



Strål
säkerhets
myndigheten

Swedish Radiation Safety Authority

Improving the results of the analysis of a complex gamma spectrum by applying the cascade summing correction

Background

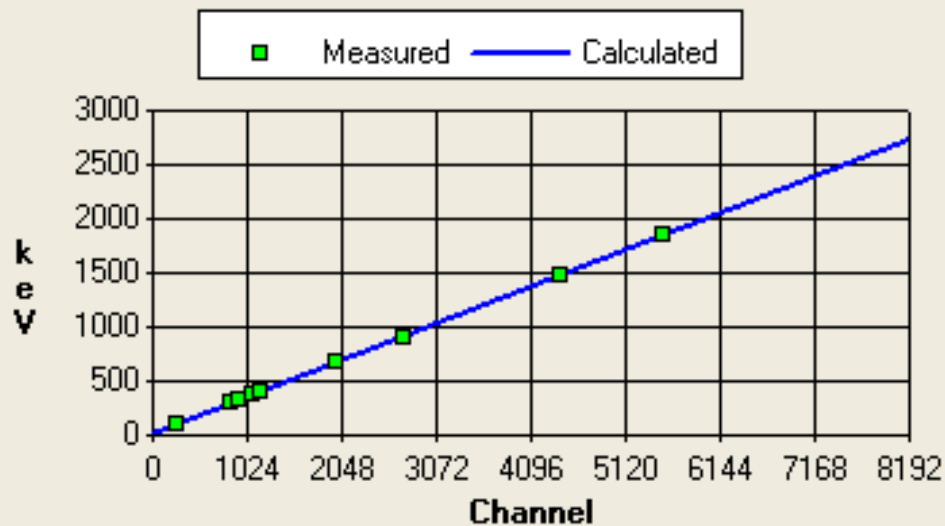
- NKS-B project REMSPEC: "Analysis of remotely accrued complex gamma ray spectra – proficiency test" (coordinator: Mark Dowdall NRPA)
- We were challenged to tune the gamma analysis software to see if the results could be improved by changing analysis settings and implementing the cascade summing correction – CSC
Gamma analysis software: Genie 3.1
- Implementation of a scenario specific library
Nuclides inventory for Swedish NPPs found in the libraries for LENA, for calculation of the plume dispersion, doses and fall-out in case of accident [Ulf Bäverstam (SSM, 2009)]
Glib_master for GammaVision [Henrik Ramebäck, (FOI, 2006)]

Tuning Genie for a complex gamma ray spectrum

CALIBRATIONS

- Calibration spectrum, K40, Y88, Ba133, Cs137
- Perform a full energy calibration (data can be loaded in by nuclide or by entry)
 - E vs. Channel
 - E vs. FWHM
 - E vs. Tailing parameter (zero since we're dealing with mathematical generated peaks)
- NO chance of loading P/T data manually: Find the P/T data for existing 'generic detector' that best matches the data given for the REMSPEC detector P/T ratio
- Load best P/T cal data
- Run a first peak analysis to enable the option "Perform cascade correction" (geometry-independent case)
- Input peak efficiency data for the efficiency calibration; check "Perform cascade correction"
- Put together an analysis sequence including cascade correction at the step NID with interference correction
- Run analysis of the calibration spectrum

Energy Calibration Curves



Curve

Energy

Shape

Order of the polynomial:

1

±

:

Peak:



Drop Pk

Datasource: C:\GENIE2K\REMSPEC-2008\info and calibration files\NKSCALIBT2.CNF

Energy = 1.029e+000 keV + 3.321e-001*Ch

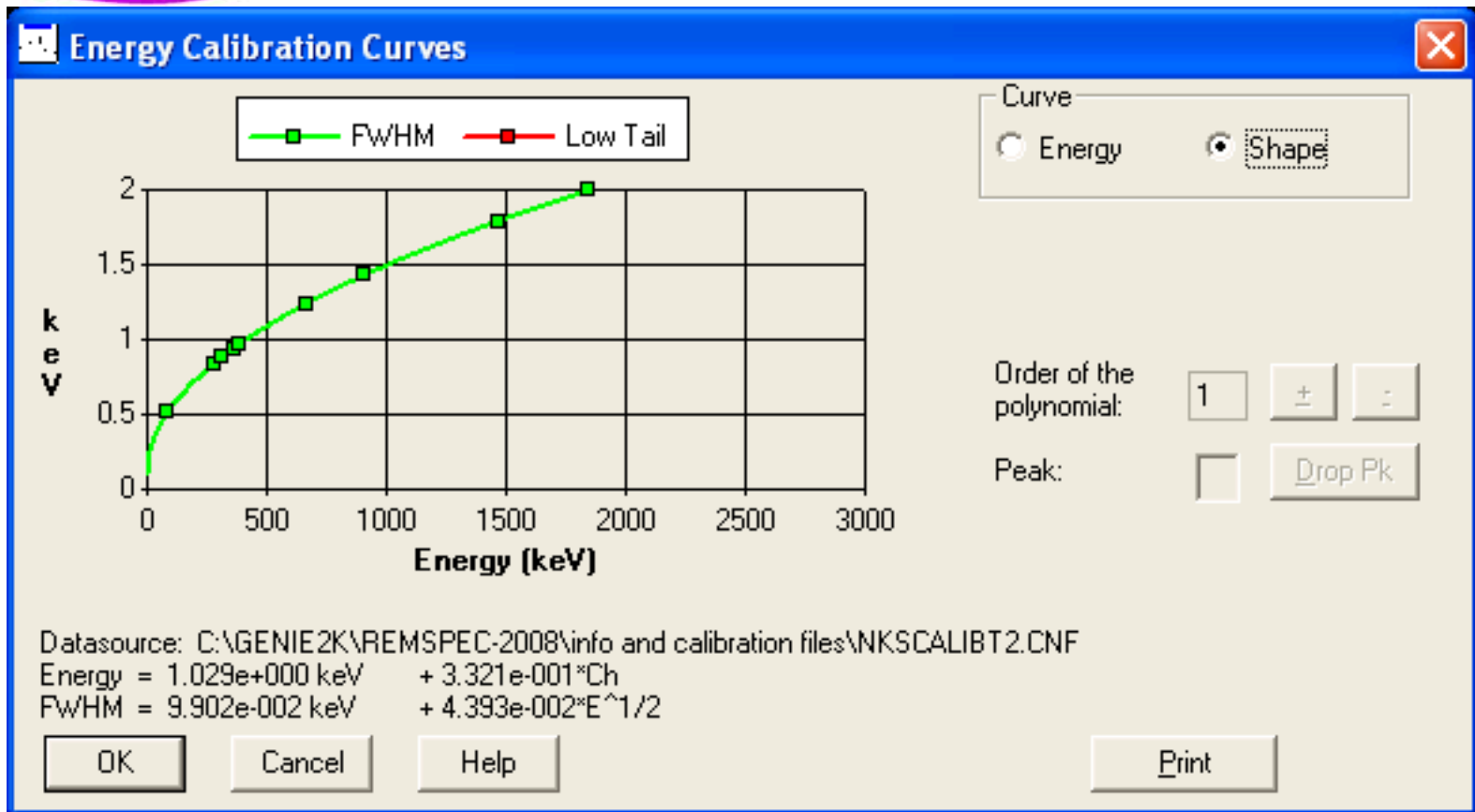
FWHM = 9.902e-002 keV + 4.393e-002*E^{1/2}

OK

Cancel

Help

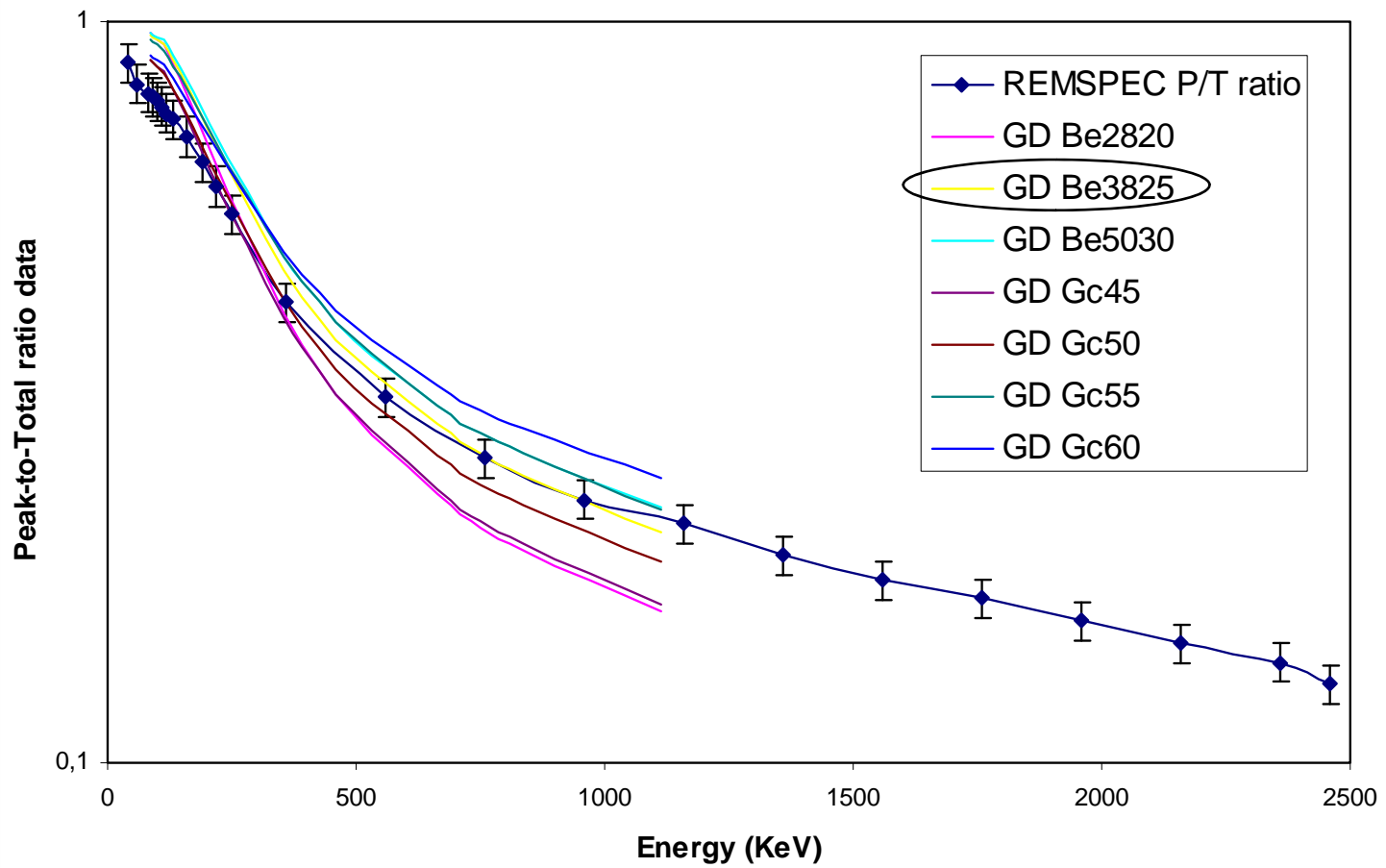
Print



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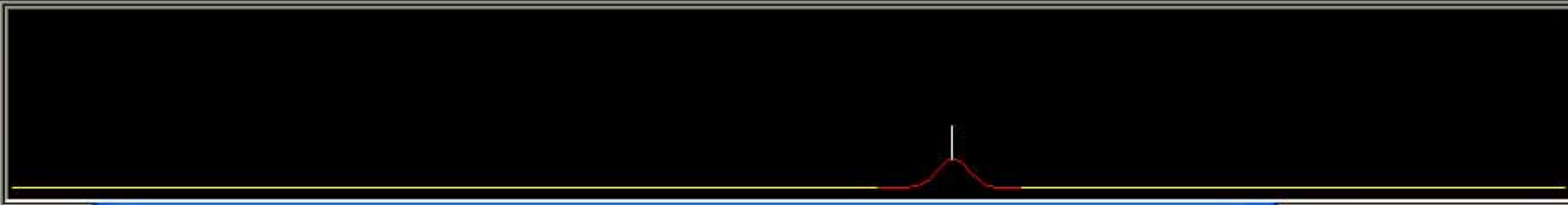
Idle Channel: 5528 : 1837.0 keV Counts: 6928 Preset: 0/37797.00

Acquire

Start Stop

Expand Off

Clear



ROI Index:

- +

Datasource

Prev Next

TIME INFO

Next

Prev

25	2980-	2988							
26	3759-	3768							
27	3976-	3995							
28	4383-	4405							
29	4841-	4855	4848.29	1810.80	1.44	1.35E+002	87.92	1.31E+003	
30	5515-	5539	5527.89	1836.98	2.03	4.48E+004	213.66	2.05E+002	
31	5843-	5852	5847.39	1943.09	0.91	1.81E+001	12.30	5.89E+001	
32	7538-	7549	7543.03	2506.26	0.92	5.19E+000	12.87	6.38E+001	

M = First peak in a multiplet region
 m = Other peak in a multiplet region
 F = Fitted singlet

Efficiency Calibration

Energy keV	Efficiency	Error (%)
40.00	0.00429	3.00
60.00	0.04531	3.00
80.00	0.08126	3.00
90.00	0.09163	3.00
100.00	0.09672	3.00
110.00	0.09977	3.00
120.00	0.09938	3.00
130.00	0.09917	3.00
160.00	0.09426	3.00
190.00	0.08408	3.00
220.00	0.07600	3.00
250.00	0.06795	3.00
360.00	0.04903	3.00

Peak Edits:

Energy: 40.00 keV Accept

Efficiency: 0.00429 Delete

Error (%): 3.00 Cross-over

Cascade Correction

Geometry: [] Select

Composer file: C:\GENIE2K\isocs\data\GEOMETRY\Labor

Generate Reports

Detector Characterized for LabSOCS Geometry Composer

OK Cancel Show... Help Auto Use-results

VFS = 64K

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IDENTIFIED NUCLIDES

Nuclide Name	Id	Energy (keV)	Yield (%)	Activity (Bq /Unit)	Activity Uncertainty
K-40	0.991	1460.81*	10.67	9.29820E+002	3.31271E+001
Y-88	0.917	898.02*	93.40	8.80282E+001	2.65684E+000
		1836.01*	99.38	9.14520E+001	2.53188E+000
BA-133	0.993	79.62*	2.55	5.04592E+001	6.96123E+000
		81.00*	33.00	9.43510E+001	1.28831E+001
		276.40*	6.90	9.46907E+001	1.15353E+001
		302.84*	17.80	1.00077E+002	1.05643E+001
		356.01*	60.00	9.70491E+001	1.01400E+001
		383.85*	8.70	1.12169E+002	1.11130E+001
CS-137	0.996	661.65*	85.12	1.14063E+002	3.84065E+000

* = Energy line found in the spectrum.

@ = Energy line not used for Weighted Mean Activity

Energy Tolerance : 1.000 keV

Nuclide confidence index threshold = 0.30

Errors quoted at 2.000 sigma

** INTERFERENCE CORRECTED REPORT

Nuclide Name	Id	Confidence	Wt mean Activity (Bq /Unit)	Wt mean Activity Uncertainty
K-40	0.991		9.298200E+002	3.312708E+001
Y-88	0.917		8.982254E+001	1.832894E+000
BA-133	0.993		8.317344E+001	4.050221E+000
CS-137	0.996		1.140631E+002	3.840654E+000

IDENTIFIED NUCLIDES

Nuclide Name	Id	Energy (keV)	Yield (%)	Activity (Bq /Unit)	Activity Uncertainty	Coinc Corr
K-40	0.991	1460.81*	10.67	9.29820E+002	3.31271E+001	miss
Y-88	0.917	898.02*	93.40	9.11762E+001	2.75990E+000	0.965
		1836.01*	99.38	9.56264E+001	2.64748E+000	0.956
BA-133	0.993	79.62*	2.55	5.45526E+001	7.93873E+000	0.938
		81.00*	33.00	1.00004E+002	1.43614E+001	0.949
		276.40*	6.90	9.78786E+001	1.22879E+001	0.967
		302.84*	17.80	1.01722E+002	1.09000E+001	0.984
		356.01*	60.00	9.85543E+001	1.04437E+001	0.985
		383.85*	8.70	1.08456E+002	1.04395E+001	1.034
CS-137	0.996	661.65*	85.12	1.14063E+002	3.84065E+000	miss

* = Energy line found in the spectrum.

@ = Energy line not used for Weighted Mean Activity

Energy Tolerance : 1.000 keV

Nuclide confidence index threshold = 0.30

Errors quoted at 2.000 sigma

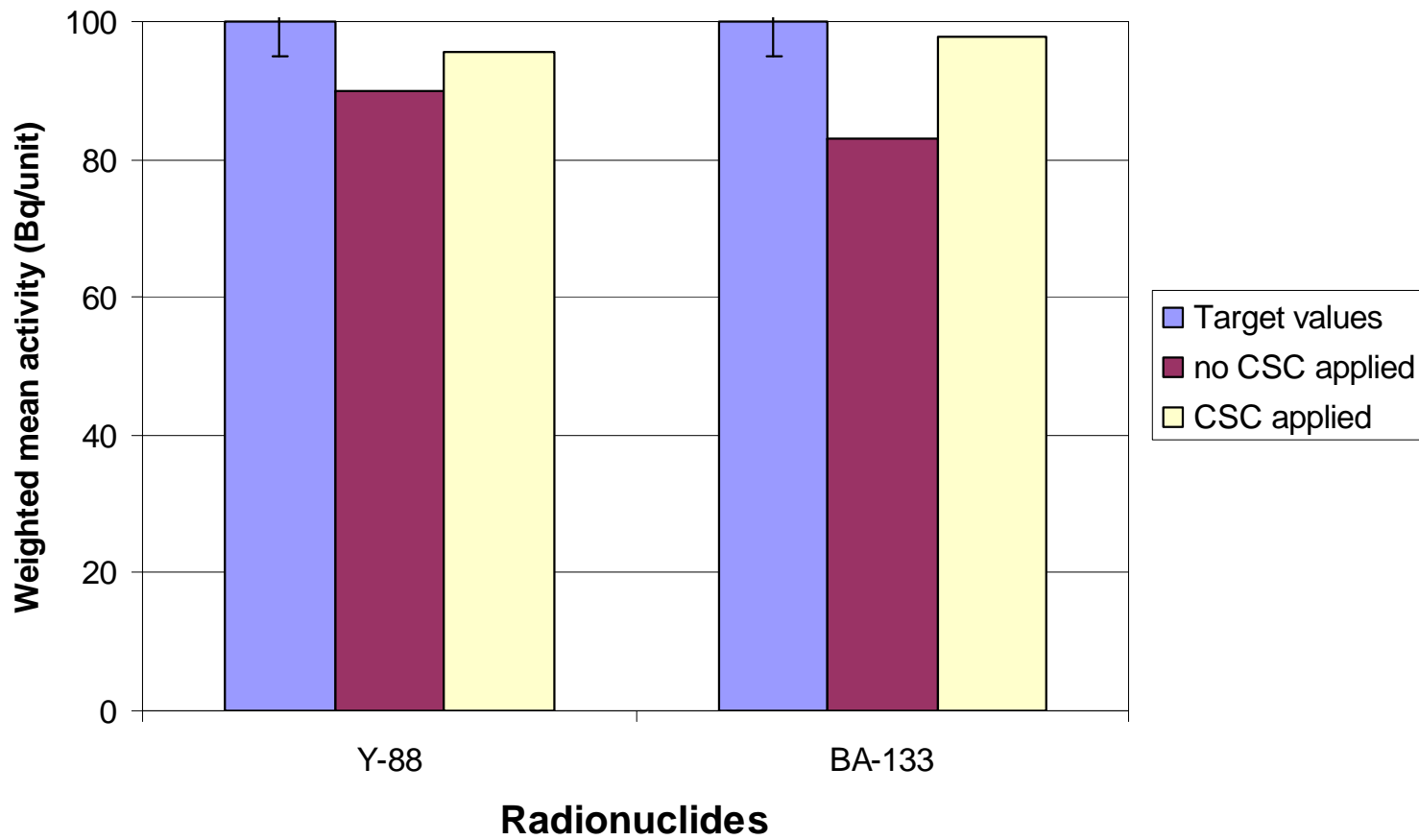
Coincidence correction performed.

free = No coincidence correction required.

miss = Nuclide energy was not found in the coincidence library.

** INTERFERENCE CORRECTED REPORT

Nuclide Name	Id	Confidence	Wt mean Activity (Bq /Unit)	Wt mean Activity Uncertainty
K-40	0.991		9.298200E+002	3.312708E+001
Y-88	0.917		9.349378E+001	1.910558E+000
BA-133	0.993		9.786830E+001	4.299358E+000
CS-137	0.996		1.140631E+002	3.840654E+000



Tuning Genie for a complex gamma ray spectrum

ANALYSIS

- Peak search step: start at sufficient high channel (100); run unidentified second differential method [Mariscotti, Nucl. Instr. Meth. (1967) 50:309; SAMPO, SAMPO80]
- Peak search step: rise the value for the significance threshold. From 3 to 5.
- Peak analysis step: fix the tailing parameter; reject zero area peaks; combination of ROI limits 5 2 2 (max number of FWHM between peaks, max number of FWHM for left limit, max number of FWHM for right limit)
- Efficiency step: load efficiency calibration, load P/T data
- NID step: link to the scenario-specific library with 1 keV FWHM tolerance
- NID step: check the option "perform cascade correction" where the same geometry as the calibration geometry is chosen.



Idle Channel: 1 : 1.4 keV Counts: 0 Preset: 0/3600.00

Acquire

Start Stop

Expand On

Clear

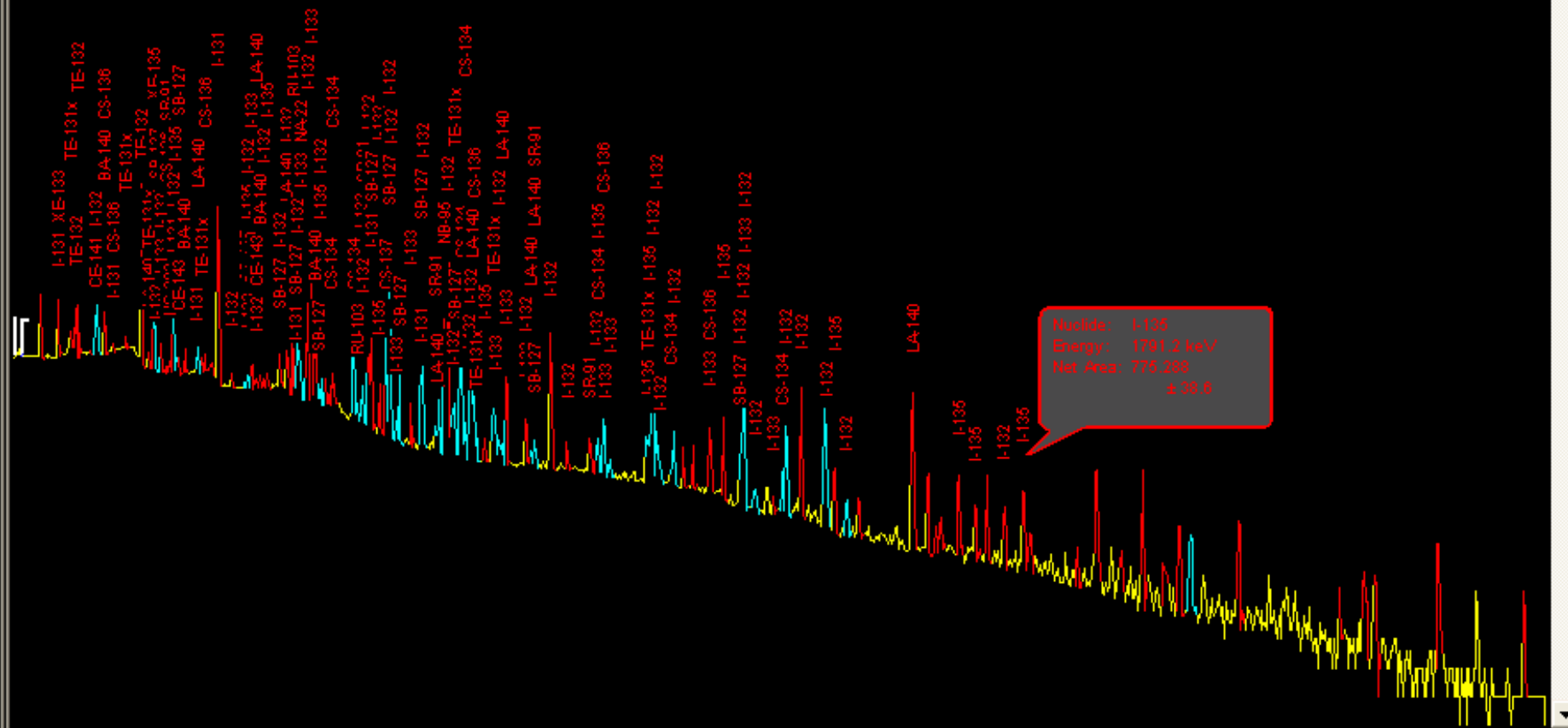
ROI Index:

- +

Datasource

Prev Next

LOG = 1000M

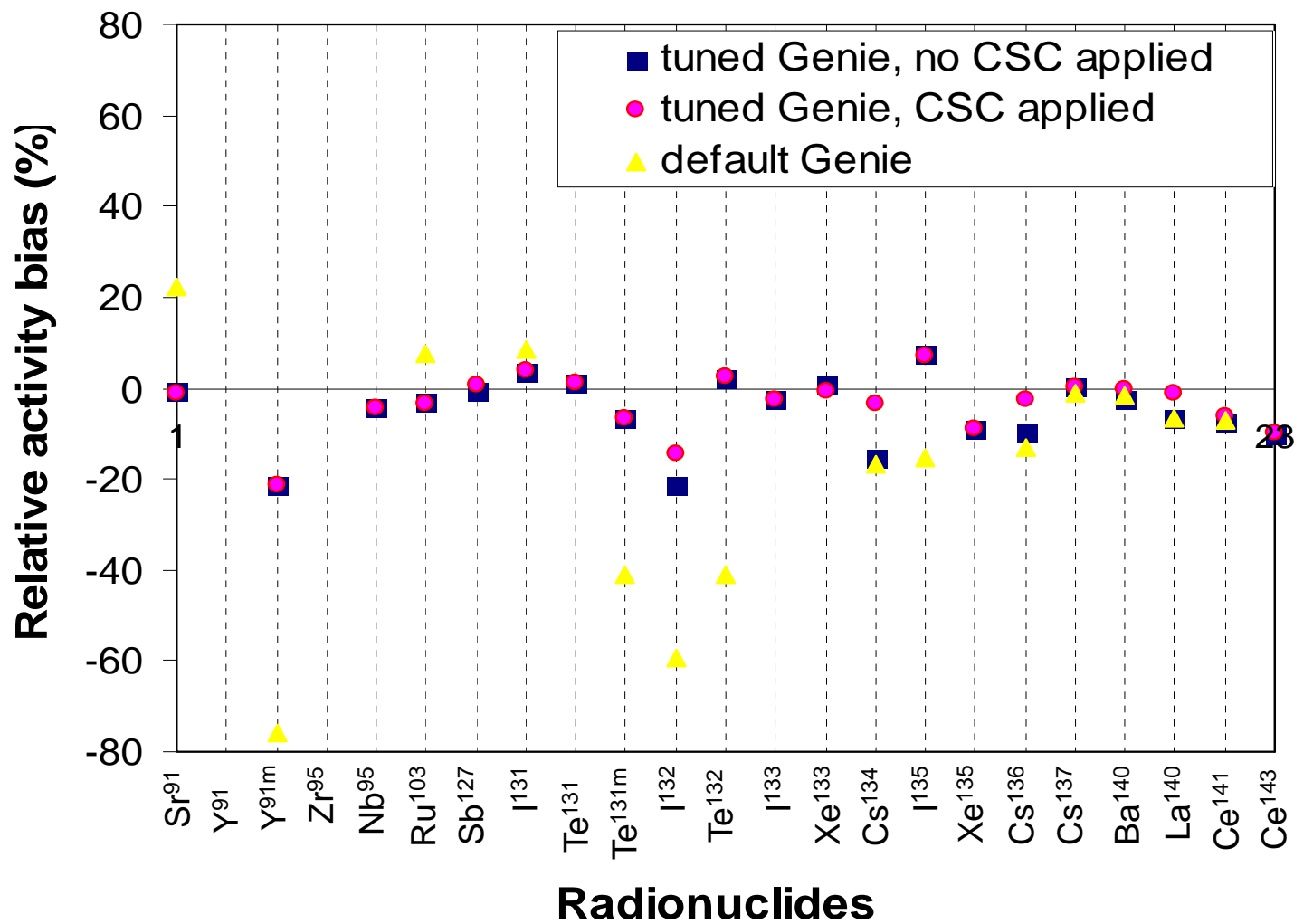


TIME INFO

Next

Prev

Acq. Start:	2008-01-01 03:45:31	Elapsed	Preset
Dead Time:	0.03%	Live (secs.):	3600.000
Comp. Preset Region:		Real (secs.):	3601.000
0 - 0 (channels)		Total (cnts.):	0.00





CONCLUSIONS

- REMSPEC was a positive and challenging exercise, good for training
- Scenario-specific libraries are an important component when analyzing 'unknown' gamma ray spectra
- There will be always settings to change to your analysis software in order to tune it for the purpose.

TACK !

