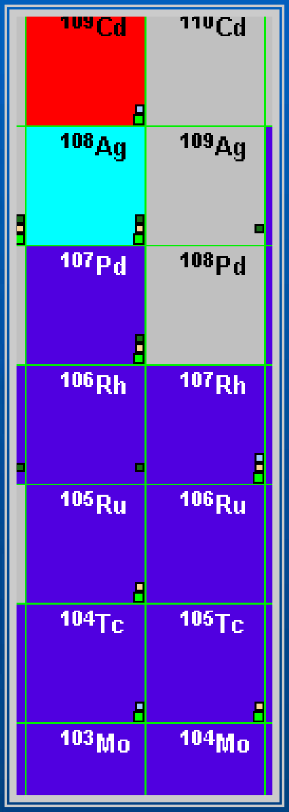
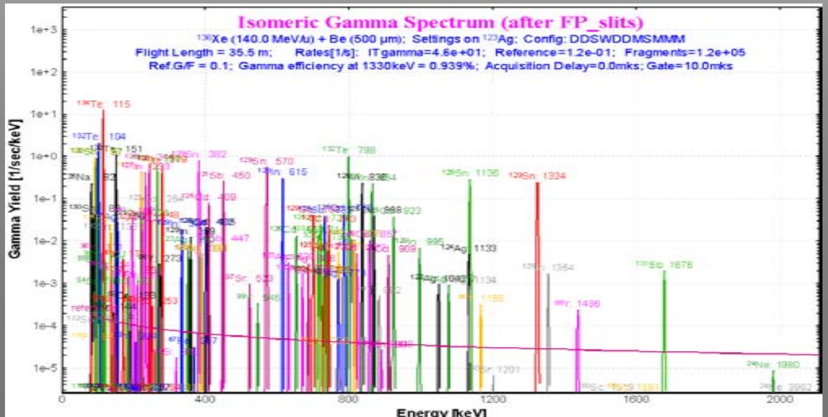
Isomers in LISE++



* Introduction
* GANIL isomer database in LISE++
* LISE internal isomer database
* γ-detector efficiency
* Rate calculation of isomer γ–rays
* Isomeric γ-spectrum
* Identification 2D-plot in coincidence with γ–rays

Version 7.6.39 from 01/16/06 available through LISE sites

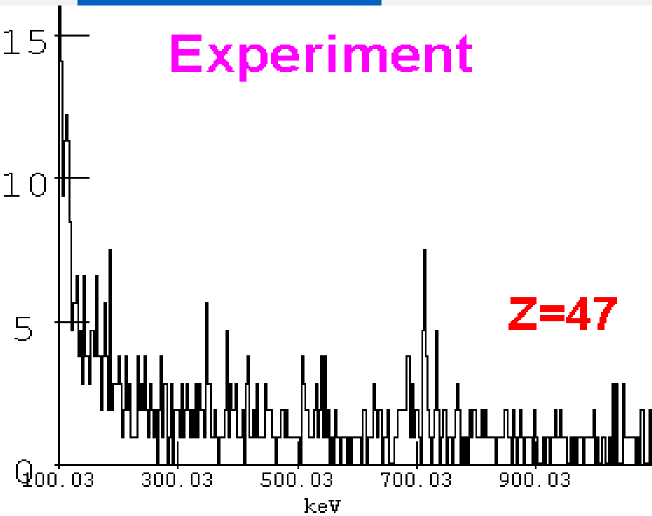


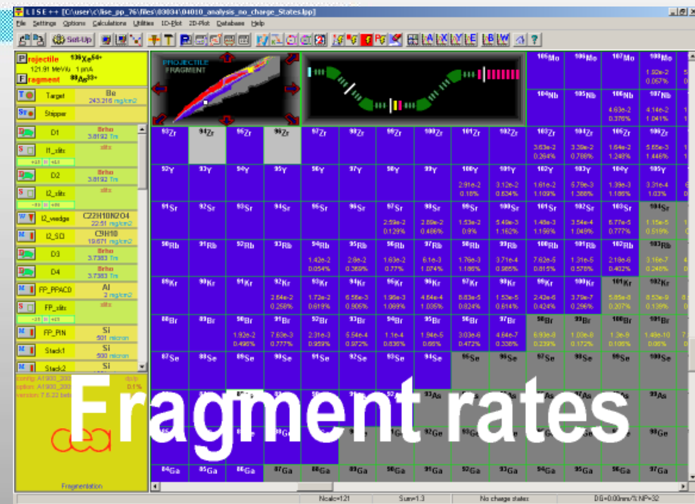
LISE++

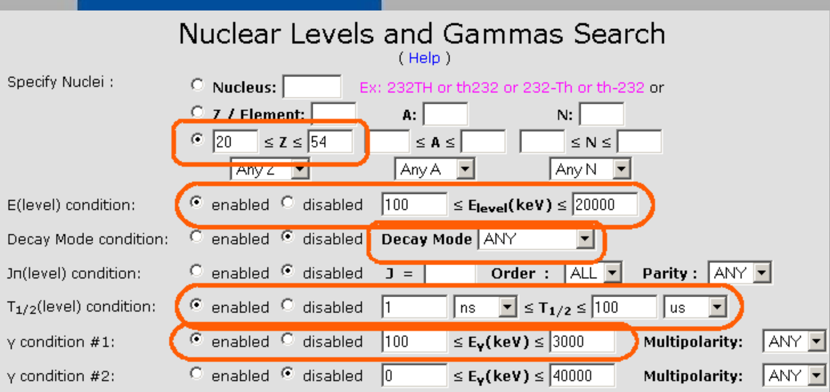
from 12/16/2005

Fragment identification using isomeric γ-rays

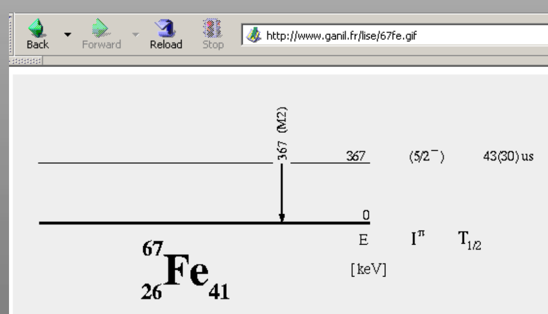
How do we work now?







Internet database (NNDC)
region of stable isotopes



Old GANIL database
available through LISE

Experiment	Isomer	Ex. Energy (keV)	γ-energies (keV)	Half-life (μs)
03034	59Cr	503	193	96
"	64Mn	135	?	>100
"	65Fe	364	?	0.430
"	67Fe	367	?	64
"	66Co	175	?	1.21
"	66Co	648	?	>100
"	69Ni	2701	148	0.439
"	70Ni	2860	183	0.232
"	72Cu	270	?	1.76
"	78Zn	2673	?	0.319
"	88Br*	273	111; 159	5.4
"	93Rb*	254	254 and 266 from 2ns level	57
"	97Sr*	308	141; 167	0.170
"	97Sr*	830	523	0.255
"	98Y*	171	50; 171	0.62
"	98Y*	496	50; 121; 170; 204	7.6
"	98Y*	1181	111; 119; 130; 158; 186; 476; 596	0.83
"	99Y*	2141	28; 126; 159; 198; 223; 245; 269; 273; 283; 546; 882; 1166; 1435; 1529	8.6
"	107Mo	66	66	0.470
"	117Ru	?	184	> 5
"	121Pd	?	136	0.694
"	123Ag	?	349; 384; 391; 630; 386; 714; 733; 769; 1049; 1077; 1133	0.214
"	124Ag	?	156; 1132	1.9
"	125Ag	?	670; 684; 715; 729	0.310
"	125Cd	?	409; 720; 743; 786; 868; 922	> 5
"	126Cd	?	220; 248; 402; 405; 652; 807; 815; 856	0.270
"	127Cd	?	739; 771; 821; 909	1.9
"	129In	?	334; 359	2.9
05028	117Ru	?	184	> 5
"	121Pd*	?	136	0.694
"	123Ag*	?	349; 384; 391; 630; 386; 714; 733; 769; 1049; 1077; 1133	0.214
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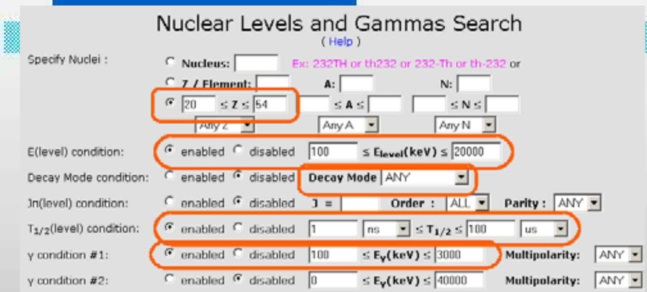
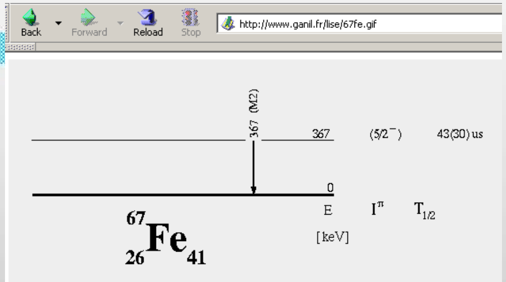
Private communications

from 12/16/2005

LISE isomer database



Internet database (NNDC)
region of stable isotopes



Old GANIL database
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Private communications

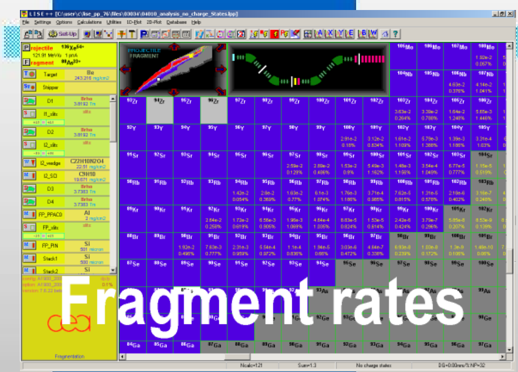
LISE++ database (dbf-format)

New experimental data

LISE++

from 12/16/2005

It will be nice to simulate…



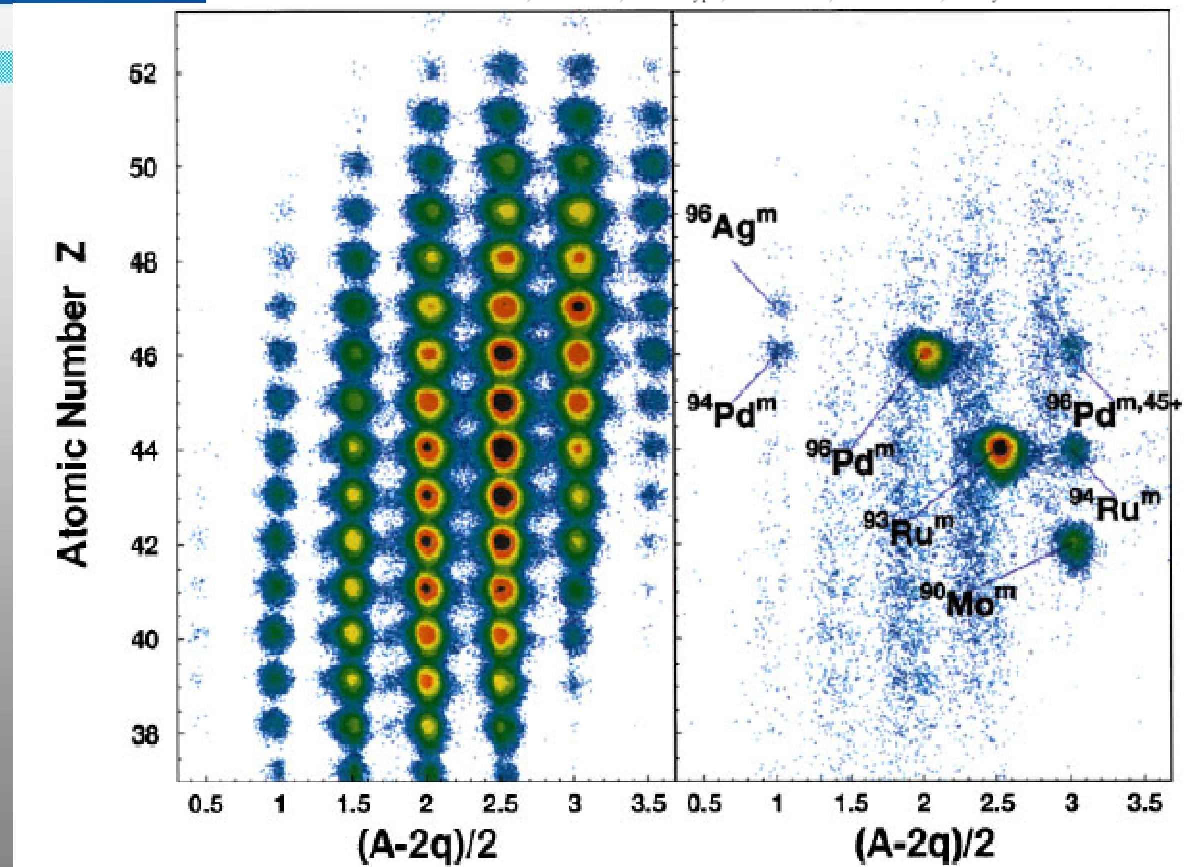
LISE++
γ–database

γ–registration settings

PHYSICAL REVIEW C VOLUME 55, NUMBER 3 MARCH 1997

New μs isomers in $T_z=1$ nuclei produced in the ^{112}Sn(63.4 MeV) + ^{nat}Ni reaction

R. Grzywacz,[1,2] R. Anne,[2] G. Auger,[2] C. Borcea,[3] J. M. Corre,[2] T. Dörfler,[4] A. Fomichov,[5] S. Grevy,[6] H. Grawe,[7] D. Guillemaud-Mueller,[6] M. Huyse,[8] Z. Janas,[7] H. Keller,[7] M. Lewitowicz,[2] S. Lukyanov,[5,2] A. C. Mueller,[6] N. Orr,[9] A. Ostrowski,[2] Yu. Penionzhkevich,[5] A. Piechaczek,[8] F. Pougheon,[6] K. Rykaczewski,[1,10] M.G. Saint-Laurent,[2] W. D. Schmidt-Ott,[4] O. Sorlin,[6] J. Szerypo,[1] O. Tarasov,[5,2] J. Wauters,[8] J. Żylicz[1]



Color identification plot of all nuclei observed (left panel) and those in correlation with gamma radiation (right panel). The (A-2q)/2 variable is equal to the T_Z of the nucleus for fully stripped ion (q=Z). A symbol " ^{96m}Pd^{45+}" denotes ^{96m}Pd nuclei transmitted and detected as a hydrogen like ions.

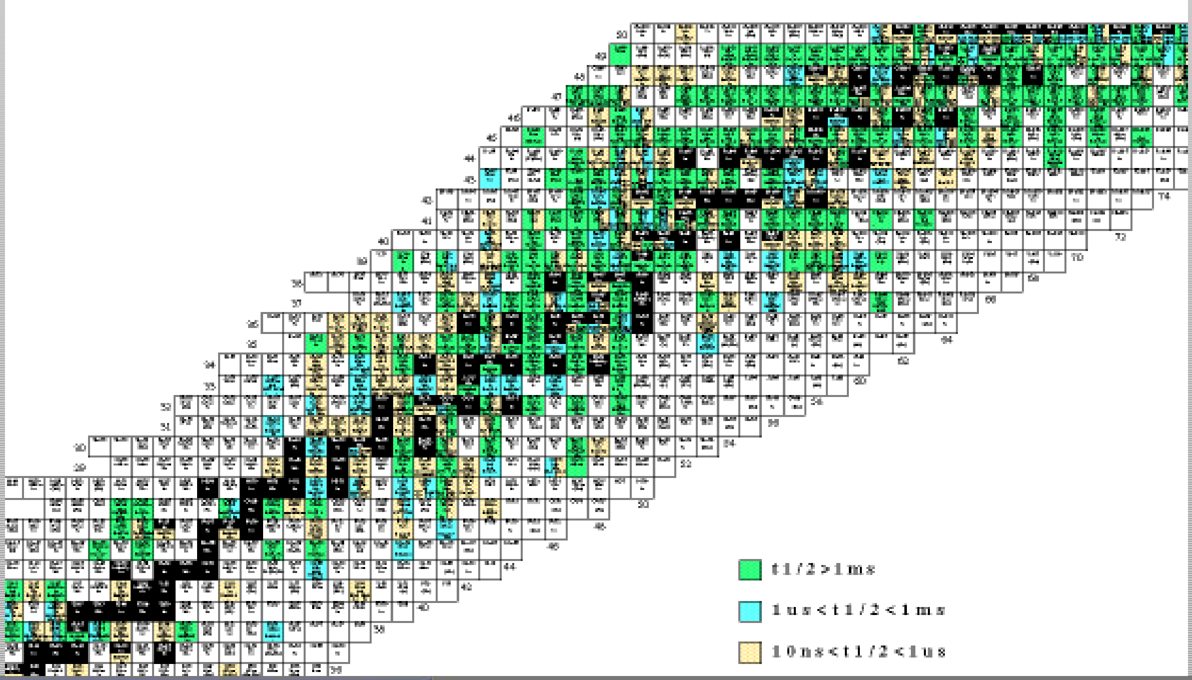
GANIL isomer database by J.M.Daugas

Nuclei from **Z=1 -50**. About 400 isomers.

GRAND ACCELERATEUR NATIONAL D'IONS LOURDS

Isomers which are referenced on this chart have a half-life greater than **10 ns**.
Three different codes of colors have been used in order to have information about the half-life of the isomeric states:

- for isomeric states with half life over 1 millisecond.
- for isomeric state with half life between 1 microsecond and 1 millisecond.
- for isomeric state with half life between 10 nanosecond and 1 microsecond.

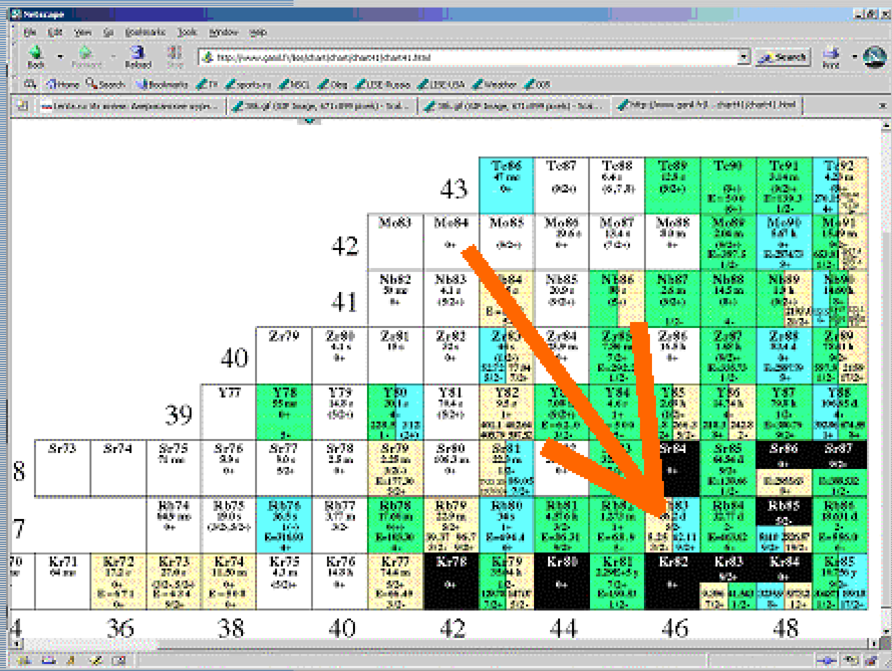


Isomer Database in Internet

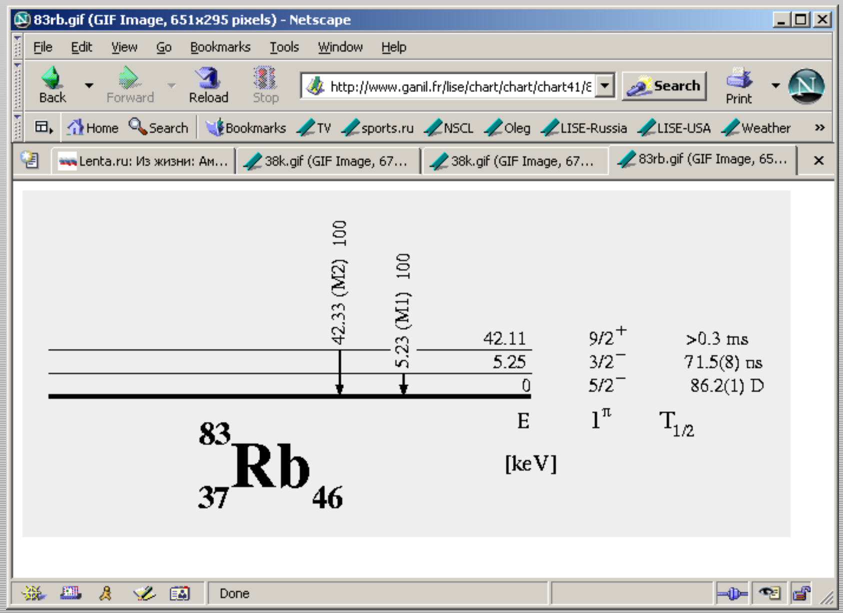
http://www.ganil.fr/lise/chart/

It is interactive!

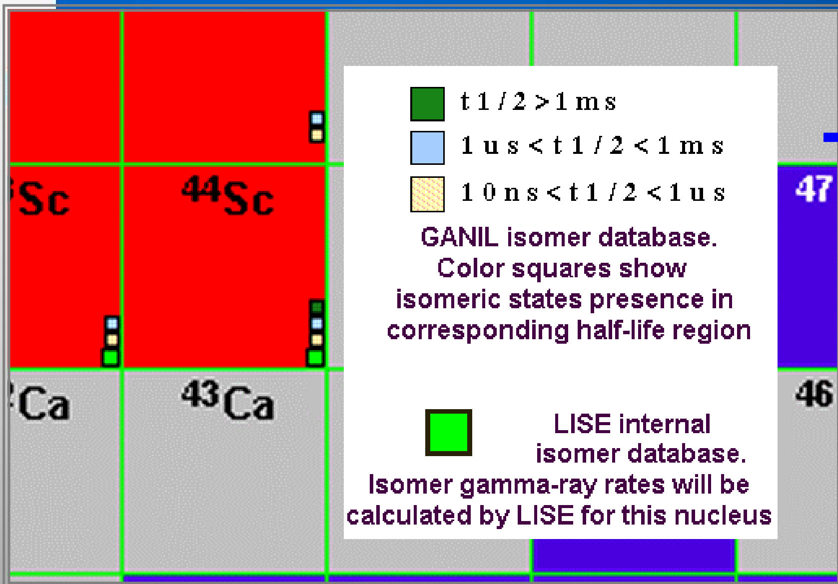
Click on the chart to have the level scheme of the request isomer

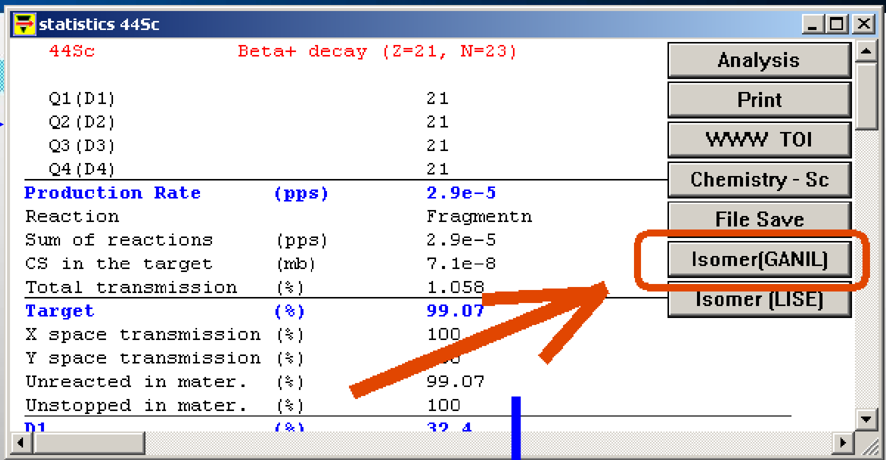


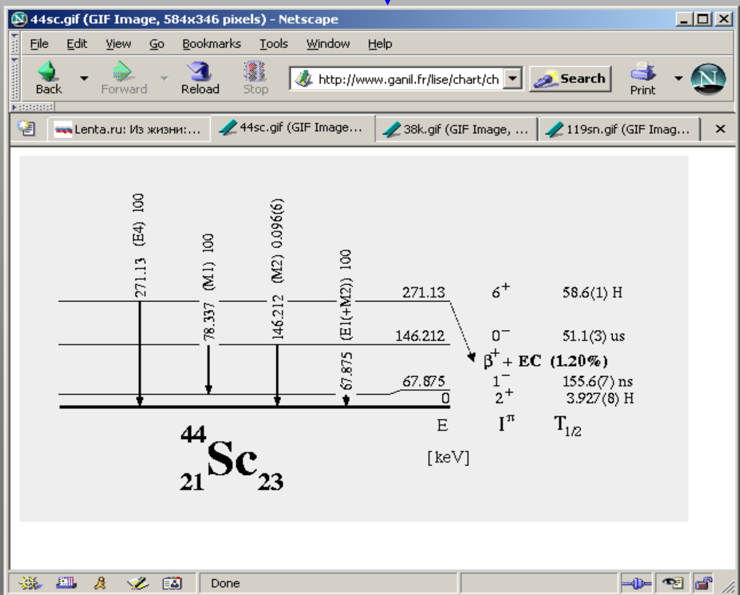
Unfortunately there are not data tables which could be transformed in a database.
Just level scheme pictures.



Using GANIL isomer database in LISE++







Information about the GANIL isomer database is kept in the **"bin/isomers.txt"** file. Fields are separated by comma. One Line per one nucleus. There are 3 fields to get a level scheme.

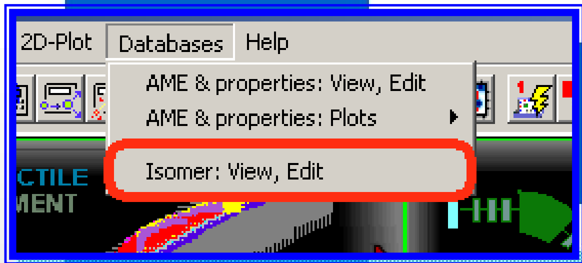
Example: **38cl, 21, 4**

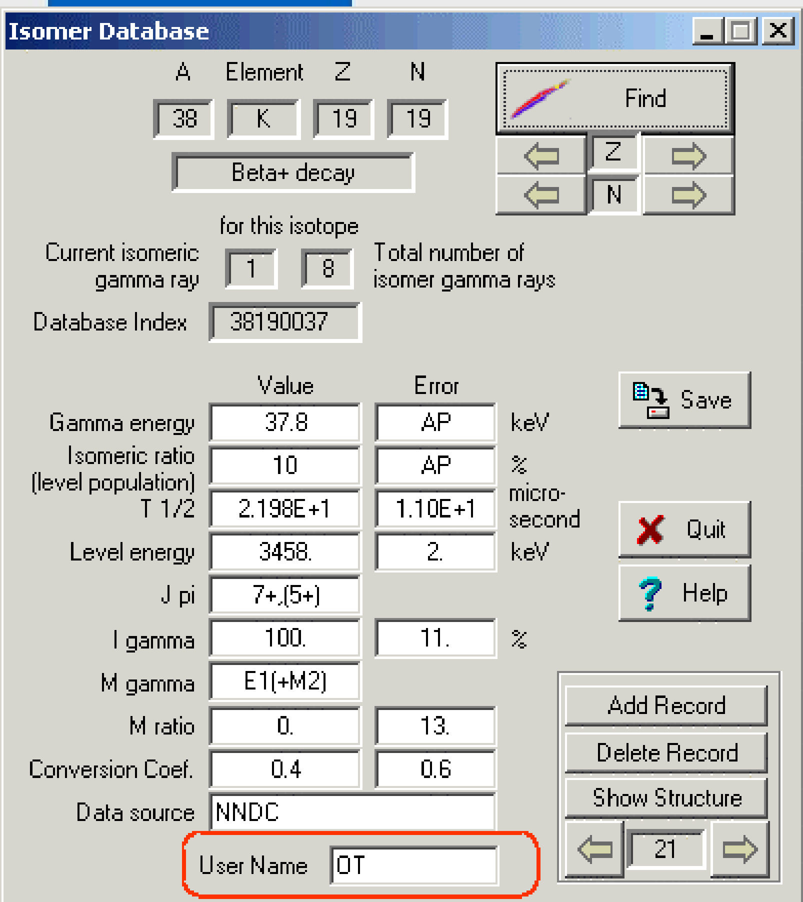
Web address: http://www.ganil.fr/lise/chart/chart/chart**21**/38cl.gif

First field: ^{A}El; Second field: Chart index (11-54)

Third field: half-life (4*Green + 2*Blue + 1*Yellow)

LISE++ isomer database





Obligatory fields

Z, A, E_γ

IT ratio, I_γ, $T_{1/2}$,

User Name

Selection from NNDC

- Z,A: no conditions
- $100 < E_{level}$ (keV) < 10000
- $100 < E_{gamma}$ (keV) < 4000
- 1 ns $< T_{1/2} < 100$ µs

NNDC	1752
Bryan Tomlin's thesis	44
Caamano, EPJA23 (2005) 201	40
GANIL JM-database	13
Daugas, PLB476(2000)213	4
Robisnon, PRC53(1996)1465	1
Grand Total (gamma-rays)	1854

LISE isomer database base (dBASE3 format) is kept initially in the “**bin/isomers.dbf**” file. All fields in “char” format.

Automatic record sorting in the database after “Add”, “Delete” and “Save” commands. Index is recalculated automatically basing on A,Z,E_γ.

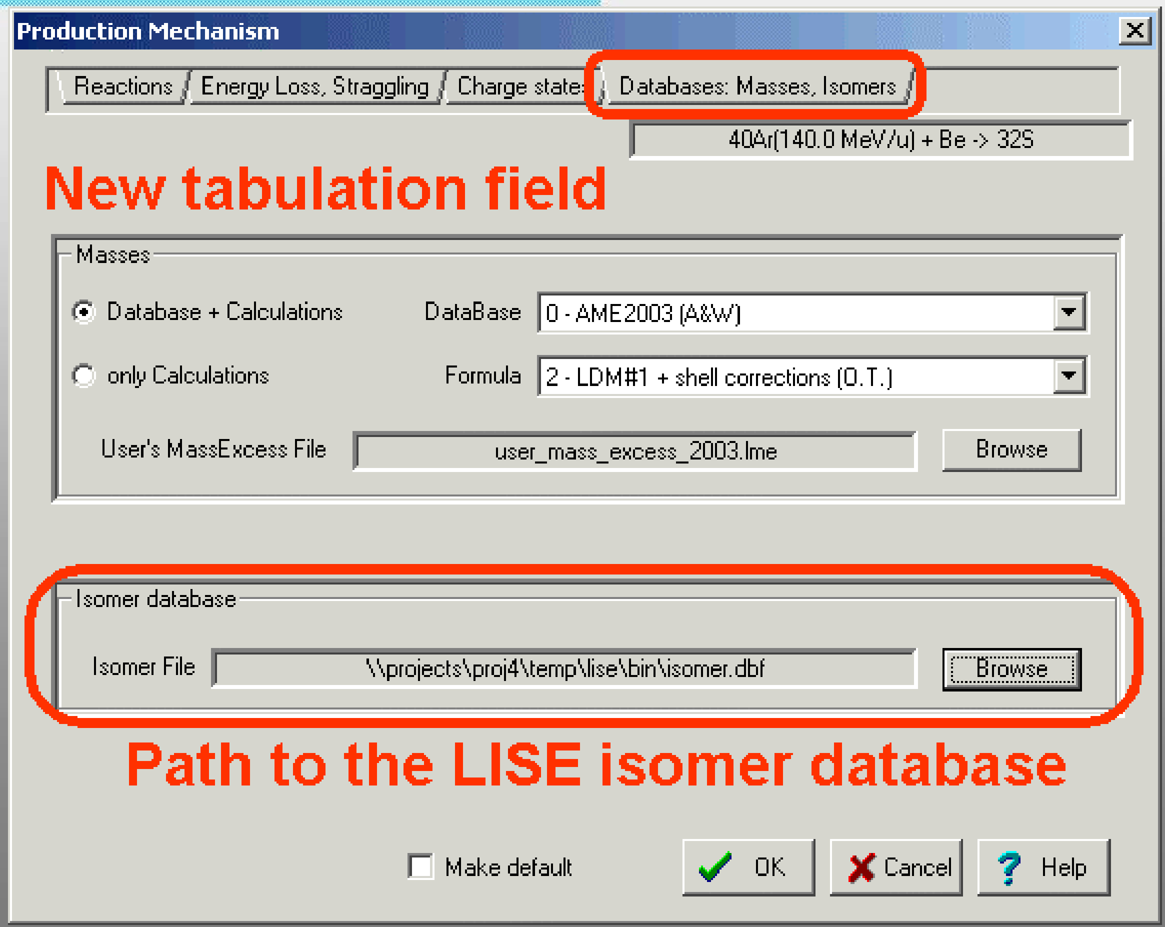
Database file size is about 360 kB. (in the LISE package)

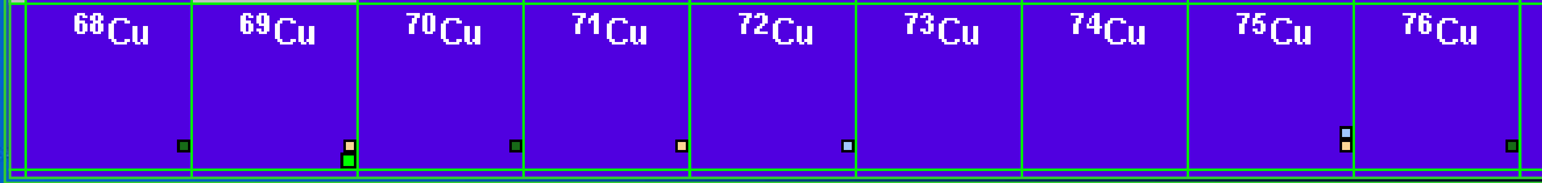
Only users with administrative privileges can modify the database in the “Program files” directory.

There is the possibility of a net database version.

Use arrow buttons in the right bottom corner to change current isomeric gamma ray.

LISE++ isomer database location (v.7.6.39)

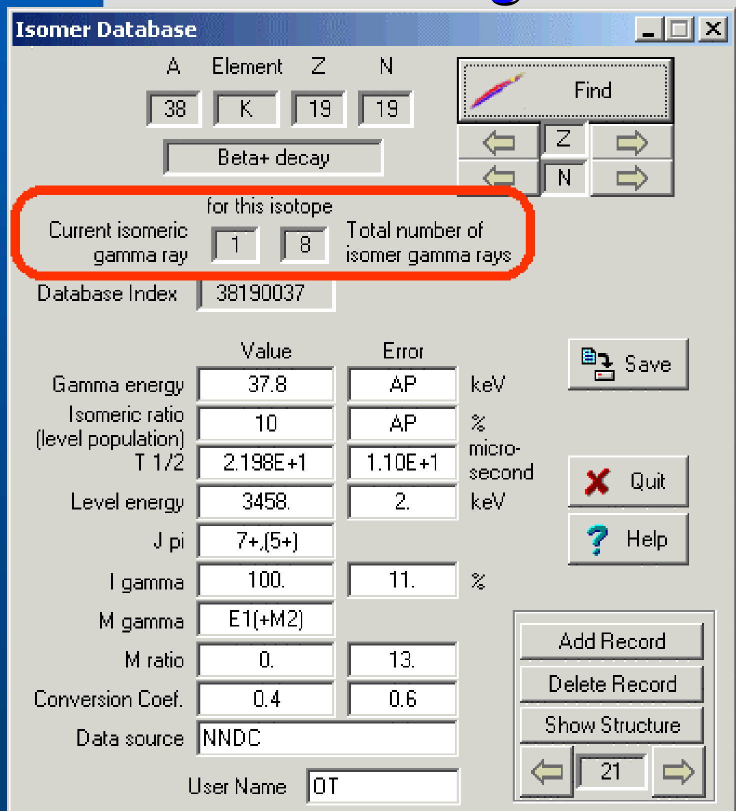


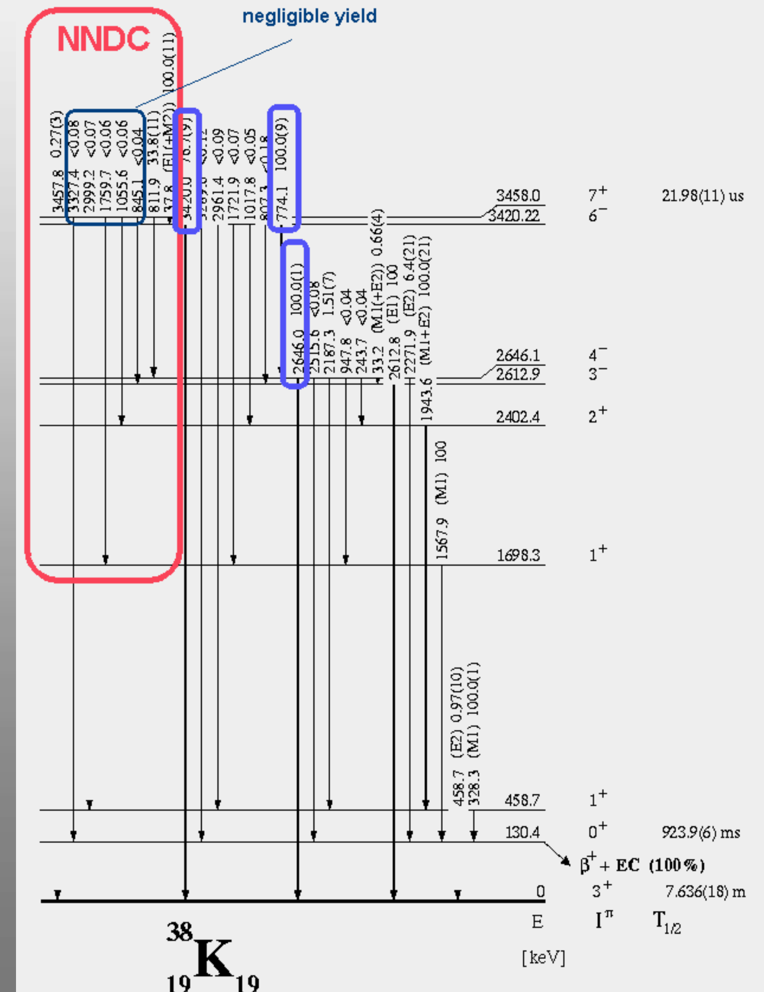


LISE database limitation

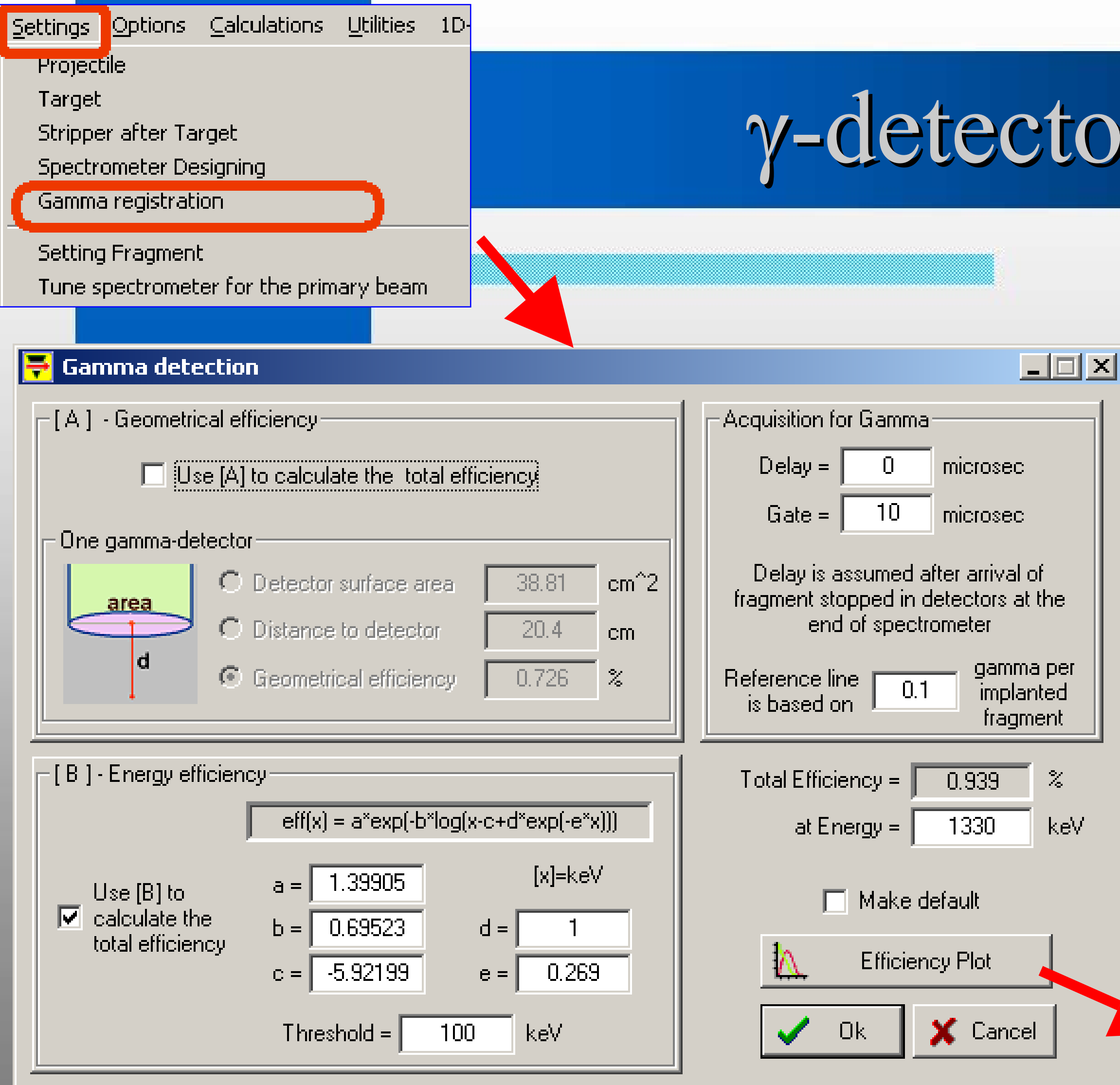
Examples

- Cu neutron-rich isotopes
- ^{38}K isomer gamma rays





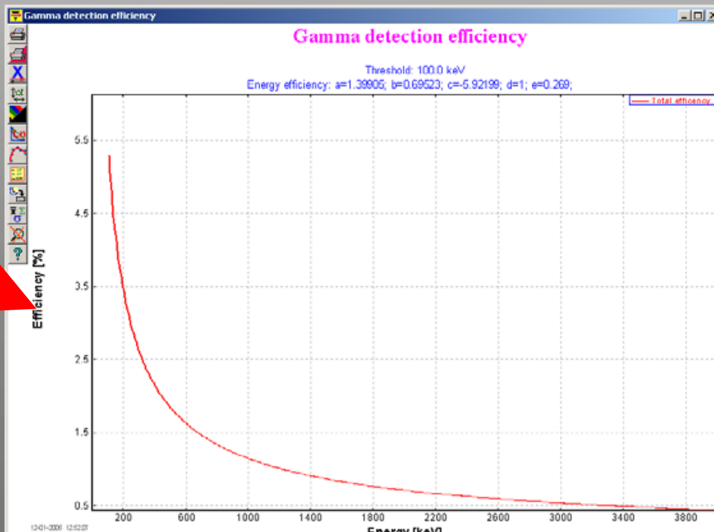
γ-detector efficiency



Reference line

Gamma-ray yield is proportional to a number of implanted fragments in the telescope at the final focal plane.
Reference gamma-rays are randomly distributed on time and on energy in region 0 – 4 MeV

If G is the number of gamma rays per implanted fragment then
R = G * Gate / 4000 [1 / keV / sec]



LISE++

Calculation of γ–rays yield

Only for isomer states from the LISE internal isomer database

- $Y_{\gamma\ isomer} = I^{m}_{ratio} \times I_{\gamma} \times Y_{fragment} \times \varepsilon_{AcqGate} \times \varepsilon_{detect}$
- $\varepsilon_{AcqGate}$: probability to be in the γ– acquisition gate

  $T_{1/2}$, Length of flight, Fragment Energy,
  Gamma-acquisition delay and gate

- ε_{detect} : detector efficiency

  geometrical efficiency or/and $f(E_{\gamma})$

- A survival of fully stripped ions in flight is not taken into account for fully stripped ions

γ–rays yield calculation result

statistics 38K

38K Beta+ decay (Z=19, N=19)

Q1(D1)		19
Q2(D2)		19
Q3(D3)		19
Q4(D4)		19
Production Rate	**(pps)**	**6.4e+2**
Reaction		Fragmentn
Sum of reactions	(pps)	6.4e+2
CS in the target	(mb)	6.71e-2
Total transmission	(%)	24.66
Target	**(%)**	**99.1**
X space transmission	(%)	100
Y space transmission	(%)	100
Unreacted in mater.	(%)	99.1

Analysis | Print | WWW TOI | Chemistry - K | File Save | Isomer(GANIL) | Isomer (LISE)

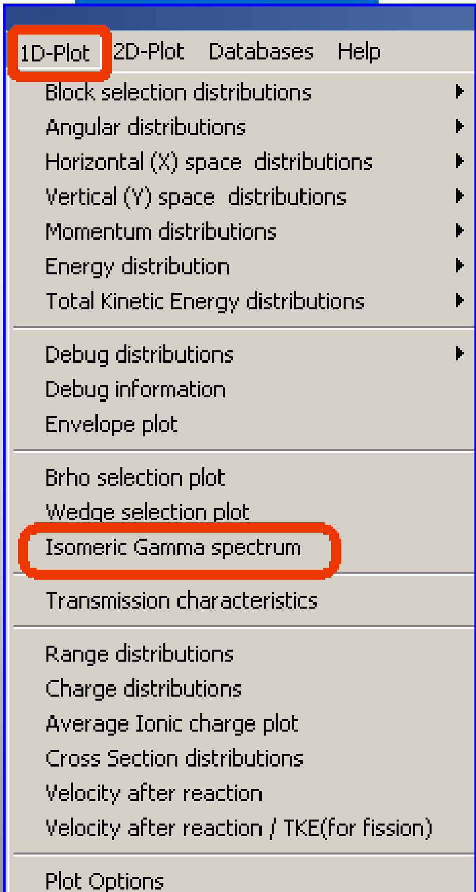
fast access to LISE isomer database

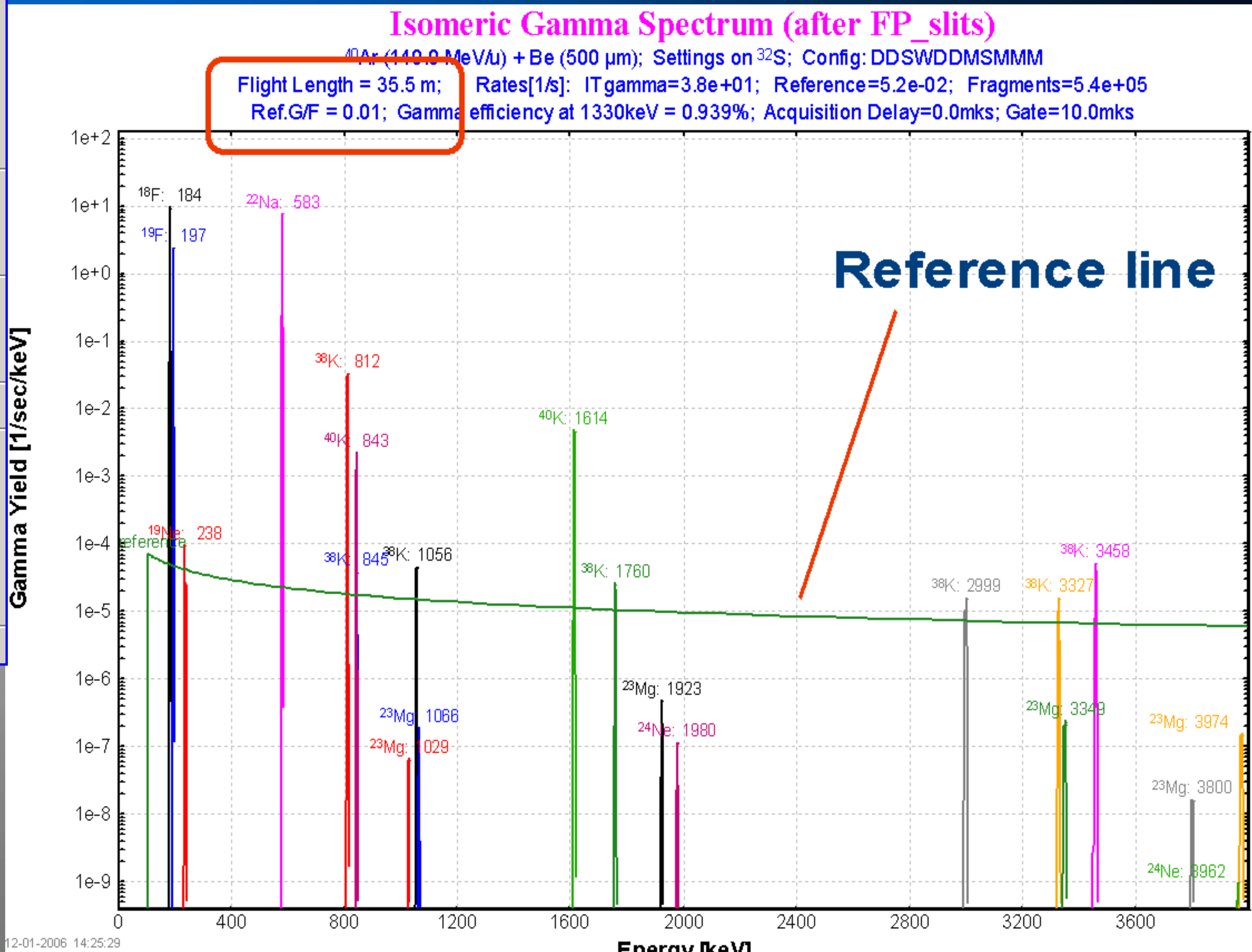
Isomeric states: gamma/frag=3.51e-07 IT=2.24e-04/s

E_gamma	T12[mks]	ITrt&Ig	Efficien	g-AcqGate	Result
37.8	2.198e+01	1.0e-01	0.00e+00	2.68e-01	0.00e+00
811.9	2.198e+01	3.4e-02	1.32e-02	2.68e-01	1.20e-04
845.1	2.198e+01	4.0e-05	1.28e-02	2.68e-01	1.38e-07
1055.6	2.198e+01	6.0e-05	1.10e-02	2.68e-01	1.77e-07
1759.7	2.198e+01	6.0e-05	7.74e-03	2.68e-01	1.25e-07
2999.2	2.198e+01	7.0e-05	5.34e-03	2.68e-01	1.00e-07
3327.4	2.198e+01	8.0e-05	4.97e-03	2.68e-01	1.07e-07
3457.8	2.198e+01	2.7e-04	4.84e-03	2.68e-01	3.51e-07

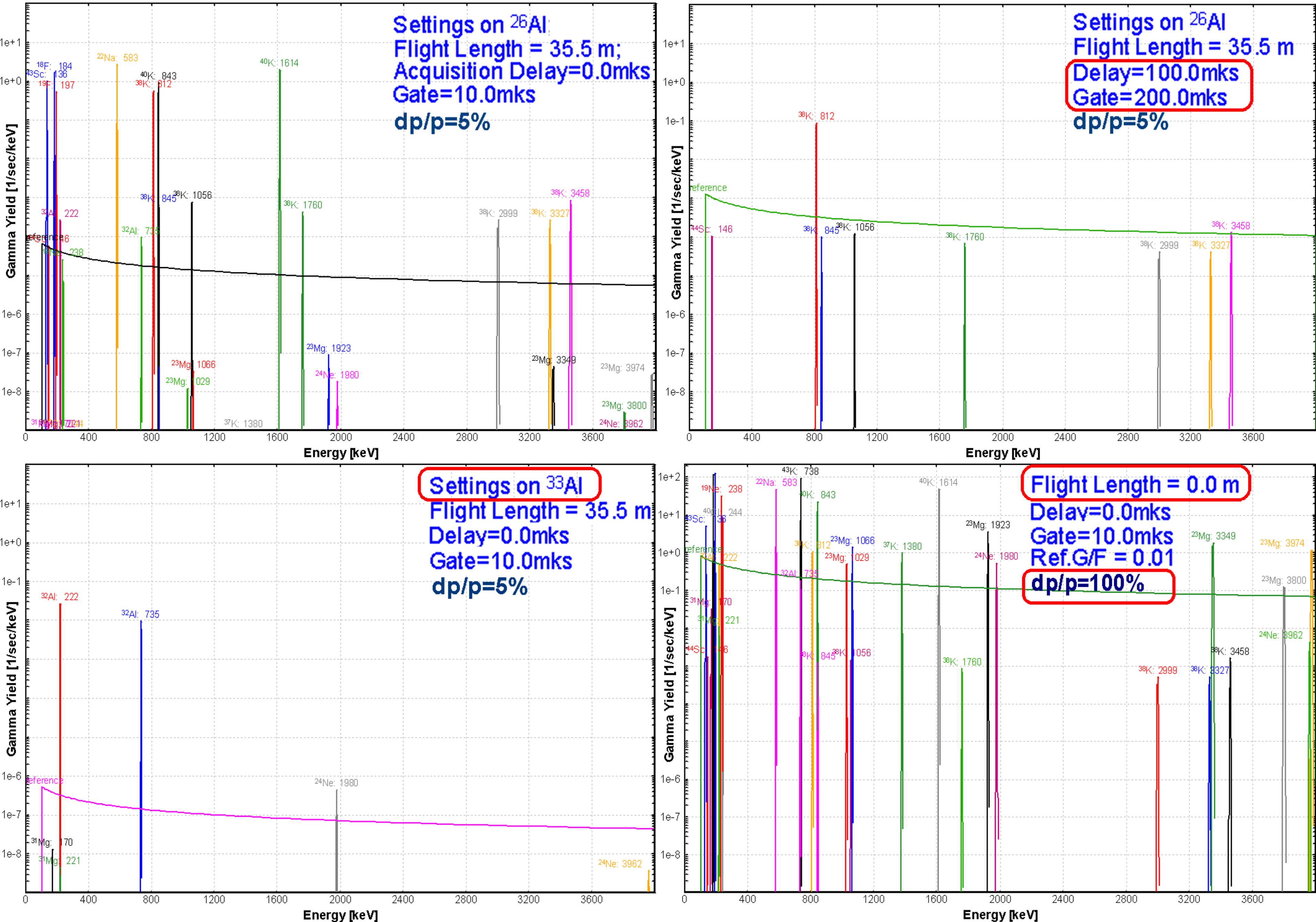
information about isomer gamma yield of given isotope in the Statistics window

Isomeric γ–spectrum

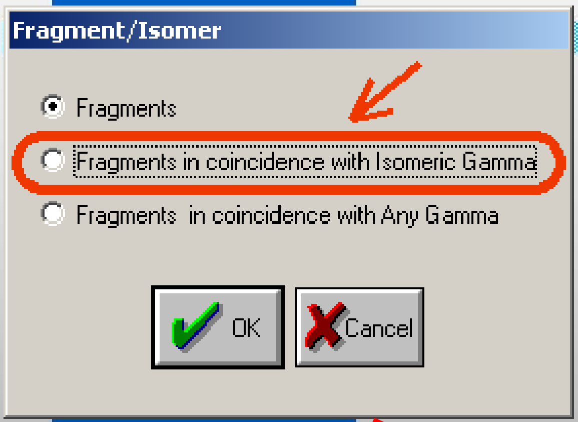


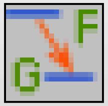


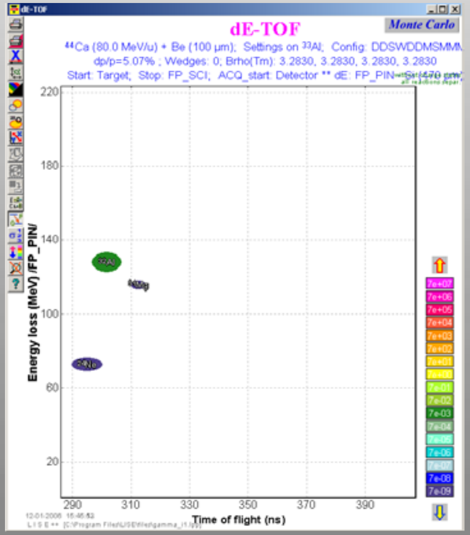
Isomeric γ–spectrum: ^{44}Ca(80MeV/u, 1pnA) + Be(100μm)

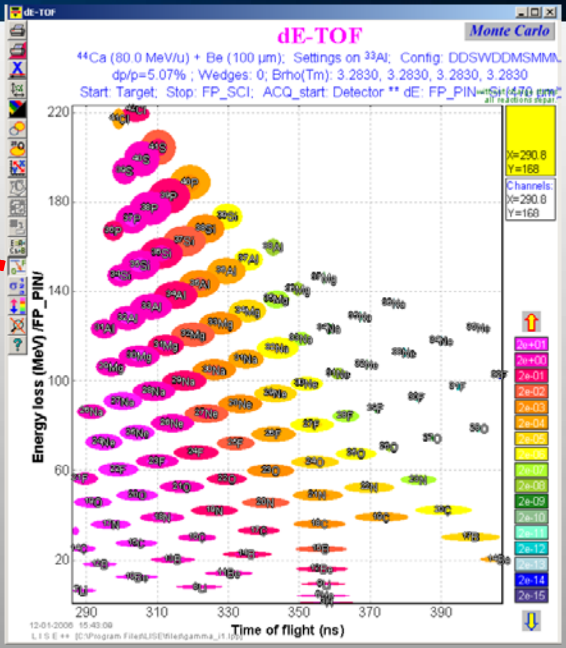


Identification 2D-plot in coincidence with γ–rays









a. $Y_{frag}(A,Z)$

b. $Y_{\gamma\ isomer}(A,Z) = Y_{frag}(A,Z)\ \sum P_{\gamma}(A,Z)$

where $P_{\gamma} = \xi_{surviv} \cdot \xi_{ITratio} \cdot \xi_{I\gamma} \cdot \xi_{detector}$

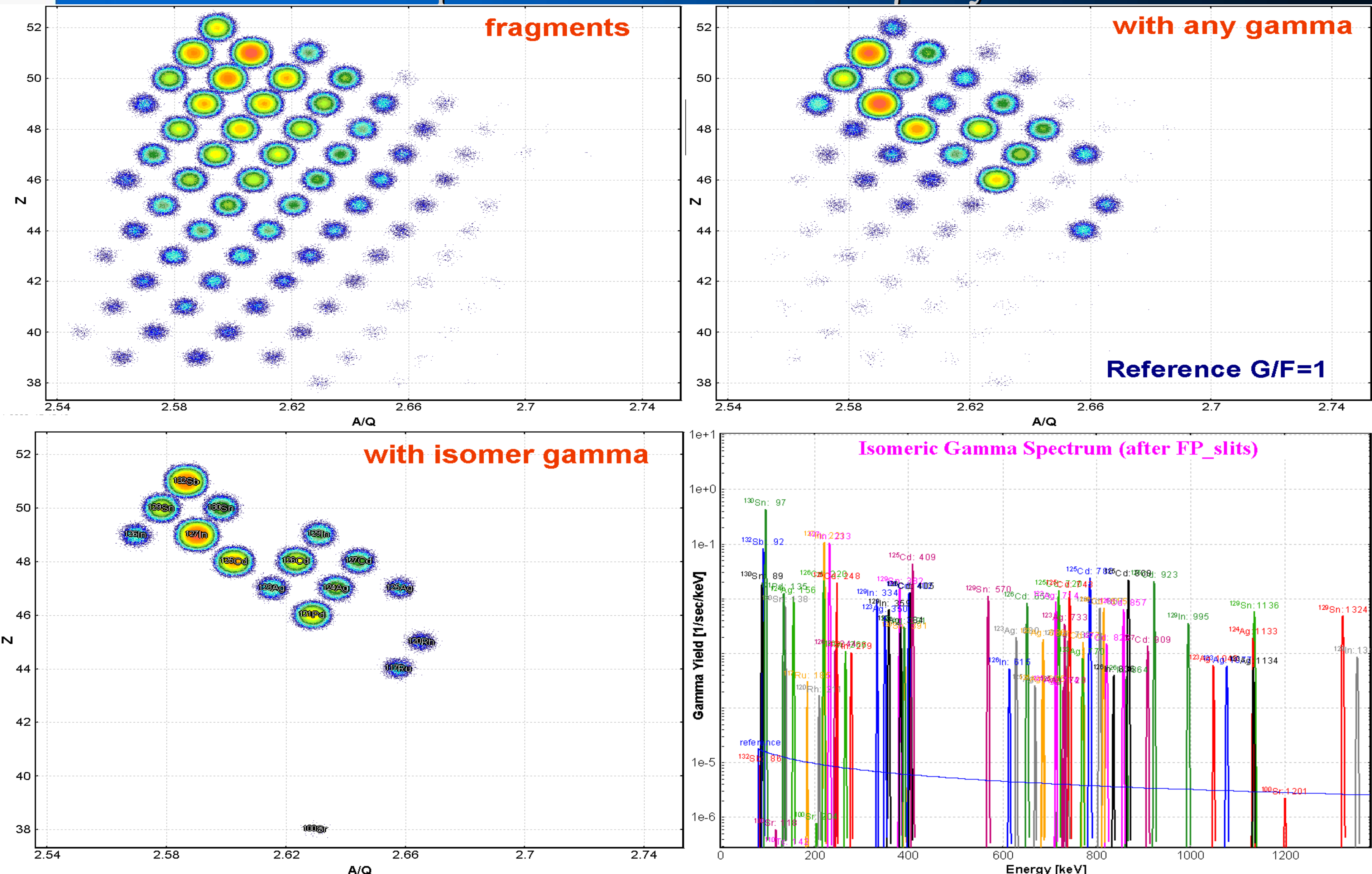
c. $Y_{\gamma}(A,Z) = Y_{frag}(A,Z) \cdot RefDens + Y_{\gamma\ isomer}(A,Z)$

It was done for both methods:
- **Monte Carlo**
- **“ellipse” mode**

LISE++

^{136}Xe (140.0 MeV/u) + Be (500 µm); Settings on ^{123}Ag

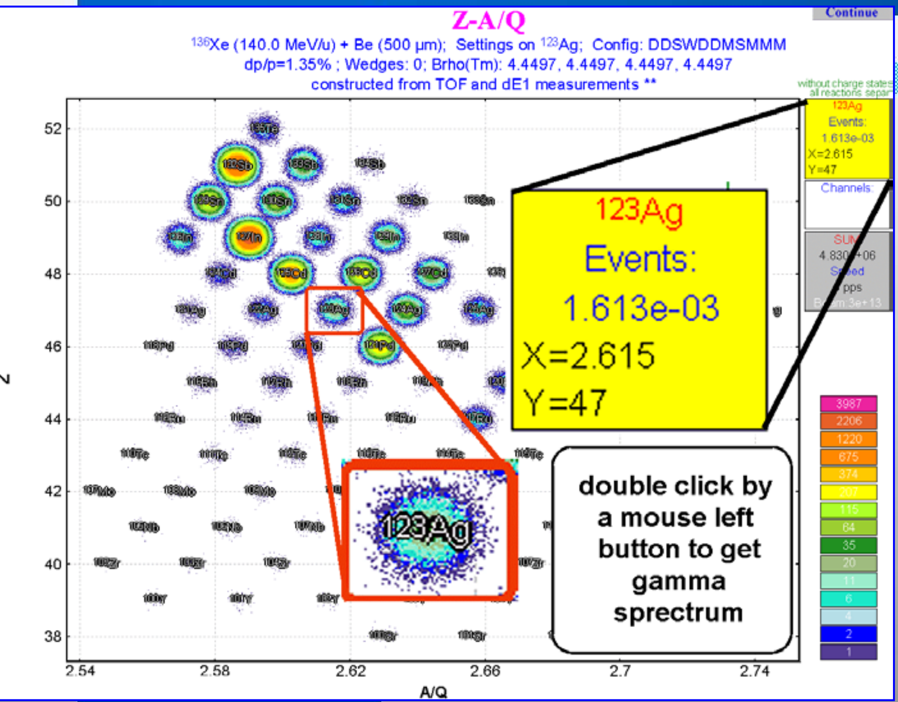
Identification 2D-plot in coincidence with γ–rays: Monte Carlo

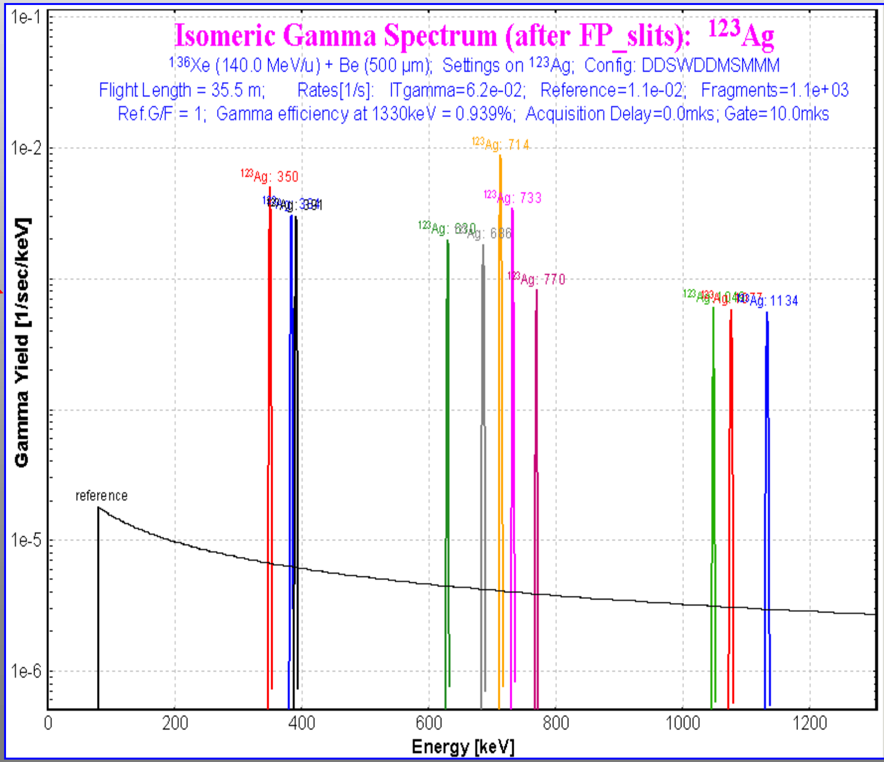


LISE++

^{136}Xe (140.0 MeV/u) + Be (500 µm); Settings on ^{123}Ag

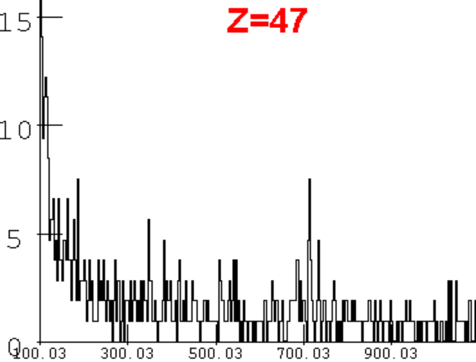
Isomer γ–spectrum (for one isotope) from the identification 2D-plot





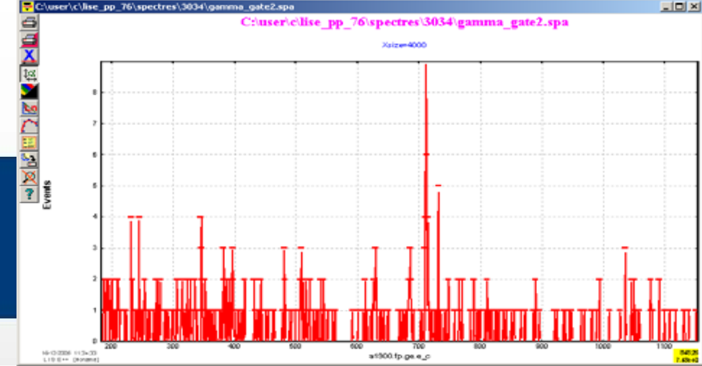
It was done for both methods:

- Monte Carlo
- “ellipse” mode



from 12/16/2005

γ-analysis: ^{123}Ag
from the experiment #3034

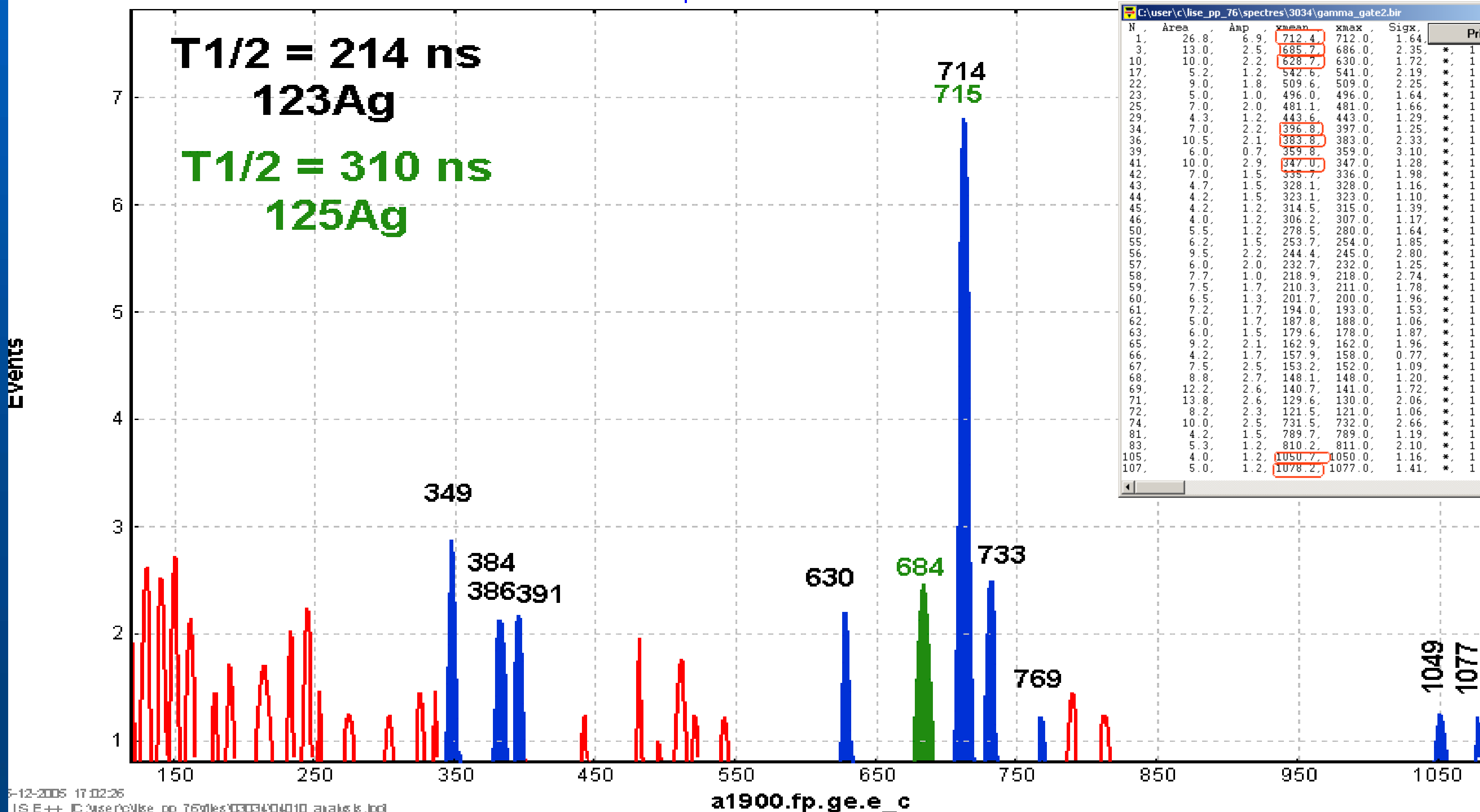


C:\user\c\lise_pp_76\spectres\3034\gamma_gate2.spa

Result file: C:\user\c\lise_pp_76\spectres\3034\gamma_gate2.bir

Xsize=4000 Global: Sum=1.10e+04; Xsigma=1.33

Input: Sx=2.0 4.9 0.8 0.01



C:\user\c\lise_pp_76\spectres\3034\gamma_gate2.bir

N ,	Area ,	Amp ,	xmean ,	xmax ,	Sigx,		
1,	26.8,	6.9,	712.4,	712.0,	1.64,		
3,	13.0,	2.5,	685.7,	686.0,	2.35,	*,	1
10,	10.0,	2.2,	628.7,	630.0,	1.72,	*,	1
17,	5.2,	1.2,	542.6,	541.0,	2.19,	*,	1
22,	9.0,	1.8,	509.6,	509.0,	2.25,	*,	1
23,	5.0,	1.0,	496.0,	496.0,	1.64,	*,	1
25,	7.0,	2.0,	481.1,	481.0,	1.66,	*,	1
29,	4.3,	1.2,	443.6,	443.0,	1.29,	*,	1
34,	7.0,	2.2,	396.8,	397.0,	1.25,	*,	1
36,	10.5,	2.1,	383.8,	383.0,	2.33,	*,	1
39,	6.0,	0.7,	359.8,	359.0,	3.10,	*,	1
41,	10.0,	2.9,	347.0,	347.0,	1.28,	*,	1
42,	7.0,	1.5,	335.7,	336.0,	1.98,	*,	1
43,	4.7,	1.5,	328.1,	328.0,	1.16,	*,	1
44,	4.2,	1.5,	323.1,	323.0,	1.10,	*,	1
45,	4.2,	1.2,	314.5,	315.0,	1.39,	*,	1
46,	4.0,	1.2,	306.2,	307.0,	1.17,	*,	1
50,	5.5,	1.2,	278.5,	280.0,	1.64,	*,	1
55,	6.2,	1.5,	253.7,	254.0,	1.85,	*,	1
56,	9.5,	2.2,	244.4,	245.0,	2.80,	*,	1
57,	6.0,	2.0,	232.7,	232.0,	1.25,	*,	1
58,	7.7,	1.0,	218.9,	218.0,	2.74,	*,	1
59,	7.5,	1.7,	210.3,	211.0,	1.78,	*,	1
60,	6.5,	1.3,	201.7,	200.0,	1.96,	*,	1
61,	7.2,	1.7,	194.0,	193.0,	1.53,	*,	1
62,	5.0,	1.7,	187.8,	188.0,	1.06,	*,	1
63,	6.0,	1.5,	179.6,	178.0,	1.87,	*,	1
65,	9.2,	2.1,	162.9,	162.0,	1.96,	*,	1
66,	4.2,	1.7,	157.9,	158.0,	0.77,	*,	1
67,	7.5,	2.5,	153.2,	152.0,	1.09,	*,	1
68,	8.8,	2.7,	148.1,	148.0,	1.20,	*,	1
69,	12.2,	2.6,	140.7,	141.0,	1.72,	*,	1
71,	13.8,	2.6,	129.6,	130.0,	2.06,	*,	1
72,	8.2,	2.3,	121.5,	121.0,	1.06,	*,	1
74,	10.0,	2.5,	731.5,	732.0,	2.66,	*,	1
81,	4.2,	1.5,	789.7,	789.0,	1.19,	*,	1
83,	5.3,	1.2,	810.2,	811.0,	2.10,	*,	1
105,	4.0,	1.2,	1050.7,	1050.0,	1.16,	*,	1
107,	5.0,	1.2,	1078.2,	1077.0,	1.41,	*,	1

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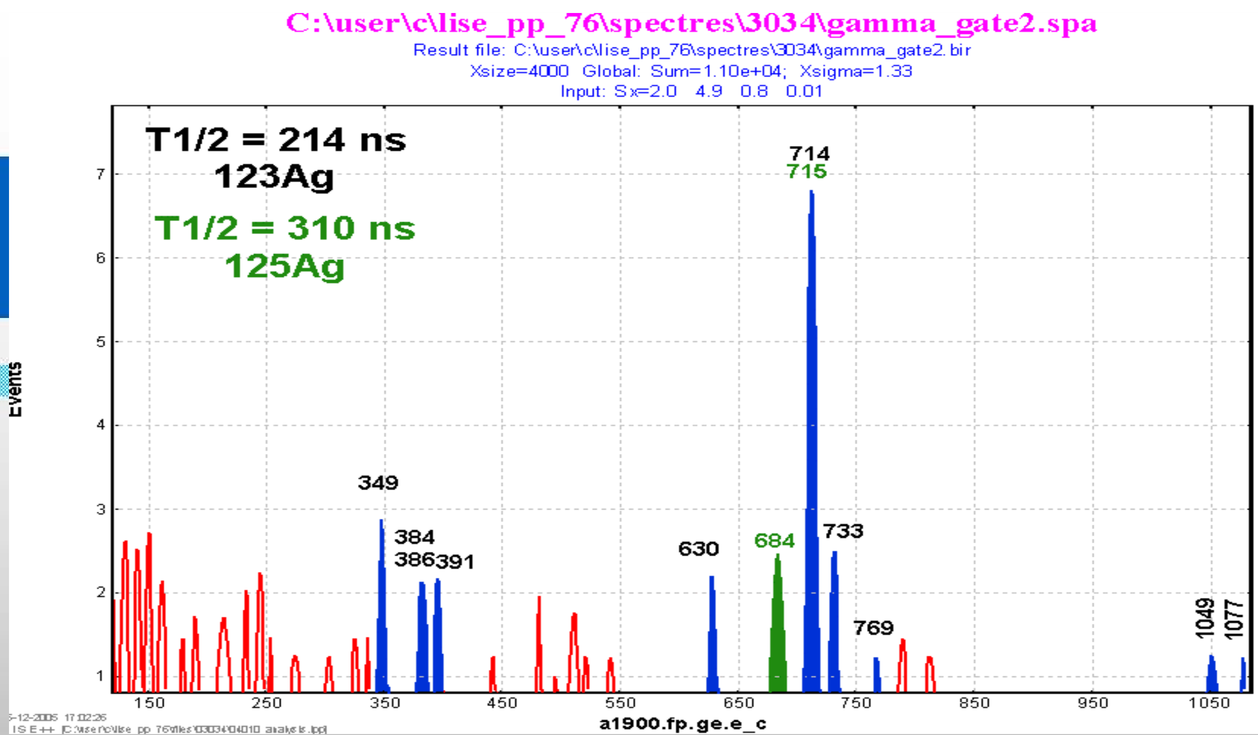
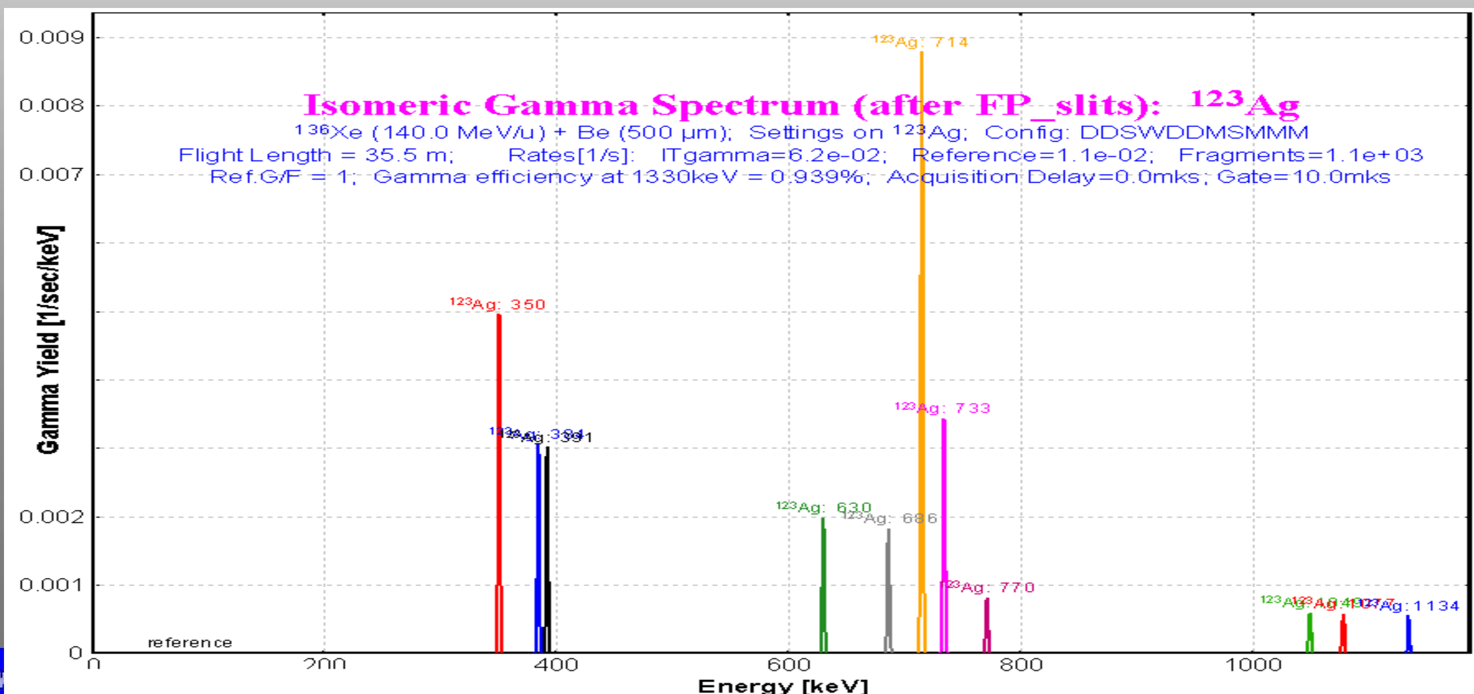
^{123}Ag γ-spectrum: from the experiment #3034 & LISE simulation



Temporary.
Waiting for
final version of
B.Tomlin's thesis

Egamma	Igamma
350.	30.
384.	20.
391.	20.
630.	20.
686.	20.
714.	100.
733.	40.
770.	10.
1049.	10.
1077.	10.
1134.	10.



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Projectile fragmentation: new option for momentum distribution