Study of the central exclusive production of $\pi^+\pi^-$, K^+K^- and $p\bar{p}$ pairs in proton-proton collisions at $\sqrt{s} = 510$ GeV with the STAR detector at RHIC

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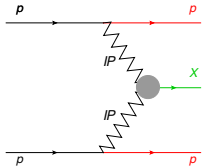
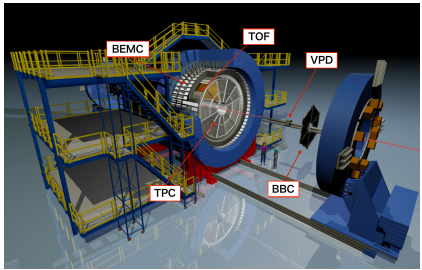
Central exclusive production:

$$p + p \rightarrow p \overset{\Delta\eta_1}{\oplus} X \overset{\Delta\eta_2}{\oplus} p$$



- Colliding protons stay intact and are measured in the Roman Pots
- Produced **central** system X is well separated by rapidity gaps from the outgoing protons p
- **Central** system X is fully measured in the TPC and in the TOF systems
- Double Pomeron Exchange is expected to be dominant at the RHIC energies
- Each proton "emits" a Pomeron, the Pomerons fuse and produce neutral system X
- Focusing on $p + p \rightarrow p\ h^+h^-\ p$, where h^+h^- stands for $\pi^+\pi^-$, K^+K^- and $p\bar{p}$
- For the **exclusive** process $p_{\mathrm{T}}^{miss} = \left(\vec{p}_1 + \vec{p}_2 + \vec{h}_+ + \vec{h}_-\right)_{\mathrm{T}} = 0$ because of the conservation of momentum $\Rightarrow$ events with small p_{T}^{miss} are **Exclusive**



STAR's unique capabilities for CEP study:

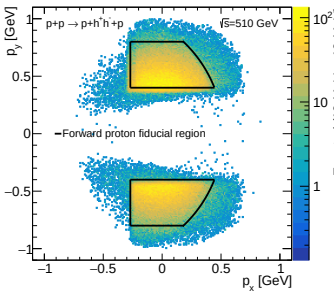
- High-resolution tracking of charged particles in the TPC covering $|\eta| < 1$ and full azimuthal angle
- Precise particle identification through the measurement of dE/dx and TOF
- Forward rapidity Beam-Beam Counters $2.1 < |\eta| < 5.0$ used to ensure rapidity gaps
- Silicon Strip Detectors in Roman Pots allowing full reconstruction of the forward proton momentum

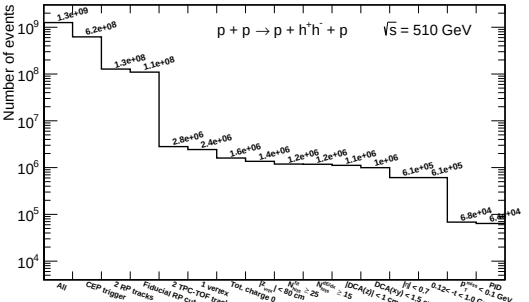
Data sample:

- Data from proton-proton collisions at $\sqrt{s} = 510$ GeV
- 622M CEP triggers were analyzed

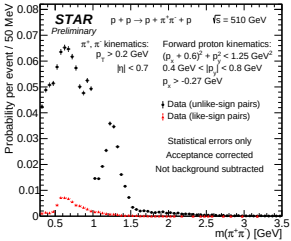
Events selection:

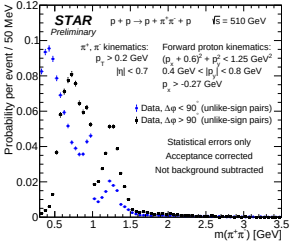
- Exactly two tracks in Roman Pots inside the p_x, p_y fiducial region with all eight silicon planes used in reconstruction
- Exactly two primary TPC tracks matched with two TOF hits and originating from the same vertex
- Total charge of those tracks equals 0 (looking for h^+h^-)
- $|z\text{-position of vertex}| < 80$ cm
- Good TPC track quality cuts and $|\eta| < 0.7$
- Four momentum transfer squared t at the proton vertices $0.12\ \text{GeV}^2 < -t < 1.0\ \text{GeV}^2$
- Sum of the transverse momentum of the measured particles $p_{\mathrm{T}}^{miss} < 100$ MeV
- Particles were identified using the dE/dx and TOF
- After all the above selection criteria:
  62077 $\pi^+\pi^-$, 1697 K^+K^- and 125 $p\bar{p}$

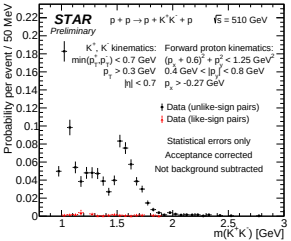


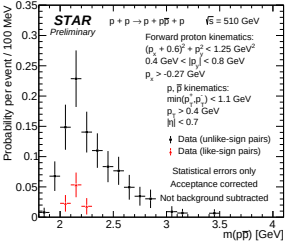


Results, summary and outlook









Summary:

- The first results on the central exclusive production of $\pi^+\pi^-$, K^+K^- and $p\bar{p}$ pairs in proton-proton collisions at $\sqrt{s} = 510$ GeV measured by the STAR experiment at RHIC have been presented
- Invariant mass of $\pi^+\pi^-$ shows the expected features, a drop at about 1 GeV and a peak consistent with the $f_2(1270)$
- Measurement of the diffractively scattered protons allowed full control of the interaction's kinematics and verification of its exclusivity

Outlook:

- There are ongoing studies of $\pi^+\pi^-$, K^+K^-, $p\bar{p}$ and $\pi^+\pi^-\pi^+\pi^-$ channels
- An analysis involving the partial wave analysis in the $\pi^+\pi^-$ channel is planned

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