

Comparison of the signal MC with data

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Data sets and tagged modes

Boss version: 7.0.6

Data sample:

\sqrt{s} (GeV)	Run ID	\mathcal{L}_{int} (pb $^{-1}$)
4.6115	64314-64360	102.35
4.6277	63075-63515	519.07
4.6405	63516-63715	536.83
4.6609	63718-63852	525.54
4.6816	63867-64015, 64365-65092	1659.22
4.6984	64028-64313	533.35
4.7397	65208-65297	58.06
4.7501	65322-65491	184.74
4.7804	65495-65605	328.72
4.8421	65647-65841	271.57
4.9180	65868-65935	121.31
4.9503	65938-66224	149.89

Single tag method with the golden mode $\Lambda_c^+ \rightarrow p^+ K^- \pi^+$ and $\bar{\Lambda}_c^- \rightarrow \bar{p} K^+ \pi^-$.

The double counting events are negligible (less than 0.5%).

MC samples

► Inclusive MC:

- including $e^+e^- \rightarrow \Lambda_c^+\bar{\Lambda}_c^-, q\bar{q}, \tau^+\tau^-, e^+e^-, \mu^+\mu^-$ and $e^+e^- + X$.
- Channel $q\bar{q}$ is generated by inclusive generator, with $\Lambda_c^+\bar{\Lambda}_c^-$ events excluded.
- Channel $\Lambda_c^+\bar{\Lambda}_c^-$ is generated by KKMC, where Λ_c decays inclusively.

► Signal **efficiency-determining** MC: $e^+e^- \rightarrow \Lambda_c^+\bar{\Lambda}_c^-$

- Generated by KKMC, where a phenomenological line-shape is implemented.
- $\Lambda_c^+(\bar{\Lambda}_c^-)$ decays to the golden mode, while $\bar{\Lambda}_c^-(\Lambda_c^+)$ decays inclusively.
- 0.6M events are generated at each c.m. energy.

► Signal **shape-extracting** MC: $e^+e^- \rightarrow \Lambda_c^+\bar{\Lambda}_c^-$

- Generated by KKMC, where a phenomenological line-shape is implemented.
- $\Lambda_c^+(\bar{\Lambda}_c^-)$ decays to the golden mode, while $\bar{\Lambda}_c^-(\Lambda_c^+)$ decays to $e^-\nu_e(e^+\bar{\nu}_e)$.
- 0.6M events are generated at each c.m. energy.

For all signal MC samples:

- Decay pattern of $\Lambda_c^+ \rightarrow pK^-\pi^+$ is modeled based on **BDT** by Xudong Yu.
- The distribution of polar angle of Λ_c^+ is implemented in generator.

Event selection

Good charged track selection:

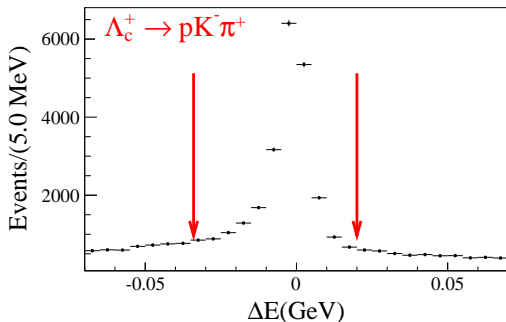
- $|V_z| < 10$ cm, $V_r < 1$ cm and $|\cos\theta| < 0.93$.
- dE/dx and TOF information are used in PID, in which the highest probability is required among the hypothesis of Proton, Kaon and Pion.
- Vertex fit is implemented.

Analysis strategy:

- ΔE and M_{BC} are used to extract signal events.
- Minimum $|\Delta E|$ is required for multiple candidates.
- The variable M_{BC} is utilized to determine the signal yields.
- Detection efficiencies are obtained by fitting M_{BC} of MC.
- $\Lambda_c^+ \rightarrow pK^-\pi^+$ and $\bar{\Lambda}_c^- \rightarrow \bar{p}K^+\pi^-$ events are treated **separately**.
- Total cross section is obtained from **weighted average**.

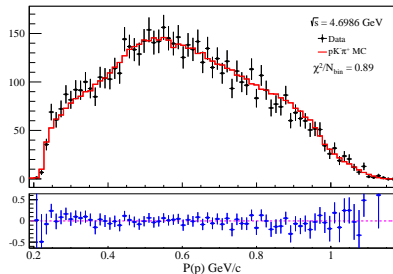
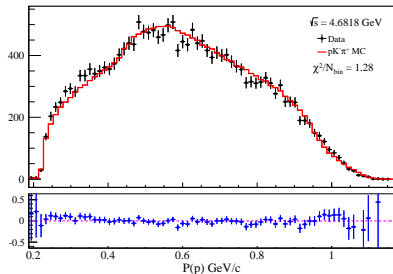
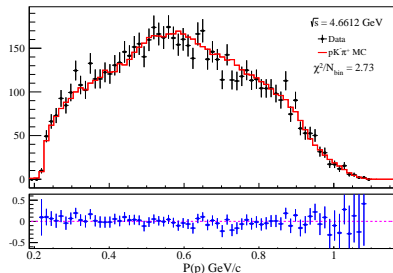
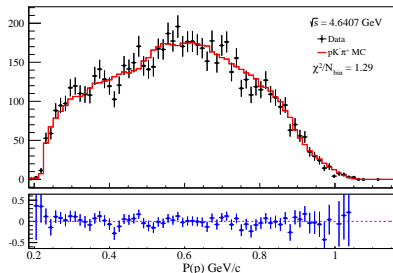
$$\Delta E = E_{\Lambda_c} - E_{\text{beam}}, \quad M_{BC} = \sqrt{E_{\text{beam}}^2/c^4 - |\vec{p}_{\Lambda_c}|^2/c^2}$$

Energy difference distribution at 4.6816 GeV



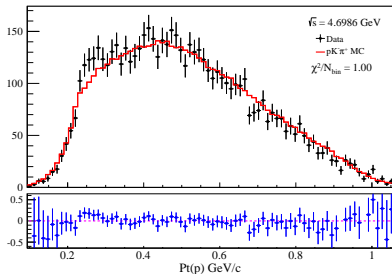
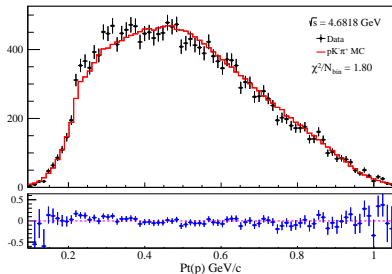
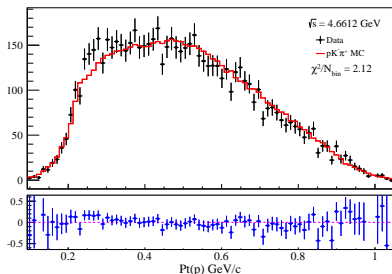
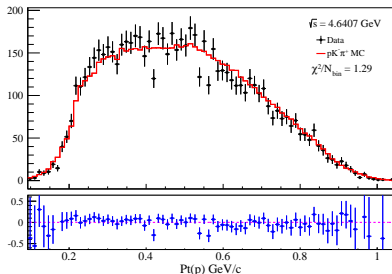
- The ΔE distribution of golden mode at $\sqrt{s} = 4.6816$ GeV.
- M_{BC} requirement, i.e. $M_{BC} \in (2.276, E_{\text{beam}})$ GeV/ c^2 is applied.
- Combined data of two charge conjugate sectors.
- Red arrows indicate signal window: $\Delta E \in (-34, 20)$ MeV.
- The signal window is applied to both Λ_c^+ and $\bar{\Lambda}_c^-$ candidates for all energies.

Comparisons between MC and data: $P(p)$



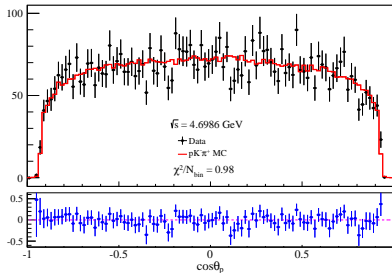
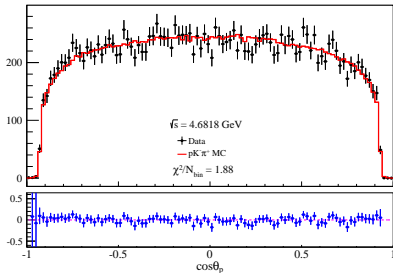
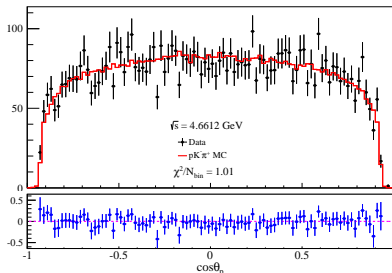
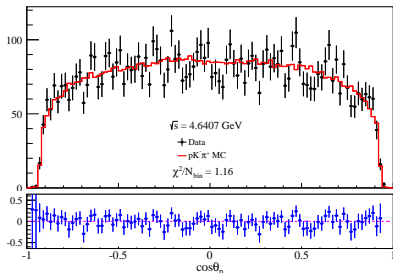
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $P_t(p)$



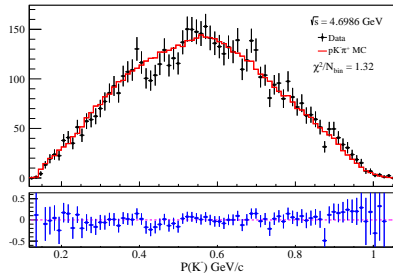
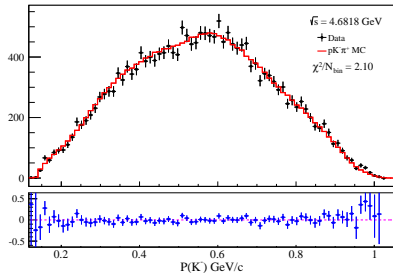
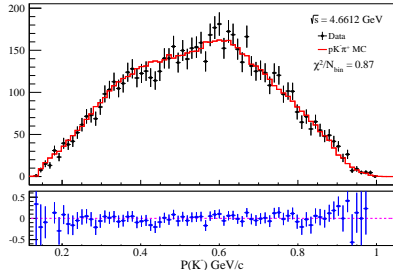
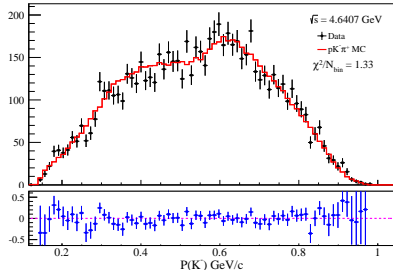
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $\cos\theta(p)$



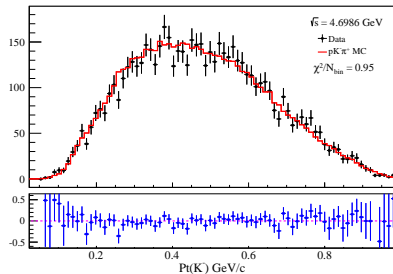
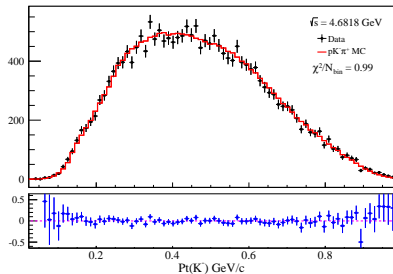
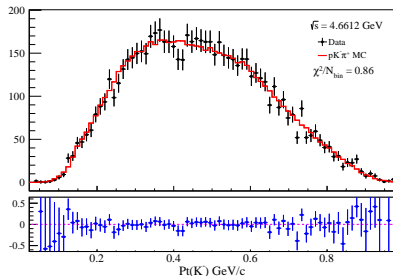
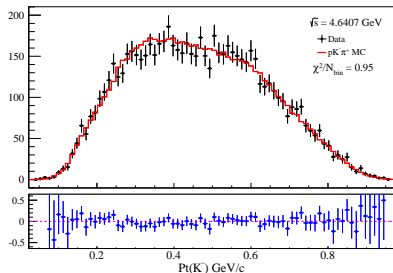
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $P(K^-)$



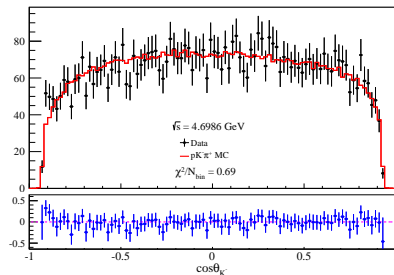
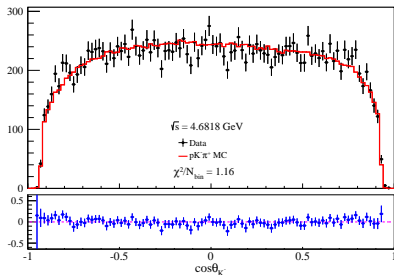
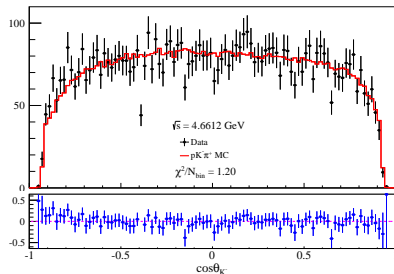
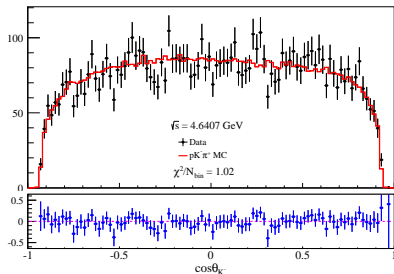
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $P_t(K^-)$



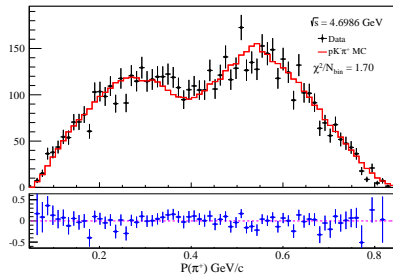
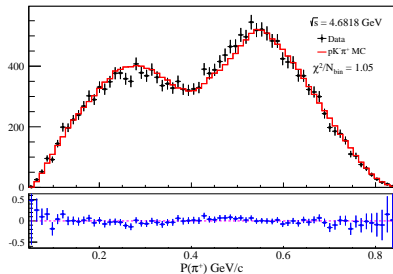
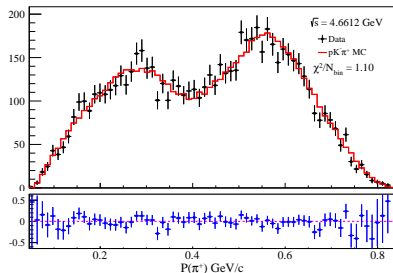
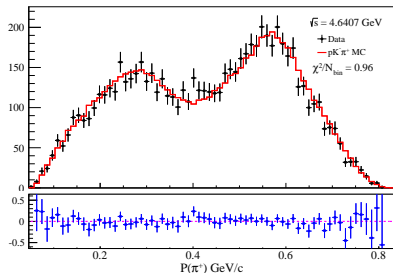
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $\cos\theta(K^-)$



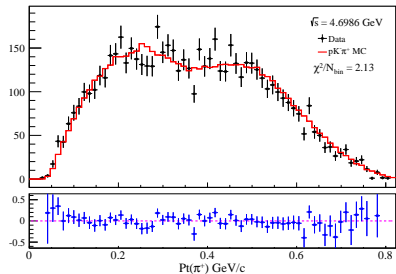
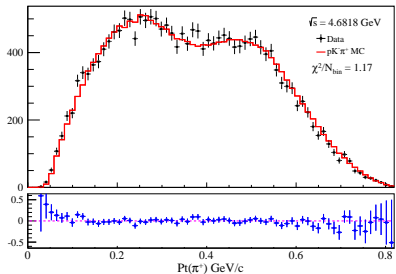
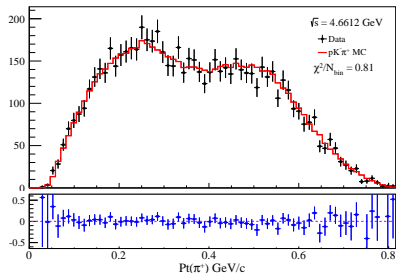
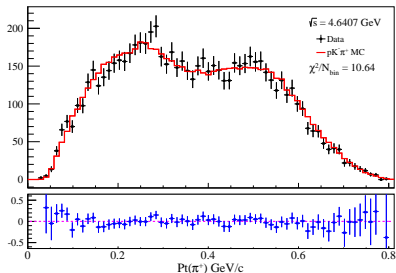
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $P(\pi^+)$



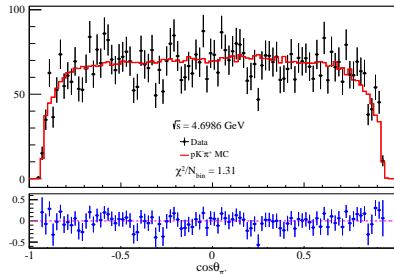
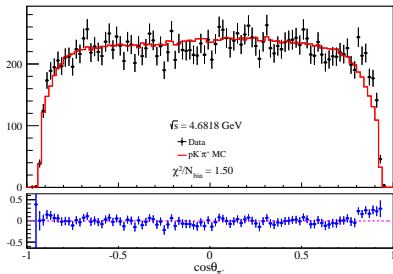
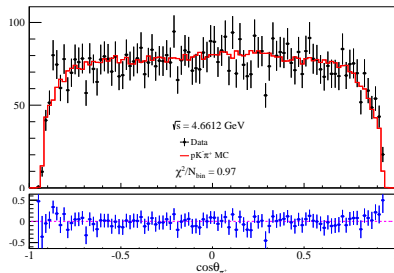
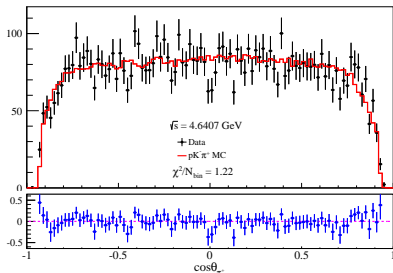
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $P_t(\pi^+)$



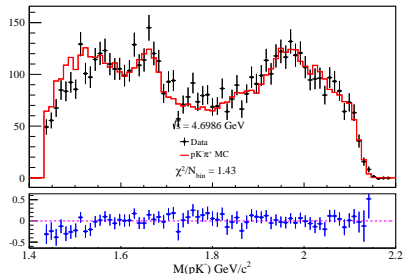
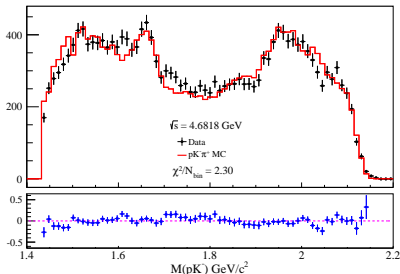
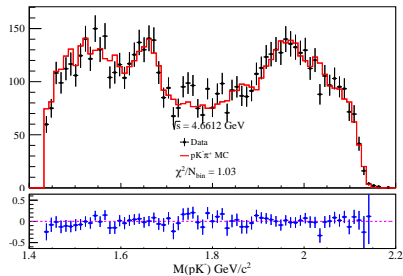
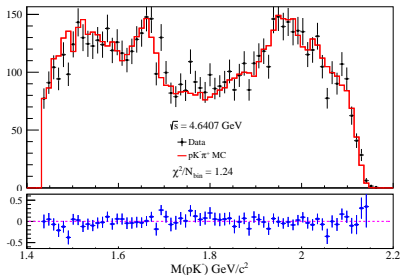
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $\cos\theta(\pi^+)$



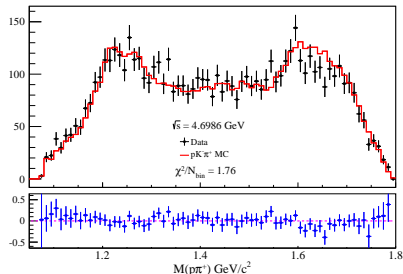
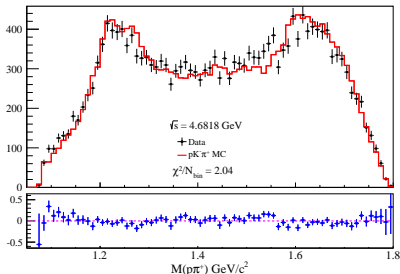
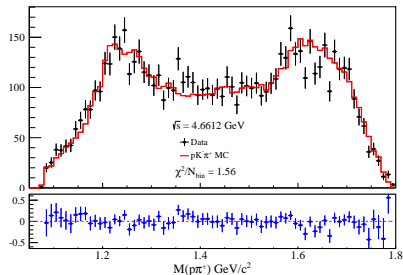
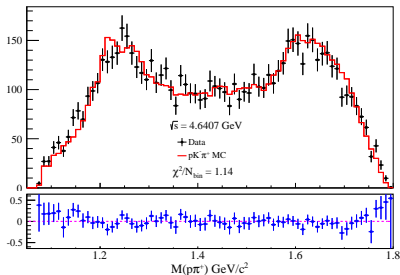
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $M(pK^-)$



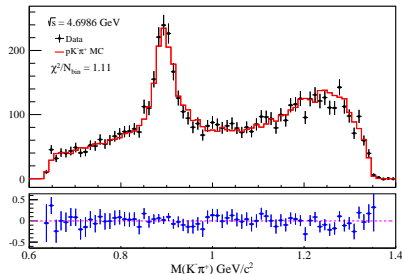
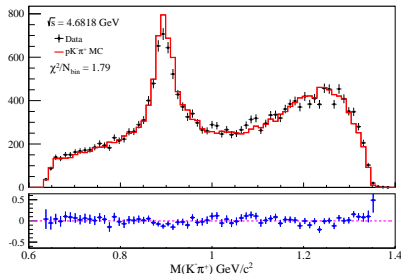
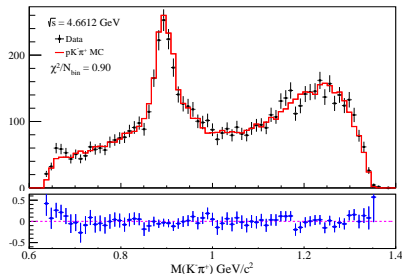
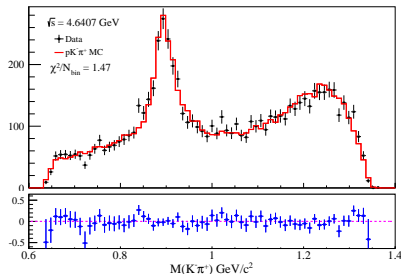
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $M(p\pi^+)$



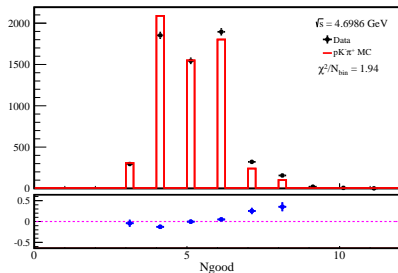
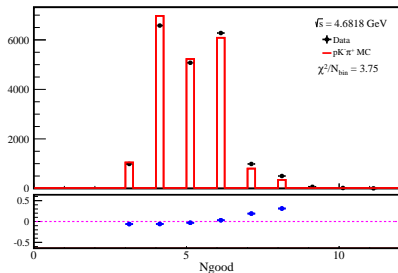
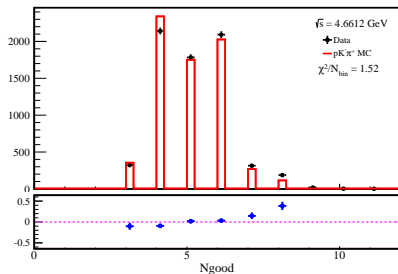
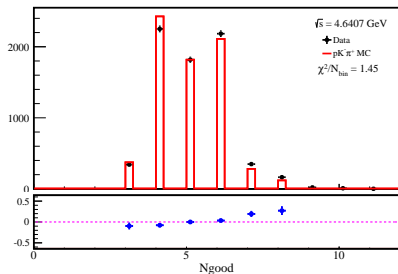
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $M(K^-\pi^+)$



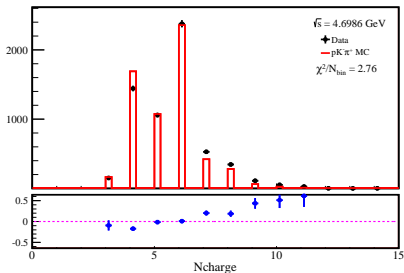
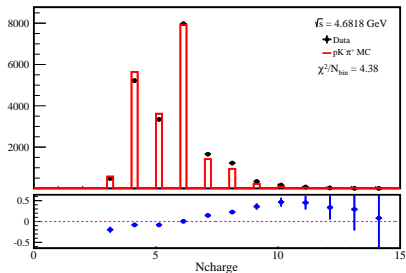
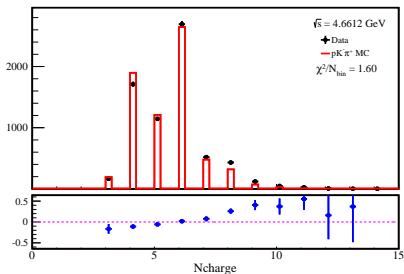
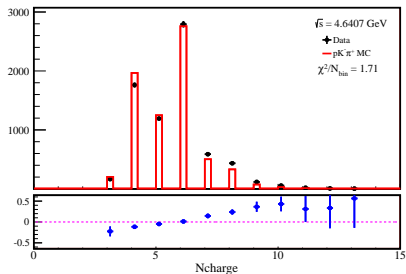
- All selection criteria for signal events are implemented.

Comparisons between MC and data: N_{good}



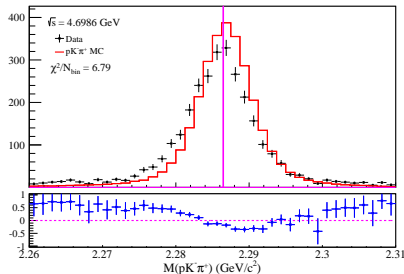
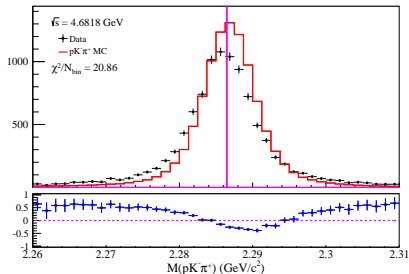
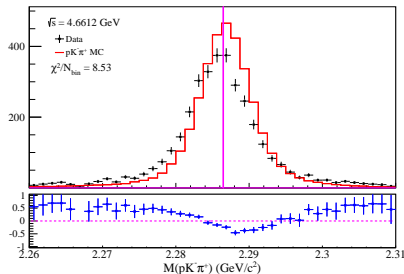
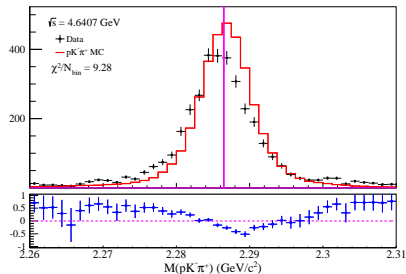
- All selection criteria for signal events are implemented.

Comparisons between MC and data: N_{charge}



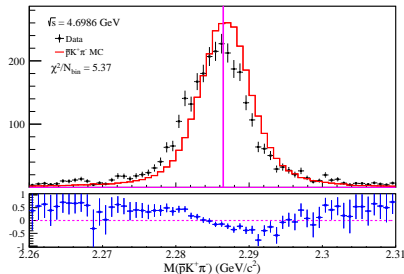
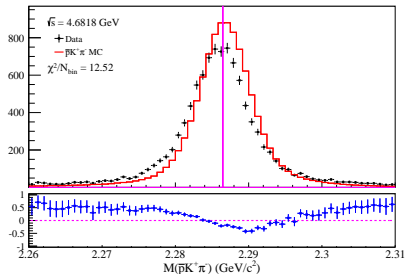
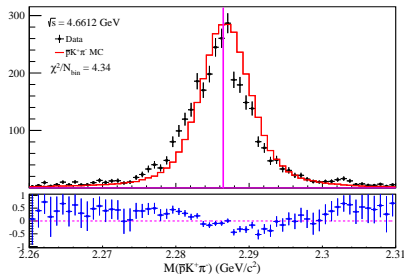
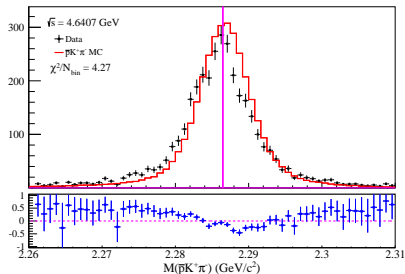
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $M(pK^-\pi^+)$



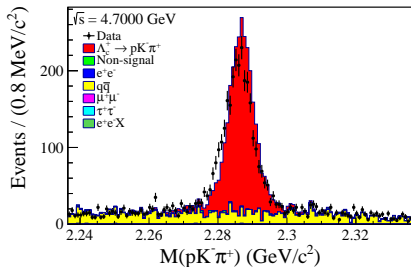
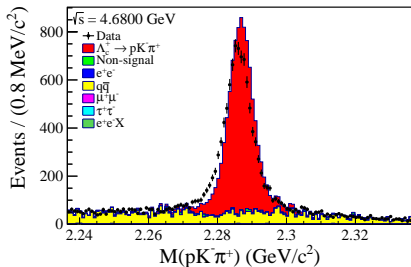
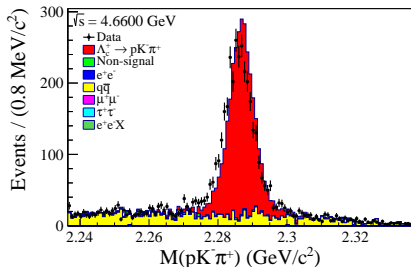
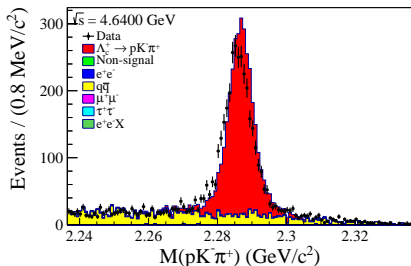
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $M(\bar{p}K^+\pi^-)$



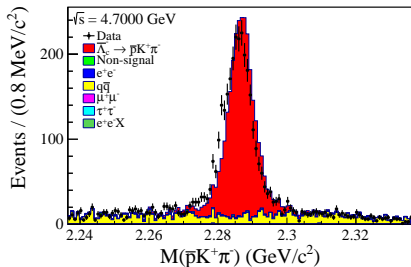
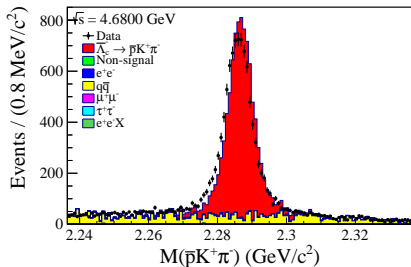
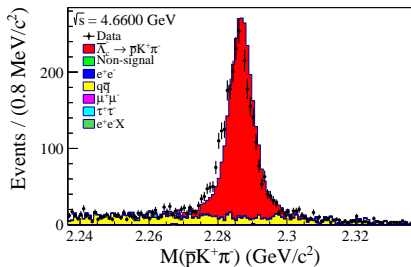
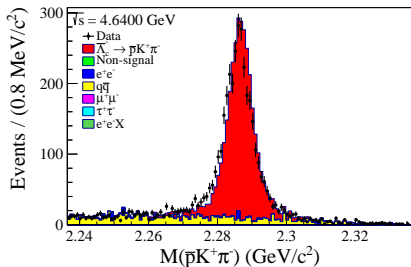
- All selection criteria for signal events are implemented.

Comparisons between MC and data: $M(pK^-\pi^+)$



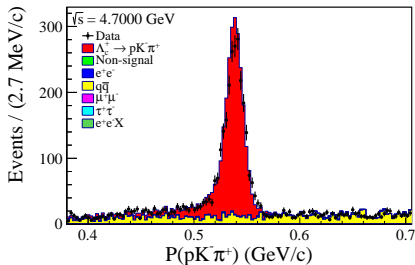
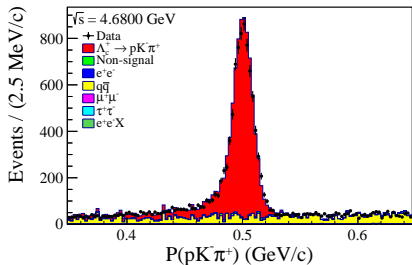
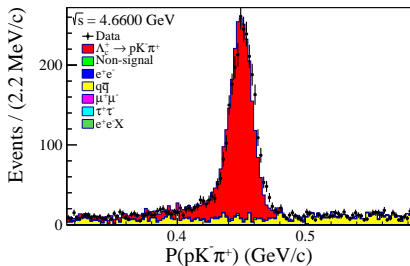
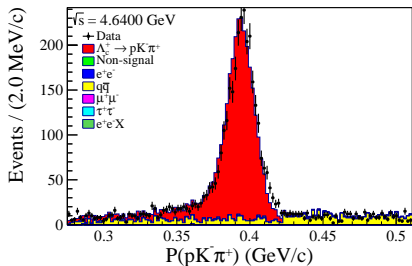
- All MC samples are normalized according to luminosity.

Comparisons between MC and data: $M(\bar{p}K^+\pi^-)$



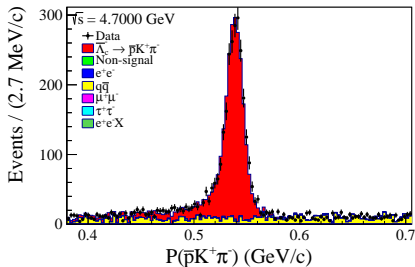
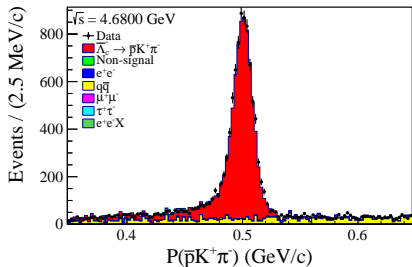
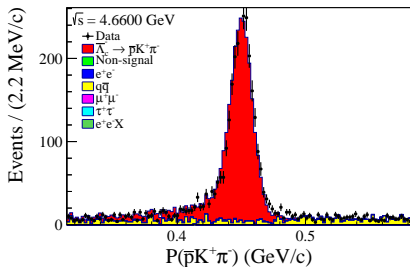
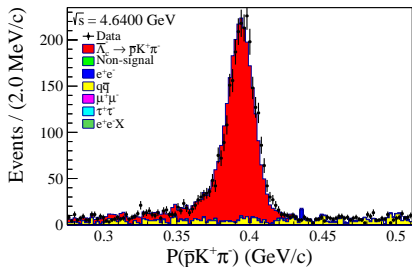
- All MC samples are normalized according to luminosity.

Comparisons between MC and data: $P(pK^-\pi^+)$



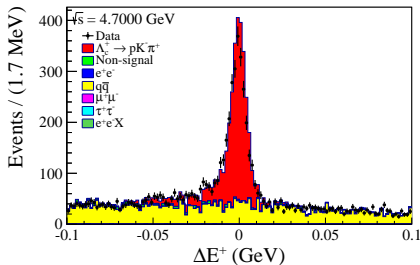
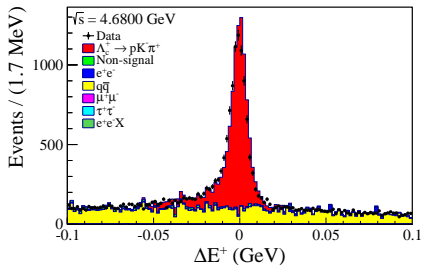
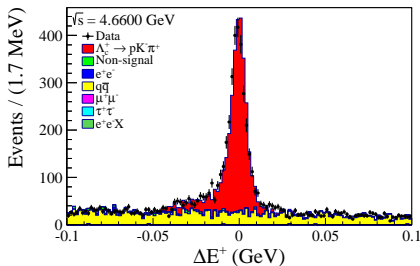
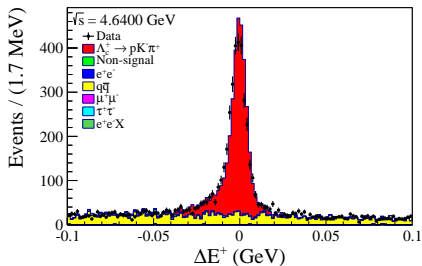
- All MC samples are normalized according to luminosity.

Comparisons between MC and data: $P(\bar{p}K^+\pi^-)$



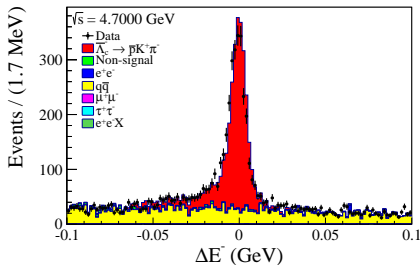
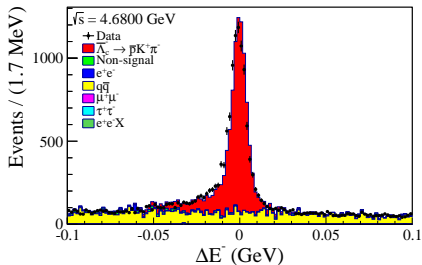
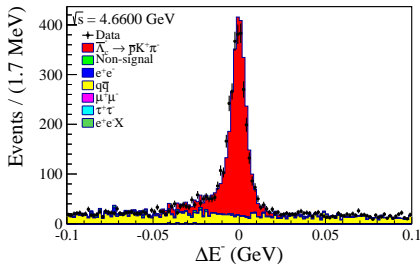
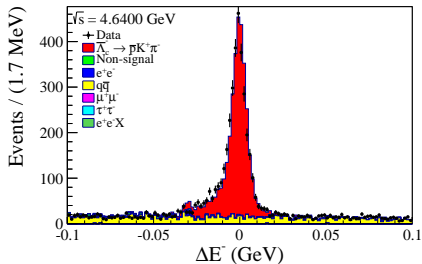
- All MC samples are normalized according to luminosity.

Comparisons between MC and data: $\Delta E(pK^-\pi^+)$



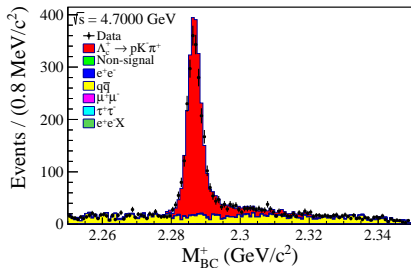
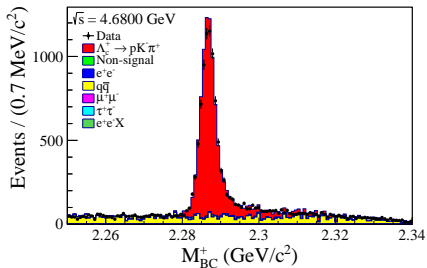
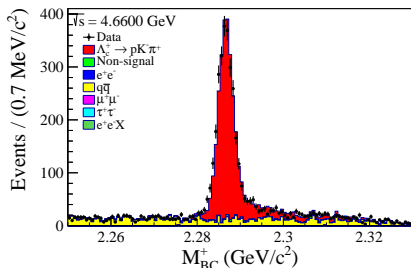
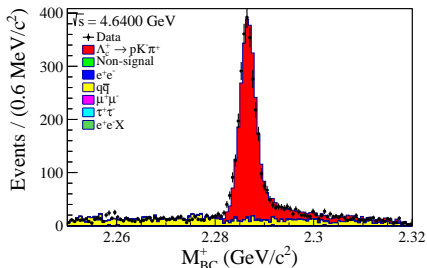
- All MC samples are normalized according to luminosity.

Comparisons between MC and data: $\Delta E(\bar{p}K^+\pi^-)$



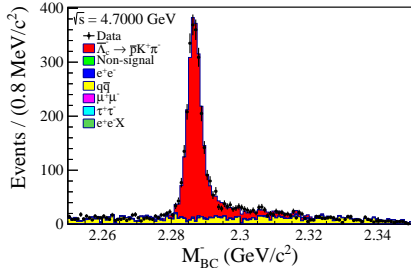
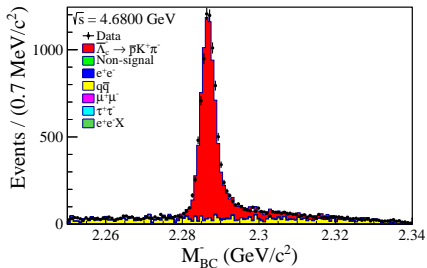
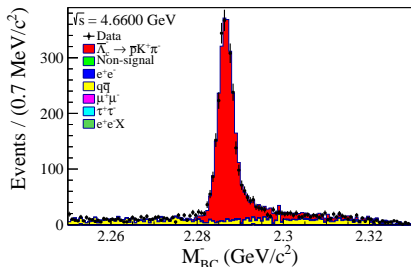
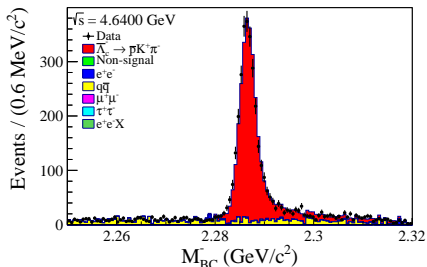
- All MC samples are normalized according to luminosity.

Comparisons between MC and data: $M_{BC}(pK^-\pi^+)$



- All MC samples are normalized according to luminosity.

Comparisons between MC and data: $M_{BC}(\bar{p}K^+\pi^-)$



- All MC samples are normalized according to luminosity.