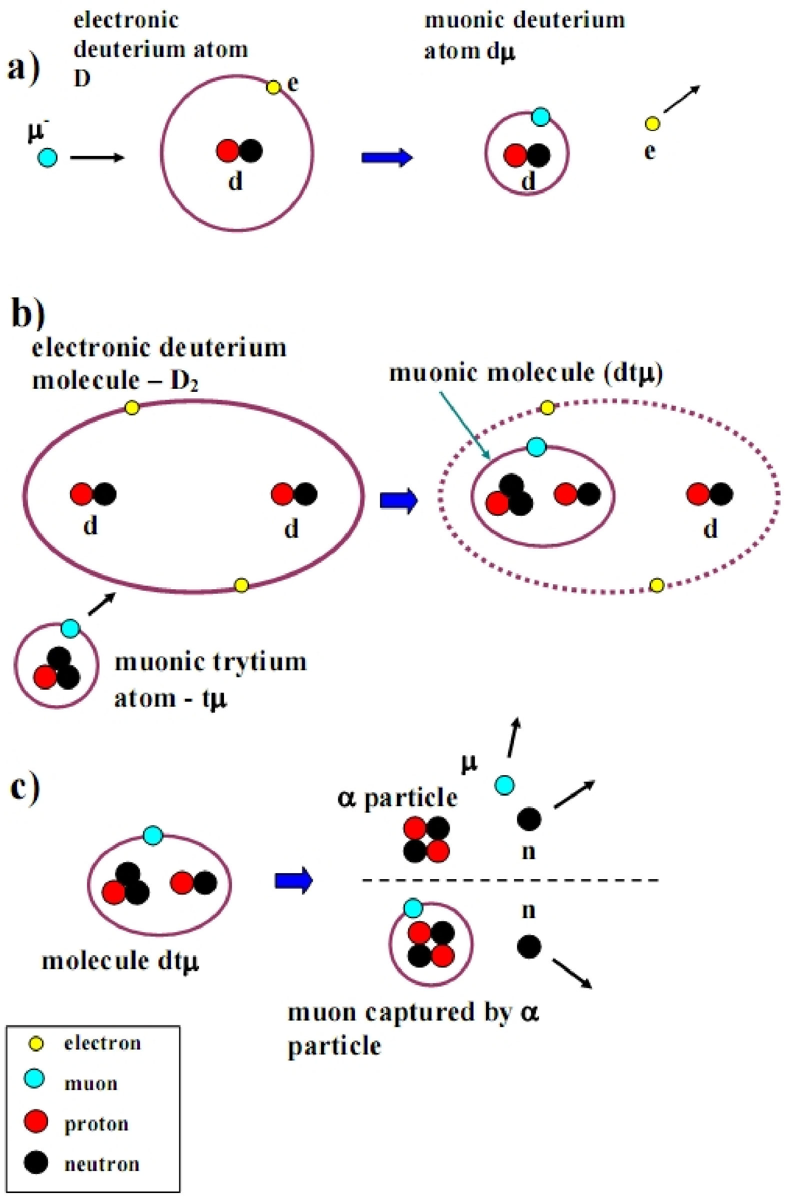
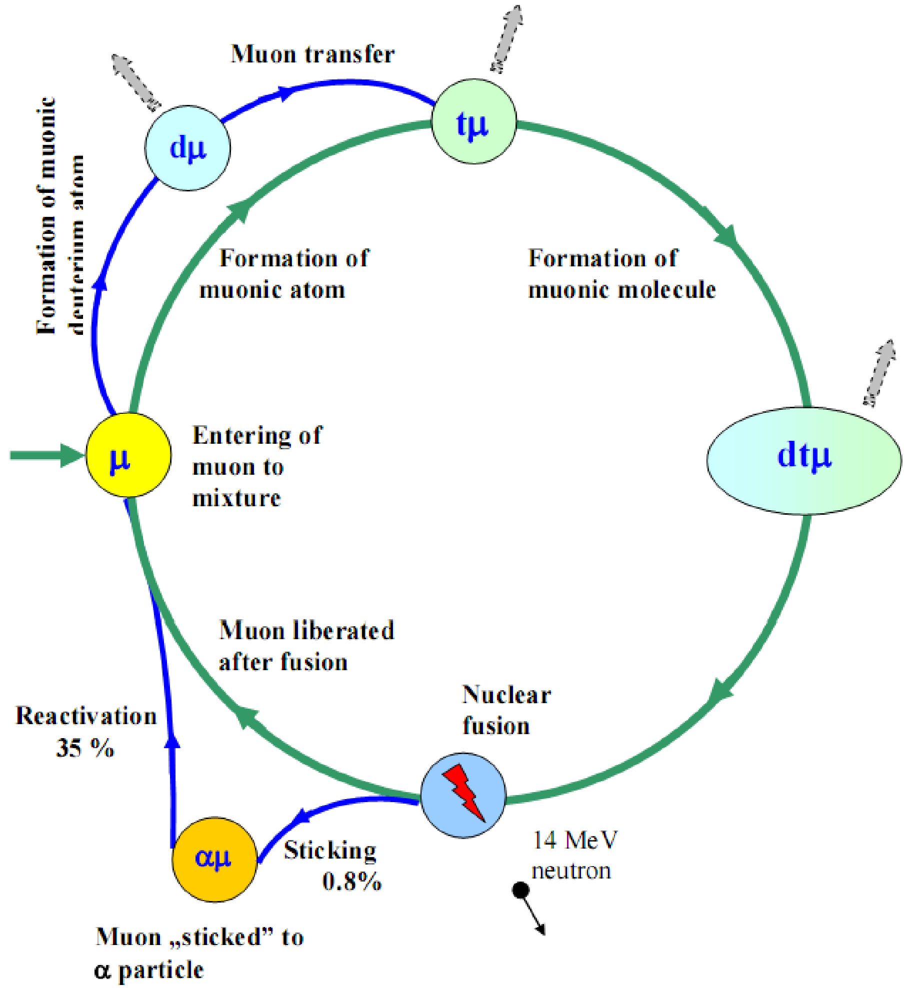
M. Filipowicz, V.M. Bystritsky, J. Woźniak

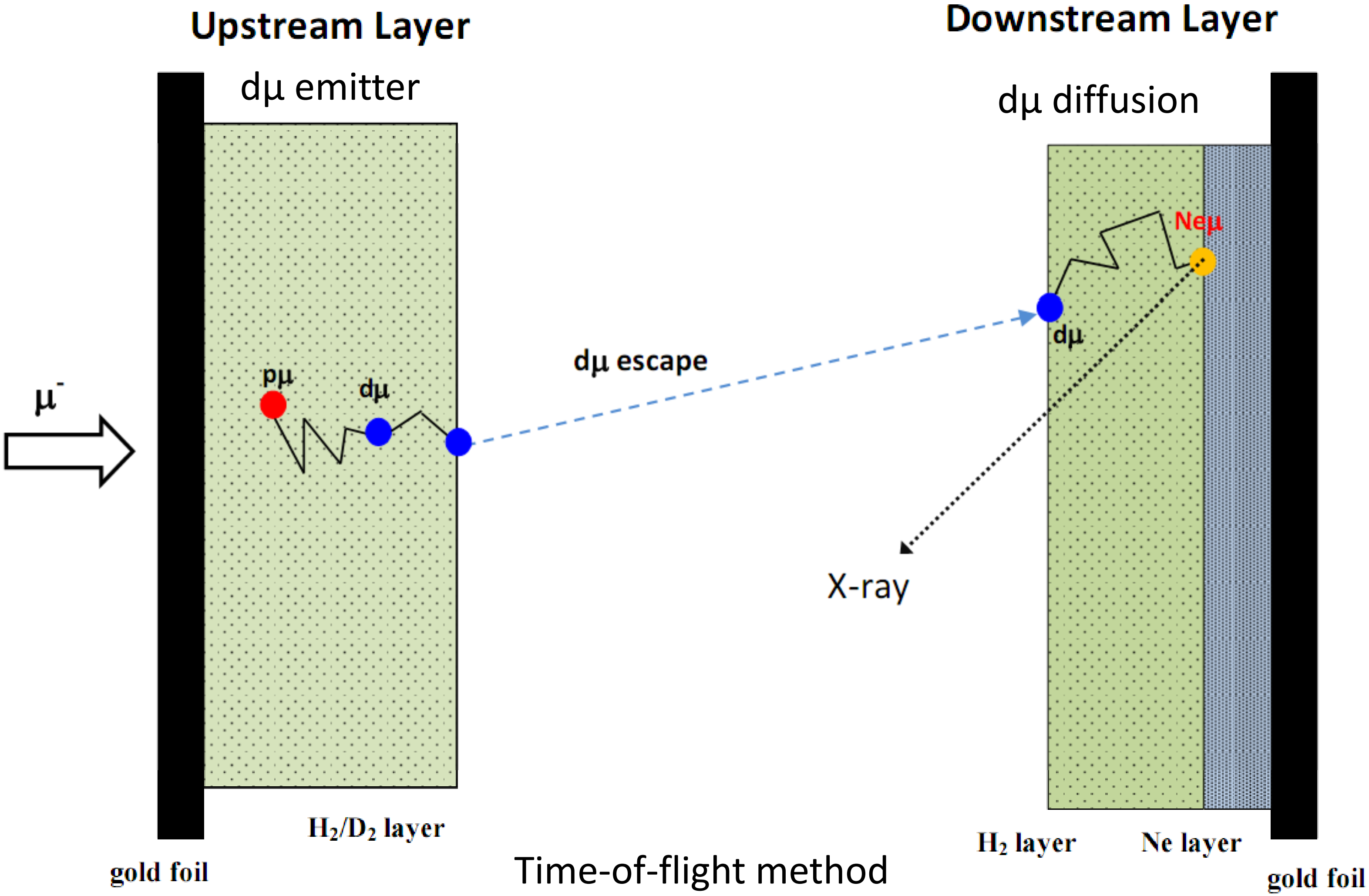
Monte Carlo fitting of data from Muon Catalyzed Fusion experiments in solid hydrogen

Main processes of MCF



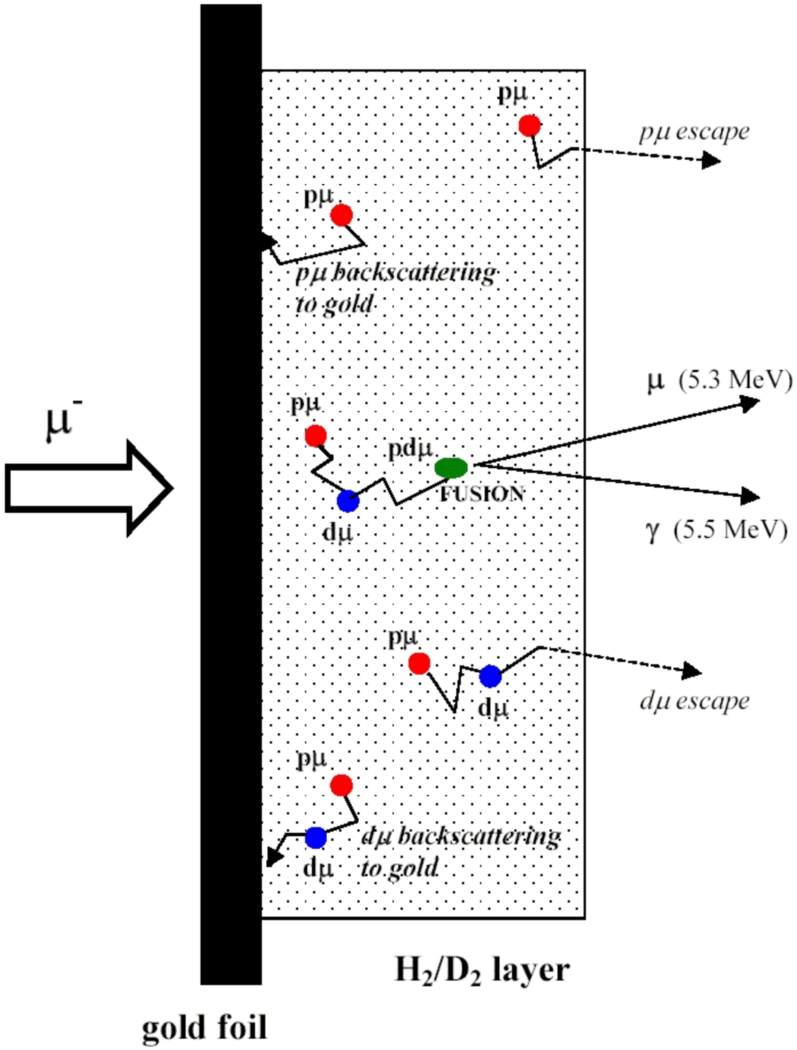


Investigations of scattering of muonic atoms

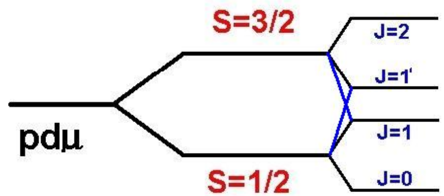


Time-of-flight method

Nuclear fusion in pdμ molecule

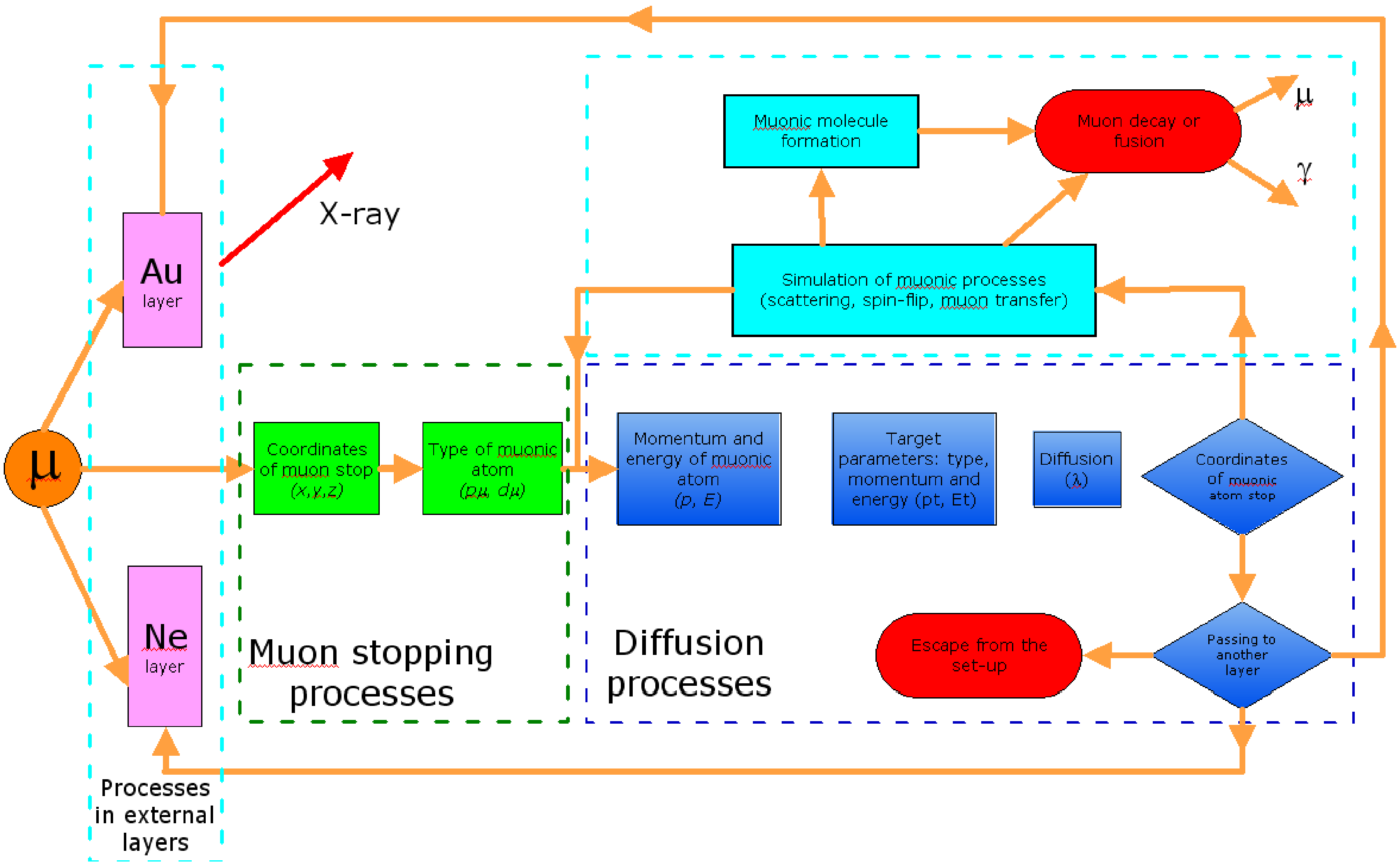


$$pd\mu \rightarrow \begin{cases} {}^3He + \mu \\ {}^3He\mu + \gamma \end{cases}$$



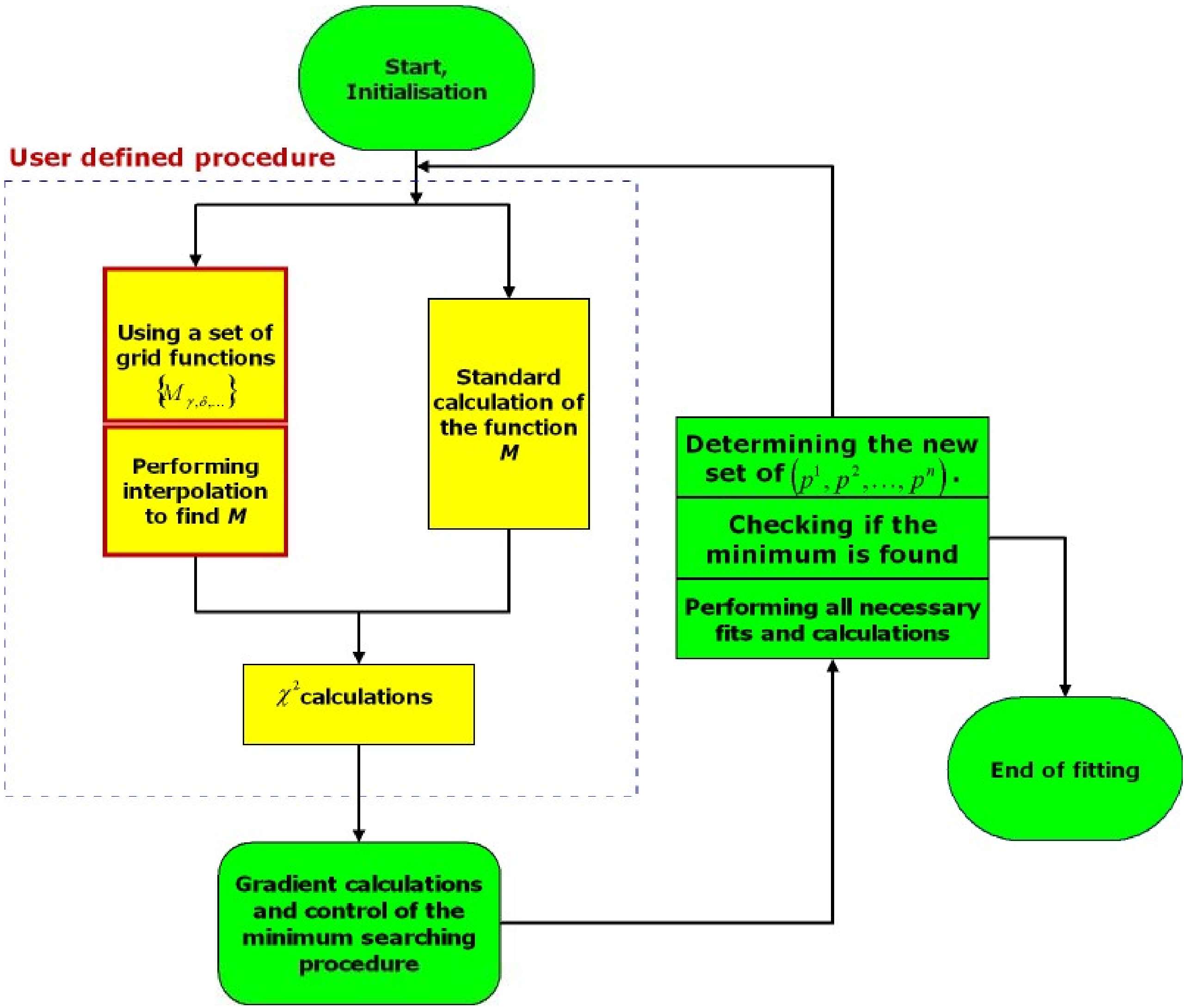
M. Filipowicz et al., „Measurements of pdμ fusion cycle parameters in the solid H/D mixture", talk on International Conference , MCF07, Bubna, Russia, 2007

MC simulation



J. Woźniak et al. „Study of muonic hydrogen transport in TRIUMF experiment 742 by the Monte Carlo method", Hyperfine Interactions 101/102(1996)573-582

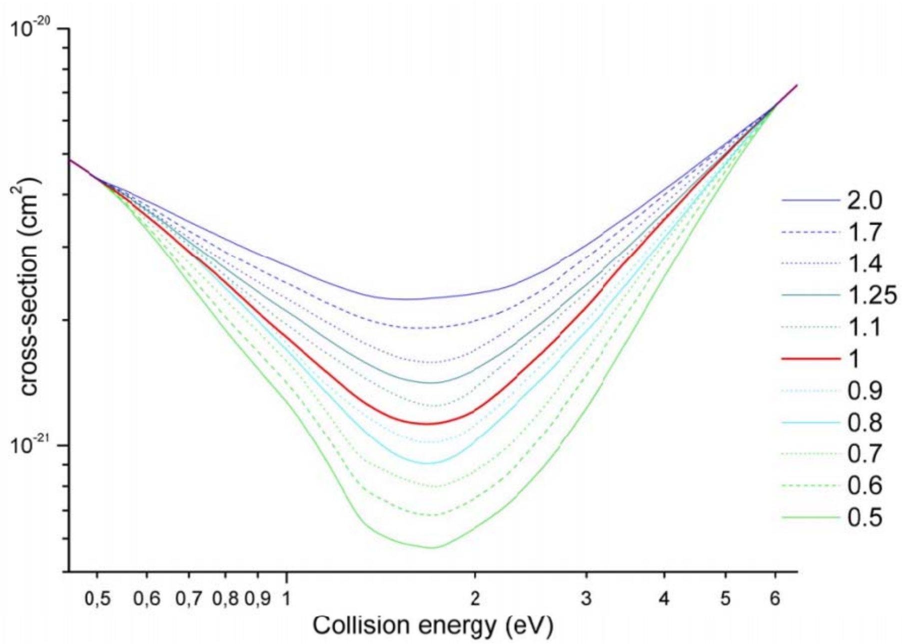
Fitting procedure



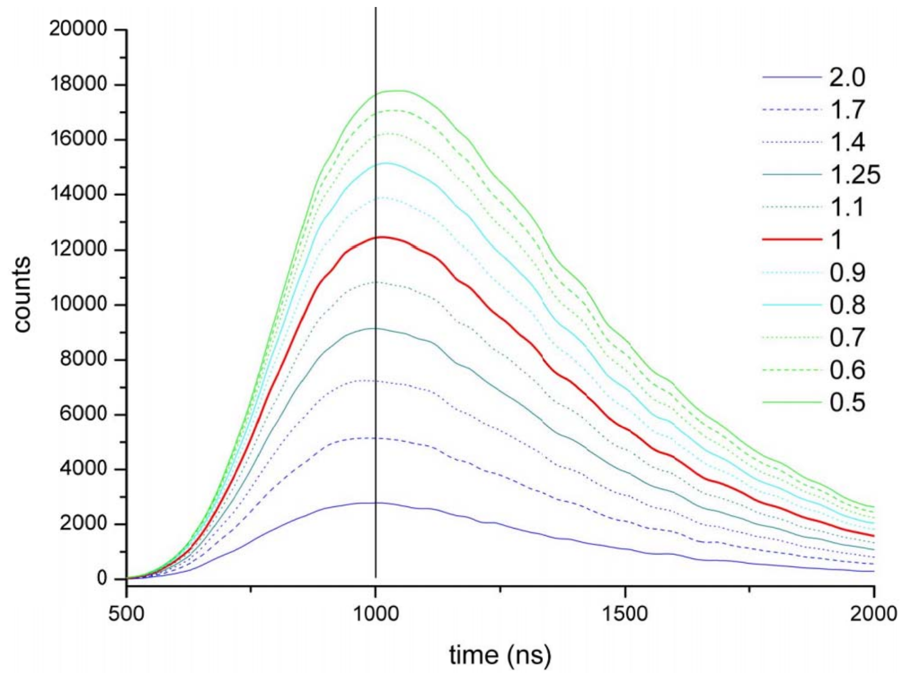
M. Filipowicz et al. „Method of Monte-Carlo grid for data analysis", Nuclear Instruments and Methods A547(2005)652-662

Scattering: R-T effect investigation

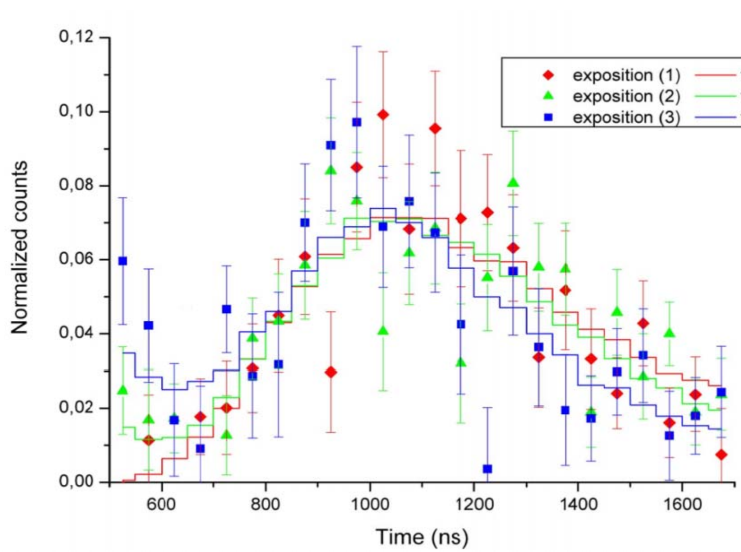
Variation of the cross-section

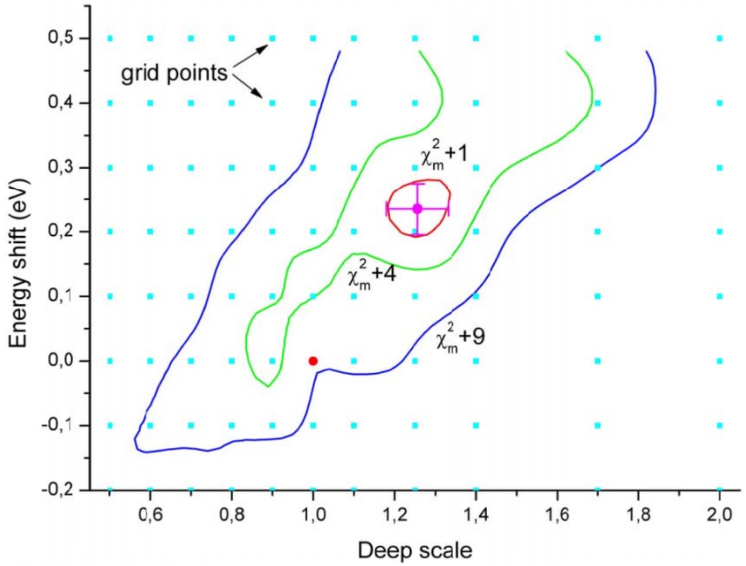


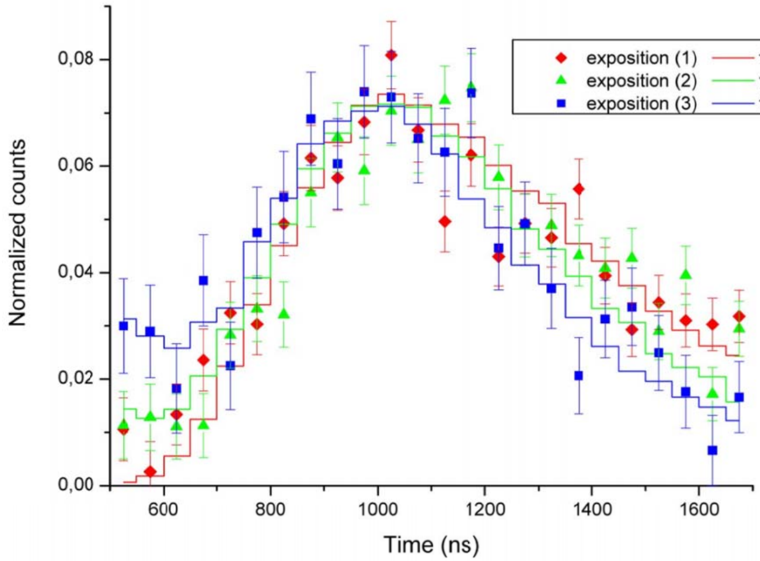
Generated time spectra of the X-ray

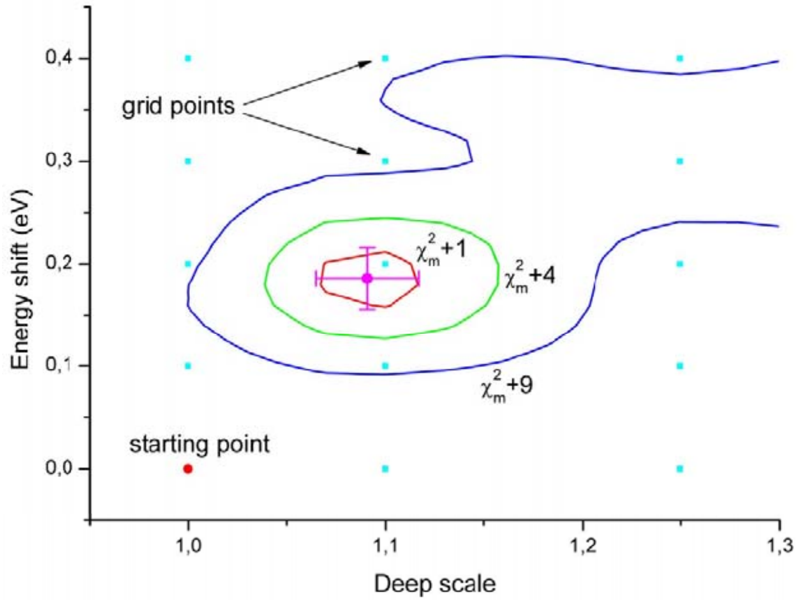


Fit results



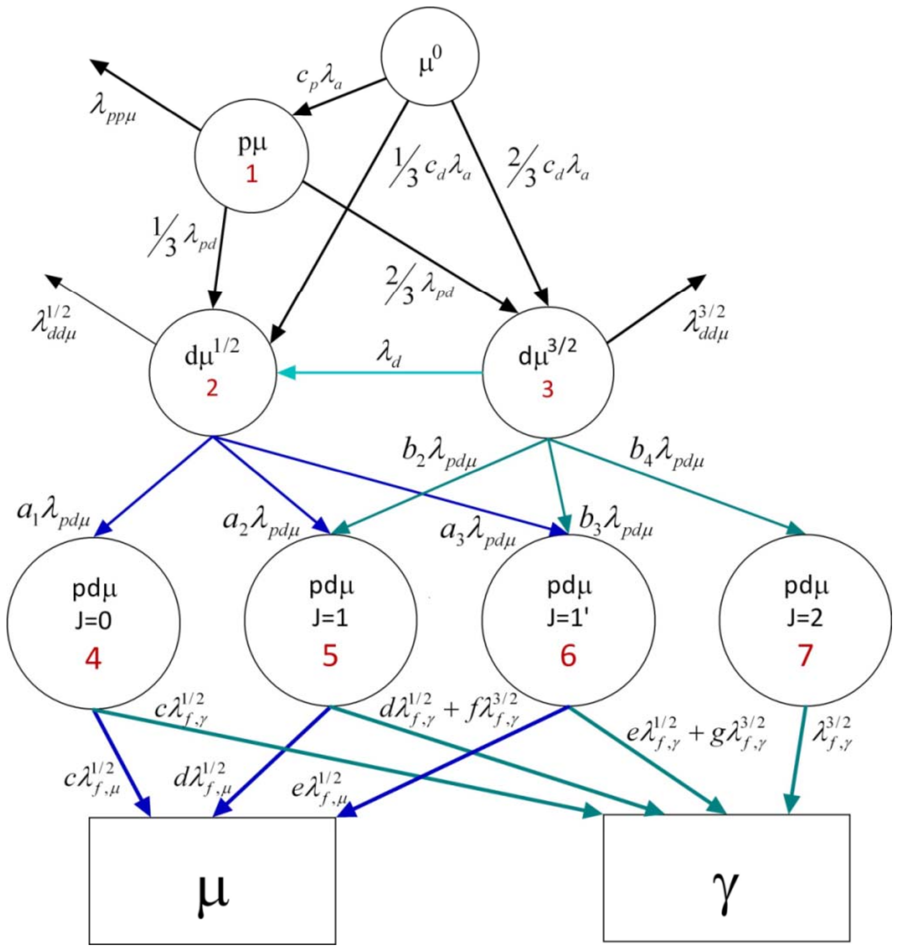






F. Mulhauser et al.,"Ramsauer-Townsend effect in muonic atom scattering", Phys. Rev. A73(2006)034501

Fusion in pdμ



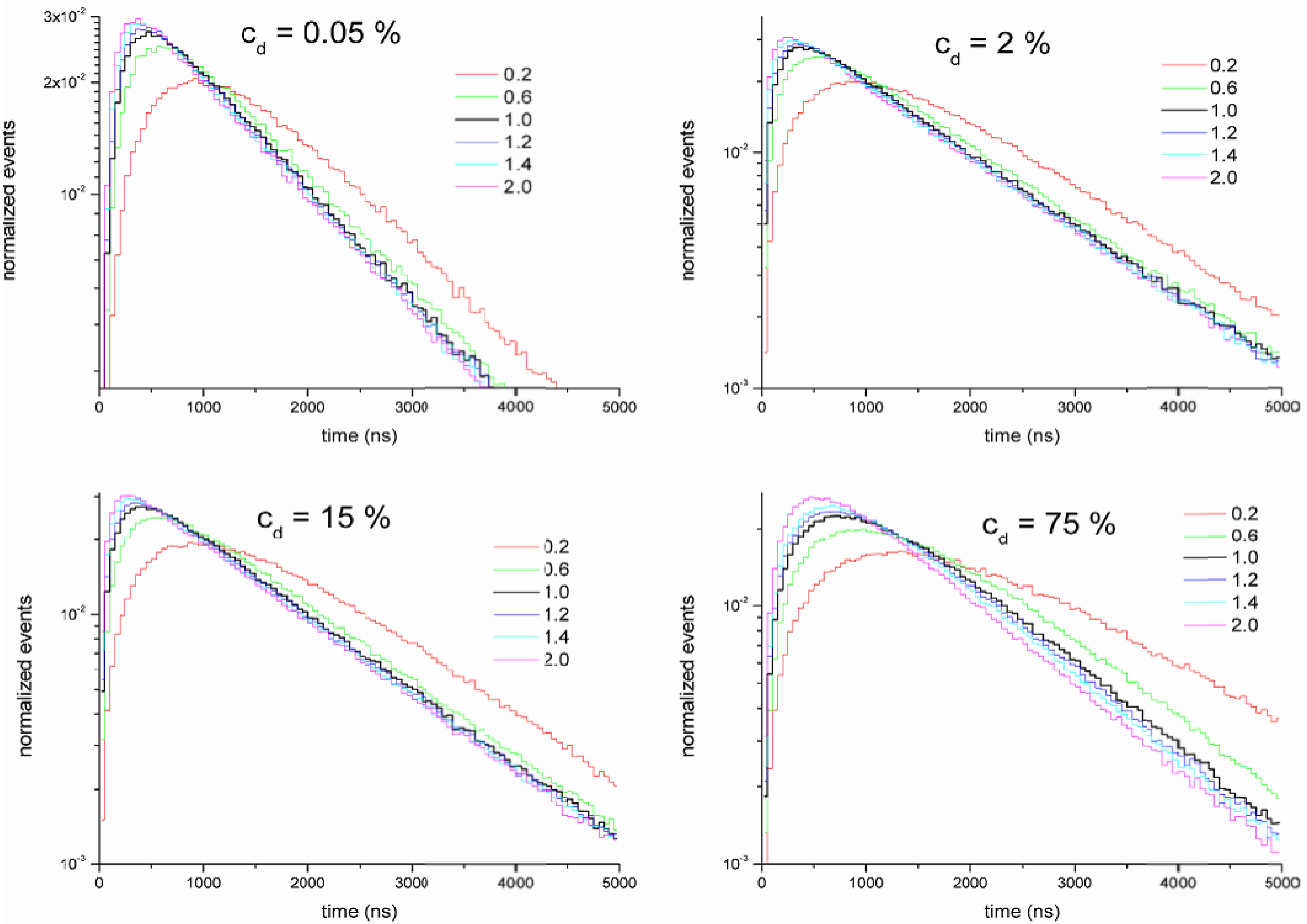
Most rates are function of energy,
In some transition energy is released (or absorbed)

MC output:

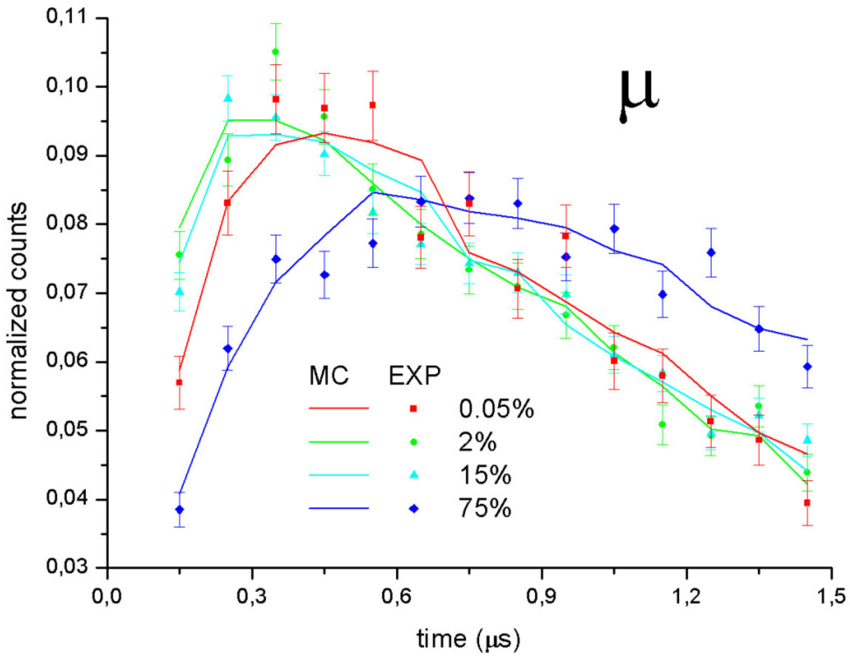
- muon (μ) and gamma (γ) spectra
- pdμ formation in J-state
- pμ and dμ escape

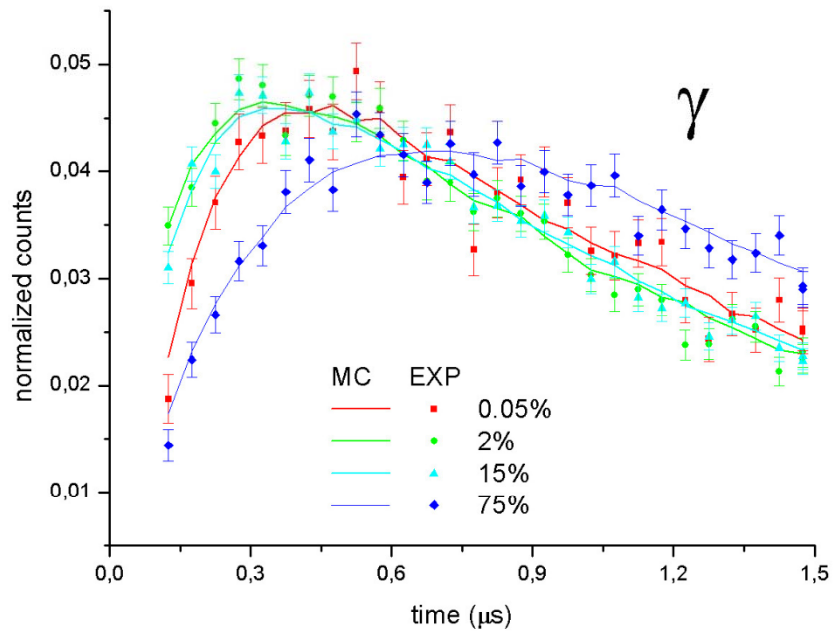
M. Filipowicz et al.,"Kinetics of muon catalyzed fusion in solid H/D mixture", European Physical J. D (2008)
DOI: 10.1140/epjd/e2008-00021-7

Grid of gamma spectra



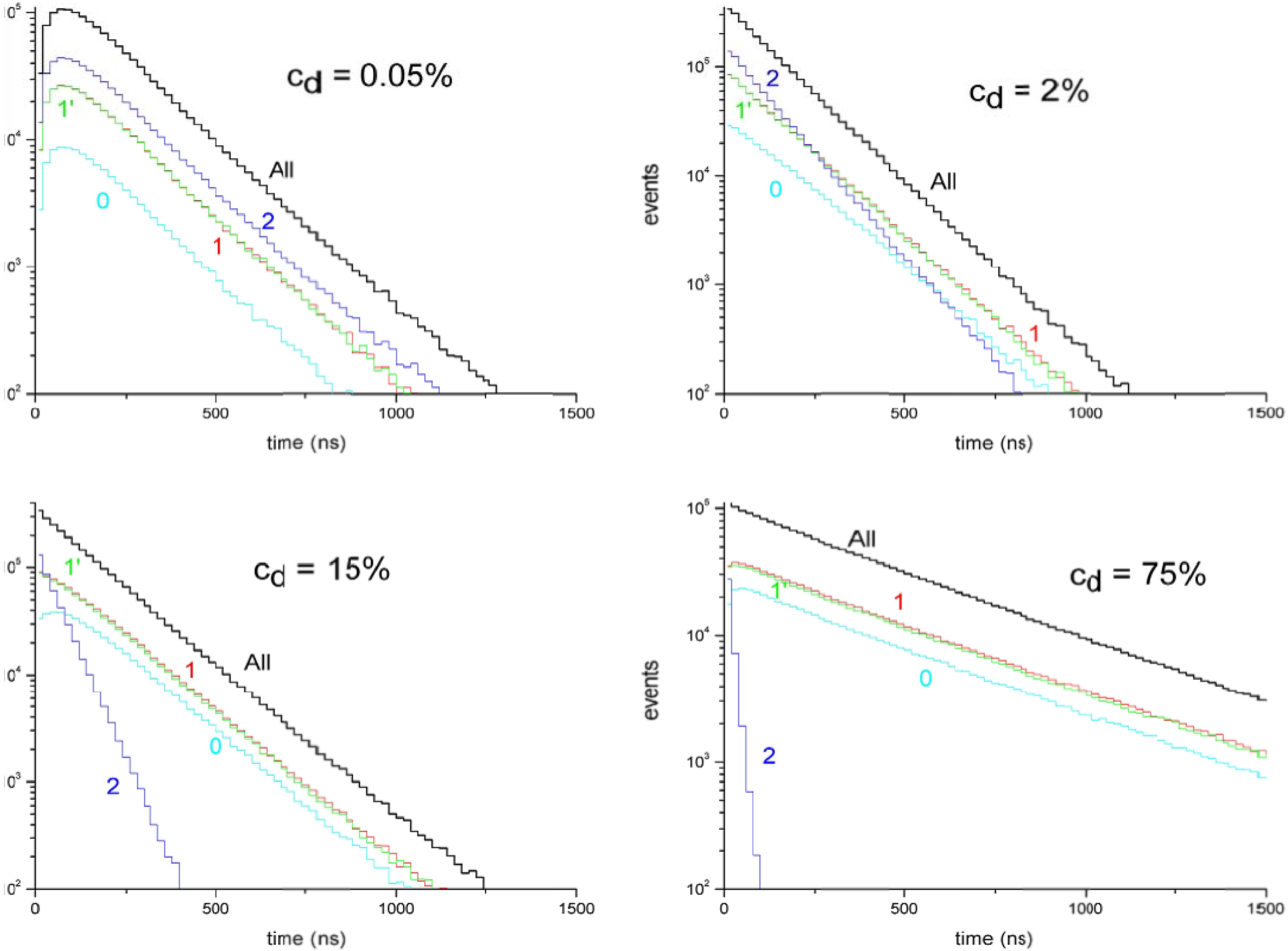
The fits results





The best fit is for scale parameter equal 1.19, it corresponds to pdμ formation rate: 6.7 10^6 s^{-1}

Simulated time distribution of the monemt of pdμ formation for J– states Q^J functions



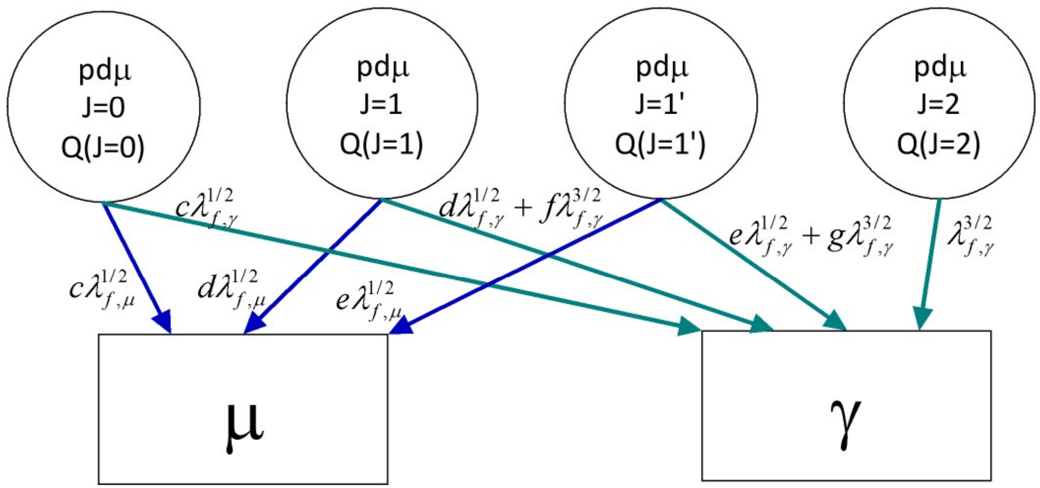
Determination of nuclear fusion rates

$$\frac{dN^{J=0}}{dt} = -\left(\lambda_0 + c\lambda_f^{1/2}\right)N^{J=0} + Q^{J=0}$$

$$\frac{dN^{J=1}}{dt} = -\left(\lambda_0 + d\lambda_f^{1/2} + f\lambda_{f,\gamma}^{3/2}\right)N^{J=1} + Q^{J=1}$$

$$\frac{dN^{J=1}}{dt} = -\left(\lambda_0 + e\lambda_f^{1/2} + g\lambda_{f,\gamma}^{3/2}\right)N^{J=1'} + Q^{J=1'}$$

$$\frac{dN^{J=2}}{dt} = -\left(\lambda_0 + \lambda_{f,\gamma}^{3/2}\right)N^{J=2} + Q^{J=2}$$



$$\frac{dN_\mu}{dt} = \lambda_{f,\mu}^{1/2} \cdot \left(cN_{pd\mu}^{J=0} + dN_{pd\mu}^{J=1} + eN_{pd\mu}^{J=1'}\right)$$

$$\frac{dN_\gamma}{dt} = \lambda_{f,\gamma}^{1/2} \cdot \left(cN_{pd\mu}^{J=0} + dN_{pd\mu}^{J=1} + eN_{pd\mu}^{J=1'}\right) + \lambda_{f,\gamma}^{3/2} \cdot \left(fN_{pd\mu}^{J=1} + gN_{pd\mu}^{J=1'} + eN_{pd\mu}^{J=2}\right)$$

The following rates were obtained:

$$\lambda_f^{1/2} = (0.42 \pm 0.01) \cdot 10^6\, s^{-1}$$

$$\lambda_{f,\mu}^{1/2} = (0.12 \pm 0.02) \cdot 10^6\, s^{-1}$$

$$\lambda_{f,\gamma}^{1/2} = (0.30 \pm 0.02) \cdot 10^6\, s^{-1}$$

$$\lambda_{f,\gamma}^{3/2} = (0.09 \pm 0.02) \cdot 10^6\, s^{-1}$$