Issues in Many Body Final States

Issues in amplitude analysis for light and heavy mesons

ATHOS 5/PWA 10
Beijing, China

- Many body final state analysis
  - Dalitzplot analysis for fixed mass initial state (heavy mesons)
  - PWA for continuous mass spectrum with coherent superposition of many J^{PC} states lLight mesons)
- Common analysis philosophy: isobar model
  - assume knowledge of amplitudes for each J^{PC} sector of isobar (fixed shapes)
  - PWA: Separation of final states with different J^{PC} and relative L to spectator (wave)

    full spin density matrix including phase info for all waves

    many waves included (wave-set design) combining MANY mother J^{PC} and isobar J^{PC}

    coherent and incoherent parts
  - Dalitzplot analysis: design coherent set of fixed shape amplitudes for ONE mother J^{PC}

Modern Analysis

Problem:

- shape of isobaric amplitudes modified by FSI
- „several“ known resonances with ONE isobaric J^{PC} can not be accomodated

NEW: release fixed isobar shapes (still isobar philosophy)

- Dalitzplot analysis so far:
  - one J^{PC} at the time (wrongly called model independent analysis)
  - obtain phase info
  - issue: amplitudes not anymore linearly independent
- Isobar freed PWA :
  - release shape assumption of many isobars from one mother J^{PC}
  - correct for ambiguities arising (*see presentation Krinner*)
  - obtain full complex amplitudes for EACH wave (maximum trial was 22 waves) for
    - EACH final state mass bin
    - EACH kinematic production variable (as e.g. four-momentum transfer)
- loose some phase info to be recovered modelling (fitting) isobaric amplitudes

Need realistic „design“ of isobaric amplitudes

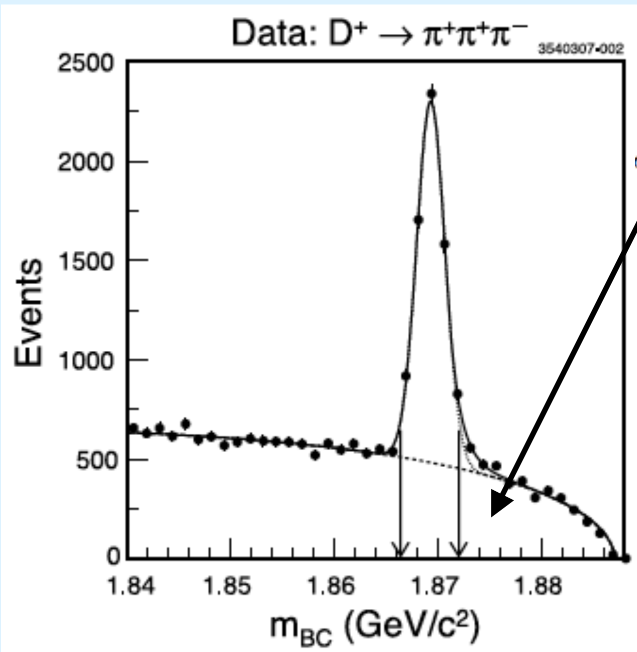
Comparison: Decay of D mesons and $\pi(1800)$

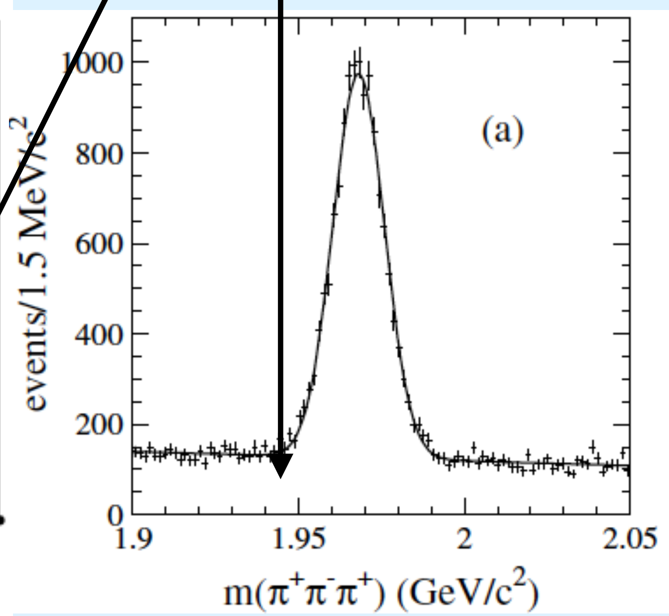
- Compare weak and strong decay and PWA from 0^{-+} system: Dalitz plots

D meson (CLEO)

D_s meson (BaBar)

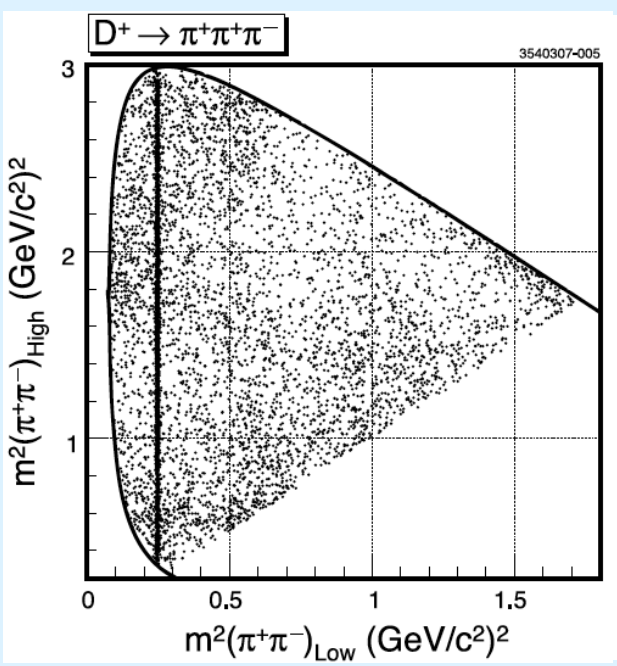
incoherent bkg

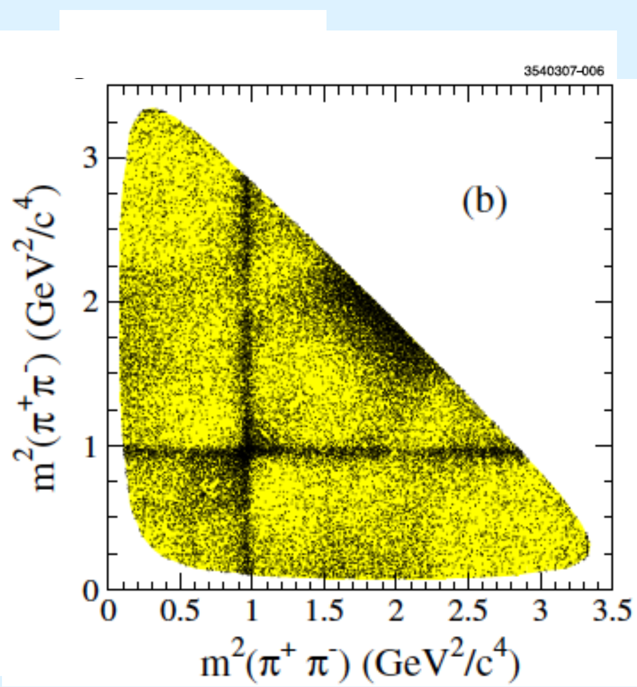




Data

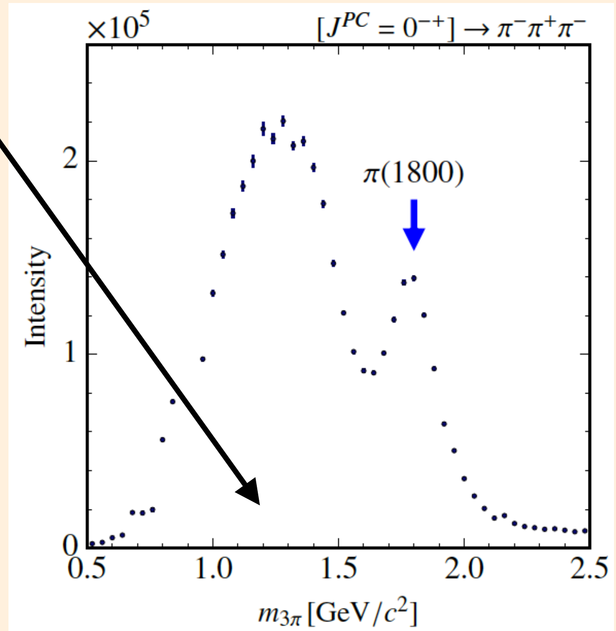
PWA Model



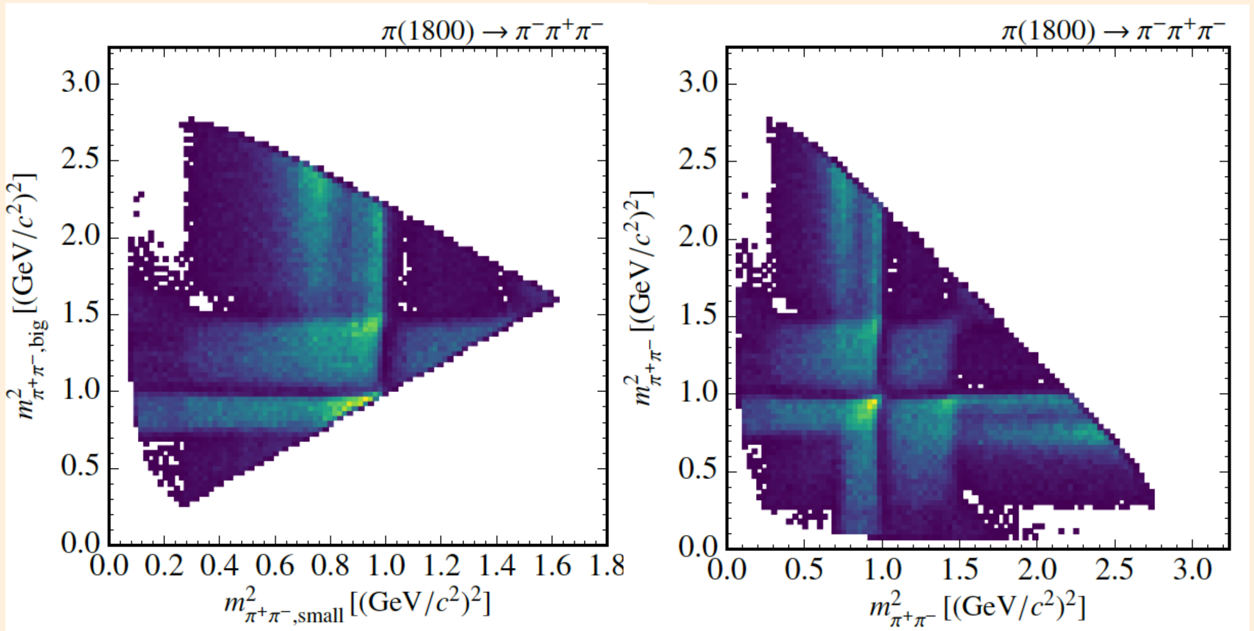


$\pi(1800)$ meson (COMPASS)

coherent bkg

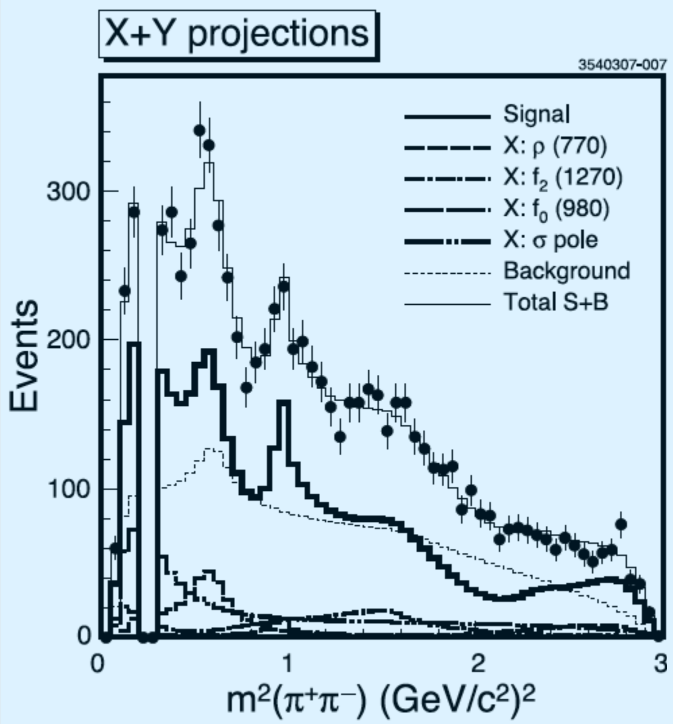


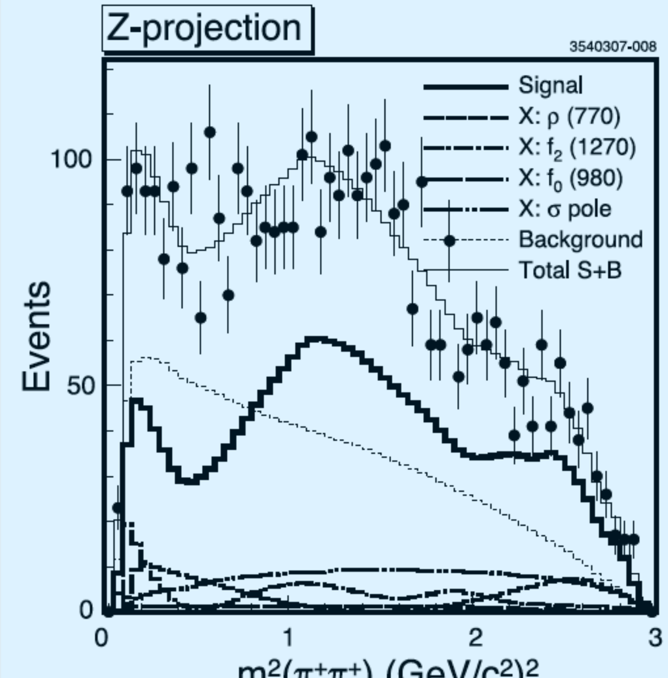
reconstructed from isobar freed fit



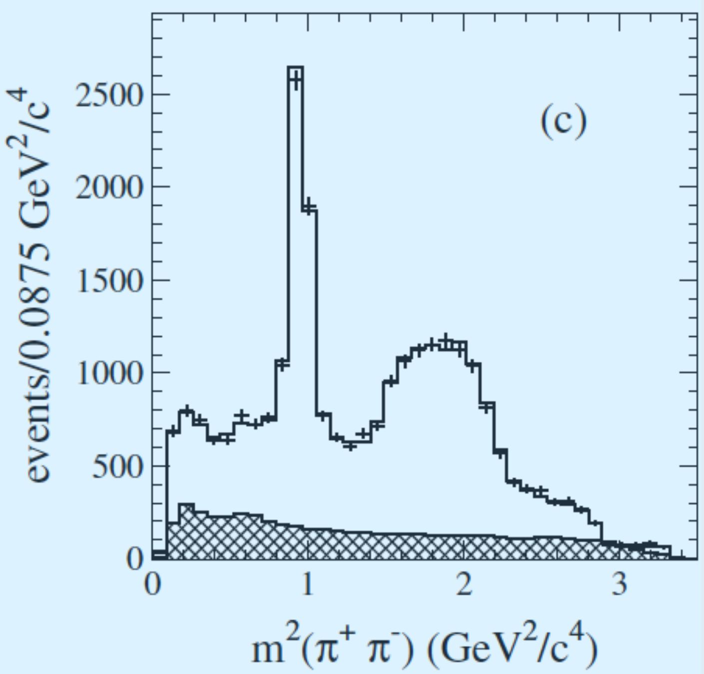
Comparison: Decay of D, D_s mesons and $\pi(1800)$

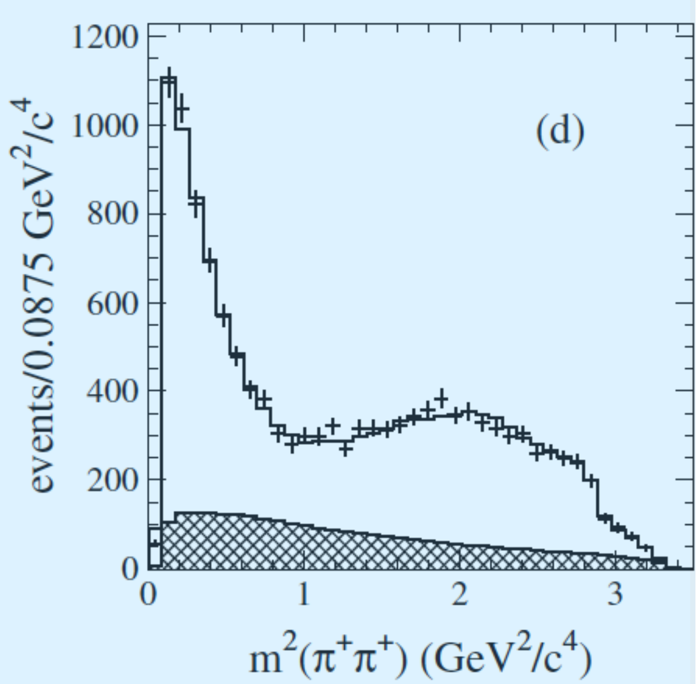
D





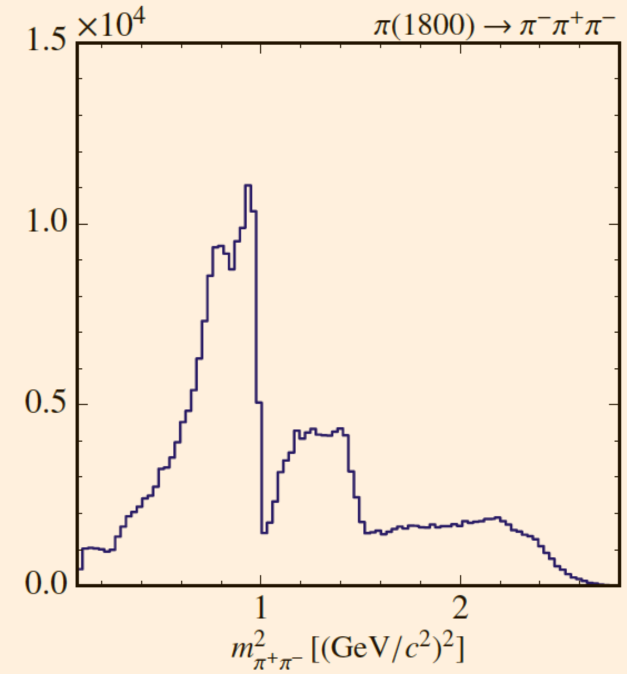
D_s



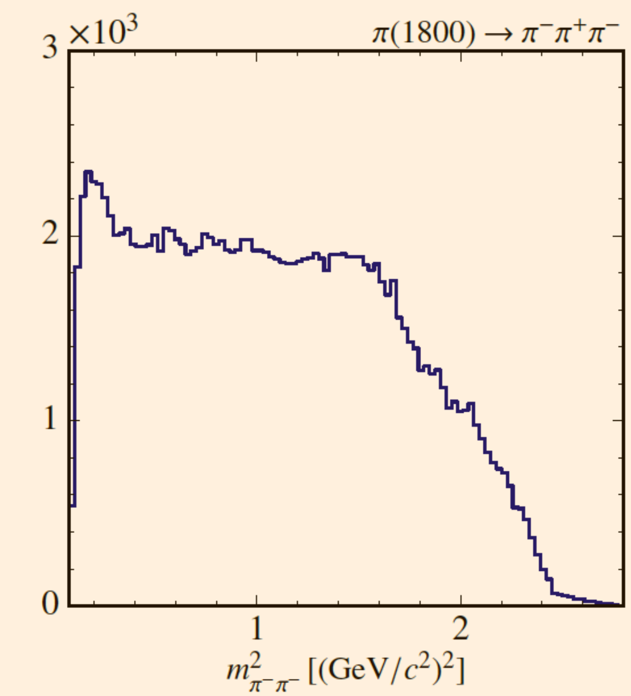


"$\pi(1800)$"

$\pi^+\pi^-$

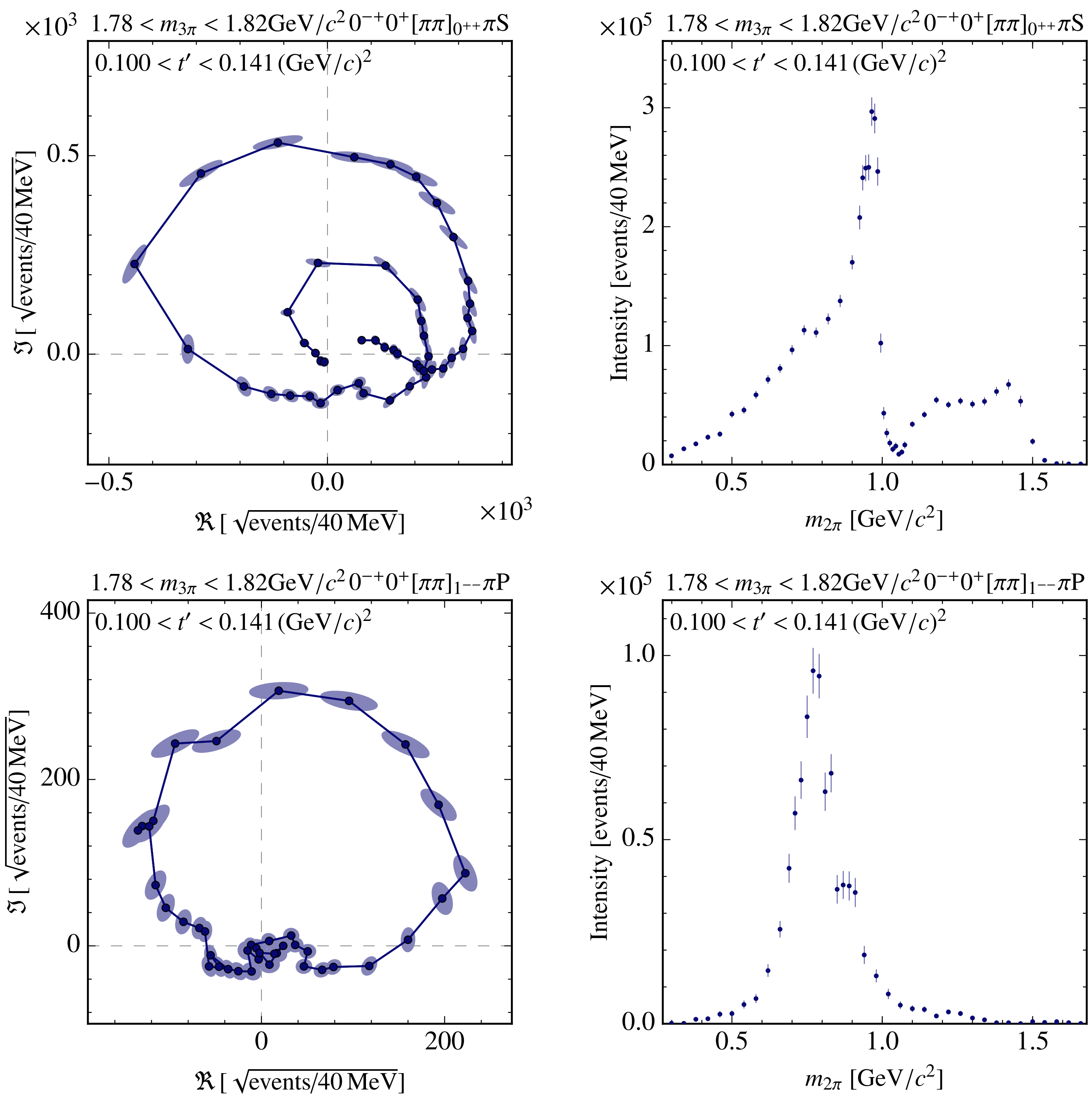


$\pi^+\pi^+$



PWA for $\pi(1800)$

- Information becoming available: Fully Isobar freed analysis
- extract complex amplitude removing hidden ambiguities



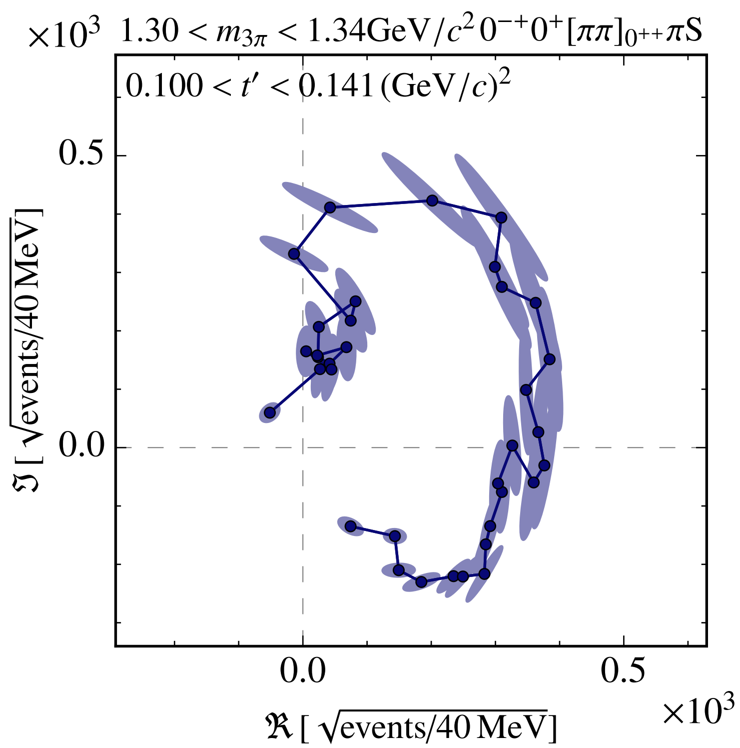
0^{++}

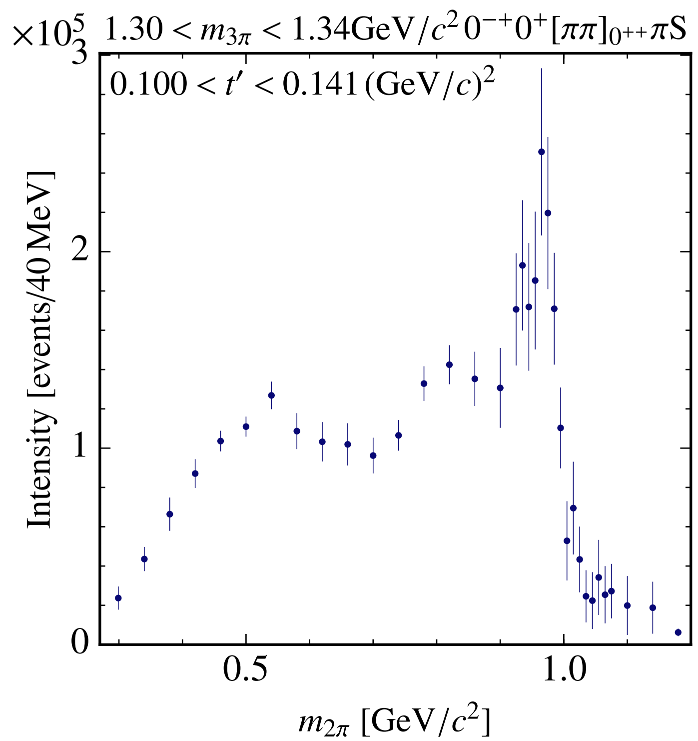
1^{--}

PWA around $\pi(1300)$

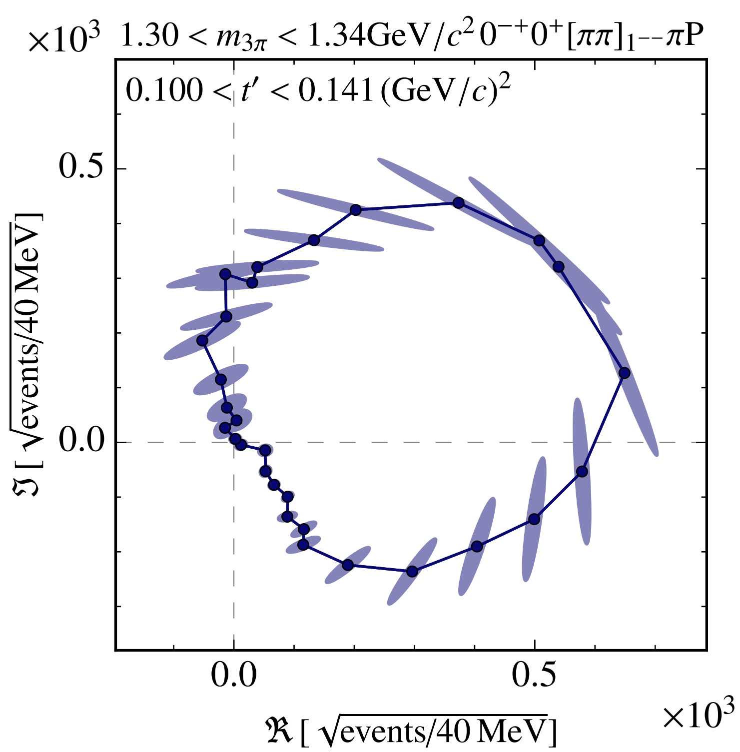
Exzellenzcluster Universe

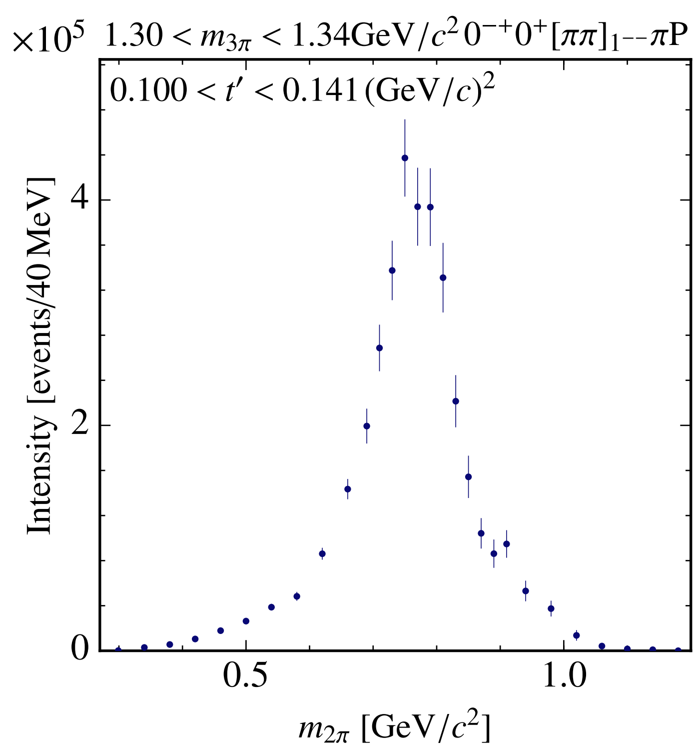
- Information becoming available: Fully Isobar freed analysis
- extract complex amplitude removing hidden ambiguities





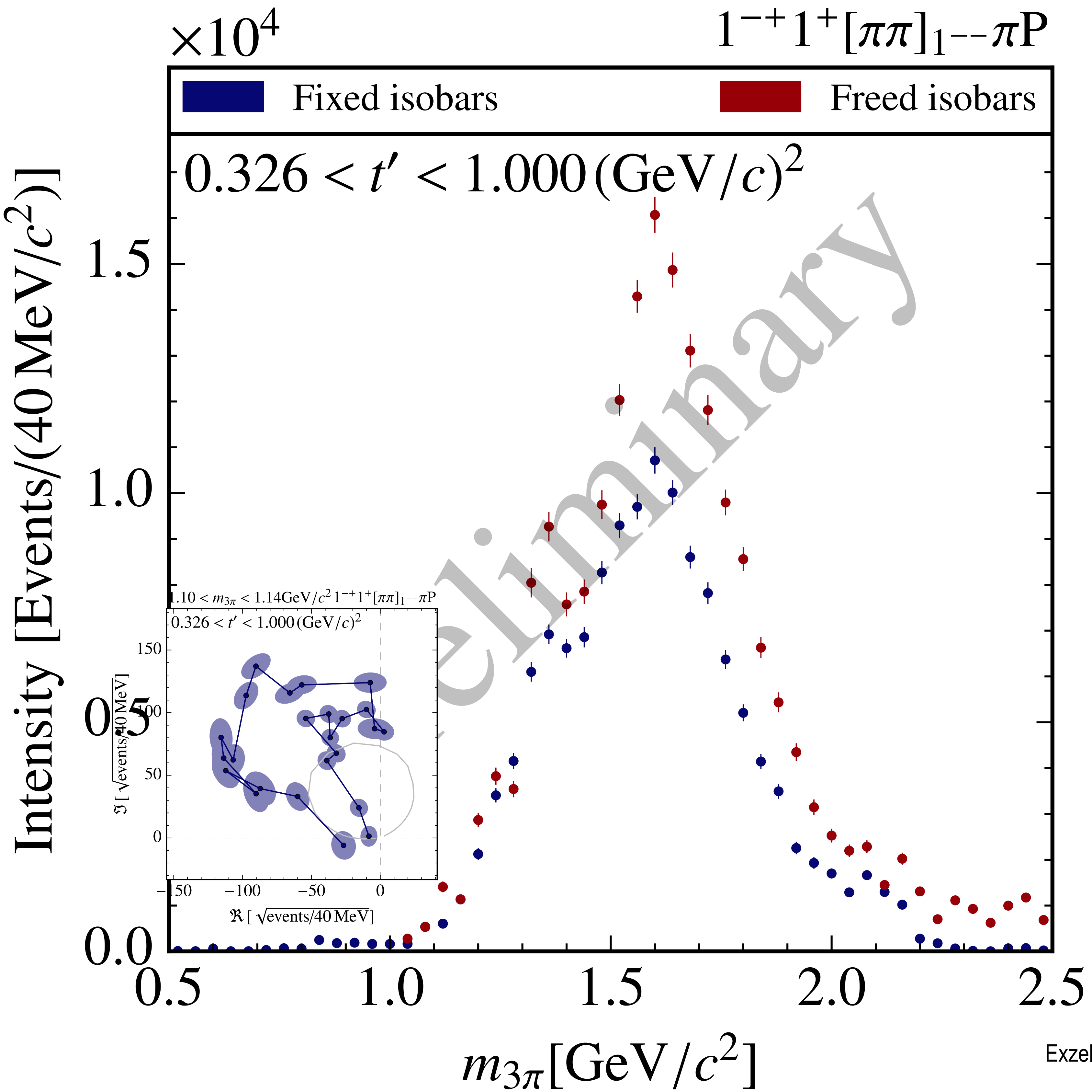
0^{++}





1^{--}

Information from Analysis



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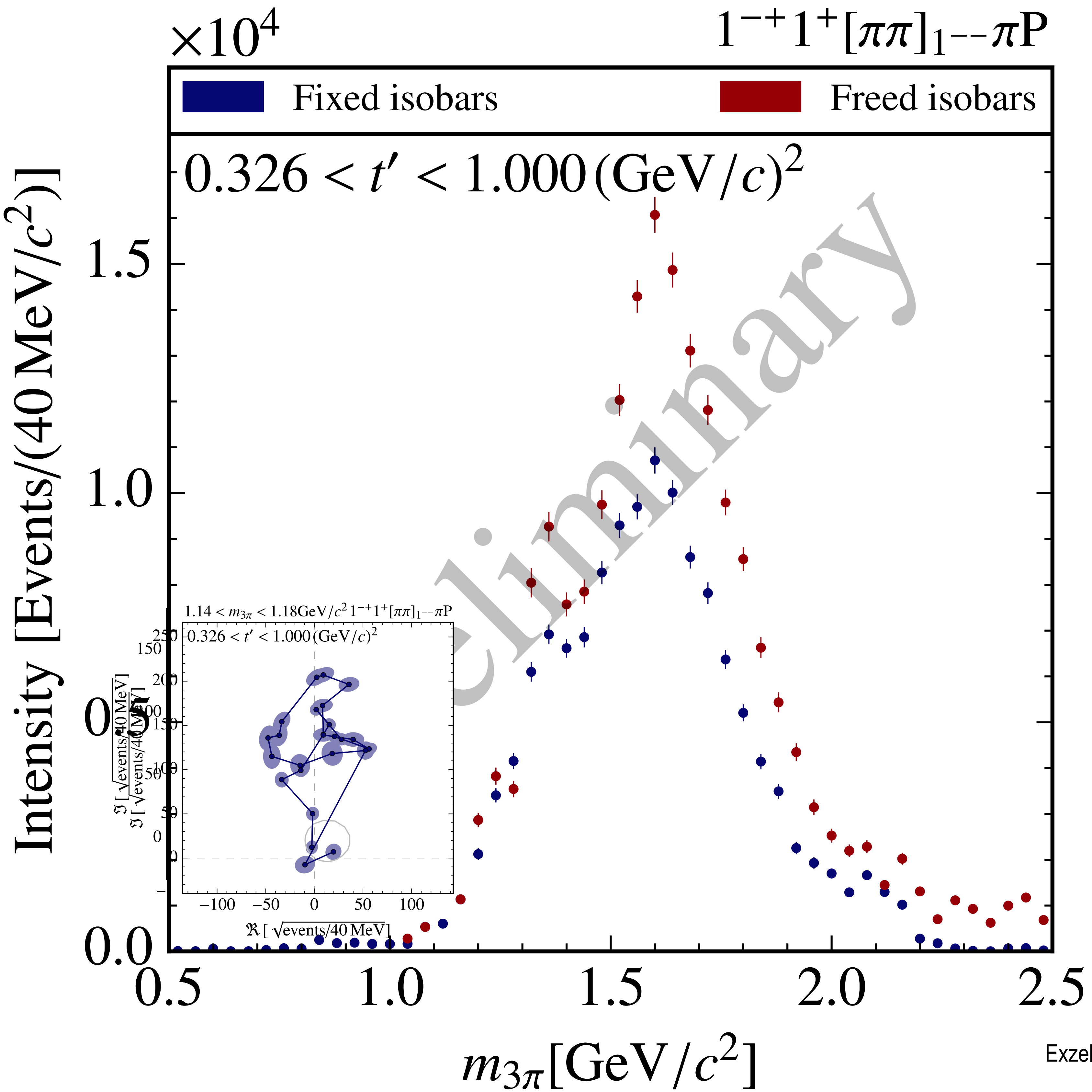

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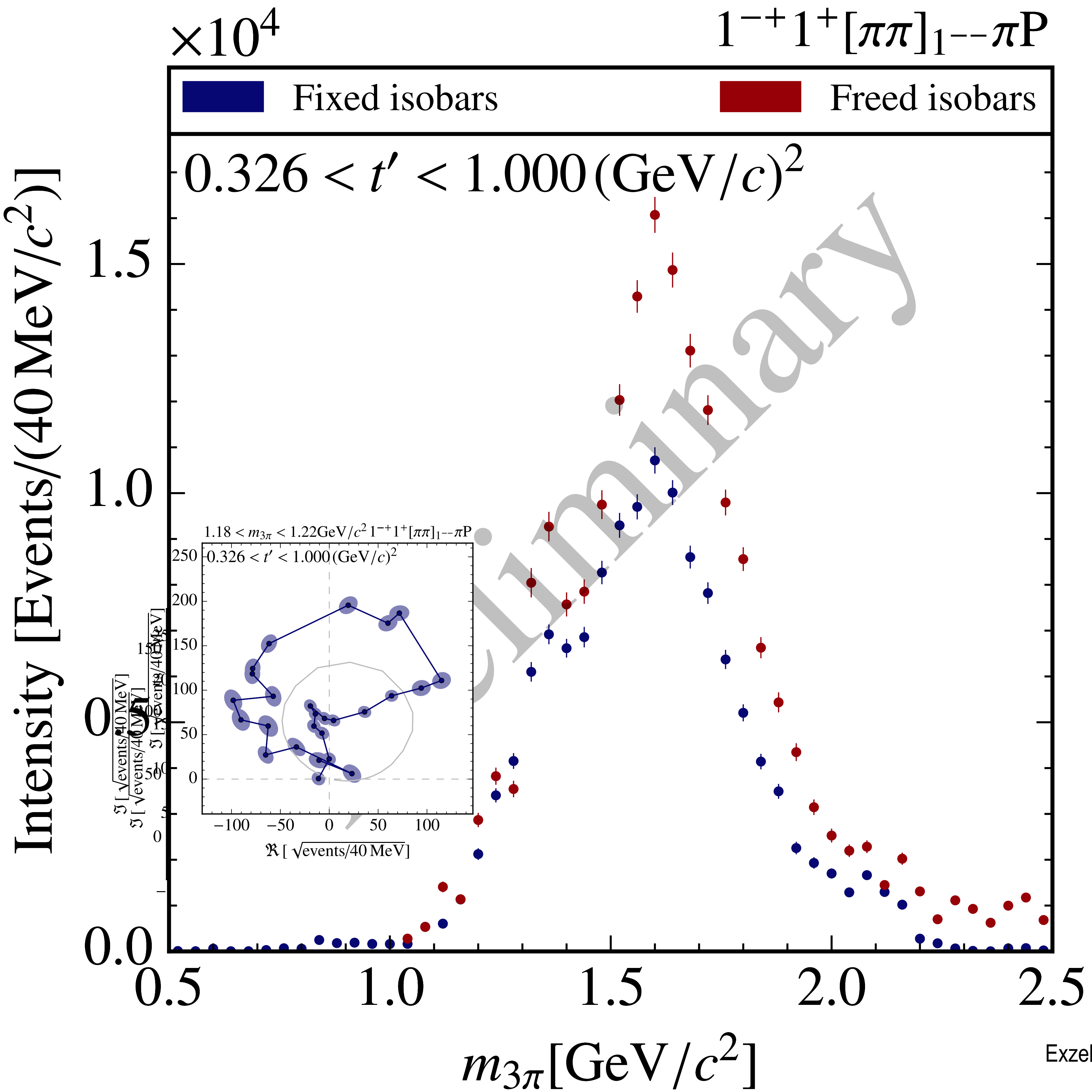

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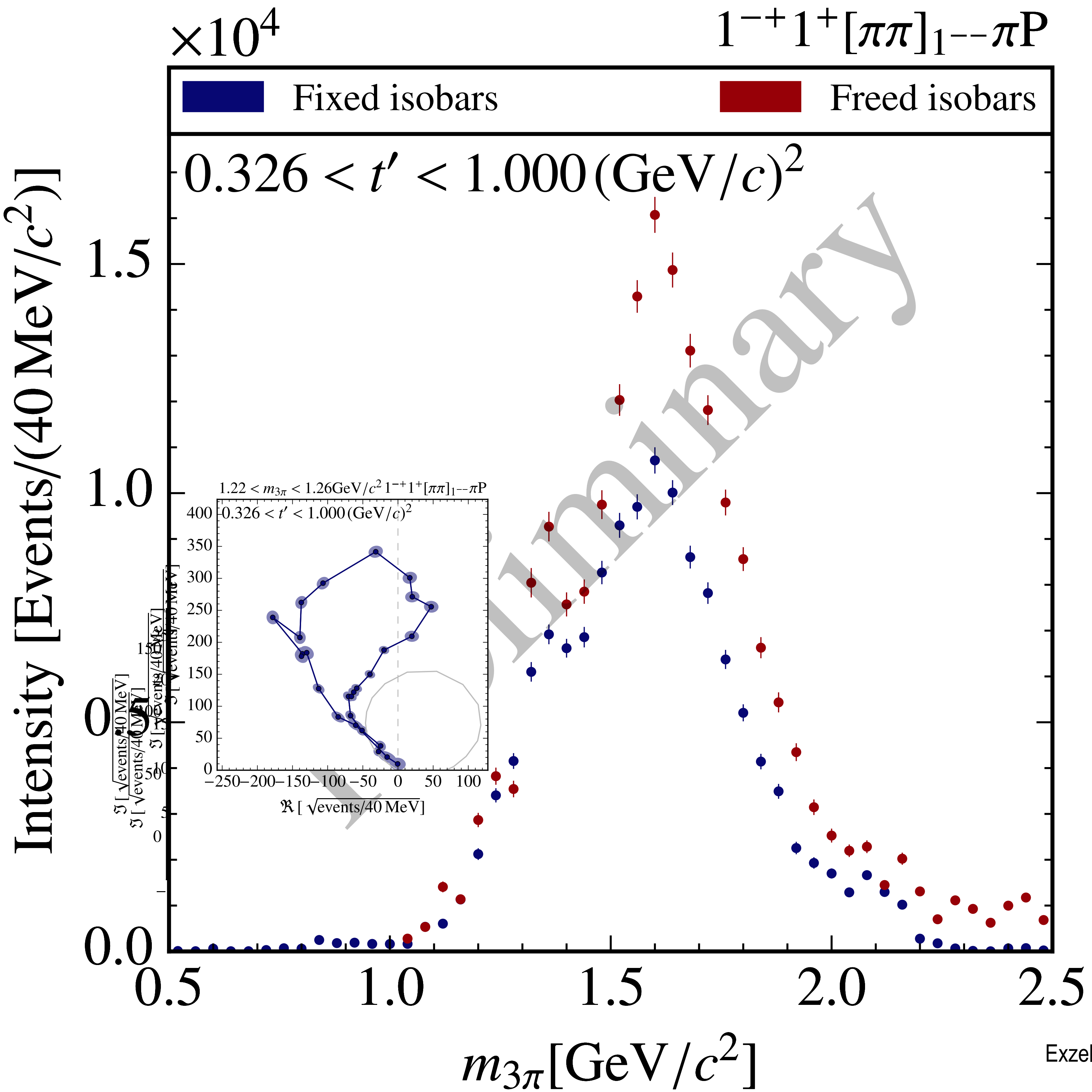

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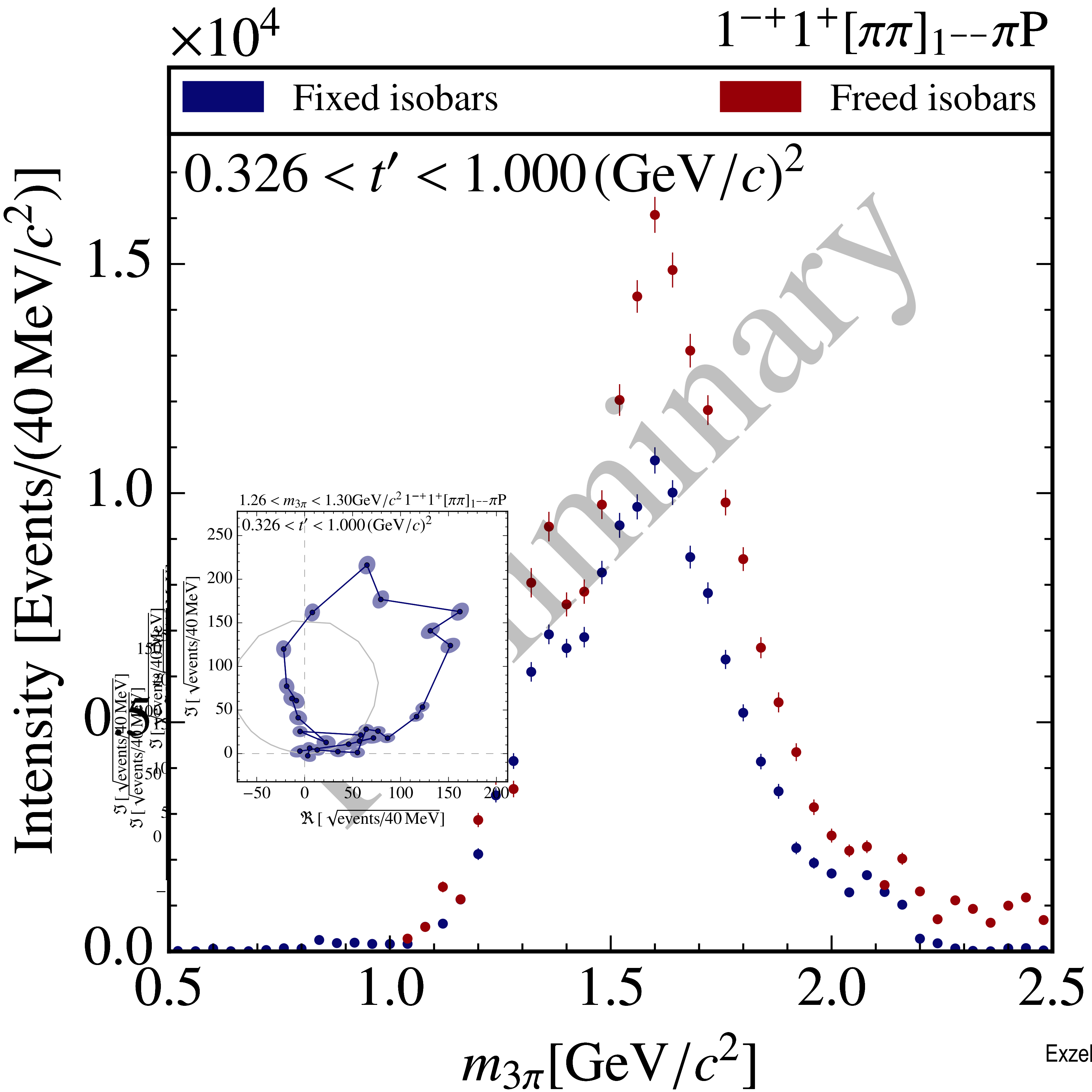

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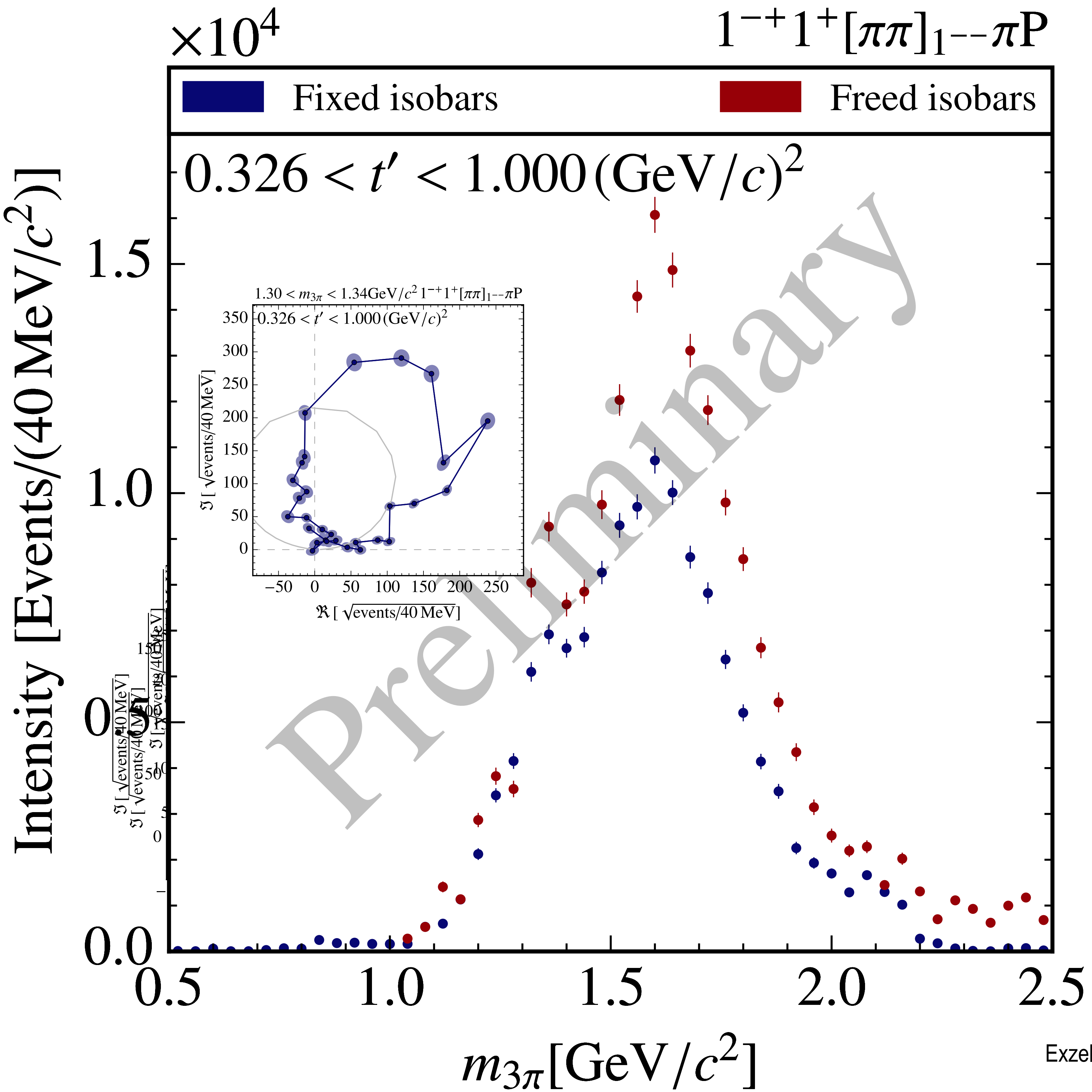
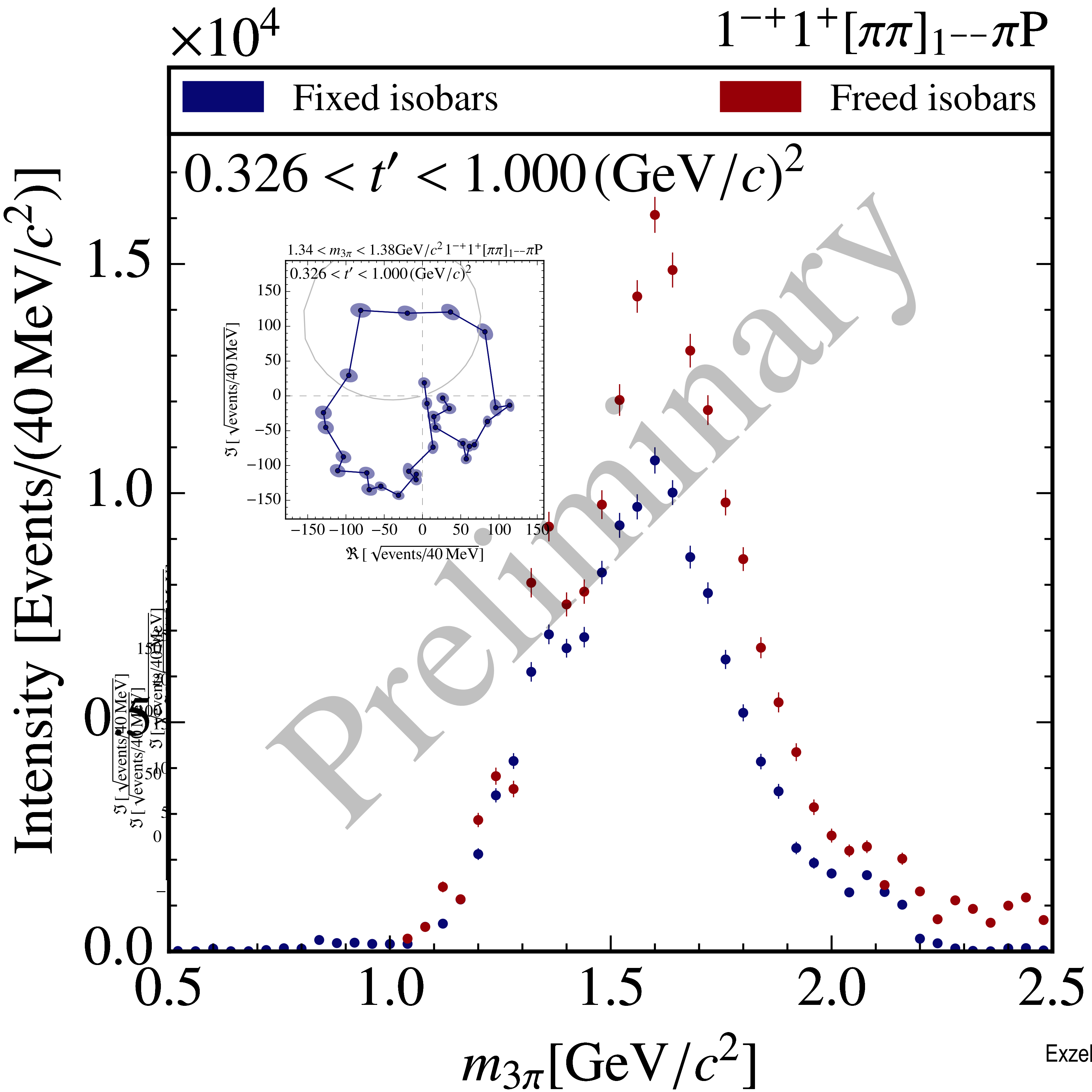


Exzellenzcluster Universe

Information from Analysis



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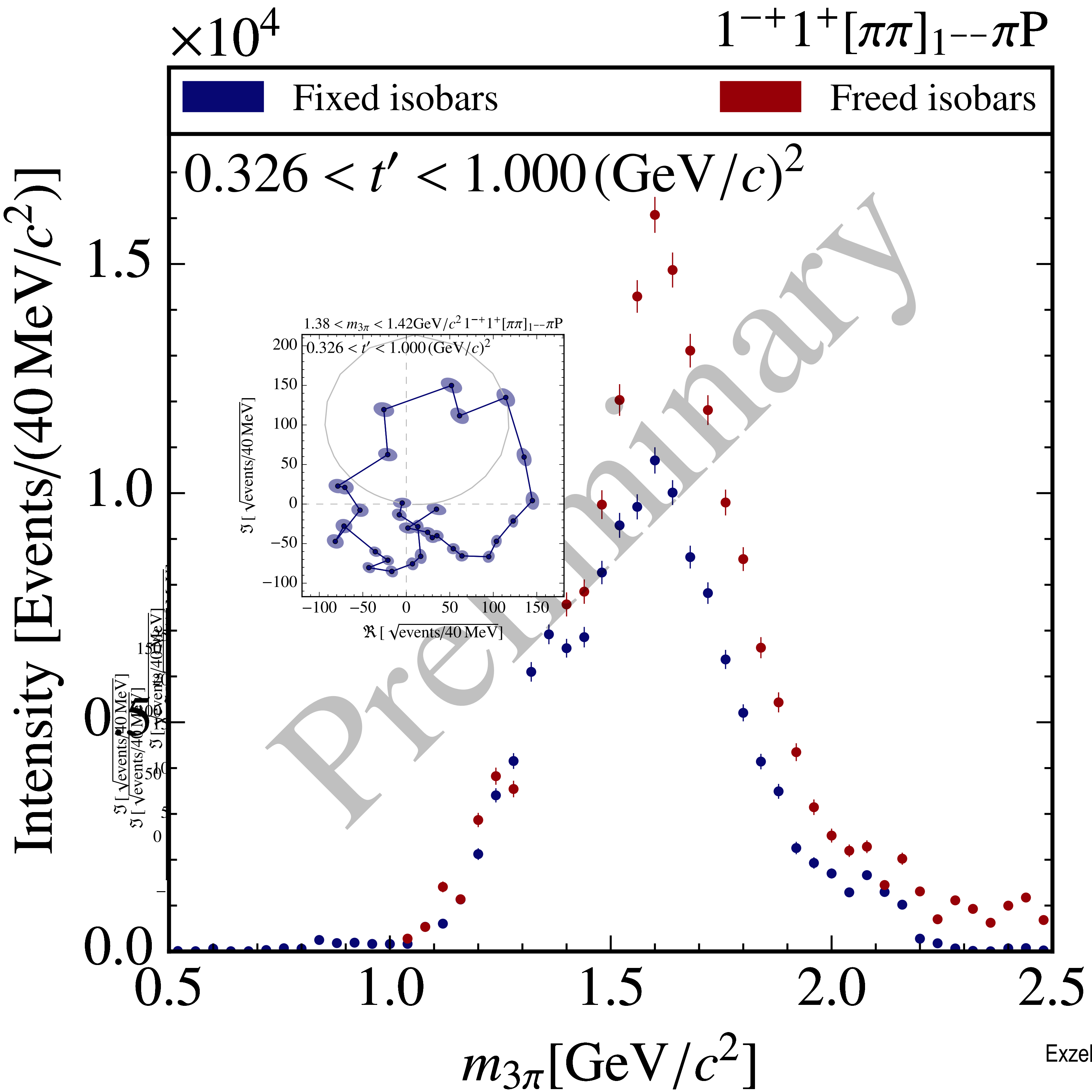

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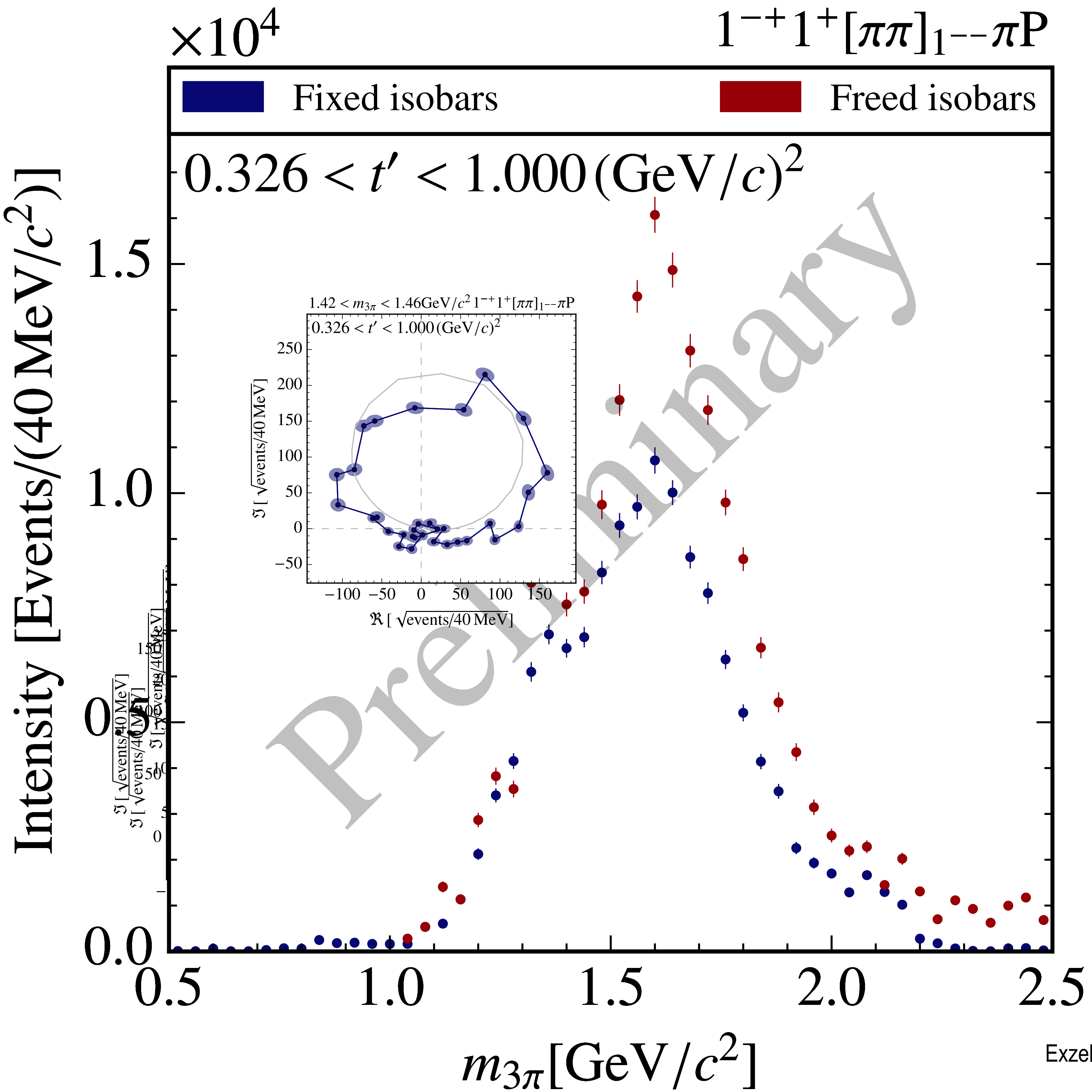

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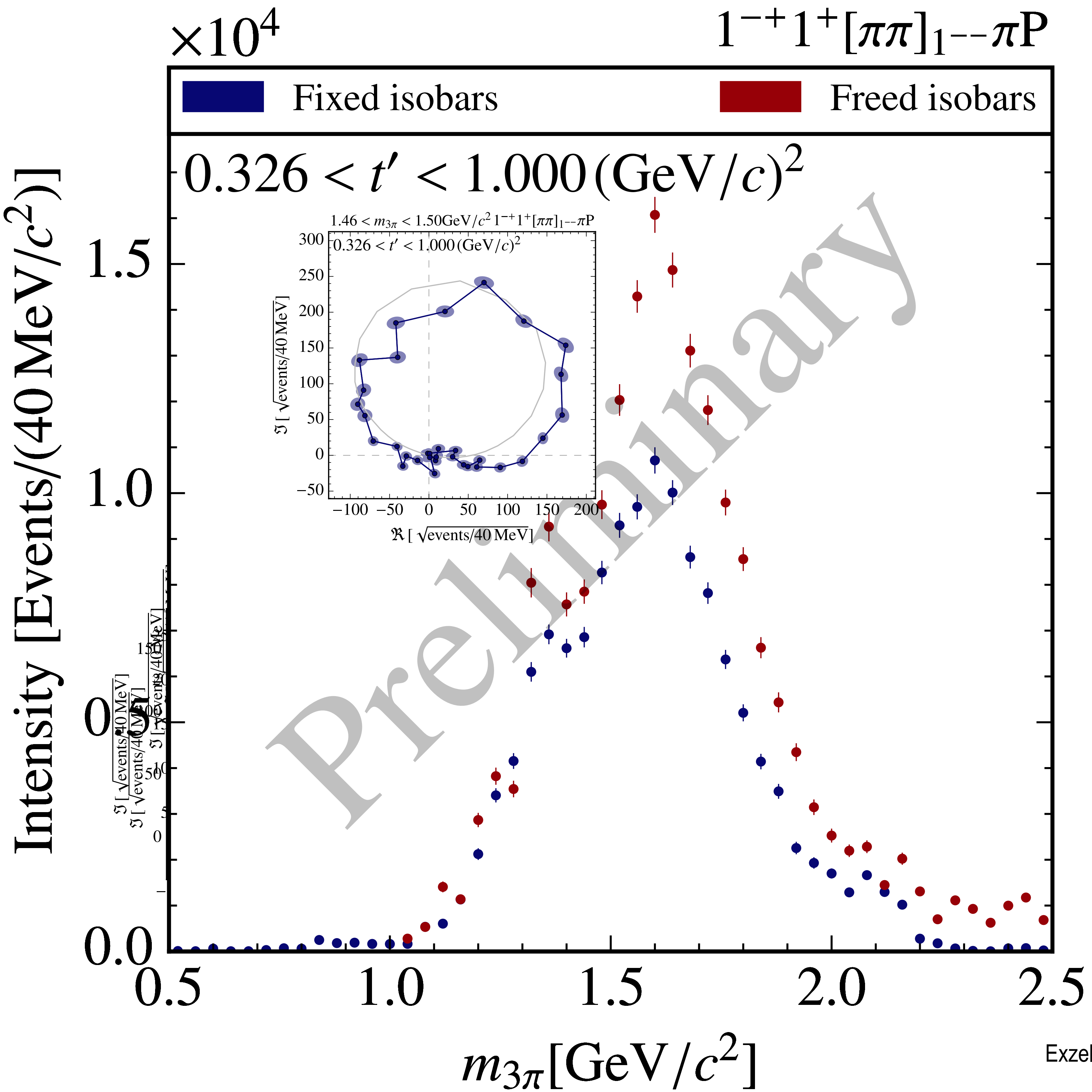

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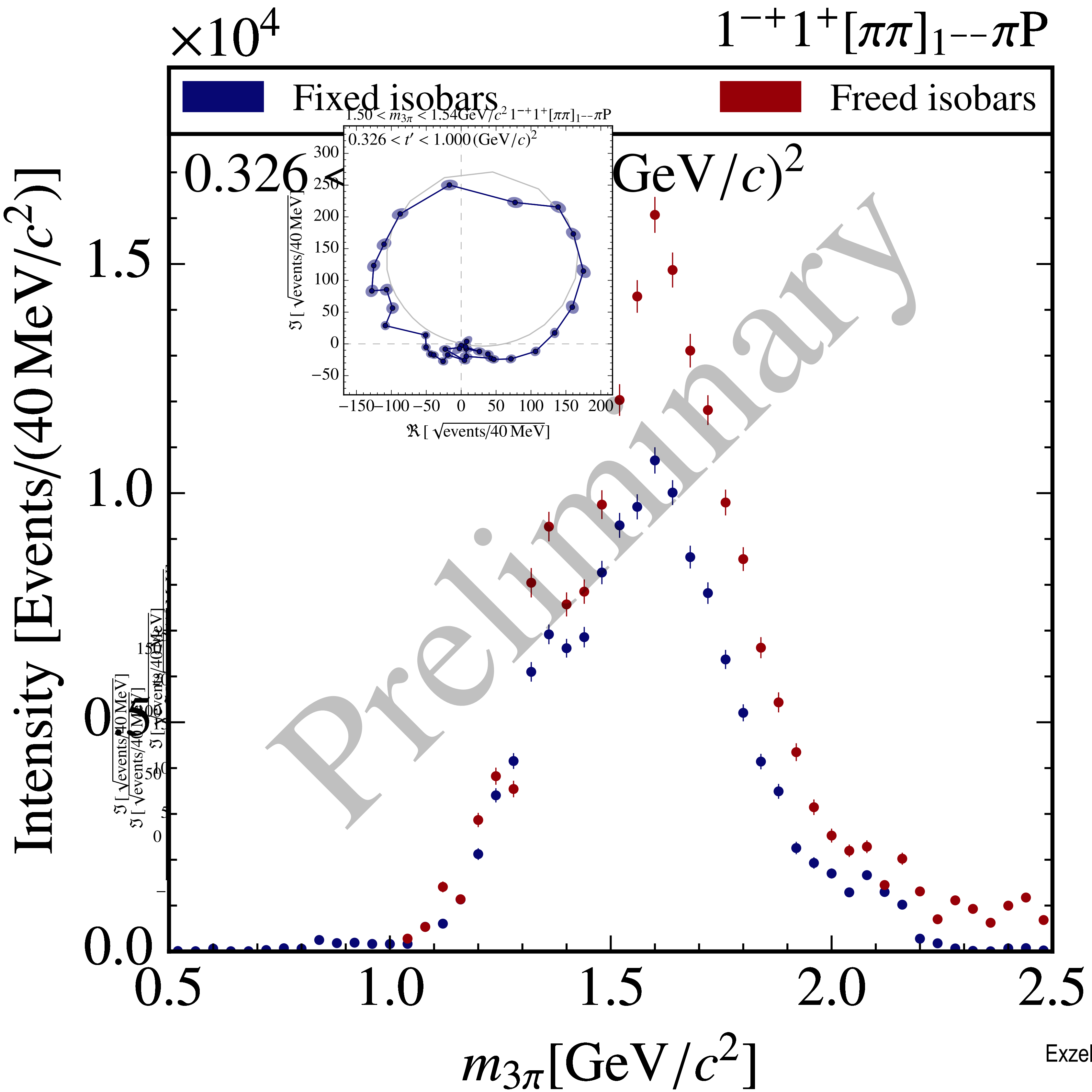

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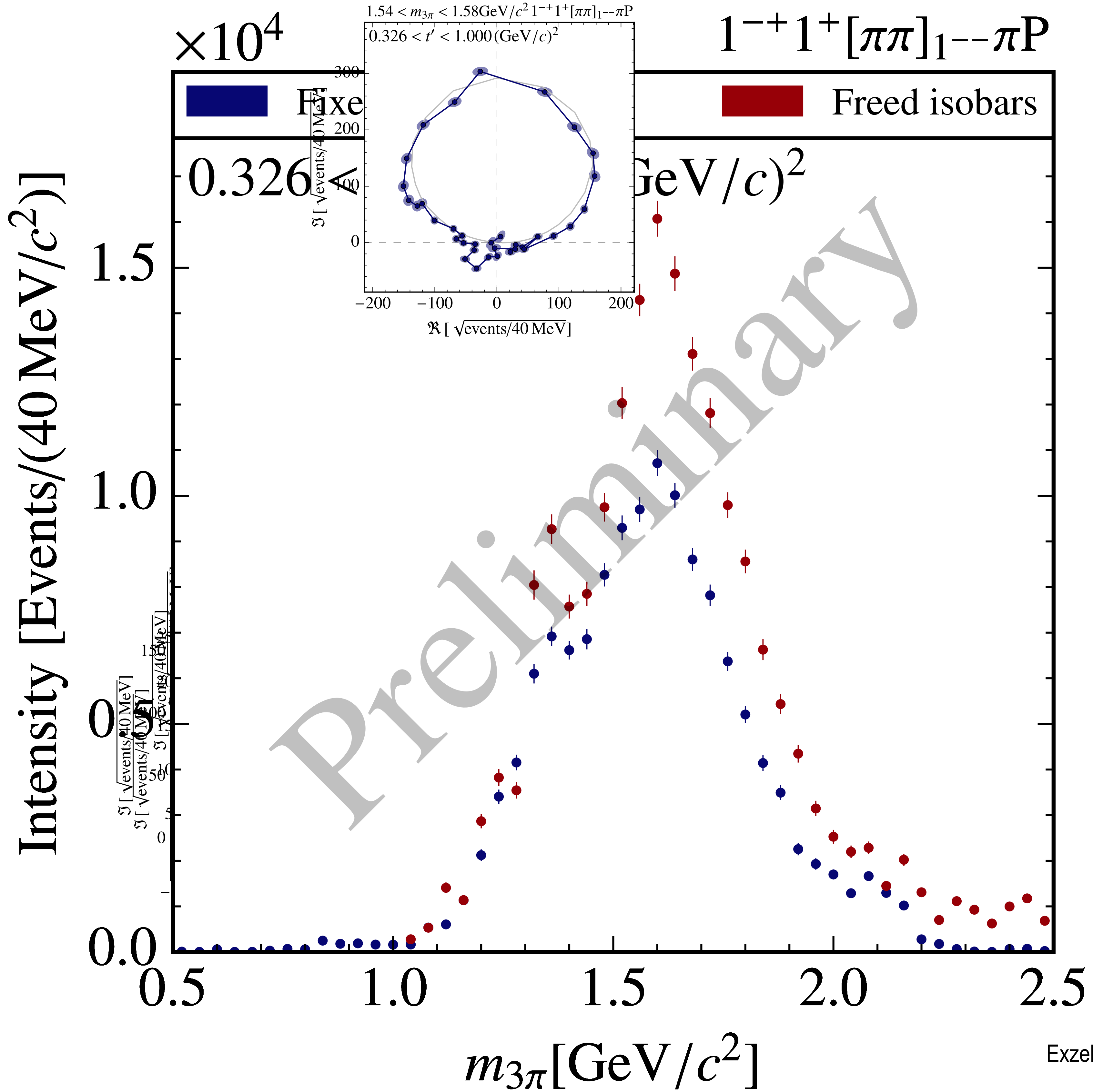

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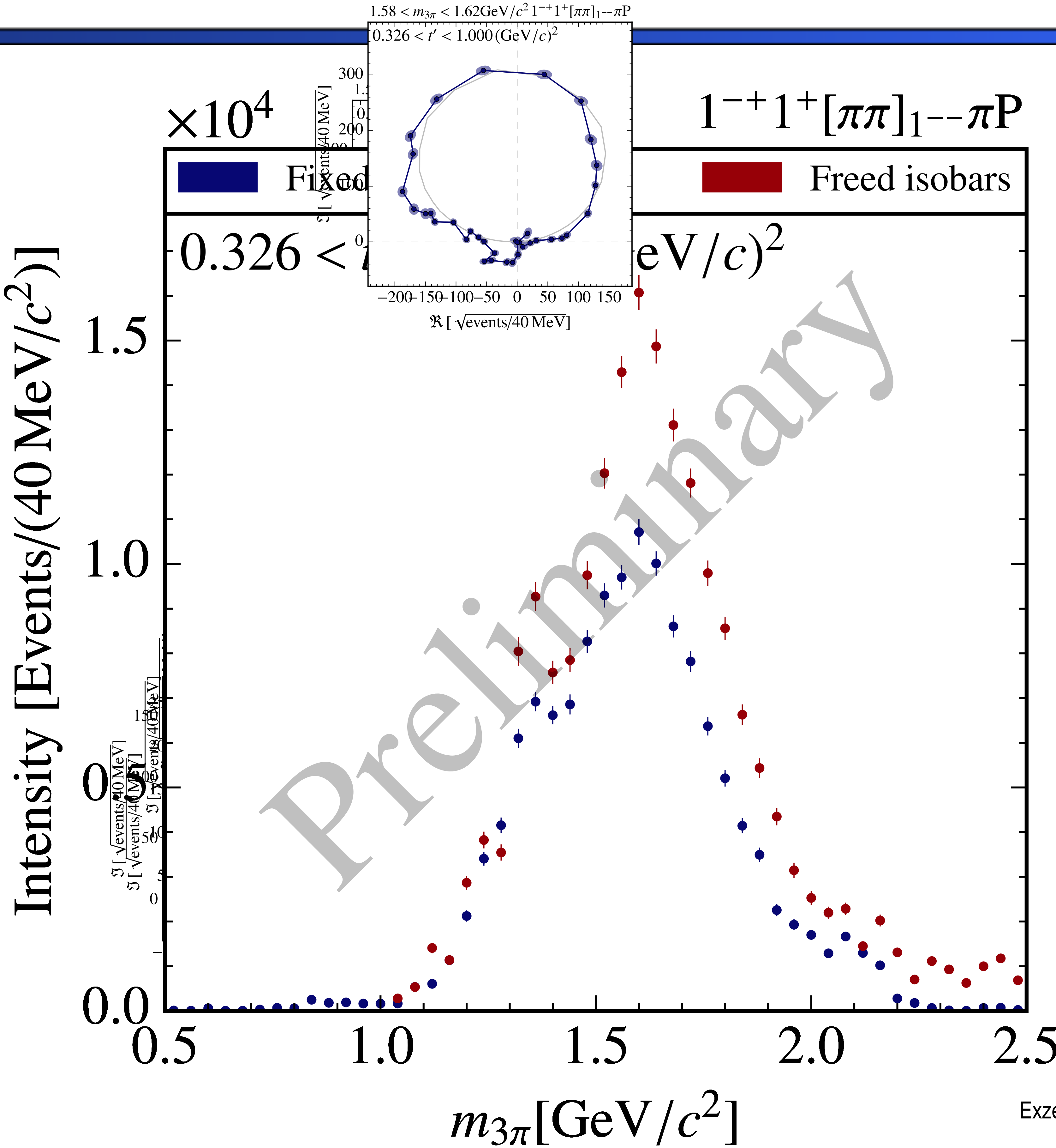

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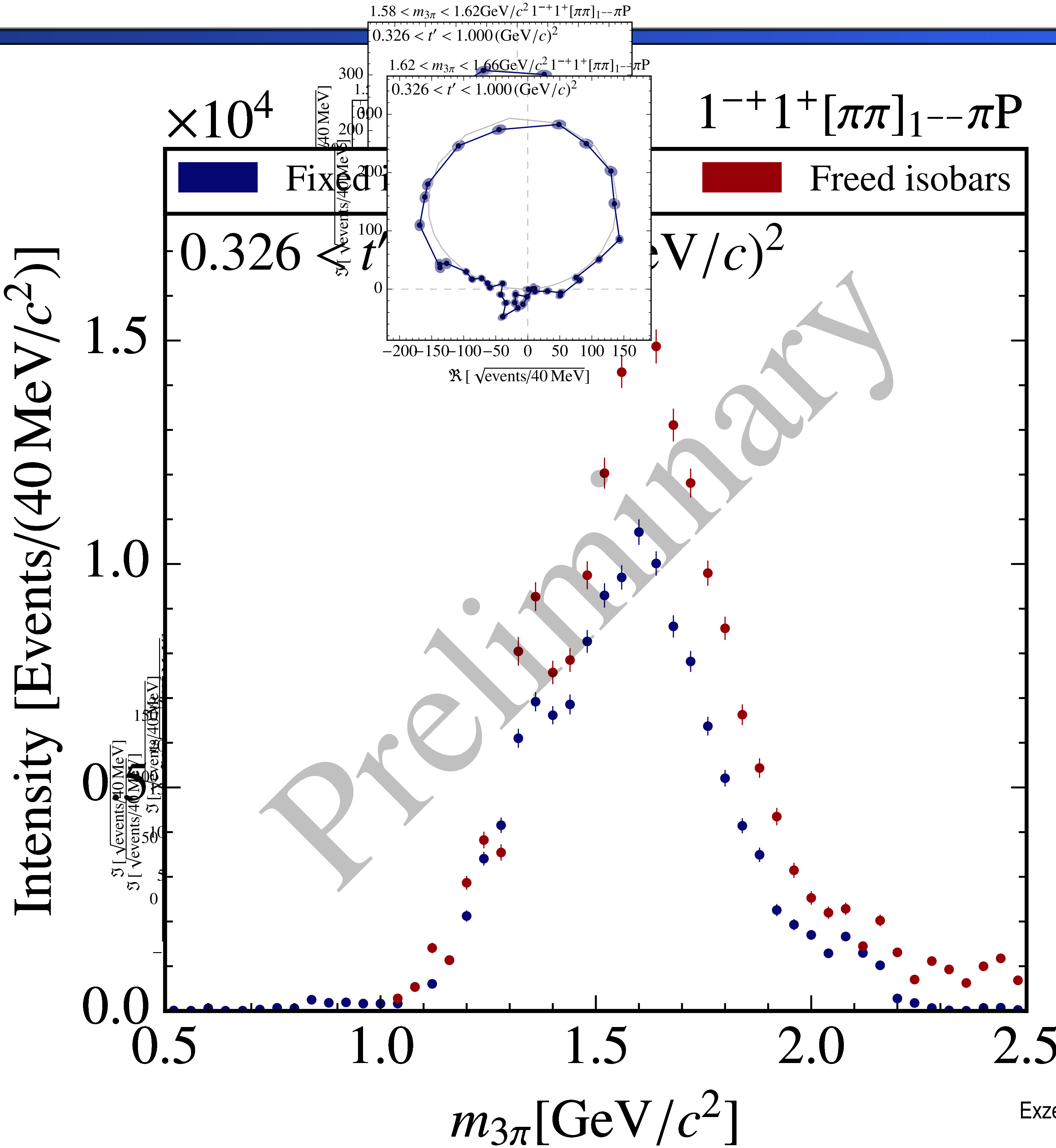

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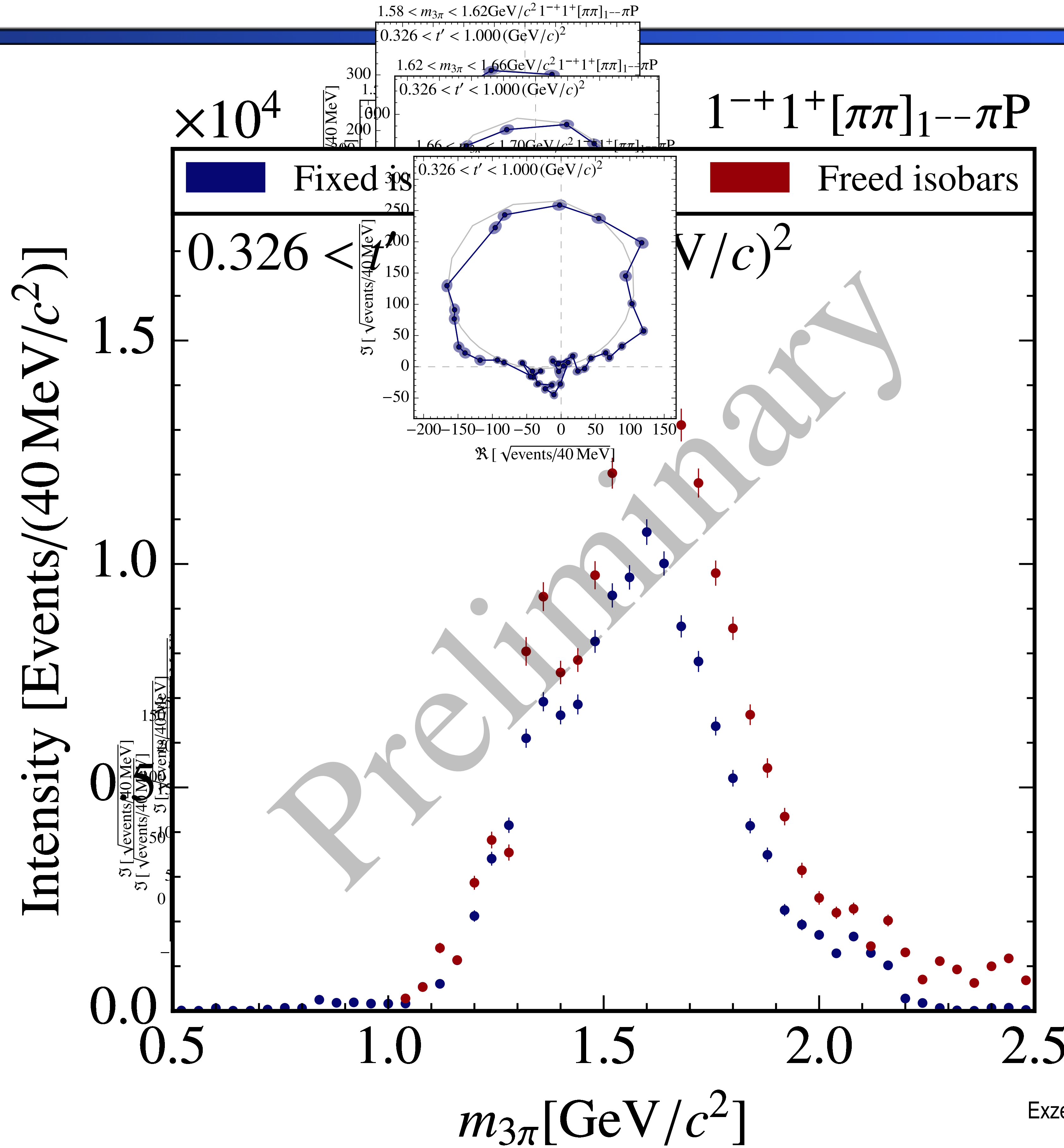

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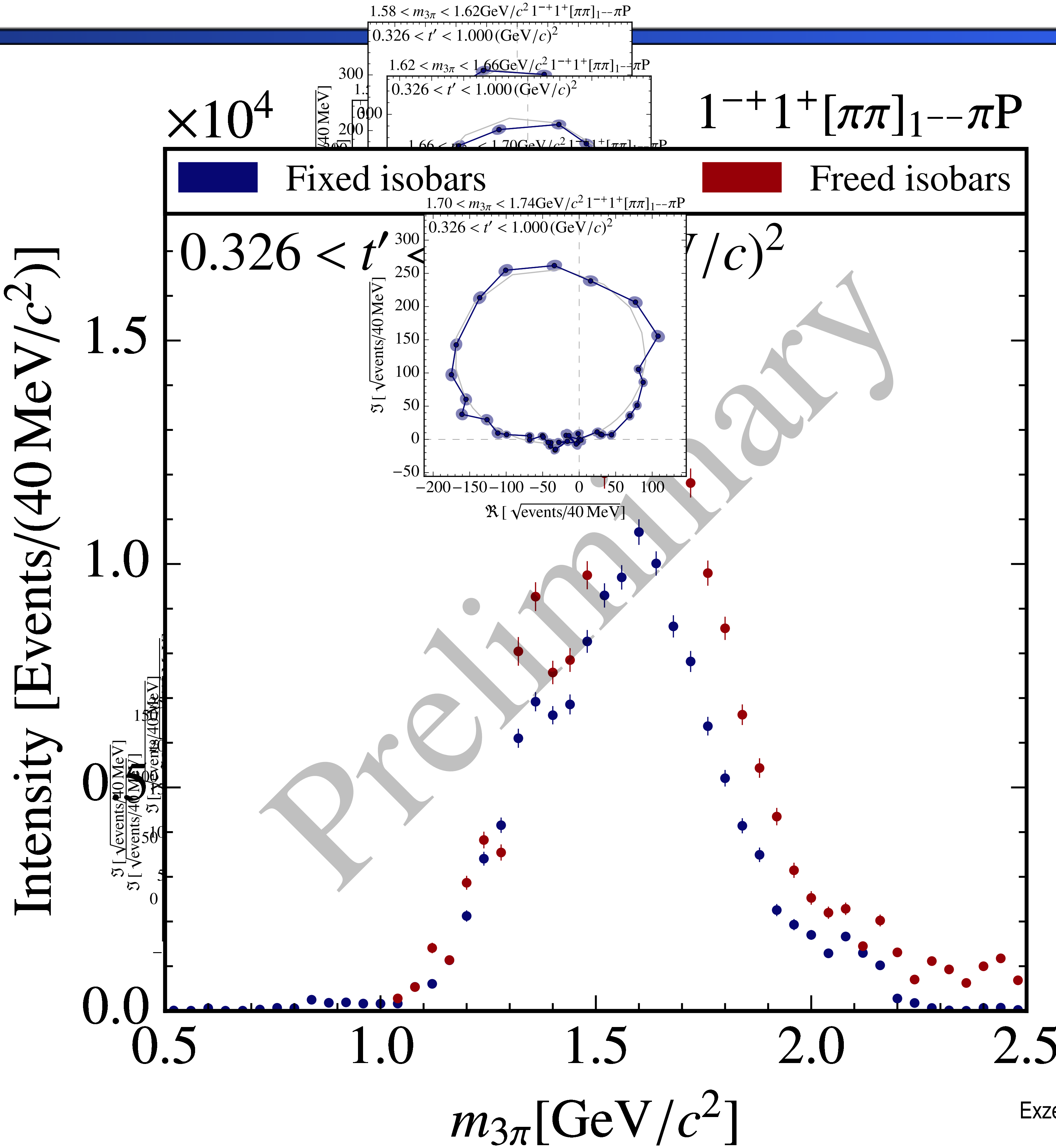

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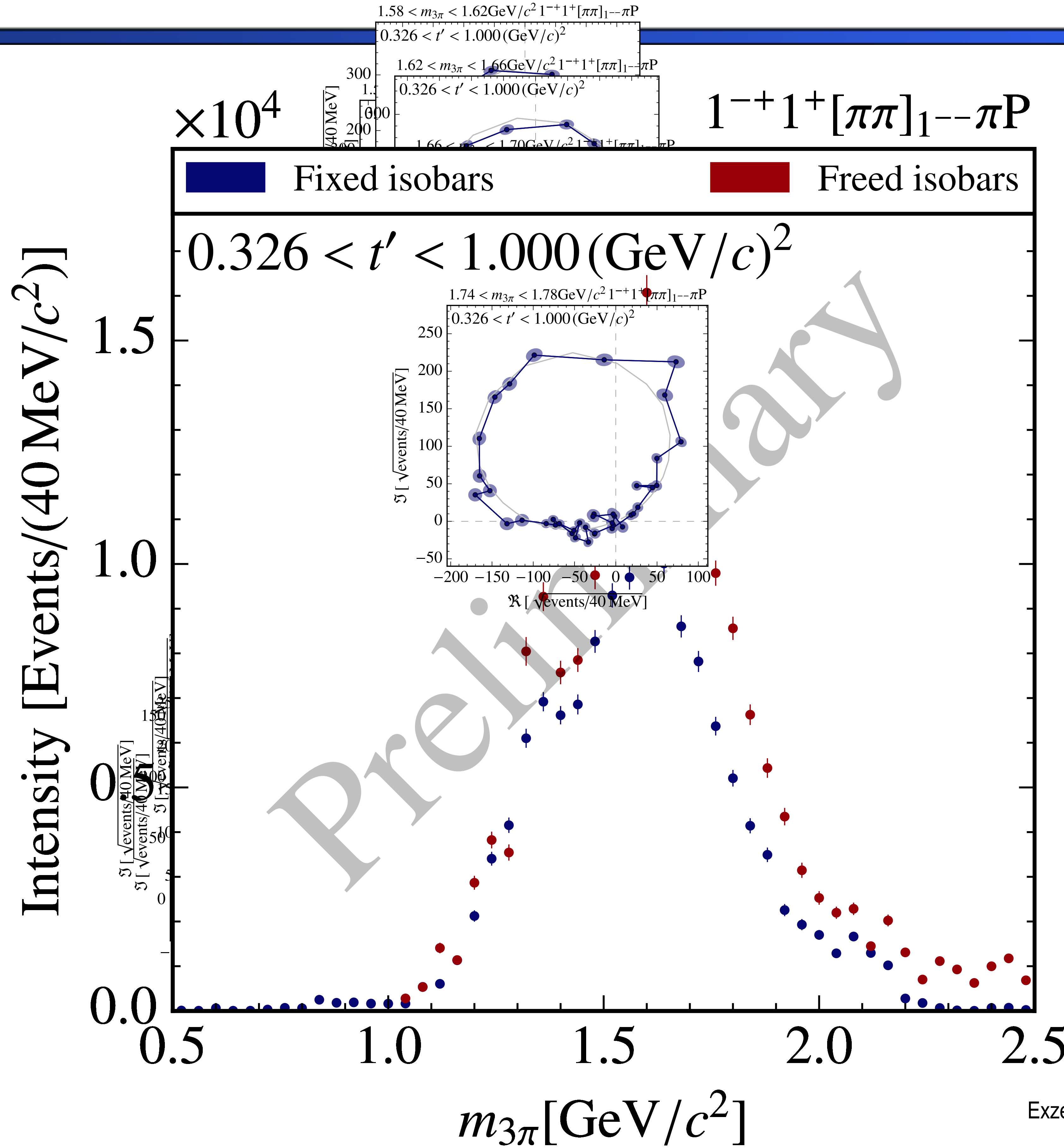

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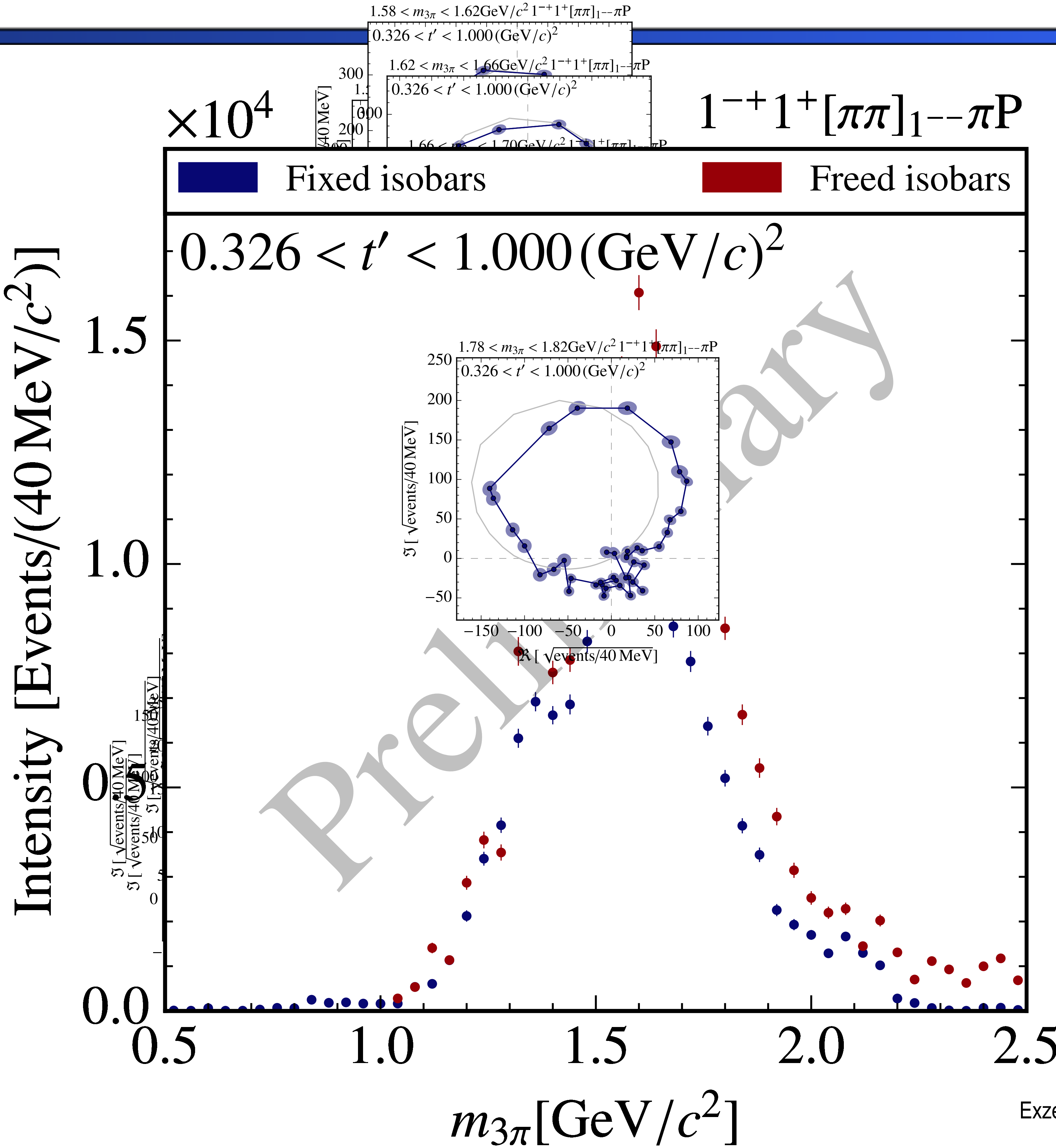

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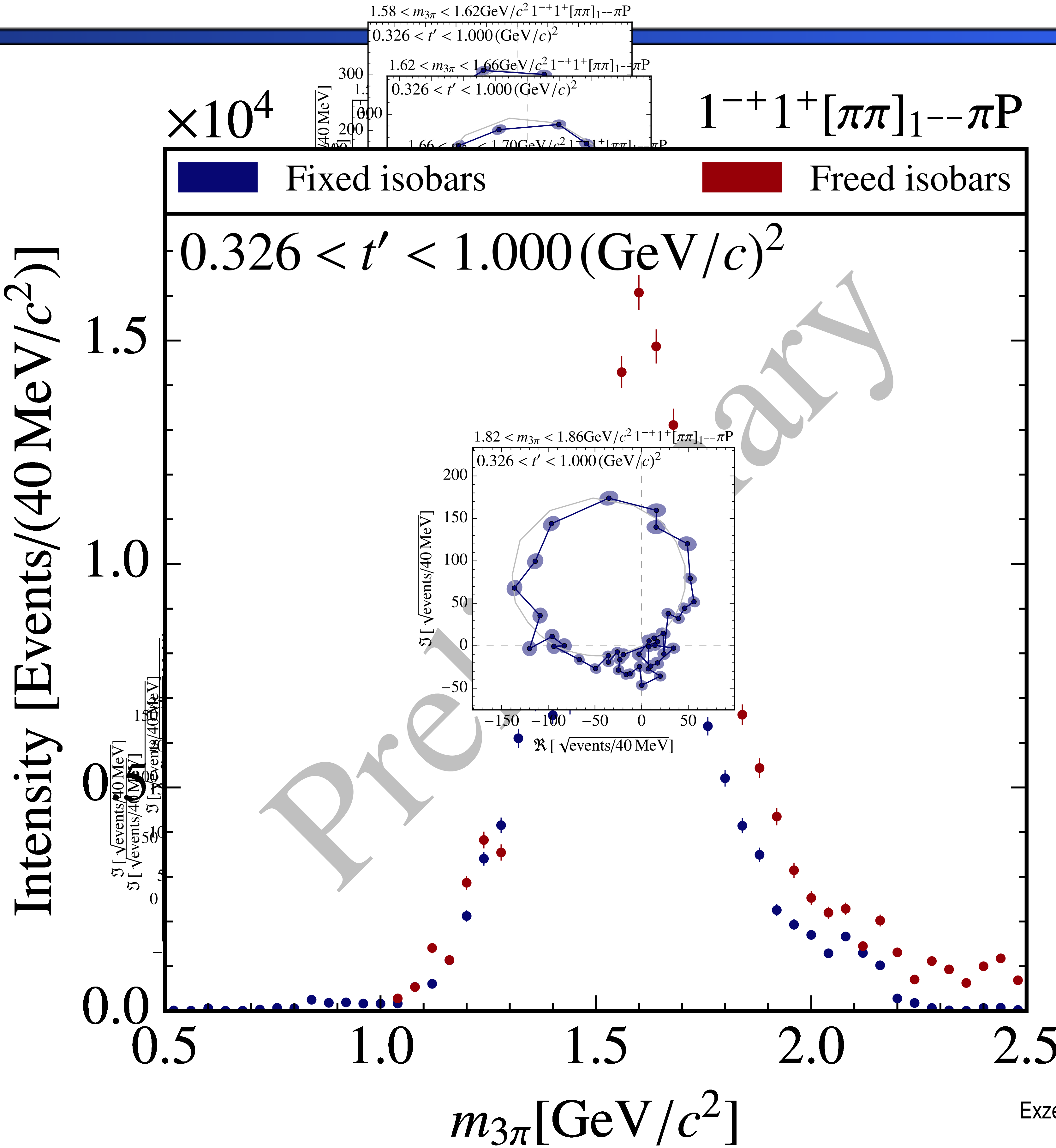

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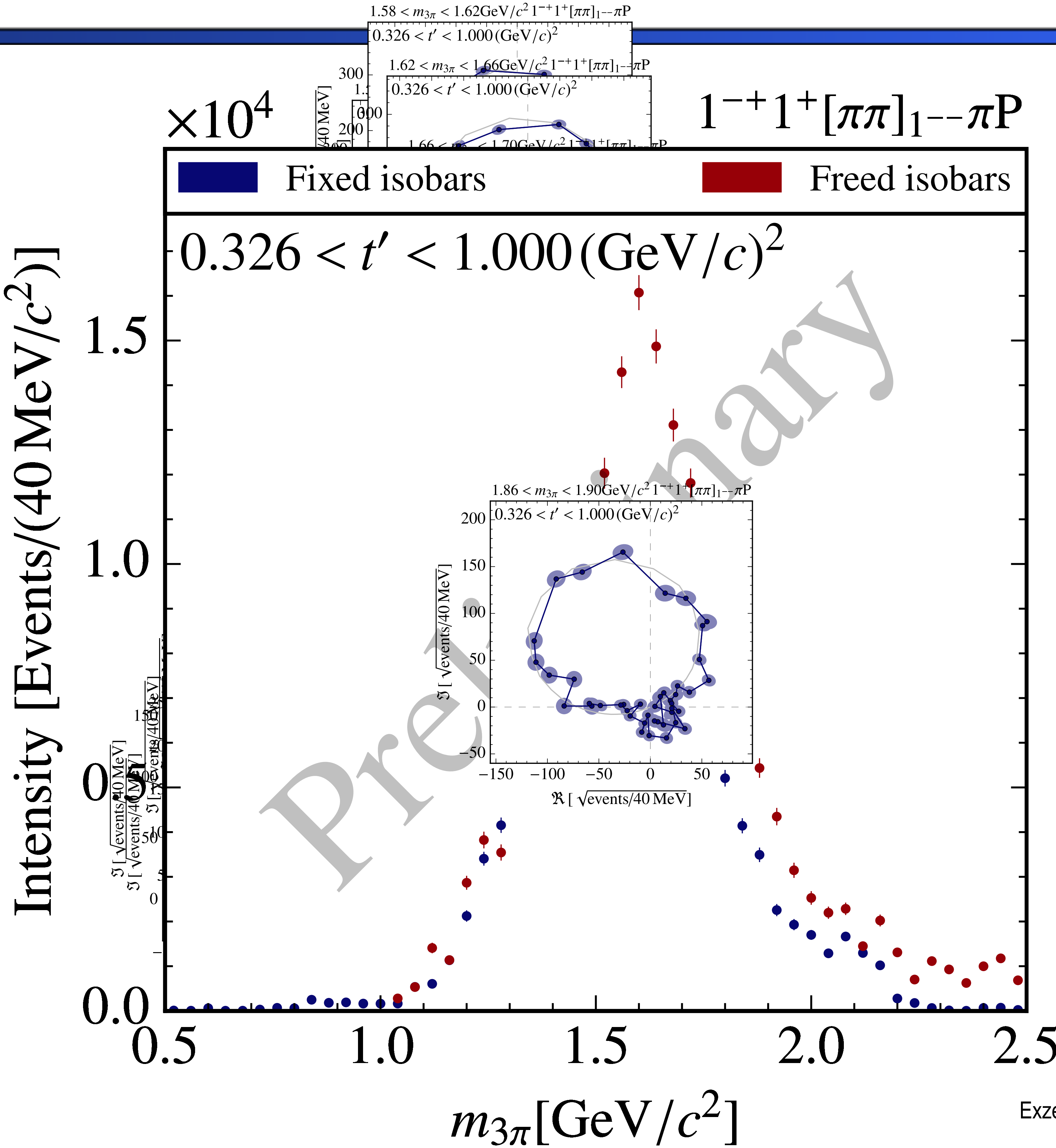

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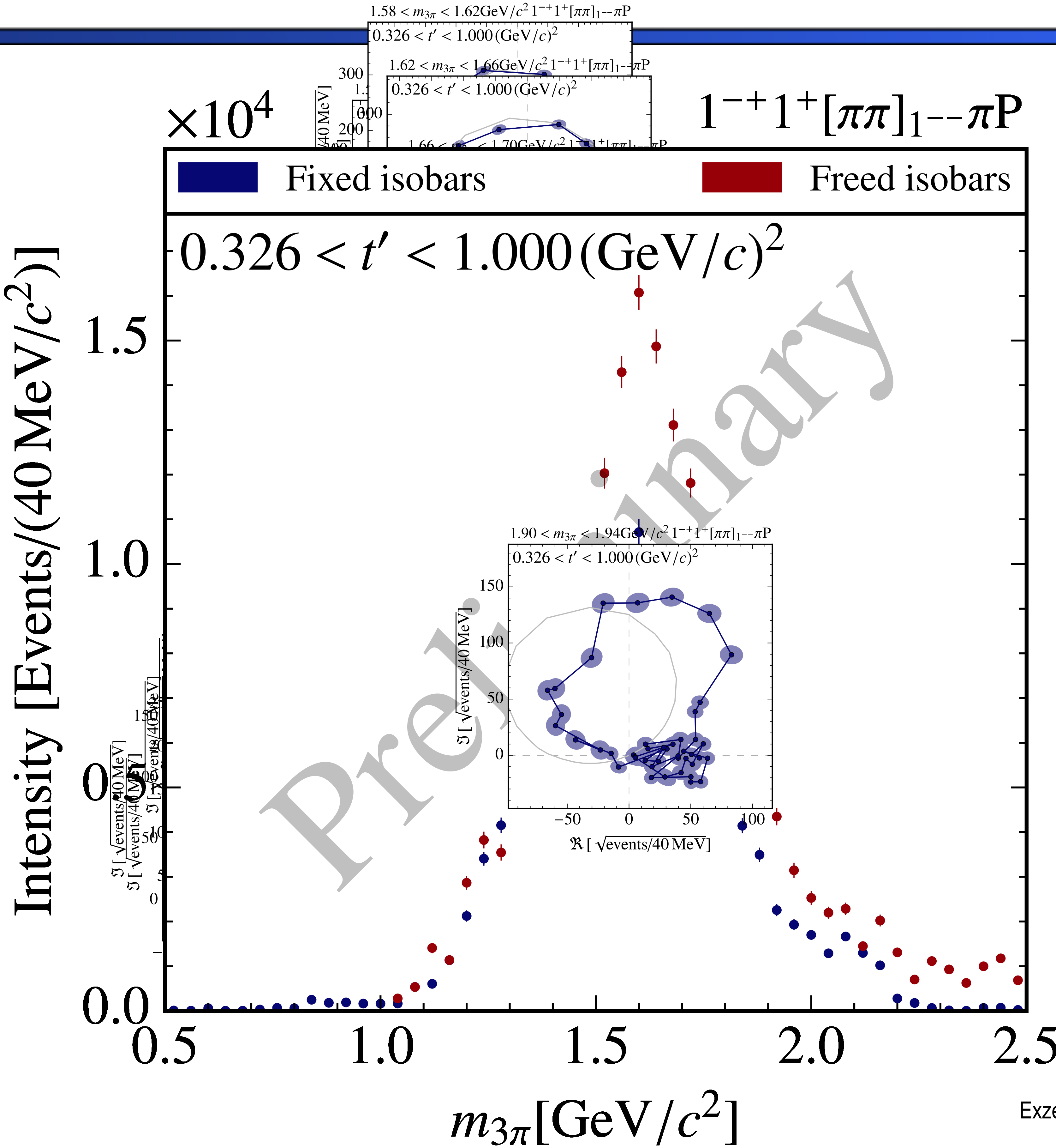

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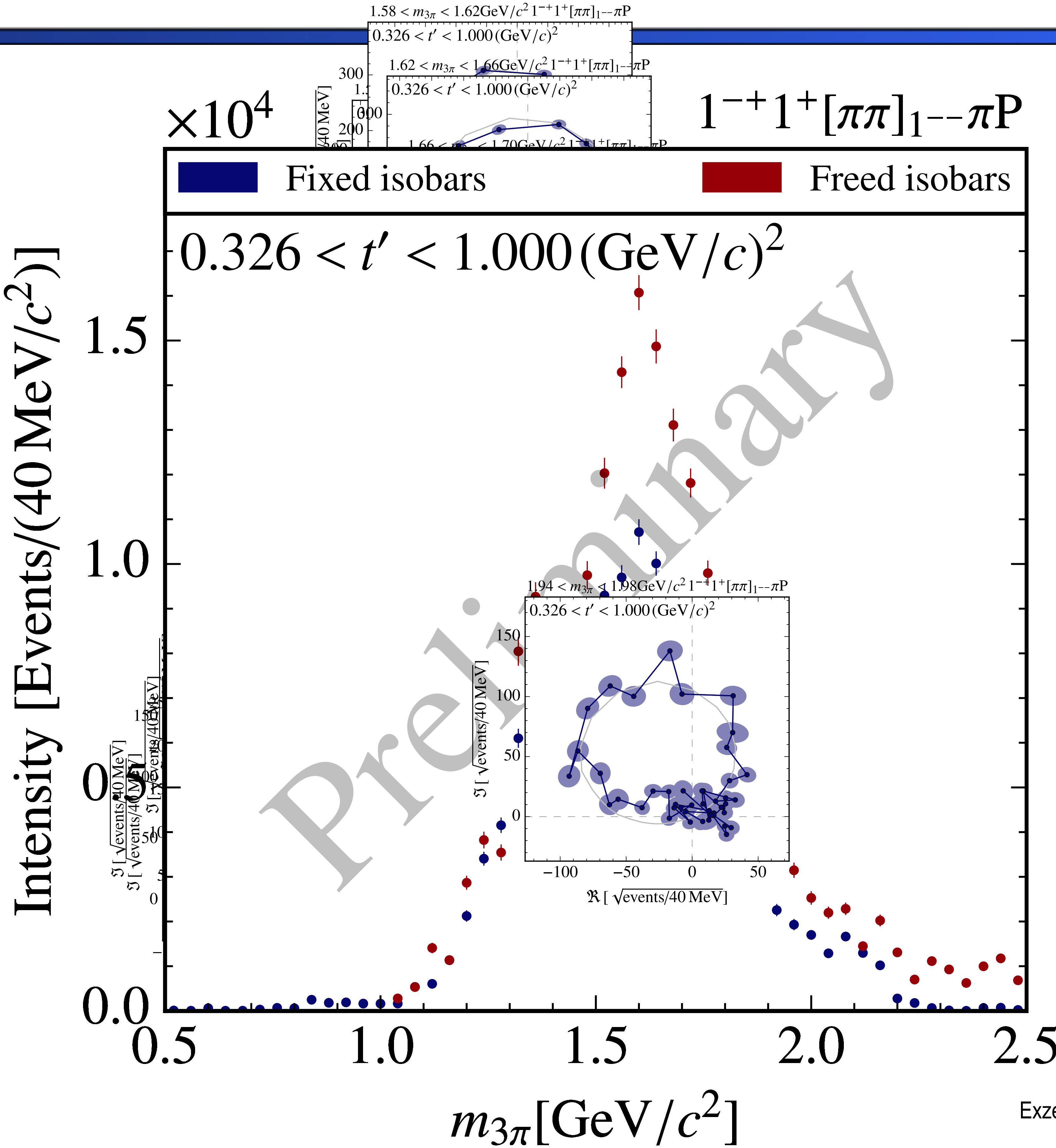

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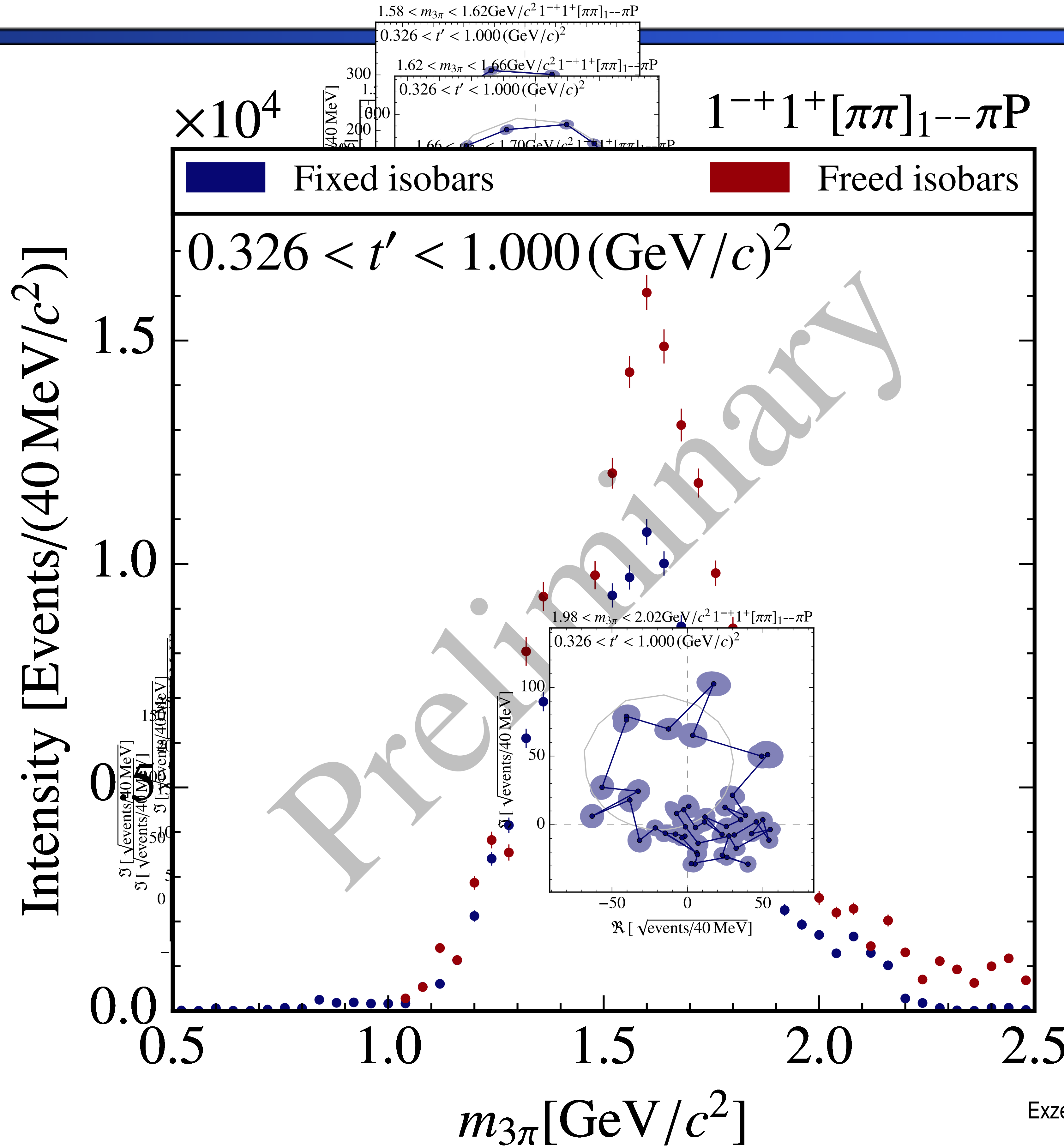

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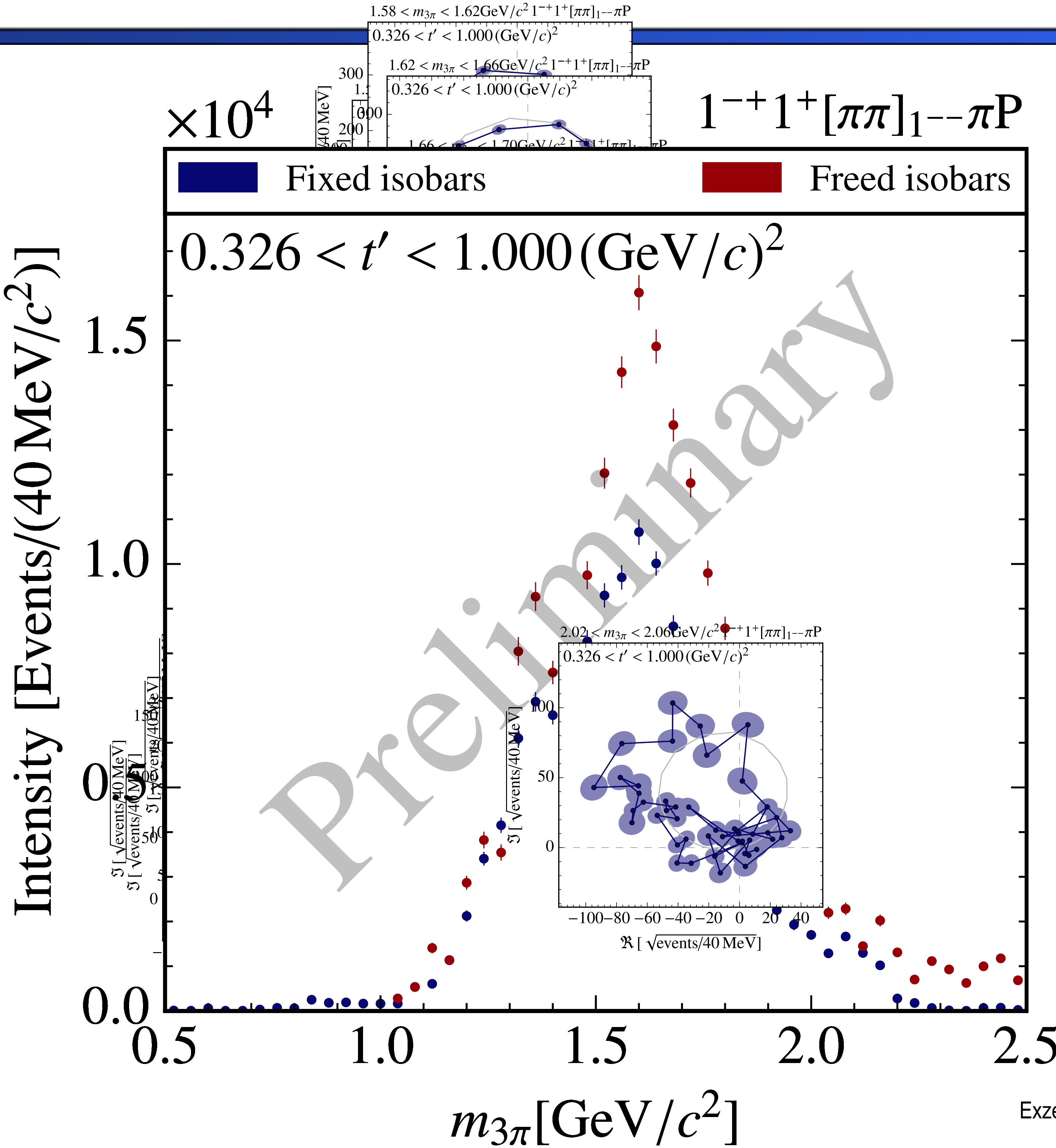

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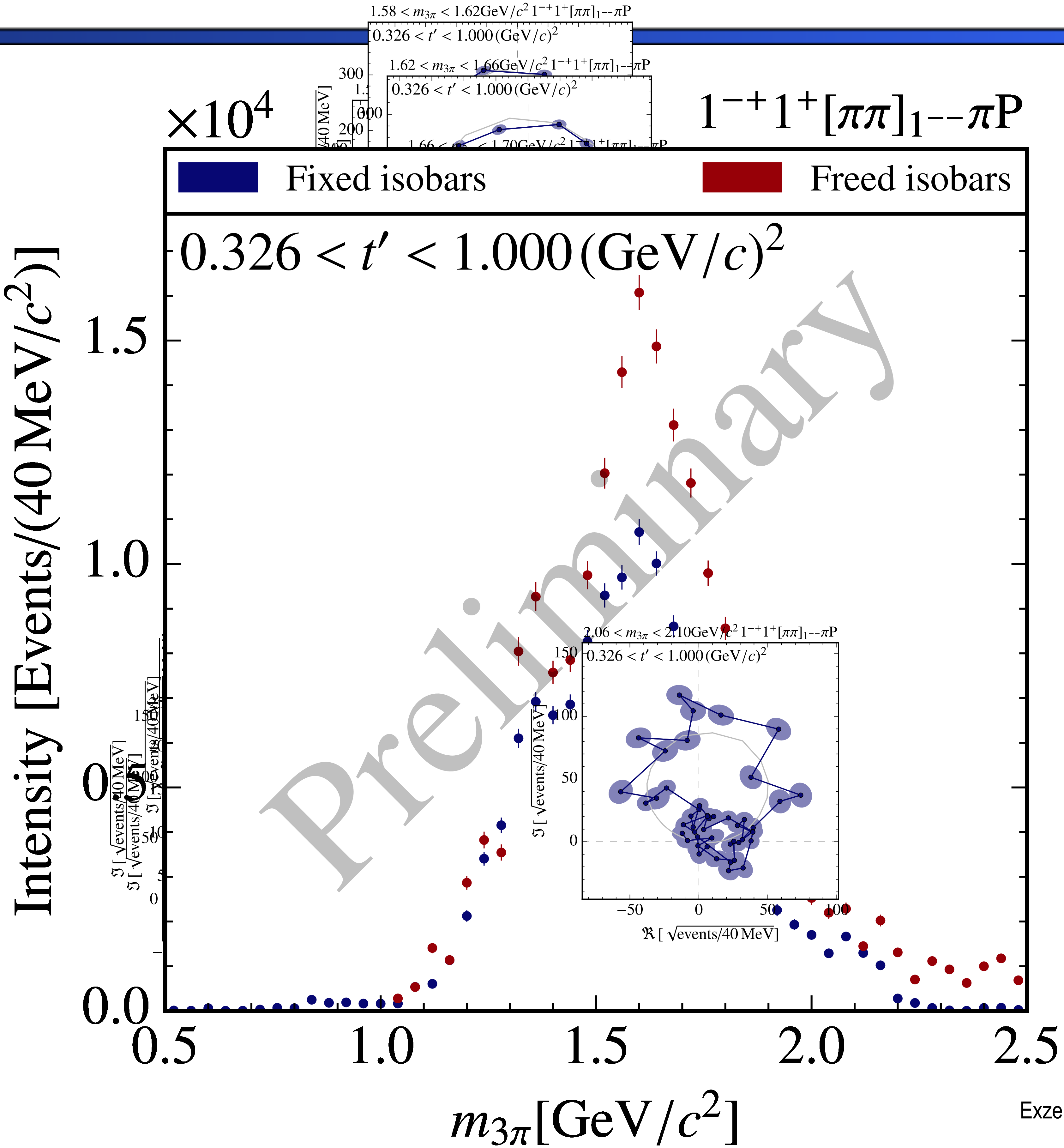

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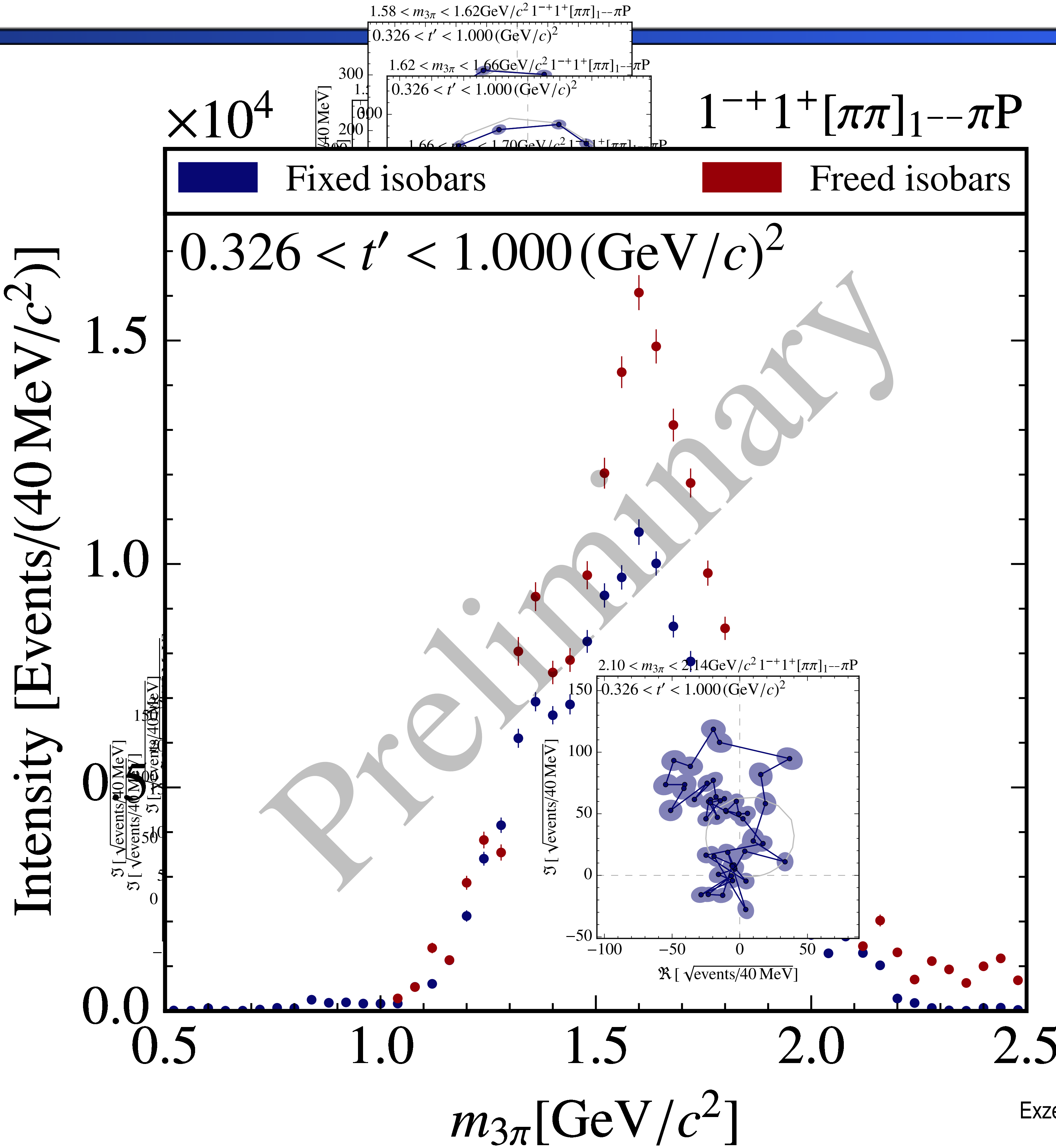

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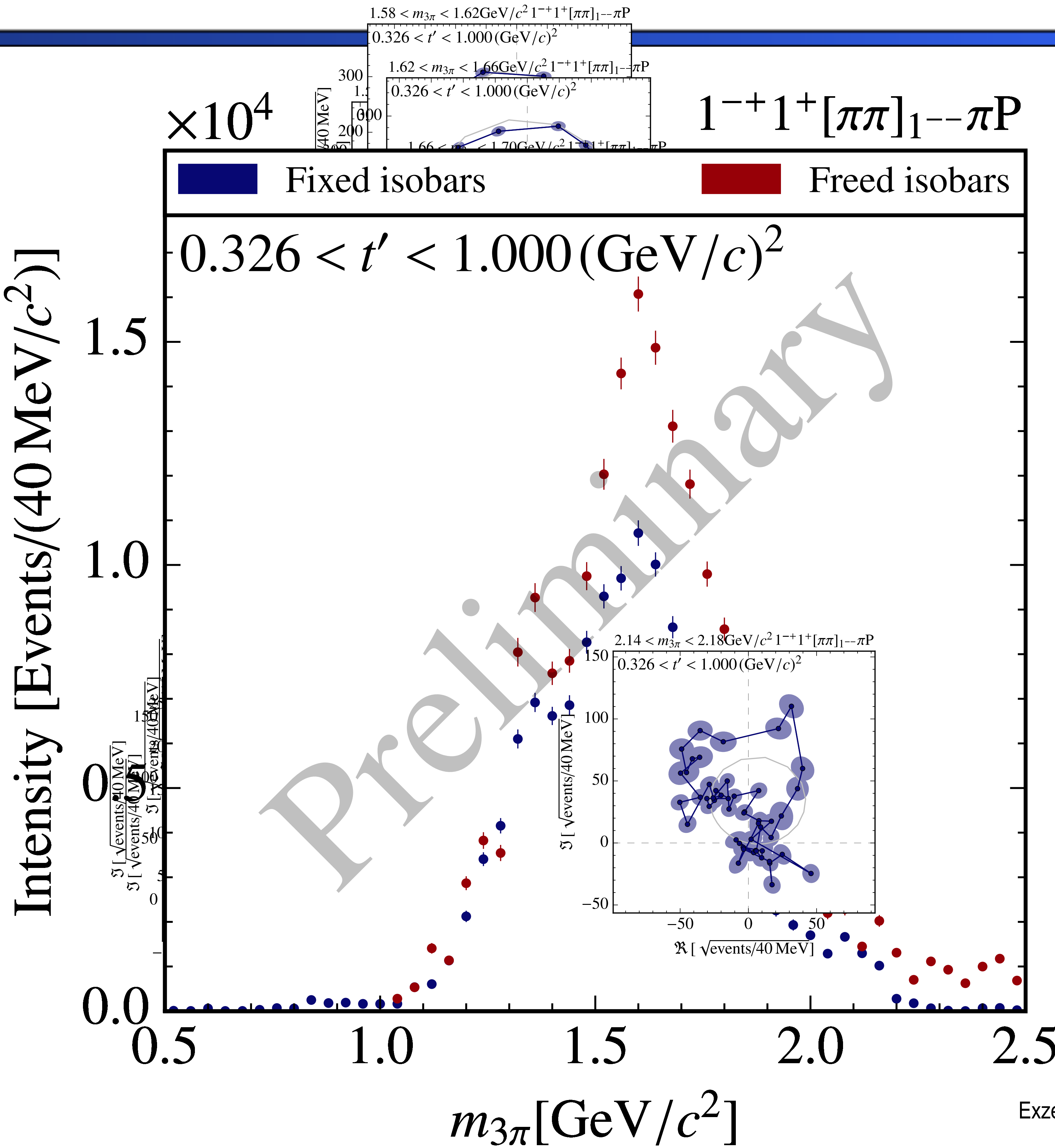


Exzellenzcluster Universe

The COMPASS challenge

Huge data sample

- Mother J^{PC} : 0^{-+}, 1^{-+}, 1^{++}, 2^{-+}, 2^{++}, 3^{-+}, 3^{++}, 4^{-+}, 4^{++}, ….
- Many different L possible
- 40 mass bins
- 4 bins in 4-momentum transfer

about 10,000 Dalitz plots

Aim:

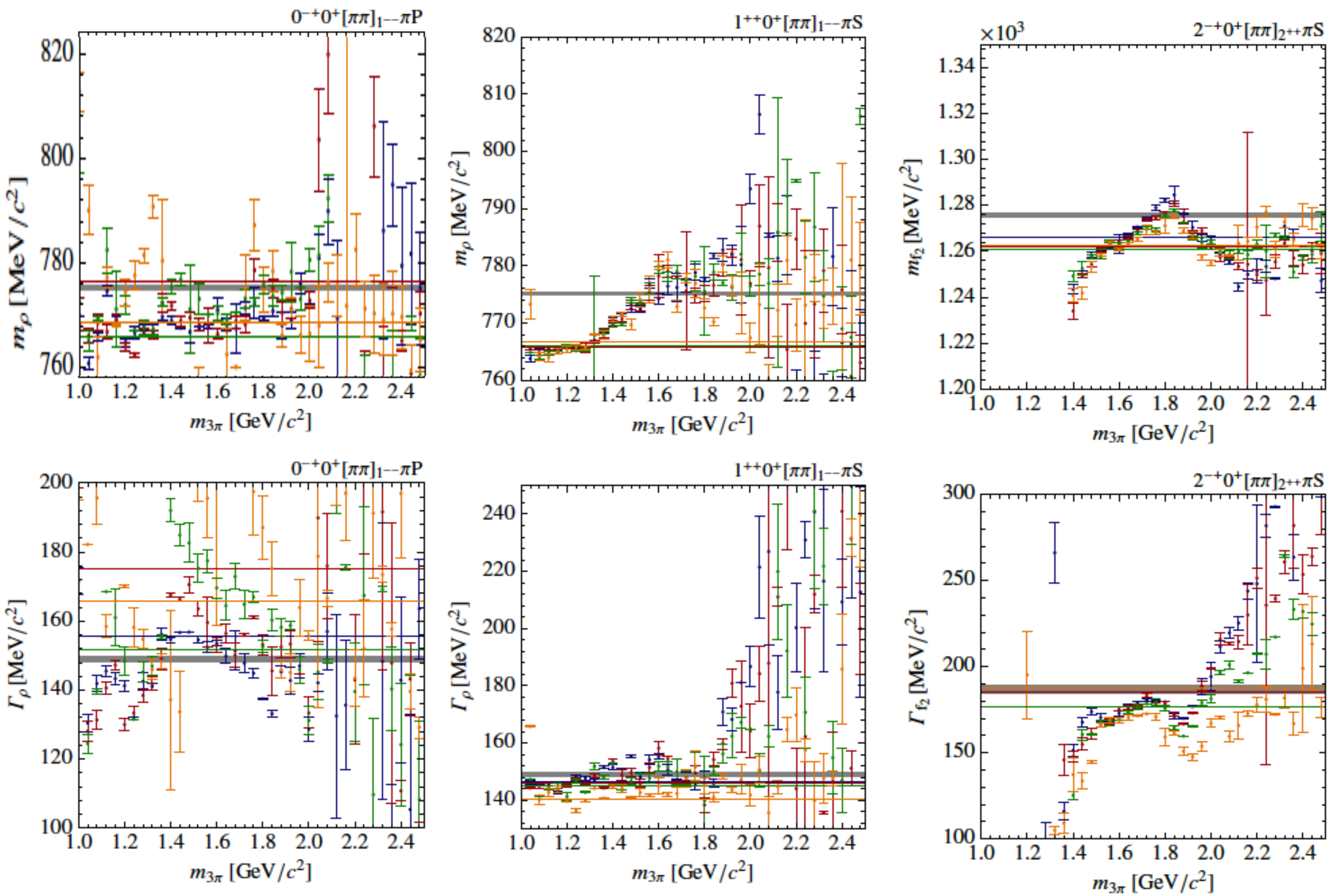
- Disentangle resonant and non-resonant 3π amplitudes
- Understand dynamics of strong decays

What we need:

- models for 2π amplitudes and FSI
- models for non-resonant 3π amplitudes

Extract „effective“ $\pi\pi$ Resonance Parameters

ρ from ρπ S-wave | ρ from ρπ P-wave | f_2 from $f_2\pi$ S-wave



Can we understand isobaric spectral functions and cause of individual effective $\pi\pi$ resonance parameters ?

What experiments need

- Many models and calculations provide amplitudes up to 1.5-1.8 GeV/c^2
- For B-decays and light meson spectroscopy:
  - $\pi\pi$, $K\pi$, KK amplitudes up to 3-5 GeV/c^2
  - analytic expressions
    - in terms of isobar amplitudes
    - closed form to be subjected to PWA decomposition