Dipole Strength in ^{86}Kr up to Neutron Separation

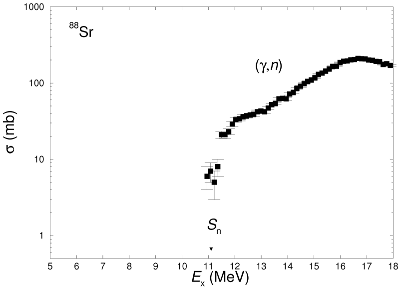
Ralph Massarczyk

Helmholtz-Zentrum Dresden-Rossendorf

24-03-2011

Dipole Strength

- **goal :** experimental information about the low-energy tail of the giant dipole resonance
- different parameterizations possible to describe the GDR
- some nuclei show extra strength in the low energy range



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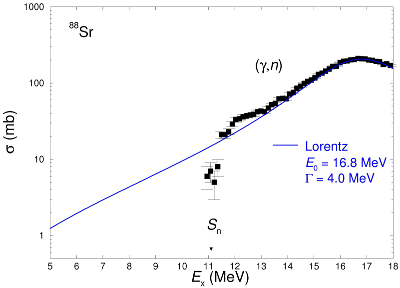

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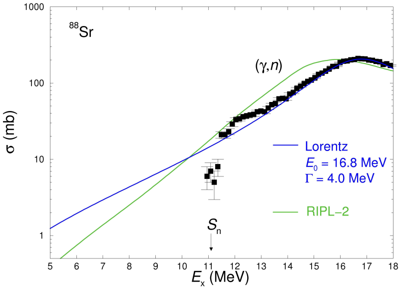

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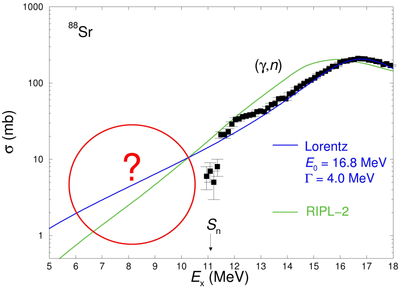

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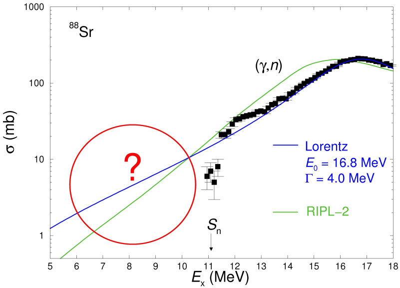

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- ^{86}Kr completes a series of experiments on the isotones $N = 50$
- first time dipole strength measurements at gaseous nuclei in Dresden
- high pressure gas container (70 bar)

89Mo 2.11 M ϵ: 100.00%	90Mo 5.56 H ϵ: 100.00%	91Mo 15.49 M ϵ: 100.00%	92Mo STABLE 14.84%	93Mo 4.0E+3 Y ϵ: 100.00%	94Mo STABLE 9.25%	95Mo STABLE 15.92%	96Mo STABLE 16.68%	97Mo STABLE 9.55%
88Nb 14.55 M ϵ: 100.00%	89Nb 2.03 H ϵ: 100.00%	90Nb 14.60 H ϵ: 100.00%	91Nb 6.8E+2 Y ϵ: 100.00%	92Nb 3.47E+7 Y ϵ: 100.00% β- < 0.05%	93Nb STABLE 100%	94Nb 2.03E+4 Y β-: 100.00%	95Nb 34.991 D β-: 100.00%	96Nb 23.35 H β-: 100.00%
87Zr 1.68 H ϵ: 100.00%	88Zr 83.4 D ϵ: 100.00%	89Zr 78.41 H ϵ: 100.00%	90Zr STABLE 51.45%	91Zr STABLE 11.22%	92Zr STABLE 17.15%	93Zr 1.53E+6 Y β-: 100.00%	94Zr STABLE 17.38%	95Zr 64.032 D β-: 100.00%
86Y 14.74 H ϵ: 100.00%	87Y 79.8 H ϵ: 100.00%	88Y 106.626 D ϵ: 100.00%	89Y STABLE 100%	90Y 64.053 H β-: 100.00%	91Y 58.51 D β-: 100.00%	92Y 3.54 H β-: 100.00%	93Y 10.18 H β-: 100.00%	94Y 18.7 M β-: 100.00%
85Sr 64.84 D ϵ: 100.00%	86Sr STABLE 9.86%	87Sr STABLE 7.00%	88Sr STABLE 82.58%	89Sr 50.57 D β-: 100.00%	90Sr 28.90 Y β-: 100.00%	91Sr 9.63 H β-: 100.00%	92Sr 2.66 H β-: 100.00%	93Sr 7.423 M β-: 100.00%
84Rb 33.1 D ϵ: 96.20% β-: 3.80%	85Rb STABLE 72.17%	86Rb 18.642 D β-: 99.99% ϵ: 5.2E-3%	87Rb 4.81E+10 Y 27.83% β-: 100.00%	88Rb 17.773 M β-: 100.00%	89Rb 15.15 M β-: 100.00%	90Rb 158 S β-: 100.00%	91Rb 58.4 S β-: 100.00%	92Rb 4.492 S β-: 100.00% β-n: 0.01%
83Kr STABLE 11.49%	84Kr STABLE 57.00%	85Kr 3916.8 D β-: 100.00%	86Kr STABLE 17.30%	87Kr 76.3 M β-: 100.00%	88Kr 2.84 H β-: 100.00%	89Kr 3.15 M β-: 100.00%	90Kr 32.32 S β-: 100.00%	91Kr 8.57 S β-: 100.00%

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Experiments in Dresden

- photon excitation at the bremsstrahlung setup at the electron accelerator ELBE
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- setup contains high purity Germanium detectors with BGO shielding
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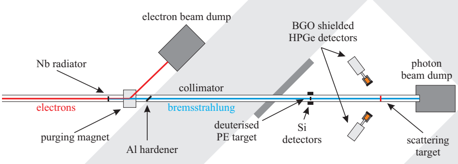

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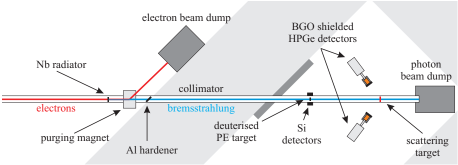

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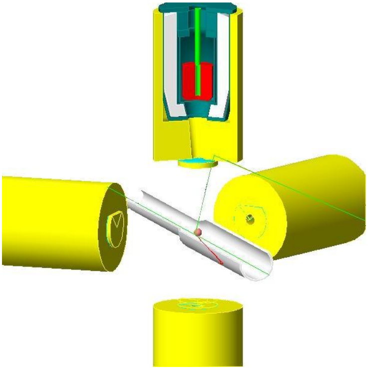

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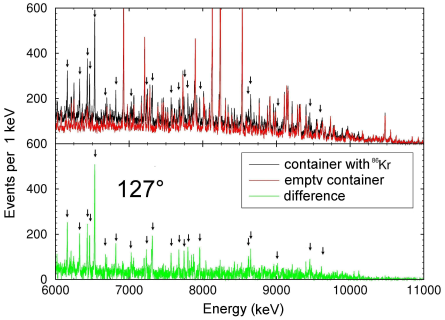
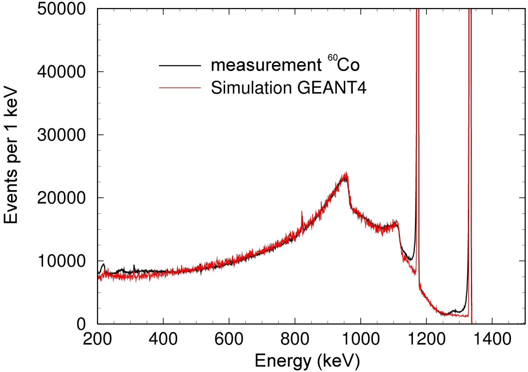


Simulations with *GEANT4*

- correction of detector response in *GEANT4*
- calculation of the detector efficiency
- estimation of the non-nuclear scattered background
- analysis of the unresolvable continuum possible
- about 66 % of the strength in the continuum



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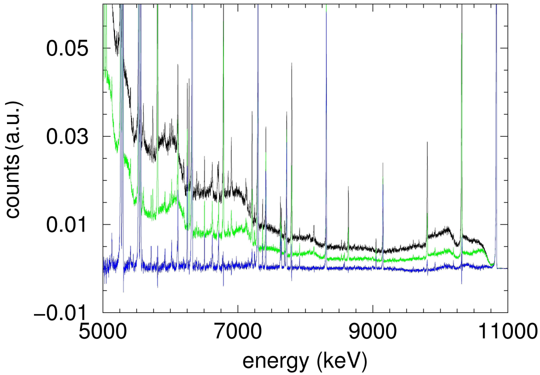

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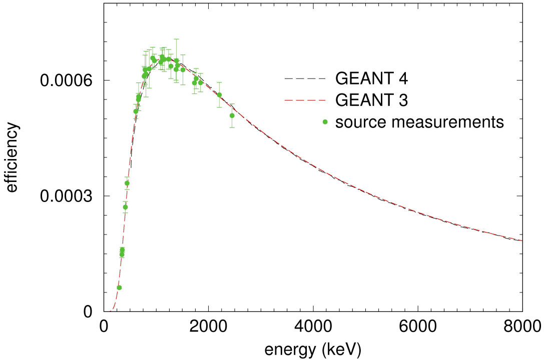

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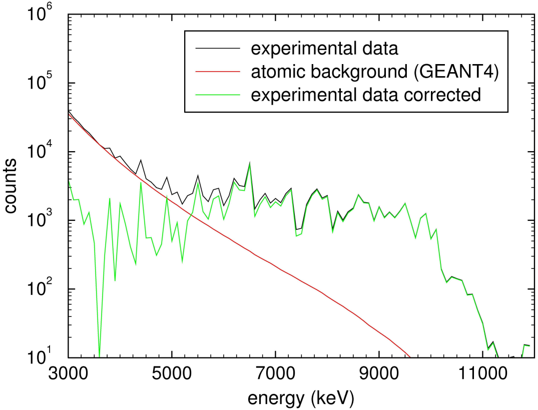

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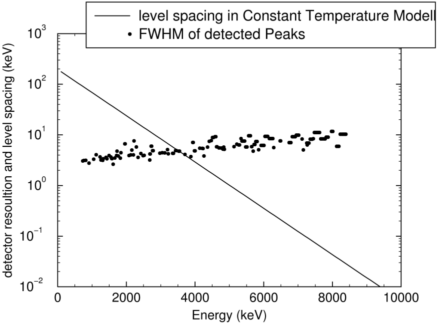

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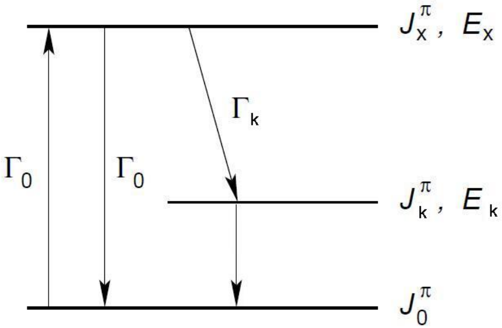
Calculated Cross Sections

- corrected for inelastic scattering necessary
- new code developed by G.Schramm



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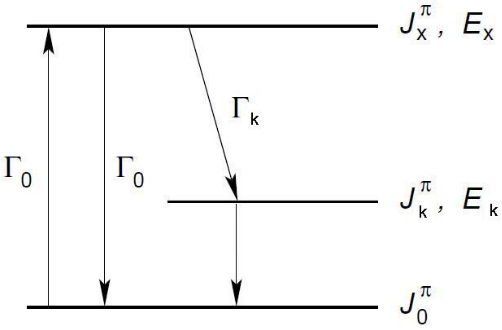
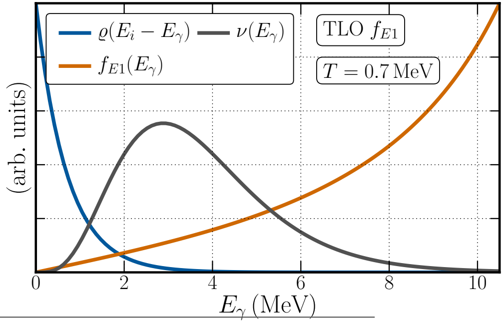


Simulation of Radiative Deexcitations

Average spectral distribution[1] of primary γ's from an excited state i with spin J :

$$\nu^J_{iXL}(E_\gamma) = E_\gamma^{2L+1} \frac{f_{XL}(E_\gamma)}{\langle \Gamma_{i,\text{tot}} \rangle} \frac{\sum_{I=|J-L|}^{J+L} \varrho(E_i - E_\gamma, I)}{\varrho(E_i, J)} \quad (1)$$



$\nu(E_\gamma)$ determined by:

- LD at final state $\varrho(E_\lambda - E_\gamma)$
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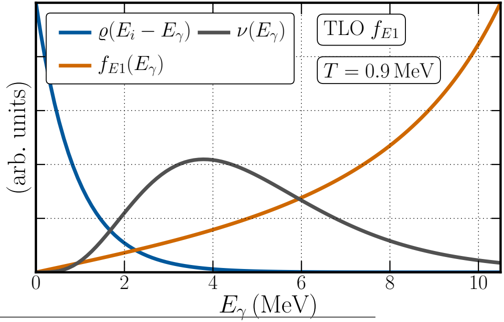

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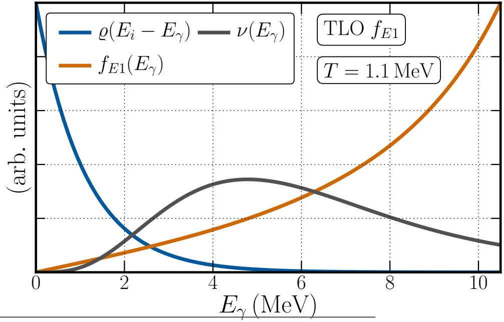

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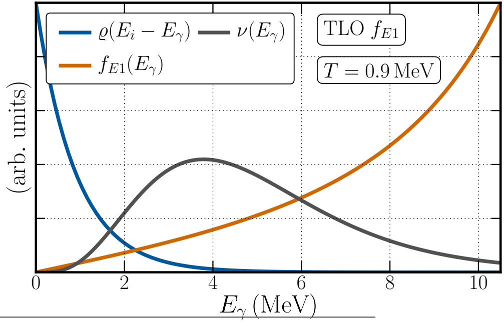

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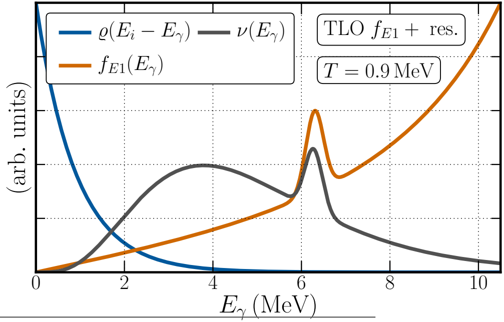

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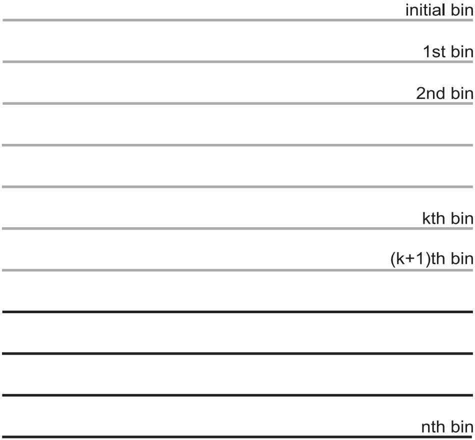
Scheme of the Simulation γDEX

- treat nucleus in energy bins
- calculate LD in all bins
- use information of known discrete levels in lowest bins
- calculate transition probabilities P_{if} for an excited bin via $\nu(E_\gamma)$
- draw random variable to pick a transition
- repeat until ground state is reached



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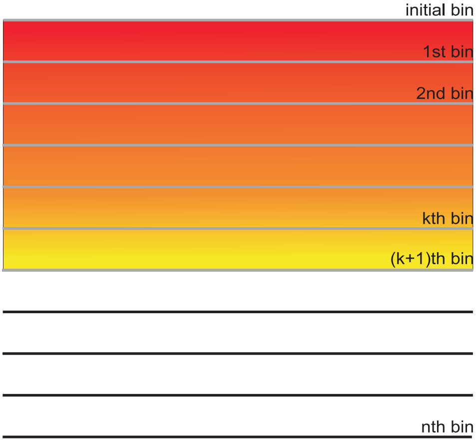

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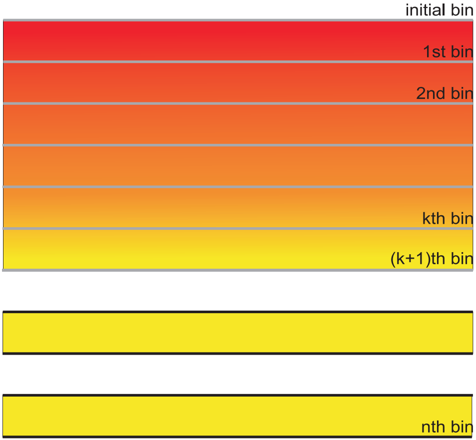

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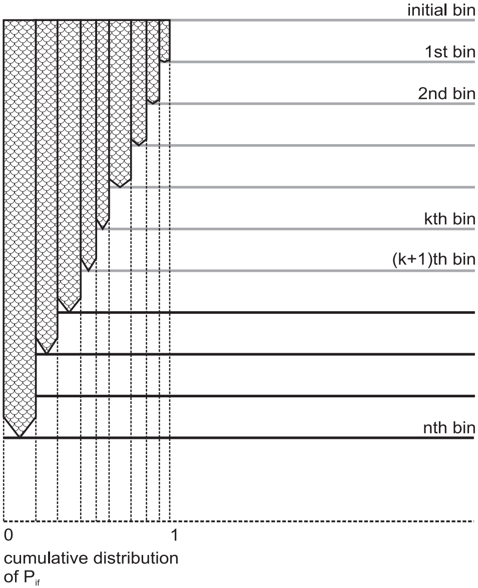

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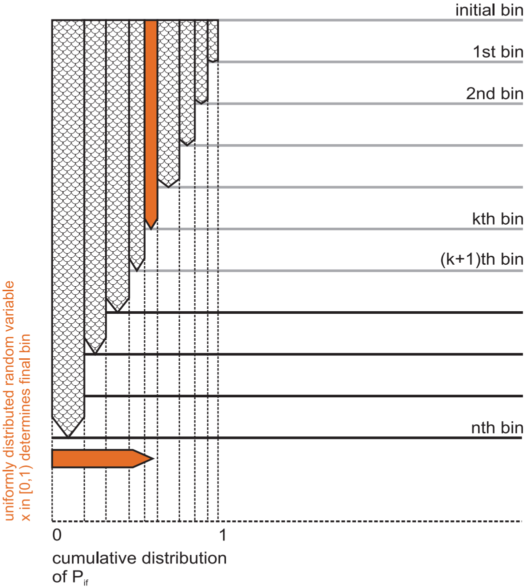

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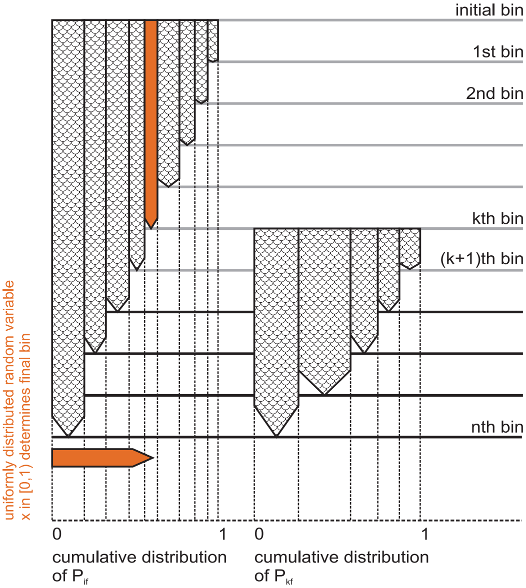

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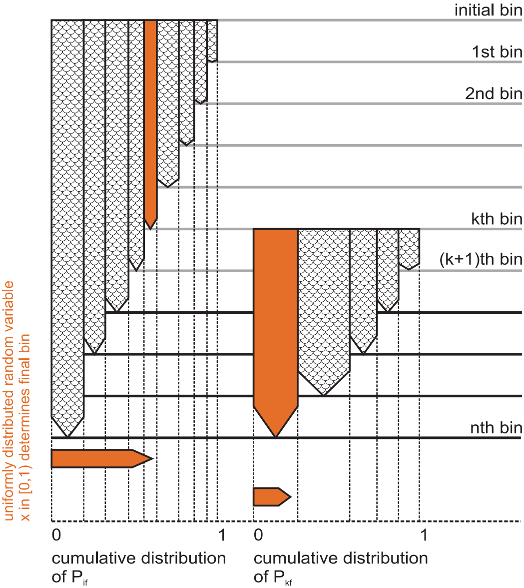
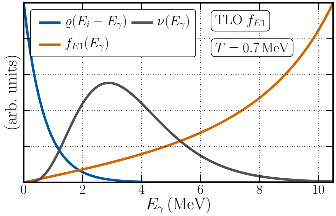
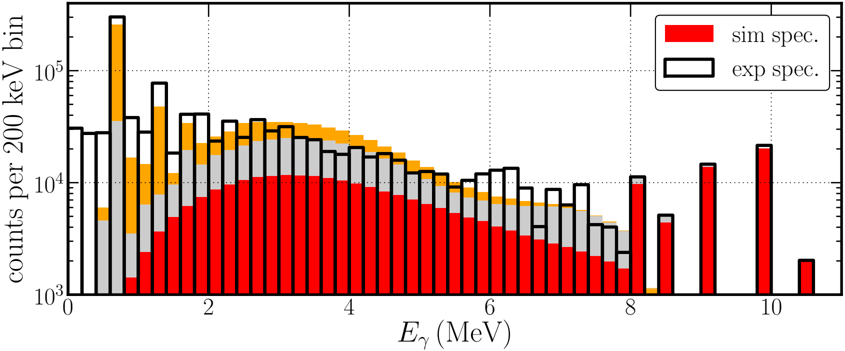


Simulation of $^{77}\mathrm{Se(n,\gamma)}$

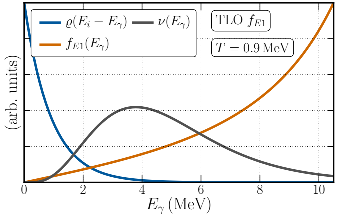
- CTM $T = 700\,\mathrm{keV}$, $D_0 = 121\,\mathrm{eV}$
- TLO f_{E1}
- $m = 3.56$, $\chi^2_\nu = 5.33$

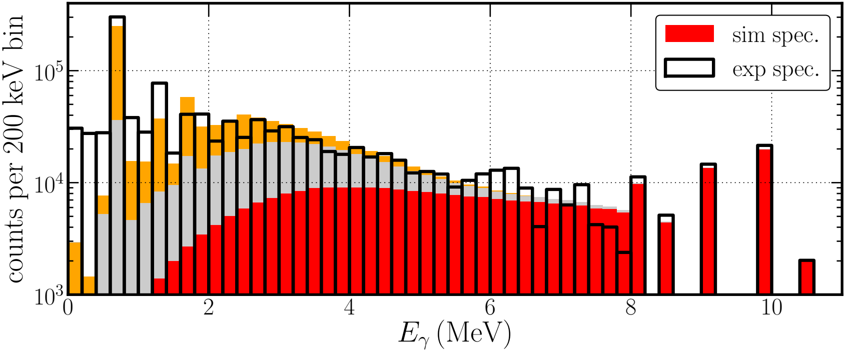




Simulation of $^{77}\mathrm{Se}(\mathrm{n},\gamma)$

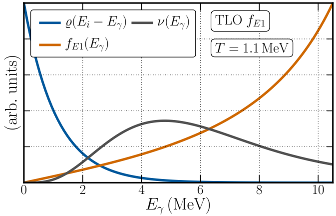
- CTM $T = 900\,\mathrm{keV},\ D_0 = 121\,\mathrm{eV}$
- TLO f_{E1}
- $m = 3.62,\ \chi^2_\nu = 2.62$

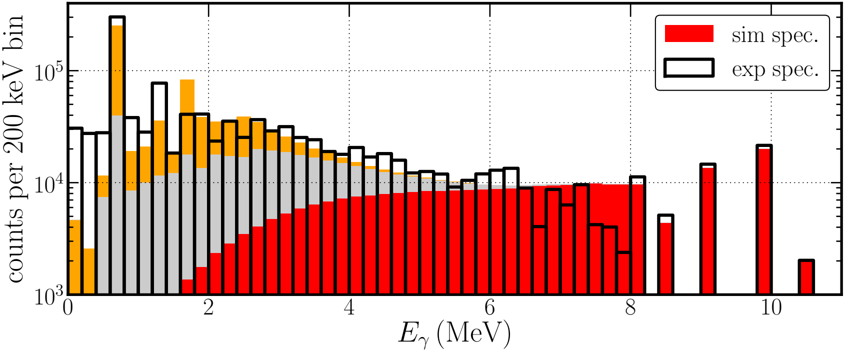




Simulation of $^{77}\mathrm{Se}(\mathrm{n},\gamma)$

- CTM $T = 1100\,\mathrm{keV},\ D_0 = 121\,\mathrm{eV}$
- TLO f_{E1}
- $m = 3.65,\ \chi^2_\nu = 4.21$





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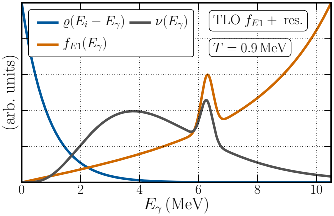
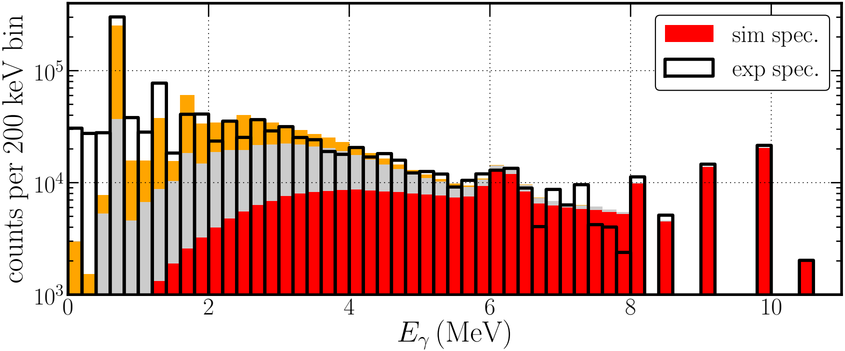
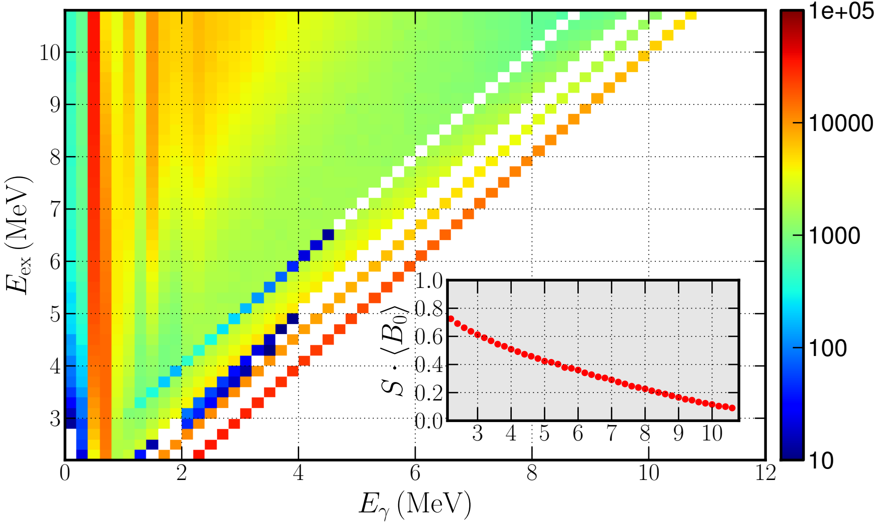
- CTM $T = 900\,\mathrm{keV}$, $D_0 = 121\,\mathrm{eV}$
- TLO f_{E1} + resonance
- $m = 3.61$, $\chi^2_\nu = 1.88$



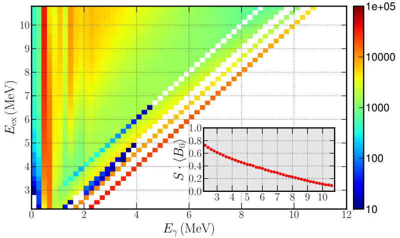


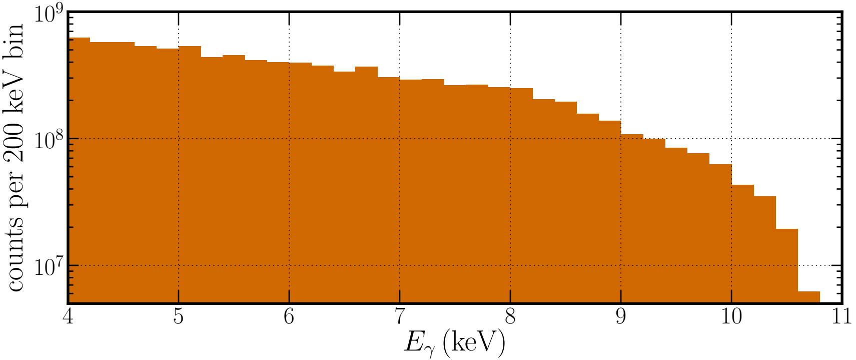
Simulation of $^{78}\mathrm{Se}(\gamma,\gamma)$



Feeding and branching correction

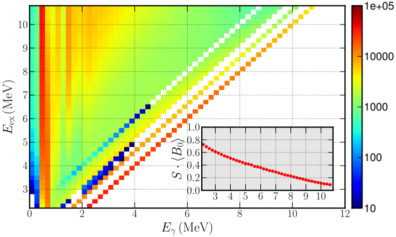
- resp.,bg.,eff. corr. spec. (orange)

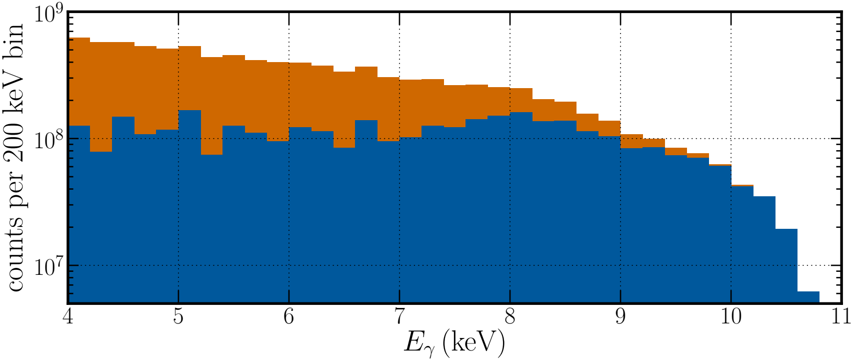




Feeding and branching correction

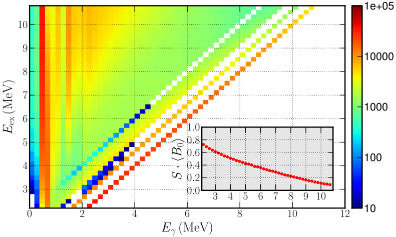
- resp.,bg.,eff. corr. spec. (orange)
- spec. of elastic transitions (blue)

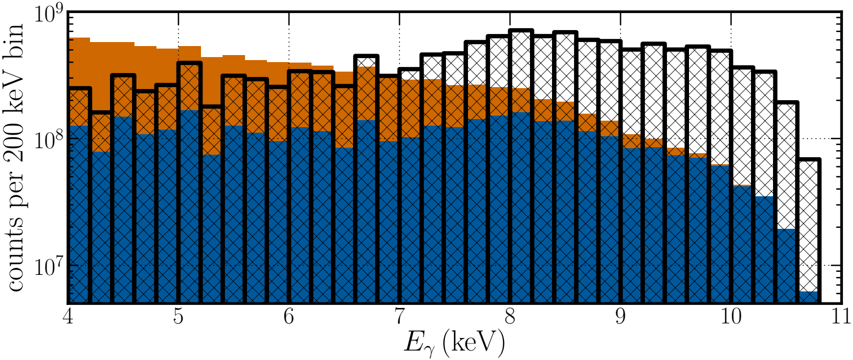




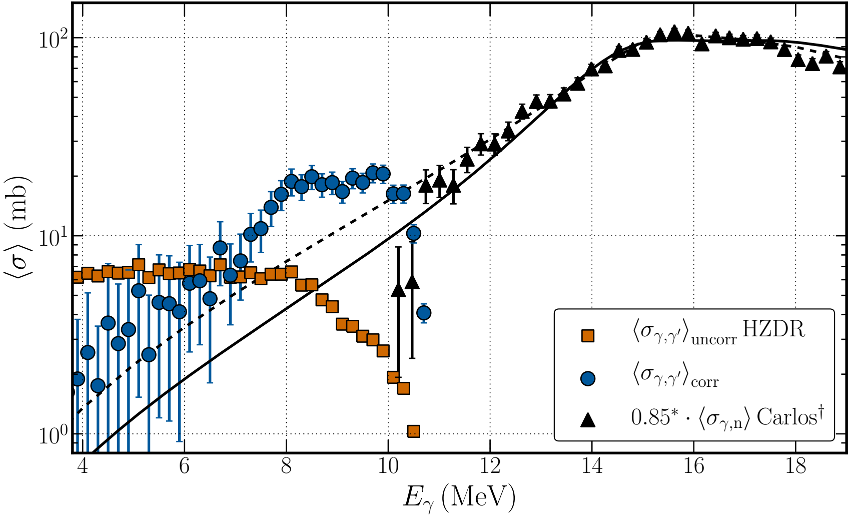
Feeding and branching correction

- resp.,bg.,eff. corr. spec. (orange)
- spec. of elastic transitions (blue)
- spec. of absorbed photons (black)





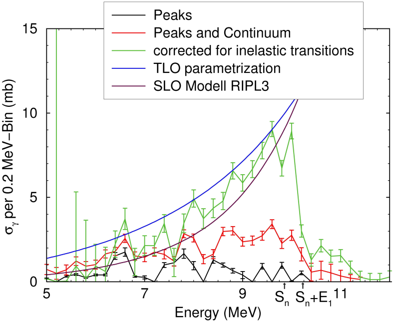
Average Photon Cross Sections ^{78}Se



* B. Berman et al., Phys. Rev. C **36** (1987) † P. Carlos et al., Nucl. Phys. A **258** (1976)

Calculated Cross Sections

- correction for inelastic transitions
- strength over the threshold, because of the momentum barrier



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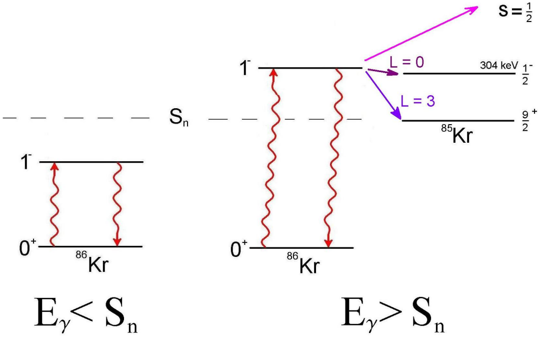

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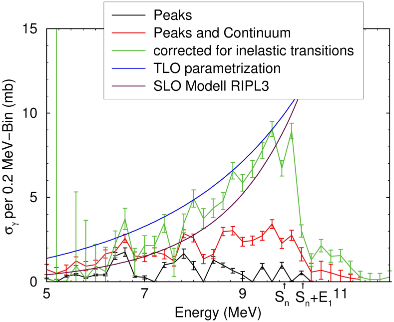
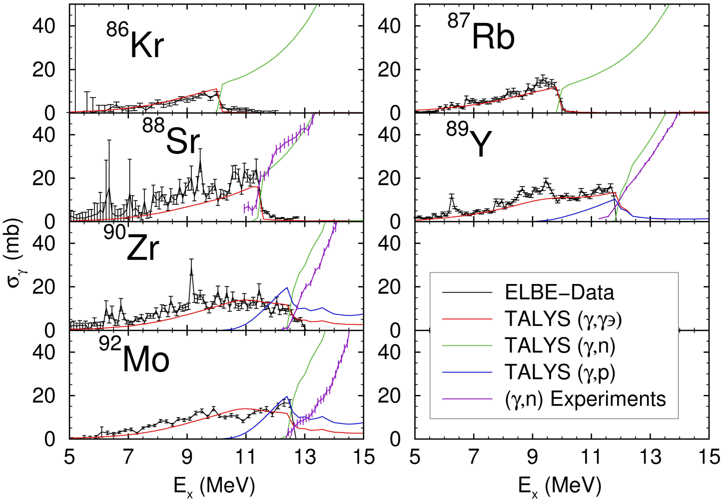


N = 50 Isotones



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Conclusions

- successful measurements in gas targets with photons up to the neutron separation
- simulations with $GEANT4$
- new deexcitation code by G. Schramm
- no extra strength in ^{86}Kr observed

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Thanks ...

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