

Investigations of Detector Signatures from $\Lambda\bar{\Lambda}$ and $\Xi^-\Xi^+$ Events

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Outline

- **Motivation**
 - Dynamical Track and Event Reconstruction
 - SttCellTrackFinder
- $\Lambda\bar{\Lambda}$ **events**
 - STT signatures
 - MVD and SciTil signals
- $\Xi\bar{\Xi}$ **events**
 - STT signatures
 - MVD and SciTil signals
- Outlook and Summary

Motivation

- Hyperons might be difficult to reconstruct due to their decay topology with e.g. displaced vertices

Hyperon	$c\tau$ [cm]
Λ	8.0
Ξ^-	4.9

- DyTER-Dynamical Track and Event Reconstruction
- STTCellTrackFinder
 - Cellular Automaton to form tracklets from STT hits
 - Riemann fit to combine tracklets

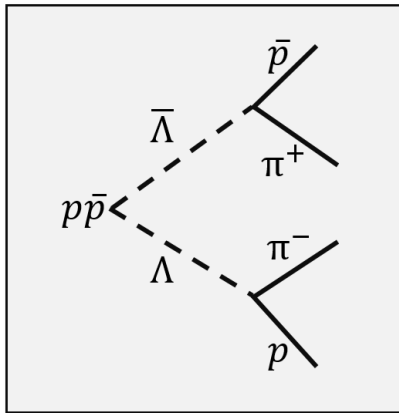
Goal: Dynamic track finder which is as general as possible but works for hyperon tracking

Motivation

Focus:

- $\Lambda\bar{\Lambda}$ and $\Xi^-\Xi^+$ events due to their complex decay topology
- MVD and STT for tracking
- MVD and SciTil for possibility of providing a t_0

$$p\bar{p} \rightarrow \Lambda\bar{\Lambda} \rightarrow p\pi^-\bar{p}\pi^+$$



$$p\bar{p} \rightarrow \Lambda\bar{\Lambda} \rightarrow p\pi^-\bar{p}\pi^+$$

- 10,000 events
- Beam momenta: 1.642 GeV, 7 GeV and 15 GeV
- Forward peaking distribution, $\bar{\Lambda}$ forward boosted
- EvtGen, entire decay chain specified
- In analysis: only consider particles actually part of the interesting reaction
- Ideal track finder, standard track functor
- Target spectrometer
 - Before bug fix
 - Standard track functor (≥ 4 hits in MVD or ≥ 6 hits in MVD+STT+GEM)
 - Bug: if this track functor was used, all tracks which do not hit forward spectrometer were classified as reconstructible
 - Bug fixed in trunk



- For events, only hits from final state particles
- Only tracks with ≥ 4 STT hits from final state particles
(from now, only tracks with ≥ 4 STT hits will be considered)

	1.642 GeV	7 GeV	15 GeV
Number of events	10,000	10,000	10,000
Events with a MVD hit	99.94 %	99.47 %	99.14 %
Events with a SciTil hit	34.64 %	3.00 %	1.36 %
Number of tracks	26,013	7,253	6,614
Tracks with a MVD hit	95.5 %	98.3 %	98.0 %
Tracks with a SciTil hit	38.7 %	5.8 %	2.9 %
Tracks with a MVD and a SciTil hit	36.9 %	5.6 %	2.7 %
Tracks with a MVD or a SciTil hit	97.3 %	98.5 %	98.2 %

- MVD itself useful for most events and tracks
- At higher beam momenta, most tracks do not reach SciTil
- MVD and SciTil together are useful at all beam momenta

STT

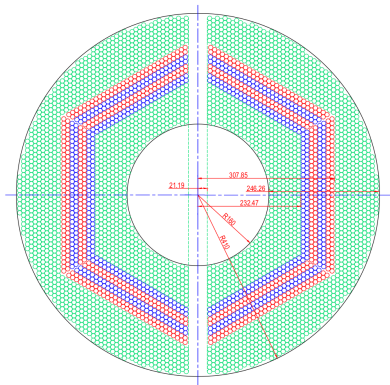
At PANDA: 20 MHz interaction rate

⇒ On average one event every 50 ns

STT

- 4,636 straws
- 27 layers
- When straw tube is hit, gas is ionized and free electrons created
- Electrons travel towards wire at center of tube - signal for readout
- Maximum drift time of electrons: 200 ns
- During drift time no more signals can be registered

⇒ one straw might be occupied for the next 3 or 4 events and might not fire if hit by a particle!



STT

Forward/backward asymmetry of distribution might cause spiralling in magnetic field since Λ decays almost at rest and its decay products are not given much energy

Challenges concerning spiralling tracks with many STT hits:

- Might be difficult to reconstruct
- Particles trapped in magnetic field - might not reach outer detectors
- Might block tubes for tracks from later events - makes later tracks harder to reconstruct

$p\bar{p} \rightarrow \Lambda\bar{\Lambda} \rightarrow p\pi^-\bar{p}\pi^+$, STT hits

Events with final state particle tracks with ≥ 50 STT hits

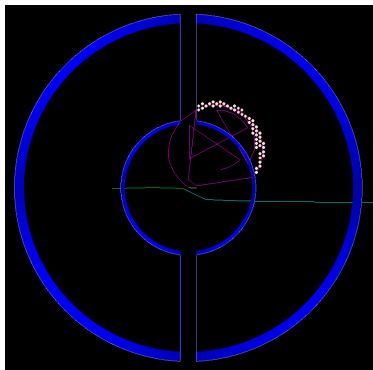
Kind of track	1.642 GeV	7 GeV	15 GeV
π^-	0.4 %	24.5 %	24.1 %
π^+	0.4 %	0 %	0 %
p	0 %	0 %	0 %
\bar{p}	0 %	0 %	0 %

Normalization: total number of events

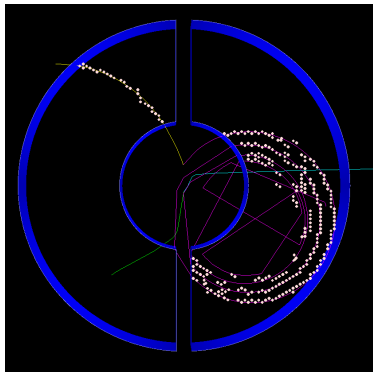
- At higher beam momenta, $\sim 1/4$ of all events contain a spiralling π^-
- \Rightarrow might cause trouble!

$p\bar{p} \rightarrow \Lambda\bar{\Lambda} \rightarrow p\pi^-\bar{p}\pi^+$, STT hits, 15 GeV

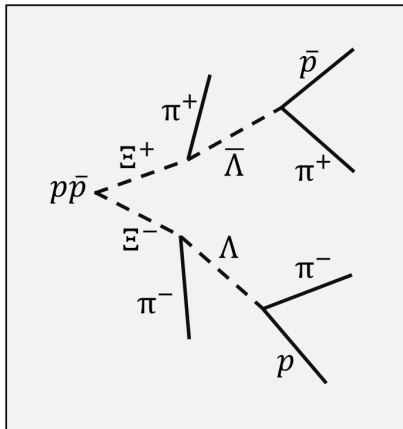
- 60 STT hits from π^-
- Spiralling confined to one quarter of the STT



- 256 STT hits from π^-
- Spiralling confined to half of the STT



$$p\bar{p} \rightarrow \Xi^-\Xi^+ \rightarrow \Lambda\pi^-\bar{\Lambda}\pi^+ \rightarrow p\pi^-\pi^-\bar{p}\pi^+\pi^+$$



$$p\bar{p} \rightarrow \Xi^-\Xi^+ \rightarrow \Lambda\pi^-\bar{\Lambda}\pi^+ \rightarrow p\pi^-\pi^-\bar{p}\pi^+\pi^+$$

- 10,000 events
- Beam momentum: 4.6 GeV
- Flat phase space distribution, isotropic
- EvtGen, entire decay chain specified
- Ideal track finder, standard track functor
- Target spectrometer
 - Before bug fix
 - Standard track functor (≥ 4 hits in MVD or ≥ 6 hits in MVD+STT+GEM)
 - Bug: if this track functor was used, all tracks which do not hit forward spectrometer were classified as reconstructible
 - Bug fixed in trunk

$$p\bar{p} \rightarrow \Xi^-\Xi^+ \rightarrow \Lambda\pi^-\bar{\Lambda}\pi^+ \rightarrow p\pi^-\pi^-\bar{p}\pi^+\pi^+$$

- For events, only hits from final state particles
- Only tracks with ≥ 4 STT hits from final state particles

	4.6 GeV
Number of events	10,000
Events with a MVD hit	99.3 %
Events with a SciTil hit	77.6 %
Number of of tracks	41,750
Tracks with a MVD hit	69.0 %
Tracks with a SciTil hit	81.3 %
Tracks with a MVD and a SciTil hit	55.0 %
Tracks with a MVD or a SciTil hit	95.3 %

- More tracks leave SciTil hit than MVD hit
 - Might be due to Λ and $\bar{\Lambda}$ decaying outside of MVD

$p\bar{p} \rightarrow \Xi^-\Xi^+ \rightarrow \Lambda\pi^-\bar{\Lambda}\pi^+ \rightarrow p\pi^-\pi^-\bar{p}\pi^+\pi^+$, STT hits

Kind of track (final state particle)	Events with tracks with ≥ 4 STT hits	Events with tracks with ≥ 50 STT hits
p	80.4 %	0 %
\bar{p}	78.8 %	0 %
First π^-	66.7 %	6.3 %
Second π^-	62.2 %	6.2 %
First π^+	67.5 %	6.2 %
Second π^+	62.0 %	6.3 %

Normalization: total number of events

- 6-25 % of all events contain spiralling pions
- ⇒ Might be a cause of concern

Outlook

- Analyse Ξ^- events further decaying the particles in Geant4
- Investigate Ω^- events
- Thorough investigation of decay vertex positions
- Investigate usefulness of GEM plates
- Investigate performance of STTCellTrackFinder for Λ , Ξ^- and Ω^- events

Summary

$\Lambda\bar{\Lambda}$ events:

- MVD useful for most events and final state particle tracks
- SciTil useful for $\sim 1/3$ of events and final state particle tracks at lowest beam momentum but not at higher beam momenta
- π^- tend to spiral in magnetic field at higher beam momenta - many π^- might not reach the SciTil

$\Xi^-\Xi^+$ events:

- MVD useful for $\simeq 99\%$ of events and $\simeq 69\%$ of final state particle tracks
- SciTil useful for $\simeq 77\%$ of events and $\simeq 81\%$ of final state particle tracks (more than MVD)

Thank you!

