

The $\pi^0\pi^0$ System in $J/\psi \rightarrow \gamma\pi^0\pi^0$

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*with much thanks to
Jake Bennett
(now at Carnegie Mellon University)*

November 19, 2014
Future Directions in Amplitude Analysis
Jefferson Lab

(Challenges in Amplitude Analysis)

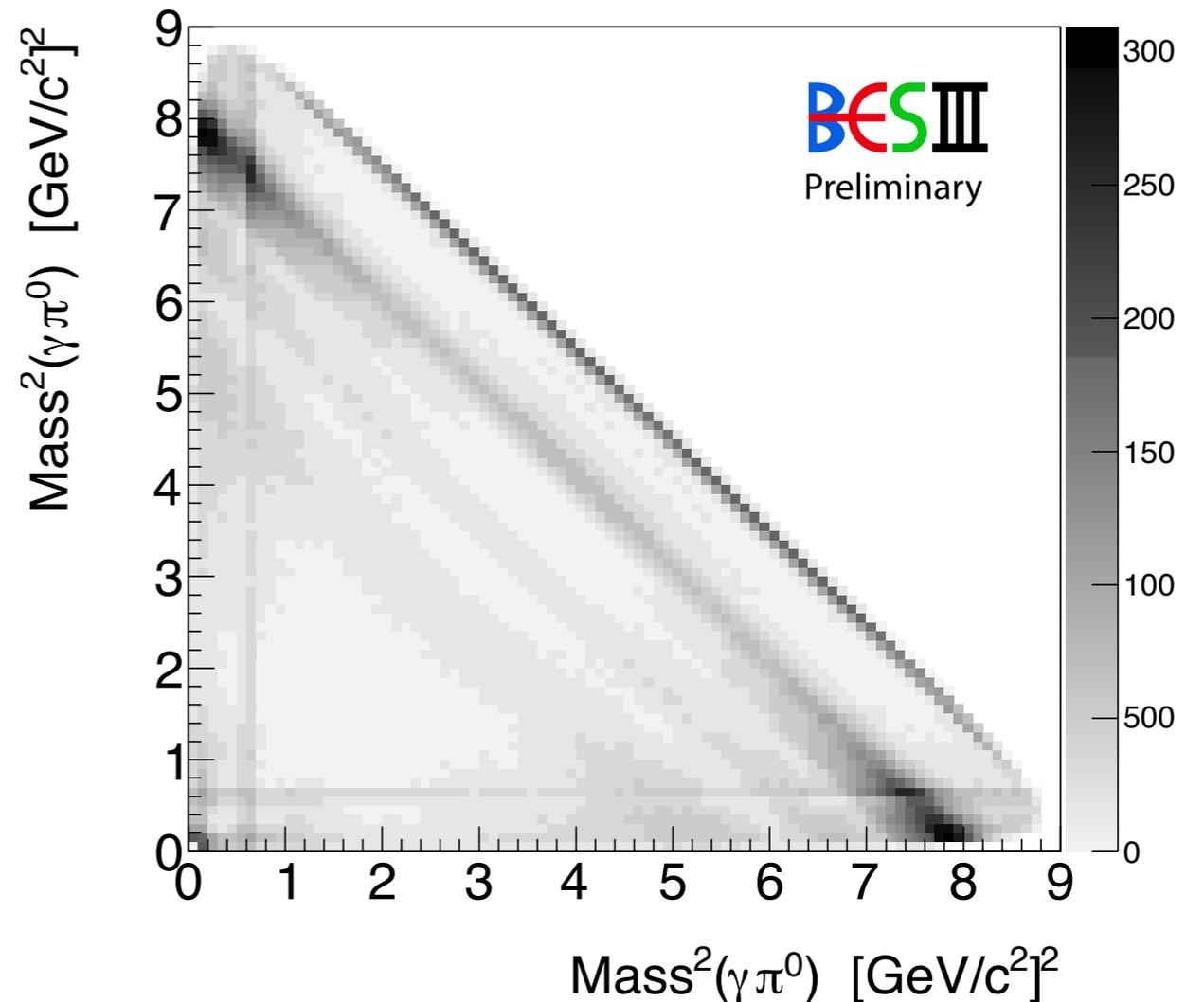
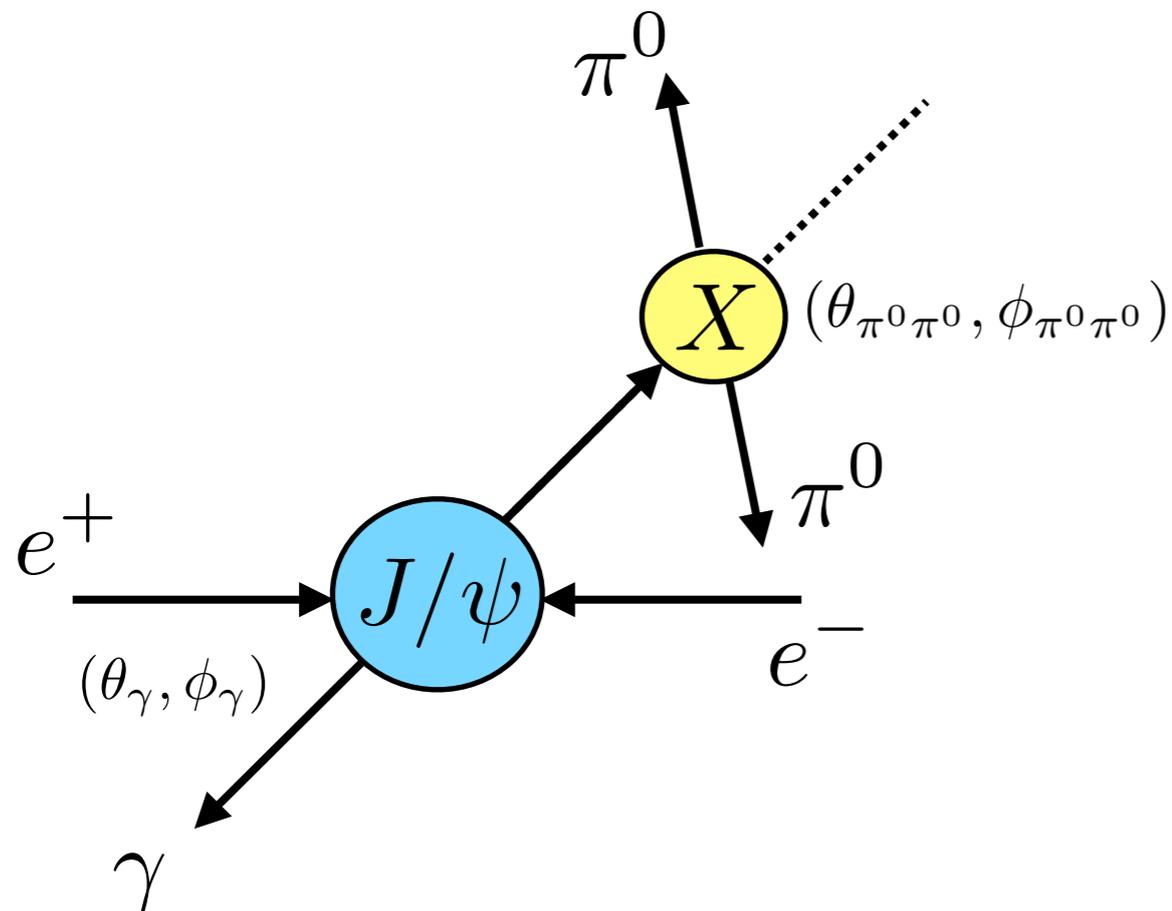
Outline

- Opportunities
 - modern experiments provide clean, high statistics data samples
- Challenge: how to analyze/publish data in a meaningful way
 - technical/computing issues
 - challenges from theoreticians
 - challenges from experimental colleagues
 - long term challenges
- *Disclaimer: not all the opinions expressed in this talk are my personal opinions!*

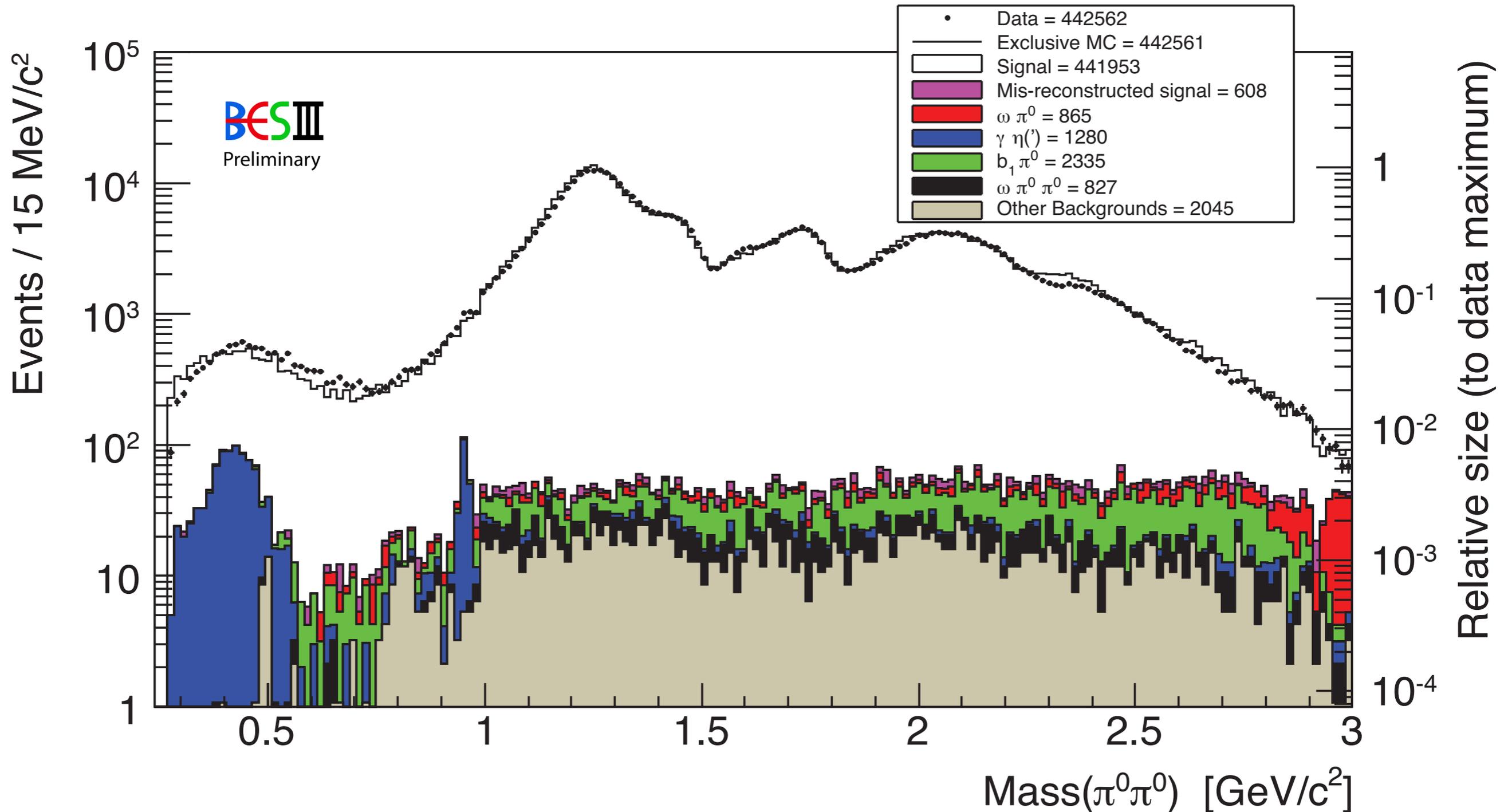


Why $J/\psi \rightarrow \gamma \pi^0 \pi^0$?

- The prototypical glueball hunting channel
- Only J^{++} with J even
- Only two strongly interacting hadrons
- Experimentally cleaner than $J/\psi \rightarrow \gamma \pi^+ \pi^-$

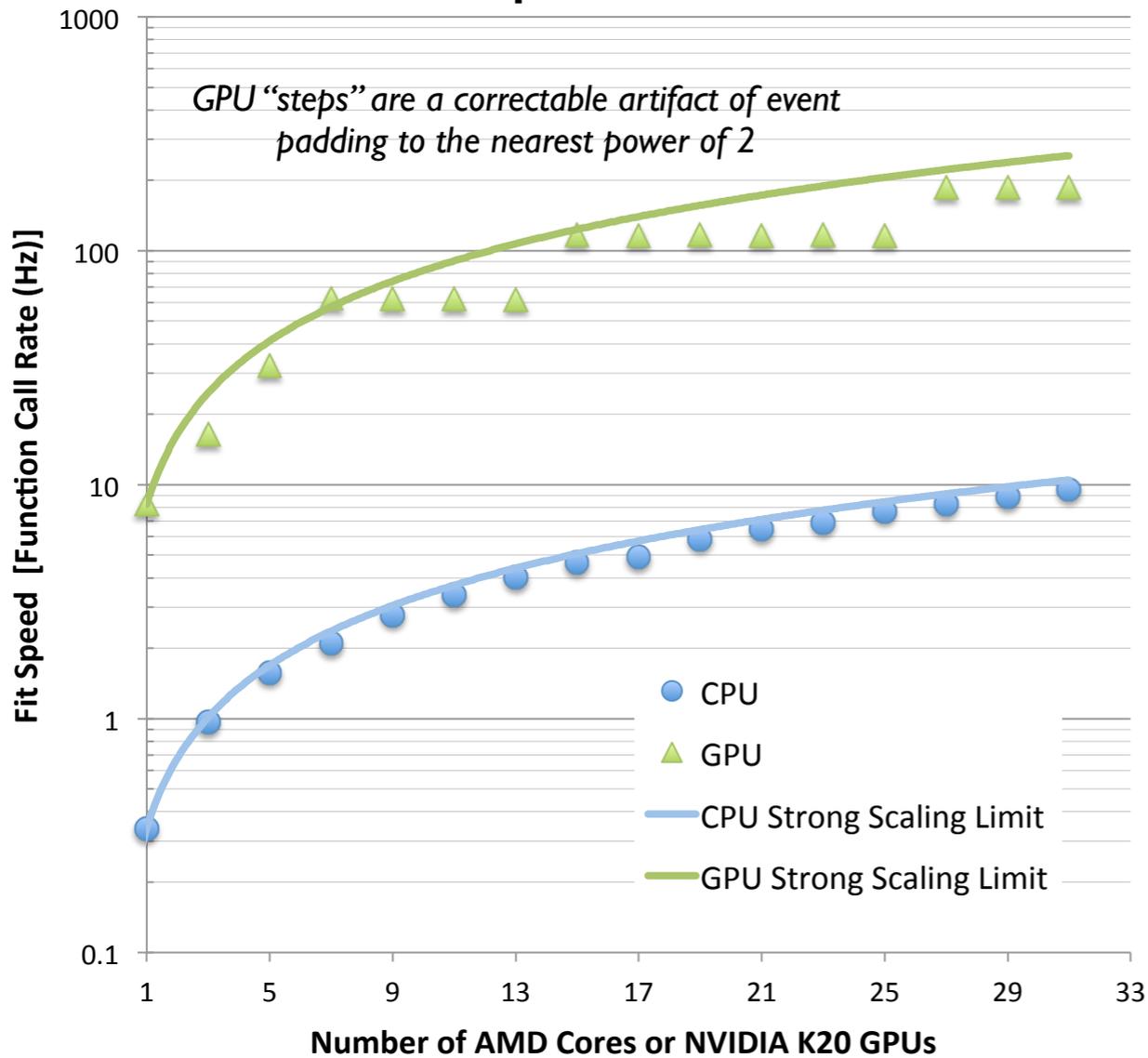


$J/\psi \rightarrow \gamma \pi^0 \pi^0$: Opportunities

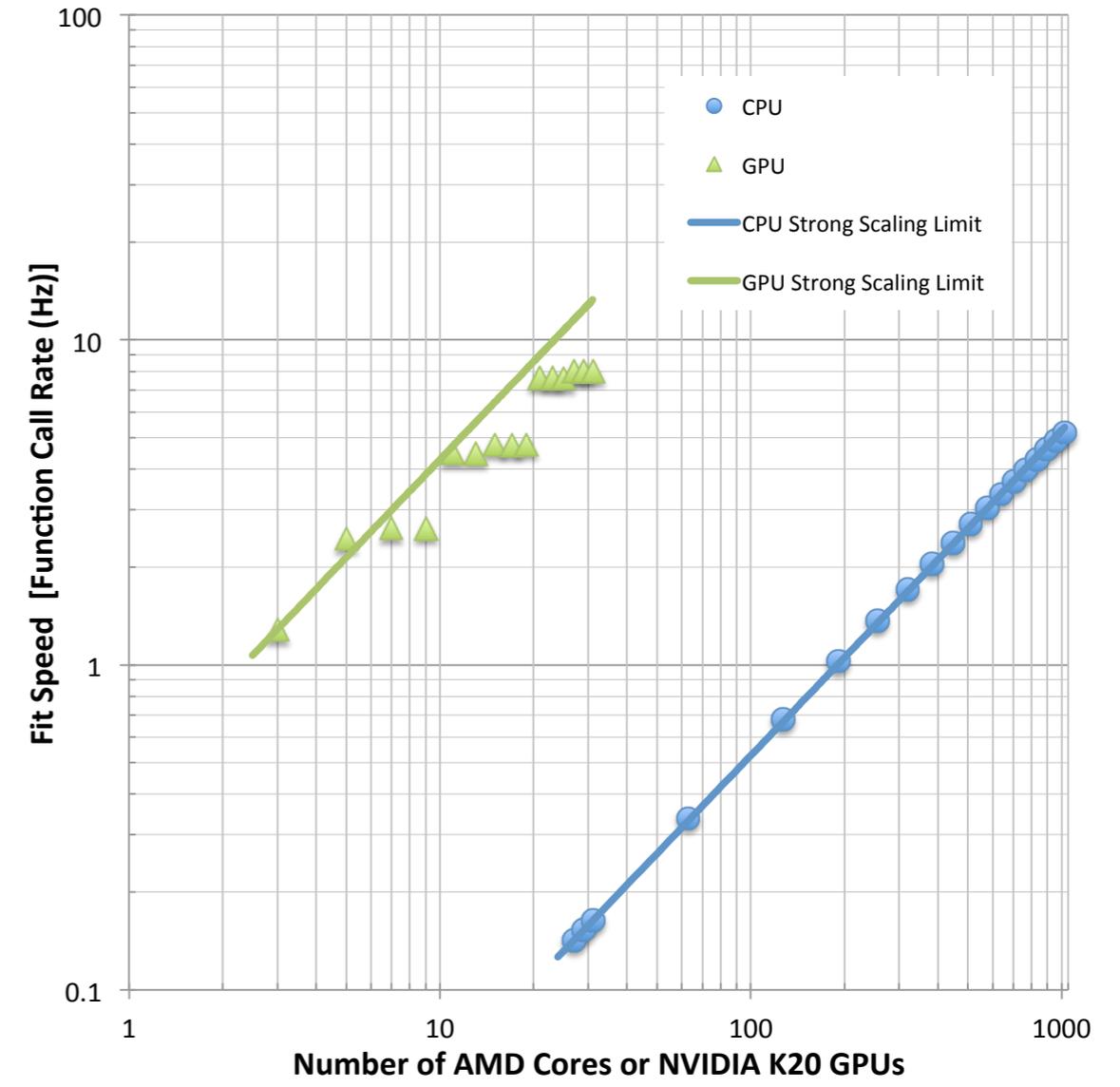


Technical Challenges

“Expensive Fit”



“Really Expensive Fit”



AmpTools: amptools.sourceforge.net

(not perfect, but has removed all technical computing challenges for this analysis)



Modeling Challenges

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 - Kinematics: D functions, spin sums,
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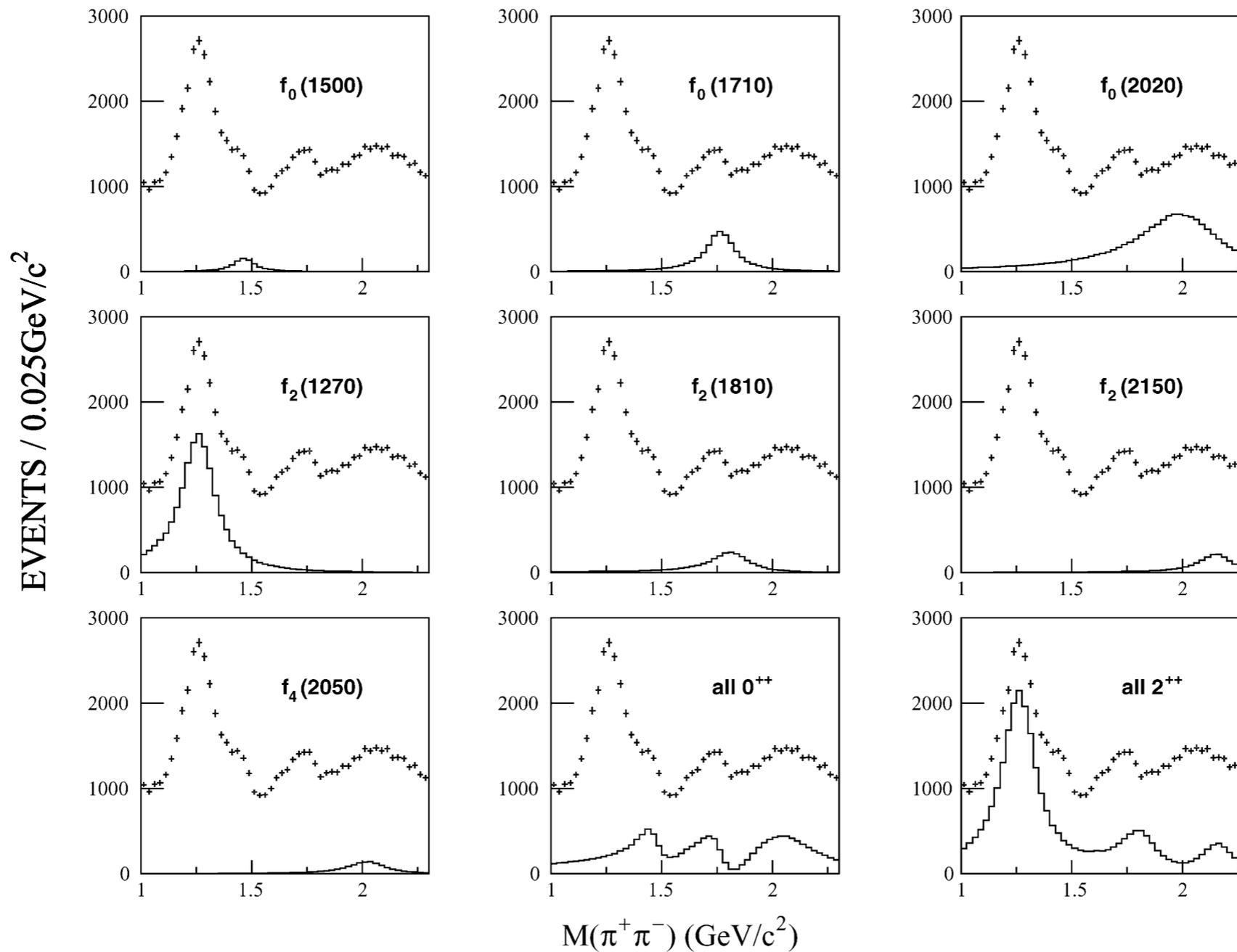
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- Modern experiments will be statistically sensitive to deficiencies in simplistic models — how to go forward?

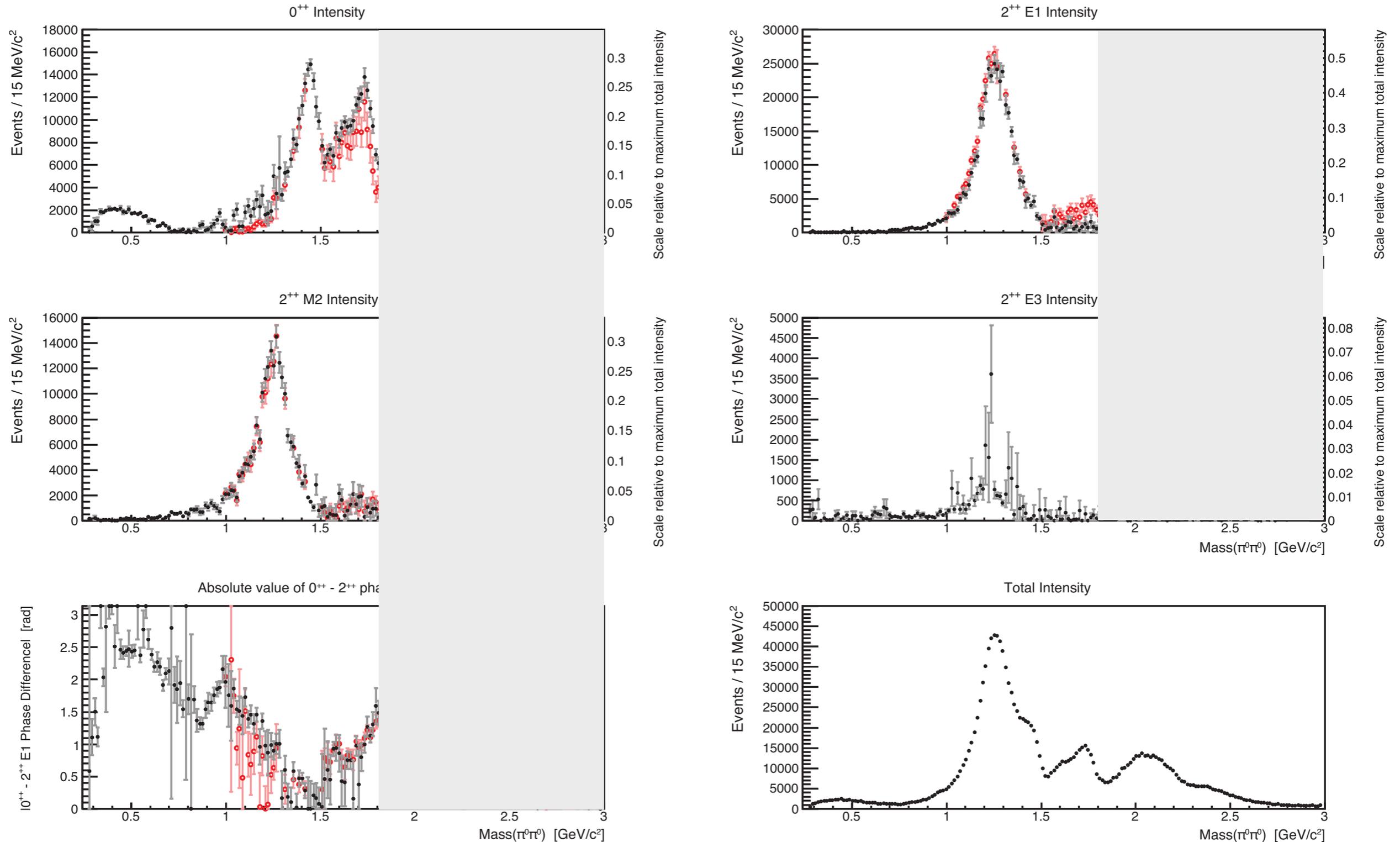


$J/\psi \rightarrow \gamma X, X \rightarrow \pi^+\pi^-$			
	Mass (MeV/c ²)	Γ (MeV/c ²)	\mathcal{B} ($\times 10^{-4}$)
$f_2(1270)$	$1262^{+1}_{-2} \pm 8$	$175^{+6}_{-4} \pm 10$	$9.14 \pm 0.07 \pm 1.48$
$f_0(1500)$	$1466 \pm 6 \pm 20$	$108^{+14}_{-11} \pm 25$	$0.67 \pm 0.02 \pm 0.30$
$f_0(1710)$	$1765^{+4}_{-3} \pm 13$	$145 \pm 8 \pm 69$	$2.64 \pm 0.04 \pm 0.75$

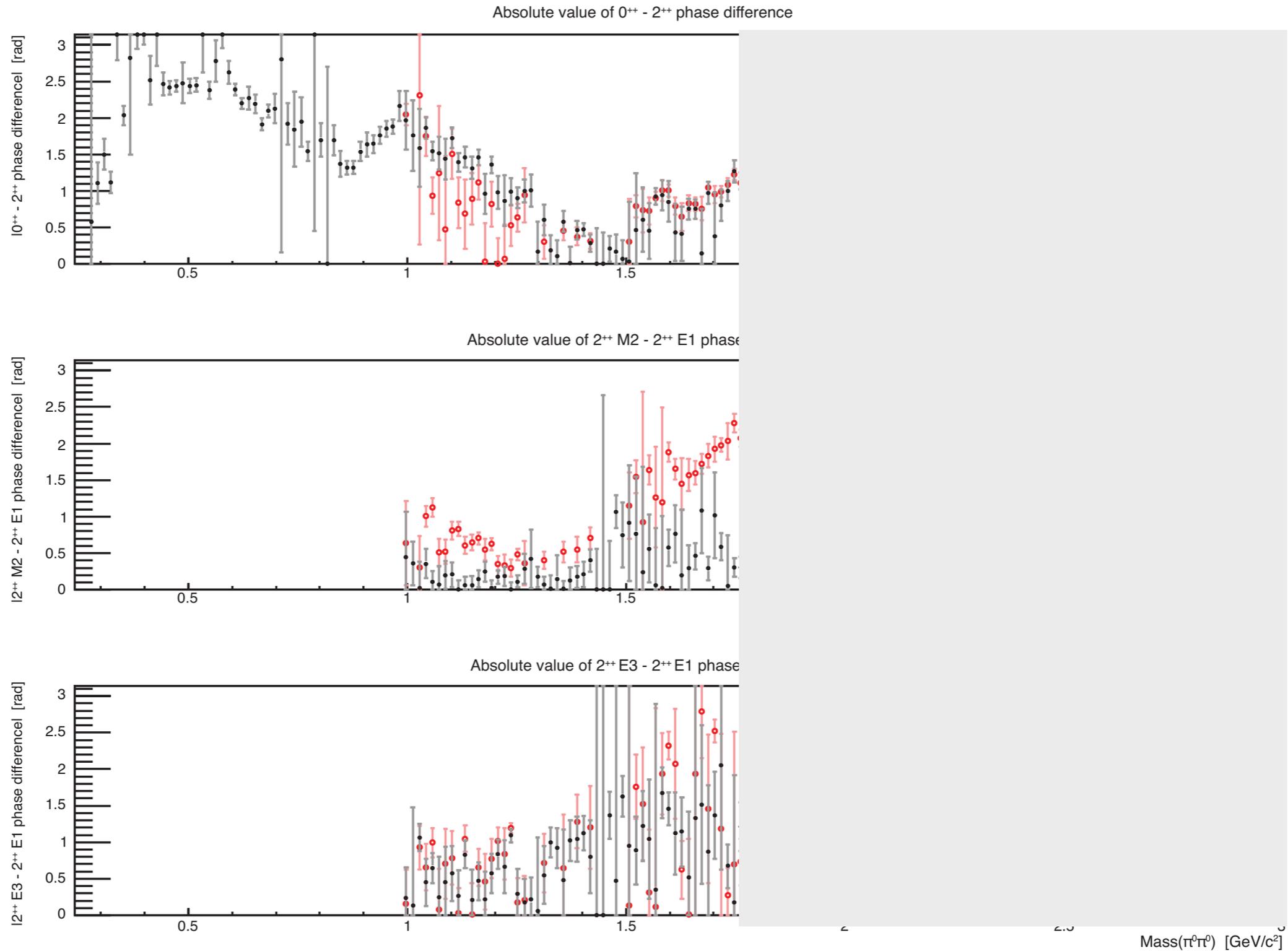
BES Collaboration / Physics Letters B 642 (2006) 441–448



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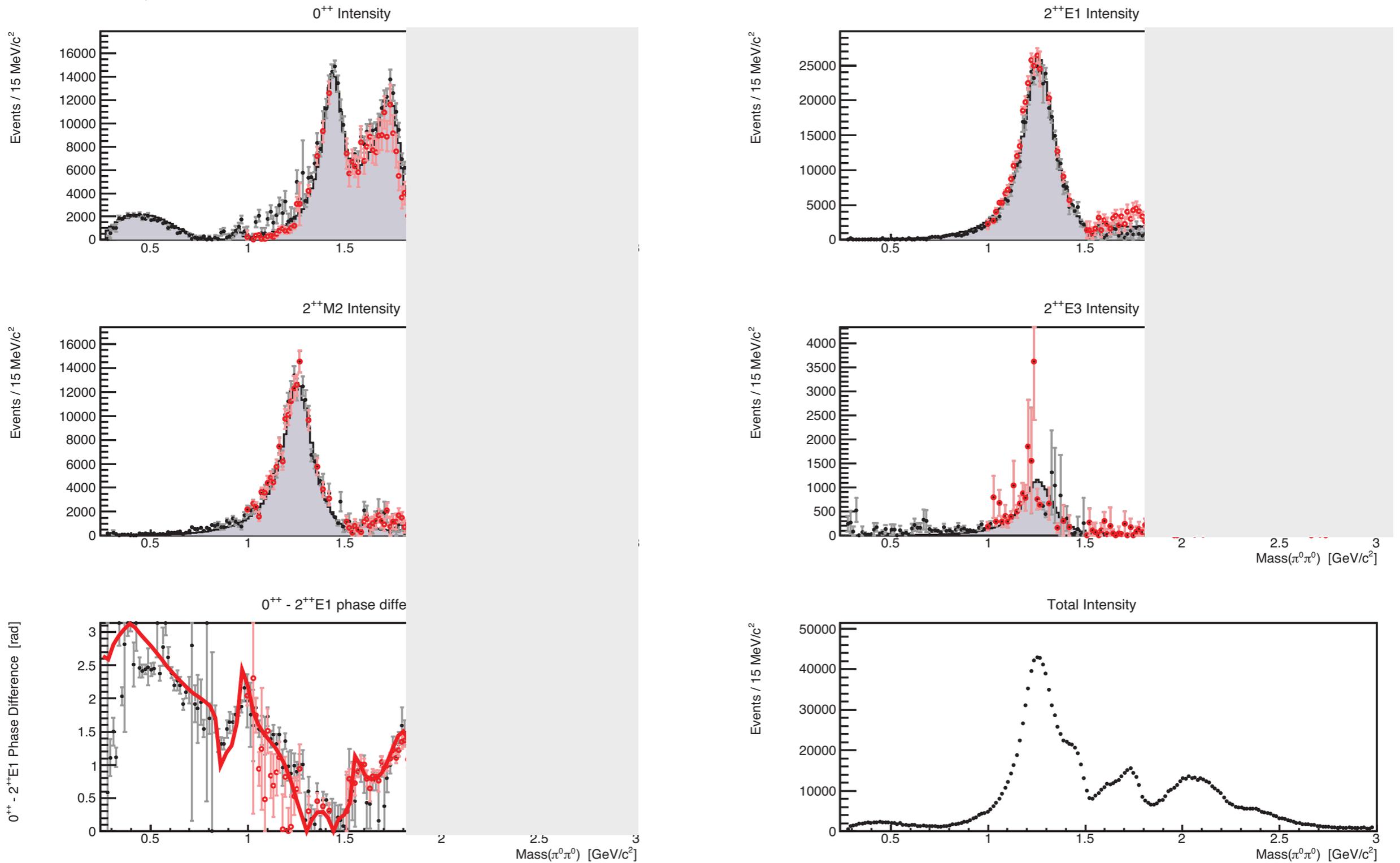


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- Combine results with other reactions from the same experiment
 - $J/\psi \rightarrow \gamma KK, J/\psi \rightarrow \gamma \eta \eta, \dots$
 - controlled study of coupled channel effects
 - $\psi' \rightarrow \gamma \pi \pi, \dots$
 - explore J/ψ and ψ' differences



$J/\psi \rightarrow \gamma \pi^0 \pi^0$



[six 0⁺⁺, four 2⁺⁺, and one 4⁺⁺ BW resonance (all with free phases)]

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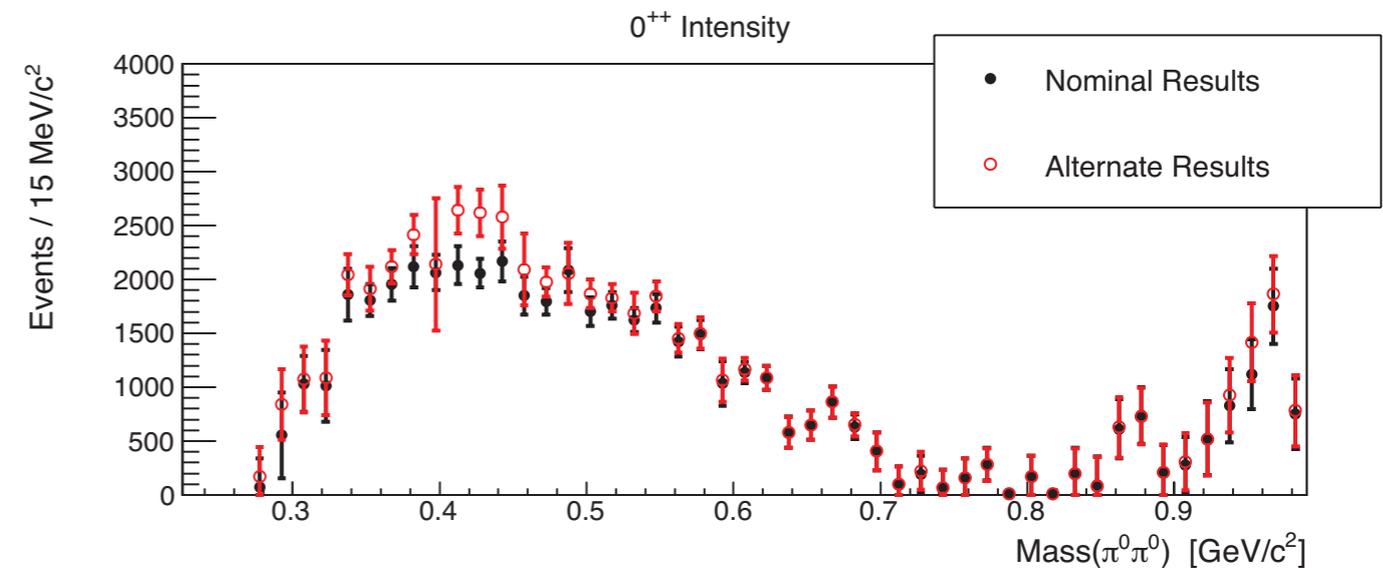
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 - Should we allow this?

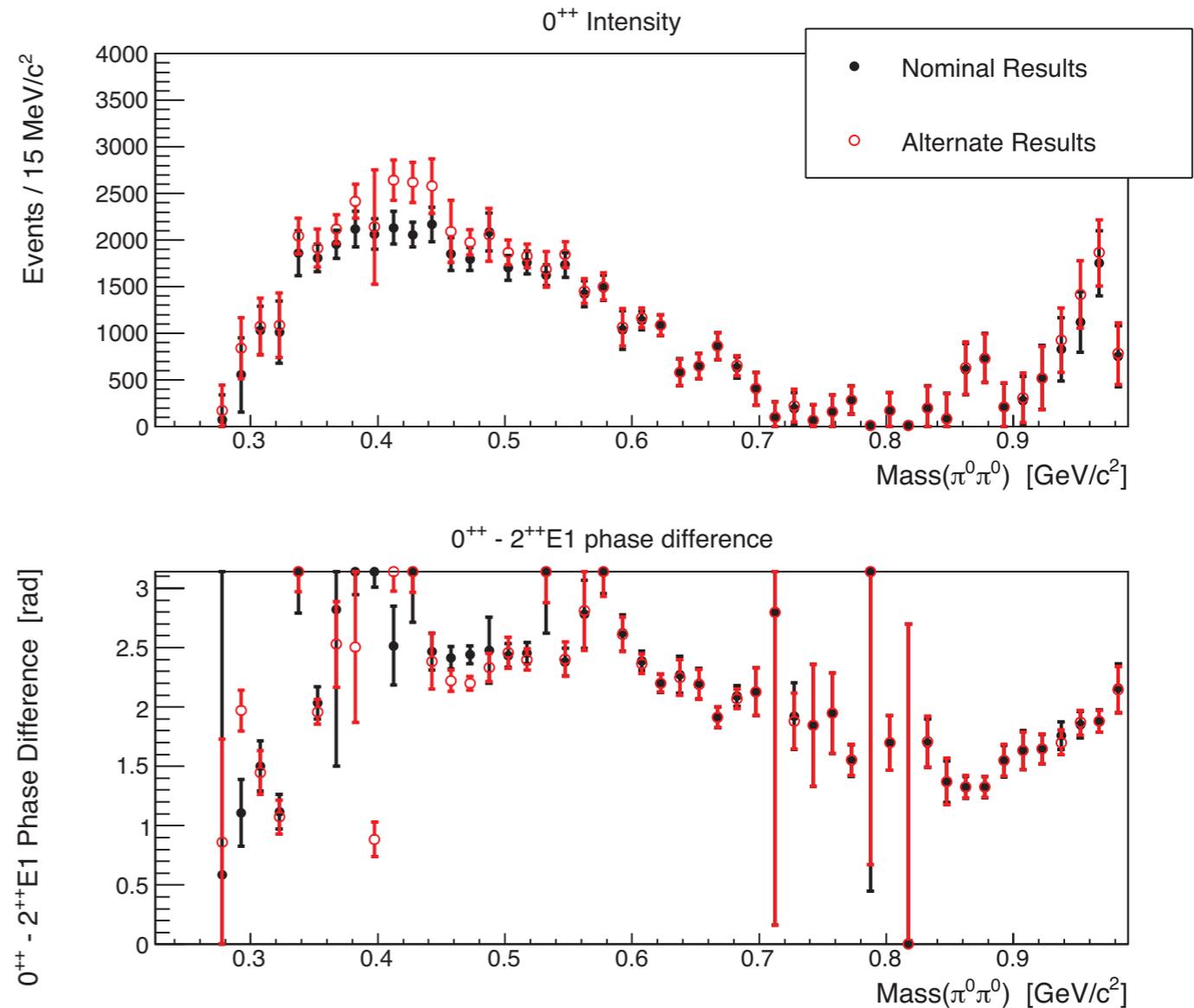
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 - some experimentally intensive
 - frequently correlated between bins
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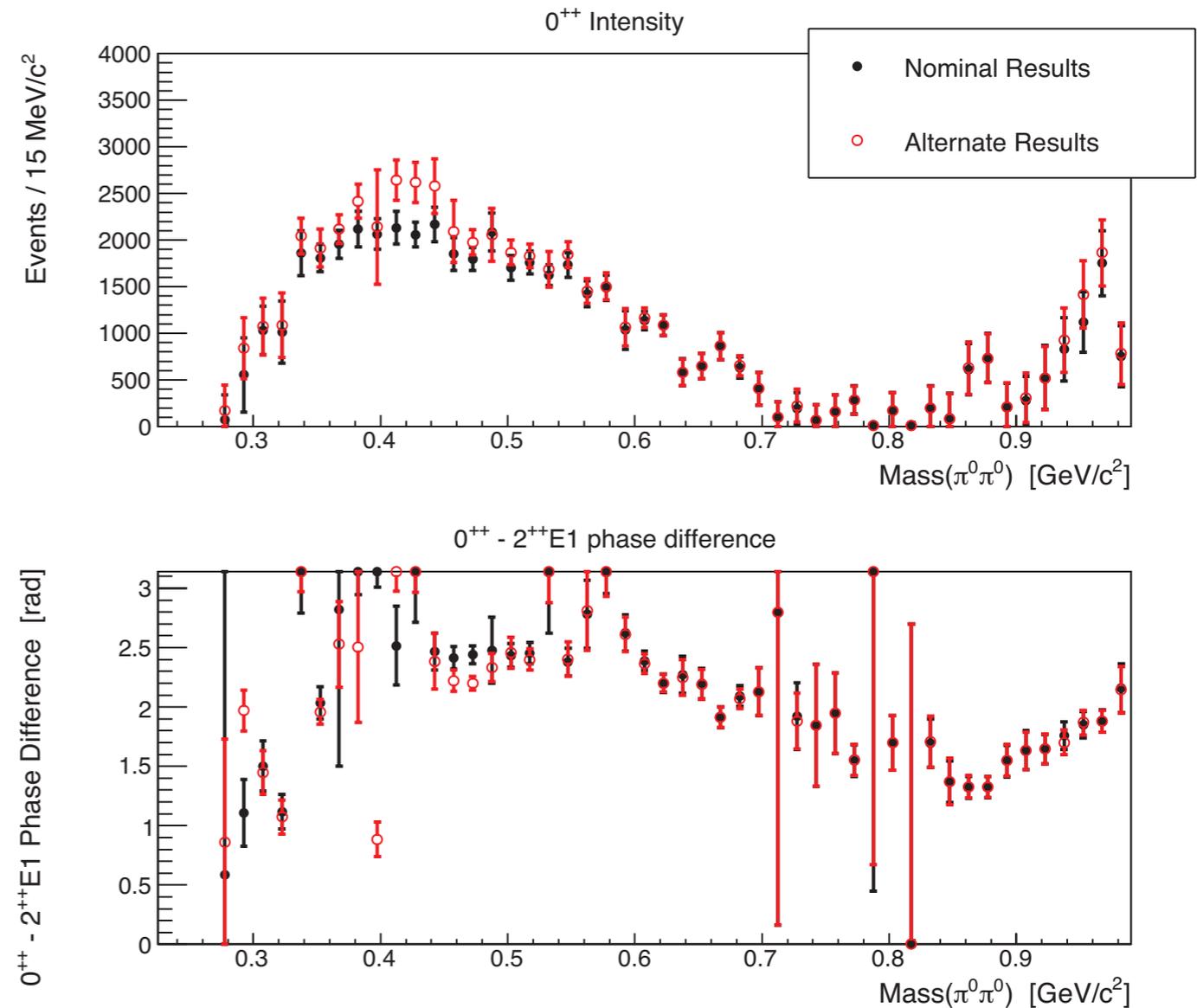
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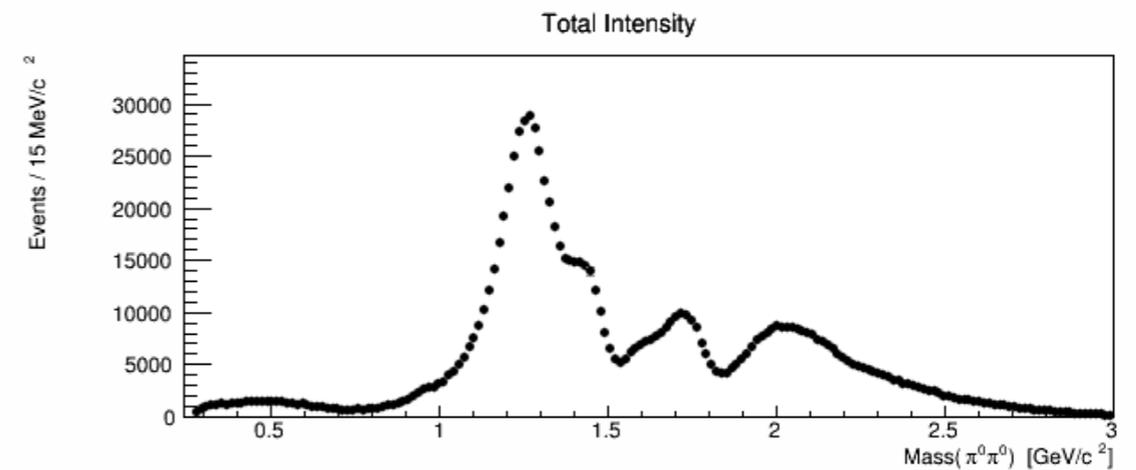
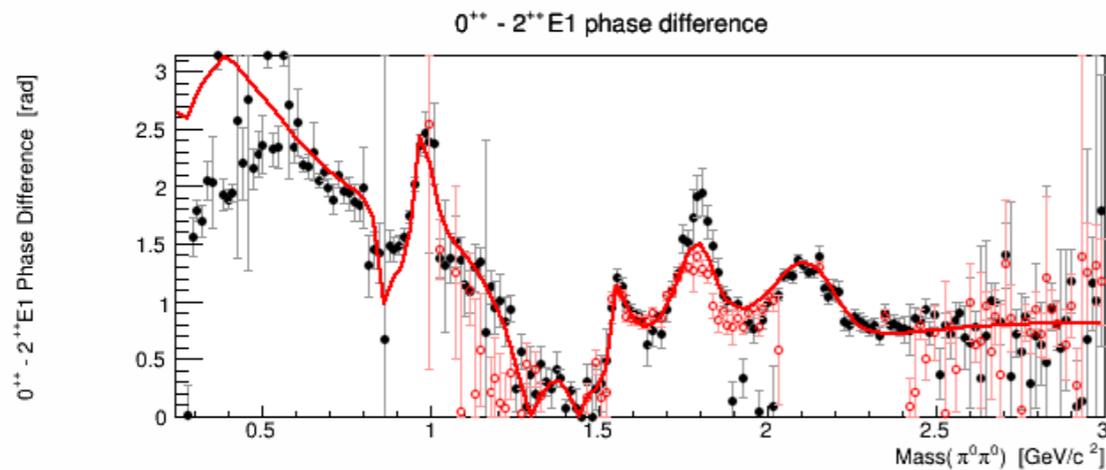
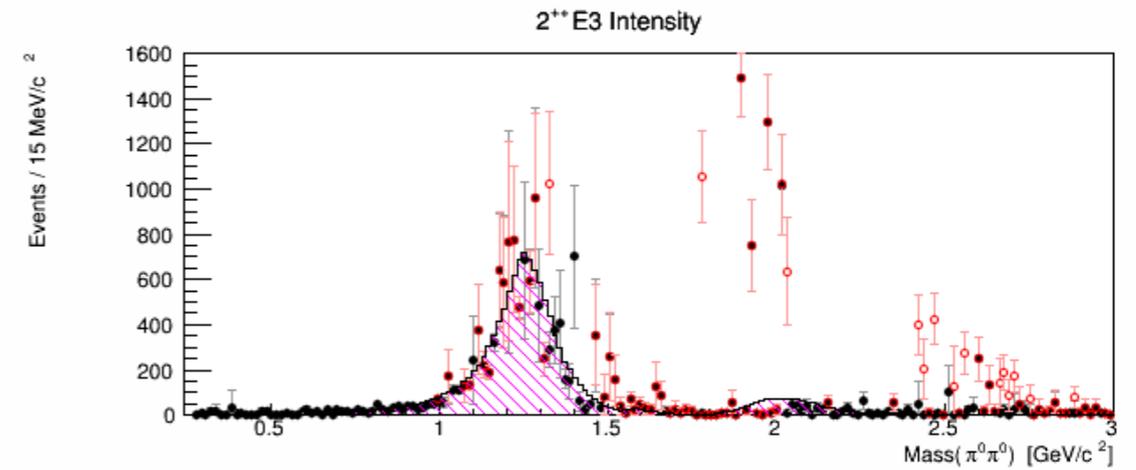
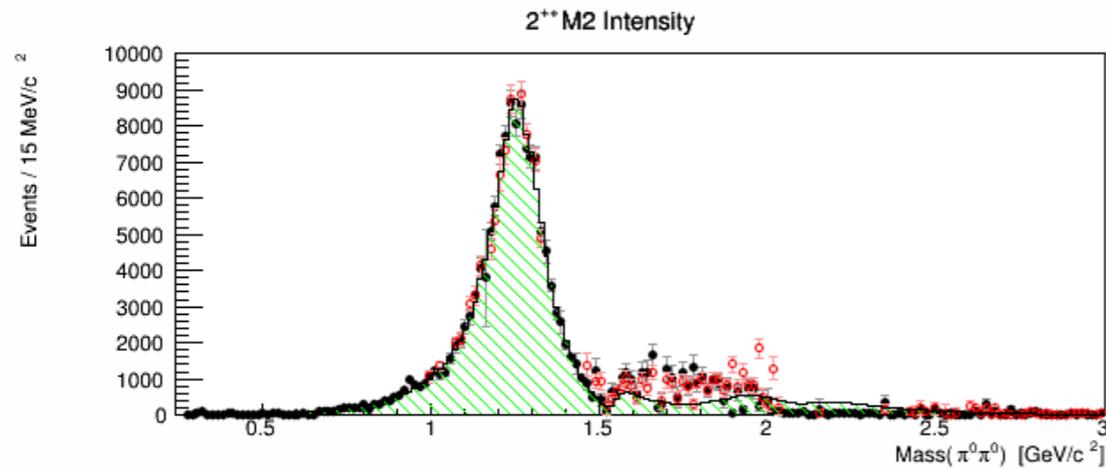
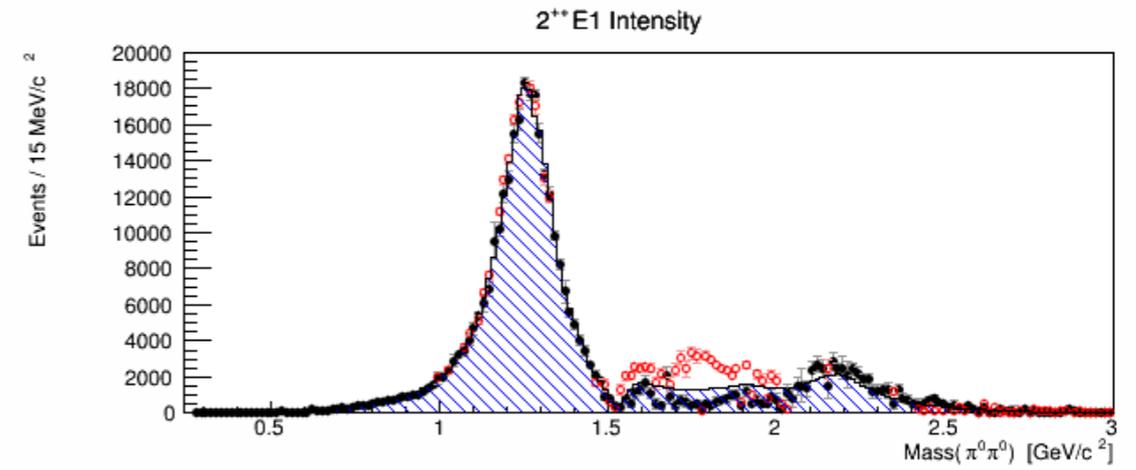
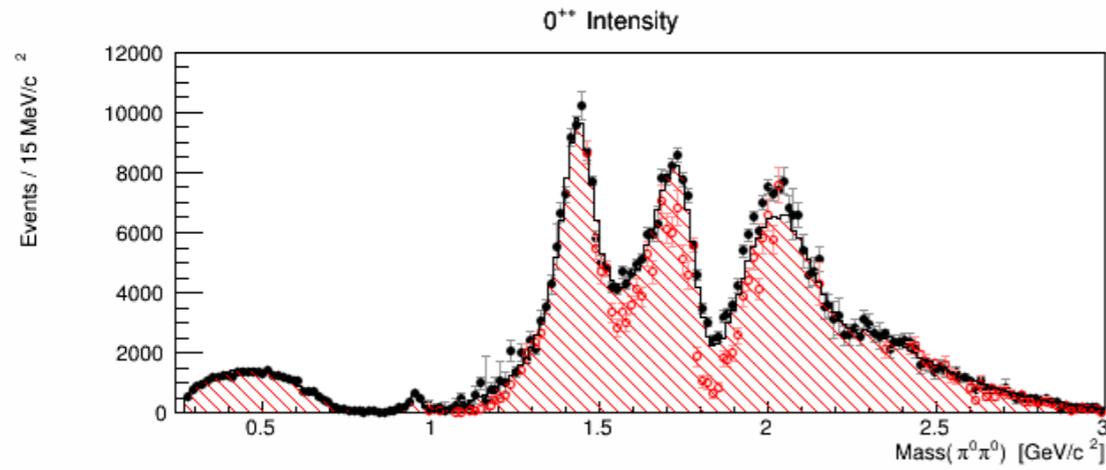


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- Desire to properly handle errors competes with desire to
 - make results easy to consume
 - get results in the public domain



Neglecting a real 4^{++} Component



NOT Data: Simulated analysis assuming perfect acceptance



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- How do we avoid over-interpreting relatively uncertain minor features?



Direct Theory/Experiment Collaboration



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 - In a collaboration with 50-100 concurrent analyses, how to allow access to part of the private information but not all of it?



Summary



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- Debate the right thing the right time
 - understand when statistical precision exceeds model precision
 - understand when assumptions are likely to affect ultimate conclusions
 - there is great cost in quantifying uncertainties

