

Study of Acceptance Effects in Angular Analysis at Belle II Experiment

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Our Goals

The aim of our project is to study how acceptance effects can impact on measurement of polarization effects in $B \rightarrow D^* h$ ($h = \pi, K^*, \rho$) decays.

Our workflow:
Baf2-software and analysis framework
Reconstruction module
Git repository

Introduction

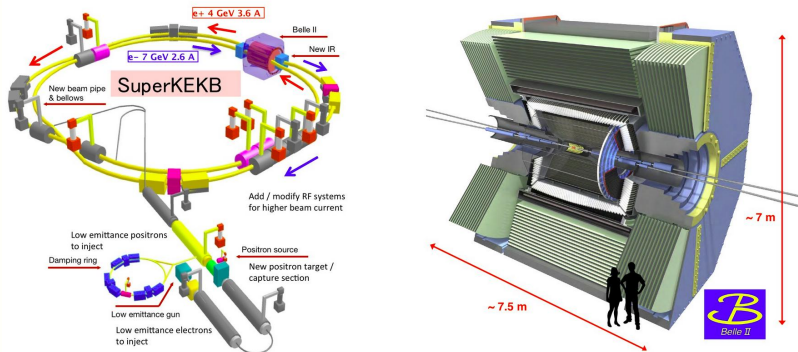


Fig.1 The Belle II detector scheme

Helicity and Polarization

Helicity h of a particle with spin J means its spin projection along its momentum.

In decays $B \rightarrow W$ three polarization states contribute, A_0 responsible for longitudinal, A_{-1}, A_{+1} - for transverse.

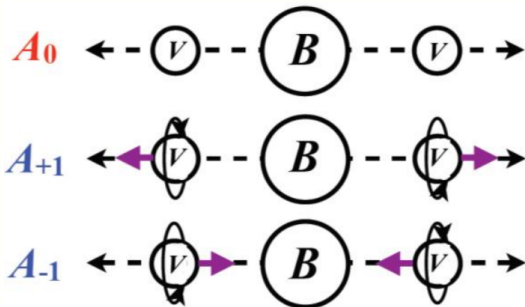


Fig.2 The directions of spin and momentum of daughter particles.
B - scalar particle

Helicity Angles

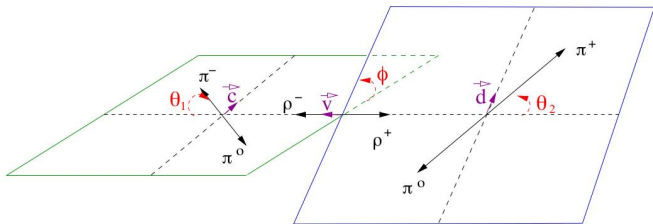


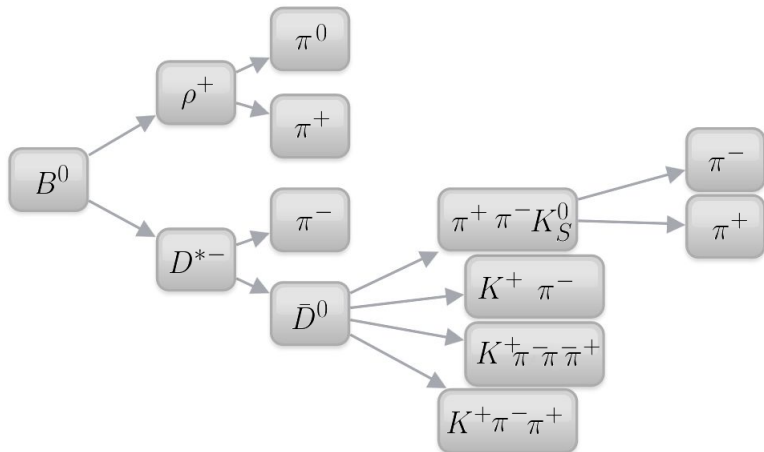
Fig.3 The angles θ_1, θ_2, ϕ defined in the helicity basis, shown in the example $B \rightarrow \rho^+ \rho^-$

For this case the differential decay rate is given by:

$$\frac{1}{\Gamma} \frac{d^2\Gamma}{d\cos\theta_1 d\cos\theta_2} = \frac{9}{4} (f_L \cos^2\theta_1 \cos^2\theta_2 + (1 - f_L) \sin^2\theta_1 \sin^2\theta_2)$$

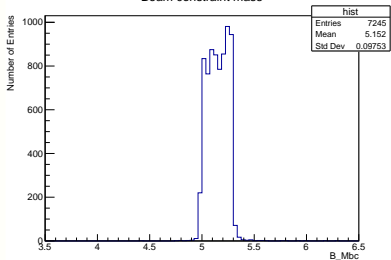
where f_L is fraction of longitudinal polarization.

Chain of reconstruction

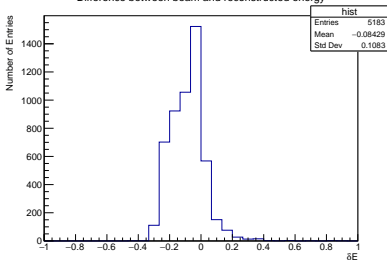


Reconstruction

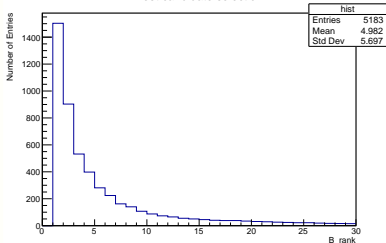
Beam constraint mass



Difference between beam and reconstructed energy



Best candidate selection

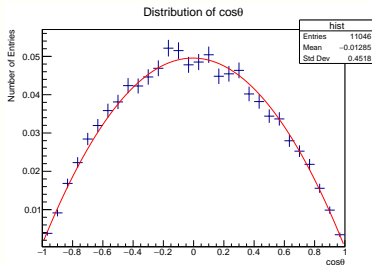
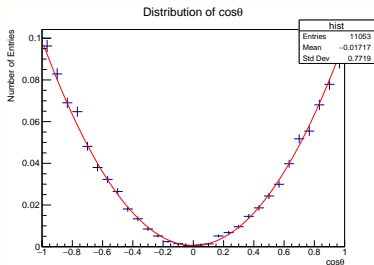


$$B_{rank} == 1$$

$$M_{bc} > 5.2 \text{ GeV}$$

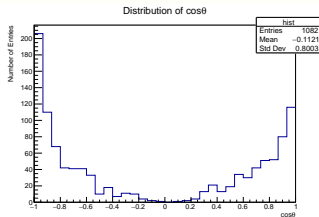
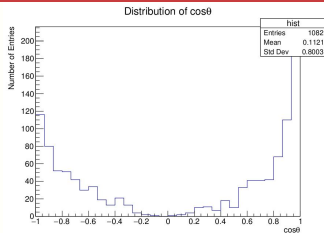
$$|\Delta E| < 0.2 \text{ GeV}$$

Generator level

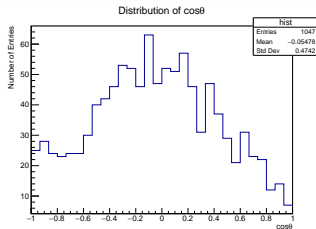
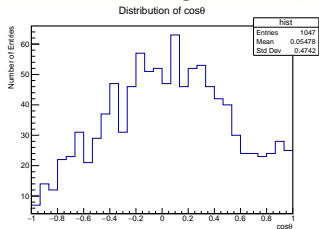


Helicity angles, longitudinal and transverse polarization correspondingly

After detector

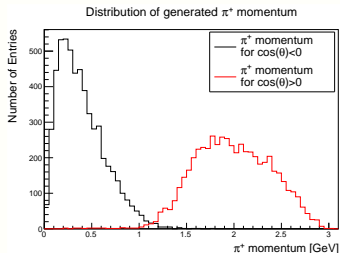
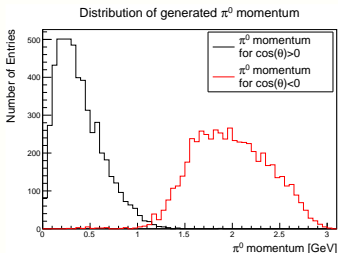


Longitudinally polarized, π^+ vs π^0

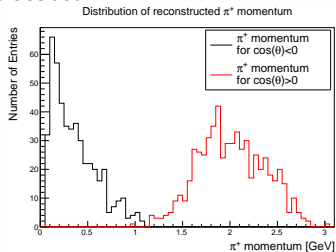
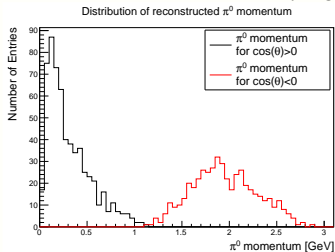


Transversally polarized, π^+ vs π^0

100% longitudinal polarize state

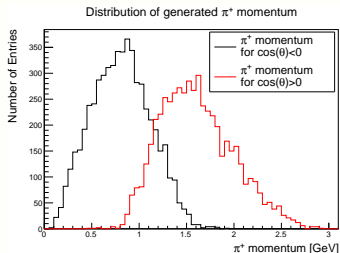
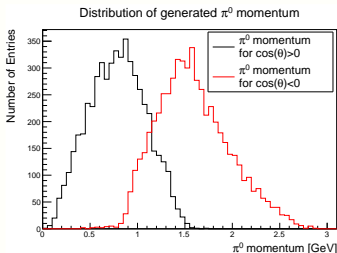


1. Before detector

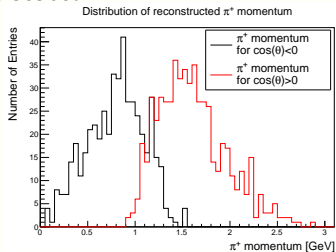
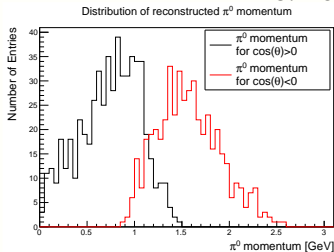


2. After detector

100% transverse polarize state



3. Before detector



4. After detector

Summary

- We prepared module for reconstruction and started validation of distributions.
- Efficiency of reconstruction seems acceptable to measure angular distributions.
- Acceptance effect should be stronger in sample which contains higher fraction of longitudinal polarization.

References



The Physics of the B Factories, Ed. A.J. Bevan, B. Golob, Th. Mannel, S. Prell,
and B.D. Yabsley

*Eur Phys J. C*74 (2014) 3026

Some bugs

```
baef2 in [6]: import pdg  
  
baef2 in [7]: whatisthis = pdg.get(-11)  
  
baef2 in [8]: print(whatisthis.GetName(), whatisthis.Charge())  
e+ 3.0
```

rhoplus_cosHelicityAngle

