Artur M. Ankowski
Jan T. Sobczyk

University of Wroclaw

Construction of Spectral Functions for Heavier Nuclei

05/31/2007

NuInt07
Batavia, IL

Goal of our research

- Improved description of nuclear effects in ν-Ar interaction
- Test of its accuracy on electron scattering off
  - ^{40}Ar (only one set of data available)
  - ^{40}Ca (similar nucleus)
  - ^{16}O (precise calculation known)

Briefly about spectral function

The spectral function (SF) of a given nucleus describes distribution of momenta and energies of nucleons inside it.

SF consists of two parts:

- mean field—free nucleons (~80%)
- correlated—interactions (~20%)

Our approximated spectral functions

- Only 2N short range correlations
  (S.A. Kulagin, R. Petti, Nucl. Phys. **A765** (2006) 126)

- Momentum distrib. independent of energy distrib.

- MF part includes all energy levels, their widths (Gaussian distribution)

- nucleons populate shells according to occupation probabilities
- momentum distrib. is an input

} G. Co′

How we treat FSI

3-momentum is **conserved:**

$$\delta^3(\mathbf{p} + \mathbf{q} - \mathbf{p}')$$ is kept,

but the spectator **modifies energy balance**

$$\delta(\ldots) \rightarrow \frac{W}{\pi}\frac{1}{W^2+(\ldots)^2}$$

where $W = \frac{1}{2}\hbar c \rho \sigma |\mathbf{p}'|/E_{\mathbf{p}'}$, with ρ=0.16 fm^{-3}, σ=15.6mb

What data are the most significant?

ν interaction:

$$E_\nu \;,\quad \omega \;,\quad |\boldsymbol{q}| \leftrightarrow \cos\theta_\nu$$

e^- scattering:

$$E_e \;,\quad \omega \;,\quad |\boldsymbol{q}| \leftrightarrow \cos\theta_e$$

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e^- scattering:

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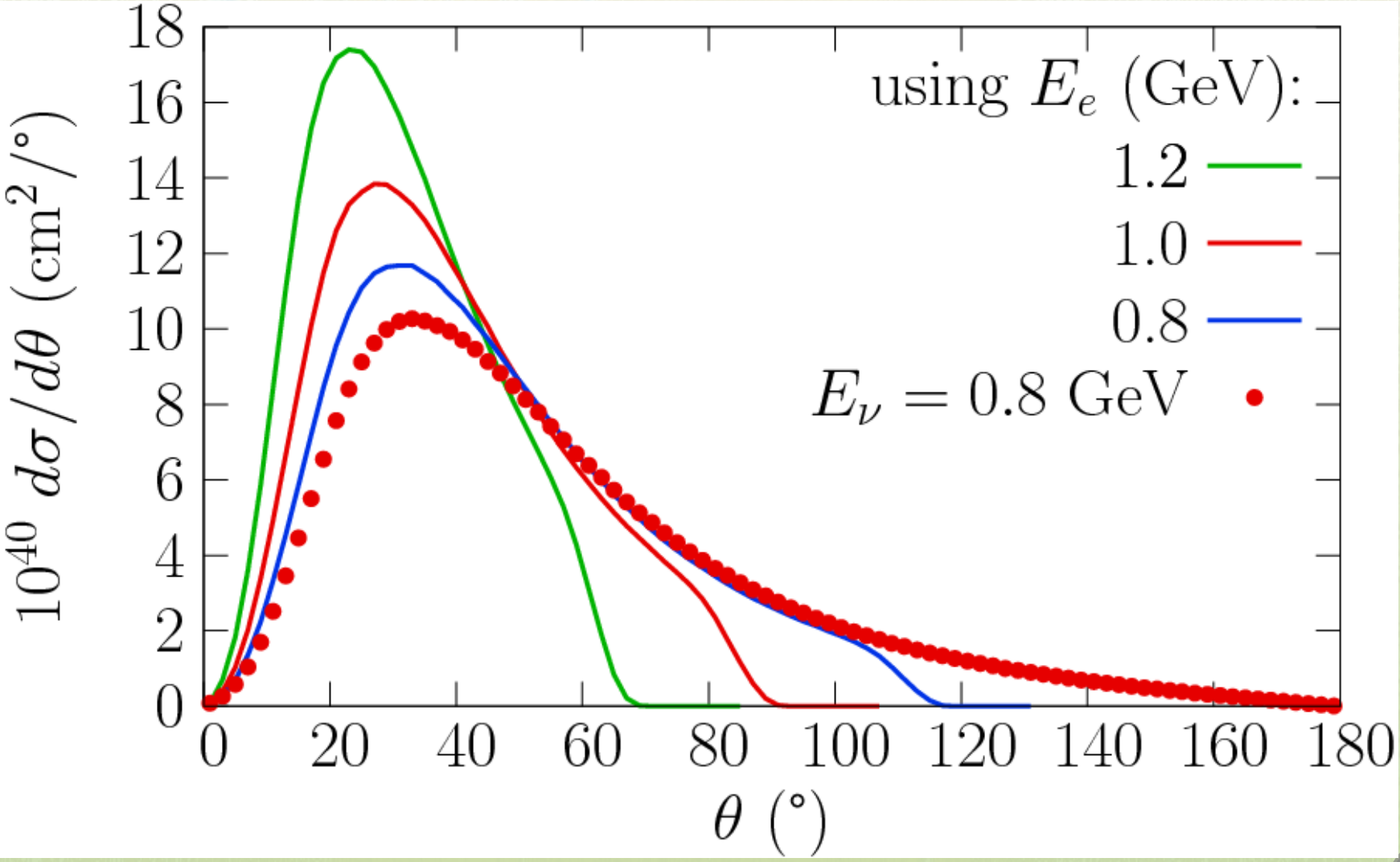
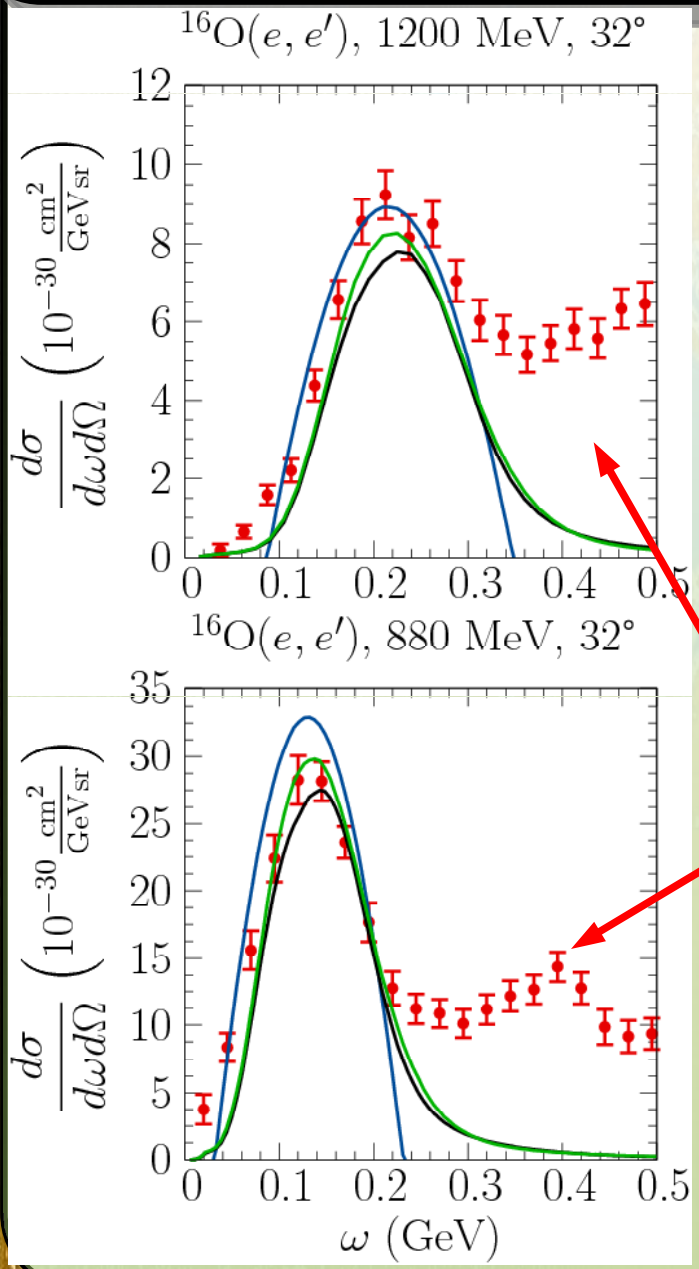
We obtain a mapping

$$\theta_\nu \longrightarrow \theta_e$$

What data are the most significant? - ctnd.



Oxygen



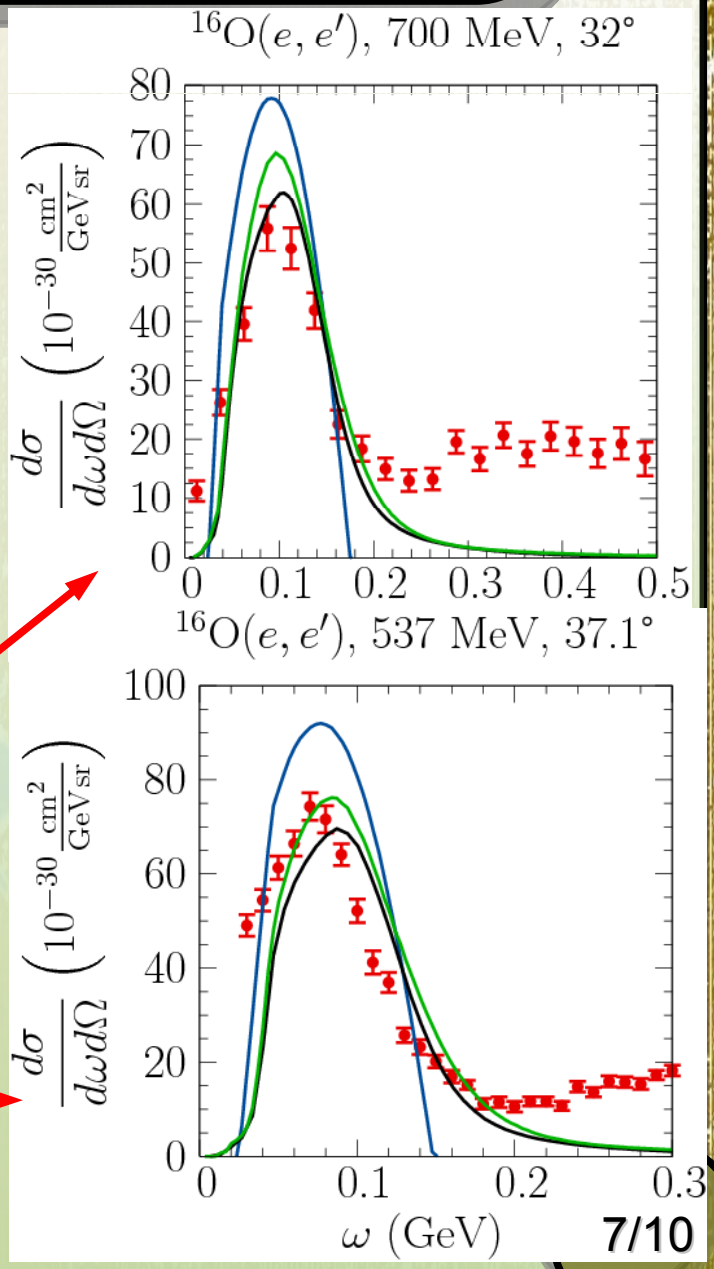
FG
p_F = 225 MeV
ε_B = 27 MeV

GSF+FSI

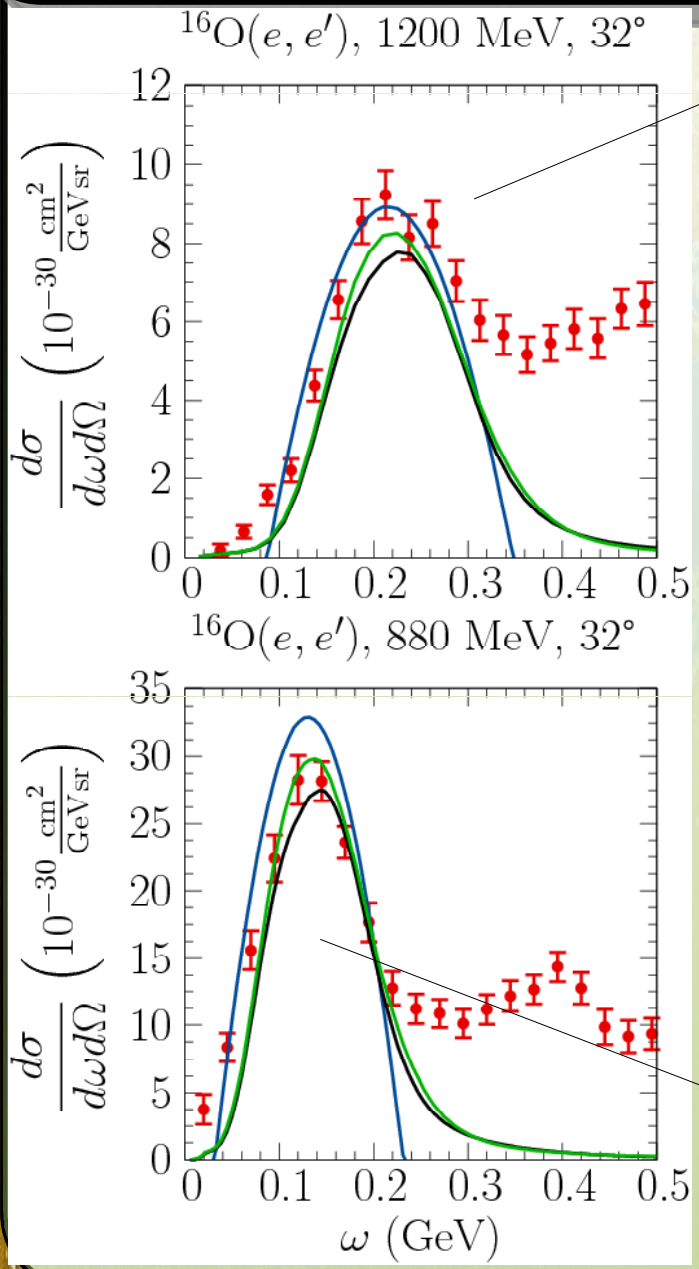
O. Benhar's SF+FSI

M. Anghinolfi et al., Nucl. Phys. A 602 (1996) 405

J.S. O'Connell et al., Phys. Rev. C 35 (1987) 1063



Oxygen

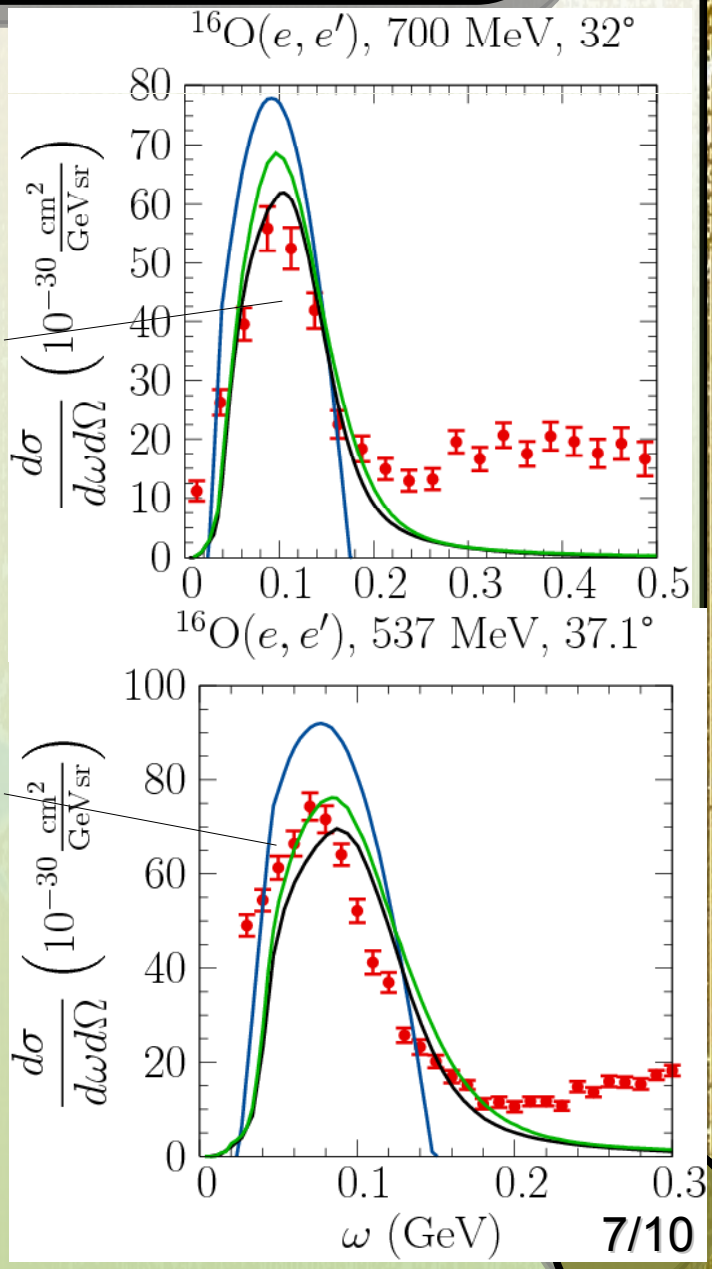


|q| ≈ 635 MeV

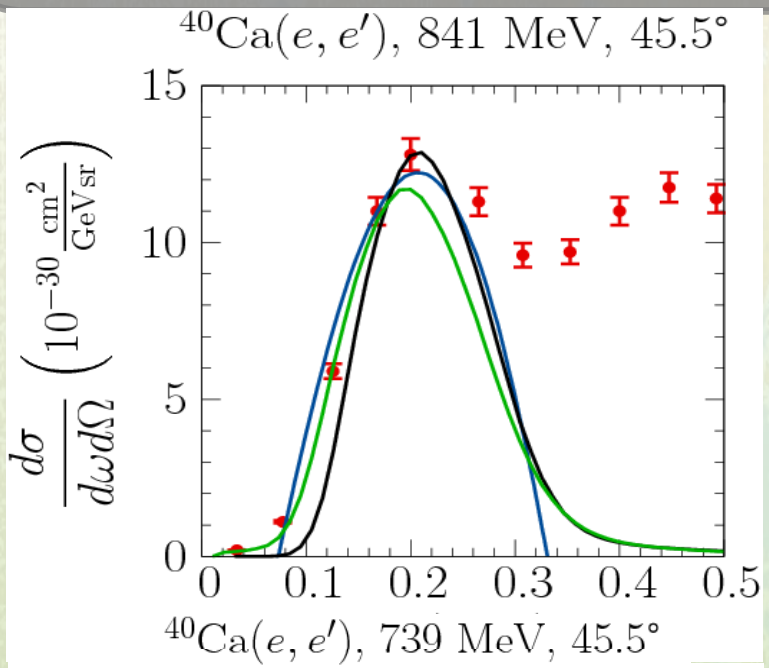
|q| ≈ 370 MeV

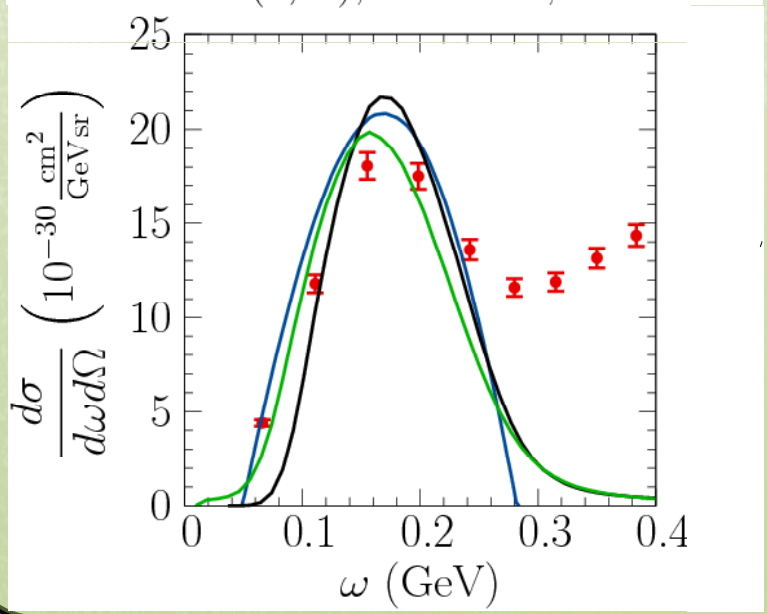
|q| ≈ 325 MeV

|q| ≈ 465 MeV



Calcium



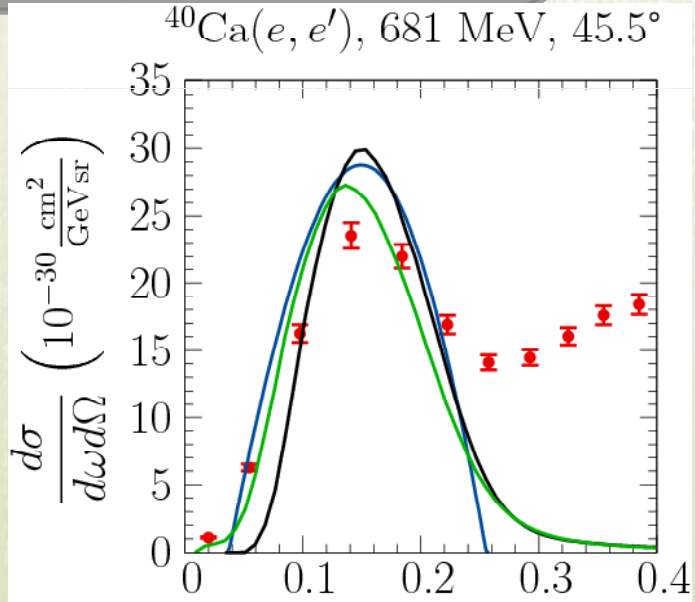


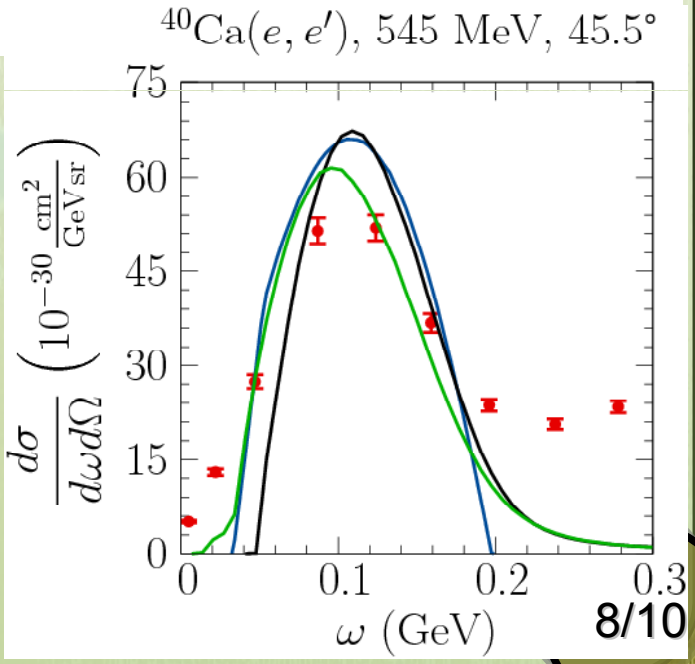
FG
p_F = 249 MeV
ε_B = 33 MeV

GSF+FSI

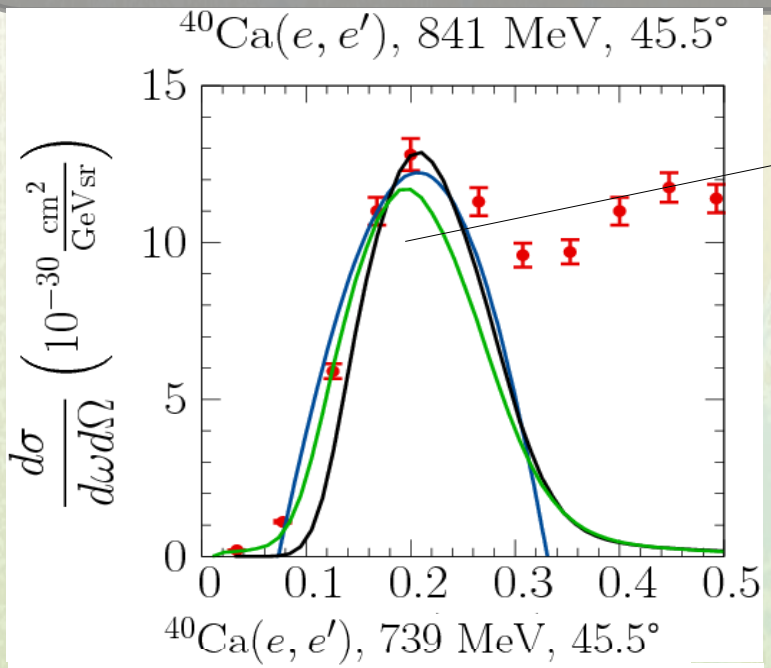
A.V. Butkevich, S.P. Mikheyev, Phys. Rev. C 72 (2005) 025501

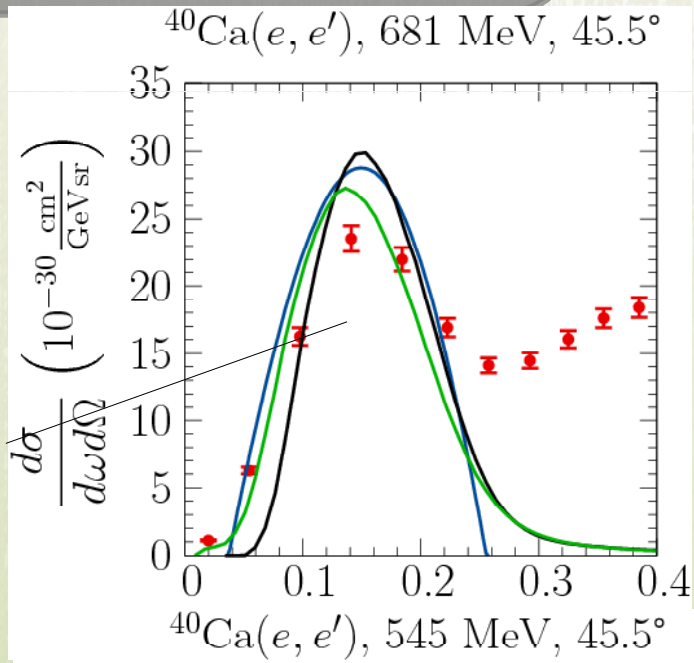
C.F. Williamson et al., Phys. Rev. C 56 (1997) 3152

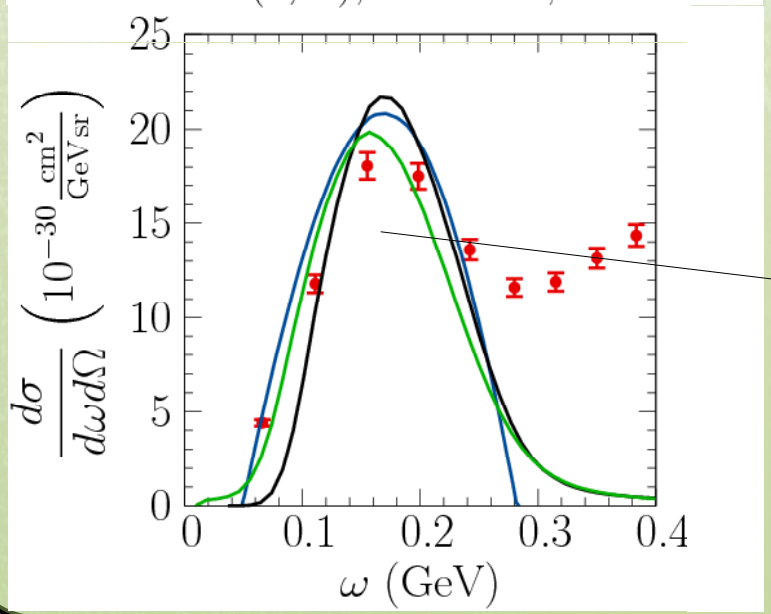


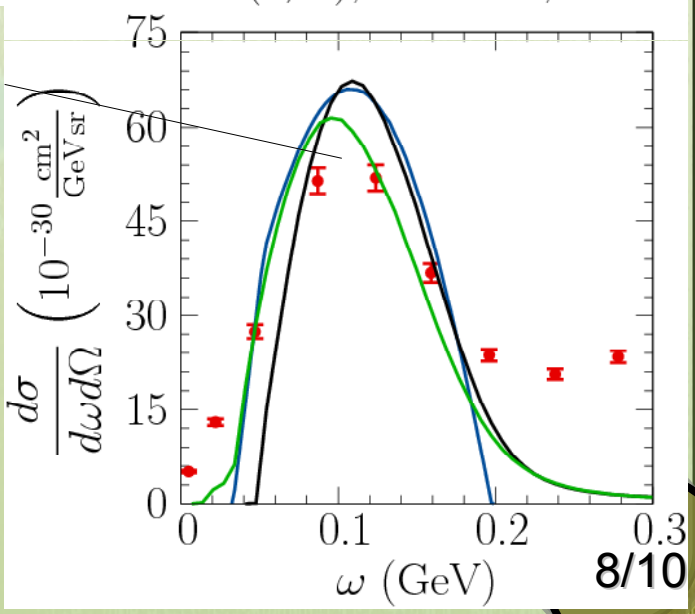


Calcium









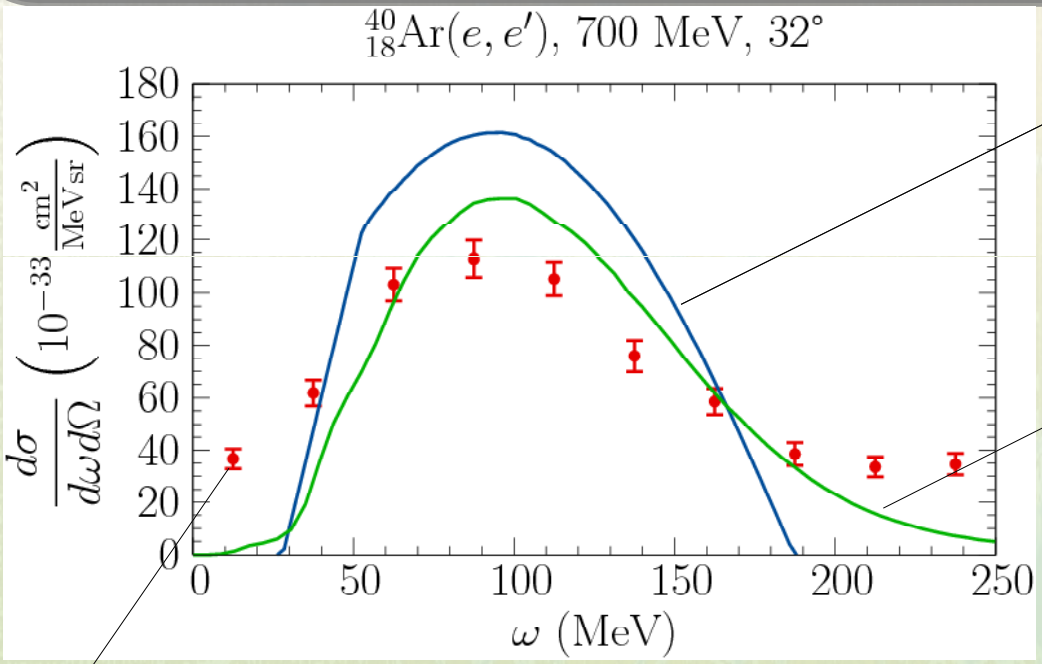
|q| ≈ 600 MeV

|q| ≈ 490 MeV

|q| ≈ 395 MeV

|q| ≈ 530 MeV

Argon

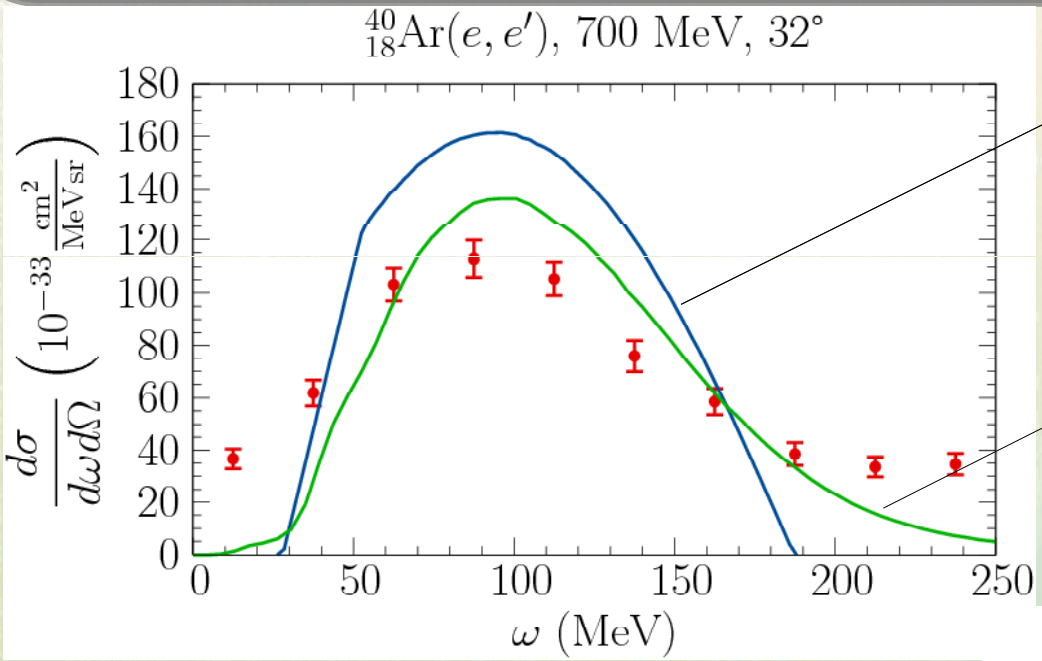


FG
p_F = 251 MeV
ε_B = 28 MeV

GSF+FSI

M. Anghinolfi et al., J. Phys. G 21 (1995) L9

Argon



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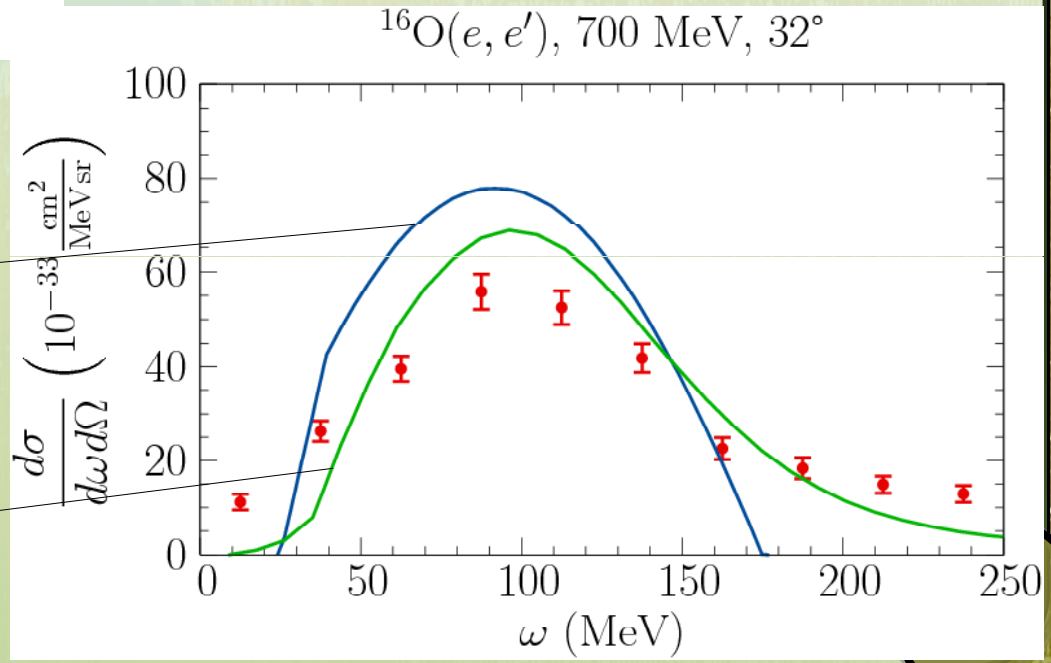
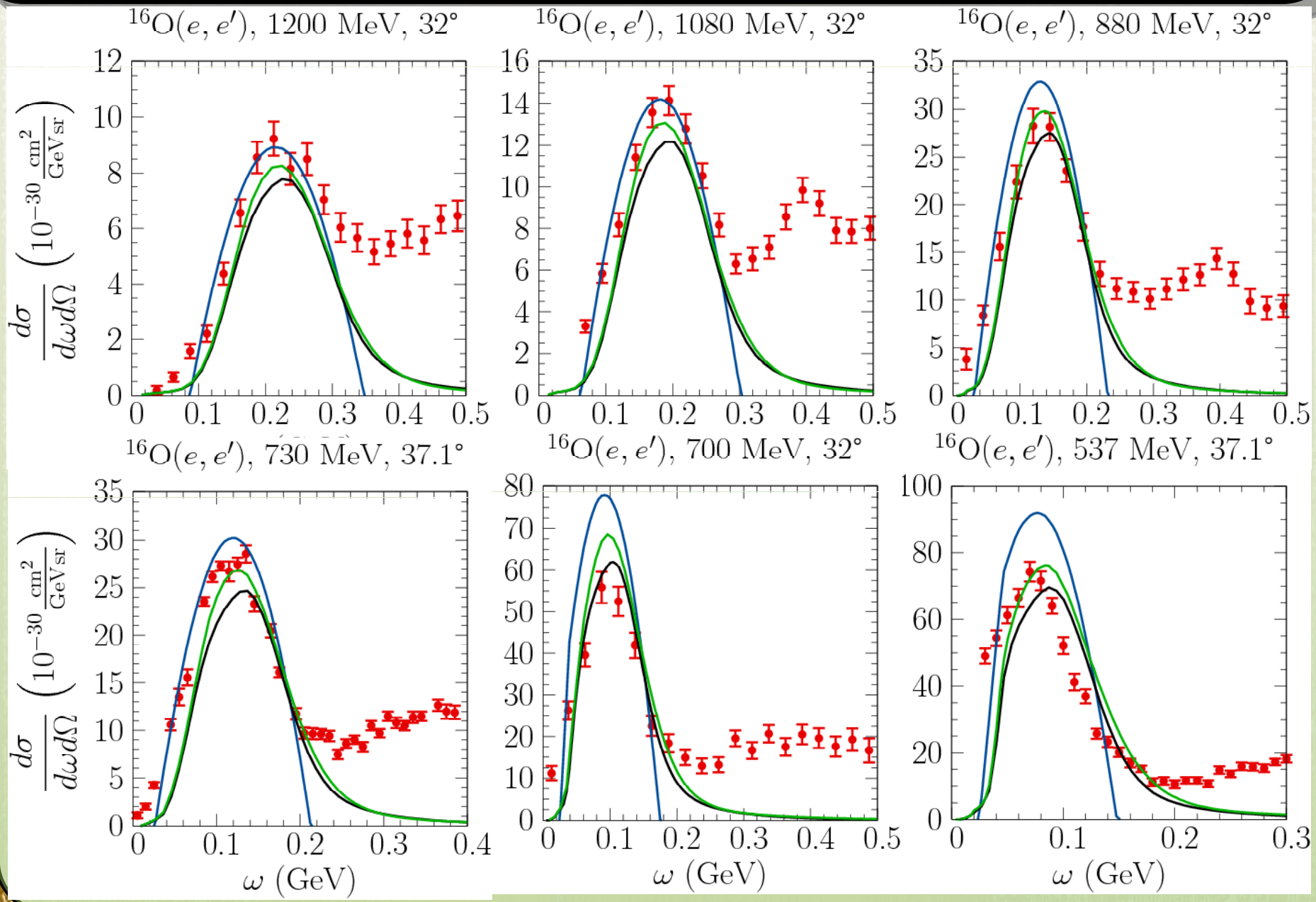
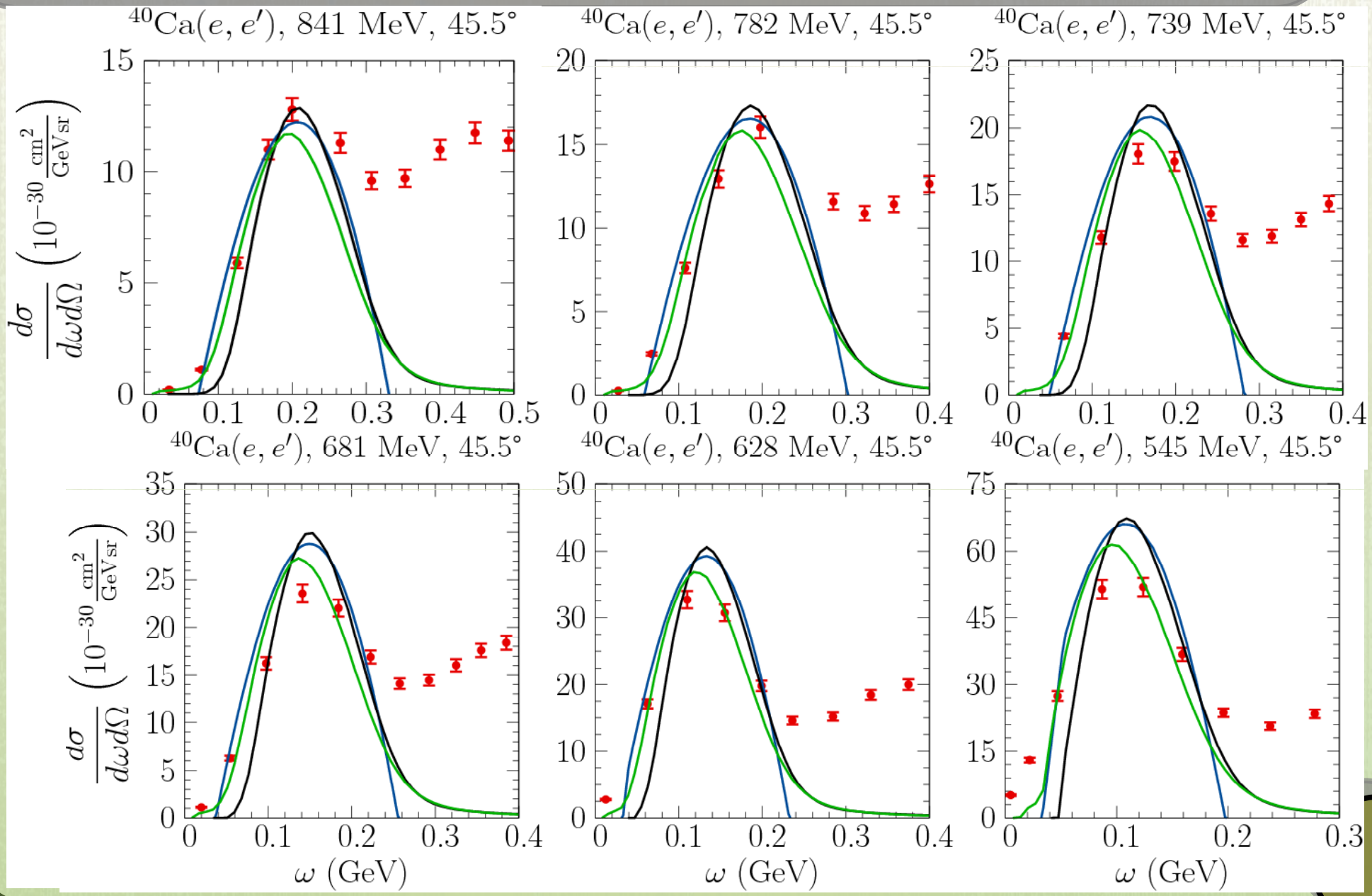


Summary

- We presented simple way to estimate SFs
- Its accuracy is checked to be quite satisfactory
- SF of argon can improve ν event simulations
- IA starts to fail for $|\mathbf{q}| \leq 450$ MeV

Back-up slides

Oxygen–(almost) complete data



Calcium–all data for E>500 MeV