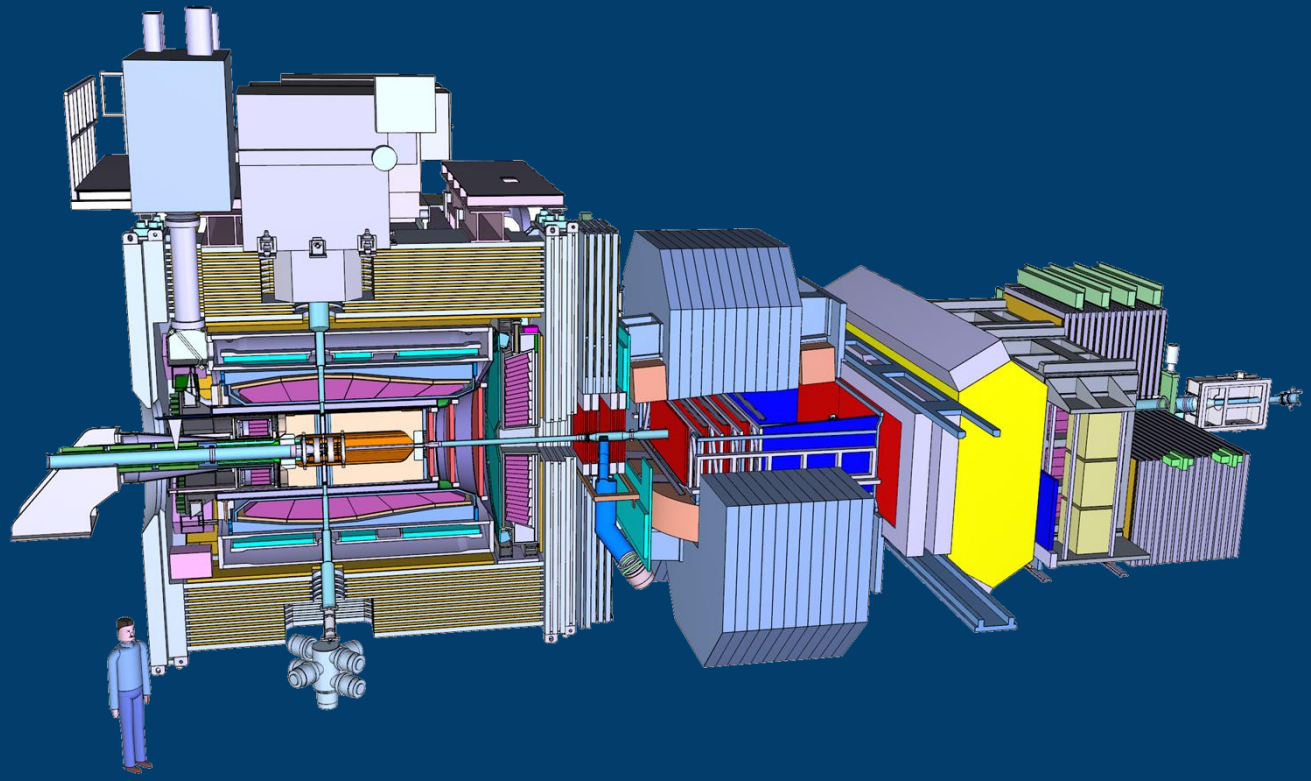
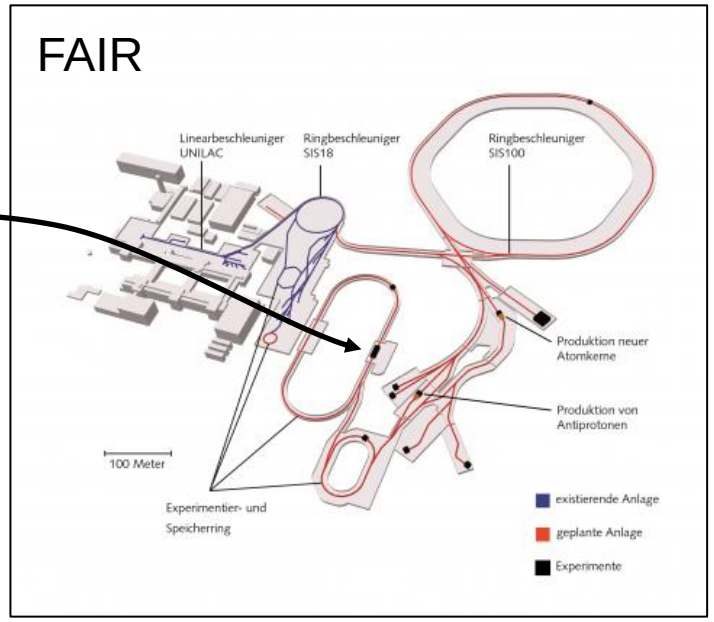
Track Finding for the PANDA Experiment

02.06.2022 I CONNECTING THE DOTS 2022 | ANNA ALICKE | IKP 1 - FZJ



INTRODUCTION

The PANDA detector



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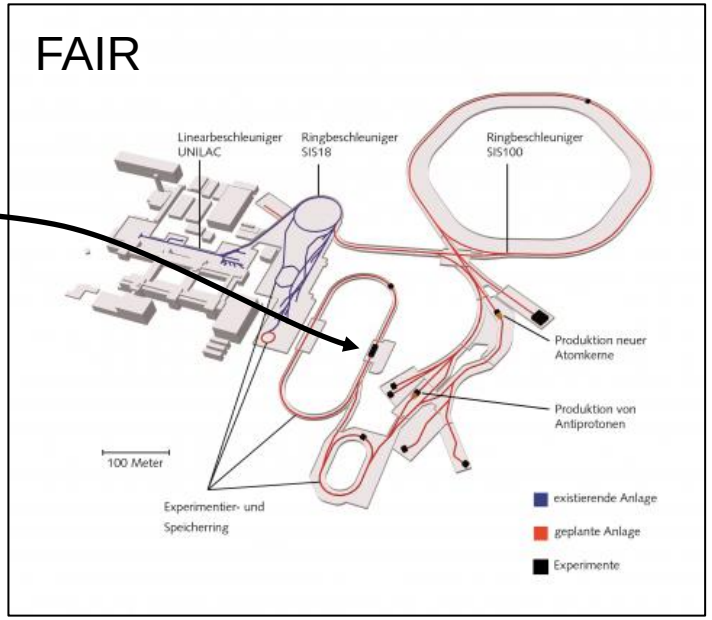

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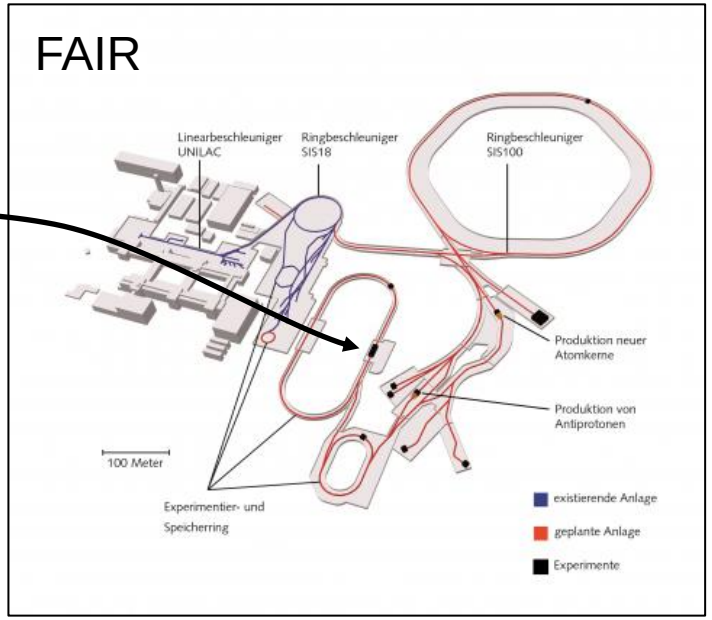
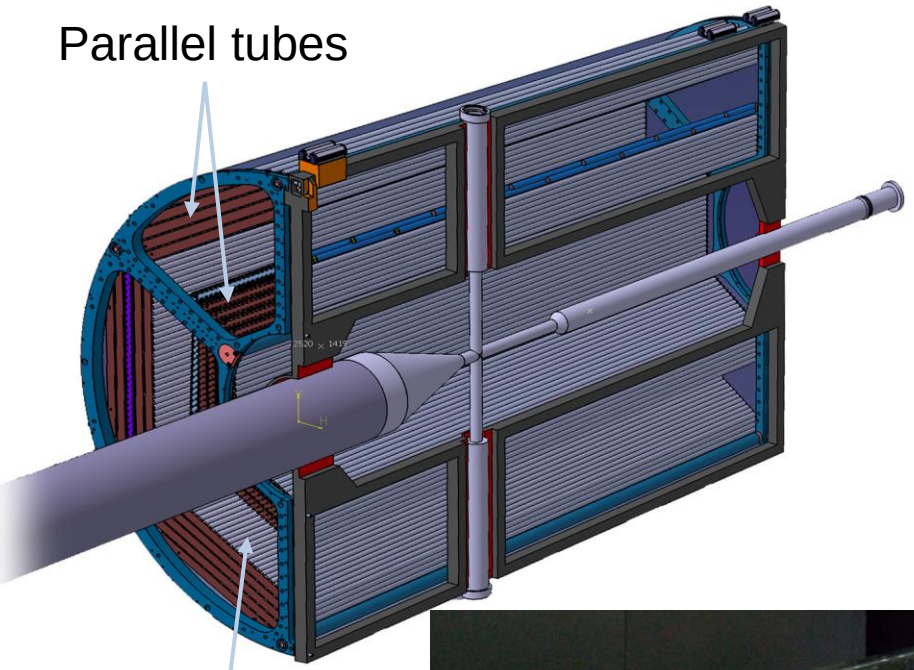
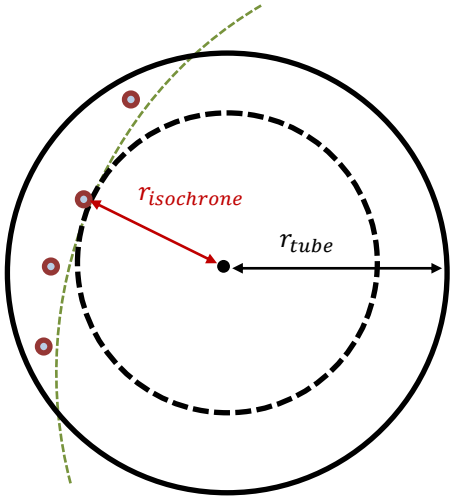


THE STRAW TUBE TRACKER

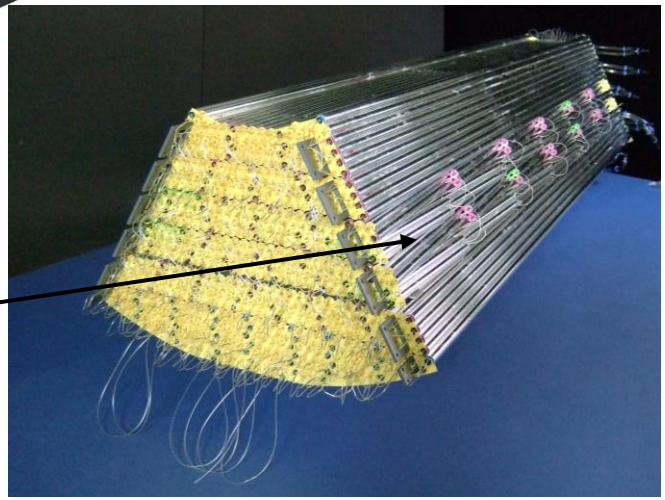
Parallel tubes

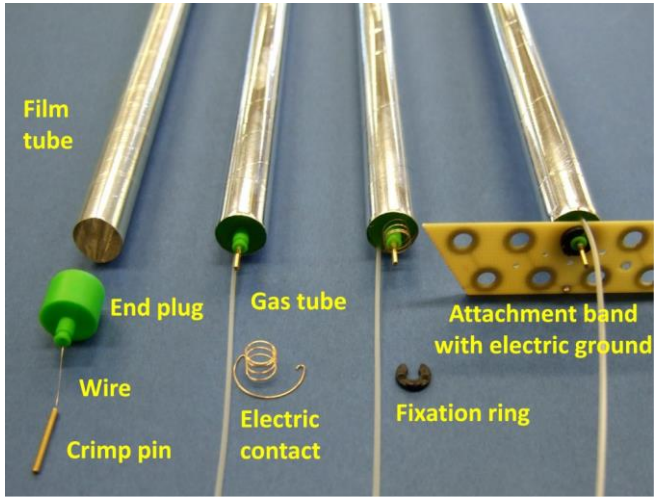


Straw tube



Skewed tubes





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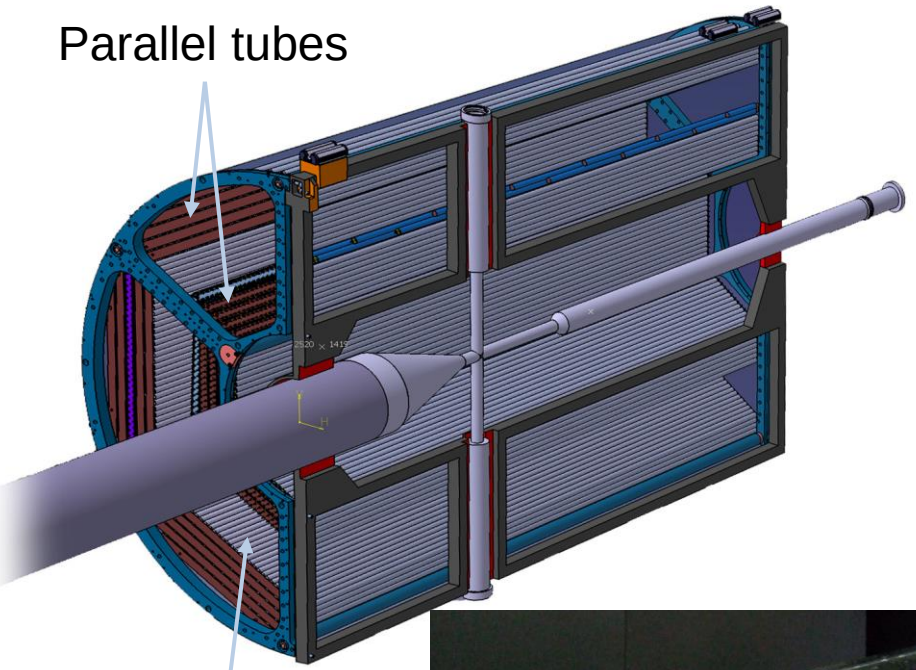

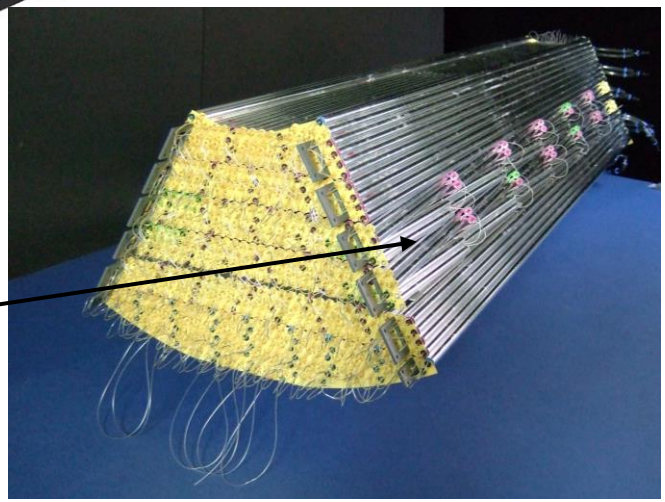

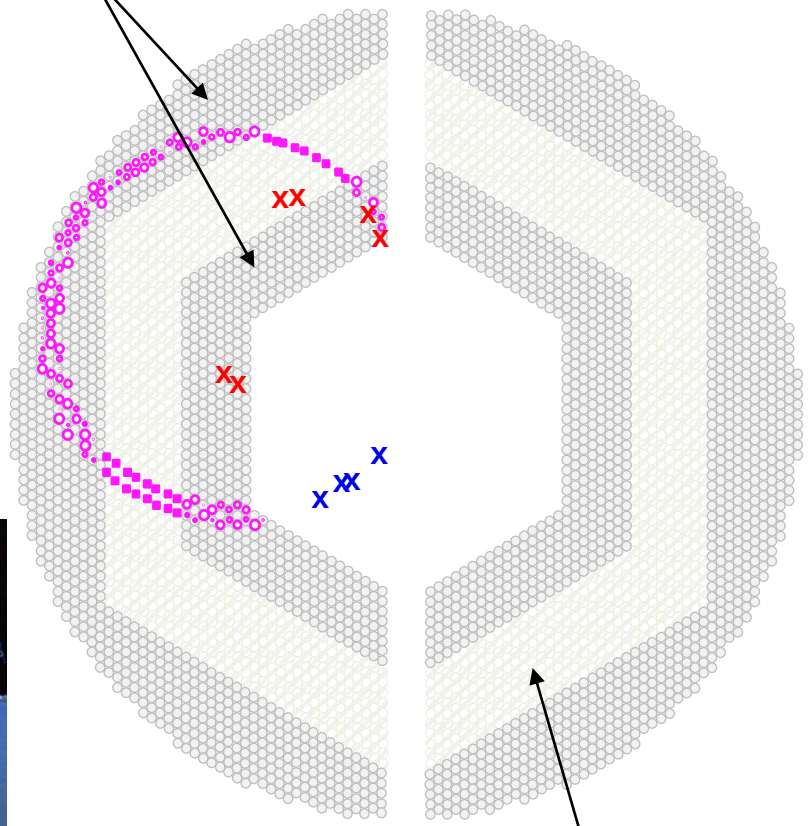

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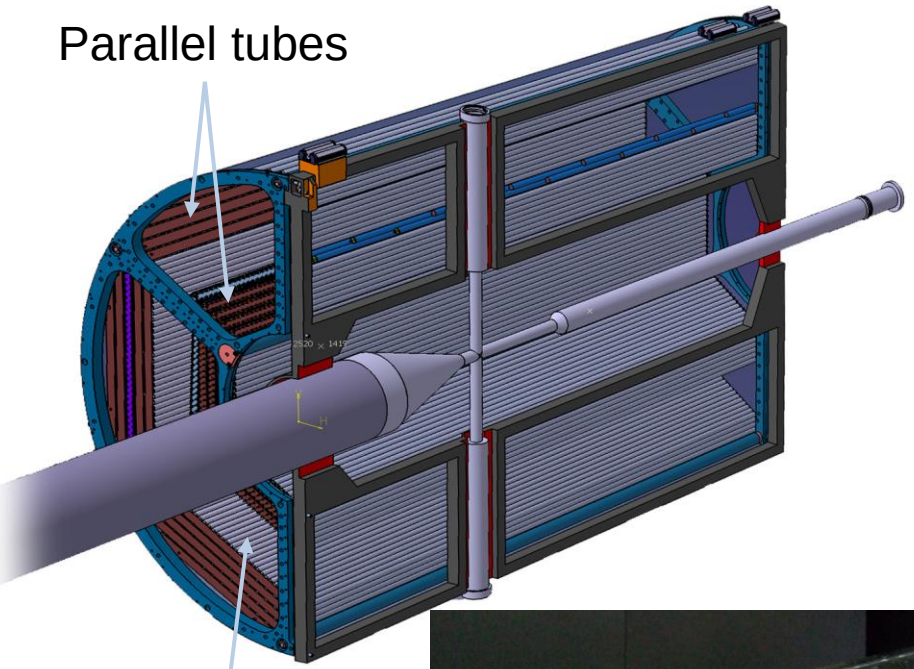
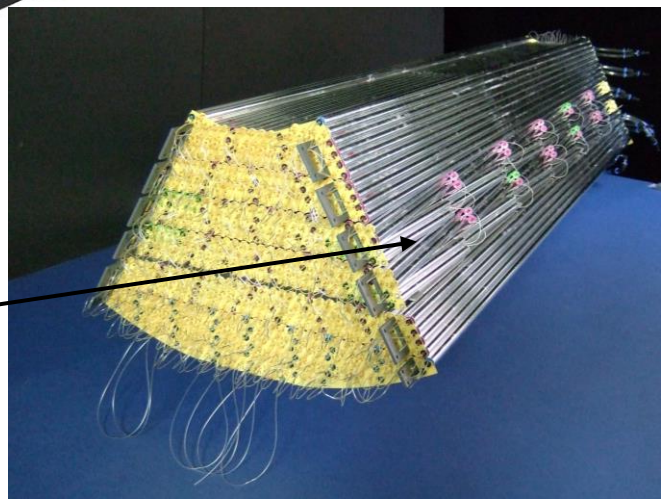
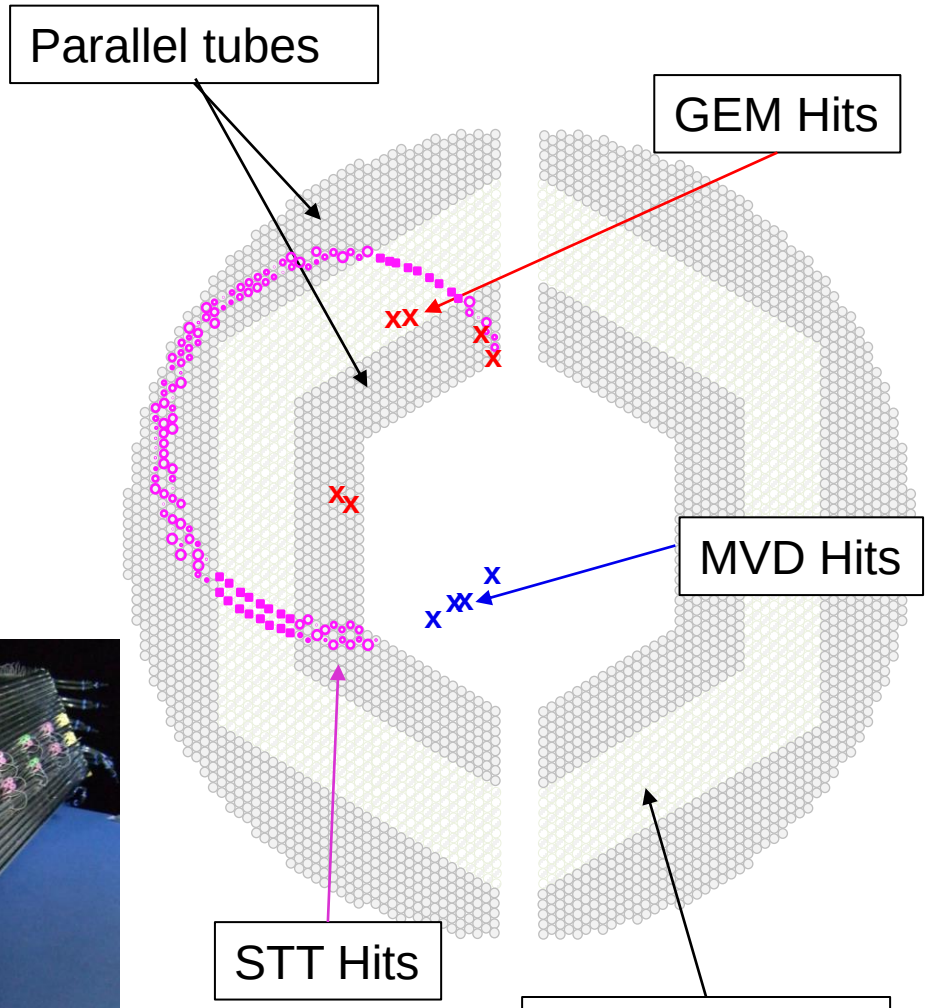
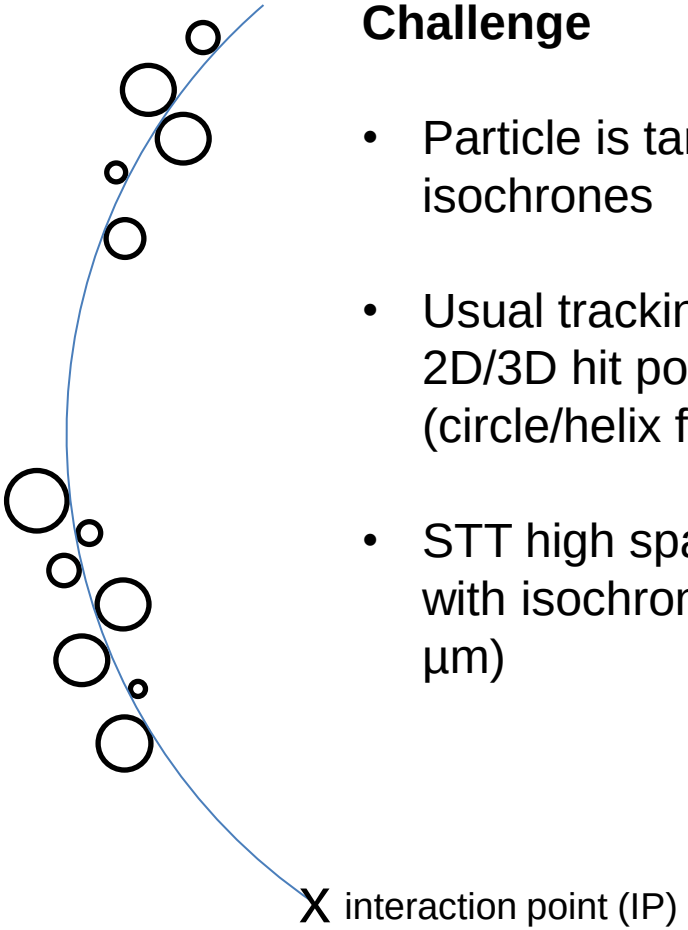






TRACK FINDING WITH ISOCHRONES

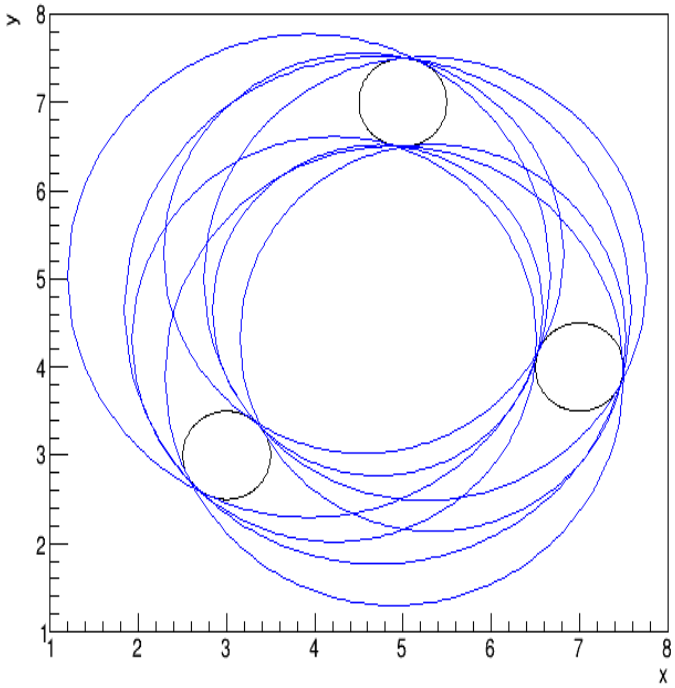


Challenge

- Particle is tangent to the isochrones
- Usual tracking algorithms use 2D/3D hit points (circle/helix fits in solenoid fields)
- STT high spatial resolution only with isochrone information (150 µm)

Approach to a Solution

“Problem of Apollonius”

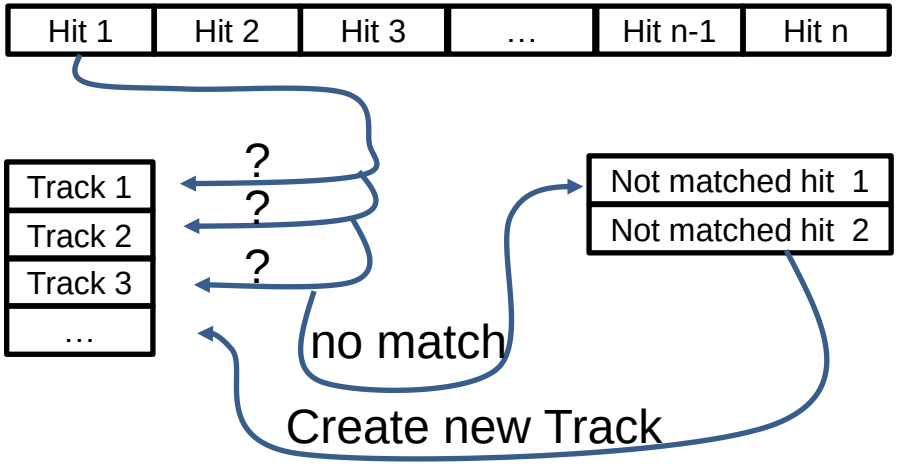


TRACKING ALGORITHMS

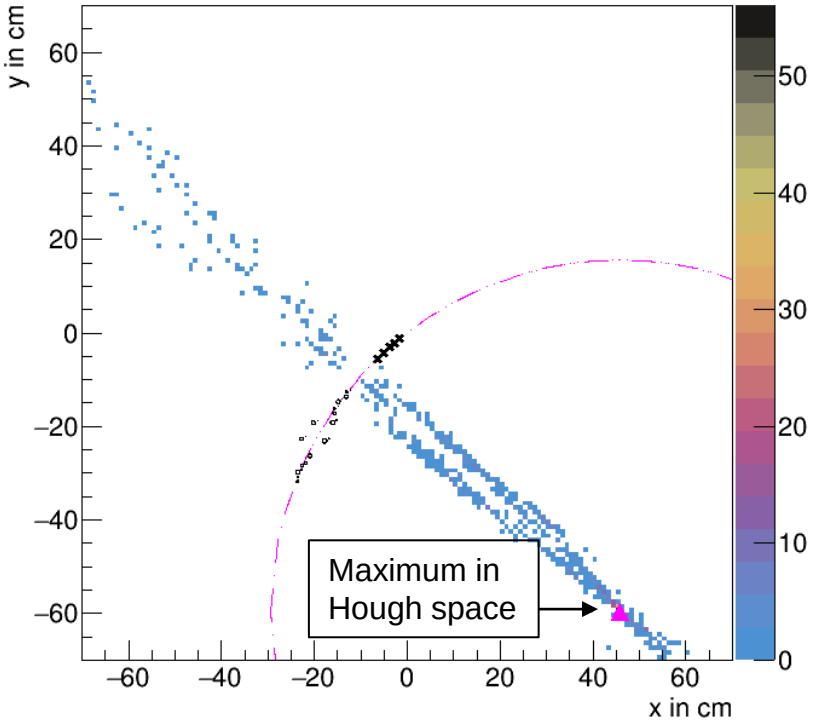
Primary track finders → Tracks originating from primary vertex

Standard Tracker

- Takes one hit after another
- Calculates circle from 3 hits
- Does hit belong to a track?

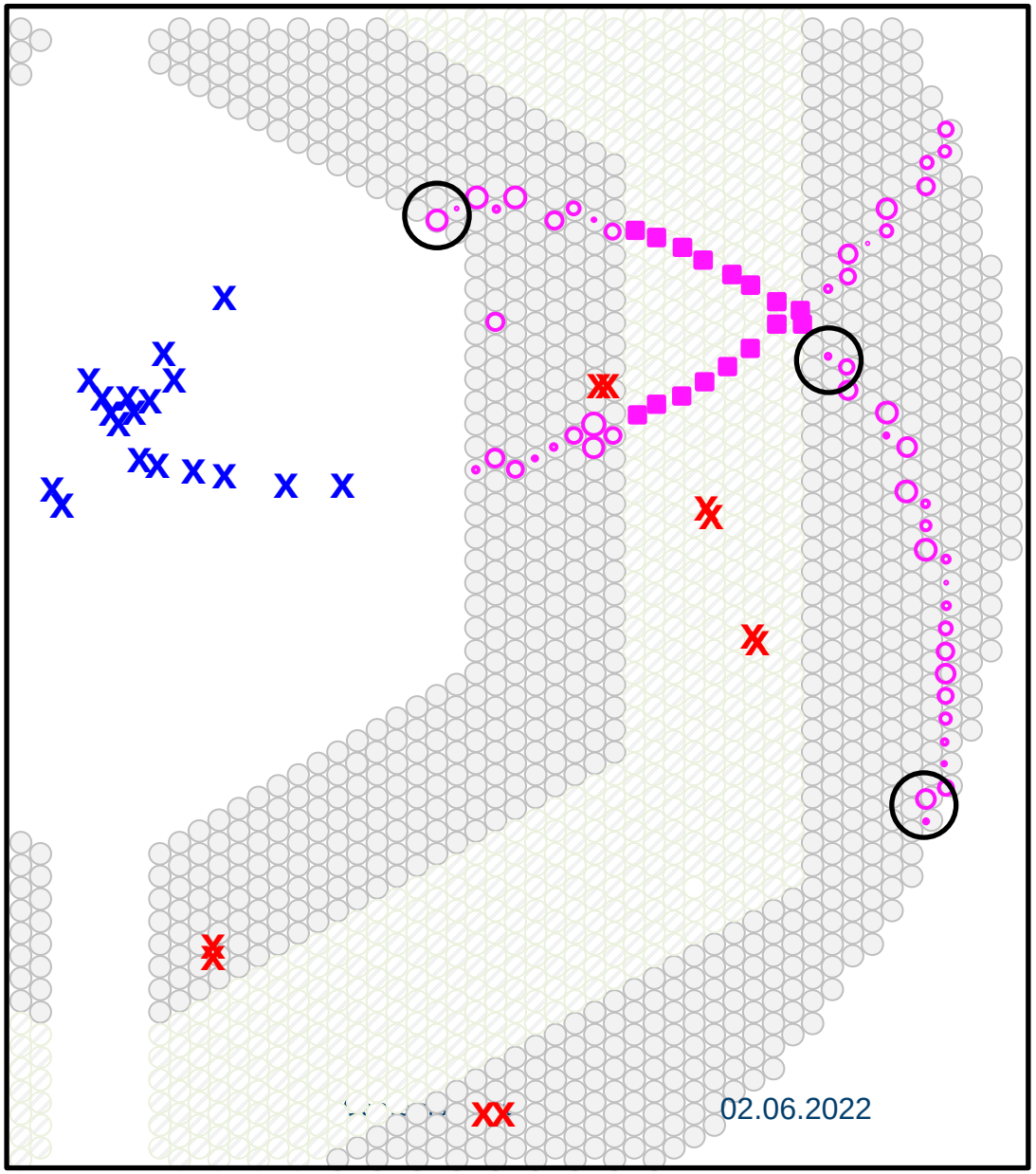


Hough Tracker



SECONDARY TRACK FINDER

→ Tracks originating from displaced secondary vertex



- Basic idea
  - Select three STT hits

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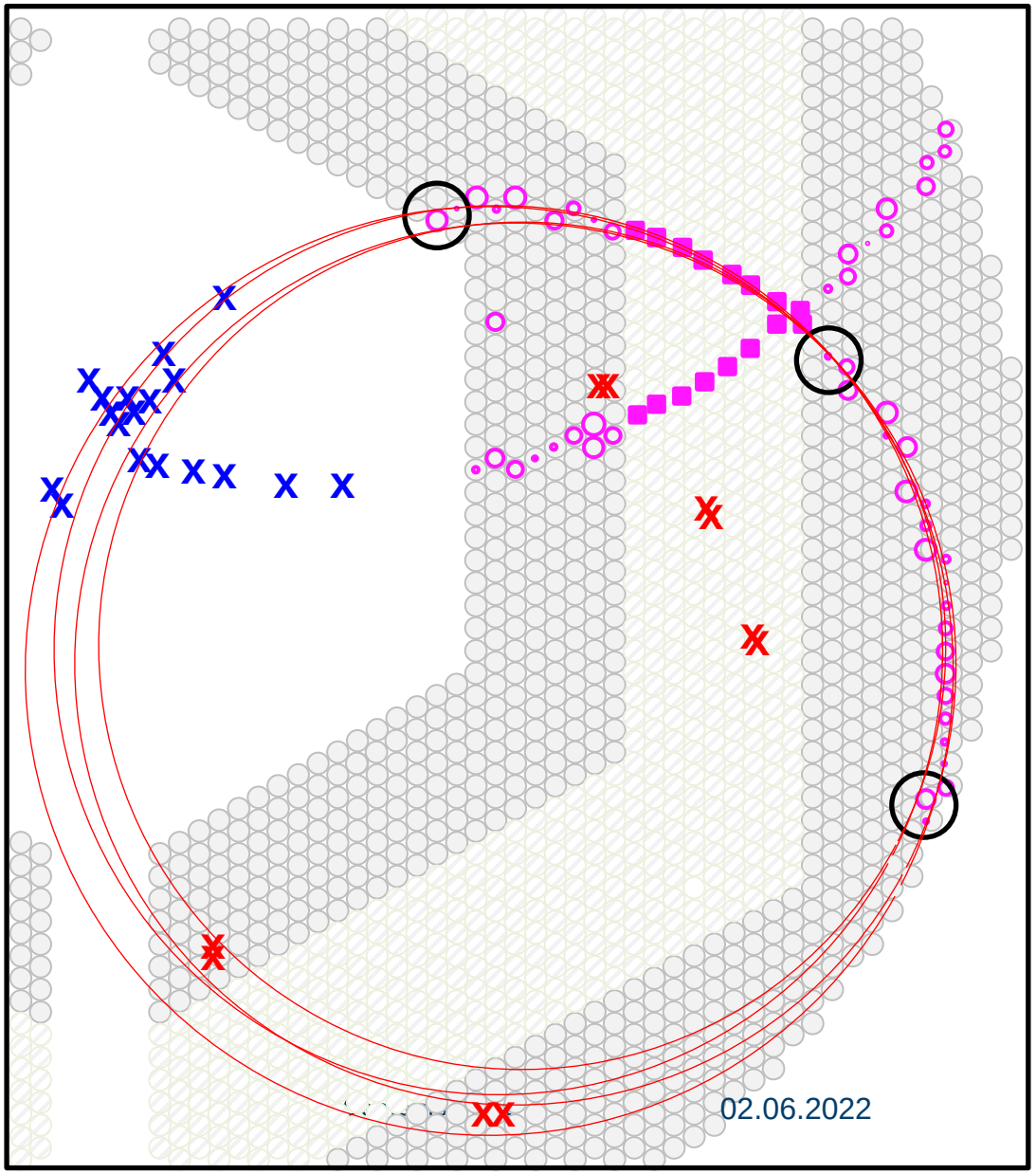

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  - Add other STT hits which are close to circles

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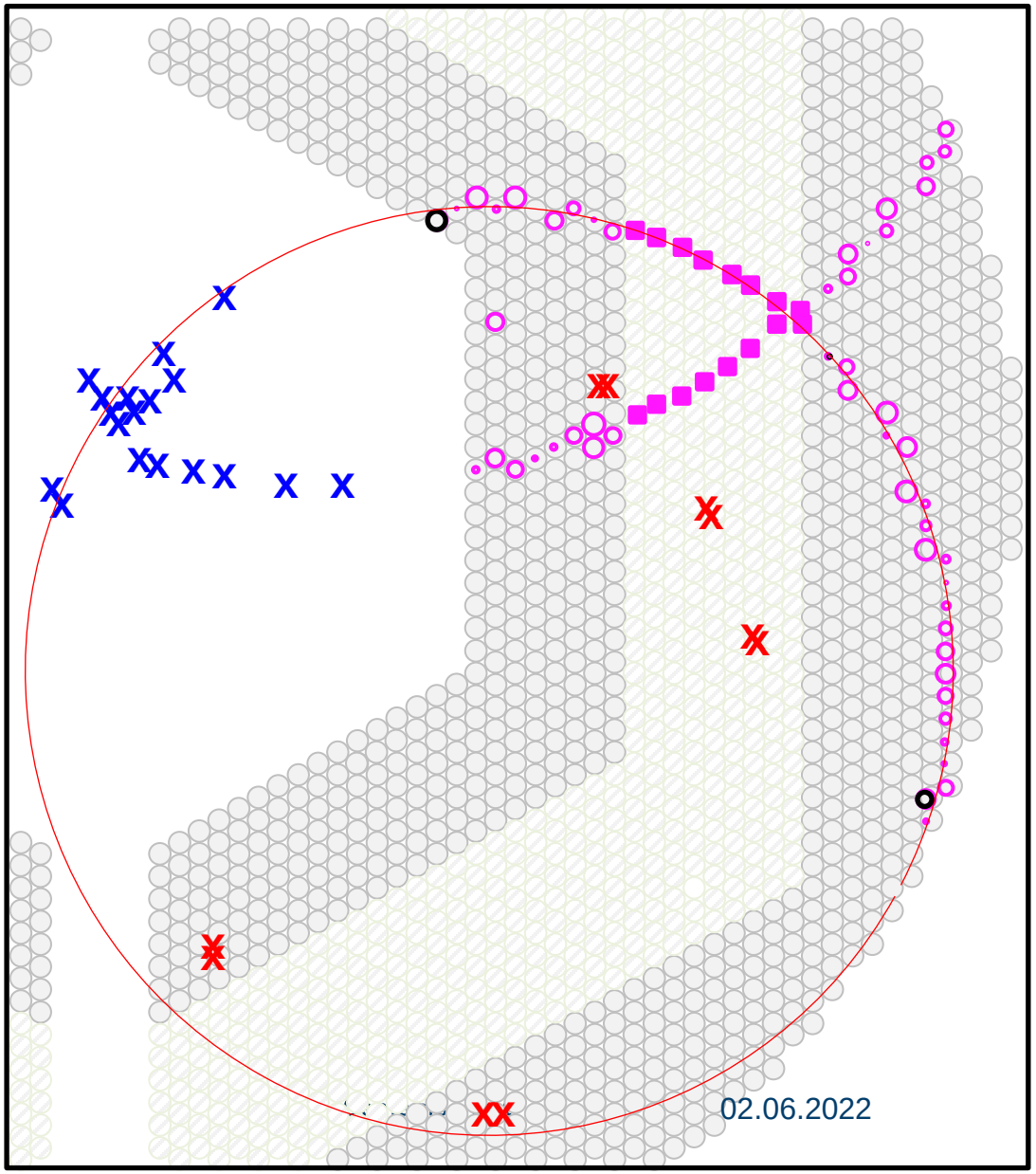

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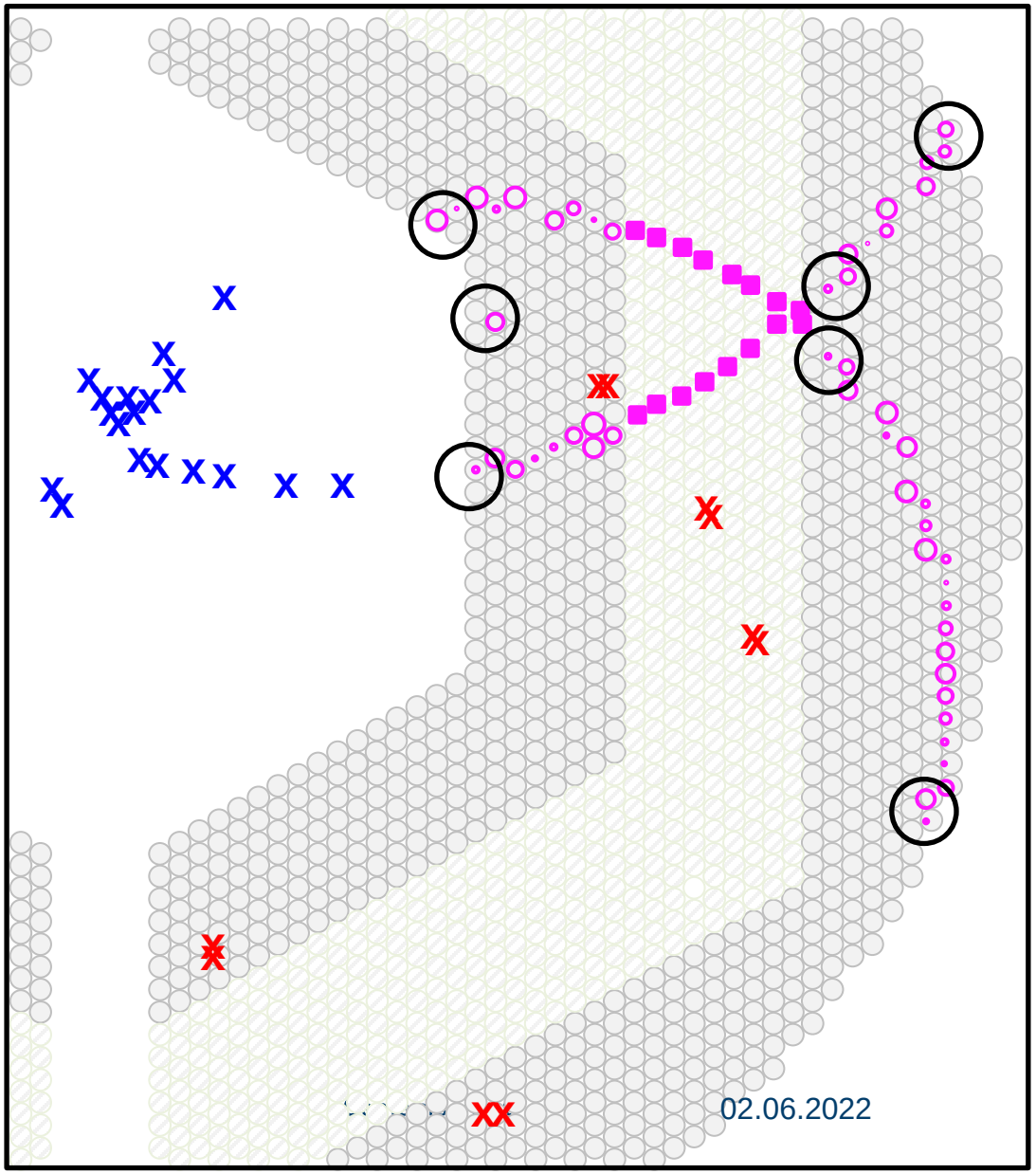

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  - Define set of inner, mid and outer STT hits
  - Too many combinations: slow
  - Too few combinations: low efficiency

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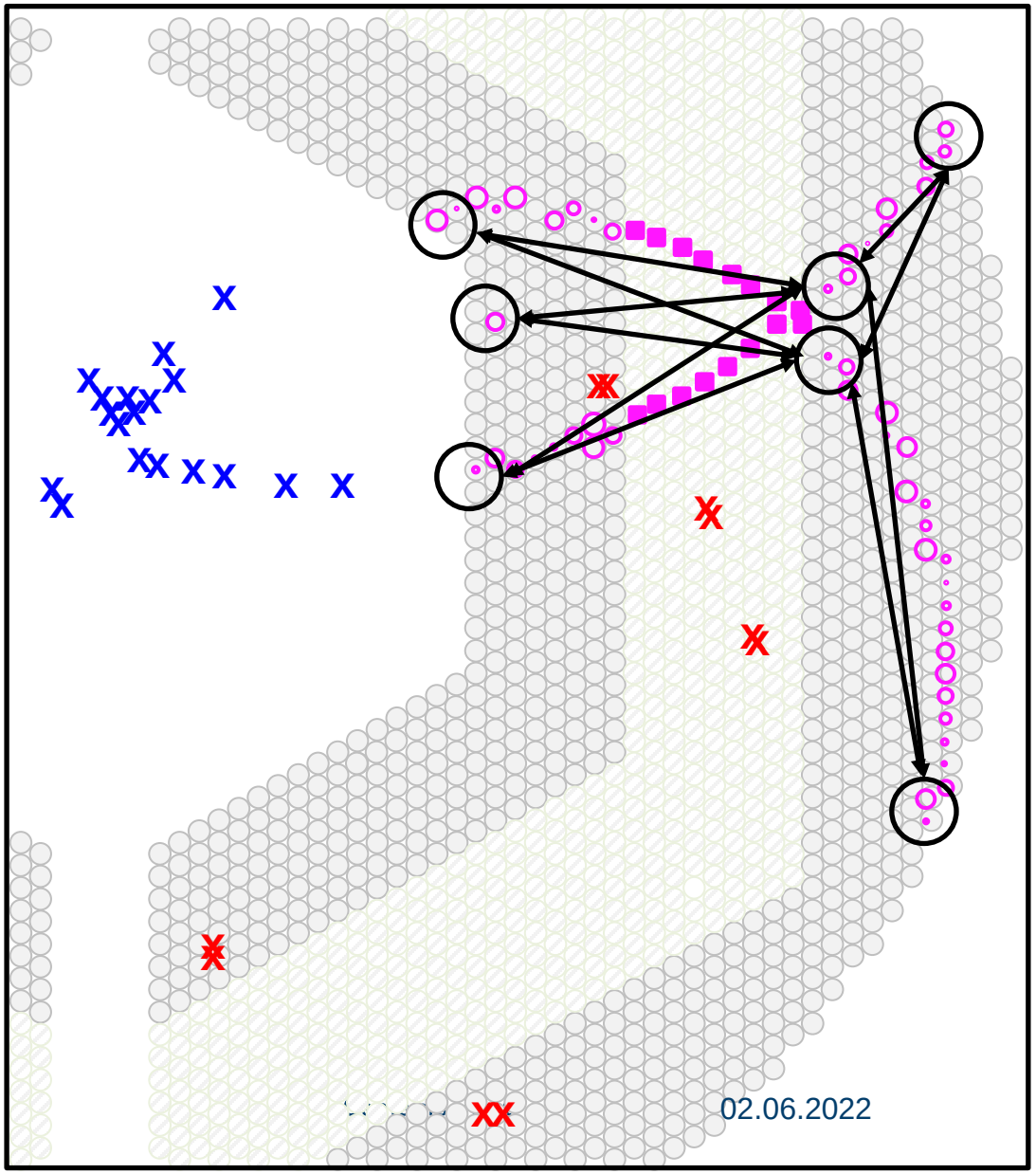

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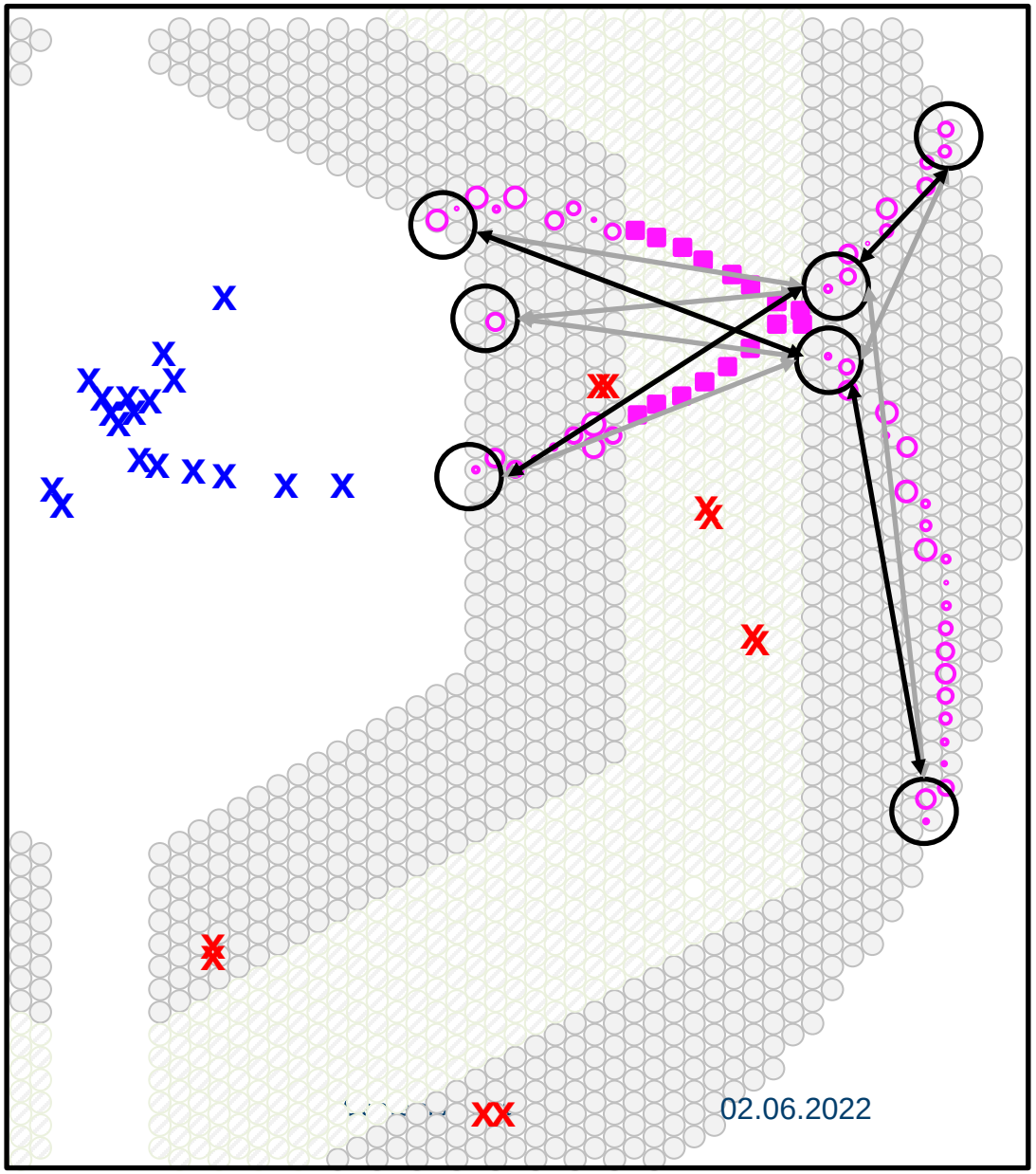

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  - Continuity check

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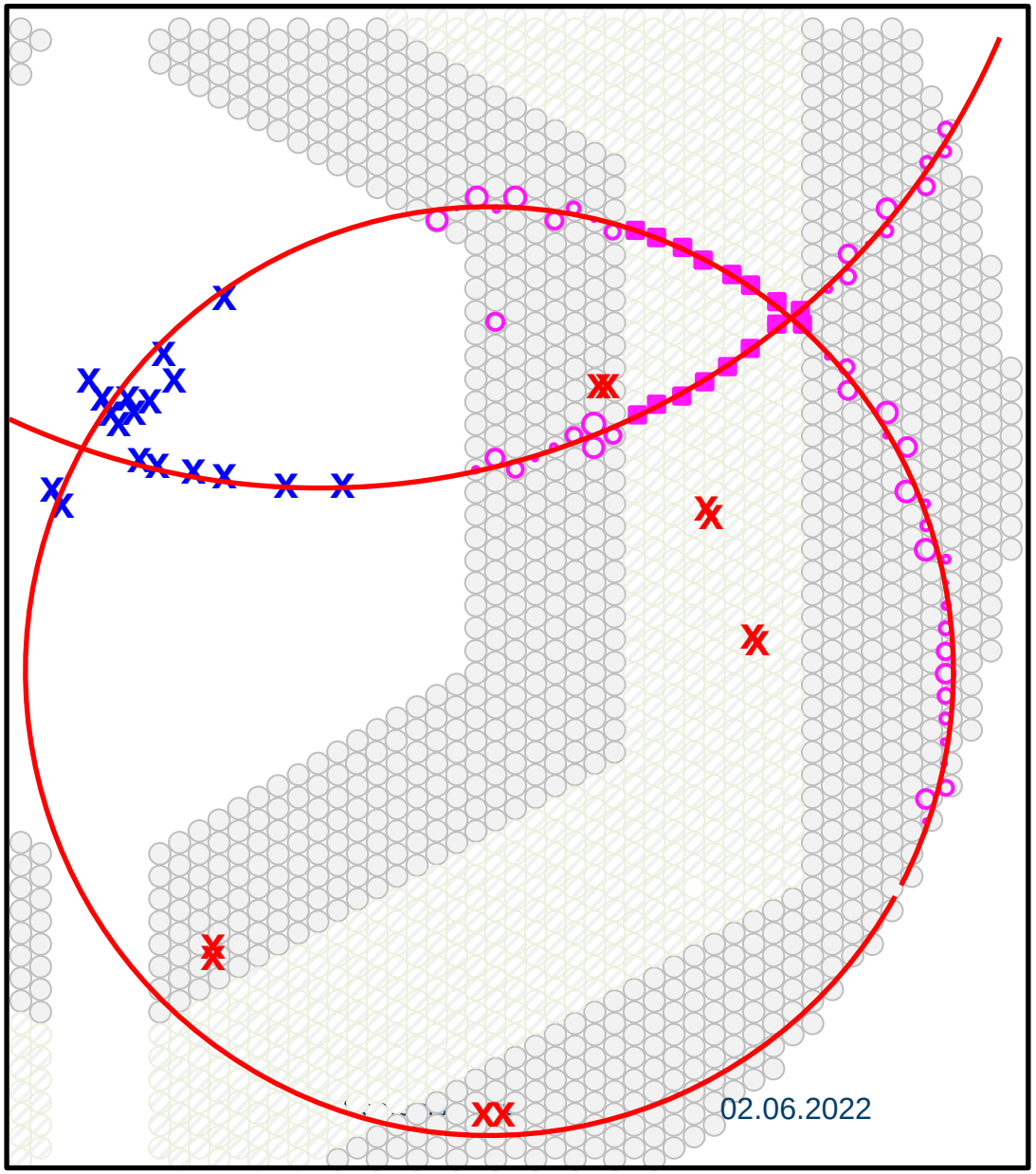

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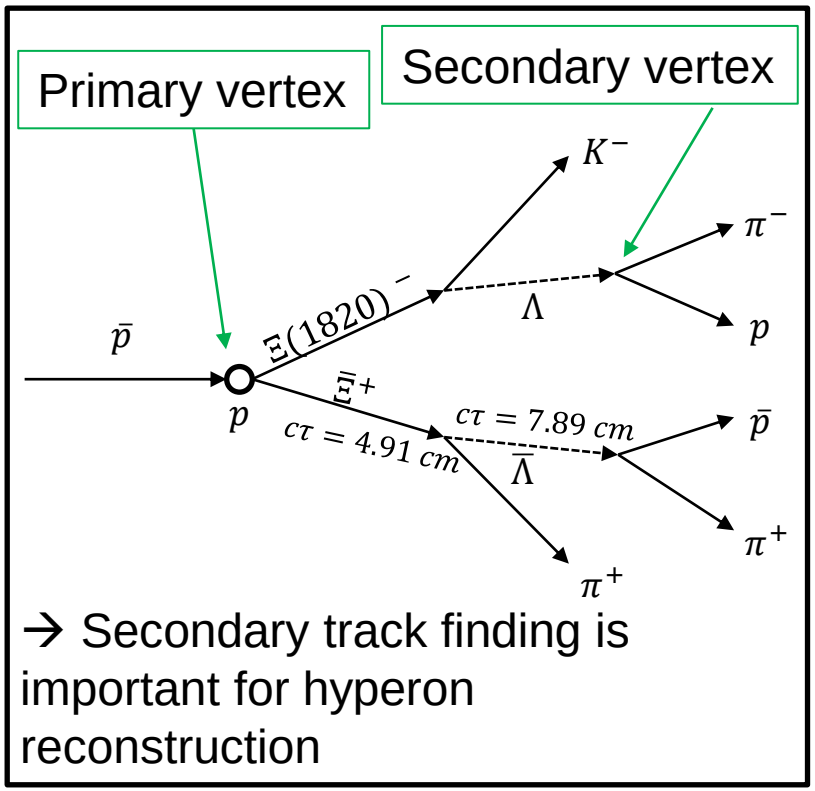
  - Too many combinations: slow
  - Too few combinations: low efficiency

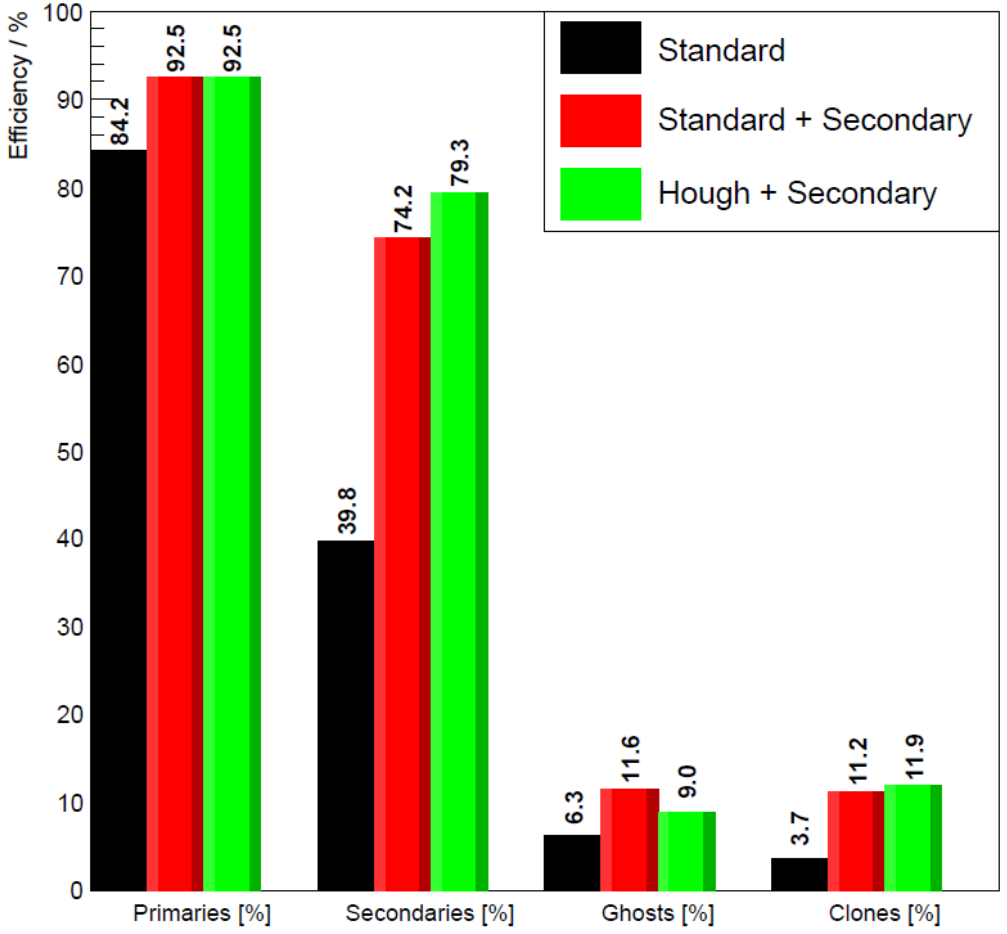
- **Which is the proper circle?**
  - Continuity check
  - Number of hits in track
  - Quadratic distance of hits to circle

TRACK FINDING RESULTS

Simulated data: 5000 events of $p\,\bar{p} \rightarrow \Xi(1820)^{-}\,\bar{\Xi}^{+} \rightarrow \Lambda\,K^{-}\,\bar{\Lambda}\,\pi^{+} \rightarrow p\,\pi^{-}K^{-}\pi^{+}\bar{p}\,\pi^{+}$



→ Secondary track finding is important for hyperon reconstruction



Final state and full event efficiencies

Simulated data: 400 000 events of $p\,\bar{p} \rightarrow \Xi(1820)^-\,\bar{\Xi}^+ \rightarrow \Lambda\,K^-\,\bar{\Lambda}\,\pi^+ \rightarrow p\,\pi^-K^-\pi^+\bar{p}\,\pi^+$

	Standard [%]	Standard + Secondary [%]	Hough + Secondary [%]
K^-	91.4	93.9	89.4
p	75.5	86.9	84.7
π^-	58.4	68.8	72.9
$\pi^+(\bar{\Xi}^+)$	67.1	86.0	88.0
$\bar{p}$	72.3	78.8	75.3
π^+	59.7	80.8	87.7
Full event	2.4	9.5	19.9

➔ Efficiencies are comparable to previously shown primary/secondary efficiencies
➔ Reconstruction efficiency strongly improved
  ➔ Factor of 4 for adding secondary track finder
  ➔ Factor of 8 for new primary + secondary track finder

SUMMARY & OUTLOOK

Summary

- Introduced new secondary track finder
- New primary track finder + secondary track finder improves reconstruction efficiency by factor of 8

Outlook

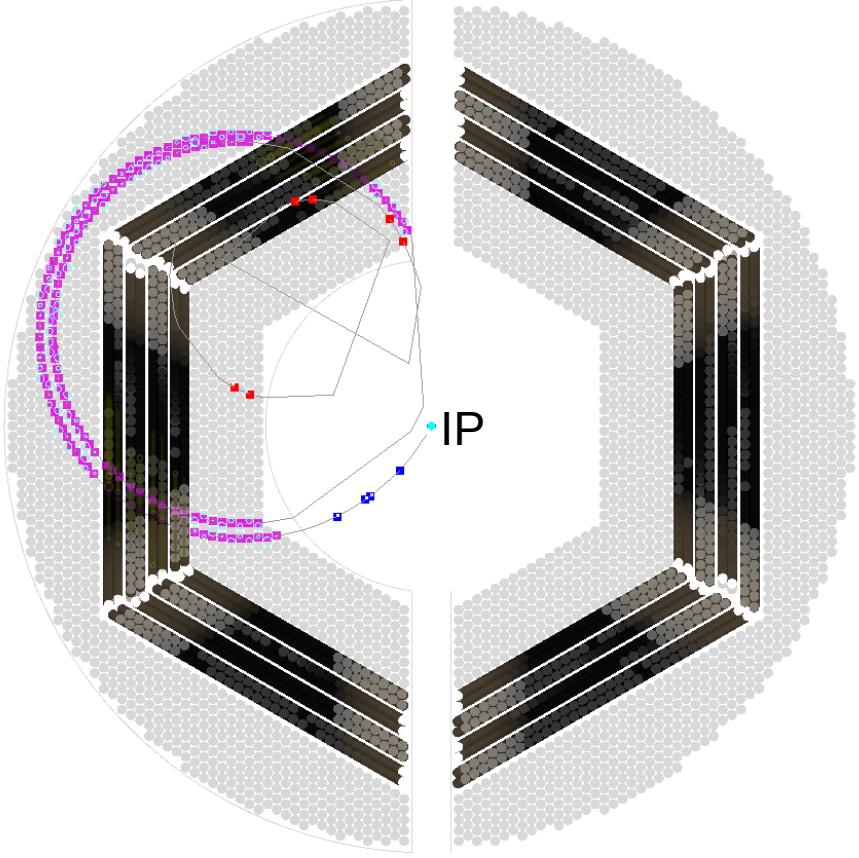
- Optimizing for speed
- Online tracking:
  - Reduce memory consumption of Hough track finder
  - Performance of secondary track finder on GPU

Thank you for
your attention!

SECONDARY TRACKING

Primary tracks

Track originates from initial interaction point (IP)
→ One precise point given



Secondary tracks

Track has a displaced secondary vertex
→ much more difficult (higher combinatorics)