$B_s \to D_s K\pi\pi$: γ measurement

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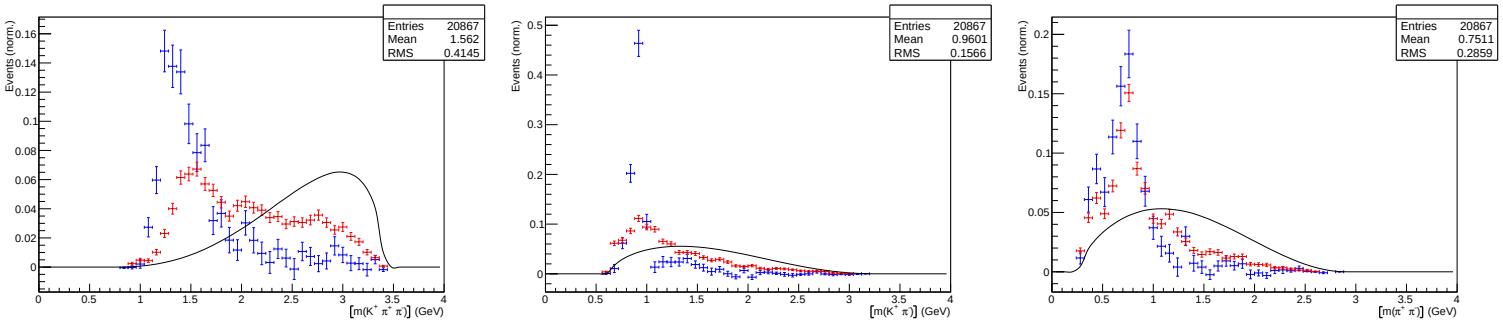
Status

A lot of progress since last update:

- re-optimized selection for γ measurement
- added 2015 & 2016 Run2 data
- use Meerkat PID sampling to control misID contributions
- developed time dependent MINT version (see last B2OC-talk)
- integrated time acceptance and resolution in TD-MINT (currently tested)

Re-optimized Selection

We now use specific phasespace cuts during preselection to suppress background:



$$m(K\pi\pi) < 1.95 GeV$$

$$m(K\pi) < 1.2 GeV$$

$$m(\pi\pi) < 1.2 GeV$$

The reduced background level allows us to loosen the BDT cut and significantly improve $\frac{S}{\sqrt{S+B}}$

New data!

Data from 2015 & 2016 now added to analysis

Slightly reorganized mass fits, now fit simultaneously in every year and D_s final state:

- years: 2011, 2012, 2015, 2016
- $D_s \to \phi\pi \to KK\pi$
- $D_s \to K^*K \to KK\pi$
- $D_s \to KK\pi$ (non-resonant)
- $D_s \to \pi\pi\pi$

Fit components

Components we model in the invariant mass distributions:

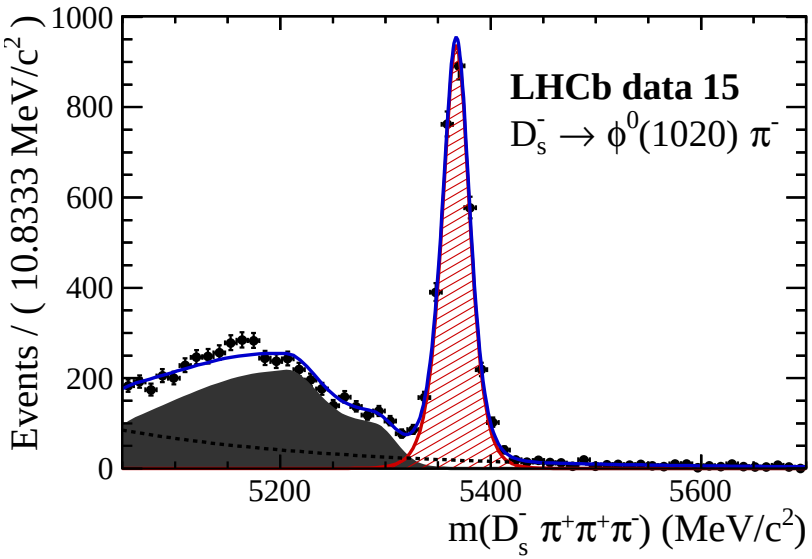
$B_s \to D_s\pi\pi\pi$:

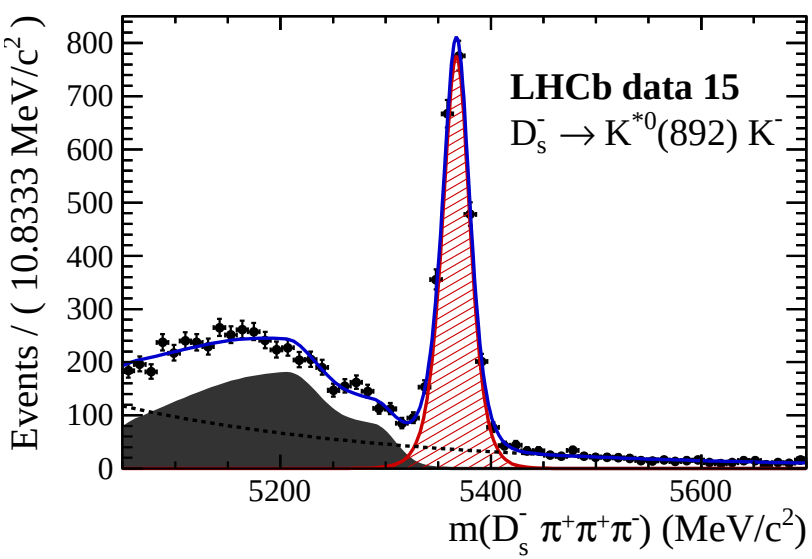
- B_s signal
- $B_s \to D_s^*\pi\pi\pi$ partial reconstructed background combinatorial
- combinatorial background

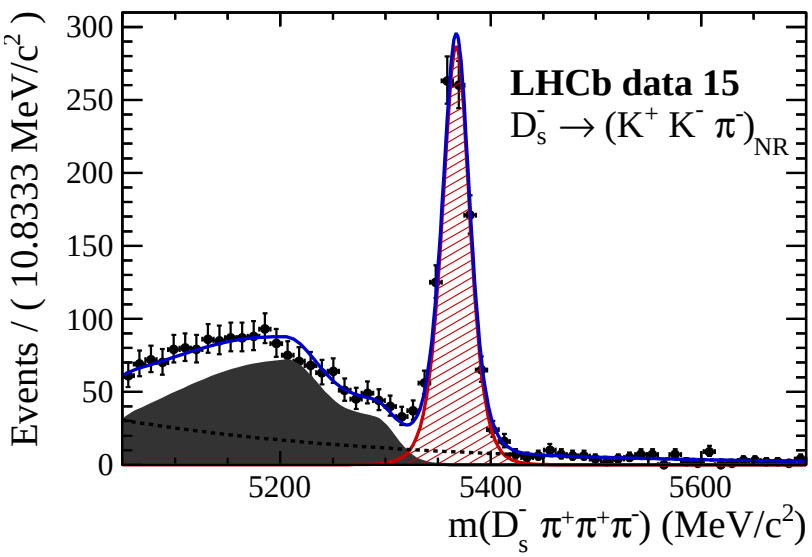
$B_s \to D_sK\pi\pi$:

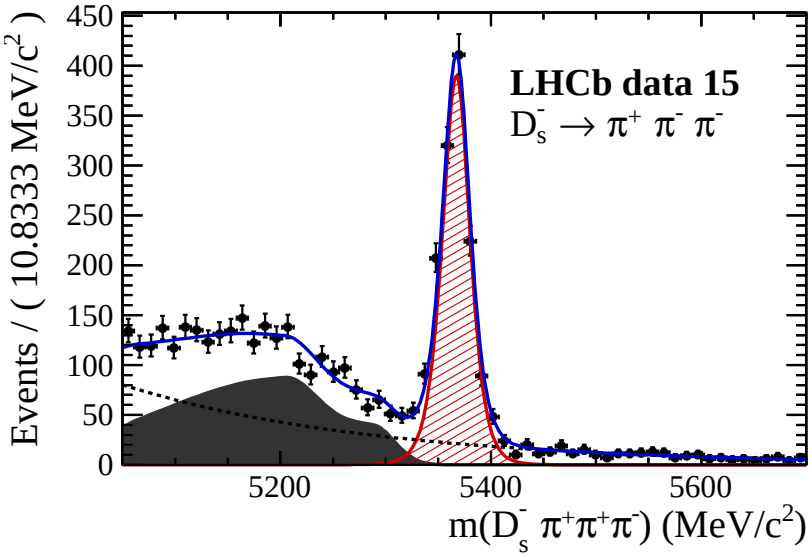
- B_s/B^0 signal
- $B_s/B^0 \to D_s^*K\pi\pi$ partial reconstructed background
- $B_s \to D_s\pi\pi\pi$ mis-ID background
- combinatorial background

Massfits norm 15

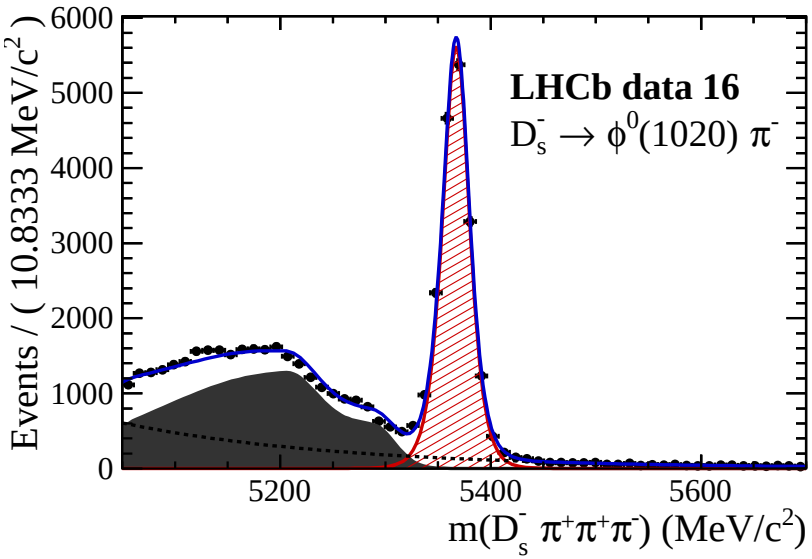


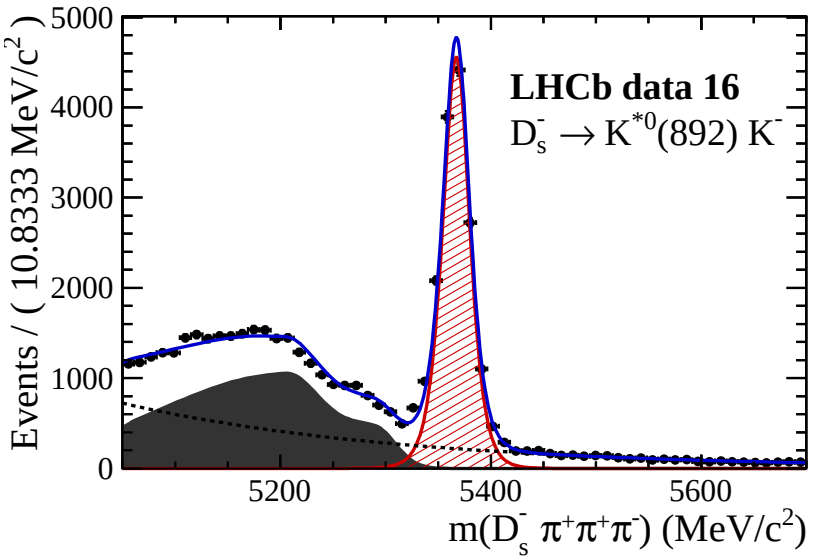


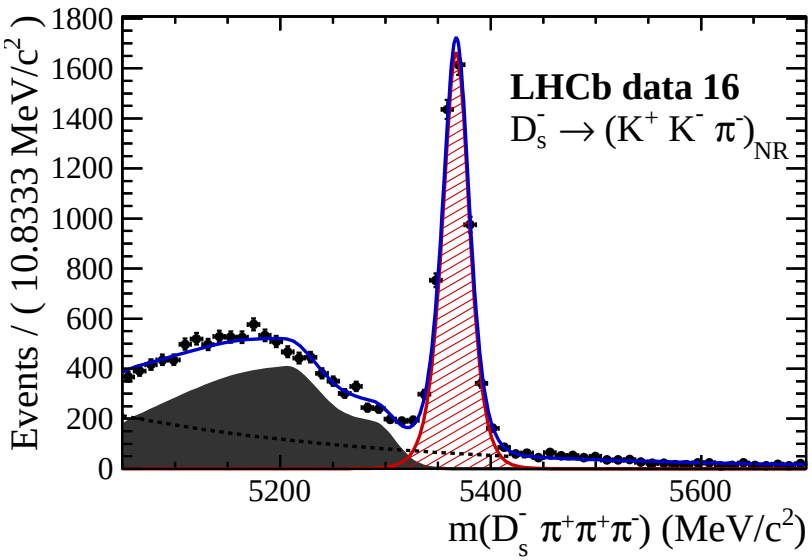


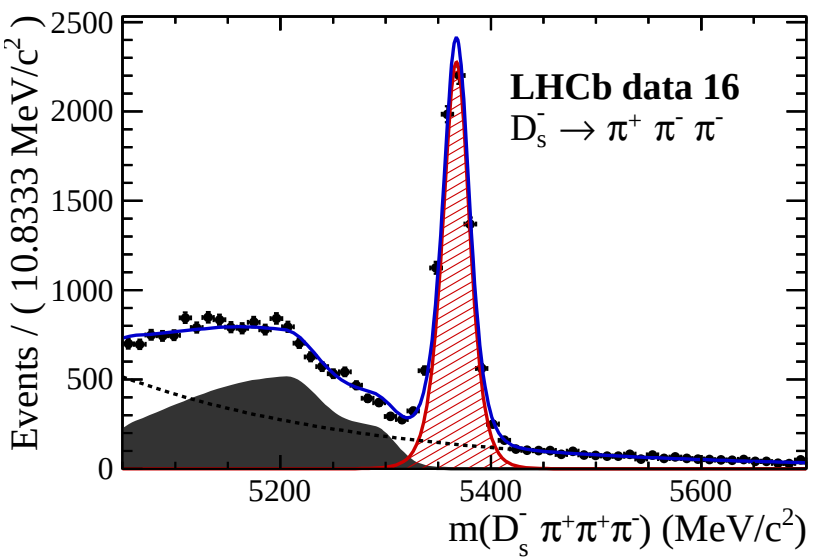


Massfits norm 16

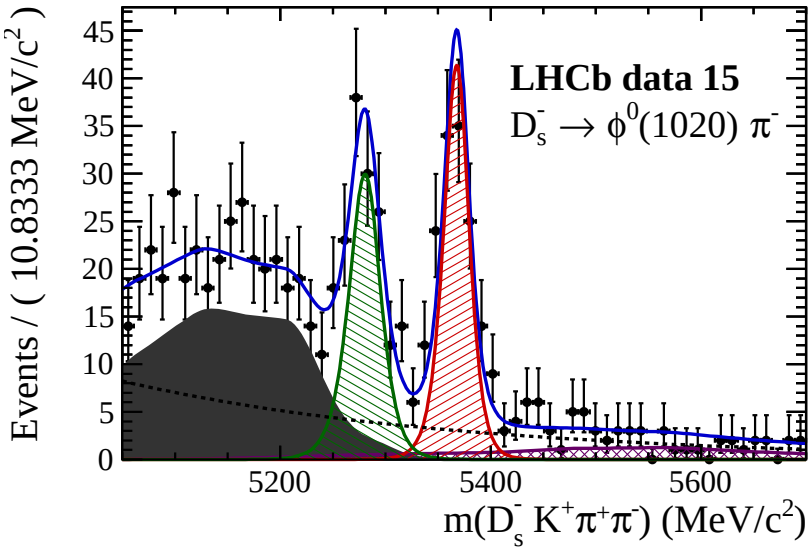


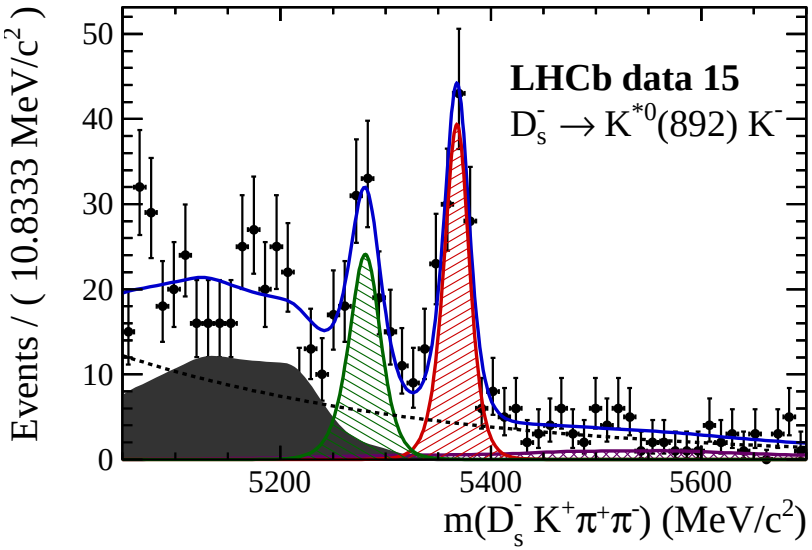


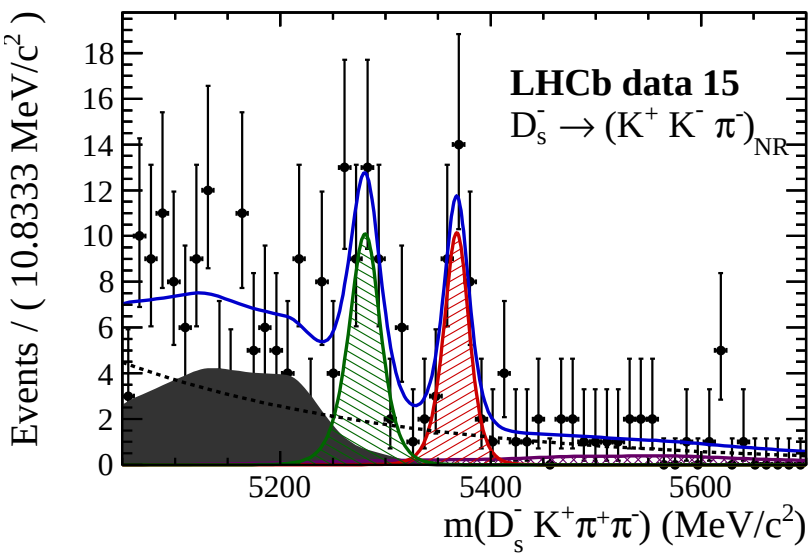


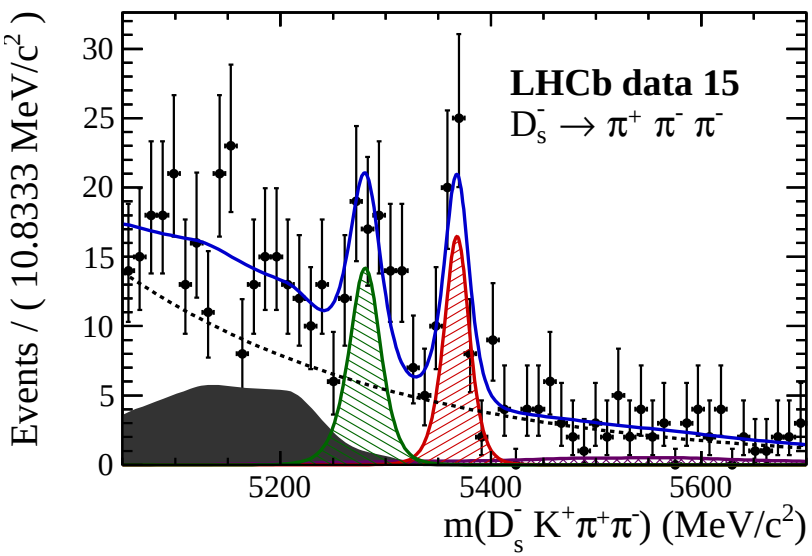


Massfits signal 15

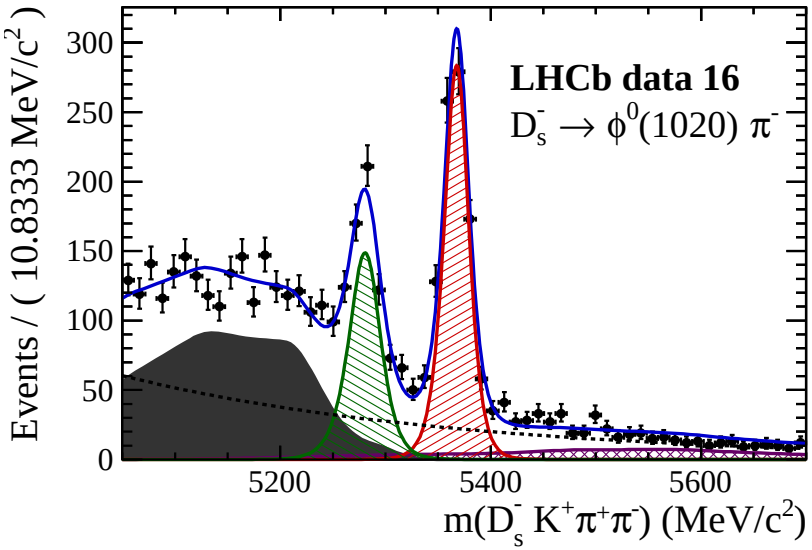


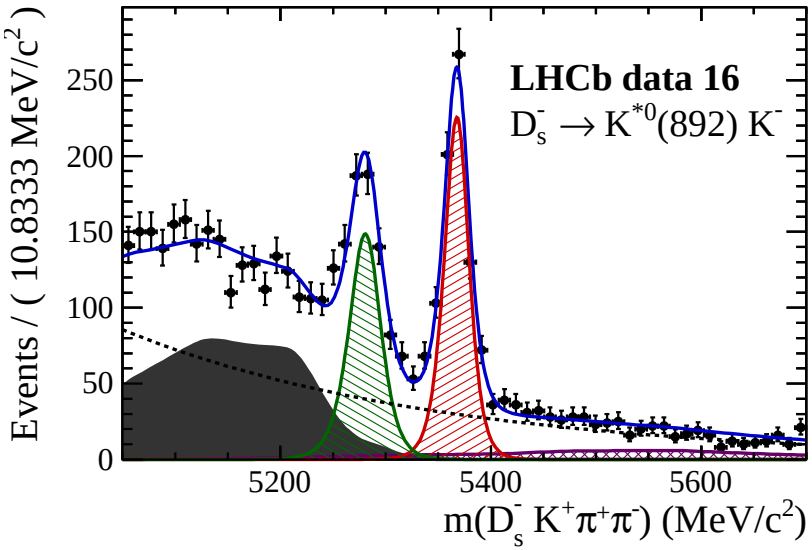


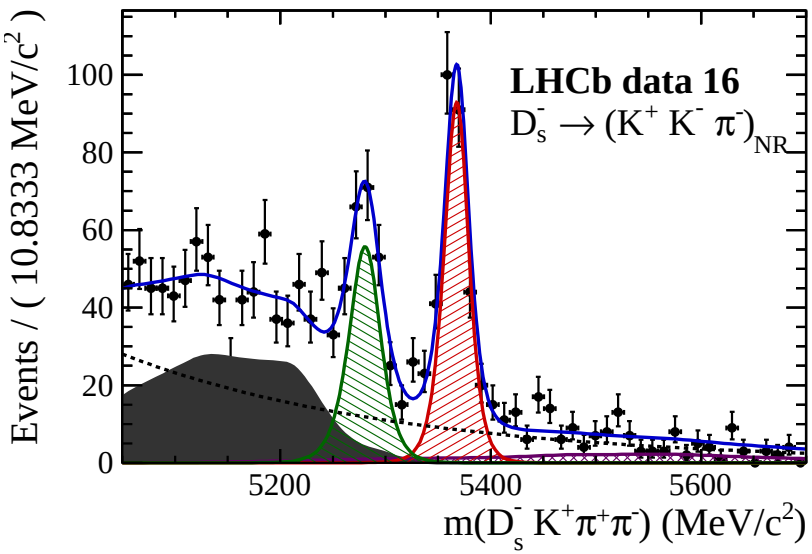


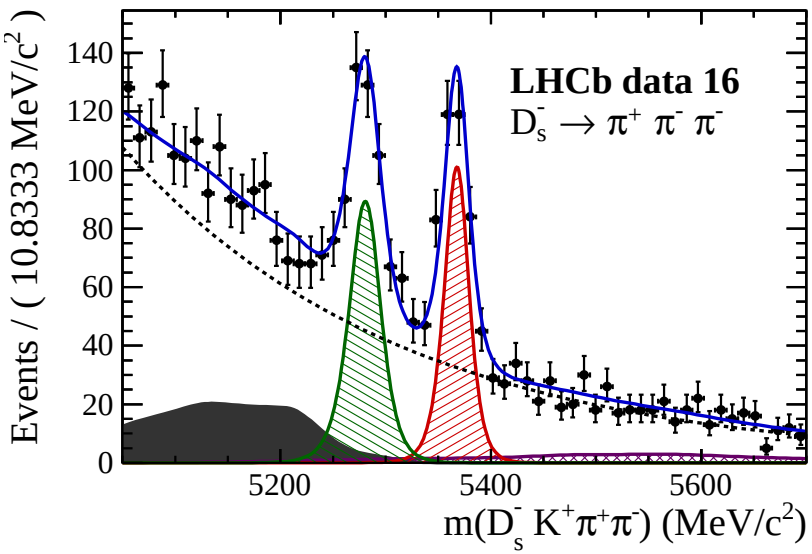


Massfits signal 16

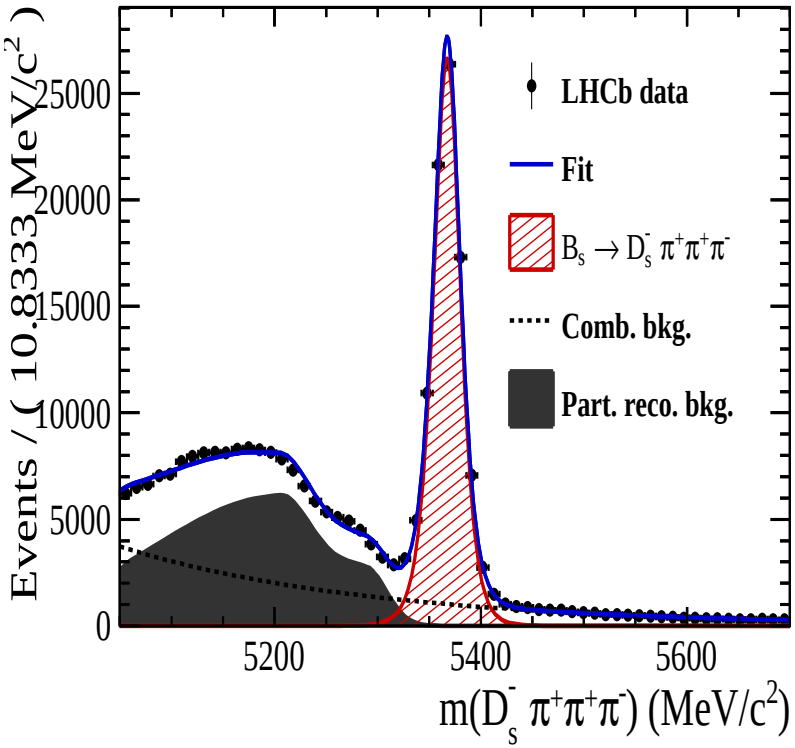


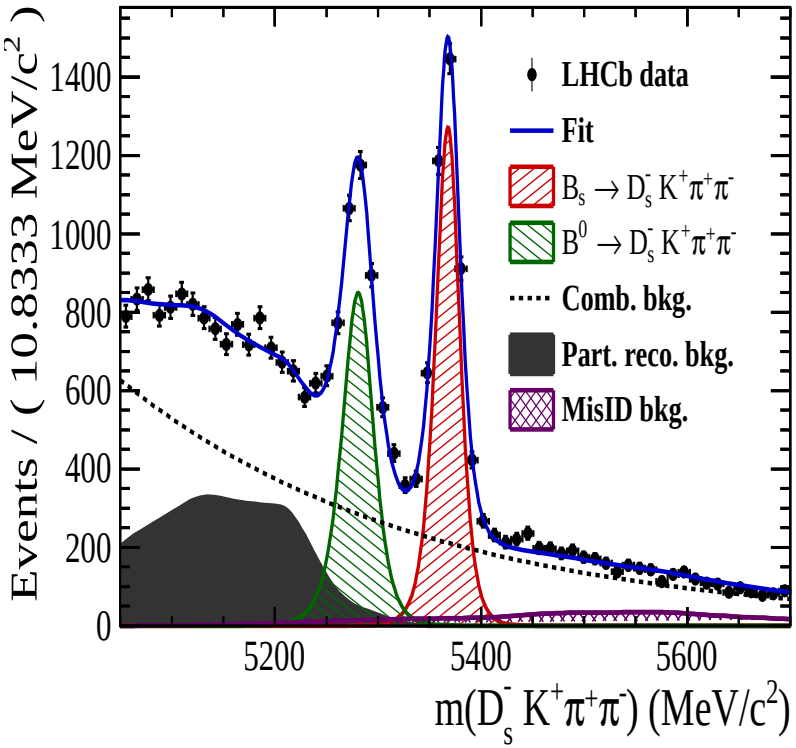






Run1 & 2 Data combined





fit component	yield 2011	yield 2012	yield 2015	yield 2016
$B_s \to D_s\pi\pi\pi$	9554 $\pm$ 204	22940 $\pm$ 316	7839 $\pm$ 185	45186 $\pm$ 452
$B_s \to D_sK\pi\pi$	426 $\pm$ 57	909 $\pm$ 71	319 $\pm$ 38	2049 $\pm$ 104

$\to$ 3700 Signals in total !

Time-Acceptance

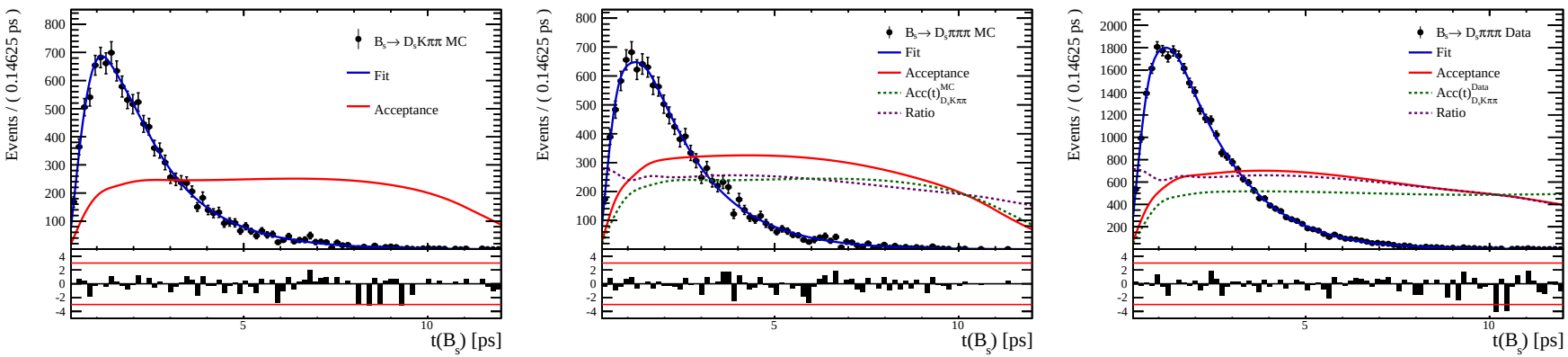
- $\frac{\Gamma(t)^{observed}}{dt} = \frac{\Gamma(t)^{theory}}{dt} \cdot \epsilon(t)$
- Use control channel $B_s^0 \to D_s^+ \pi^- \pi^+ \pi^-$
- describe $\epsilon(t)$ using cubic splines
- fit flavour averaged t-distribution, e.g.

$$\mathcal{P}(t', \vec{\lambda}) = \left[(e^{\Gamma_s t} \cdot cosh(\frac{\Delta\Gamma_s t}{2}) \times \mathcal{R}(t - t') \right] \cdot \epsilon(t', \vec{\lambda})$$

- fix $\Delta\Gamma$ and Γ to PDG, float polynomials
- We also imported the Spline Product class (see talk by Agnieszka) to check corrections between $B_s \to D_s \pi\pi\pi$ and $B_s \to D_s K \pi\pi$

Time-Acceptance

- Fit MC samples and Data simultaneously to propagate error correctly
- $Acc(t)^{MC}_{D_s K\pi\pi}$
- $Acc(t)^{MC}_{D_s \pi\pi\pi} = Acc(t)^{MC}_{D_s K\pi\pi} \cdot R(t)$
- $Acc(t)^{Data}_{D_s \pi\pi\pi} = Acc(t)^{Data}_{D_s K\pi\pi}(t) \cdot R(t)$
- knots at 0.3, 0.5, 1, 1.5, 2, 3, 9, 11, 12 ps

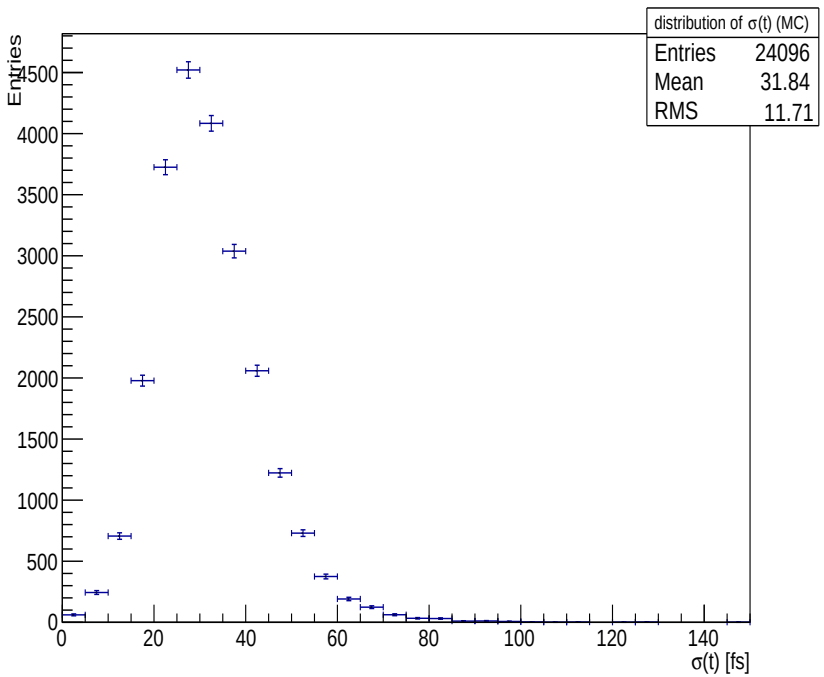


Need more MC statistic for this fit !

Resolution

Per-event decay-time error σ_t estimated by the decay tree fitter

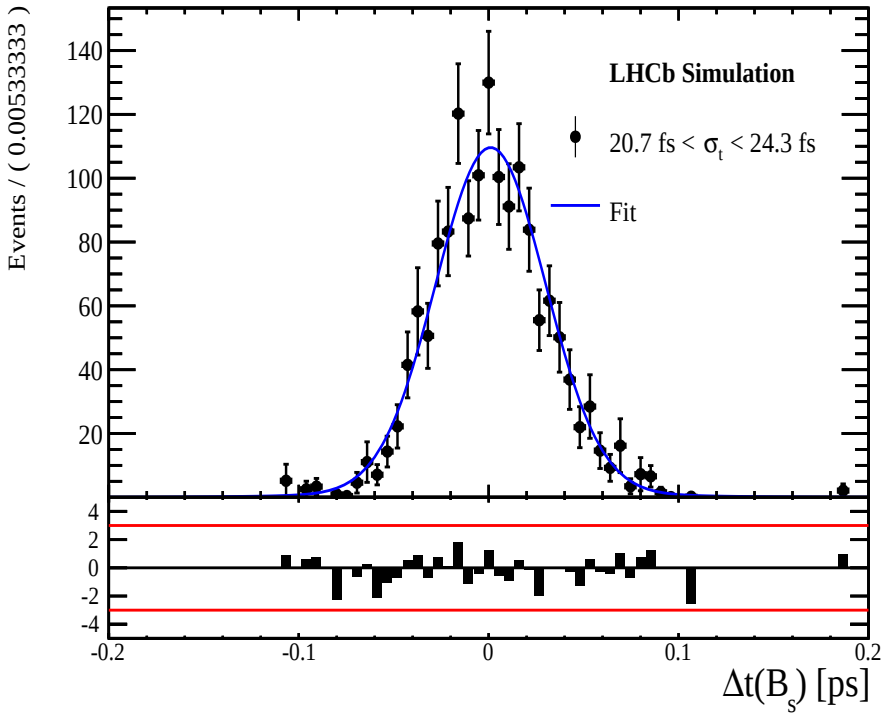
Problem: Not calibrated, real decay-time error will be shifted



Fit double Gaussian to distribution of $\Delta t = t_{true} - t_{observed}$ in every Bin, on MC

Derive effective resolution from Dilution of CP-observables

Resolution

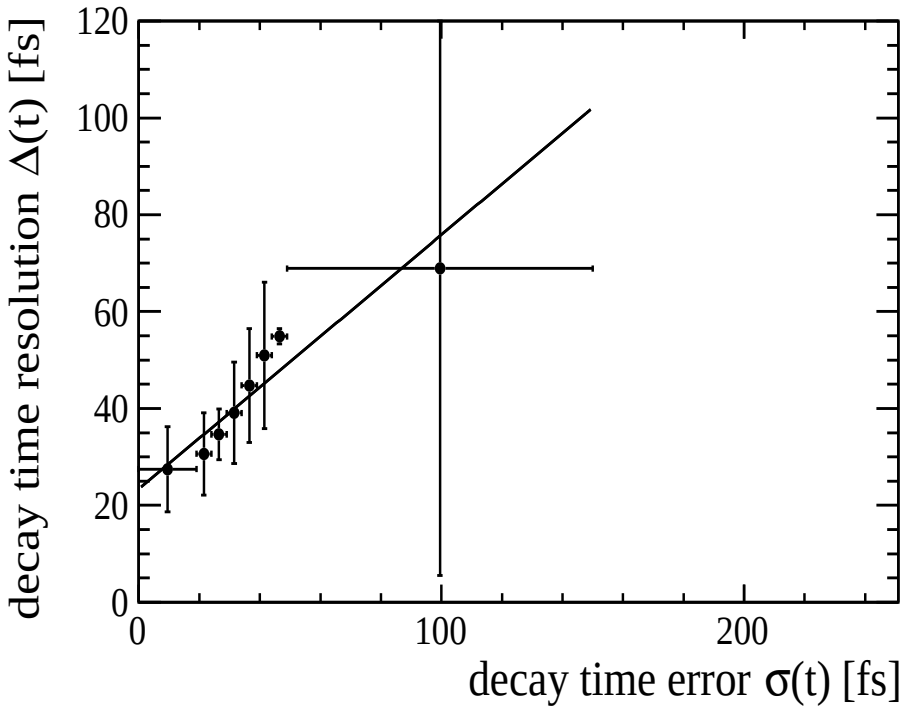


$$\mathcal{D} = f_1 e^{-\sigma_1^2 \Delta m_s^2/2} + (1 - f_1) e^{-\sigma_1^2 \Delta m_s^2/2}, \mathcal{D} \in [0, 1]$$

$$\sigma_{eff} = \sqrt{(-2/\Delta m_s^2) \ln D}$$

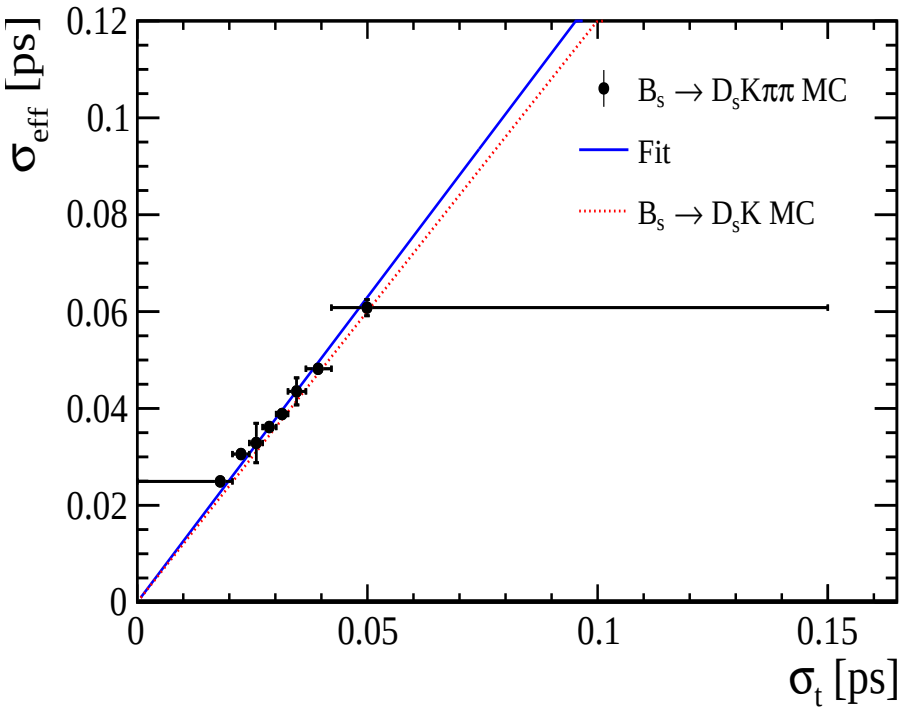
Resolution

Plot σ_t from decay tree fitter against σ_{eff} from Gaussian fits



Fitted with first order polynomial

Resolution



comparison of
$B_s \to D_s K\pi\pi$,MC
$B_s \to D_s K$,MC
$B_s \to D_s K$,Data

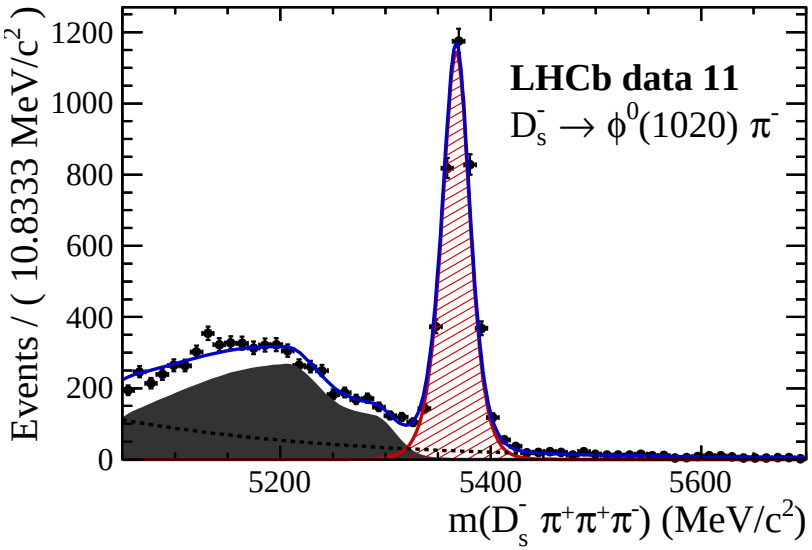
$$\to \text{assume } \frac{\sigma_{eff}(\sigma_t)_{D_sK,Data}}{\sigma_{eff}(\sigma_t)_{D_sK,MC}} \approx \frac{\sigma_{eff}(\sigma_t)_{D_sK\pi\pi,Data}}{\sigma_{eff}(\sigma_t)_{D_sK\pi\pi,MC}}$$

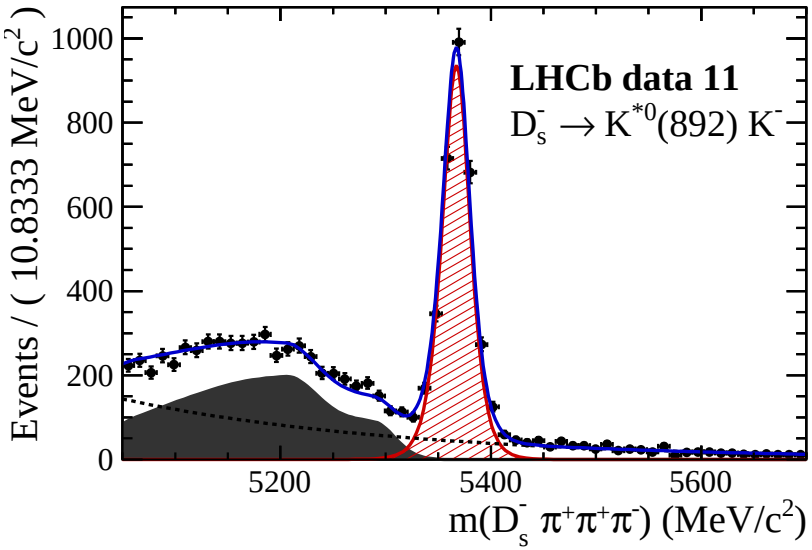
$$\Leftrightarrow \sigma_{eff}(\sigma_t)_{D_sK\pi\pi,Data} \approx \frac{\sigma_{eff}(\sigma_t)_{D_sK,Data}}{\sigma_{eff}(\sigma_t)_{D_sK,MC}} \cdot \sigma_{eff}(\sigma_t)_{D_sK\pi\pi,MC}$$

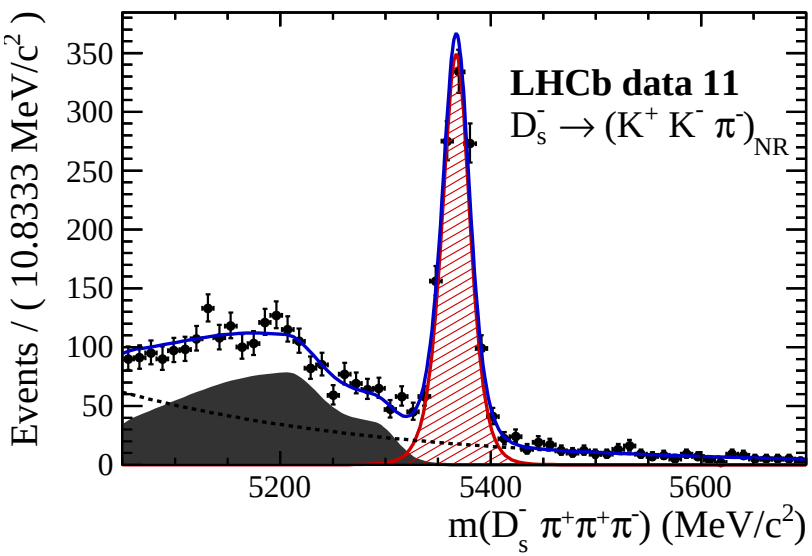
Might be able to get LTU data by re-stripping due to HLT bug !

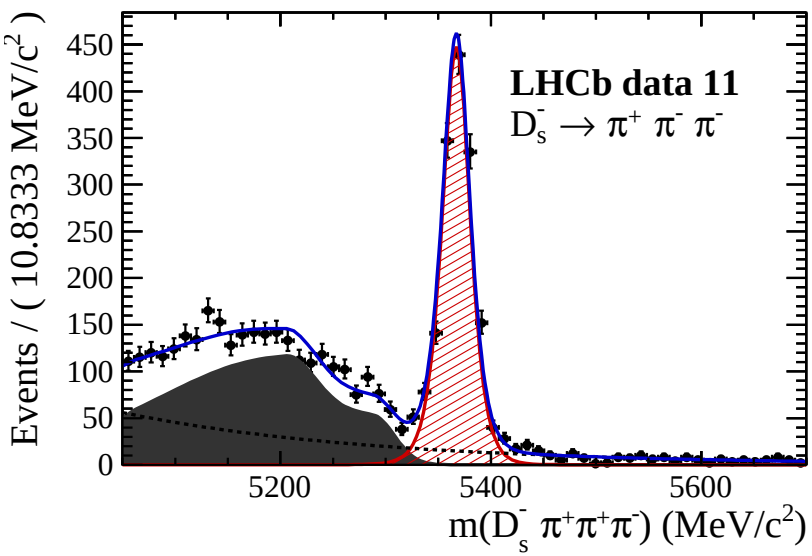
Appendix

Massfits norm 11

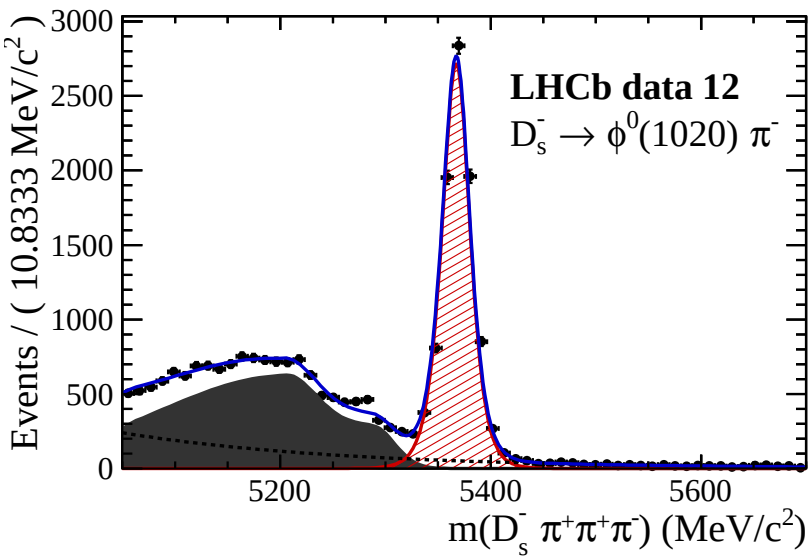


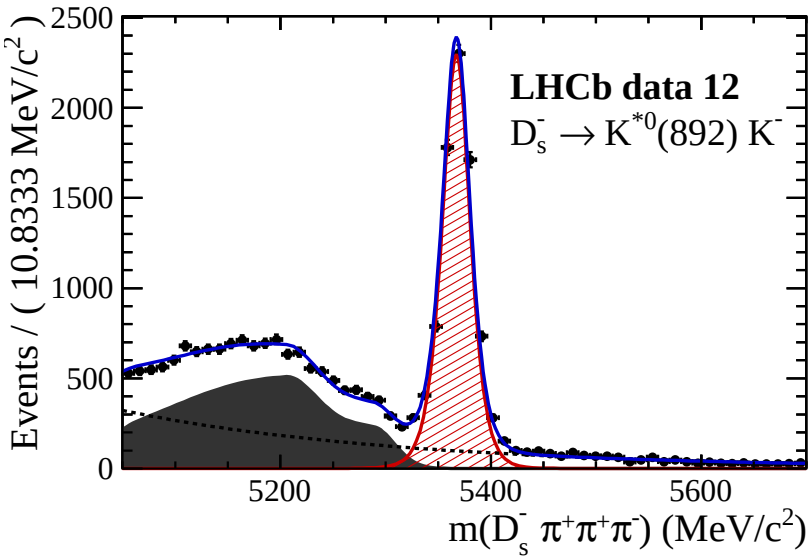


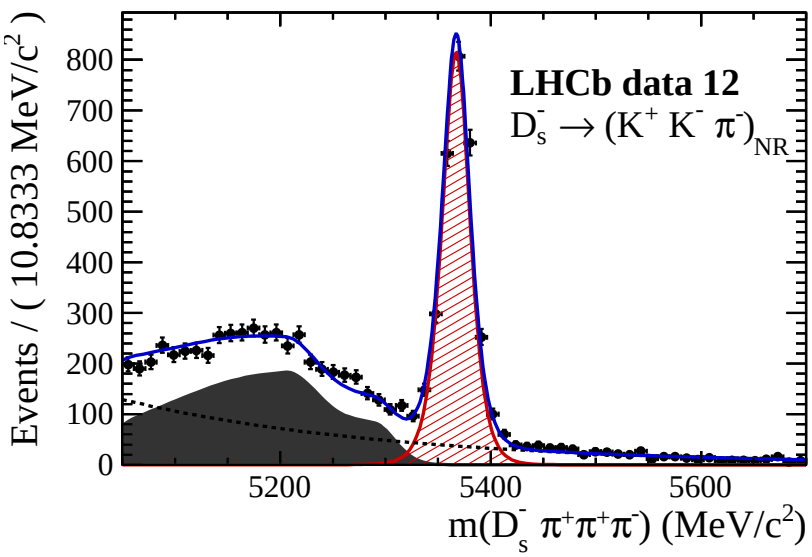


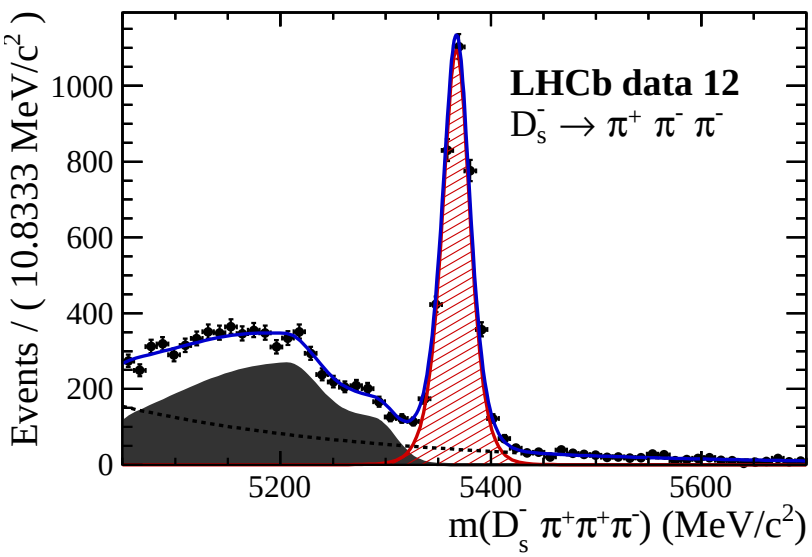


Massfits norm 12

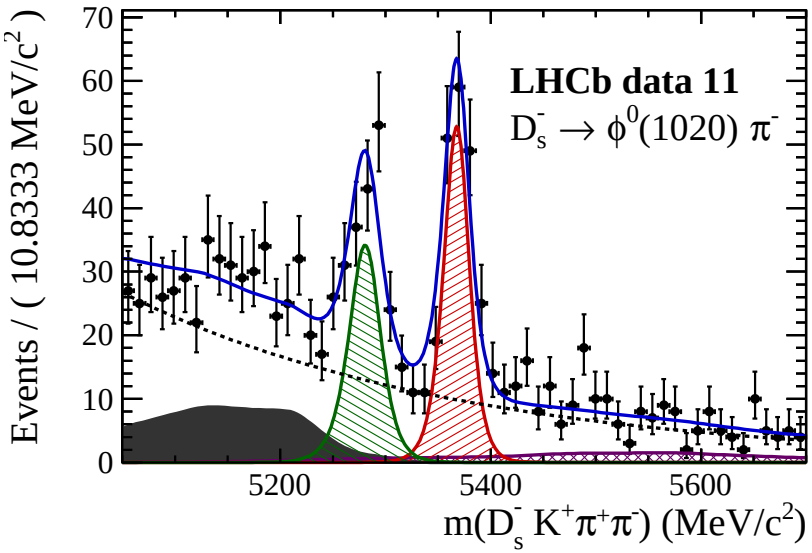


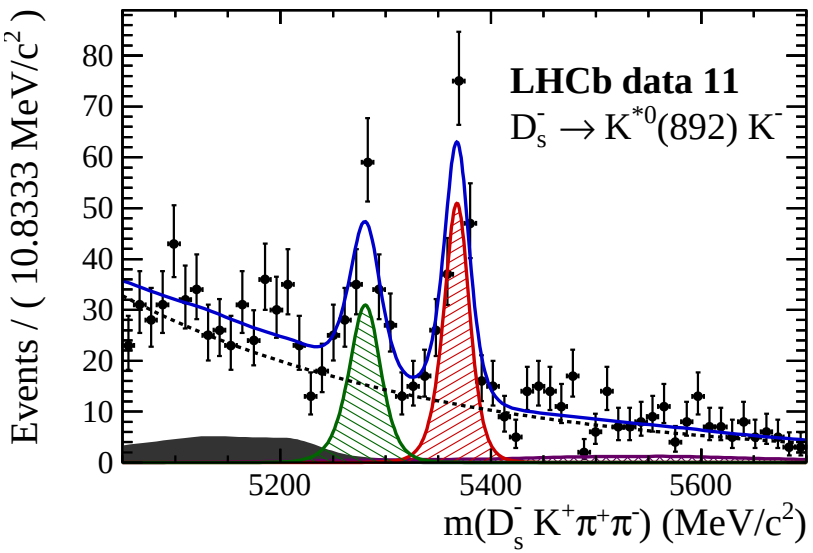


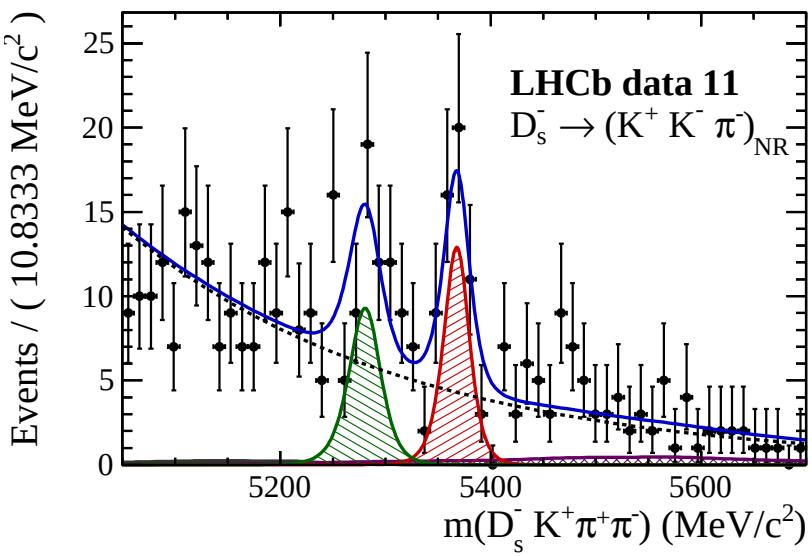


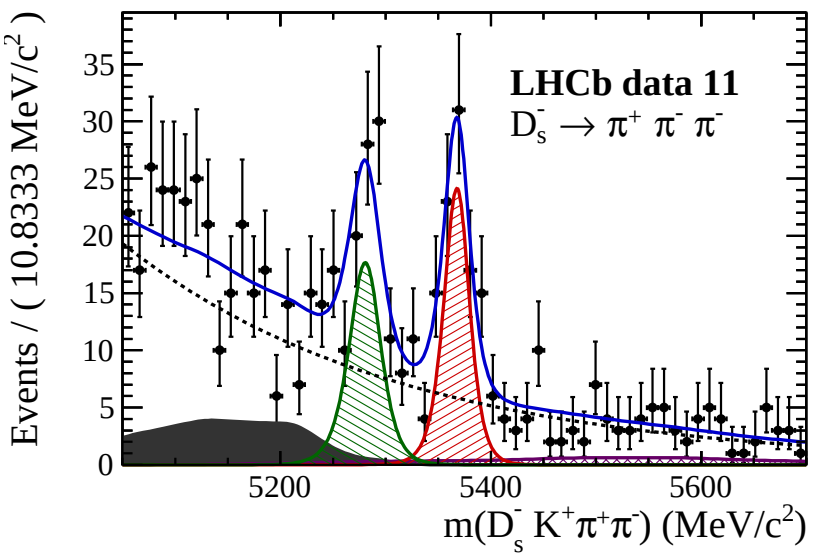


Massfits signal 11









Massfits signal 12