^{nat}La(p,x) XS Review

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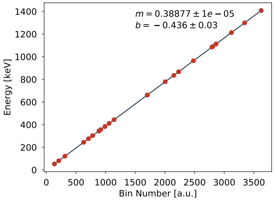
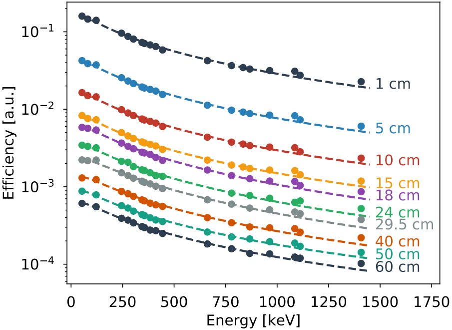
Methodology

- Detector calibration
- Peak fitting
- Verify $T_{1/2}$
- Determining beam current and energies
- Generate cross-sections
- Compare results to EXFOR, TALYS and EMPIRE

Calibration

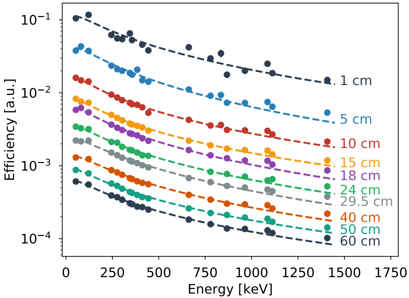


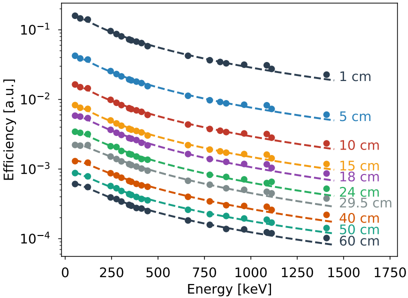
$$E = m \cdot i + b$$



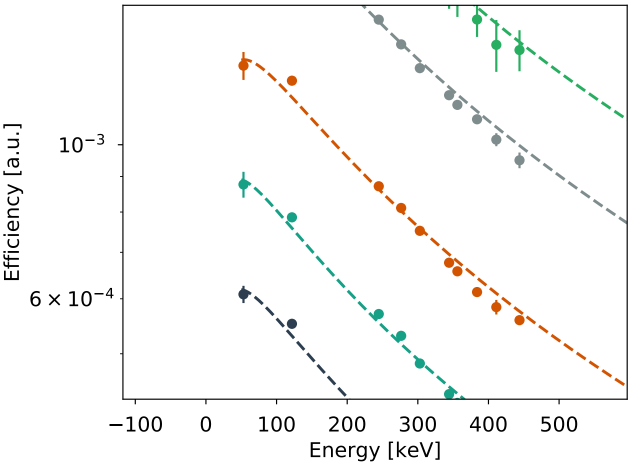
$$\epsilon(E) = exp[a \cdot ln(E)^2 + b \cdot ln(E) + c]$$

Normalizing to ^{137}Cs and ^{54}Mn





Efficiency Turnaround Region

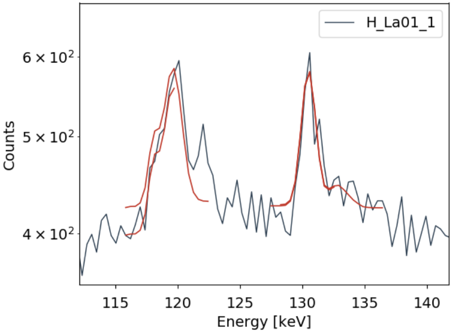


Peak Fitting

Fit to $P(i) = A \cdot e^{-\frac{(i-\mu)^2}{2\sigma^2}} + m \cdot i + b$ where i is bin #.

$N = \sqrt{2\pi}\sigma A$

$N(130.4keV) = 577 \pm 135$, ($\chi^2_\nu = 22.13$)



Cross-section Equations

$$A_0 = \frac{\lambda N_c}{(1-e^{-\lambda t_m})e^{-\lambda t_c} I_\gamma \epsilon}$$
$$A_0 = \sigma I_p \rho \Delta r (1 - e^{-\lambda t_i})$$

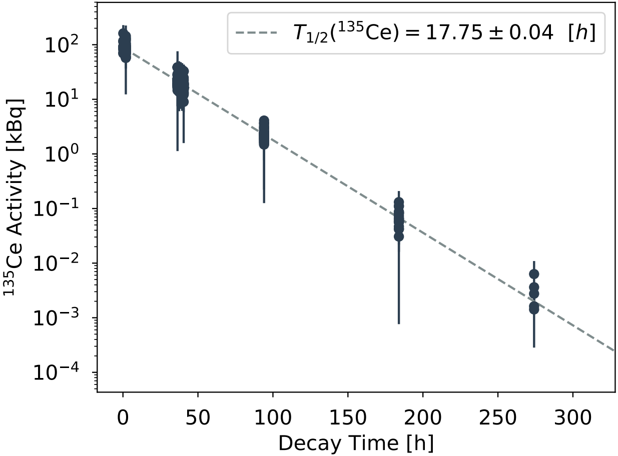
A_0: End-of-beam activity
t_m: Measurement time
t_c: Cooling time
t_i: Irradiation time
I_p: Beam current
$\rho \Delta r$: Areal density

Calculating A_0

$N(130.4keV) = 577 \pm 135$
$I_\gamma = 0.209\%,\ \epsilon(1cm, 130.4keV) = 0.095$
$\lambda = 2.53E-06s^{-1},\ t_m = 8603s,$
$t_c = 6.62E05s$
$A_0 = \frac{\lambda N_c}{(1-e^{-\lambda t_m})e^{-\lambda t_c} I_\gamma \epsilon}$
$A_0 =$
$\frac{2.53E-06s^{-1}577}{(1-e^{-2.53E-06s^{-1}8603s})e^{-2.53E-06s^{-1}6.62E05s}0.00209\cdot 0.095}$
$A_0 = 1822.9s^{-1} = 1.82kBq$

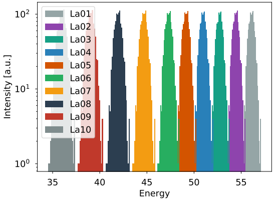
A_0: End-of-beam activity
t_m: Measurement time
t_c: Cooling time

Verifying $T_{1/2}$ of fits

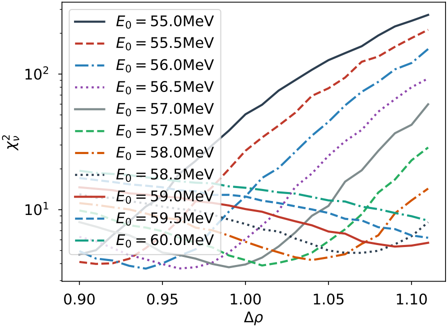


Accepted $T_{1/2} = 17.7 \pm 0.3h$.

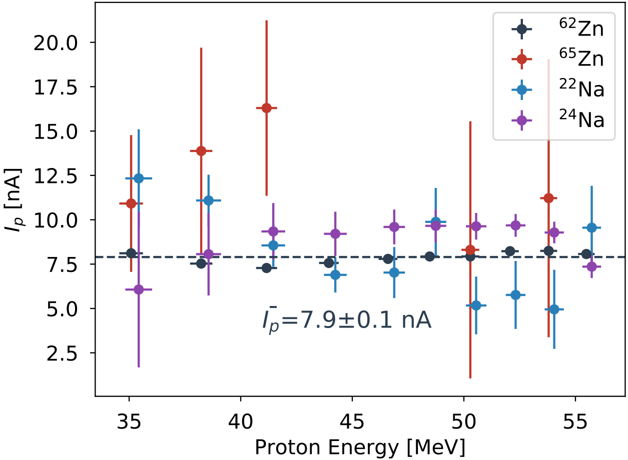
Determining Beam Current



Optimum E_0 and $\Delta\rho$ determined by χ^2 minimization using Anderson and Ziegler

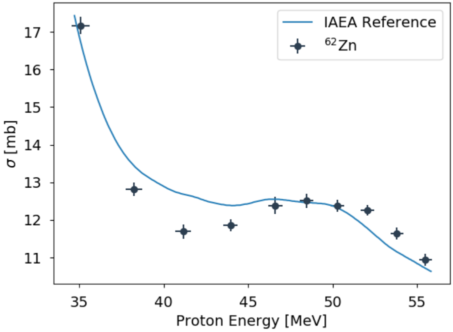


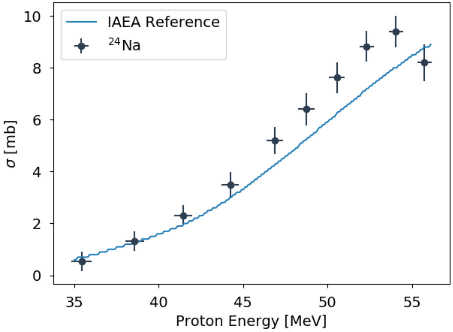
Optimized Beam Current

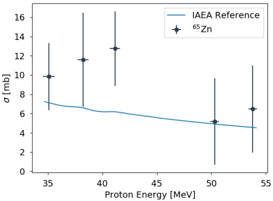


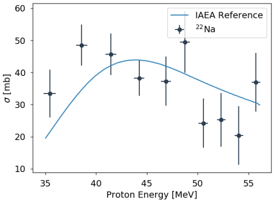
Optimum values of E_0 and $\Delta\rho$: 57.0 MeV, 0.99

Monitor Cross-Sections



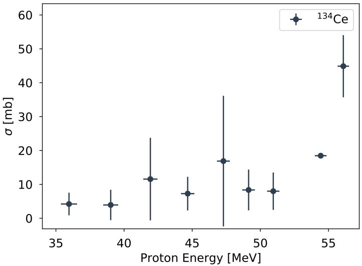




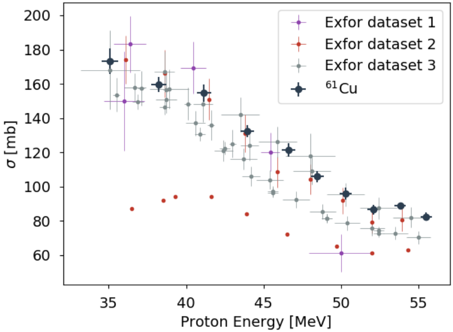


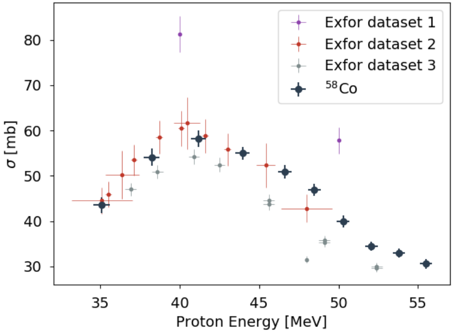
Calculating Cross-Section

$\sigma = \frac{A_0}{I_p \rho \Delta r (1 - e^{-\lambda t_i})}$
$I_p = 7.9nA = 4.93E10s^{-1}$, $\rho \Delta r = 14.6mg/cm^2 = 6.32E-08mb^{-1}$, $t_i = 5844s$, $\lambda = 2.53E-06s^{-1}$ and $A_0 = 1.82kBq$
$\sigma = \frac{1822.9}{4.93E106.32E-08(1-e^{-2.53E-06s^{-1} \cdot 5844s})}$
$\sigma = 39.86mb$

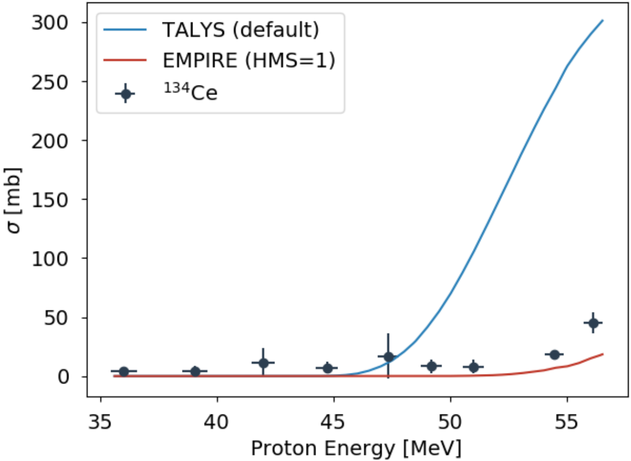


Verifying Method with EXFOR Data

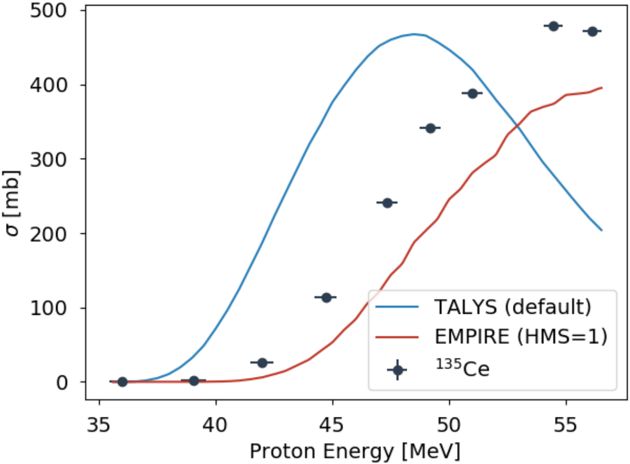




Comparison to TALYS, EMPIRE



^{135}Ce Cross-Section



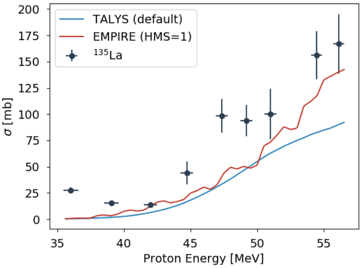
Daughter Nuclide Cross-Sections

From 1^{st} Batemann eqn. $N_D(t) = N_{p0}\frac{\lambda_p}{\lambda_D-\lambda_p}(e^{-\lambda_p t} - e^{-\lambda_D t}) + N_{D0}e^{-\lambda_D t}$

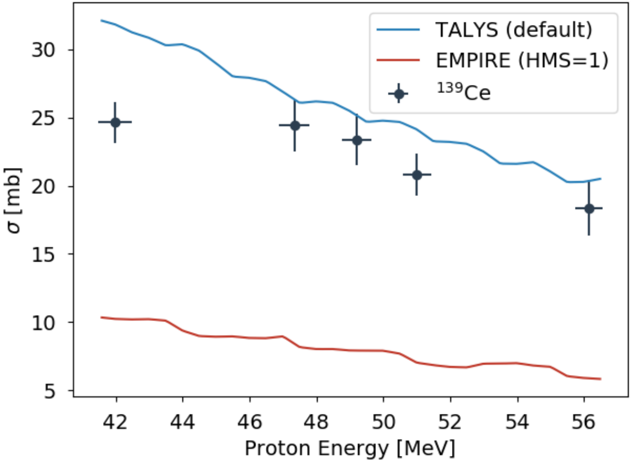
Rewrite for activity: $A_D(t) = A_{p0}\frac{\lambda_D}{\lambda_D-\lambda_p}(e^{-\lambda_p t} - e^{-\lambda_D t}) + A_{D0}e^{-\lambda_D t}$

So initial daughter activity is $A_{D0} = A_D(t) - A_{p0}\frac{\lambda_D}{\lambda_D-\lambda_p}(e^{-(\lambda_p-\lambda_D)t} - 1)$

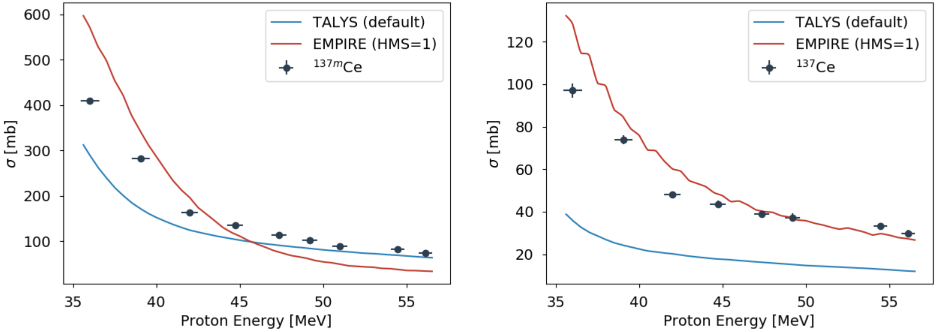
Here t is cooling time (previously t_c)



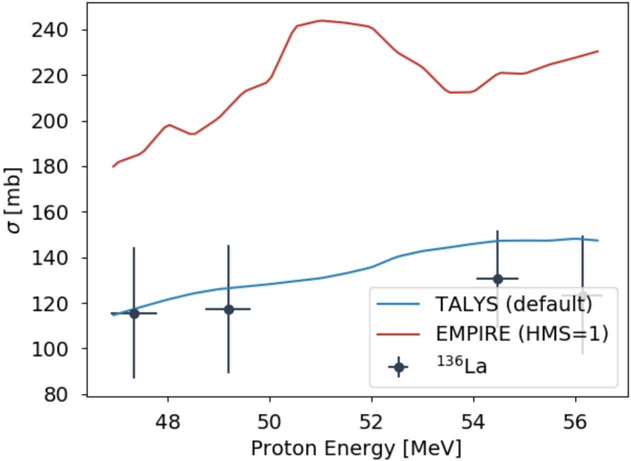
^{139}Ce Cross-Section



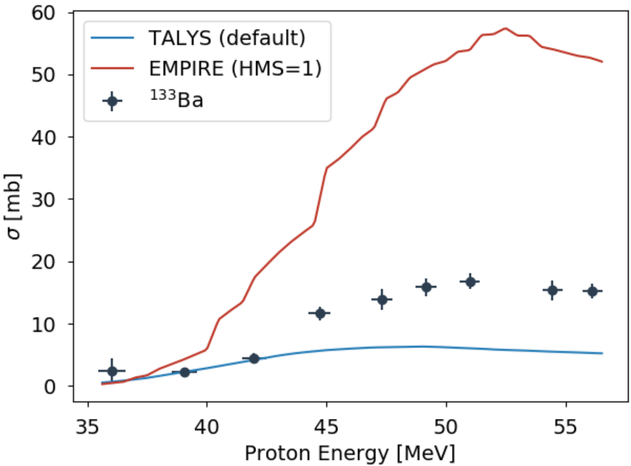
^{137m}Ce and ^{137}Ce Cross-Sections



^{136}La Cross-Section



^{133}Ba Cross-Section



^{132}Cs Cross-Section