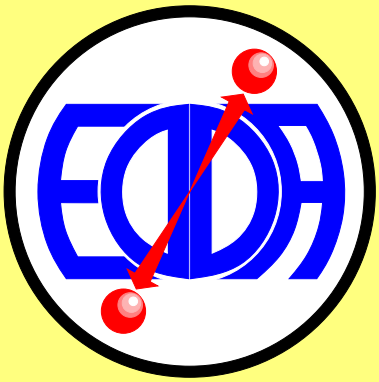
Nuclear Physics Spring Meeting, Cologne March 8-12, 2004



@

Spinobservables in Proton-Proton Elastic Scattering

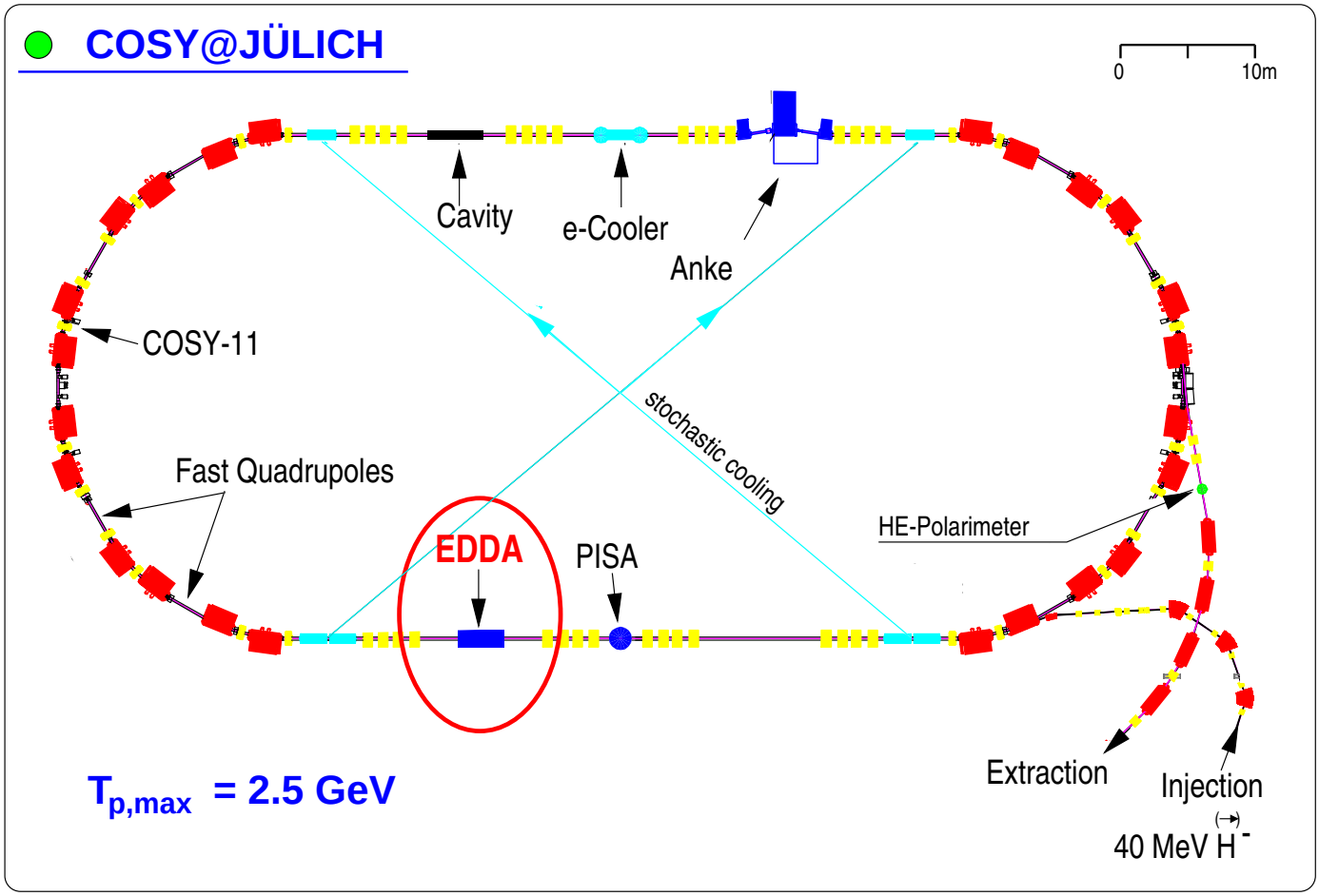
H. Rohdjeß, ISKP Uni-Bonn
für die EDDA-Kollaboration (Bonn, Hamburg, Jülich)

$\vec{p}\,\vec{p} \longrightarrow p\,p$ $\quad T_p = 0.25 \ldots 2.6$ GeV

$$\frac{d\sigma}{d\Omega} \quad A_N \quad A_{NN} \quad A_{SS} \quad A_{SL}$$

Experimental Technique

COSY@JÜLICH



internal experiment

p + CH_2 fiber	→	$\frac{d\sigma}{d\Omega}$	√
p + $\vec{p}$ atomic beam	→	A_N	√
$\vec{p}$ + $\vec{p}$ atomic beam	→	A_{NN} A_{SS} A_{SL}	(√)

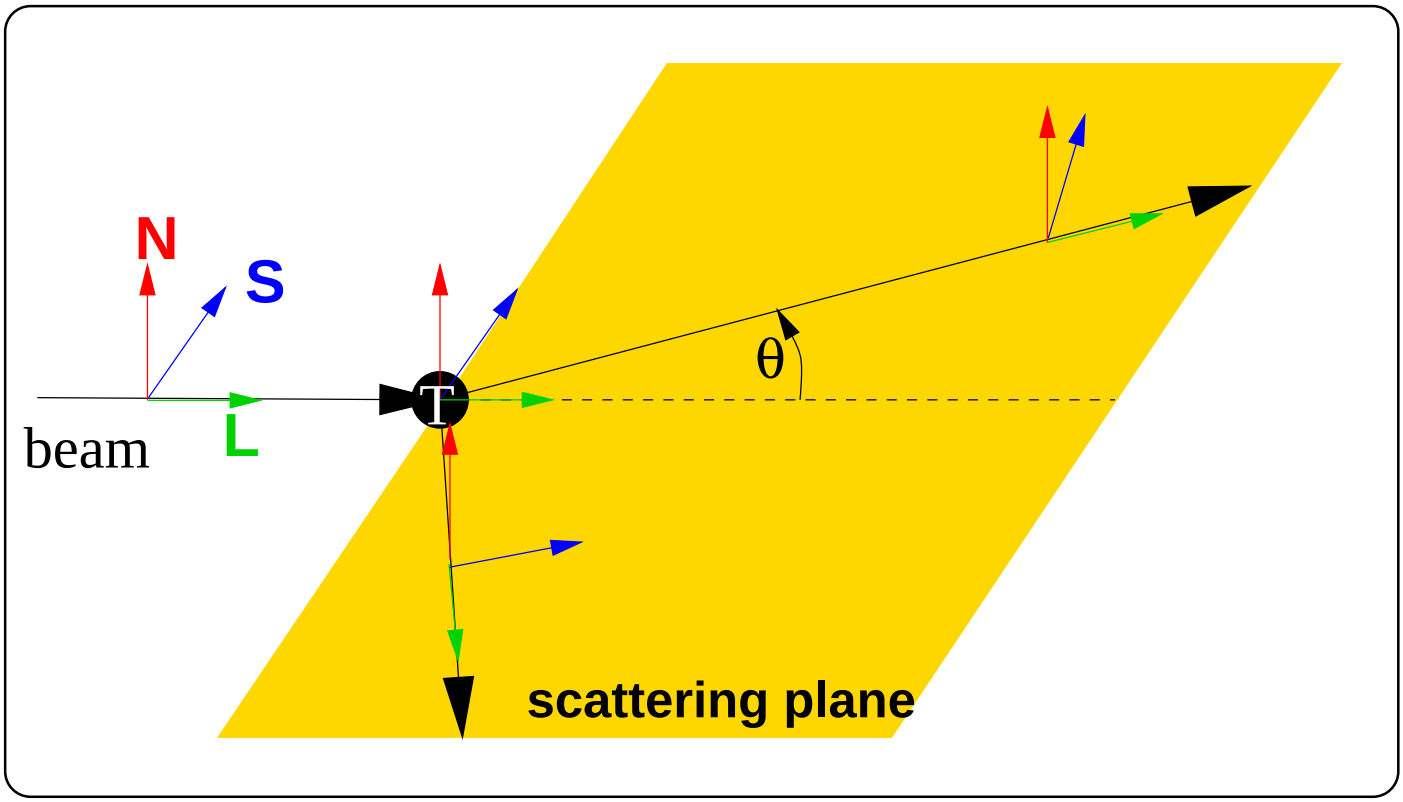
excitation functions

DAQ during acceleration / (deceleration)

T_p = 300 .... 2500 MeV in 2 s

small energy steps p p → B_2 → p p

Γ? W_R?



Phase Shift Analysis (PSA)

- partial wave decomposition

$$S_J = e^{2i\delta_J} \quad ; \quad \vec{J} = \vec{L} + \vec{S}$$

- constraints

e.g.: $L > L_{max}$: OPE

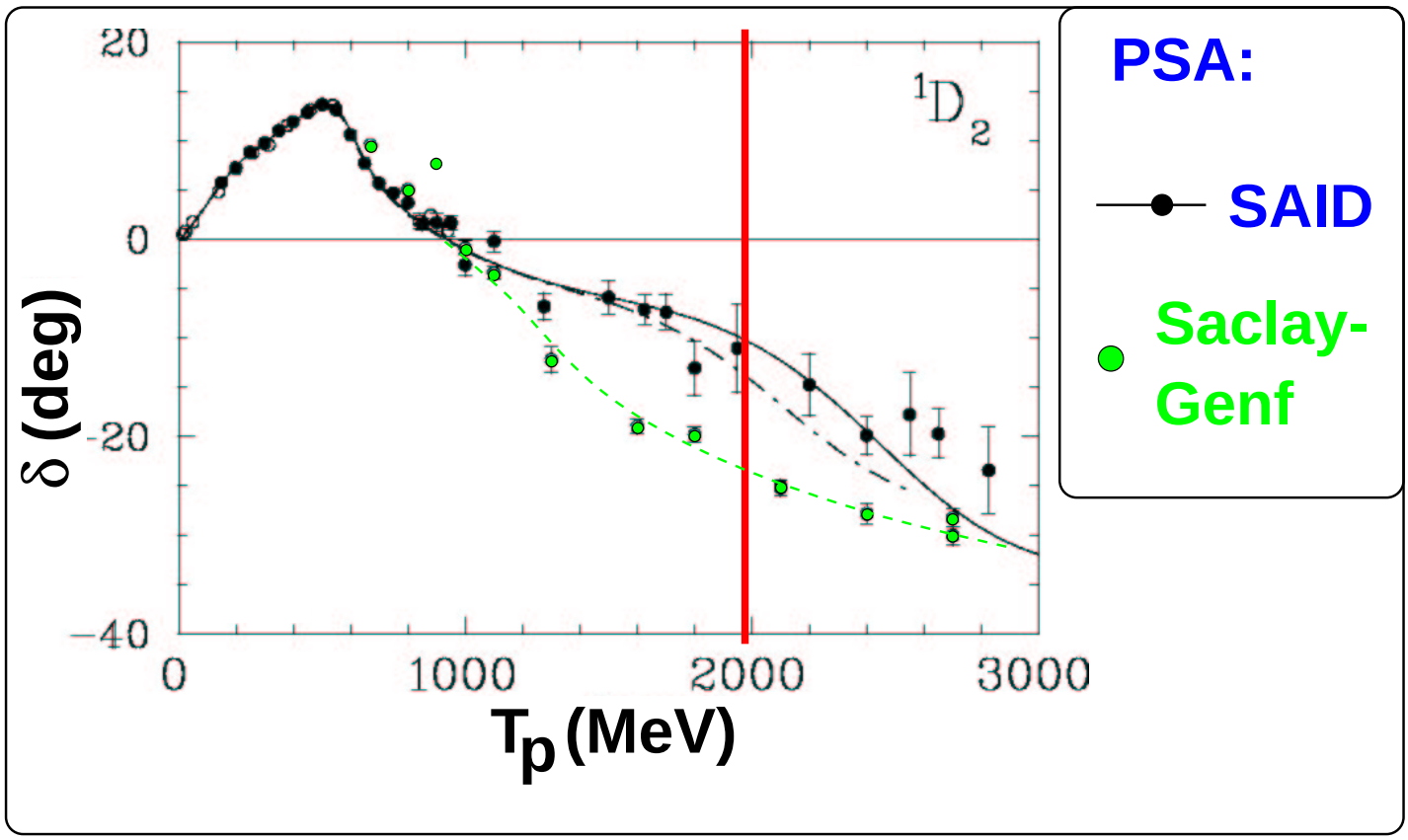
→ predicitive power !!

e.g. VPI (SAID) R. Arndt et al.

$T_p \in$ 0-3 GeV : 23000 / 12000 pp / np data points

↔ theory

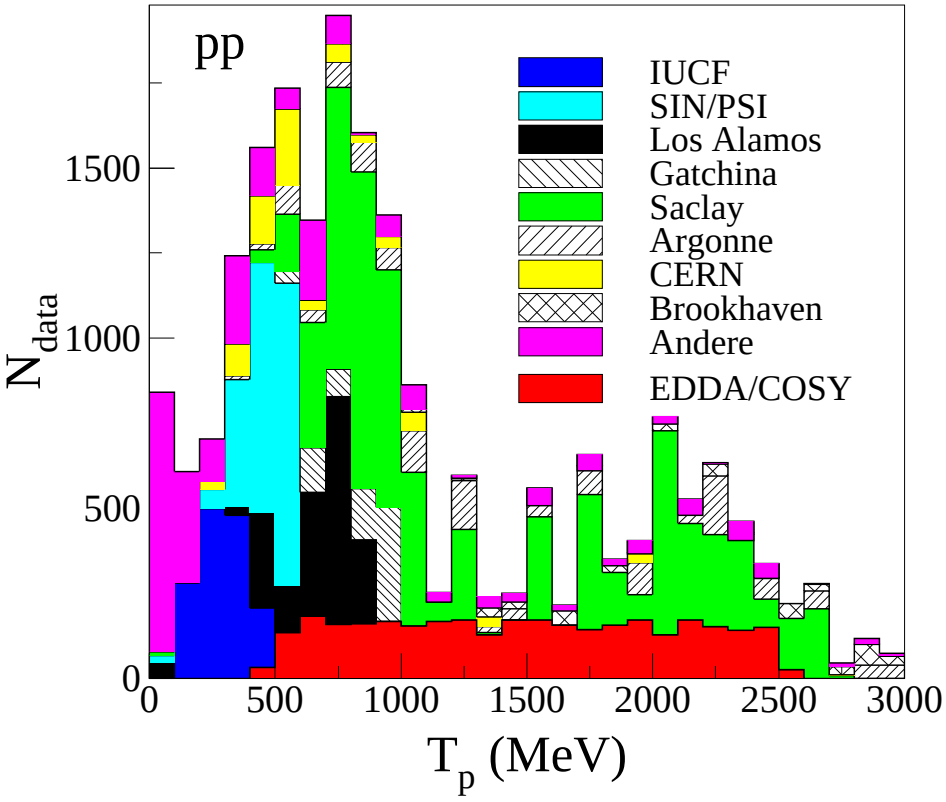
ambiguities in phase shifts

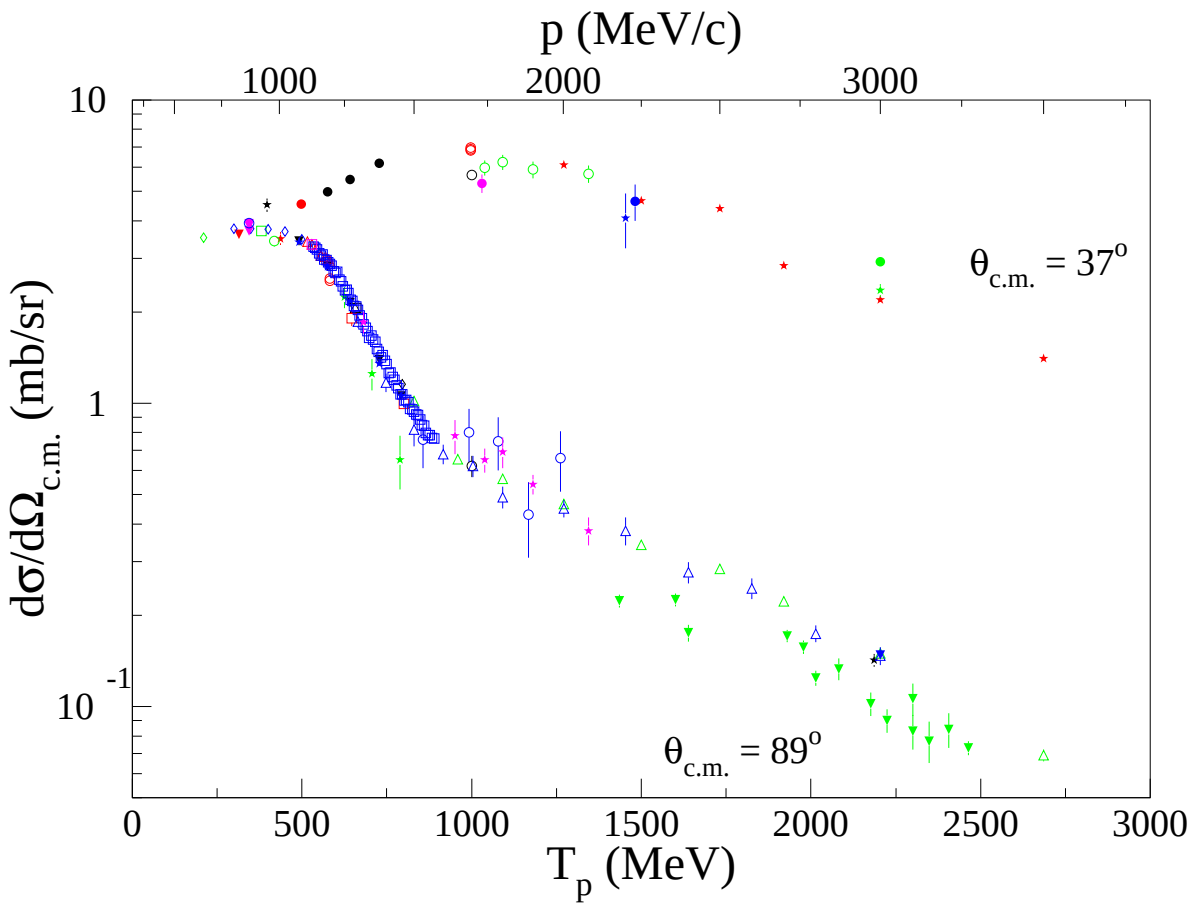


Bystricky, Lechanoine-Leluc, Lehar Eur. Phys. J. C4, 607 (1998)

Arndt, Strakovsky, Workman, Phys. Rev. C62, 034005 (2000)

NN Database

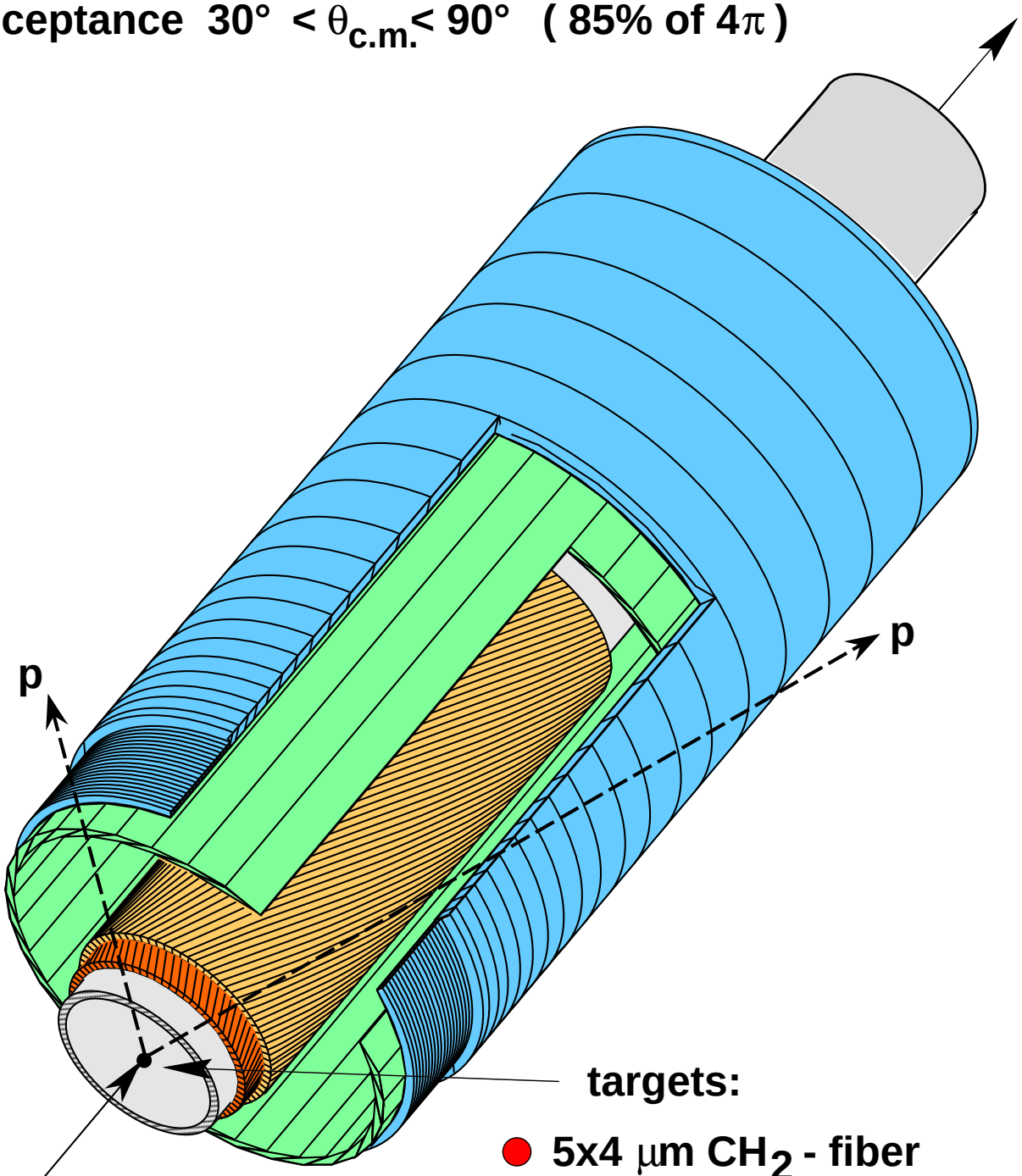

pp
IUCF
SIN/PSI
Los Alamos
Gatchina
Saclay
Argonne
CERN
Brookhaven
Andere
EDDA/COSY
N_data
T_p (MeV)


p (MeV/c)
dσ/dΩ_c.m. (mb/sr)
θ_c.m. = 37°
θ_c.m. = 89°
T_p (MeV)

EDDA@COSY: Detector

Bonn,Hamburg,Jülich

- acceptance $30° < \theta_{c.m.} < 90°$ (85% of 4π)



targets:

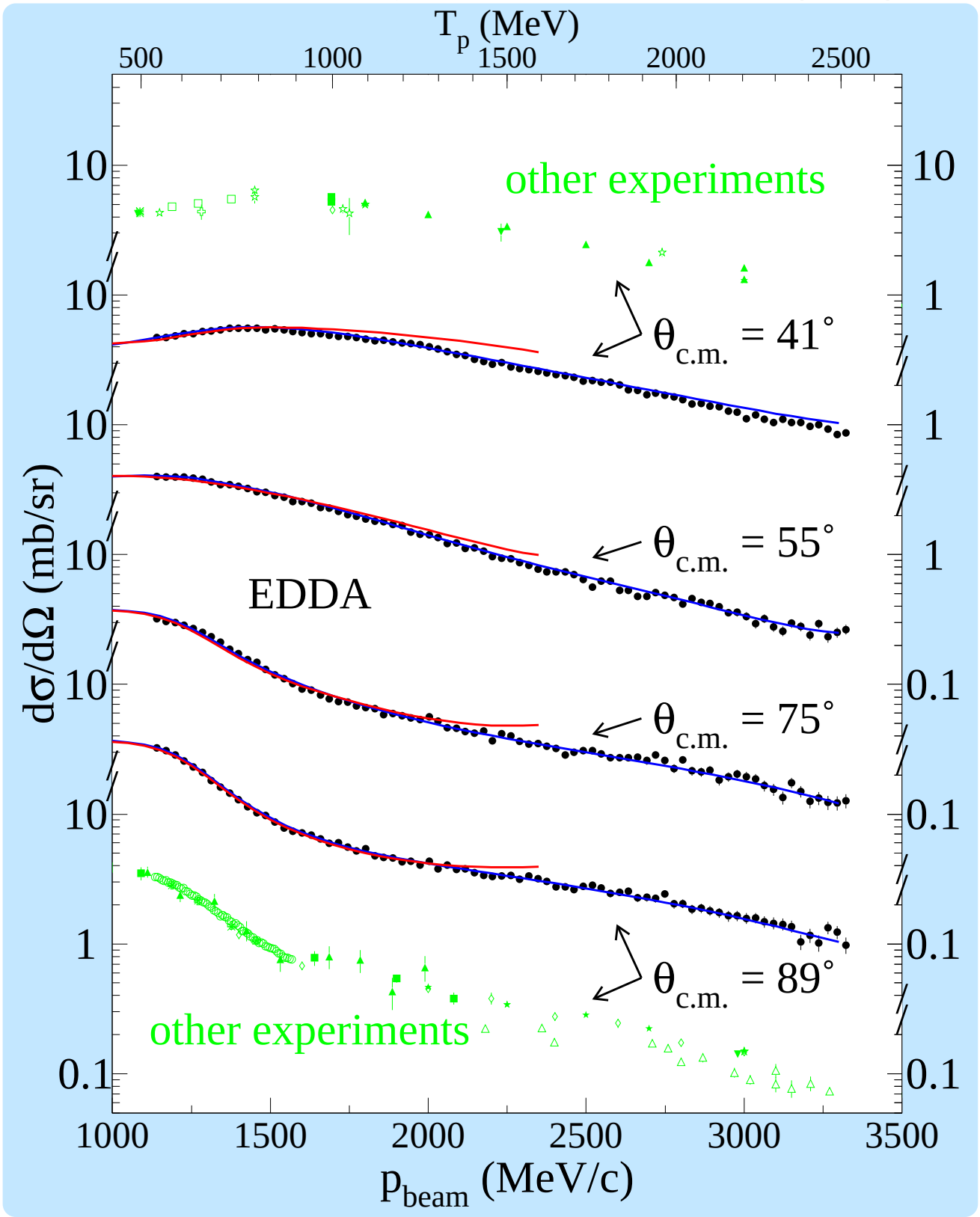
- 5x4 μm CH_2 - fiber
- H-atomic beam

COSY-beam

10 cm

EDDA Results: $\frac{d\sigma}{d\Omega}$

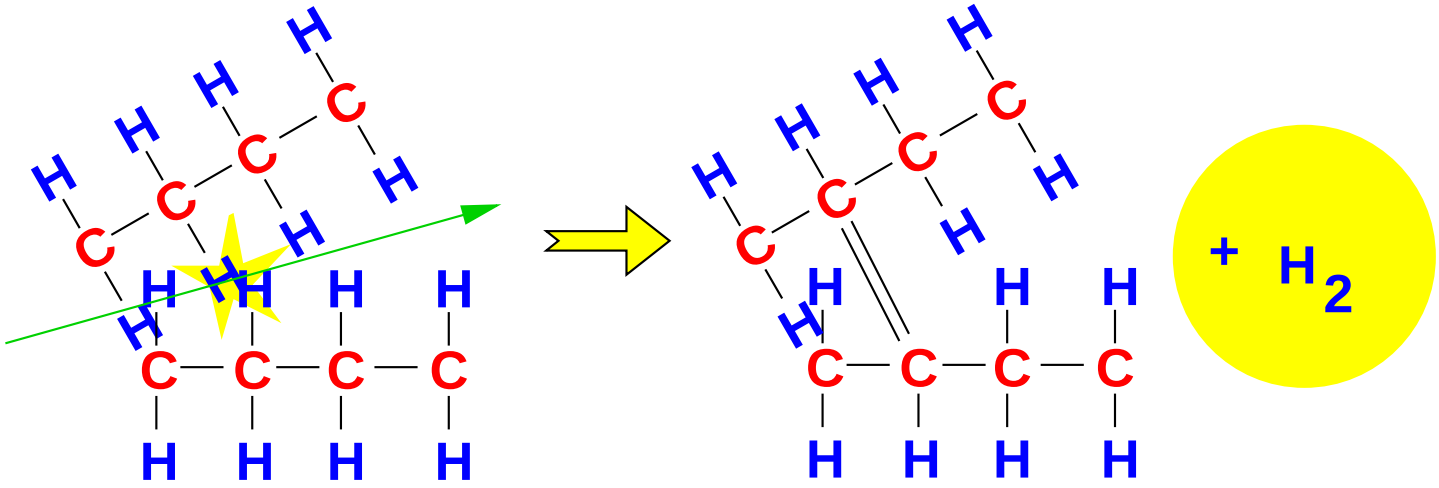
D.Albers et al.*Phys. Rev. Lett.* **78**, 1652 (1997)



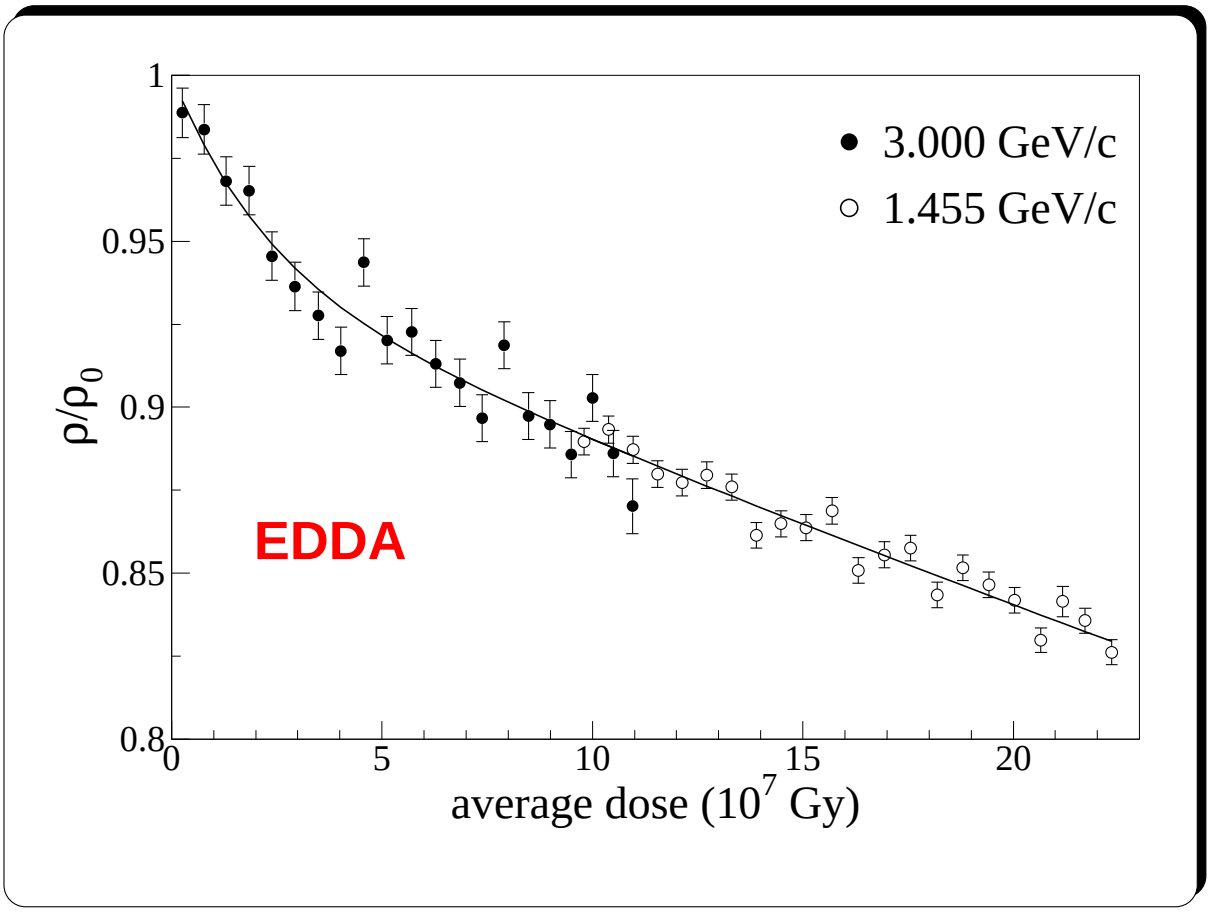
SAID PSA: SM94, SM97

Radiaton Damage of CH_2 -Targets

"cross linking" (+ chain scission)



Loss of Hydrogen (10% / 12h)

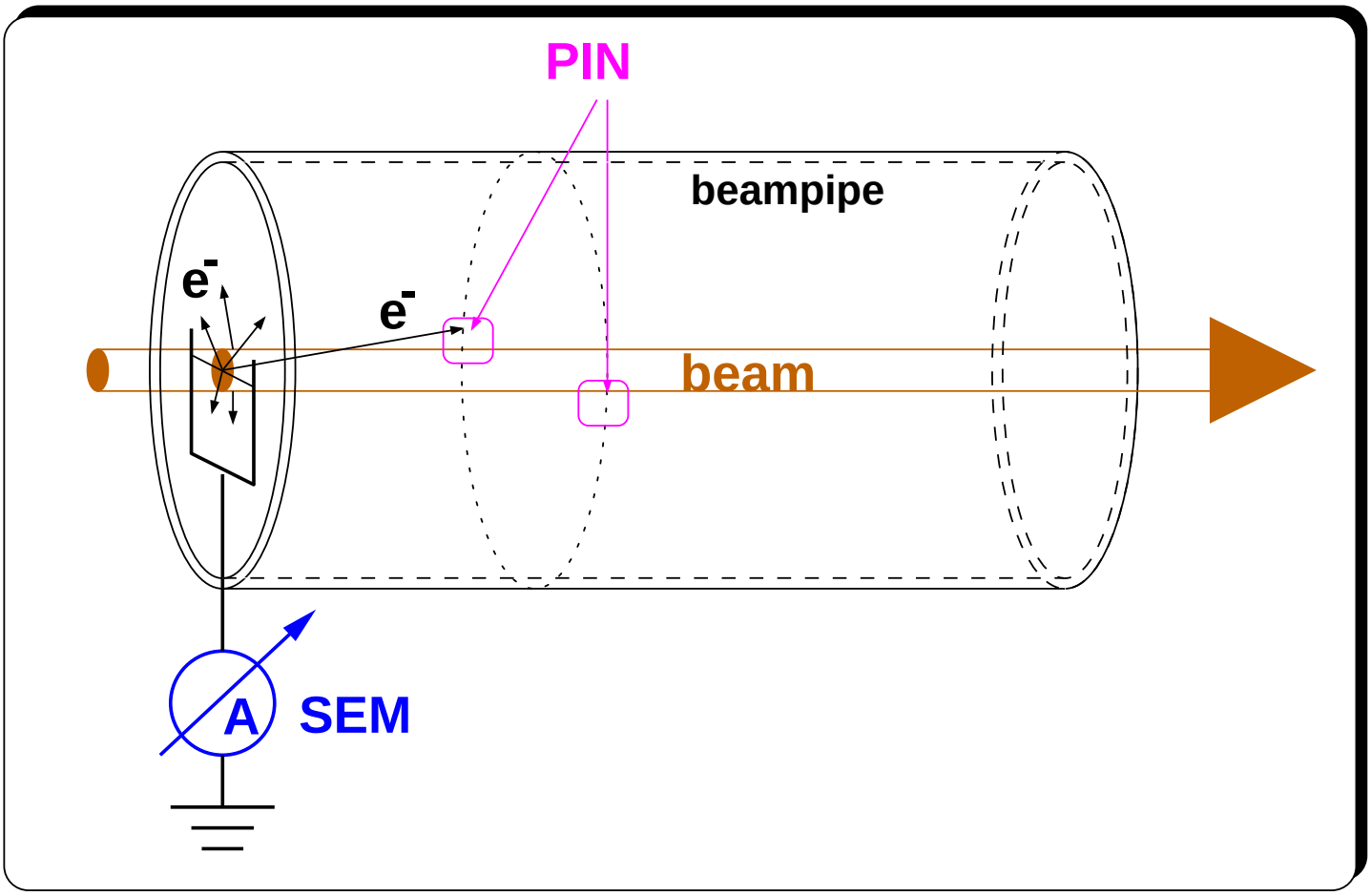


Normalization

relative:

- e (p, e) p

$R_{PIN} \propto \sigma_{ROSENBLUTH}$



- secondary electrons

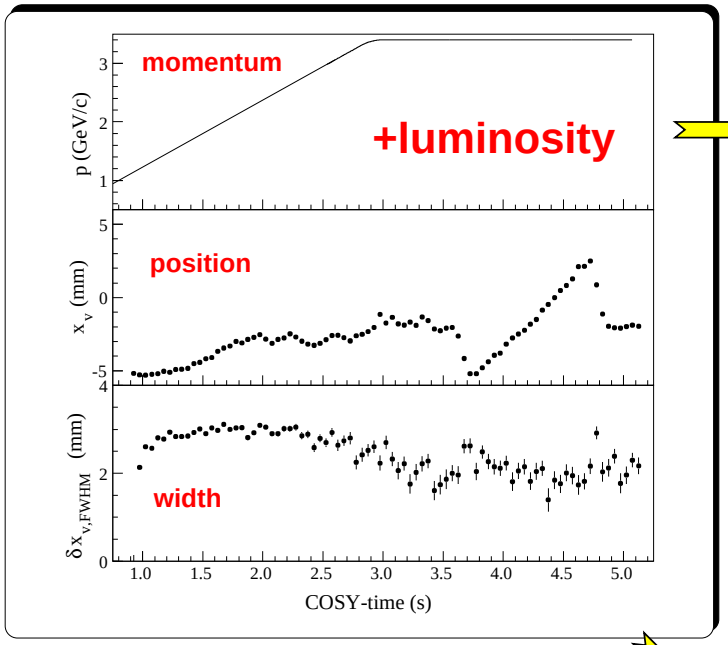
$I_{SEM} \propto \Delta E$

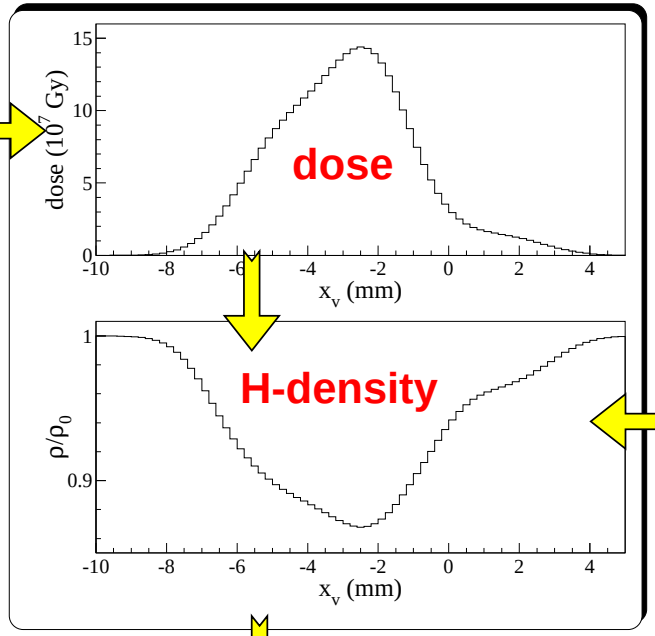
absolute:

T_P = 793 MeV ⟶ 1%

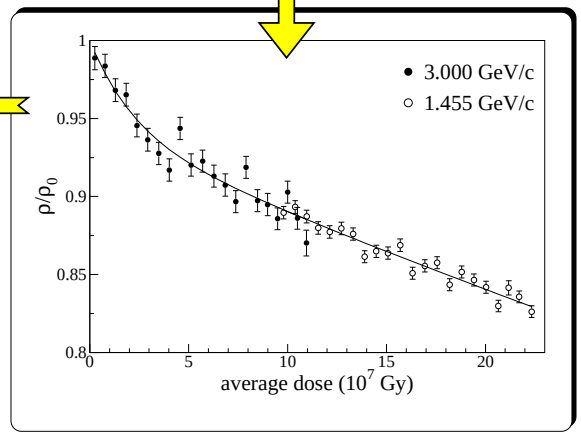
Simon et al. (LAMPF), Phys. Rev. C48, 662 (1993)

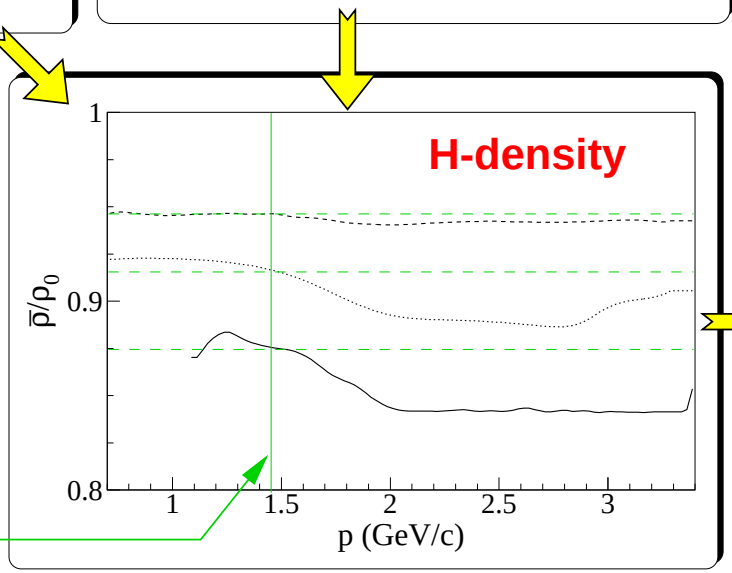
Radiaton Damage of CH_2 -Targets





Data at fixed momentum



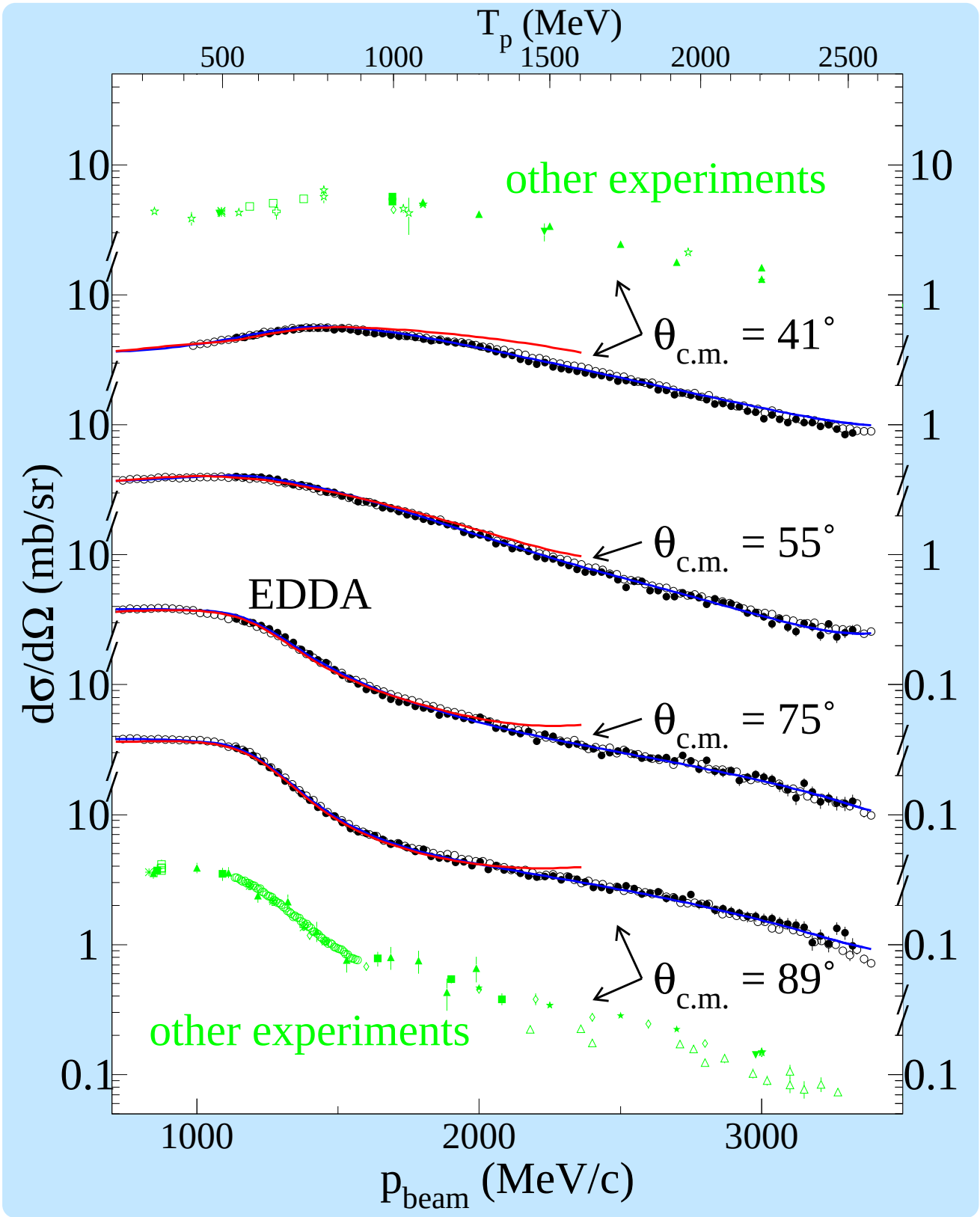


correction factor

absolute normalization

EDDA Results: $\frac{d\sigma}{d\Omega}$

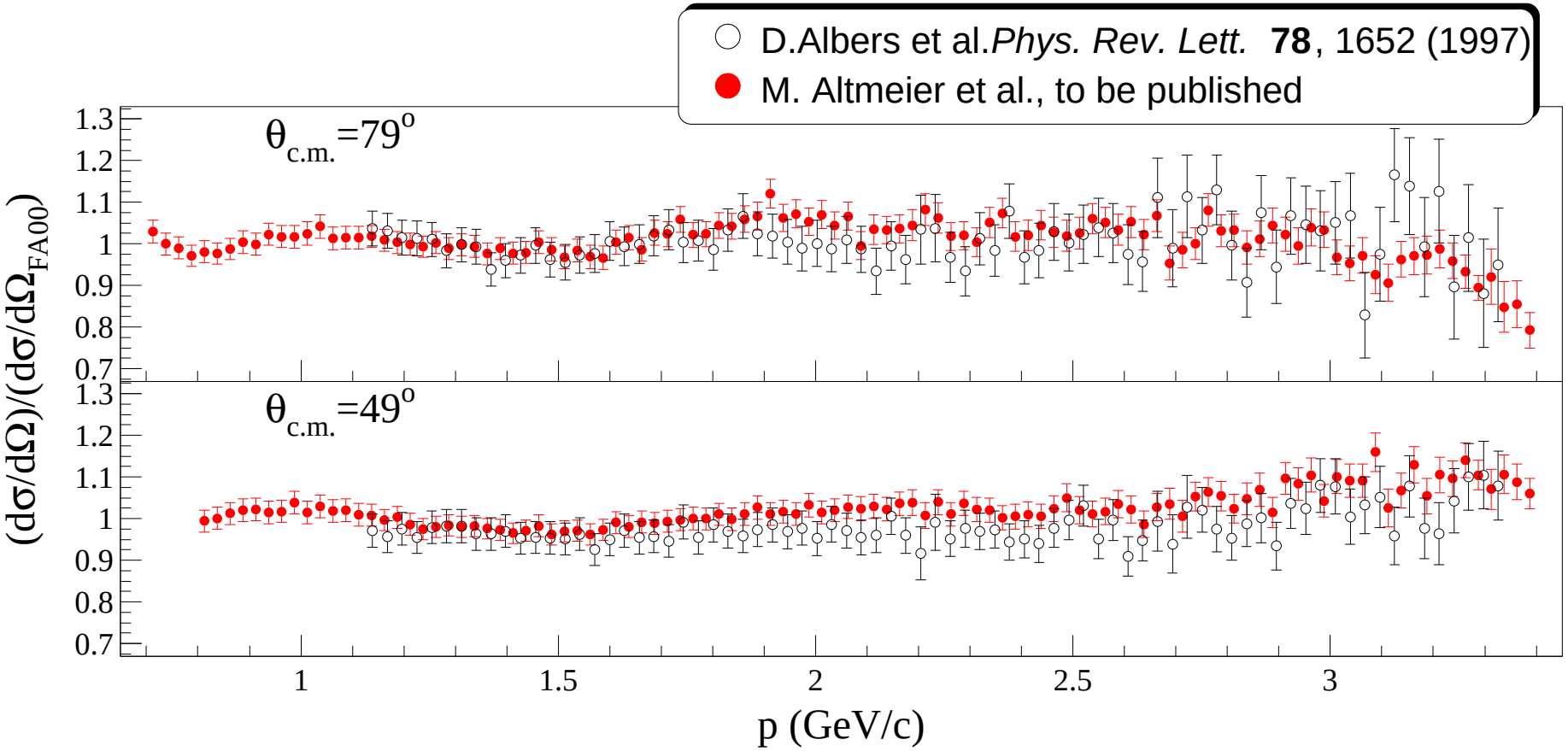
- D.Albers et al.*Phys. Rev. Lett.* **78**, 1652 (1997)
- M. Altmeier et al., to be published



SAID PSA: SM94, SM97

updated analysis of unpolarized data: $\frac{d\sigma}{d\Omega}$

- increased statistical precision
- reduced contribution from pC scattering
- correction for radiation damage of CH_2-targets
- larger momentum range



Dibaryons

- color singlet states

	Baryons	Mesons	
Why are	qqq	$q\bar{q}$	observed
but not	$qqqq\bar{q}$	$qq\bar{q}\bar{q}$	??
	$qqqqqq$		

- numerous theoretical predictions

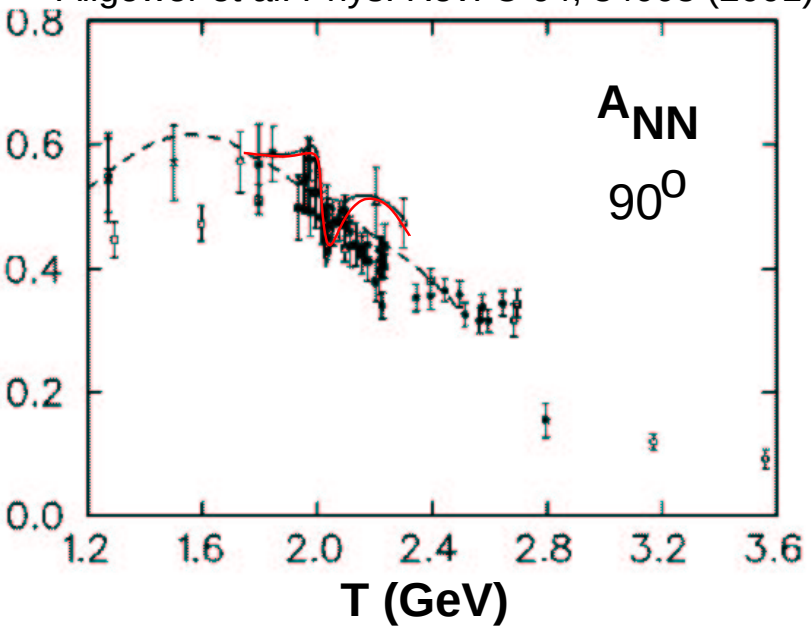
  for I=1 ,S=0 : $W_R \approx$ 2.1 ... 2.7 GeV

  $\Gamma =$ 10...150 MeV

  no experimental evidence !

NN@Saturne

Allgower et al. Phys. Rev. C 64, 34003 (2001)



EDDA@COSY

upper limits for $\eta_{el}=\Gamma_{el}/\Gamma_{tot}$

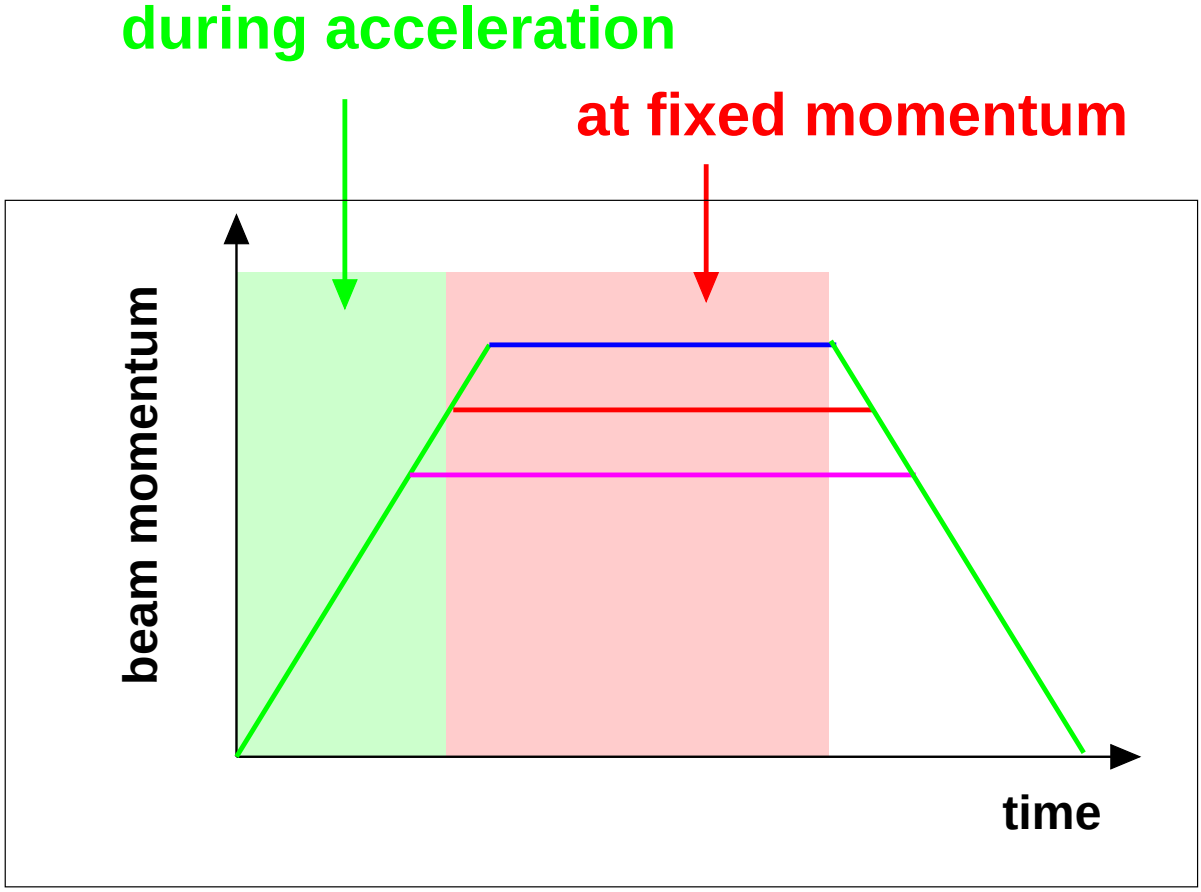
W_R = 2.2 ... 2.8 GeV

Γ = 10 ... 100 MeV

η_{el} >	0.09	($^1S_0$)
	0.05	($^1D_2$)
	0.10	($^3P_0$)
	0.03	($^3P_1$)
	0.06	($^3F_3$)

excluded with 99% confidence level

Data Taking with $\vec{p}\,\vec{p}$



spin-orientations: beam (p) + target(q)

$$\frac{\sigma}{\sigma_0}(\phi) = 1 + A_N\{(p_y + q_y)\cos\phi + q_x \sin\phi\}$$

$$+ A_{NN}\{p_y q_y \cos^2\phi - q_x p_y \sin\phi\cos\phi\}$$

$$+ A_{SS}\{p_y q_y \sin^2\phi + q_x p_y \sin\phi\cos\phi\}$$

$$+ A_{SL}\; p_y q_z \cos\phi$$

Results: Analyzing Power

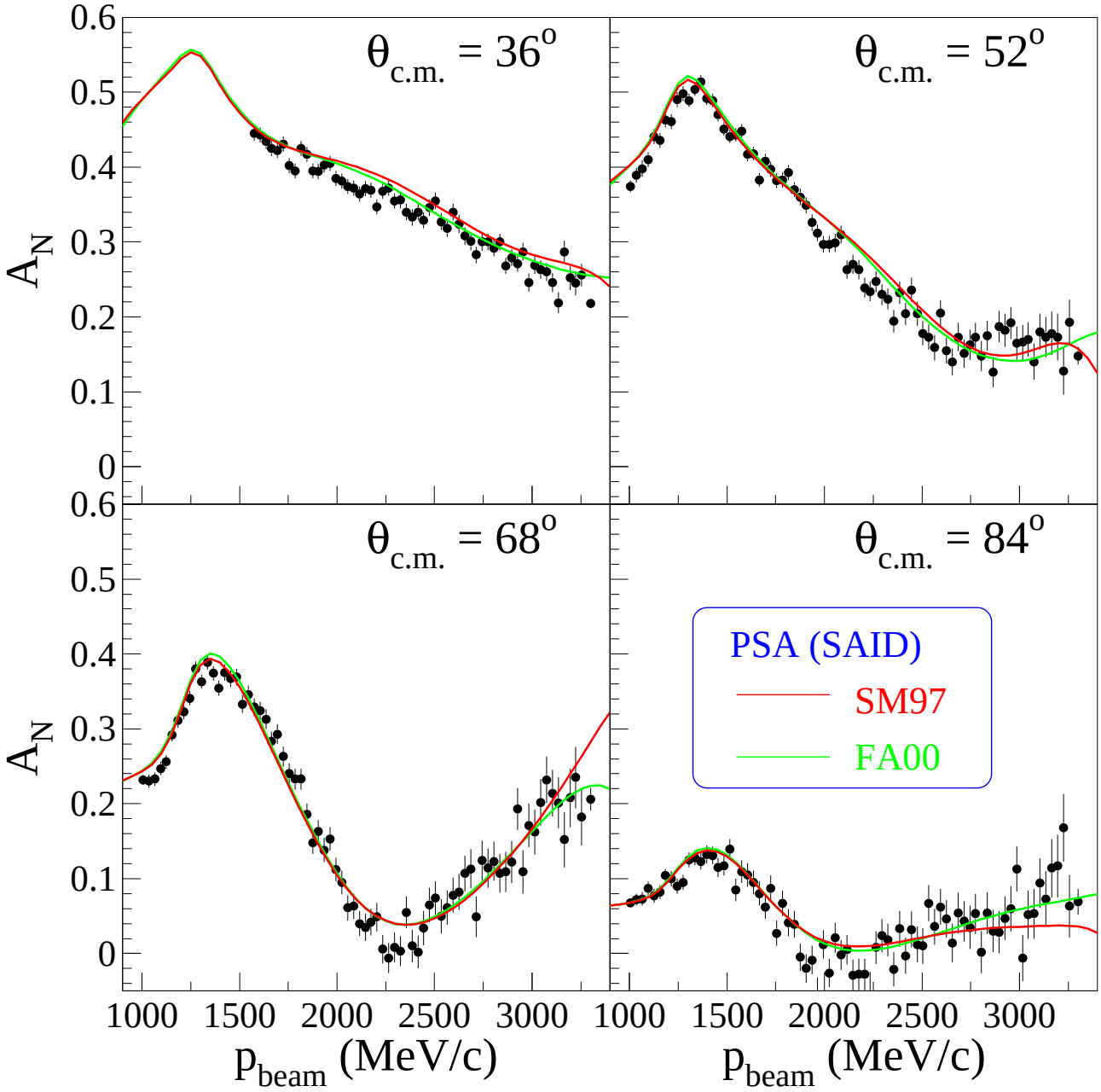
M.Altmeier et al. *Phys. Rev. Lett.* **85** ,1819 (2000)

$p \vec{p}$

25×10^6 Events

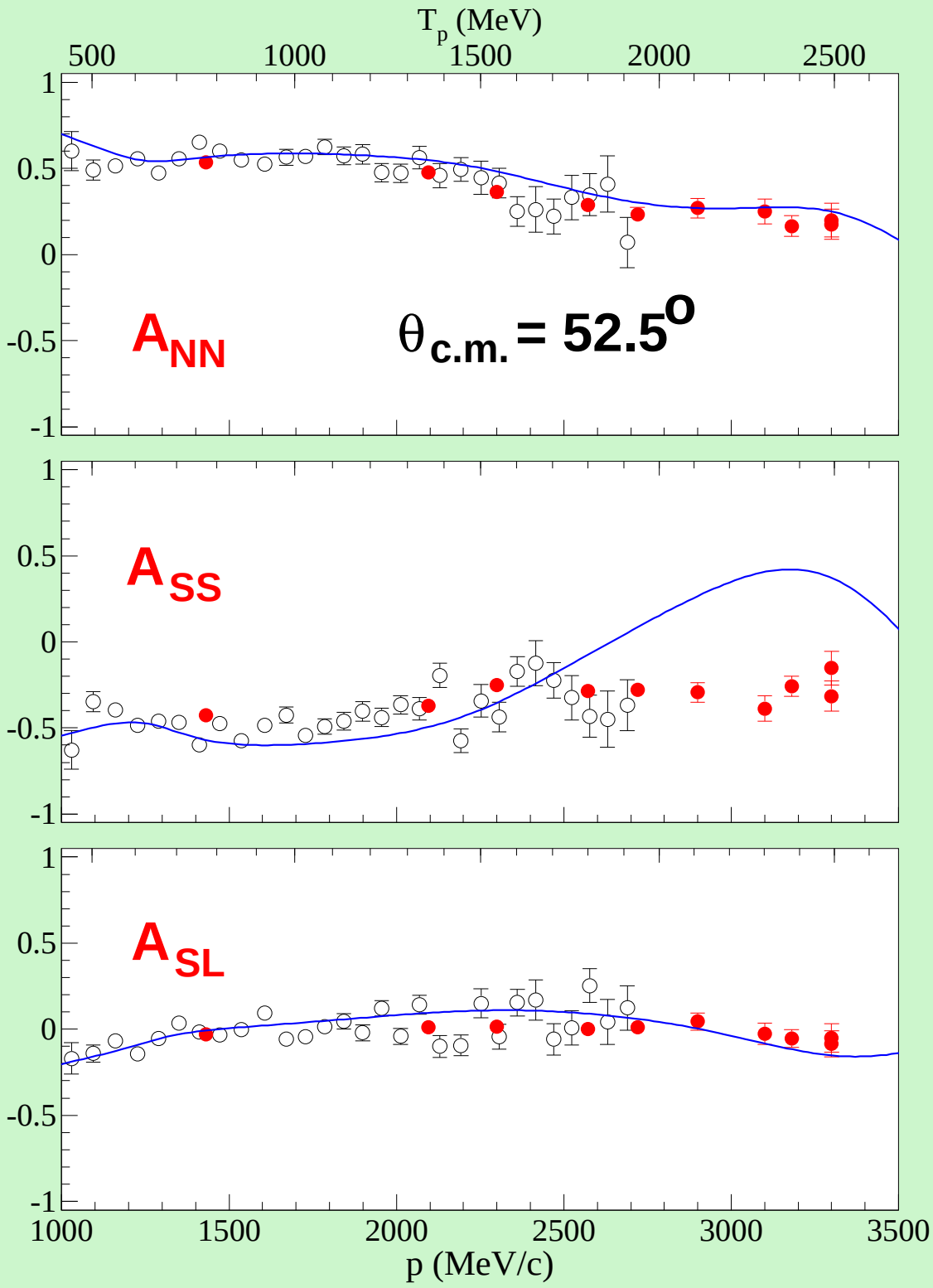
$\Delta\theta = 4°$

$\Delta p = 30$ MeV/c



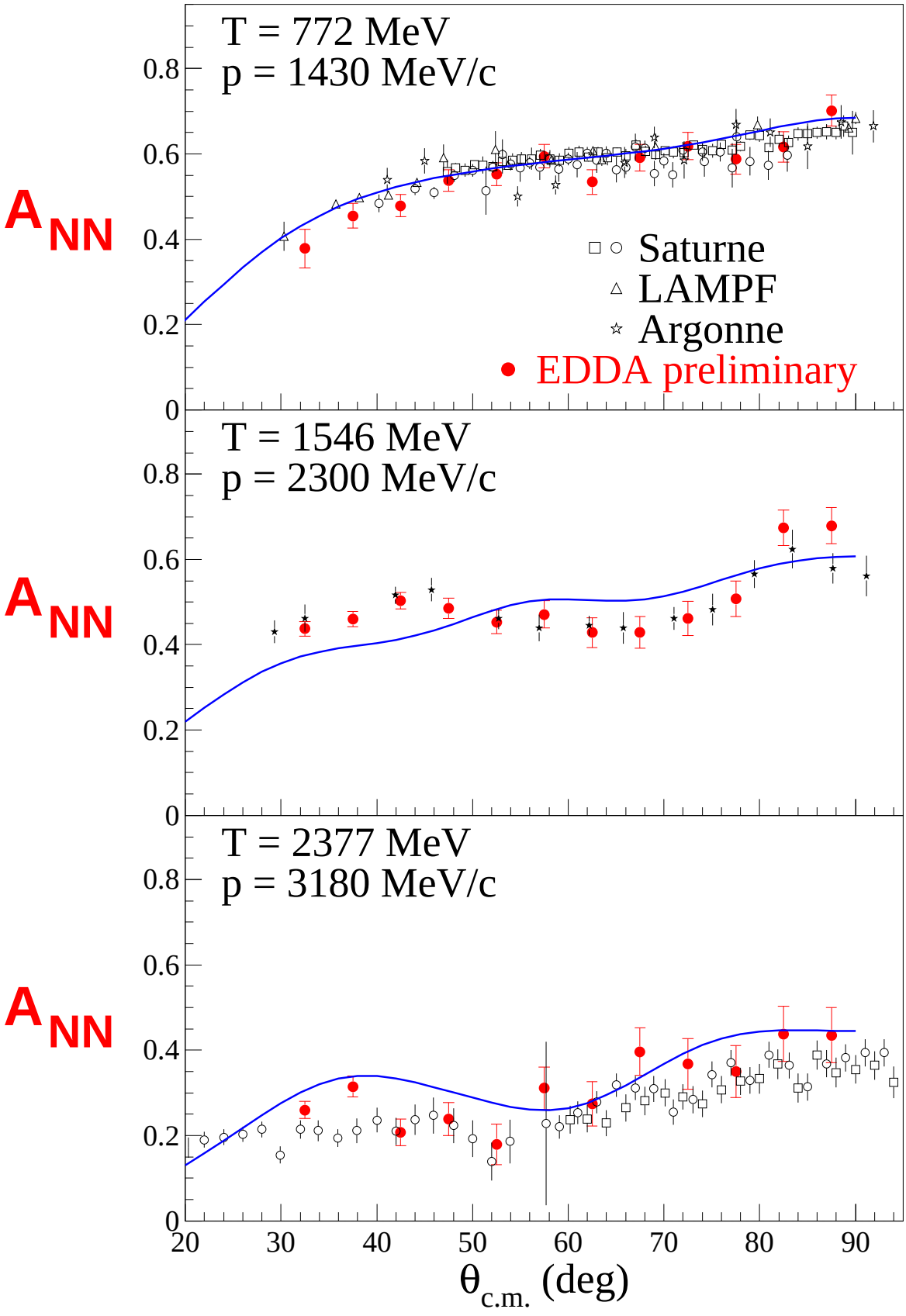
Anregungsfunktionen

EDDA preliminary



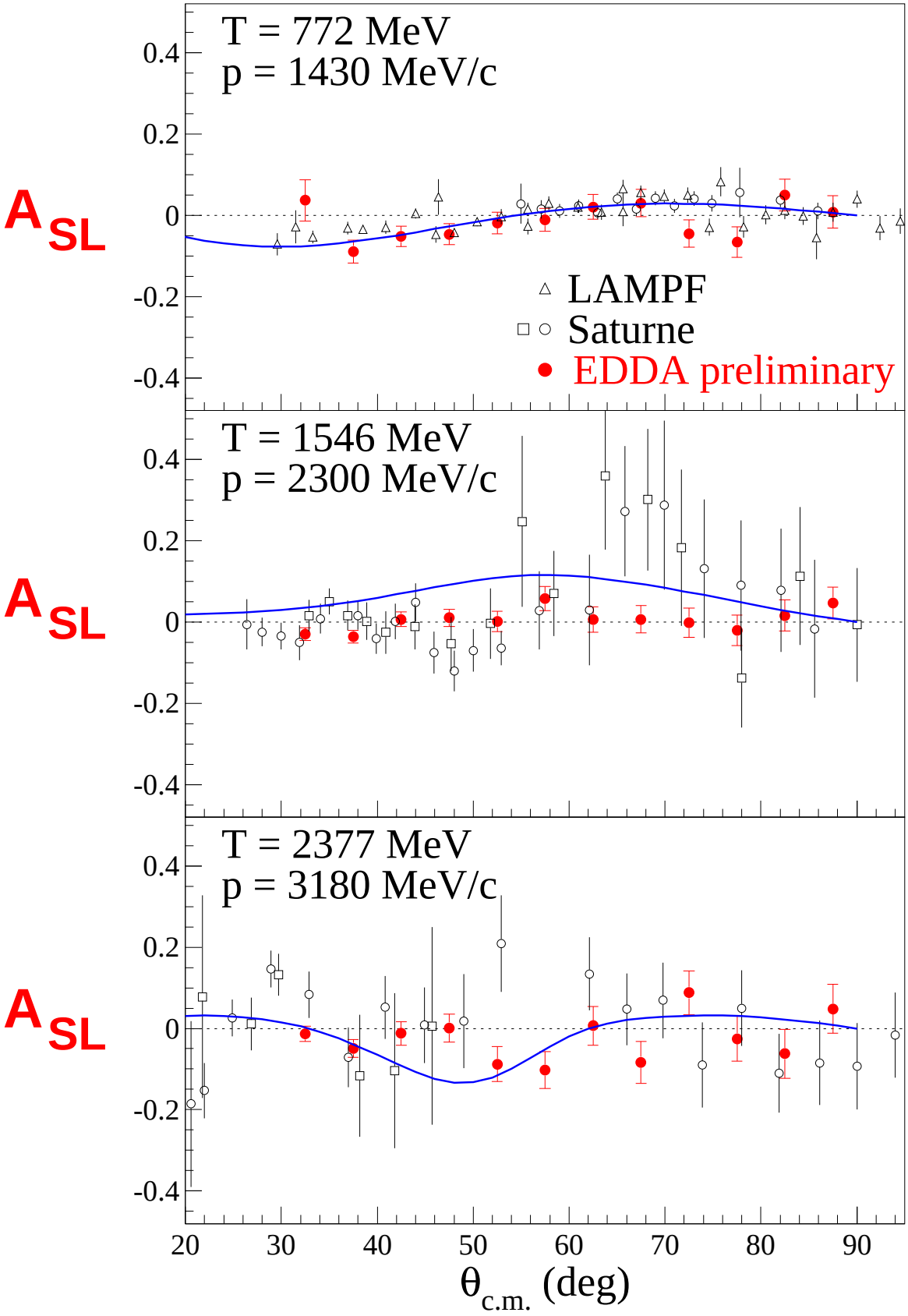
PSA (SAID SM00)

Spinkorrelationsparameter



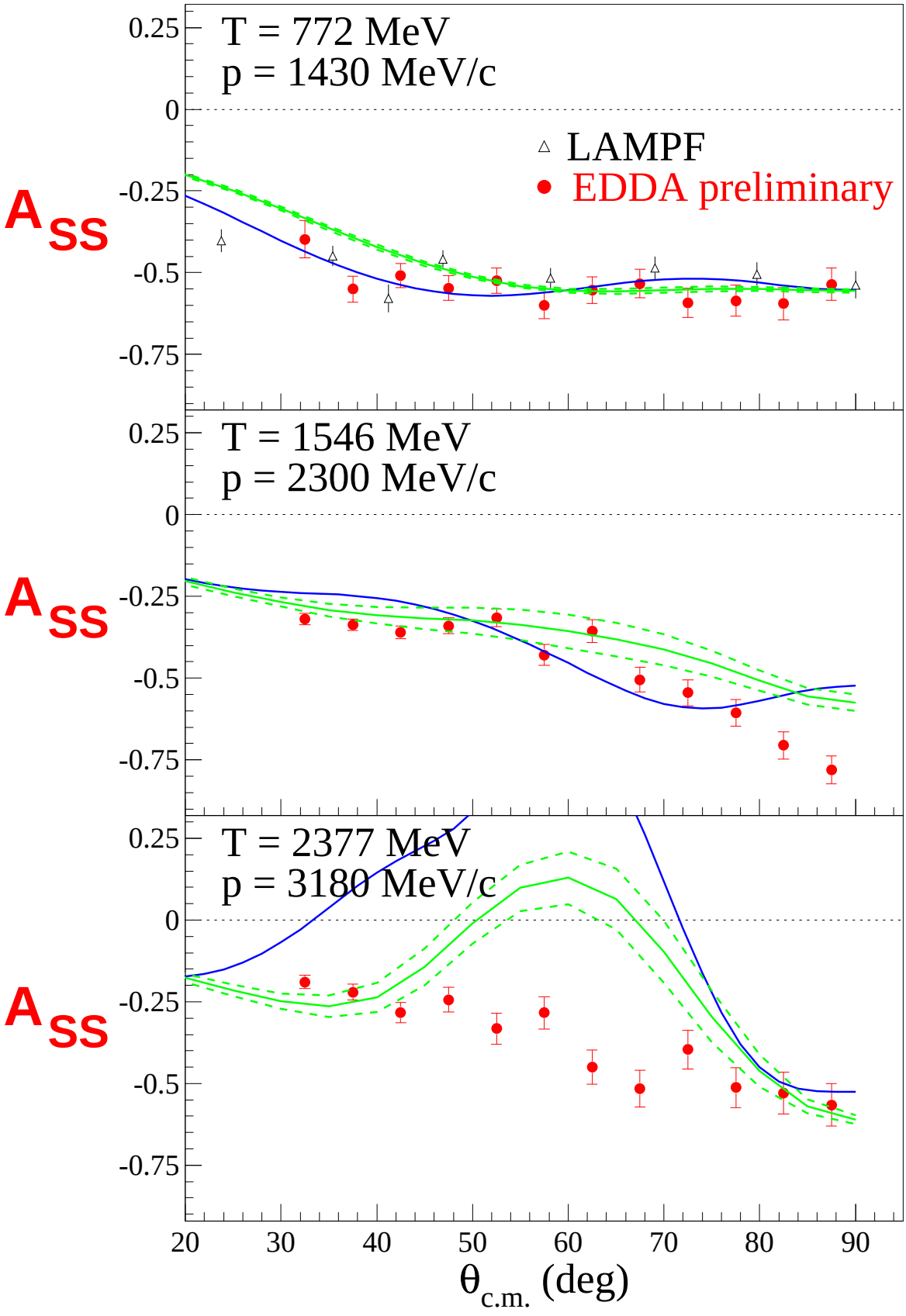
PSA: SAID(SM00)

Spinkorrelationsparameter



PSA: SAID(SM00)

Spinkorrelationsparameter



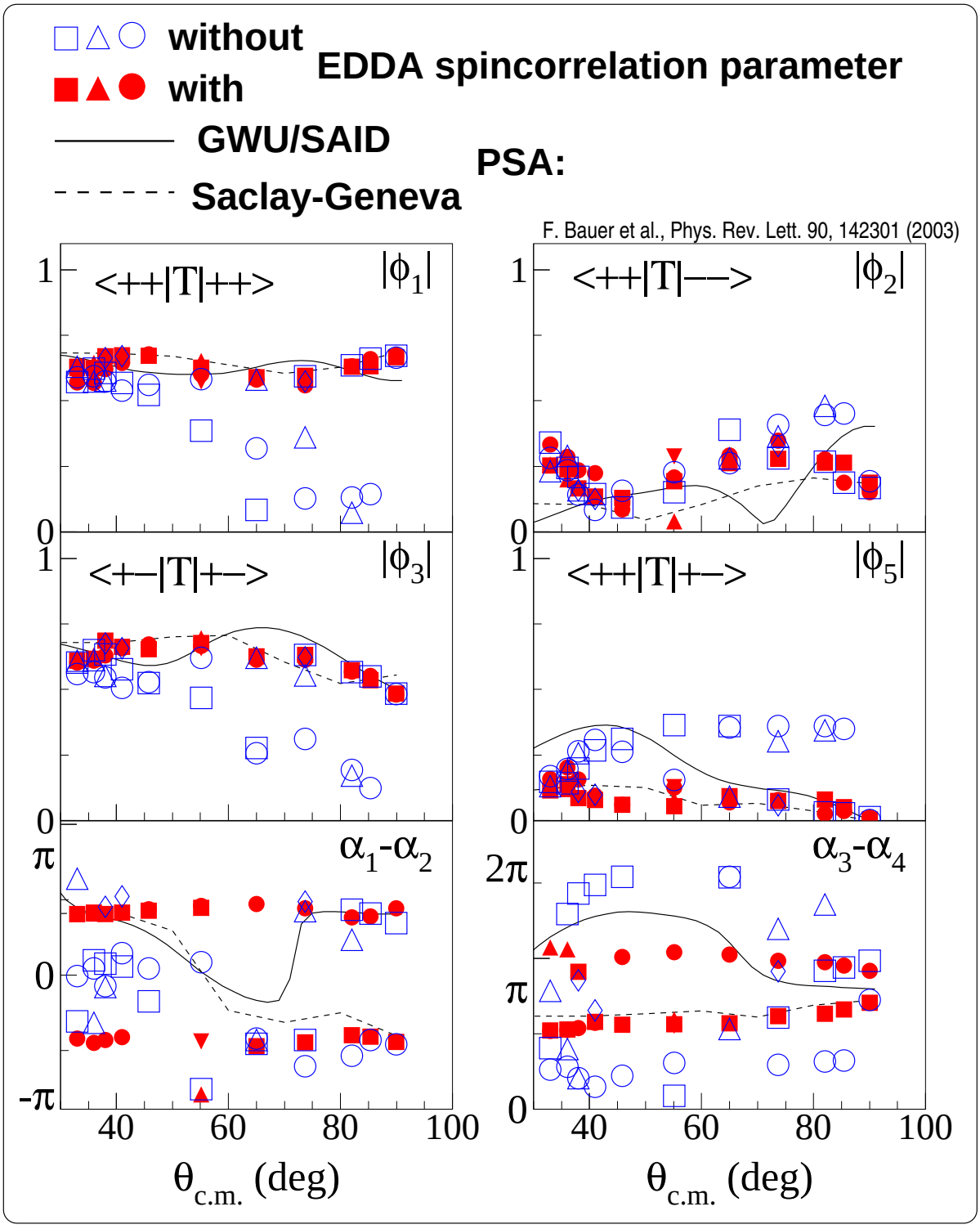
PSA: SAID(SM00) Saclay-Genf

Amplitude Reconstruction

Helicity-amplitudes: $\phi_k = |\phi_k|\, e^{i\alpha_k}$

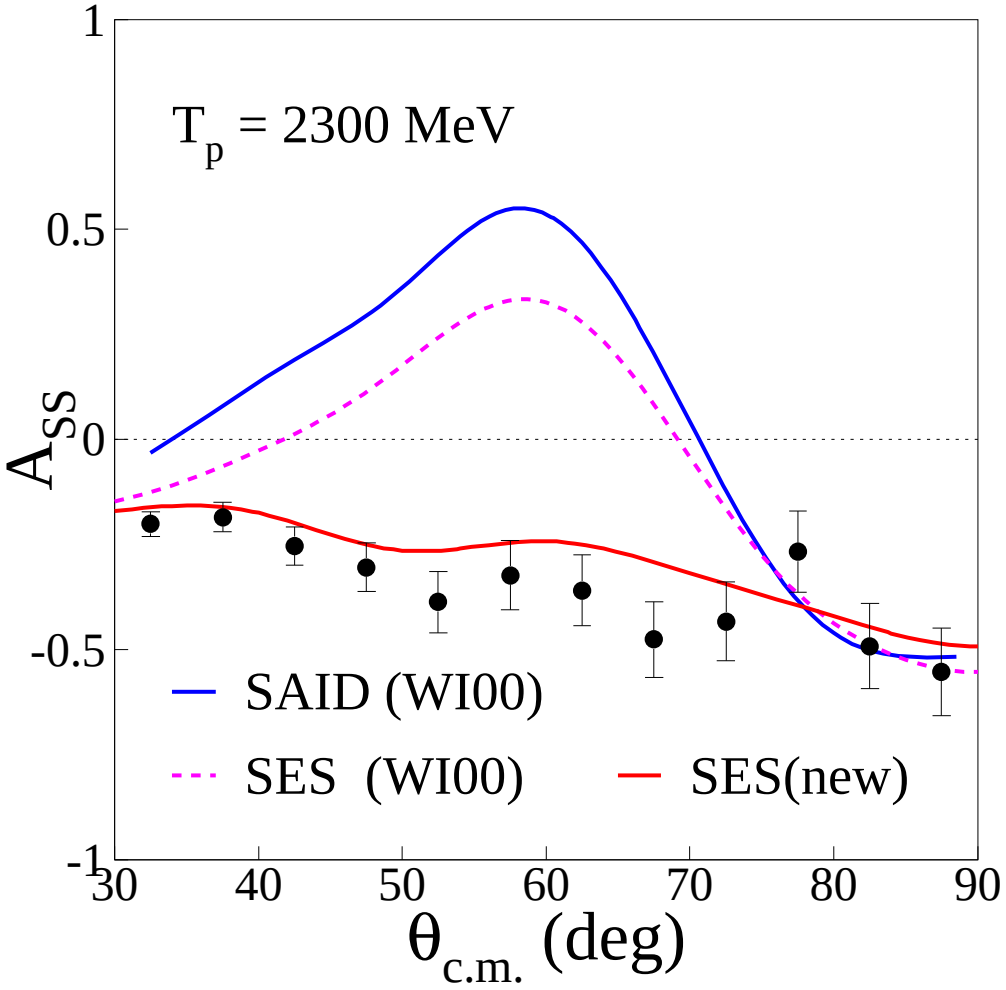
Observables: e.g.

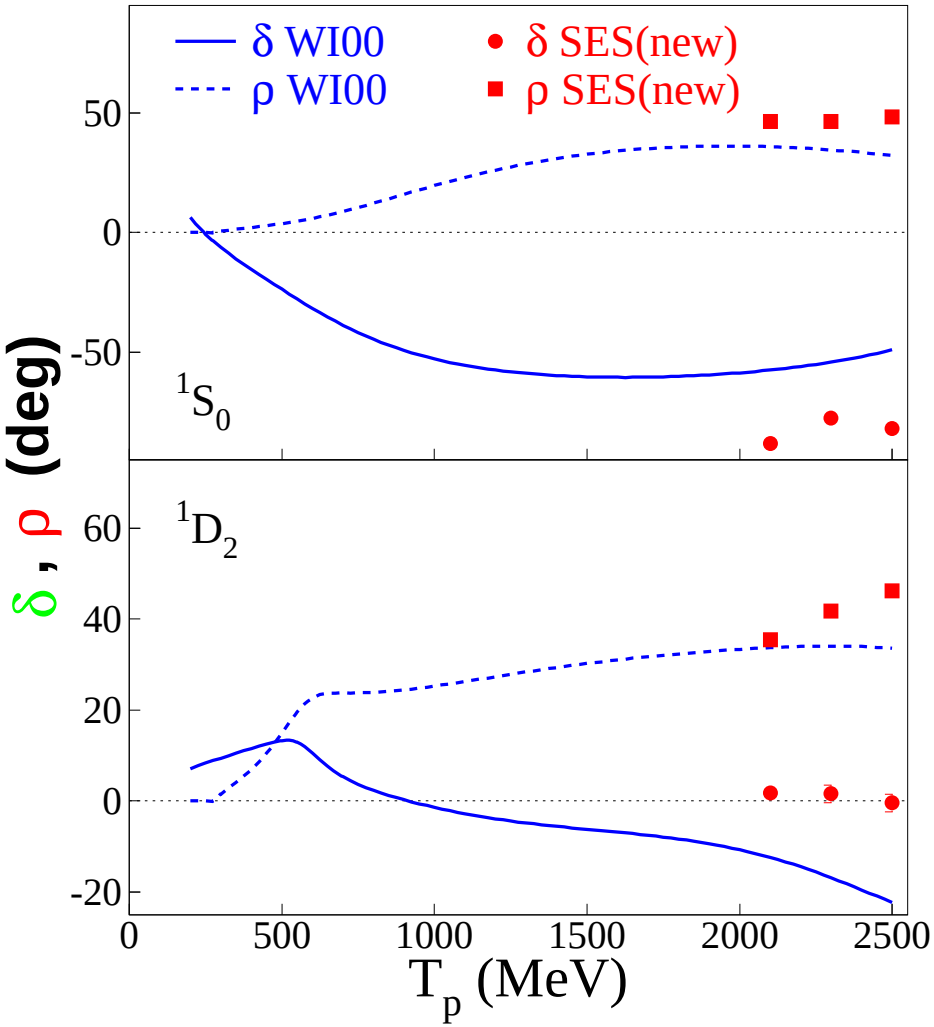
$$A_{SS}\sigma_0 = |\phi_1||\phi_2|\cos(\alpha_1-\alpha_2)+|\phi_3||\phi_4|\cos(\alpha_3-\alpha_4)$$



F.Bauer et al., Phys. Rev. Lett. 90, 142301 (2003)

A_{SS} : Influence on PSA





Status of Theory

Low Energy 0-300 (500) MeV

- phenomenological potentials
- meson exchange (e.g. Bonn,Paris) 80s
- effective field theory (χPT) > 1990

? **COSY-Energies 0.5 -2.5 GeV** ?

- inelastic channels
- resonances
- short-range

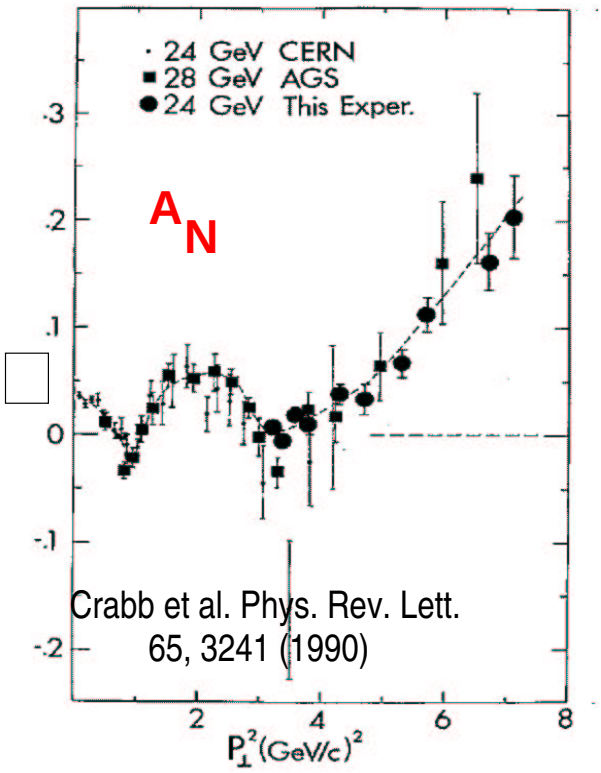
High Energy >> 10 GeV

- Regge-theory
- pQCD (s,t $\longrightarrow \infty$)

$$d\sigma/dt \propto F(\theta)/s^{10}$$

$$\phi_5 = \langle ++|T|+-\rangle = 0$$

$\Rightarrow$ $A_N = 0$

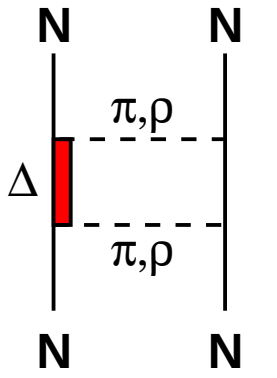


Meson Exchange Model

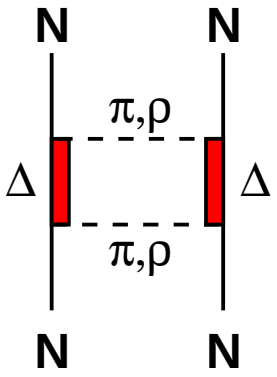
OBE

π,ρ,ω,σ,δ,η

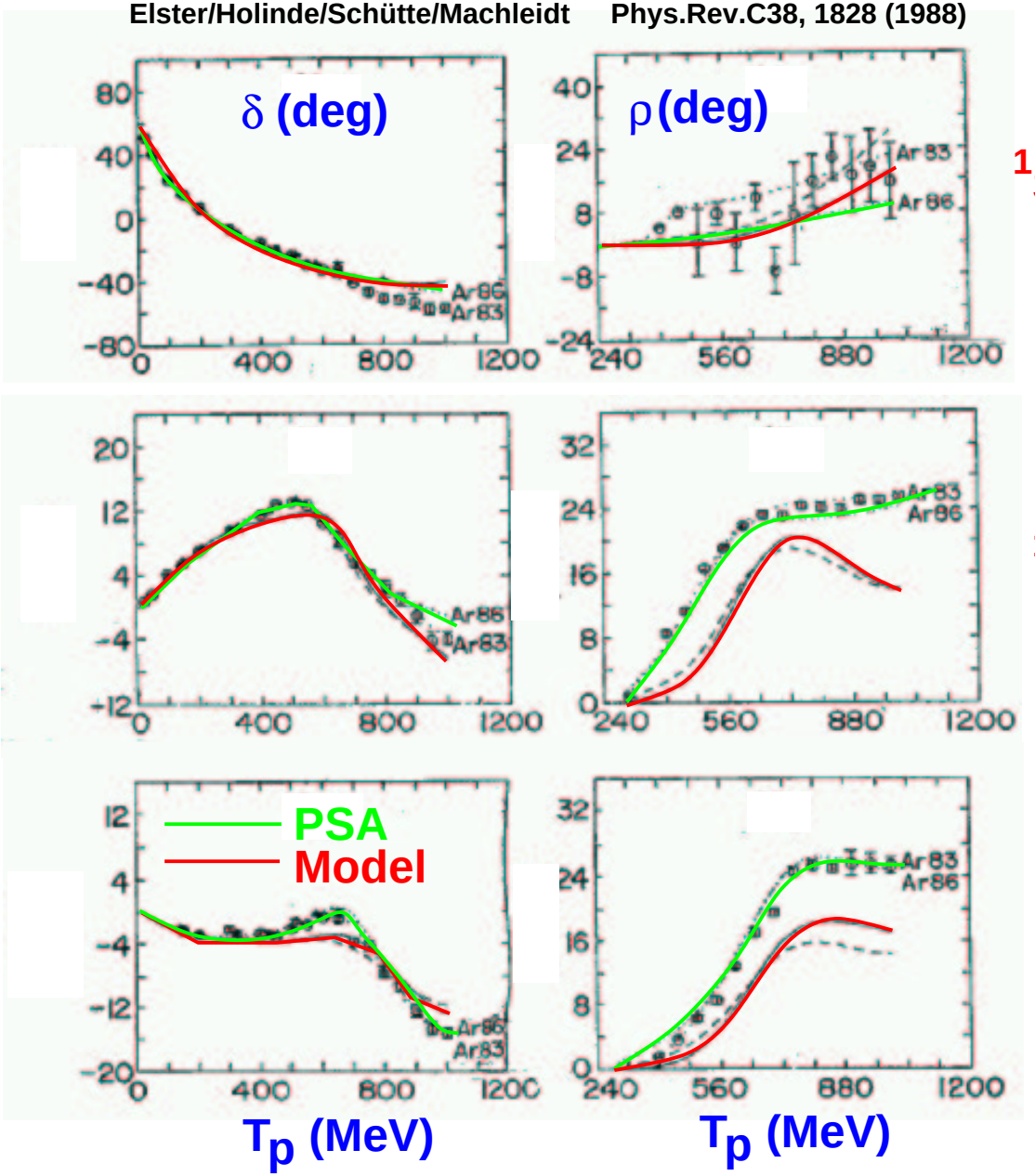
+

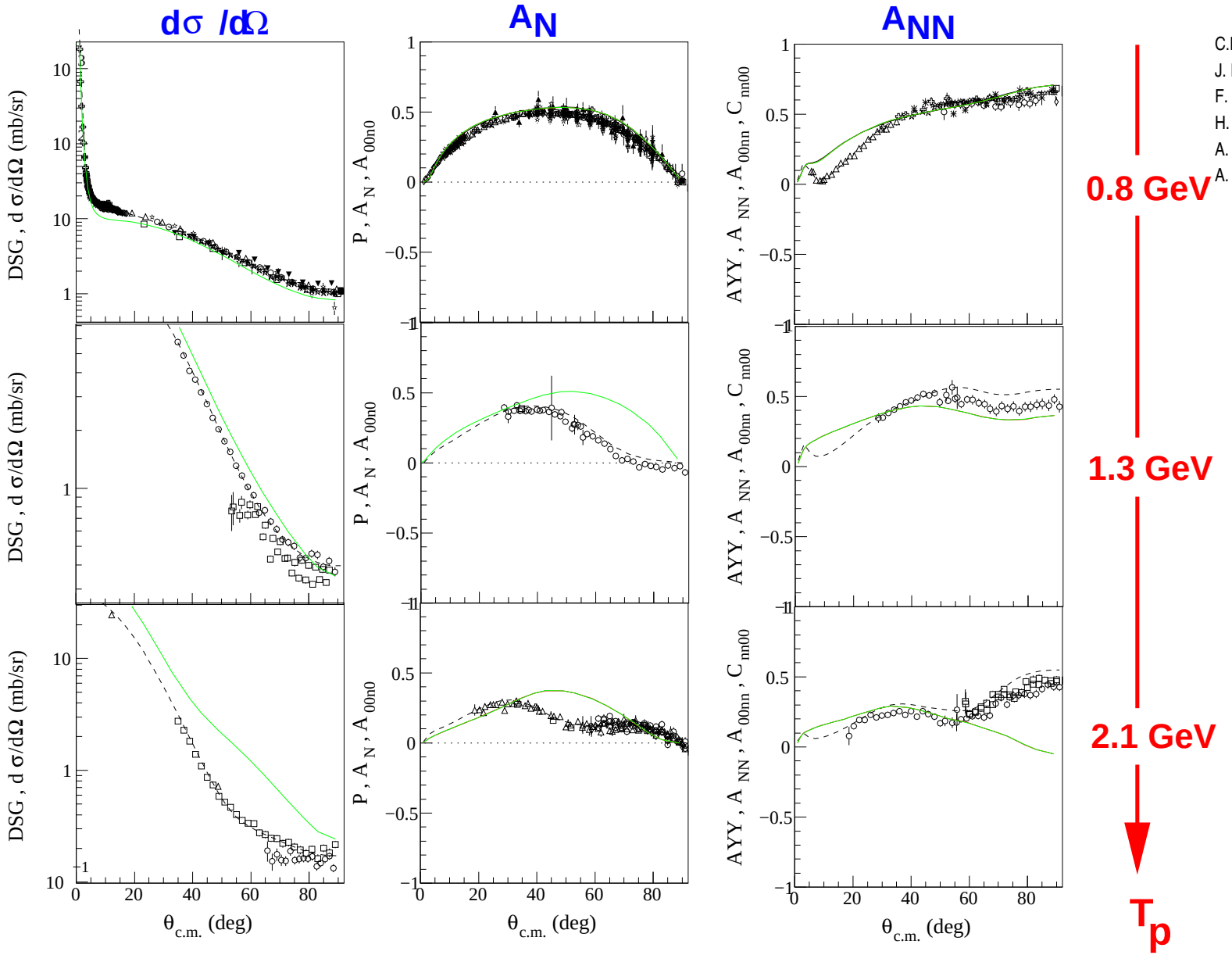


+



Elster/Holinde/Schütte/Machleidt Phys.Rev.C38, 1828 (1988)




dσ /dΩ
A_N
A_NN
DSG , d σ/dΩ (mb/sr)
P , A_N , A_00n0
AYY , A_NN , A_00nn , C_nn00
θ_c.m. (deg)
0.8 GeV
1.3 GeV
2.1 GeV
T_p
C.Elster
J. Haidenbauer
F. Hinterberger
H. Rohdjess
A. Schwick
A. Sibirtsev

Conclusion

$\frac{d\sigma}{d\Omega}$: updated analysis increased precision

⇒ resonant contributions excluded

W_R = 2.2...2.8 GeV , Γ = 10...100 MeV

$\eta_{el} >$ 3..10% with 99% CL

A_N : polarization standard in COSY energy range

A_{NN} A_{SS} A_{SL}

⇒ reduce ambiguities in amplitudes

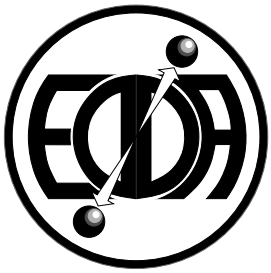
⇒ PSA

< 1 GeV ✓

> 1 GeV ?

Theory for NN → NN above 1 GeV?

⇒ work has started



The EDDA Collaboration

Spokesmen: J. Bisplinghoff, F. Hinterberger and W. Scobel,

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