Lifetime measurements by Doppler methods with the RoSphere array

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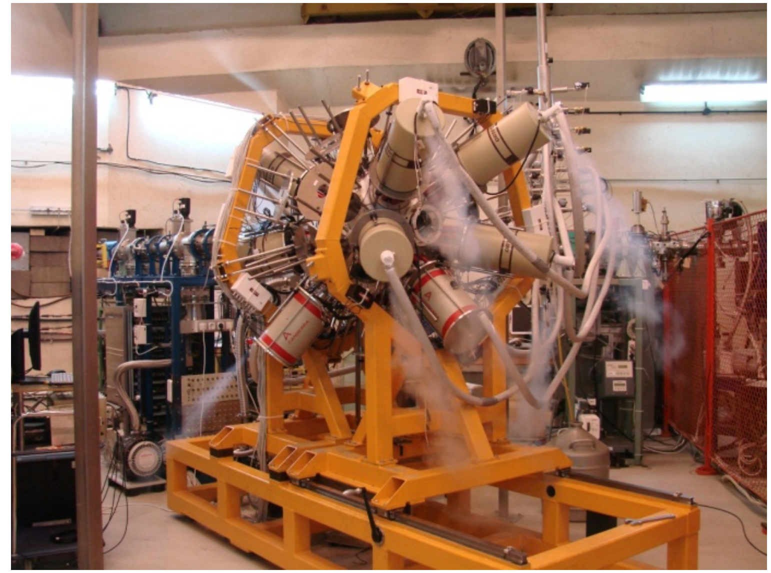
The Bucharest 9 MV FN TANDEM Accelerator

Upgraded to PELLETRON charging system
Nanosecond pulsing system
Delivers p, ^{4}He, ^{6,7}Li, ^{9}Be, ^{10}B, ^{12,13}C, ^{16,18}O, ^{19}F, etc

Lifetime measurements by:
- *In-beam fast timing (FT)*
- *Recoil distance Doppler shift (RDDS)*
- *Doppler shift attenuation method (DSAM)*

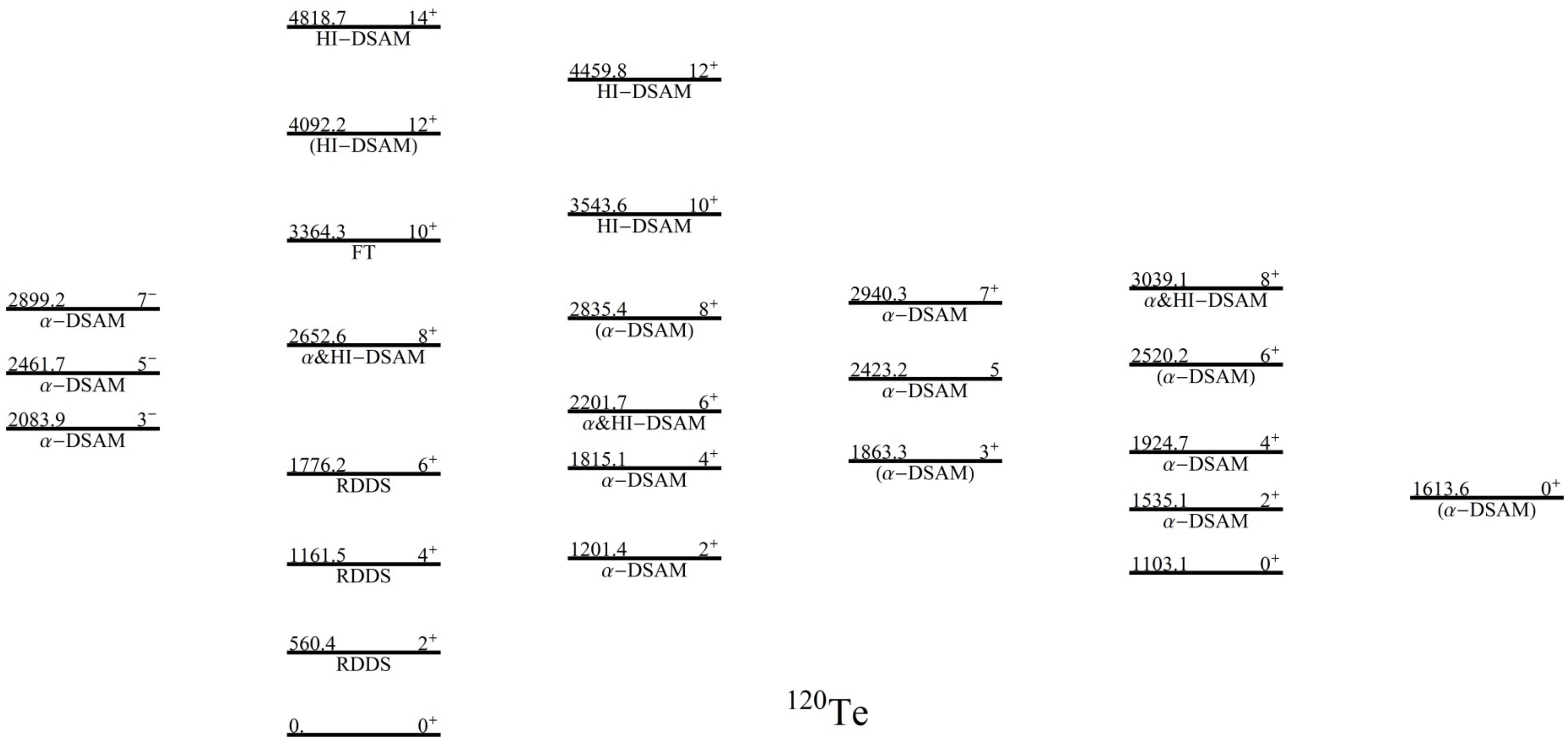
ROSPHERE



ROmanian array for γ-SPectroscopy in HEavy ion REactions
25 positions sphere on 5 rings (37° ,70°, 90°, 110°, 143°) x 5 positions
2 configurations envisaged:
- *Mixed array with 15 50% HPGe detectors with BGO shields and 10-20 $LaBr_3$(Ce) scintillators*
- *25 HPGe detectors array*

Quasi-complete lifetime measurements

The ^{120}Te nucleus

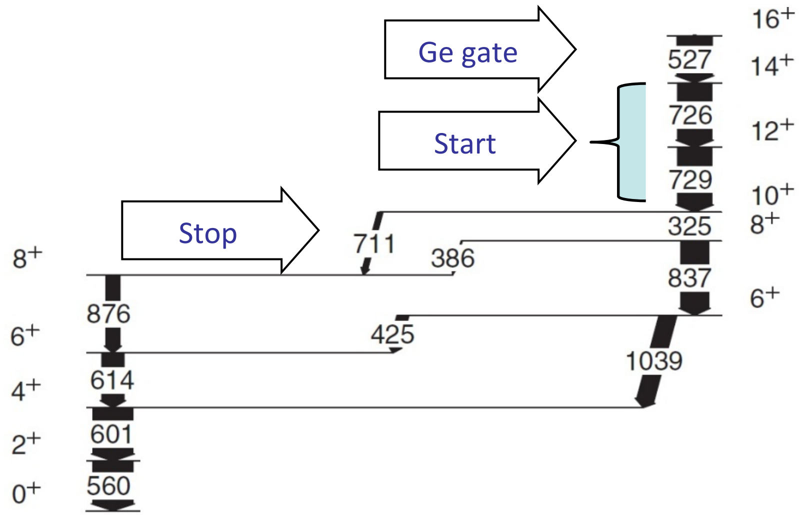


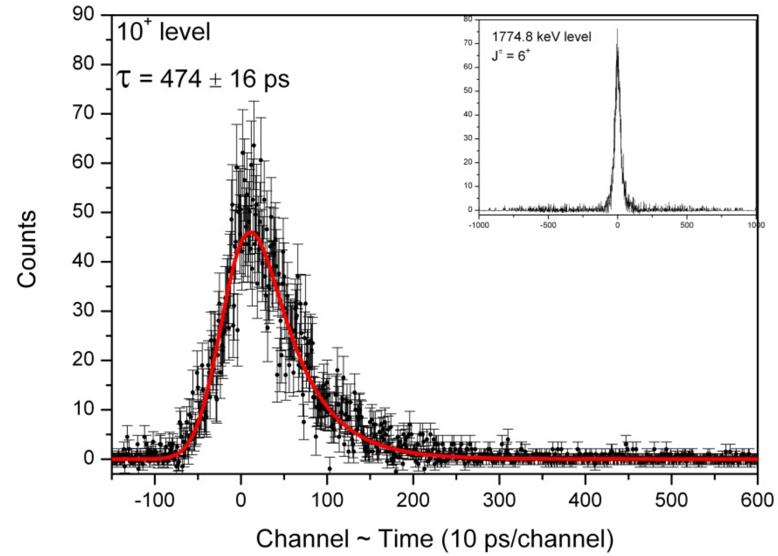
Quasi-complete lifetime measurements by a combination of methods and reactions:

- RDDS and in-beam FT in the ^{110}Pd(^{13}C,3n) ^{120}Te reaction
- DSAM in the ^{117}Sn(α,n)^{120}Te and ^{110}Pd(^{13}C,3n) ^{120}Te reactions

In-beam Fast-timing lifetime measurements

Lifetime of the 10^{+} yrast level in ^{120}Te





$^{110}Pd(^{13}C,3n)\,^{120}Te$ @50 MeV

6.5 mg/cm^2 ^{110}Pd

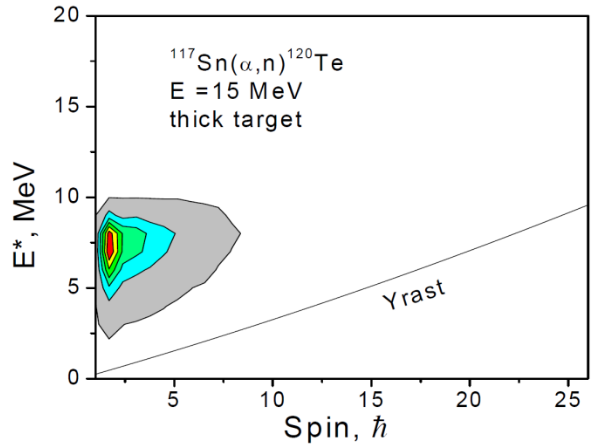
14 HPGe detectors

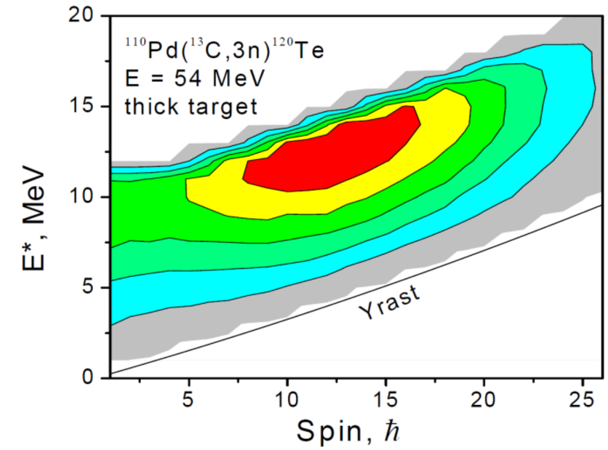
11 $LaBr_3$ scintilators

C. R. Nita, PhD thesis

DSAM lifetime measurements in (α,n) reactions

Goal: lifetime measurements for non-yrast states in Te isotopes





Advantages:

- clean spectra and large cross-sections
- non-yrast states are reasonably well populated
- low contribution from cascade feeding

Difficulties:

- low recoil velocity v/c~0.3%
- nuclear stopping power becomes important, resulting in short stopping time
- short cascades, feeding should be parameterized

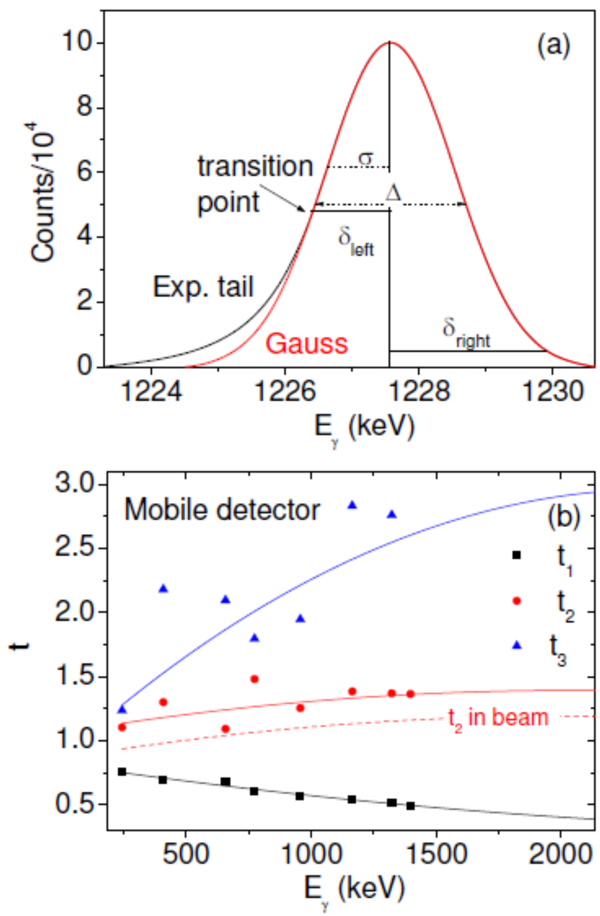
Ingredients for DSAM analysis

- Instrumental response function
- Stopping power
- Side-feeding model

Lineshape analysis by Monte Carlo codes :

- COMPA statistical model reaction code,
- GAMMA simulates the slowing-down process and population of discrete states
- SHAPE χ^2 analysis of experimental and simulated lineshapes

E. Grodner, A.A. Pasternak et al. Eur. Phys J. A27 (2006) 325



Obtained using ^{152}Eu and ^{60}Co gamma sources

Side-feeding model

The population of discrete levels from the entry point proceeds mainly through fast E1 transitions

$$f_{E1} = 8.7 \cdot 10^{-8} \sigma_0 E_\gamma^2 \Gamma_0^2 / [(E_\gamma^2 - E_0^2)^2 + E_\gamma^2 \Gamma_0^2]$$

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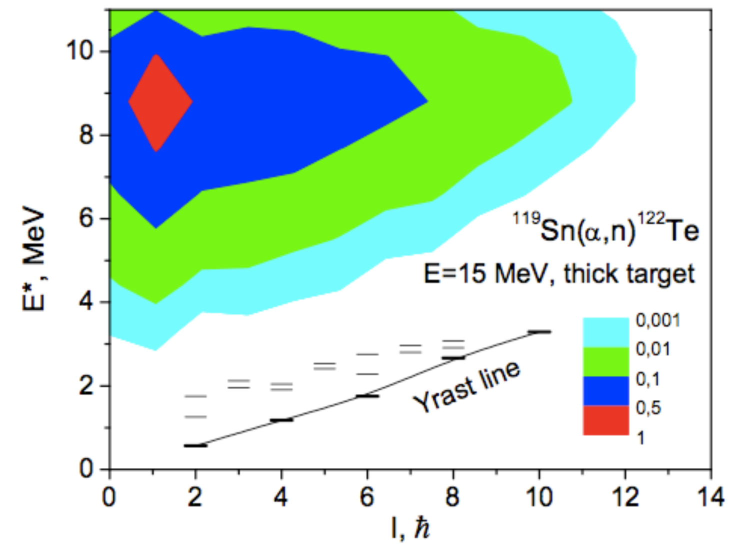
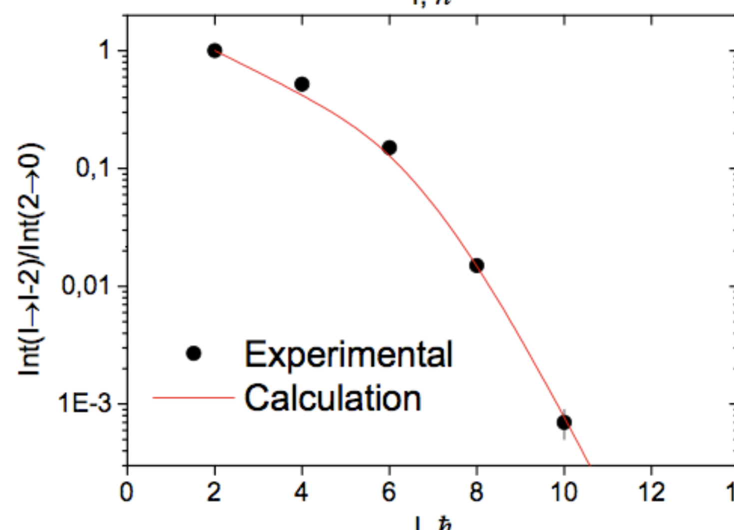
SF model parameters deduced from direct comparison of lifetimes measured in the ^{119}Sn(α,n)^{122}Te with values obtained in the ^{122}Te(n,n')^{122}Te (S.F. Hicks et al, Phys. Rev. C71, 034307, (2005))



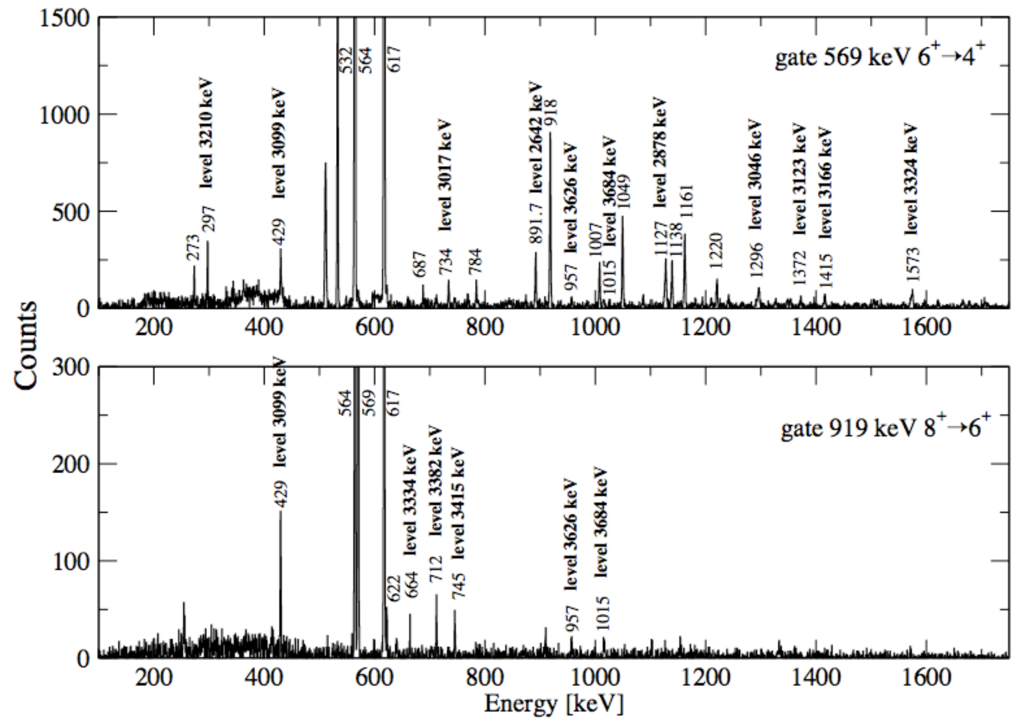


Population of the yrast cascade

^{122}*Te experiment: validation of the SF model parameters*

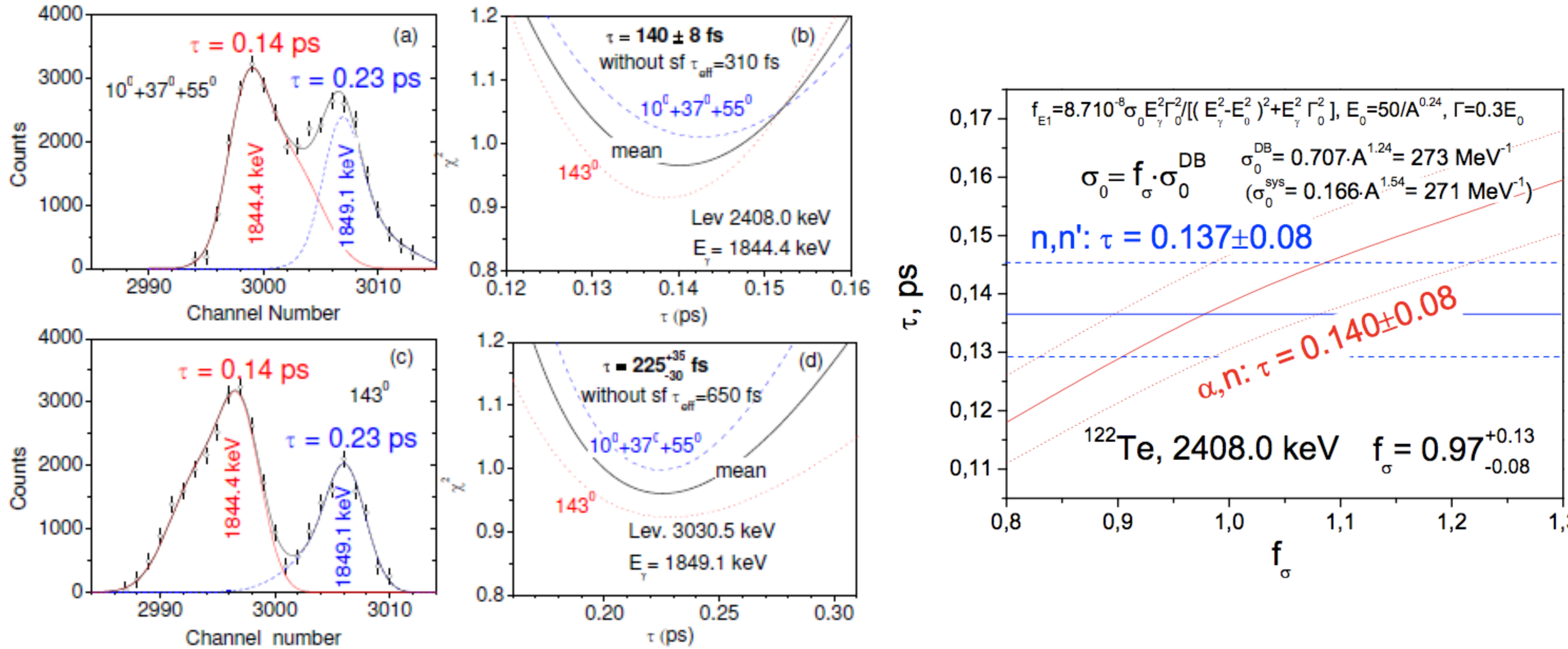
^{119}Sn(α,n)^{122}Te E_{α} = 15 MeV

- 7 lifetimes measured in (α,n) compared with (n,n') data
- 11 new lifetimes measured or revised
- 25 new levels placed in the level scheme
- Side feeding model confirmed



C. Mihai, A.A. Pasternak et al,
Phys. Rev. C 81 034314(2010)

^{122}Te experiment: validation of the SF model parameters

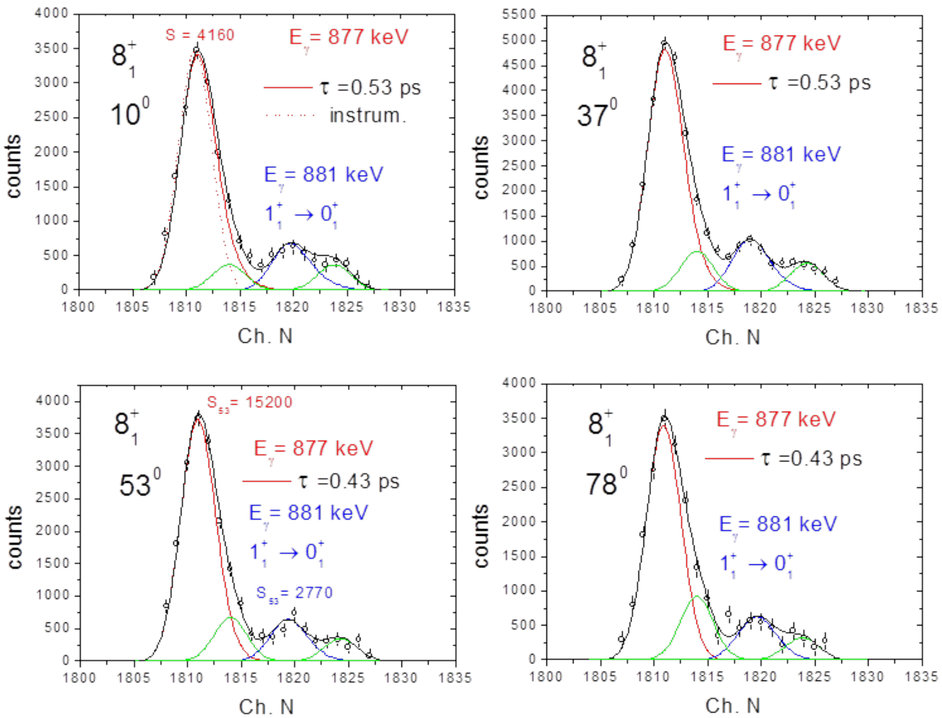


Comparison between lifetimes measured in (α,n) with (n,n') data

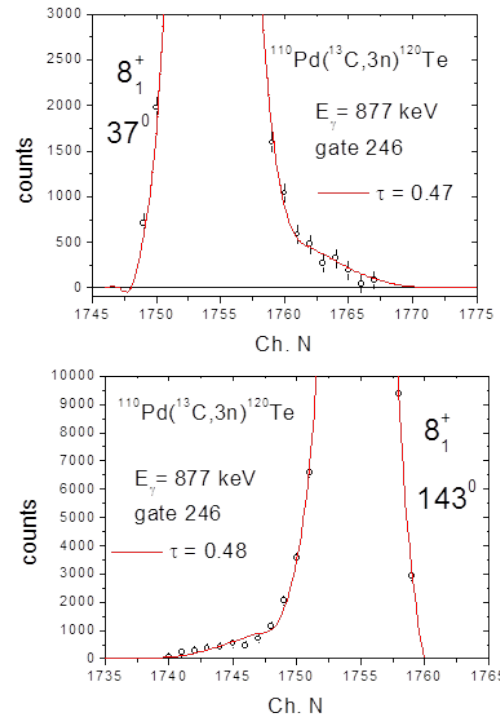
^{120}*Te experiment*

Same parameters for the SF model

α-DSAM



HI-DSAM

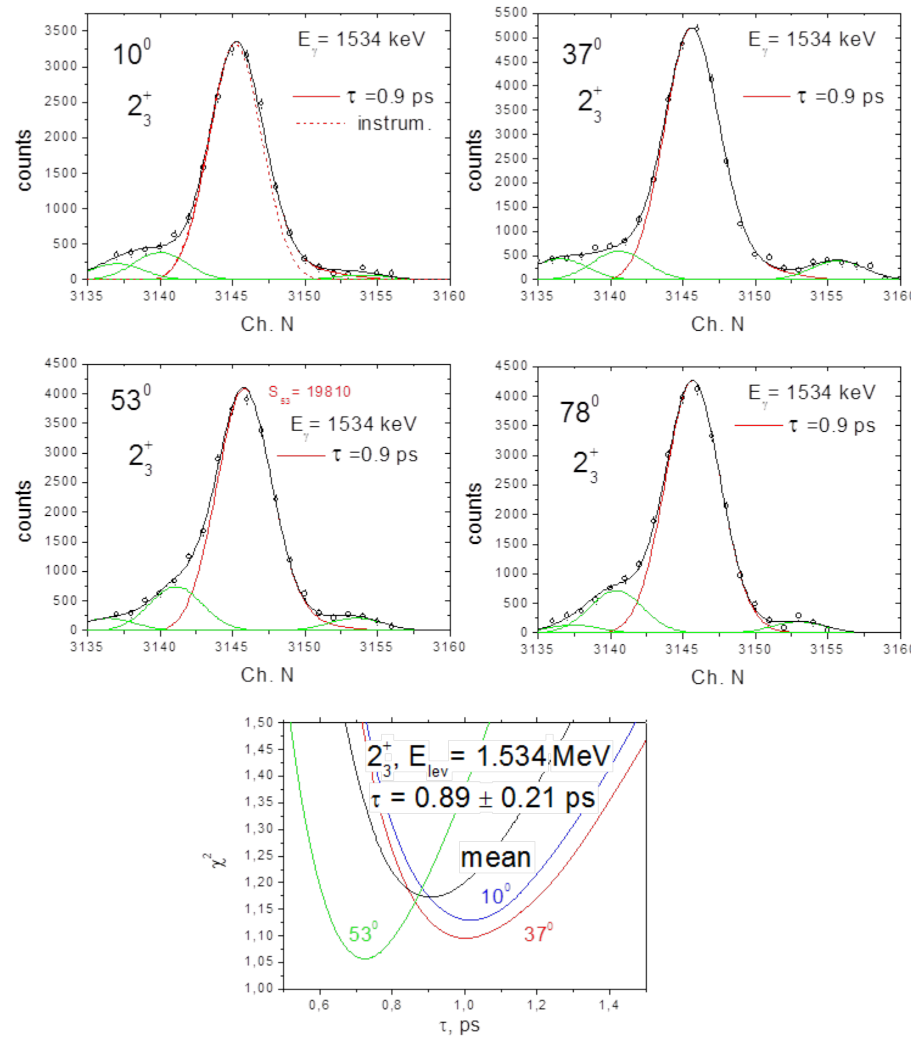


Adopted value $\tau = 0.46(8)$

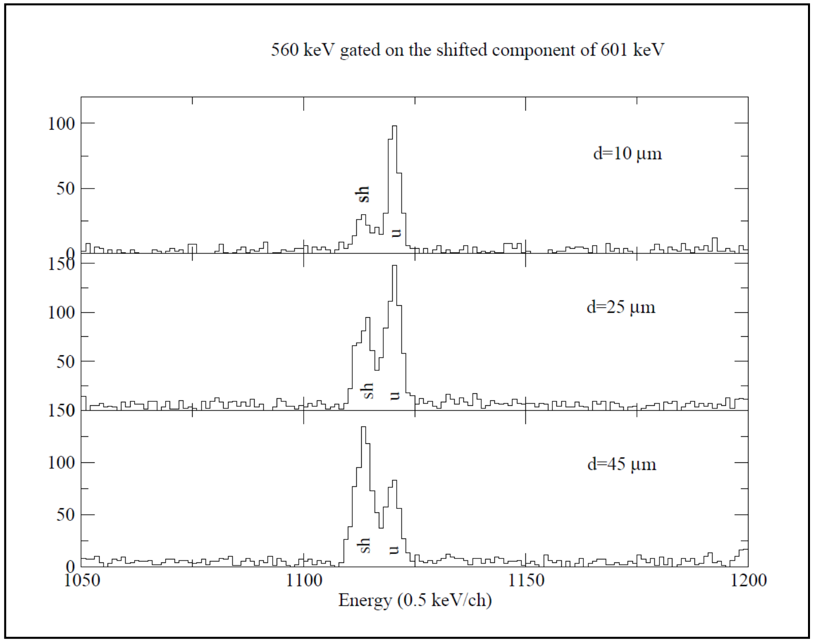
^{120}Te experiment

Results

- *32 lifetimes measured*
- *24 new levels placed in the level scheme*



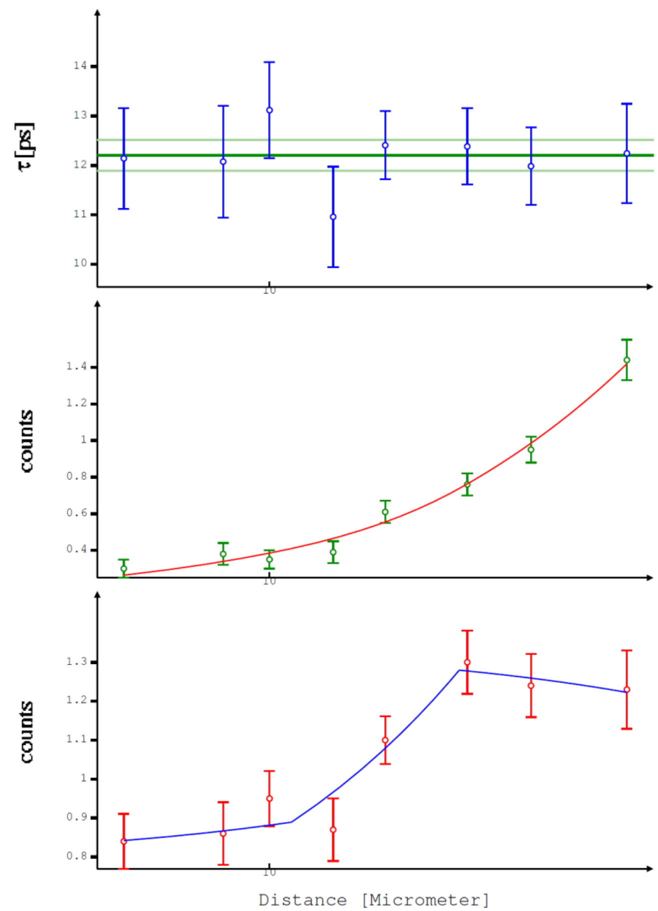
RDDS lifetime measurements in ^{120}Te



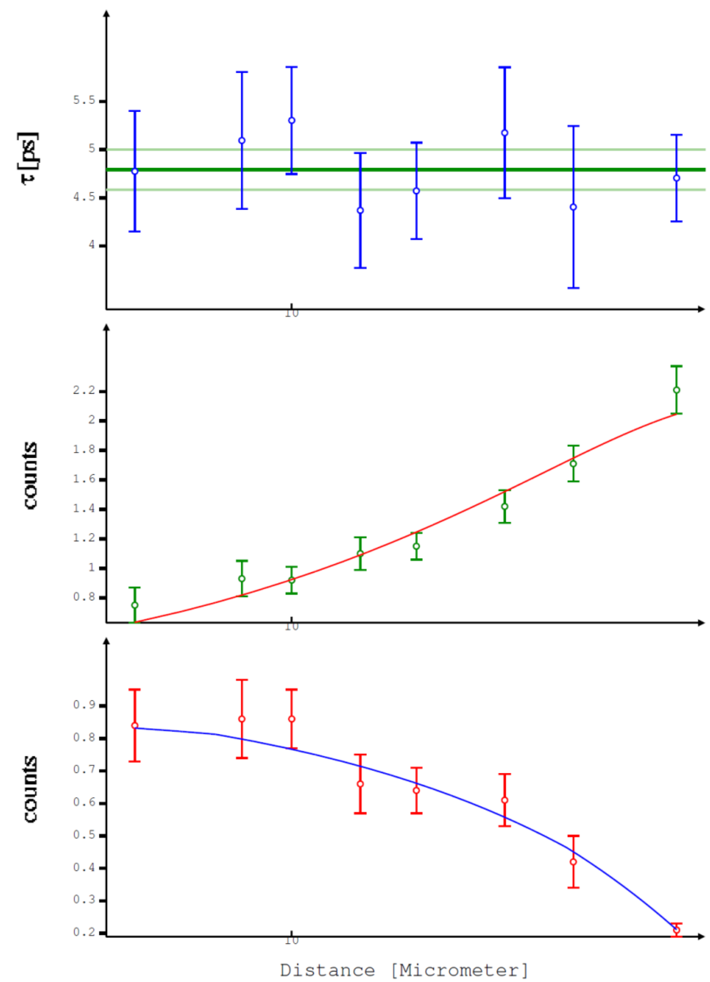
$^{110}Pd(^{13}C,3n)$ ^{120}Te @50 MeV
0.7 mg/cm^{2} ^{110}Pd self-supported
Koln-Bucharest plunger device
12 HPGe detectors mounted:
5 @ 37° + 5 @ 143°
1 @ 70° + 1 @ 110°

DDCM analisys : Very preliminary results

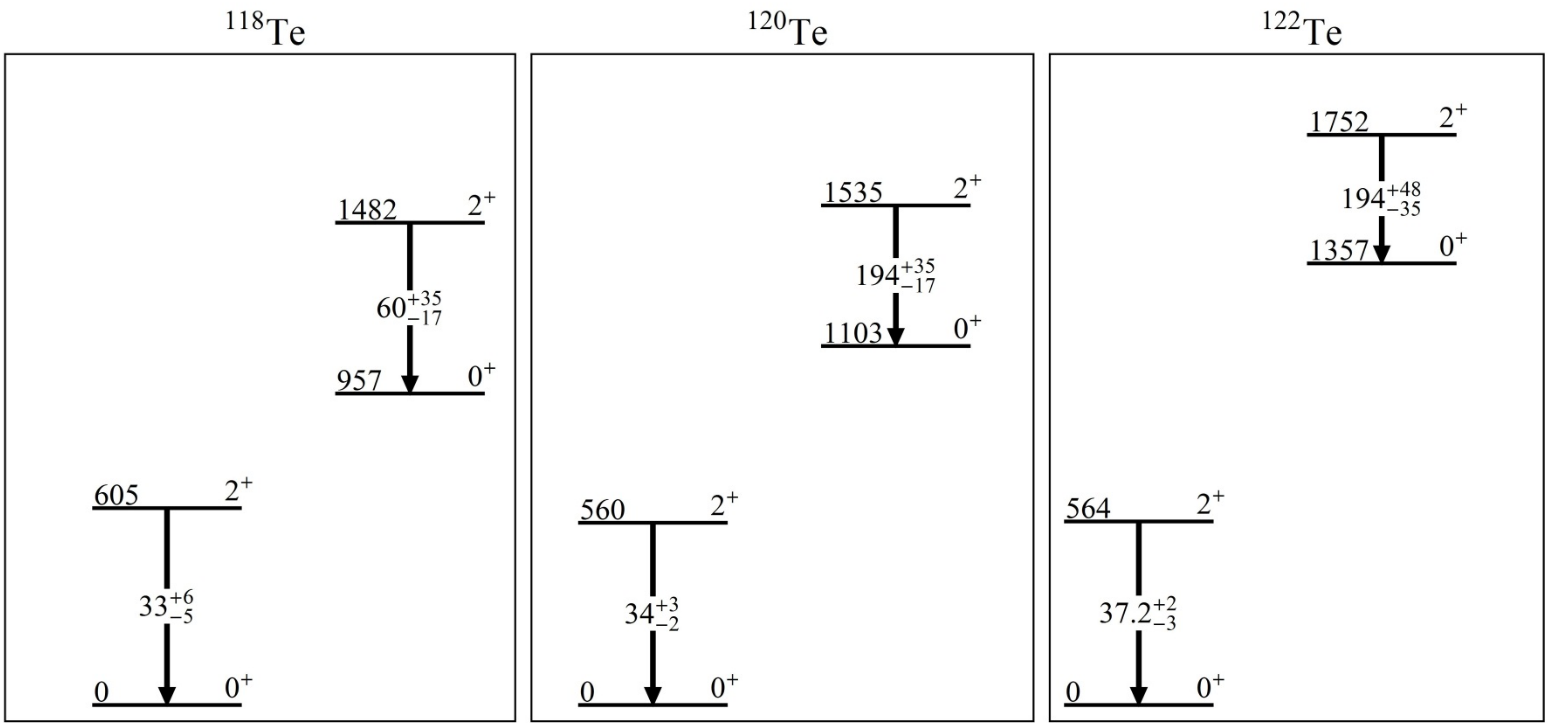
2^+ 560 keV τ=12.2(4)



4^+ 1161 keV τ=4.8(4)



Intruder states in even-even Te



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A.A. Pasternak[2], C. R. Nita[1], D. Bucurescu[1], G. Cata-Danil[1,3], I. Cata-Danil[1], R.B. Cakirli[4,5], D. Deleanu[1], D. Filipescu[1], D.G. Ghita[1], I. Gheorghe[1], T. Glodariu[1], M. Ivascu[1], L. Kucuk[5], R. Lica[1], N. Marginean[1], R. Marginean[1], A. Negret[1], S. Pascu[1], T. Sava[1], L. Stroe[1] , G. Suliman[1] , R. Suvaiala[1], S. Toma[1], and N.V. Zamfir[1]

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Thank you for your attention