Karlsruhe Institute of Technology

Status report for sensitivity studies of $B^0 \to K^0_s K^0_s K^0_s$

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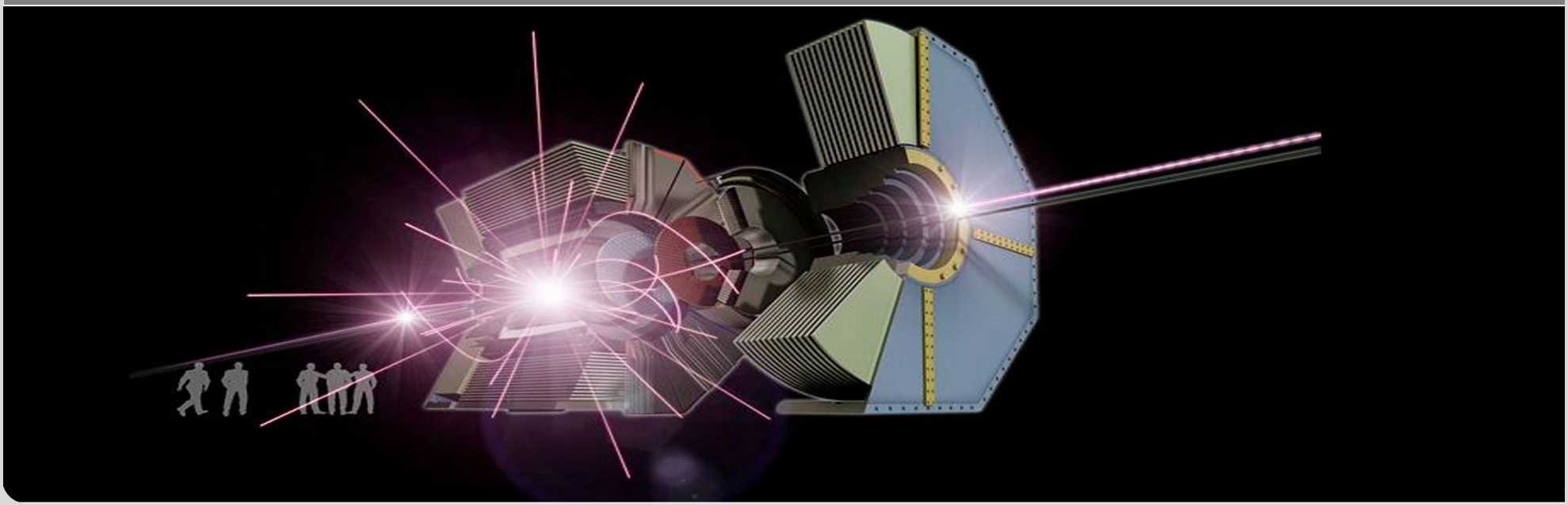


Motivation

- First part of my thesis: set up K_s^0 training and selection.
- Do we want experiment wide ”standard-cuts” and particle lists?
- General cuts (like BDToutput on Figure of Merit) might not be optimized for a specific measurement $\rightarrow$ continue with analysis driven approach.
- Idea: Measure the time dependent CP-Violation parameters S_f and A_f. Then refeed the uncertainty of these parameters to optimize the B^0-selection and study implicit effects on K_S^0 selection.
- $B^0 \rightarrow K_s^0 K_s^0 K_s^0$ channel of choice, since the B-Vertex only depends on Ks information without further constraints.

Current default cuts on K_S^0 in basf2

inside V0-module:

- $\chi^2 < 50$ cut on vertex quality
- cut on Extrapolation to cylinder: *"This is intended to reject tracks that curl away before meeting"*
- cut on V0 mass inside beampipe $r < 1cm$: $60MeV$ mass window

at analysis stage:

- $400MeV$ mass window at FillParticleList (before KFit)
- $40MeV$ mass window after KFit

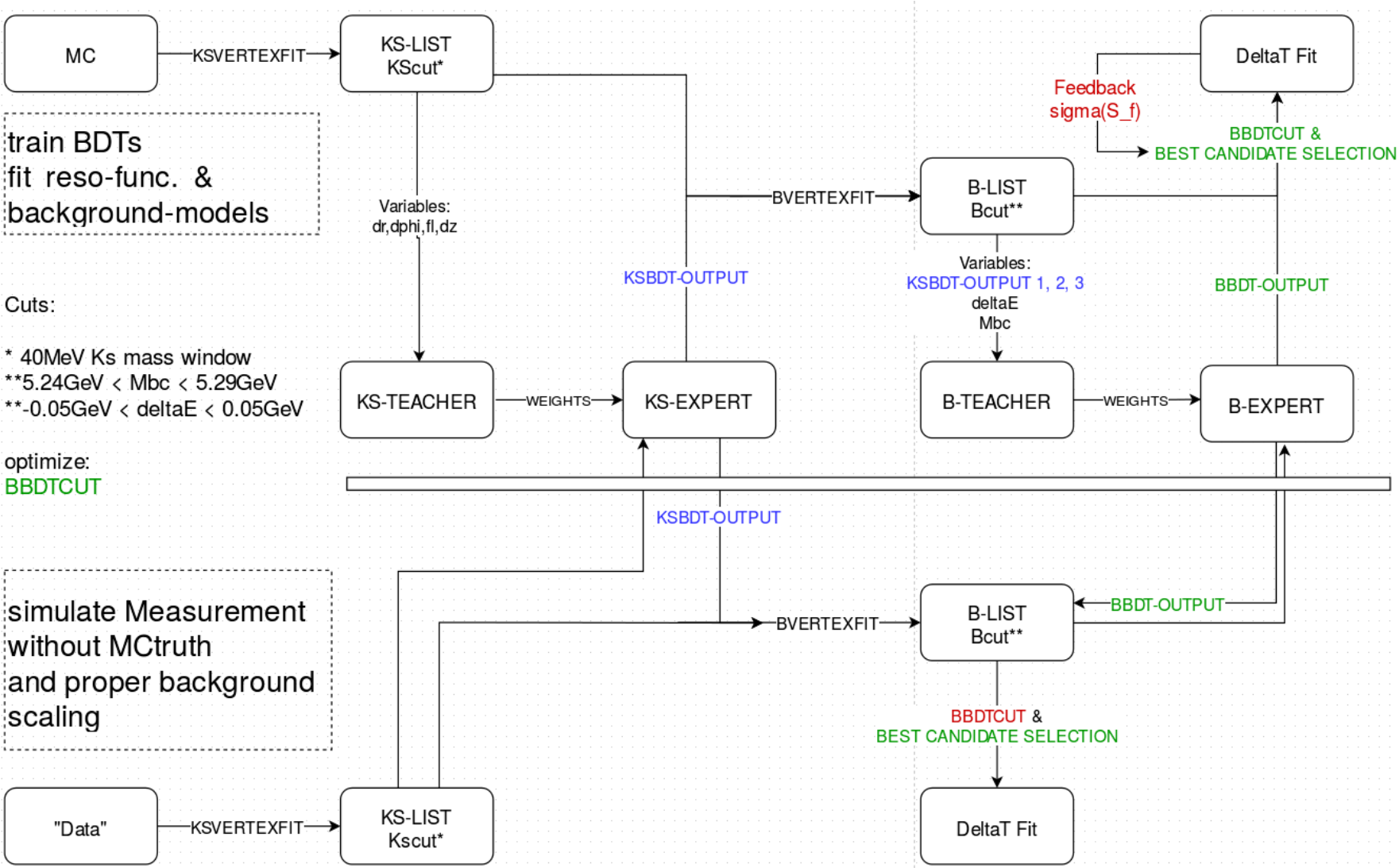
Ideas:

- First take out all cuts for validation and debugging
- One visible and accesable place for cuts instead of several hidden ones.

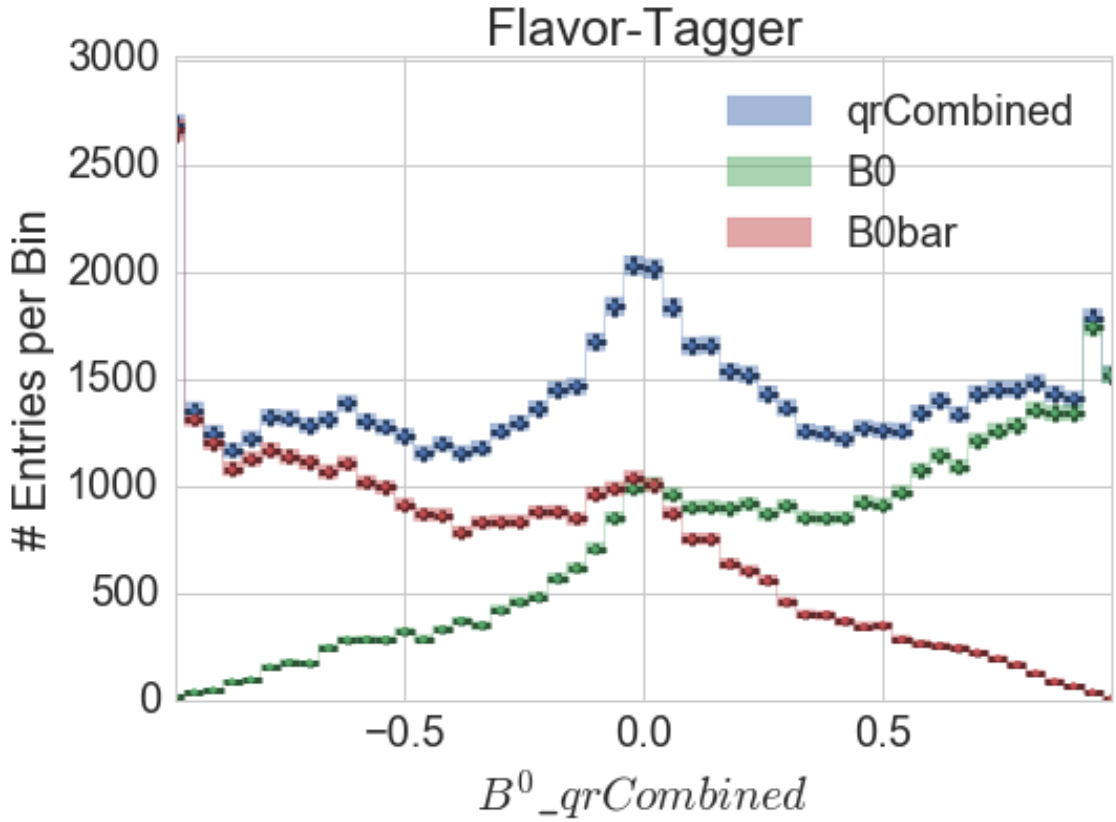
$B^0 \to K_s^0 K_s^0 K_s^0$

- Branching fraction: $6.0 * 10^{-6}$.
- Start with Signal MC only
  - Described cuts in in the V0-module make centrally produced Signal MC not usable $\to$ better to have all cuts on analysis-level.
  - Self-Production of Signal MC necessary
- basf2 version: 2015-12-04

Flowchart

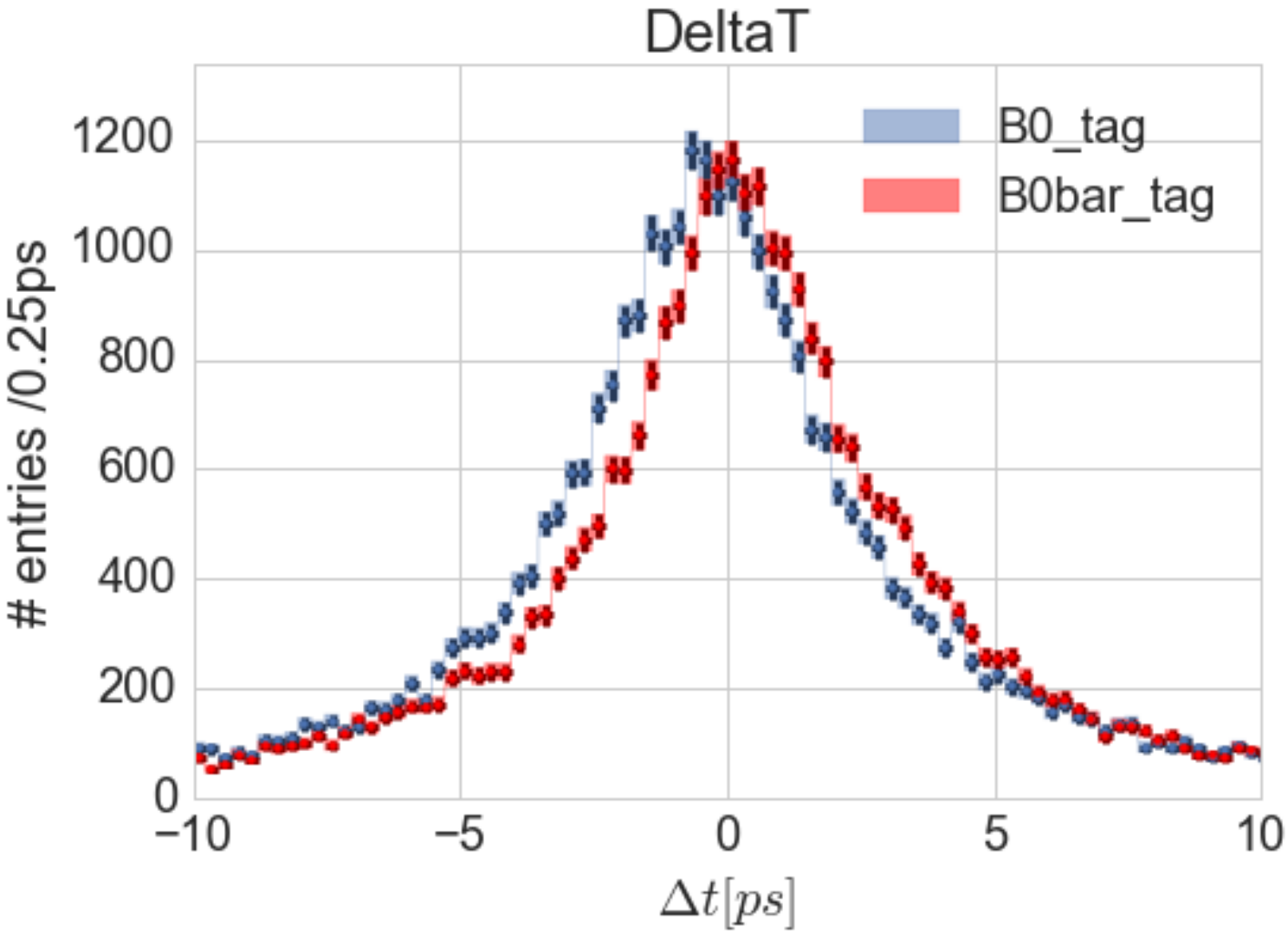

MC
KSVERTEXFIT
KS-LIST
KScut*
DeltaT Fit
Feedback
sigma(S_f)
BBDTCUT &
BEST CANDIDATE SELECTION
train BDTs
fit reso-func. &
background-models
Variables:
dr,dphi,fl,dz
BVERTEXFIT
B-LIST
Bcut**
KSBDT-OUTPUT
Variables:
KSBDT-OUTPUT 1, 2, 3
deltaE
Mbc
BBDT-OUTPUT
Cuts:
* 40MeV Ks mass window
**5.24GeV < Mbc < 5.29GeV
**-0.05GeV < deltaE < 0.05GeV
KS-TEACHER
WEIGHTS
KS-EXPERT
B-TEACHER
WEIGHTS
B-EXPERT
optimize:
BBDTCUT
KSBDT-OUTPUT
simulate Measurement
without MCtruth
and proper background
scaling
BVERTEXFIT
B-LIST
Bcut**
BBDT-OUTPUT
BBDTCUT &
BEST CANDIDATE SELECTION
"Data"
KSVERTEXFIT
KS-LIST
Kscut*
DeltaT Fit

Flavor-Tagger

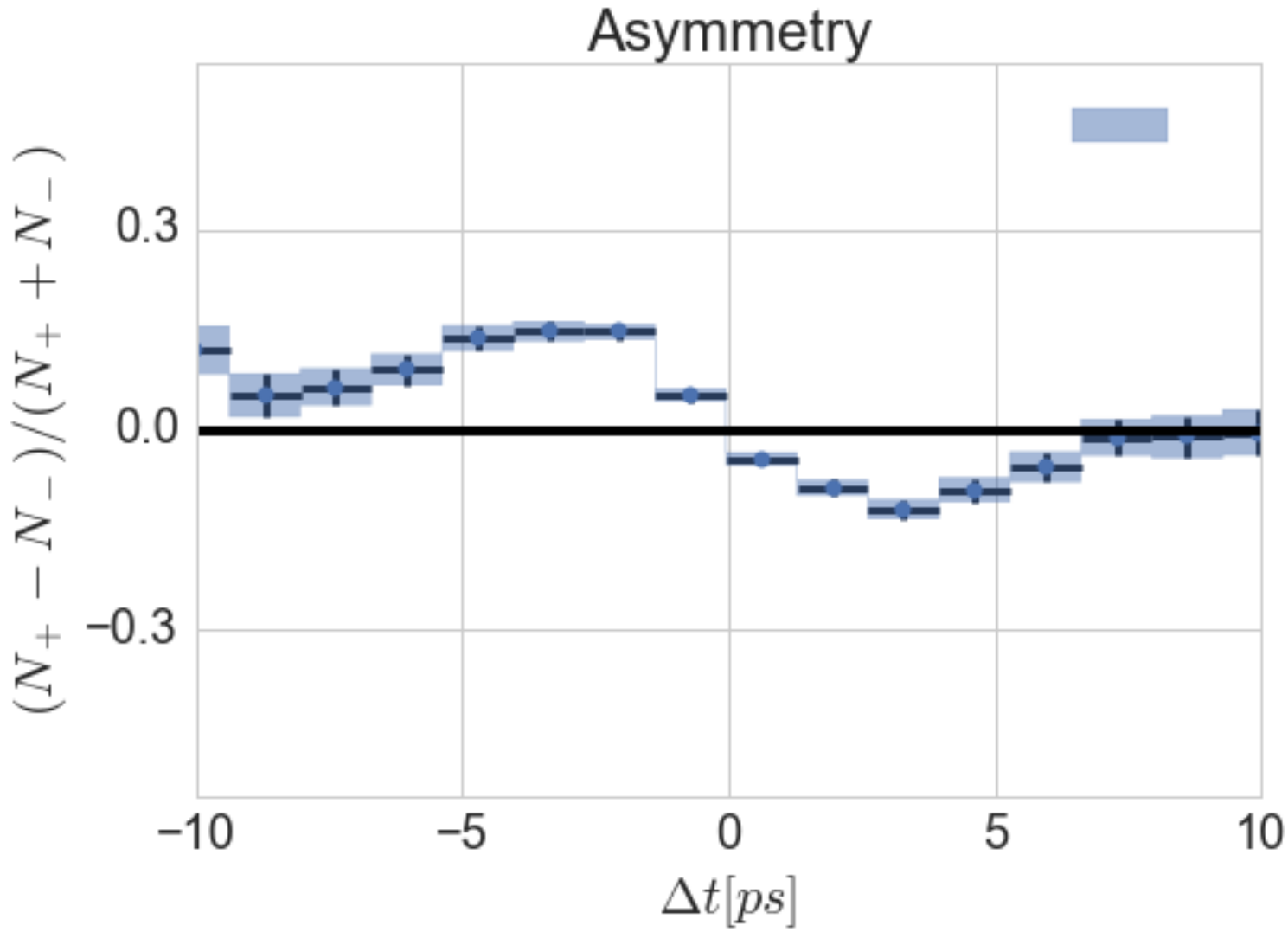


- Self-training of Flavour-Tagger was performed.
- Effective tagging efficiency according to Belle binning:
  $Q = \sum_{i=1}^{6} \epsilon_i (1 - 2w_i)^2 = 0.335$

Δt Distribution



Asymmetry



CP-Violation measurement

- In order to measure the parameters S_f and A_f, we need to perform a Maximum Likelihood-Fit to the Δt distribution using the following model:

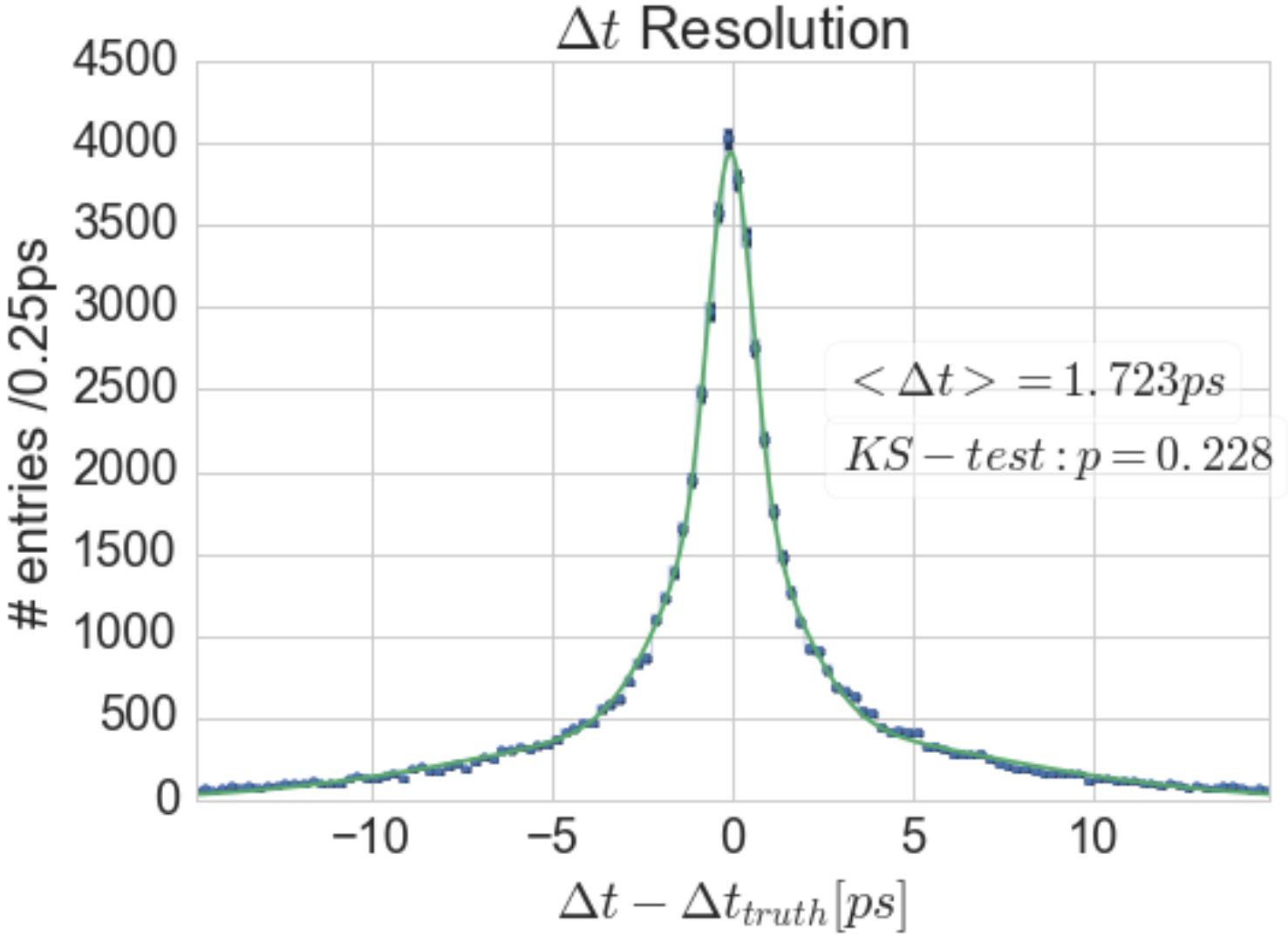
$$P_{sig}(\Delta t) = \frac{e^{-|\Delta t|/\tau_{B0}}}{4\tau_{B0}} * [1 + q(S_f sin(\Delta m_d \Delta t) + A_f cos(\Delta m_d \Delta t))]$$

- This model is convoluted with the proper-time resolution function R_{sig}, in order to take into account the finite vertex resolution:

$$P_i = \int [P_{sig}(\Delta t') R_{sig}(\Delta t_i - \Delta t')] d(\Delta t')$$

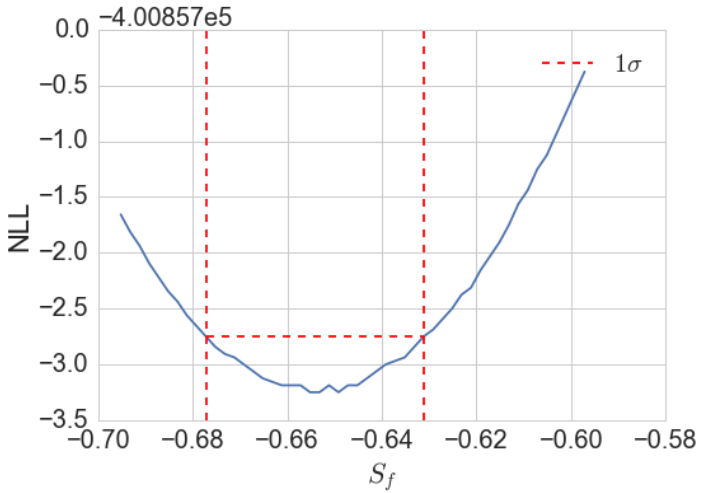
Resolution function

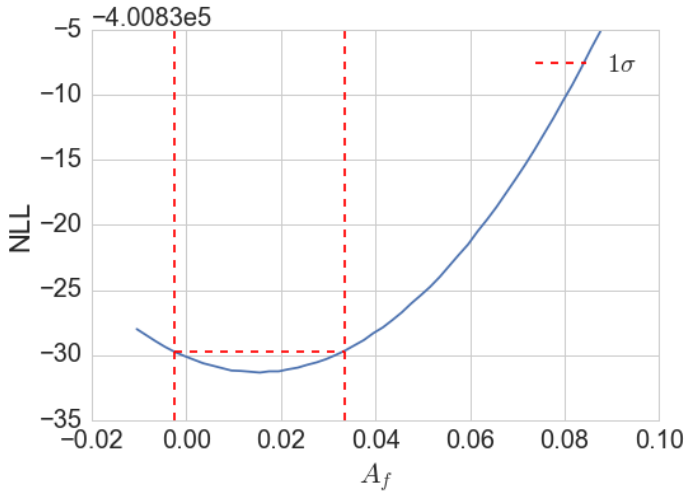
- To model the signal resolution a triple Gaussian is used.



Fit-Results and uncertainty

	S_f	A_f
Truth	-0.7	0
B^0 McMatched	-0.680 ± 0.005	0.006 ± 0.005
B^0 AllCandidates	-0.652 ± 0.023	0.001 ± 0.017





Outlook

- Optimize B^0_S-selection according to uncertainty and study implicit effects on K^0_S-selection.
- Include Background MC in correct scaling. Also extend fit with $P_{bg}(\Delta t)$ and $R_{bg}(\Delta t)$:

$$P_i = \sum_k f_k \int [P_k(\Delta t') R_k(\Delta t_i - \Delta t')] d(\Delta t')$$

- Look at systematics
- Implement $K^0_S \to \pi^0\pi^0$-cases. Currently B^0 Vertex-Fit not possible with Rave.

```
[WARNING] Error Matrix is not 7x7   { module: ParticleVertexFitter_K_S0:ks00 }
[rave::KinematicTreeFactory] VertexException saying ``ExtendedPerigeeTrajectoryError::unable to invert covariance matrix'' occured (3)
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