SPIN 2002, BNL

Spinobservables in Proton-Proton Elastic Scattering

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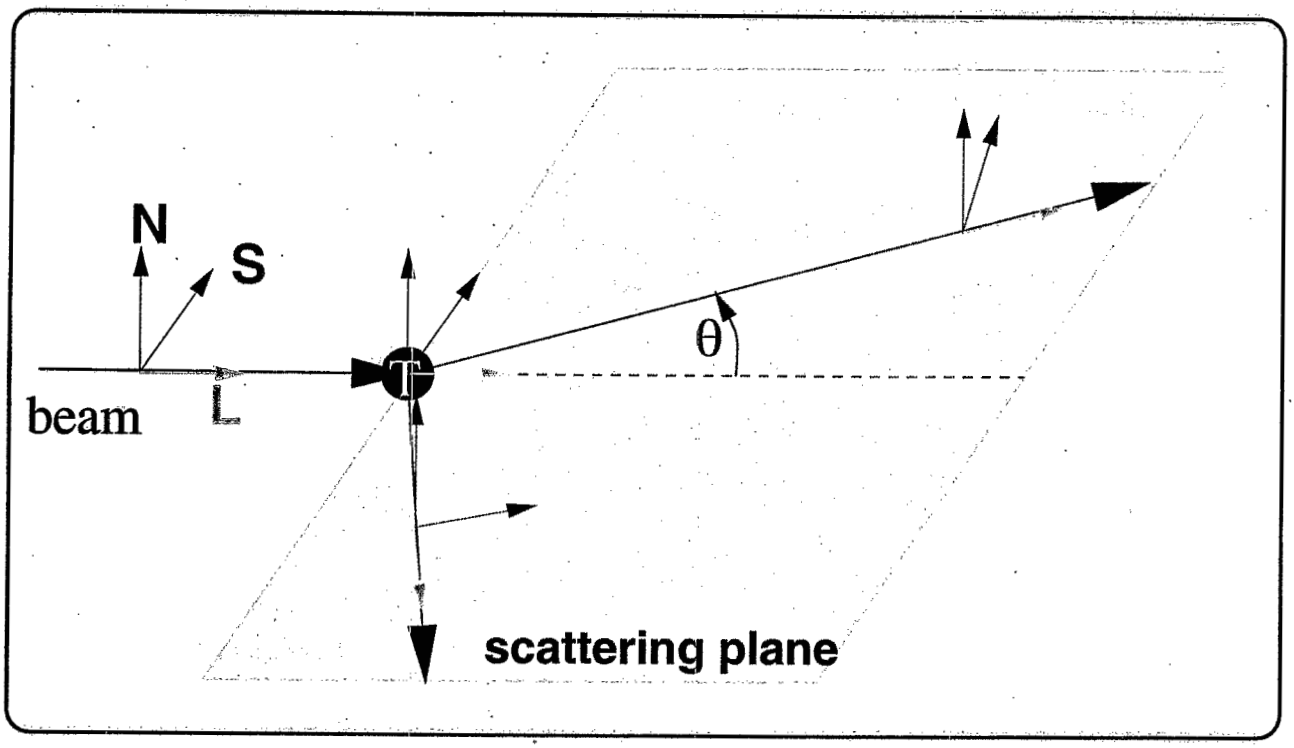
for the EDDA-collaboration (Bonn, Hamburg, Jülich)

$\overset{(\rightarrow)}{p}\ \overset{(\rightarrow)}{p} \longrightarrow p\ p \qquad T_p = 0.5 \ldots 2.5\ \mathrm{GeV}$

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



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

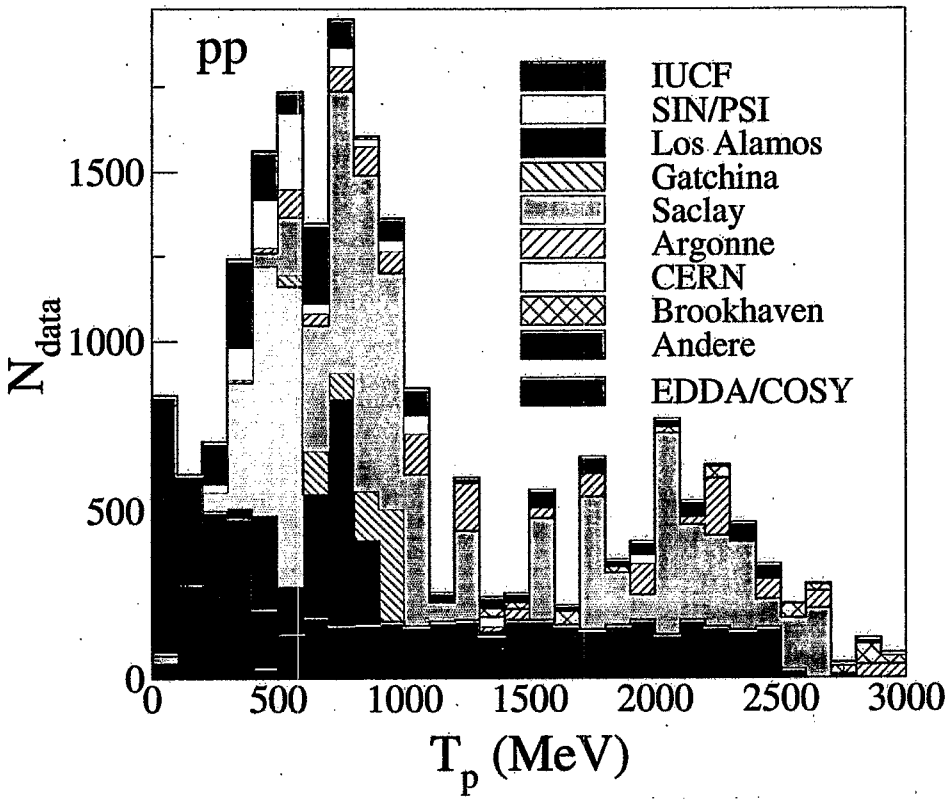
→ **predicitive power !!**

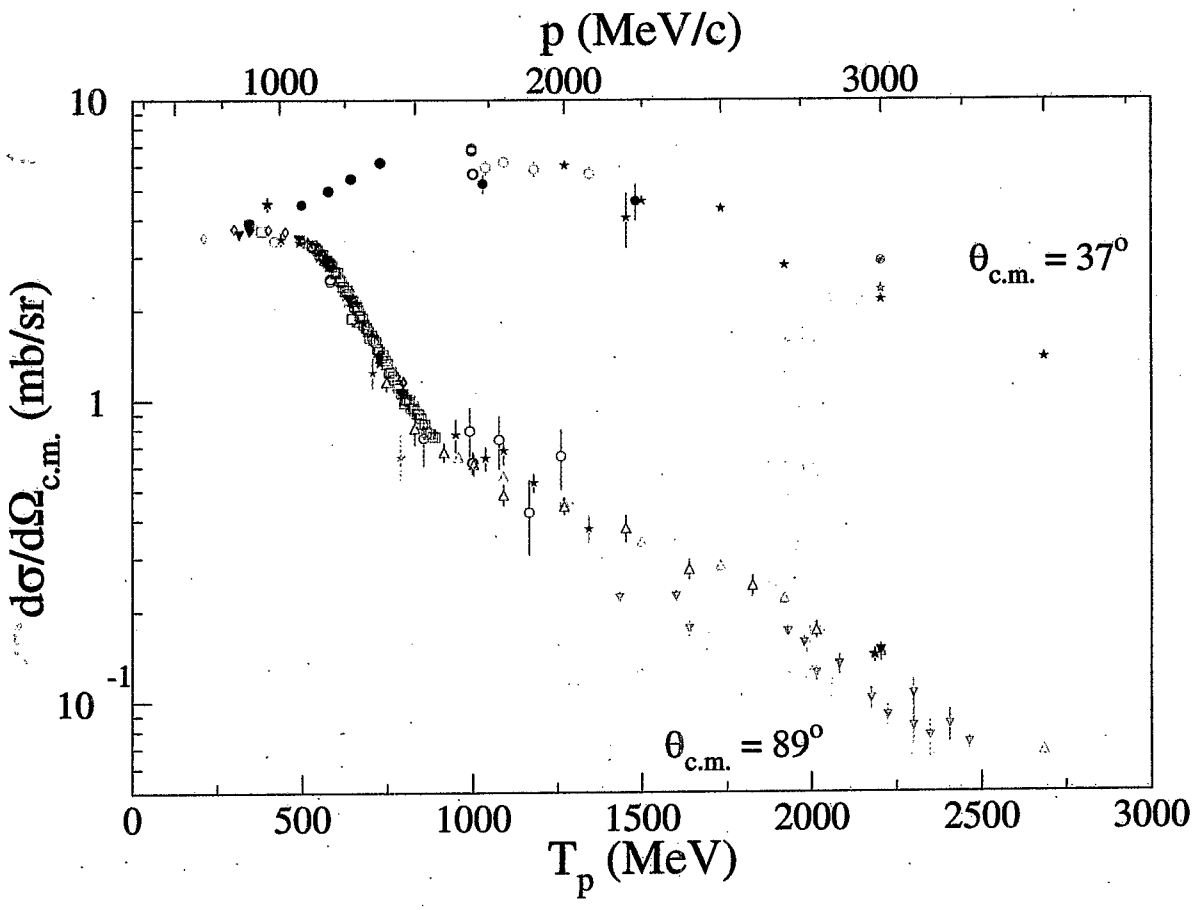
e.g. VPI (SAID) R. Arndt et al.

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

⟷ **theory**

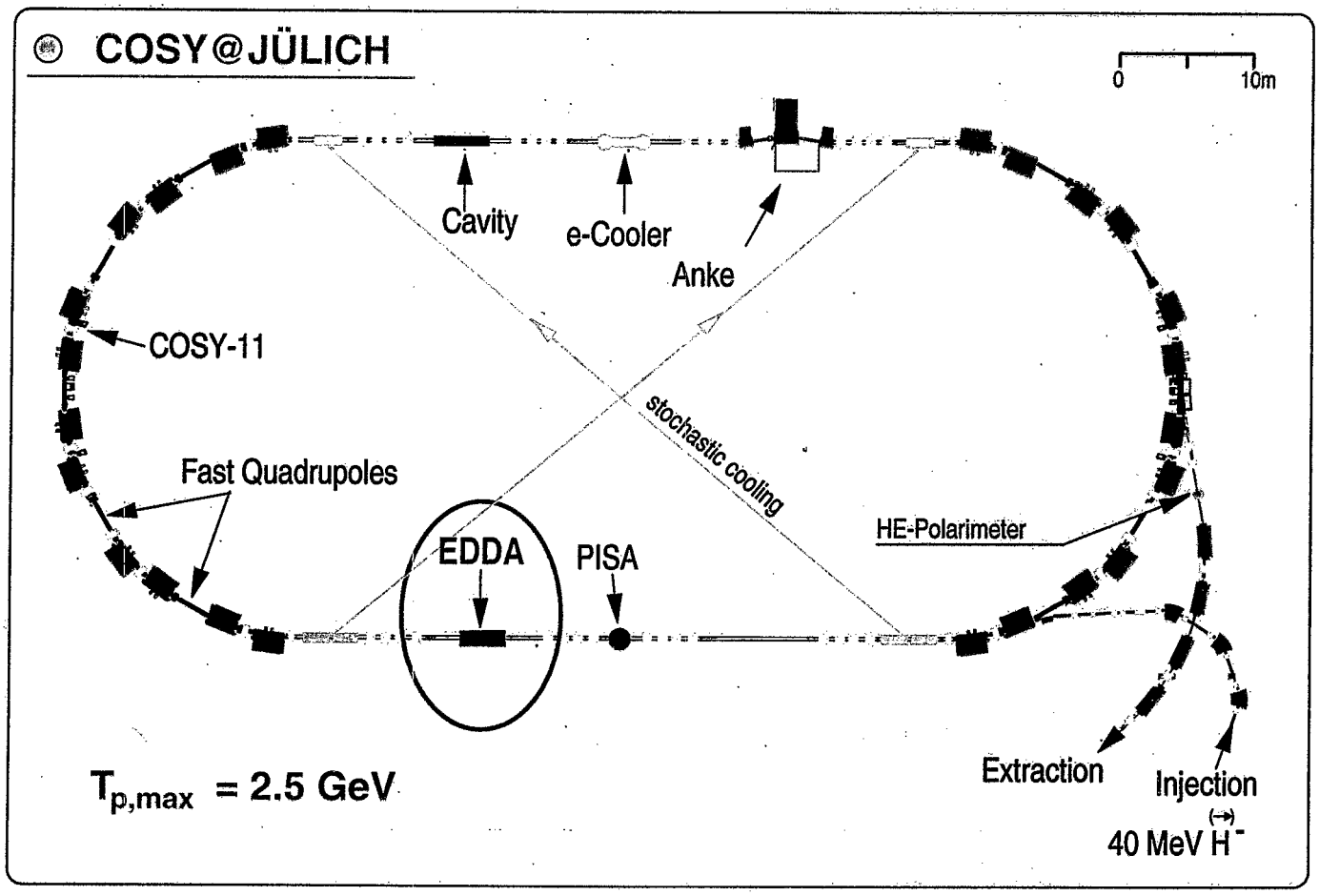
NN Database


pp
IUCF
SIN/PSI
Los Alamos
Gatchina
Saclay
Argonne
CERN
Brookhaven
Andere
EDDA/COSY
N_{data}
0
500
1000
1500
0
500
1000
1500
2000
2500
3000
T_p (MeV)


p (MeV/c)
1000
2000
3000
10
1
10^{-1}
$d\sigma/d\Omega_{c.m.}$ (mb/sr)
$\theta_{c.m.} = 37^o$
$\theta_{c.m.} = 89^o$
0
500
1000
1500
2000
2500
3000
T_p (MeV)

Experimental Technique

COSY@JÜLICH



$T_{p,max}$ = 2.5 GeV

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

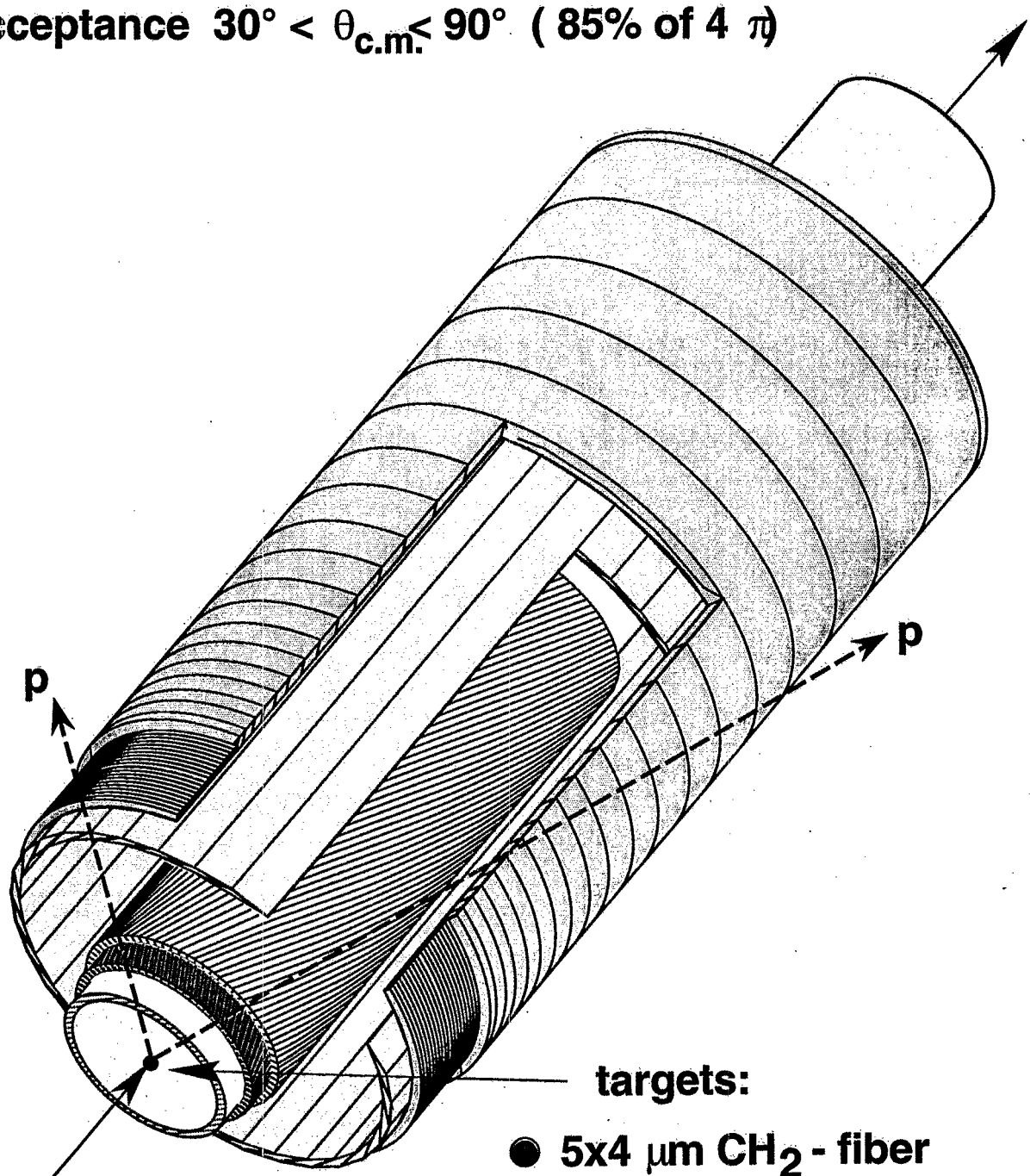
small energy steps $p\,p \longrightarrow B_2 \longrightarrow p\,p$

Γ? W_R?

EDDA@COSY: Detector

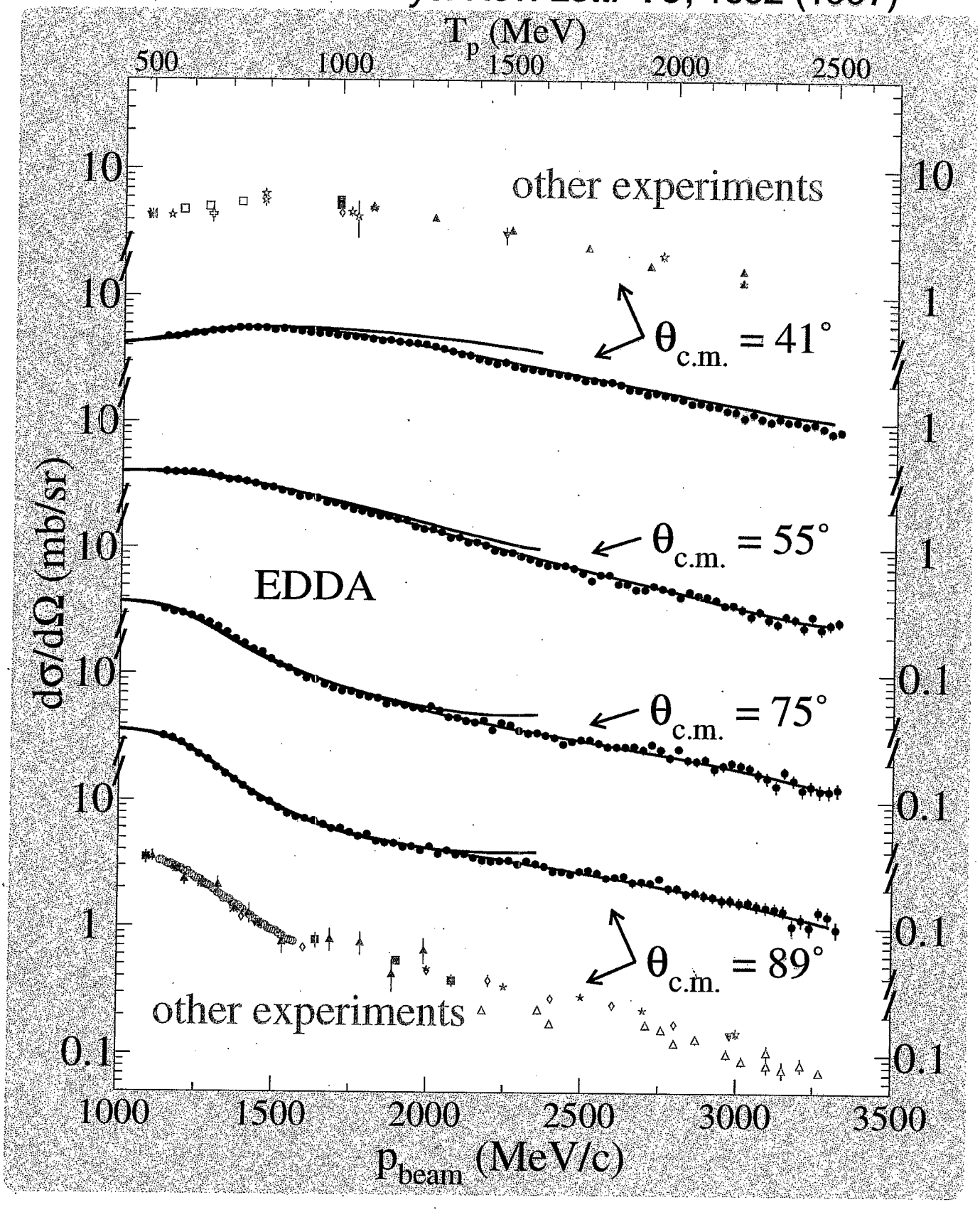
Bonn,Hamburg,Jülich

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



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

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



SAID PSA: SM94, SM97

Results: Analyzing Power

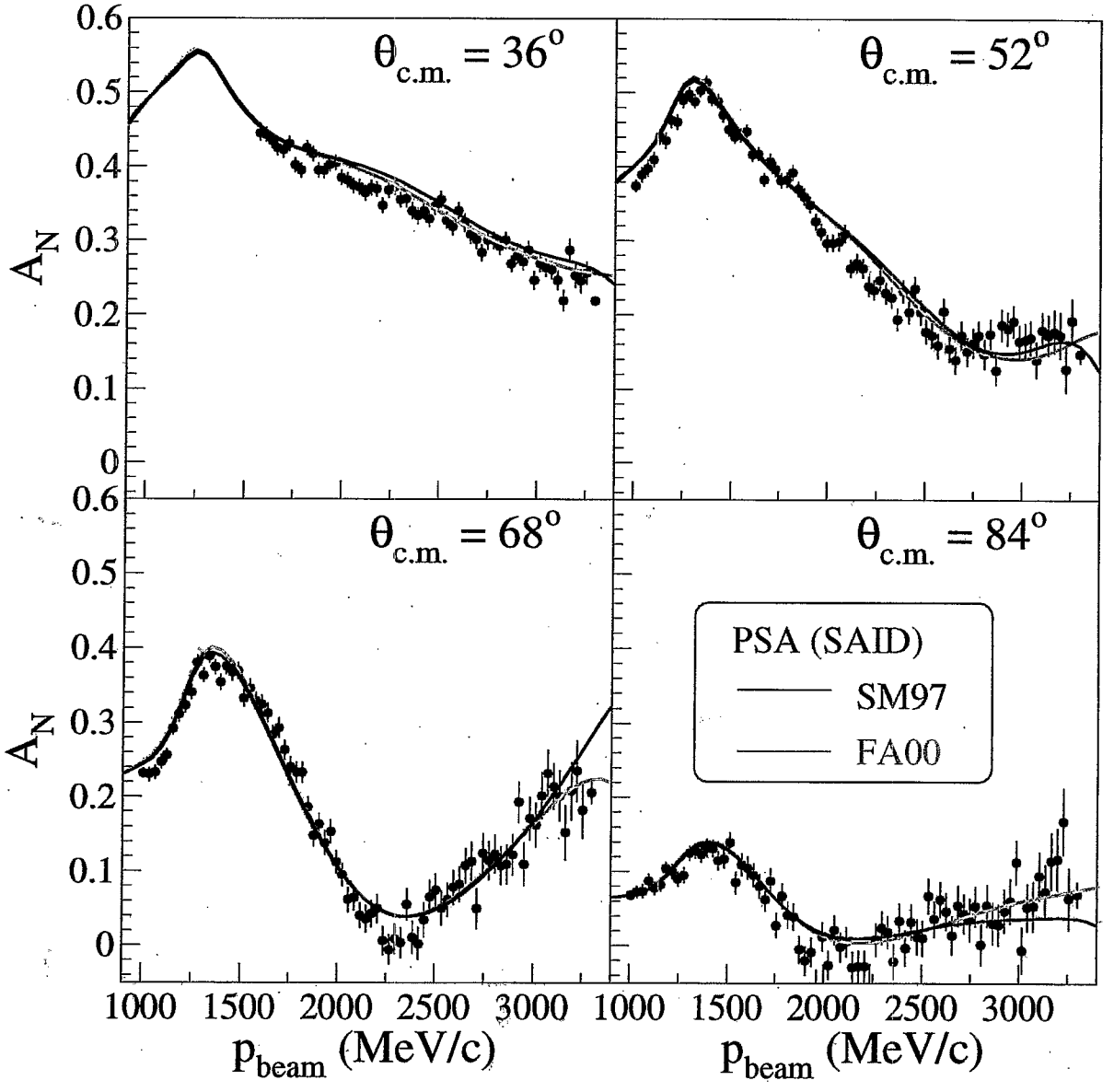
M.Altmeier et al. *Phys. Rev. Lett.* **85** ,1819 (2000)

$p\vec{p}$

25×10^6 Events

$\Delta\theta = 4°$

$\Delta p = 30$ MeV/c



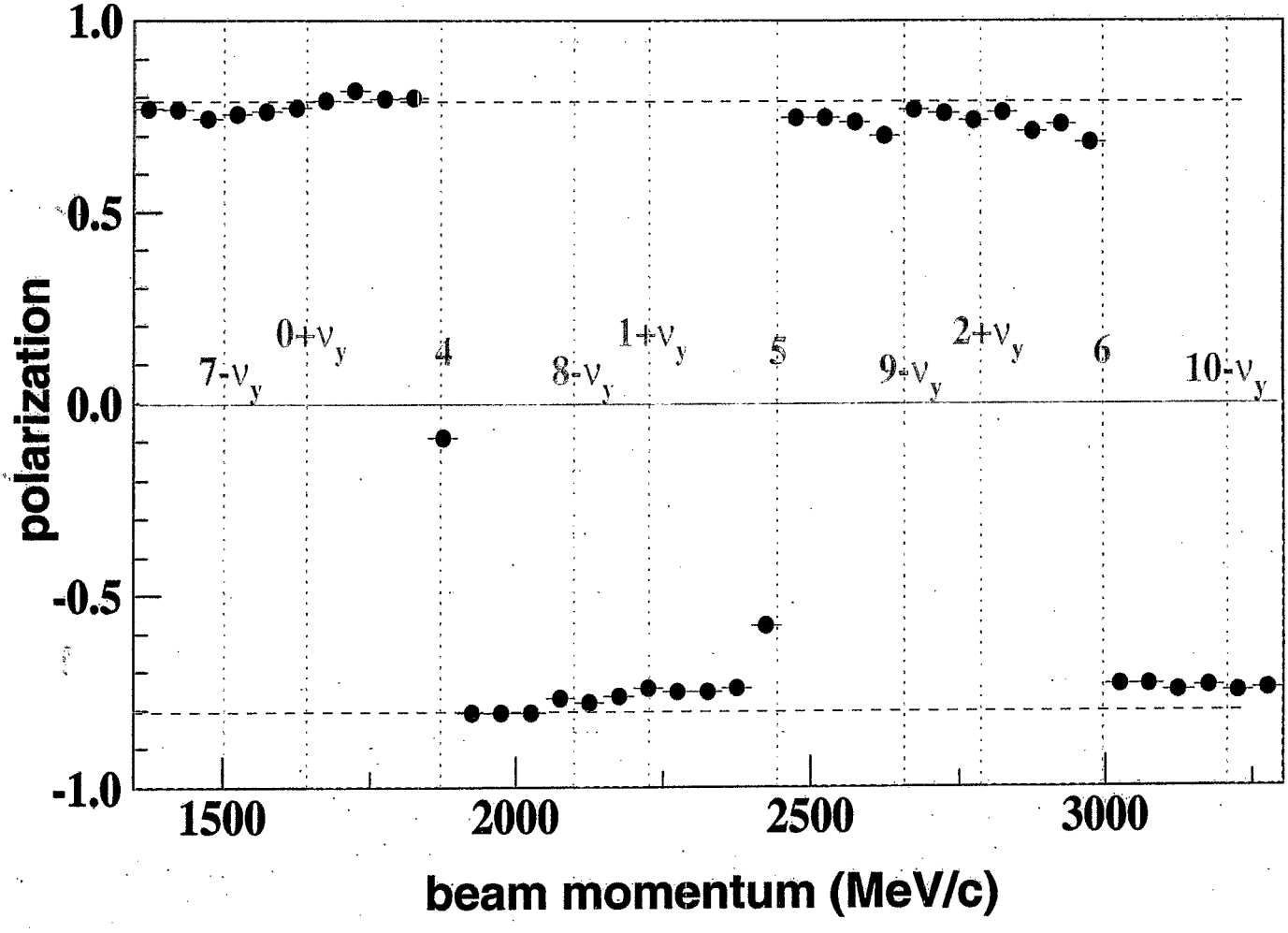
Polarized Beam

- depolarizing resonances

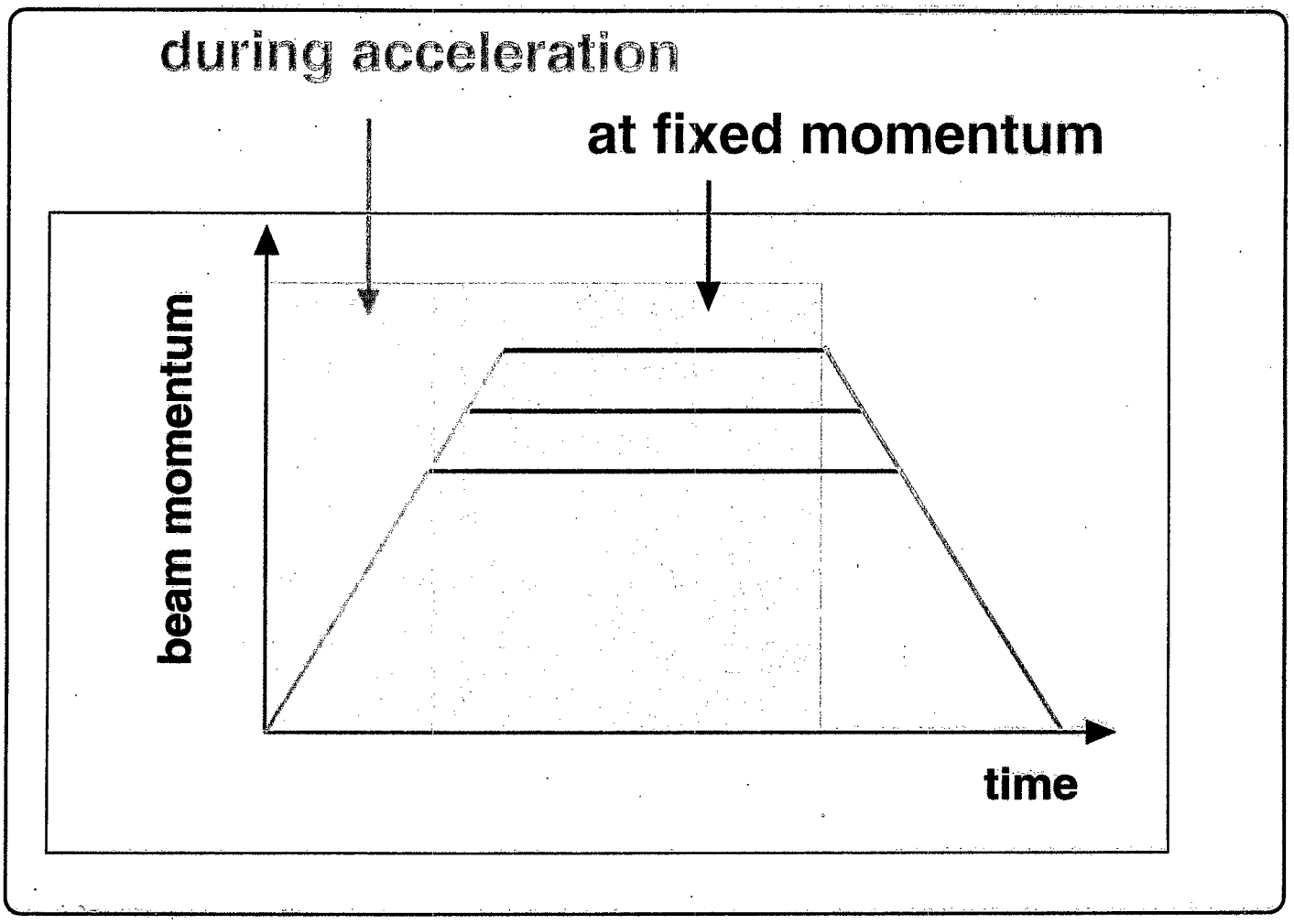
- EDDA as internal polarimeter

$$\varepsilon = \frac{L-R}{L+R} = p\ A_N$$

Status June 2000:



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



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

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

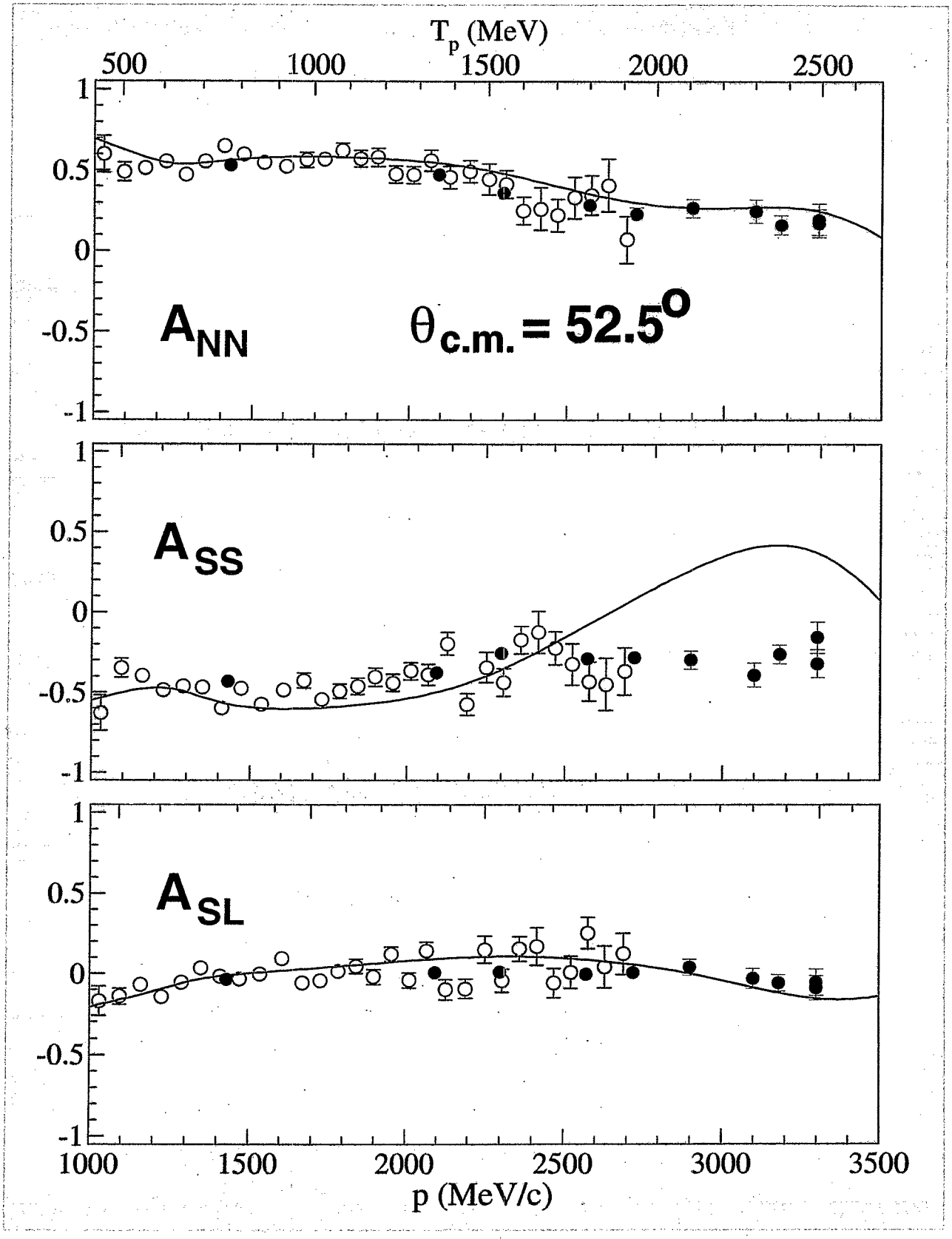
$$+ A_{NN}\{p_y q_y \cos^2\phi - q_x p_y \sin\phi\cos\phi\}$$

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

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

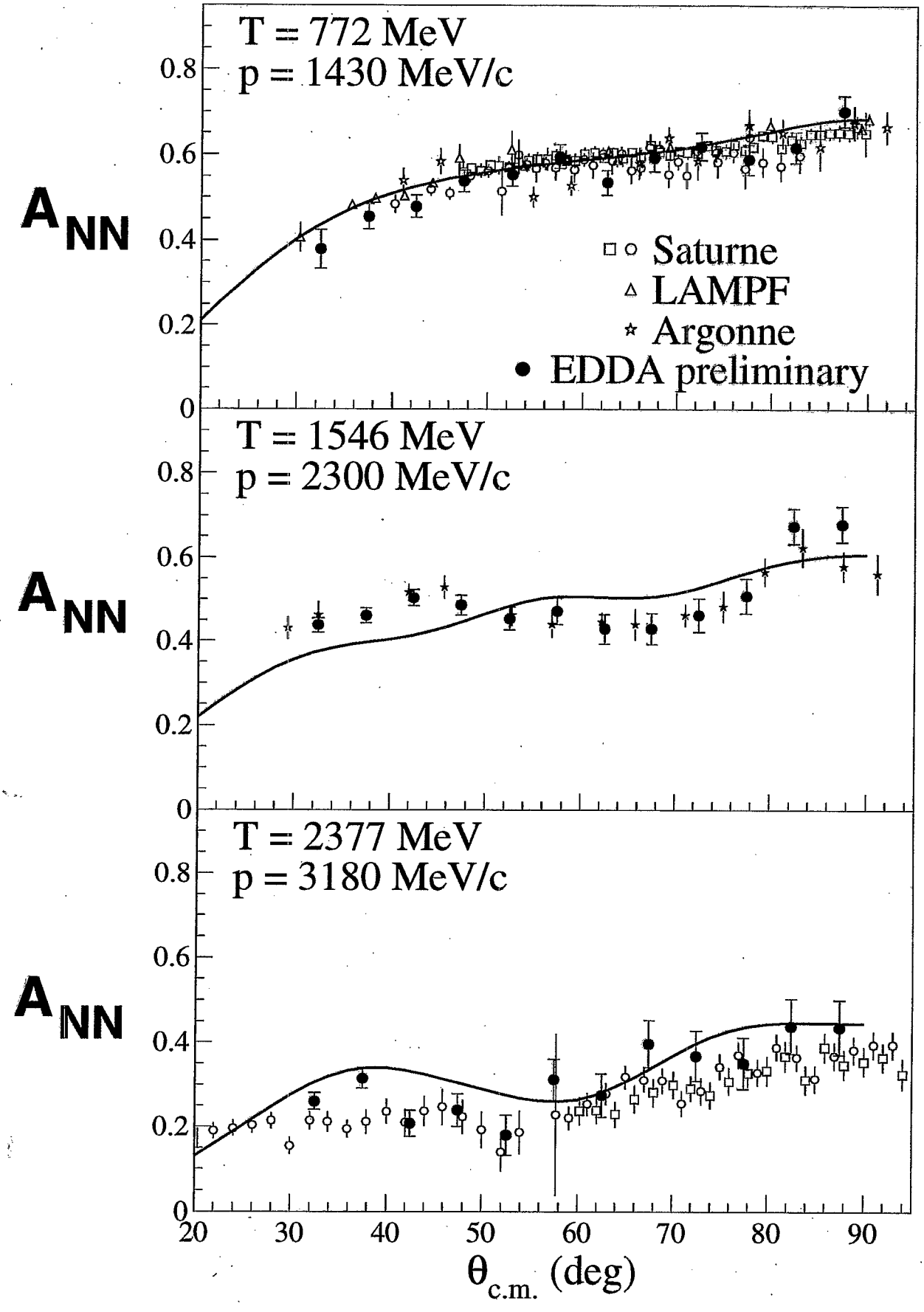
Anregungsfunktionen

EDDA preliminary



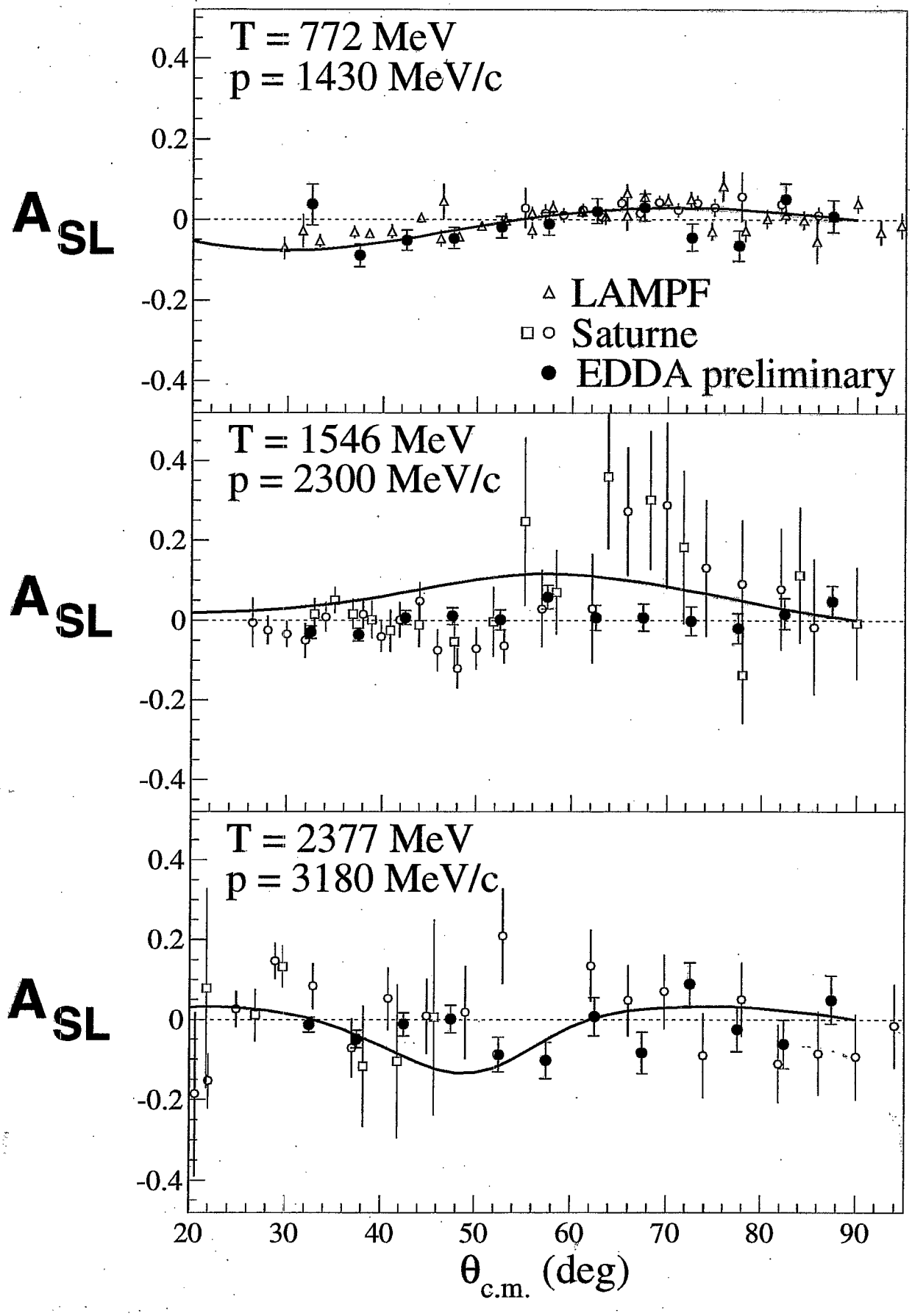
——— PSA (SAID SM00)

Spinkorrelationsparameter



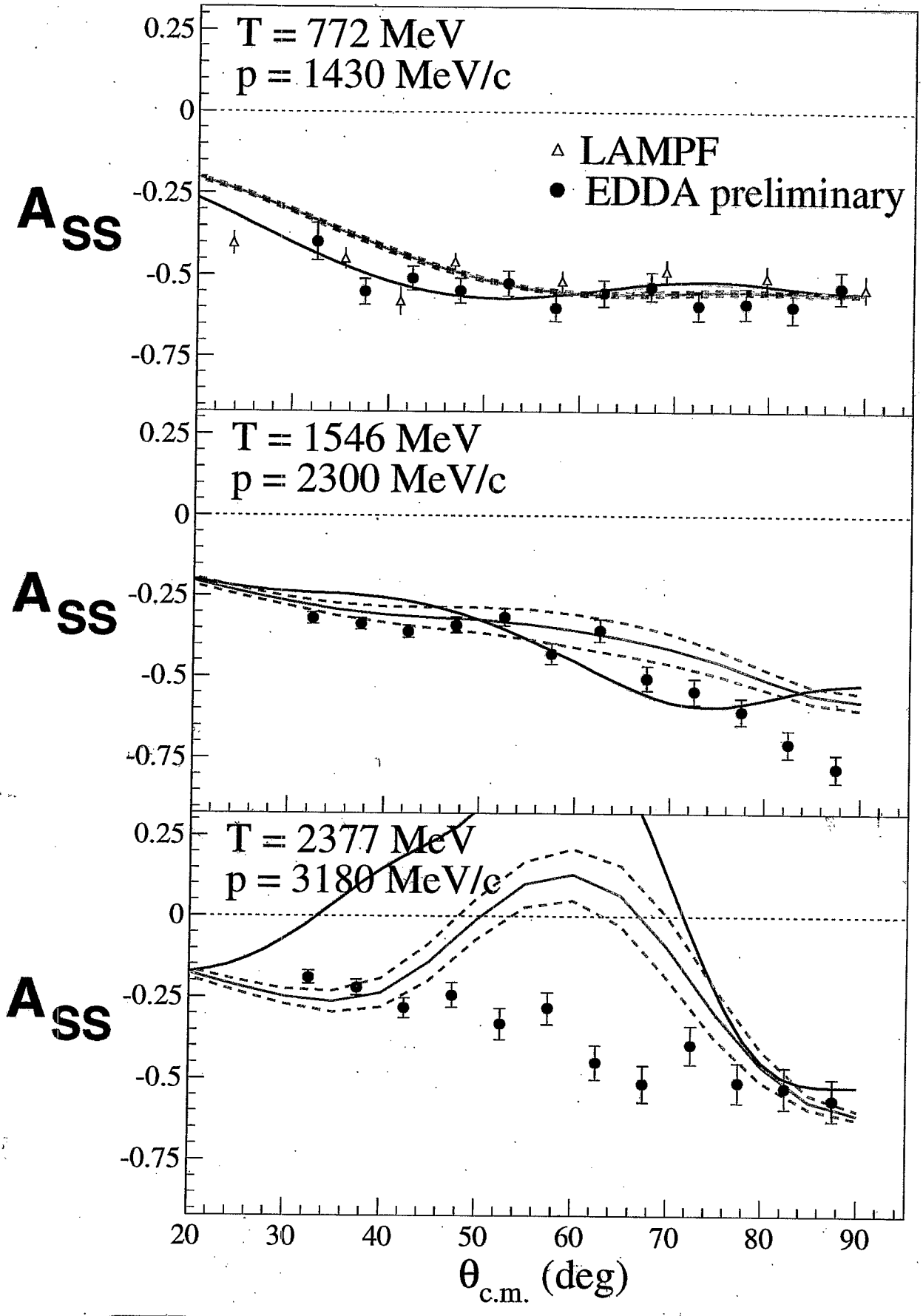
PSA: SAID(SM00)

Spinkorrelationsparameter



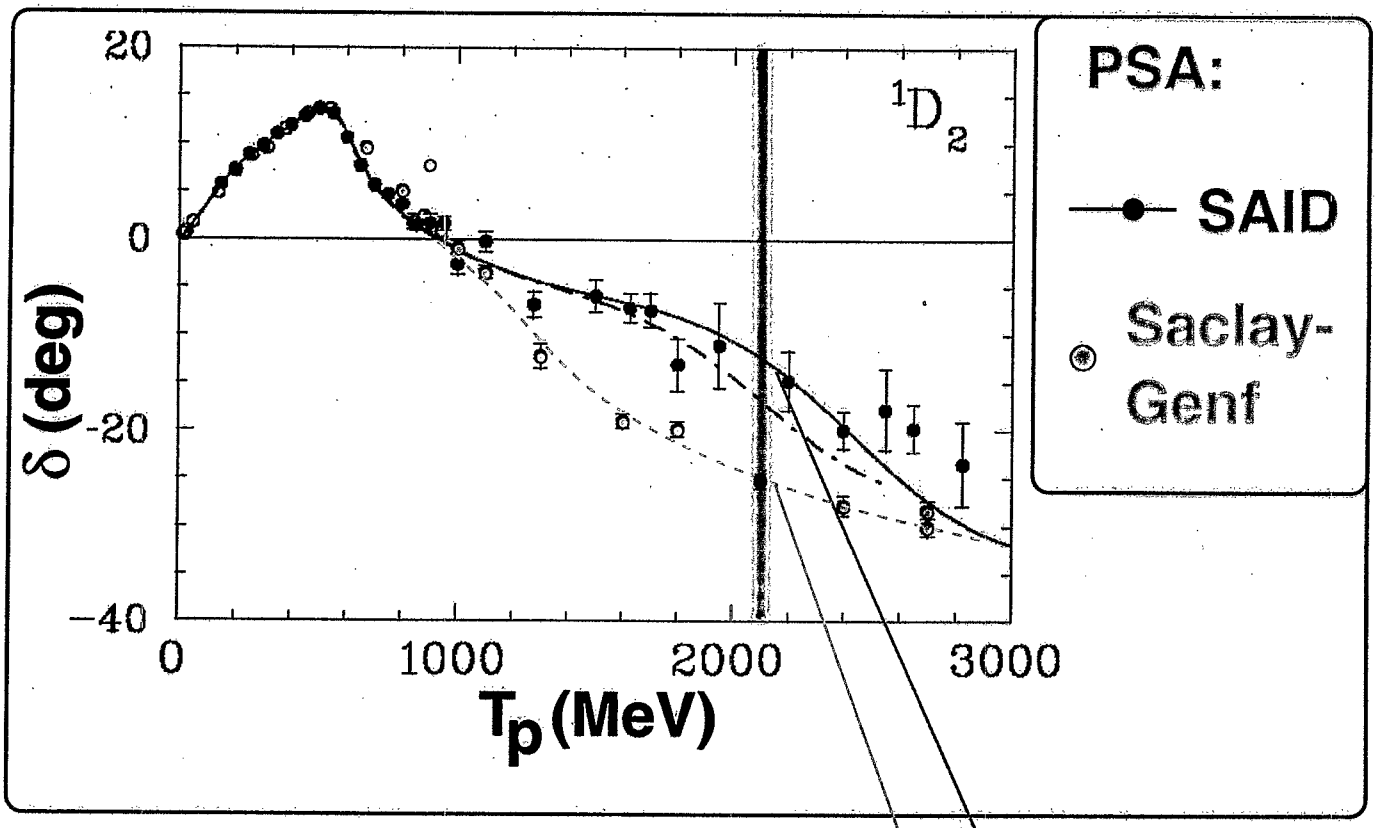
PSA: SAID(SM00)

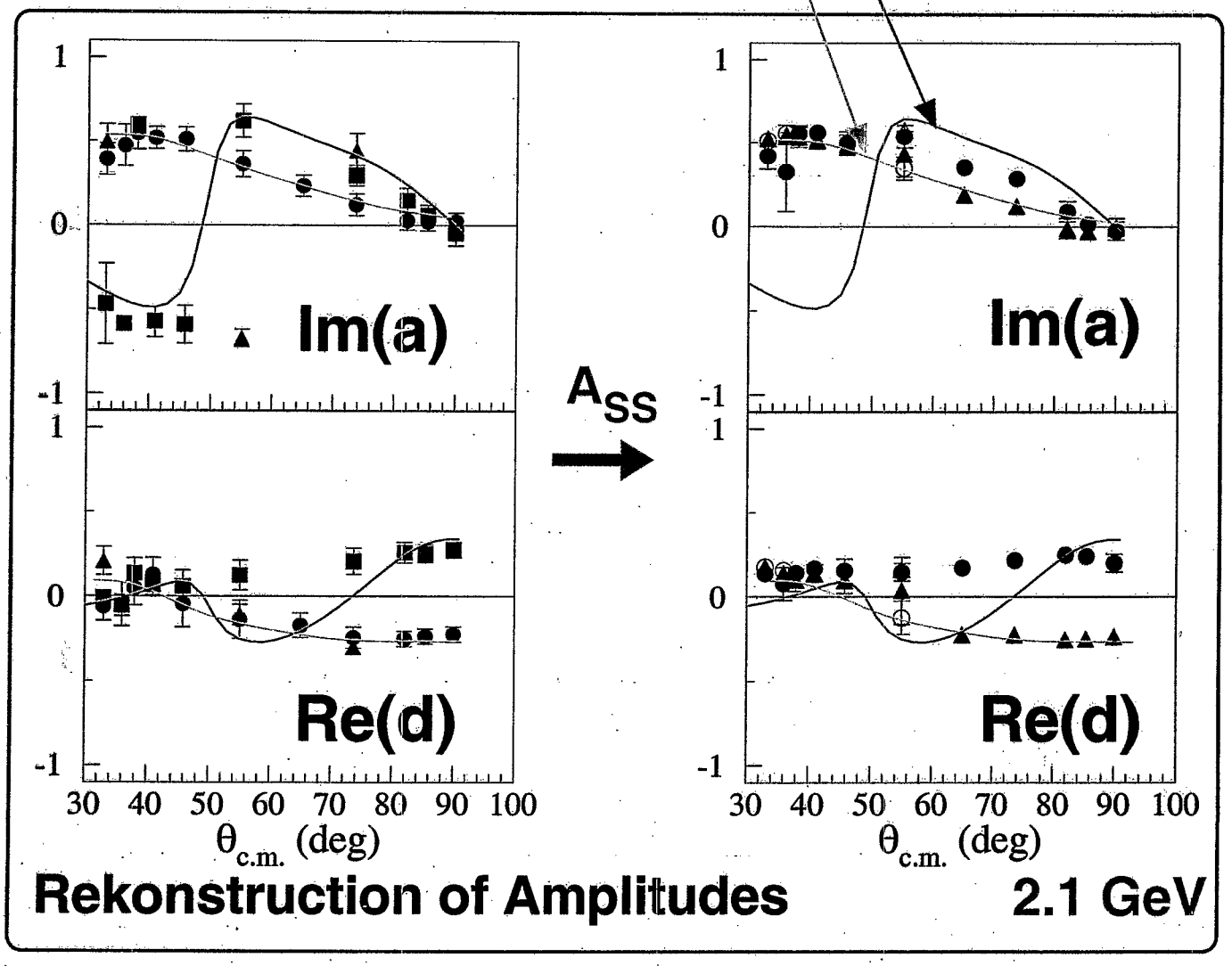
Spinkorrelationsparameter



PSA: SAID(SM00) Saclay-Genf

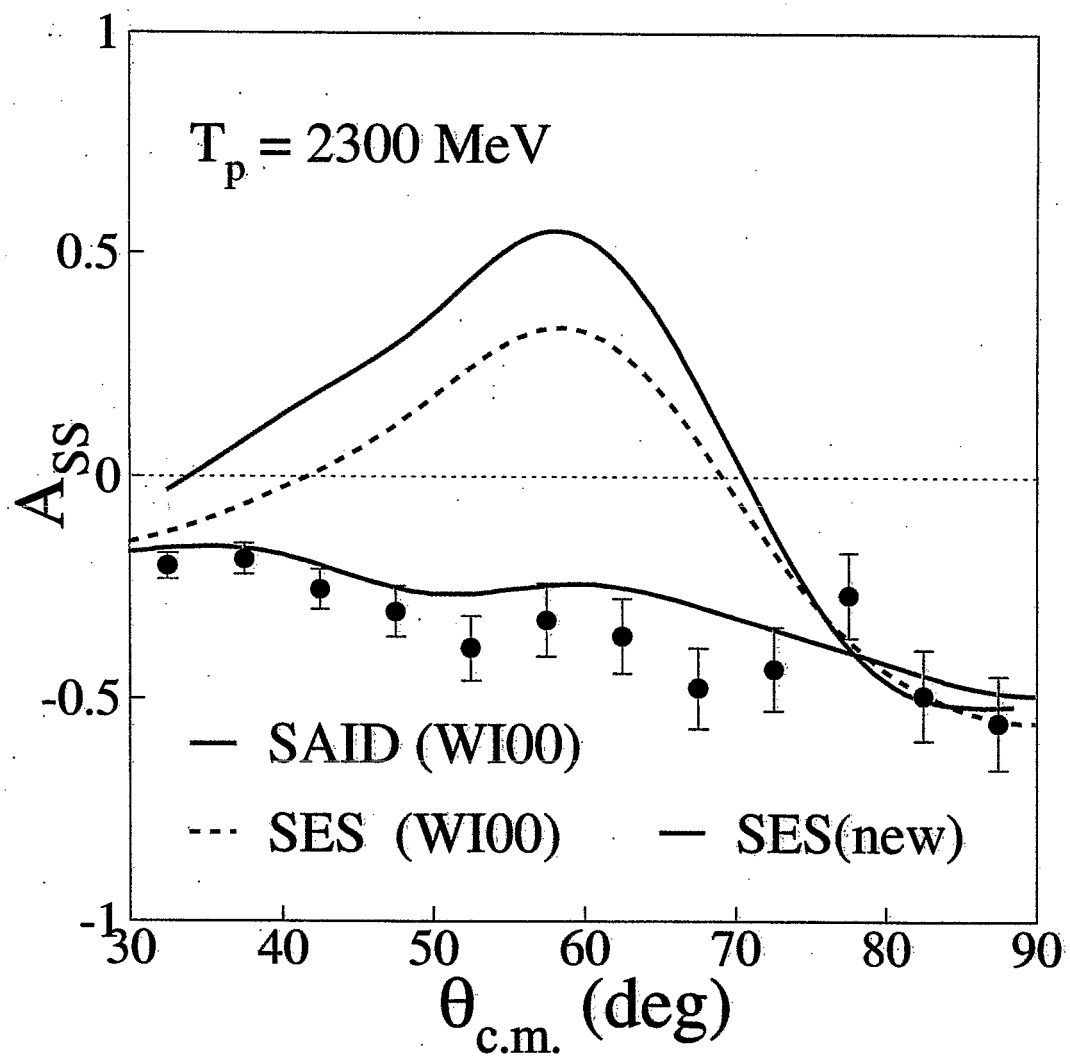
Ambiguities in PhaseShifts

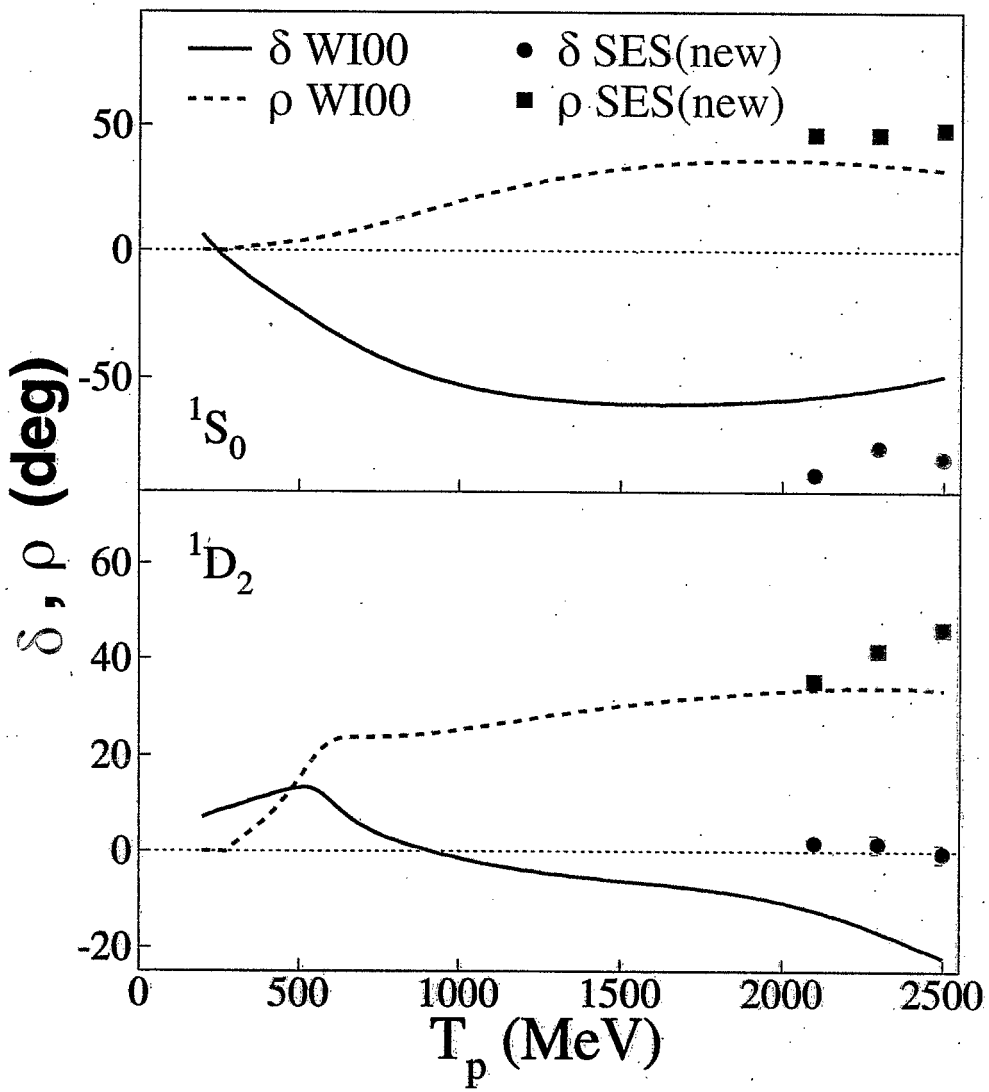




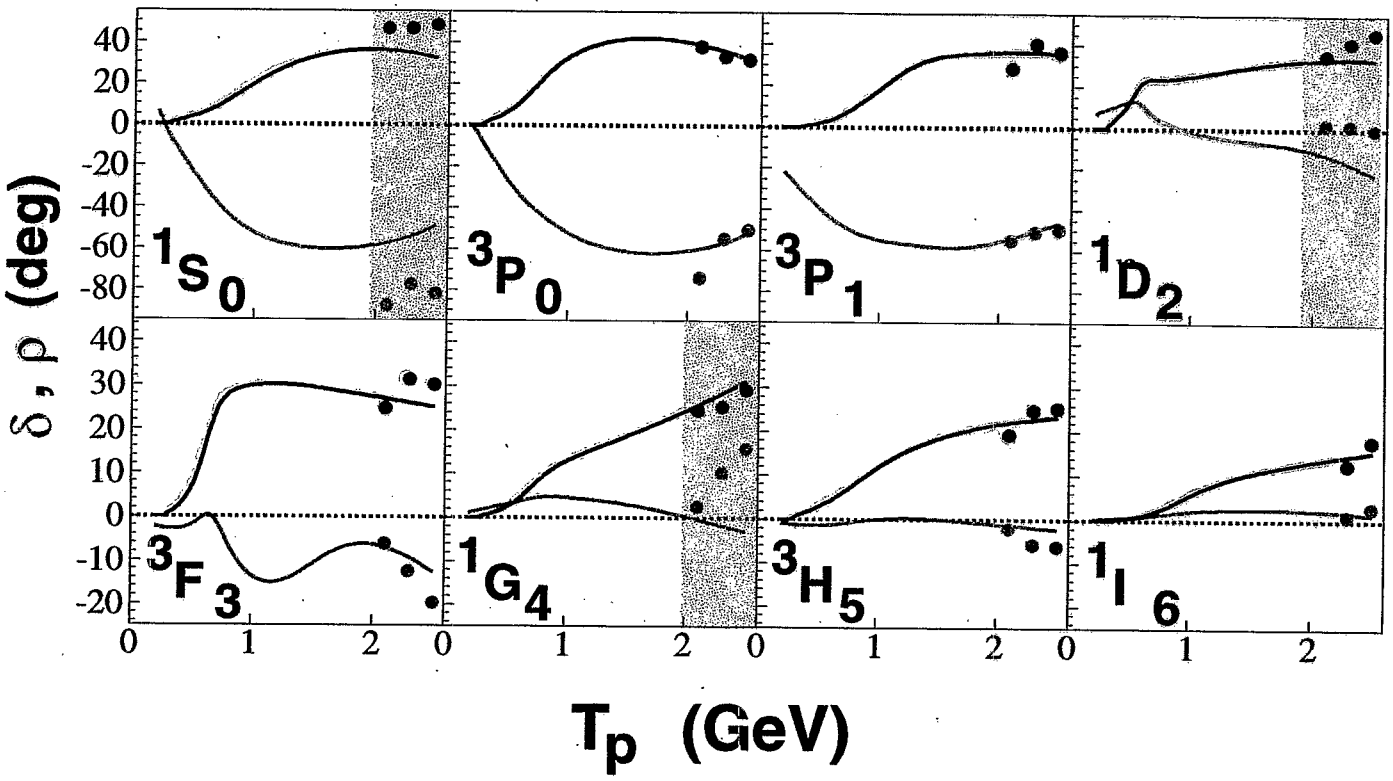
Rekonstruction of Amplitudes **2.1 GeV**

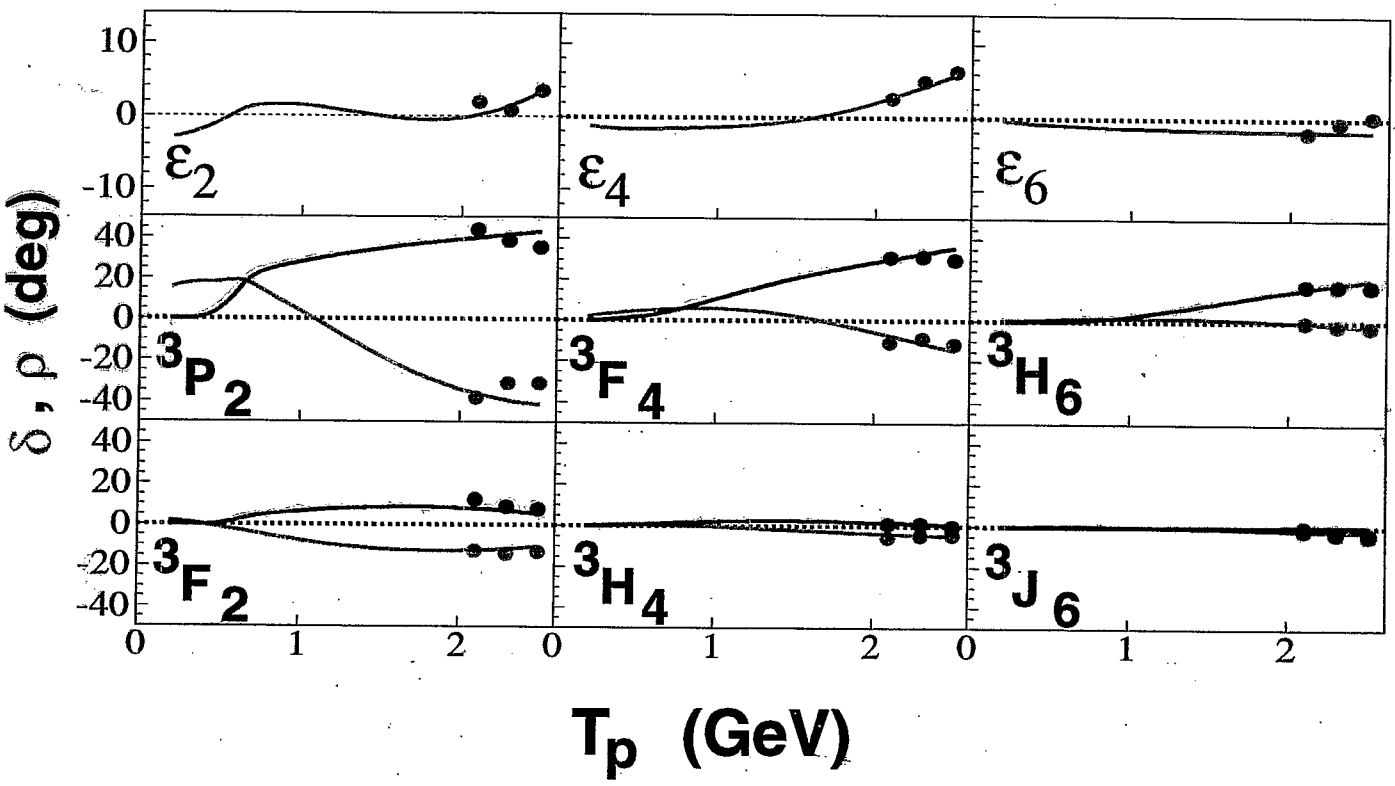
A_{SS} : Influence on PSA





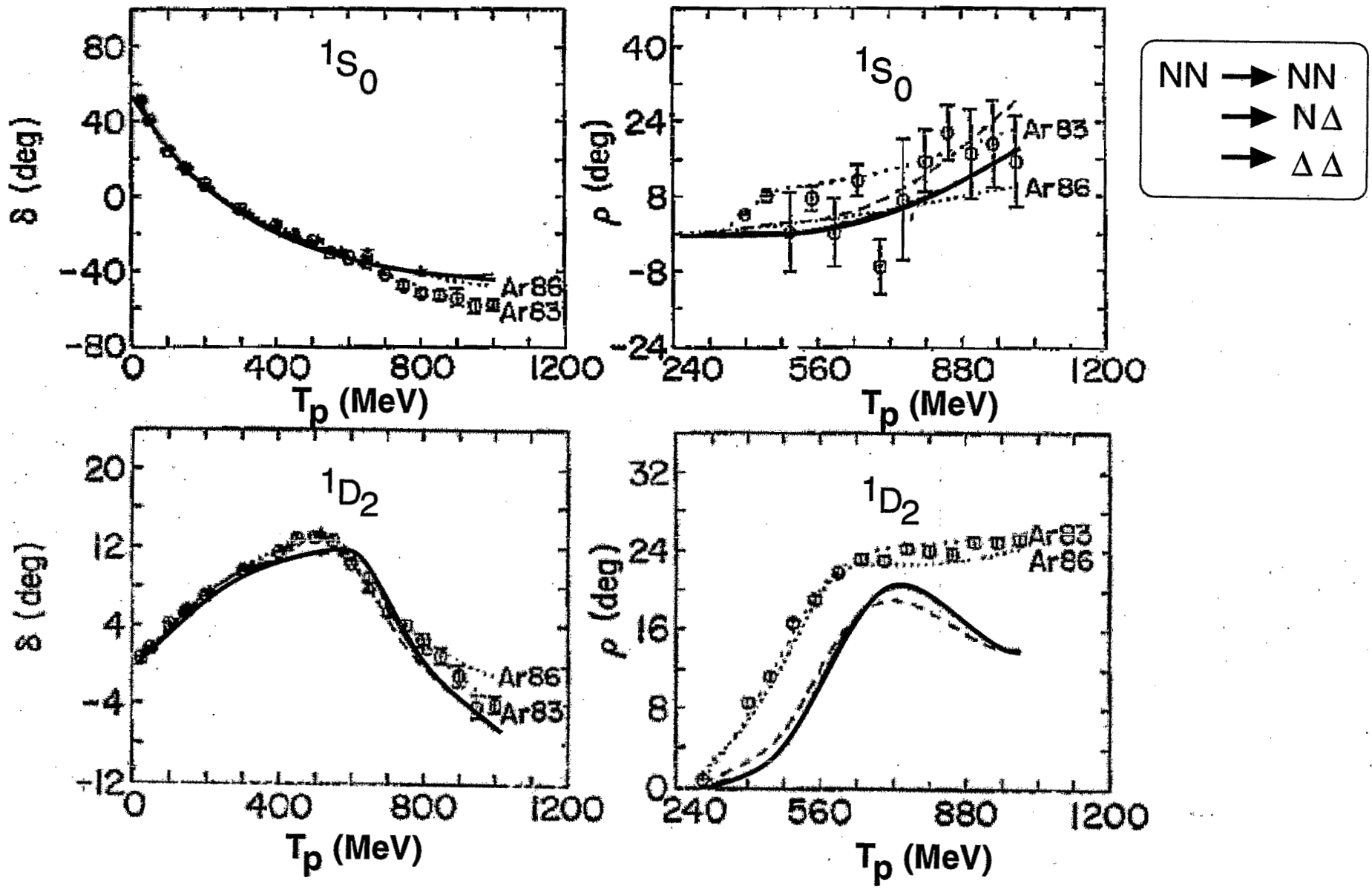
Phasenanalysen mit A_{SS}





Vergleich mit Mesonenaustauschmodellen

C. Elster et al. Phys. Rev. C 38, 1828 (1988)



Dibaryons

- color singlet states

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

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

  $\Gamma =$ 10...150 MeV

  no experimental evidence !

- known structures:

$^1D_2(2170)$ $\Gamma \approx$ 80 MeV

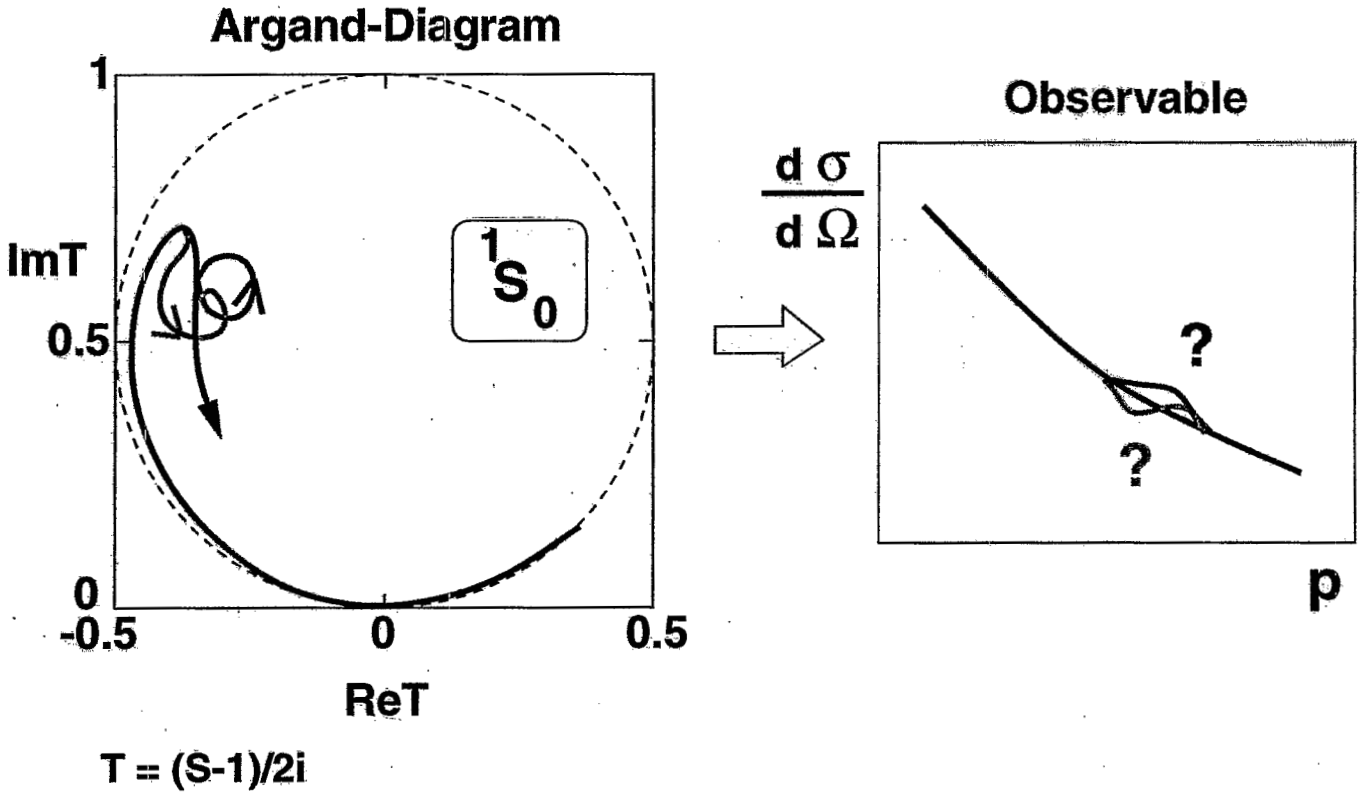
$^3F_3(2250)$ $\Gamma \approx$ 150 MeV

} NΔ threshold/resonance $^5S_2$, $^5P_3$

Dibaryons ?

- **NO EVIDENCE** !!

- **UPPER LIMITS ?**



$$S_{LJ} = \eta'_{LJ} e^{2i\delta'_{LJ}} = e^{2i\delta_{LJ}} \left(\eta_{LJ} - \frac{i\,\Gamma\,\eta_{el} e^{2i\phi}}{W - W_R + i\,\Gamma/2} \right)$$

Goal: for any (W_R ,Γ), find upper limit for

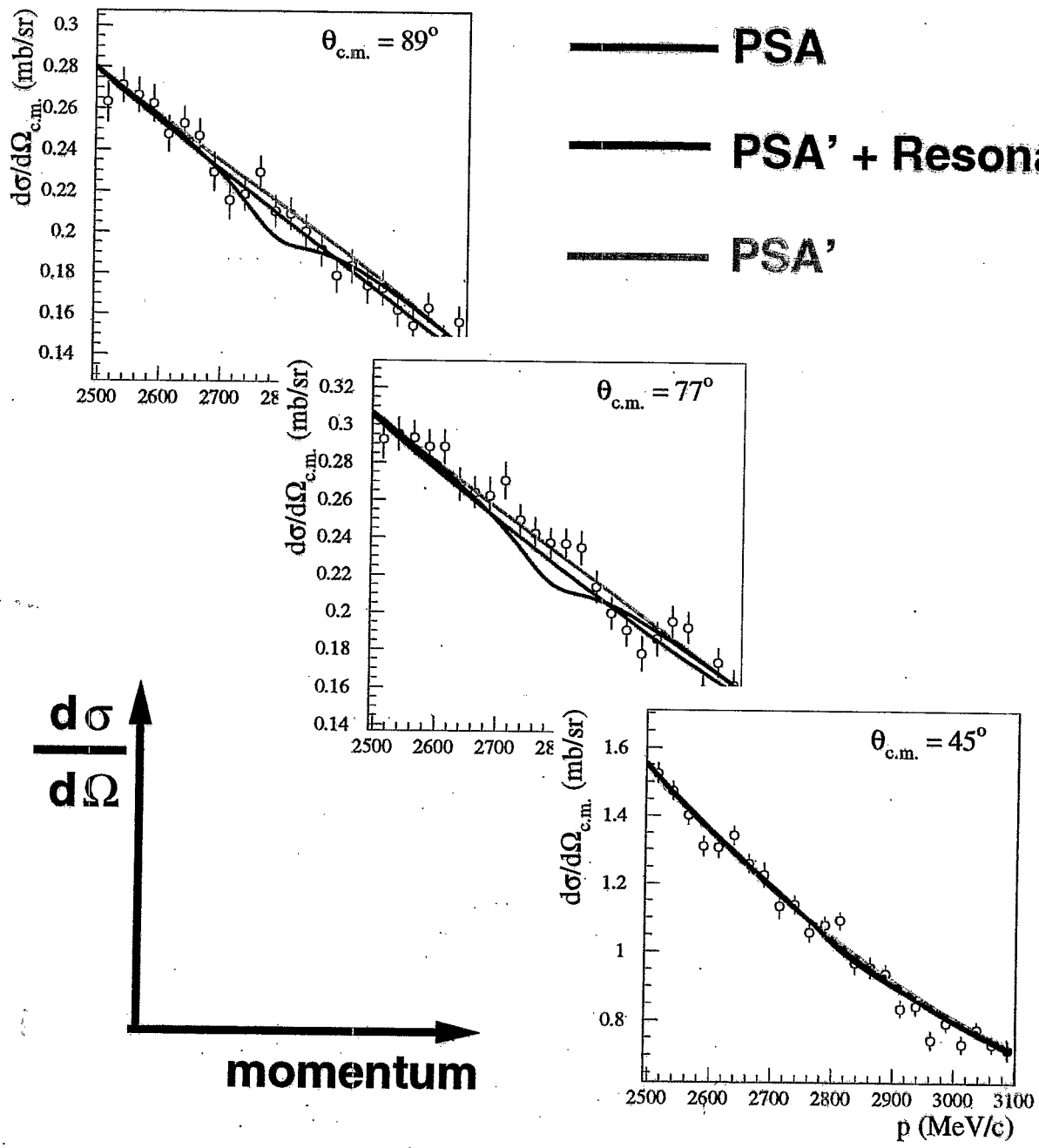
$$\eta_{el} = \Gamma_{el} / \Gamma$$

Upper Limits on Γ_{el}/Γ_{tot}

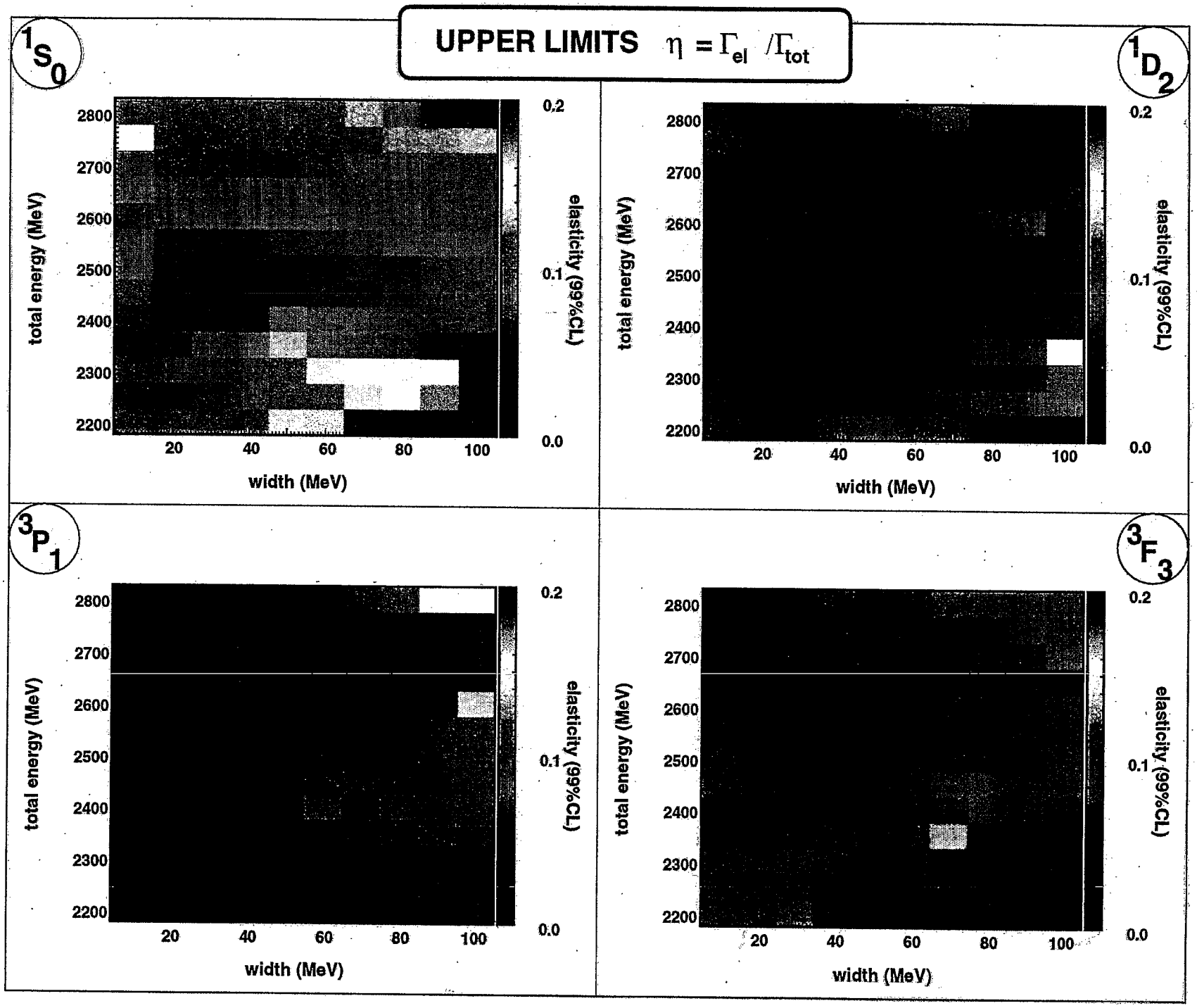
Example: $^1S_0$ $W_R = 2700$ MeV

$\Gamma_{tot} = 50$ MeV

$\phi = -60^o$



$\Rightarrow$ $\eta_{el} = \Gamma_{el}/\Gamma_{tot} < 0.07$; 99% CL


UPPER LIMITS $\eta = \Gamma_{el} / \Gamma_{tot}$
$^1S_0$
$^1D_2$
$^3P_1$
$^3F_3$
total energy (MeV)
2800
2700
2600
2500
2400
2300
2200
width (MeV)
20
40
60
80
100
elasticity (99%CL)
0.2
0.1
0.0

upper limits for $\eta_{el} = \Gamma_{el} / \Gamma_{tot}$ (99% CL)

W_R = 2.2 ... 2.8 GeV

Γ = 10 ... 100 MeV

$\eta_{el} >$	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

Conclusion

- excitation functions $\frac{d\sigma}{d\Omega}$, A_N

  ⇨ PSA

  ⇨ resonant contributions excluded

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

  η_{el} > 3..10% with 99% CL

- spin-correlation parameter

  A_{NN} $\underline{A_{SS}}$ A_{SL}

  ⇨ reduce ambiguities in amplitudes

  ⇨ PSA ?

The EDDA Collaboration

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

M. Altmeier, F. Bauer, J. Bisplinghoff, K. Büßer, M. Busch, T. Colberg, L. Demirörs, C. Dahl, F. Dohrmann, P.D. Eversheim, O. Eyser, O. Felden, R. Gebel, M. Glende, J. Greiff, R. Groß-Hardt, F. Hinterberger, R. Jahn, E. Jonas, H. Krause, R. Langkau, C. Lehmann, T. Lindemann, J. Lindlein R. Maier, A. Meinerzhagen, O. Nähle, C. Pauli, D. Prasuhn, H. Rohdjeß, D. Rosendaal, P. von Rossen, N. Schirm, W. Scobel, H.J. Trelle, K. Ulbrich, E. Weise, A. Wellinghausen, T. Wolf, K. Woller, R. Ziegler

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