm^2

Estimate for L0 striplets occupancy





$$Occ = B \cdot T \cdot p\sqrt{2} \cdot W = 0.8\%$$ at radius 15.64 mm

4.0% with x5 safety factor

B = *hit rate/Area* = 17 MHz/cm^2

T = 50 ns *(L0 sensitive window)*

p = 50 μm *(pitch)*

W = 13.9 mm *(detector width)*

Changes also in striplets efficiency 99.0% (95.4% x5 safety factor)

Now in FastSim we have 90%

dead time due to analog 2.5 x shaping time

Comparison with occupancy for Layer1 of the BaBar SVT

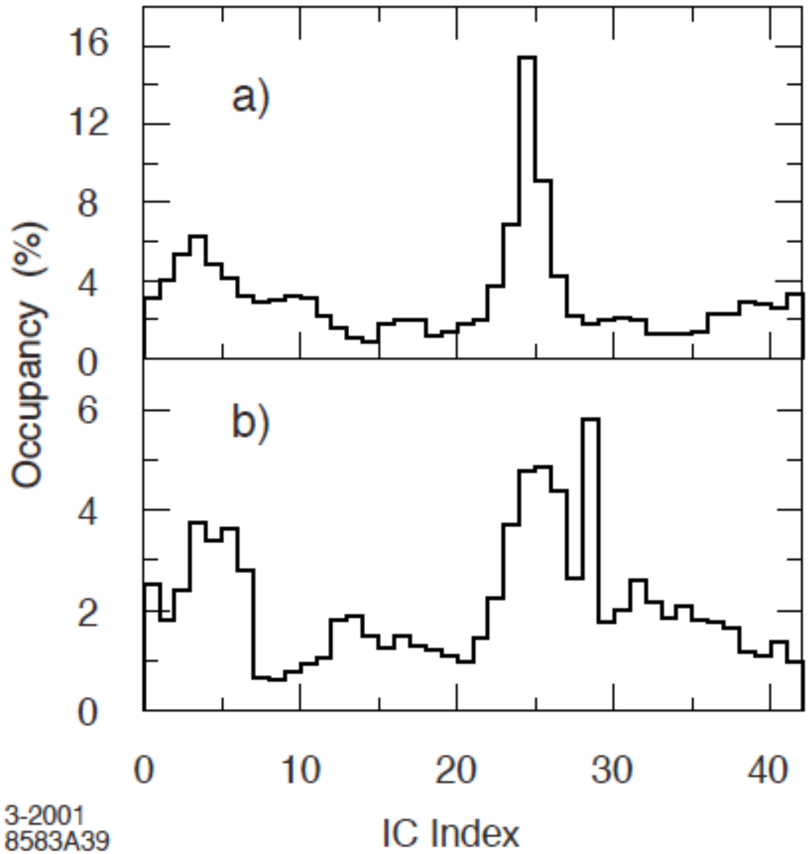


Figure 23. Typical occupancy in percent as a function of IC index in layer 1, ϕ side for a) forward half-modules and b) backward half-modules. The IC index increases with azimuthal angle and the higher occupancy in the horizontal plane is visible near chip indices 3 and 25.

Under normal running conditions, the average occupancy of the SVT in a time window of 1 μs is about 3% for the inner layers, with a significant azimuthal variation due to beam-induced backgrounds, and less than 1% for the outer layers, where noise hits dominate. Figure 23 shows

The offline time window cut in BaBar was 200ns. Hence, the offline average occupancy for L1 was 0.6%, to be compared with 0.8% (4.0% with x5 safety factor) occupancy for L0 striplets detector of SuperB.

Present status and next steps

- L0 parameters should be updated in the FastSim and FullSim simulation according to new Bosi design and new specifications.
- Estimates for bkg rates of QED pairs should be evaluated according to new Bosi design. Tentative estimates show a reduction in rates for QED pairs bkg.
- The impact of QED bkg on SVT performances should be moderate under these hypotheses and according to BaBar experience. Still to be estimated.
- Working on studies to be included in TDR: updating studies with new information and detector configurations. Working on relevant plots and tables.

6 Silicon Vertex Tracker

Rizzo. Pages ??

6.1 Vertex Detector Overview G.Rizzo - 12 pages

6.2 Backgrounds R.Cenci - 4 pages

6.3 Detector Performance Studies N.Neri - 6 pages

6.3.1 Introduction *(about 1/2 page)*

- write some considerations about the main differences between BaBar and SuperB (i.e. luminosity, boost, beampipe, beamspot);
- describe the main idea behind the new detector design focusing on performances;
- cite BaBar TDR and BaBar NIM paper as reference for strip detectors.

6.3.2 Impact of Layer0 on detector performances *(about 2 pages)*

- definition of Layer0 requirements for physics (material budget, inner radius vs boost, outer radius, intrinsic resolution, coverage);
- B^0 decay and tag vertex and B^0 proper time resolution for different solutions;
- baseline solution performances;
- discussion of pro and cons.

6.3.3 Sensitivity studies for time-dependent analyses *(about 2 pages)*

- studies of benchmark channels $B^0 \to \phi K^0_S$, $B^0 \to \pi^+\pi^-$, etc.;
- include time-dependent sensitivity studies at charm threshold?
- impact of background on detector performances.

6.3.4 Vertexing and Tracking performances *(about 1 pages)*

- track parameter resolutions;
- considerations for pattern recognition, efficiency vs numbers of layers, reconstruction capabilities for low momentum tracks, K^0_S reconstruction.

6.3.5 Particle Identification *(about 1/2 pages)*

- dE/dx resolution and relevance for QED pairs suppression.
- discussion of relevance of ToT information and number of bits of the FEE.

6.4 Silicon Sensors L. Bosisio - 8 pages

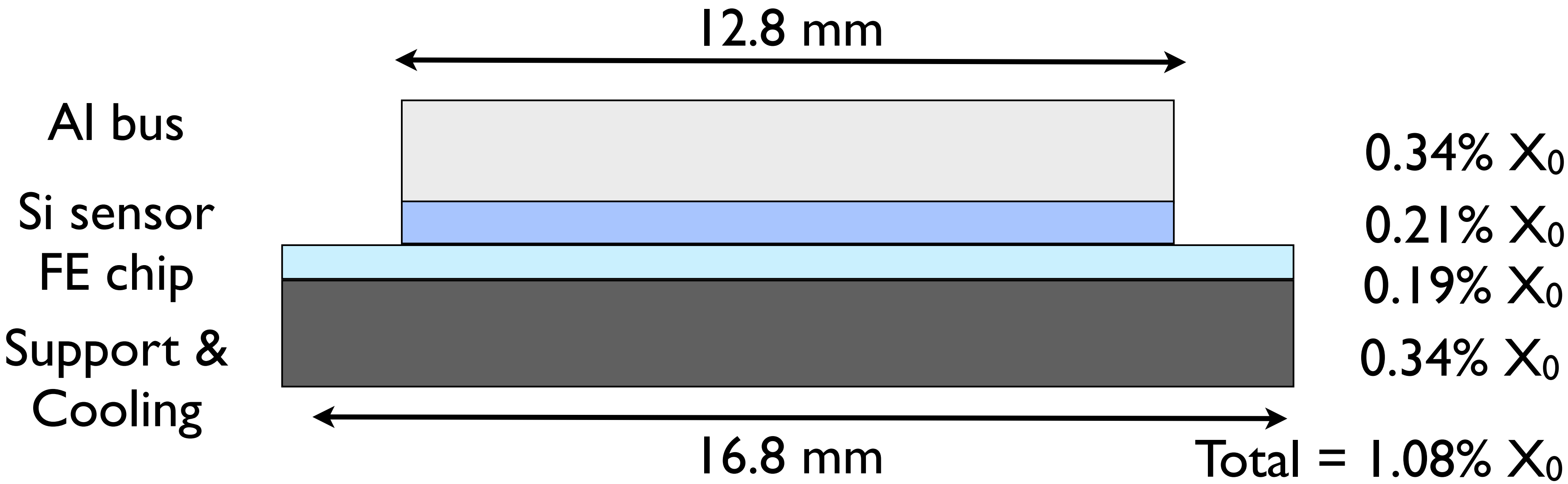
(Striplets will be discussed together with the other sensors)

Short introduction (a few lines).

Backup slides

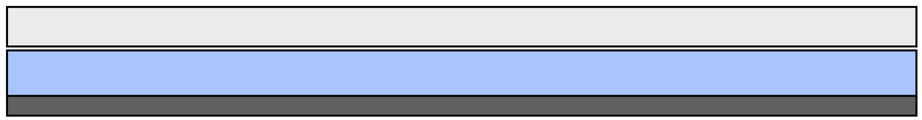
Hybrid pixel solution

- Module cross section

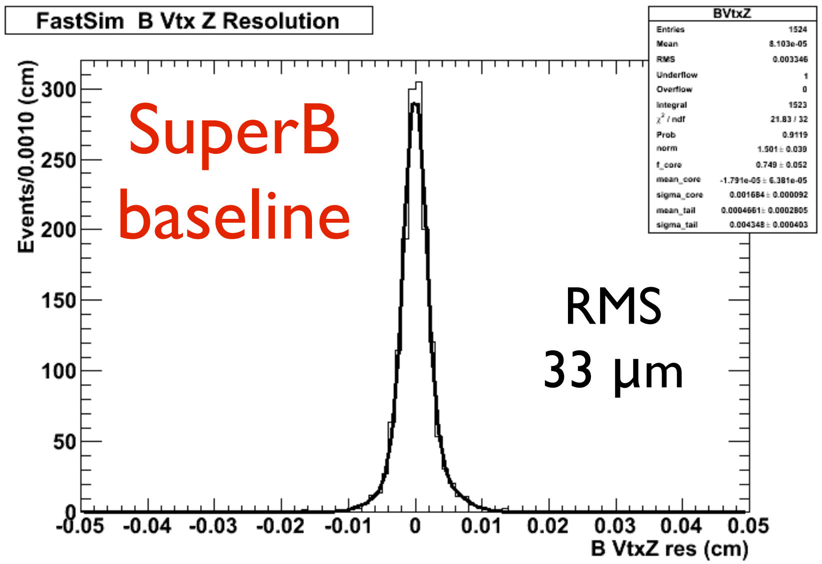


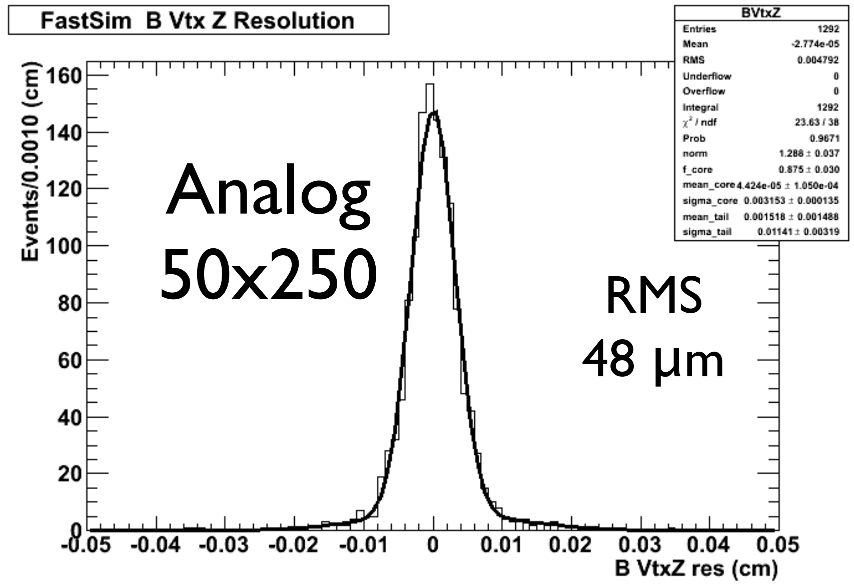
Striplet solution

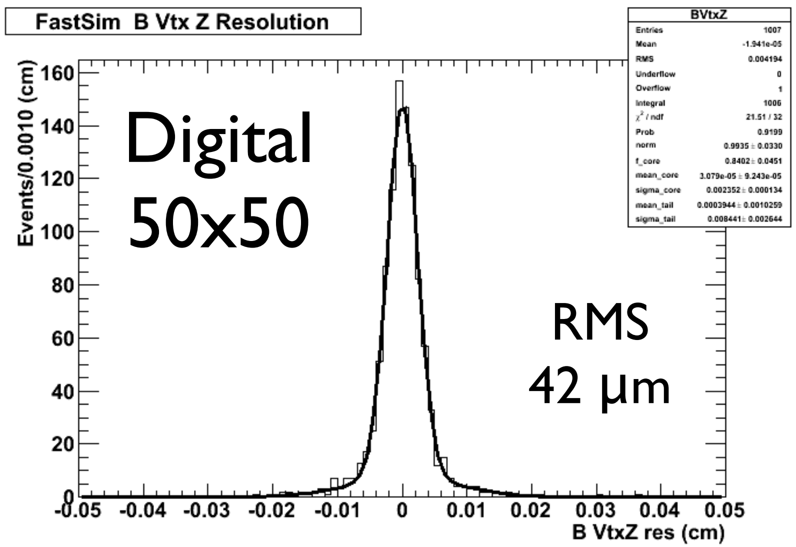
- Module cross section

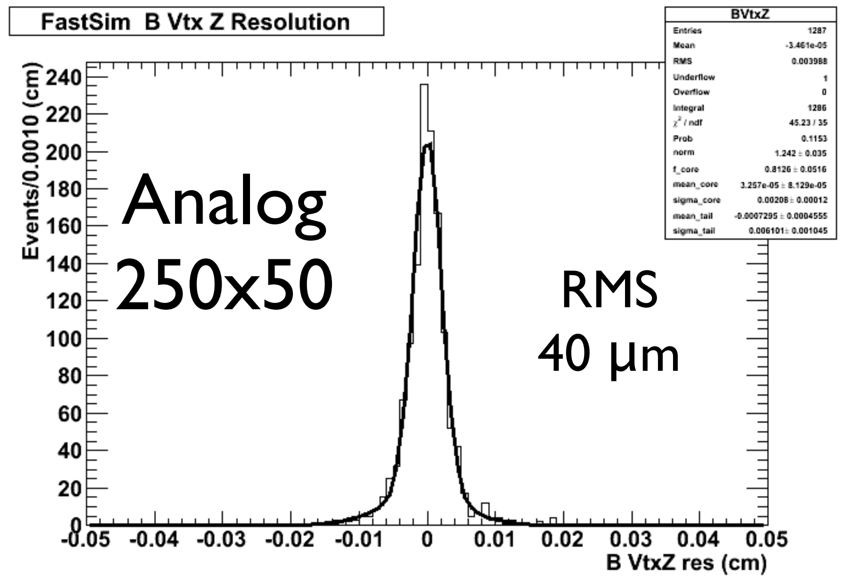


Decay vertex resolution

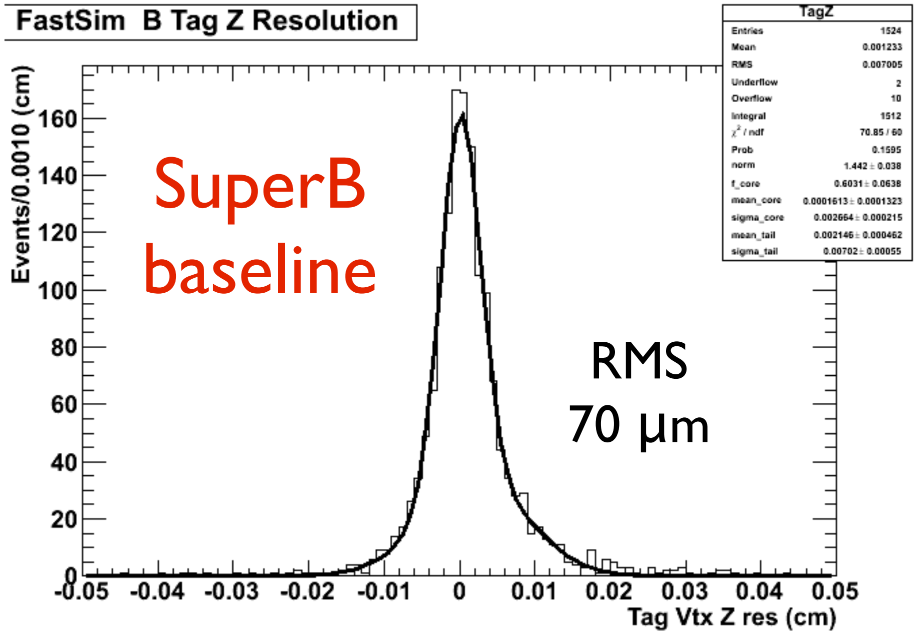


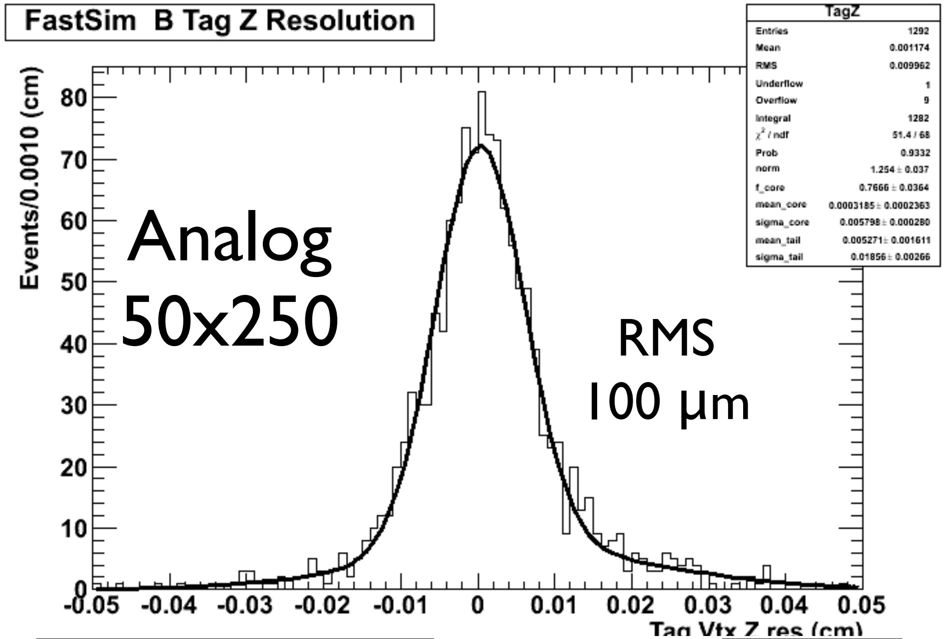


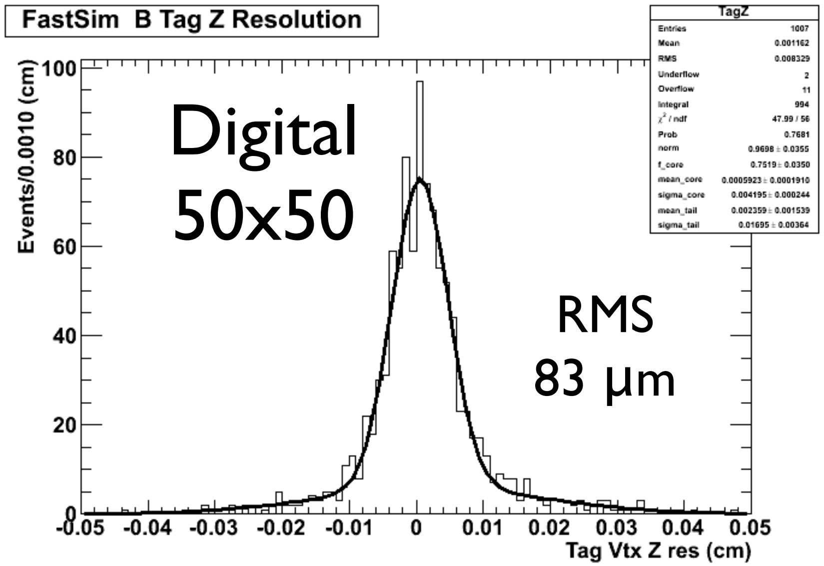


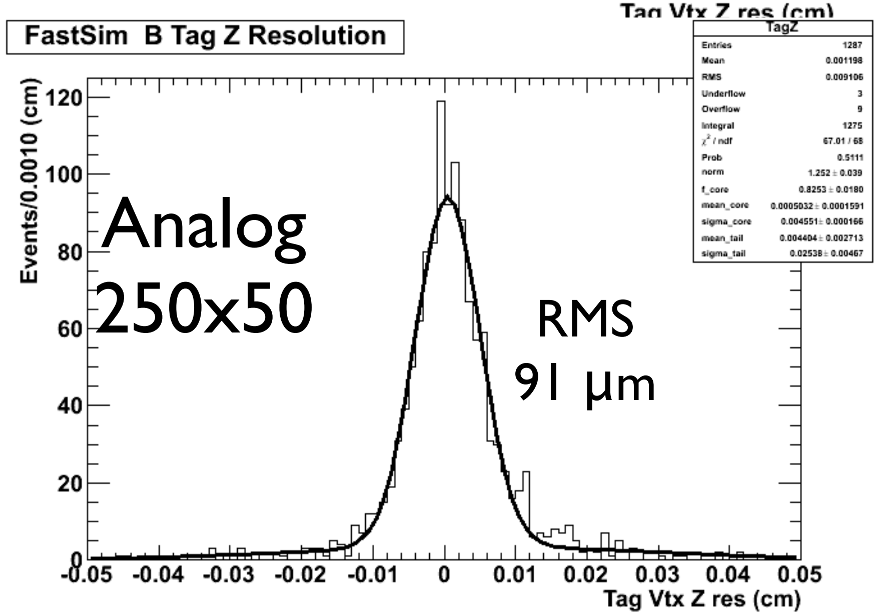


Tag side vertex resolution

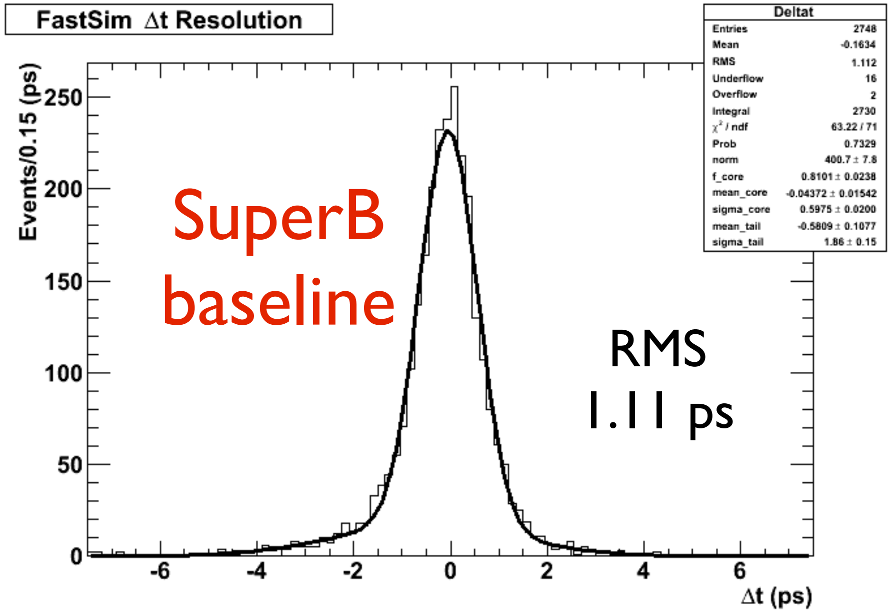


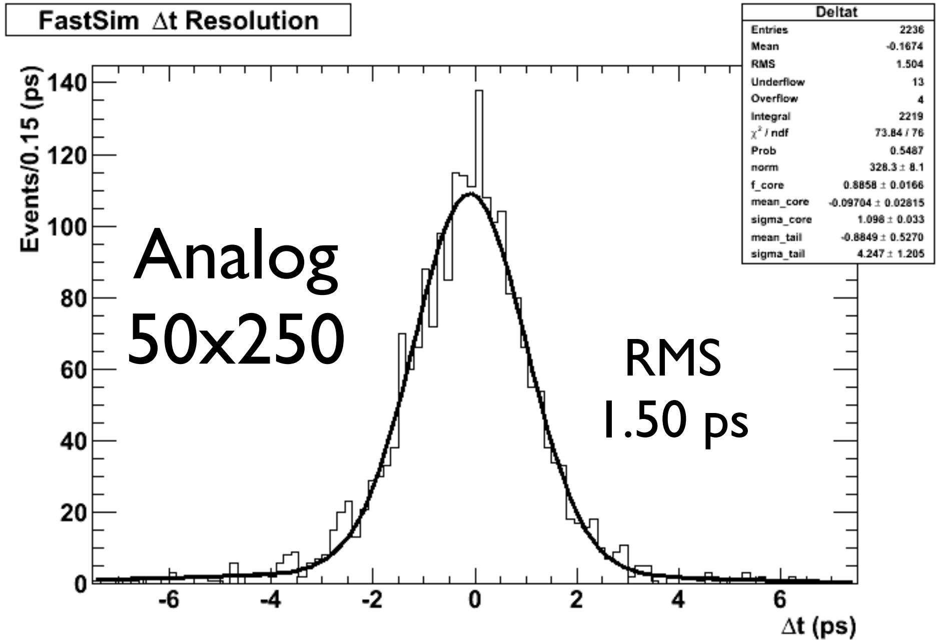


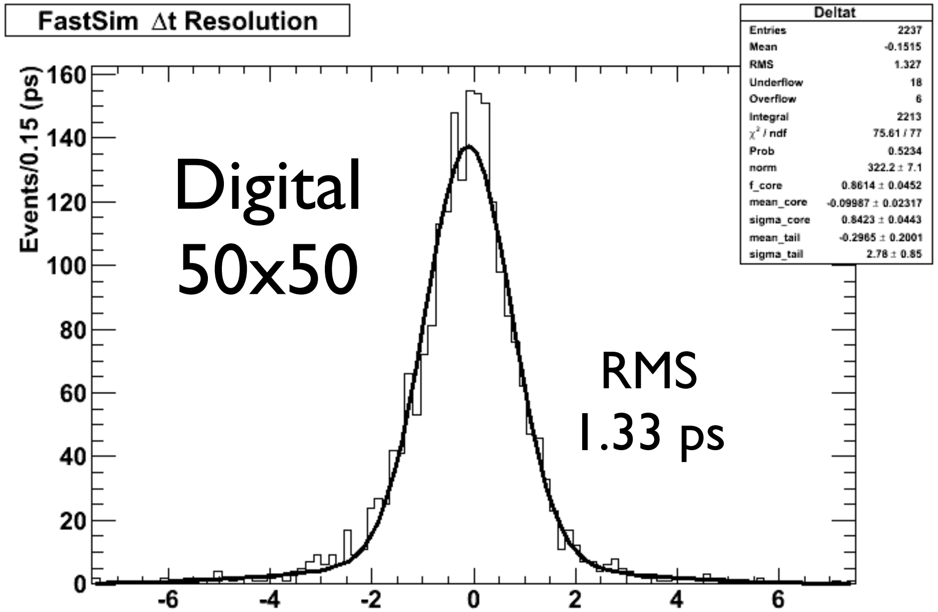


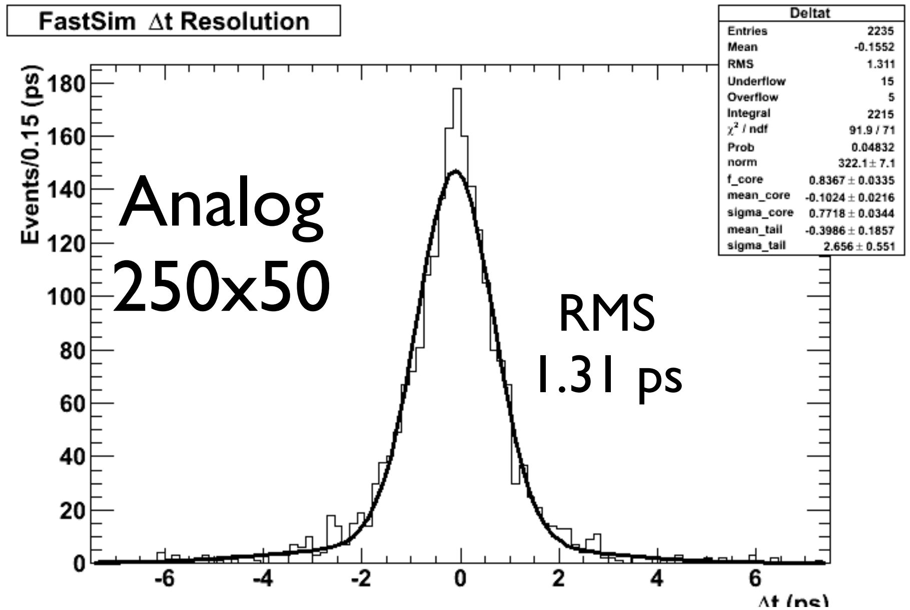


Δt resolution

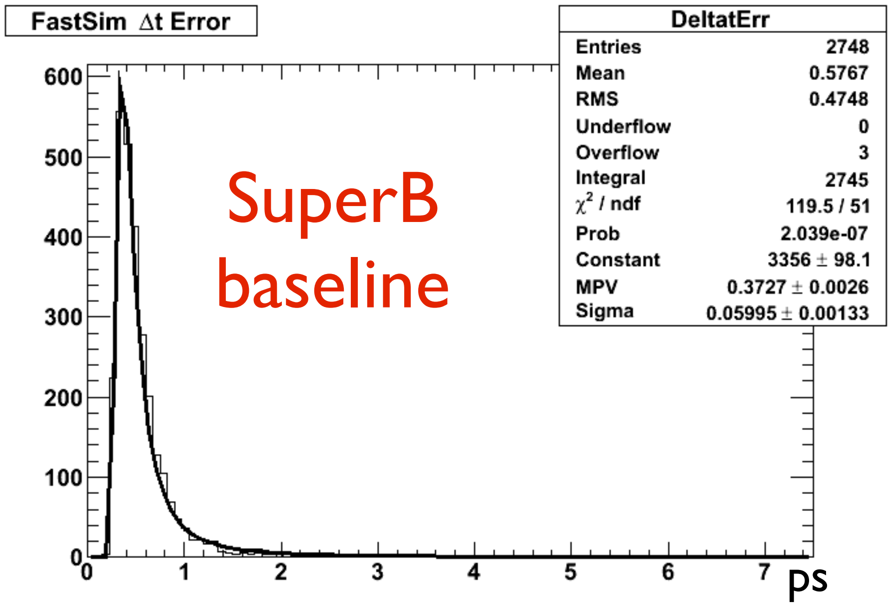


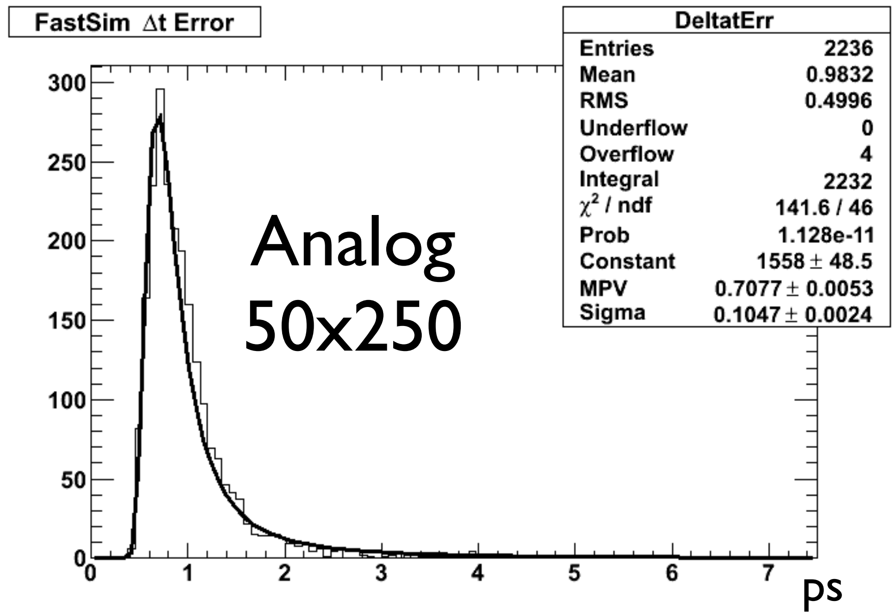


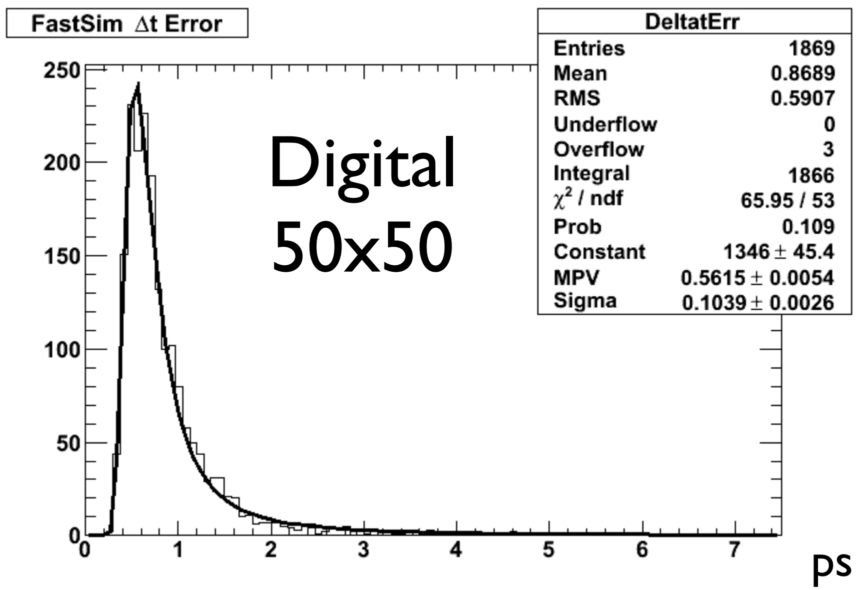


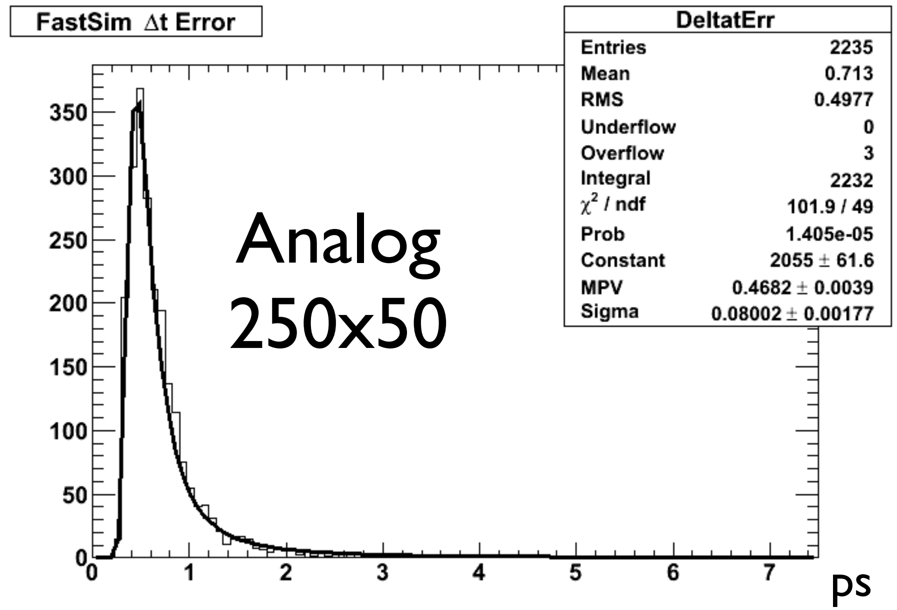


Δt error distribution







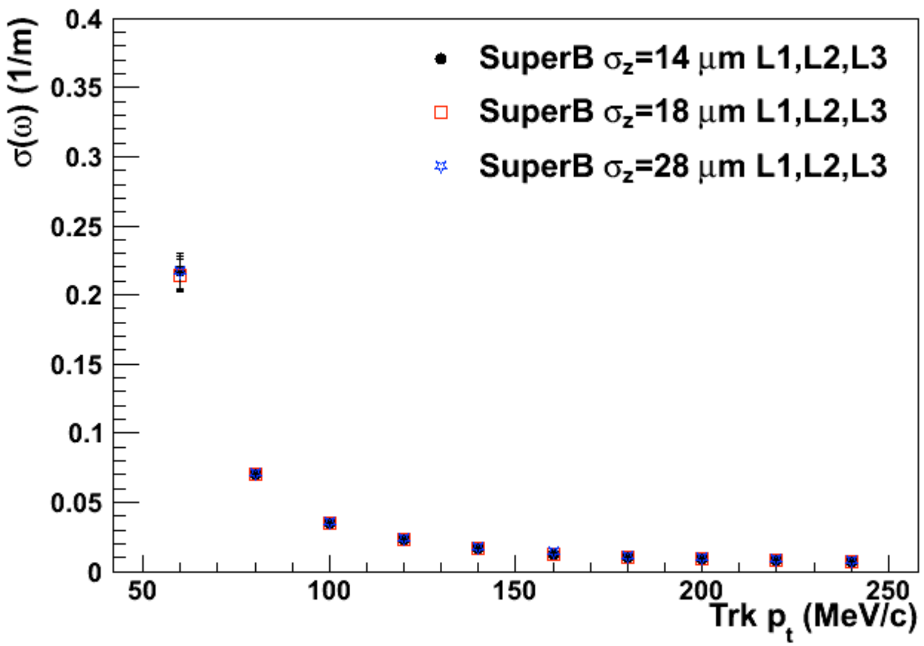


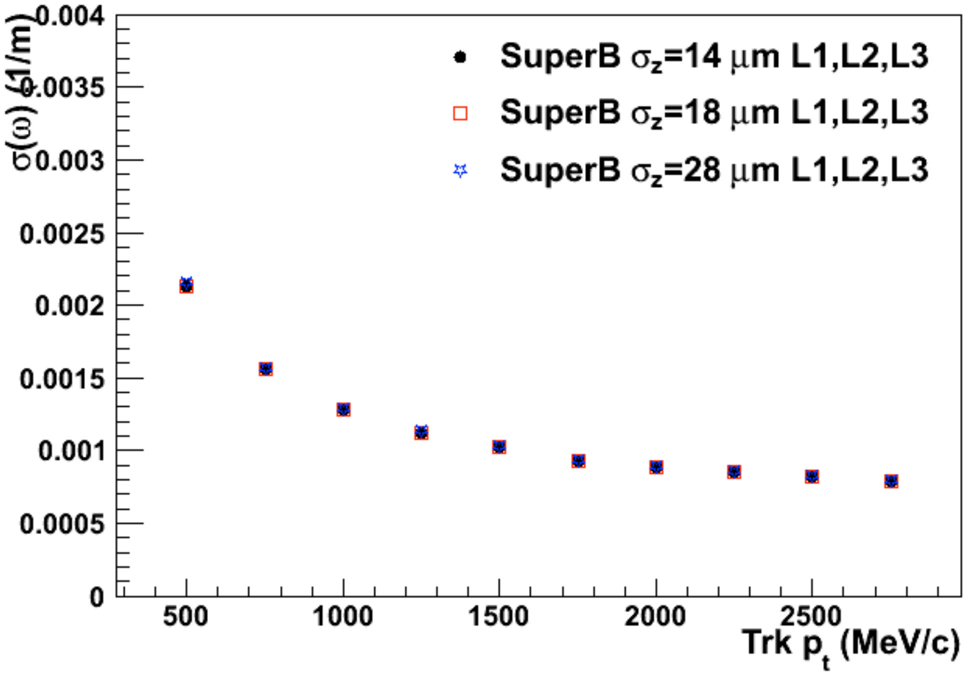
ω resolution

$\omega = 1/\rho\,(cm^{-1})$ $\phi = \phi_0 + \omega L$ L = path length

"Low" pT

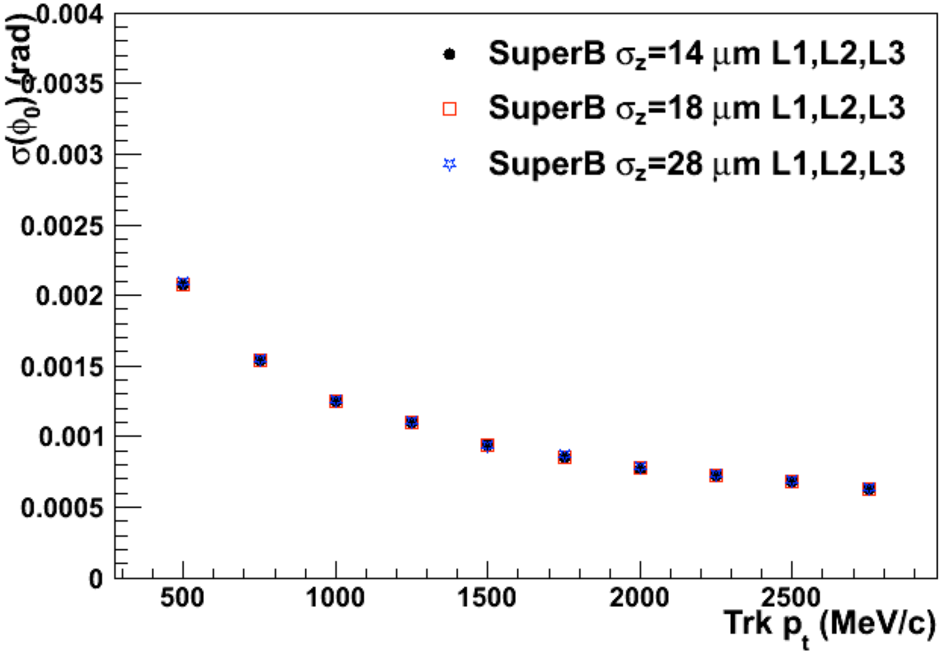
"High" pT



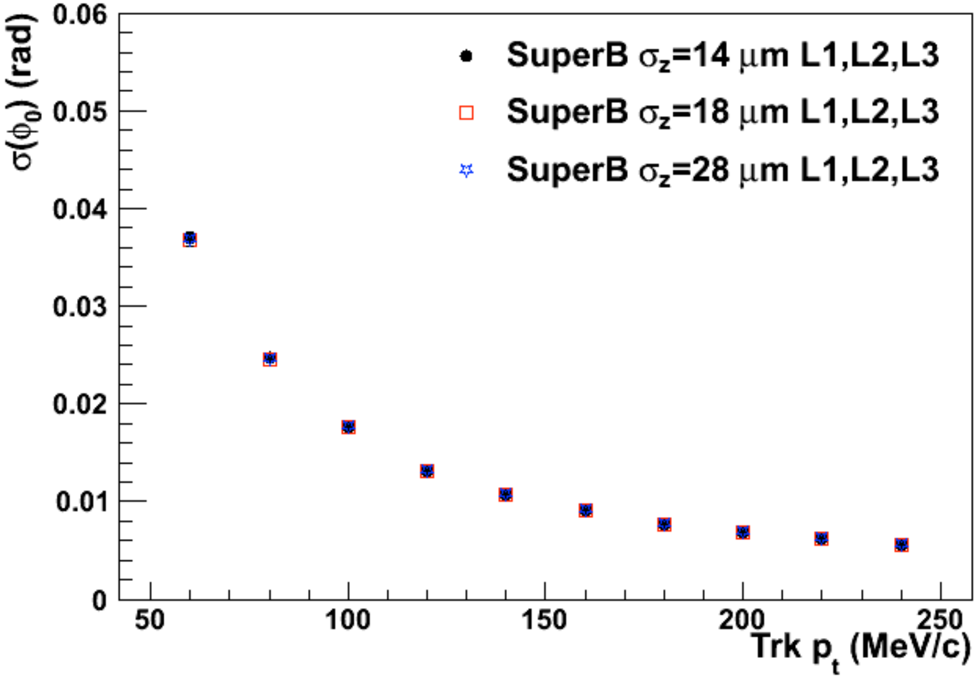


ϕ_0 resolution

“Low” pT

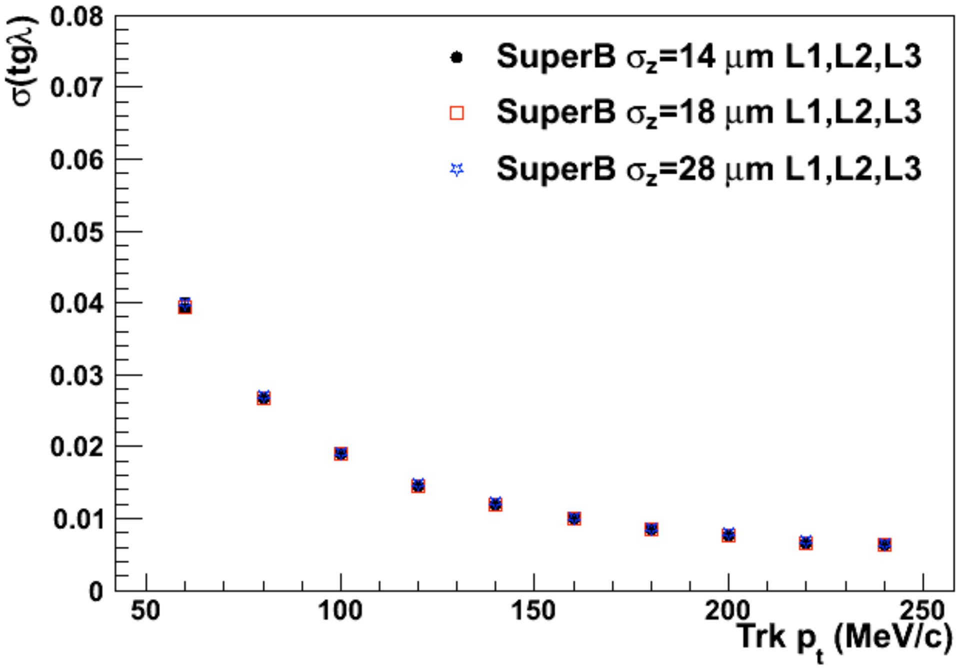


“High” pT



tg(λ) resolution

"Low" pT



"High" pT