EbE Vertexing for Mixing

Alex

For the LBLB group

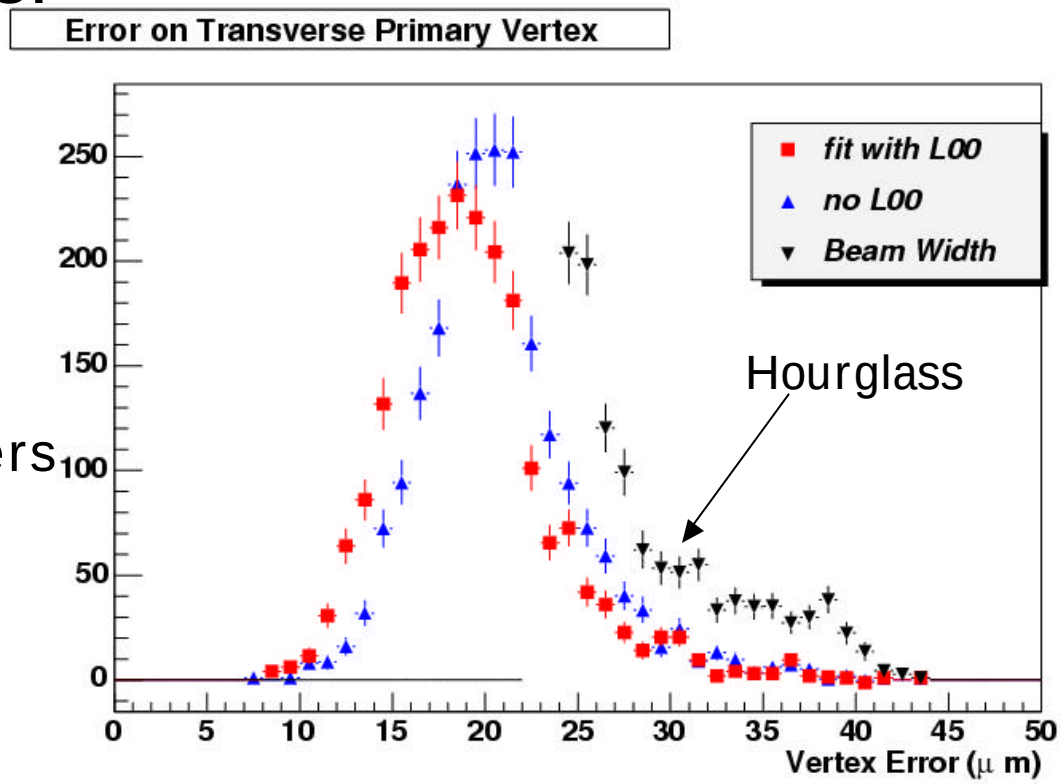
Outline

- Current status
  - What was used for the mixing results
  - What is the current understanding of Ebe
- Plans for improvements
  - How can we improve?

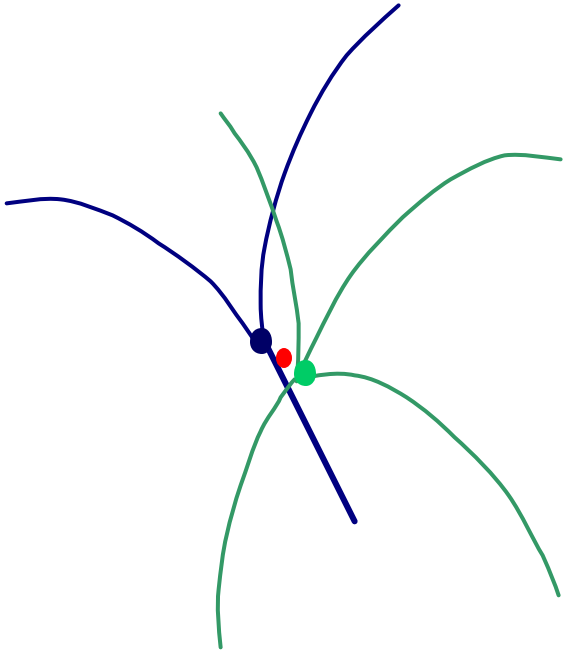
Current status

EbE: itearative track selection/pruning algorithm to provide an unbiased estimate of the PV position on an Event-by-Event basis

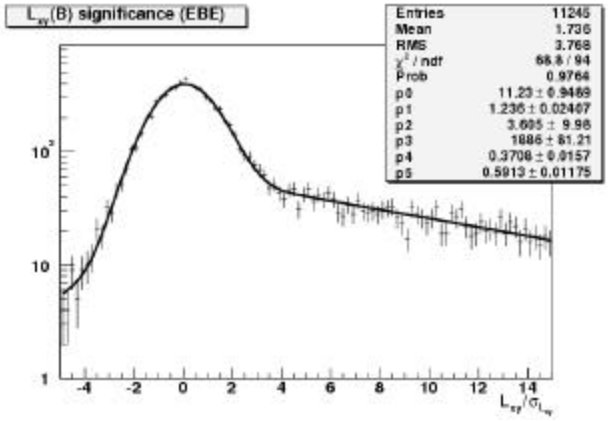
- Hadronic analyses used a flat ~25um beamline!
- Possible improvements:
  - Move to “hourglass”
  - Move to EbE
  - EbE + Hourglass
    - One of the ½ leptonic analyses used this with fixed hourglass parameters



The tools



- Prompt peak
- V-truth
- V1-V2
- d_0/σ

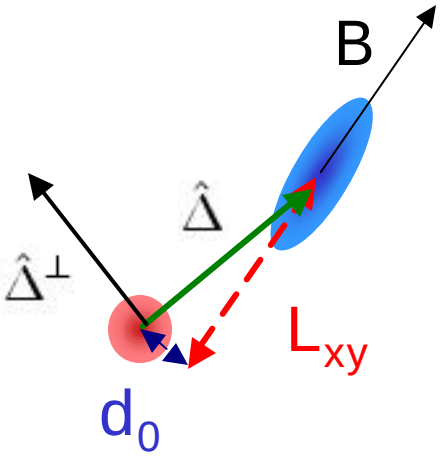


$$L_{xy} := \vec{\Delta} \cdot \hat{P}_B$$

$$d_0^B := \left| \vec{\Delta} - \frac{P_B^2}{\vec{P}_B \cdot \vec{\Delta}} \vec{P}_B \right| \approx \vec{\Delta}^{\perp} \cdot \hat{P}_B$$

$$\sigma_{L_{xy}} = {}^t\hat{\Delta} \Sigma_V^2 \hat{\Delta}$$

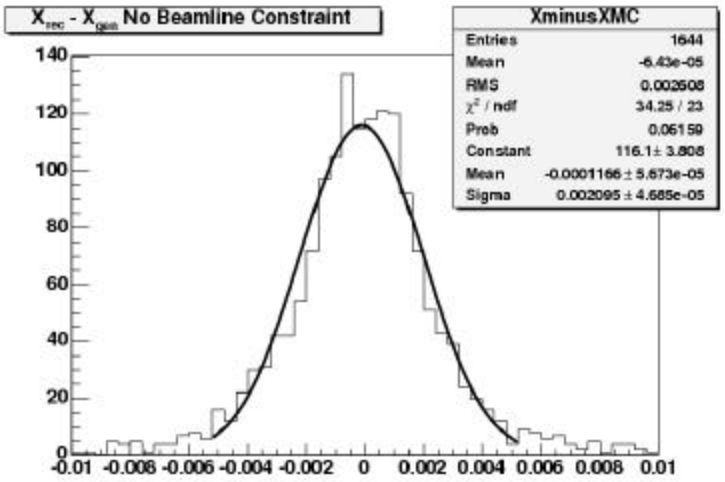
$$\sigma_{d_0^B} = {}^t\hat{\Delta}^{\perp} \Sigma_V^2 \hat{\Delta}^{\perp}$$

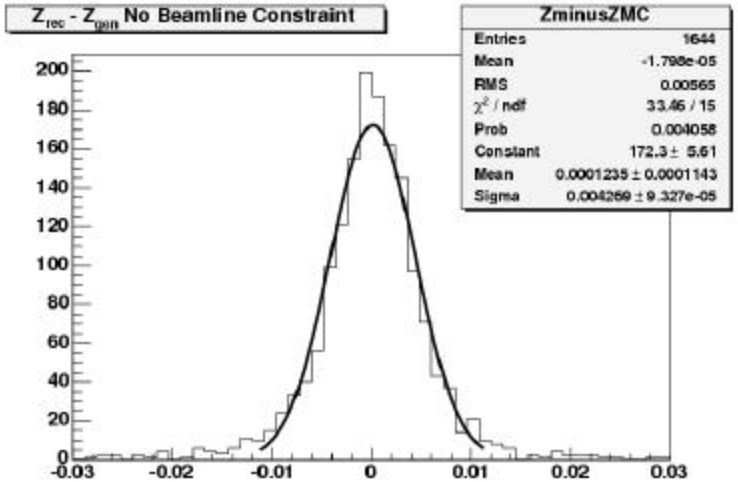


$$\hat{\Delta} = (x, y) \Rightarrow \hat{\Delta}^{\perp} = (y, -x)$$

What do we know about EbE?

- Unbiased estimator of PVTX





Reasonable (~5%) control of systematics

Mode	x scale	y scale	z scale
$B^{\pm} \to \psi K^{\pm}$	1.327 ± 0.035	1.399 ± 0.035	1.375 ± 0.029
$B^{\pm} \to D^0 \pi^{\pm}$	1.408 ± 0.030	1.398 ± 0.031	1.367 ± 0.29
$B^0 \to D^{\pm} \pi^{\mp}$	1.426 ± 0.034	1.336 ± 0.029	1.288 ± 0.027

	Transverse	**Z**
Data (V_1-V_2)	1.33±0.035	1.37±0.035
MC (V_1-V_2)	1.192±0.034	1.26±0.035
MC (V-truth)	1.24±0.036	1.23±0.032
J/ψ Prompt Peak	1.236±0.024	~ND~
J/ψ d_0/s	1.176±0.019	~ND~

Cross checks using I.P.(B)

Pull on Impact Parameter

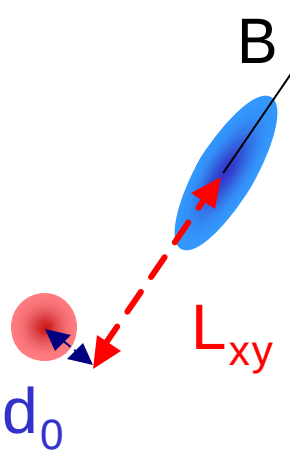
Mode	Beamline $\sigma = 25\mu$	Beamline z dependent σ	Event-by-Event w/beam constraint	Event-by-Event w/o beam constraint
$B^{\pm} \to D^0\pi^{\pm}$	1.297 ± 0.025	1.178 ± 0.039	1.202 ± 0.021	1.050 ± 0.025
$B^0 \to D^{\pm}\pi^{\mp}$	1.256 ± 0.026	1.118 ± 0.027	1.163 ± 0.020	1.046 ± 0.027

Z dep. Beamline improves pulls!

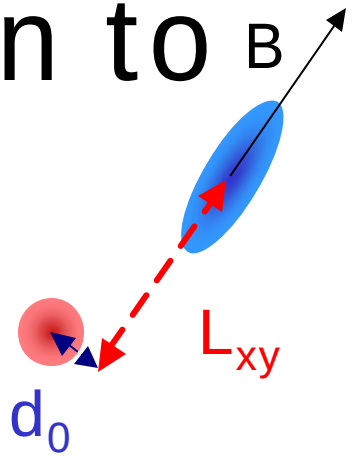
Something funny when beamline is used!

Scale factors work!

- L_{xy} involves three ingredients:
  - EbE
  - Secondary vertex
  - Beamline (in beamline constrained fits)



Relative PV/BV contribution to IP and Lxy pulls



- L_{xy} involves three ingredients:
  - EbE
  - Secondary vertex
  - Beamline (in beamline constrained fits)

	Not Beam Constrained		Beam Constrained	
	σ_{d0}	σ_{Lxy}	σ_{d0}	σ_{Lxy}
PV	23	27	17	17
SV	12	36	12	36
Sum	27	45	21	43

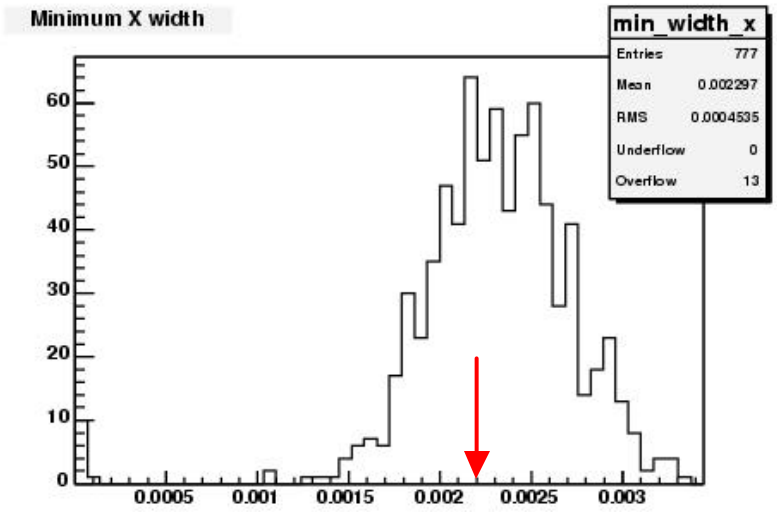
D_0 and L_{xy} probe different regimes of σ_{d0}/σ_{Lxy}

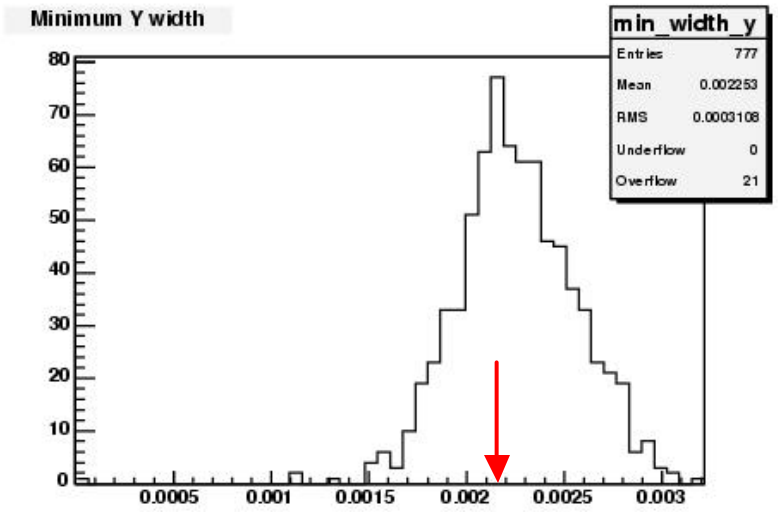
…Improvements:

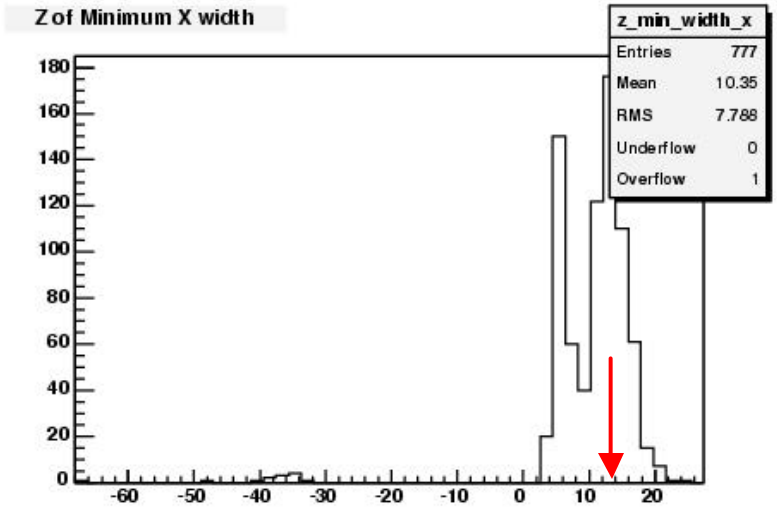
- PV pulls w BC $\Rightarrow$ need to revisit modeling of beamline
- Difference of relative contributions of PV/SV to L_{xy} and d_0 $\Rightarrow$ need additional methods to study SV resolution

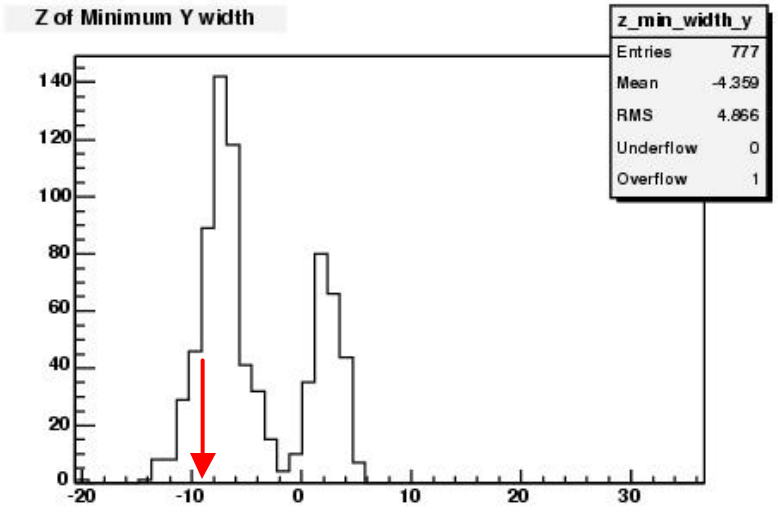
Hourglass parameters from DB

Profiles

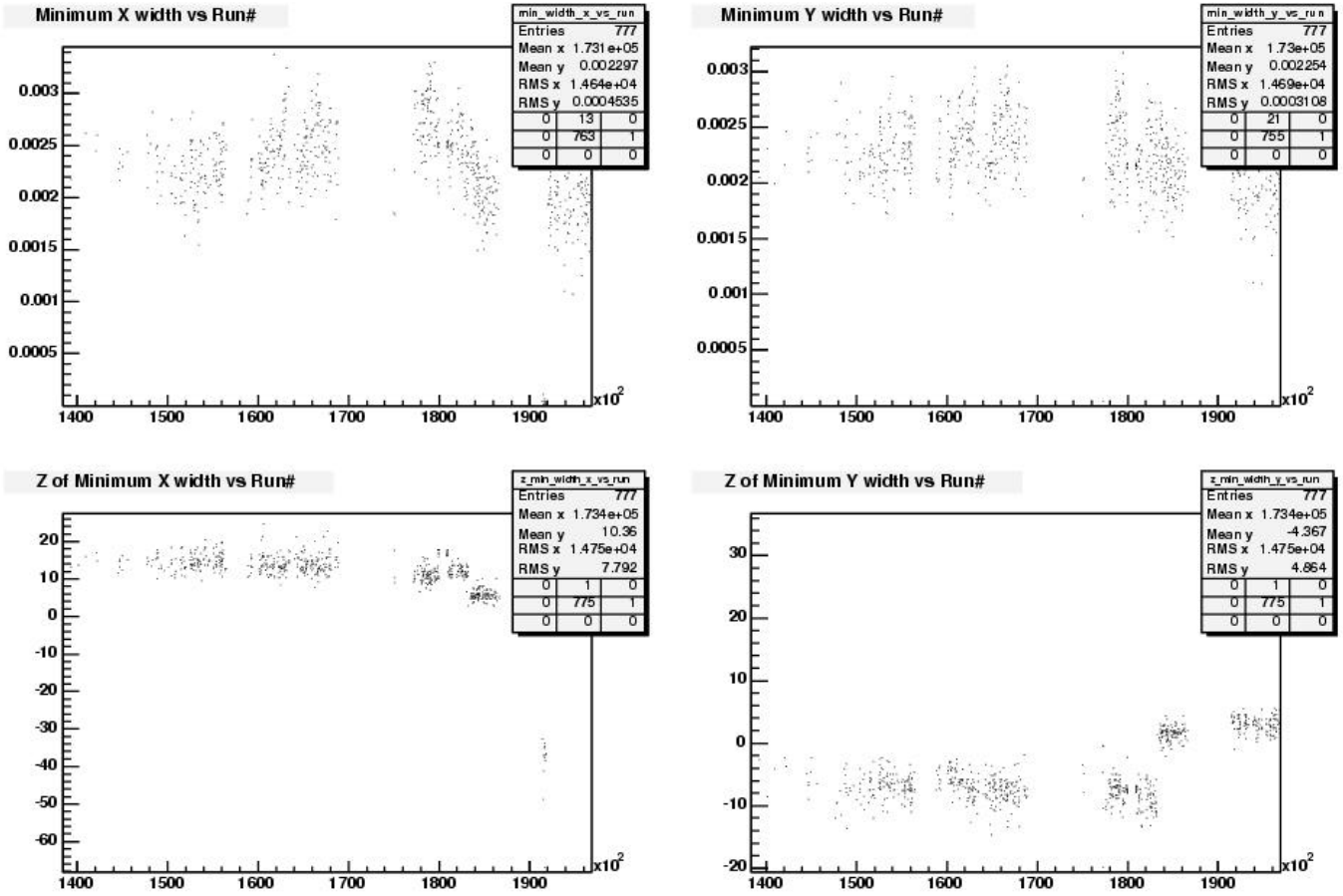






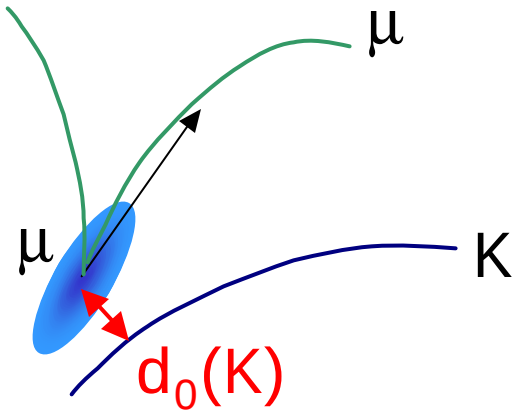


Time dependence of Hourglass parameters



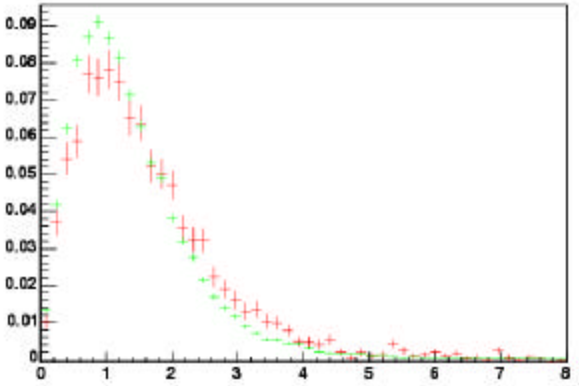
Implementing DB access of time-dependent parameters

SV contribution



Moments to the rescue:

- Example $B \rightarrow \psi K$
  - Fit ψ vertex alone
  - Look at $d_0(K)$ wrt ψ vertex
- Can repeat this study with other multi-prong vertices (D^+, D^0 etc.). Result might depend on:
  - Momentum
  - Vertex multiplicity
- Plenty of statistics to study all this



- Cross check the study on MC, after shimming L_{00} efficiency

…hence the plans for improvements!

A Prioritized List:

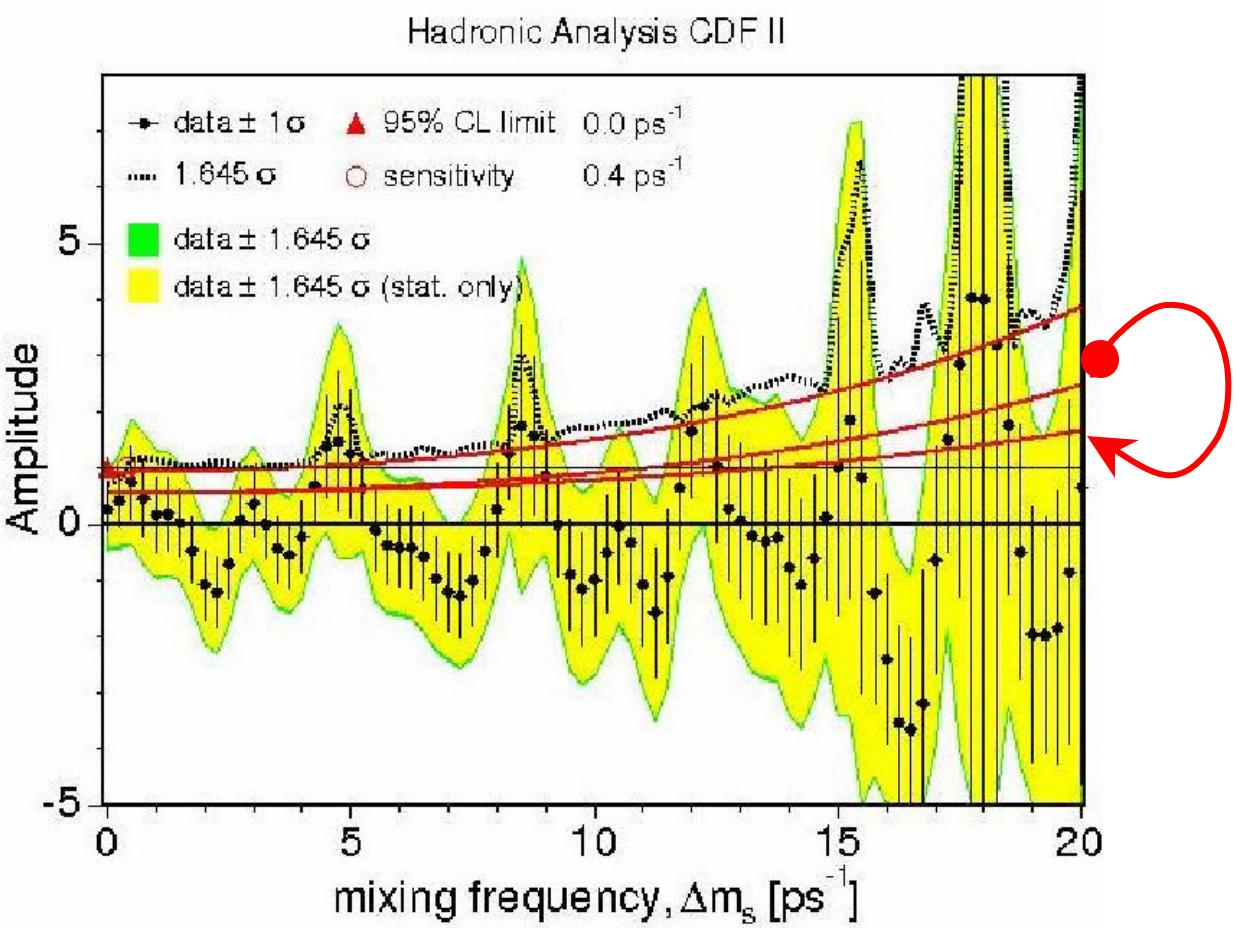
1. Understand beamline parameterization:
   I. Is it modeled correctly
   II. Is it measured correctly
   ⇒ Include our best knowledge of it!
2. Are secondary vertex pulls ok?
   I. Check with montecarlo truth
   II. Use n-prong vertices ($J/\psi K$, $K\pi\pi^{+/0}$, $K\pi\pi\pi^{+/0}$)
3. Do we understand the CTVMFT PV scale factor?
4. (connected to 3.) investigate dependencies (Pt?, z?, multiplicity, η?)

Backup

What do we gain?

Euphemism

1. 15-20% In vertex resolution!
2. Better control of systematics (hard to evaluate)
3. Correct EbE resolution (it is not clear that it is correct now)



- Red arrow is the effect of 1. Only
- Point 2. Affects mostly the green area (tiny ?)
- Point 3. Has an effect qualitatively similar to 1., but hard to evaluate

Hadronic analysis systematics

source	selected Δm_s scan points				
	0.0	5.0	10.0	15.0	20.0
$B_s \to D_s K$ level	0.019	0.024	0.030	0.037	0.047
dilution scale factors	0.143	0.168	0.205	0.254	0.314
dilution templates	0.119	0.147	0.178	0.211	0.246
fraction of Λ_b	0.014	0.009	0.009	0.011	0.012
Punzi term for σ_{ct}	0.009	0.008	0.022	0.033	0.030
dilution of $B \to DX$	0.025	0.001	0.000	0.000	0.001
σ_{ct} scale factor	0.000	0.024	0.061	0.090	0.144
usage of L00 in bias curve	0.001	0.001	0.001	0.001	0.001
Bs lifetime uncertainty	0.001	0.001	0.001	0.001	0.001
reweighted p_t spectrum	0.001	0.001	0.001	0.001	0.001
non-Gaussian tails in ct resol.	0.001	0.027	0.052	0.078	0.104
neglect B^0 in fit	0.039	0.036	0.033	0.031	0.028
effect of $\Delta\Gamma/\Gamma = 0.2$	0.028	0.028	0.028	0.028	0.028
Total systematic	0.195	0.232	0.289	0.357	0.443
Statistical	0.393	1.129	1.010	2.652	5.281