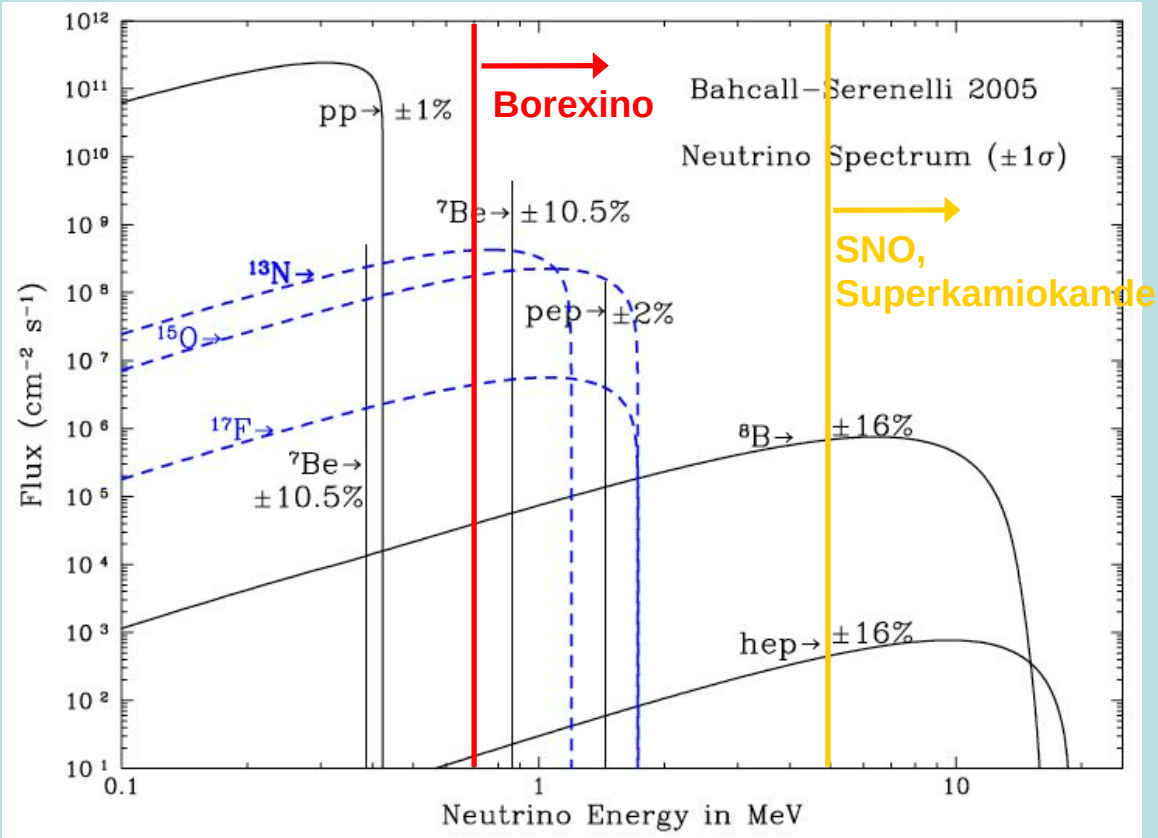
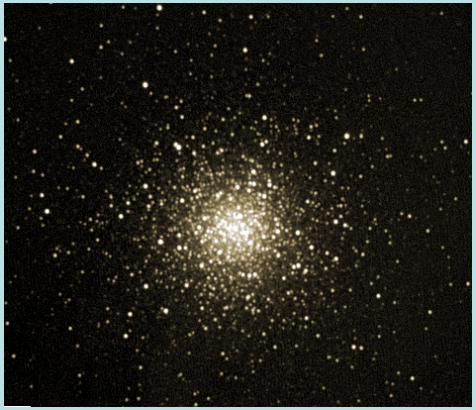
- Theoretical calculation of neutrino fluxes from the Sun

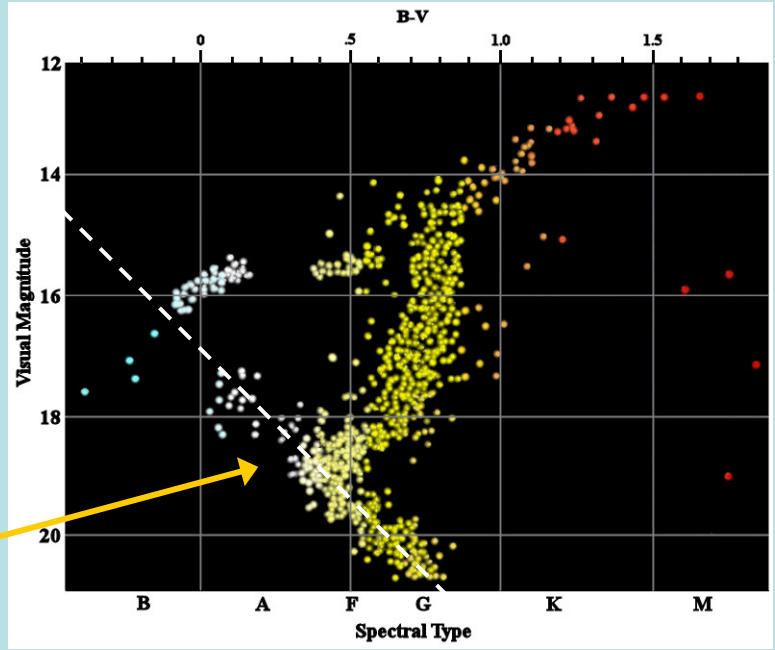


Age determination

- Globular clusters: most ancient objects in the Galaxy
- Dating based on observed luminosity at „turnoff“ transition and theoretical relation between luminosity and age
- depends on slowest reaction rate of CNO cycle:

bottleneck $^{14}N(p,\gamma)^{15}O$



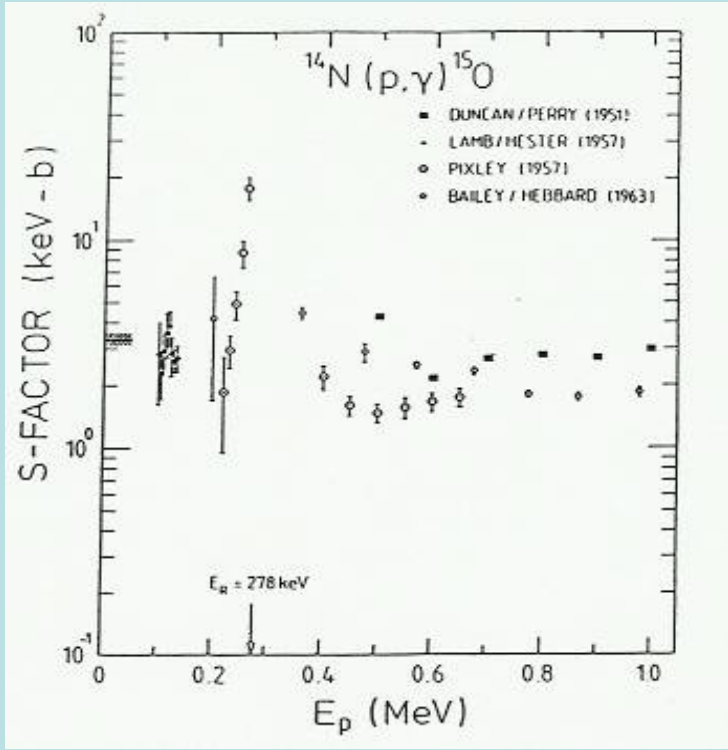


Turnoff luminosity

History

slightly biased

1949	Woodburry, Hall, Fowler	activation
1951	Ducan, Parry	activation at low energy
1955	Bashkin,Carlson and Nelson	
1957	Lamb and Hester	activation at low energy
1957	Pixley	NaI
1957	Hebbard and Baily	NaI
1959	Povh and Hebbard	NaI



History

1949		Woodburry, Hall, Fowler	activation
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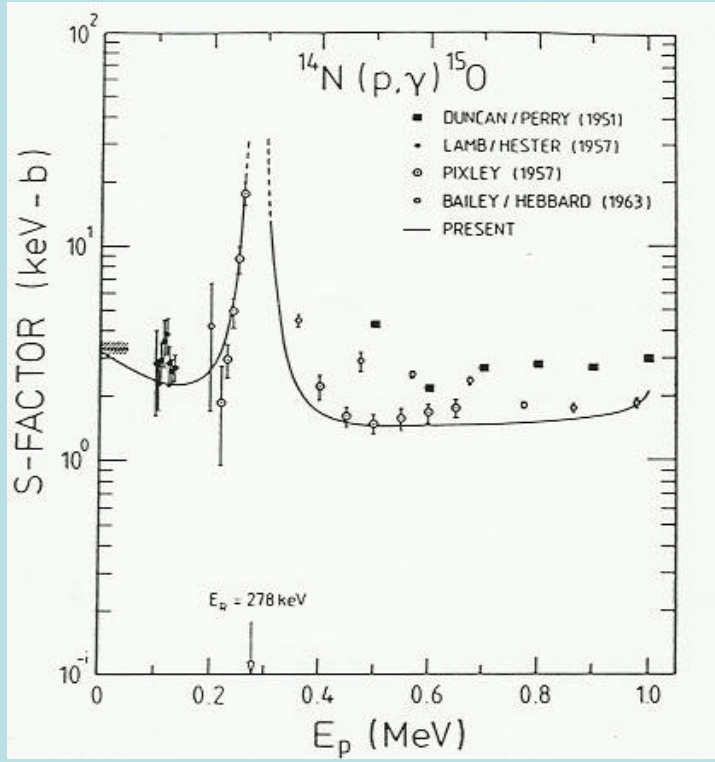
1959		Povh and Hebbard	NaI
1970	1973	Production of thousends of N-targets for 14N(α,γ)18F	
73	76	production of 14N enriched targets	
		first experiments on 14N(p,γ)15O in Toronto	
76	87	14N(p,g)15O programm started in Münster, Bochum and Toronto	
		targets: evaporated, implanted and gas target	
		Schröder Publication	high extrapolation of gs transition (Breit Wigner)



History

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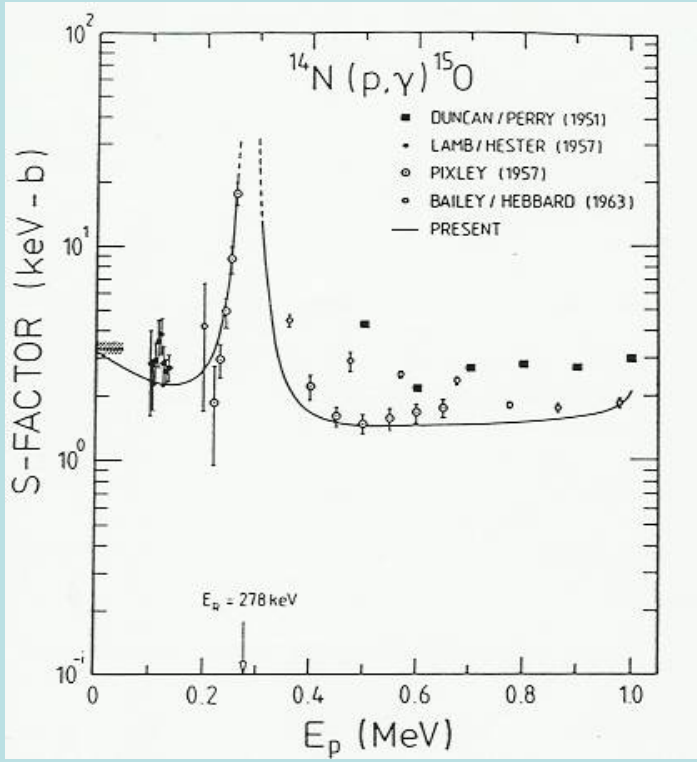
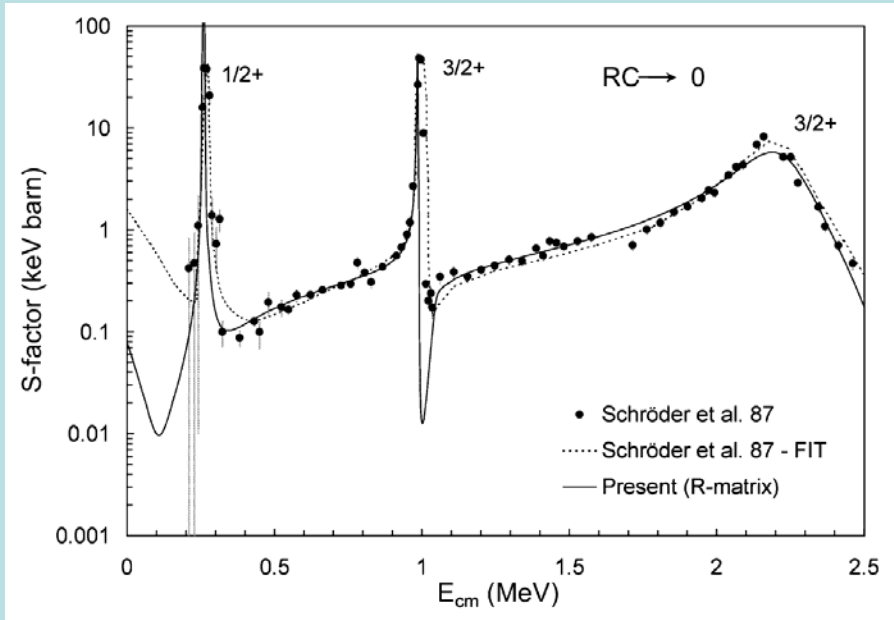
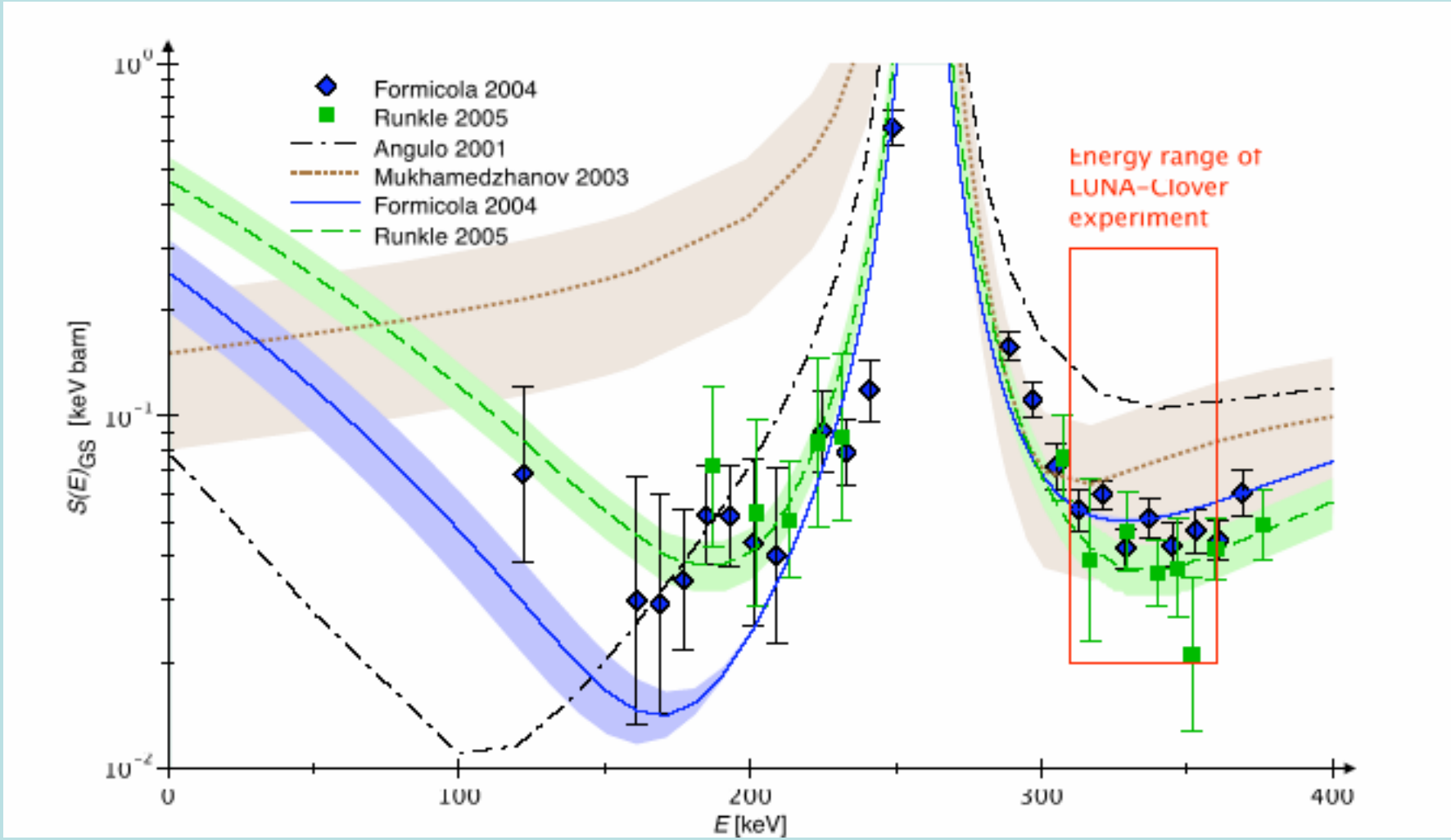
2001		R-matrix fit of Schröder data by Carmen Angulo	gs greatly reduced
2001		Tunl measurement of ANC	
2002		Tunl Doppler shift measurement	
2002		start of LUNA2	
		start of LENA	
2003		Mukhamedzanov	
2004		Yamada livetime	
2004	today	LUNA/ LENA BOCHUM	





Status on grounstate transition



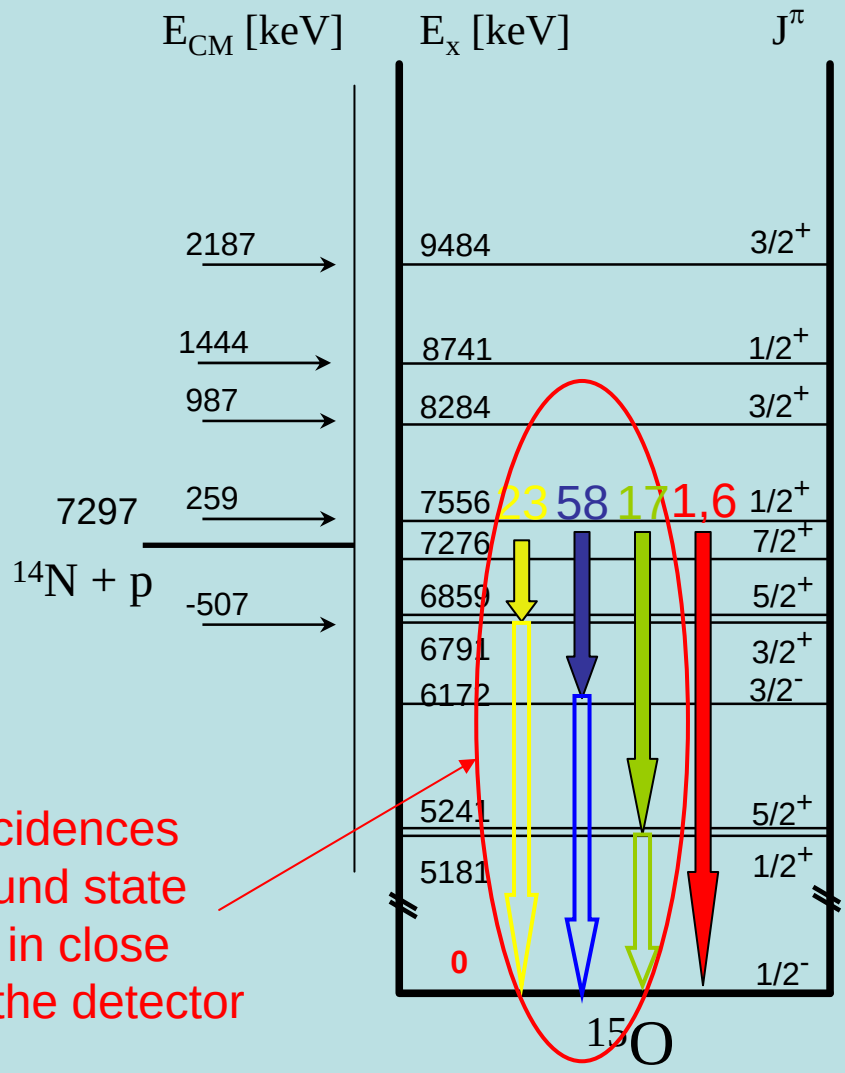
State of the art for $^{14}N(p,\gamma)^{15}O$

Transition to	LUNA 2004 Formicola et al. Phys.Lett.B 591 (2004) 61	LENA 2005 R.C. Runkle et al Phys. Lett. B, 94(2005)82503
	S(0) [keV · b]	
6.79 MeV	1.20 ± 0.0	1.15 ± 0.05
6.17 MeV	0.08 ± 0.03	0.04 ± 0.01
others	0.080 ± 0.004	
GS	**0.25 ± 0.06**	**0.49 ± 0.08**
total	1.61 ± 0.0	1.68 ± 0.09

ok within ± 2%

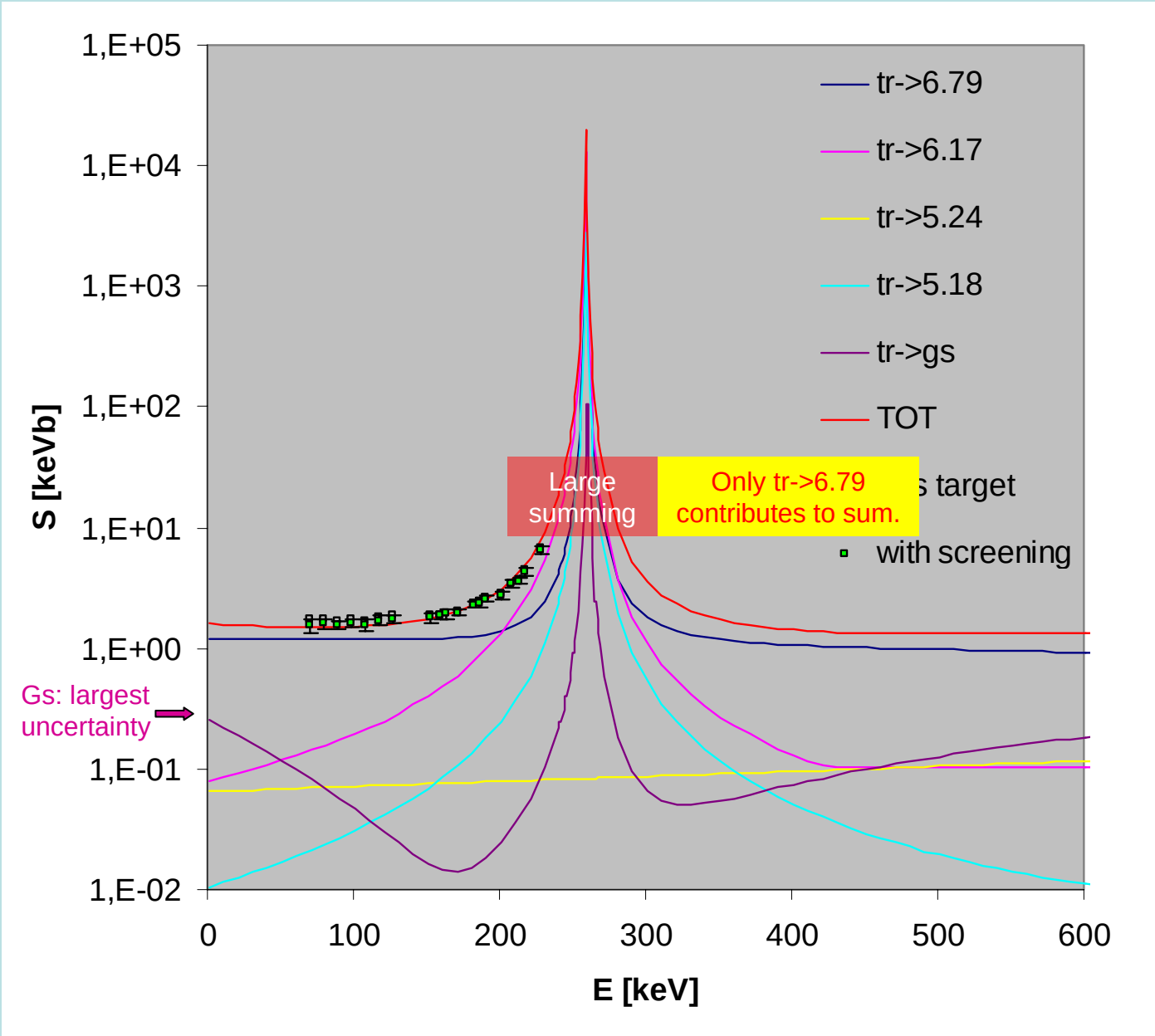
Factor 2!

$^{14}N(p,\gamma)^{15}O$

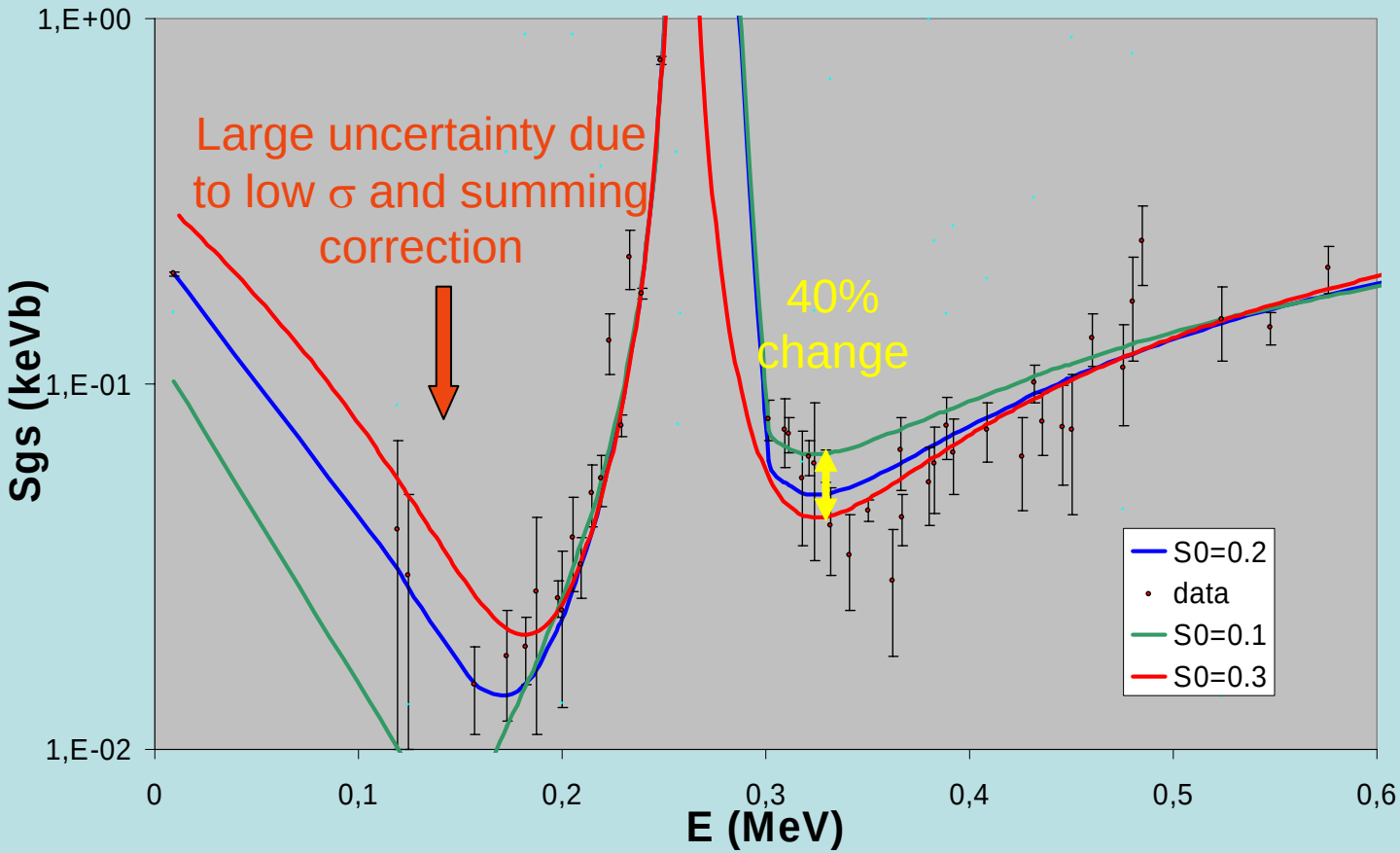


True coincidences mimic ground state transition in close geometry of the detector

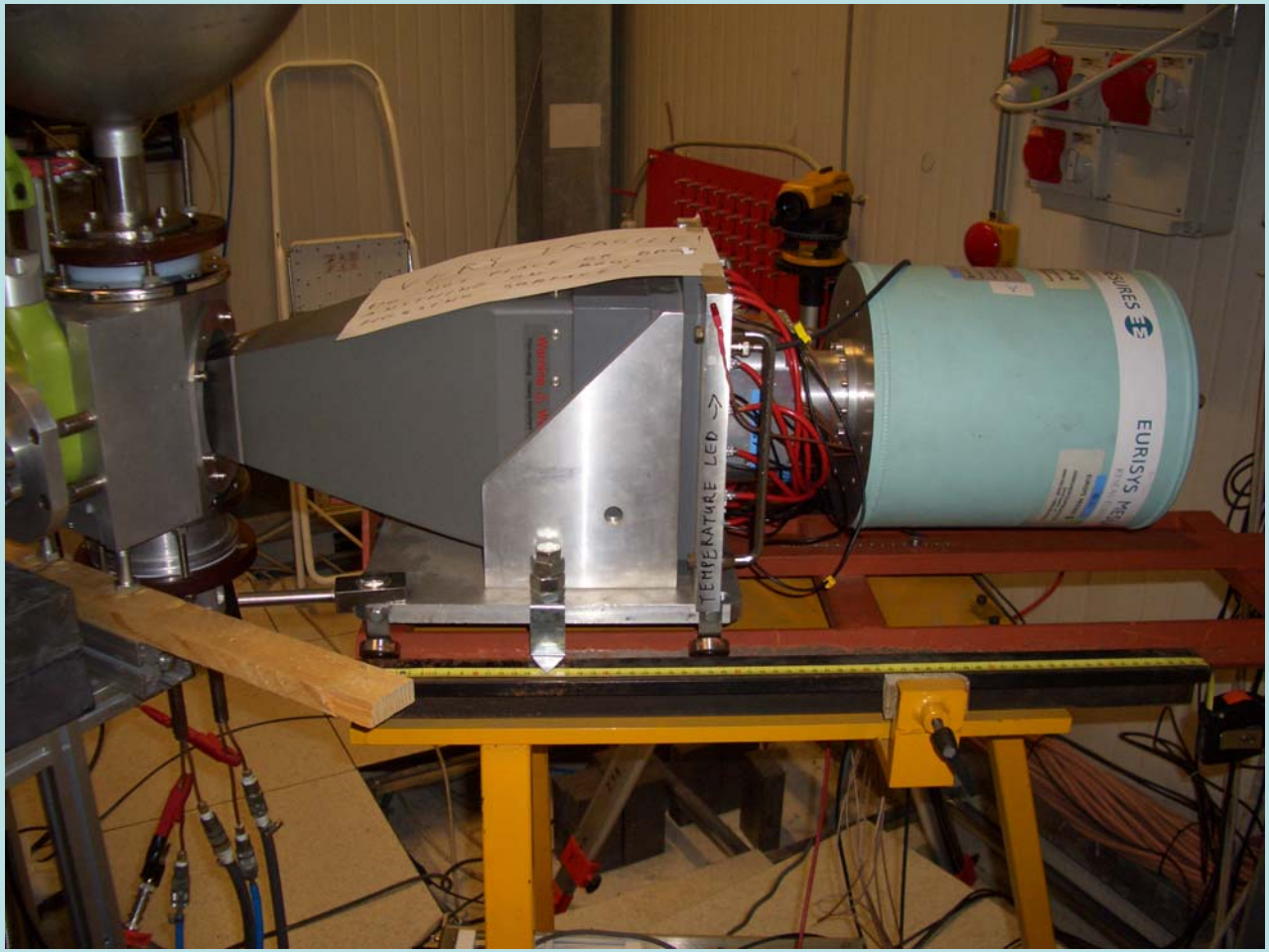
Total S-factor [keVb]



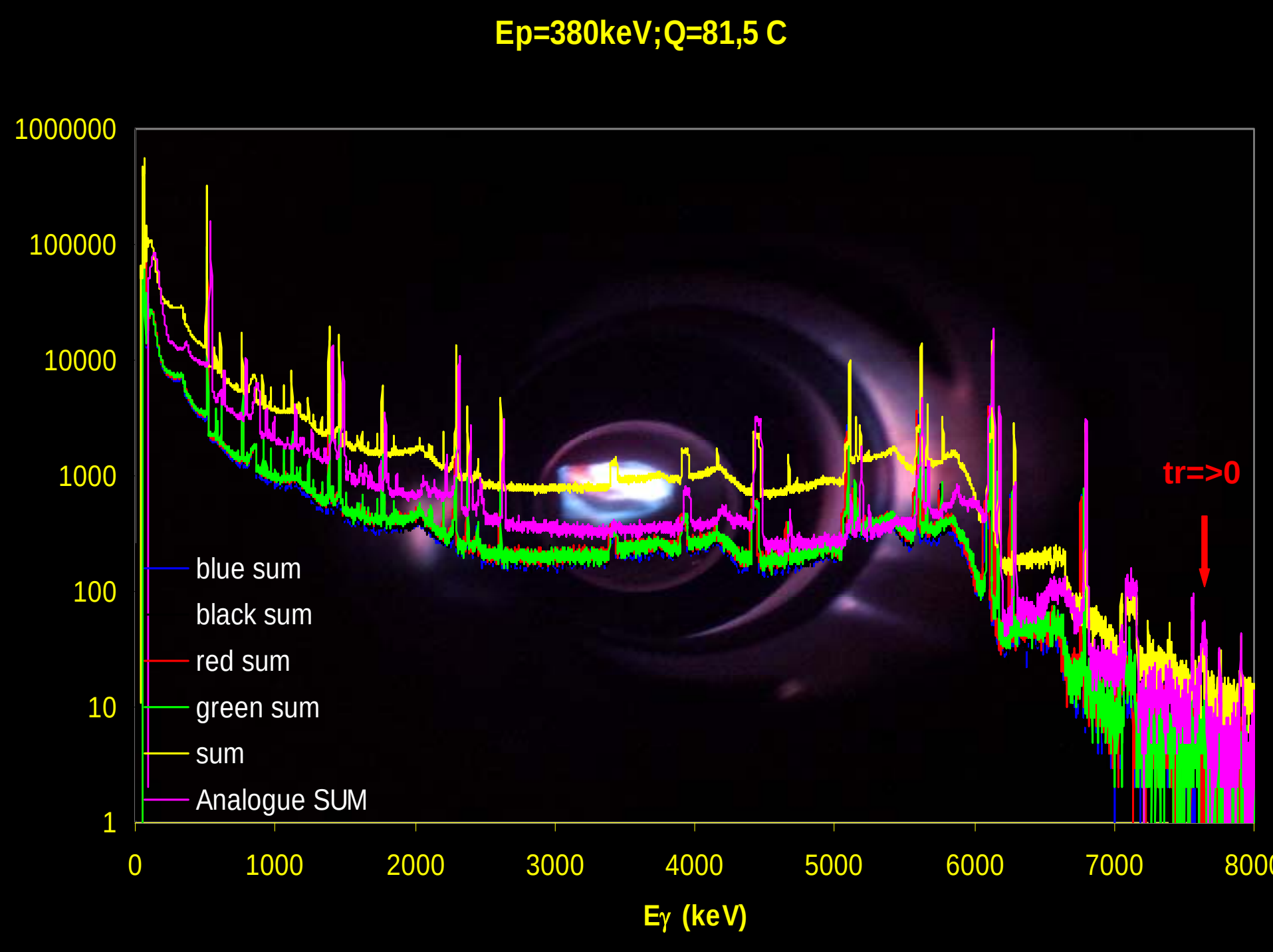
S–factor for ground state transition using AZURE by Ed Simpson



Answer to the summing problem



Clover detector set up
distance to target: 9 cm

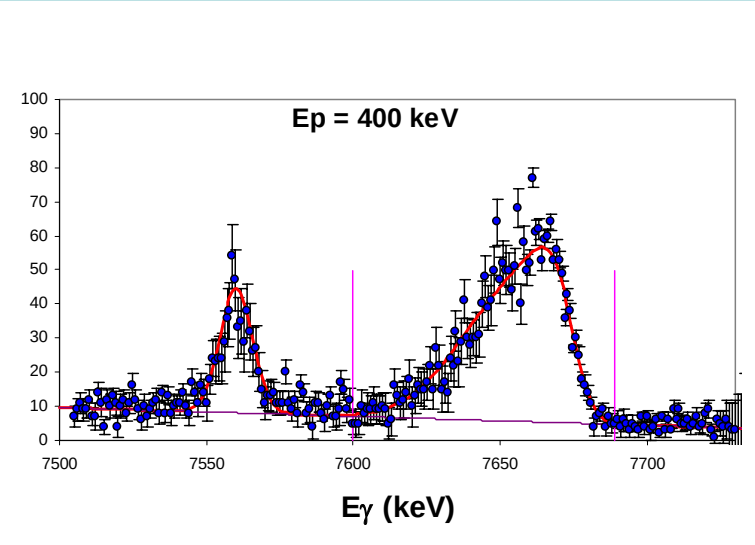

Ep=380keV;Q=81,5 C
1000000
100000
10000
1000
100
10
1
0
1000
2000
3000
4000
5000
6000
7000
8000
Eγ (keV)
tr=>0
blue sum
black sum
red sum
green sum
sum
Analogue SUM

- Relative to Tr => 6.79MeV state

$$\sigma_{gs} = \sigma_{6.79} \frac{Y_{gs}}{Y_{6.79}}$$

uncertainty in σ_{dc} from LUNA and LENA combined 3%
res contribution in 6.79 MeV γ-peak
angular distribution in primary line
but independent of
- Charge
- Stoichometry
- $\omega\gamma$

- Line shape analysis



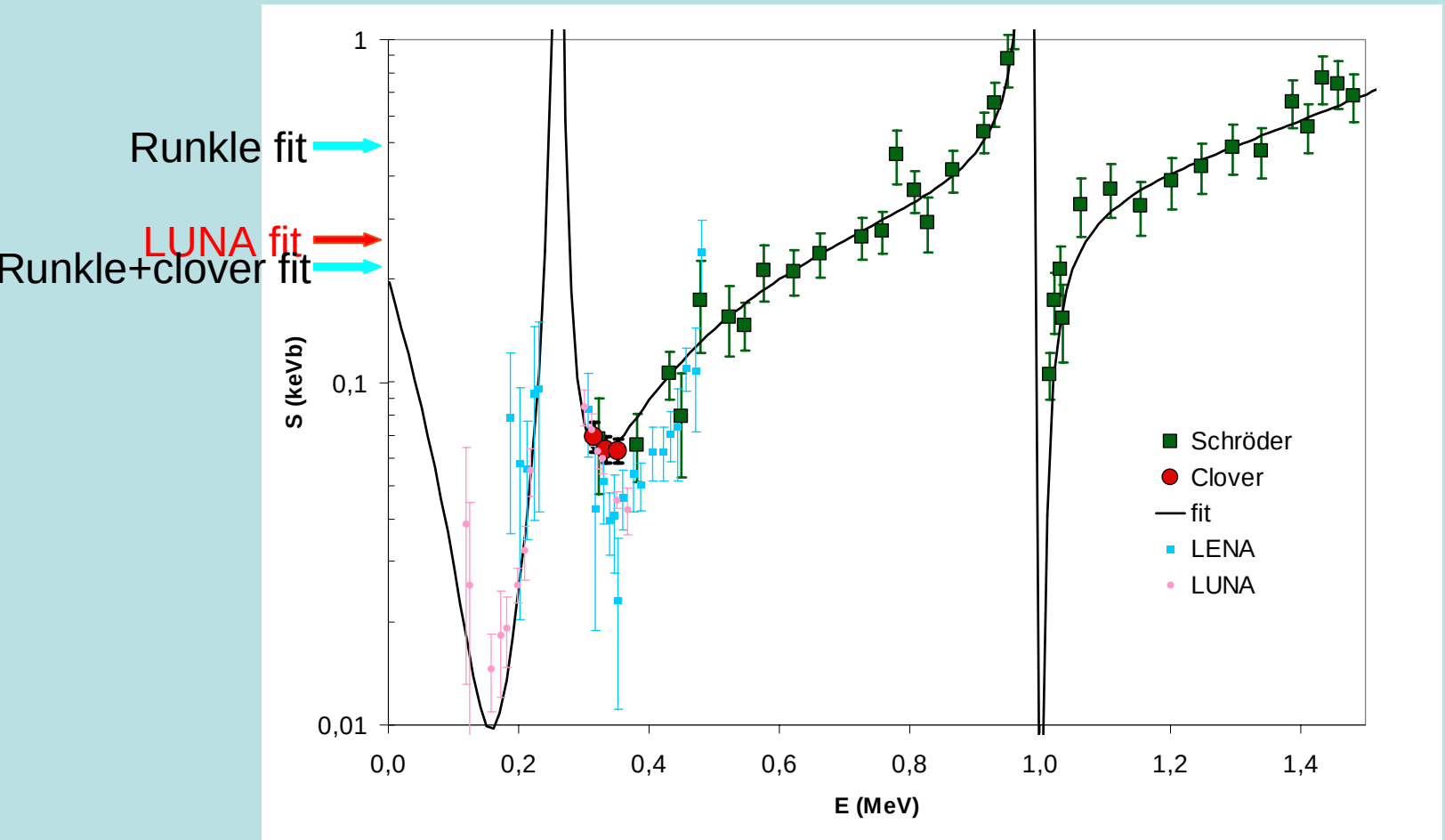
Same as absolute

But Δ fitted

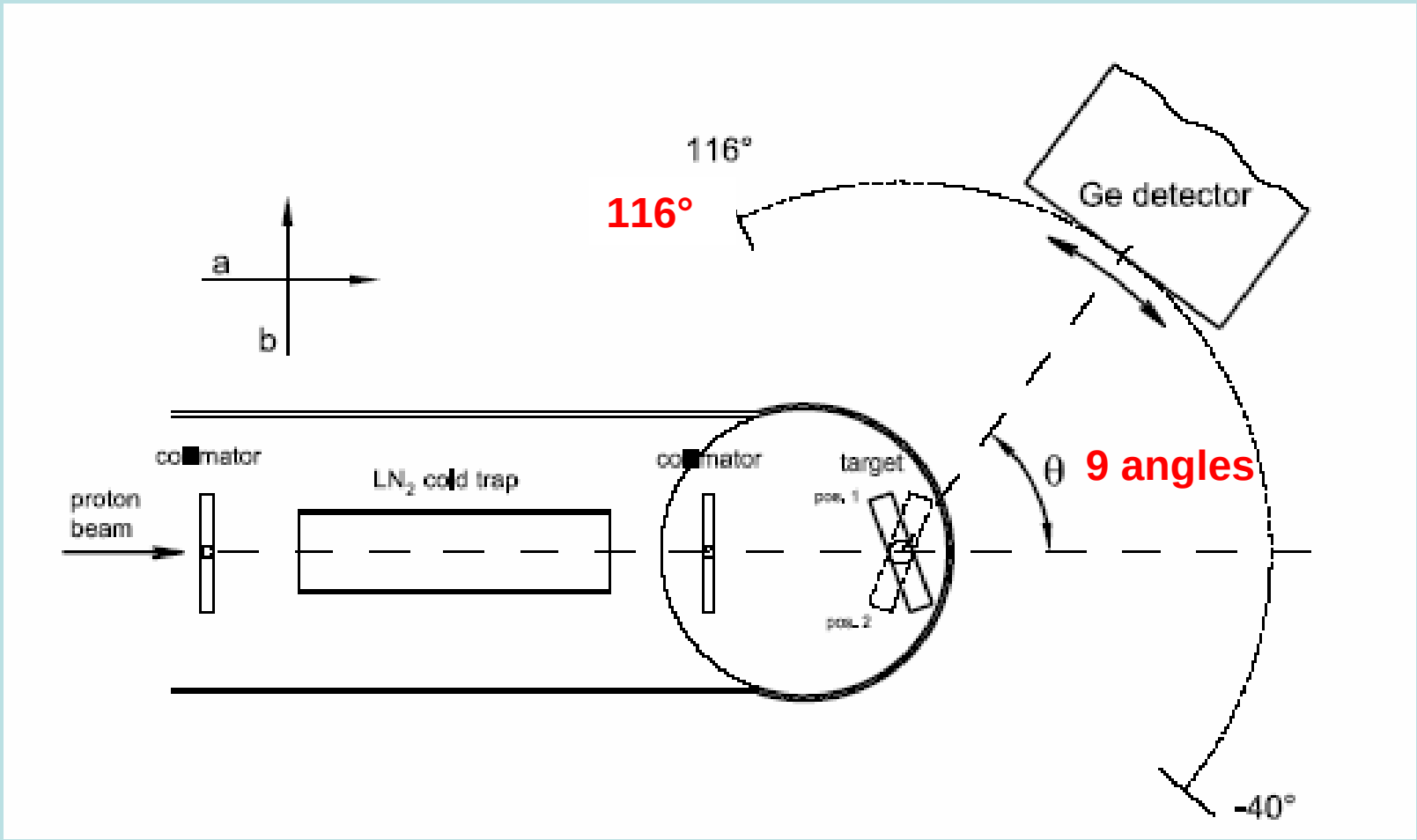
No effective energy needed

Check on background lines

Result

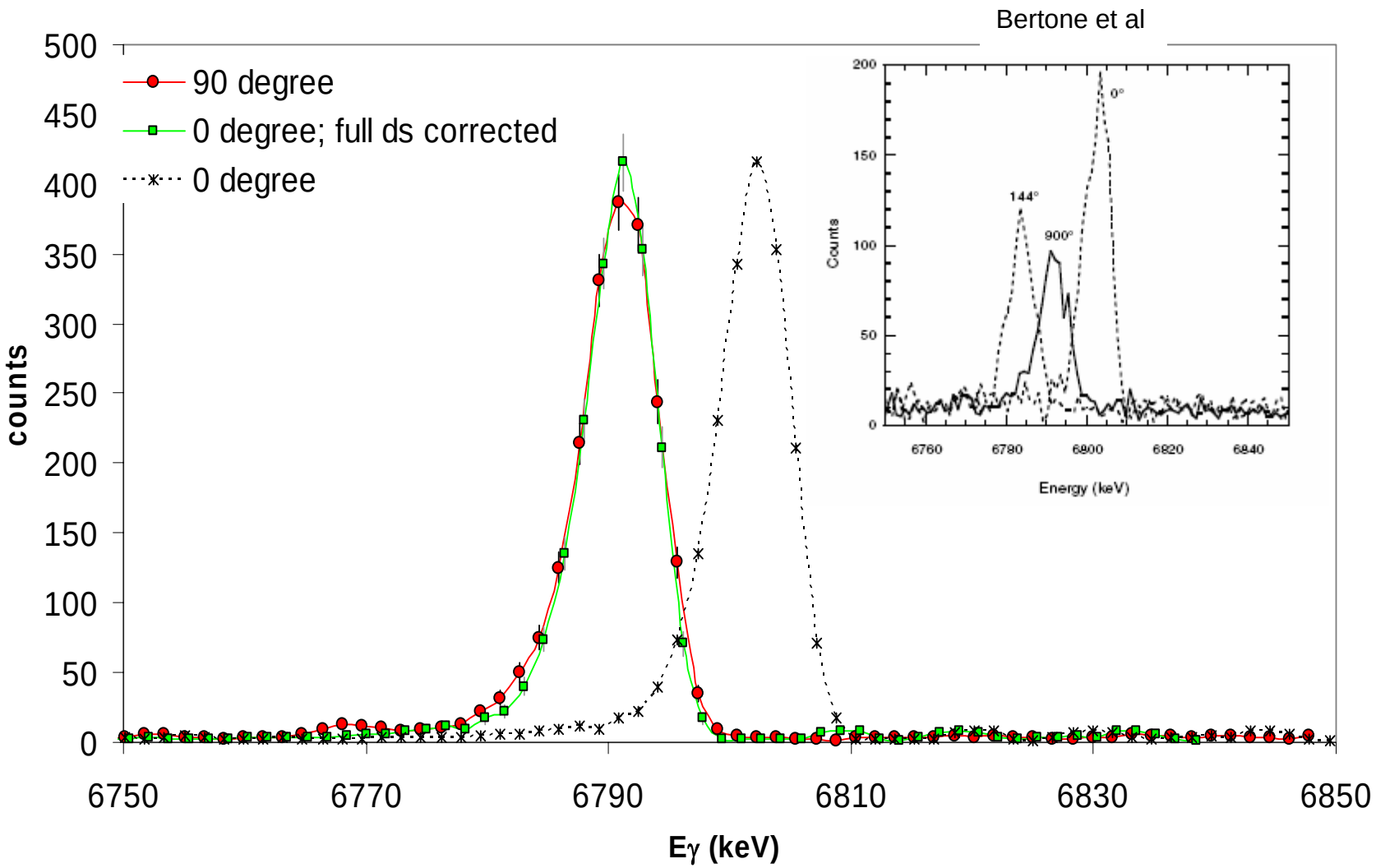

Runkle fit
LUNA fit
Runkle+clover fit
1
0,1
0,01
S (keVb)
0,0
0,2
0,4
0,6
0,8
1,0
1,2
1,4
E (MeV)
Schröder
Clover
fit
LENA
LUNA

Set up for DS measurement

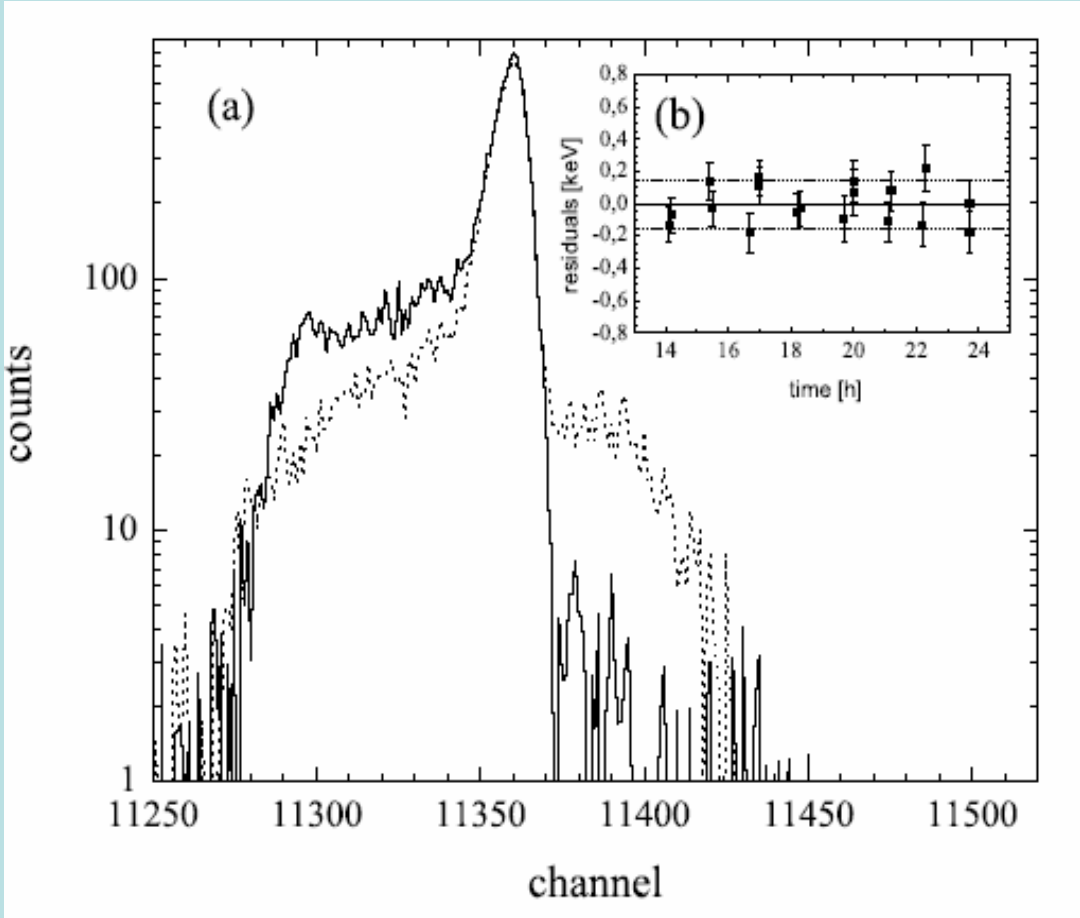


- 40°

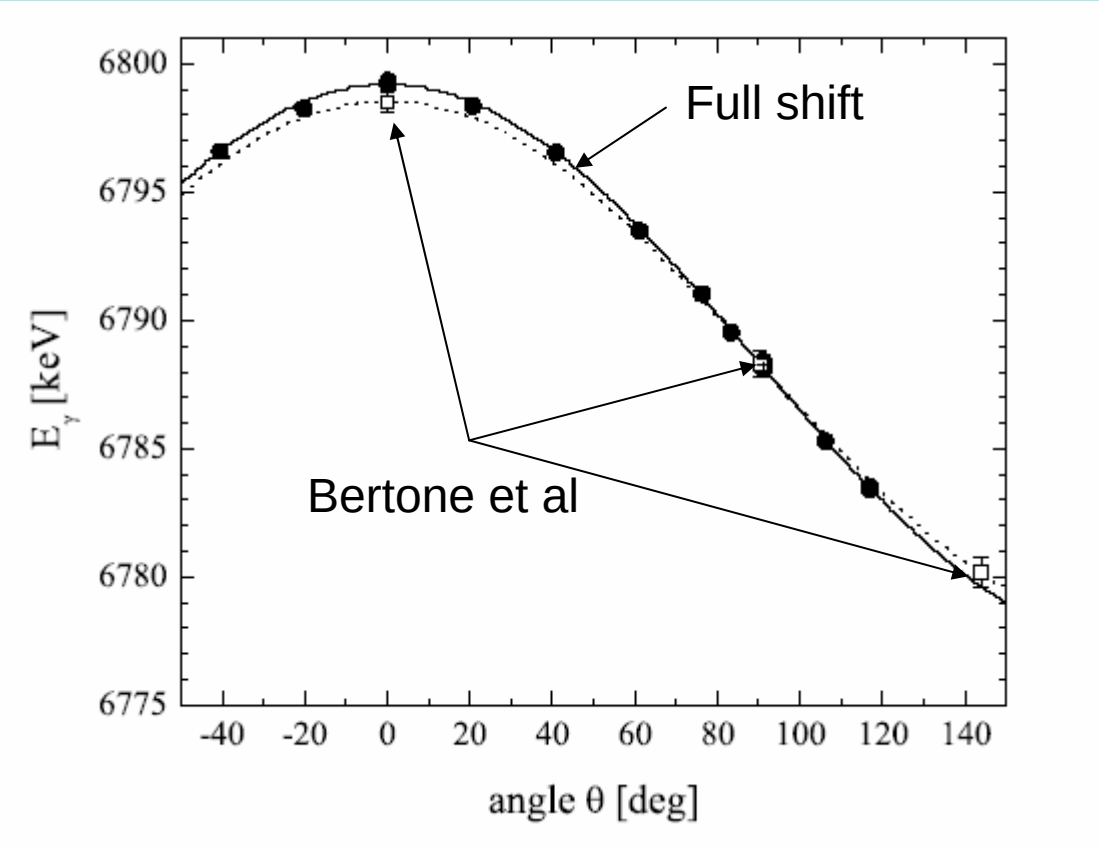
F(τ)=1


Bertone et al
90 degree
0 degree; full ds corrected
0 degree
counts
Eγ (keV)
0°
144°
900°
Counts
Energy (keV)

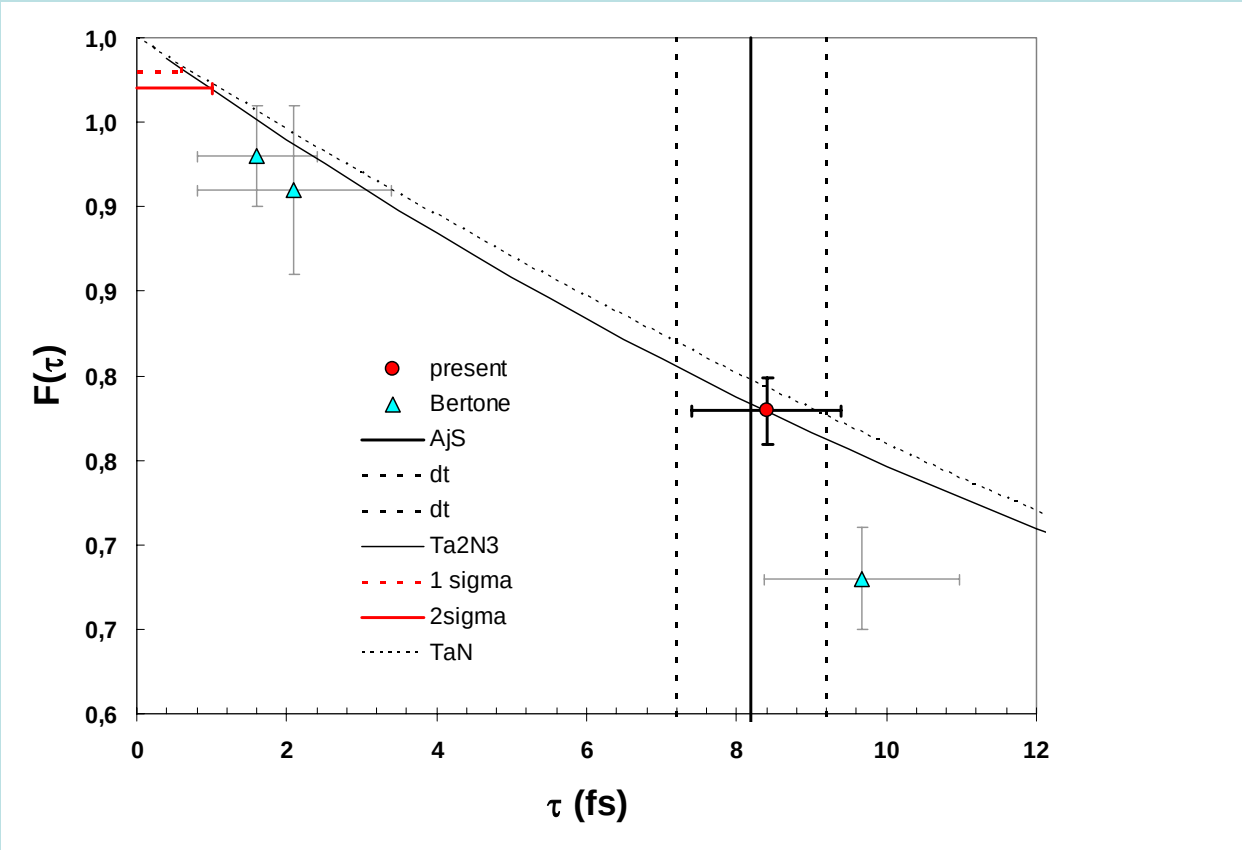
Gain stability test



Doppler shift for the 6.79MeV line



Doppler shift result

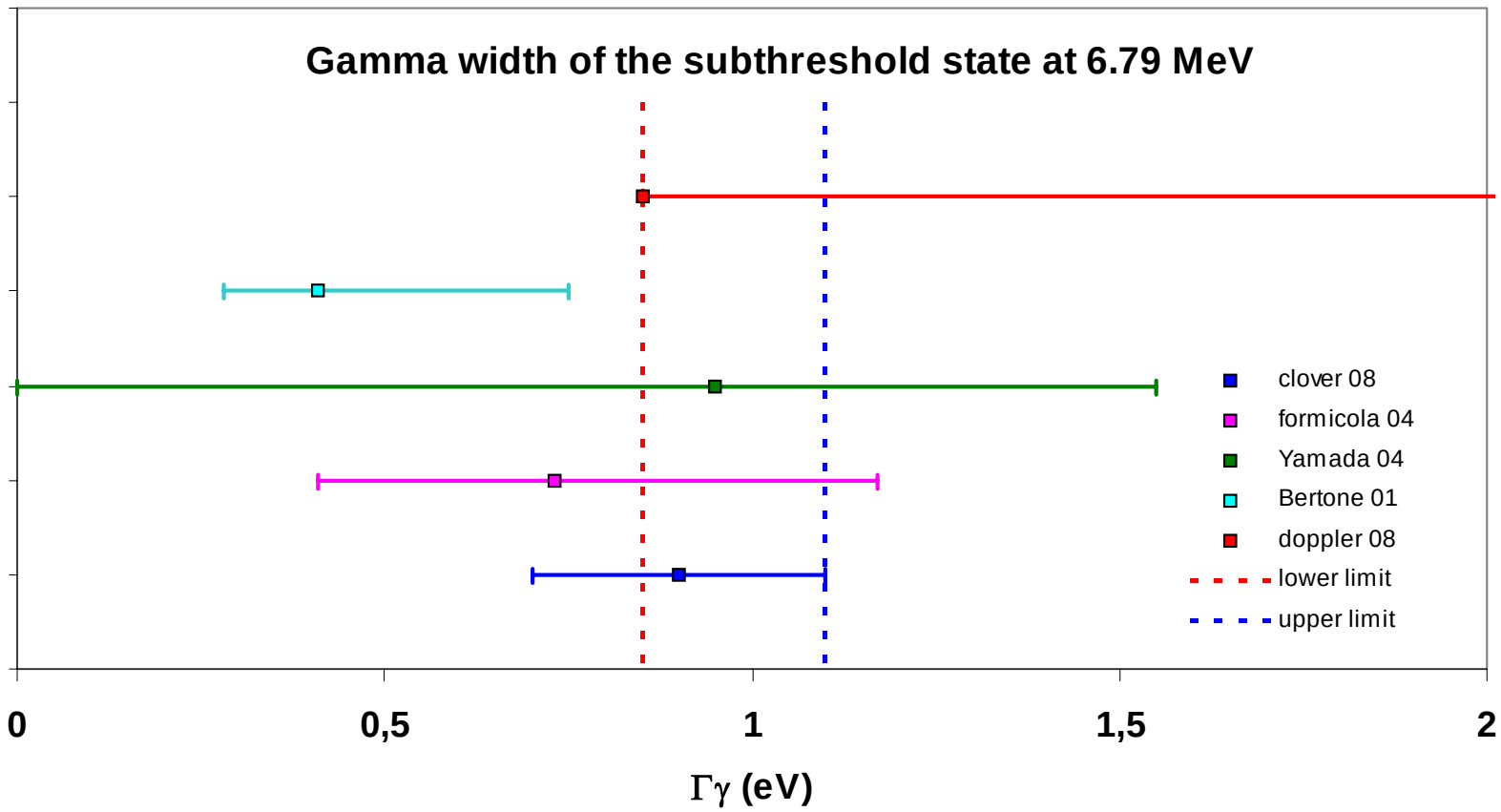


Lifetime measurement of the 6792 keV state in 15O important for the astrophysical S factor extrapolation in 14N(p,)15O

D. Schürmann,1, ∗ R. Kunz,1 I. Lingner,1, † C. Rolfs,1 F. Schümann,1, ‡ F. Strieder,1, § and H.-P. Trautvetter1

Accepted in Pys Rev C

Γ_γ from lifetime, r-matrix and coulomb breakup



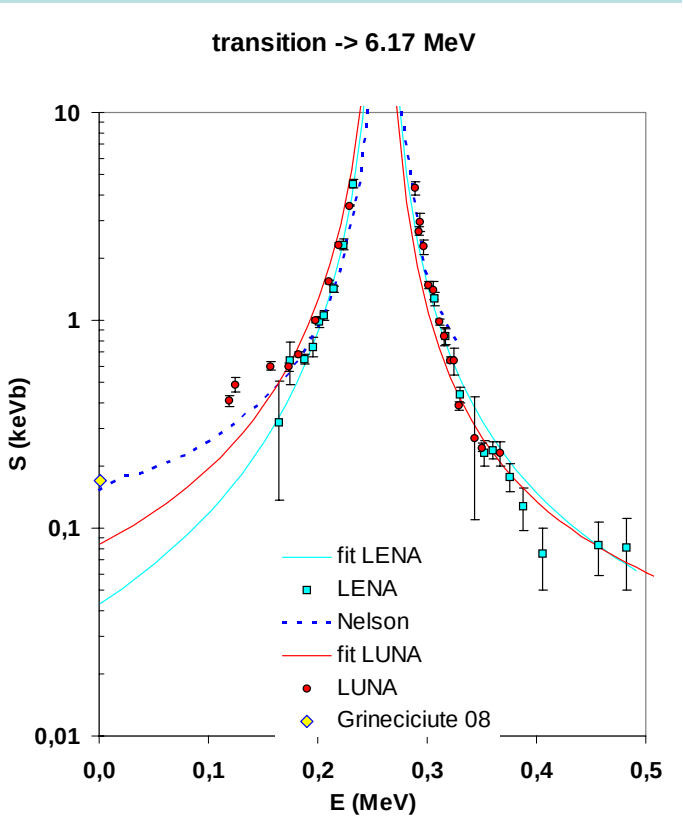
Possible M1 component in DC

PHYSICAL REVIEW C **68**, 065804 (2003)

Analyzing power measurement for the 14N(*p*, g)15O reaction at astrophysically relevant energies

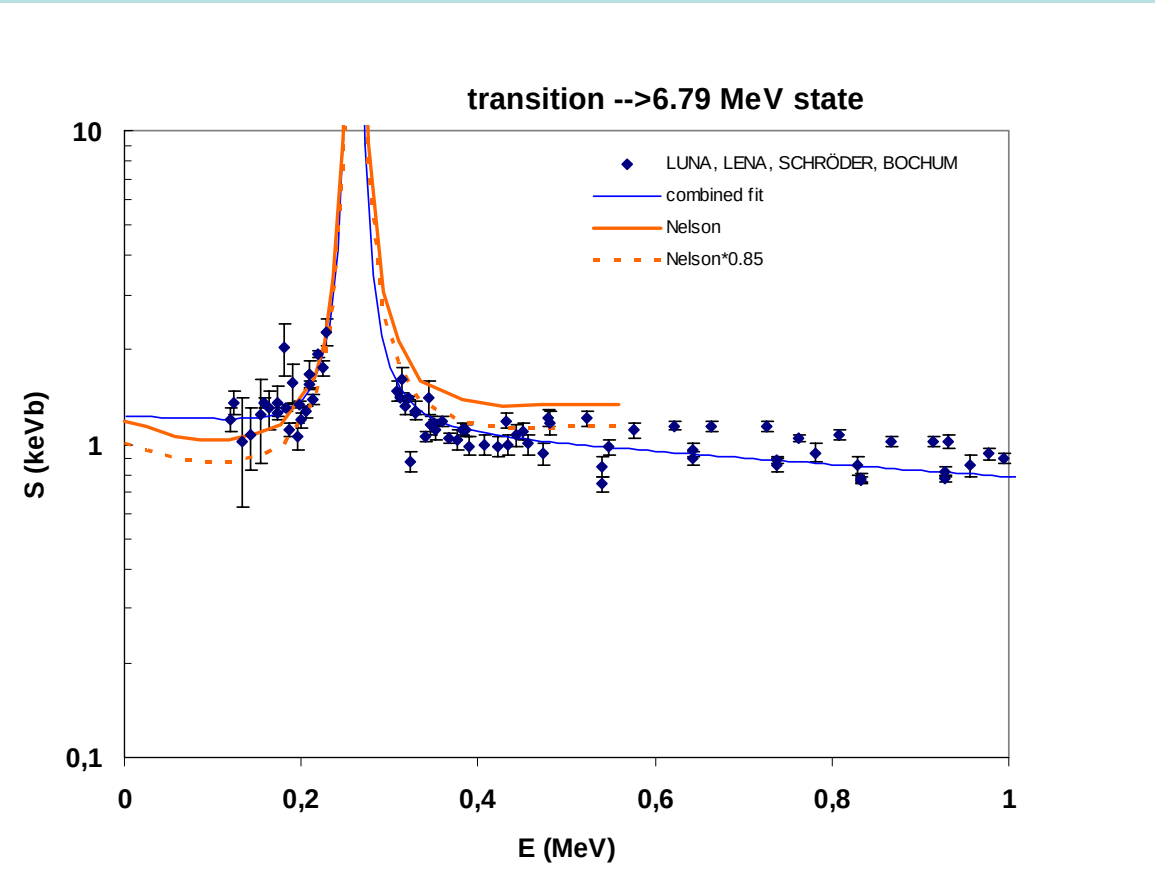
S. O. Nelson,1,2 M. W. Ahmed,1,2 B. A. Perdue,1,2 K. Sabourov,1,2 A. L. Sabourov,1,2 A. P. Tonchev,1,2 R. M. Prior,3,2
M. Spraker,3,2 and H. R. Weller1,2
1*Department of Physics, Duke University, Durham, North Carolina 27708, USA*
2*Triangle Universities Nuclear Laboratory, Duke Station, Durham, North Carolina*

Remaining uncertainty



Result: S(0) = 0.09 ± 0.07 keVb

4% on S_{tot}



Result: S(0) = 1.1± 0.1 keVb

11% max on S_{tot}

END

- Thank you Dick for all you offered me:
- Physics
- Human relation
- Friendship
- Wisdom
- Good humor