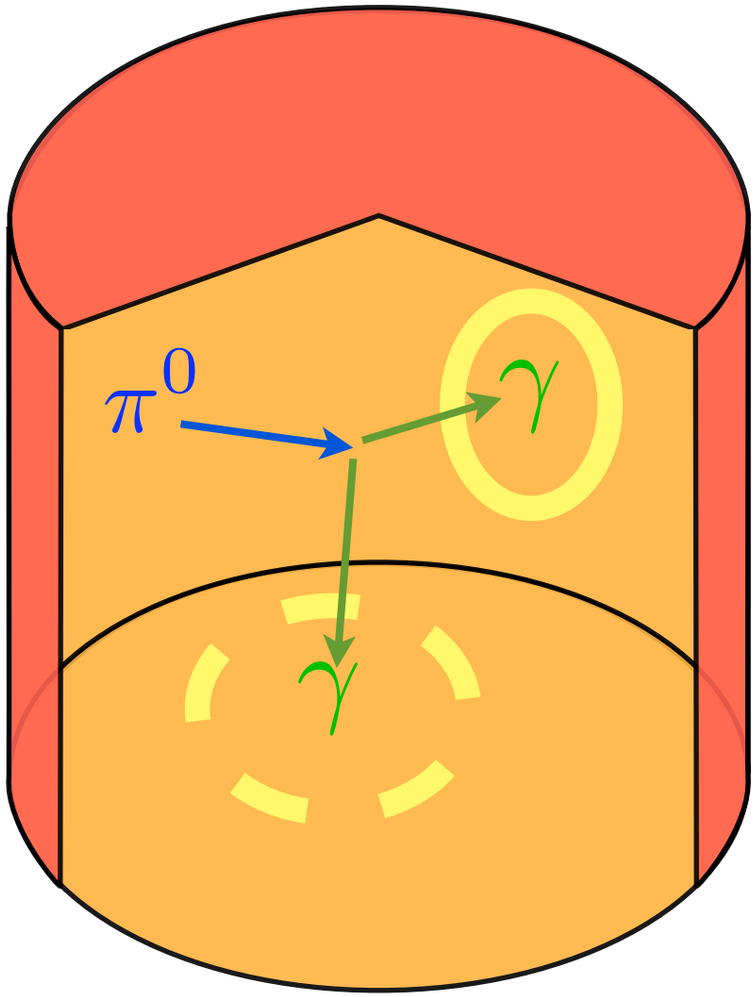
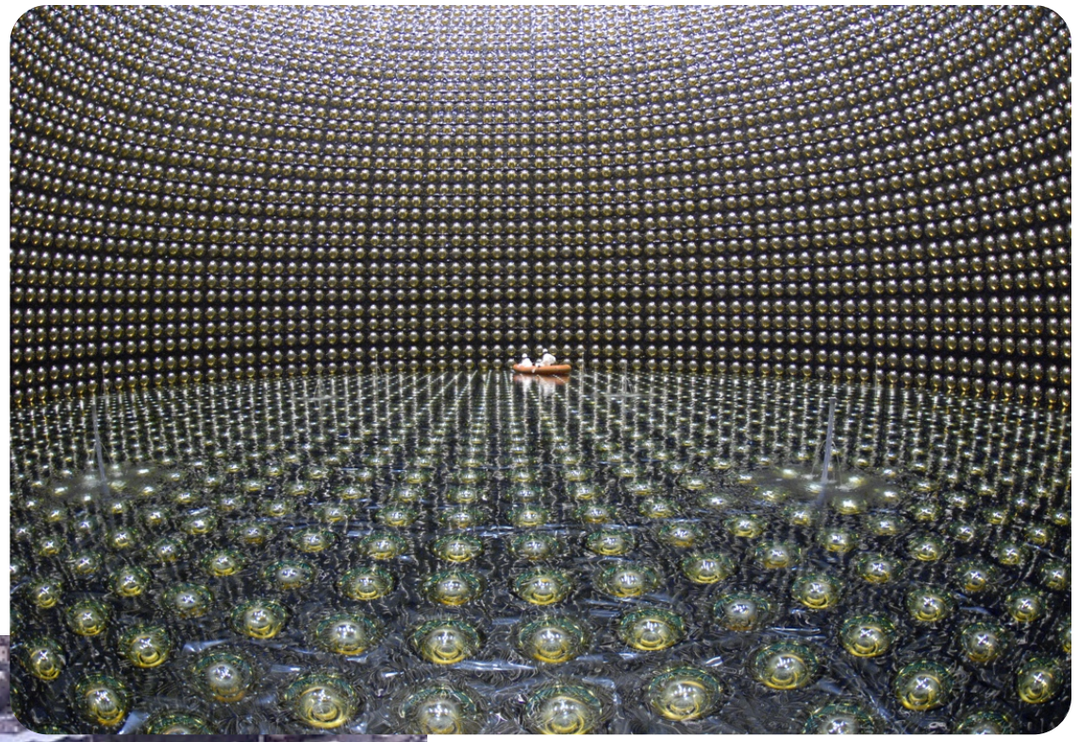


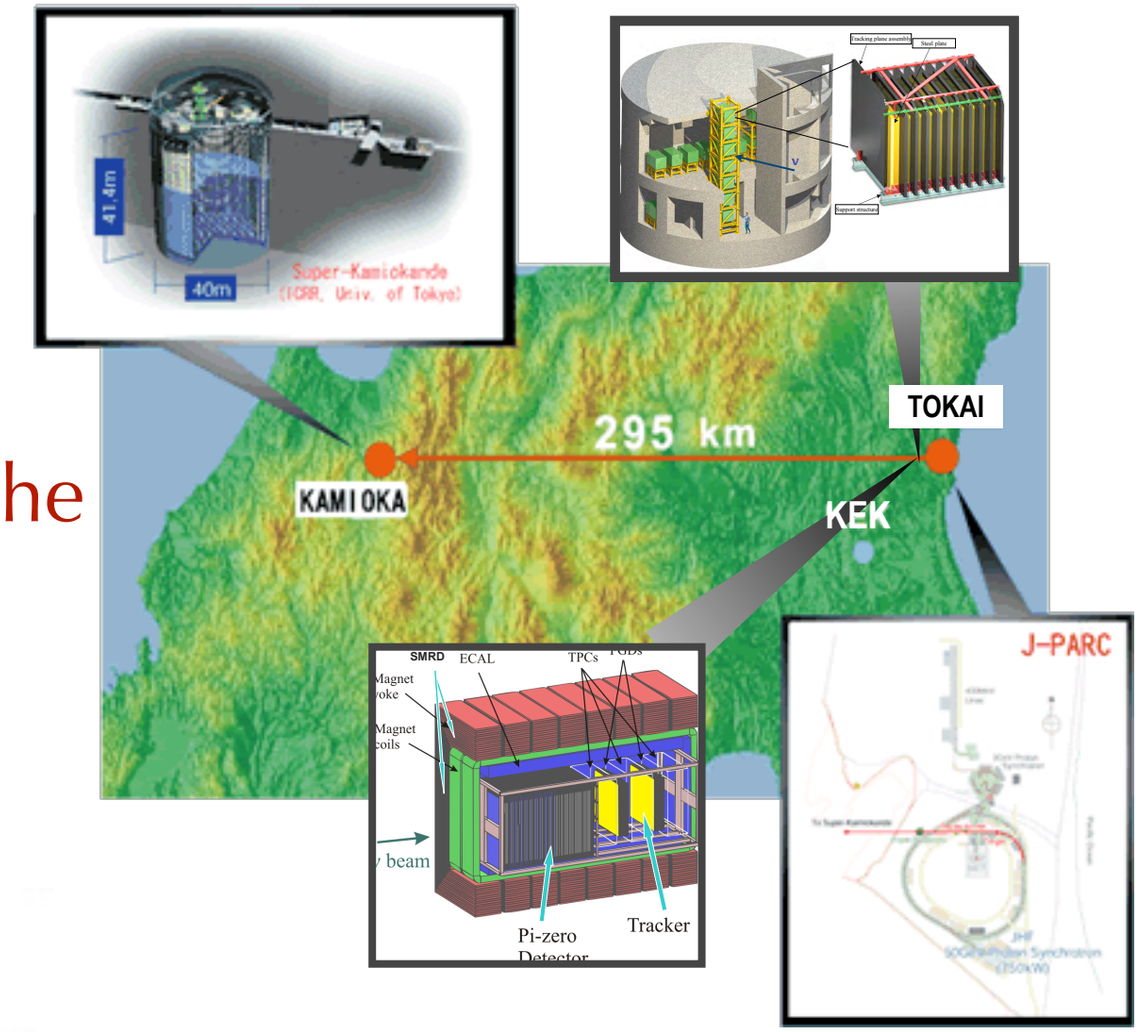
Neutral-Current π^0 Backgrounds for T2K



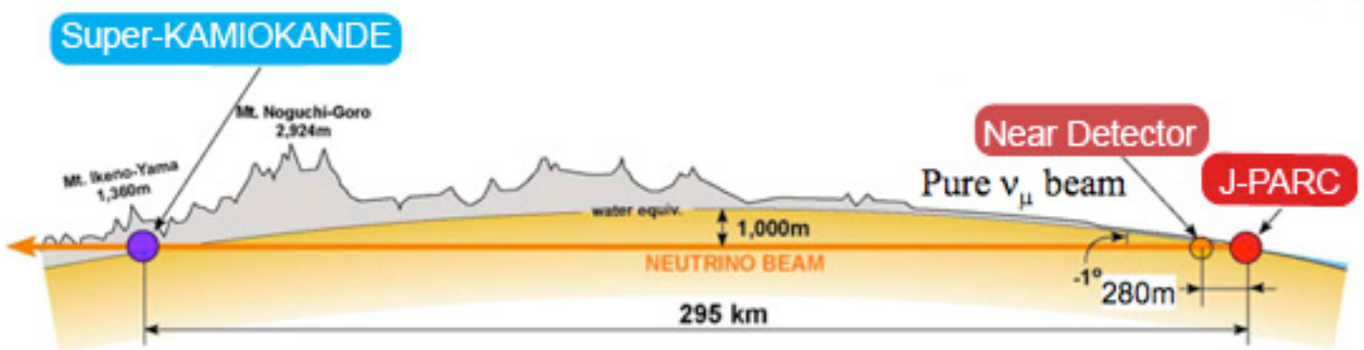
Joshua Albert
Duke University
March 11, 2010
Rencontres de Moriond YSF

T2K Overview

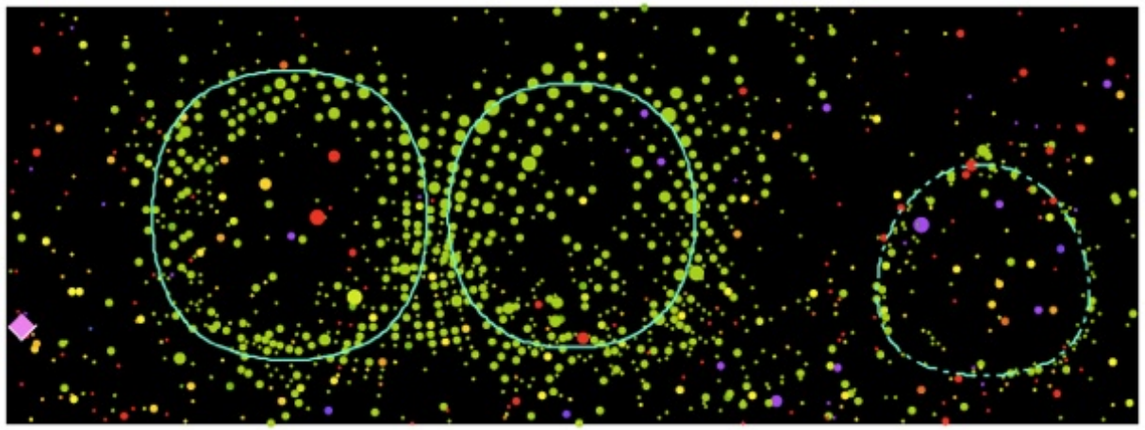
- High intensity beam of ν_μ travels 295 km beneath Japan from the synchrotron at J-PARC in Tokai to the Super-Kamiokande Detector (SK).



- Near detectors at 280m measure unoscillated beam



- First T2K ν seen at SK in Feb 2010!



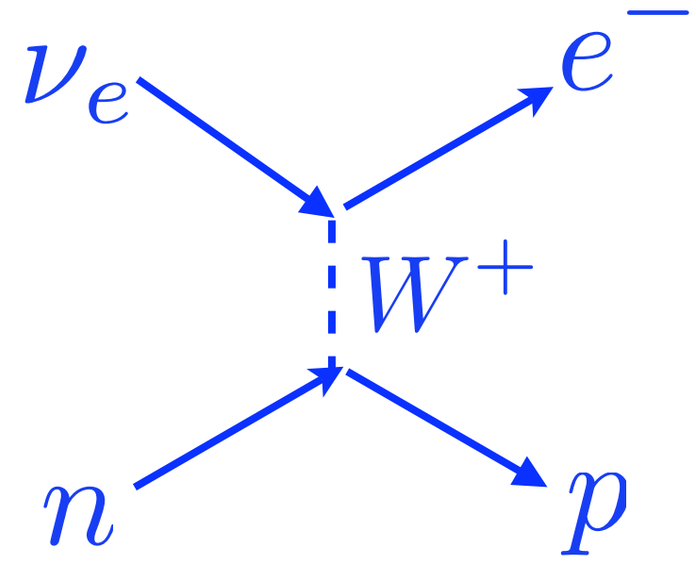
- Detection of excess ν_e at SK is evidence for oscillation induced by θ_{13}. Whether this mixing angle is non-zero is currently unknown.

Identifying ν_e Signal

- Our primary signal is Charged Current Quasi-Elastic (CCQE) ν_e events.

Identifying ν_e Signal

CC: Mediated by $W^{\pm}$
Produces lepton, revealing ν flavor
Affected by oscillation



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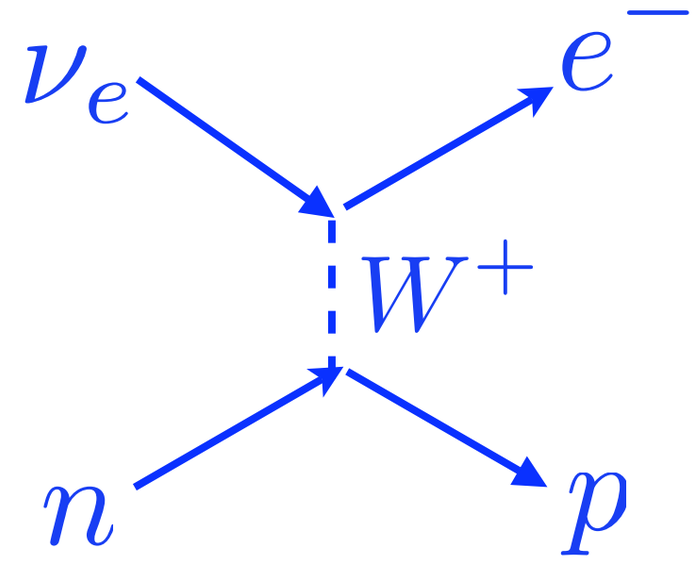

- Our primary signal is Charged Current Quasi-Elastic (CCQE) ν_e events.

QE: Only the lepton is produced.
Kinematics are simple enough that we can reconstruct parent ν energy.

$$E_\nu = \frac{m_N E_l - m_l^2/2}{m_N - E_l + p_l \cos\theta_l}$$

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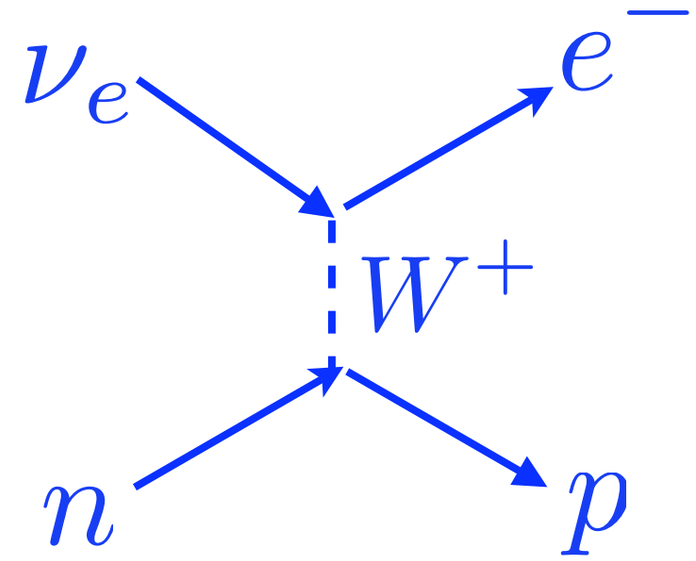

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- Look for single electron!

- Backgrounds: Beam ν_e, ν_μ mis-recon

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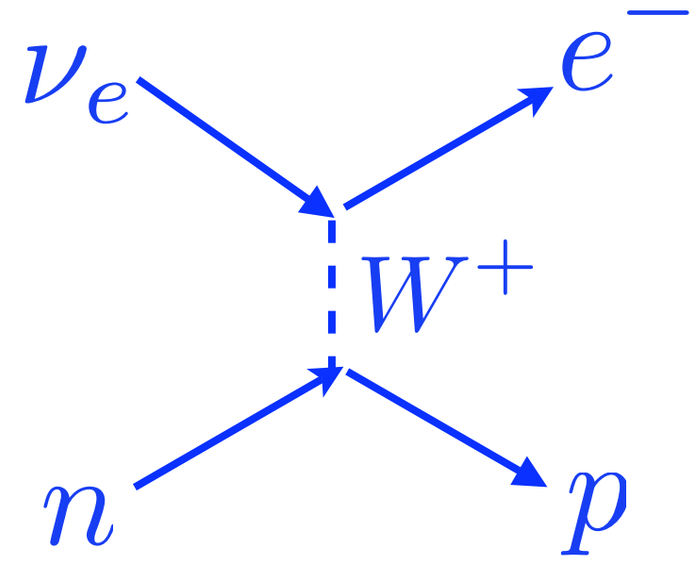

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Virtually Irreducible

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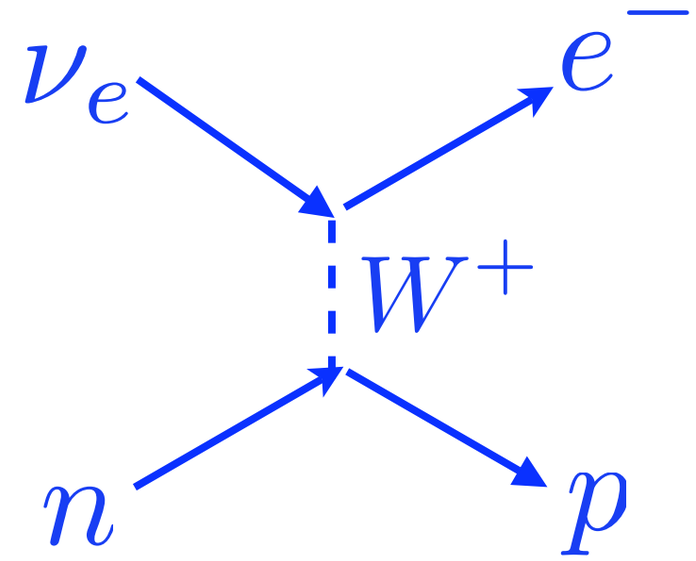

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Affected by oscillation

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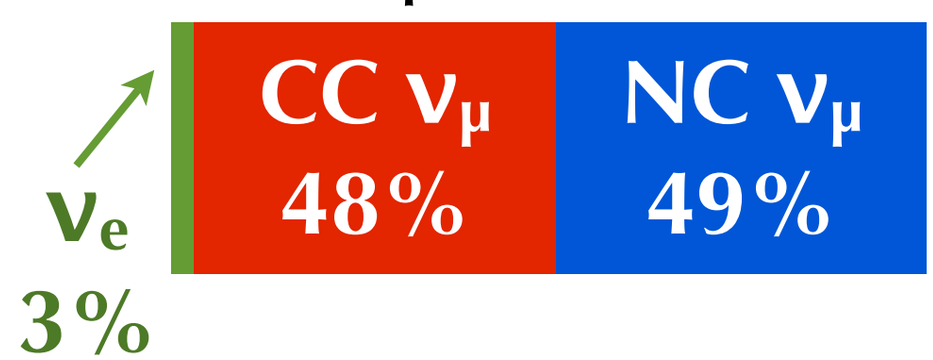
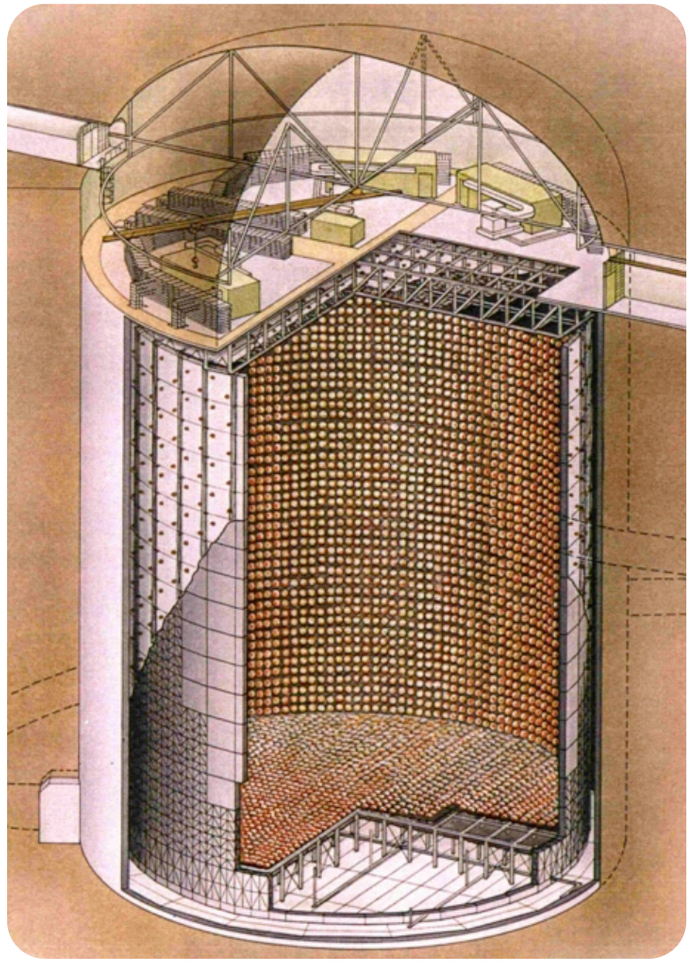
Virtually Irreducible

CC and NC

- Backgrounds: Beam ν_e, ν_μ mis-recon

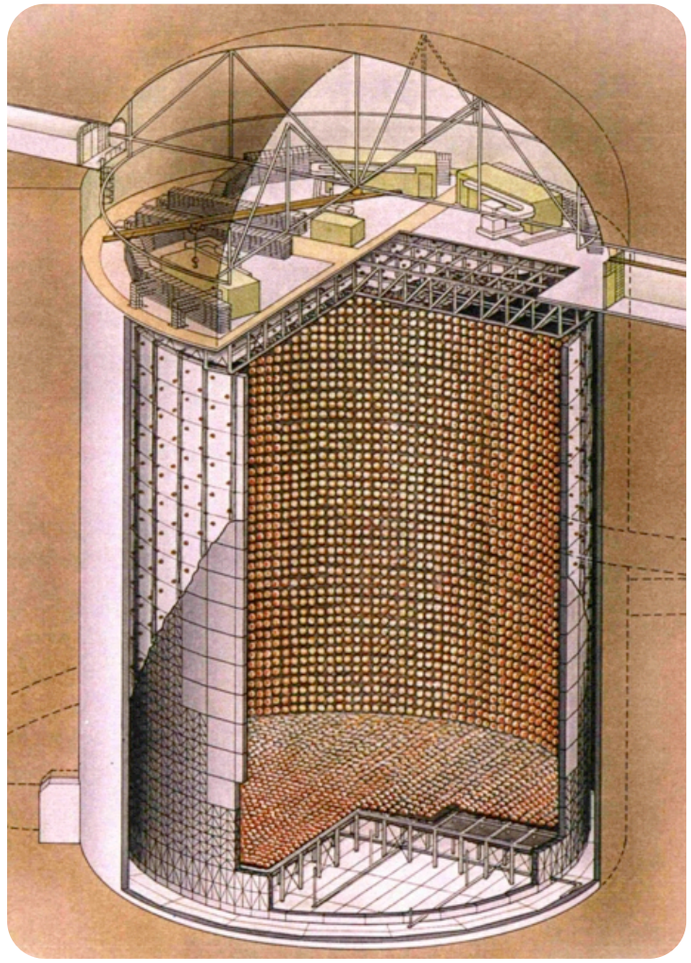
No cuts Bkg expectation:





Detection at SK

- Cherenkov light from charged particles traveling with $\beta > 0.75$ (the speed of light in water) is detected by PMTs on the walls.
- Pos, Mom, Dir, calculated from patterns and timing info.



Detection at SK

- Cherenkov light from charged particles traveling with $\beta > 0.75$ (the speed of light in water) is detected by PMTs on the walls.
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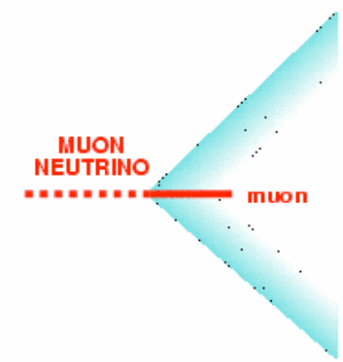
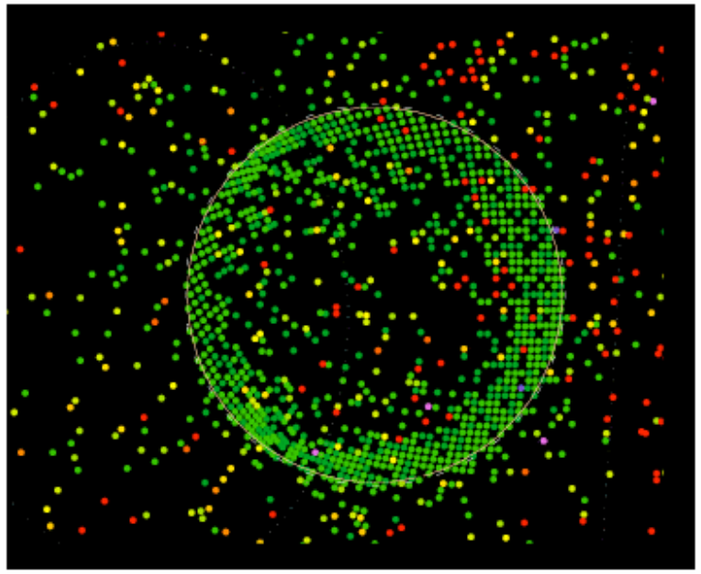
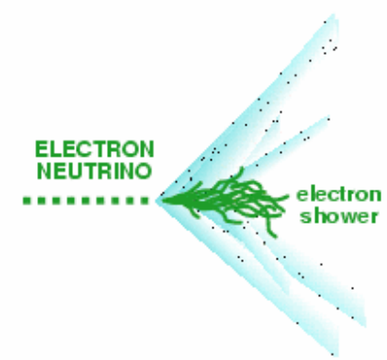
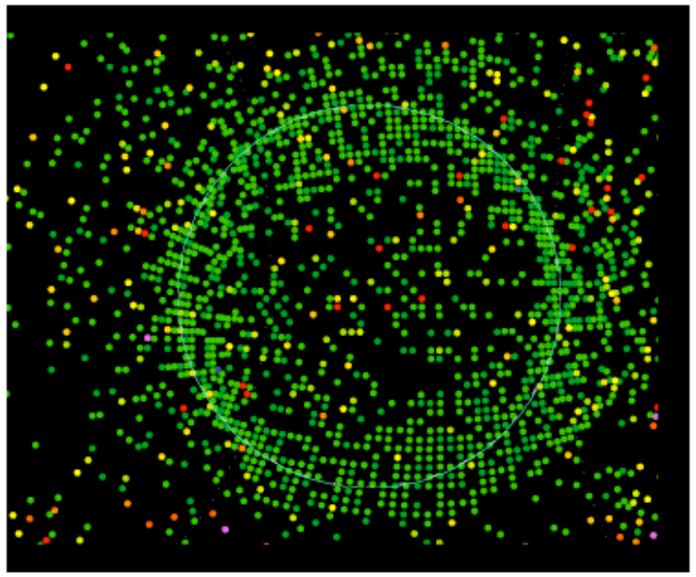
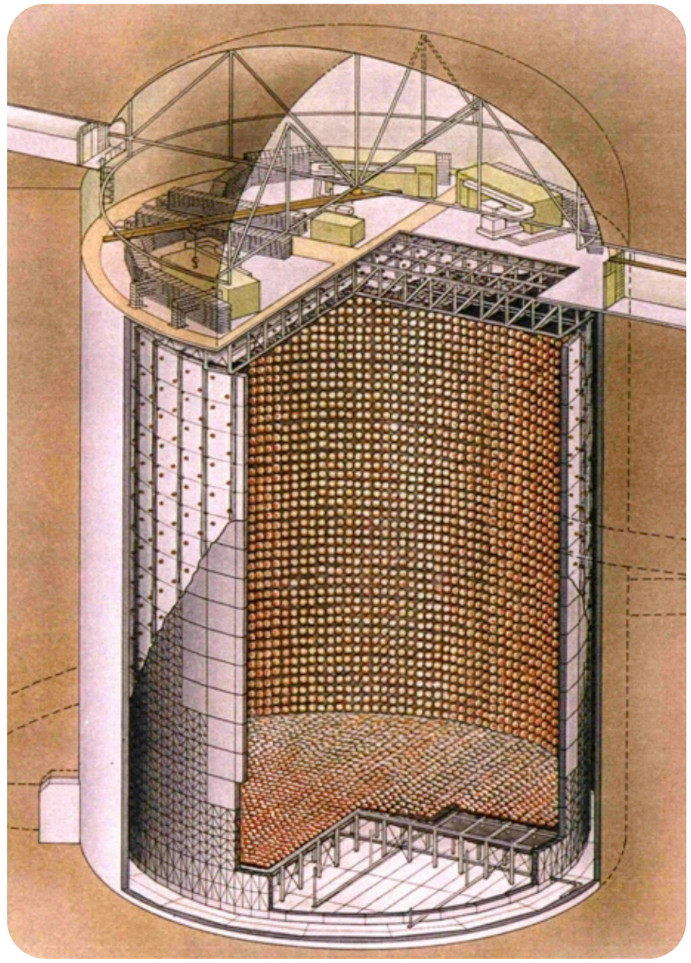
- Sharp boundary ➠ non-showering particles ➠ (μ, p, $\pi^{\pm}$...)
- Diffuse boundary ➠ showering (pair-producing) particles ➠ (γ, e)











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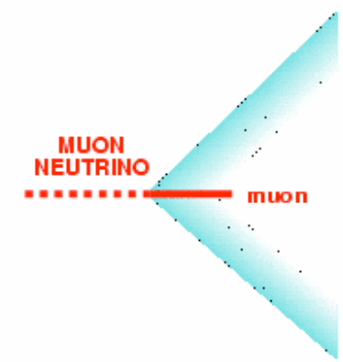

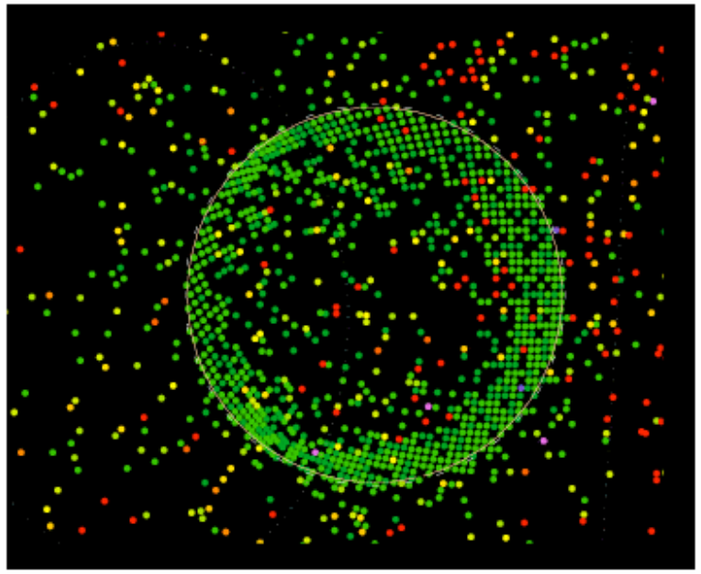

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CC ν_μ
7%

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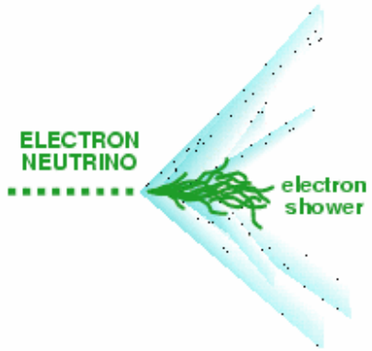
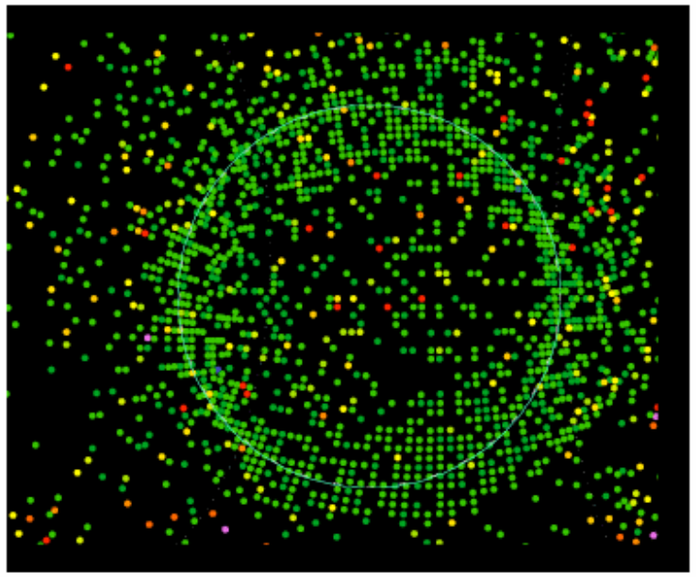
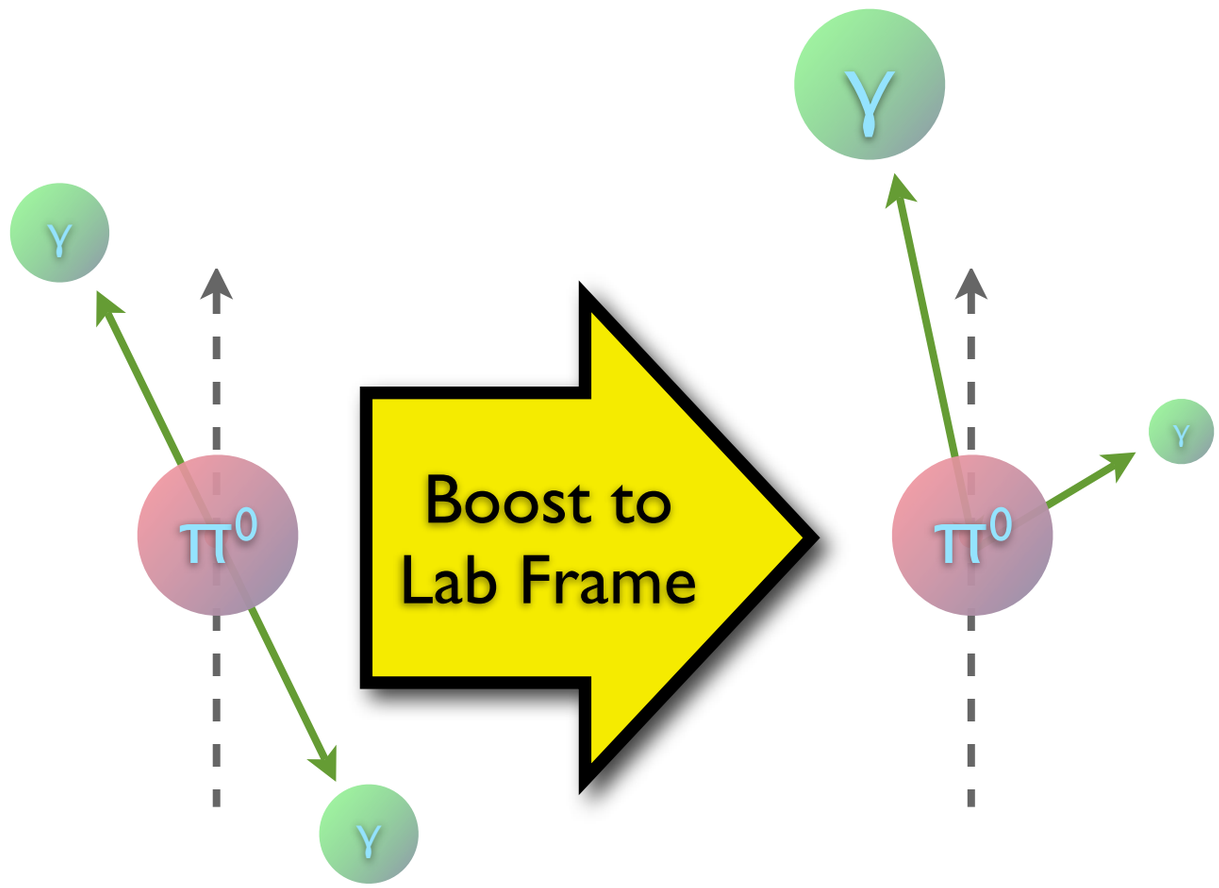




1R, e-like, no decay-e

NC π^0 Background

- NC π^0 events can emulate our signal through asymmetric decay



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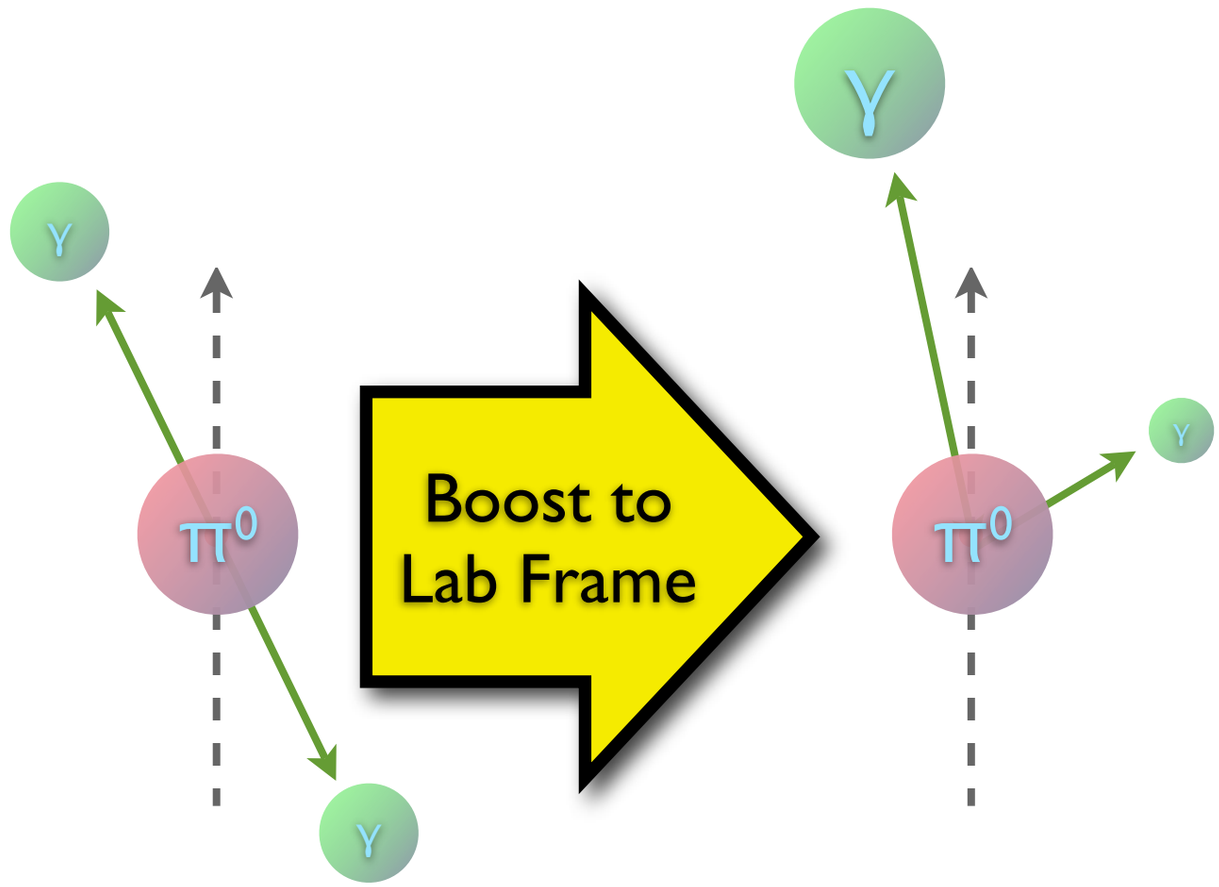
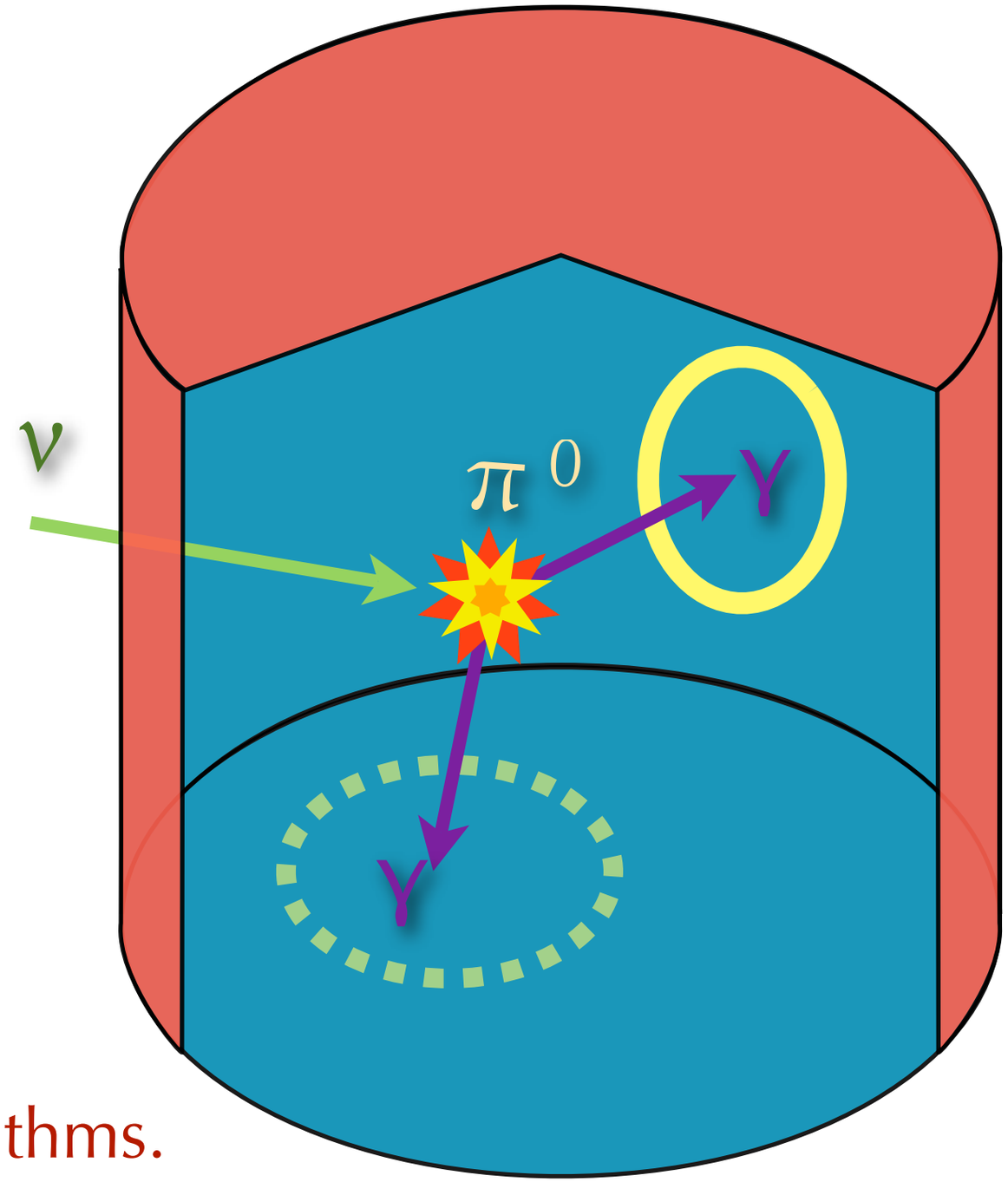
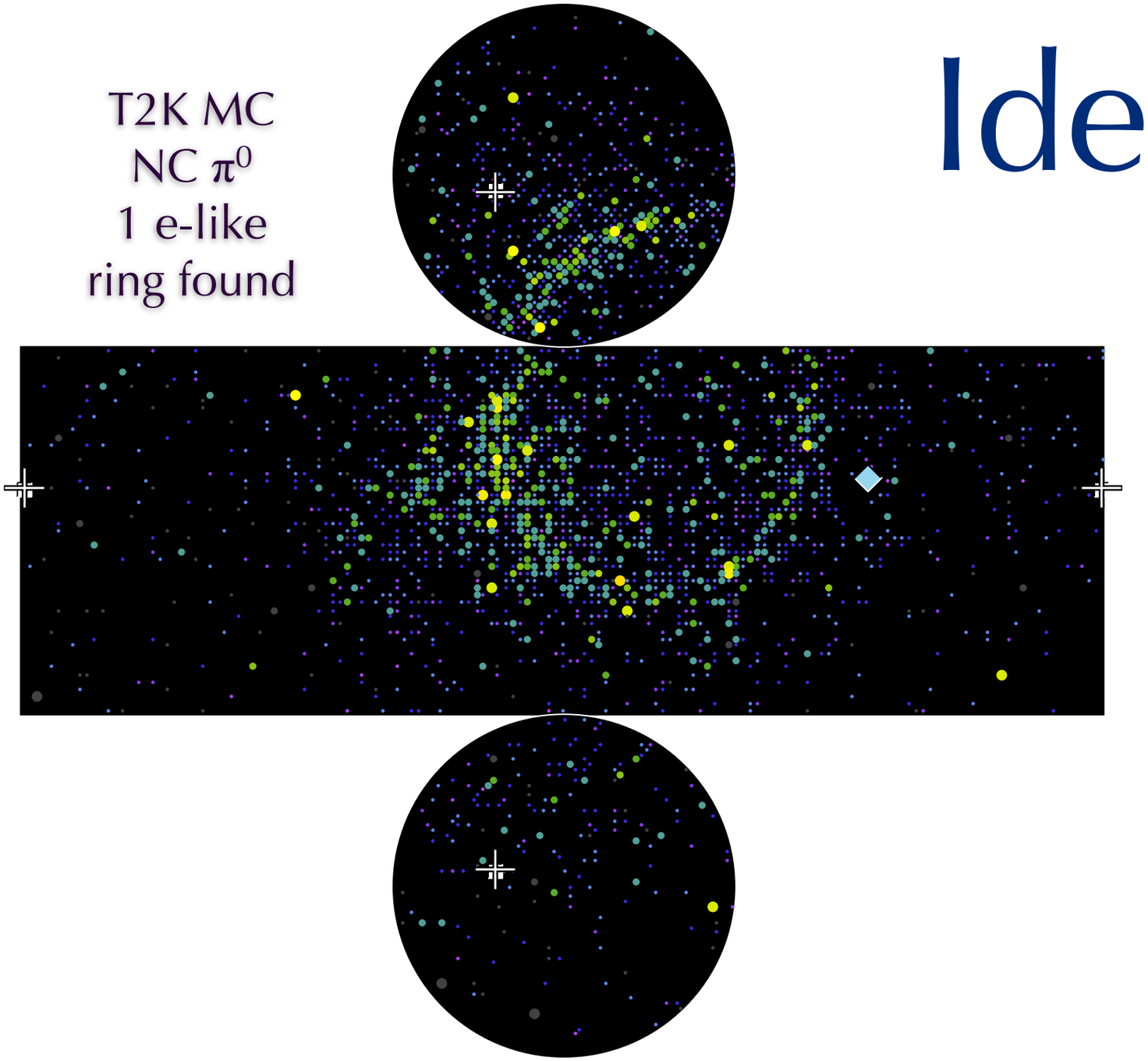




- The much fainter 2nd ring may be missed in normal ring-finding algorithms.
- Remaining γ-ring is indistinguishable from an e-ring.

Identifying π^0s

T2K MC
NC π^0
1 e-like
ring found



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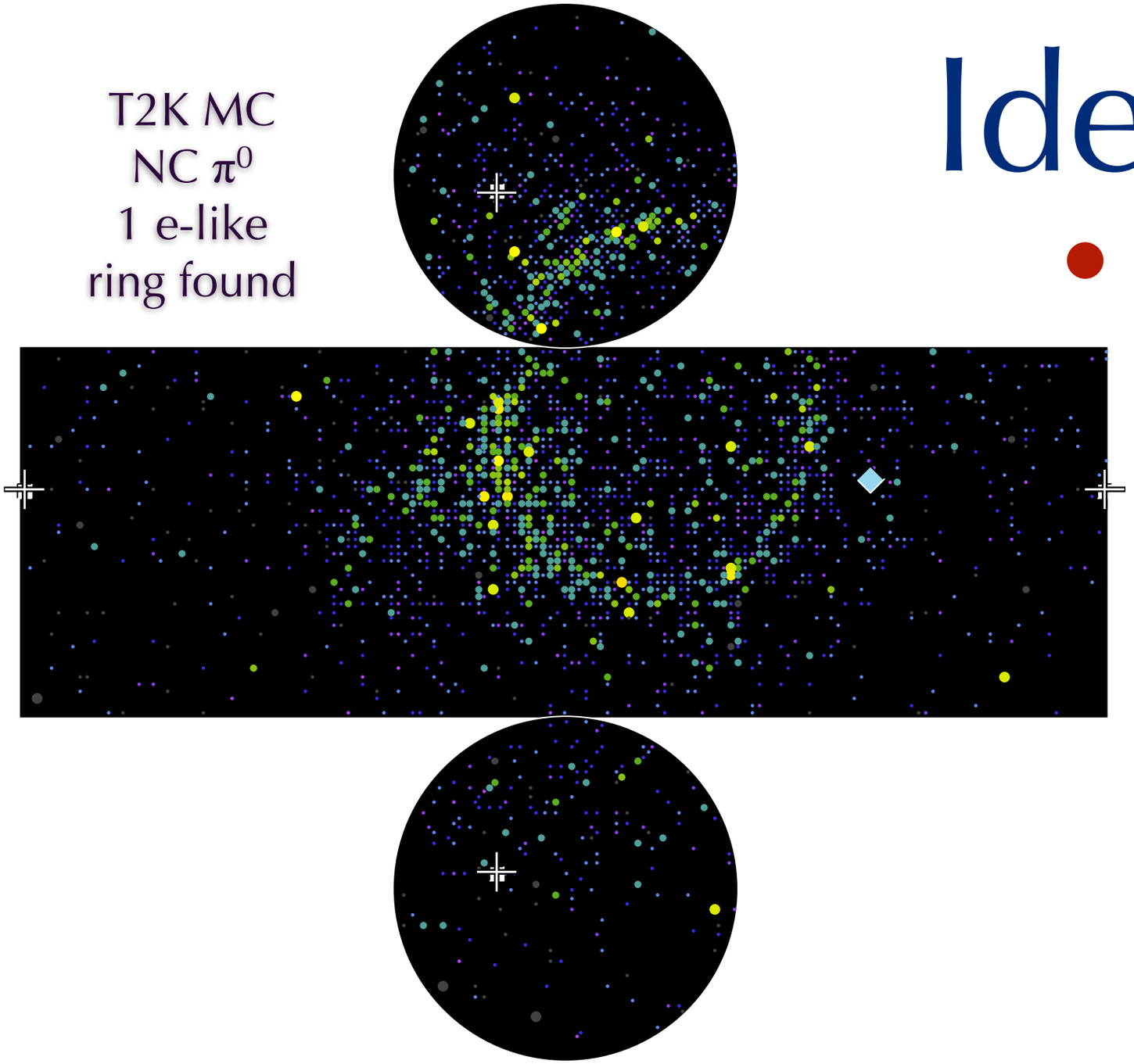

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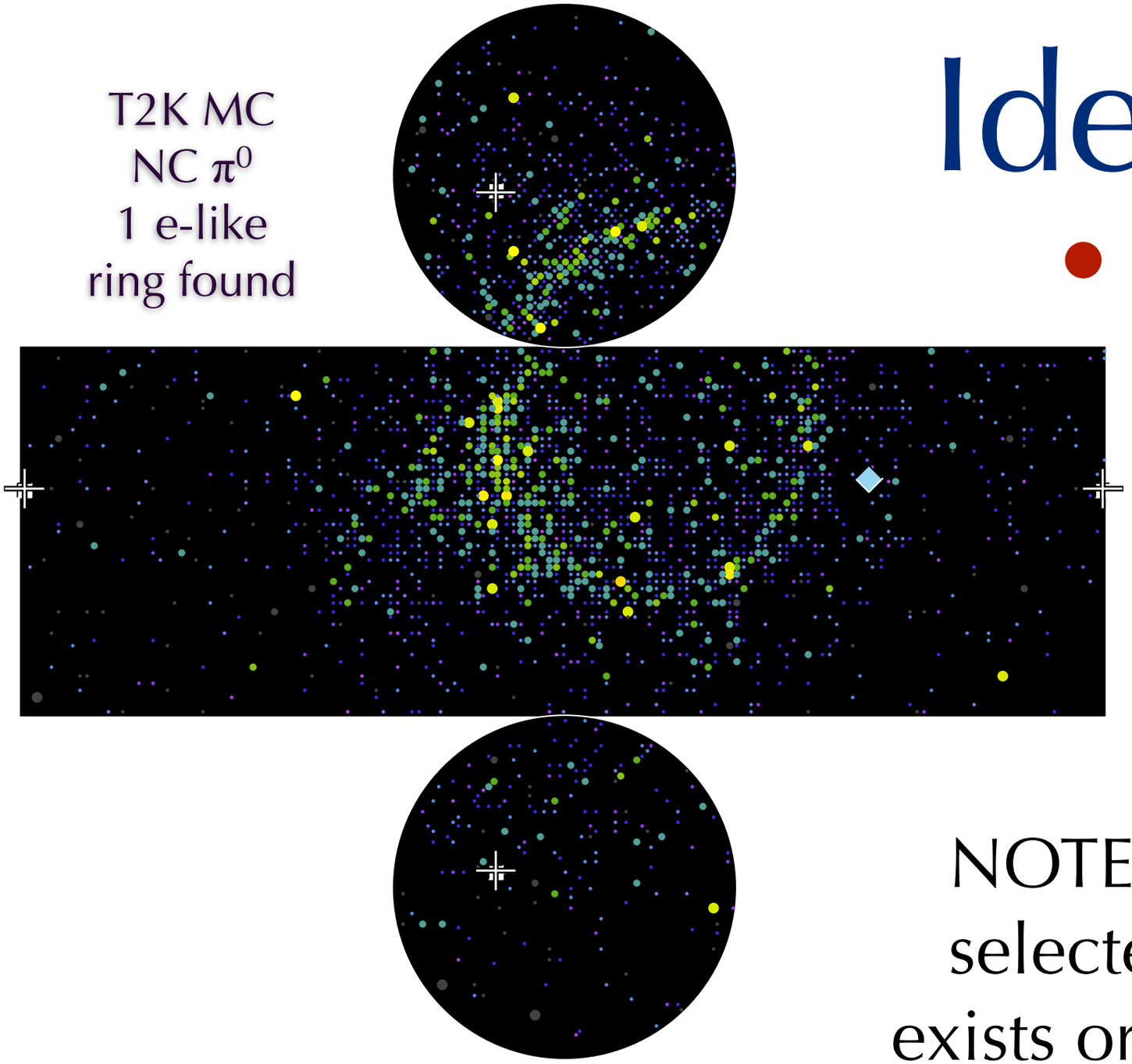

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NOTE: A 2nd ring will be selected whether or not it exists or is more favored over 1-ring hypothesis!

Identifying π^0s

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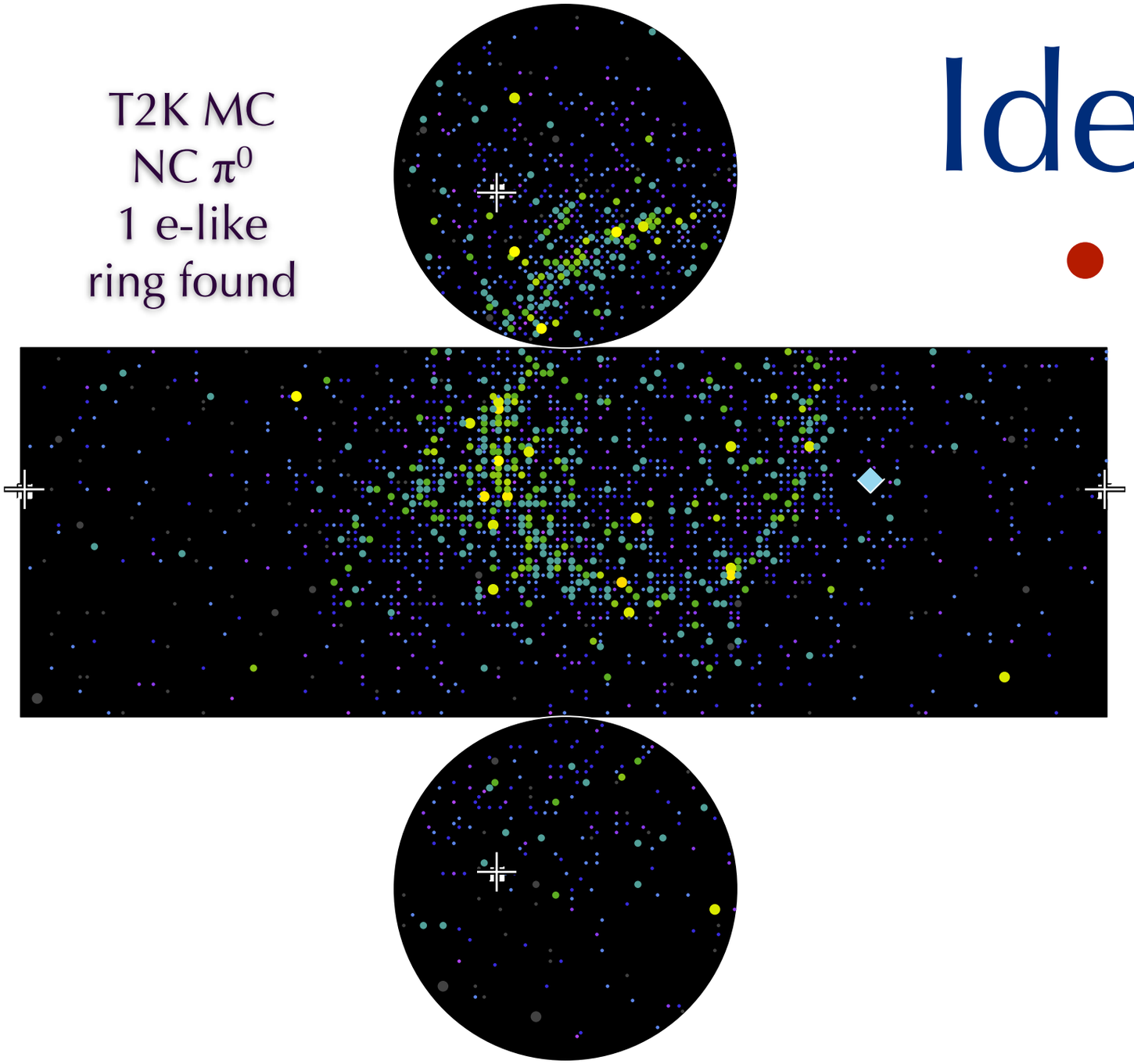

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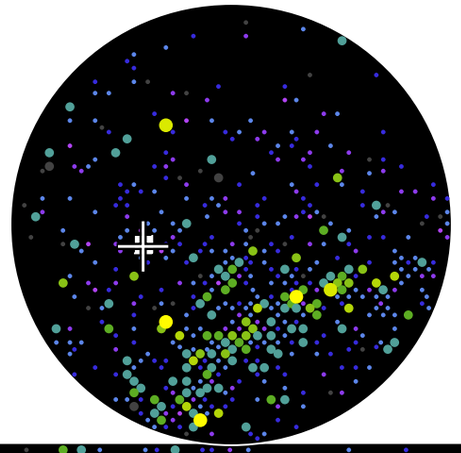
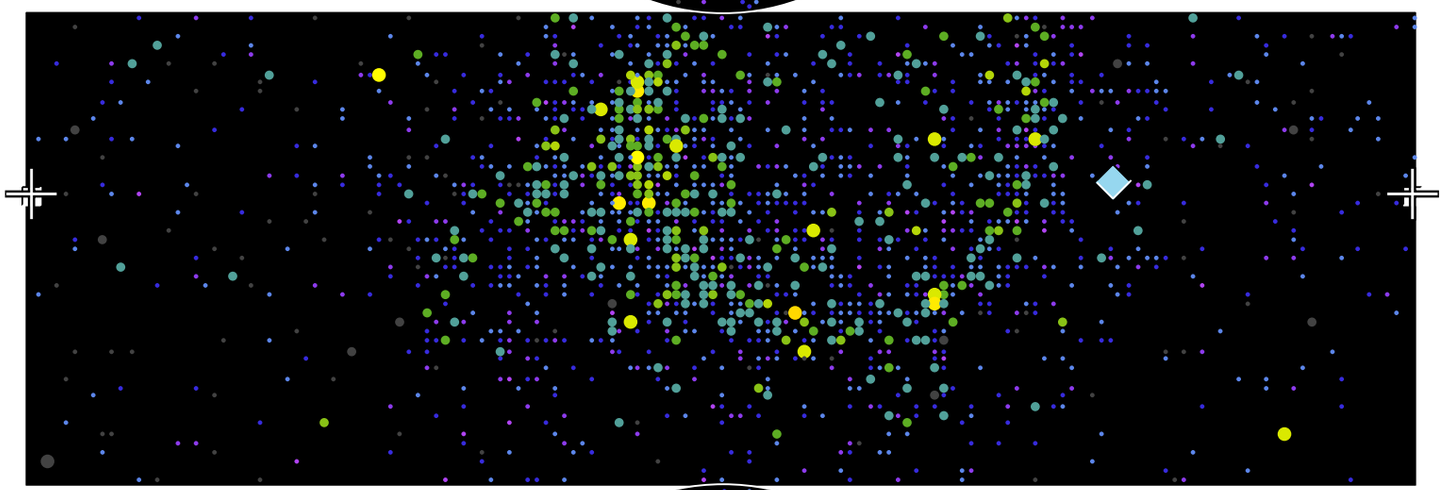
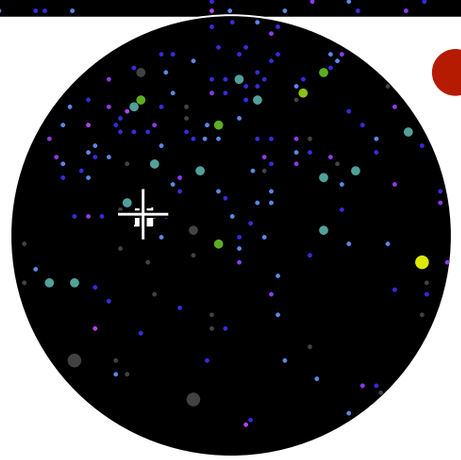
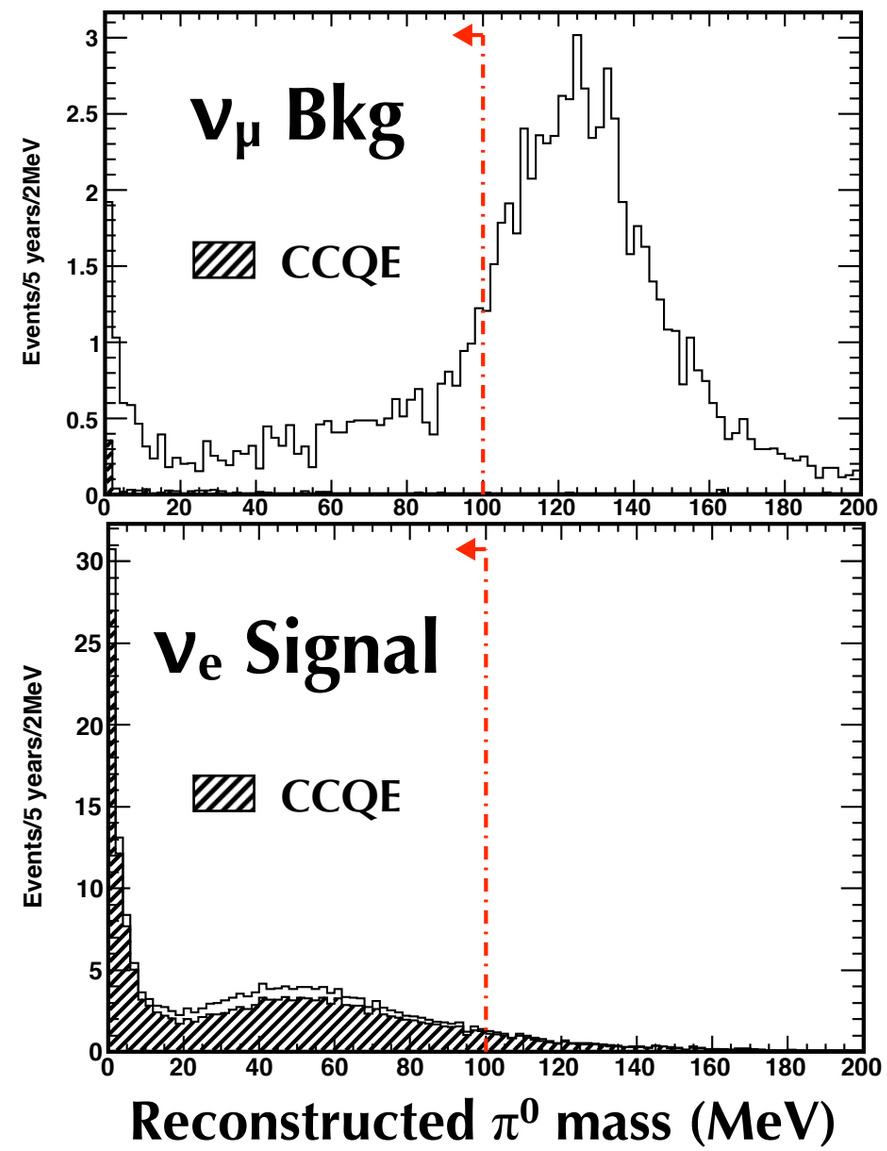






- Select most likely 2nd ring from vertex using likelihood.
  - Construct invariant mass
- Reject 74% of NC bkg by cutting on π^0 mass!



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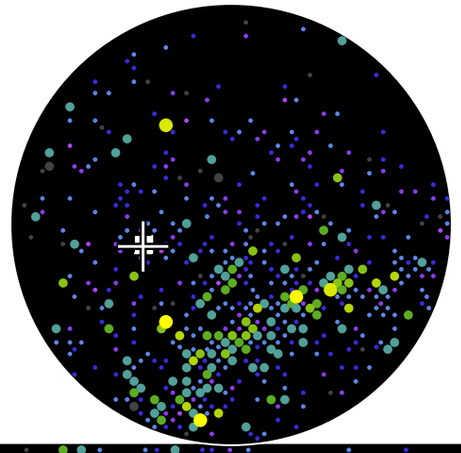

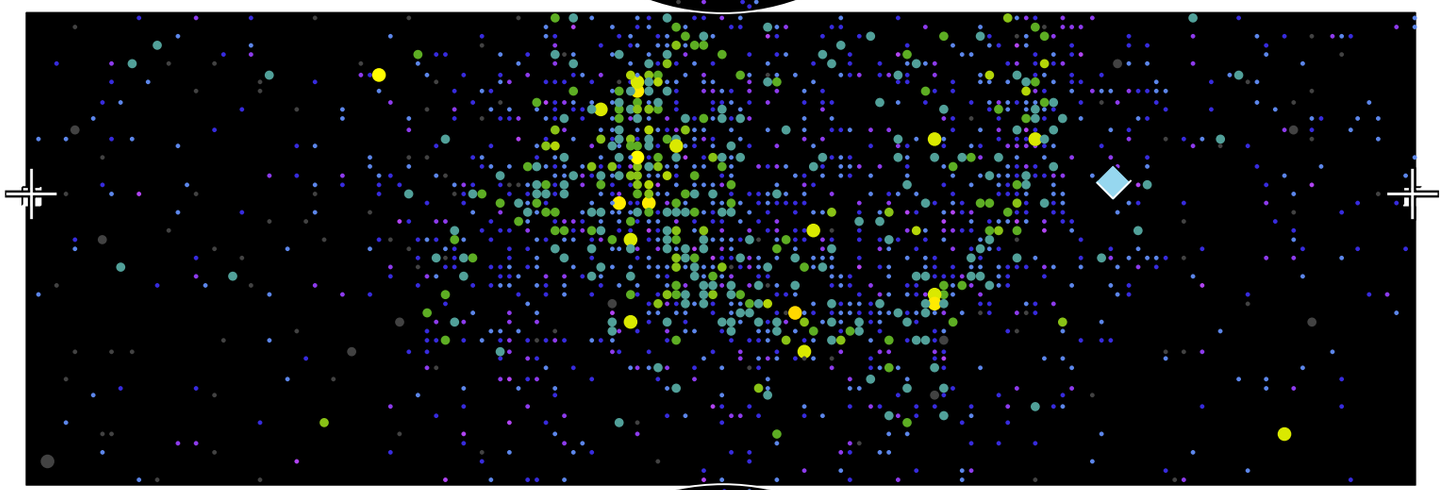

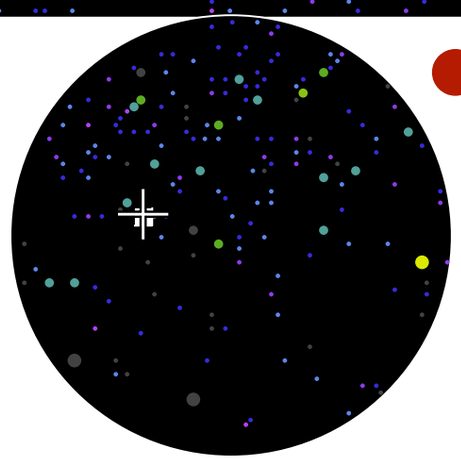

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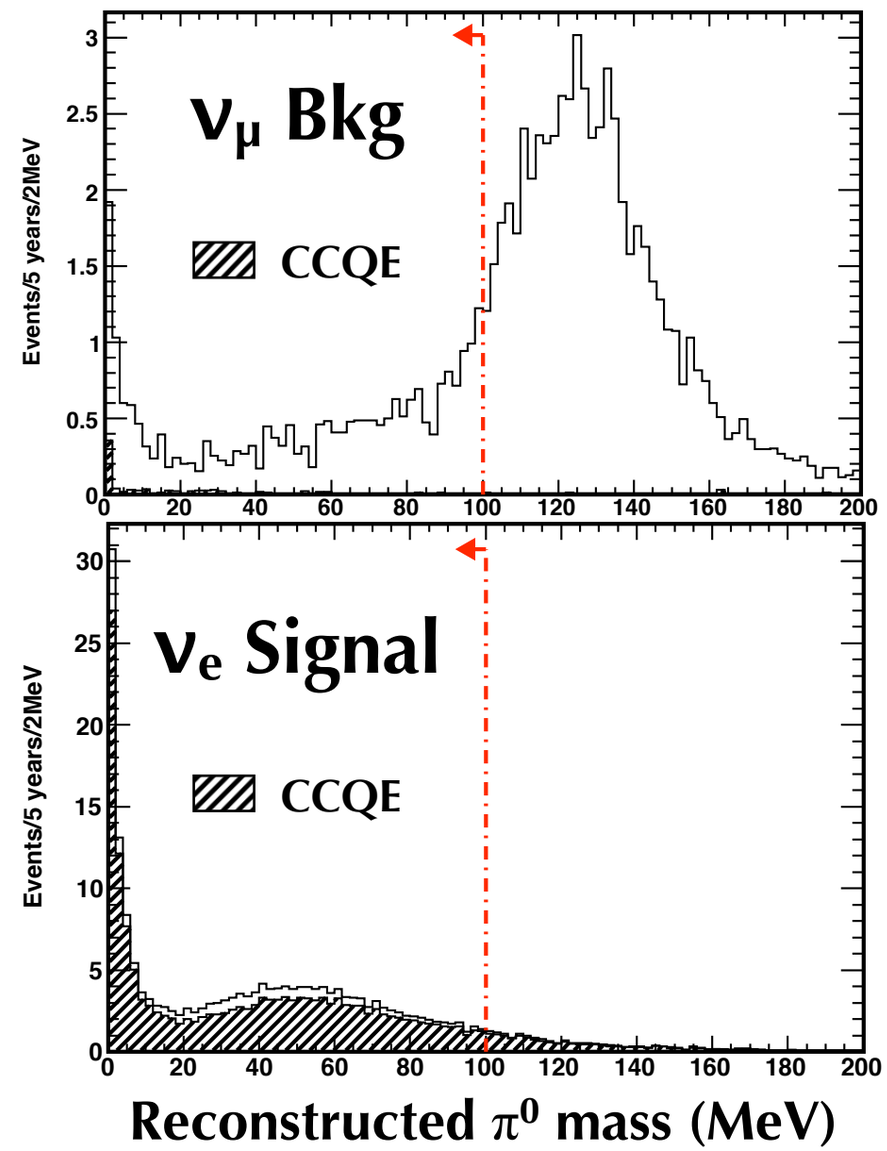

Final Bkg
(all cuts)
(preliminary)

CC ν_μ 1.7%

Beam ν_e	NC ν_μ
61%	38%

Identifying π^0s

T2K MC
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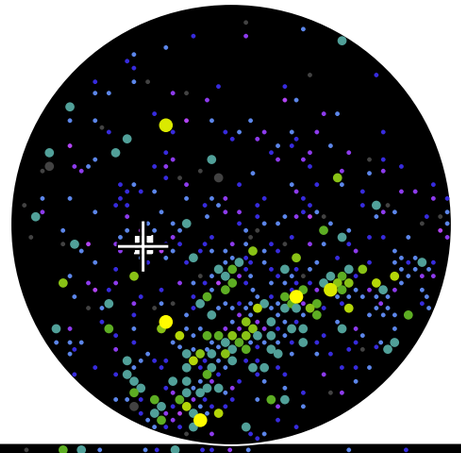

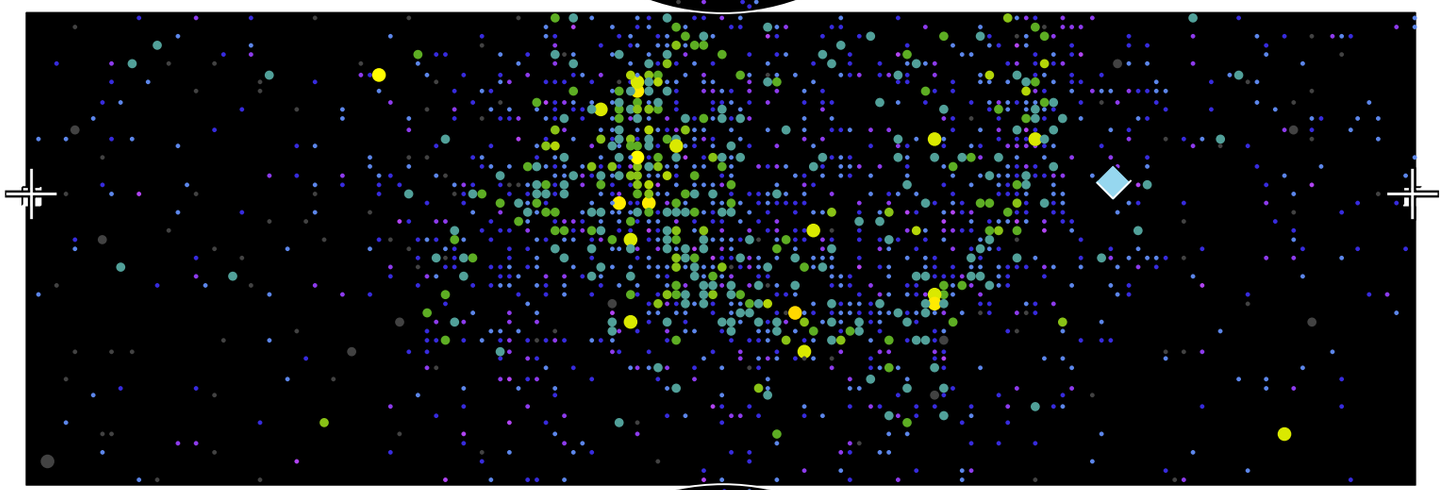

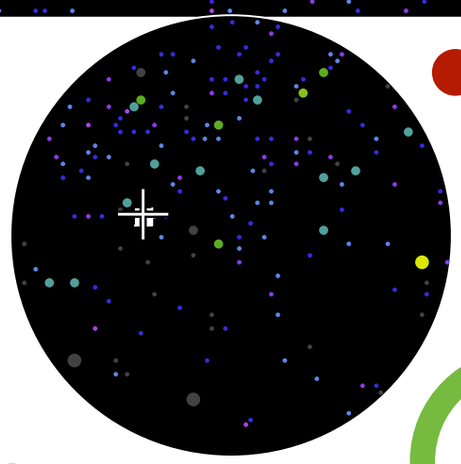

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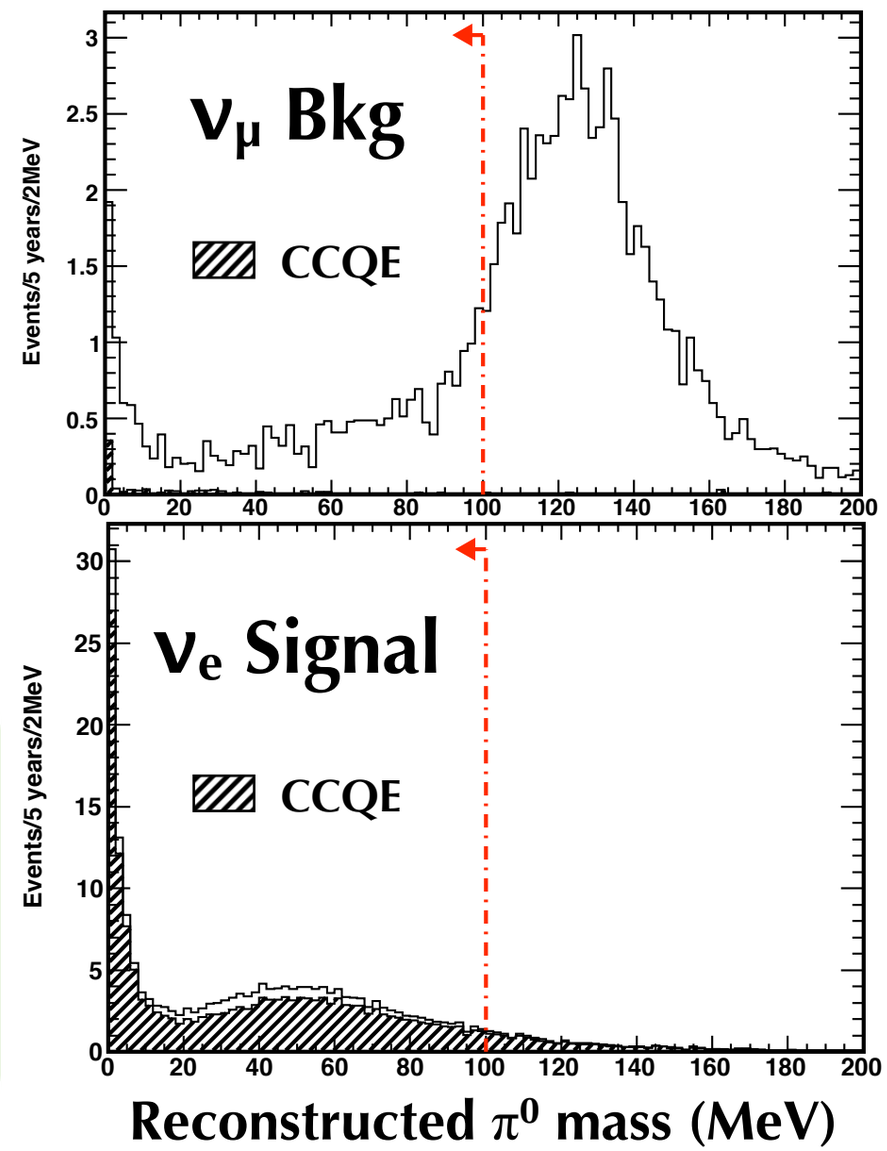

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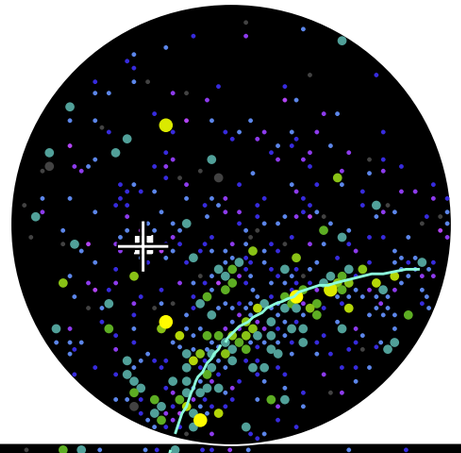
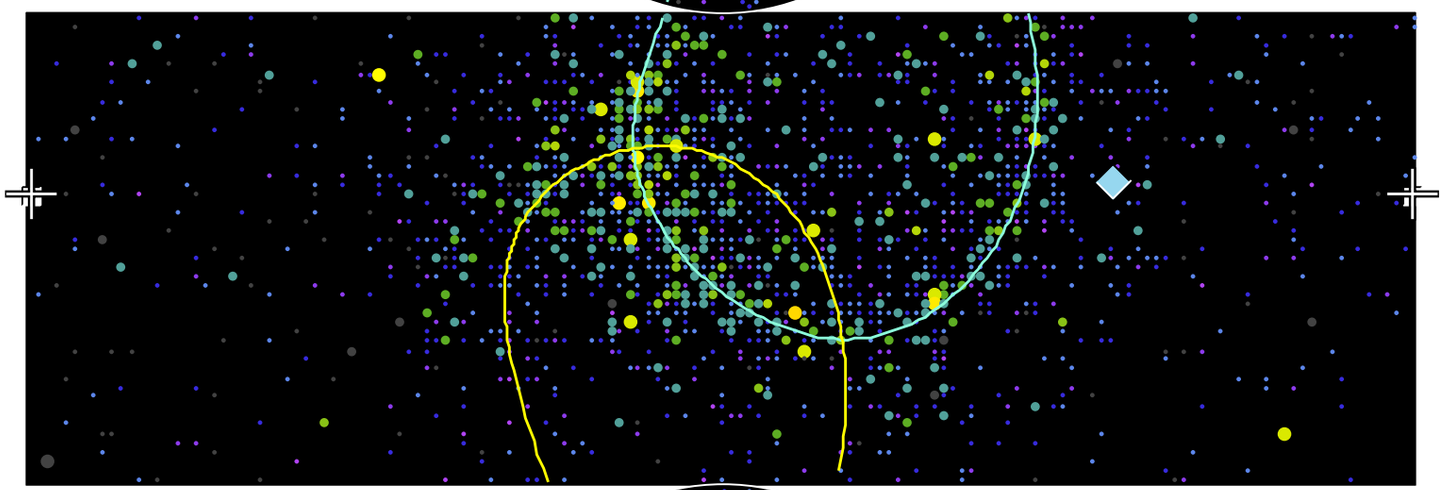
Summary

By assuming a 2nd ring and checking 2R mass, we bring reducible bkg well below irreducible!

Thank You

Identifying π^0s





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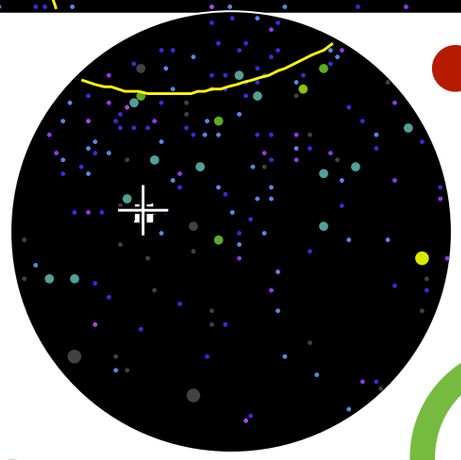
e-like ring

most likely 2nd ring



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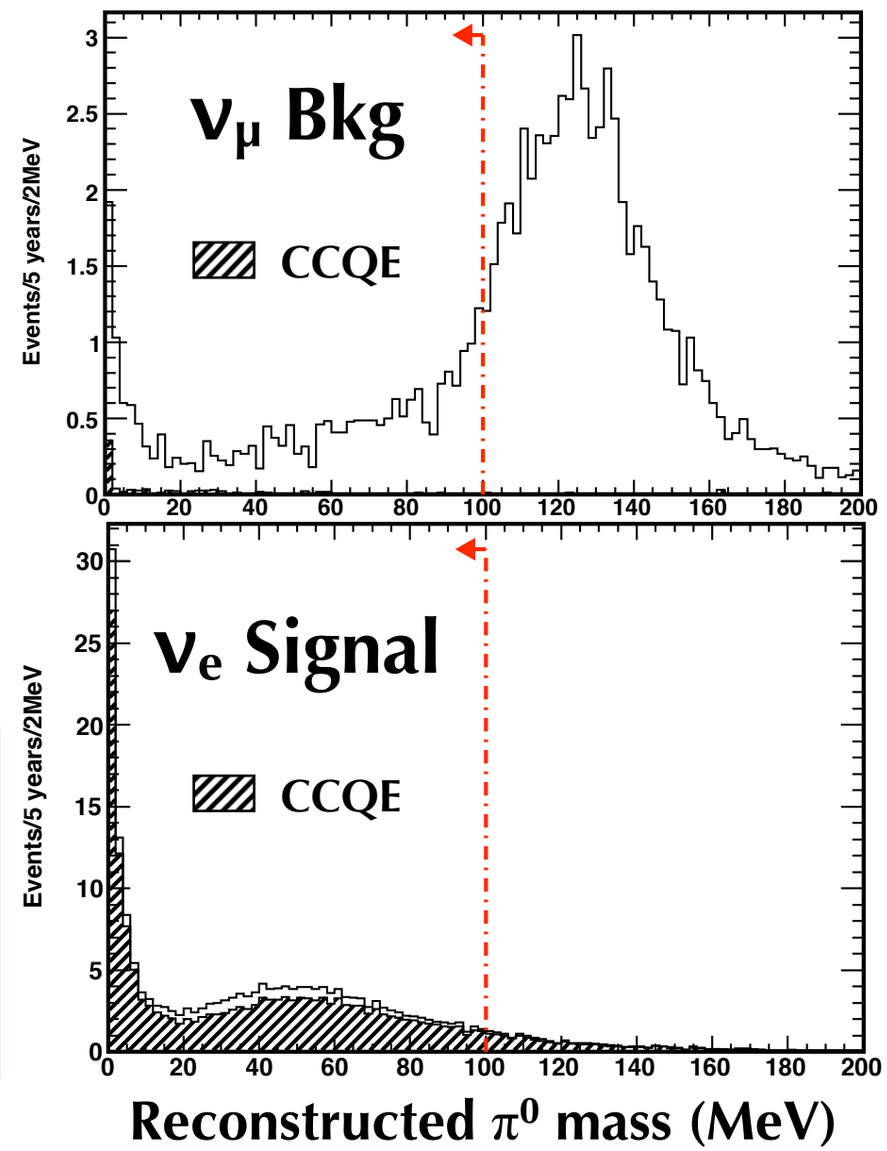

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