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Zara Bagdasarian
for the ANKE Collaboration

z.bagdasarian@fz-juelich.de

Forschungszentrum Jülich
Ivane Javakhishvili Tbilisi State University

Proton-Proton Elastic Scattering Measurements at COSY-Jülich

July 2014 Tbilisi, Georgia
6th Georgian-German School and Workshop in Basic Science

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OUTLINE

Motivation

Experiment

Data Analysis

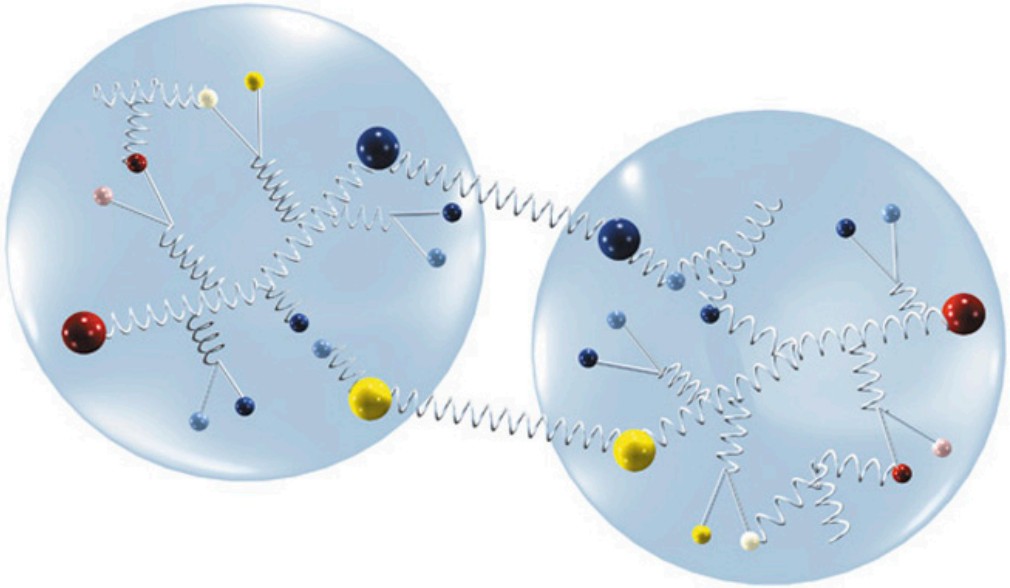
Results

Conclusions & Outlook

MOTIVATION: Nucleon-Nucleon interaction

Characterize short-range nucleon-nucleon interaction by pinning down the parameters for the Phase Shift Analysis (PSA)

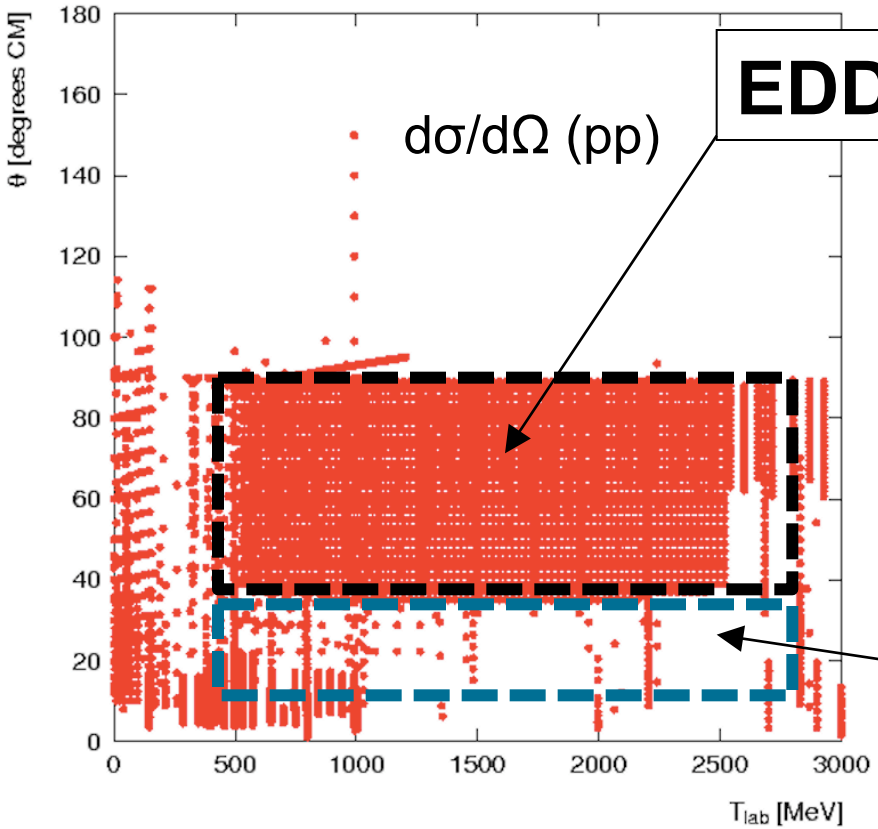
→ need to measure experimental observables



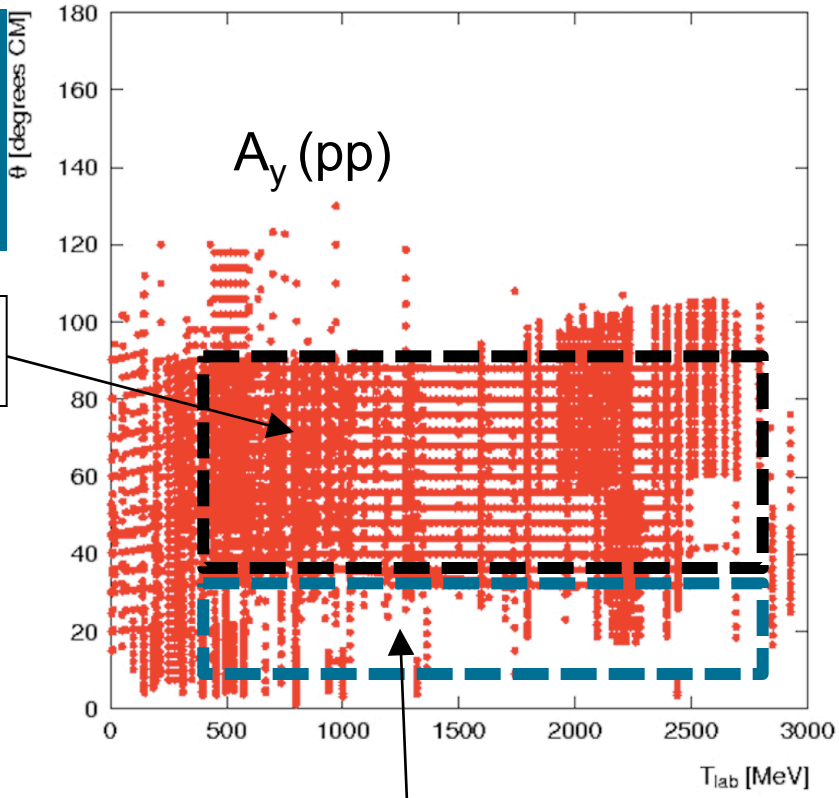
MOTIVATION: Status of pp elastic data base

Wealth of data ($35° < \theta_p < 90°$) $T_p \leq 2.5$ GeV

Scarce experimental data at smaller angles ($\theta_p < 35°$) above $T_p = 1.0$ GeV



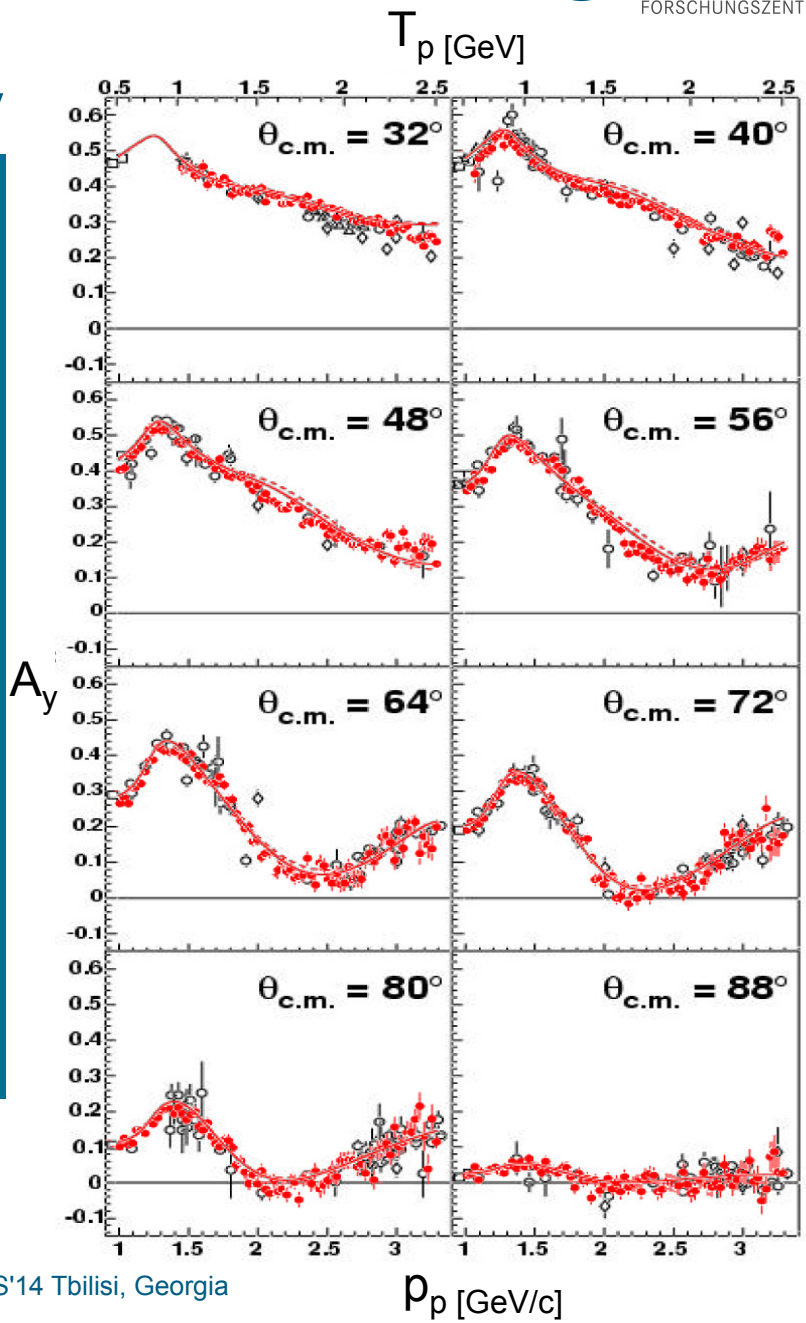
EDDA



ANKE

MOTIVATION: EDDA Legacy

- Measurements: wide energy & angular range:
  - $0.5<T_p<2.5$ GeV
  - $30°<\theta_{cm}<90°$
  - High precision, consistency for pp (I=1)-system
- Results:
  - ***Large Impact on Phase Shift Analysis***
  - *dσ/dΩ PRL 78 (1997); EPJ A 22(2004)*
  - A_y PRL 85 (2000); EPJ A 23 (2005)



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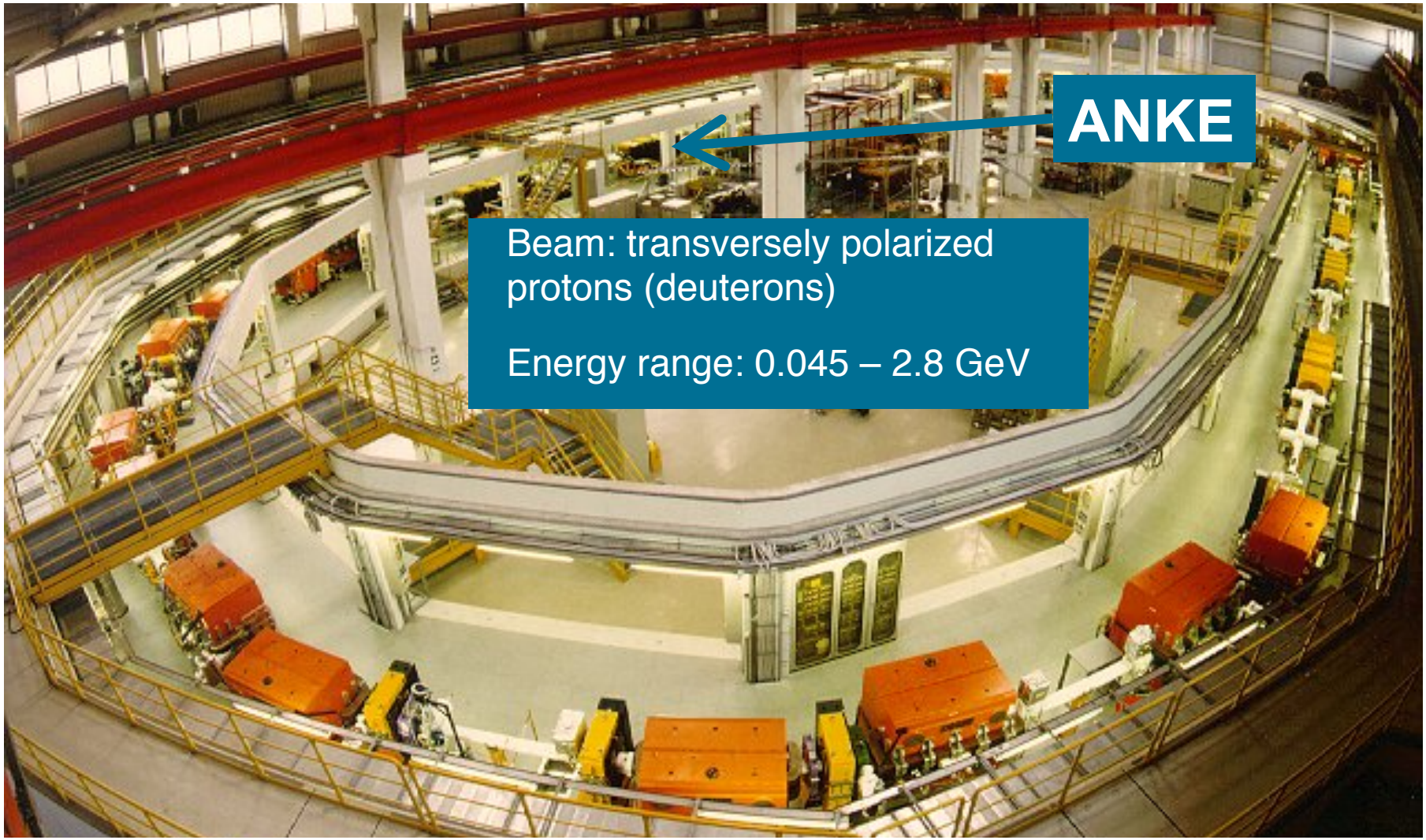
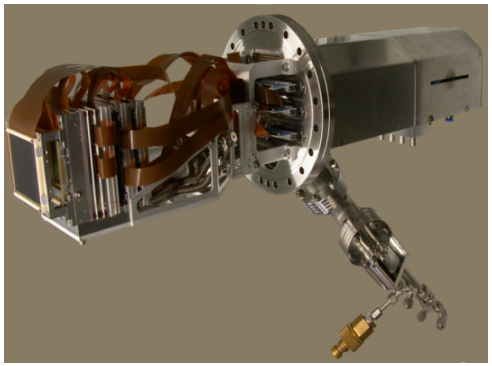
EXPERIMENT: COSY (Cooler Synchrotron)

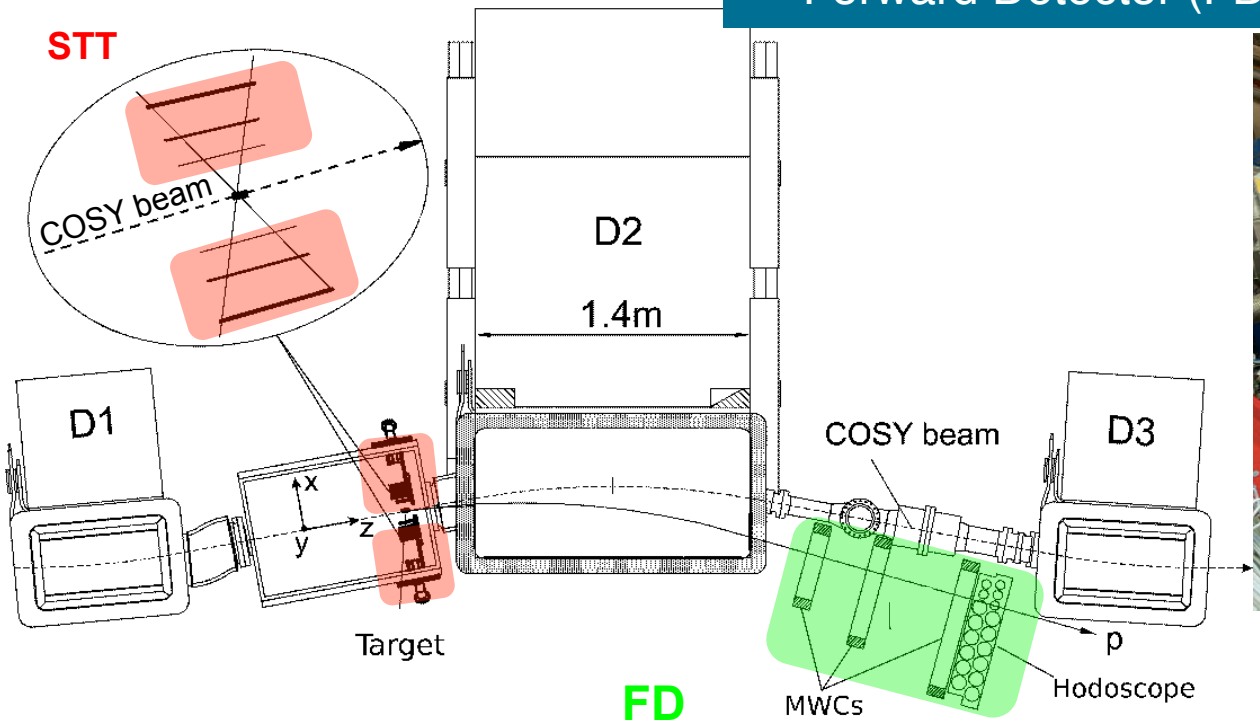


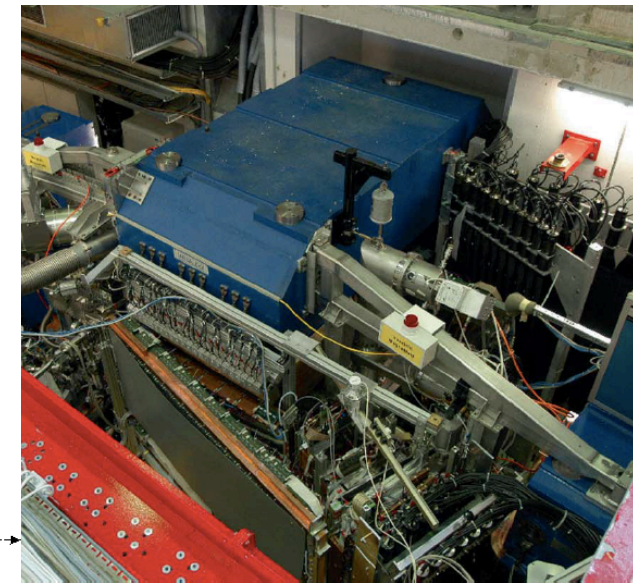
EXPERIMENT: ANKE



ideal for small angle elastic scattering studies

- Cluster target (hydrogen or deuterium)
- Silicon Tracking Telescope (STT): ($5^\circ < \Theta^p_{cm} < 30^\circ$)
- Forward Detector (FD): ($10^\circ < \Theta^p_{cm} < 30^\circ$)

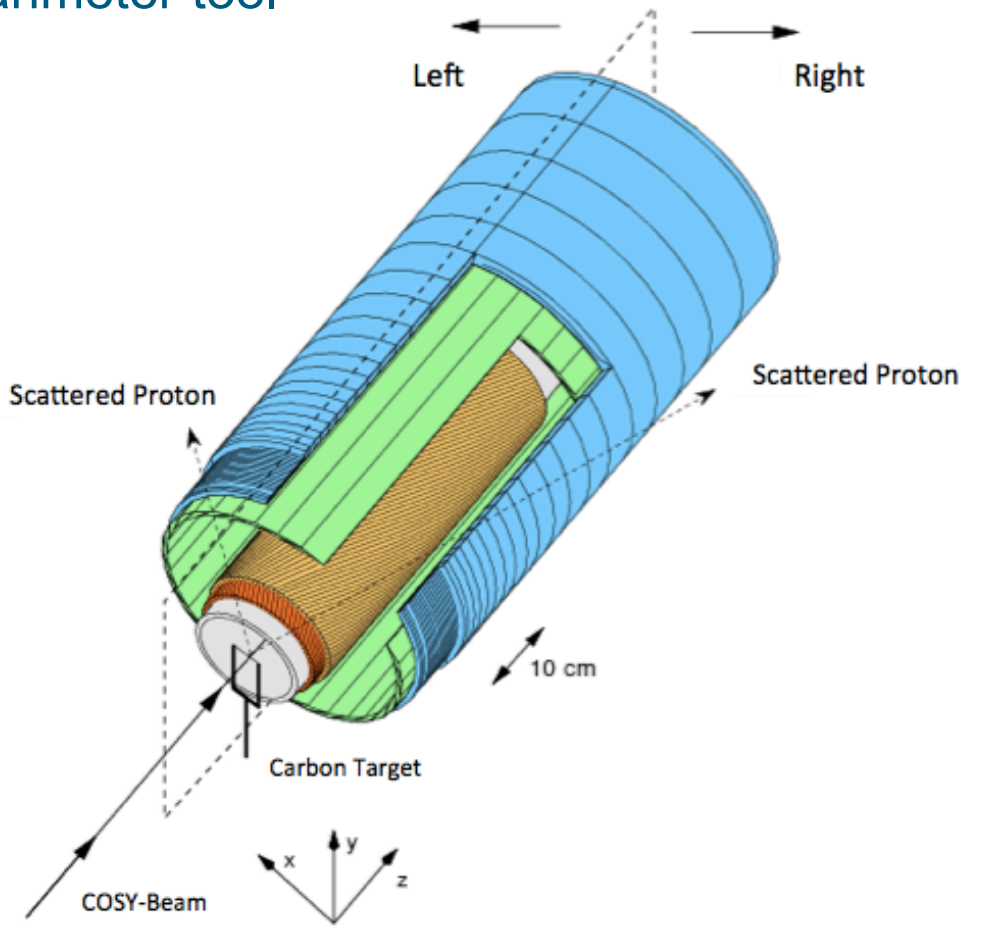




EXPERIMENT: EDDA Detector

fast polarimeter tool

- Carbon Target:
  Polarimetry reaction pC->pX
- Scintillator Semi-rings (θ_{lab}):
  Count-rate asymmetry
- Ring effective analyzing powers are already known!

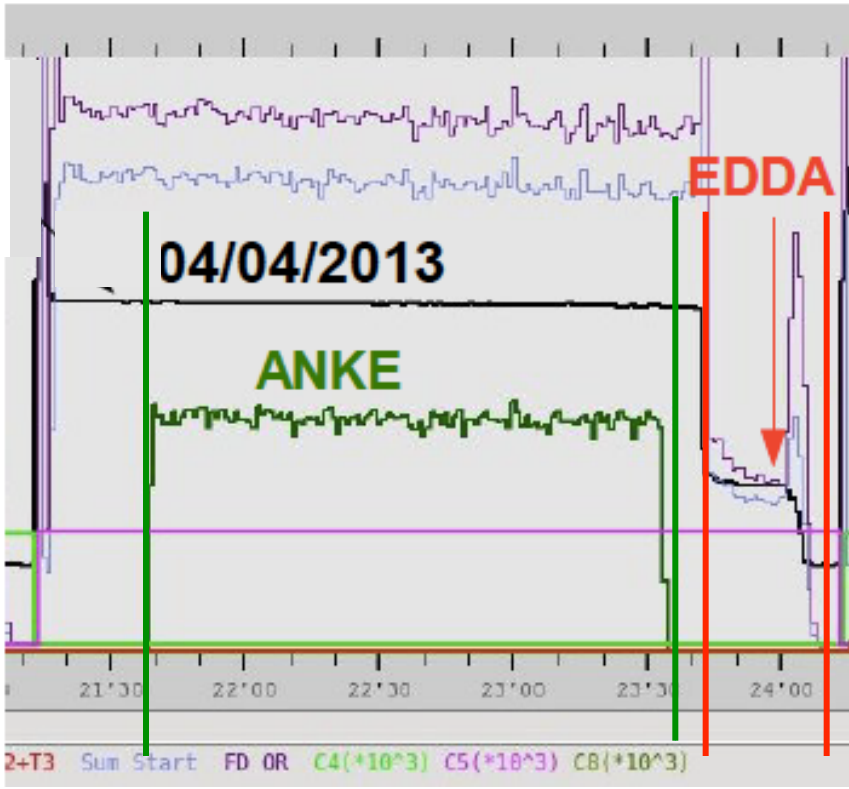


EXPERIMENT: Strategy

Polarized proton beam at 6 energies:

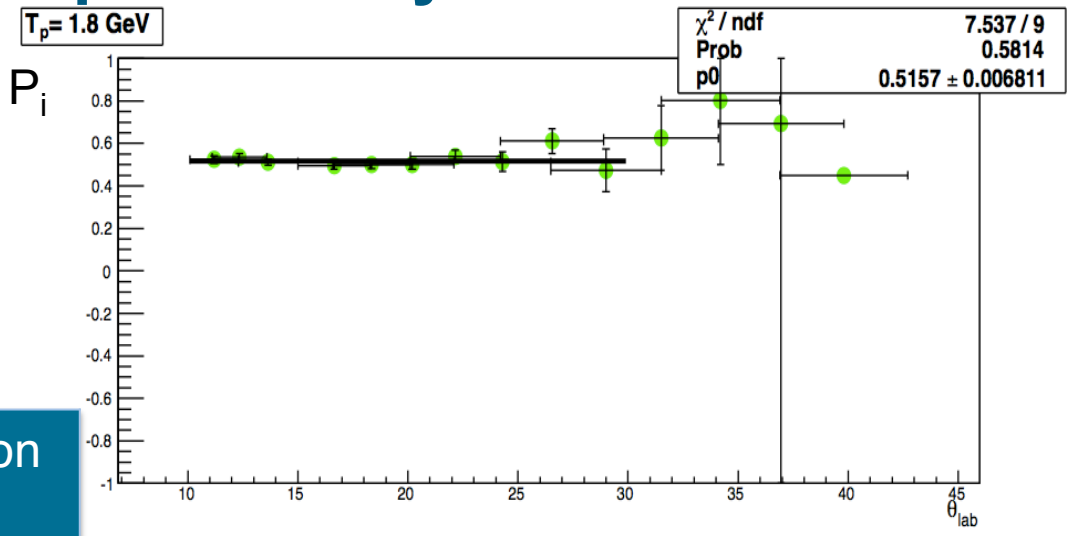
- 0.8 GeV (compare with existing experimental data)
- 1.6 GeV, 1.8 GeV, 2.0 GeV, 2.2 GeV, 2.4 GeV (new)

- Measurement at the constant energy
- 180 second cycle
- Last 20 seconds polarization measurement at EDDA



DATA ANALYSIS: EDDA polarimetry

Arithmetic weighted average of the polarizations deduced for each ring



Beam Energy T_p [GeV]	Av. Polarization P
0.796	0.554
1.600	0.504
1.800	0.516
1.965	0.429
2.157	0.501
2.368	0.435

i, number of the ring

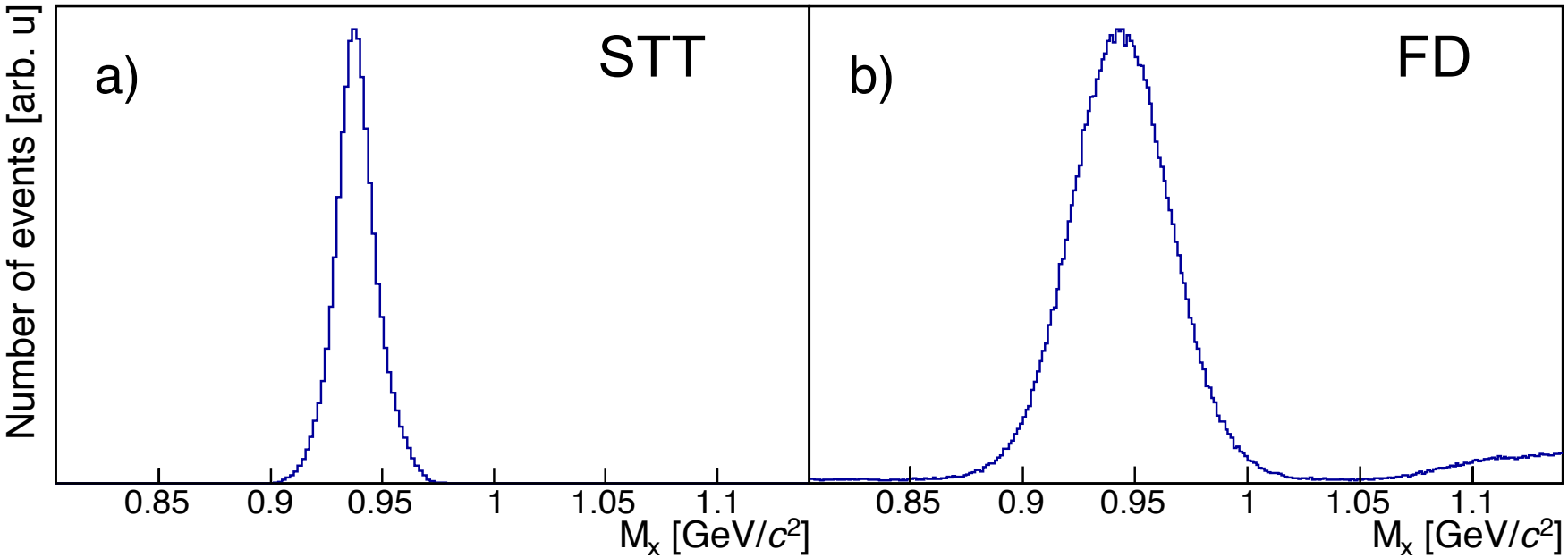
Example: T_p= 1.6 GeV

Statistical uncertainties < 0.015

Systematic errors are estimated to be 3%*

*E.Weise. PhD thesis

DATA ANALYSIS: Reaction identification



Example: T_p = 1.6 GeV pp→ pX

Missing Mass spectra when detecting one proton in the Silicon Tracking Telescope (a) and the Forward Detector (b)

Clean proton peaks

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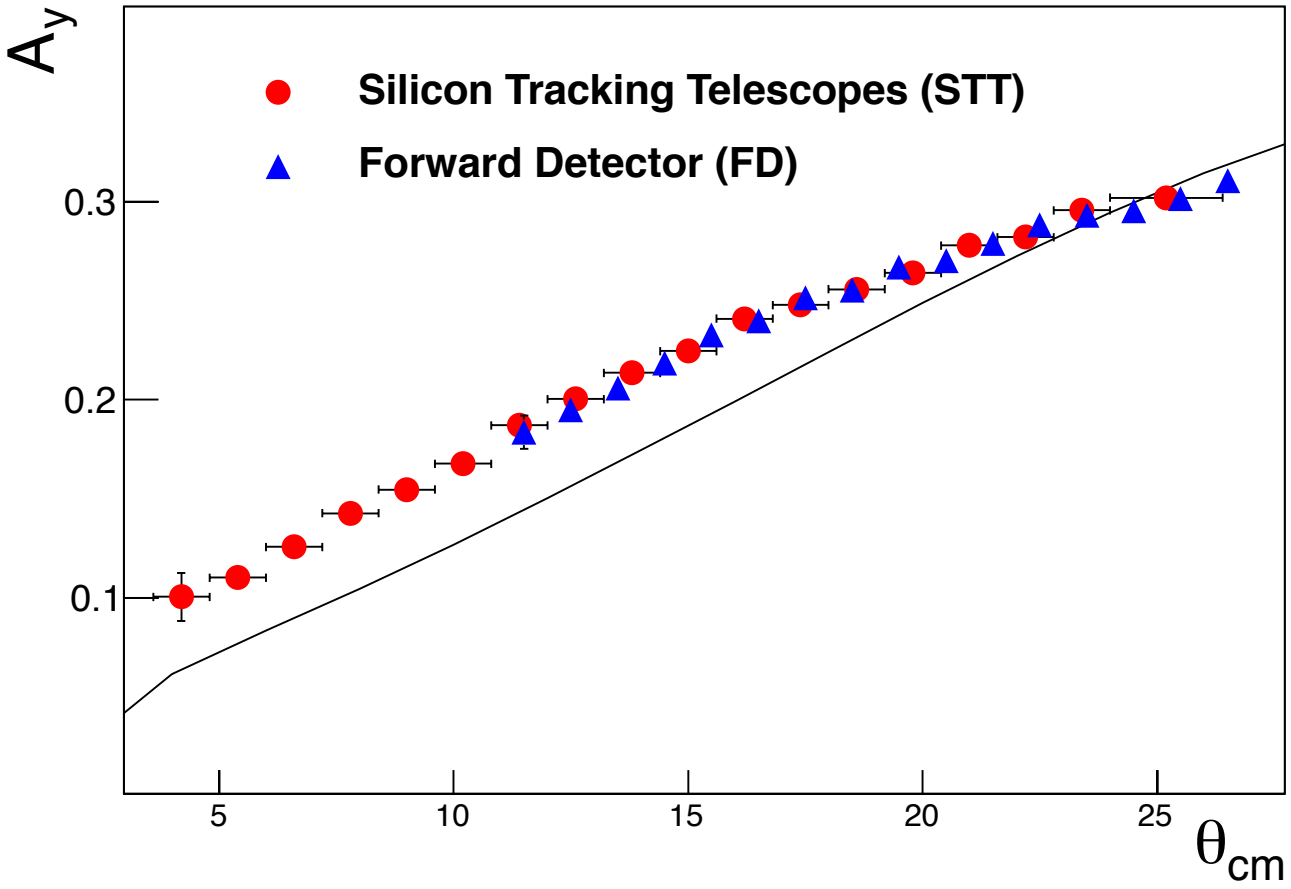
RESULTS: STT and FD



- Cross check
- Increasing the angular range
- Consistency

RESULTS: Analyzing Power

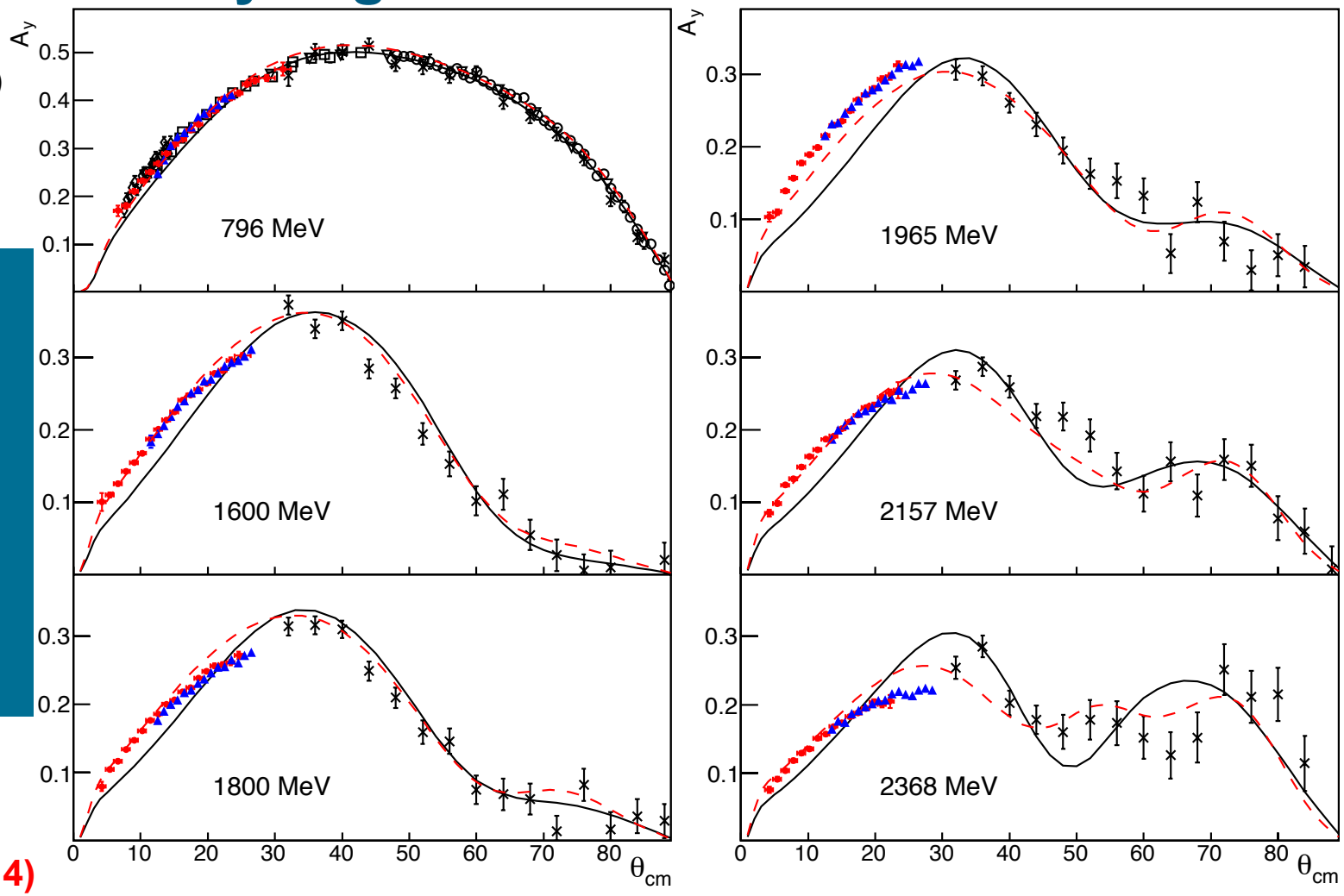
SAID recent solution (2007)

ANKE STT
ANKE FD
EDDA

Agreement with the existing data at 0.8 GeV

Brand New Data for ~~SALE~~ SAID!

- SAID new solution (2014)



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Conclusions and Outlook

- Proton-proton elastic scattering analyzing power at incident beam energy T_p = 0.8 GeV:
  - agrees with the existing experimental data

- New data at 5 discrete energies in the 1.6-2.4 GeV energy range at small angles (θ_{cm}<30°)
  - shapes differently from SAID predictions
  - Phase Shift Analysis has been modified

- SAID group has pinned down the phase shift parameters
- The paper has been submitted (waiting for the reviews)

- pp scattering cross section dσ/dΩ at 6 energies
- pn cross section dσ/dΩ and analyzing power A_y above 1.1 GeV

Thanks for your attention!

Thanks to the organizers!

Question are welcome now, later on the poster session
or even later by e-mail z.bagdasarian@fz-juelich.de

EXPERIMENT: Polarimetry (double ratio method)

$$\left(\frac{d\sigma}{d\Omega}\right)_{pol}(\vartheta,\varphi)=\left(\frac{d\sigma}{d\Omega}\right)_{0}(\vartheta)\left(1+P_y A_y(\vartheta)\cos\varphi\right)$$

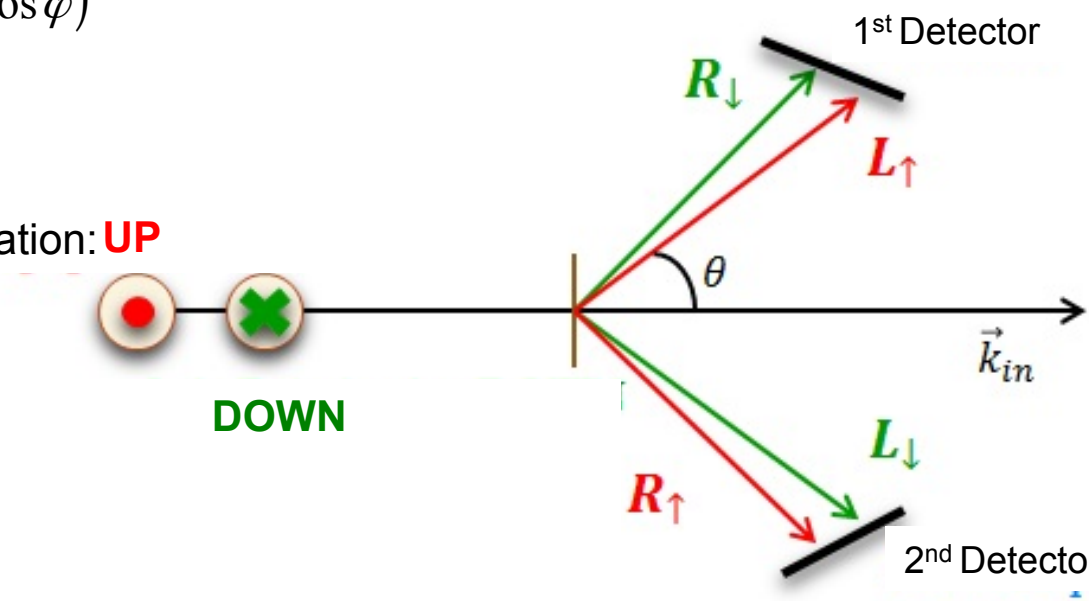
$$\varepsilon(\vartheta)\sim P_y\cdot A_y(\vartheta)$$

Beam Polarization: **UP**

DOWN

$$L=\sqrt{L_{\uparrow}L_{\downarrow}} \qquad R=\sqrt{R_{\uparrow}R_{\downarrow}}$$

$$\varepsilon(\theta)=\frac{L-R}{L+R}$$



Independent of relative detector efficiencies and solid angles,
as well as relative integrated charge and target thickness