Impact of Layer0 (in)efficiency on TD measurements

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DGWG
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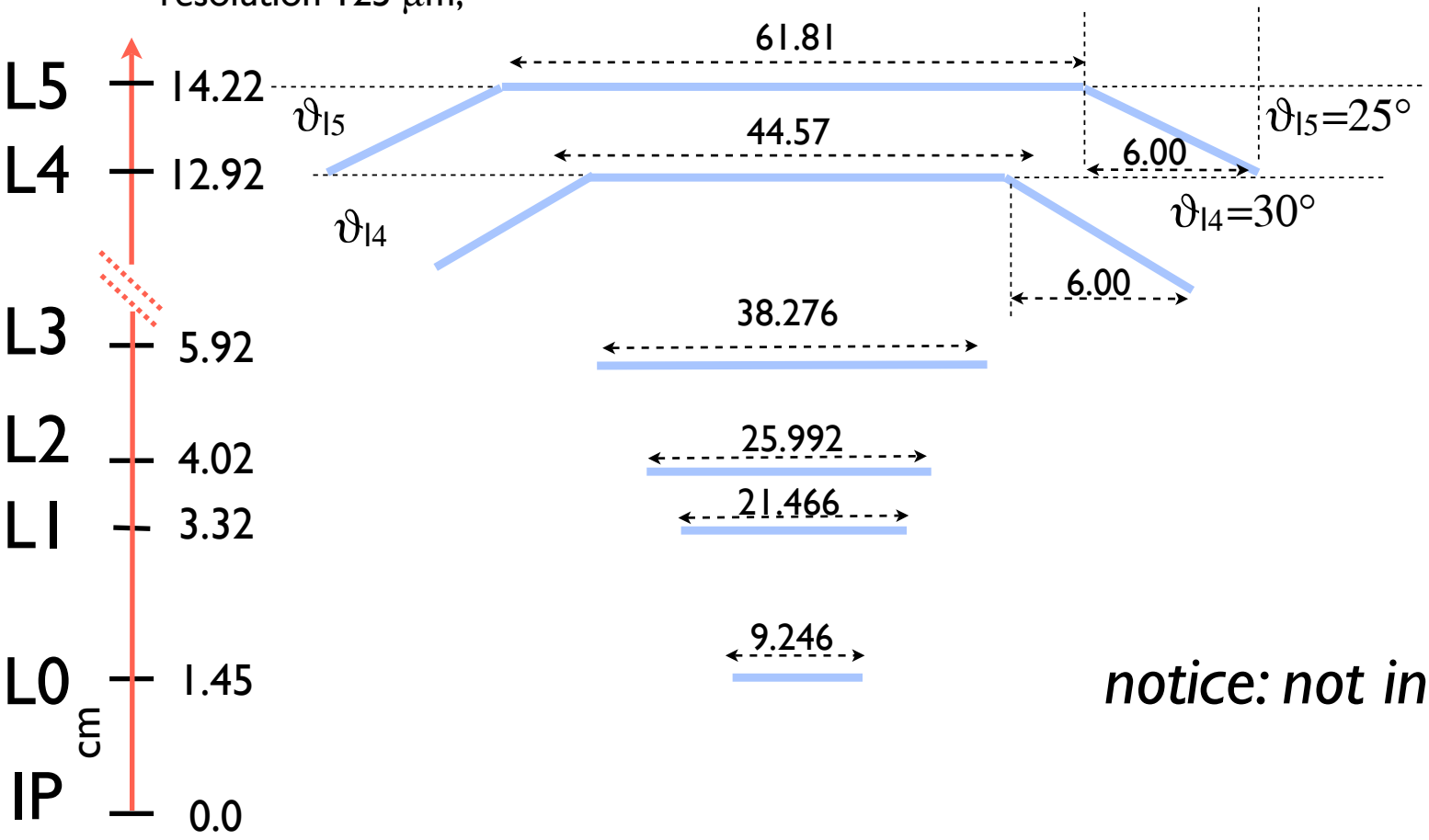
1. SuperB baseline:

- SVT baseline: L0 (Hybrid Pixel) + L1-L5 strip detectors, ±300 rad angular coverage;
- DCH baseline: 10 SuperLayers (4 cell layers per SL); inner radius 23.6 cm, spatial resolution 125 μm;



notice: not in scale

Coverage down to 300 mrad FW and BW

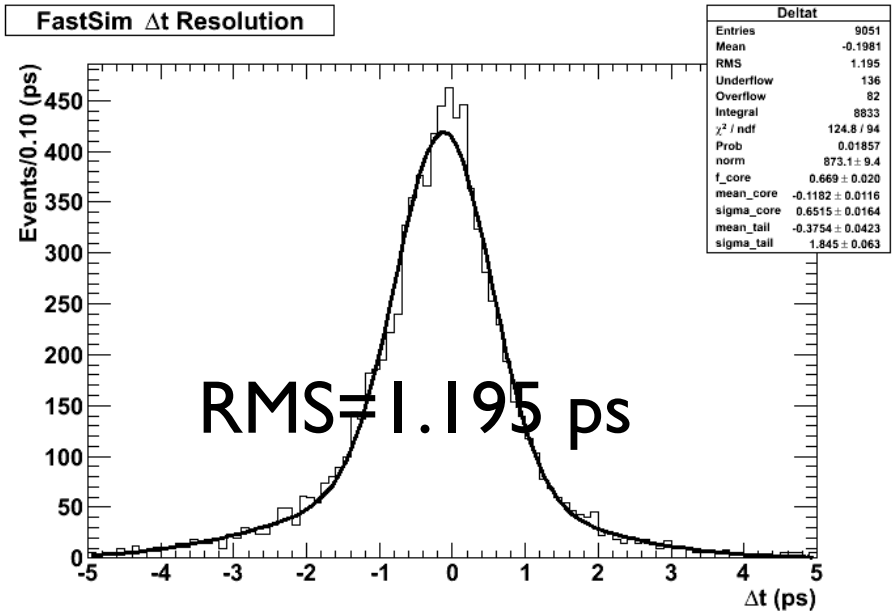
Layer0 impact on Δt resolution for $B^0 \to \phi K_S$

- Reconstruct $B^0 \to \phi K_S$ with $K_S \to \pi^+ \pi^-$
  - Δt resolution using TreeFitter vertex algorithm with beam constraint. Apply loose selection cuts: m_{ES}>5.27 GeV, Δt error <5.0 ps, nB=1.

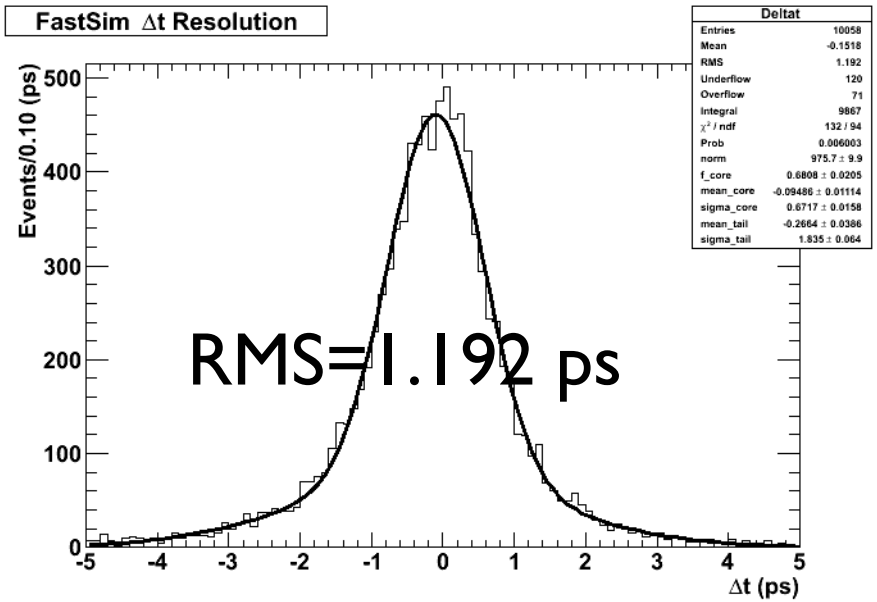
FastSim V0.0.9

$B^0 \to \phi K_S$ proper time resolution

BaBar



SuperB

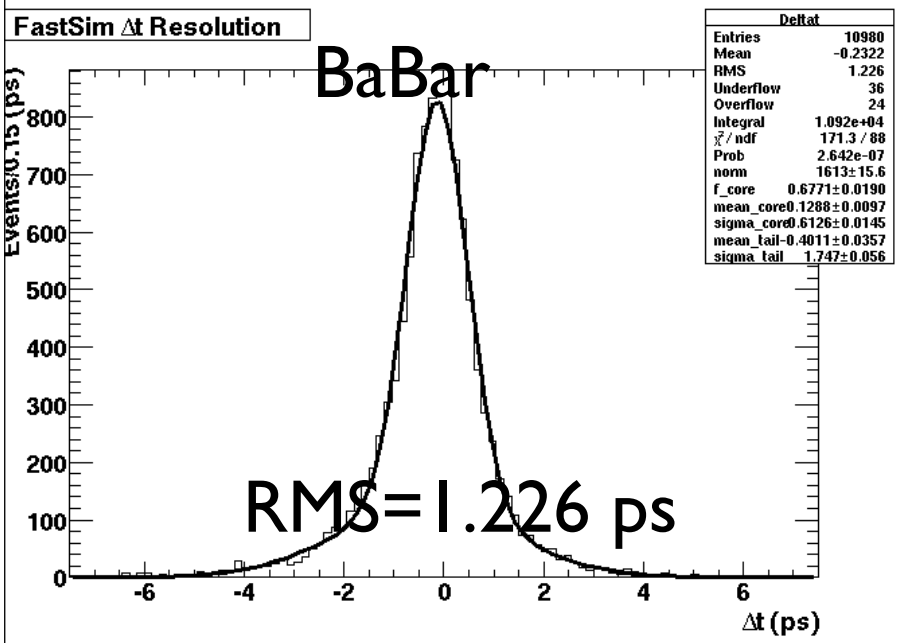


Use 2 Gaussian resolution function to fit the proper time residual.

Applied a cut on proper time error < 2.5 ps.

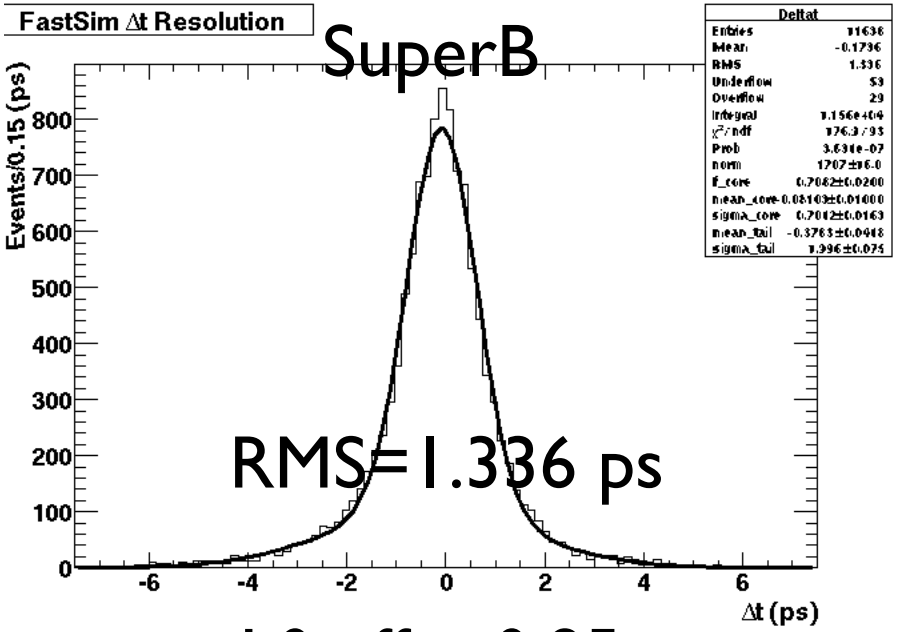
FastSim V0.1.1

$B^0 \rightarrow \phi K_S$ proper time resolution



BaBar

RMS=1.226 ps



SuperB

RMS=1.336 ps

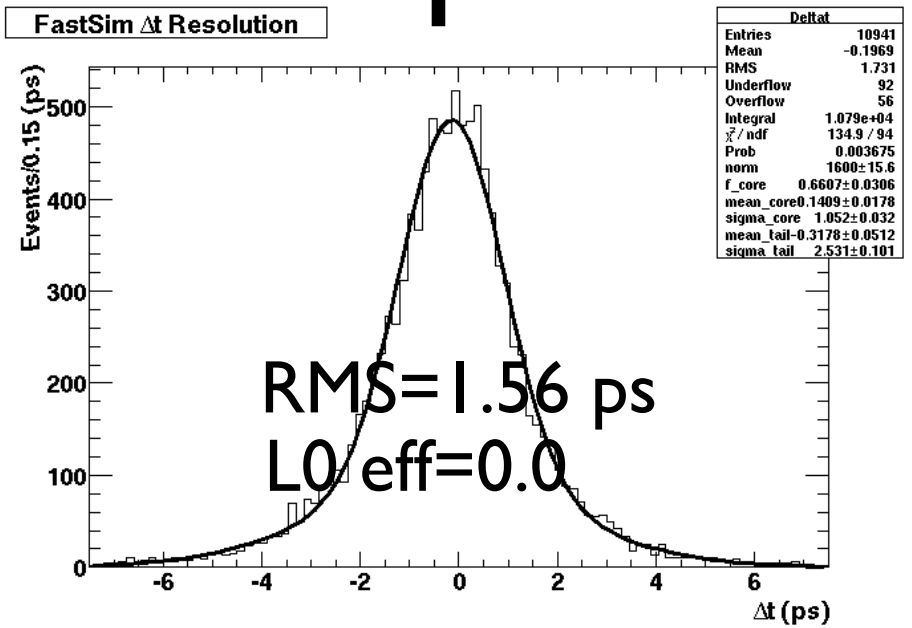
L0 eff = 0.95

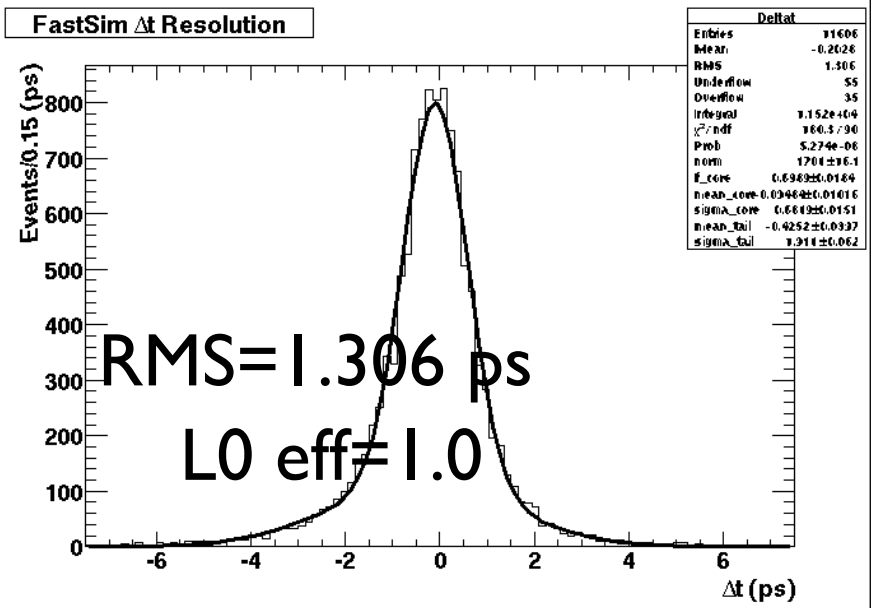
Use 2 Gaussian resolution function to fit the proper time residual.

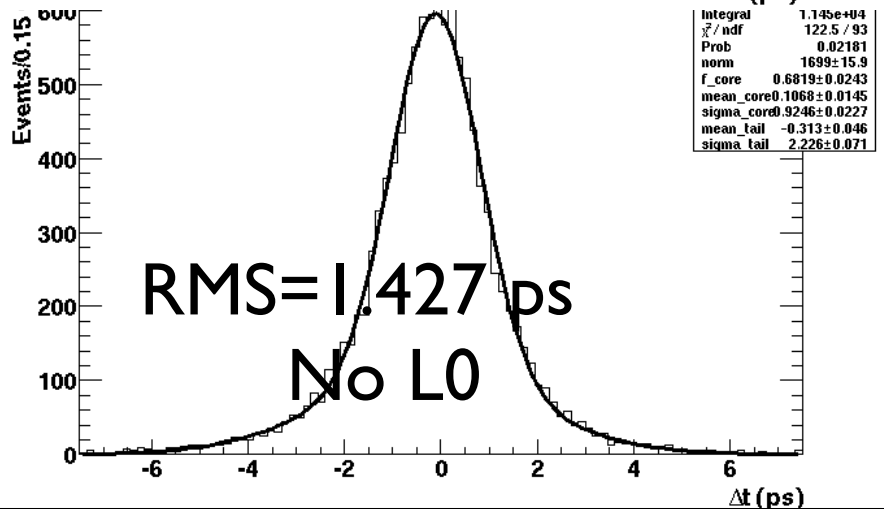
Applied a cut on proper time error < 5.0 ps.

FastSim V0.1.1

Proper time resolution



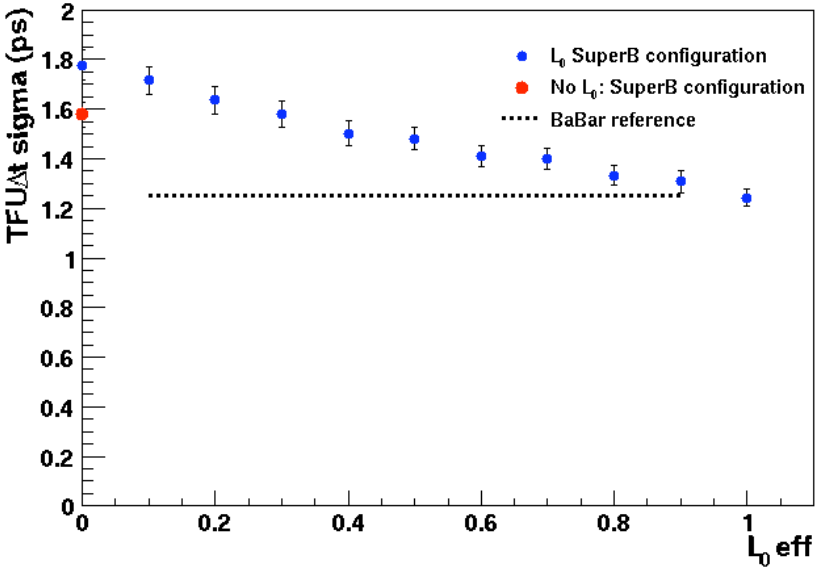




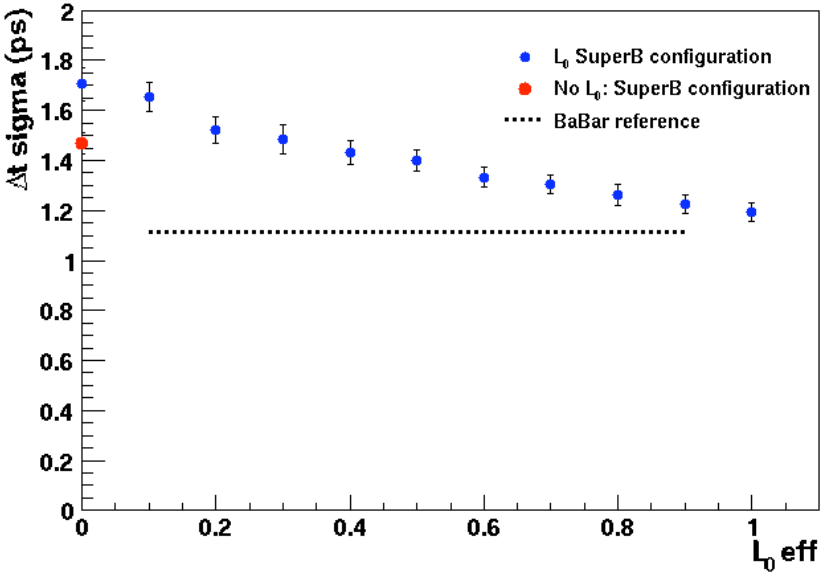
removing the L0 (No L0) improves the DeltaT resolution with respect to the case of small L0 efficiency.

DeltaT resolution

TreeFitter Upsilon



Standard BaBar algorithm



TreeFitter has worst resolution wrt the standard algorithm which is against the expectation.

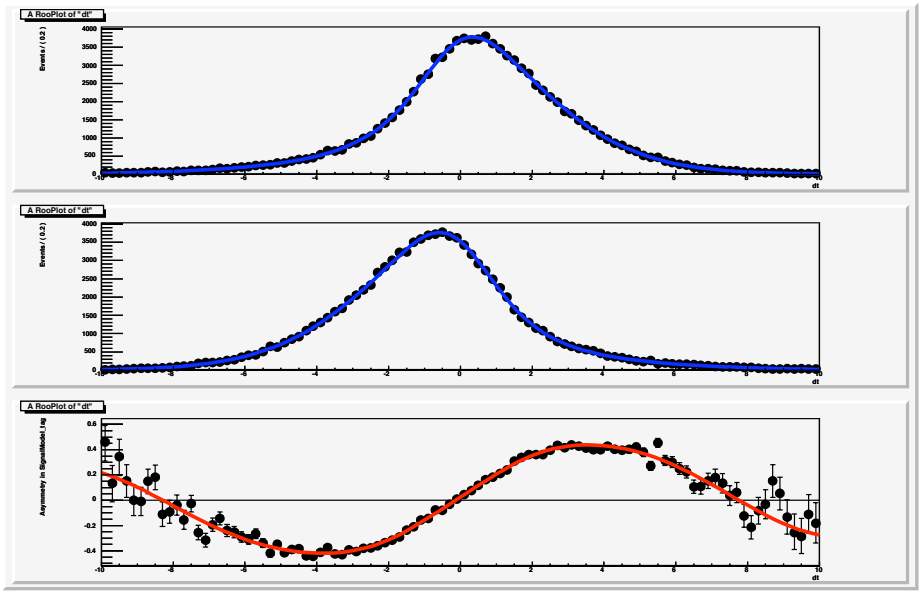
Needs to be further investigated.

It is worth to keep the L0 inside the tracking volume if efficiency > 40%.

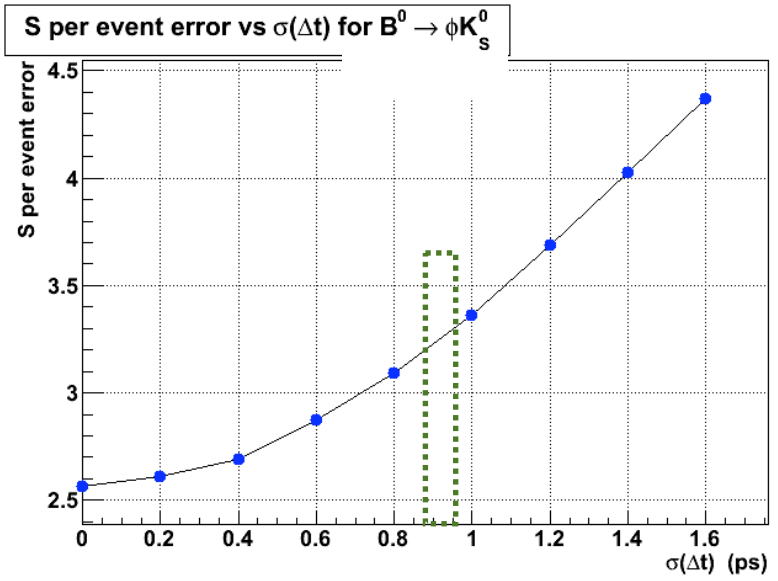
Impact on TD measurement

ToyMC fit with perfect tagging: use 2 Gaussian proper time resolution function tuned to FastSim residual.

100K signal Evts. S_{GEN}=0.70

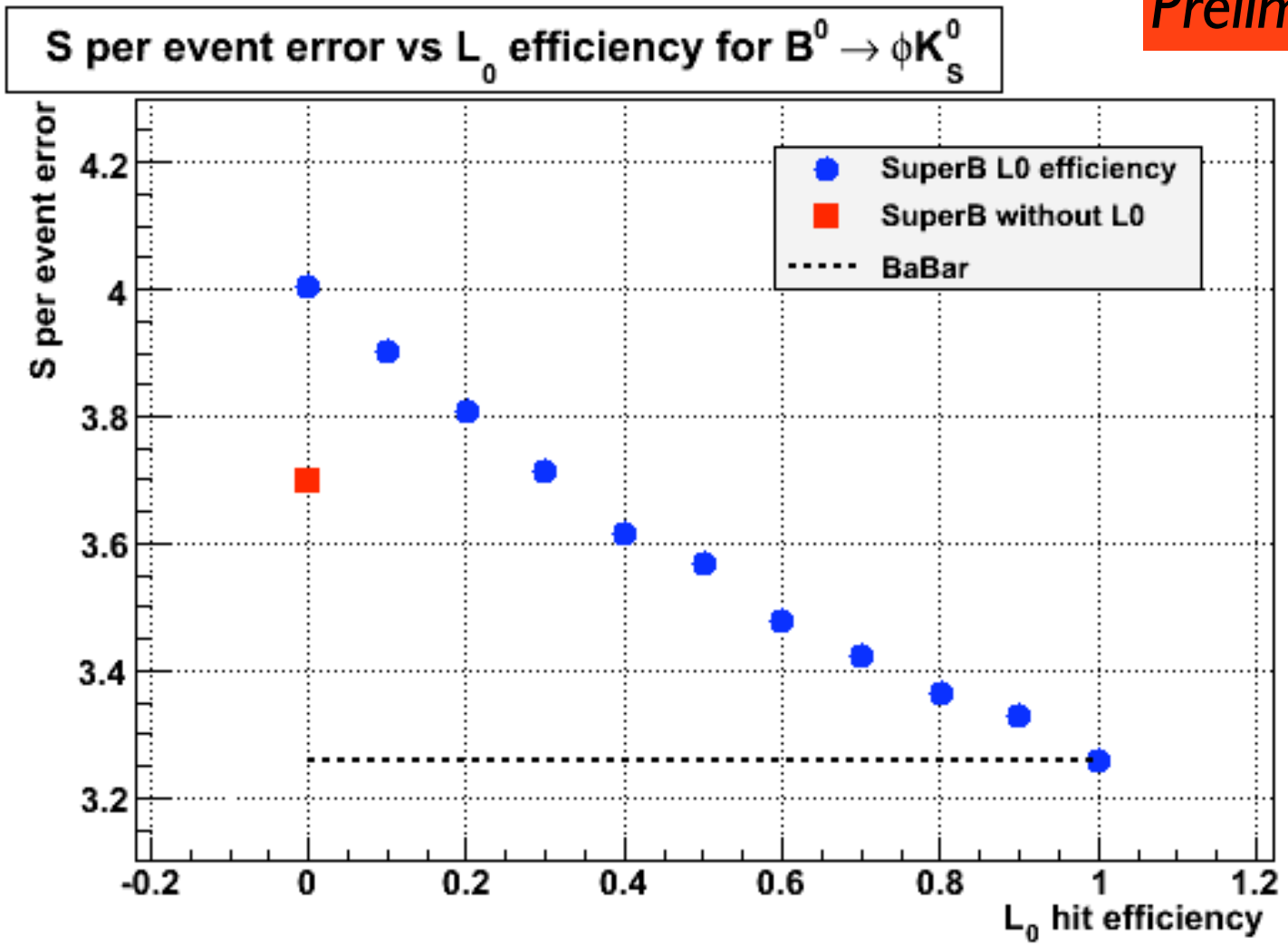


S per event error normalized to BaBar result:
Phys.Rev.D71:091102,2005.



From "AFit" Toy MC

Preliminary



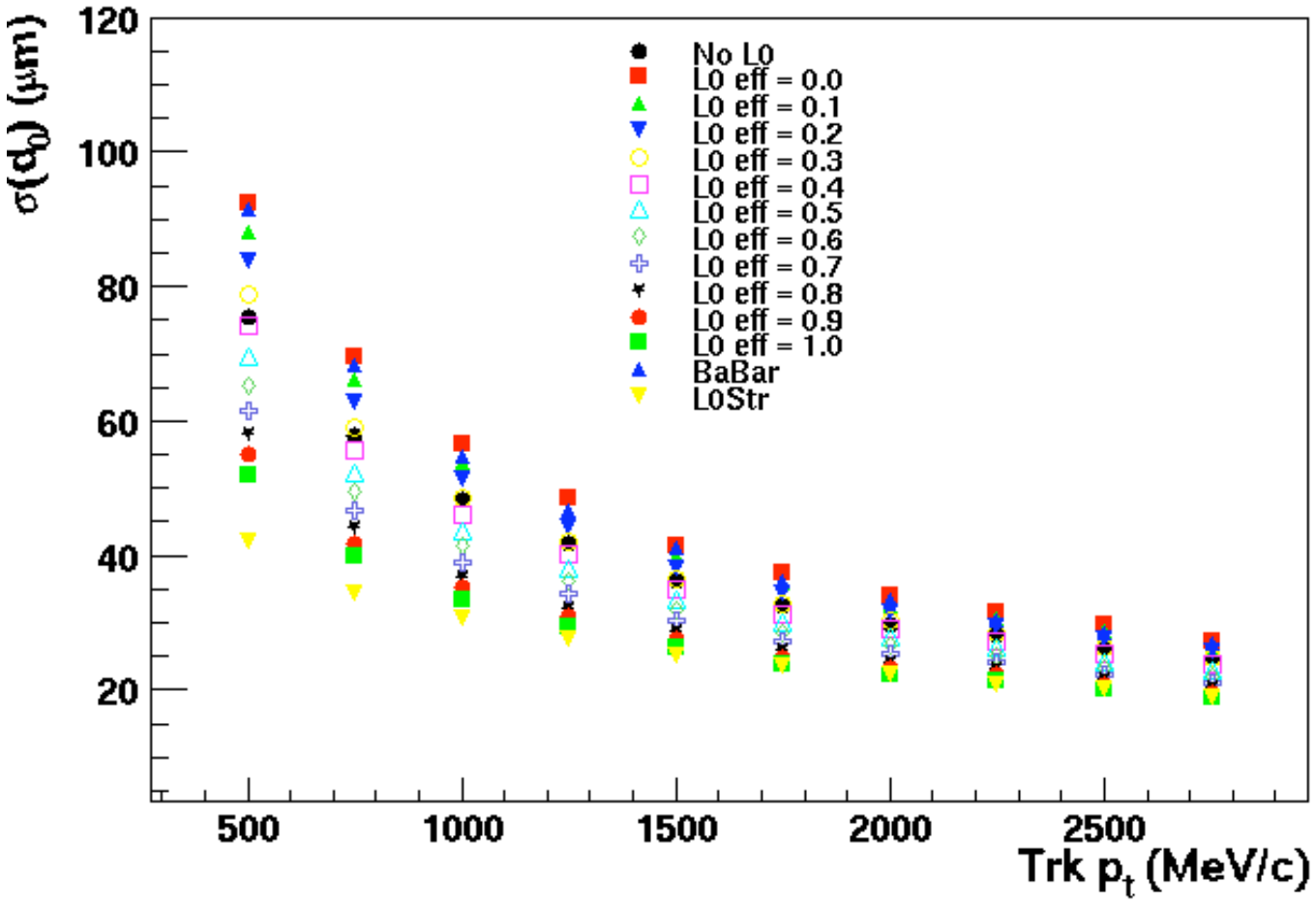
It is worth keeping Layer0 inside SVT

if efficiency is greater than 40%

Cross checks

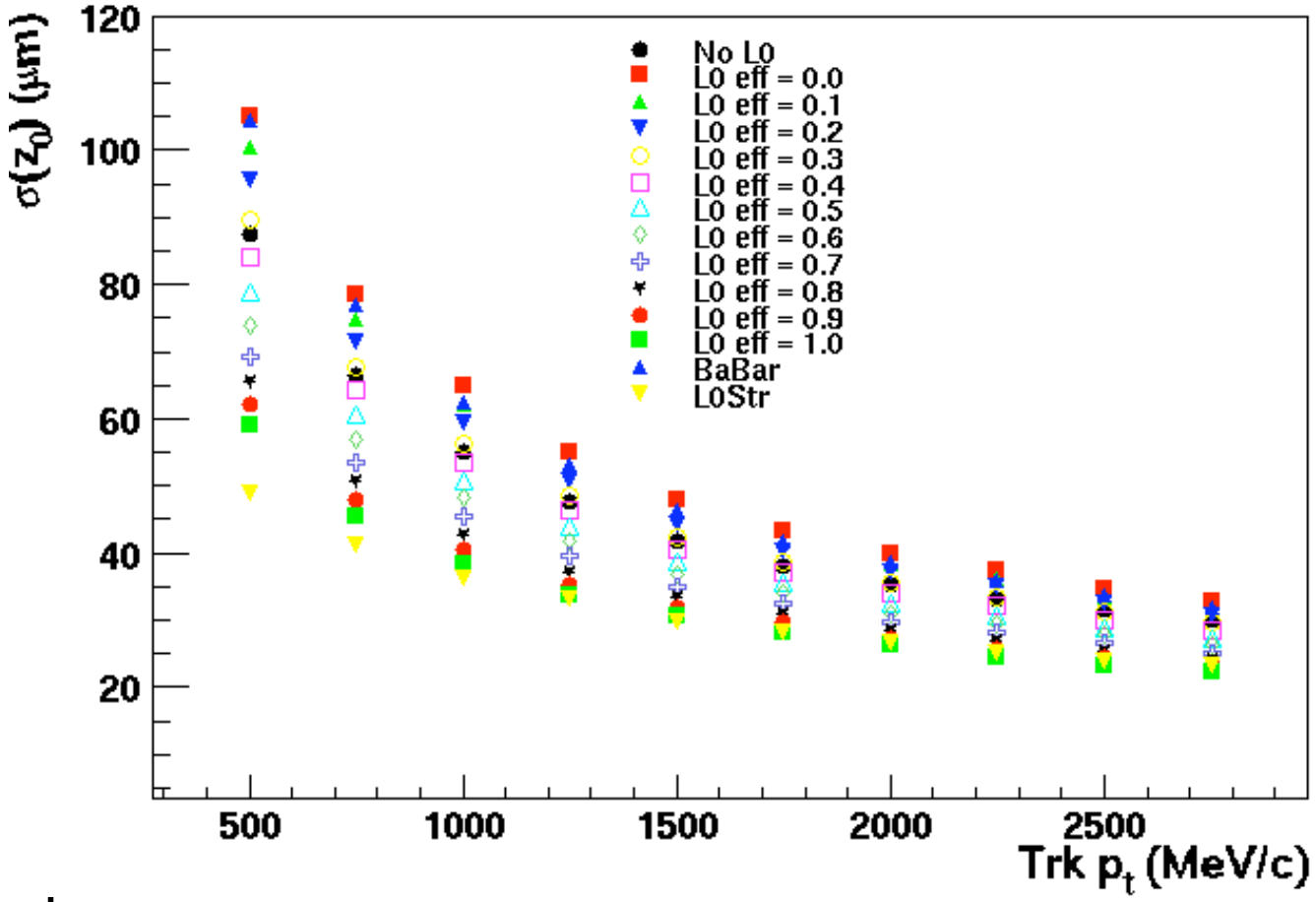
- track parameters
- Tag vertex
- CP vertex

d_0 resolution



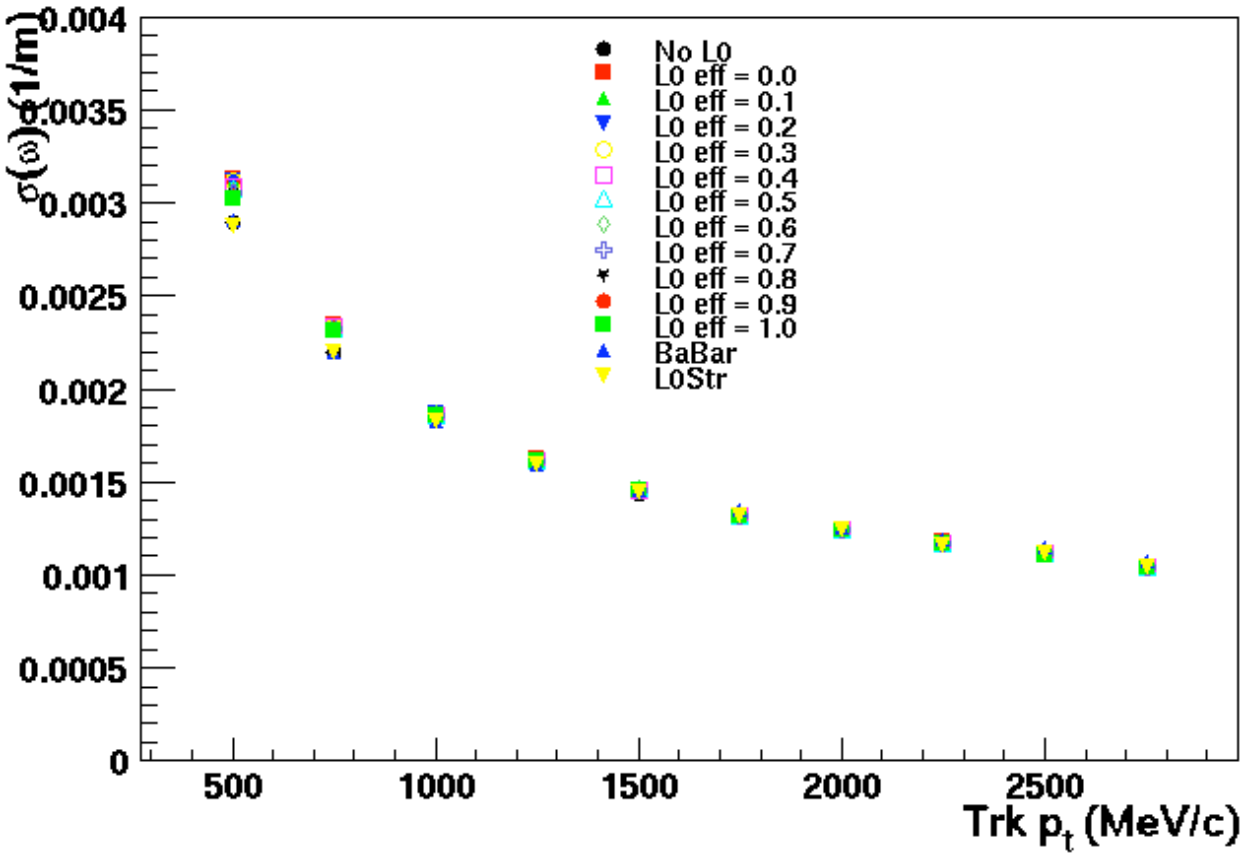
Legenda:
L0Str = L0 Strip detector

z_0 resolution



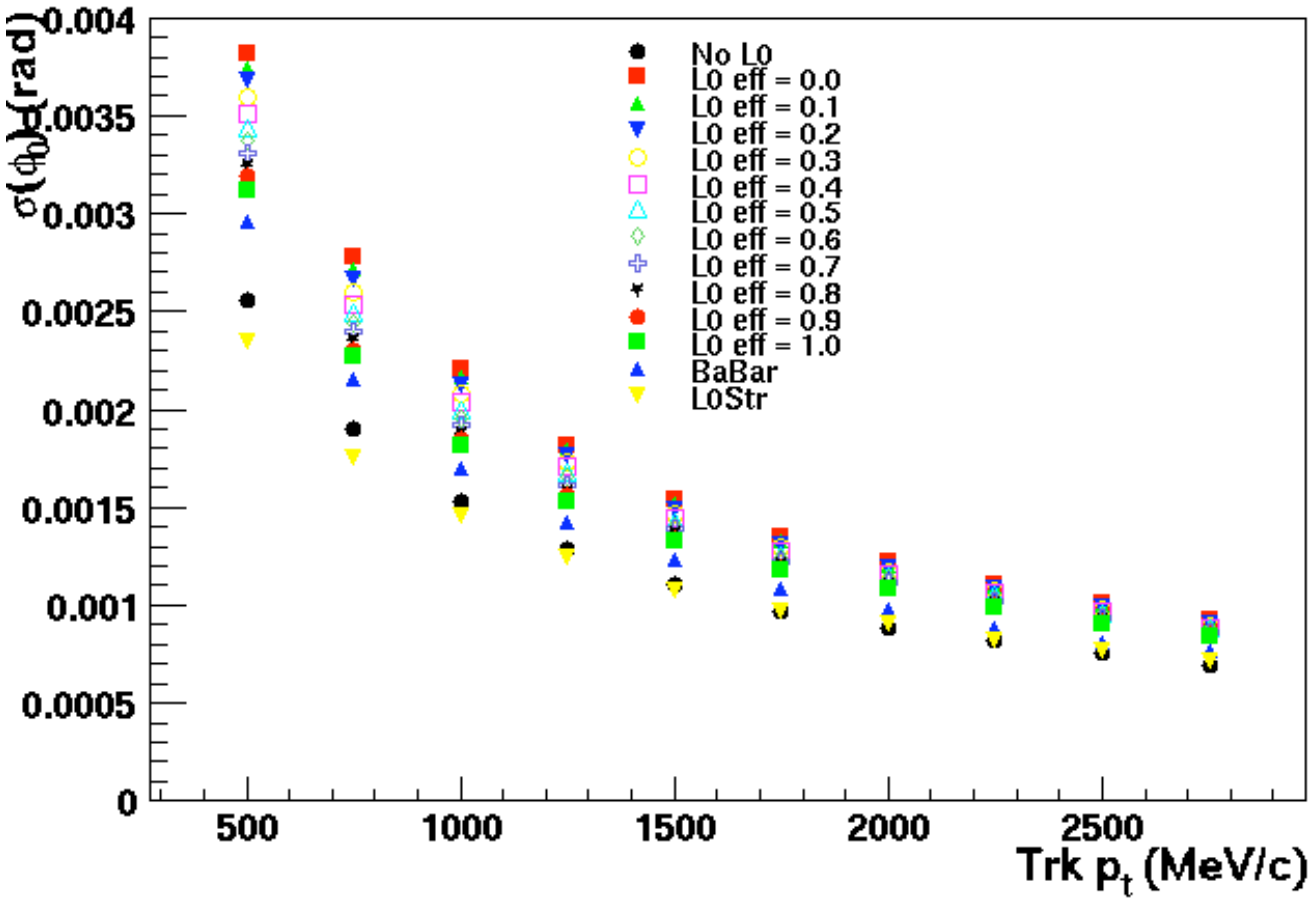
Legenda:
L0Str = L0 Strip detector

ω resolution



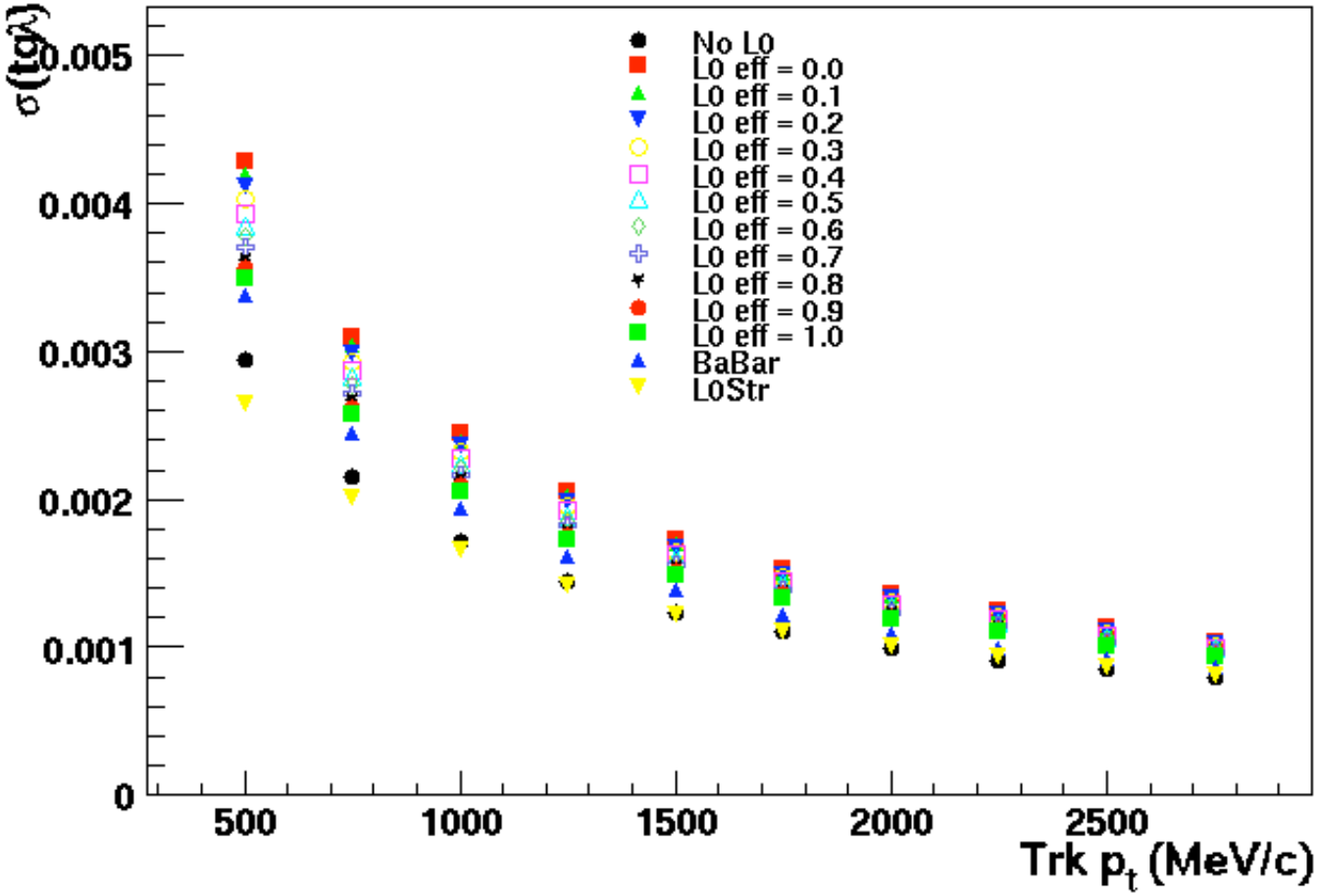
Legenda:
L0Str = L0 Strip detector

ϕ_0 resolution



Legenda:
L0Str = L0 Strip detector

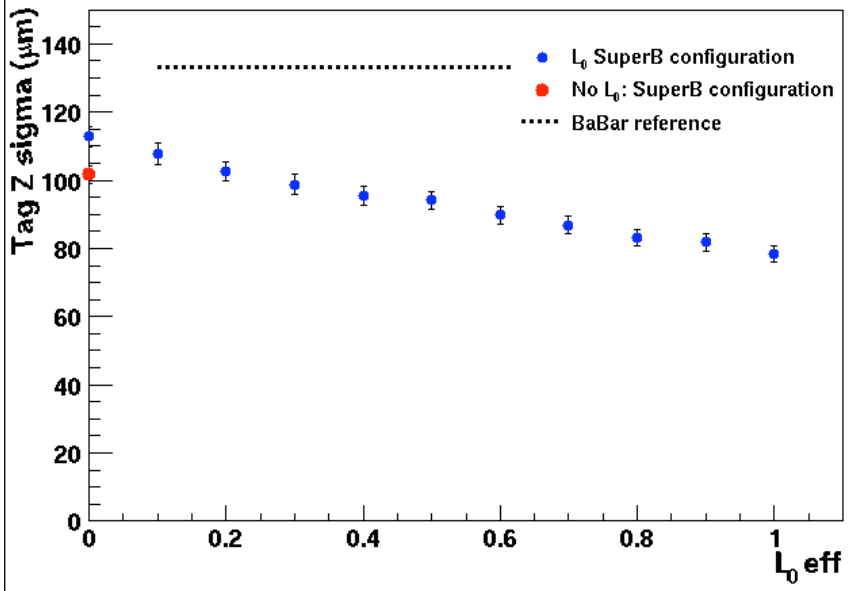
tgλ resolution



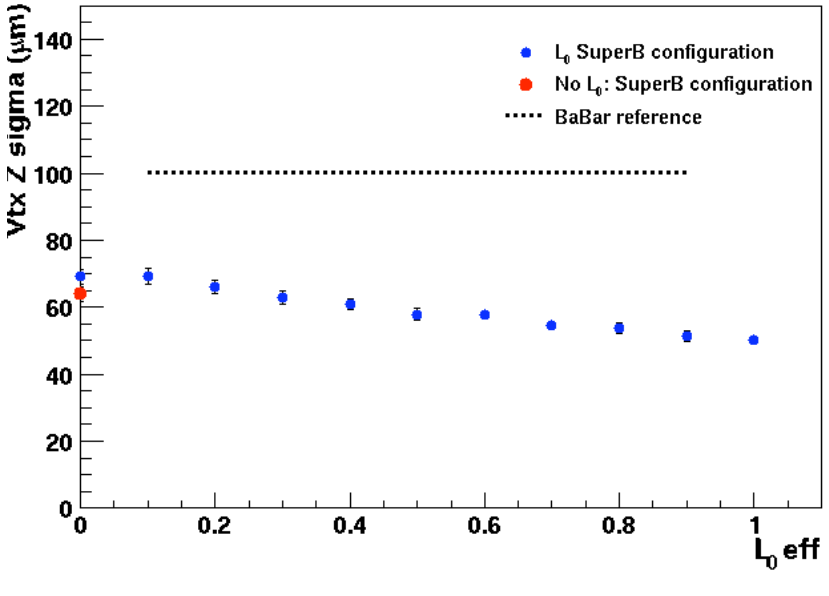
Legenda:
L0Str = L0 Strip detector

Tag and CP vertex

Tag vertex



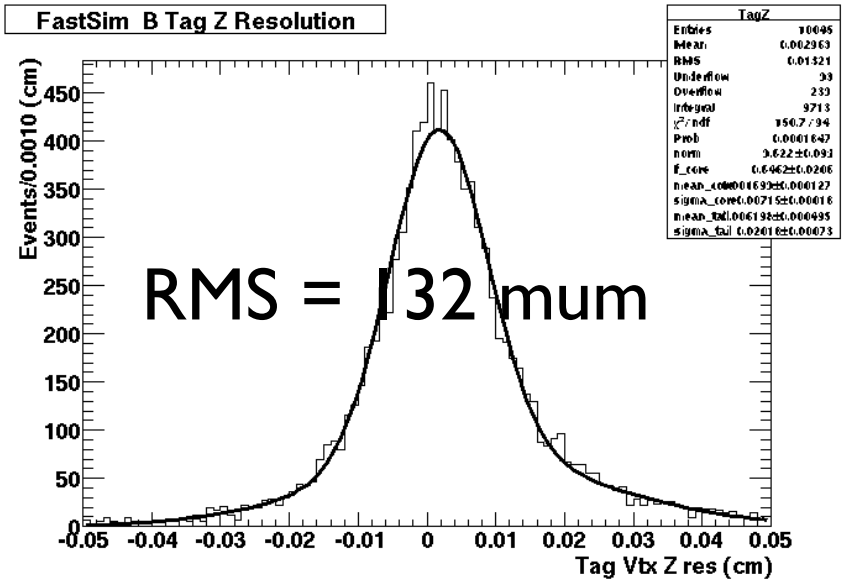
CP vertex



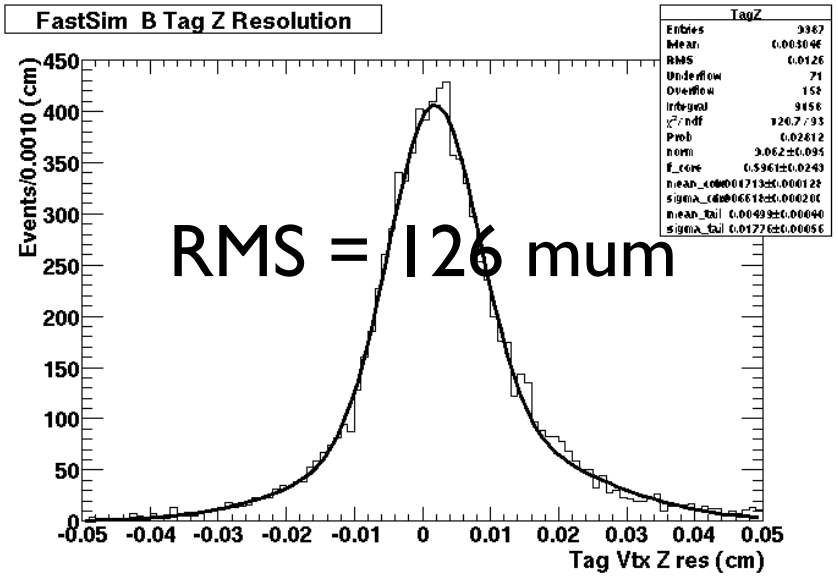
Better resolution with respect to BaBar even when No L0 configuration. How is it possible? See next slide.

Tag vertex test

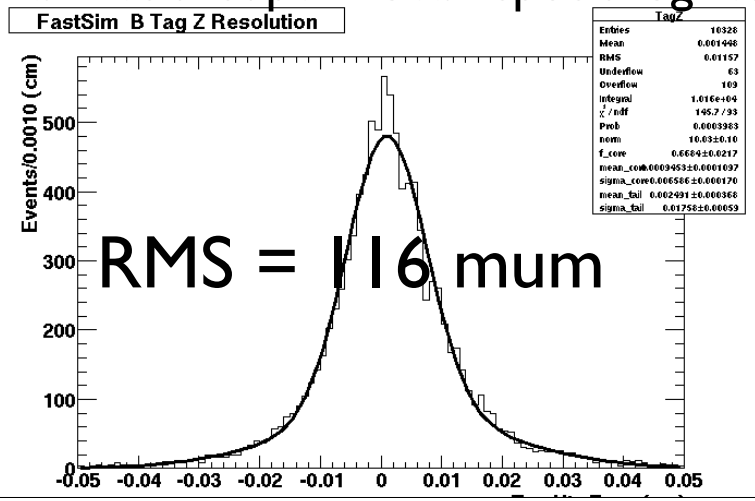
BaBar detector



BaBar det & SuperB beamspot



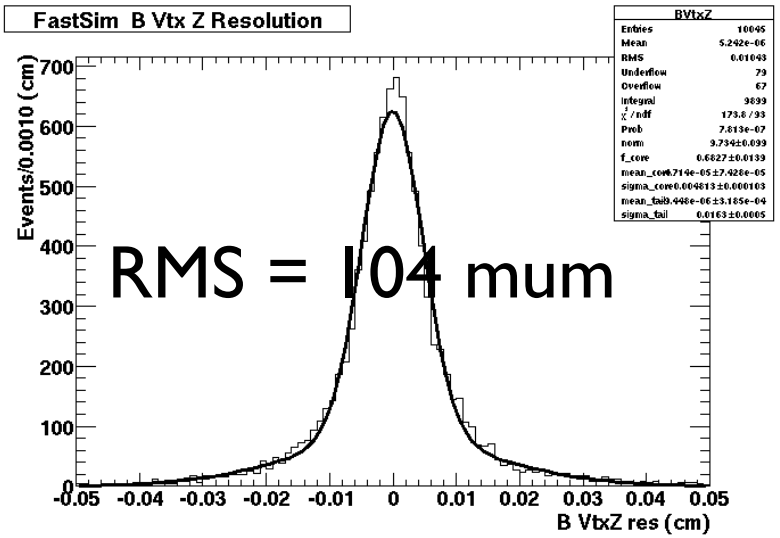
BaBar det & SuperB beamspot & bg=0.28



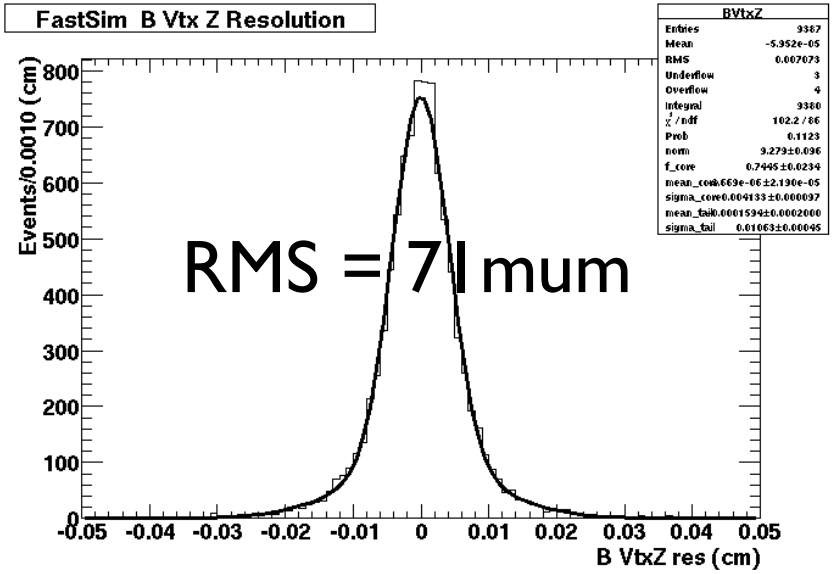
Tag vertex improves because of better beamspot and smaller boost (smaller charm vertex bias)

B_{CP} vertex test

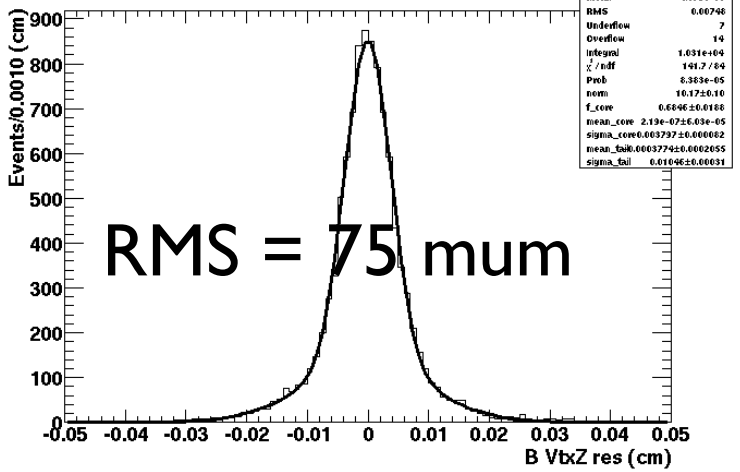
BaBar detector



BaBar det & SuperB beamspot

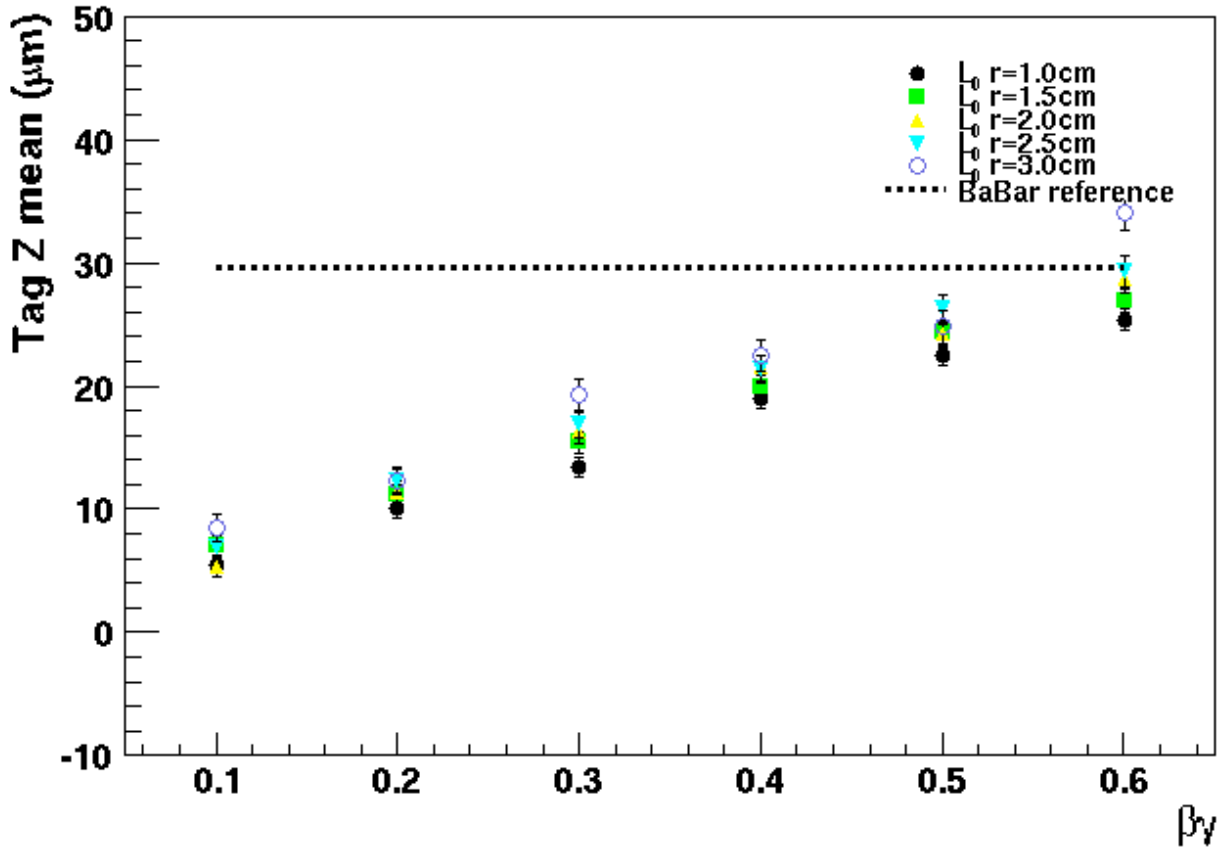


BaBar det & SuperB beamspot & bg=0.28



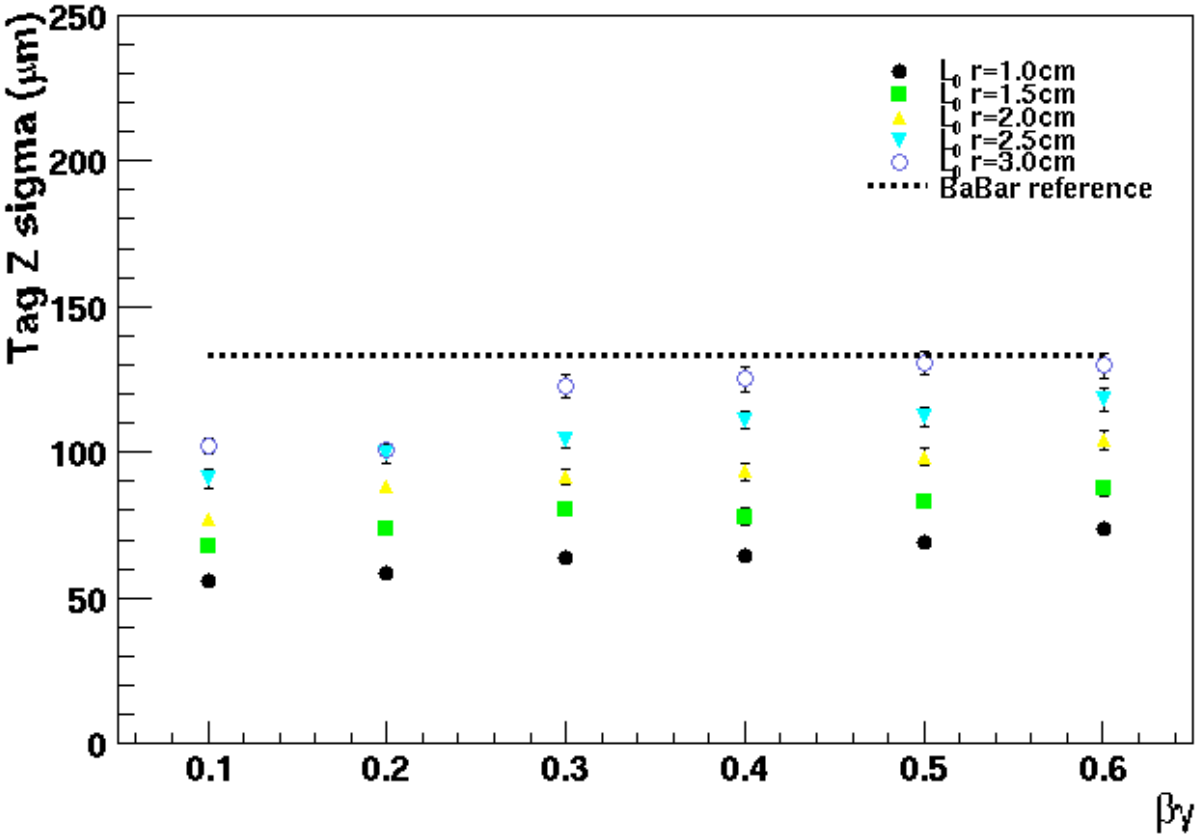
CP vertex improves because of better beamspot but does not improve reducing the boost

Tag vertex bias



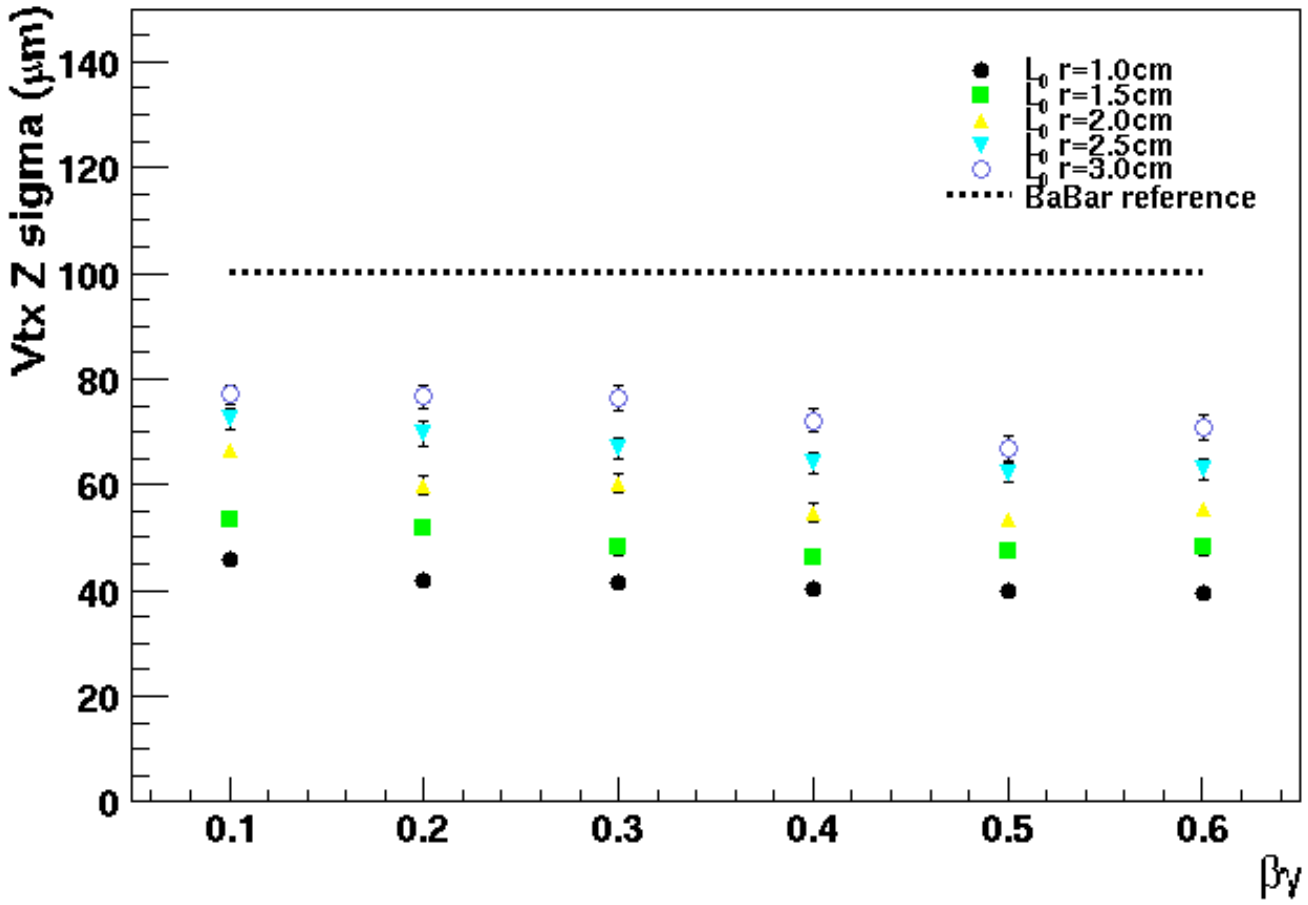
Tag vertex bias increases with boost

Tag vertex resolution



Tag vertex sigma increases with boost oppositely to B CP vertex sigma. Charm vertex bias is not compensated by reduction of multiple scattering effect due to the increase of the average track momentum

B_{CP} vertex resolution



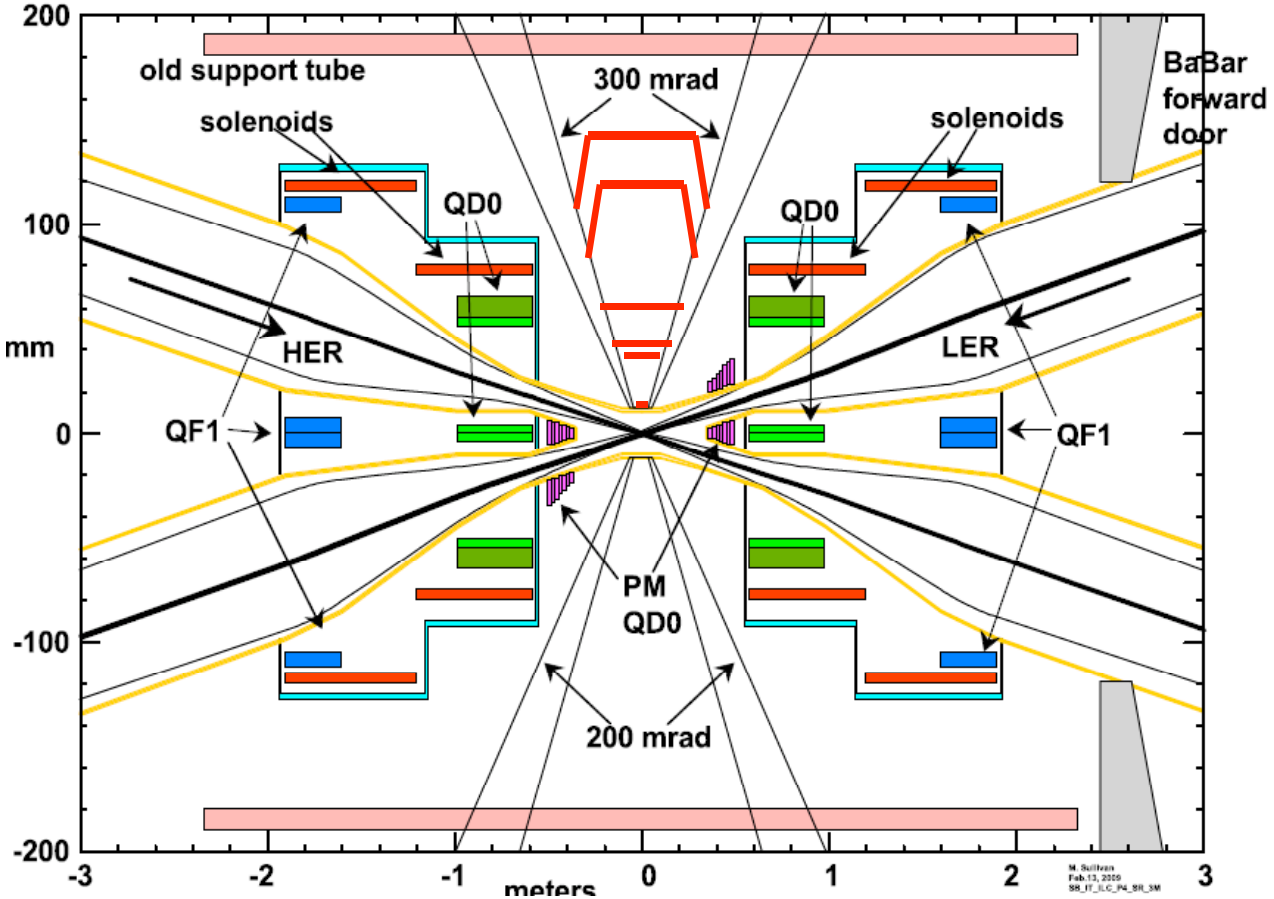
B_{CP} vertex sigma decreases with boost: reduction of multiple scattering increasing the average track momentum

To do list

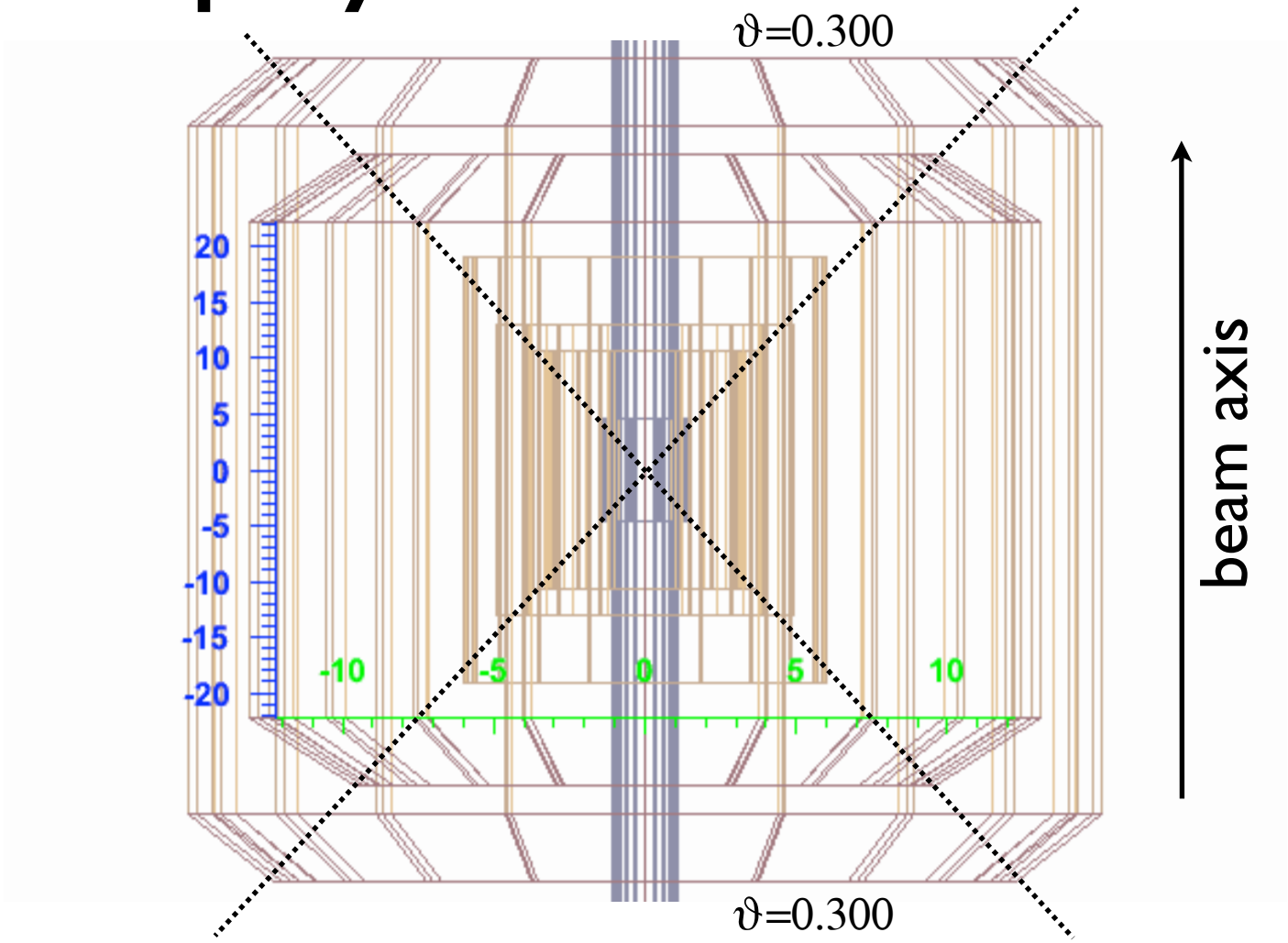
- Complete the study for sensitivity to S:
  - varying the beampipe radius;
  - using striplet detectors for L0;
  - varying the L0 resolution.
  - other suggestions?

Backup

Angular coverage down to 300 mrad FW and BW



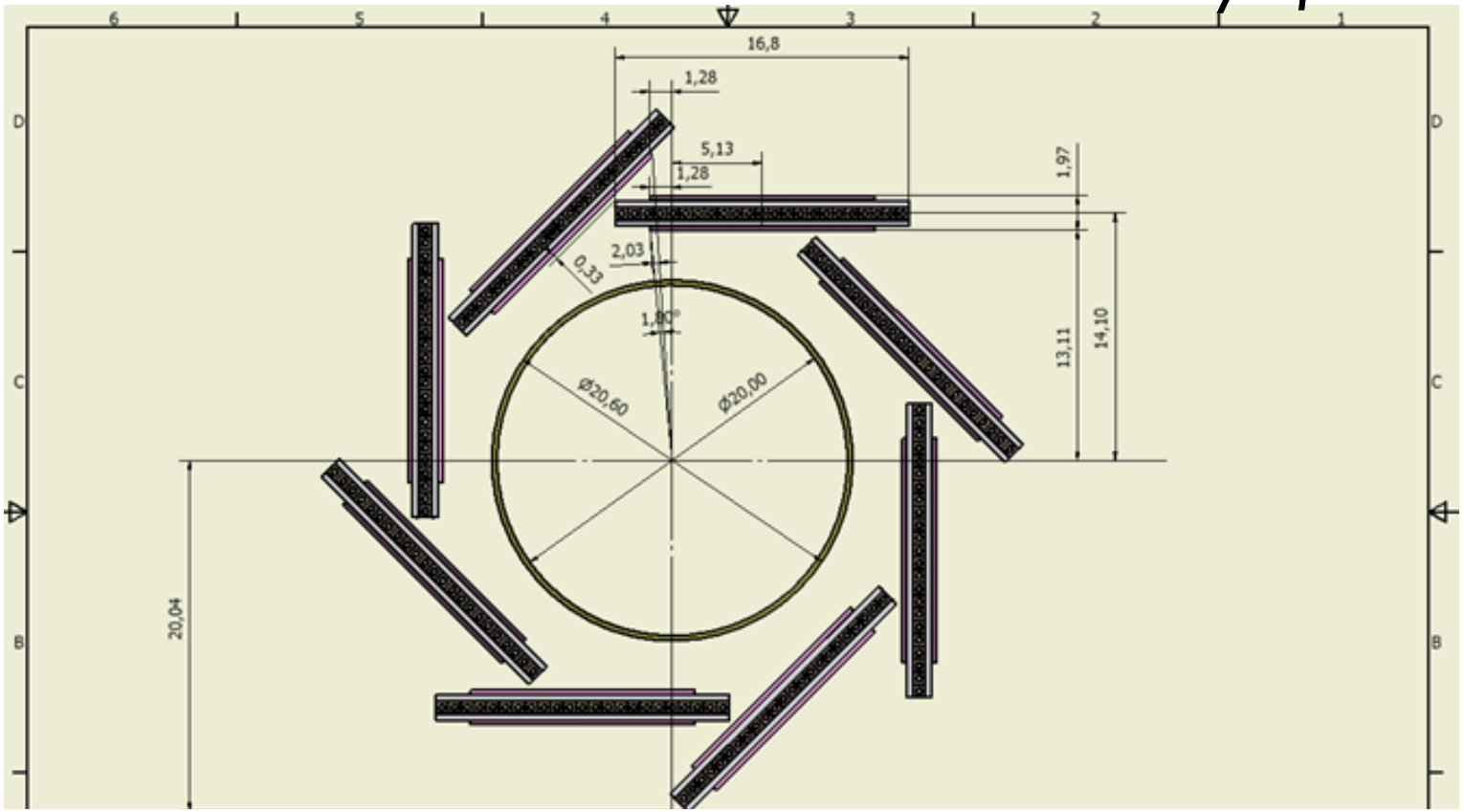
Display of SVT modules



angular coverage in CM_{25}~ 95% (BaBar SVT ~89%)

Pinwheel layout for L_0

courtesy of F. Bosi

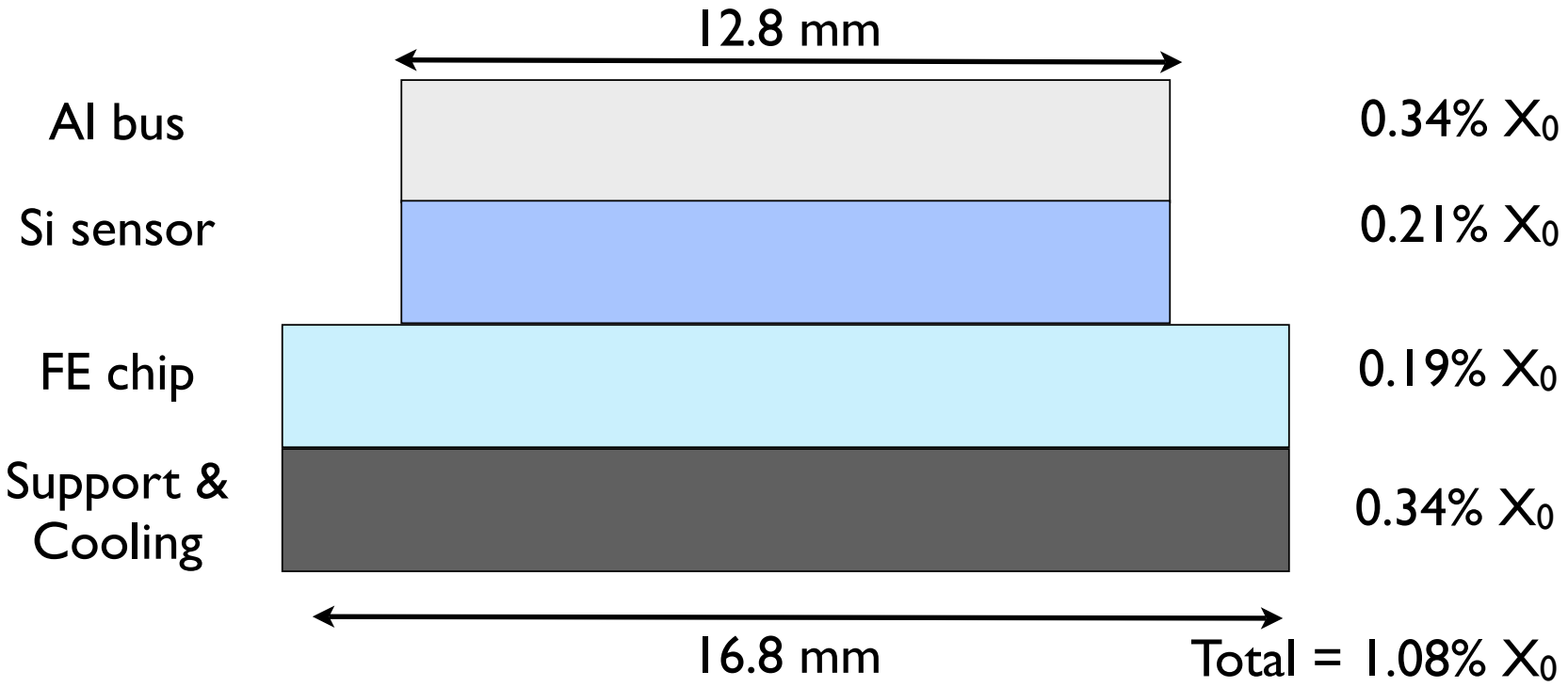


Design for MAPS solution

Mechanical design can be considered valid also for Hybrid Pixel solution though small changes could be applied when finalized design will be ready.

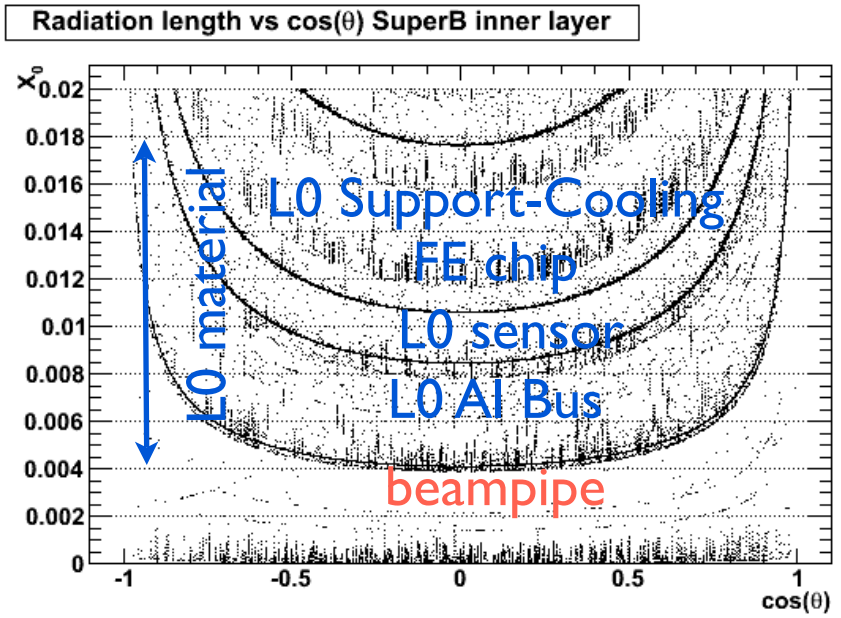
Hybrid pixel solution

- Module cross section

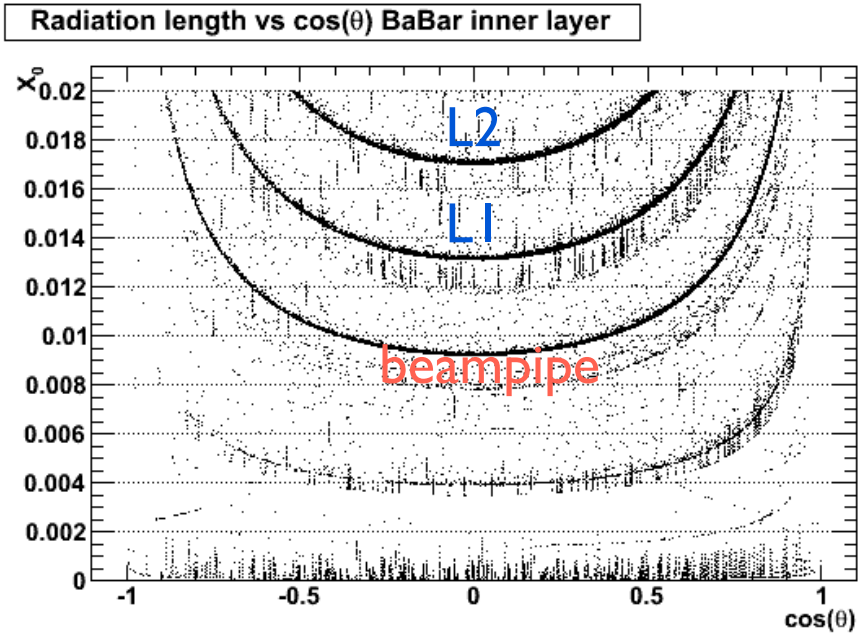


Radiation length vs cos(theta) in FastSim

SuperB



BaBar



Total amount of L0 material is ~1.36% X_0 considering overlap of passive material.
Relative amount of material for Al bus and support-cooling requires small adjustments.