TDCPV in B -> K_L J/Psi with release-00-08-00/gbasf2

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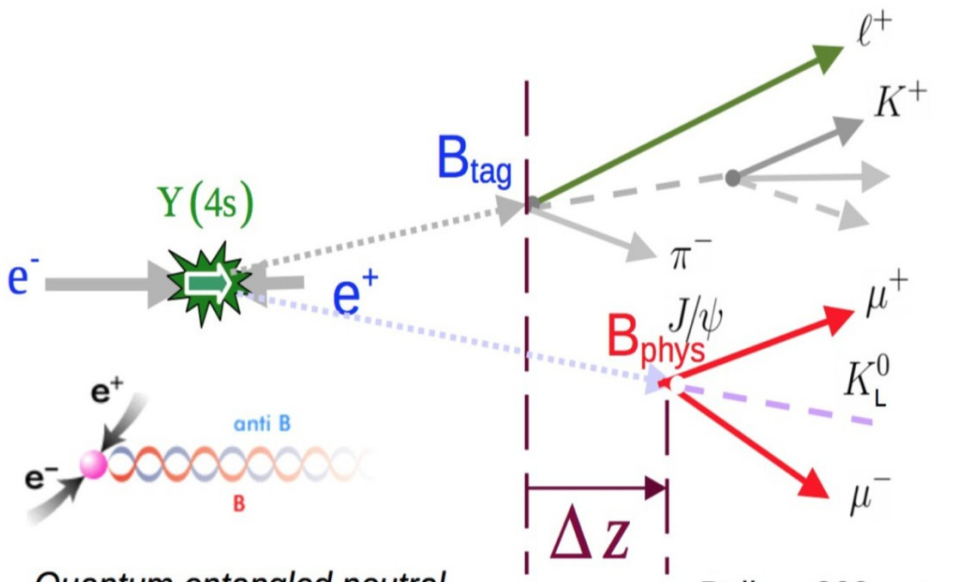
Analysis basics

$$\Delta t = \frac{\Delta z}{\beta \gamma c}$$

Resolution on Δt will be dominated by the resolution of the tagging side vertex

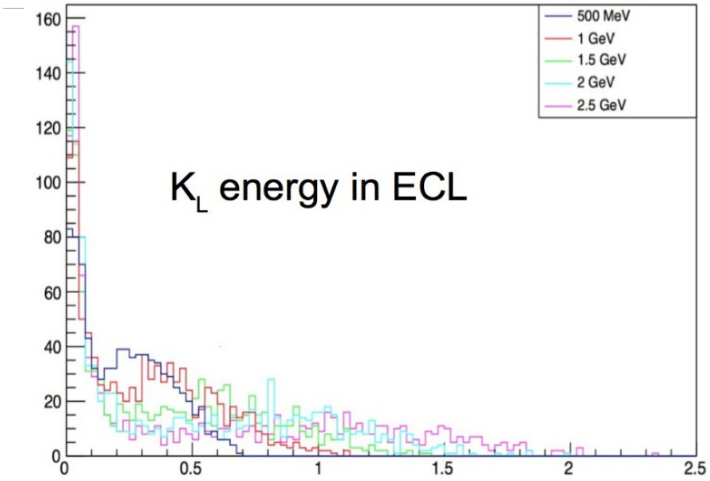


Quantum entangled neutral B meson pair production

Belle ~ 200 μm
Belle II ~ 130 μm

Δt probability parametrization $\mathcal{P}(\Delta t, q) = \frac{e^{-|\Delta t|/\tau_{B^0}}}{4\tau_{B^0}} \left[1 + q\left(\mathcal{A}_{CP}\cos\Delta m_d \Delta t + \mathcal{S}_{CP}\sin\Delta m_d \Delta t\right)\right]$

- Complementary to B -> J/Psi K_s
- Main issue: K_L reconstruction
- Benchmark channel for early run 3 data !

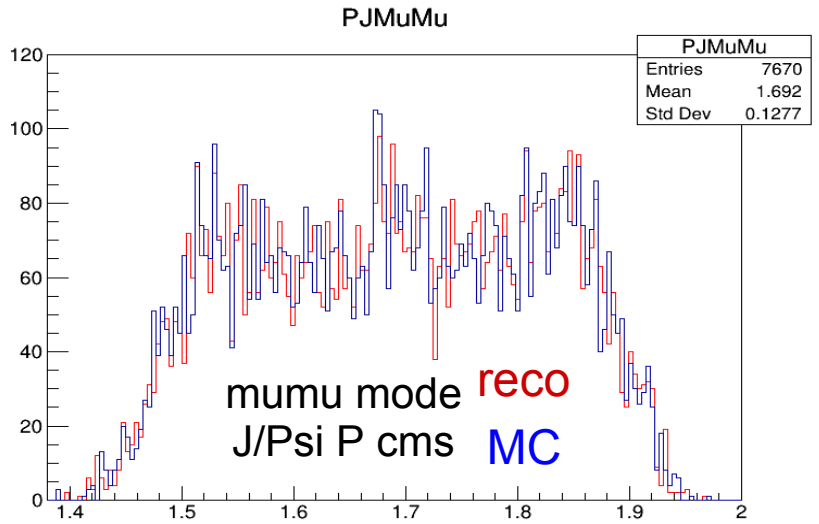


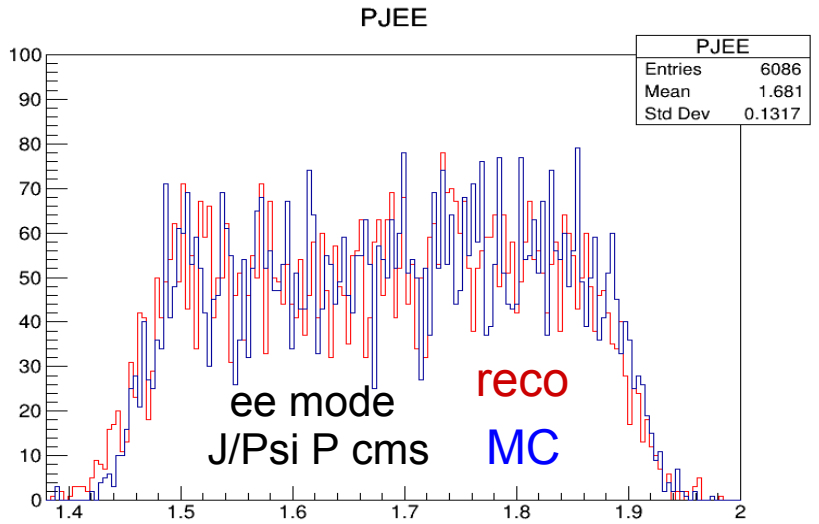
Analysis basics (2)

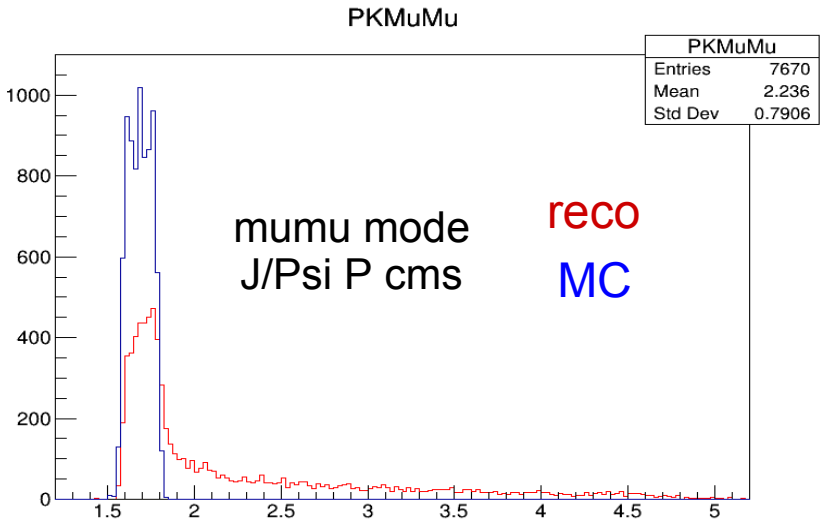
- Analysis tuned & code tested on release-00-08-00 @ KEKCC
  then adapted to gbasf2
- Use J/Psi -> e e, J/Psi -> mu mu (stdLooseMu, stdLooseE)
- Use std K_L0 list (KLM)
- Preliminary selection:
  - Rave Vertex J/Psi: $3.0 < M_{J/Psi} < 3.15$ GeV/c^2
  - Recalculate K_L and B momenta from reconstructed K_L direction constraining nominal K and B mass
  - Reconstruct ROE
  - Apply: TagV (+ FlavorTagger, not used yet)

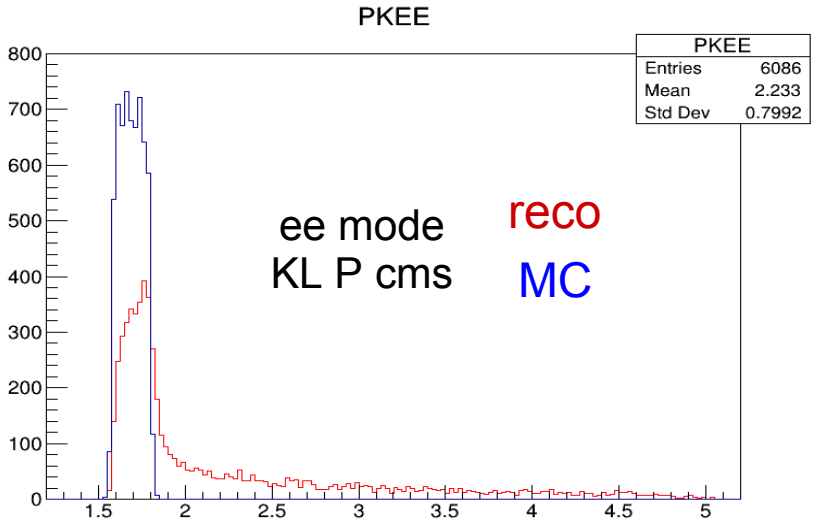
Reconstruction

- 10000 signal events for each: J/Psi -> e e, J/Psi -> mu mu



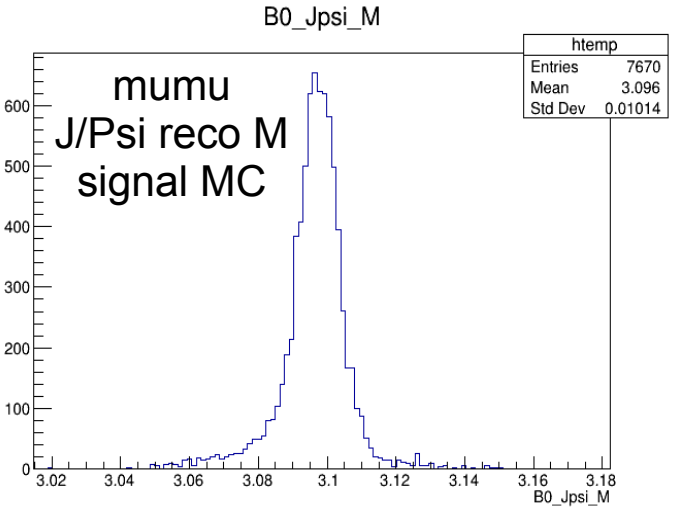


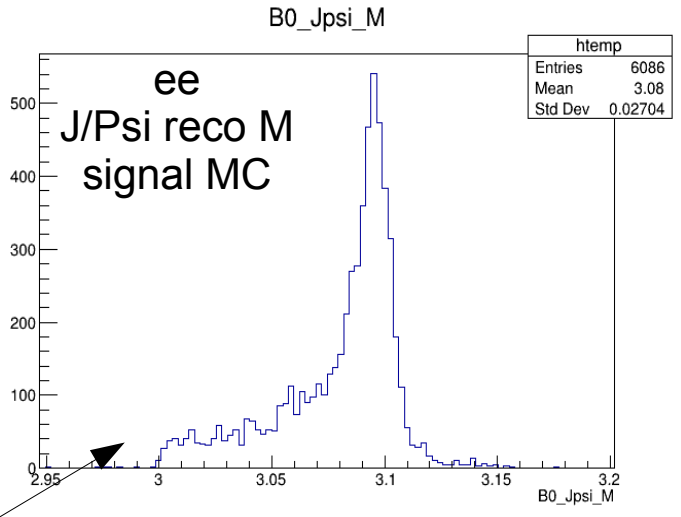




Full selection

- Final selection:
  - Take best B^0 candidate per event from vertex fit
  - M_JPsi: 3.08 < M < 3.12 (mu mu), 3.0 < M < 3.12 (mu mu)
  - PID(e,mu) > 0.9 both candidates
  - Pcms_JPsi: p > 1.6
  - Pcms_K_L0: 1.5 < p < 2.0
  - M_bc > 5.27 (mu mu), 5.26 (e e)
  - |DeltaE| < 0.01



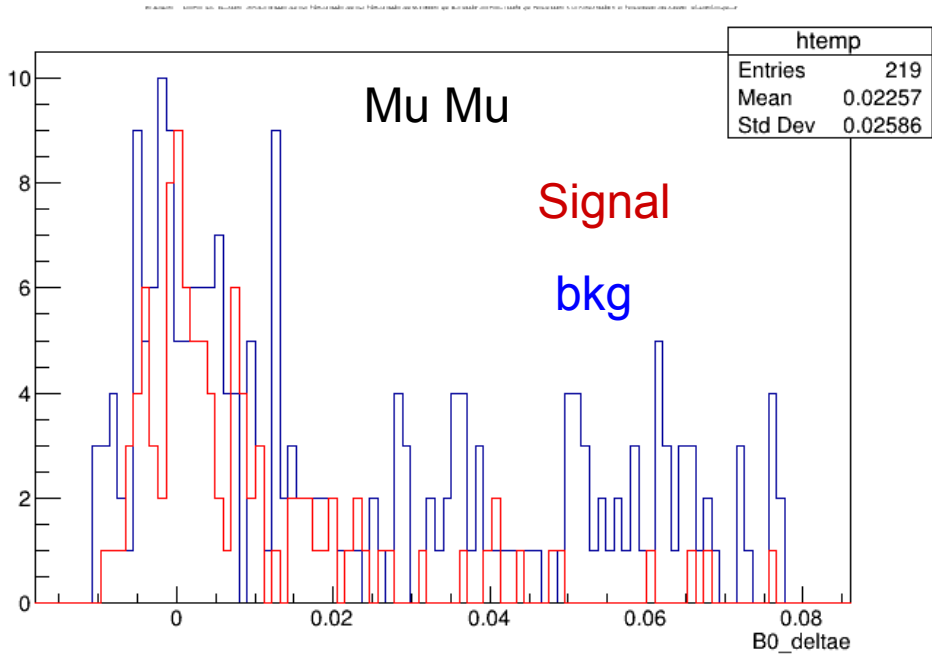


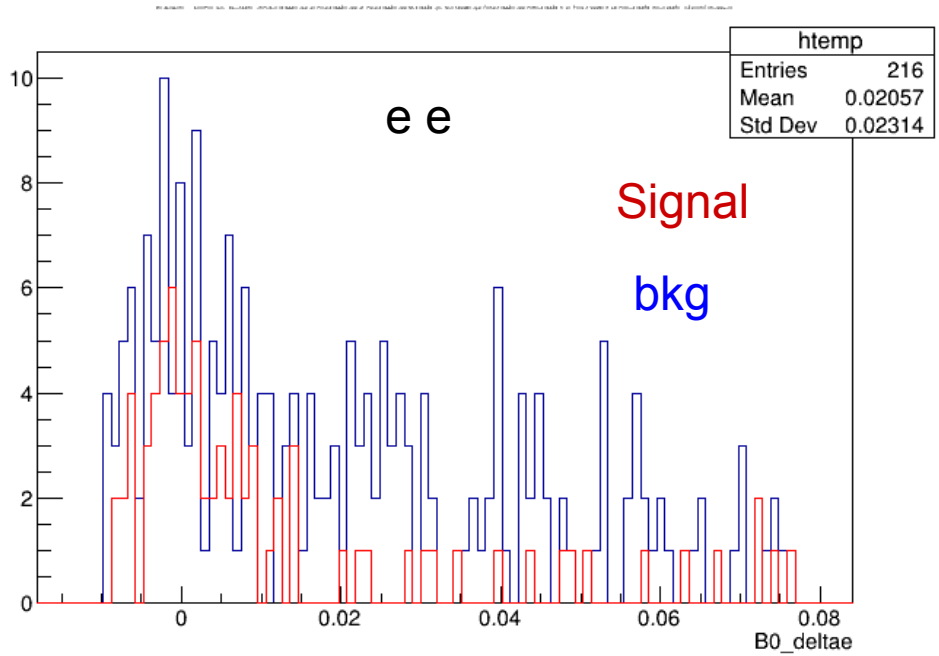
Bremsstrahlung tail

DeltaE

- ~14M generic $B^0\overline{B}^0$ events, corresponding to ~28 fb^{-1}
- std Belle .dec decay file

All cuts applied except DeltaE and M_{bc} (M_{bc}>5.2)





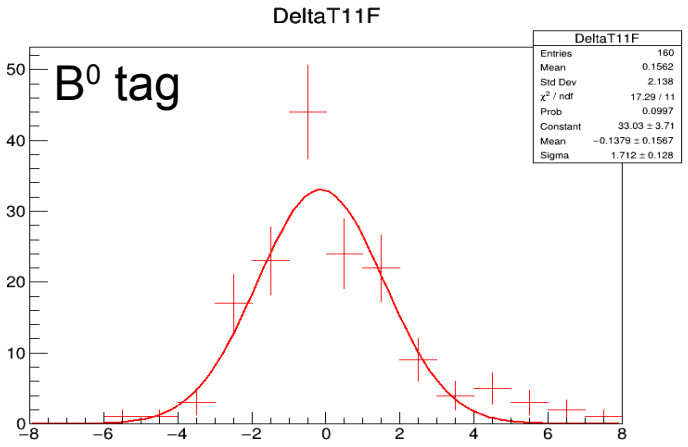
Final efficiencies (w all cuts applied): mu mu: 8.3%
e e: 7.9%

Yields comparison

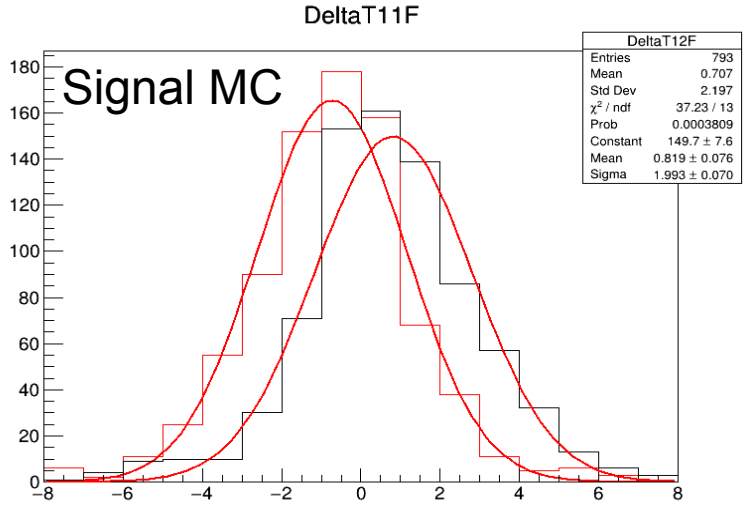
	BaBar 1*	BaBar 2**	Belle***	This	This, sum
Luminosity (fb^-1)	23	32	29	~28	~28
Candidates (both LFs)	256	273	569	170 (mu mu) 152 (e e)	322
Purity (%)	39	51	61	42 (mu mu) 37.5 (e e)	40
Yield/fb^-1	11.1	8.5	19.6	7.2 (mu mu) 7.6 (e e)	11.5
Notes	No CPV Evidence	1st CPV Evidence	1st CPV Evidence	~14M $B^0\overline{B}^0$	~14M $B^0\overline{B}^0$

*Phys.Rev.Lett.86:2515-2522,2001
**Phys.Rev.Lett.87:091801,2001
***Phys.Rev.Lett.87:091802,2001

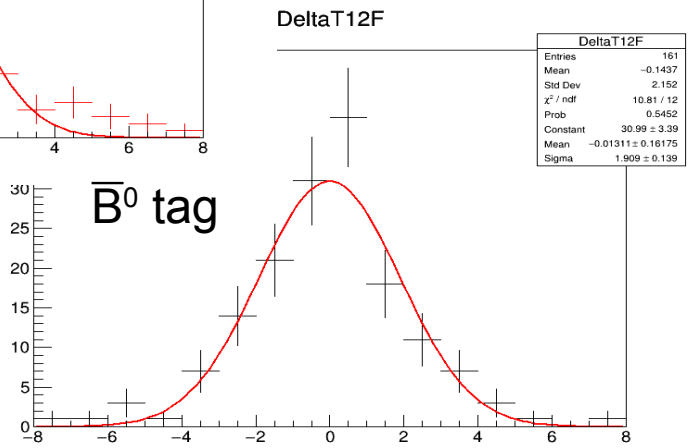
Asymmetries: first results

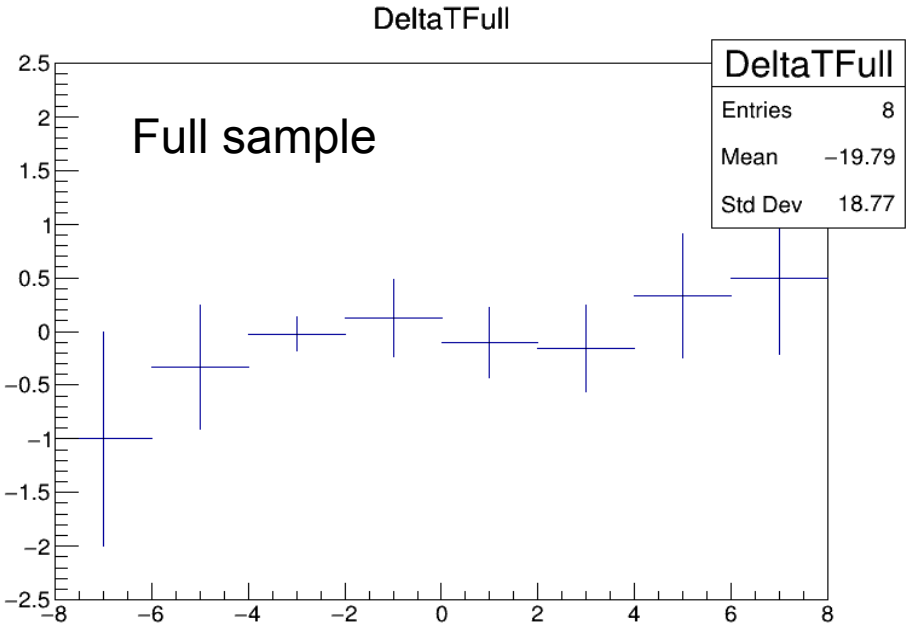


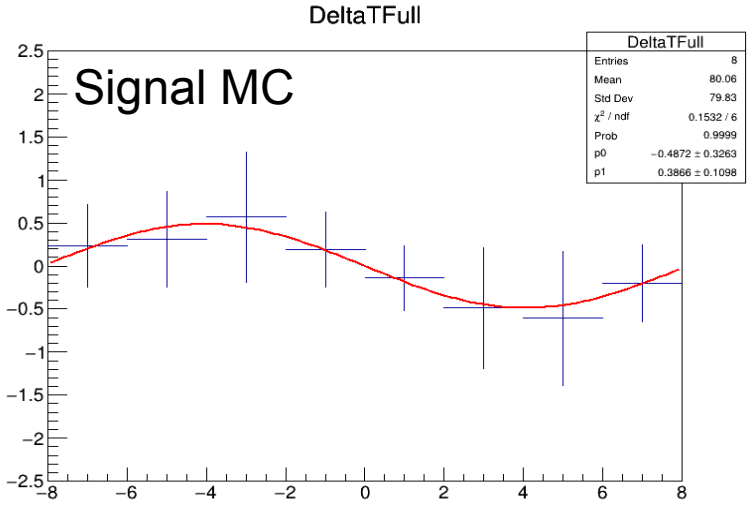
MCTag



Full sample







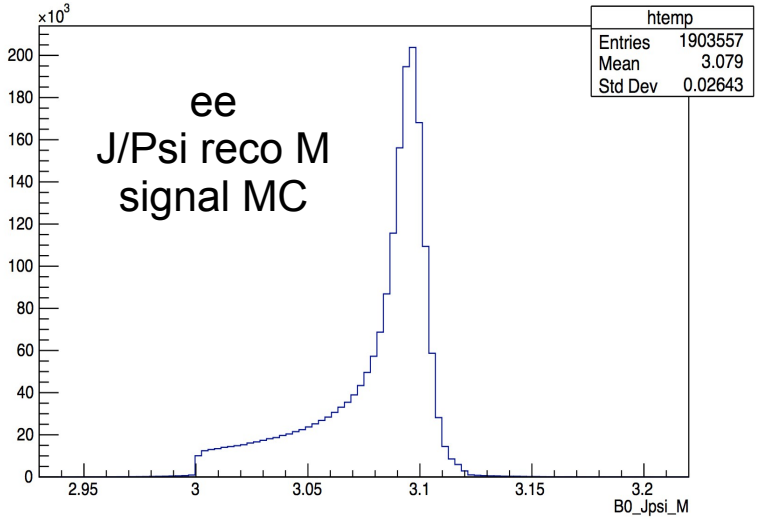
Analysis on grid

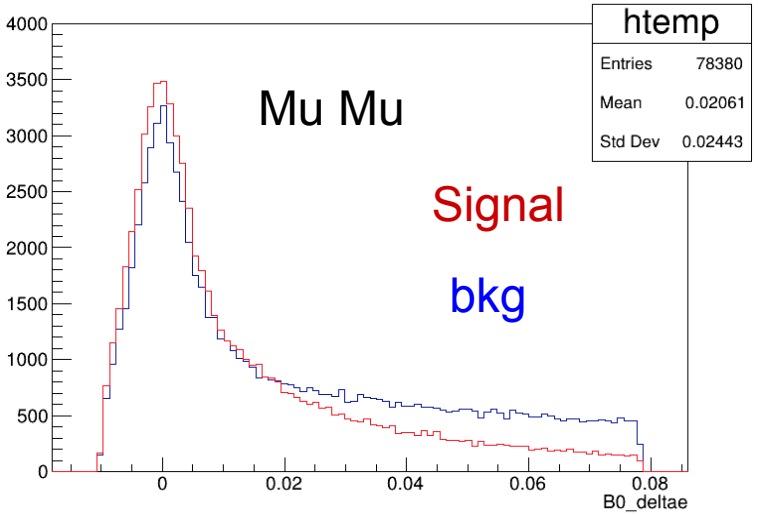
- Almost all bkg from B decays which contain a real J/Psi in final state
- Use centrally produced MC8 J/Psi cocktail, i.e. events in which one B has a J/Psi in the final state, whether as direct decay product or not, and the other B decays generically
- Instead of dedicated .dec file skim generic $B\overline{B}$ at generator level in order to get an inclusive J/Psi sample -> relatively fast and we can rely on default_Belle.dec
- ~80M events in final sample, equivalent luminosity: 48 ab^{-1}!

- The analysis includes user-defined modules which have been compiled with release8 and then linked with gbasf2 -f option
- We also cloned some default .py scripts to include the modules in std analysis path

Analysis on grid (2)

- Output looks in reasonable agreement with proto-analysis on release-00-08-00, however..

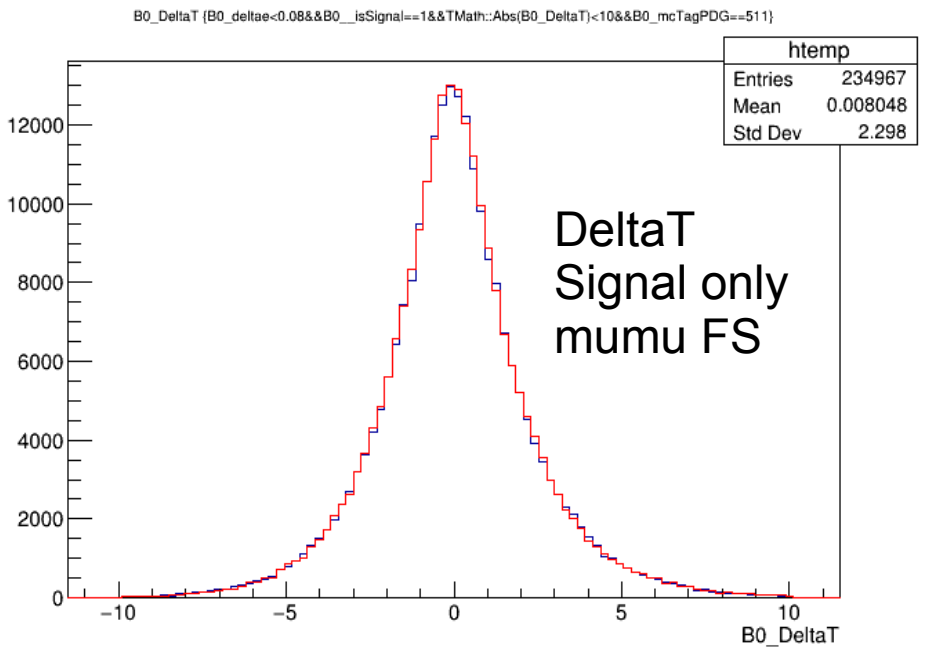


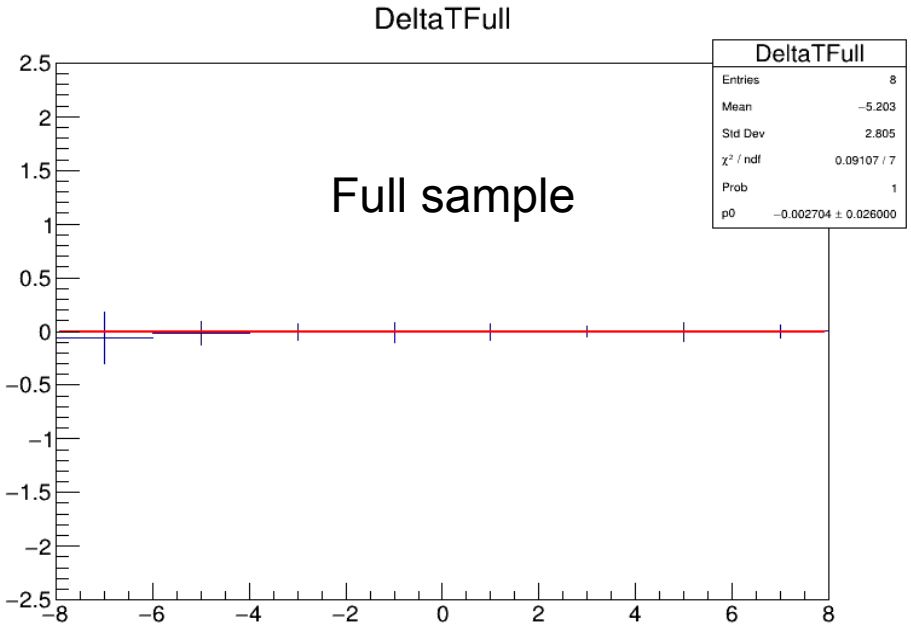


	GRID	release8
Luminosity (fb^-1)	~48000	~28
Candidates (both LFs)	532898	322
Purity (%)	50.4	40
Yield/fb^-1	11.1	11.5
Notes	~24x10^3 M $B^0\overline{B}^0$	~14M $B^0\overline{B}^0$

Analysis on grid (3)

- ..there is no CPV at all!



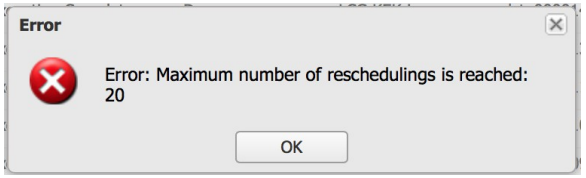


gbasf2, computing remarks

- Running the analysis is a rush, I got my 80M events done in ~1 hour w bkg (0.4 h w/o bkg), however downloading mdst to KEKCC is much slower (~5/6 hours, O(1Gb) total)
- Folder structure of MC8 production not so user friendly in our case:

  /belle/MC/release-00-08-00/DB00000208/MC8/prod00001998/s00/e0000/4S/r00000/1191820000/sub00

  Usually just 2 folders (w and w/o bkg), I had 48 folders (from 1998 to 2045, due to skimming) and for each I had to launch the job individually
- gb2_ds_get * does not work (i.e. It's bugged), I had to download every project (i.e. folder) individually
- Rescheduling function is bugged (terminal), low max limit via DIRAC



- Some (few) sites have much higher job failure rates -> makes rescheduling quite useless

49578398	Failed	Ma...	Failed Input Data ...	LCG.CESNET.cz	mdst_000012_prod00002...	2017-04-30 21:16:37
49578397	Done	Exe...	Done	LCG.CESNET.cz	mdst_000011_prod00002...	2017-04-30 17:21:04
49578396	Failed	Ma...	Failed Input Data ...	LCG.CESNET.cz	mdst_000010_prod00002...	2017-04-30 21:00:19
49578395	Done	Exe...	Done	LCG.CESNET.cz	mdst_000009_prod00002...	2017-04-30 17:12:36
49578394	Failed	Ma...	Failed Input Data ...	LCG.CESNET.cz	mdst_000008_prod00002...	2017-04-30 21:40:58

gbasf2, software remarks

- Own defined modules are quite straightforward to implement in gbasf2
- Not so straightforward how to implement user-defined quantities in NtupleTools: user variables have to be defined in analysis/VariableManager and are than linked in libanalysis.so
  -> major showstopper
- Flavor tagger does not work on grid, usual problem with weight files input

Outlook

- Analysis output looks reasonable so far
- Next steps:
  - Understand why the grid is CP-conserving
  - Use tag from FlavorTagger instead of MCTag
  - Include "K_L-crash" from ECL -> will need new NeutralCluster object
  - Refine and optimize selection cuts
- Remarks:
  - Yield difference between BaBar and Belle is puzzling,

    not yet understood (KLM?)