Ω_c^0 lifetime measurement

Dong Ao

About tau fit

LHCb-ANA-2016-068
March 7, 2017
Final version

Measurement of the decay-width difference between the B_s^0 and B^0 mesons and the D_s and D mesons

A binned least-squares fit is used to extract $\Delta(D)$, by minimizing

$$\chi^2 = \sum_i^{\text{bins}} \frac{(n_i - R_i d_i)^2}{\sigma_{n_i}^2 + R_i^2 \sigma_{d_i}^2}, \tag{8}$$

where n_i (d_i) is the yield of the numerator (denominator) in time bin i, σ_{n_i} (σ_{d_i}) its uncertainty, and R_i is the expected ratio defined as

$$R_i = N\, A_i \frac{\int_{T_i} \text{pdf}_n(t_D)\, dt_D}{\int_{T_i} \text{pdf}_d(t_D)\, dt_D}. \tag{9}$$

For the bin i, T_i is the corresponding t_D interval, A_i is the ratio between the decay-time acceptances of the numerator over the denominator, $\text{pdf}_{n(d)}$ is the pdf of the numerator (denominator), and N a normalisation factor. The integral over t is done numerically with 100 steps per decay-time bin. Each pdf is written as

$$\text{pdf}_j(t) = e^{-\Gamma_j t_D} \otimes \mathcal{G}_j^{\text{res}} \qquad (j = n, d), \tag{10}$$

Model

$$\chi^2 = \sum_{i}^{bins} \frac{(n_i - R_i d_i)^2}{\sigma_{n_i}^2 + R_i^2 \sigma_{d_i}^2}$$

- n_i (d_i) is the yield of the numerator (denominator) in time bin i, $\sigma_{n_i}^2(\sigma_{d_i}^2)$ is its uncertainty , R_i is the expected ratio

$$R_i = N \frac{\int_{T_i} pdf_n(t)dt}{\int_{T_i} pdf_d(t)dt}$$

- Here use simple pdf:

$$pdf(t) = e^{-\frac{t}{\tau}}$$

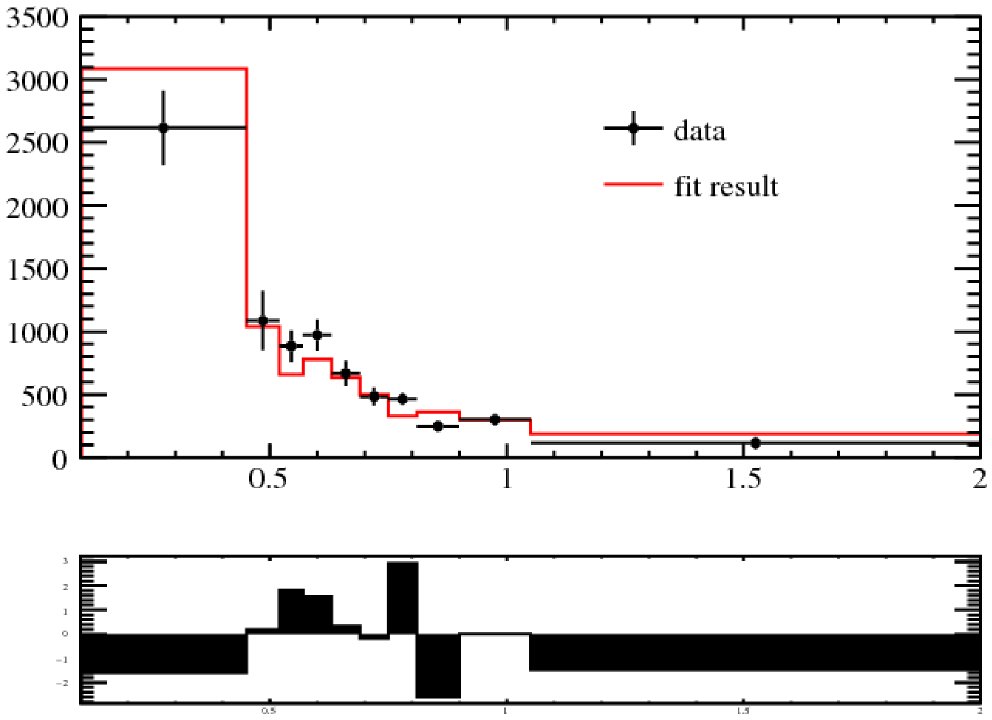
Double ratio fit

- Use double ratio $\frac{n_{d\Xi}/n_{\mathrm{m}\Xi}}{n_{dD}/n_{mD}}$, n_d is yield of signal, n_{m} is yield of MC
- $\frac{n_{d\Xi}/n_{\mathrm{m}\Xi}}{n_{dD}/n_{mD}} = \frac{R_\Xi}{R_D}$

$$\chi^2 = \sum_i^{bins} \frac{\left(n_{d\Xi i} - \frac{R_{\Xi i}}{R_{Di}} * n_{\mathrm{m\Xi i}} * n_D/d_D\right)^2}{\sigma^2_{n_{d\Xi i}} + \frac{R^2_{\Xi i}}{R^2_{Di}}\left(\frac{\sigma^2_{n_{m\Xi\mathrm{i}}} n^2_{dDi}}{n^2_{mDi}} + \frac{\sigma^2_{n_{\mathrm{dDi}}} n^2_{m\Xi\mathrm{i}}}{n^2_{mDi}} + \frac{\sigma^2_{n_{mDi}} n^2_{m\Xi\mathrm{i}} n^2_{dDi}}{n^4_{mDi}}\right)}$$

- Here $R_i = N \frac{\int_{T_i} pdf_d\,(t)dt}{\int_{T_i} pdf_m\,(t)dt}$ and $pdf(t) = e^{-\frac{t}{\tau}}$

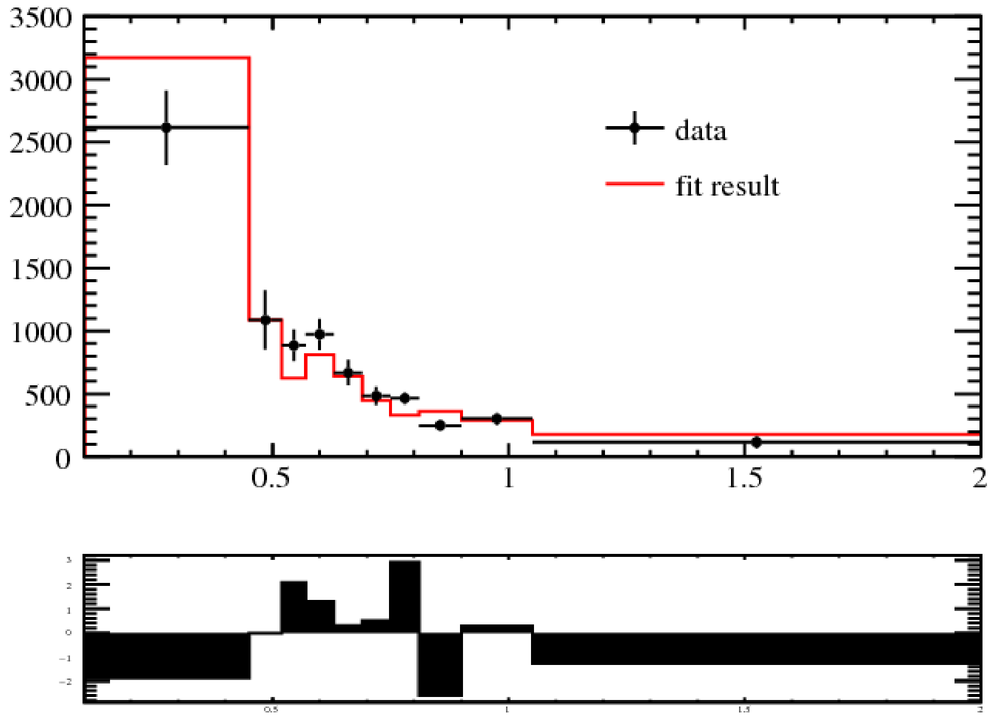
Fit $\tau_{\Xi_c^0}$ use Ξ_c^0 and D^0 data and MC



- $\tau = 150.4 \pm 4.0\ fs$
- $\chi^2/ndf = 22.6/8$

- Input :
  - D0 MC: tau=410fs
  - Xic0 MC: tau=250fs
- MC correction:
  - PIDCalib
  - Dalitz reweight

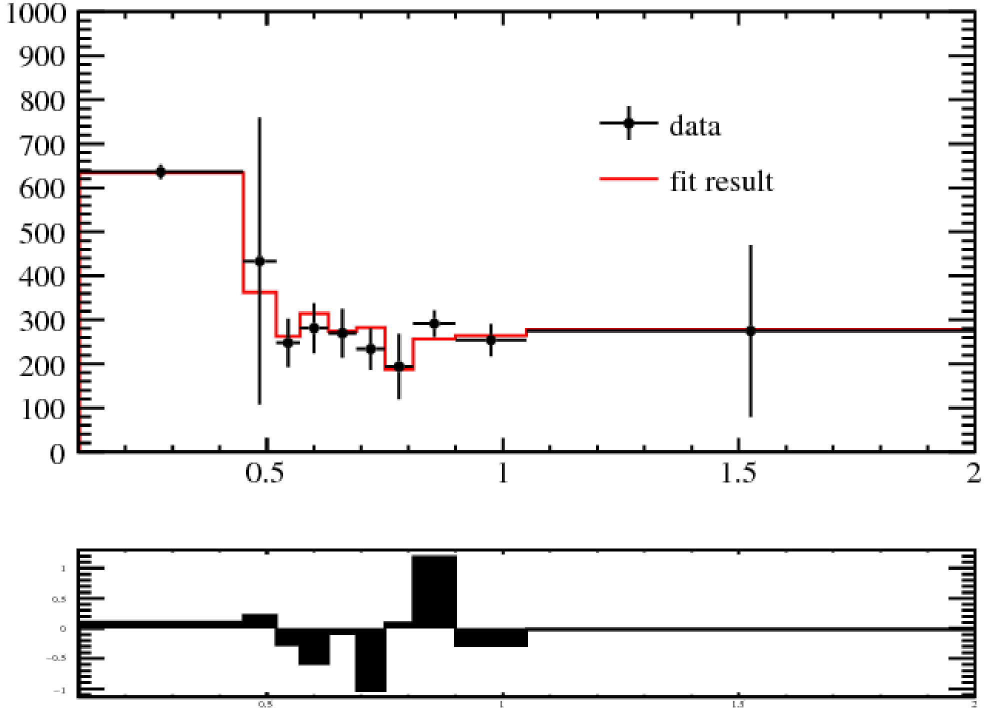
Fit $\tau_{\Xi_c^0}$ use Ξ_c^0 and D^0 data and MC



- $\tau = 145.8 \pm 5.0\ fs$
- $\chi^2/ndf = 14.8/8$

- Input :
  - D0 MC: tau=410fs
  - Xic0 MC: tau=250fs
- MC correction:
  - PIDCalib
  - L0HadronTOS efficiency correction
  - Dalitz reweight

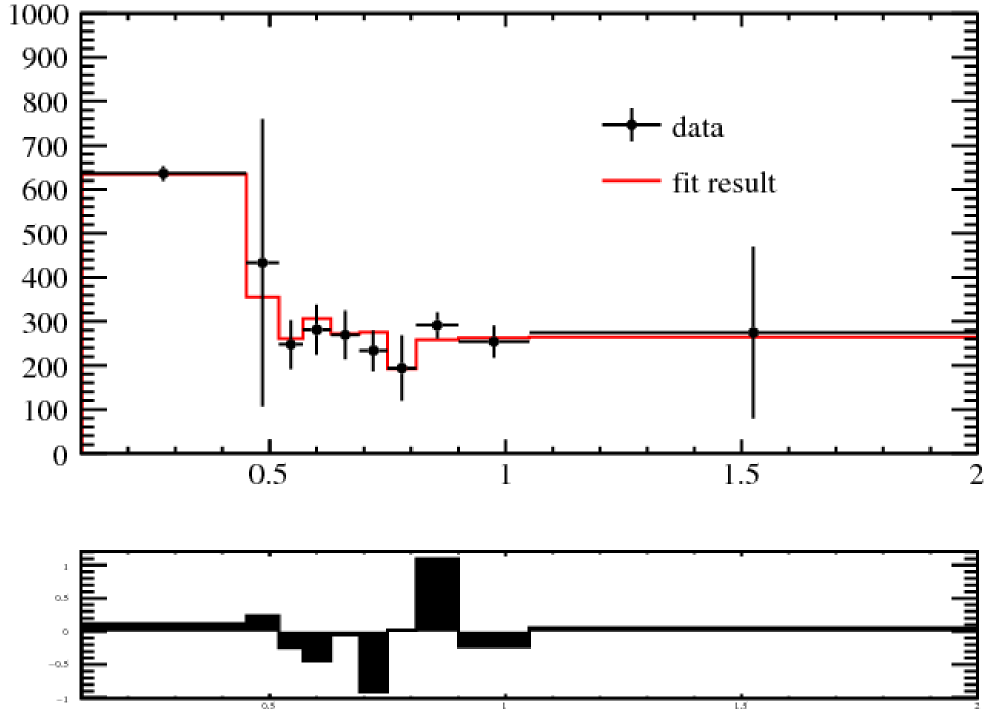
Fit $\tau_{\Omega_c^0}$ use Ω_c^0 and D^0 data and MC



- $\tau = 261.7 \pm 8.9\ fs$
- $\chi^2/ndf = 2.79/8$

- Input :
  - D^0 MC: tau=410fs
  - Ω_c^0 MC: tau=250fs
- MC correction:
  - PIDCalib
  - Dalitz reweight

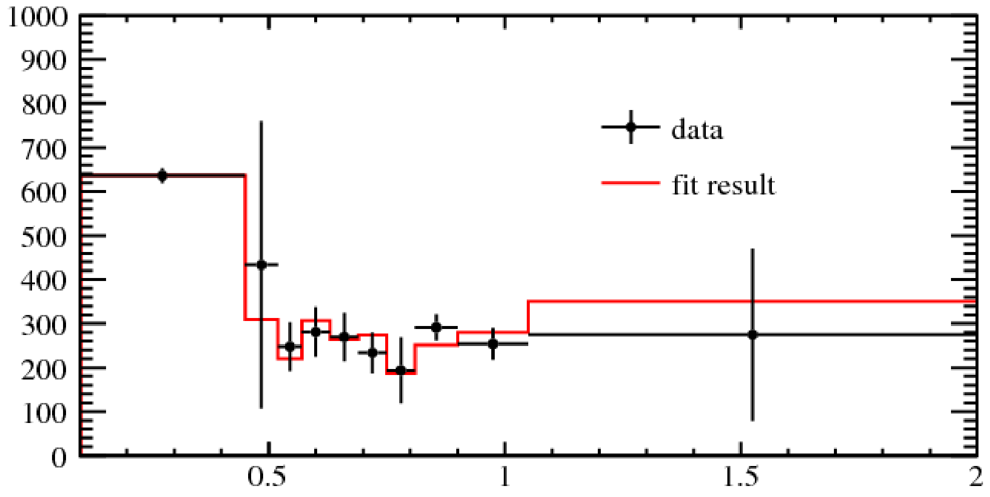
Fit $\tau_{\Omega_c^0}$ use Ω_c^0 and D^0 data and MC

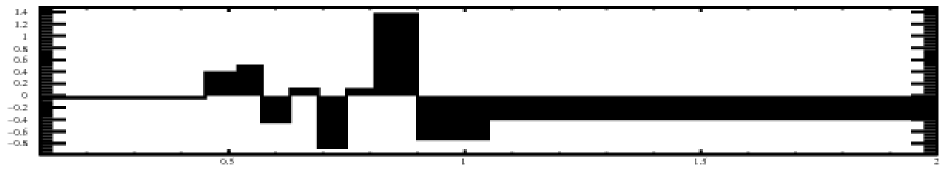


- $\tau = 248.6 \pm 8.8\ fs$
- $\chi^2/ndf = 1.86/8$

- Input :
  - D^0 MC: tau=410fs
  - Ω_c^0 MC: tau=250fs
- MC correction:
  - PIDCalib
  - L0HadronTOS efficiency correction
  - Dalitz reweight

Fit $\tau_{\Omega_c^0}$ use Ω_c^0 and D^0 data and MC



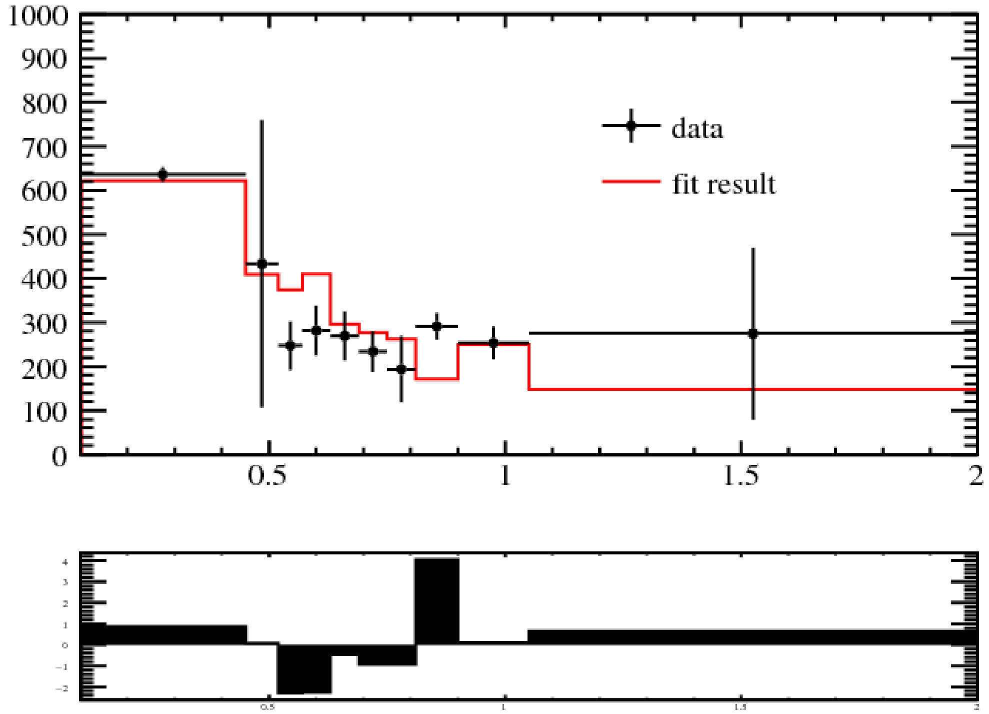


- $\tau = 300 \pm 11\ fs$
- $\chi^2/ndf = 3.7/8$

- Input :
  - D^0 MC: tau=410fs
  - Ω_c^0 MC: tau=500fs
- MC correction:
  - PIDCalib
  - Dalitz reweight

- Effect of MC lifetime?

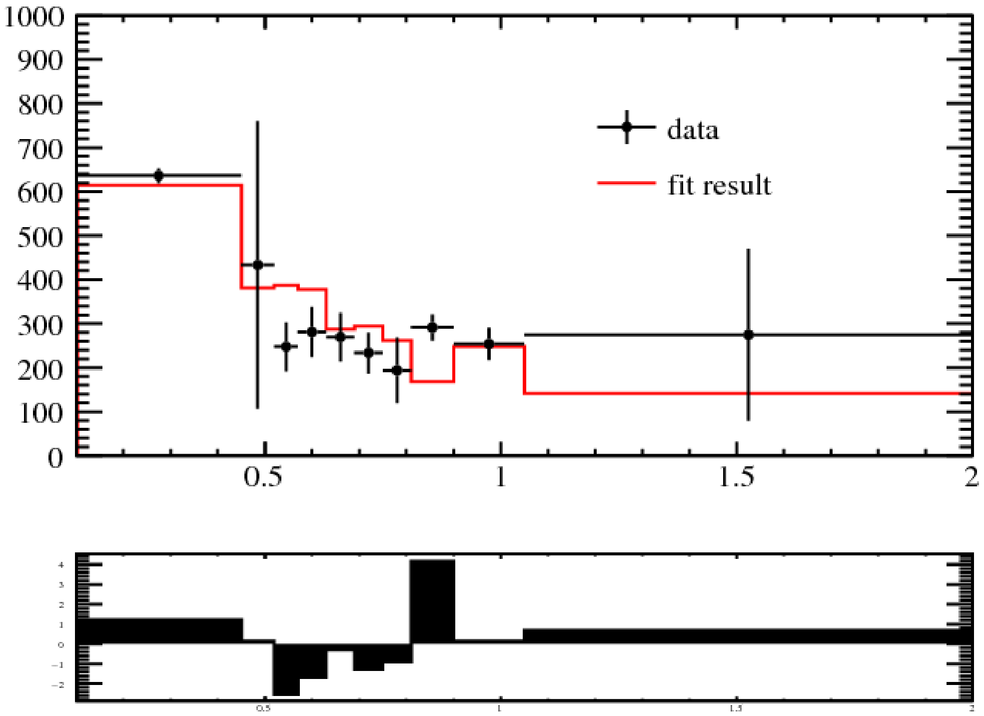
Fit $\tau_{\Omega_c^0}$ use Ω_c^0 and Ξ_c^0 data and MC



- $\tau = 244.0 \pm 8.8\ fs$
- $\chi^2/ndf = 24.6/8$

- Input :
  - Ξ_c^0 MC: tau=150fs
  - Ω_c^0 MC: tau=250fs
- MC correction:
  - PIDCalib
  - Dalitz reweight

Fit $\tau_{\Omega_c^0}$ use Ω_c^0 and Ξ_c^0 data and MC



- $\tau = 240.0 \pm 11.1\ fs$
- $\chi^2/ndf = 15.6/8$

- Input :
  - Ξ_c^0 MC: tau=150fs
  - Ω_c^0 MC: tau=250fs
- MC correction:
  - PIDCalib
  - L0HadronTOS efficiency correction
  - Dalitz reweight