The quest for new data on the Space Star Anomaly in pd breakup

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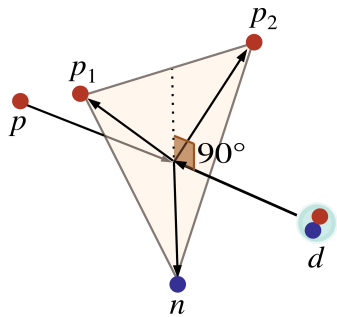
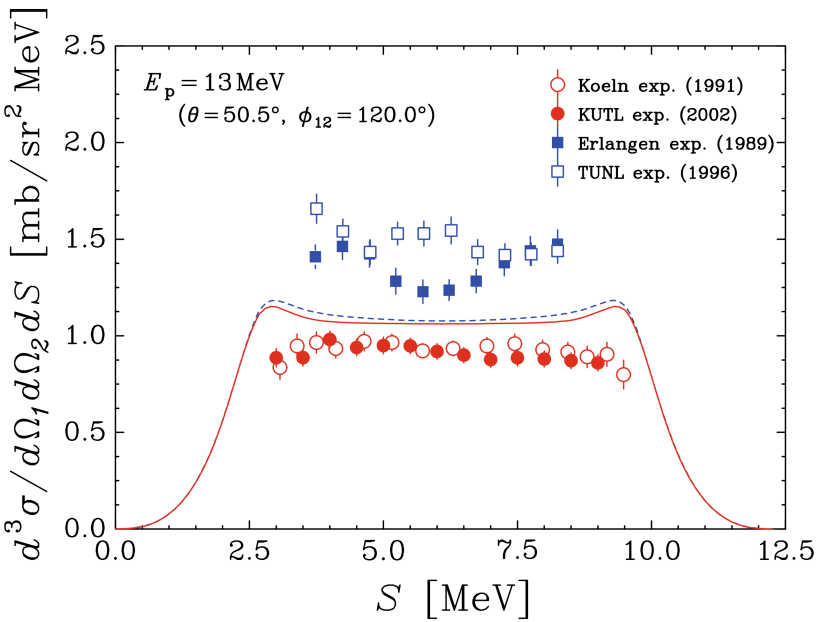
What is the Space Star Anomaly

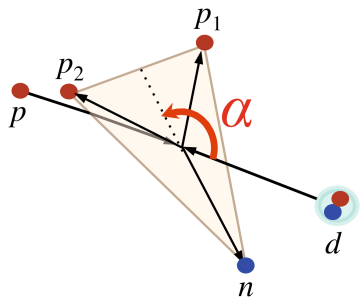
- Space Star is a specific configuration where momenta of the final state nucleons form an equilateral triangle and the decay plane is perpendicular to the beam direction
- The effect was discovered in 1989 in n+d breakup by Erlangen group (Strate et al.) (30% above the predictions)
- It was confirmed TUNL in 1996 (Setze et al.)
- The effect is opposite in p+d breakup (15% below theory)
- Mainly s-wave of binary NN interaction
- Energy too low for 3NF to be apparent (max. few %)
- Coulomb force and relativistic effects negligible



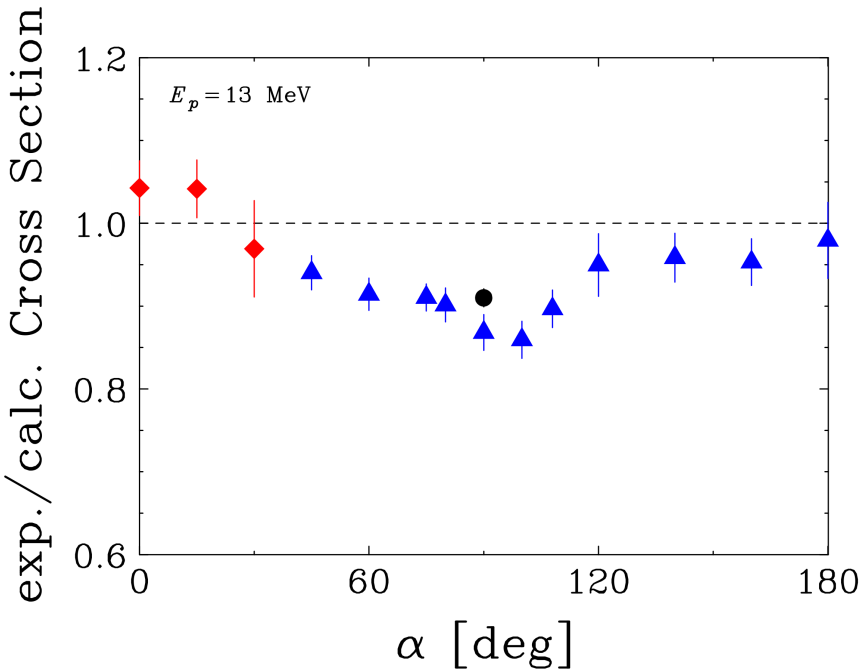


K. Ohnaka et al. Few-Body Syst. 55 725 (2014)

Inclination angle



- Ohnaka et al. measured the dependence of the cross section on inclination angle
- By varying α one finds the discrepancy peaks at the Space Star (90°).
- Forward and Backward Plane Star configurations follow the theoretical predictions



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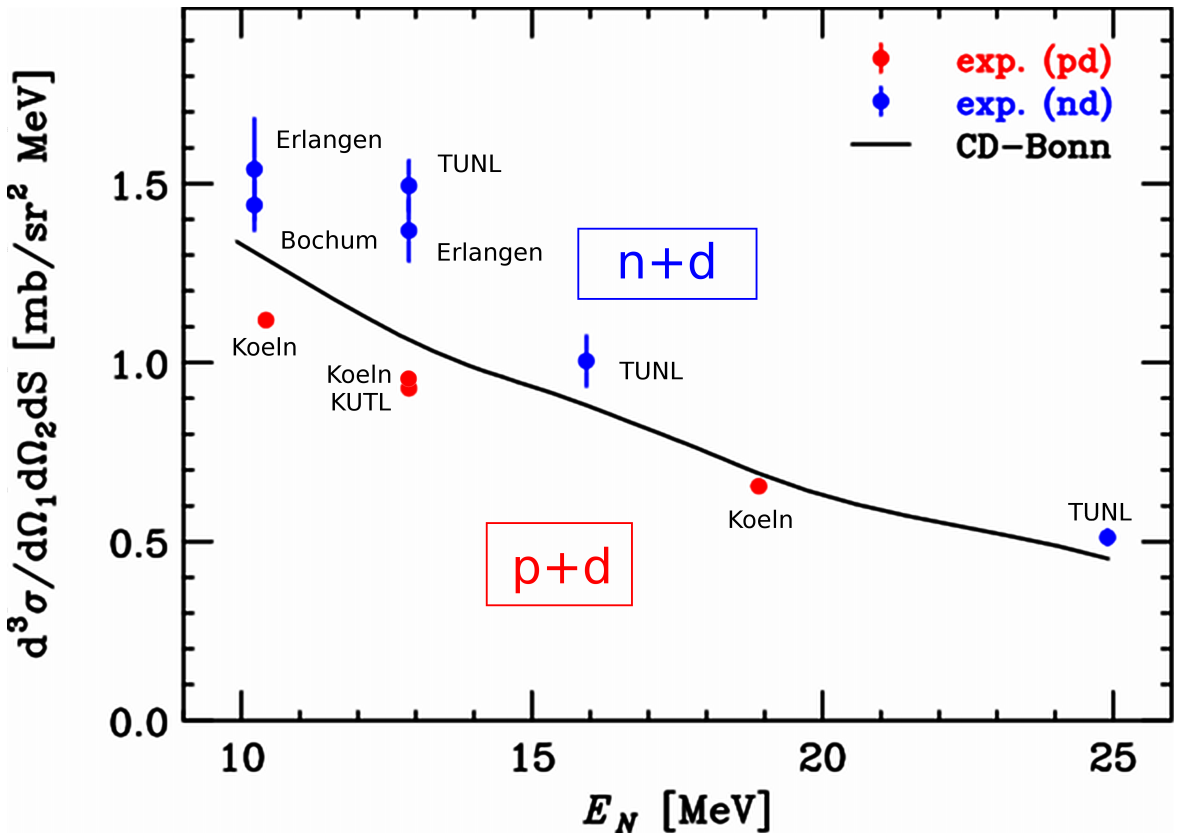
Energy dependence

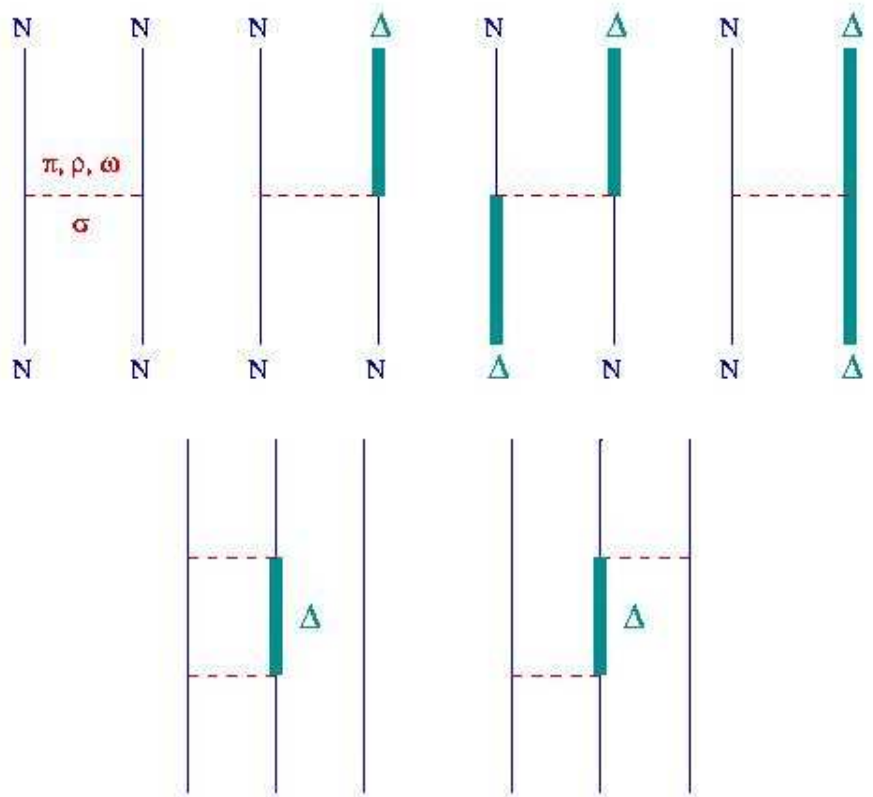
- The highest ever measured p+d energies are 19 and 65 MeV
- In both cases the data are consistent with the theoretical predictions
- The effect appears at energies about 9-13 MeV
- What about higher energies?



Y. Eguchi. Fb19 conference presentation.

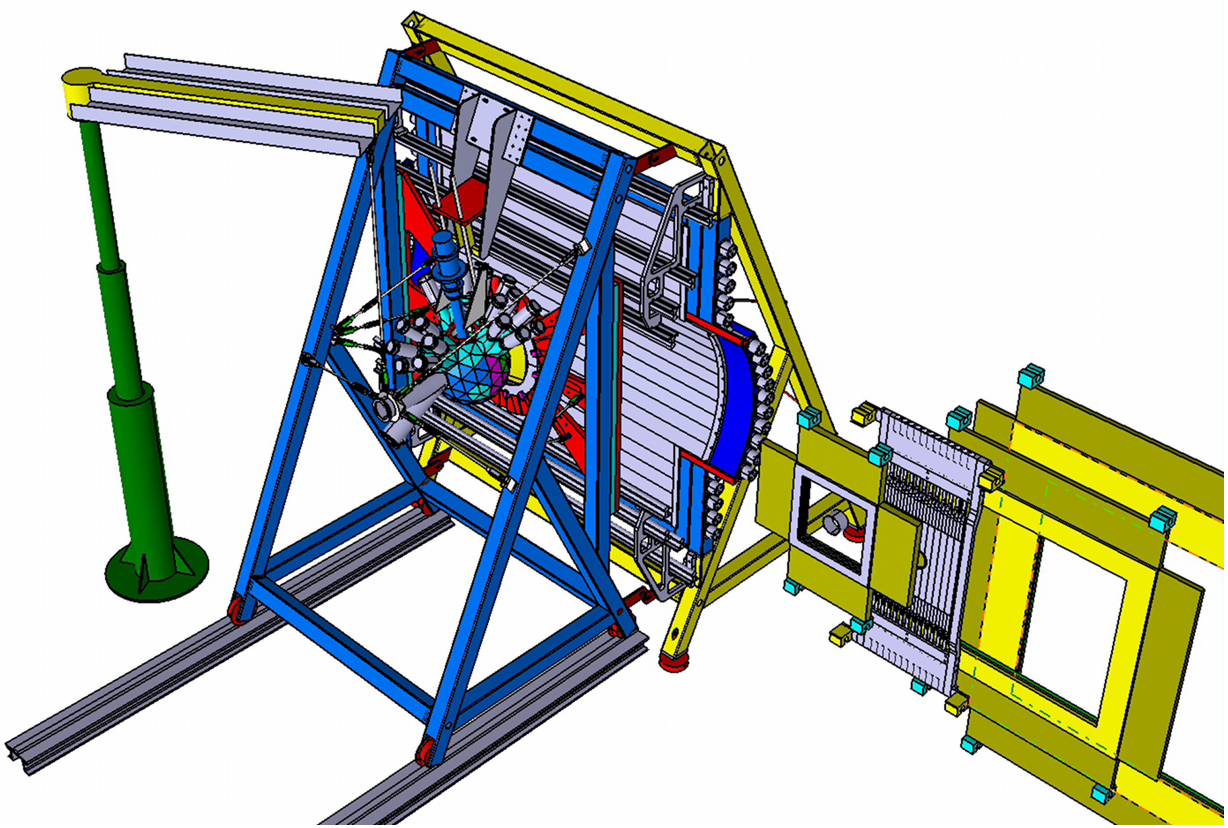
CD-Bonn+Δ+C

- CD-Bonn is a realistic potential
- Addition of Δ excitation enables to describe 3NF
- Coulomb effects are introduced by A. Deltuva



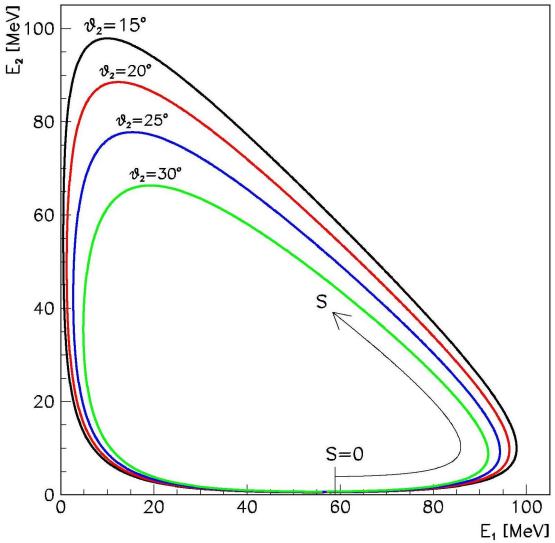
BINA@CCB

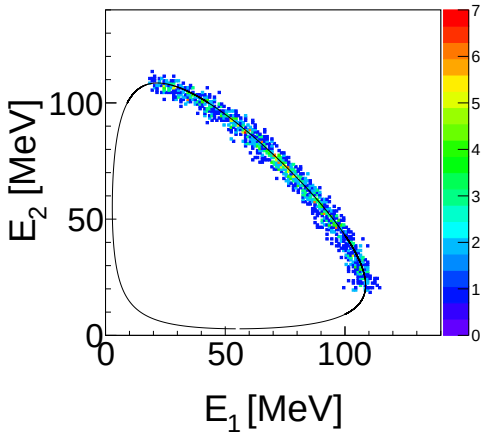
- A 4π geometry facilitates a simultaneous measurement of a set of the star configurations with different $\alpha \rightarrow$ the same luminosity
- Axial symmetry makes possible to rotate the configuration about the beam axis $\rightarrow$ systematic effect
- MWPC and Wall $\theta \in$ 10-35°
- Ball $\theta \in$ 40-165°

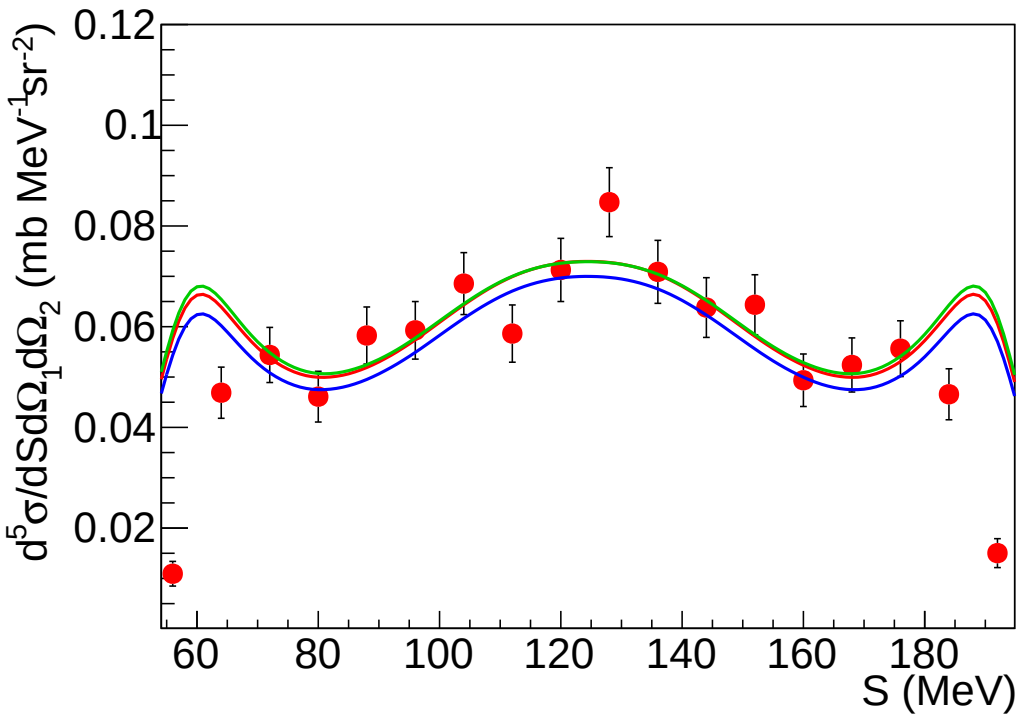


First preliminary results

Configuration: $\theta_1 = \theta_2 = 25.11^\circ$, $\phi_{12} = 147.80^\circ$ $(\alpha = 30^\circ)$
Reaction: p(d(160 *MeV*),pp)n







CD-Bonn+Δ+Coulomb
CD-Bonn+Δ
CD-Bonn+Coulomb

Outlook

- The measurements are within the scope of a recently started project (National Science Centre, Poland 2016/23/D/ST2/01703)
- The project aims at obtaining cross sections for deuteron on proton breakup for energies 50, and 80 MeV/nucleon (already measured), as well as for proton beam of energy 108, 135, and 160 MeV (partially measured)
- This will fill the gap in the energy scan of the process and find whether the SSA is characteristic only to the lowest energies
- Some new theoretical predictions are awaited (theories calculated in relativistic framework, χEFT.
- New data will be collected soon