

# **TOP reconstruction and simulation studies III**

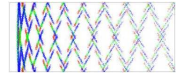
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**18-Mar-2009**

2nd Open meeting of the SuperKEKB

- ◆ Simulation & reconstruction
- ◆ Performance of various TOP configurations



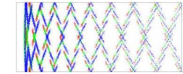
## *TOP simulation & reconstruction*

### Simulation (not Gean)

- ◆ Input: particles from a MC generator or single tracks/event generated randomly in  $\Omega$  and  $p < 5$  GeV/c
- ◆ Tracks propagated to TOP in a magnetic field of 1.5T
  - ▷ no multiple scattering, no secondaries
  - ▷ 10 ps (r.m.s)  $T_0$  uncertainty
- ◆ Cherenkov photons: emitted randomly along track helix inside Q-bar; propagated along the Q-bar including reflection on focusing mirror
- ◆ Uncorrelated background: 20 hits/bar-side/50ns
- ◆ PMT response (assume GaAsP, 50ps TTS)
- ◆ Electronics response
  - ▷ simple CFD model (delay=500ps)
  - ▷ multi-hit TDC (1024ch, 50ps/ch, 5 ns double-pulse resolution)

### Reconstruction

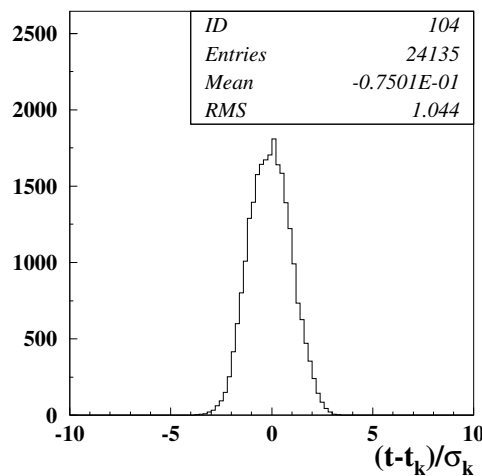
- ◆ Extended max. likelihood, with analytically derived likelihood function
- ◆ Likelihood function adopted to focusing TOP (cylindrical or spherical mirror)



## TOP simulation & reconstruction

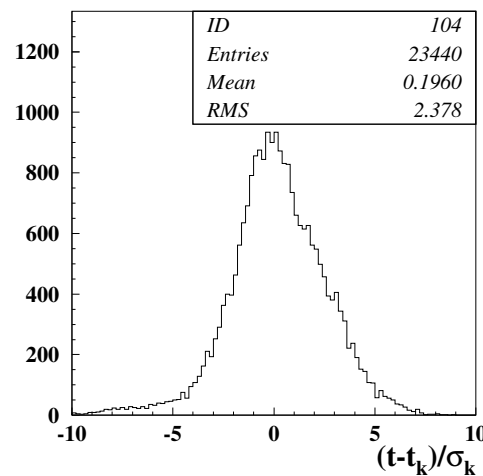
- ◆ At December SuperKEKB meeting:
  - ▷ linear optics used in MC for photon reflection at the mirror
- ◆ Replaced now with the true reflection on sphere (cylinder)
- ◆ For reconstruction:
  - ▷ linear optics still good for cylindrical mirror
  - ▷ but next order corrections must be used for spherical mirror
- ◆ Pulls (TTS of PMT not included):

cylindrical mirror  
linear optics



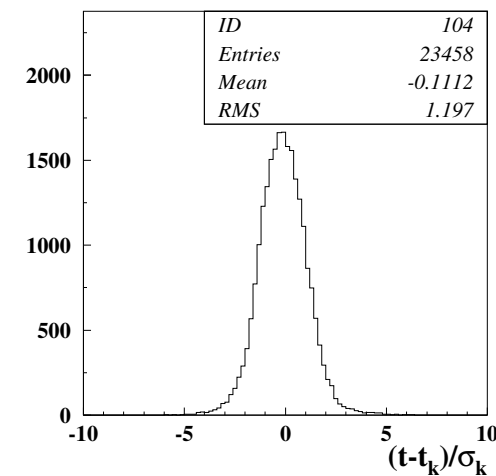
$$\sigma = 1.04$$

spherical mirror  
linear optics



$$\sigma = 2.38$$

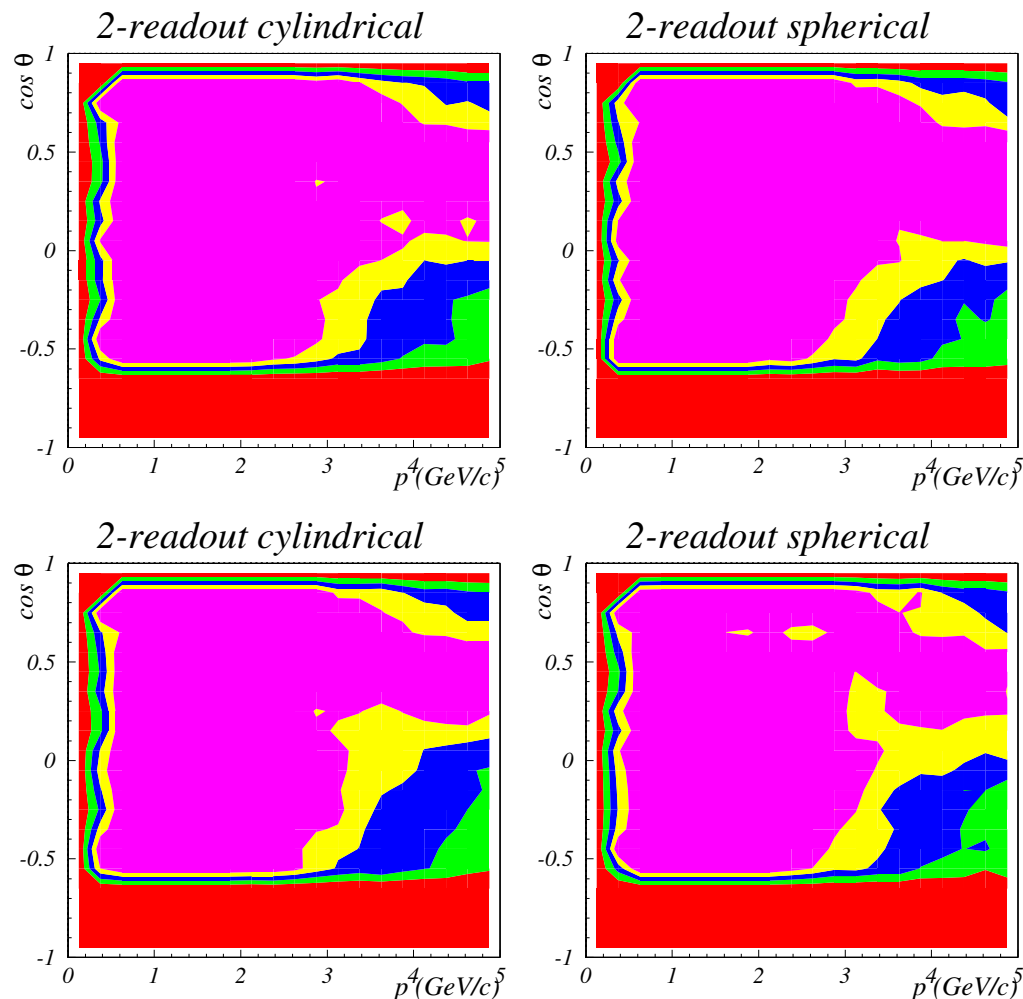
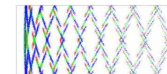
spherical mirror  
linear+next order



$$\sigma = 1.20$$



## $K - \pi$ separation



MC: linear optics

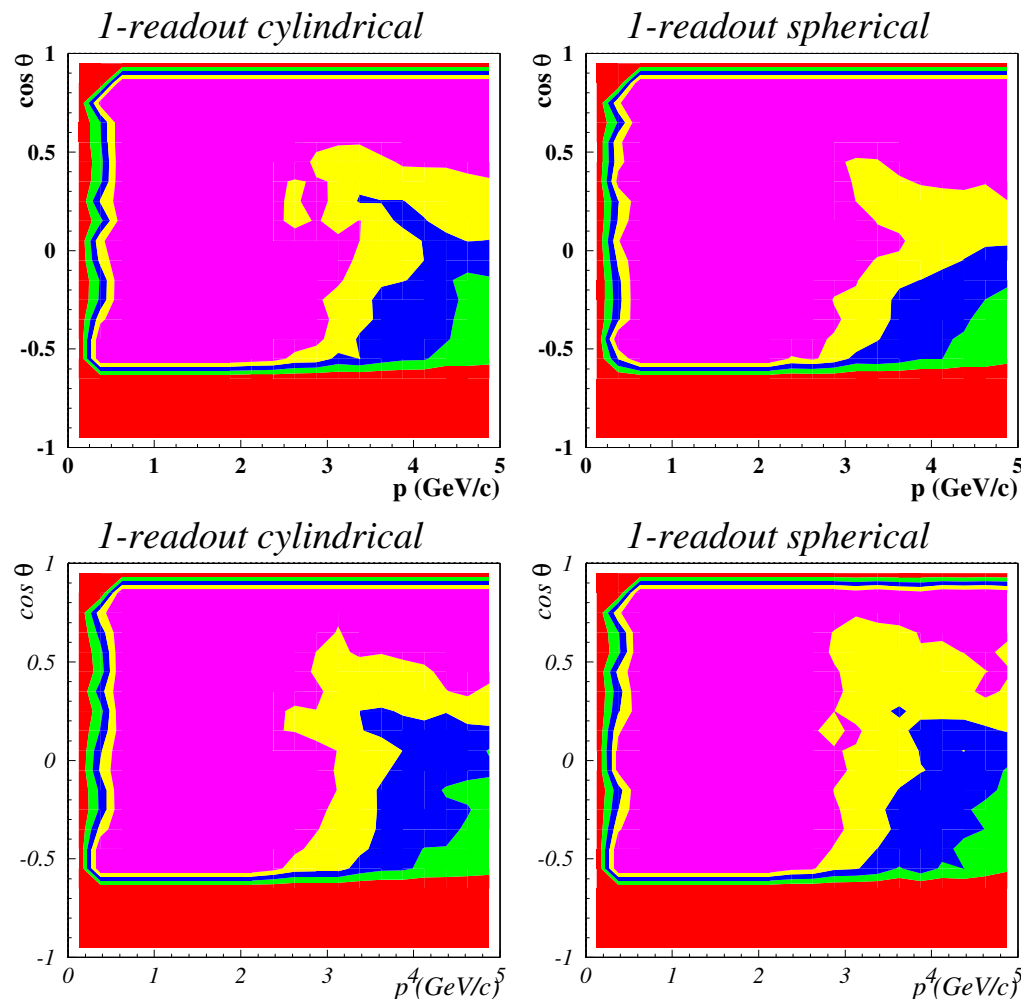
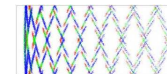
$> 4\sigma$   
 $> 3\sigma$   
 $> 2\sigma$   
 $> 1\sigma$

MC: exact treatment of reflection (R=5m)

Some performance degradation possibly due to mirror optical aberrations



## $K - \pi$ separation

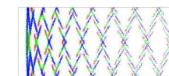


MC: linear optics

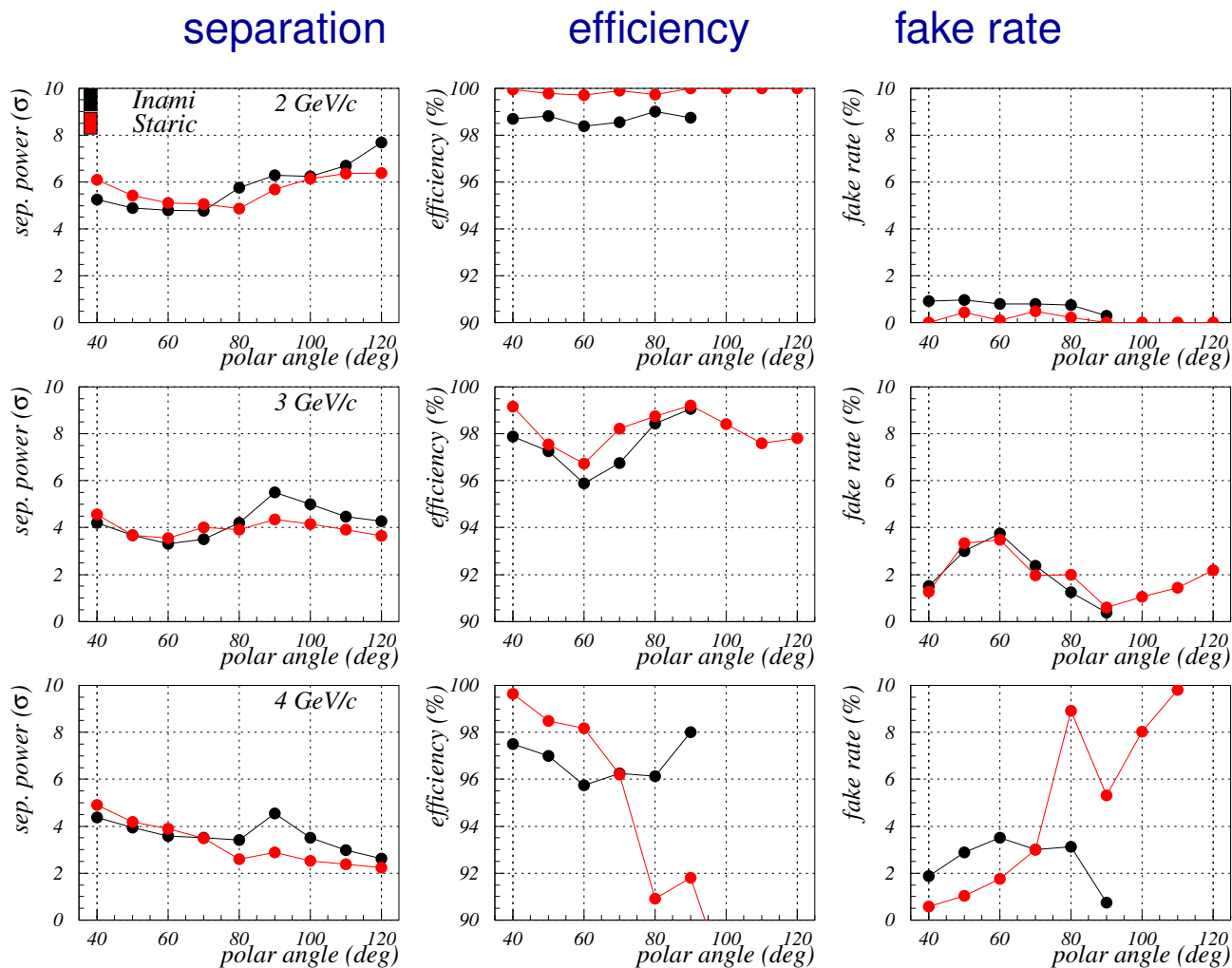
$> 4\sigma$   
 $> 3\sigma$   
 $> 2\sigma$   
 $> 1\sigma$

MC: exact treatment of reflection (R=7m)

Some performance degradation possibly due to mirror optical aberrations

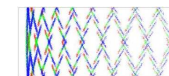


# Comparison with Inami-san (1-readout spherical)

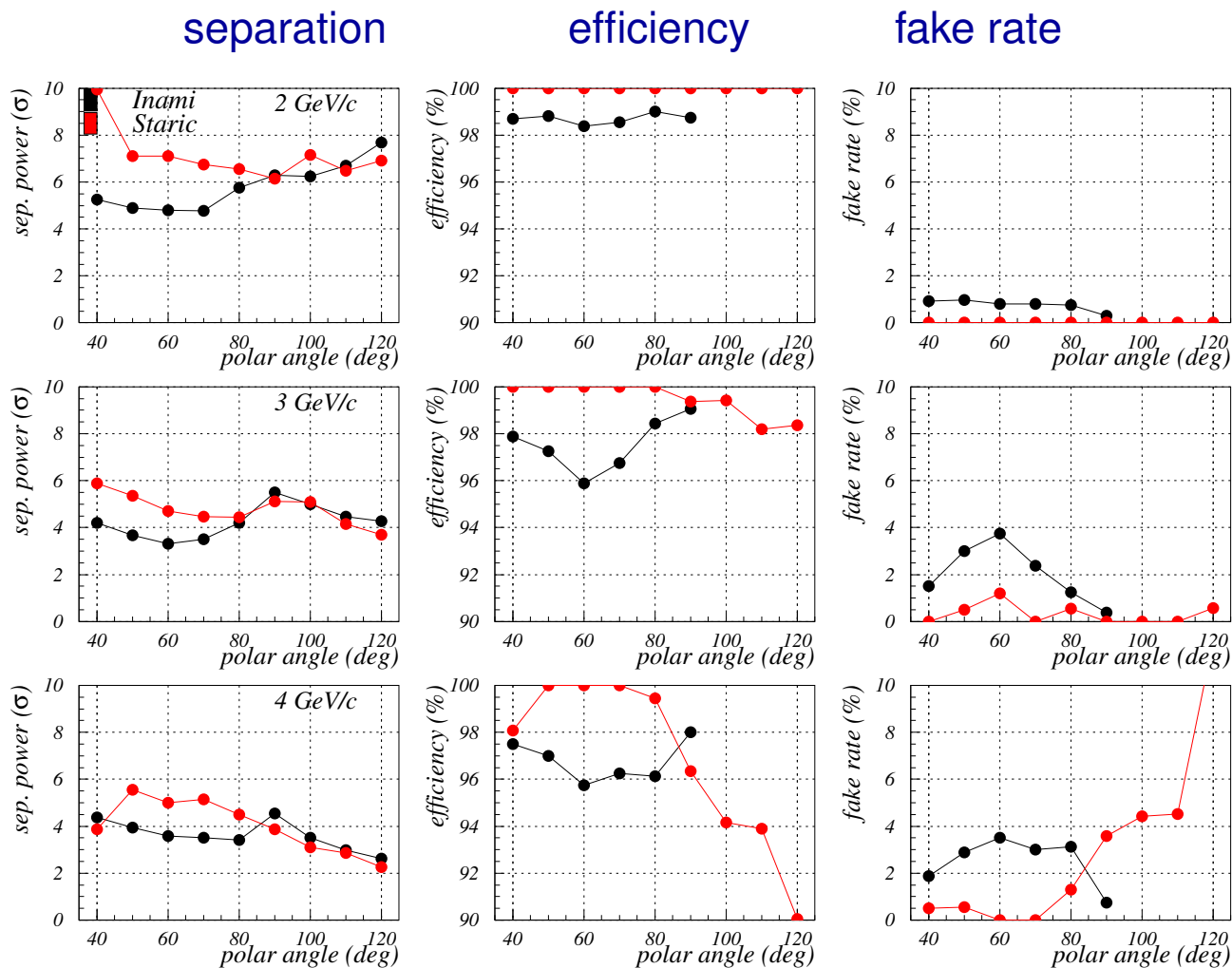


● Inami-san slides 2009/2/20 page 7

● 50ps TTS,  $\mathcal{L}_\pi > \mathcal{L}_K$



# Comparison with Inami-san (1-readout spherical)

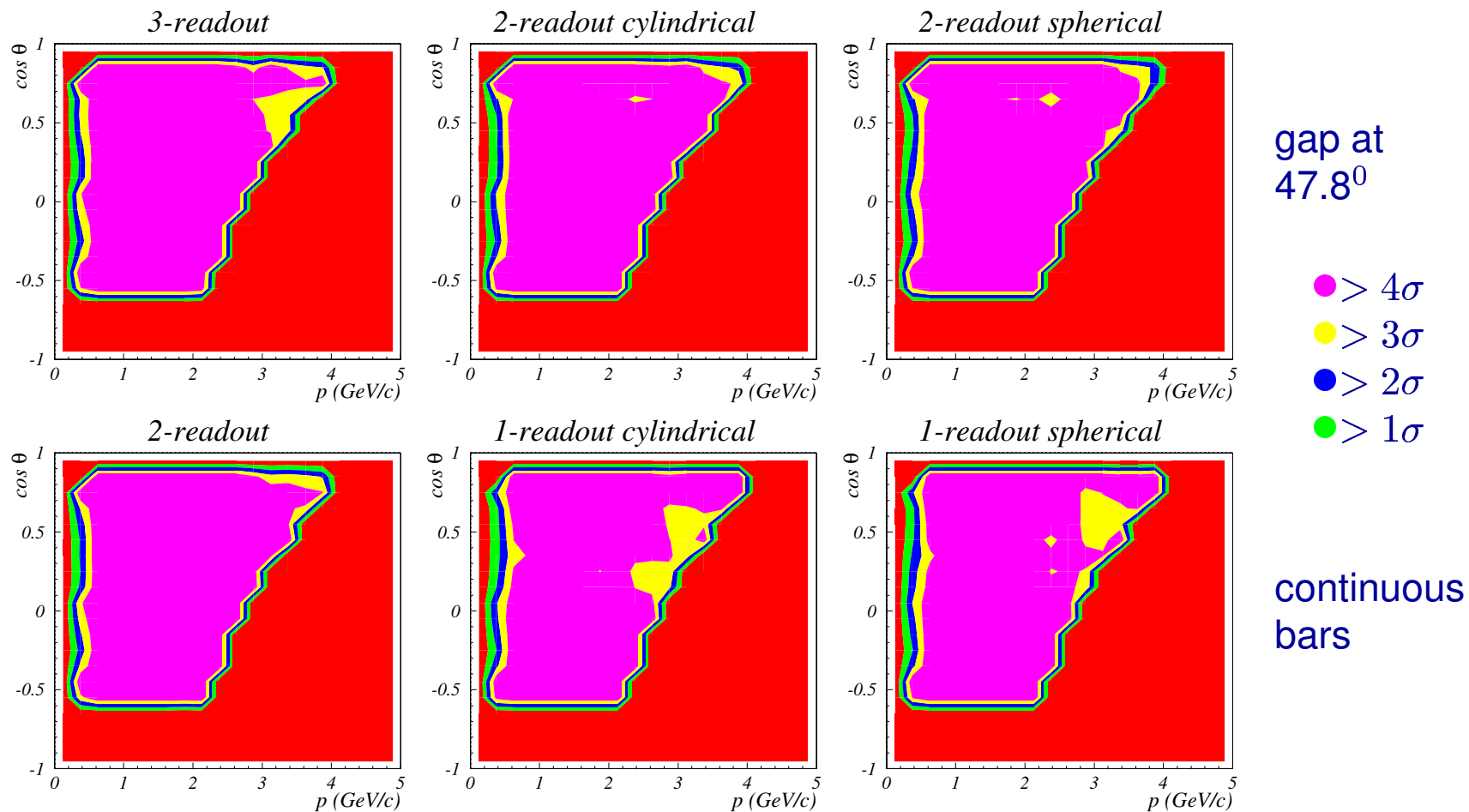
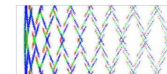


● Inami-san slides 2009/2/20 page 7

● 35ps TTS,  $\mathcal{L}_\pi > \mathcal{L}_K$

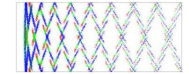


$B \rightarrow K\pi, \pi\pi$



$B^0 \rightarrow K^+\pi^-(80\%), \pi^+\pi^-(20\%), \bar{B}^0 \rightarrow$  generic  
generated event sample the same for all TOP configurations





$$B \rightarrow K\pi, \pi\pi$$

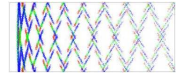
- ◆ Number of generated decays:

	$B^0 \rightarrow \pi^+\pi^-$	$B^0 \rightarrow K^+\pi^-$
No. of decays	5007	20008

- ◆  $\sim 66\%$  decays inside TOP geometrical acceptance
- ◆ After pion selection (for both tracks:  $\mathcal{L}_\pi > \mathcal{L}_K$ ):

TOP configuration	$B^0 \rightarrow \pi^+\pi^-$	$B^0 \rightarrow K^+\pi^-$
2-readout type	2957	58
3-readout type	2862	88
2-readout cylindrical	2953	59
2-readout spherical	2957	106
1-readout cylindrical	2940	133
1-readout spherical	2950	172

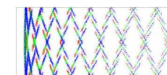
note: non-Geant simulation



## Conclusions

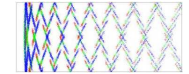
- ◆ Construction of likelihood function for focusing TOP:
  - ▷ for cylindrical focusing mirror linear optics OK
  - ▷ for spherical focusing mirror next order corrections used;  
modeling still not perfect (pull=1.2) - impact to performance
- ◆ Comparison to Imani-san: agreement not very good; hard to find the reasons.
  - ▷ maybe we should exchange our simulated data
- ◆  $B^0 \rightarrow \pi^+ \pi^-$ : surprisingly, 2-readout non-focusing type seems to perform the best (?).

Next step: write reconstruction in C++



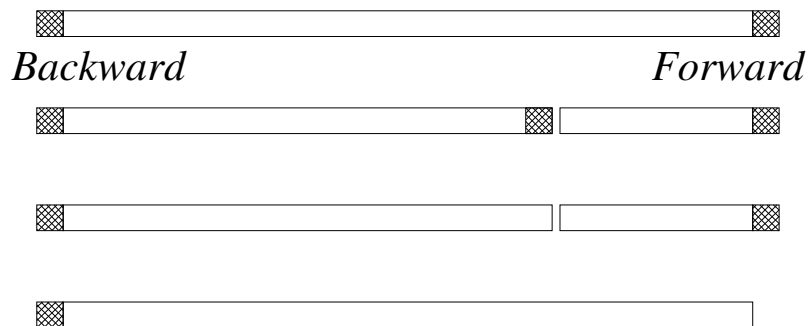
*backup slide:  $B \rightarrow K\pi, \pi\pi$*

TOP configuration	$B^0 \rightarrow \pi^+\pi^-$			$B^0 \rightarrow K^+\pi^-$		
	angular coverage %	active area %	PID effi. %	angular coverage %	active area %	PID effi. %
2-readout type	66.6	90.3	98.1	65.6	90.7	0.5
3-readout type	66.6	87.4	98.2	65.6	87.3	0.8
2-readout cylindrical	66.6	89.7	98.7	65.6	89.9	0.5
2-readout spherical	66.6	89.7	98.8	65.6	89.9	0.9
1-readout cylindrical	66.6	90.3	97.6	65.6	90.7	1.1
1-readout spherical	66.6	90.3	97.9	65.6	90.7	1.4



## *backup slide: TOP configurations*

- ◆ Different geometry configurations studied; parameters according to *sBelle Design Study Report*
- ◆ Quartz bars (18 segments in  $\phi$  at  $R = 118$  cm)
  - ▷ dimensions: 261 cm  $\times$  40 cm  $\times$  2 cm
  - ▷ non-splitted or splitted at  $47.8^\circ$
  - ▷ with cylindrical or spherical mirror
- ◆ MCP-PMT's:
  - ▷ GaAsP, >400 nm filter, 35% collection efficiency
  - ▷ 4  $\times$  4 pads; pad size 0.55 mm
  - ▷ PMT size 27.5 mm  $\times$  27.5 mm
  - ▷ 14 pieces fitted to Q-bar exit window



2-readout type

3-readout type

2-readout focusing type

1-readout focusing type