# Covariances for Fission Products in ENDF/B-VII

C.M. Mattoon

Port Jefferson, June 23 2010

# Background:

- H.I. Kim (KAERI) used Empire to evaluate 32 fission products for ENDF-VII, including $^{109}$Ag, $^{133}$Cs, $^{95}$Mo, $^{141}$Pr, stable Dy, Nd and Sm isotopes, and others [1]

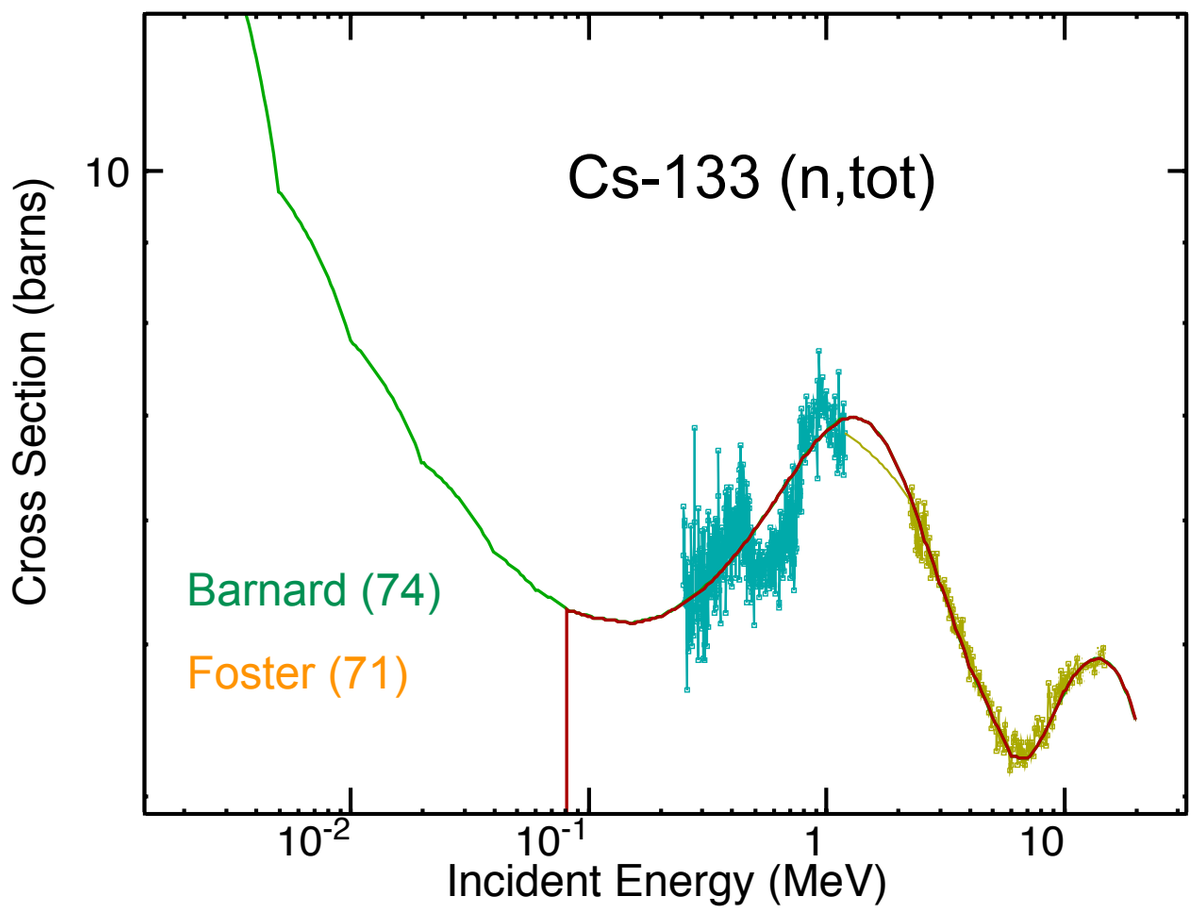
- Resulting Empire inputs have been saved, and should now be used to attach covariances to these files in ENDF-VII.1 (no change to existing cross sections)

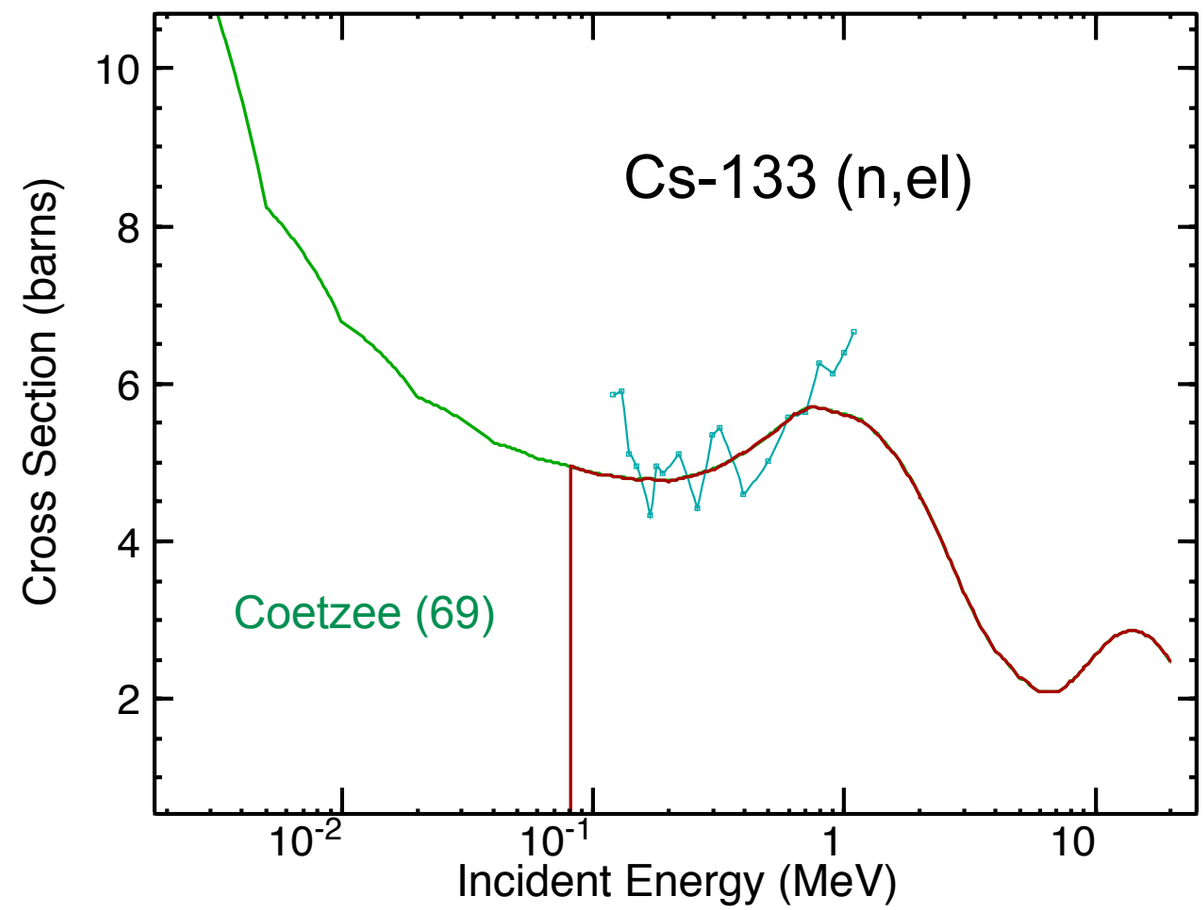
  - [1] H.I. Kim et al., Proc.Conf.ND2007, 20070422

- Trouble: Empire has changed substantially since ENDF-VII release. New calculations with old inputs may differ...
  - Level densities modified

- Current solution: use latest version, rely on GLSQ adjustment for reasonable agreement with ENDF-7

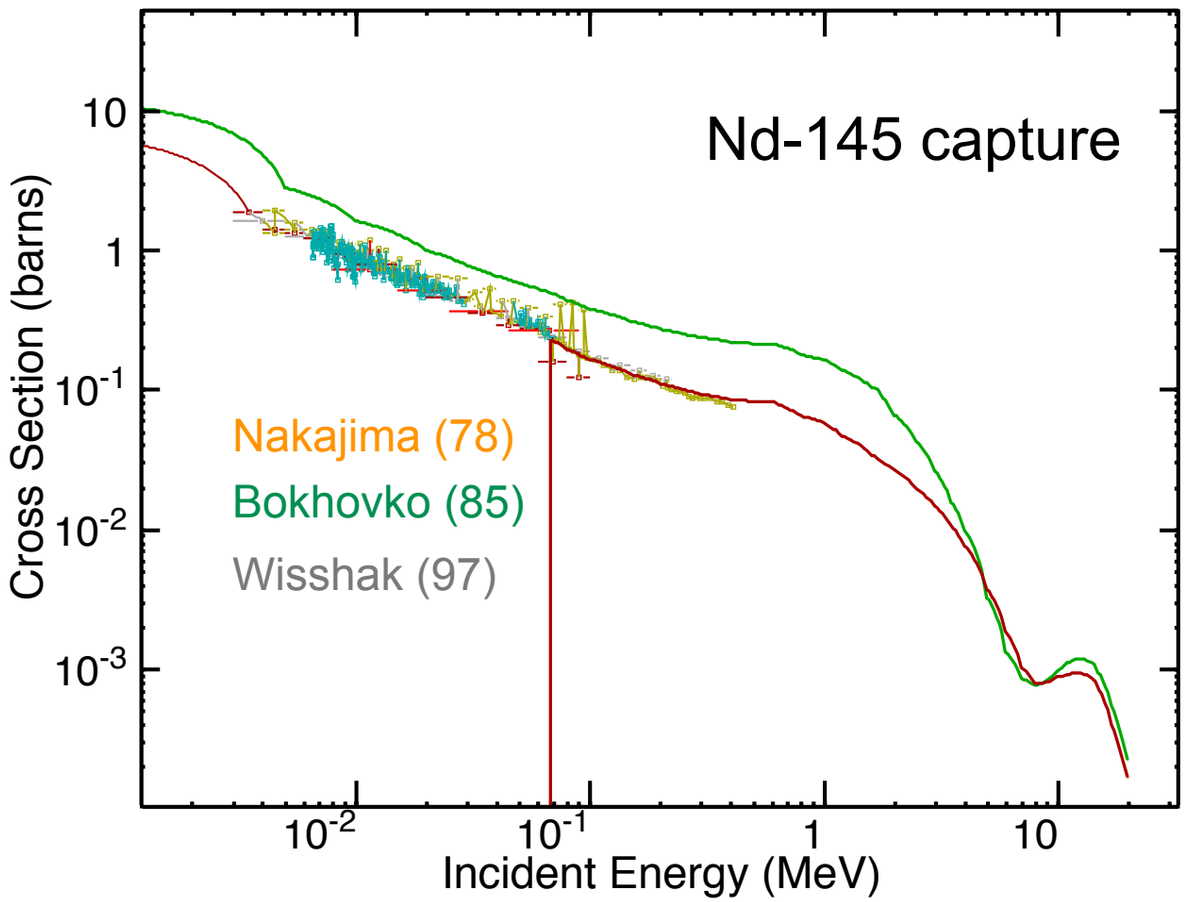
# Comparing cross sections:

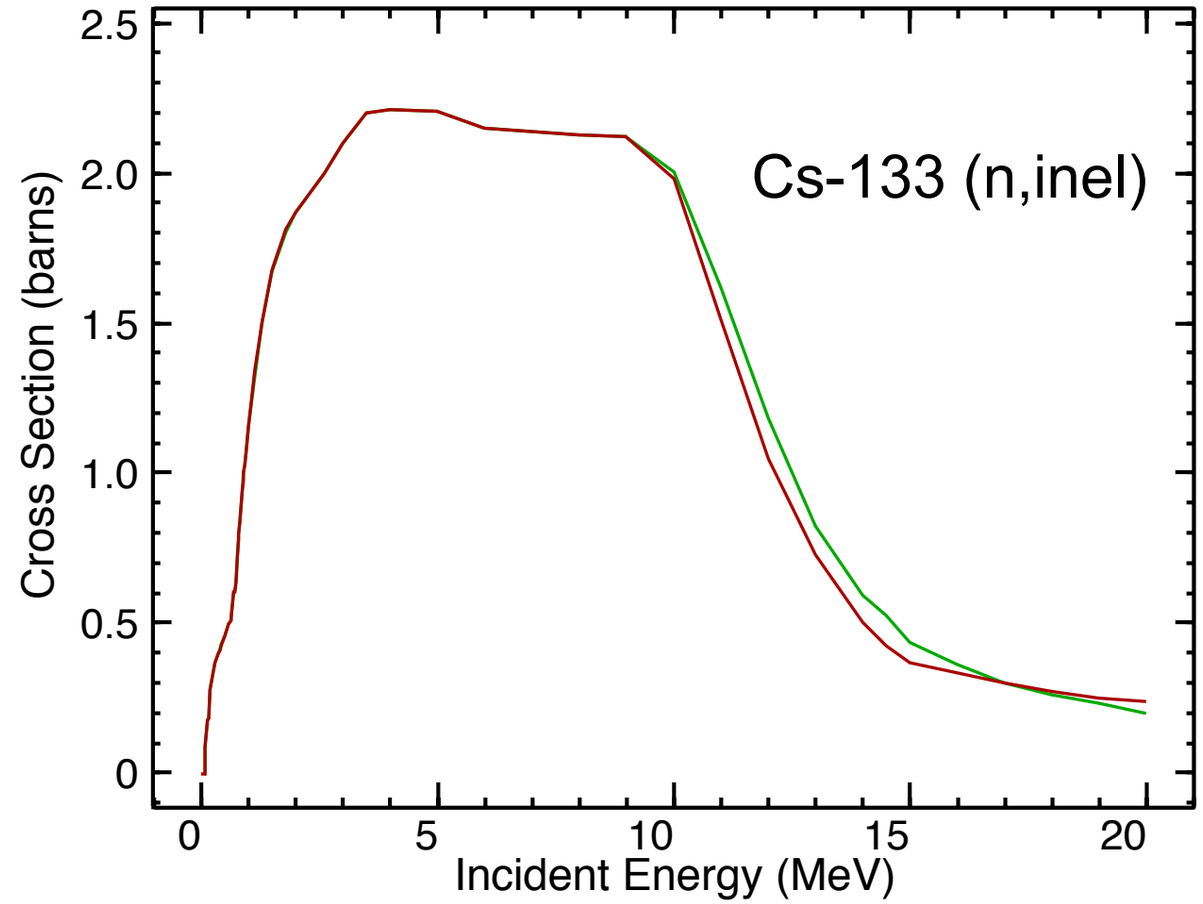


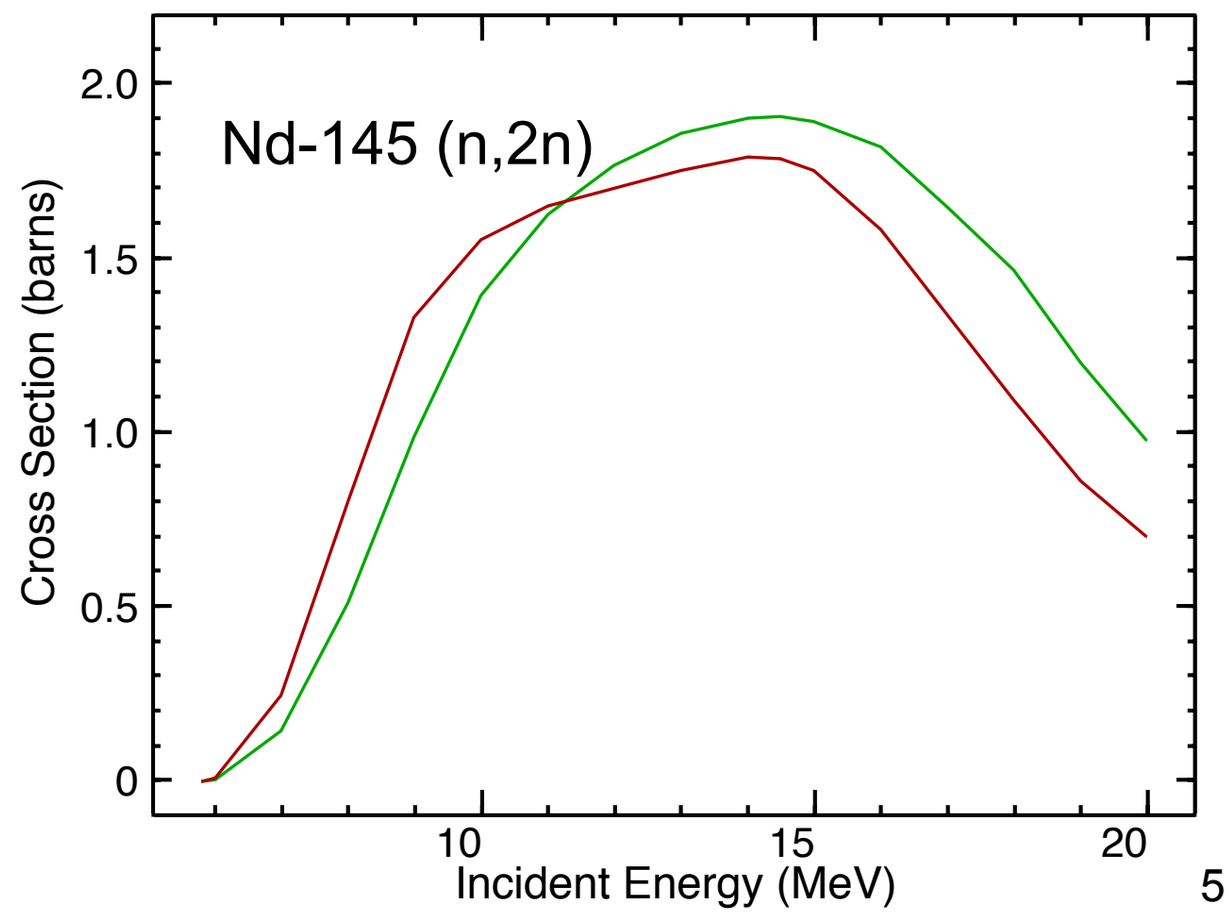

Empire
ENDF-7

- Still good agreement with ENDF-VII for total and elastic

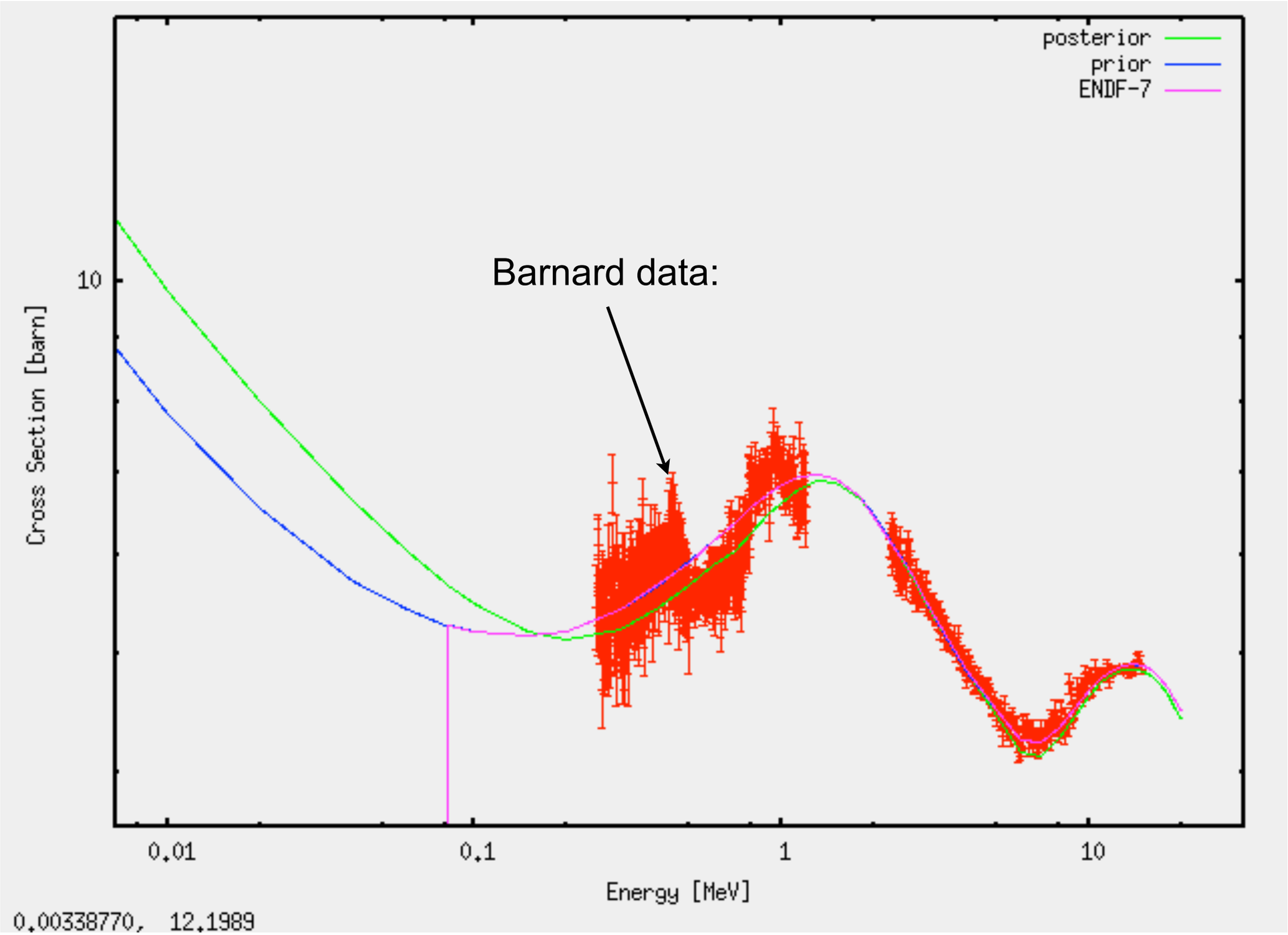


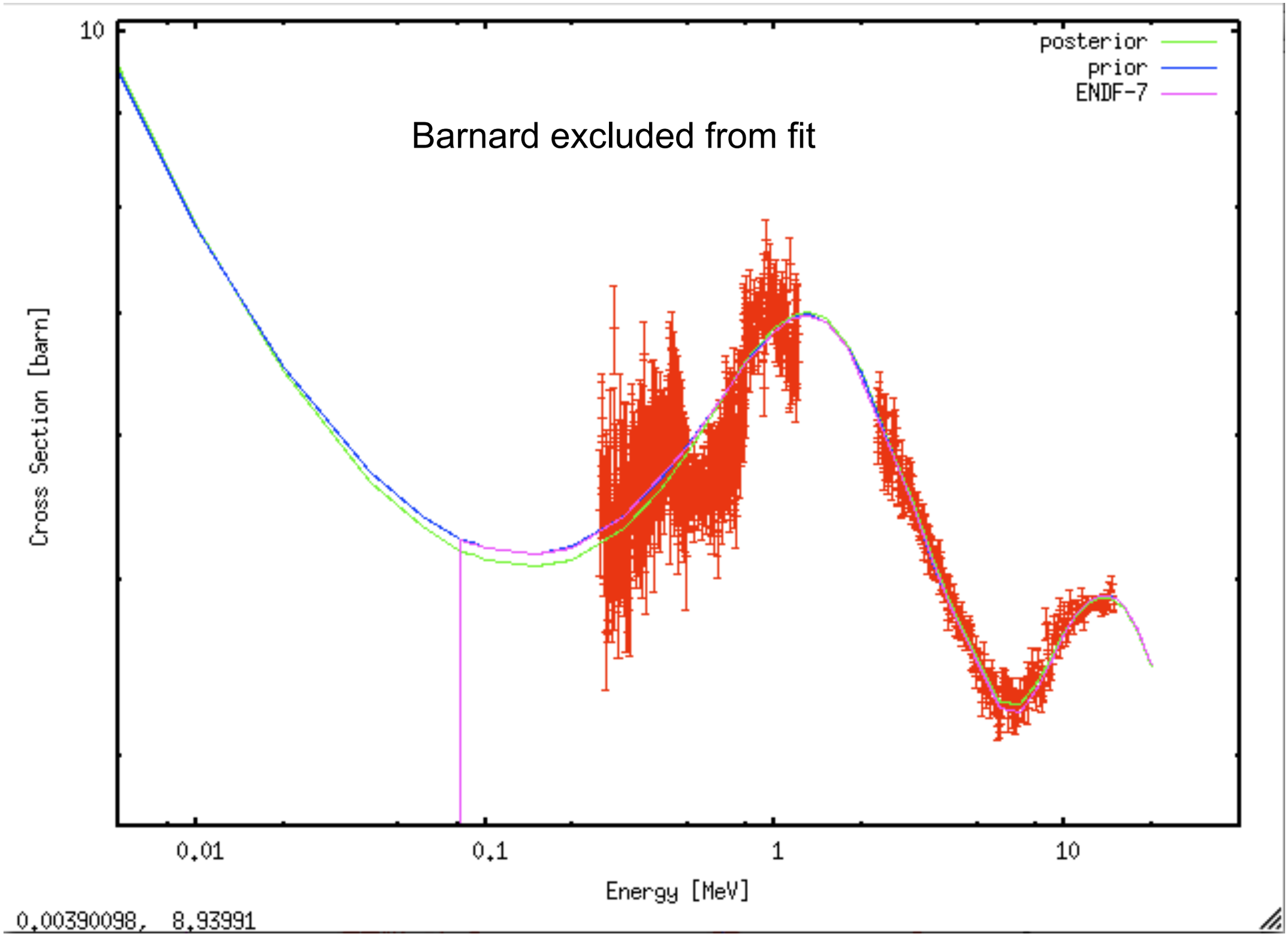

- Results vary for other channels



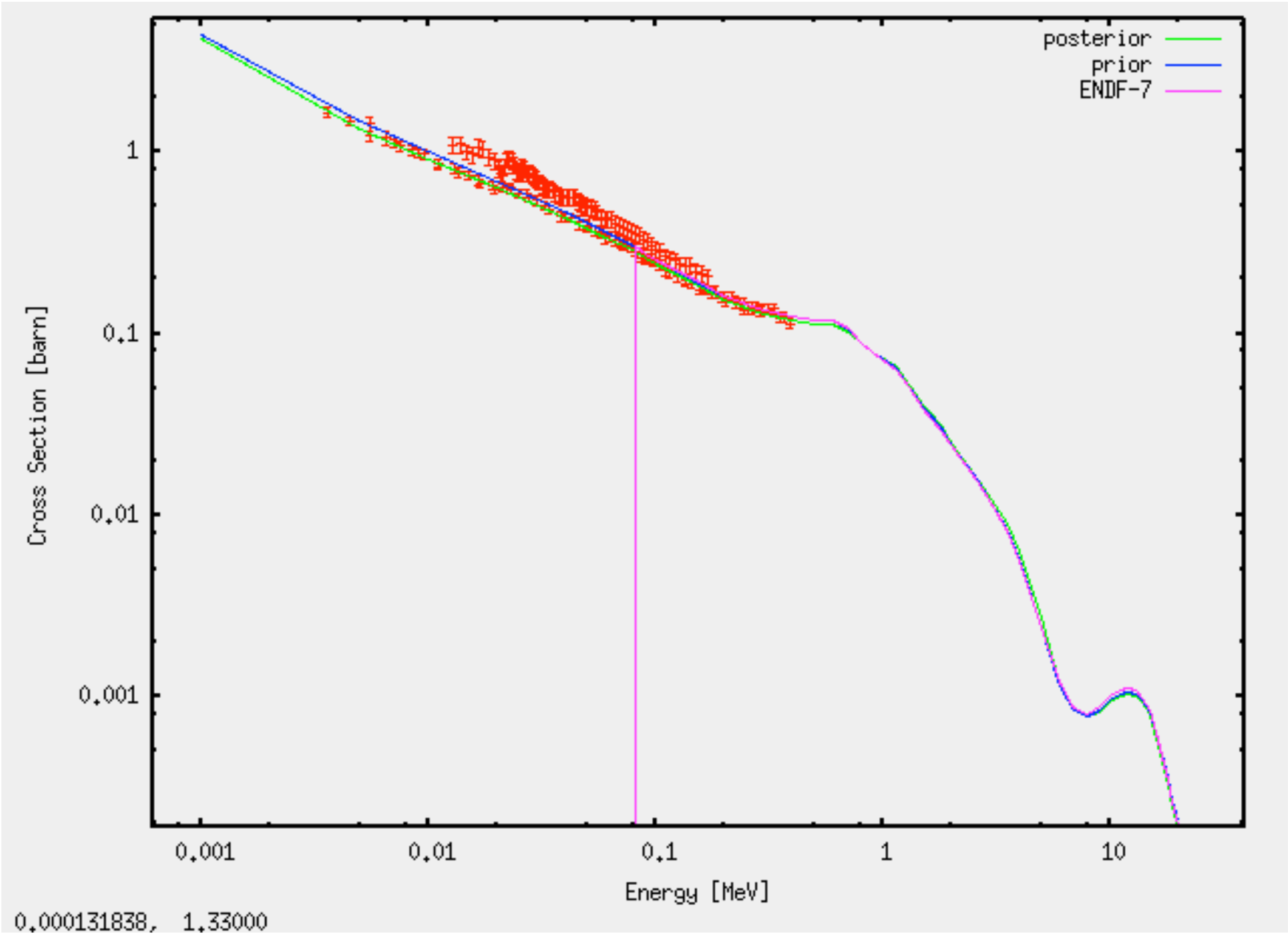
# Cs-133 (n,tot)


posterior
prior
ENDF-7
Barnard data:
10
Cross Section [barn]
0.01
0.1
1
10
Energy [MeV]
0.00338770, 12.1989

# Cs-133 (n,tot)

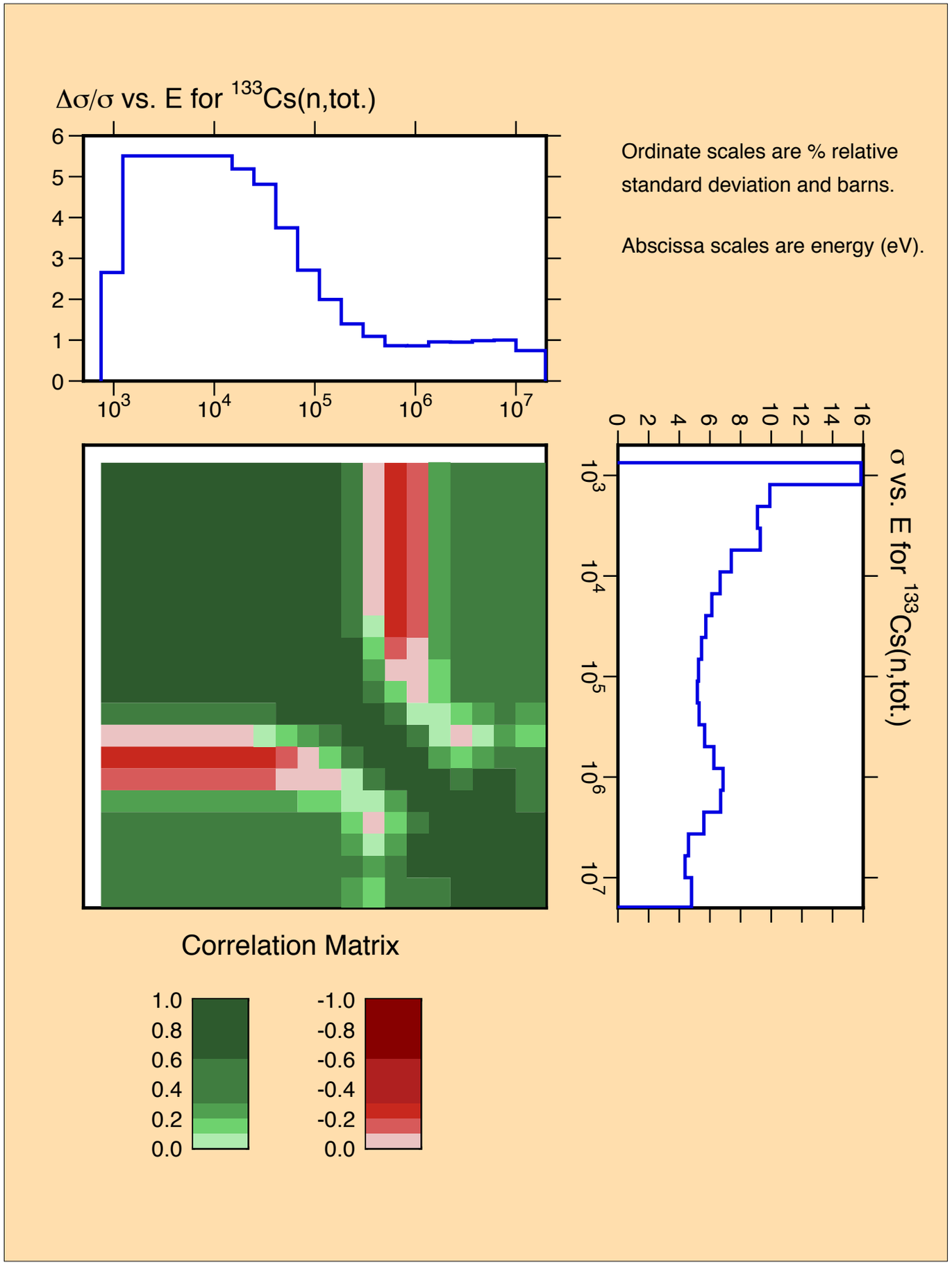

posterior
prior
ENDF-7
Barnard excluded from fit
10
Cross Section [barn]
0.01
0.1
1
10
Energy [MeV]
0.00390098, 8.93991

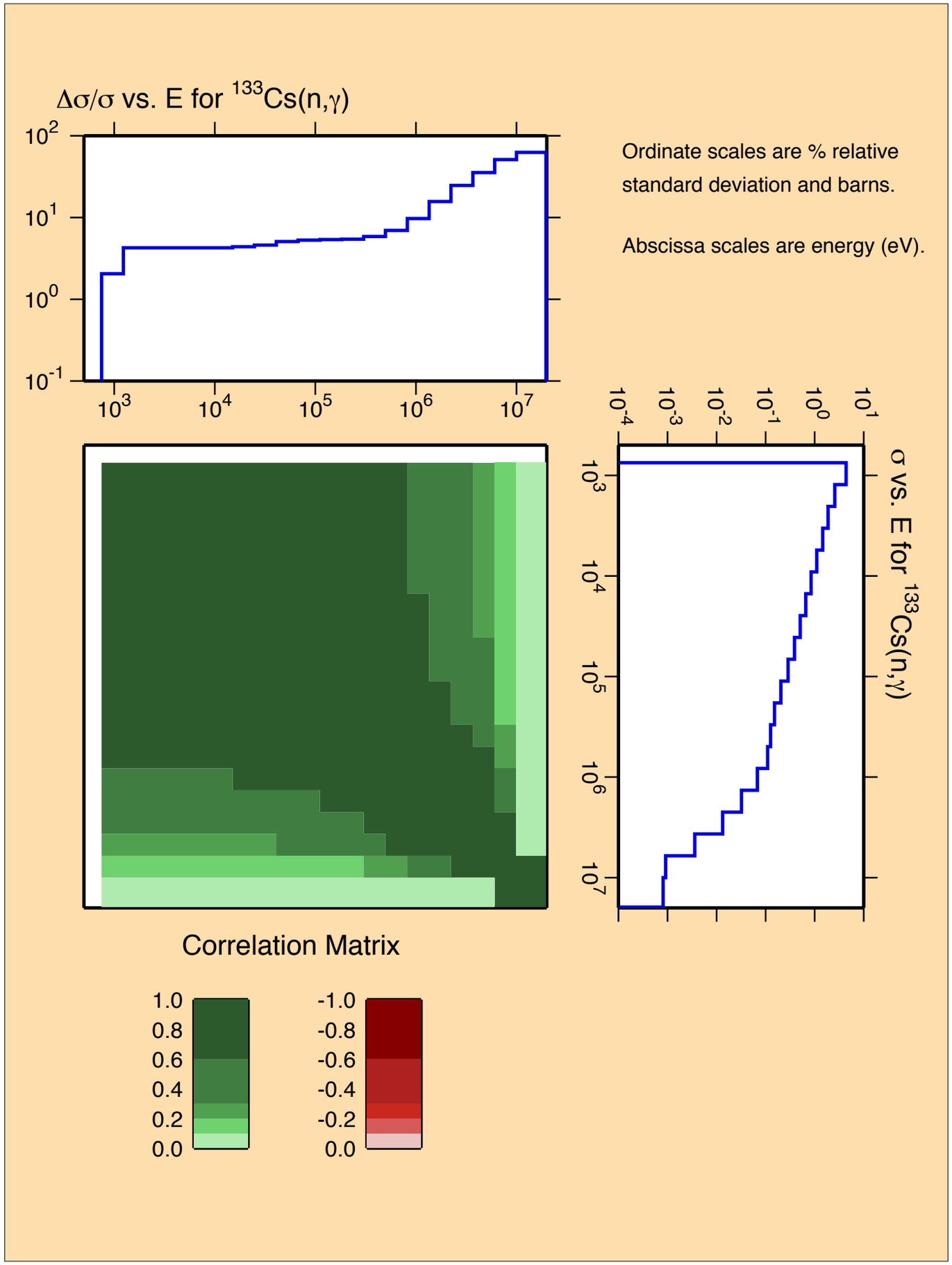
# Cs-133 capture



Fitting all channels together,

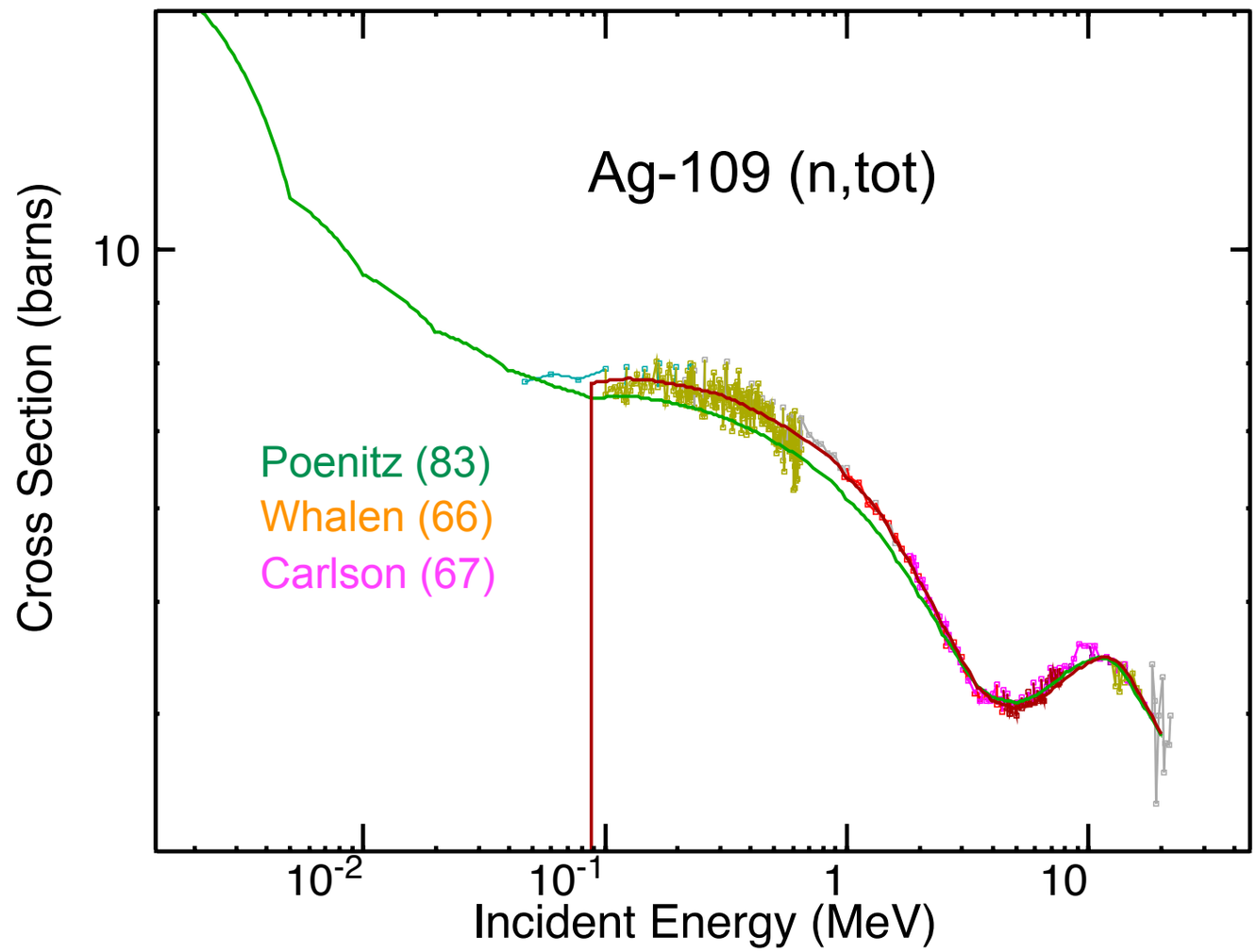
Uncertainties scaled up by reduced chi square



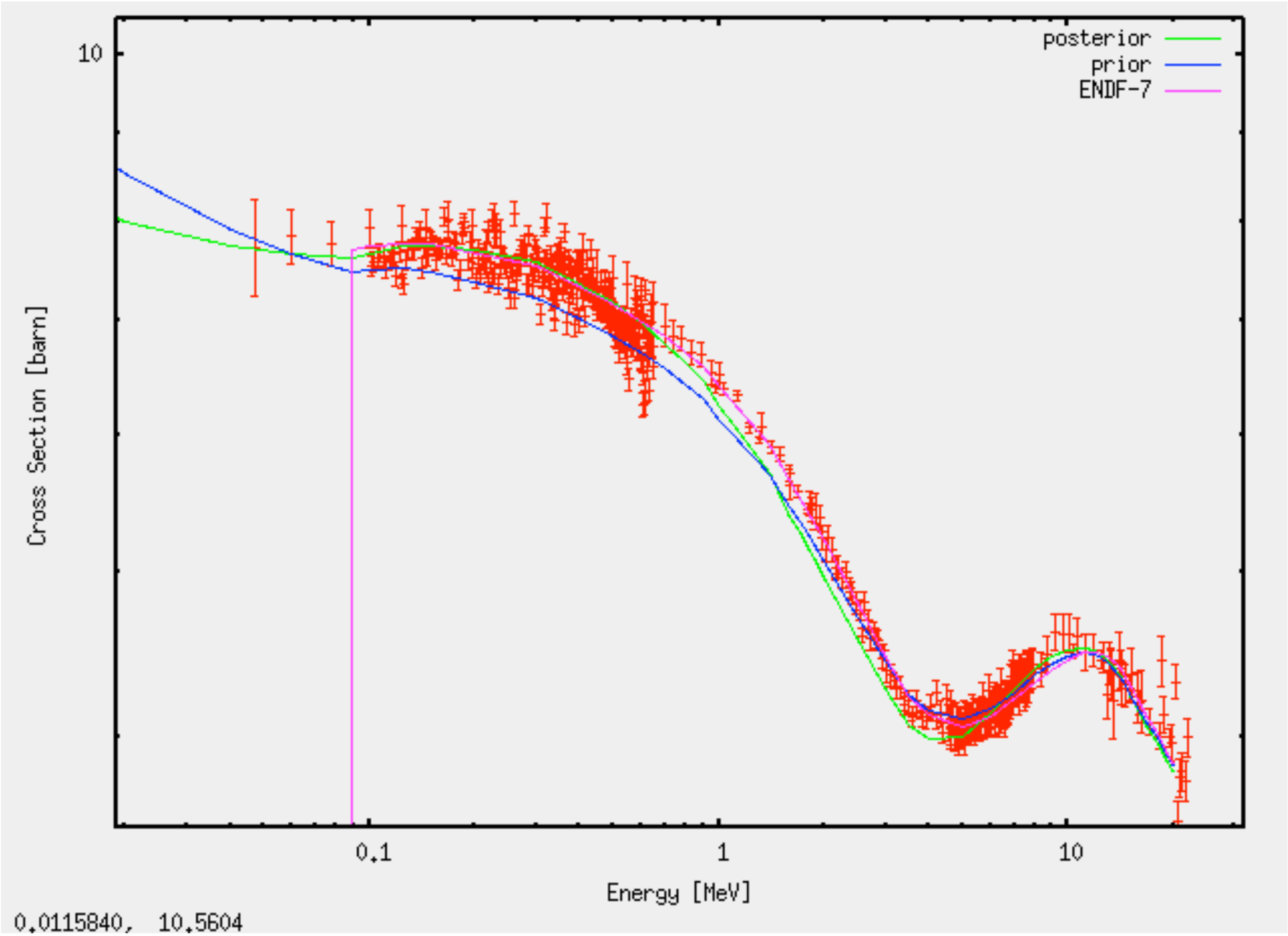

Δσ/σ vs. E for 133Cs(n,γ)
Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).
σ vs. E for 133Cs(n,γ)
Correlation Matrix
1.0
0.8
0.6
0.4
0.2
0.0
-1.0
-0.8
-0.6
-0.4
-0.2
0.0

# $^{109}$Ag

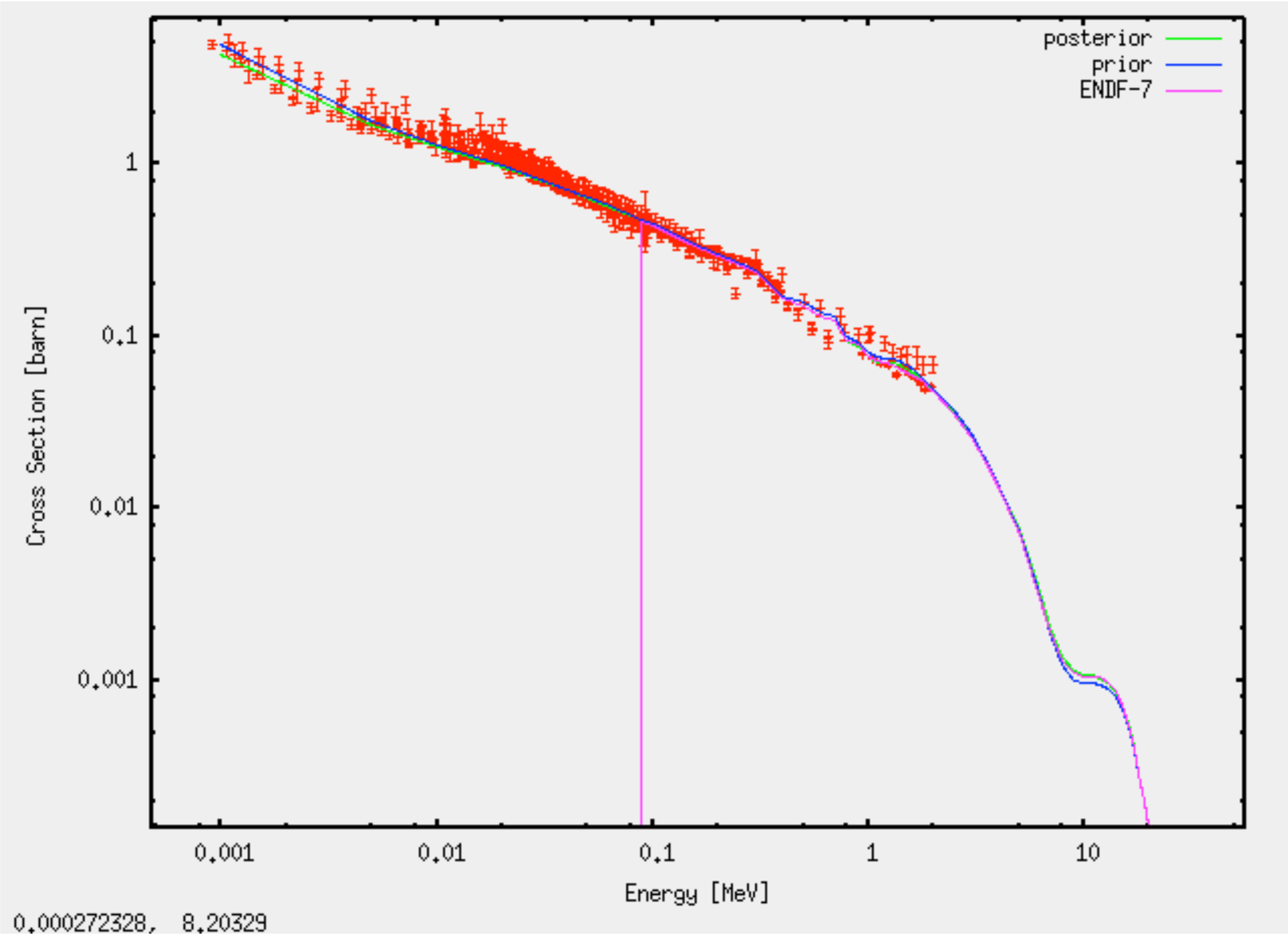
- (n,tot) under-estimated in original input:

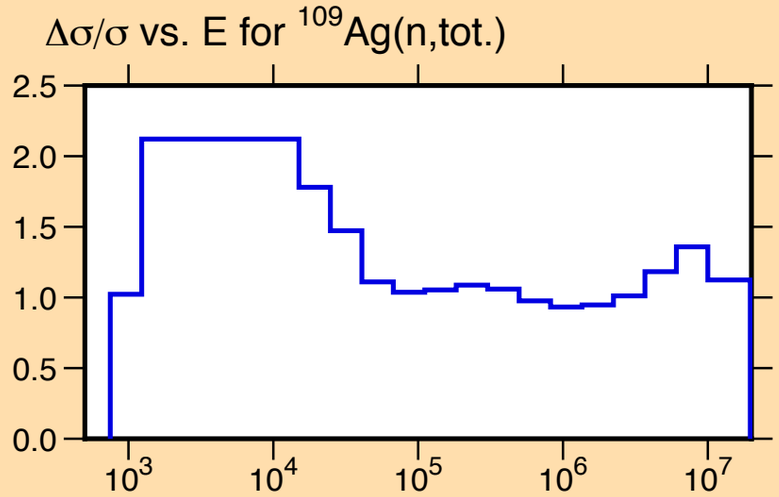


# Ag-109 (n,tot)


posterior
prior
ENDF-7
10
Cross Section [barn]
0.1
1
10
Energy [MeV]
0.0115840, 10.5604

# Ag-109 capture

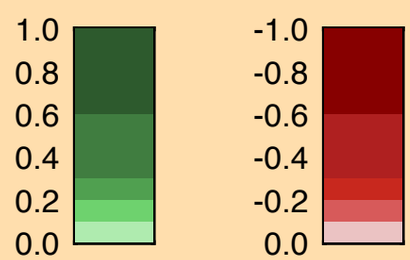


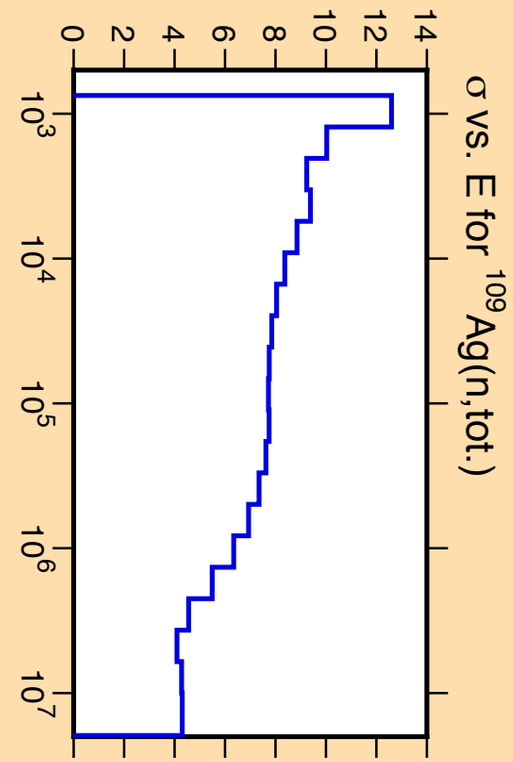


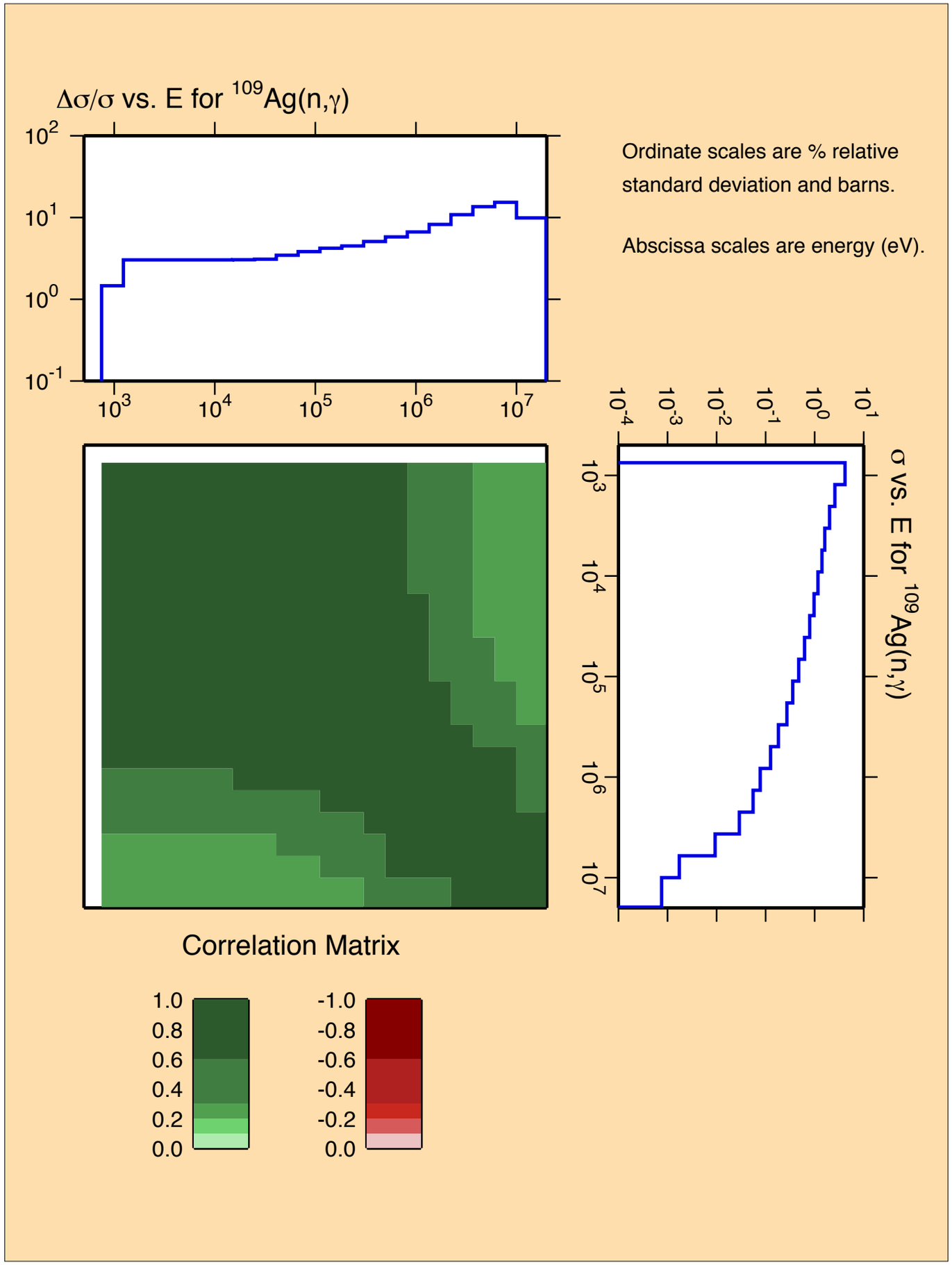

Ordinate scales are % relative standard deviation and barns.

Abscissa scales are energy (eV).

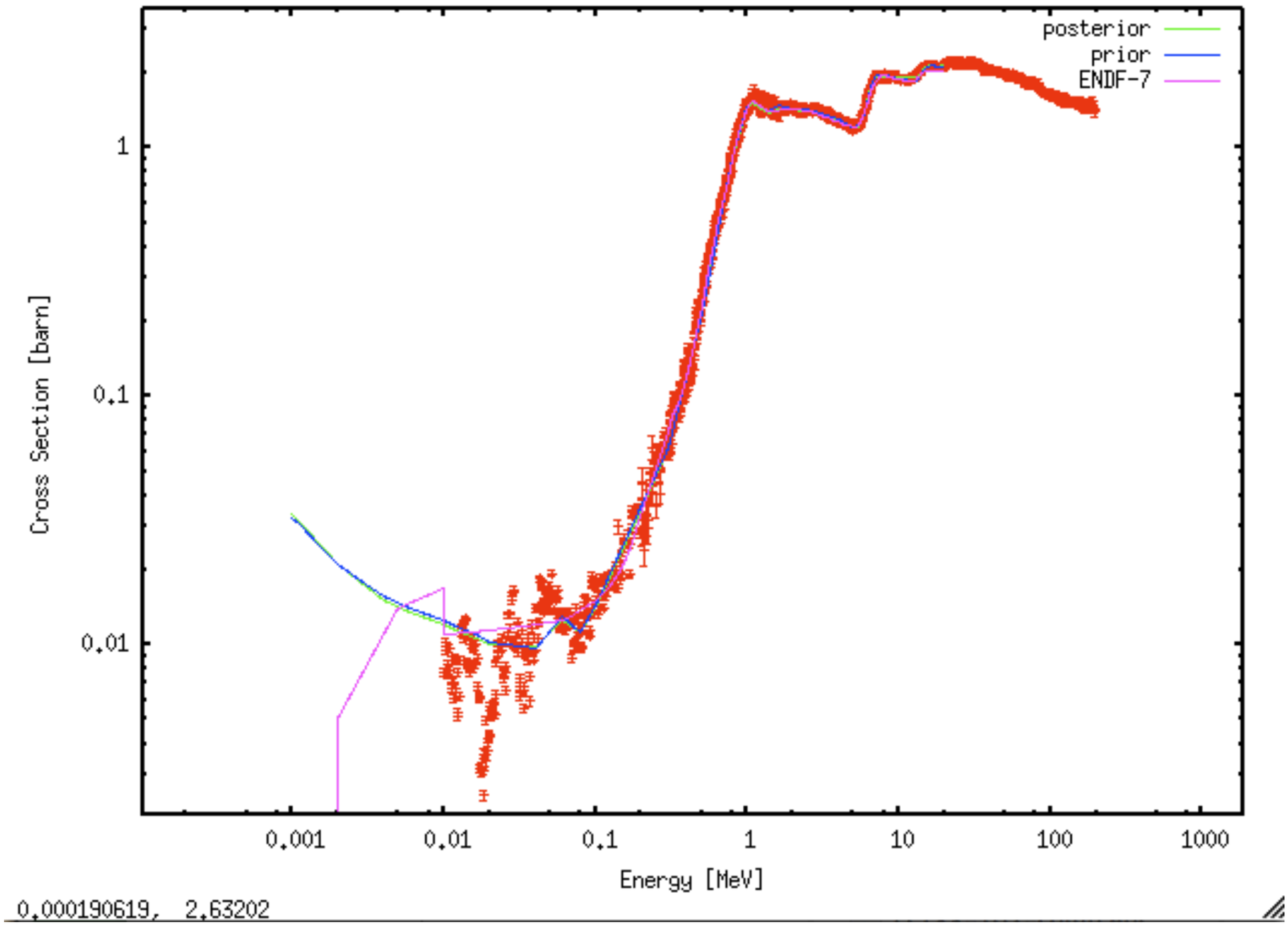
Correlation Matrix



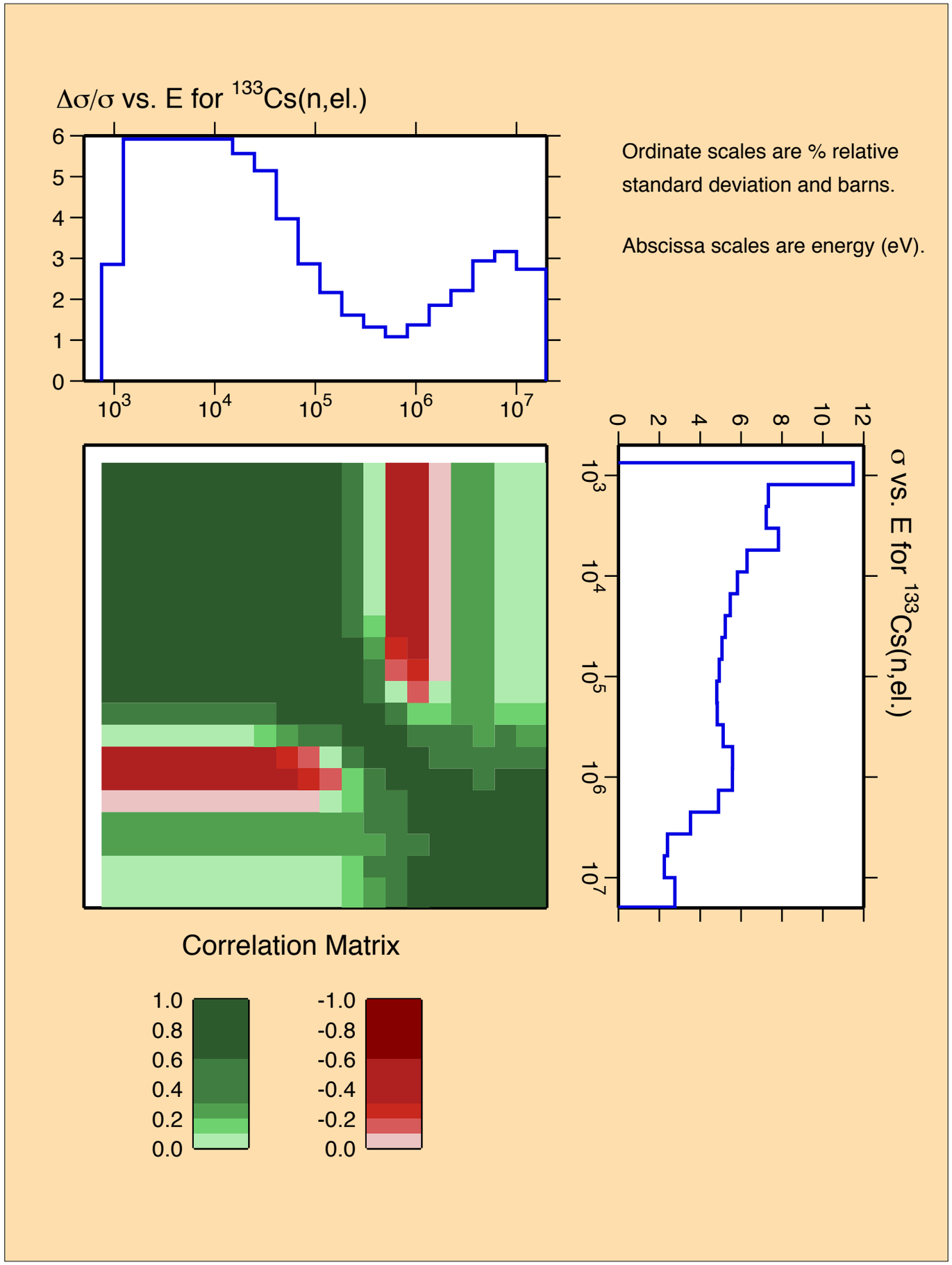



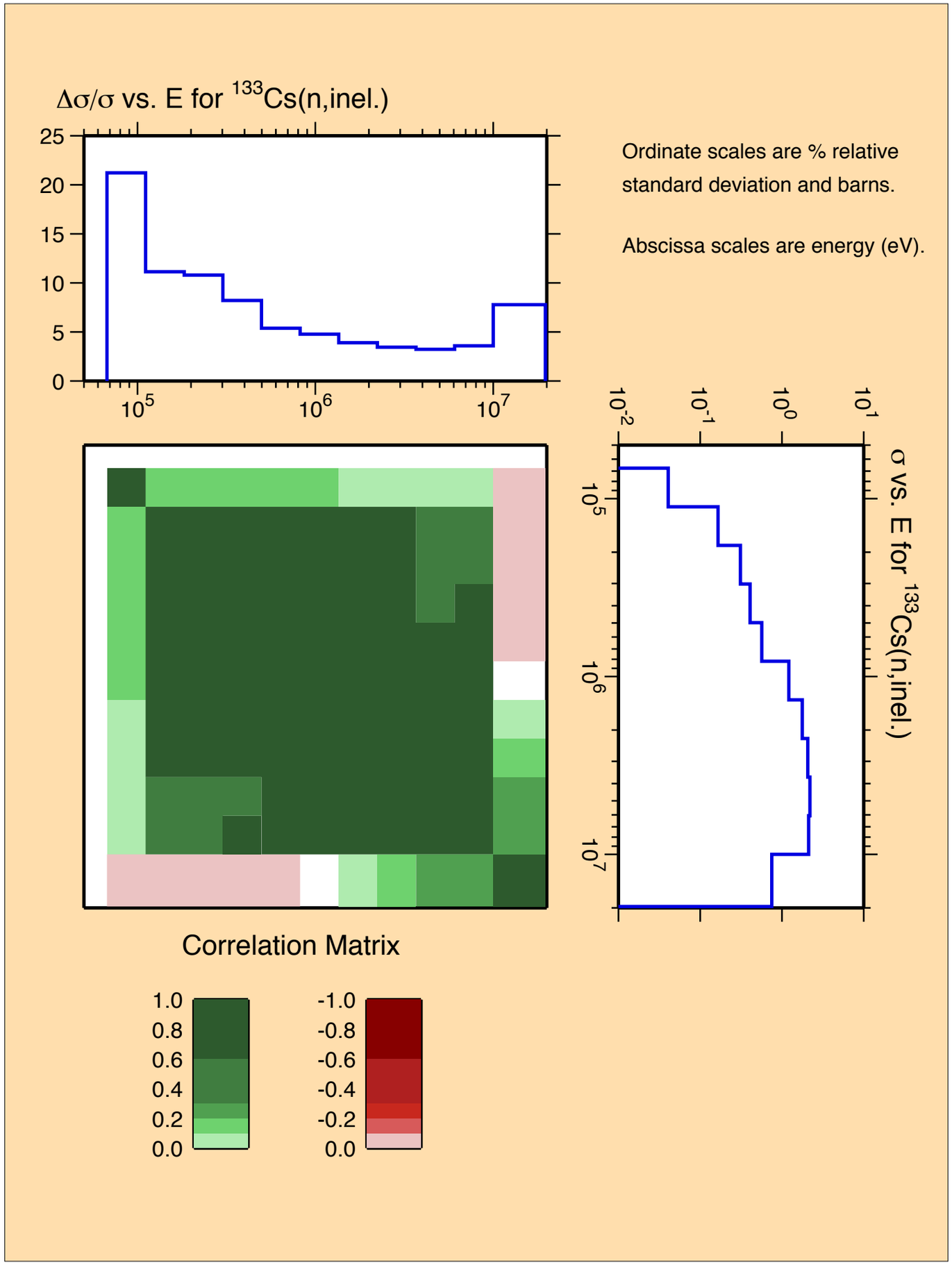

Δσ/σ vs. E for 109Ag(n,γ)
Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).
σ vs. E for 109Ag(n,γ)
Correlation Matrix
1.0
0.8
0.6
0.4
0.2
0.0
-1.0
-0.8
-0.6
-0.4
-0.2
0.0

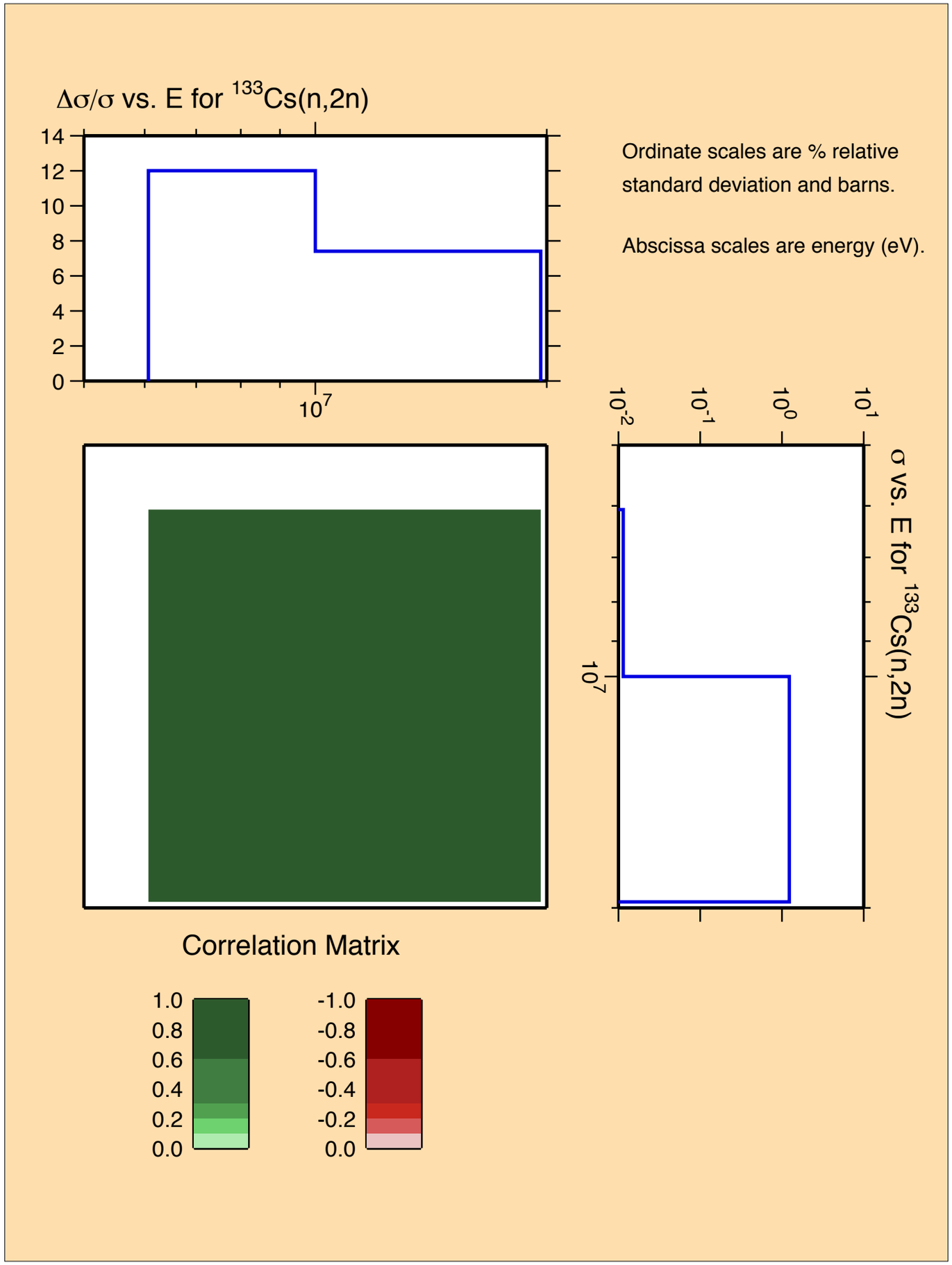
# Pu-242 (n,fission)



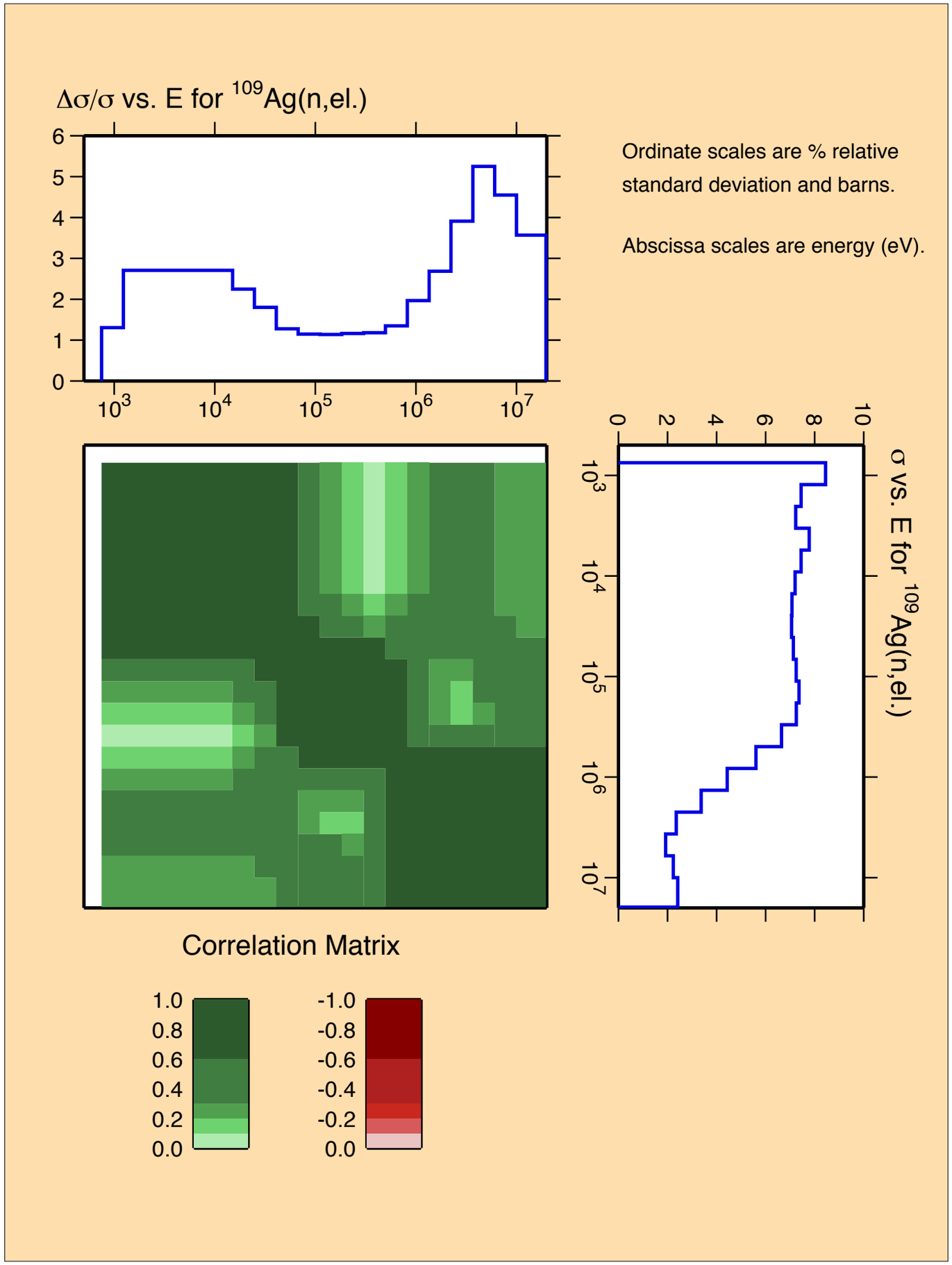
# Cs-133 other channels:

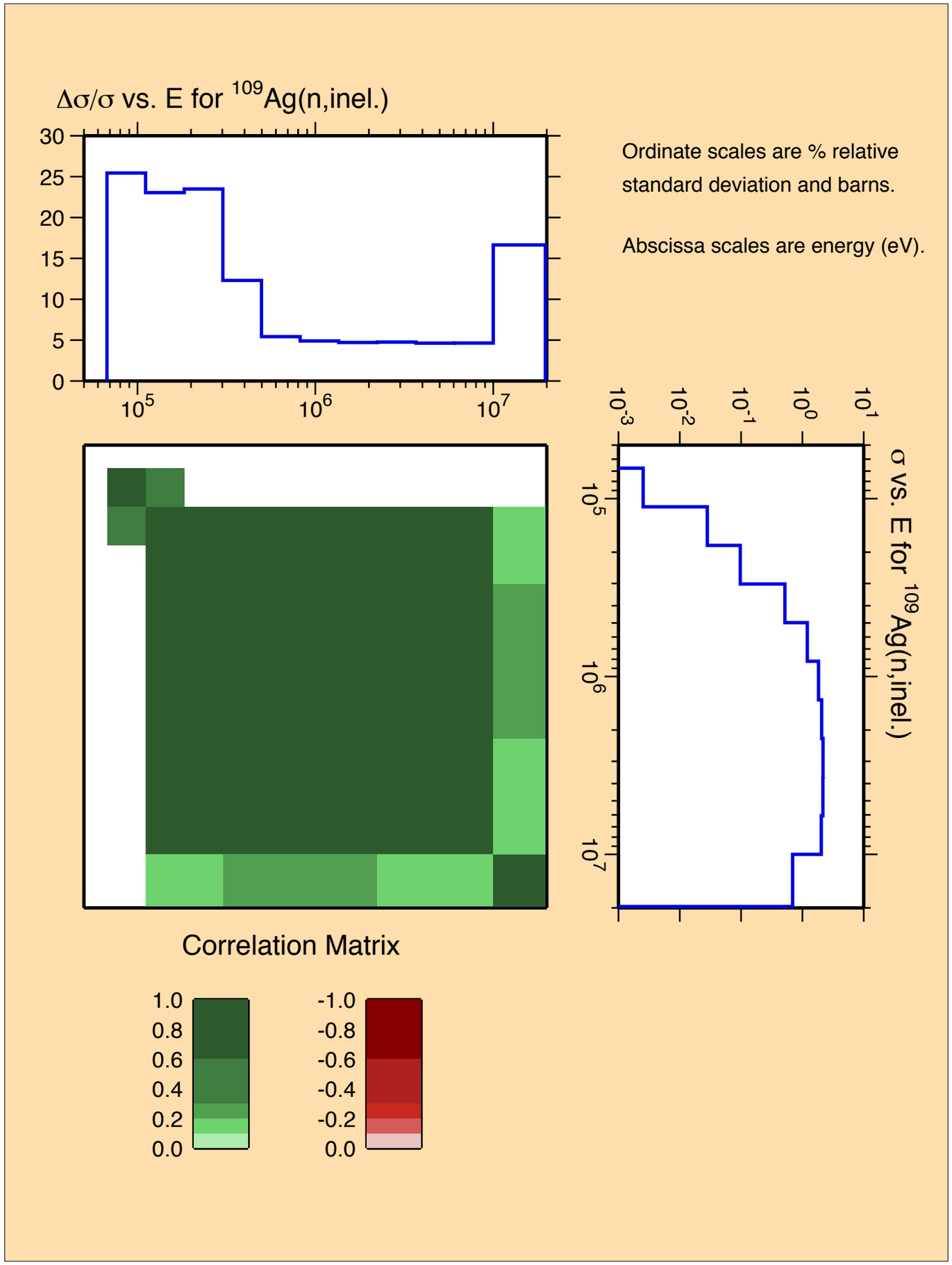

Δσ/σ vs. E for 133Cs(n,el.)
Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).
σ vs. E for 133Cs(n,el.)
Correlation Matrix
1.0
0.8
0.6
0.4
0.2
0.0
-1.0
-0.8
-0.6
-0.4
-0.2
0.0

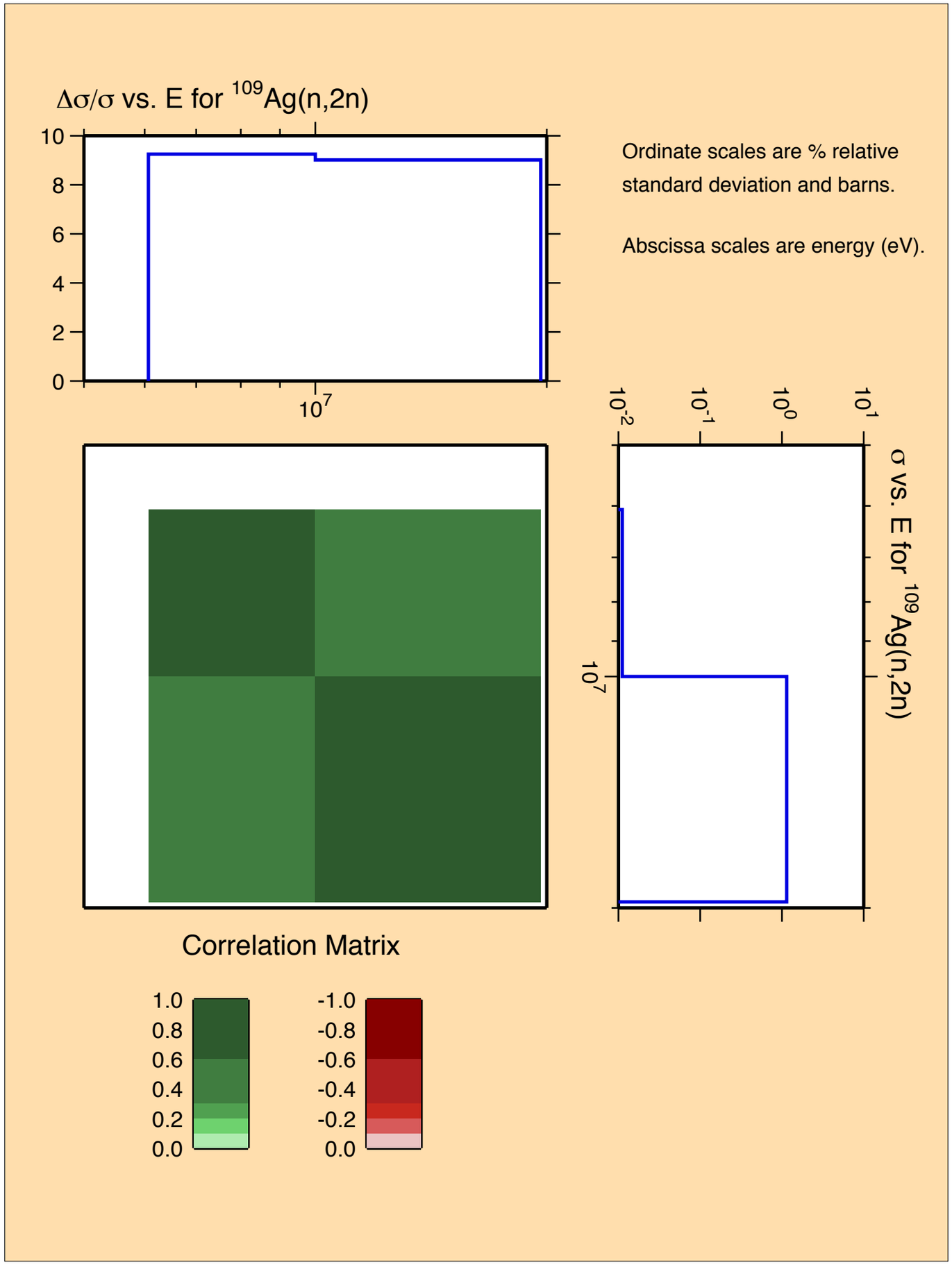

Δσ/σ vs. E for 133Cs(n,inel.)
25
20
15
10
5
0
10^5
10^6
10^7
Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).
σ vs. E for 133Cs(n,inel.)
10^-2
10^-1
10^0
10^1
10^5
10^6
10^7
Correlation Matrix
1.0
0.8
0.6
0.4
0.2
0.0
-1.0
-0.8
-0.6
-0.4
-0.2
0.0


Δσ/σ vs. E for 133Cs(n,2n)
14
12
10
8
6
4
2
0
10^7
Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).
σ vs. E for 133Cs(n,2n)
10^-2
10^-1
10^0
10^1
10^7
Correlation Matrix
1.0
0.8
0.6
0.4
0.2
0.0
-1.0
-0.8
-0.6
-0.4
-0.2
0.0

# Ag-109 other channels:


Δσ/σ vs. E for 109Ag(n,el.)
Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).
σ vs. E for 109Ag(n,el.)
Correlation Matrix
1.0
0.8
0.6
0.4
0.2
0.0
-1.0
-0.8
-0.6
-0.4
-0.2
0.0


Δσ/σ vs. E for 109Ag(n,inel.)
30
25
20
15
10
5
0
10^5
10^6
10^7
Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).
σ vs. E for 109Ag(n,inel.)
10^-3
10^-2
10^-1
10^0
10^1
10^5
10^6
10^7
Correlation Matrix
1.0
0.8
0.6
0.4
0.2
0.0
-1.0
-0.8
-0.6
-0.4
-0.2
0.0


Δσ/σ vs. E for 109Ag(n,2n)
10
8
6
4
2
0
10^7
Ordinate scales are % relative standard deviation and barns.
Abscissa scales are energy (eV).
σ vs. E for 109Ag(n,2n)
10^-2
10^-1
10^0
10^1
10^7
Correlation Matrix
1.0
0.8
0.6
0.4
0.2
0.0
-1.0
-0.8
-0.6
-0.4
-0.2
0.0