Heavy-meson reconstruction at the FCC-ee

Update Talk

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Repetition: Origin of the D^0

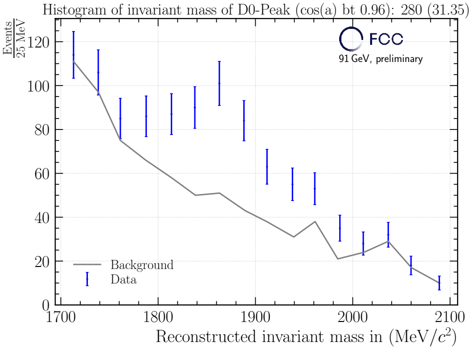
- **Goal**: Consideration of CP violation
- **Problem**: Need to know if reconstructed D^0 was particle or anti-particle
- **Solution**: Focusing on the D^0 produced from D^{*+}
  - In an inclusive $e^+e^- \to c\bar{c}$ sample: $\approx 24\%$

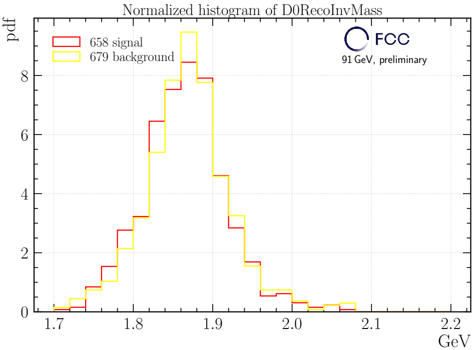
$$D^{\star +} \to D^0 \pi^+ \qquad D^{\star -} \to \bar{D}^0 \pi^-$$

- Charge of the additional pion correlates to nature of the D^0
- Potentially reducing background events in signal region

Repetition: Where we stand

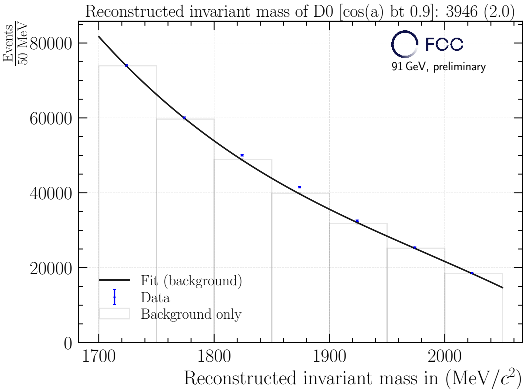
- Reconstructed D^0 peak from the inclusive $c\bar{c}$-sample
- Found $D^{*+} \to D^0\pi^+$ events, but no peak
- Using D^{*+} decay to label D^0 and $\bar{D}^0$

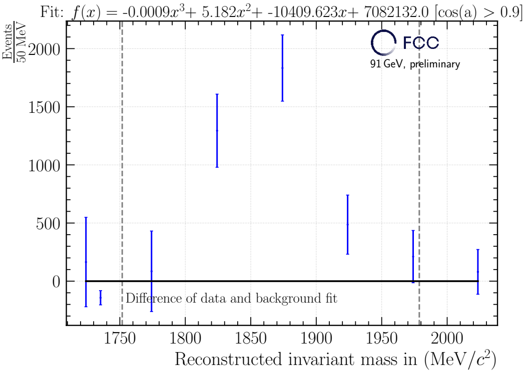




New method to identify peak

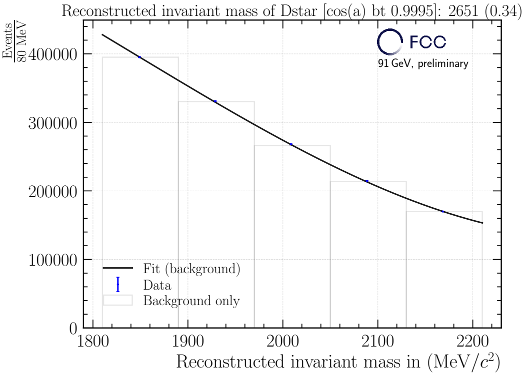
- Fitting background distribution to estimate background in each bin
- Considering $(D^0_{cand} - D^0_{bg-fit})$ to visualize signal peak

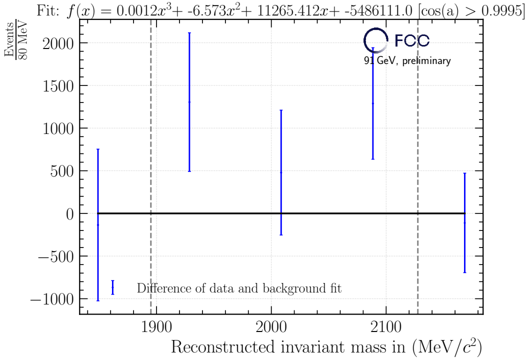




Using new method for D^{*+} peak

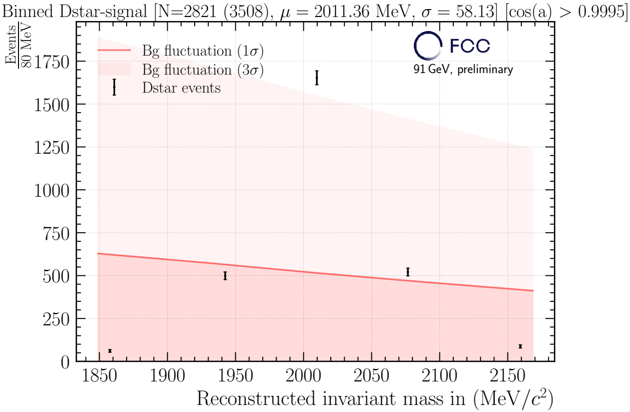
- Considering $(D^{*+}_{cand} - D^{*+}_{bg-fit})$ to visualize signal peak
- Bad result, because signal is in the order of magnitude of background uncertainty





Handling the D^{*+} peak

- D^{*+} signal is in the order of magnitude of background uncertainty (100 Mil. events)



To achieve

$N_{sig} > 3\sigma_{bg} = 3\sqrt{N_{bg}}$

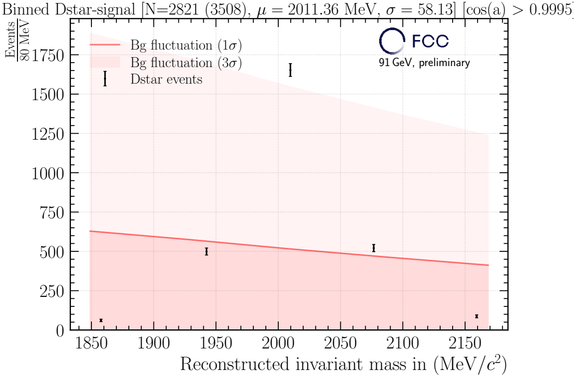
- More statistics
- Wider binning
- Better selection (cuts)

Additonally fitting is crucial

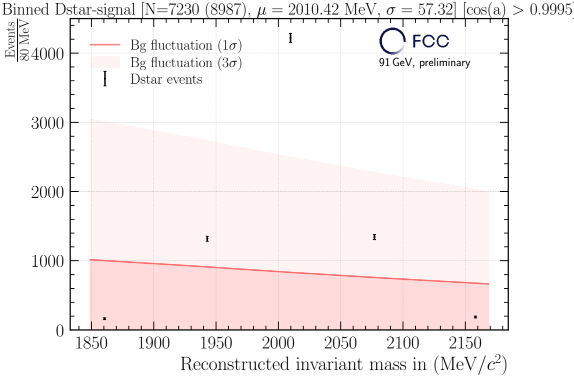
More statistics: D^{*+} peak

- With more statistics (N=250 Mil. events), signal becomes more significant
- Signal grows linear with N, background with $\sqrt{N}$

$N_{events} = 100$ Mil.

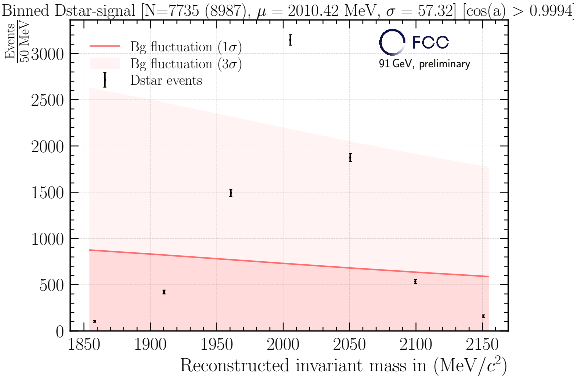


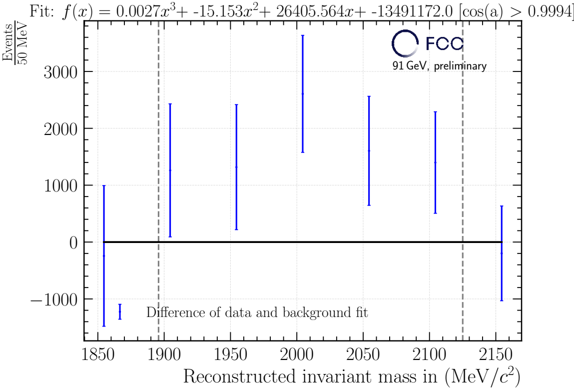
$N_{events} = 250$ Mil.



More statistics: D^{*+} peak

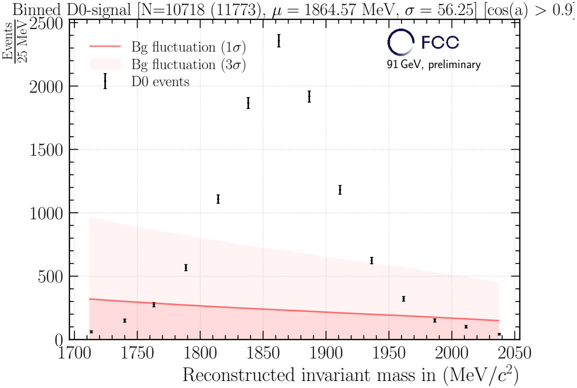
- Considering $(D^{*+}_{cand} - D^{*+}_{bg-fit})$ to visualize signal peak (250 Mil. events)

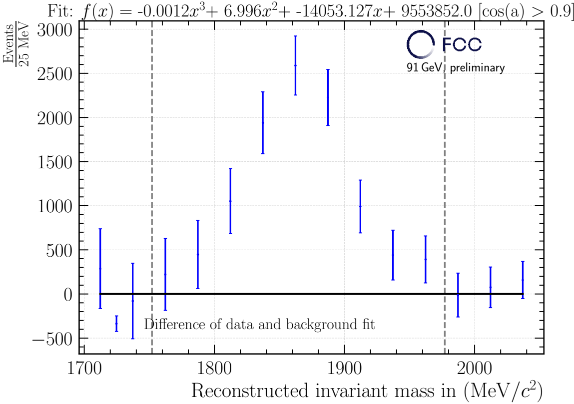




More statistics: D^0 peak

- Considering $(D^0_{cand} - D^0_{bg-fit})$ to visualize signal peak (250 Mil. events)





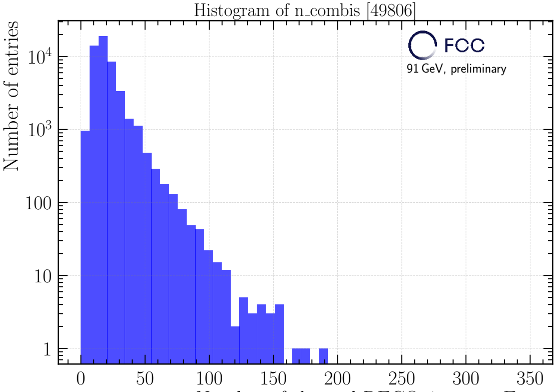
Do a better selection to decrease $N_{background}$ - Reduce combinatorics

Simple selection:

- Only D^0-candidate with the biggest momentum
- Choose π^0 with smallest angle to this D^0
- $n_{D^*} = n_{D^0} \times n_{\pi^+} = 1 \times 1 = 1$

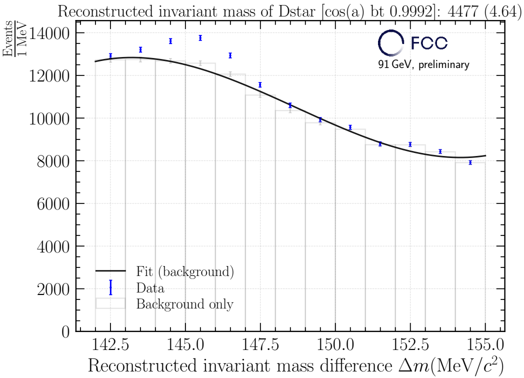
To achieve: $N_{sig} > 3\sigma_{bg} = 3\sqrt{N_{bg}}$

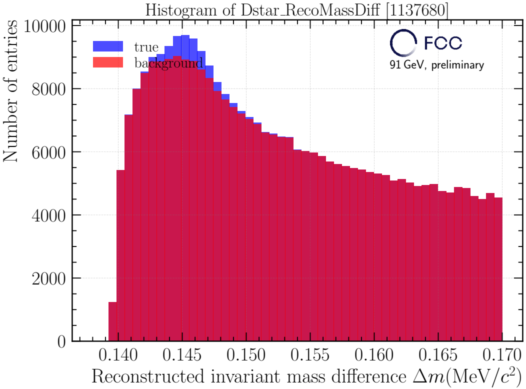
- More **statistics**
  $\rightarrow$ Using all avaible
- Wider **binning**
  $\rightarrow$ Maximize resolution
- Better selection (**cuts**)



Plot mass difference $\Delta m = m(D^{*+}) - m(D^0)$

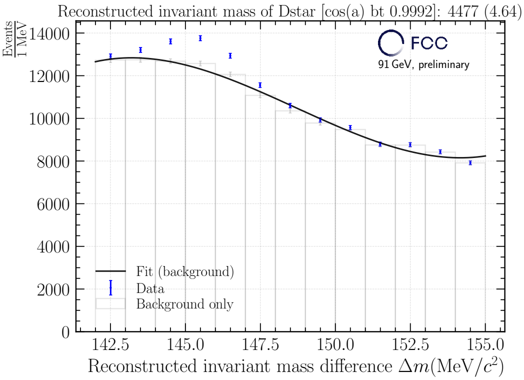
- Considering the mass difference reduces the impact of statistical fluctuations, leading to improved signal-to-background ratio

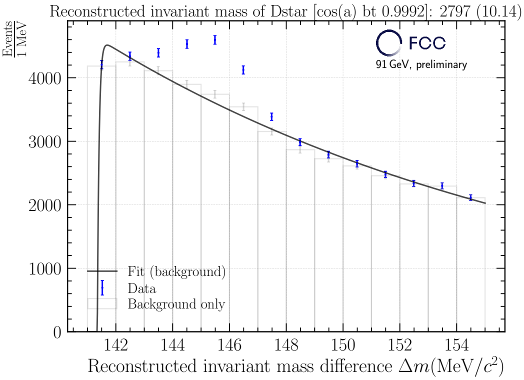




Plot mass difference $\Delta m = m(D^{*+}) - m(D^0)$

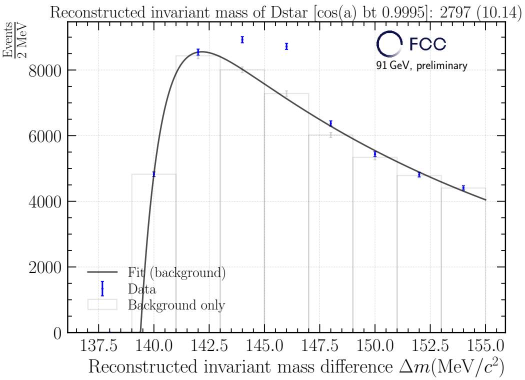
- Reducing background by setting requirement $1.8 GeV < m(D^0) < 1.93 GeV$ to the choosen D^0 candidate

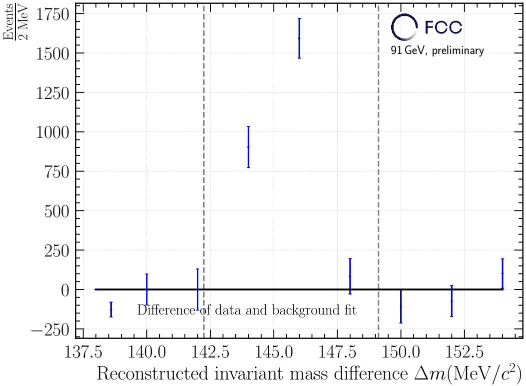




Plot mass difference $\Delta m = m(D^{*+}) - m(D^0)$

- **Result** of $(\Delta m_{cand} - \Delta m_{bg-fit})$ for **50 Mil. events**
- Fit data next to signal region with $F(x, a, b, c) = a(1 - e^{-bx})e^{-cx} * H(d)$
- Selection and fit are both **WIP**





Summary & Outlook

- **Mass difference** $\Delta m = m(D^{*+}) - m(D^0)$ is the **variable of interest**
- With right relation of N_{signal} and $N_{background}$ **peak can be reconstructed**
  - More **statistics** $\rightarrow$ Using all avaible
  - Wider **binning** $\rightarrow$ Maximize resolution
  - Better selection (**cuts**) $\rightarrow$ Optimize with **MVA?**

Thanks for listening!

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