Search for in-medium modifications of the ω meson with the CB/TAPS detector system in Mainz

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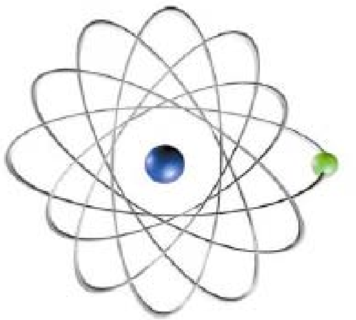
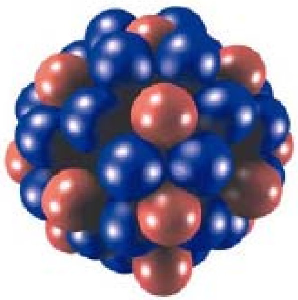
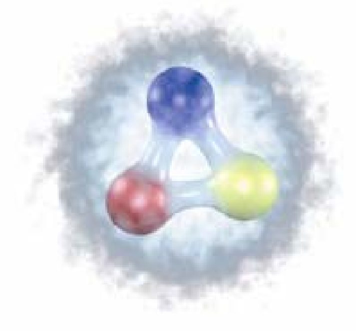
outline:

- motivation and theoretical prediction
- detector setup
- first online data
- conclusion and outlook

A2 Collaboration

TAPS

mass of composite systems

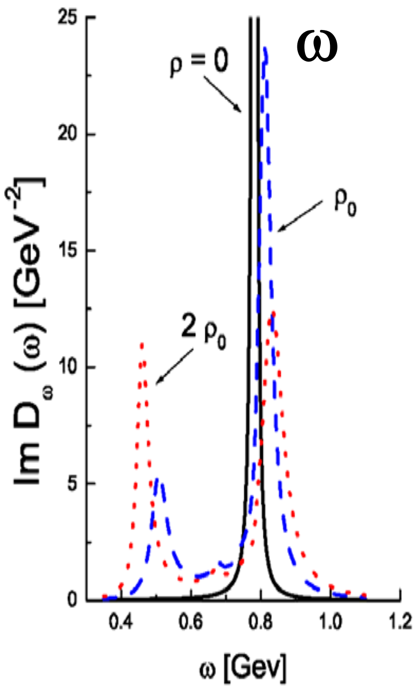
atom	nucleus	hadron
		
$M_{atom} \approx \Sigma m_i$	$M_{nuclues} \approx \Sigma m_i$	$M_{hadron} >> \Sigma m_i$

M_N (≈1GeV) >> Σm_i (≈10MeV)

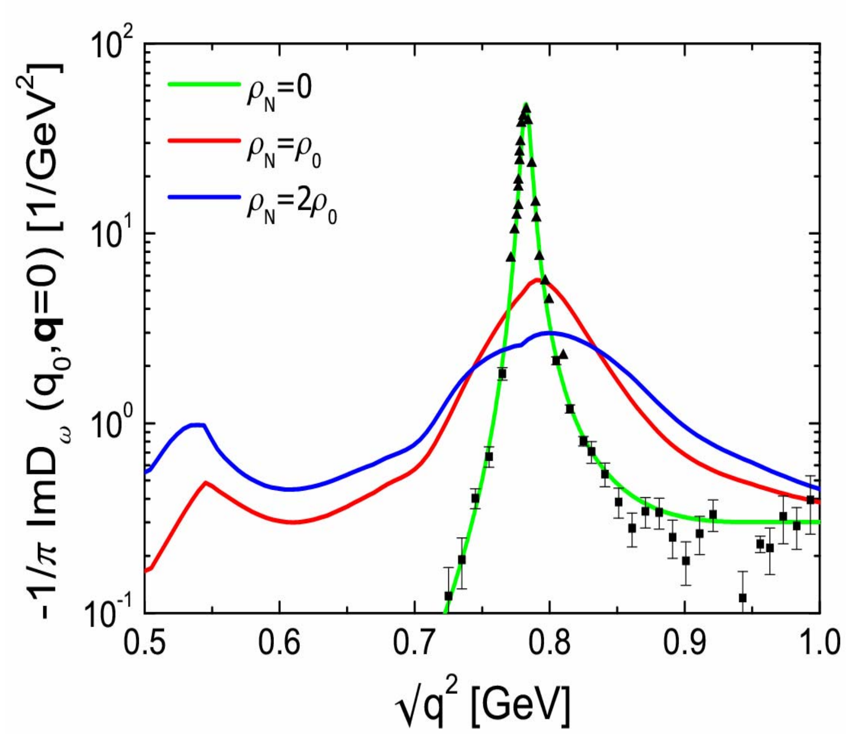
- ❖ $m = E/c^2$, „mass without mass“ (Wilczek)
- ❖ mass given by energy stored in motion of quarks and by energy in colour gluon fields

model prediction for spectral function

M. Lutz et al., Nucl. Phys. A 706 (2002) 431



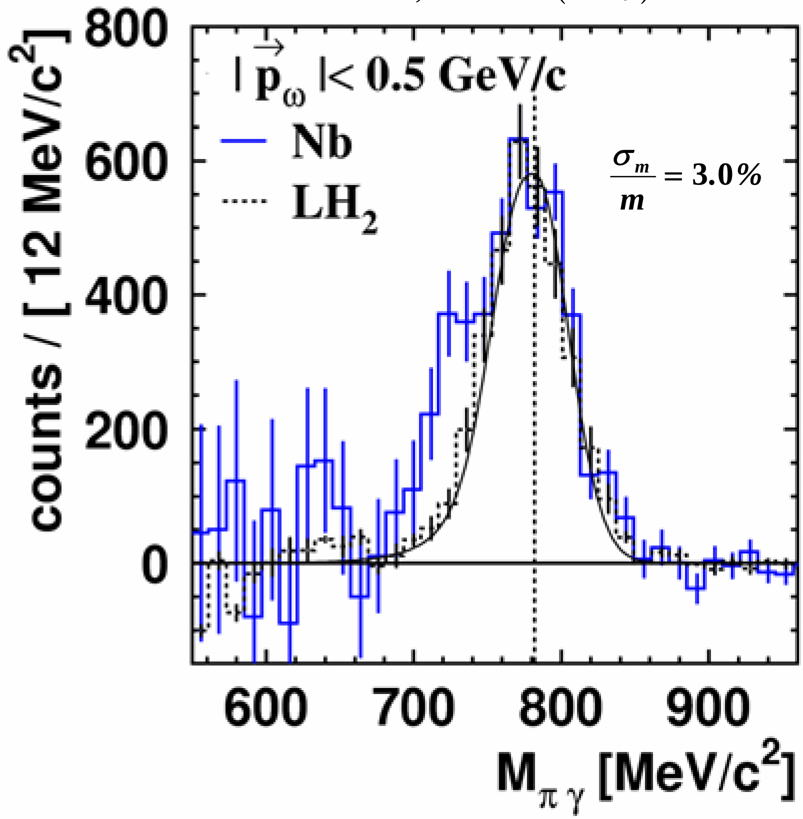
P. Mühlich et al., NPA 780 (2006) 187

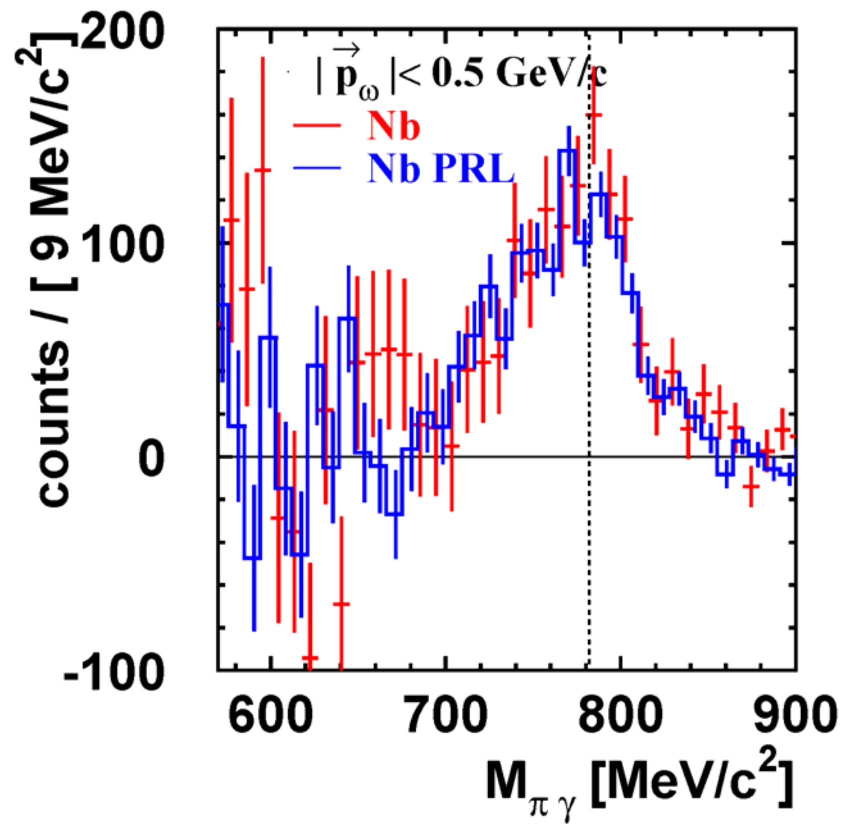


structure due to coupling to S_{11} and D_{13} resonances

comparison of former analyses, CB/TAPS@ELSA data

D. Trnka et al., PRL 94 (2005) 192303





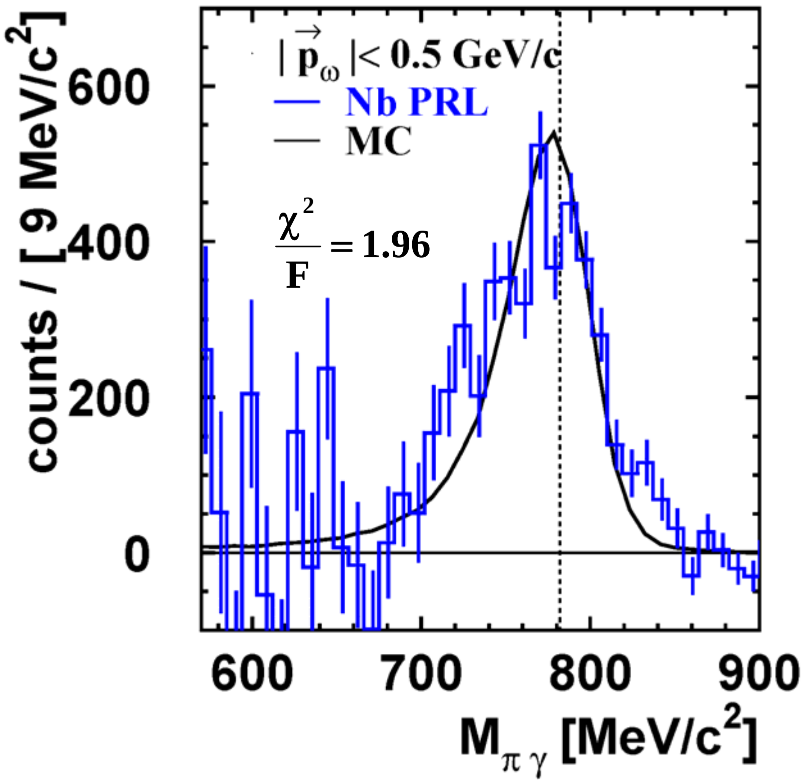
consistent with
drop off in-medium ω mass
by 14% at $\rho=\rho_0$

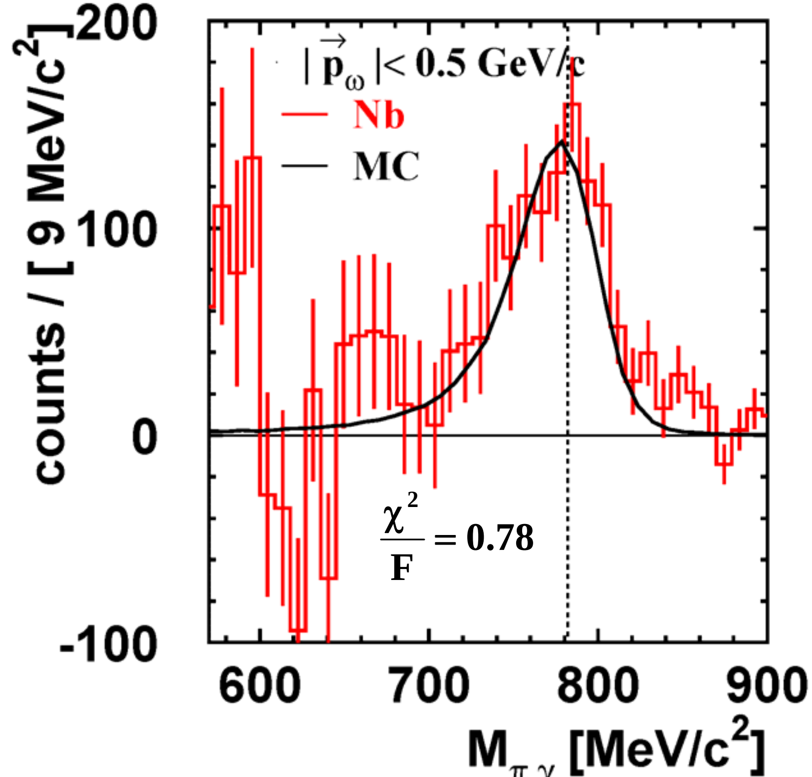
comparison of ω signals
after background subtraction
➡ signal not inconsistent
with D. Trnka analysis

comparison of former analyses, CB/TAPS@ELSA data

fit the data with MC histogramm – the amplitude is a free parameter

D. Trnka et al., PRL 94 (2005) 192303



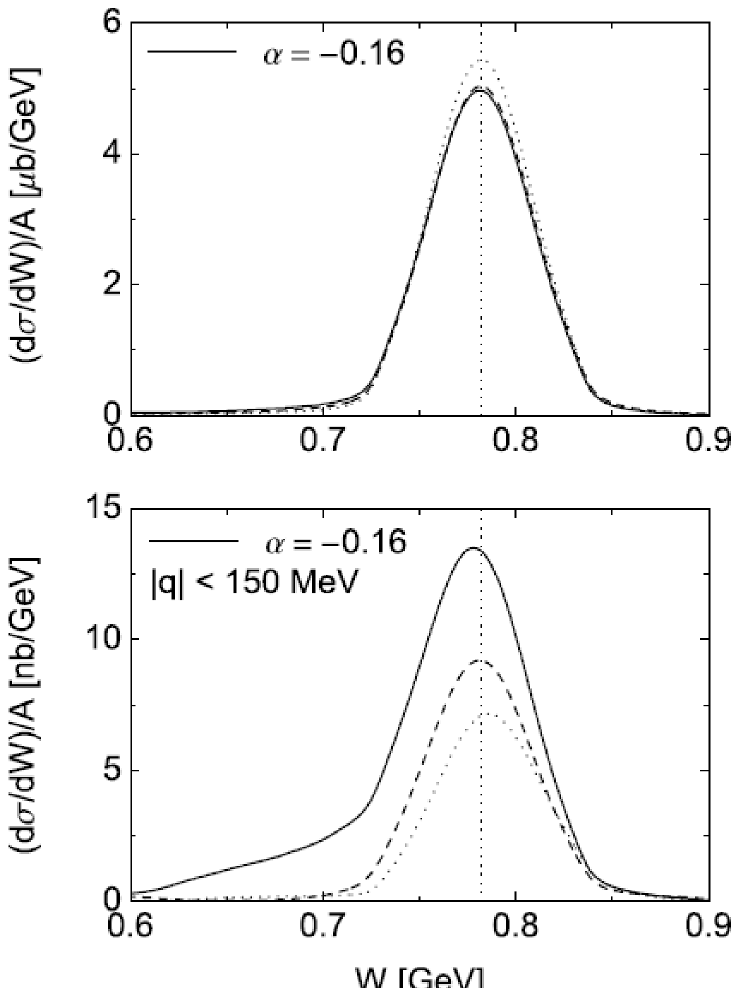


ω signal in re-analysis consistent with Monte-Carlo simulation assuming no mass shift

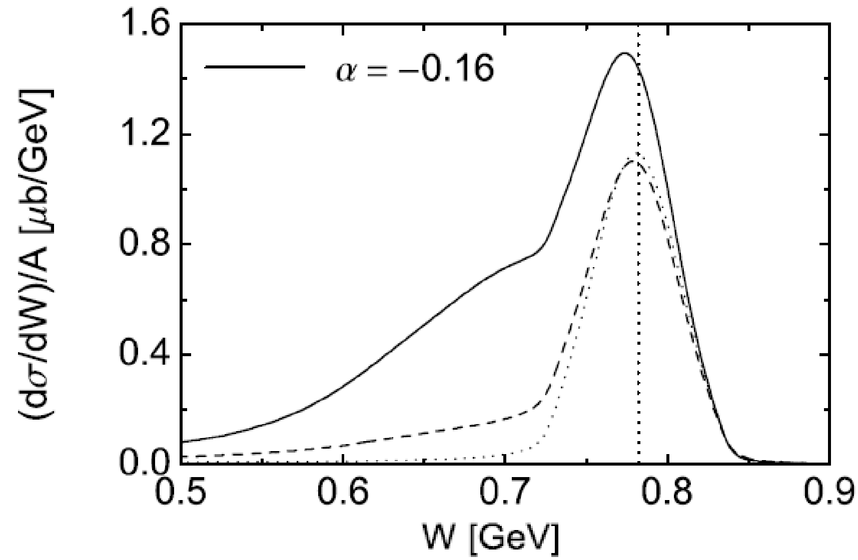
search for ω in-medium effects near threshold

theoretical prediction (Gi-BUU simulations)

E_γ = 1500 – 2200 MeV



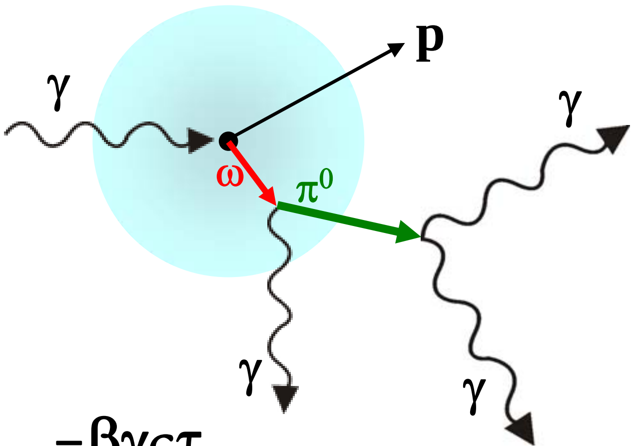
E_γ = 900 – 1200 MeV



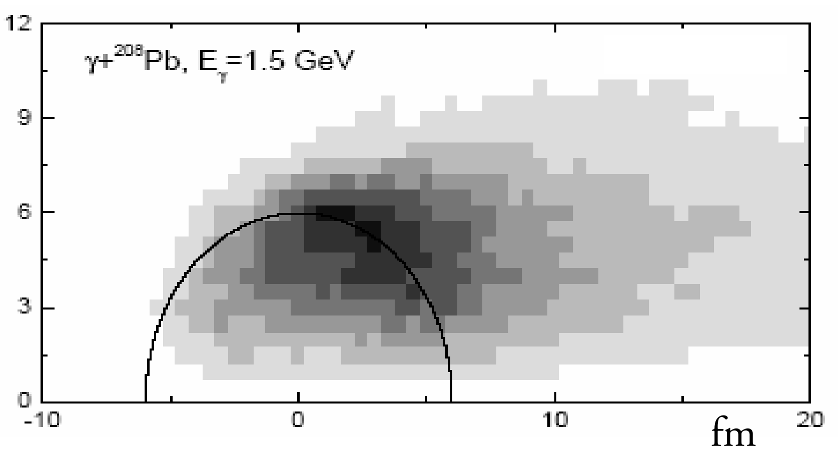
❖ lower photon energies: possible mass shift observable near threshold even without cut on ω momentum

❖ higher photon energies: effect only observable for extremely hard cut on ω momentum

search for ω in-medium effects near threshold



$l_{decay} = \beta\gamma c\tau$



channel of interest:

$\gamma A \rightarrow \omega + X$

$\quad\quad \llcorner\rightarrow \pi^0\gamma$

$\quad\quad\quad\quad \llcorner\rightarrow \gamma\gamma$

- ❖ disadvantage: distortion due to π^0 FSI
- ❖ advantage: clean ω probe

BR $\omega \rightarrow \pi^0\gamma \rightarrow \gamma\gamma\gamma$: $8.7 \cdot 10^{-2}$

BR $\rho \rightarrow \pi^0\gamma \rightarrow \gamma\gamma\gamma$: $7.9 \cdot 10^{-4}$

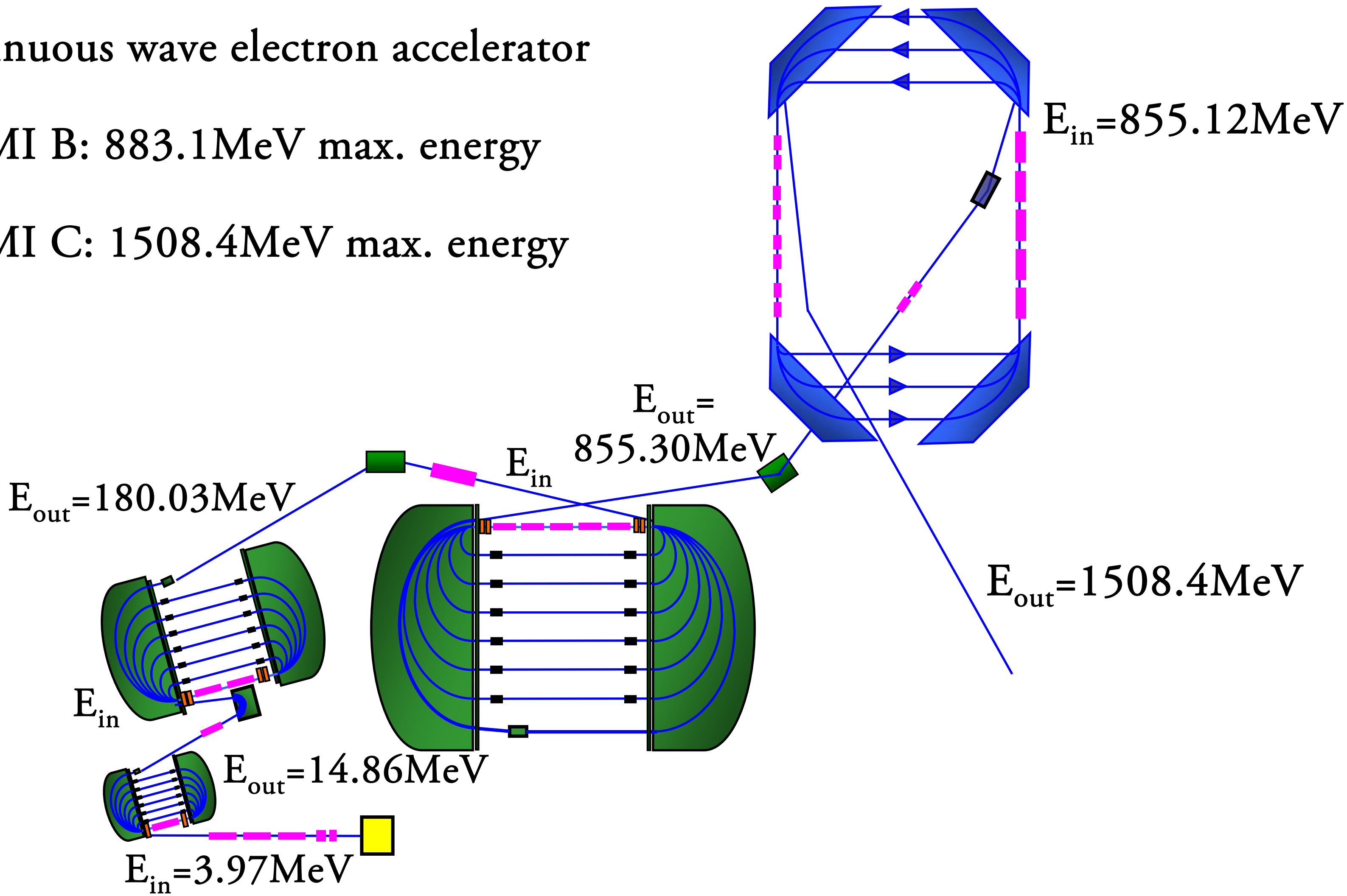
run conditions:

❖ beam energy	: 1508 MeV
❖ collimator	: 4 mm (W)
❖ radiator	: 10 μm copper
❖ targets	: Nb (1mm)
	: C (15mm)

➡ **155000 ω for Nb-beamtimes, 110000 ω for C-beamtime**

Mainz Microtron (MAMI)

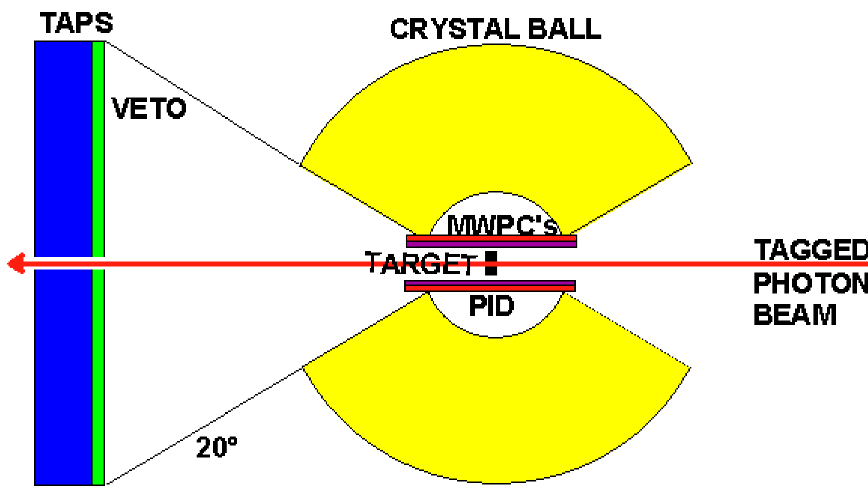
- continuous wave electron accelerator
- MAMI B: 883.1MeV max. energy
- MAMI C: 1508.4MeV max. energy

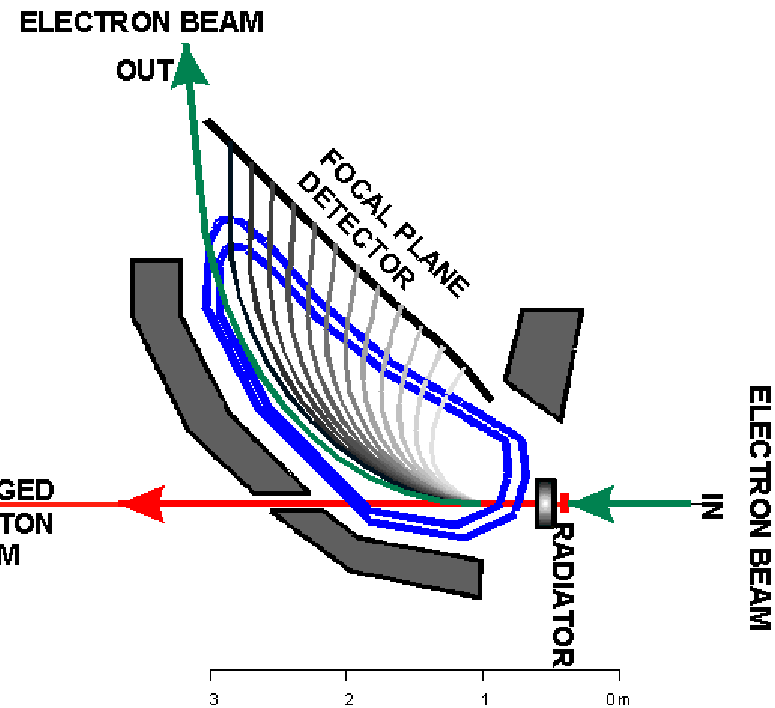


detector setup

- ❖ TAPS ϑ coverage: 1° - 20°
- ❖ CB ϑ coverage: 20° - 160°

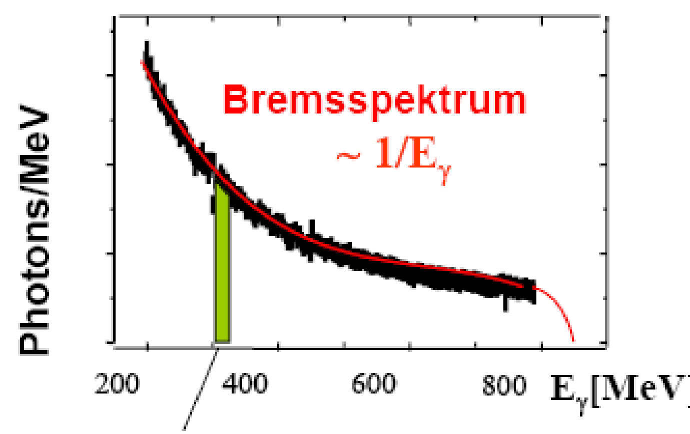
➡ 4π setup





energy determination of bremsstrahlung photons in the range 73MeV – 1402MeV

$$E_\gamma = E_{beam} - E_{e-}$$



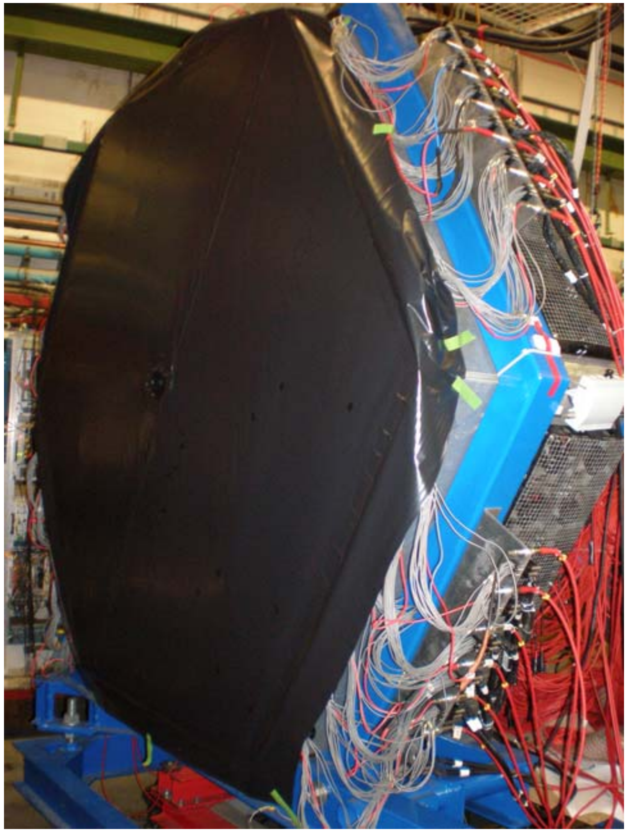
detector setup

Crystal Ball

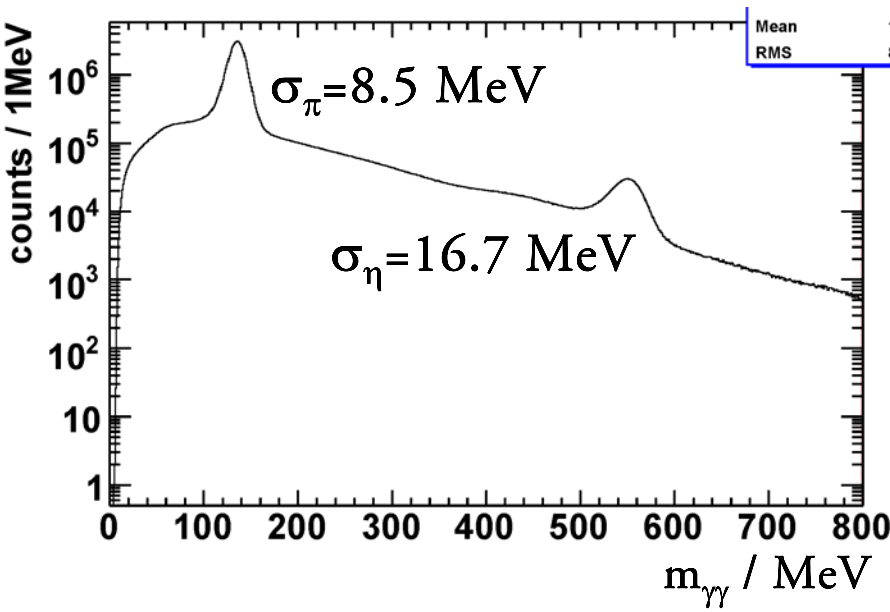
❖ 672 NaI(TI) crystals

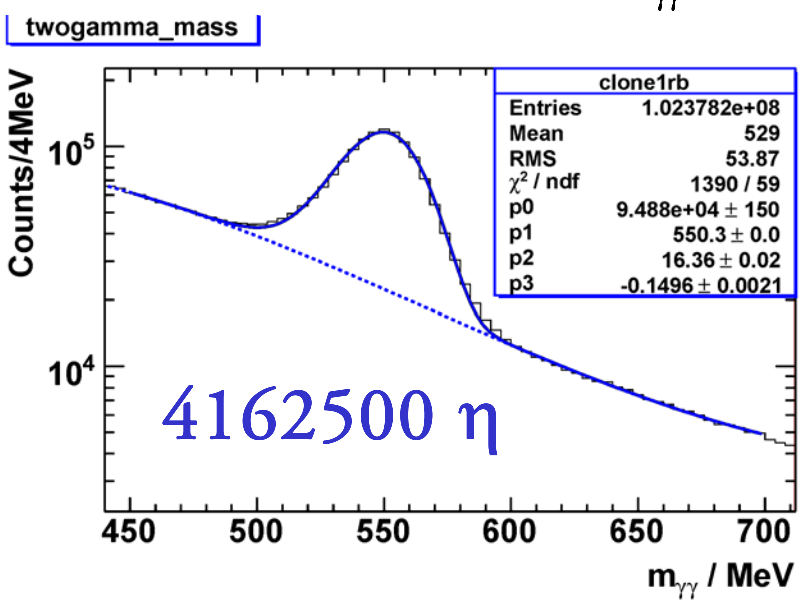
TAPS

❖ 378 BaF_2 cystals
❖ 24 $PbWO_4$ crystals in the inner ring
❖ 384 Veto plastic scintillators

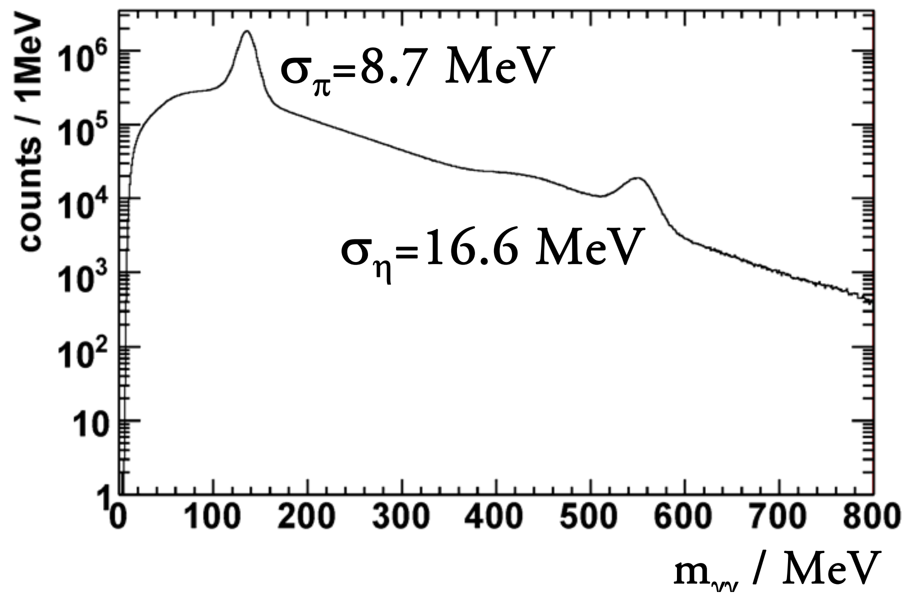


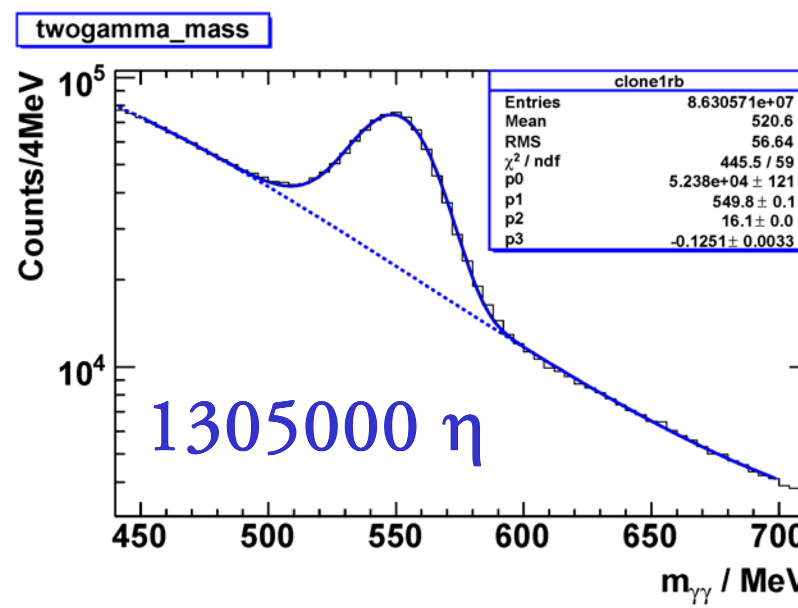
june beamtime, C target



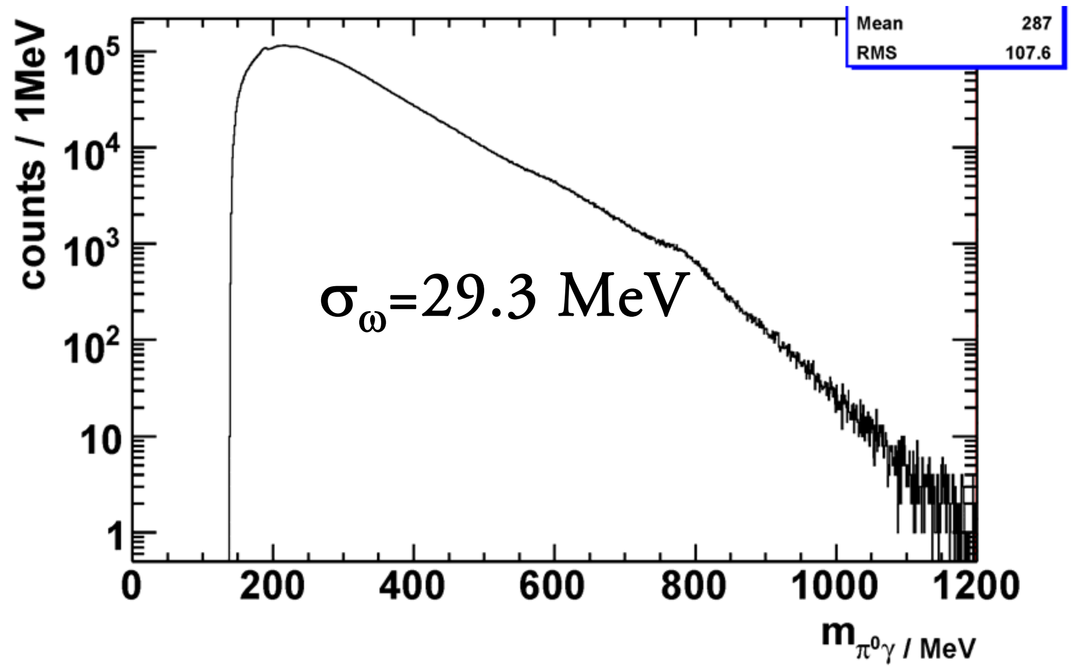


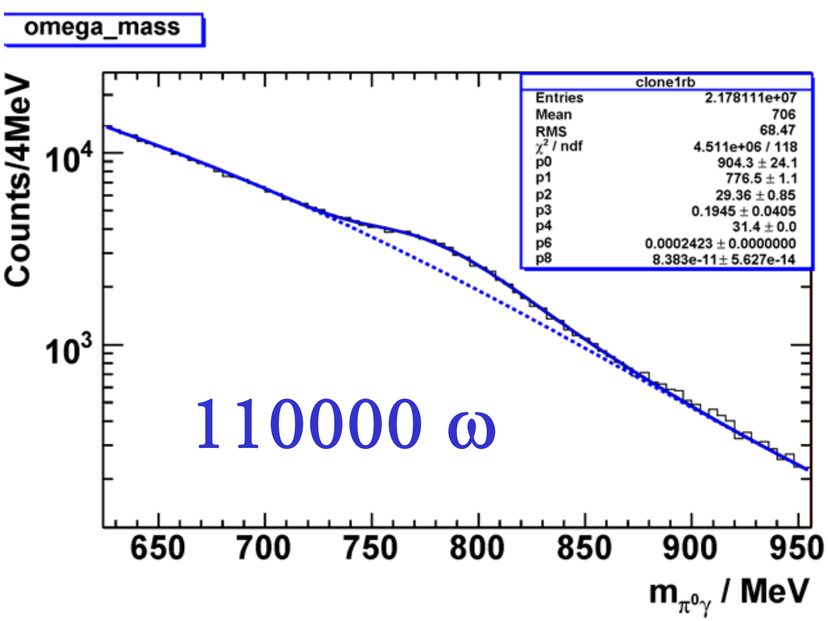
april/mai beamtime, Nb target

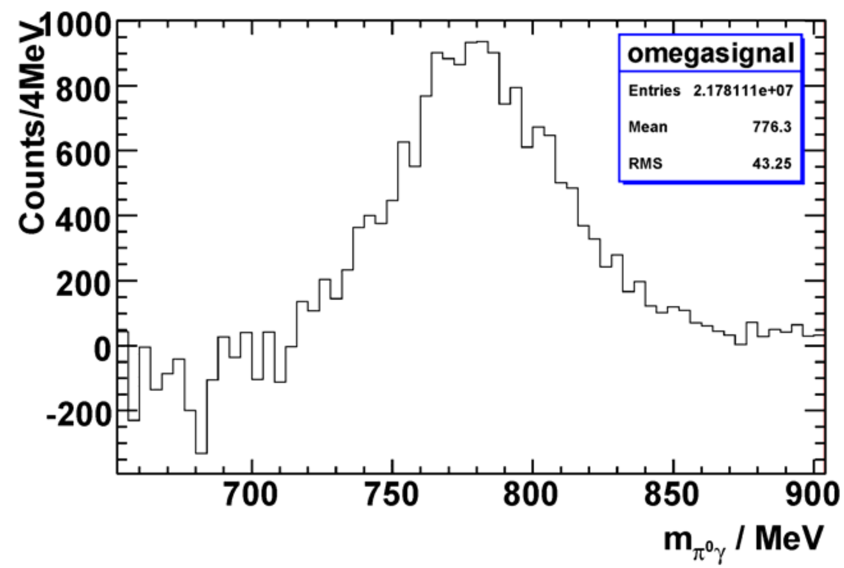




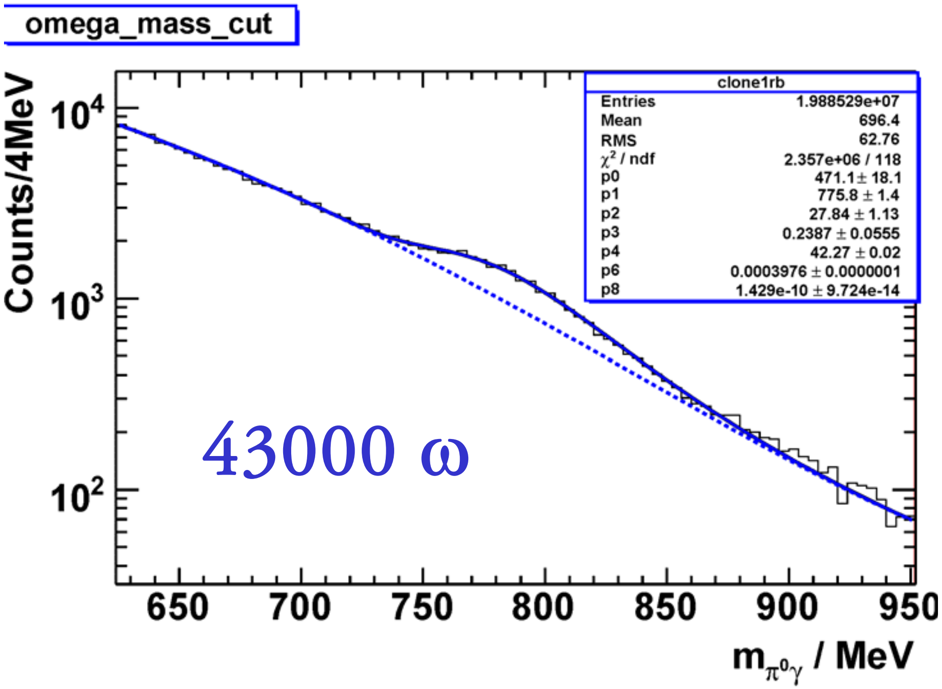
june beamtime, C target, 225 hours analysed



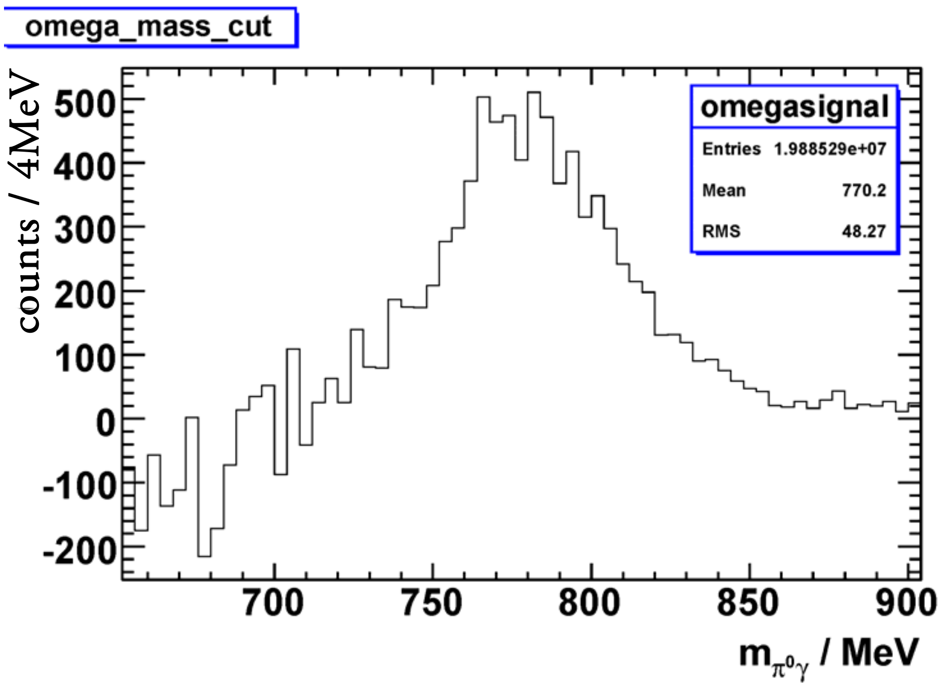




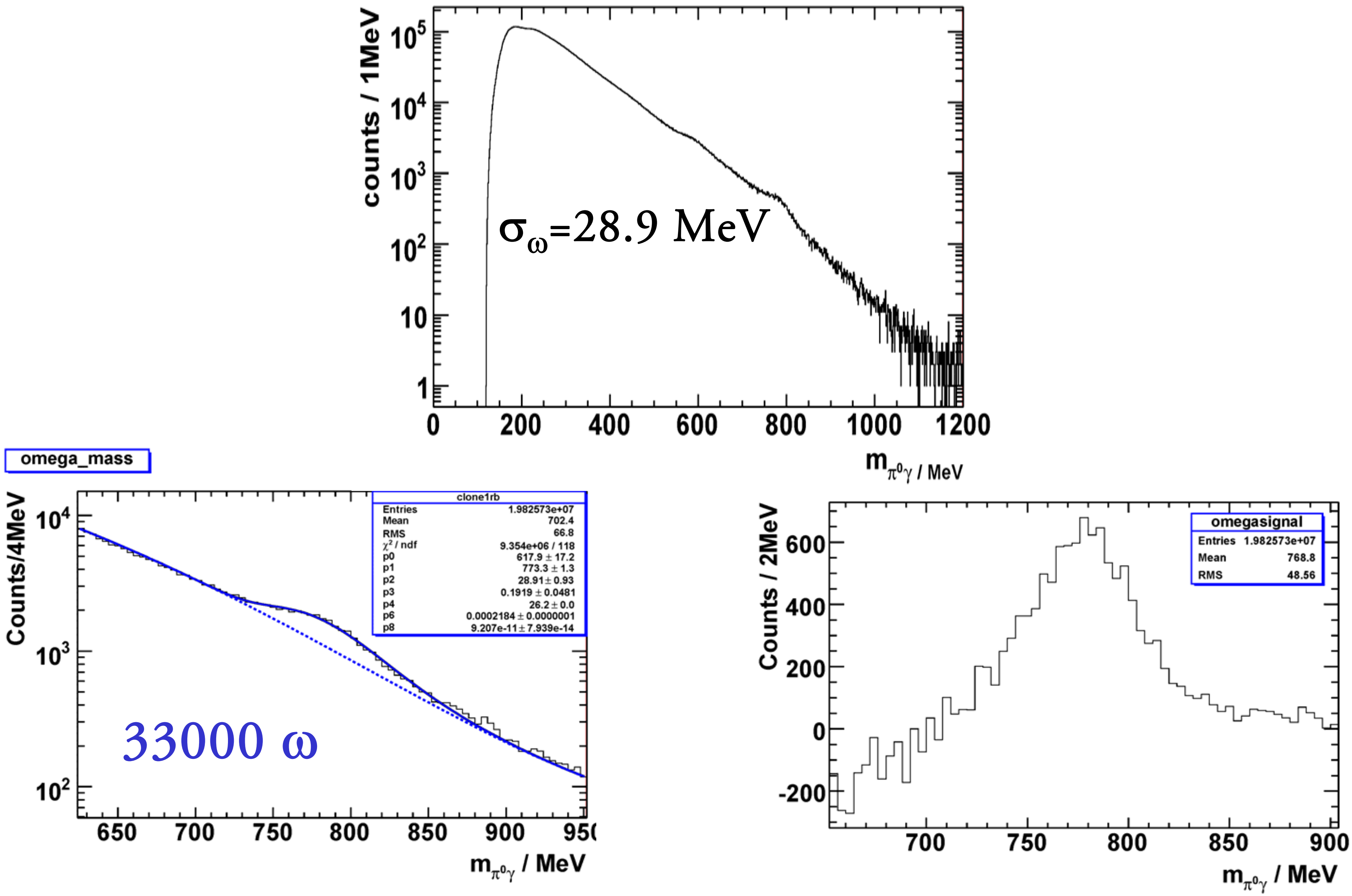
june beamtime, C target, 225 hours analysed



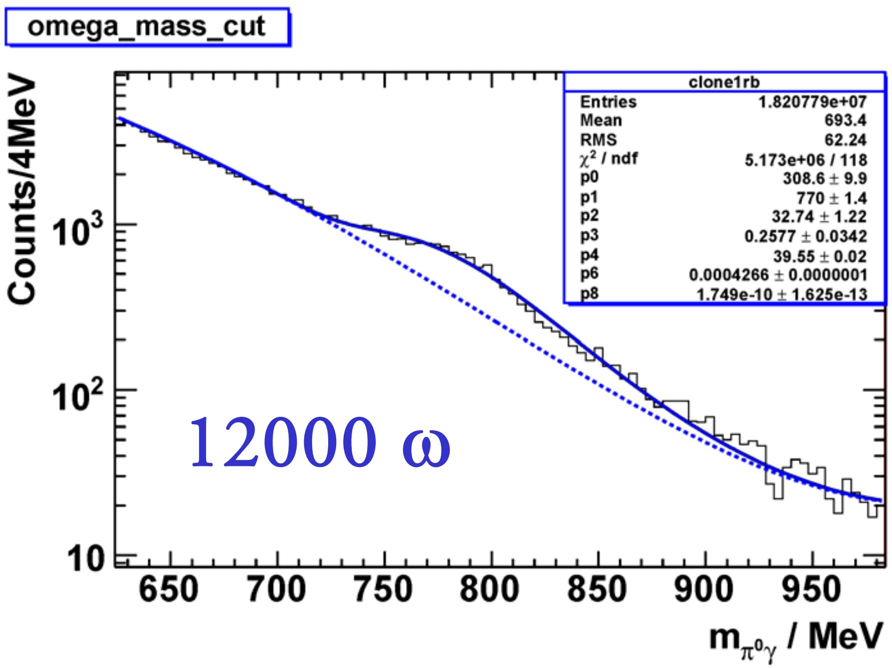
$|\vec{p}_\omega| < 500$ MeV/c



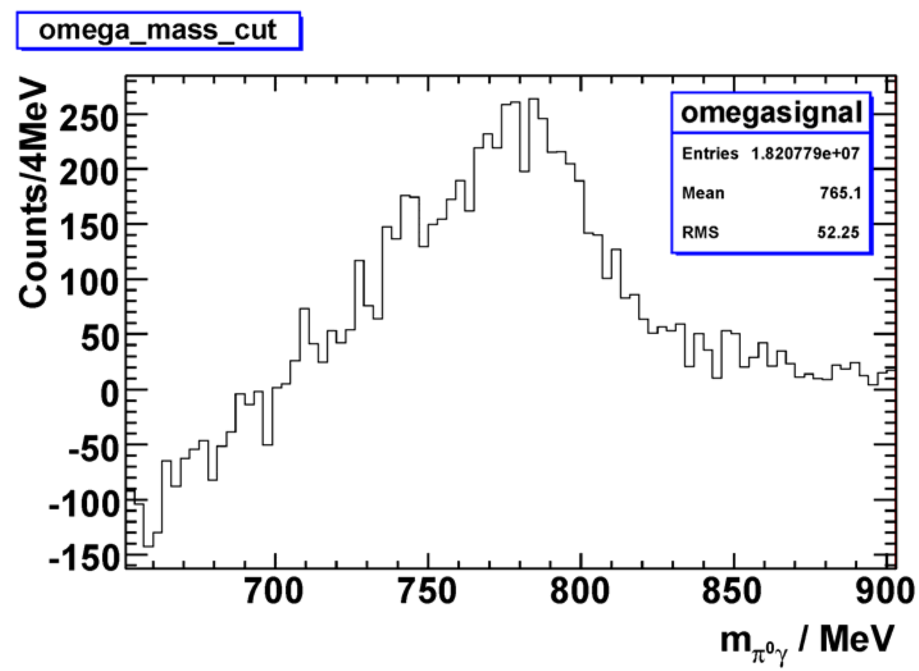
april/mai beamtime, Nb target, 150 hours analysed



april/mai beamtime, Nb target, 150 hours analysed



$|\vec{p}_\omega| < 500$ MeV/c



conclusion and outlook

conclusion:

- new $PbWO_4$ insert in TAPS allows higher intensities
- 265000 ω for Nb and C beamtimes in 1000 hours of data taking
- calibration for april/mai and june nearly finished

outlook:

- calibration for august beamtime
- detailed analysis of calibrated data
- good statistics ➡ solving the ω in-medium effect question