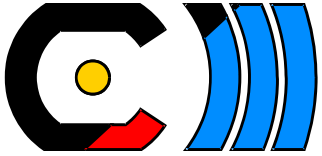


Towards a Measurement of the ω–π Transition Form Factor

Farha Anjum Khan

for the WASA-at-COSY Collaboration

06/01/12

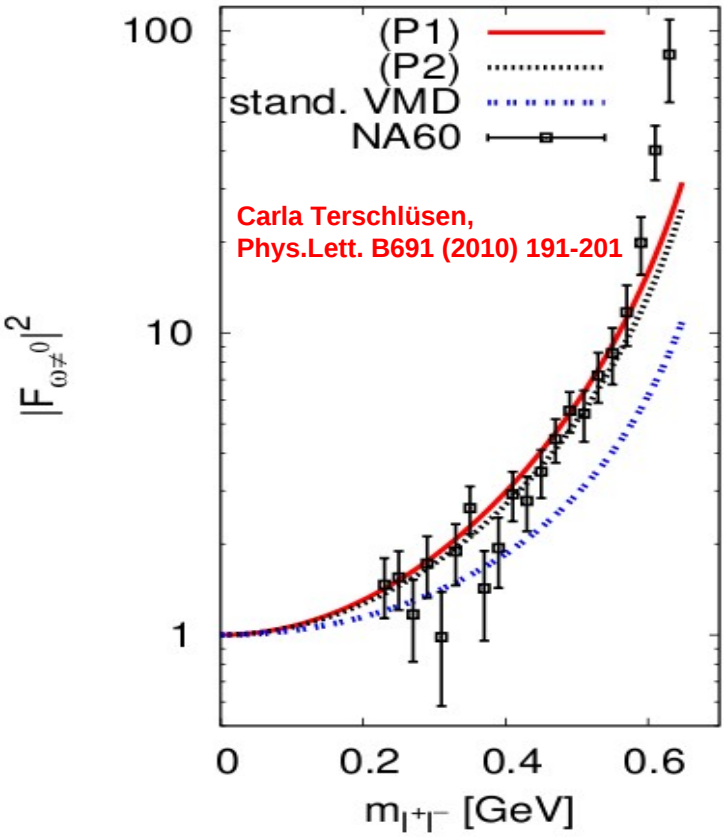
MESON 2012 – May/June 2012

Electromagnetic transition form factor of the ω meson via the *Dalitz decay* $\omega \to \pi^0 e^+ e^-$

$$d\Gamma/dq^2 = [d\Gamma/dq^2]_{QED} * |F(q^2)|^2$$

point like Form factor

Observable : invariant mass of dilepton.



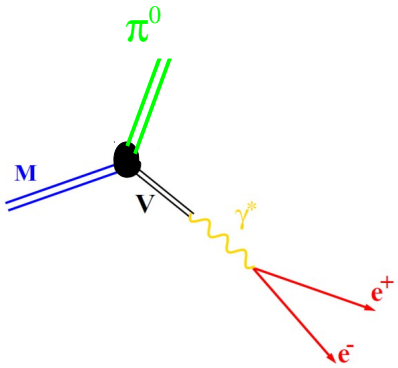
Form Factor $F(q^2)$:

$$F(q^2) = \frac{1}{(1 - q^2/m_V^2)}$$

Vector meson ρ:

$m_V = m_\rho = 0.77\,GeV$

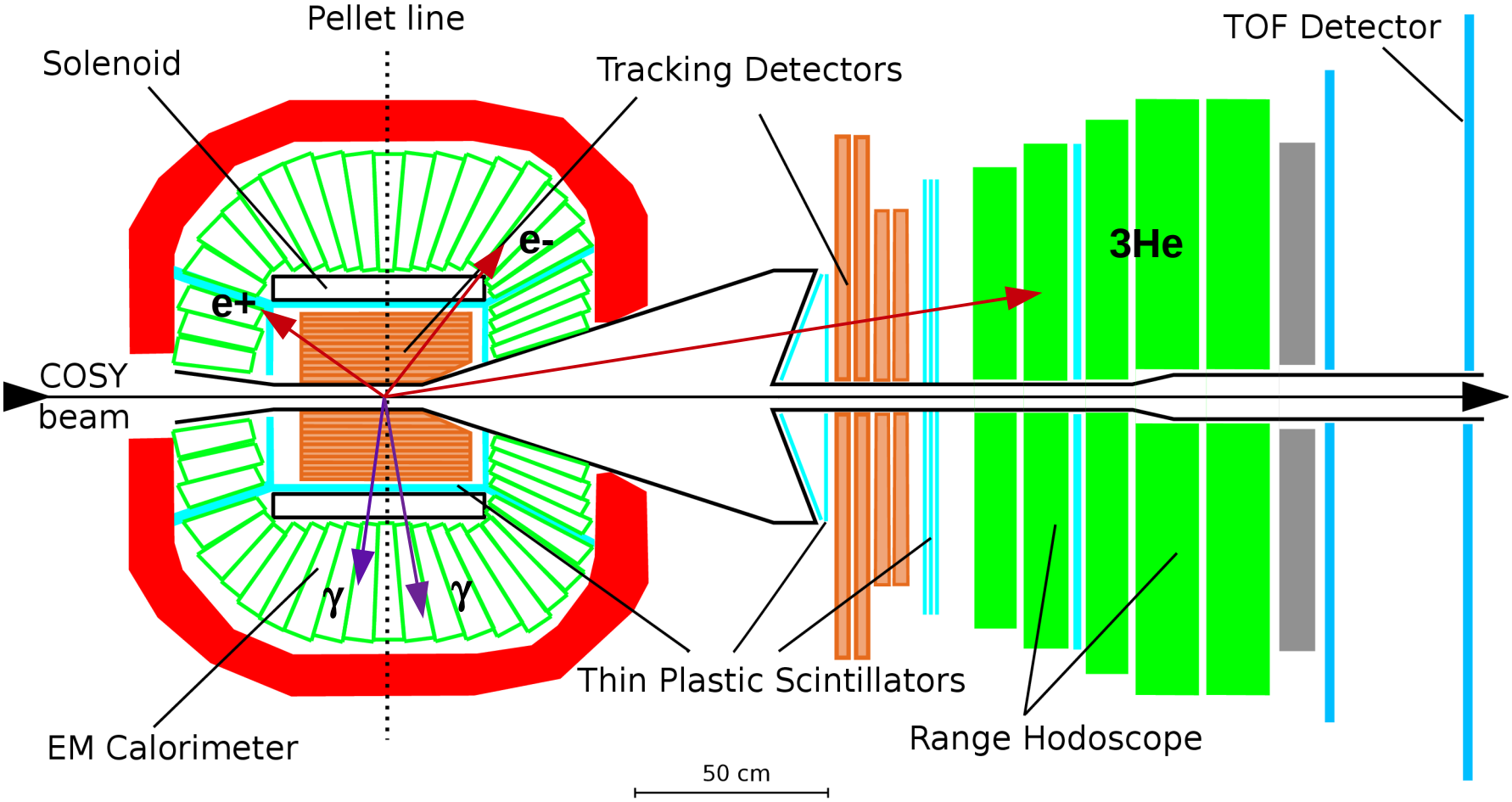
=> Resonance at $m_{\gamma^*} = q = m_\rho$



- *comparing with point-like QED prediction.*
- *ω does not agree with VMD predictions.*
- *$\pi^0 \to \gamma e^+e^-$ and $\eta \to \gamma l^+l^-$ agrees.*
- *Interpretation of g-2 experiments.*

- *different experimental method*
- *elementary reaction*
- *smaller virtual photon masses*
- *full reconstruction of the decaying meson.*

Wide Angle Shower Apparatus (WASA)

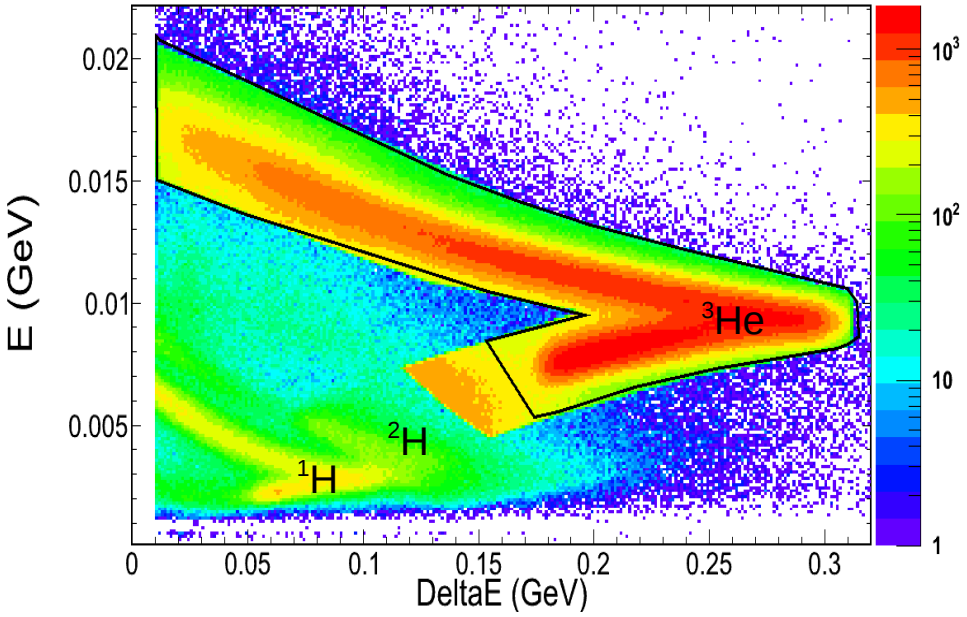


Experiment: p + d → ^{3}He + ω T = 1.45,1.5 GeV; time~12 days; σ=83nb

- find event candidates for $\omega \rightarrow \gamma^* \pi^0 \rightarrow e^+ e^- \pi^0$ BR: $(7.7 \pm 0.6) \times 10^{-4}$ (PDG)
- start with the real photon case $\omega \rightarrow \gamma \pi^0$ BR: $(8.28 \pm 0.28)\%$ (PDG)

ω meson tagging using missing mass of ^{3}He

Lena Heijkenskjöld : Meson2012, Poster:Hadronic decays of the ω meson, June 2nd



Fit: polynomial and Gaussian peak. (Smooth pion background)

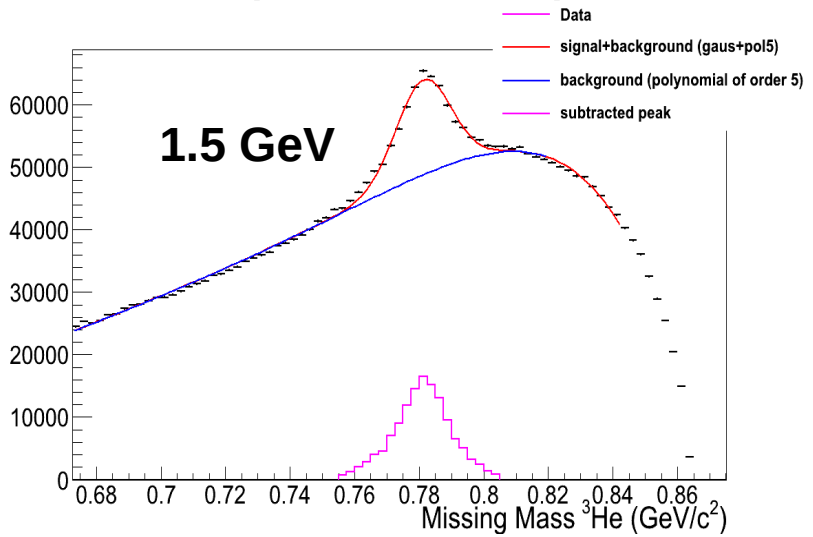
Beam Kinetic Energy	Number of events in peak
1.5	113k
1.45	92k

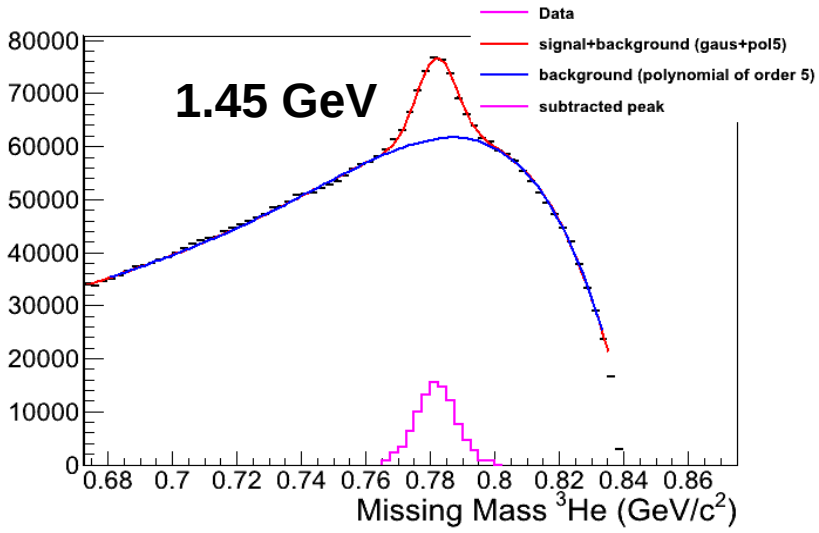
Total 2.5x10^5 ω produced in beamtime

Missing Mass after ^{3}He selection

p + d → ^{3}He +ω

$$M_X = \sqrt{(E_p + m_d - E_{3He})^2 - (\vec{p}_p - \vec{p}_{3He})^2}$$





Full reconstruction of $\pi^0\gamma$ final state: $p + d \rightarrow {}^3He + \omega[\pi^0\gamma]$

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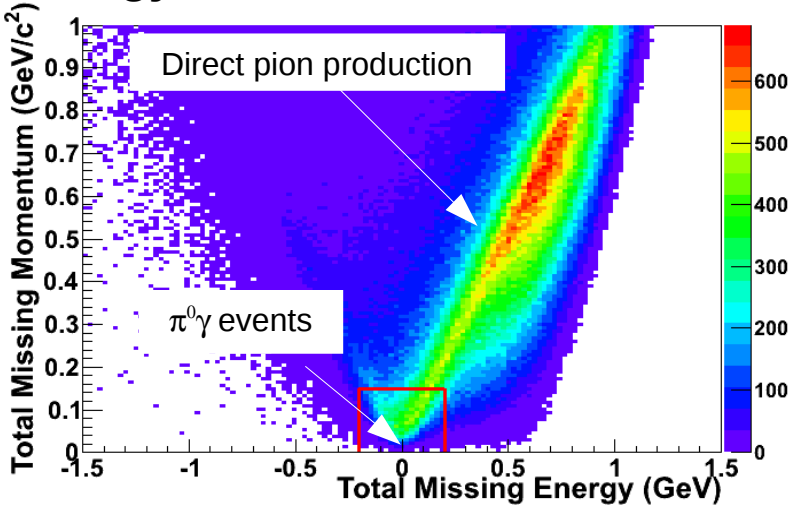
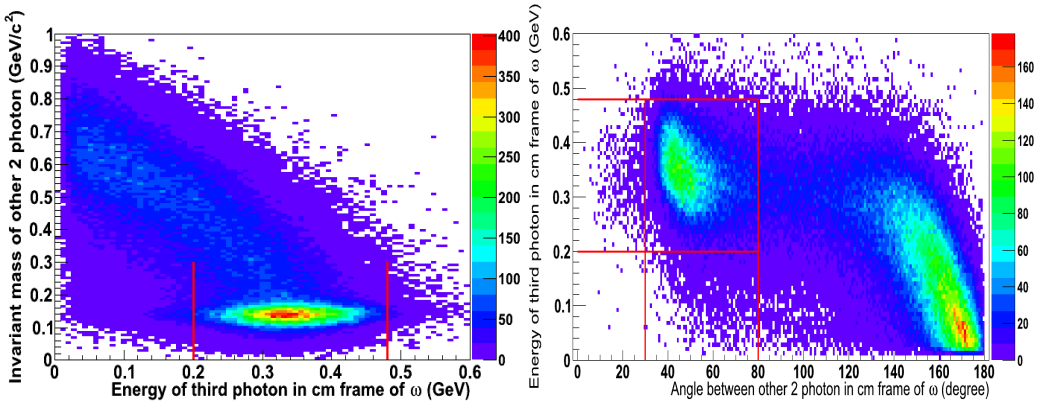
Central Detector: photon reconstruction for $\omega[\pi^0[\gamma\gamma]\gamma]$

Energy and Momentum conservation



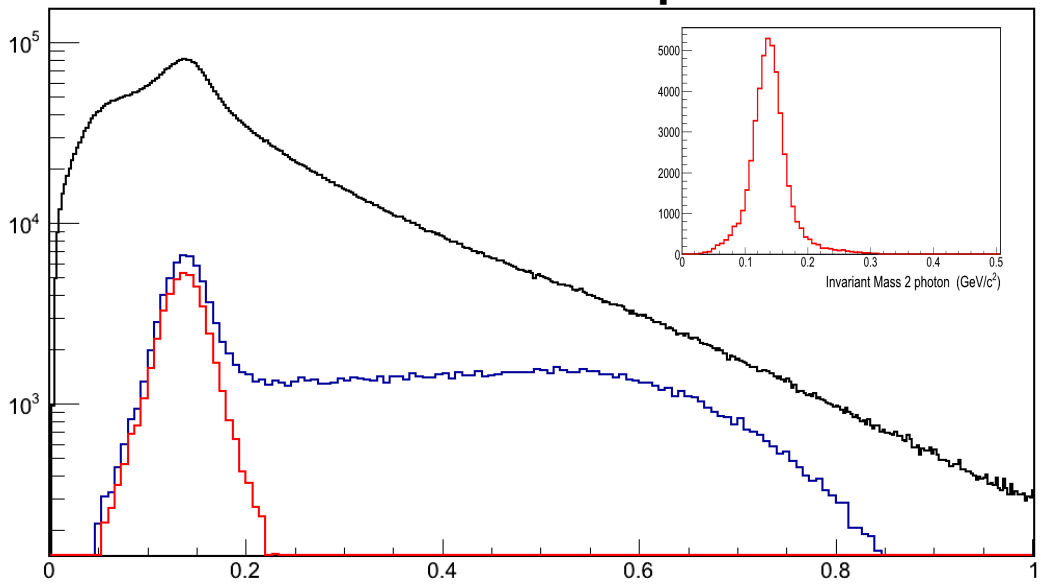
Condition I

$\pi^0\gamma$ selection



Condition II

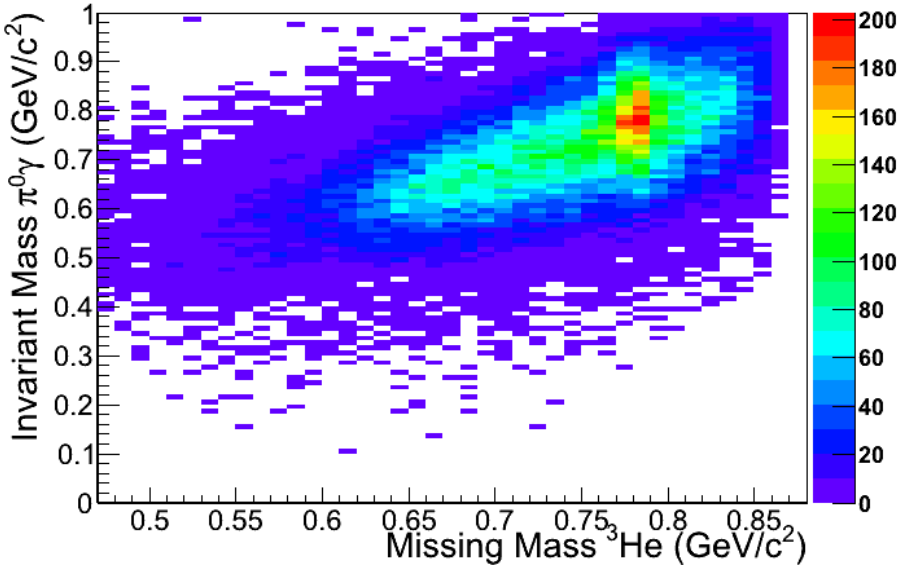
Invariant mass of 2 photons



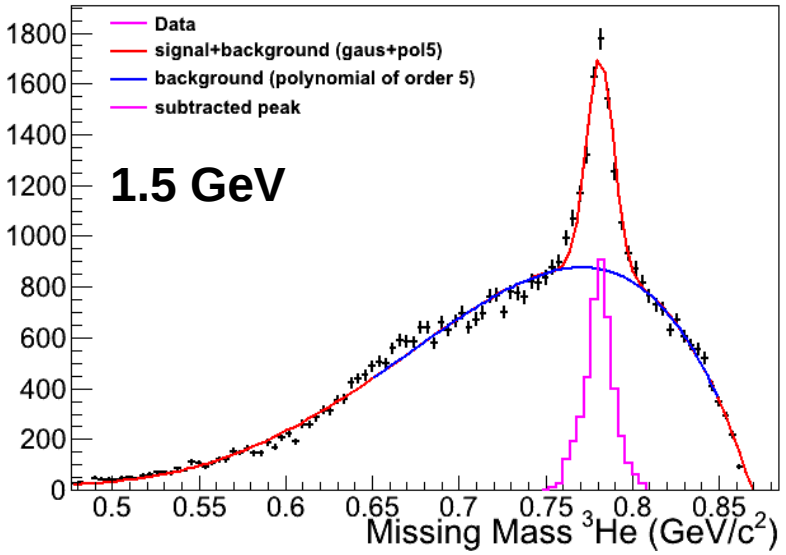
___IM any 2 photon combination
___IM any 2 photon combination after condition I
___IM photon constitute π^0 after condition II

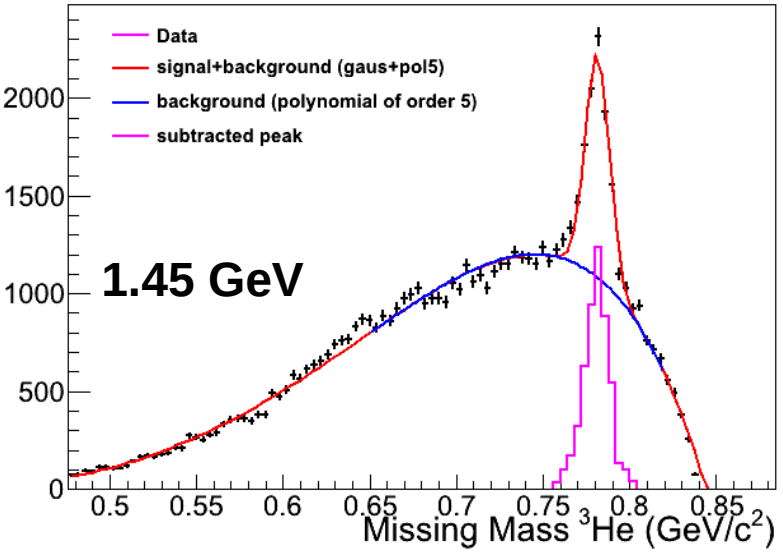
- **combinatorics reduced**

Missing mass ^{3}He vs Invariant mass of $\pi^0\gamma$



Missing Mass after ^{3}He and $\pi^0\gamma$ selection





- Number of $\pi^0\gamma$ events expected in peak ~7.1k
- Number of $\pi^0\gamma$ events in peak ~ 8.7k
- Other decays of ω in peak?

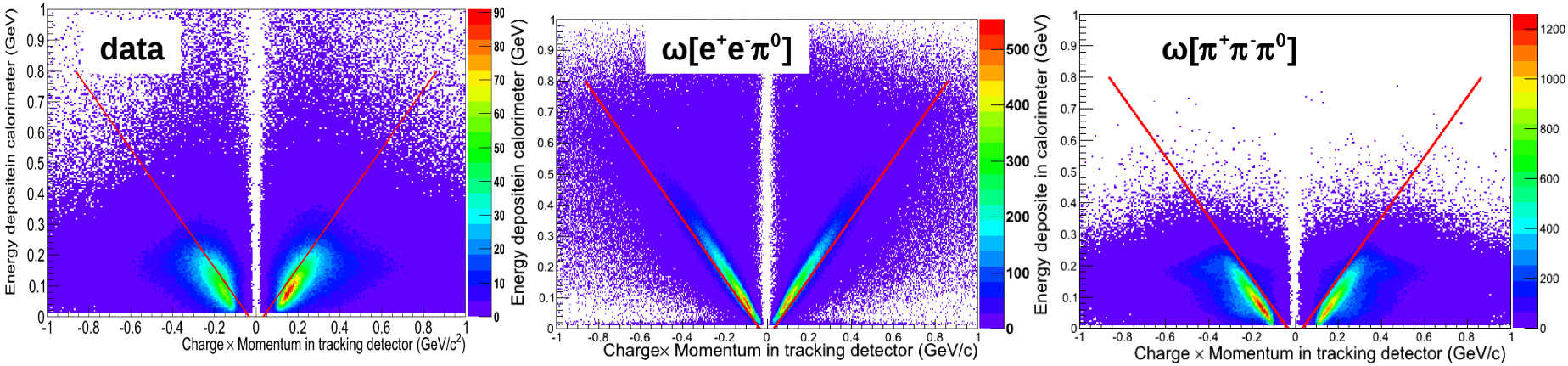
- Further development of analysis-
  cross check branching ratio

Full reconstruction of $e^+e^-\pi^0$ final state

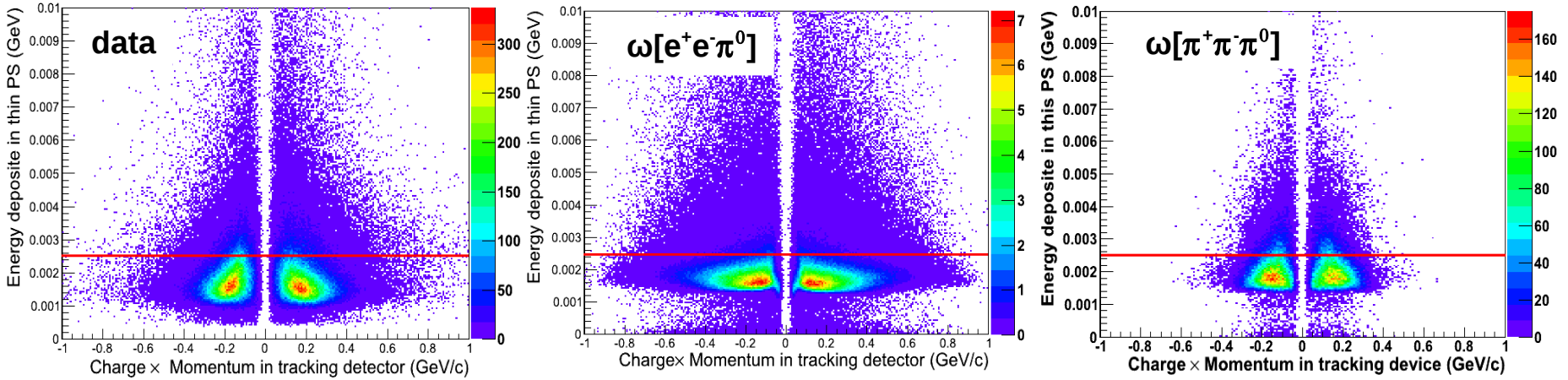
$$p + d \rightarrow {}^3He + \omega[e^+e^-\pi^0]$$

- **e^+e^- selection:** Particle Identification for charged tracks in tracking device(MDC)
  "*signed momentum*"

•Energy deposited in Calorimeter vs signed momentum in tracking device



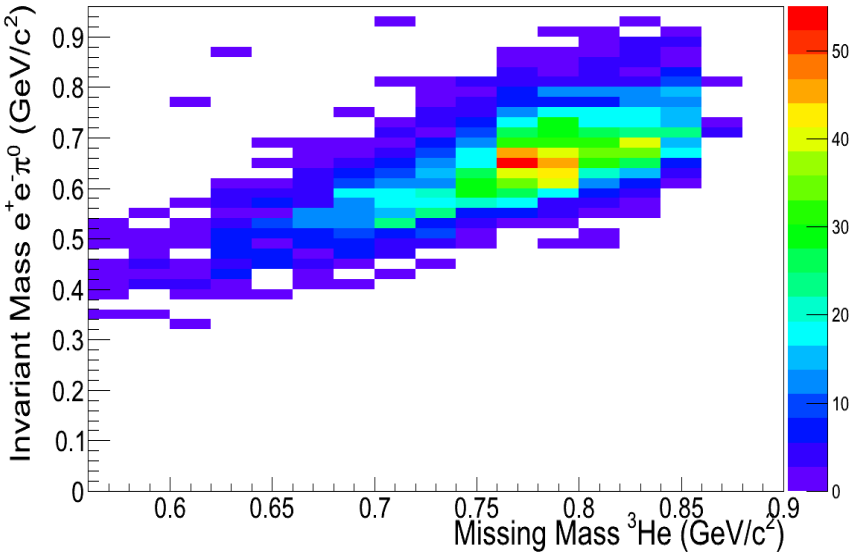
• Energy deposited in thin plastic scintillator vs signed momentum in tracking device



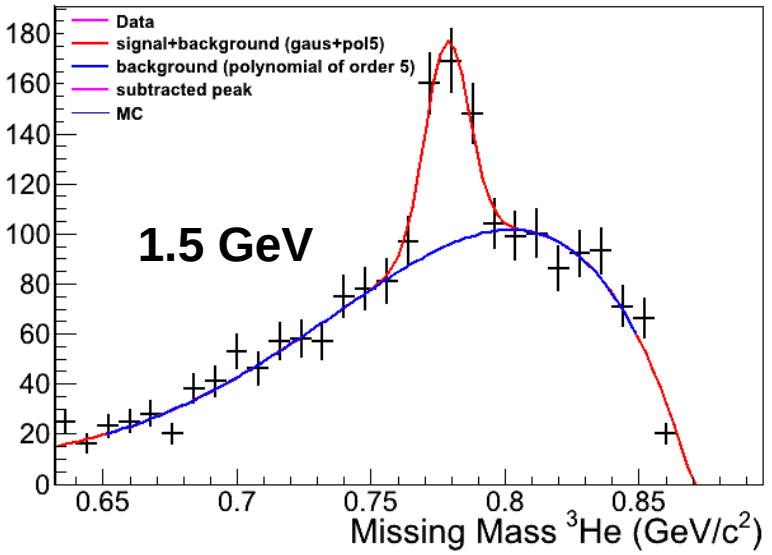
This PS: Thin Plastic Scintillator

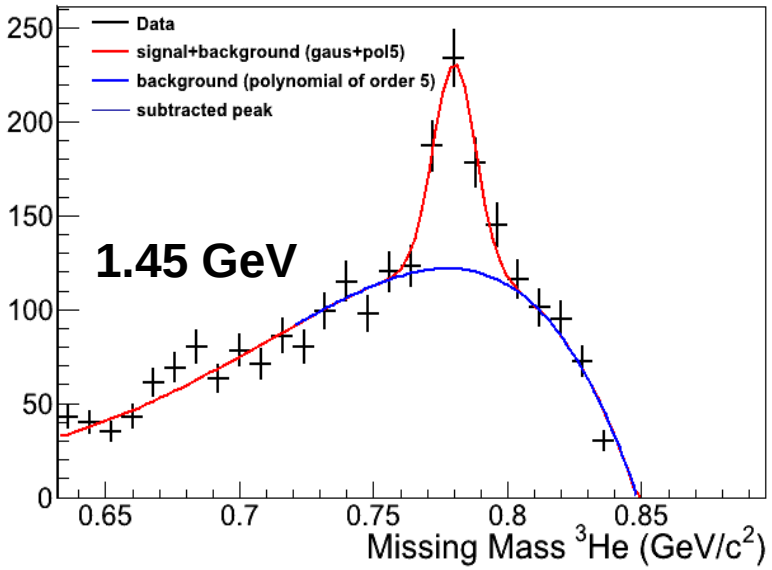
- **Dominance of $\pi^+\pi^-\pi^0$**

Missing Mass of ^{3}He vs invariant mass of $e^+e^-\pi^0$



Missing Mass of ^{3}He after $e^+e^-\pi^0$ selection





- pion background and ω signal
- Need to further suppress the background contributions from other ω decays

Outlook:

- Fine tuning Calibration.
- Match MC with data
- Further suppress background in ω peak
- cross check branching ratio for $\pi^0\gamma$
  -data quality and analysis procedure
- $\omega \rightarrow e^+e^-\pi^0$ Branching Ratio
  (Form Factor has influence on branching ratio)
- Complementary analysis: pilot beam time p+p
- Compare two analyses
  - 2 experimental approaches
  - 2 different analysis

=> strategy for planned high-statistics run and analysis

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Backup

Electromagnetic transition form factors of light vector mesons

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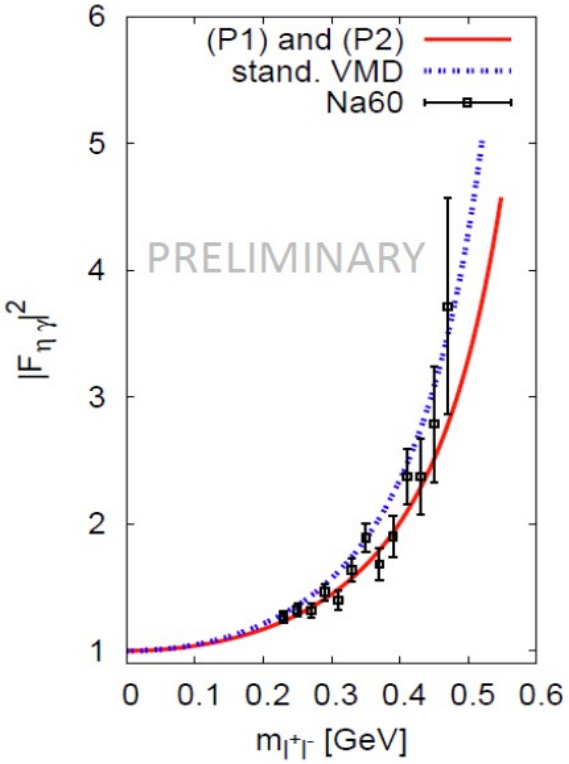
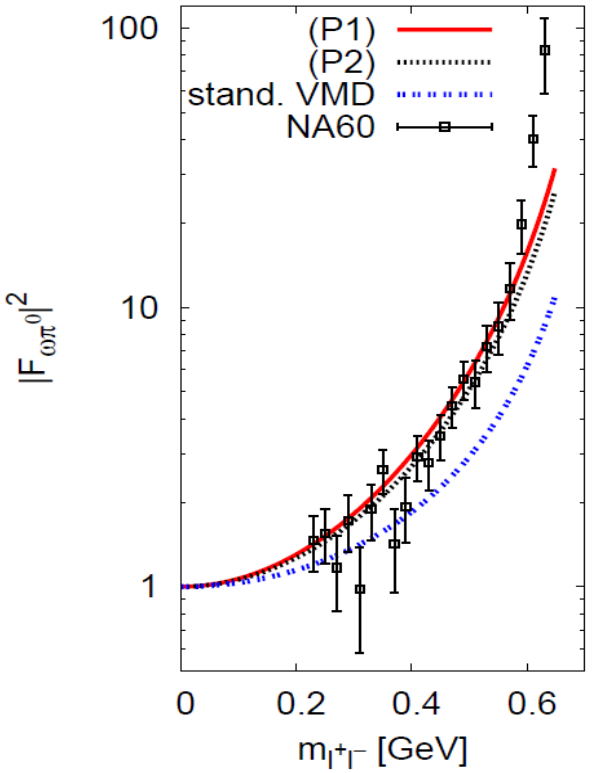
Stefan Leupold
Institutionen för fysik och astronomi, Uppsala Universitet, Sweden

Phys.Lett. B691 (2010) 191-201

M. F. M. Lutz and S. Leupold, Nucl. Phys. A813, 96 (2008),
S. Leupold and M. F. M. Lutz, Eur. Phys. J. A39, 205 (2009),

chiral Lagrangian including light vector mesons and Goldstone bosons (in leading order)





P1 and P2 are parameter sets.

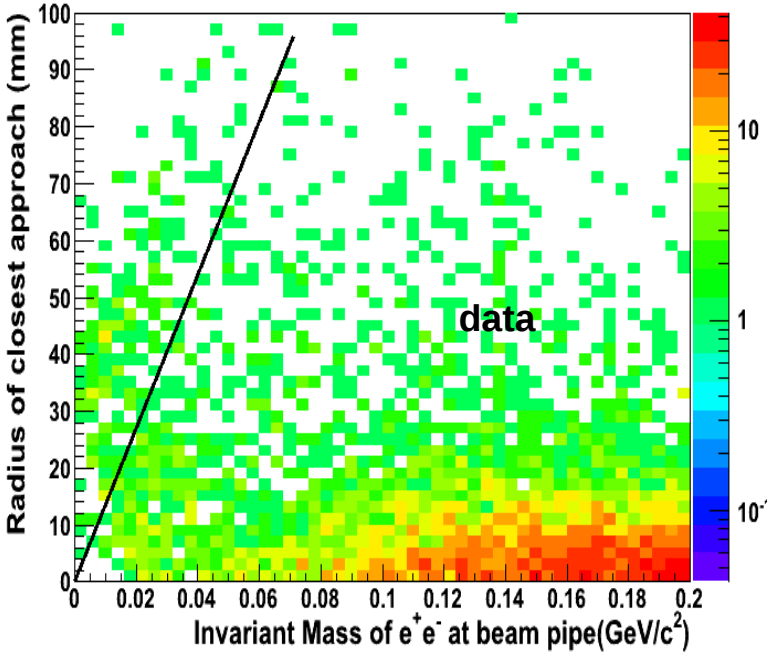
indicate influence of next-to-leading terms - error estimate

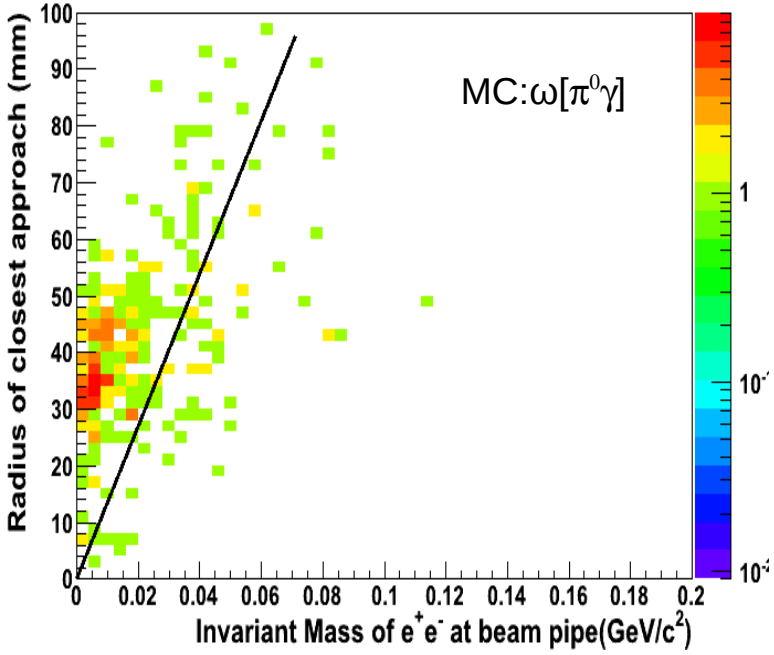
roughly:
without (P1) and with (P2) non-VMD
(contact) term

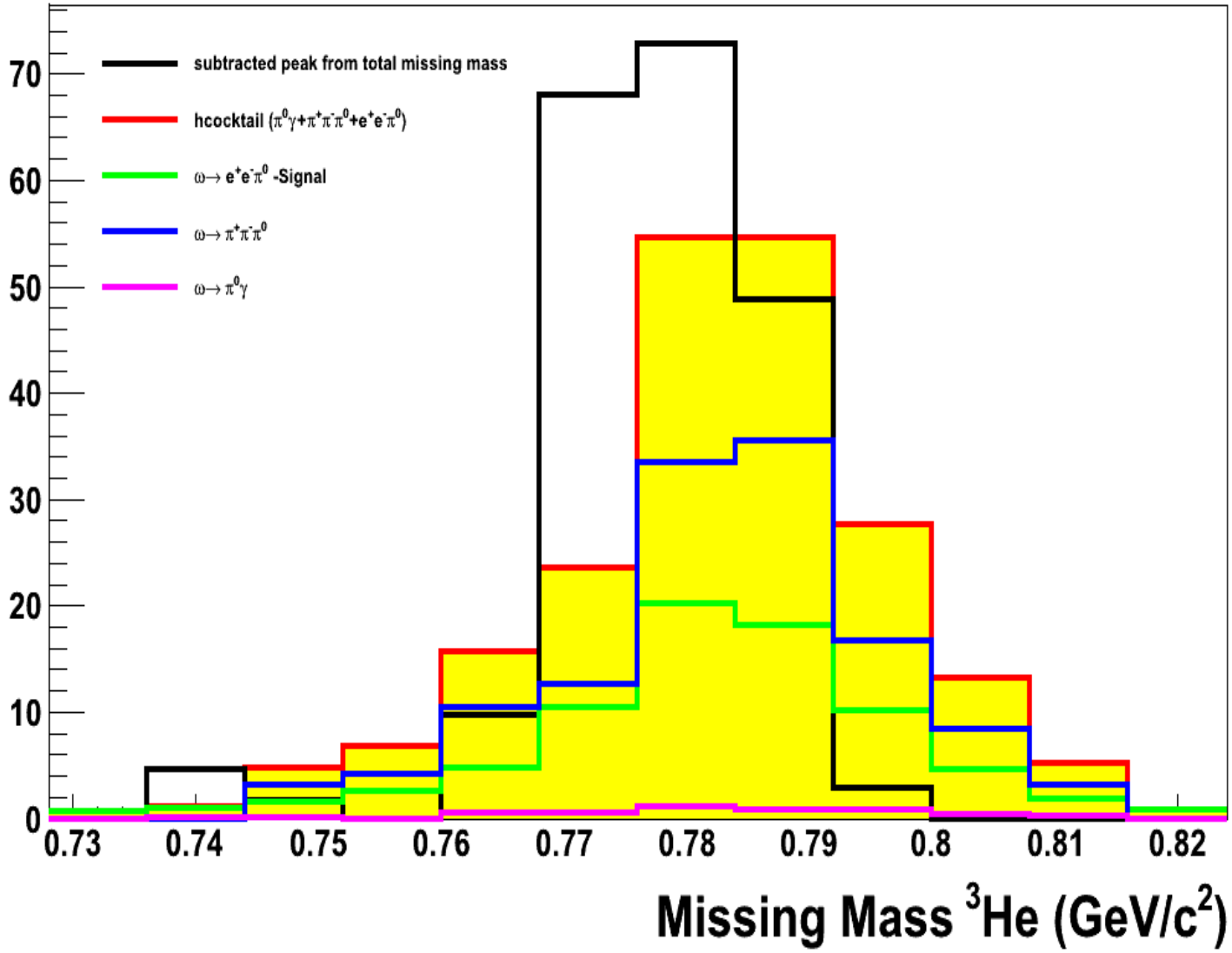
→ good agreement
... but at higher masses

needed for next-to-leading-order calculations:
'further experimental results for all available channels ... extremely helpful'

- **External conversion**






subtracted peak from total missing mass
hcocktail ($\pi^0\gamma+\pi^+\pi^-\pi^0+e^+e^-\pi^0$)
$\omega\rightarrow e^+e^-\pi^0$ -Signal
$\omega\rightarrow \pi^+\pi^-\pi^0$
$\omega\rightarrow \pi^0\gamma$
0
10
20
30
40
50
60
70
0.73
0.74
0.75
0.76
0.77
0.78
0.79
0.8
0.81
0.82
Missing Mass ^{3}He (GeV/c^2)