



IAEA

International Atomic Energy Agency
Atoms for Peace and Development

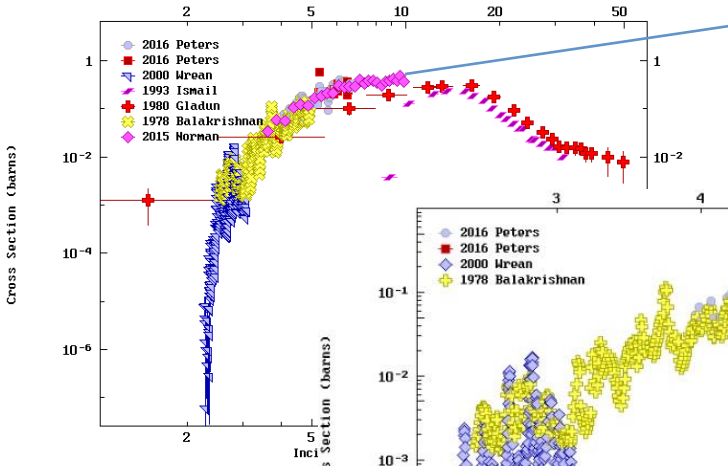
Preliminary work on $^{19}\text{F}(\alpha, n)$

Paraskevi (Vivian) Dimitriou
Nuclear Data Section,
Division of Physical and Chemical Sciences
Dept. of Nuclear Applications

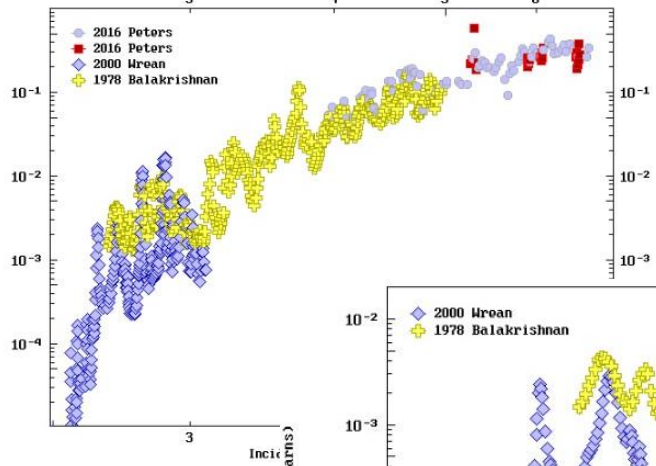
$^{19}\text{F}(\alpha, n)$: data needs

- Nonproliferation, spent fuel management, homeland security
 - Non-destructive assay of clean or spent nuclear fuel (UF_6 , PuF_4 , etc)
 - Alphas from alpha-emitters (Am, Bk, Cf, Cm, Np, Pu, Th, U) with alpha-decay energies < 6.5 MeV
- Rare-event experiments
 - Low-background measurements
 - Alphas from radioactive natural background (U and Th decay chains, Rn emanation)
 - Alpha energies < 9 MeV
- Fusion technologies

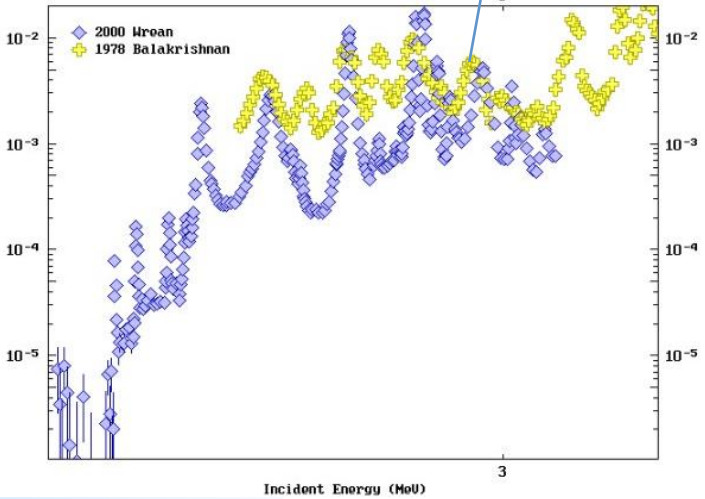
9-F-19(a,H)11-HA-22,,SIG



Cross sections derived from thick-target yield data

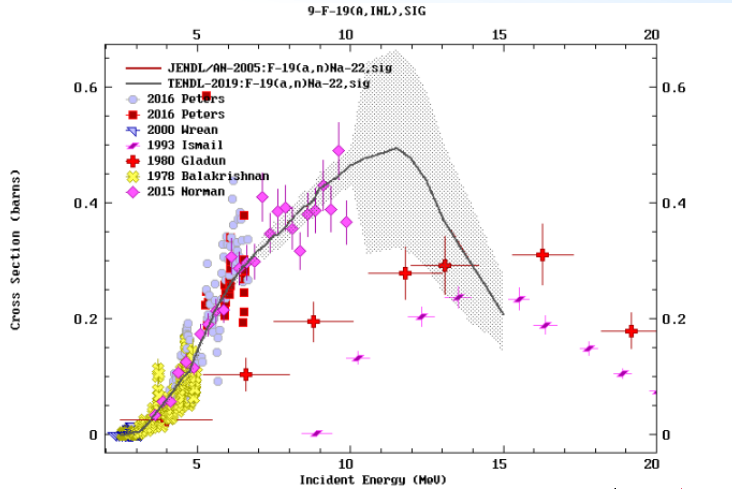


Wrean: sys.unc. 8%
Balakrishnan: syst. Unc. 15%



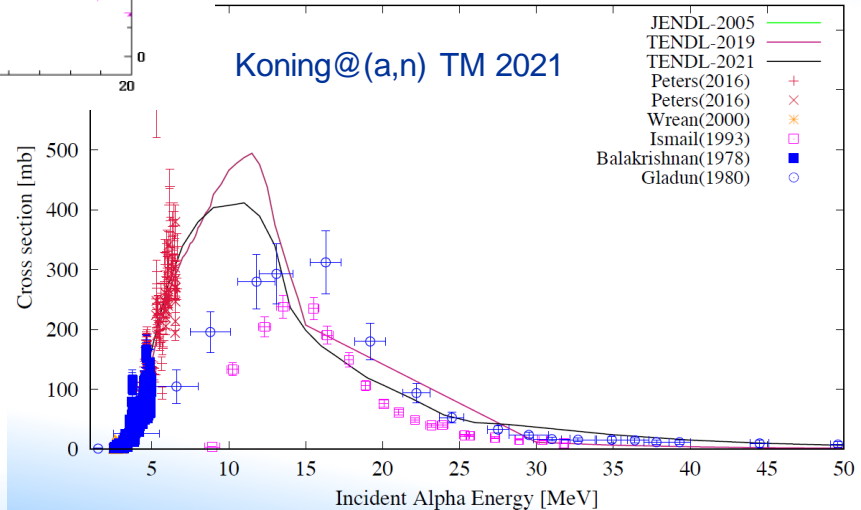
Other data:
0 deg excitation functions (van der Zwan and Geiger 1977)
(a,n), (a,p) partial differential data

Data libraries



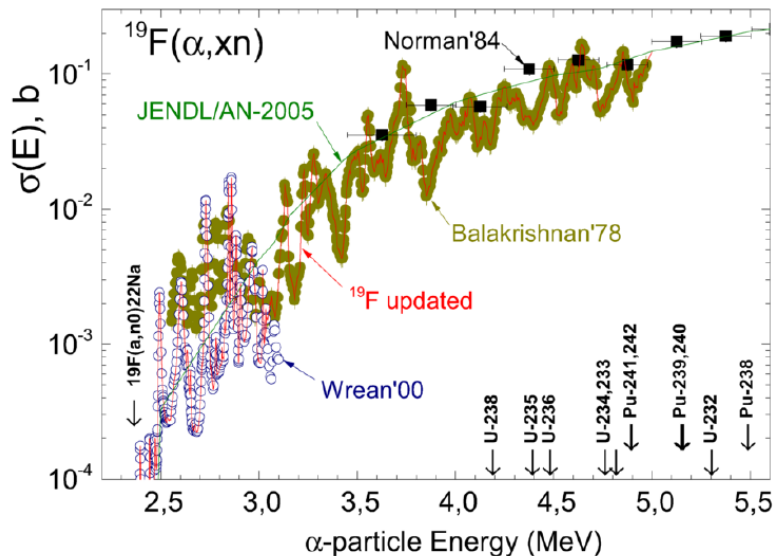
$^{19}\text{F}(\alpha,n)^{22}\text{Na}$

Koning@ (α,n) TM 2021



Resolved Resonance region

Simakov et al., NDS 137 (2017) 190



IAEA evaluation of cross-section data:

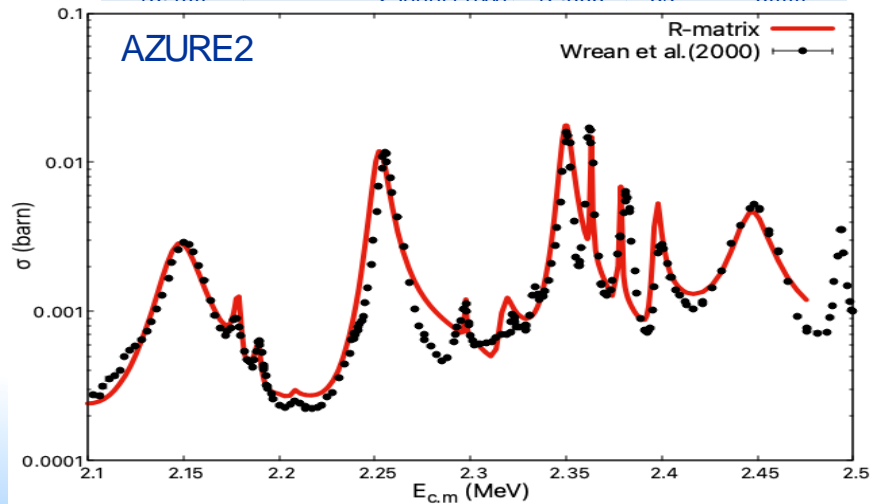
- Up to 3 MeV adopt Wrean et al data
- From 3 to 5 MeV adopt Balakrishnan et al data

Measured (ENSDF)

Fit to Wrean data

Parameter	Channel radii (fm)
$\alpha_c(^{19}\text{F}+\alpha)$	5.96
$\alpha_c(^{22}\text{Na}+n)$	5.32
	Atomic mass (μ)
M_n	1.00866
M_α	4.00260
$M_{^{19}\text{F}}$	18.9984
$M_{^{22}\text{Na}}$	21.9944
Q	-1952 MeV

E_x (MeV)	Jpi	Γ_α (eV)	E_x (MeV)	Jpi	Γ_α (eV)
12.419	(7/2+,5/2+)	116(20)			
12.488	(13/2+)	5000(2000)	12.5	3/2-	35000
12.625		25000	12.615	1/2+	23000
12.640		10000(5000)	12.643	3/2-	9800
12.729		130000(2000)	12.652	1/2-	5000
12.800		6000(3000)	12.653	3/2-	9000
12.818		5000(2000)	12.6665	3/2-	30000
12.848		11000(5000)	12.674	3/2-	6300
12.852		9000(4000)	12.678	1/2-	7000
12.927		6000(3000)	12.723	3/2-	15000
13.074		12000(4000)	12.75	1/2-	70000
13.184		9000(4000)	12.763	3/2+	100000
13.196		9000(4000)	12.766	3/2+	55000
13.248		10000(5000)	12.795	3/2+	50000
13.279		14000(7000)	12.817	1/2+	7000
13.337		8000(4000)	12.83	3/2-	20
13.399		13000(6000)	12.845	3/2-	30
13.460		23000(11000)	12.865	3/2-	5000



c/o: Nelli Vagena

ENSDF 2022: ²³Na

E _α (MeV)	E _x (MeV)	Jpi	Γ _α (eV)
2.363	12.419	(7/2+,5/2+)	116(20)
2.446	12.488	(13/2+)	5000(2000)
2.612	12.625		25000
2.630	12.64		10000(5000)
2.738	12.729		130000(2000)
2.824	12.8		6000(3000)
2.846	12.818		5000(2000)
2.882	12.848		11000(5000)
2.887	12.852		9000(4000)
2.978	12.927		6000(3000)
3.156	13.074		12000(4000)
3.289	13.184		9000(4000)
3.304	13.196		9000(4000)
3.366	13.248		10000(5000)
3.404	13.279		14000(7000)
3.474	13.337		8000(4000)
3.549	13.399		13000(6000)
3.623	13.46		23000(11000)
3.682	13.509		10000(5000)
5.064	14.65	(13/2+)	
11.044	19.59	(5/2+)	1900(800)
18.077	25.4		67000(2000)

(α,p₀) measurements Schier et al, 1976

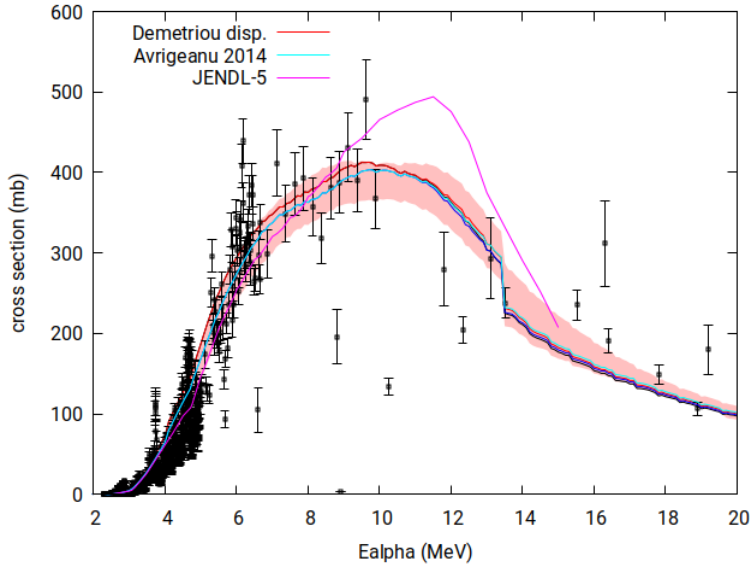
E _α	E _x	Jpi
1.318	11.556	1/2+
1.492	11.700	1/2 +-
1.507	11.712	3/2-
1.879	12.019	1/2+,5/2+
1.954	12.081	1/2+-
2.002	12.121	1/2-
2.081	12.186	5/2+
2.102	12.203	5/2+
2.199	12.284	1./2+,1/2-
2.319	12.383	3/2-
2.402	12.451	7/2-
2.45	12.491	3/2+
2.538	12.564	3/2+,3/2-
2.639	12.647	3/2-
2.742	12.732	5/2+,7/2-
3.036	12.975	1/2+,7/2-
3.165	13.082	1/2+,7/2-
3.266	13.165	5/2+,7/2-
3.308	13.200	7/2-,9/2+
3.361	13.243	5/2+,5/2-
3.548	13.398	3/2-,7/2-
3.735	13.552	1/2-,5/2+
3.87	13.664	5/2+,7/2-
4.115	13.866	1/2-,7/2-
4.186	13.925	3/2-,5/2+
4.344	14.056	3/2-,7/2-
4.5	14.184	3/2-,3/2+
4.616	14.280	3/2-,3/2+
4.704	14.353	1/2+,7/2-
4.825	14.453	1/2+,7/2-
4.895	14.511	1/2-,9/2+



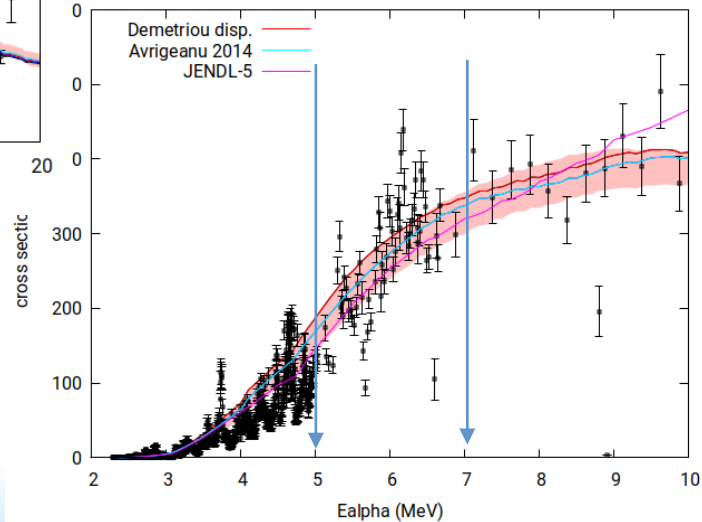
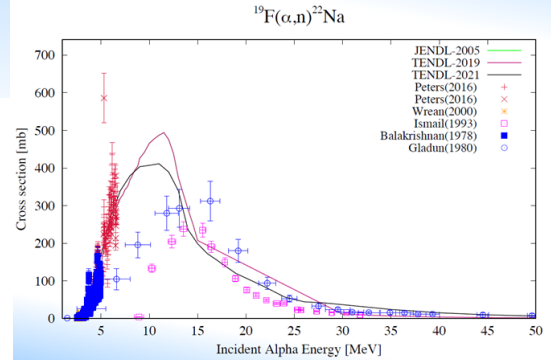
IAEA

Kuperus
1965

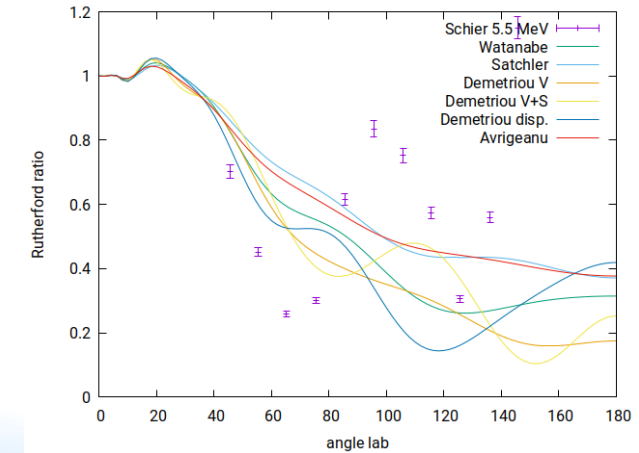
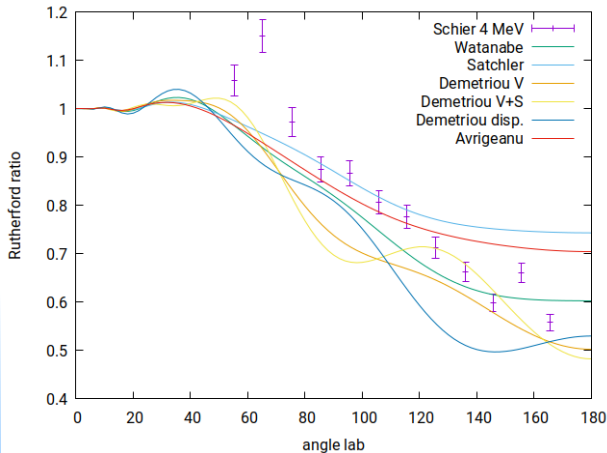
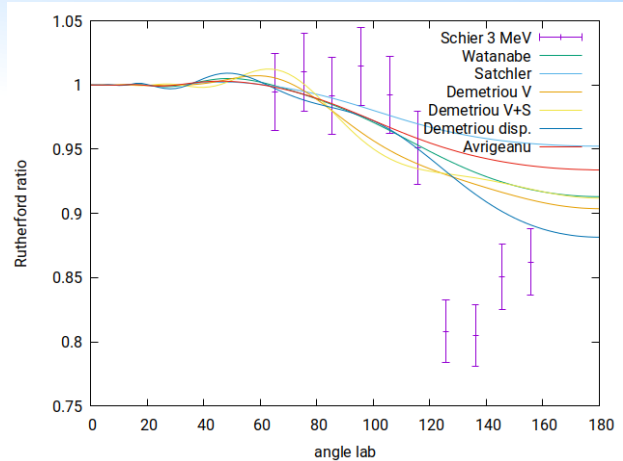
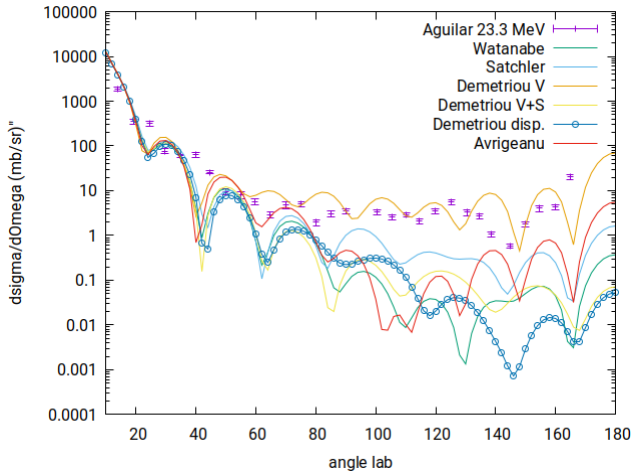
Statistical approach



Shaded area: all alpha OP, NLDs, γ SFs in TALYS



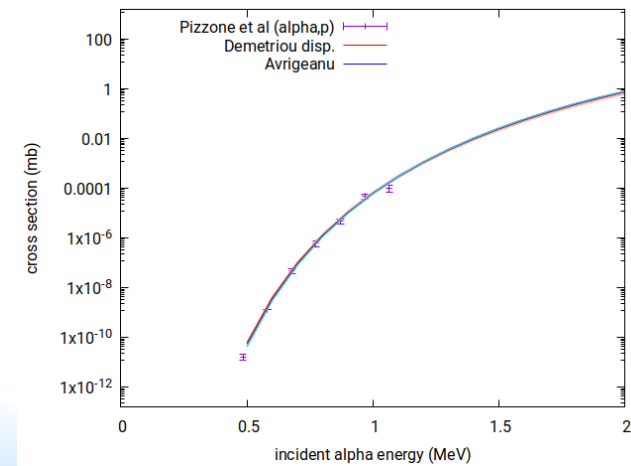
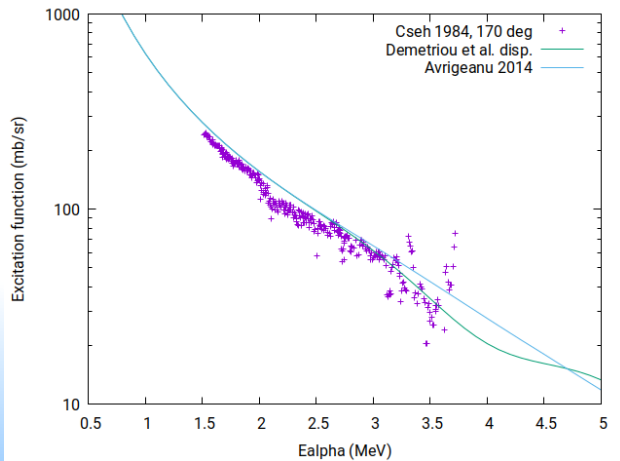
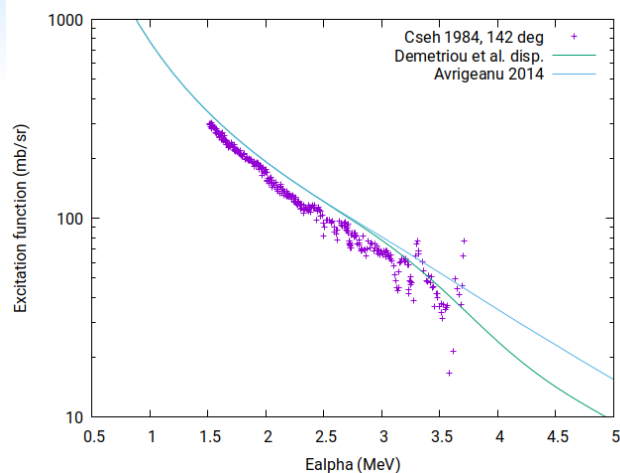
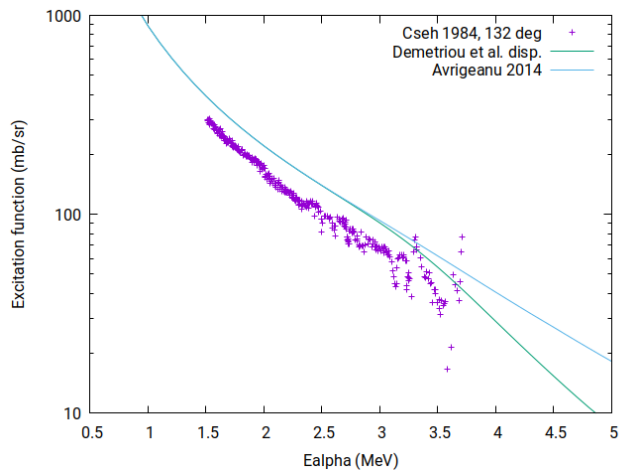
Elastic scattering data



Elastic scattering, (α,p)



AEA



Work in progress –to do

- R-matrix analysis up to 5 MeV and 7 MeV: all open channels and data – add Schier levels (AZURE2)
- Include $n+^{22}\text{Na}$ in R-matrix analysis
- Statistical calculations from 7 MeV (5 MeV) up to 20 MeV: all available data, improve parameters (OP)
- Uncertainties

*In collaboration with Nelli Vagena



IAEA

International Atomic Energy Agency
Atoms for Peace and Development

Thank you!



$\alpha+^{19}\text{F}$: outgoing channels

