Science & Technology Facilities Council
Rutherford Appleton Laboratory

University of Glasgow

First year of B→hh data: impact of misalignments

Jacopo Nardulli & Eduardo Rodrigues

Outline

- → *Alignment issues [Will treat only B→ππ]*
- →*0.01/fb*
- →*0.1/fb*
- →*0.5/fb*
- →*What is needed & conclusions*
- →*Ongoing studies*

Statistics roughly corresponding to 0.01, 0.1 and 0.5/fb

To produce sets corresponding to 0.01, 0.1 and 0.5/fb we run on $B_d \rightarrow \pi\,\pi$ DSTs.

At the end we have three sets

→1 set with ~0.01/fb

→1 set with ~0.1/fb

→1 set with ~0.5 /fb

[In DC04 the annual yield was ~36k events, for 2/fb]

We repeat this three times:

Perfect, Software and Hardware alignment

Number of events

	0.01/fb	0.1/fb	0.5/fb (not enough statistics)
Perfect Alignment	205	2093	7339
Software Alignment	166	1429	5322
Hardware Alignment	93	487	551

Why ?
Pattern recognition efficiency

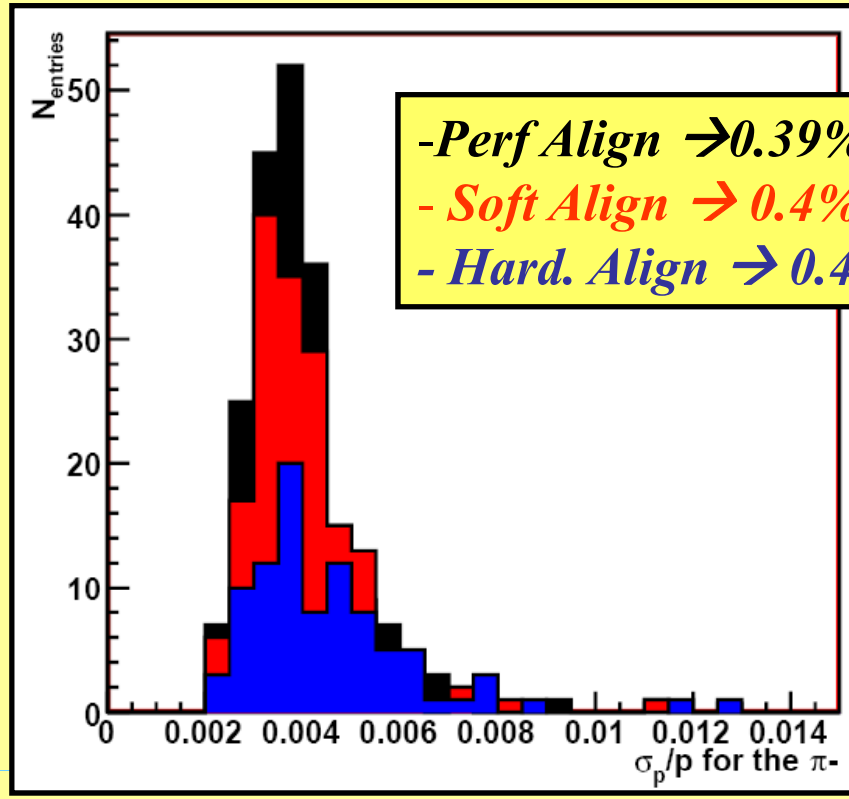
Perfect Alignment	$\varepsilon_{Forward}$ ~ 86% ε_{Match} ~ 81%	ε_{Velo3D} ~ 97%
Software Alignment	$\varepsilon_{Forward}$ ~ 20% ε_{Match} ~ 78%	ε_{Velo3D} ~ 97%
Hardware Alignment	$\varepsilon_{Forward}$ ~ 13% ε_{Match} ~ 55%	ε_{Velo3D} ~ 86%

- *PR efficiencies for "long" tracks*
- *The degradation in finding efficiency is dramatic!*
- *Forward and Match both provide long tracks*

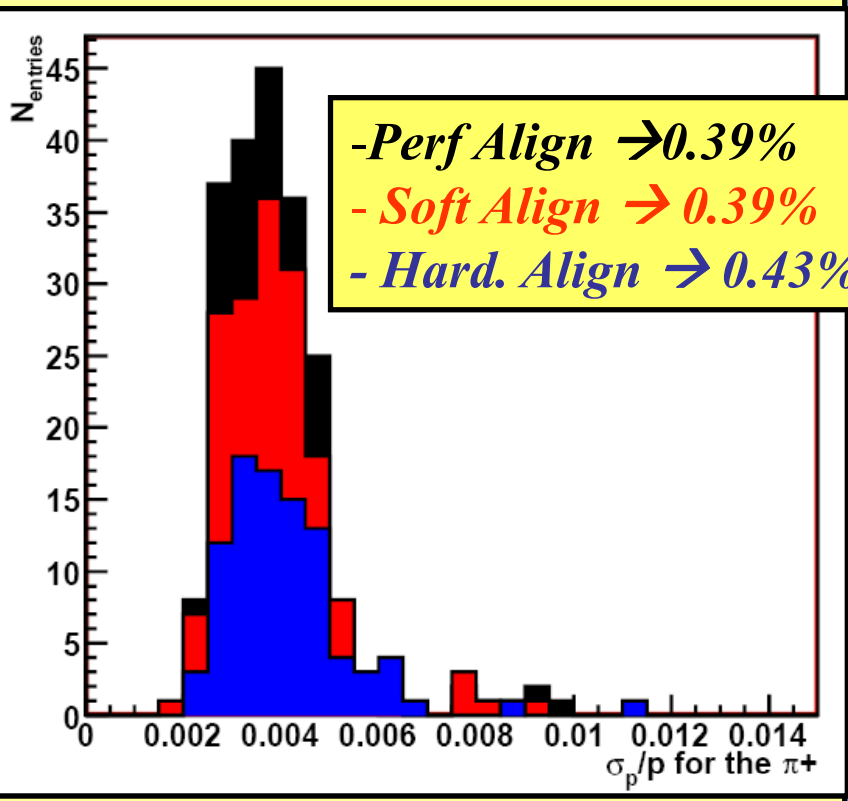
→ *Main drop from software to hardware alignment*

0.01/fb

σ_p/p

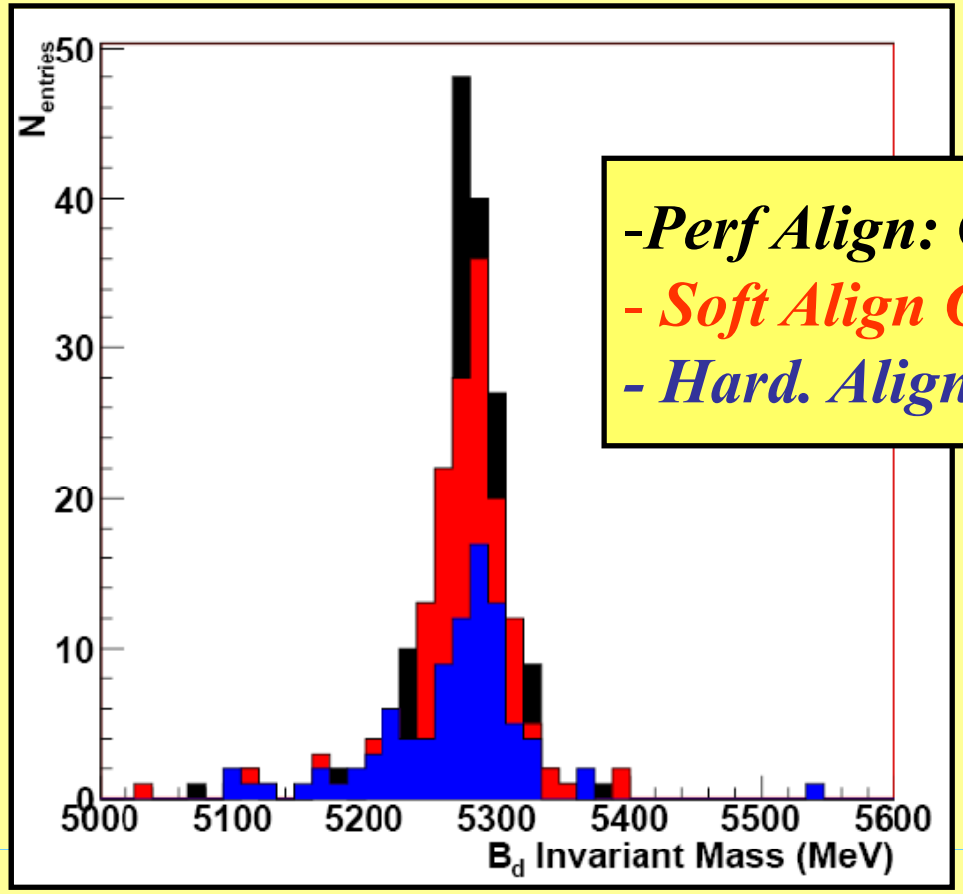


-Perf Align →0.39%
- Soft Align → 0.4%
- Hard. Align → 0.46%



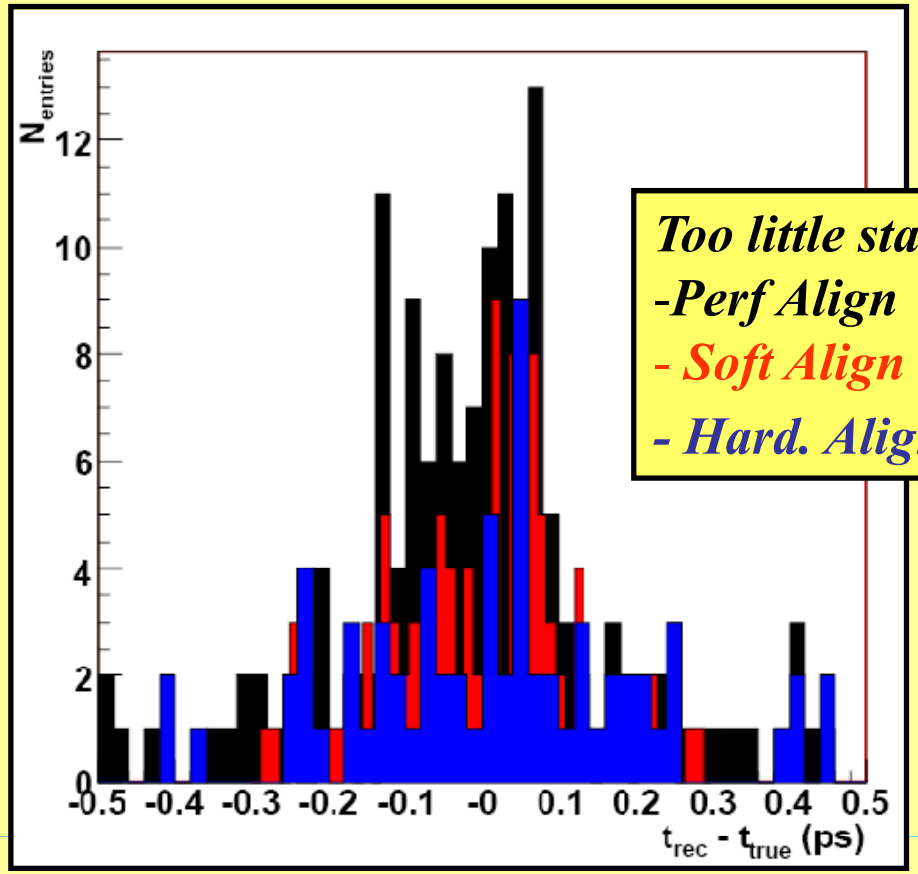
-Perf Align →0.39%
- Soft Align → 0.39%
- Hard. Align → 0.43%

0.01/fb
Mass distribution



-Perf Align: Gauss σ → 23MeV
- Soft Align Gauss σ → 25MeV
- Hard. Align Gauss σ → 36 MeV

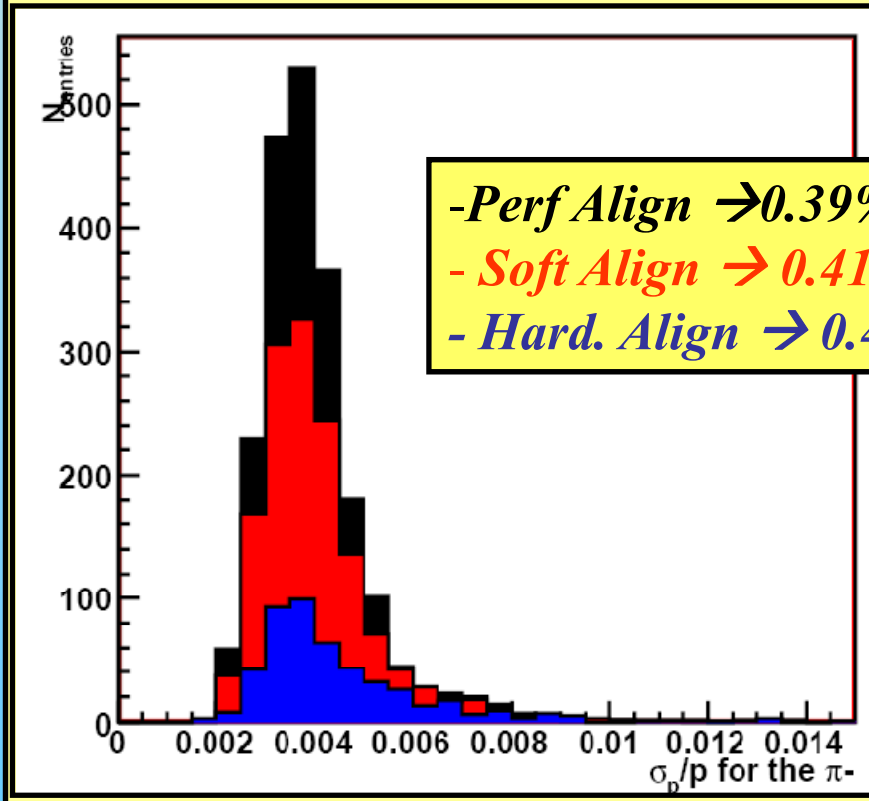
0.01/fb
Proper time



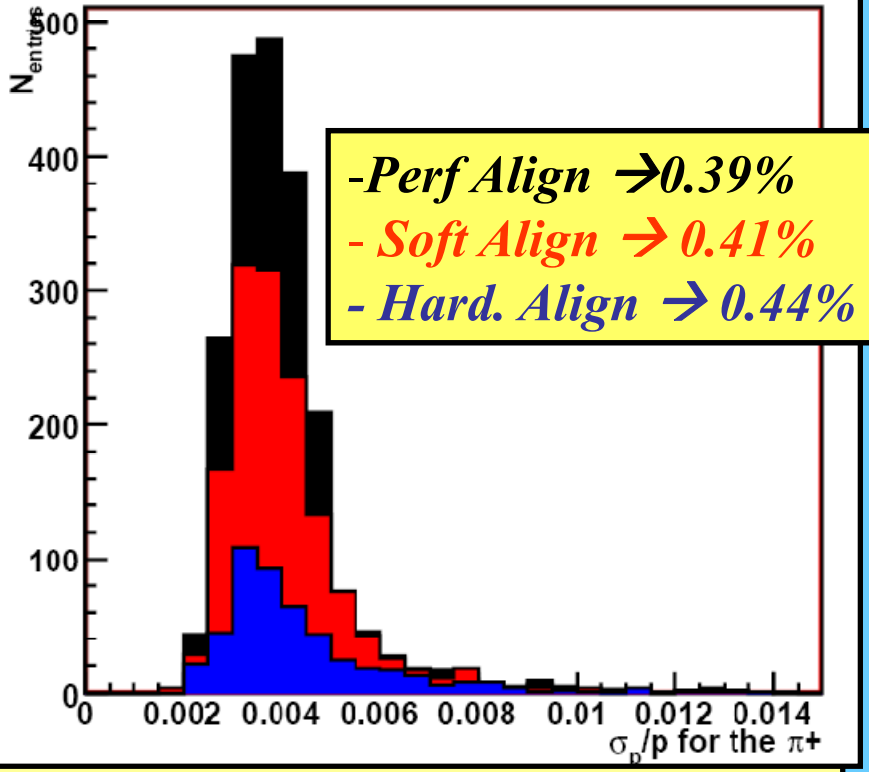
Too little statistics to perform fit
-Perf Align
- Soft Align
- Hard. Align

0.1/fb

σ_p/p

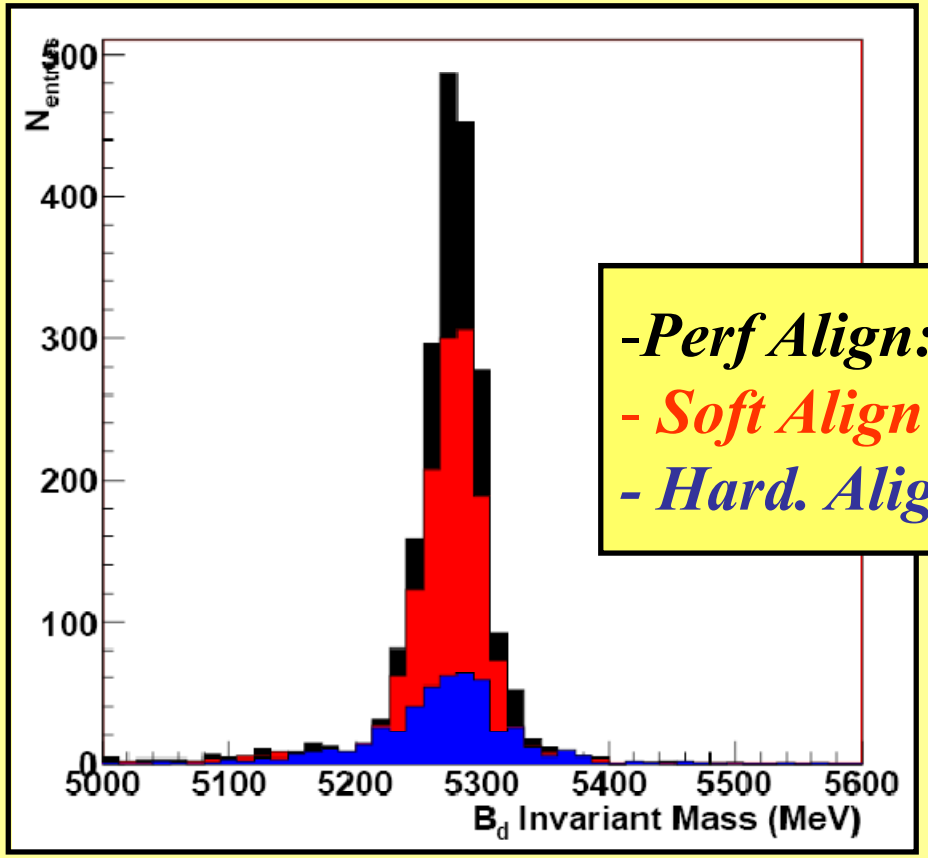


-Perf Align →0.39%
- Soft Align → 0.41%
- Hard. Align → 0.46%



-Perf Align →0.39%
- Soft Align → 0.41%
- Hard. Align → 0.44%

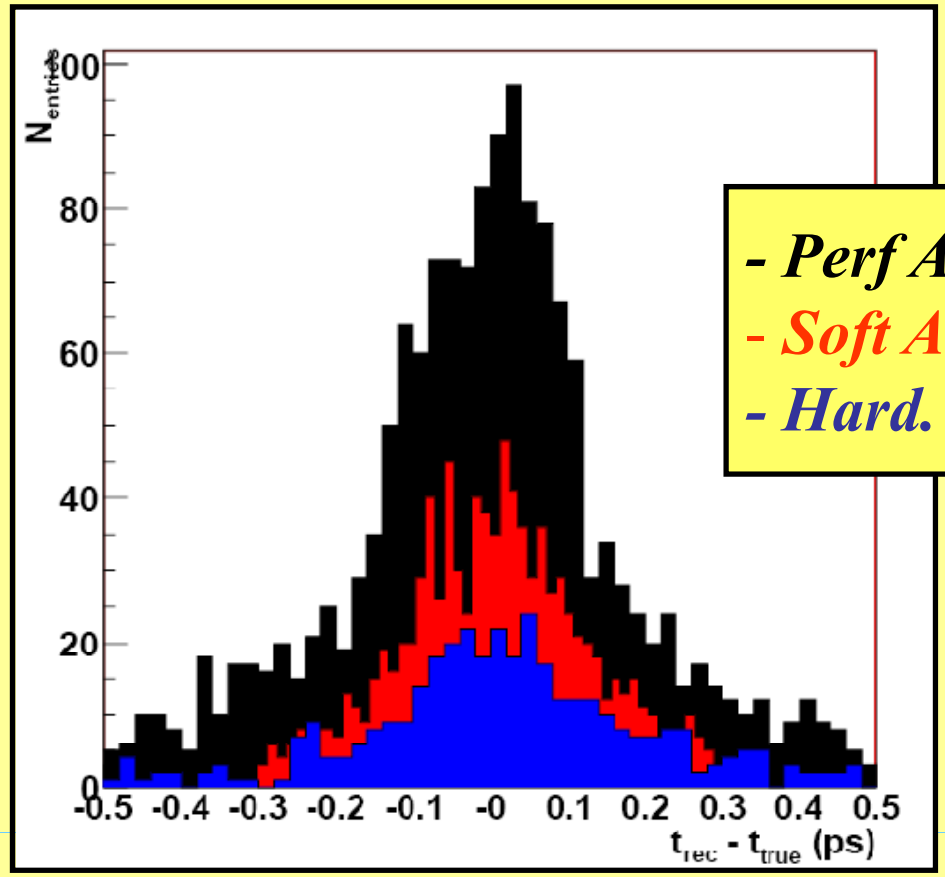
0.1/fb
Mass distribution



-*Perf Align: Gauss σ → 23MeV*
- *Soft Align Gauss σ → 25MeV*
- *Hard. Align Gauss σ → 43 MeV*

0.1/fb

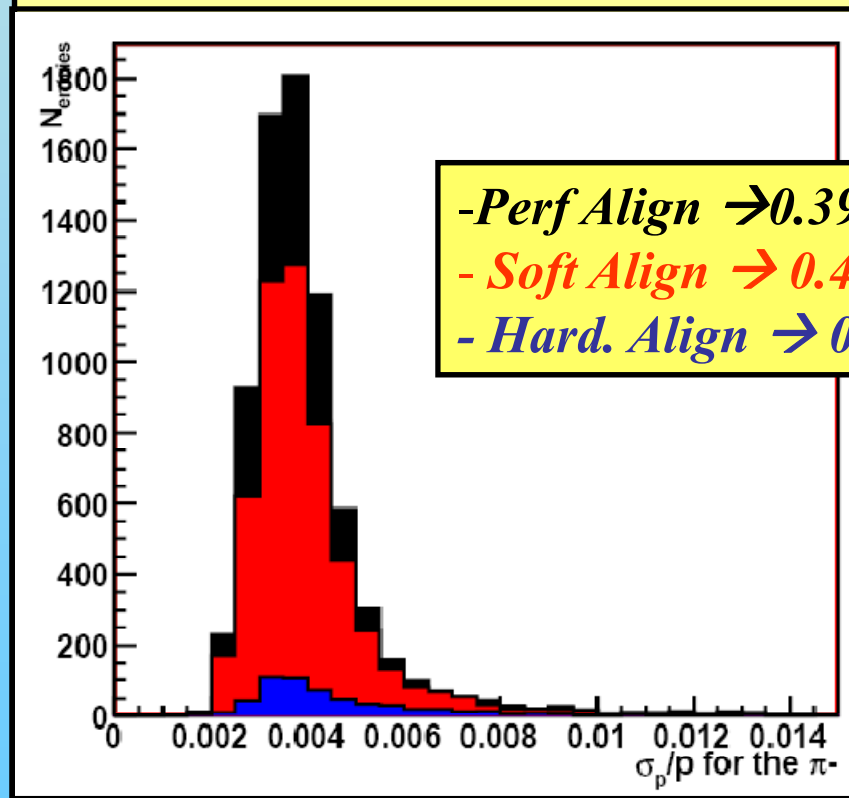
Proper time



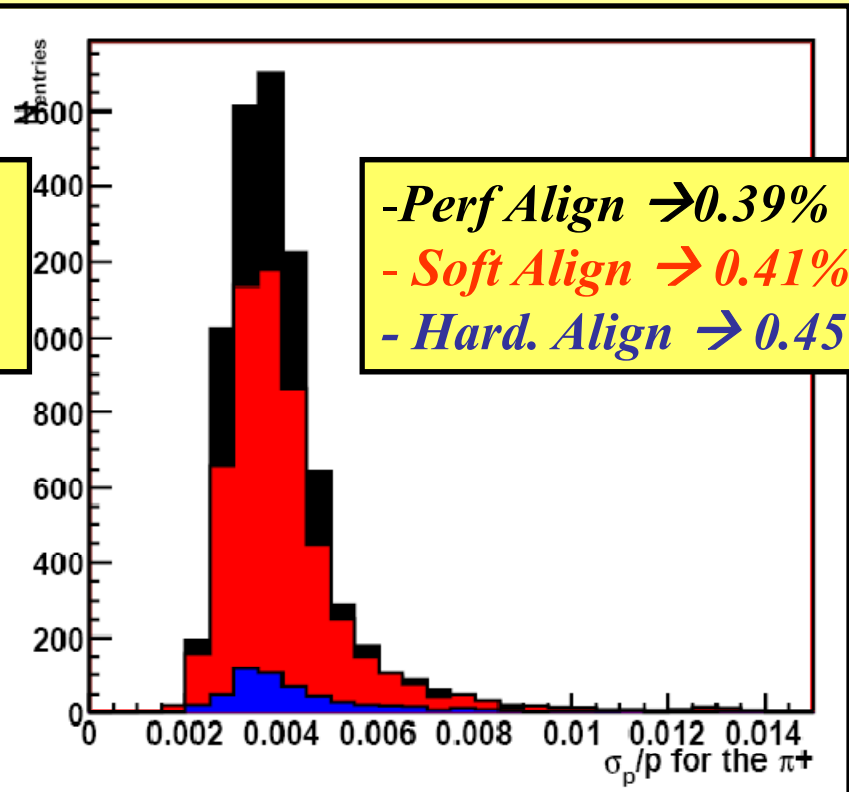
- *Perf Align*
- *Soft Align*
- *Hard. Align*

0.5/fb

σ_p/p

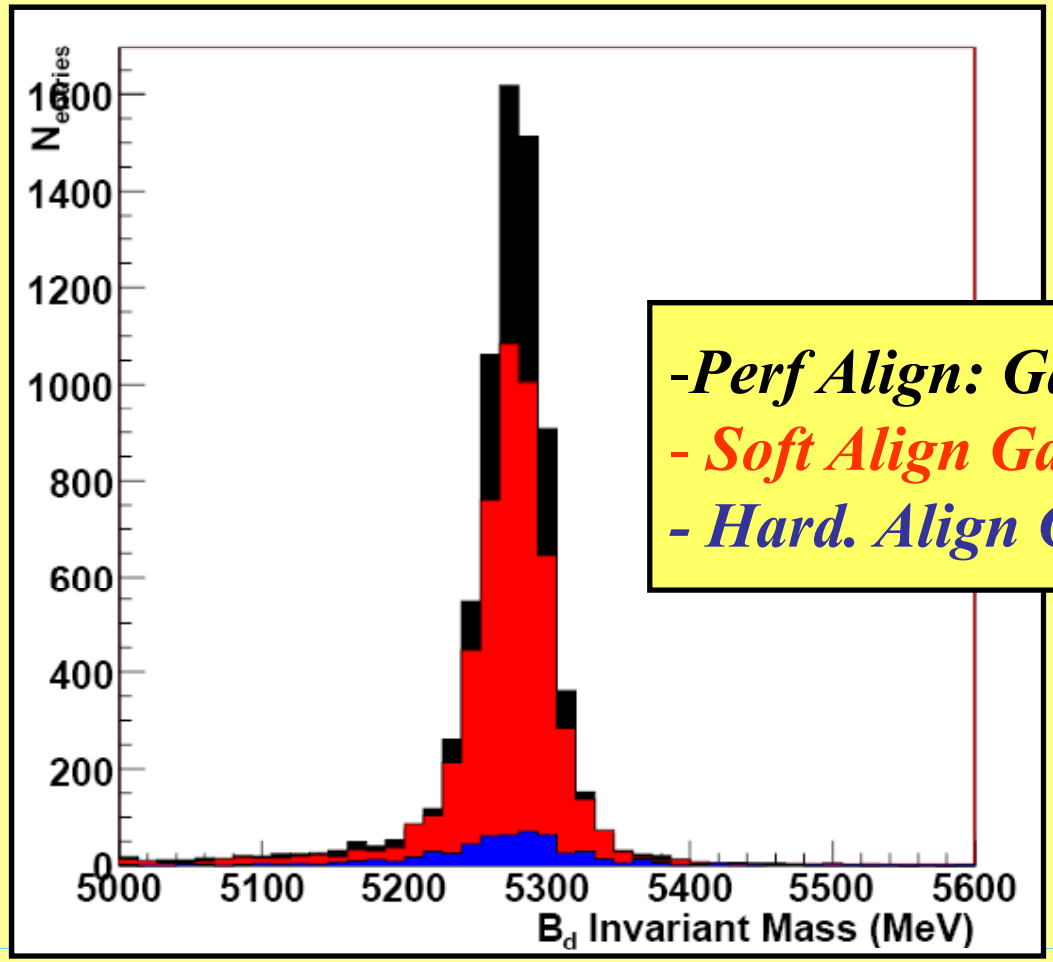


-Perf Align →0.39%
- Soft Align → 0.41%
- Hard. Align → 0.46%



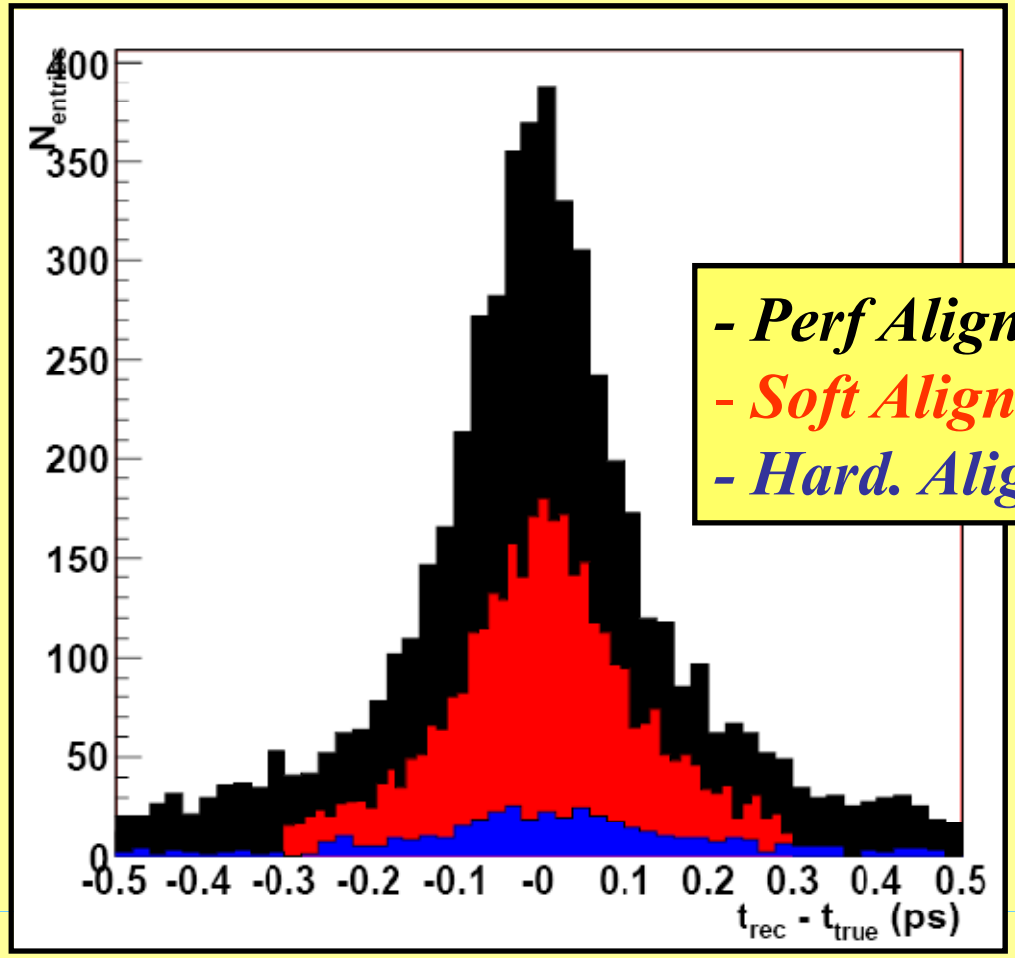
-Perf Align →0.39%
- Soft Align → 0.41%
- Hard. Align → 0.45%

0.5/fb
Mass distribution



-*Perf Align: Gauss σ → 23MeV*
- *Soft Align Gauss σ → 26MeV*
- *Hard. Align Gauss σ → 43 MeV*

0.5/fb
Proper time



- *Perf Align*
- *Soft Align*
- *Hard. Align*

Outlook

- *What happens to the physics ?*

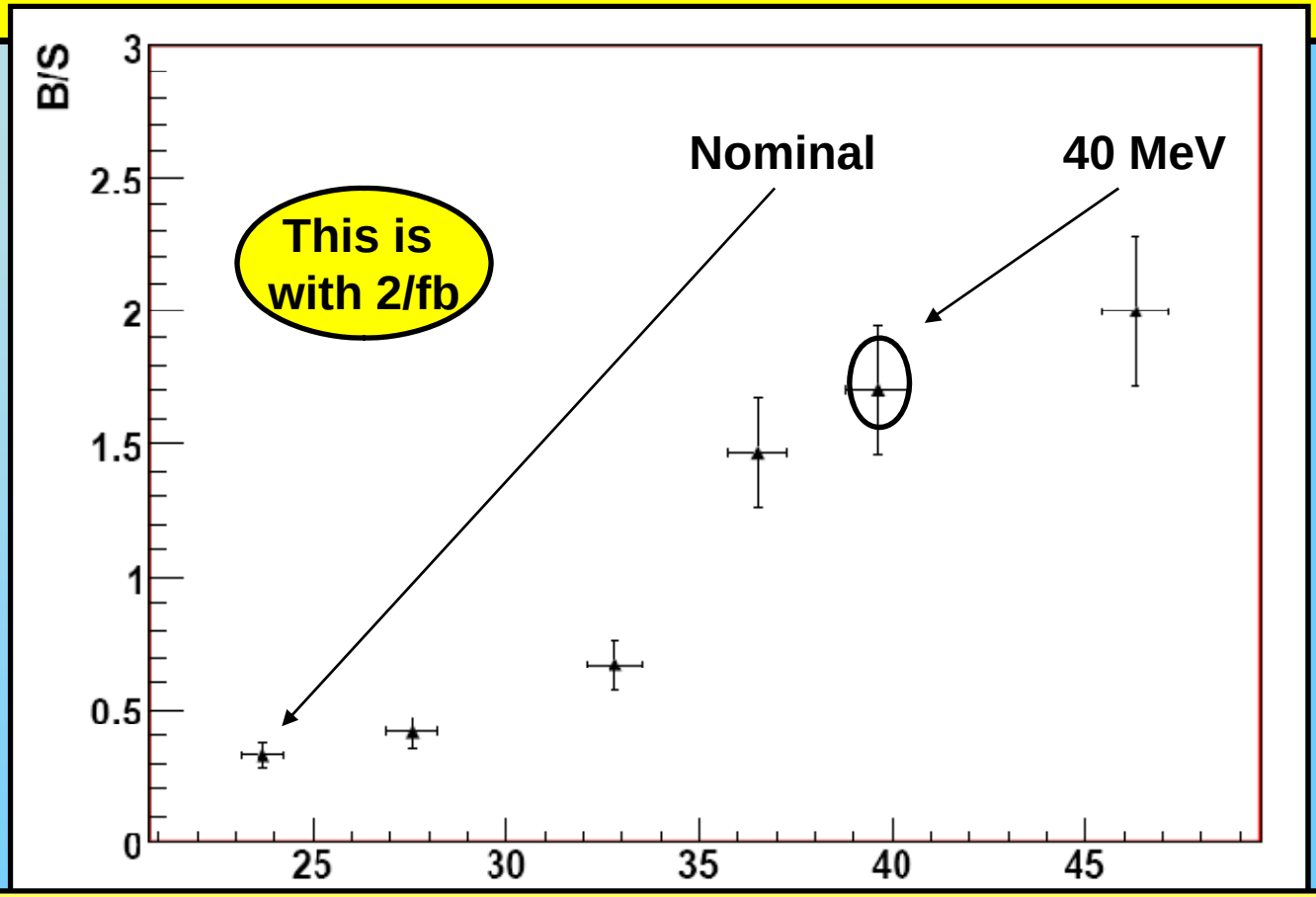
- *Main problem is significant loss of events*
  → some tracks can probably be recovered with flexible PR algorithms (e.g. Match vs. Forward PR)
- *Momentum and mass resolutions degrade fast as well*

- *Software alignment :*
  → If we achieve the precisions we quote, reconstruction and physics performance suffer little
- *Hardware alignment :*

→ Mass resolution ~40 MeV is a very serious issue

→ see $B_s \rightarrow \pi K$ as an example

$B_s \rightarrow \pi K$



- *Signal :$B_s \rightarrow \pi K$*
- *Background : $B_d \rightarrow \pi K$,*

  separation only through mass resolution
- *Plot made through smearing studies*

Ongoing studies

J. Nardulli/E. Rodrigues/M.Gersabeck

- *Start with misalignments on the $B_d \rightarrow \pi\pi$*
  - *Start to look at effects on momentum/mass [IT/OT]*
  - *proper time [VELO]*
  - *Combined effects of Velo/T-Station misalignments*
- *Cross-check with other decays (Bs $\rightarrow \pi K$)*
- *Look at B/S ratio*
- *Effects on CP sensitivity*
- *Final effects after introducing (software) re-alignment*

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Spares

Alignment details

- Software/Hardware alignments are 1/5 sigma
- Sigma:
  - VELO : 3 / 3 / 10 μm --- 1.0 / 1.0 / 0.3 mrad
  - OT : 50 / 0 / 100 μm --- 0.1 / 0.1 / 0.1 mrad
  - IT : 15 / 25 / 50 μm --- 0.1 / 0.1 / 0.1 mrad

Alignment details

- IT/OT Misalignment for layers
- Velo Misalignments for sensors

- Gaussian misalignments with a defined sigma for layers/sensors

Why ?
Pattern recognition efficiency

Perfect Alignment	$\varepsilon_{Forward}$ ~ 86%	ε_{Velo3D} ~ 97%
	ε_{Match} ~ 81%	ε_{Best} ~ 97%
Software Alignment	$\varepsilon_{Forward}$ ~ 20%	ε_{Velo3D} ~ 97%
	ε_{Match} ~ 78%	ε_{Best} ~ 96%
Hardware Alignment	$\varepsilon_{Forward}$ ~ 13%	ε_{Velo3D} ~ 86%
	ε_{Match} ~ 55%	ε_{Best} ~ 87%

- *PR efficiencies for "long" tracks*
- *The degradation in finding efficiency is dramatic!*