

# Summary of Gamma-ray Spectrometry Measurements

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# $^{82}\text{Sr}$ Half Life Measurements

Measurements were performed at NIST using gamma-ray spectrometry and a  $4\pi$  pressurized ionization chamber

- Measurement were performed using 5ml NIST standard ampoules
- The ampoule for the gamma-ray spectrometry measurements was spiked with  $^{137}\text{Cs}$  to compensate for possible instrument fluctuations
- $^{85}\text{Sr}$  impurity measurements were performed with the HPGe detector to check  $4\pi$  pressurized ionization chamber measurements
- The  $^{82}\text{Sr}$  half-life was determined to be  $25.36 \pm 0.03$  days ( $k = 1$ ) using the gamma-ray spectrometry system and  $25.34 \pm 0.02$  days ( $k = 1$ ) using the pressurized ionization chamber.

**Both measurements agree within stated uncertainties**

# $^{82}\text{Sr}$ Half Life Measurements

There is a need to add  $^{82}\text{Sr}$  to the “Monographie BIPM-5” due to the long period of time between revisions of ENSDF

Reference	$T_{1/2}$ (days)
Present Work Gamma Spectrometry	$25.36 \pm 0.03$
Present Work Ionization Chamber	$25.34 \pm 0.02$
Woods <i>et. al.</i> (1987)	$25.342 \pm 0.053$
Hoppes <i>et. al.</i> (1987)*	$25.36 \pm 0.80$
<b>Grant <i>et. al.</i> (1978)</b>	<b><math>25.55 \pm 0.15</math></b>
Kruger <i>et. al.</i> (1953)	$25.5 \pm 0.5$
Litz <i>et. al.</i> (1953)	$27 \pm \text{NA}$

← Half life used in ENSDF

\* In this publication, uncertainty  $\pm 0.03$  is reported in the abstract, while a value  $\pm 0.08$  is quoted as a result of calculation of the uncertainty budget for  $T_{1/2} = 25.36$  days. Therefore, the latter is used in this table.

Differences in half life created problems with activity measurements for  $^{82}\text{Sr}/^{82}\text{Rb}$  radiopharmaceutical sources

# $^{82}\text{Sr}$ - $^{82}\text{Rb}$ Emission Probability Measurements

There is a need to review published results and perform new measurements

Energy (keV)	Relative Probability (NIST1987)	Uncertainty (%)	Relative Probability (ENSDF)	Percent Difference (%)
698.3	1.54E-02	1.2	9.88E-03	55.9
710.6	4.70E-03	4.5	3.78E-03	24.3
776.5	1	0.72	1	0.0
1395.2	3.52E-02	0.82	3.51E-02	0.3
1474.8	6.01E-03	2.3	5.90E-03	1.9
1704	3.30E-03	3.5	3.35E-03	-1.5

Because of published emission probability it is only possible to provide gamma rate measurements when source manufacturers require activity measurements

	Emission Probability (%) 776 keV $\gamma$ -ray	Uncertainty (%)
Emission Probability – NIST HPGe Spectrometry (1987)	15.2	0.3
Emission Probability – NIST liquid scintillation (1987)	14.5	0.2
ENSDF	15.08	Not given

# HPGe Digital Electronics Comparison

Compared instrument performance using analog and digital electronics



Digital Electronics  
*ORTEC DSPEC Pro*

## Analog Electronics

- Power supply: ORTEC Model 660
- Amplifier: Model 673 (time constant 6  $\mu$ s)

## n-type HPGe Detector Information

- Diameter = 58 mm
  - Length = 57.6 mm
- Beryllium window (0.5 mm)



G - Detector

# Digital Electronics Settings

- Enhanced Throughput Mode (ET) – allows for higher count rate, loses resolution (accepts new pulses when first pulse does not reach baseline)
- Low frequency Rejector (LFR) Filter – reduced noise produced mainly by a mechanical cooler, no need to use for liquid nitrogen cooled detectors
- Resolution Enhancement Mode (RE) – corrects for charge trapping (uses the fact that the rise time changes for signal due to trapped charges)
- Zero Dead-Time Correction – uses a different method to that of the classical extended-live-time clock (extends live time to compensate for dead time). This new method applies time corrections in real time, e.g. for very short lived radionuclide the corrections will be larger at the start of the run compared to the end of the run (do not use for regular applications)

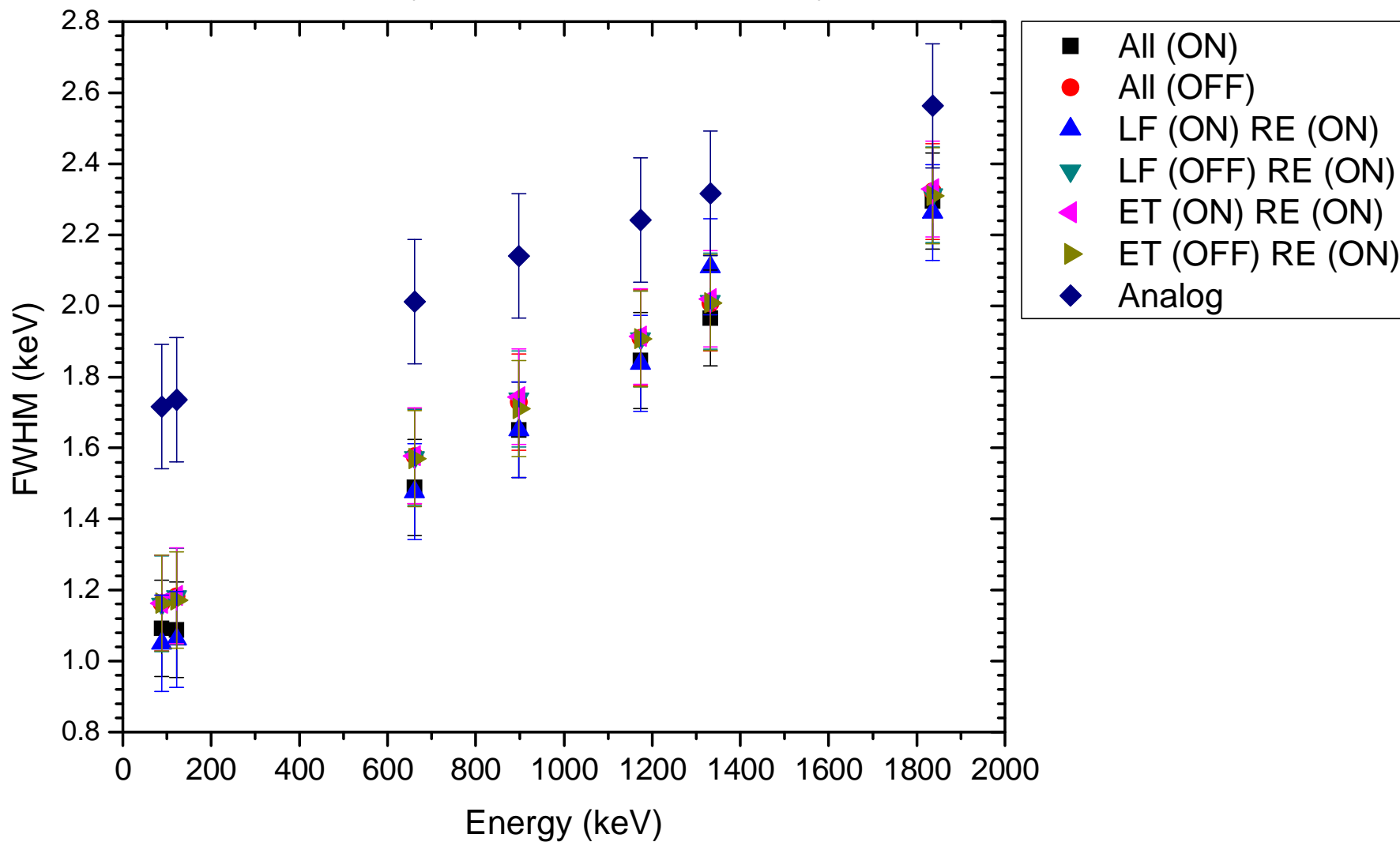
The digital system automatically optimizes (through an iteration process):

- Integration time (automatic flattop logic)
- Pole Zero

Manual settings of Rise Time, Pole Zero and Flattop is available but it can only be viewed through the Insight mode (similar to digital oscilloscope)

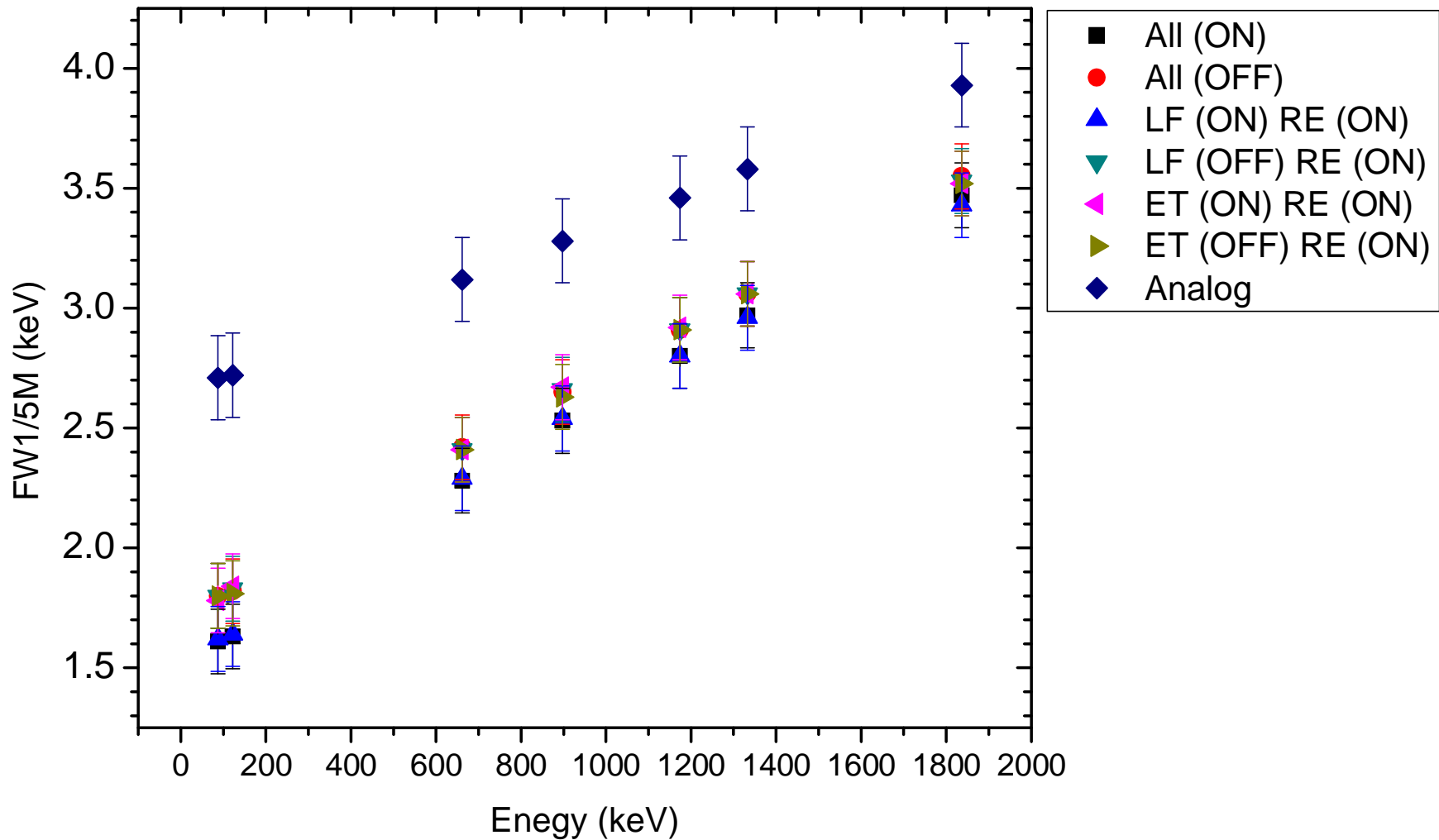
# HPGe Digital Electronics Comparison

Efficiency 20 cm Ampoule Geometry



# HPGe Digital Electronics Comparison

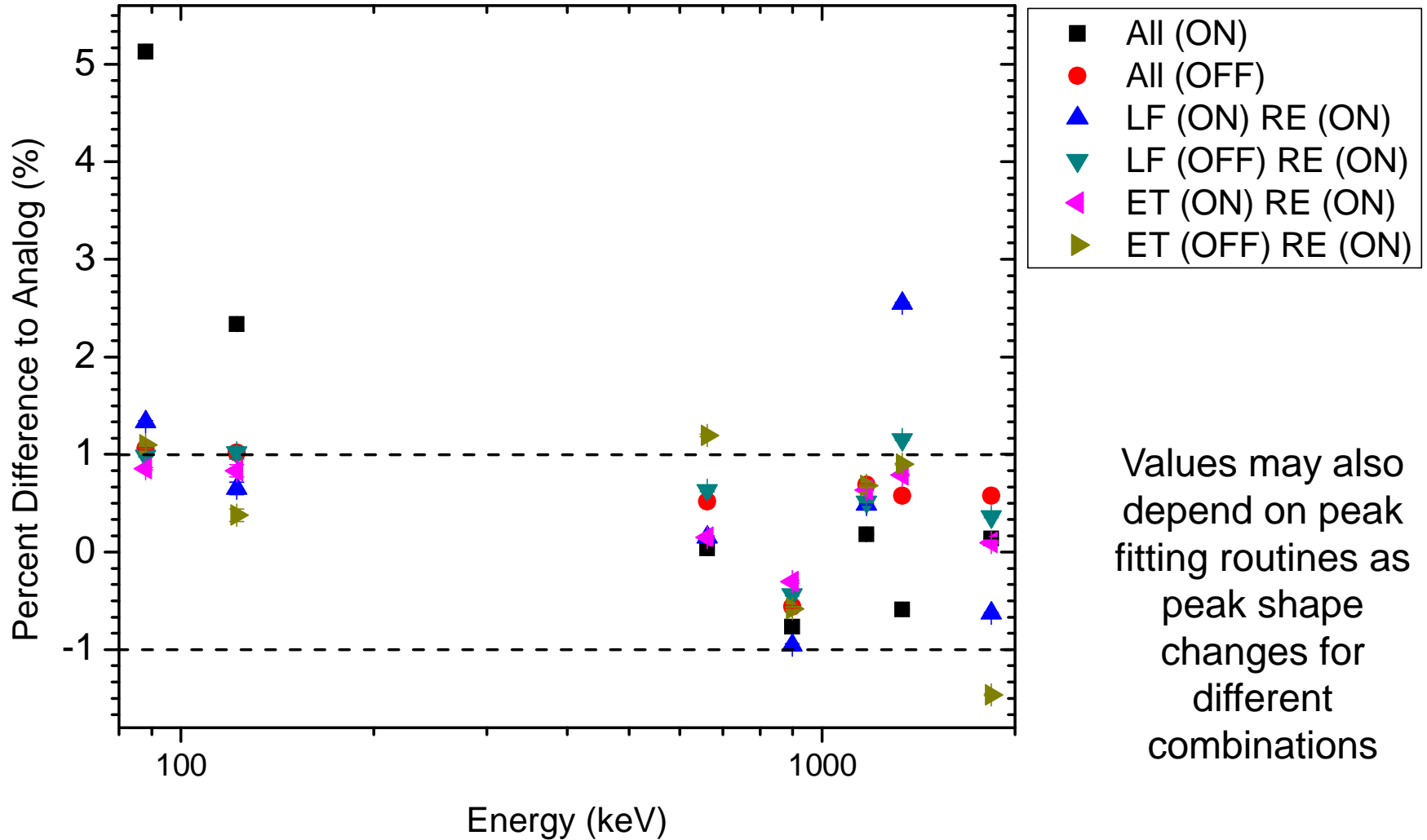
Efficiency 20 cm Ampoule Geometry





# HPGe Digital Electronics Comparison

Efficiency 20 cm Ampoule Geometry



# Available Standards for HPGe Detectors

**Several standards are being revised to include digital electronic applications**

**ANSI N42.14-1999** (Revision of ANSI N42.14-1991)

**American National Standard for Calibration and Use of Germanium Spectrometers for the Measurement of Gamma-Ray Emission Rates of Radionuclides**

**IEEE Std 325-2004** (Revision of IEEE Std 325-1996)  
*Recognized as an American National Standard (ANSI)*

**IEEE Standard Test Procedures for Germanium Gamma-Ray Detectors Used in Analog and Digital Signal Processing Systems**

**IEC 60973** (under revision)

**Test Procedures for Germanium Gamma-ray Detectors**

**In USA labs use ANSI standards for setup of HPGe detectors**