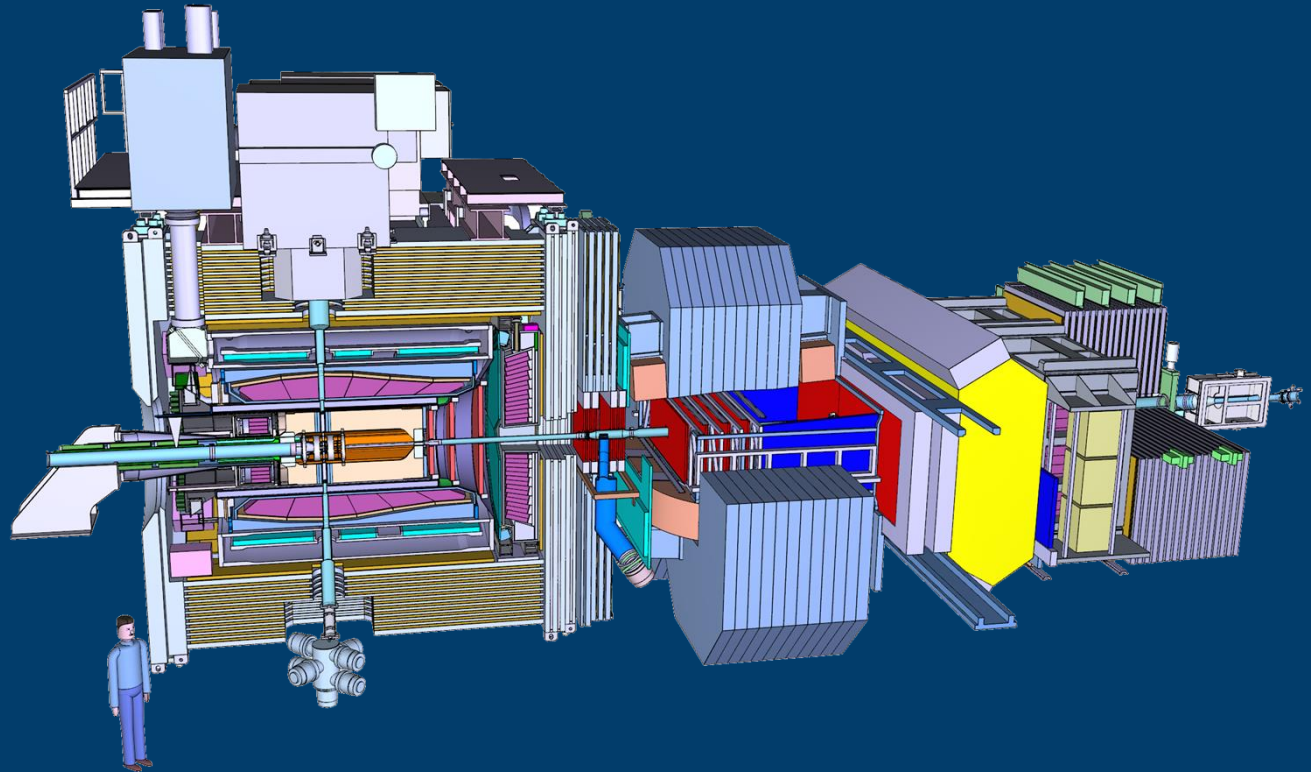


# Secondary Track Finding for PANDA

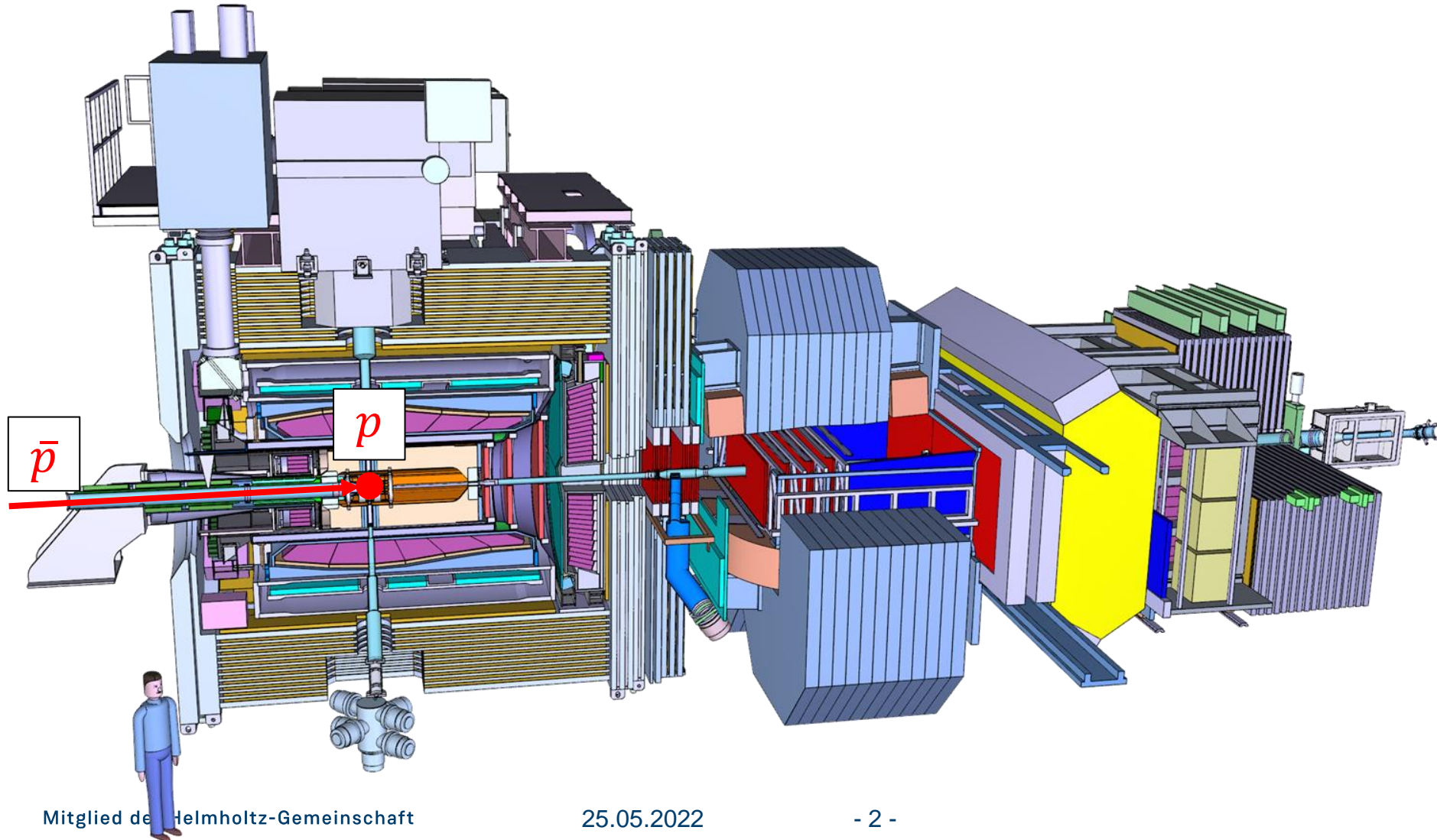
25.05.2022 | FAIRNESS | ANNA ALICKE | IKP 1 - FZJ



# INTRODUCTION



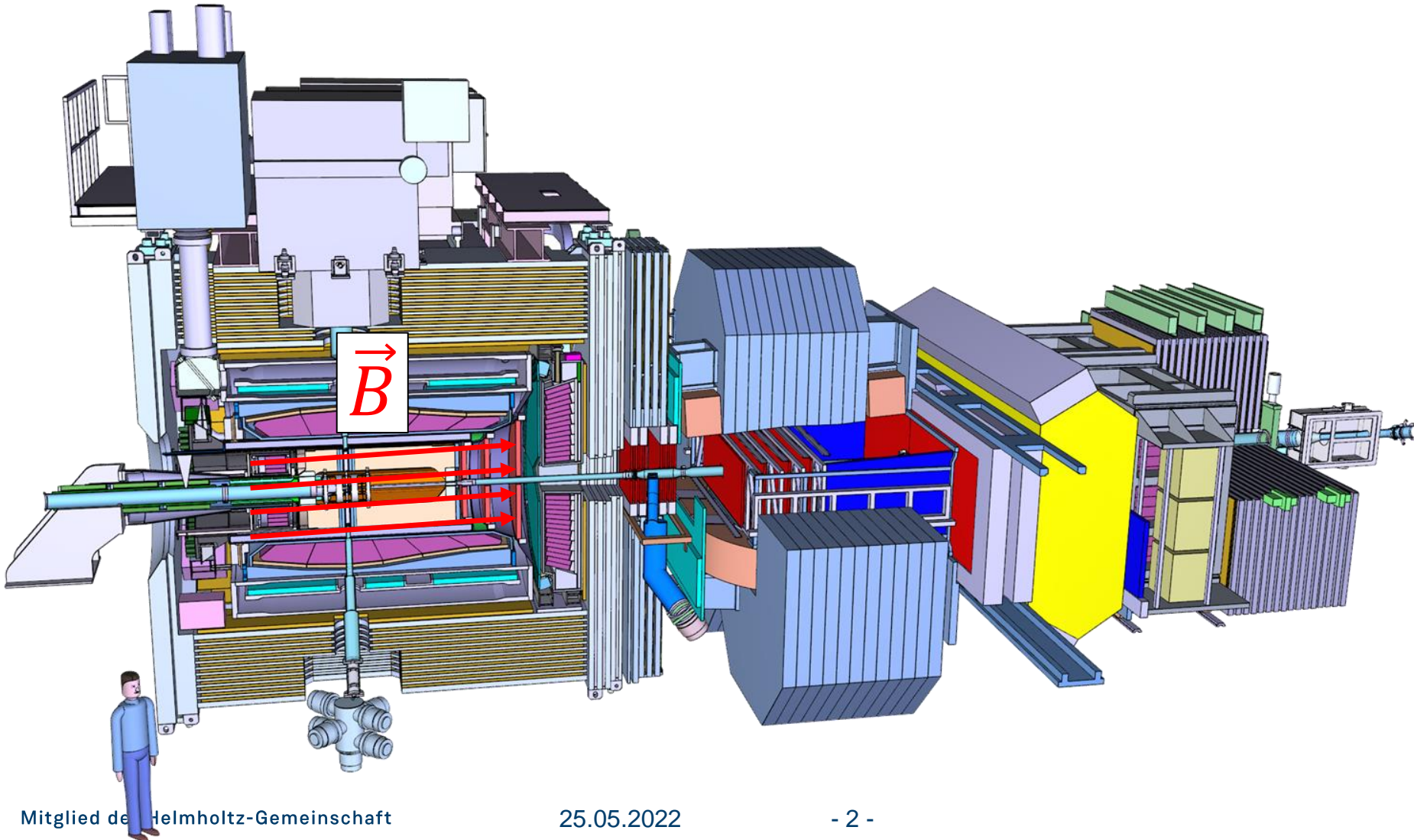
## The PANDA detector



# INTRODUCTION



## The PANDA detector

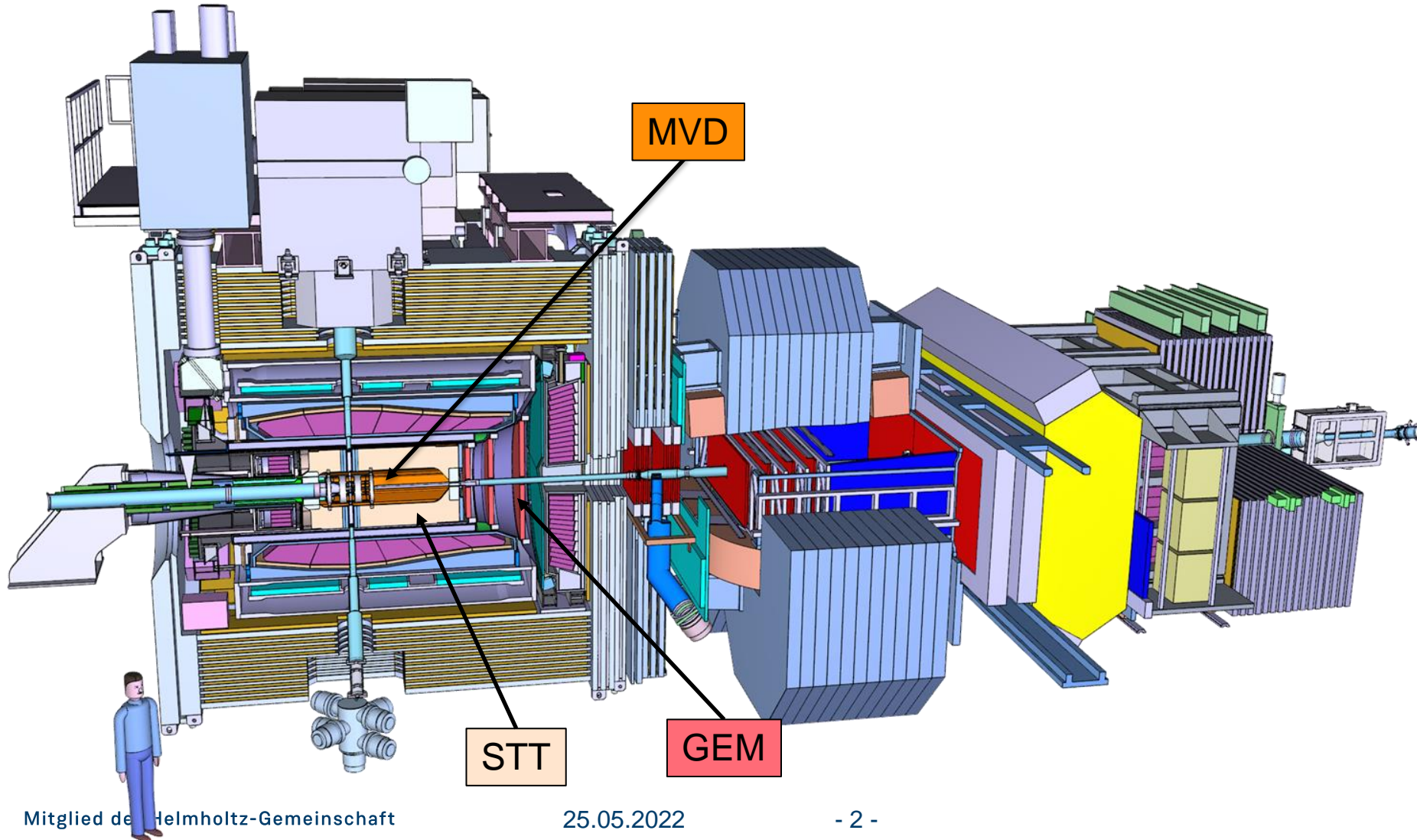




# INTRODUCTION



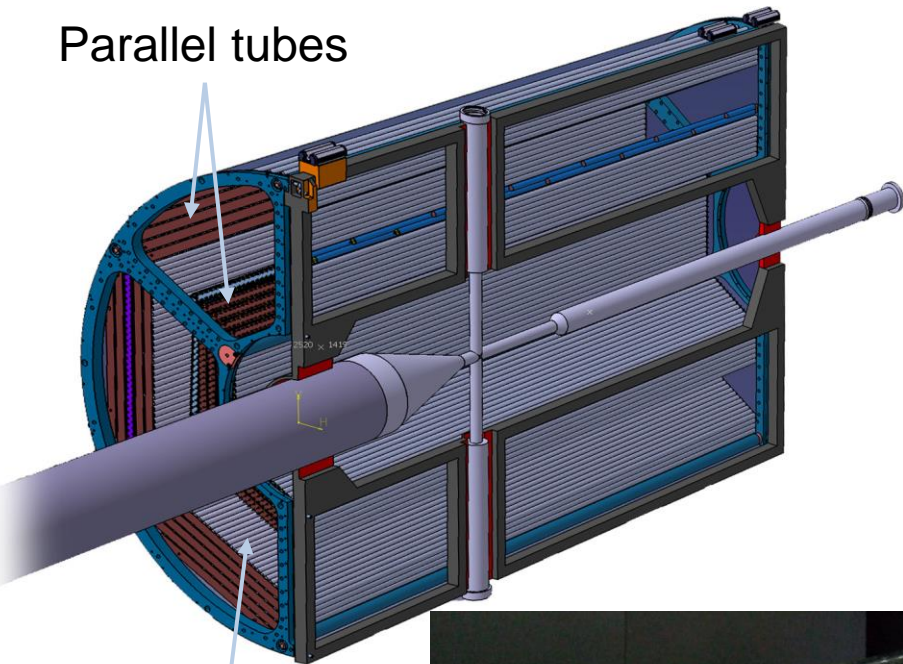
## The PANDA detector



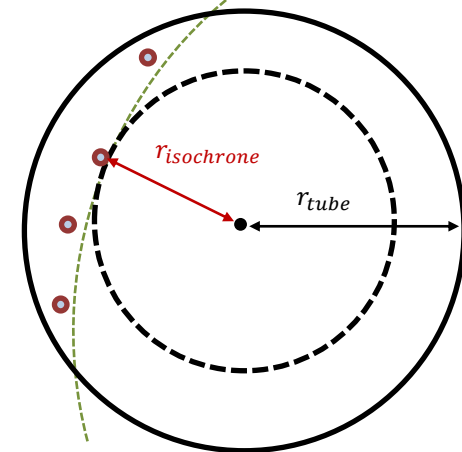
# THE STRAW TUBE TRACKER



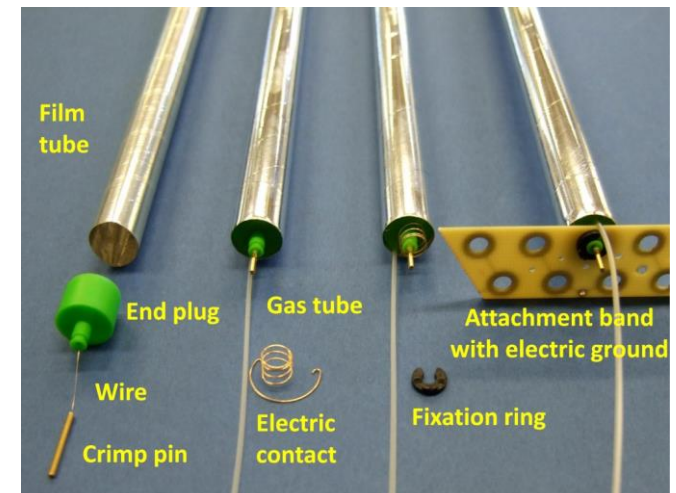
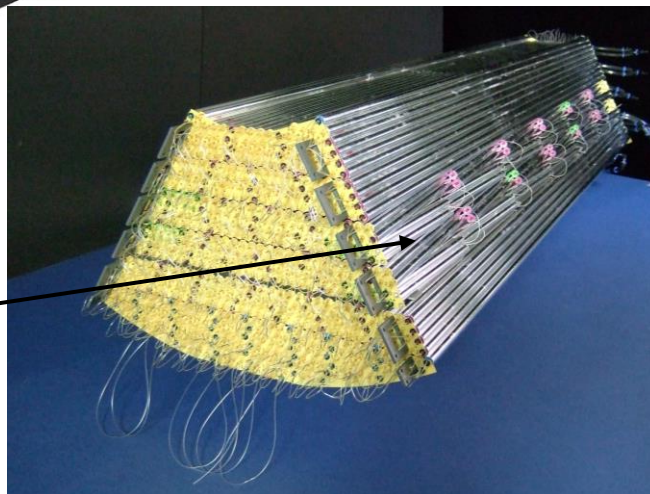
Parallel tubes



Straw tube



Skewed tubes

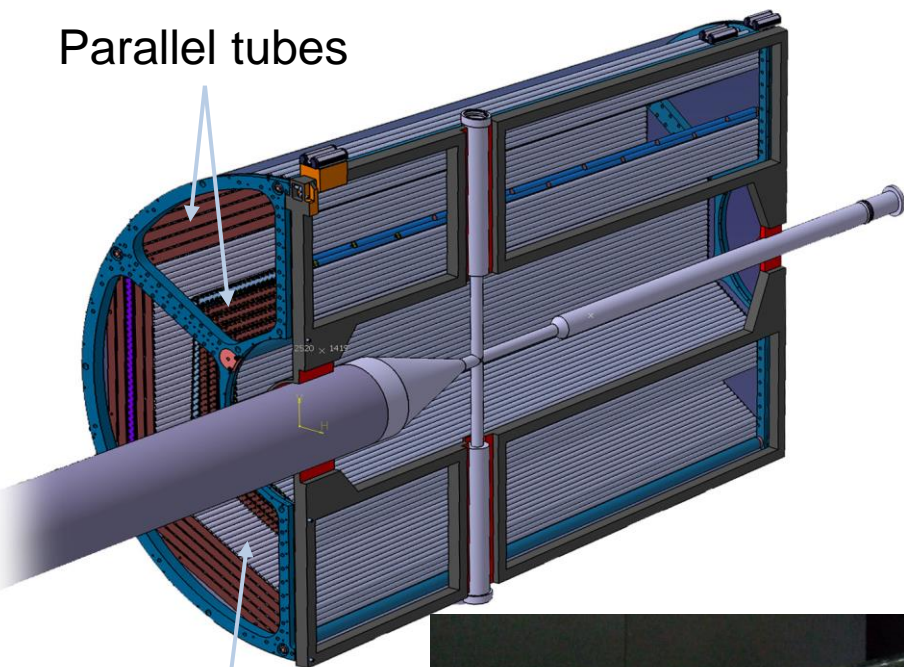




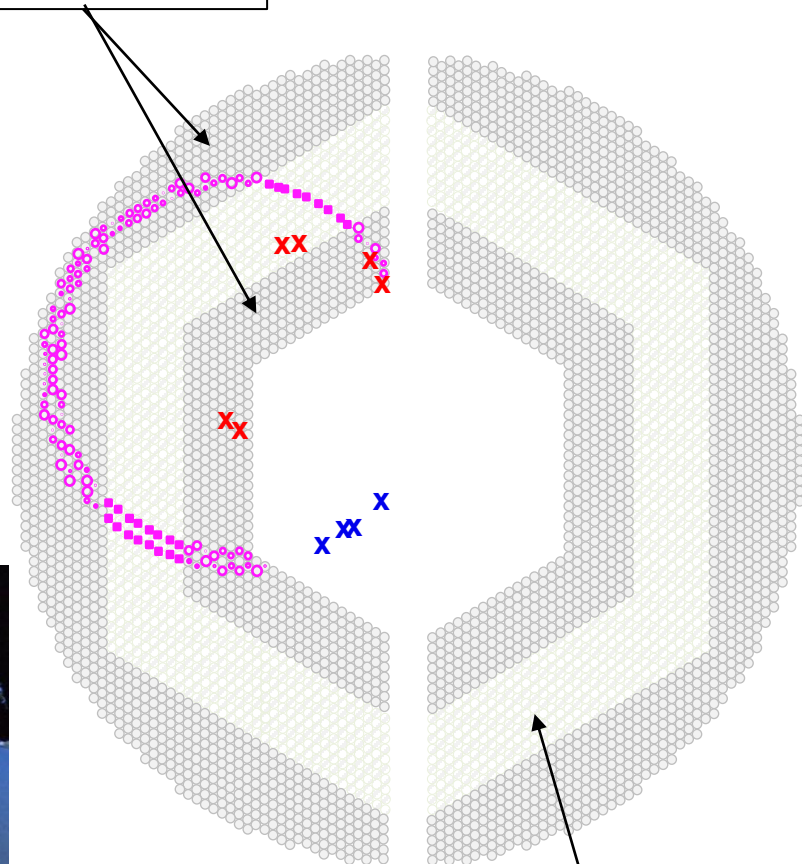
# THE STRAW TUBE TRACKER



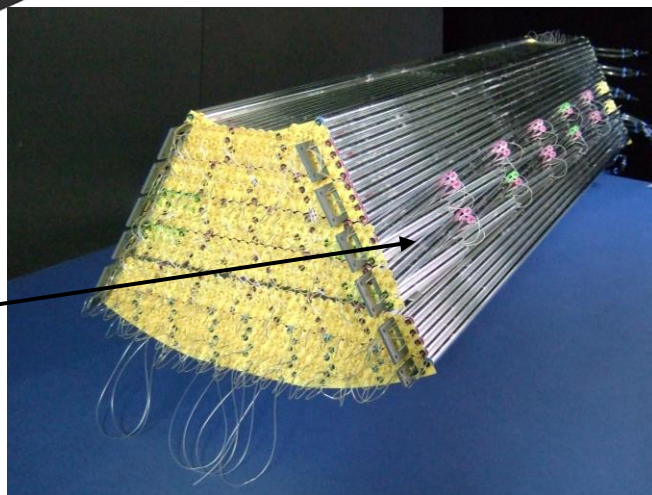
Parallel tubes



Parallel tubes



Skewed tubes

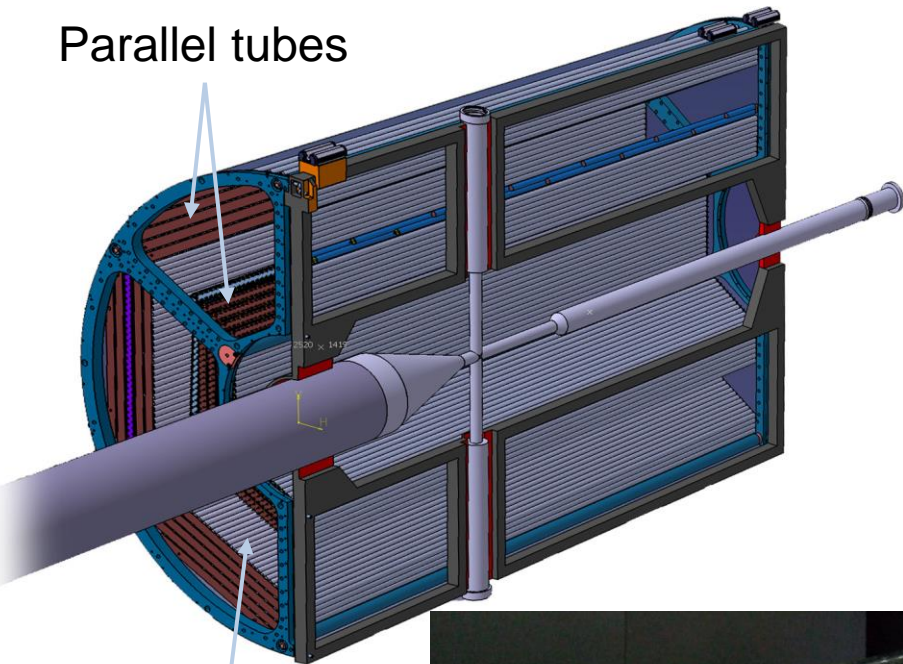


Skewed tubes:  
Important for z  
component

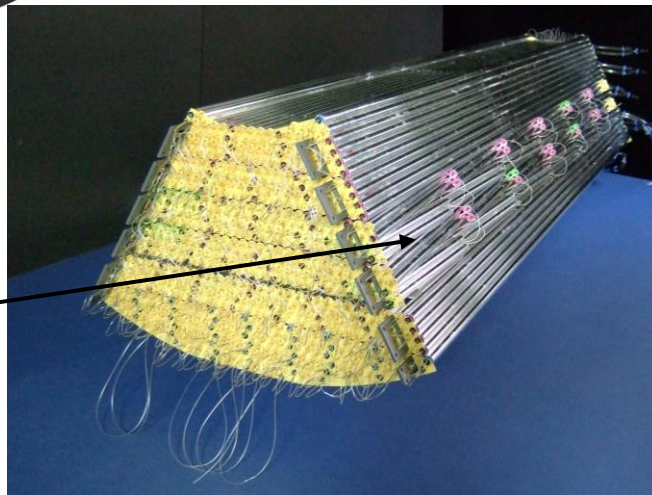
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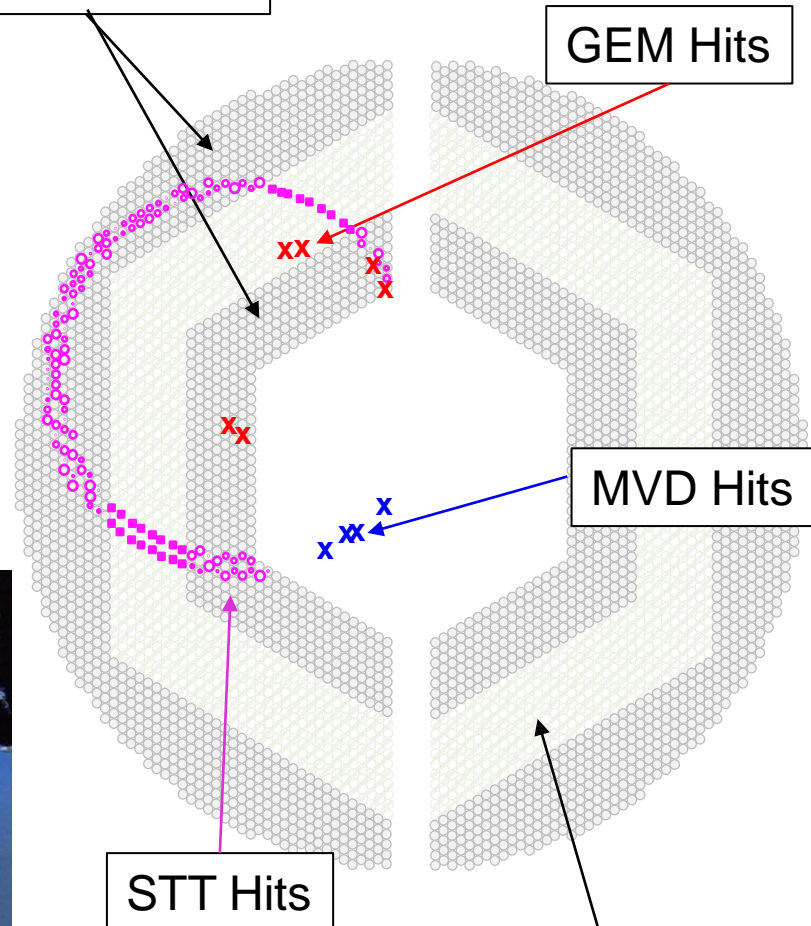
Parallel tubes



Skewed tubes



Parallel tubes



GEM Hits

MVD Hits

STT Hits

Skewed tubes:  
Important for z  
component

# TRACK FINDING WITH ISOCHRONES

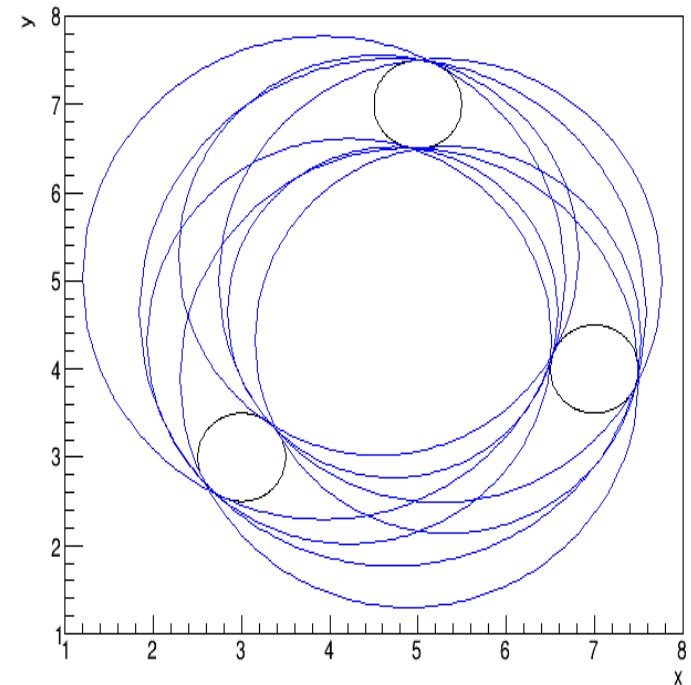
## Challenge

- 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  $\mu\text{m}$ )

X interaction point (IP)

## Approach to a Solution

“Problem of Apollonius”





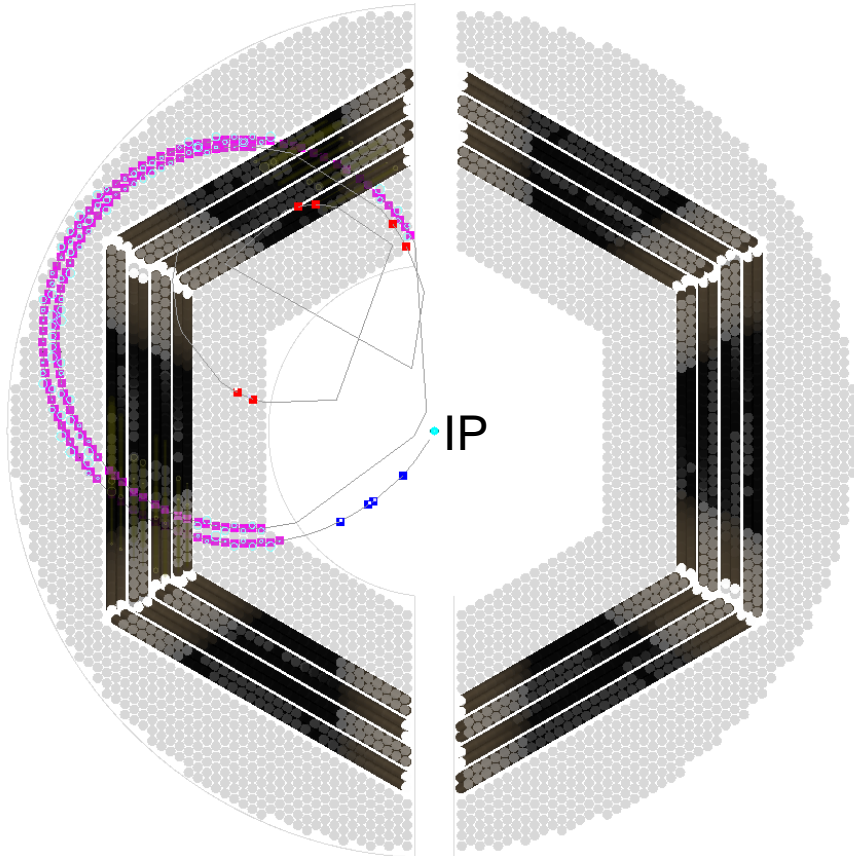
# SECONDARY TRACKING



## Primary tracks

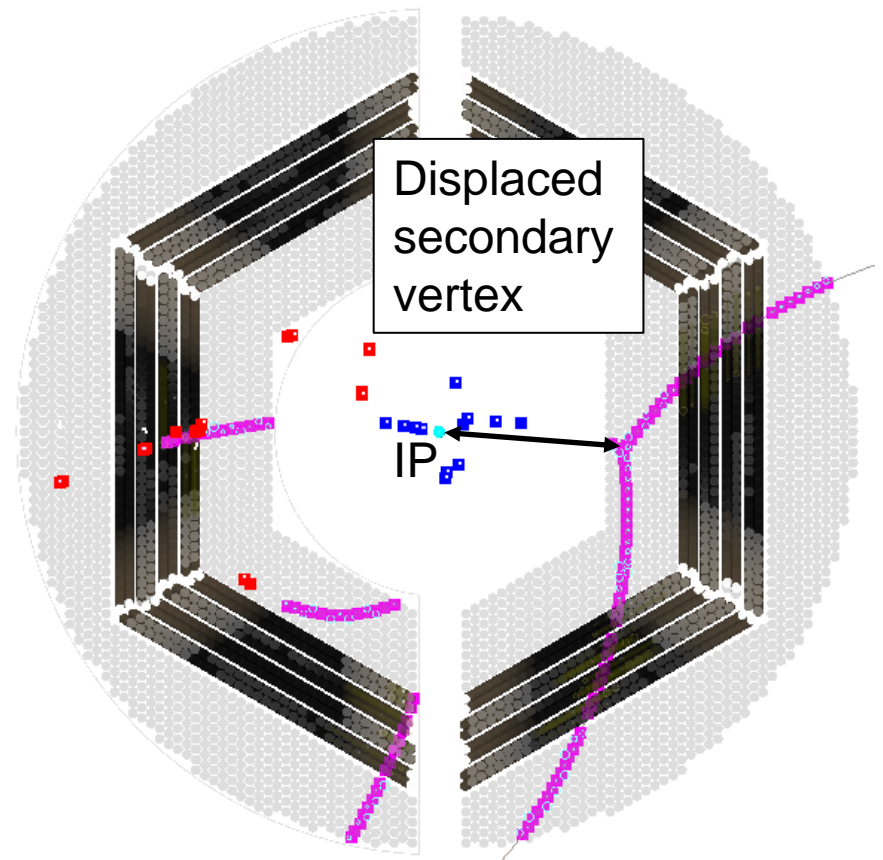
Track originates from initial interaction point (IP)

→ One precise point given



## Secondary tracks

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



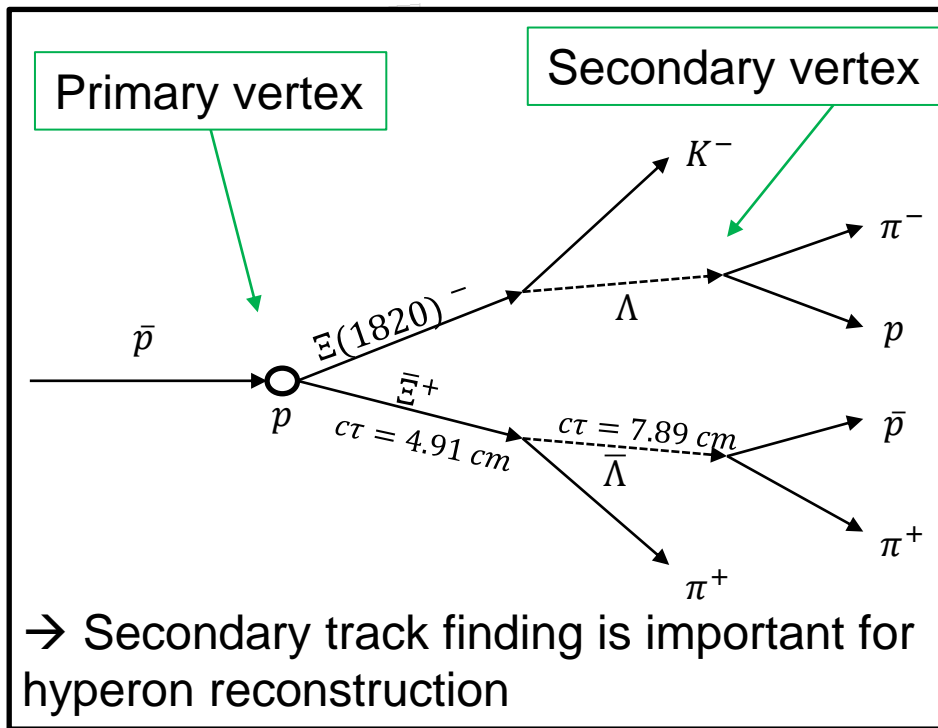
# SECONDARY TRACKING



## Primary tracks

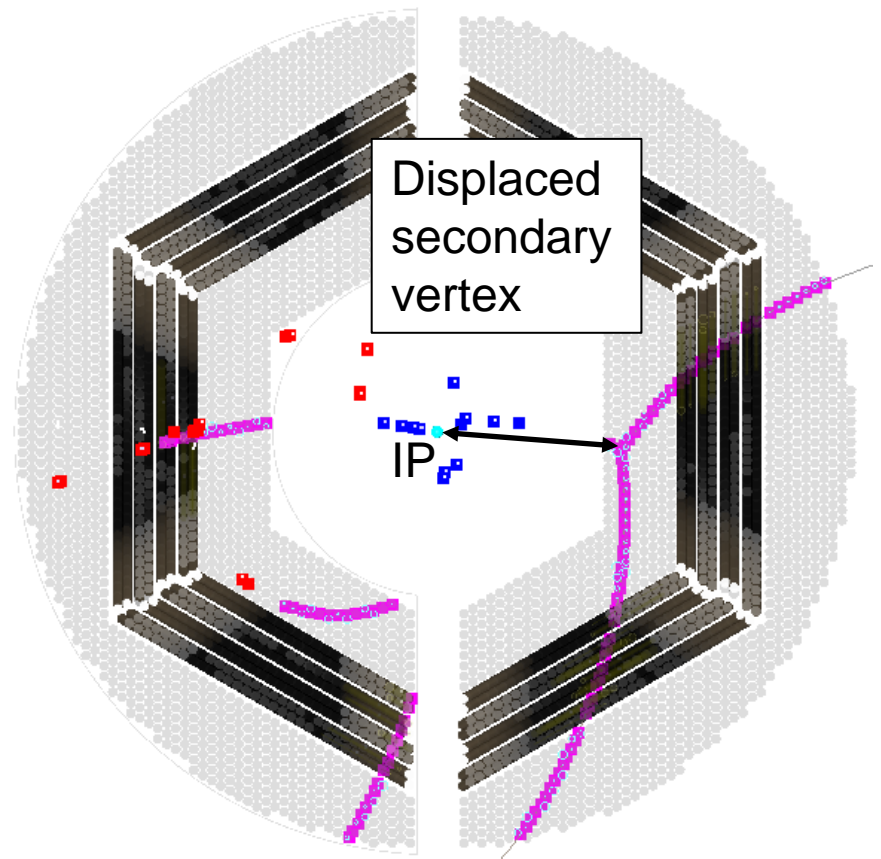
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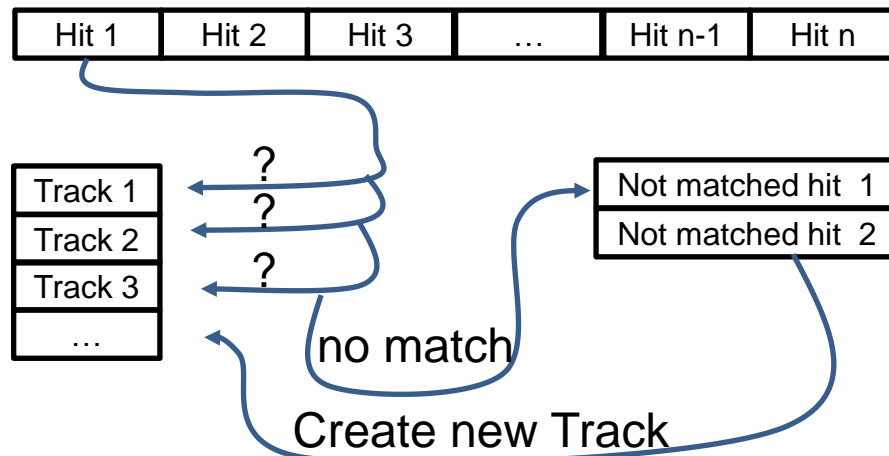
# TRACKING ALGORITHMS



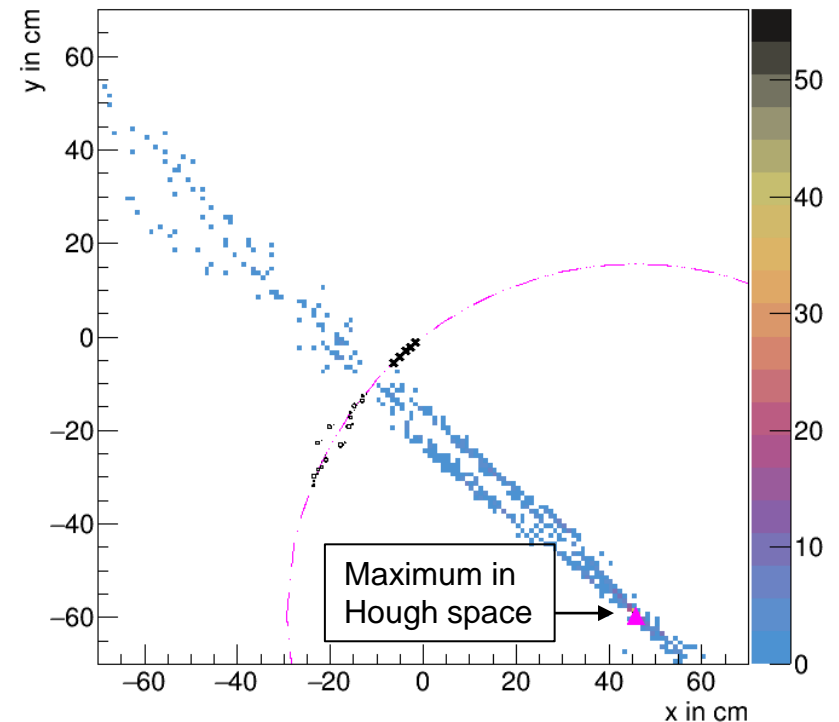
## Primary track finders

### Standard Tracker

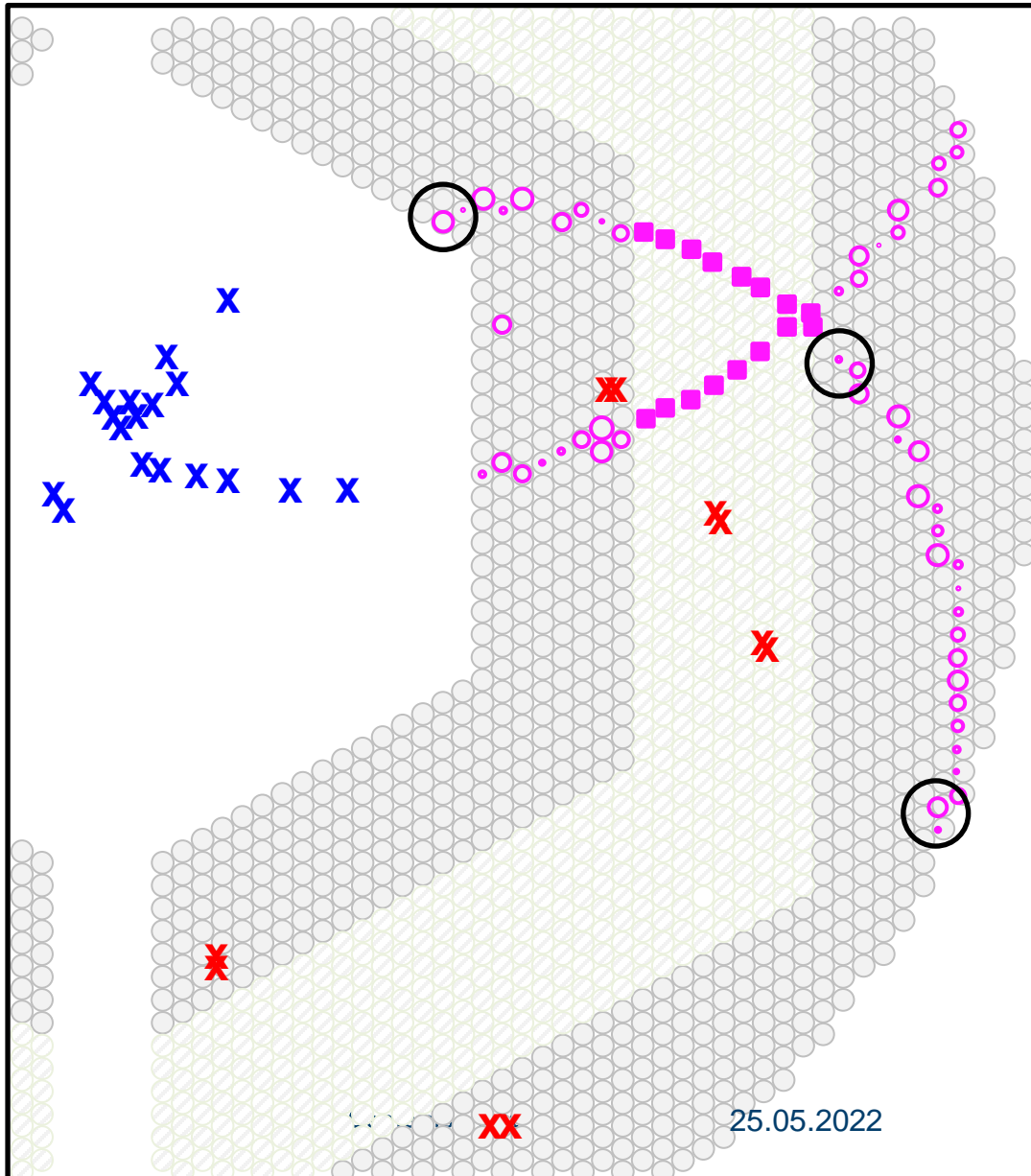
- Takes one hit after another
- Calculates circle from 3 hits
- Does hit belong to a track?



### Hough Tracker



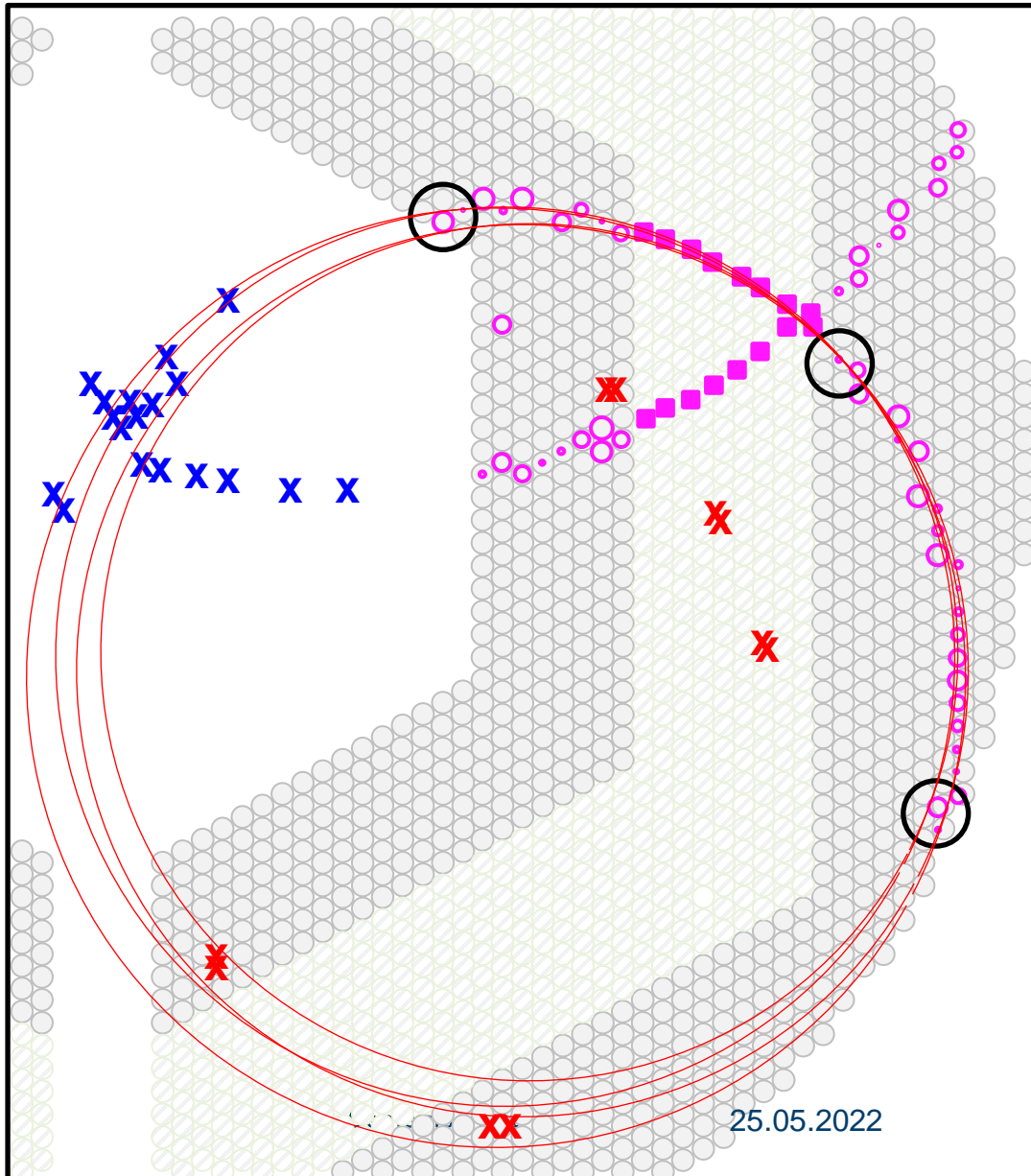
# SECONDARY TRACK FINDER



- Basic idea
  - Select three STT hits

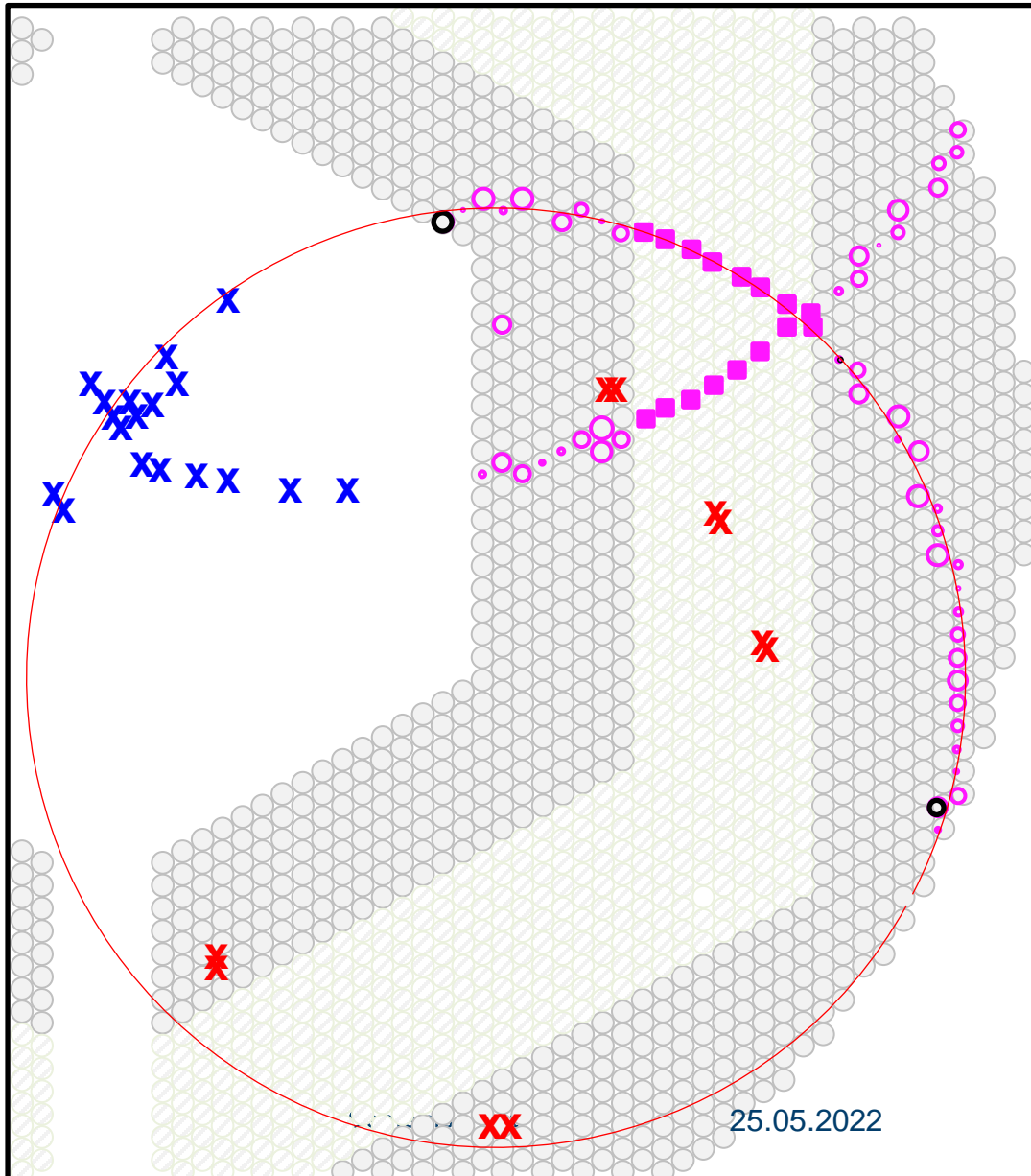


# SECONDARY TRACK FINDER



- Basic idea
  - Select three STT hits
  - Calculate Apollonius Circles
  - Add other STT hits which are close to circles

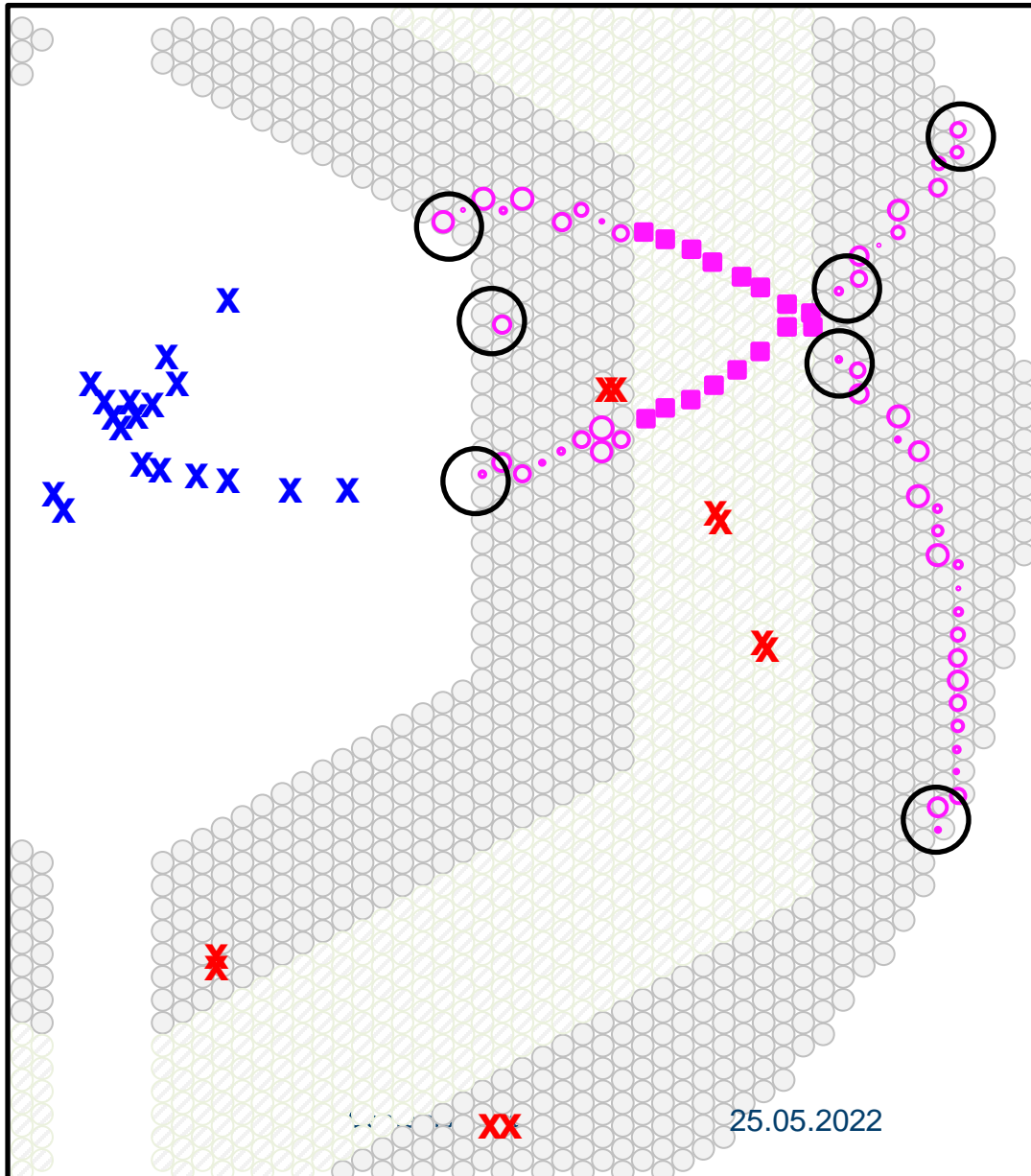
# SECONDARY TRACK FINDER



- Basic idea
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  - Add other STT hits which are close to circles
  - Select best solution(s)

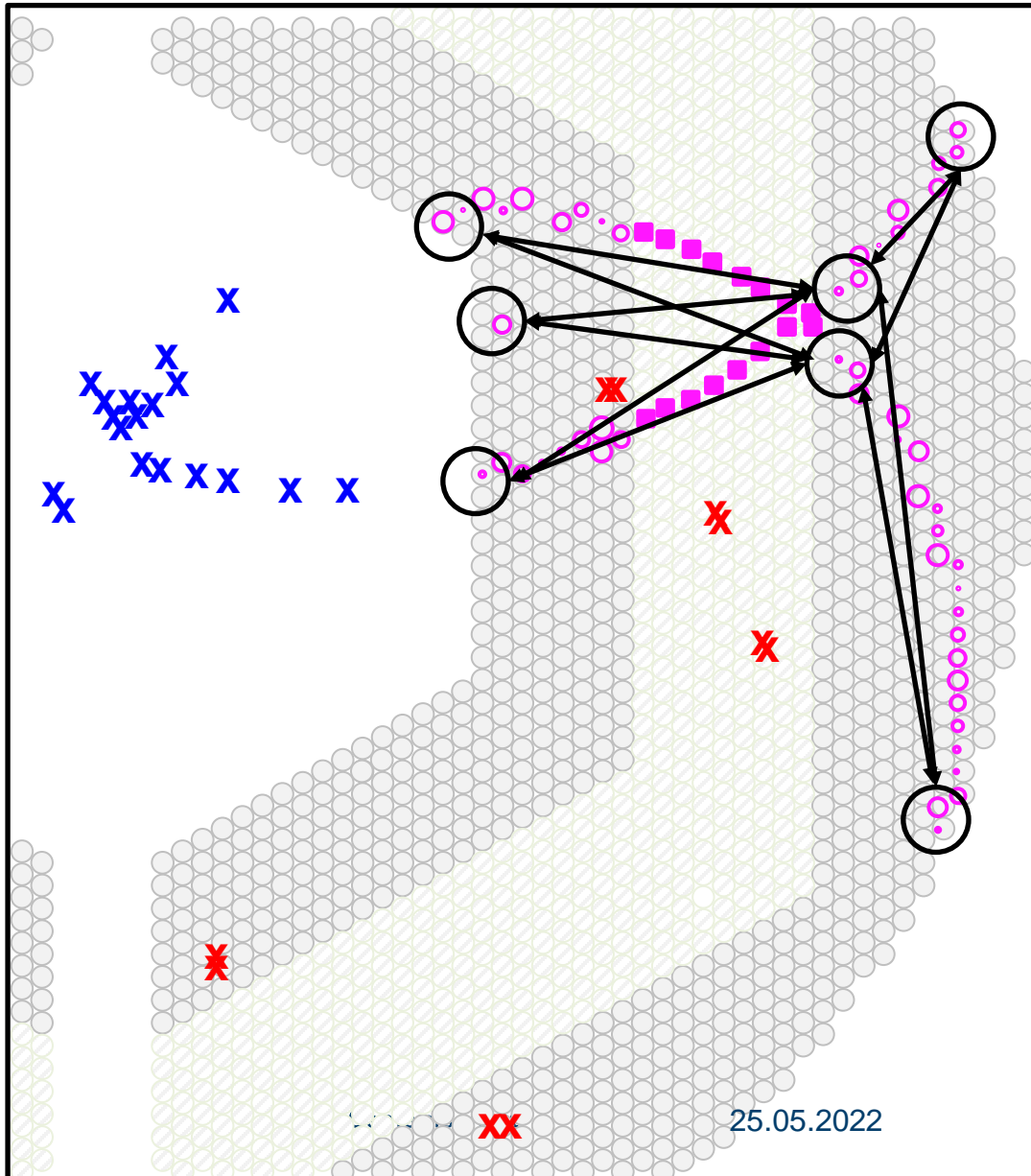


# SECONDARY TRACK FINDER



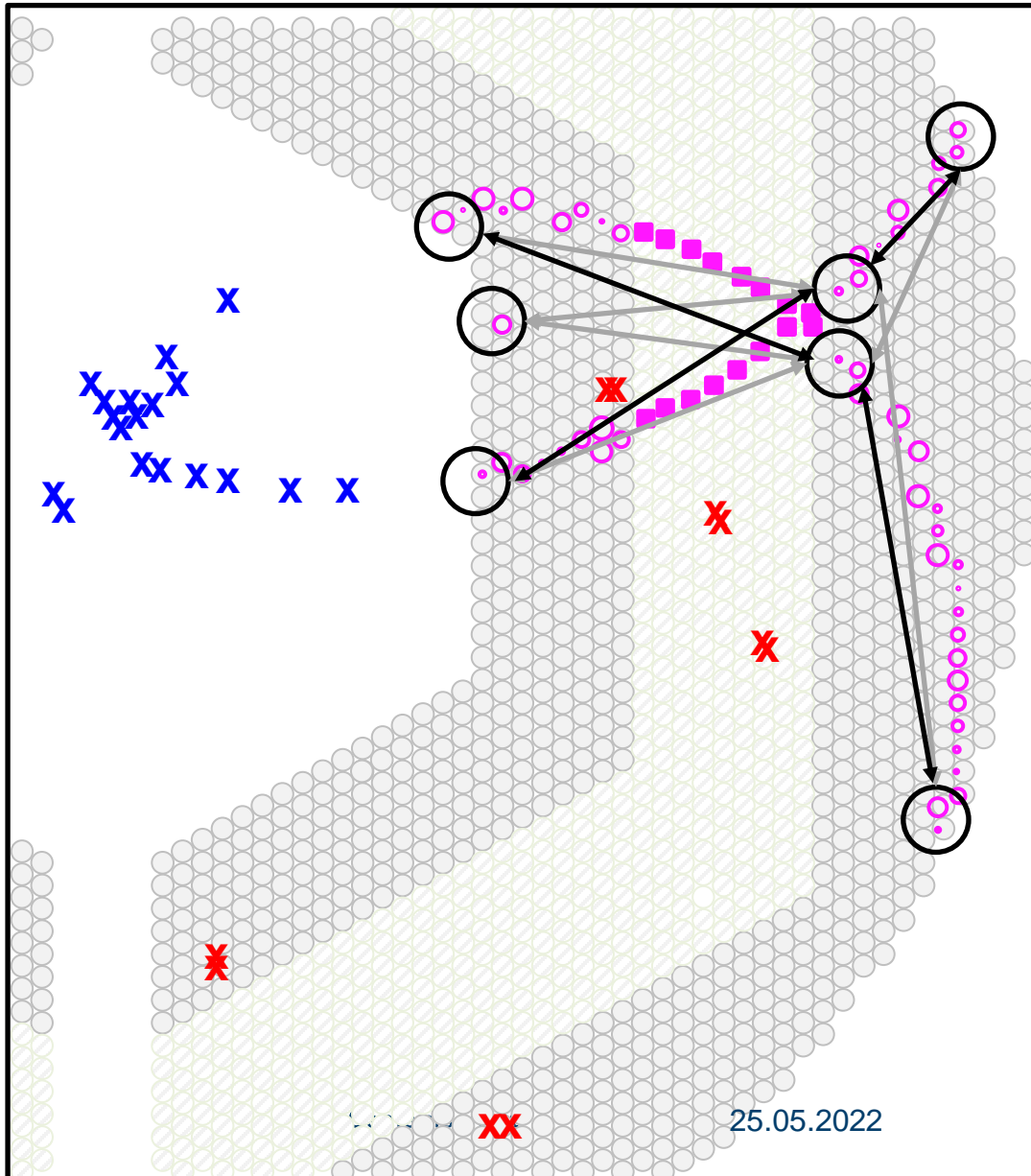
- Basic idea
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  - Select best solution(s)
- **How to find a good triplet?**
  - Define set of inner, mid and outer STT hits
  - Too many combinations: slow
  - Too few combinations: low efficiency

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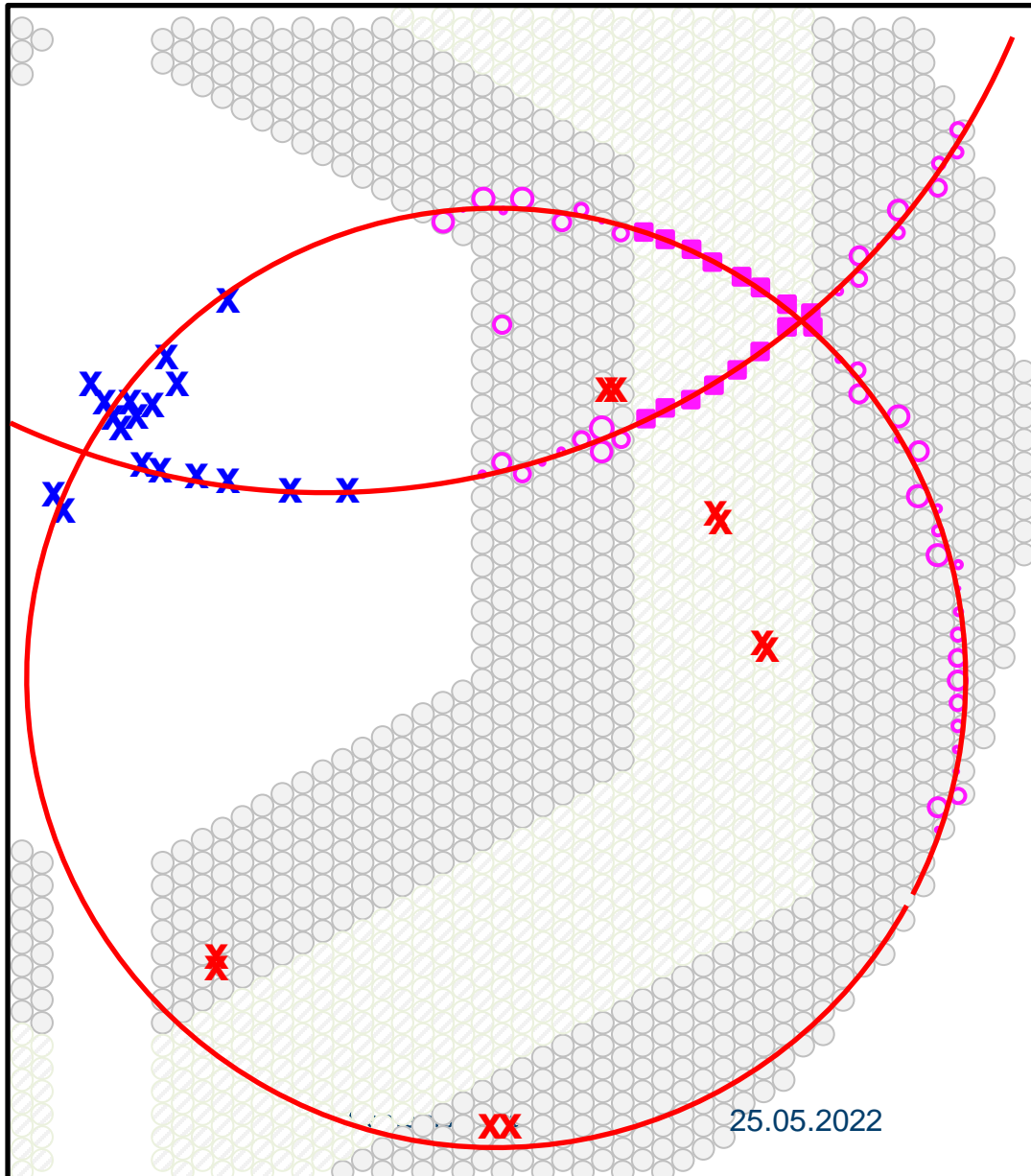
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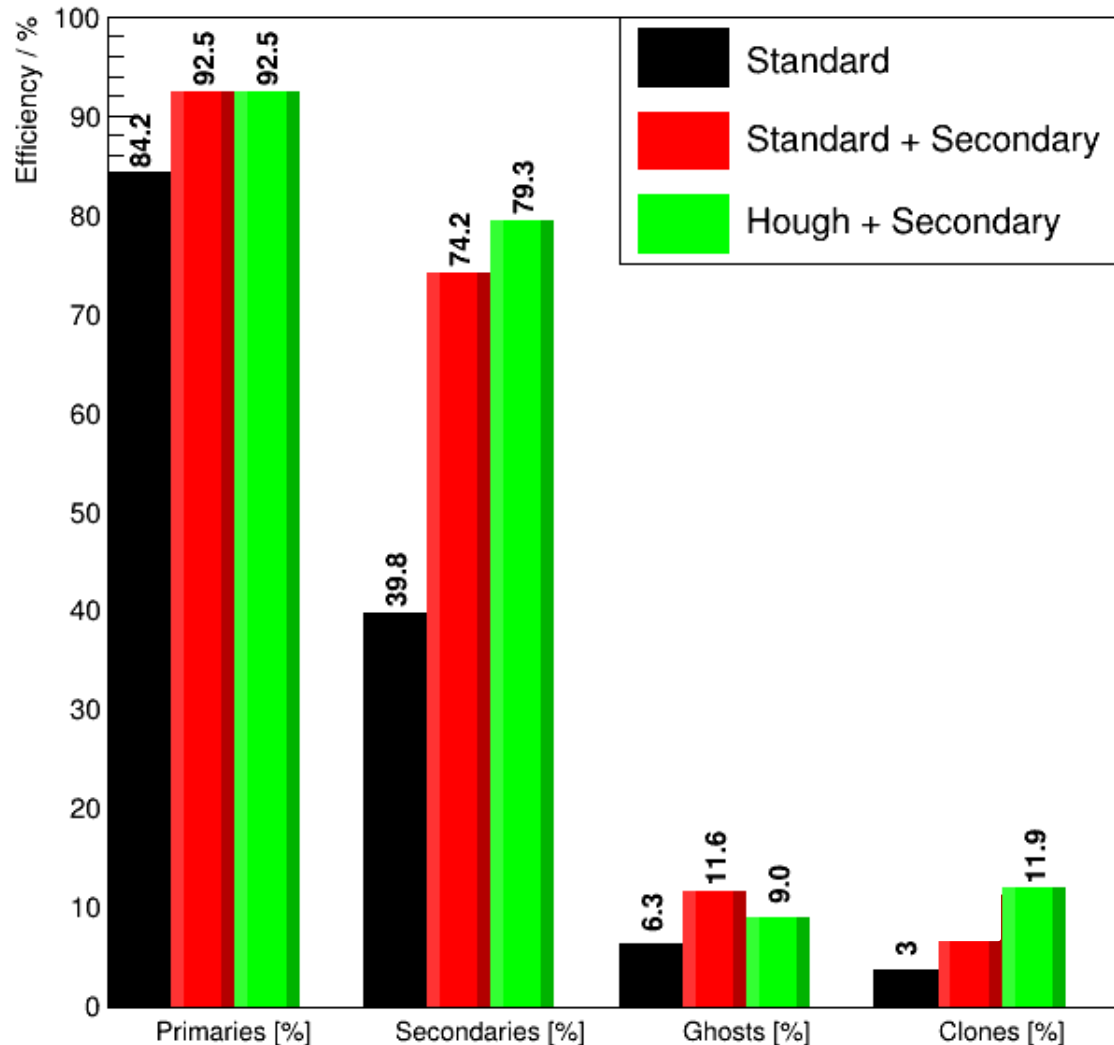


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- **Which is the proper circle?**
  - Continuity check
  - Number of hits in track
  - Quadratic distance of hits to circle

# TRACK FINDING RESULTS



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



# 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
$\pi^-$	58.4	68.8	72.9
$\pi^+(\bar{\Xi}^+)$	67.1	86.0	88.0
$\bar{p}$	72.3	78.8	75.3
$\pi^+$	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!