Low-Energy Dipole Modes in the heavy deformed nucleus ^{154}Sm via inelastic polarized proton scattering at zero degree *

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HK 6.5

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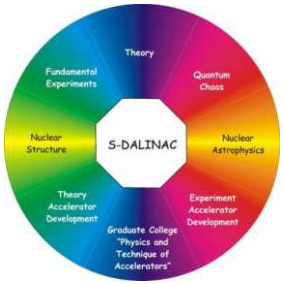
Darmstadt / iThemba LABS / Kyoto / Miyazaki / Niigata / Osaka / Witwatersrand Collaboration

RCNP



* Supported by the DFG through SFB 634 and NE679/3-1

Outline

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- Motivation
- Polarization transfer observables
- Experiment
- First results
- Summary & Outlook

Spinflip M1 Resonance in heavy deformed nuclei

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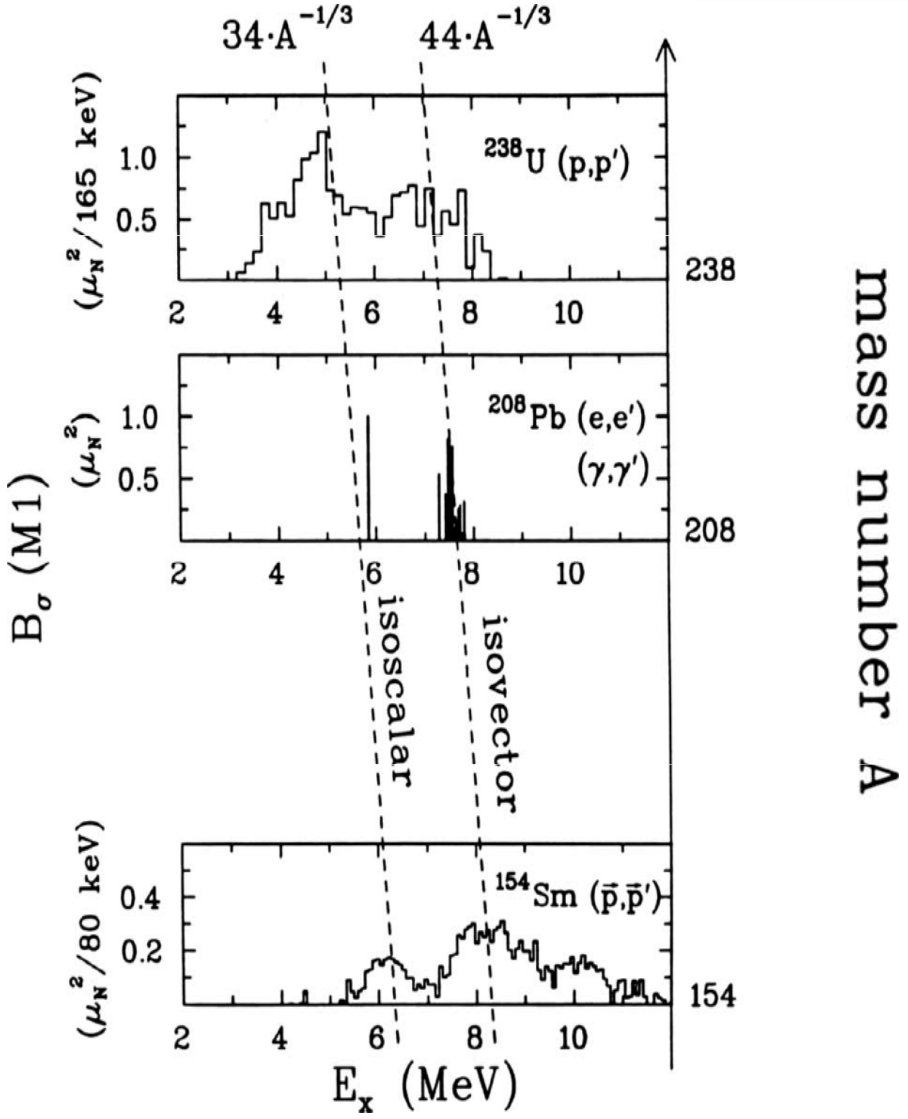
- Appears in heavy nuclei at $1\hbar\omega$ energy ($E \approx 40 \cdot A^{-1/3}$)
- Problem:
  Quenching and little data
- Strength distribution:
  double hump structure?



Richter, A., 1995, Prog. Part. Nucl. Phys. **34, 261.**

Spinflip M1 Resonance in ^{154}Sm

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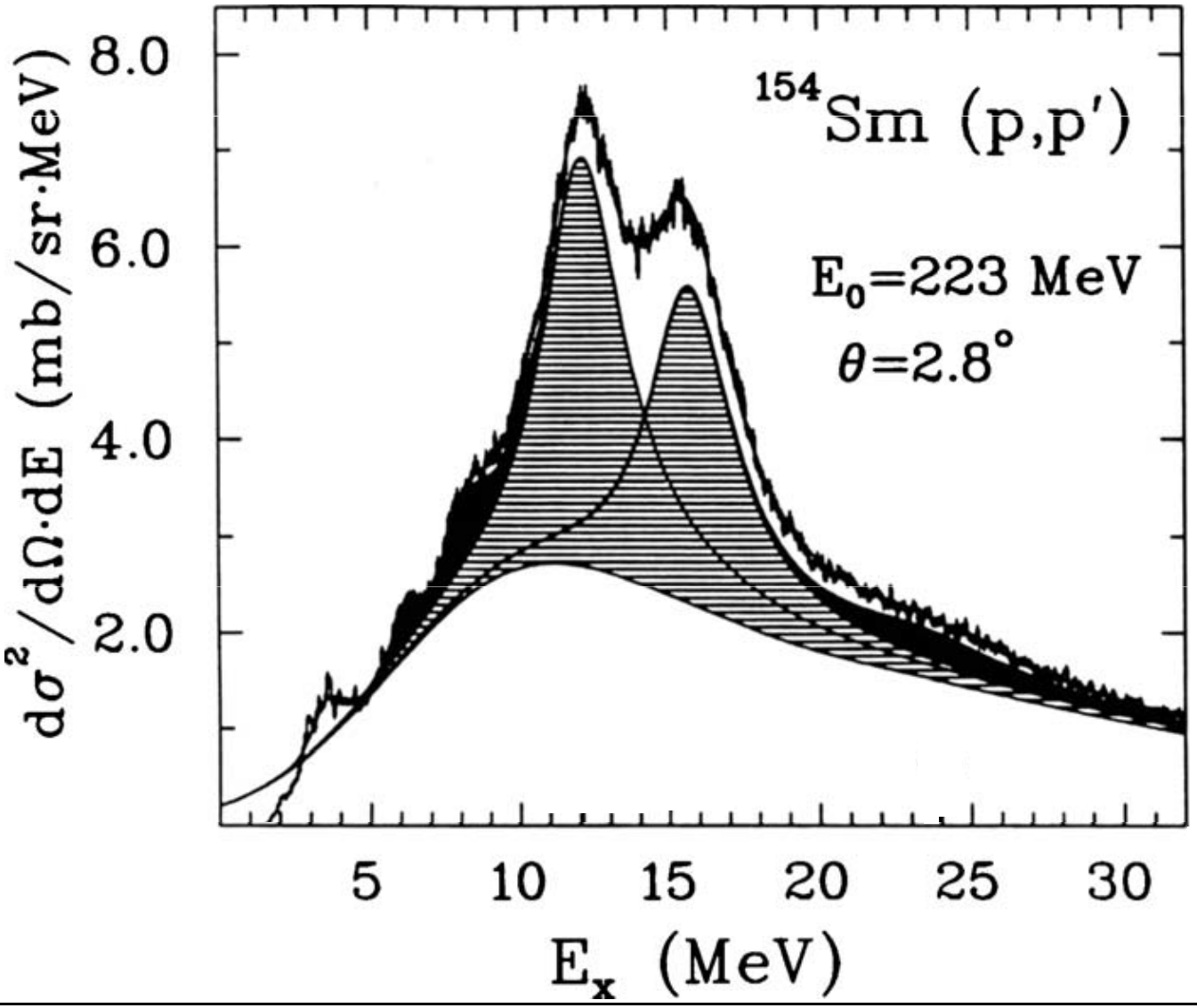
H.J. Wörtche, Doctoral thesis, TU Darmstadt (1994)



Determine E1 and M1 Strength Distributions

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- Polarized proton scattering at 0°
  - Intermediate energy: 300 MeV optimal
  - High energy resolution: ΔE = 25 keV (FWHM)
  - Angular distributions: E1 / M1 separation
  - Polarization observables: spinflip / non-spinflip separation

- ^{208}Pb as a reference case (I. Poltoratska)

  → HK 13.7

- Application to ^{154}Sm (because of finite angle TRIUMF data)

E1/M1 Decomposition by Spin Observables

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- Polarization observables → spinflip / non-spinflip separation*

  (model-independent)

$$D_{SS} + D_{NN} + D_{LL} = \begin{cases} \text{-1 for } \Delta S = 1 \\ \text{3 for } \Delta S = 0 \end{cases}$$

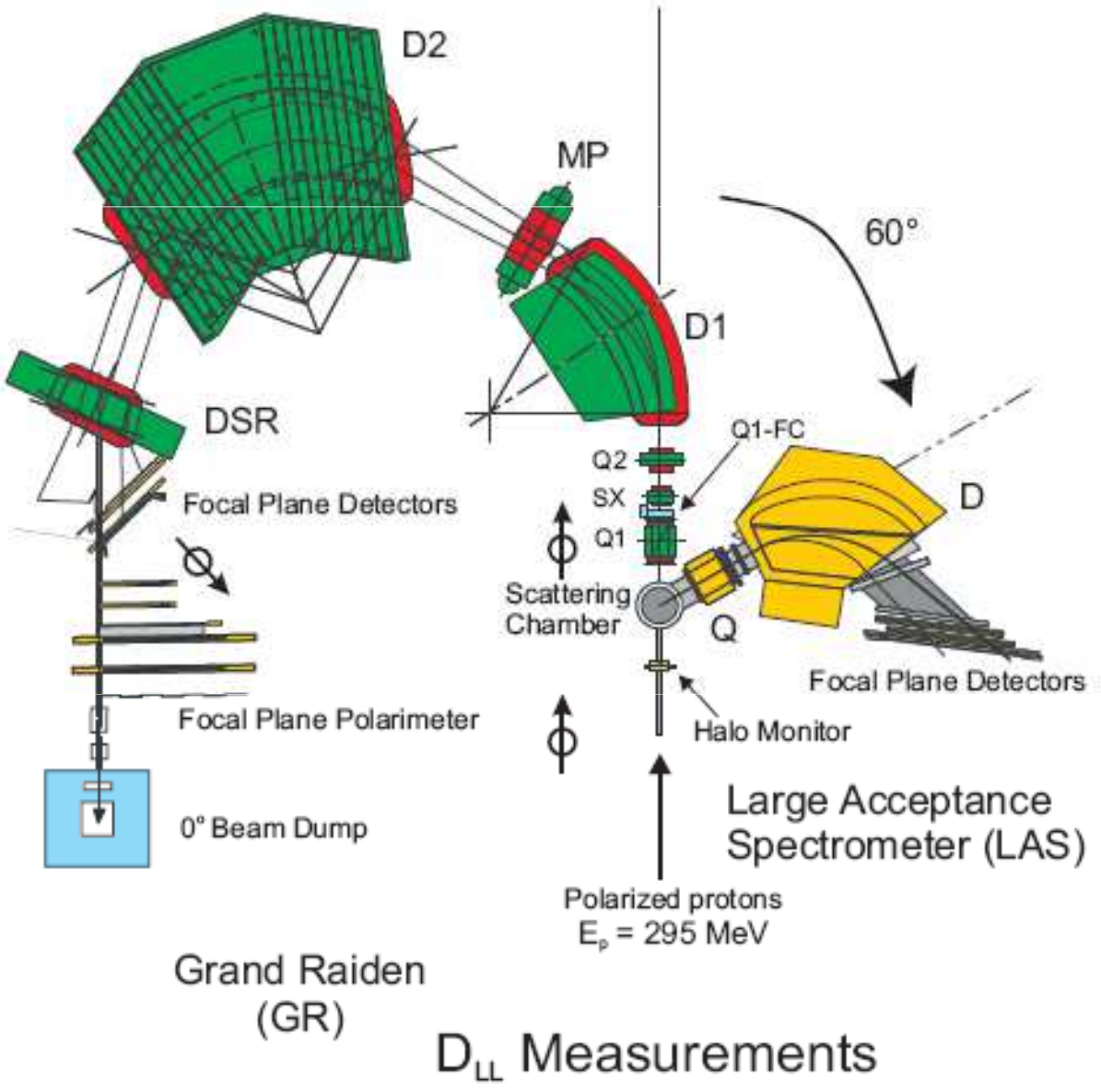
→ E1 and M1 cross sections can be decomposed

At 0° $D_{SS} = D_{NN}$

$$\text{Total Spin Transfer } \Sigma \equiv \frac{3-(2D_{NN}+D_{LL})}{4} = \begin{cases} 1 \text{ for } \Delta S = 1 & \textbf{(M1)} \\ 0 \text{ for } \Delta S = 0 & \textbf{(E1)} \end{cases}$$

T. Suzuki, Prog.Theo.Phys. 103 (2000) 859

0º Setup at RCNP in Osaka



- Similar setup for normal polarization measurement
- Measurement at 3° for angular distribution (unpolarized beam)

Scheme of the FPP / Grand Raiden Setup

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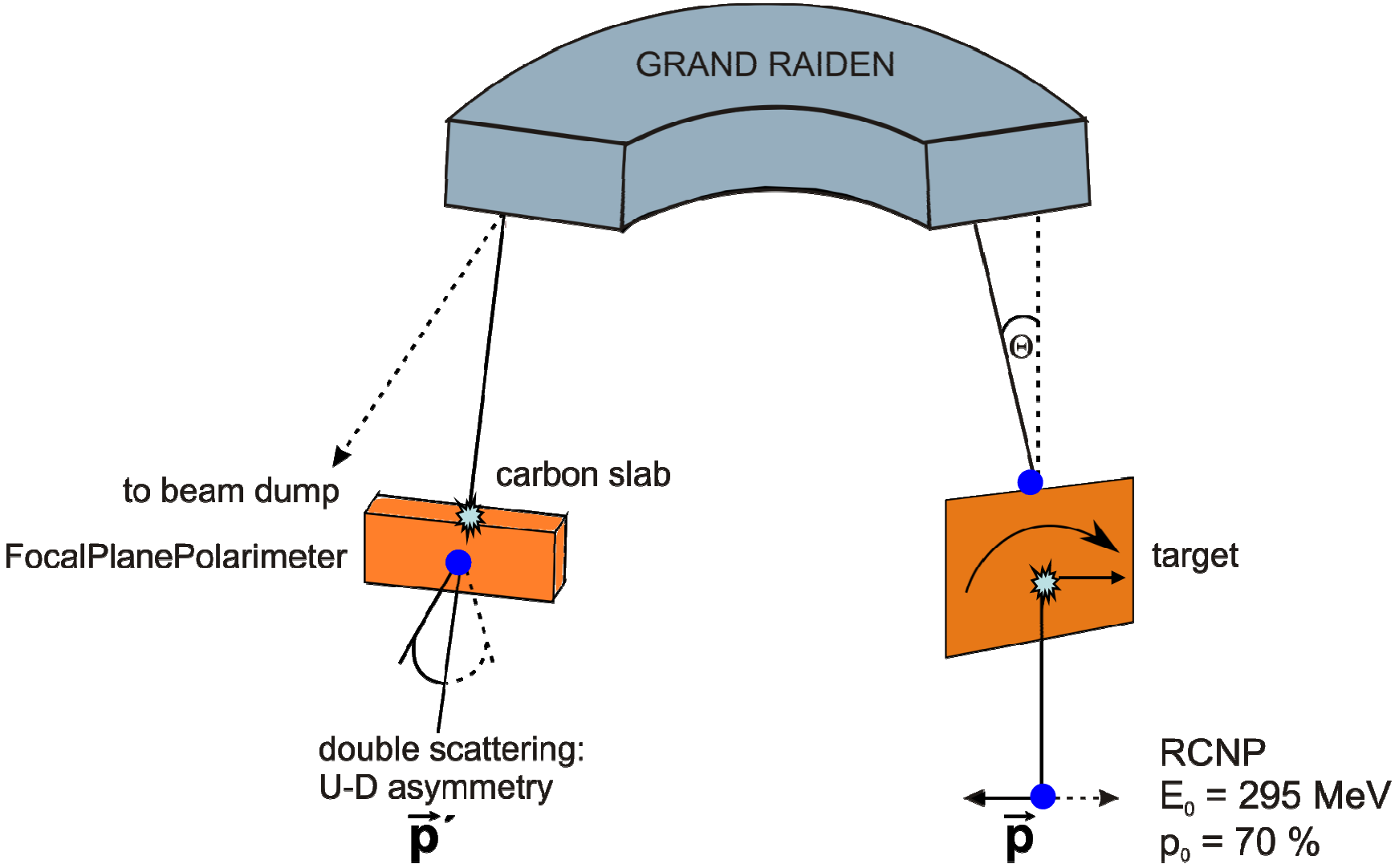
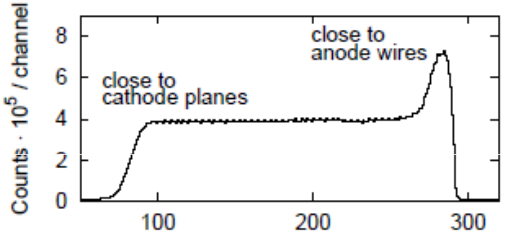


Animation by I. Poltoratska

Analysis steps

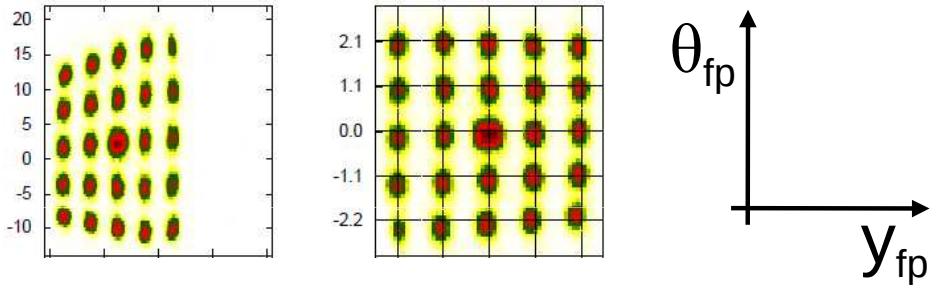
- Drift time to drift length conversion



- Determination of efficiency of VDCs

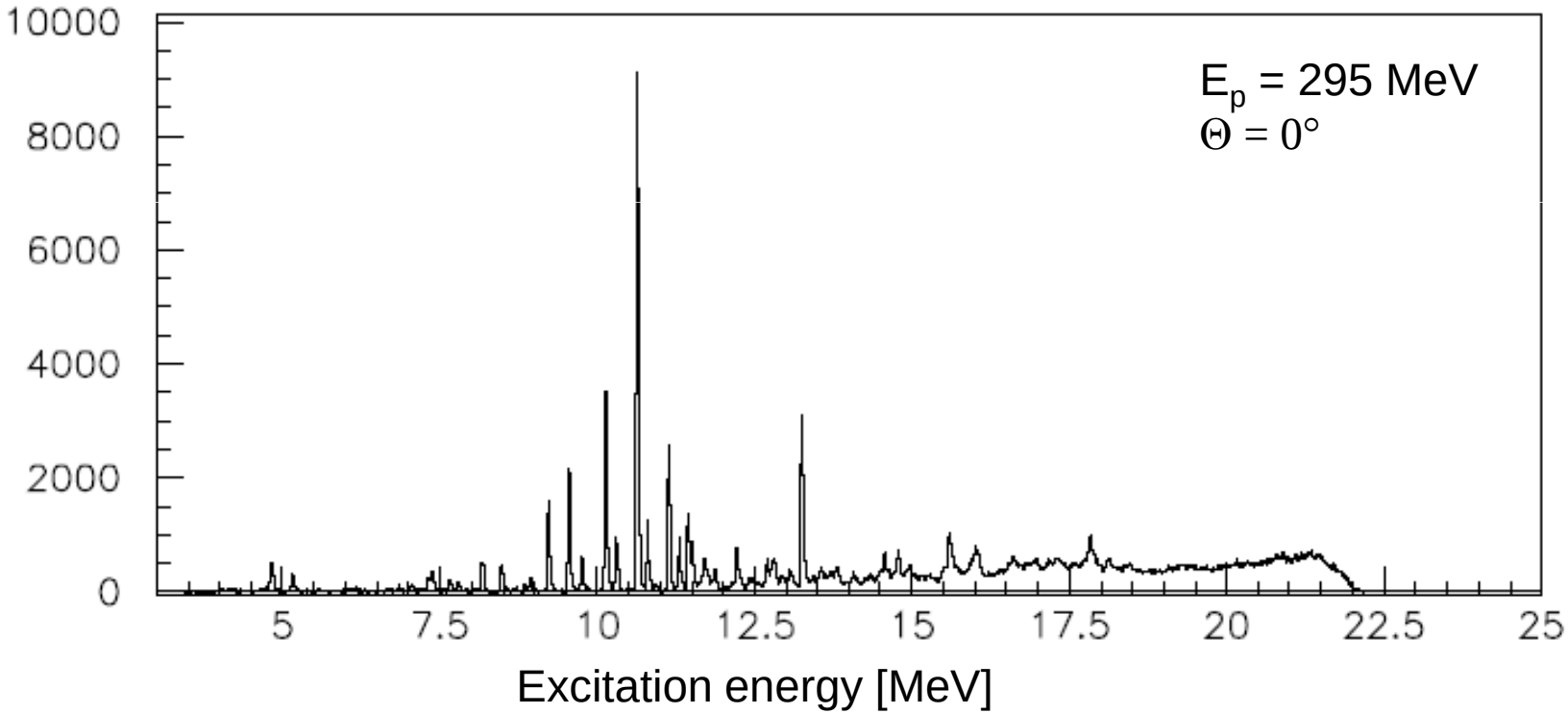
$$\epsilon_{total} = 88\%$$

- Calibration of scattering angles



- Excitation energy calibration and test of polarization transfer analysis
  - ^{26}Mg runs after each ^{154}Sm run
  - Many prominent 1^+ states in ^{26}Mg
  - Test of the polarization transfer analysis (Spinflip M1 transitions)

Preliminary Results: background subtracted spectrum ^{26}Mg



- Background events: flat distribution in non-dispersive focal plane
- True events focus at y_{fp} = 0 (measurement with LAS)

Preliminary Results: Polarization transfer observables in ^{26}Mg

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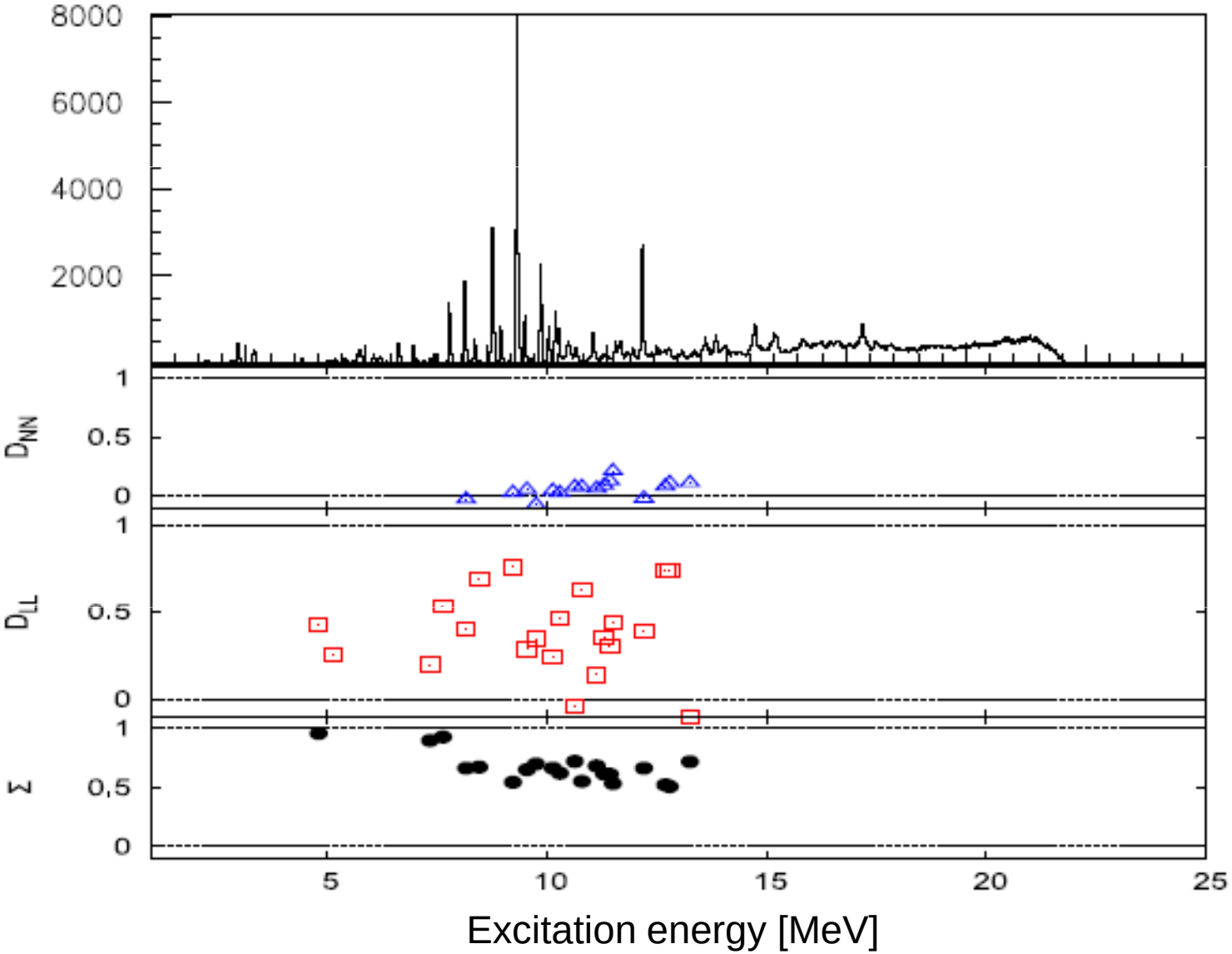

Preliminary Results: background subtracted spectrum ^{154}Sm

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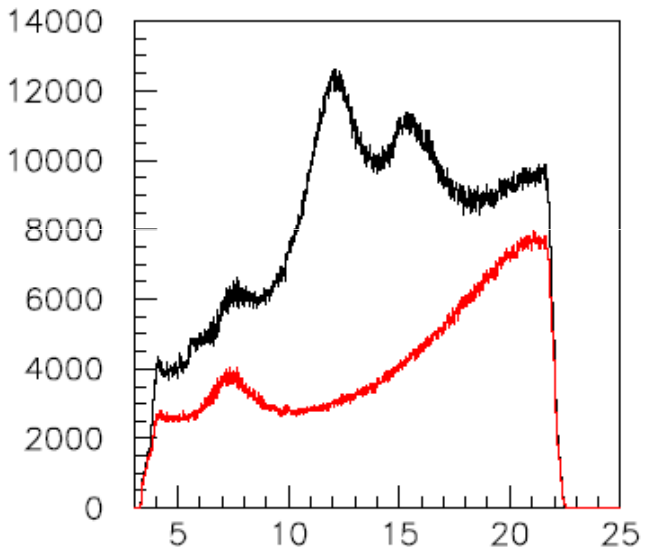
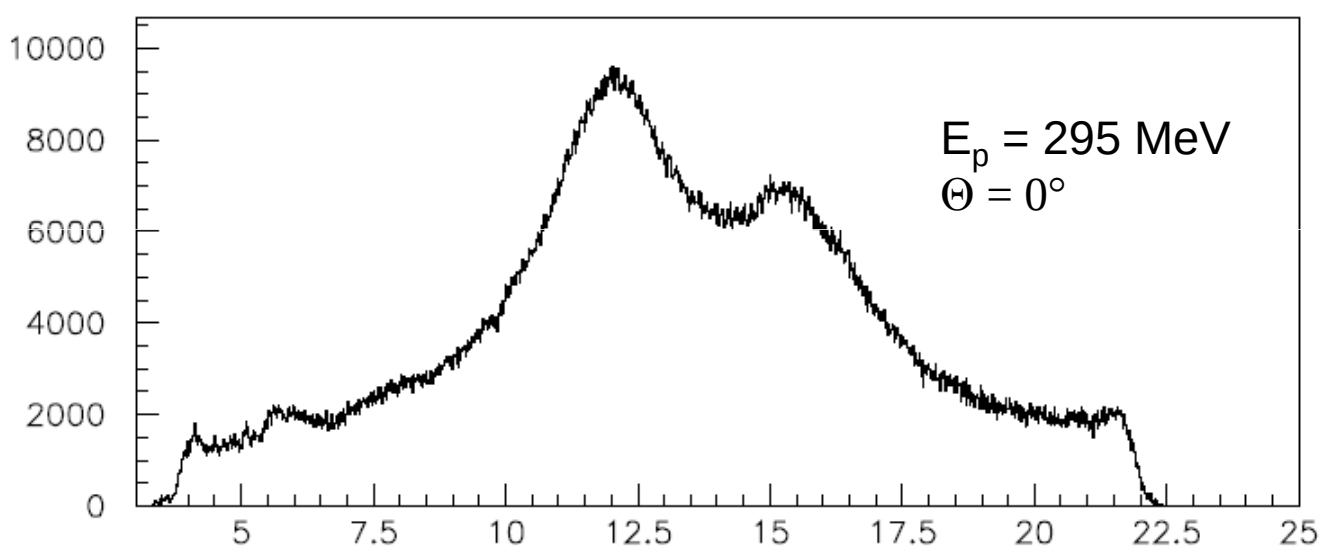


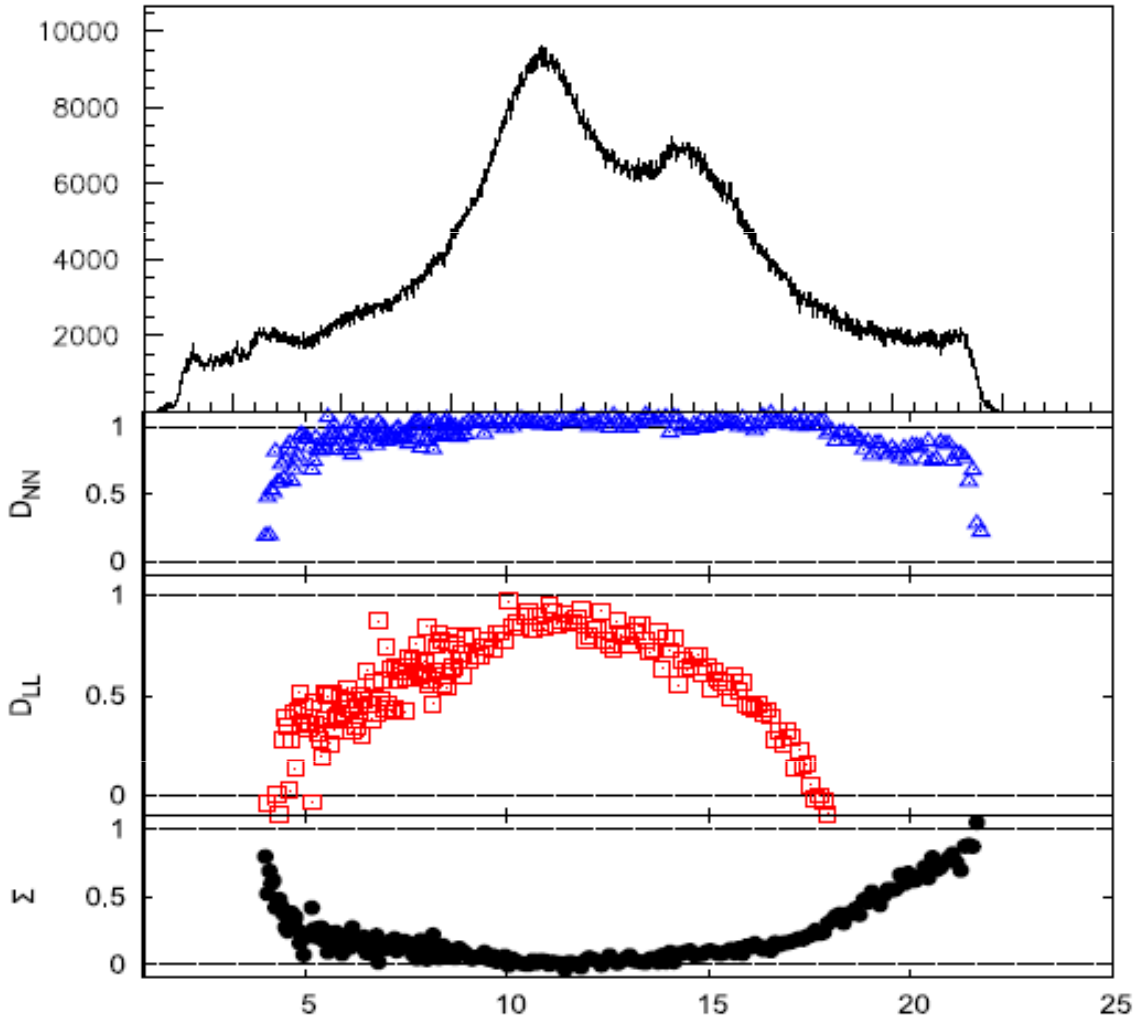
Excitation energy [MeV]



Excitation energy [MeV]

- Clear observation of GDR double structure
- No discrete peaks, therefore ^{26}Mg measurement needed
- Spin-M1 and PDR at lower excitation energies
- „Quasi-free“ scattering at higher excitation energies

Preliminary Results: Polarization transfer observables in ^{154}Sm



Summary

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- 300 MeV polarized proton scattering experiment at ^{154}Sm
- Scattering at 0° as a tool to distinguish E1 and M1 excitations
- Preliminary test with ^{26}Mg
- Preliminary polarization transfer observables for ^{154}Sm

Outlook

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- Extract spinflip-M1 cross section from polarization transfer observables
- Extract Pygmy Dipole Strength
- Angular distribution (define scattering angle cuts for measurements at 0° and 3°)
- Compare angular distribution for PDR, Spin-M1 and GDR with QPM-Calculations
- Investigate the role of the deformation for the PDR (combine results with measurements at ^{144}Sm)

Thank you for your attention!

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- Further talks to this experimental method at this conference:

– Dipole strength in ^{48}Ca(p,p‘) under extreme forward angles

→ HK 6.6: J. Birkhan

– Complete dipole response from inelastic proton scattering in ^{208}Pb

→ HK 13.7: I. Poltoratska

– Extraction of the total electric dipole strength in ^{120}Sn

→ HK 13.5: A.M. Krumbholz

→ HK 36.6: J. Simonis

– Investigation of the reaction ^{144}Sm(p,p‘) under extreme forward angles

→ HK 47.3: D. Martin

- Planned Experiments:

– Test of the Axel-Brink hypothesis via ^{96}Mo(p,p‘) experiments