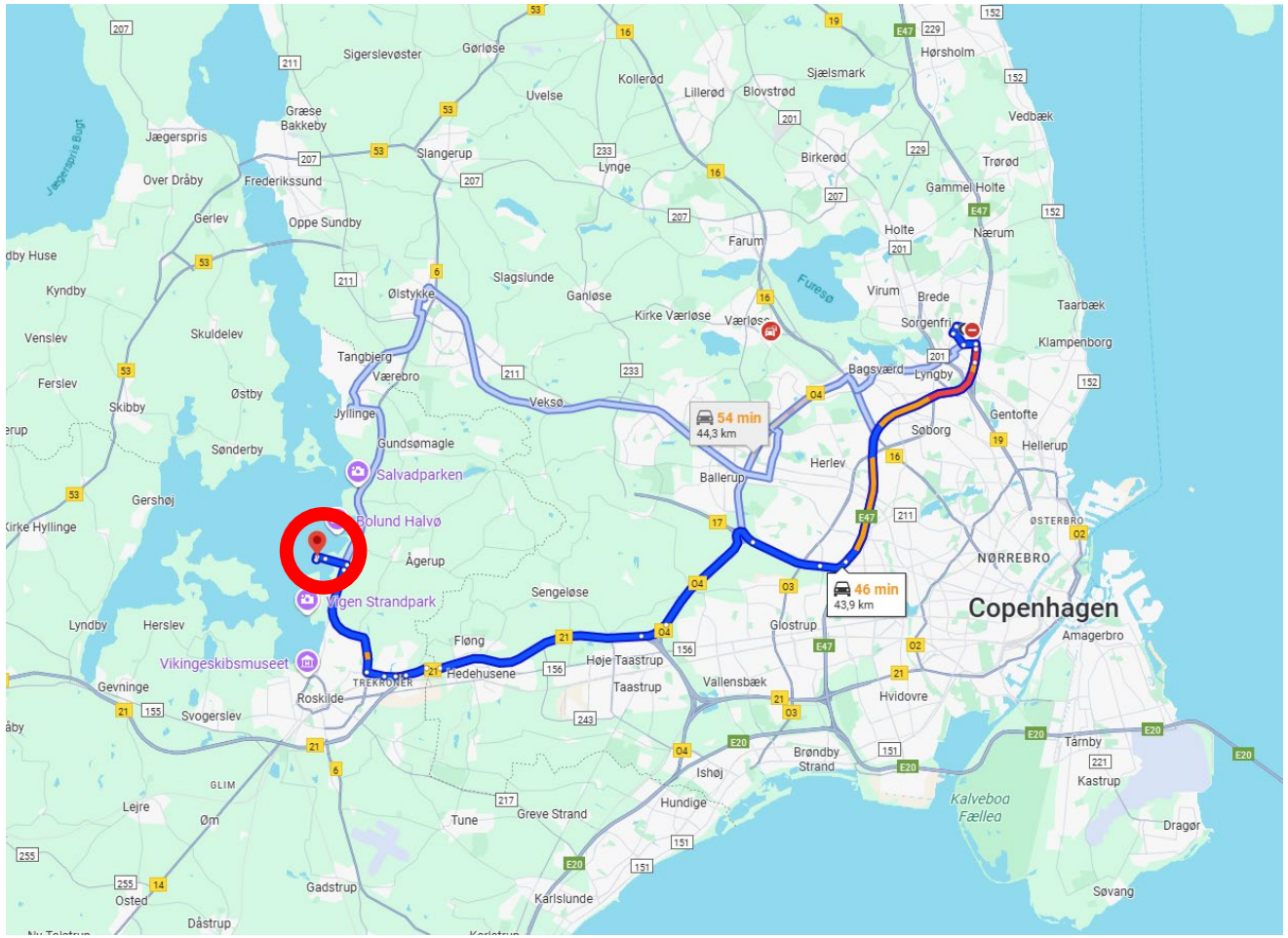
Gamma Laboratory Risø

Guillaume Lutter, DTU

NKS GammaAI 2025, 08-09 October 2025

Radioecology and Tracer Studies (RTS)

- 1956-2006: Risø National Laboratory
- 2007-2011: Risø DTU
- 2012-2019: DTU Nutech
- 2020-2022: DTU Environment
- 2022-present: DTU Sustain



Radioecology and Tracer Studies (RTS)

Facilities

- 6 x Chemistry lab (22 fume hoods)
- 1 x seawater lab (2 fume hoods, 3 work stations)
- 1 x sample preparation building (2 fume hoods, 8 ovens, 3 drying cabinets)
- 16 x alpha spectrometers
- 12 x (low-bkg) gamma spectrometers
- 35 x low-bkg gas flow beta counters
- 2 x low-bkg LSC (Quantulus, Tricap)
- 1 x TDCR LSC (Hidex 300 SL)
- 1 x ICP-MS (Agilent 8800 ICP-QQQ)
- 1 x ICP-OES (Agilent 5800)


Scintillation Counter

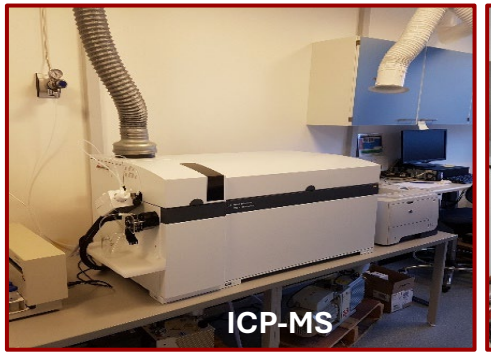

Beta Counter


Wet Chemistry Lab


Seawater Lab


Sample Preparation Lab


Gamma Spectrometer

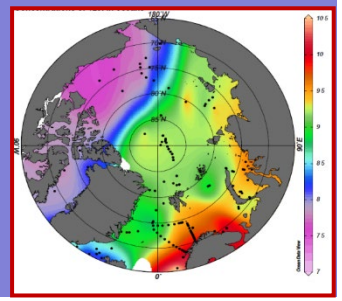

ICP-MS

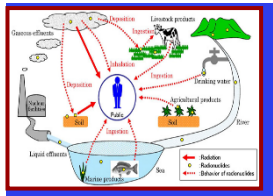

Alpha spectrometer

Main activities

Radioecology & Tracer study

Development of radioanalytical methods





Environment monitoring

Scientific advice

Scientific Advice (commercial service)

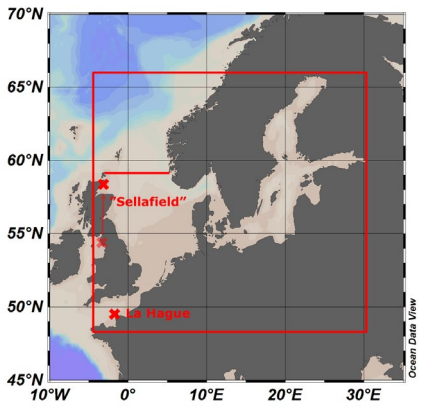
- Analytical work under accreditation (ISO/IEC 17025:2005)

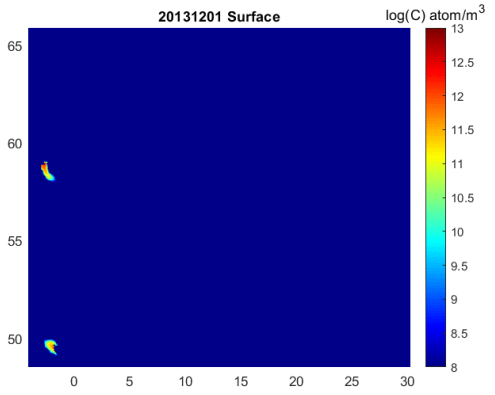
- Surveillance and waste characterization for Danish Decommissioning
- Commercial analysis for nuclear decommissioning abroad, industry (import/export) and other research institutes

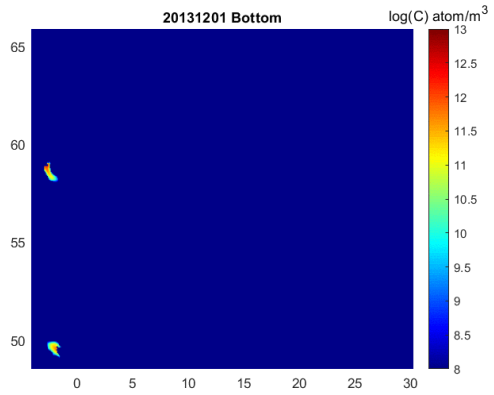
- Training on radiochemical analysis
- Consultancy in radiation protection, analytical method development, environmental monitoring, etc.

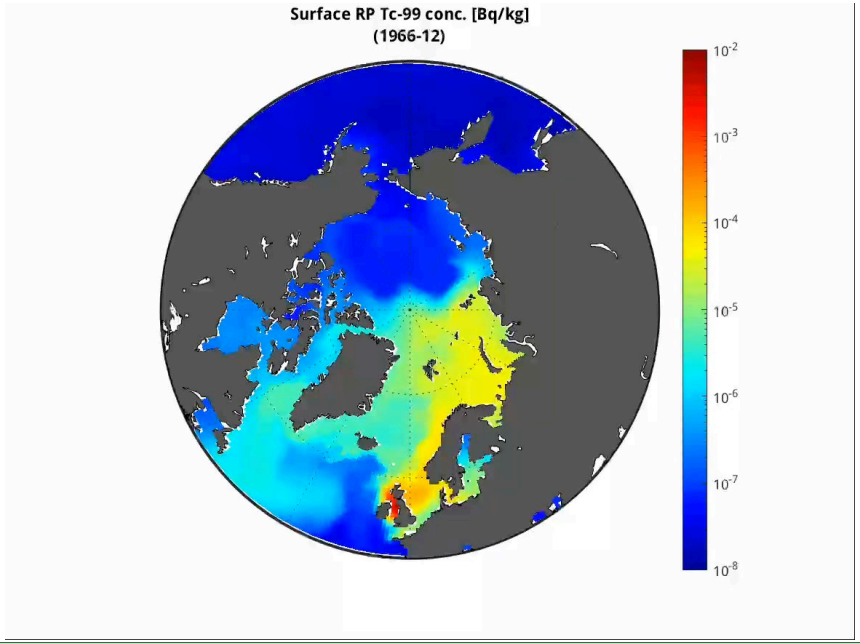
Radioecology and Tracer studies

- Geological dating (Pb-210, C-14)
- Soil erosion (Cs-137, Pu-239,240)
- Oceanographic studies (Tc-99, I-129, U-233,236, H-3)
- Sedimentation (Th-234, U-238, Pb-210, Pu-239, 240, Cs-137)
- Air pollution (Be-7,10, Pb-210, Po-210)









Monitoring of Environmental Radioactivity

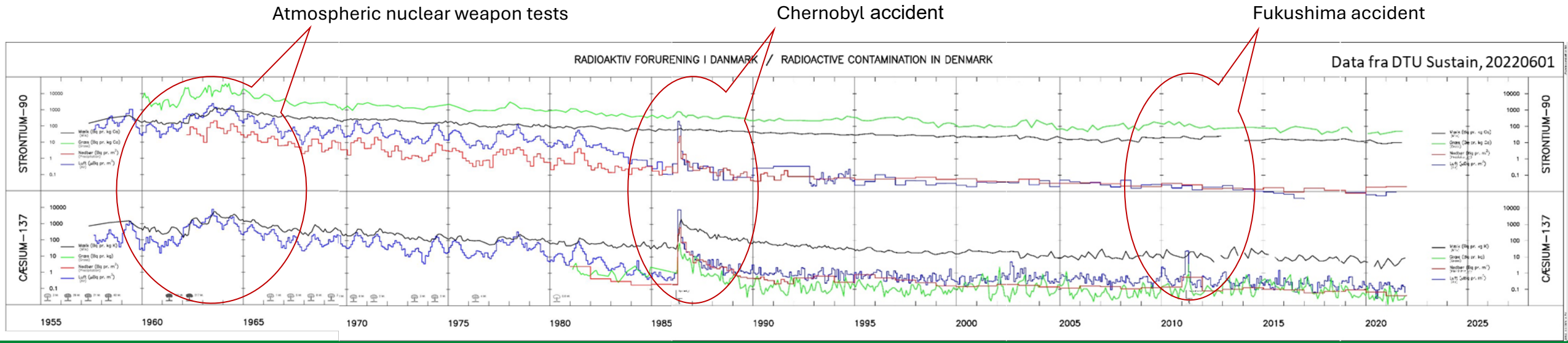
Regions:

- Risø site
- Denmark
- Greenland
- Faroe Islands

= Routine samples

Sample type and radionuclides:

- Air, water, soil, vegetation, food
- γ, ^{3}H, ^{137}Cs, ^{90}Sr, ^{99}Tc, $^{239,240}Pu$, ^{237}Np
- 2000 analysis/year



Gamma-ray spectrometry laboratory

10 HPGe detectors

Type:

- 5 low background
- 6 ultra-low background

Geometry:

- 1 Well
- 4 Coaxial
- 5 Planar

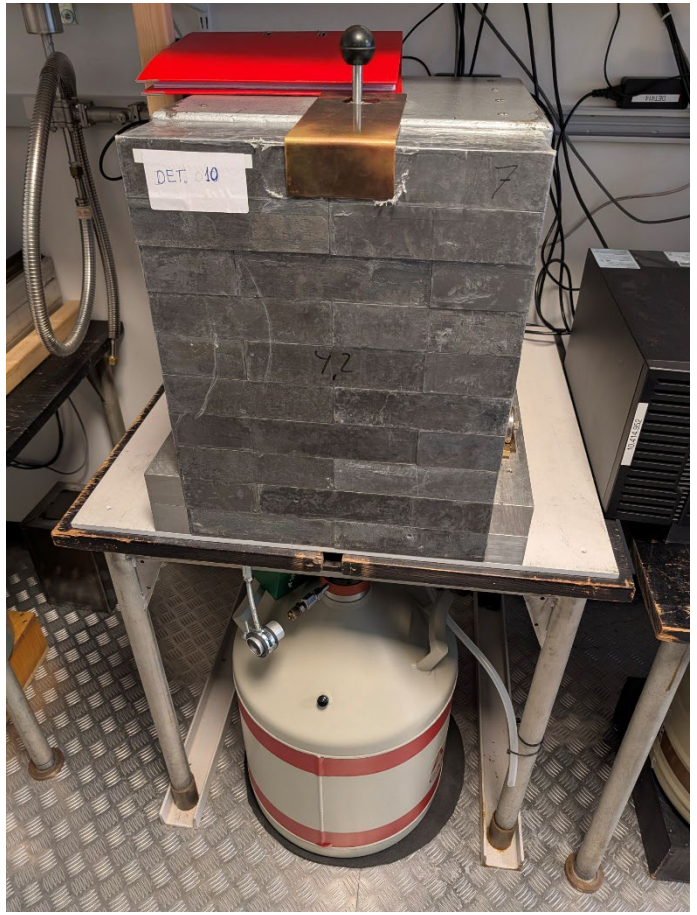
Name	Geometry/Model	Entrance window	Relative Eff (%)
Det002	Coaxial/GEM-35190	Al	
Det003	Coaxial/GMX-33200-S	Be	33
Det006	Planar/ BE3830 ULB	Carbon Epoxy	35
Det007	Well/GCW5023/S ULB	Al	50
Det008	Planar/BE5030 ULB	Carbon Epoxy	48
Det009	Planar/ BE5030 ULB	Carbon Epoxy	48
Det010	Planar/ BE5030 ULB	Carbon Epoxy	48
Det011	Planar/BE5030 ULB	Carbon Epoxy	48
Det083	Coaxial/ GC6020	Al	64
Det952	Coaxial/ GMX-30200 LB	Be	30

+ 2 NaI detectors

Gamma-ray spectrometry laboratory

Typical setup

- Liquid nitrogen cooling
- Standard shield: 10 cm low background Pb
  + few mm Cu or Cd
- Acquisition: 2 Mirion DSA-LX
  2 Canberra AIM
  6 Mirion LYNX-II
- Software: Mirion Genie 3.4



Typical setup

Full Energy Peak efficiency calibration

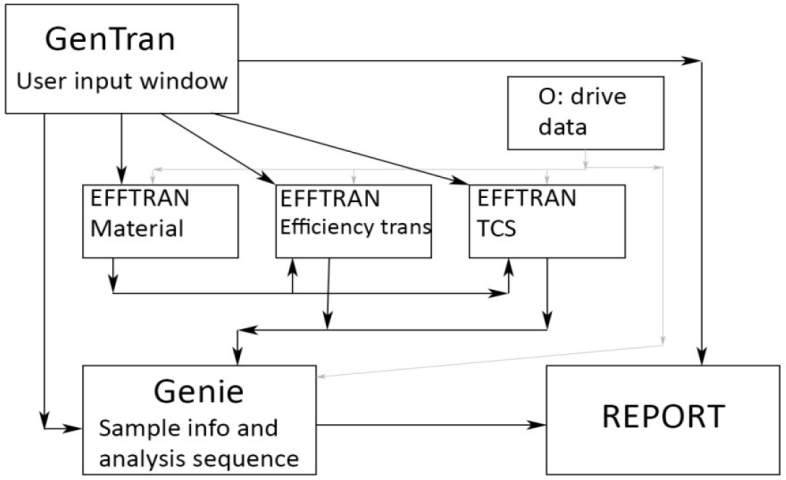
- Calibration using a multinuclides from SI traceable solution
- Efficiency transfer technique + coincidence summing corrections using EFFTRAN
- Geometries:

Environmental samples:

Efficiency calibration at different heights, except Marinelli

Sample analysis: GenTran

Data flow



EFFTRAN: efficiency transfer (geometry + self-absorption) and TCS correction

Genie2000: peak identification, background subtraction, nuclide identification in Analysis Sequence (using batch commands)

All data (calibrations, background spectra, detector description, ASF …) on local O drive

[GenTran - user interface for Genie2000/EFFTRAN based gamma analysis,](#)

[Nikola Markovic](#)

NKS GammaSpec 2017

GUI running EFFTRAN & Genie in the background

→ user select file & provide sample information

→ adjust material (density) and send to EFFTRAN
→ select FEP eff. calibration (closest calib. geometry)
→ ask EFFTRAN for efficiency transfer
→ ask EFFTRAN for TCS correction
→ send corrected FEP efficiencies to Genie
→ call Genie Analysis Sequence
(peak, background, nuclide)

→ final check by user with 'Interactive Peak fit'

→ build a report

Sample database

- All routine sample have a number YYYY-XXXX (L)
- A SQL database has been built to store:

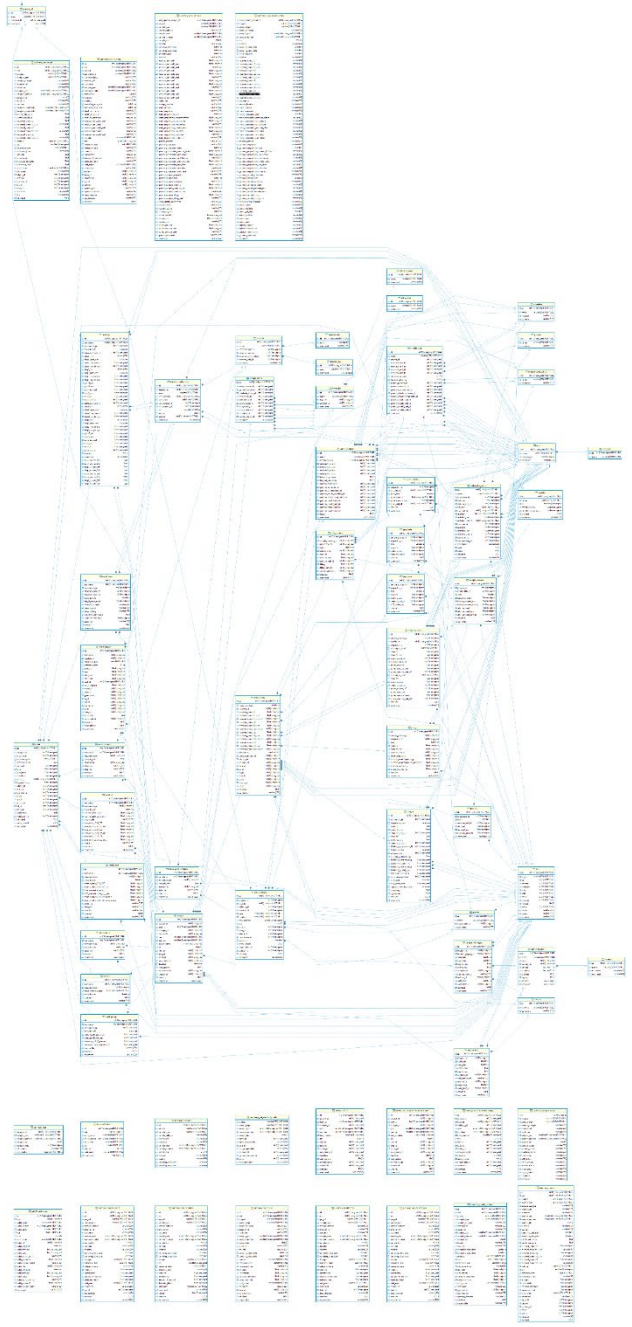
➢ sample information (type, collection date, amount,...)

➢ sample preparation (process, container, amount in container, height,...)

➢ results from gamma-ray measurements, but also others (alpha, beta)

- Interface to interact with the SQL database:

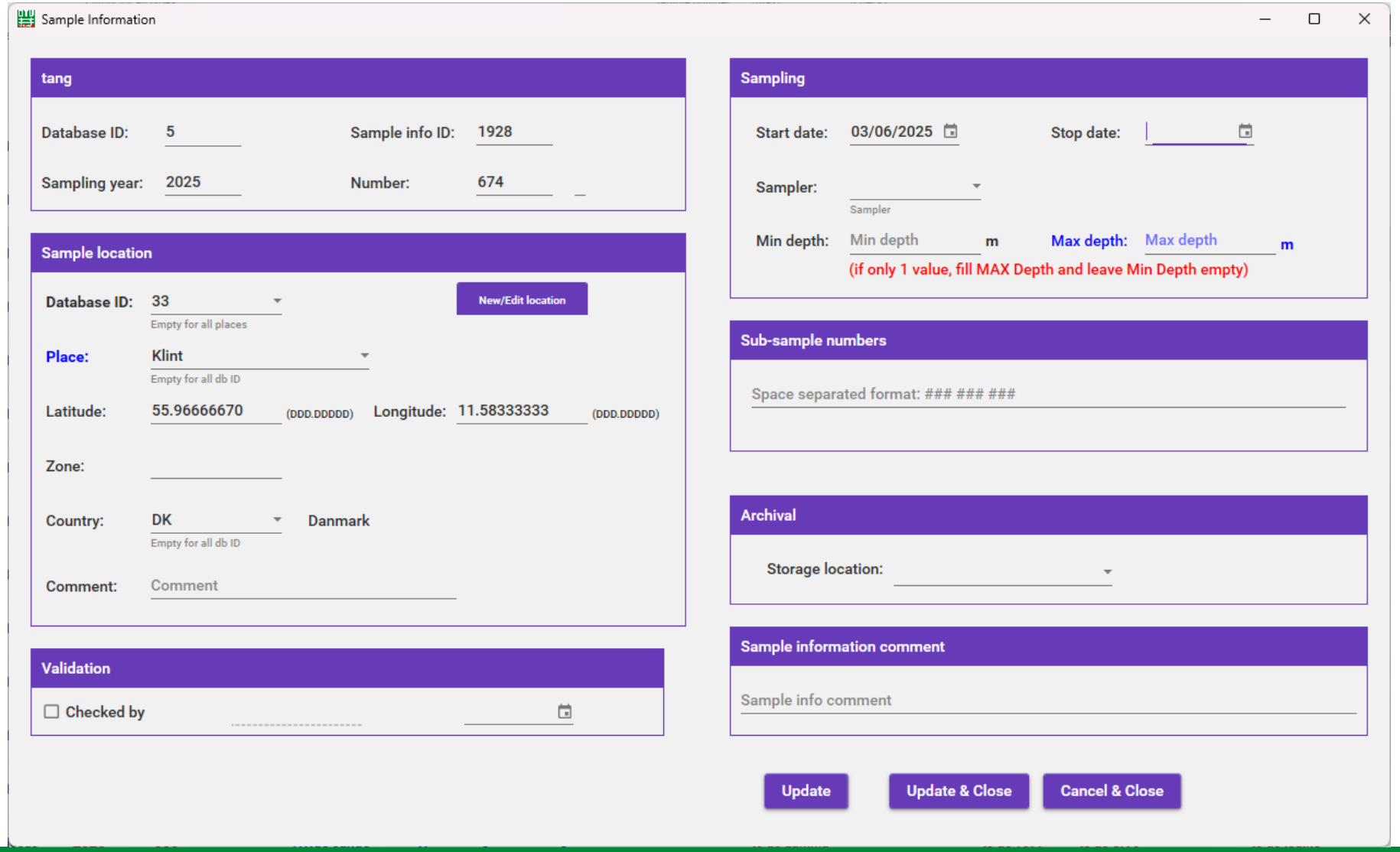
  GUI software written in C# + WPF



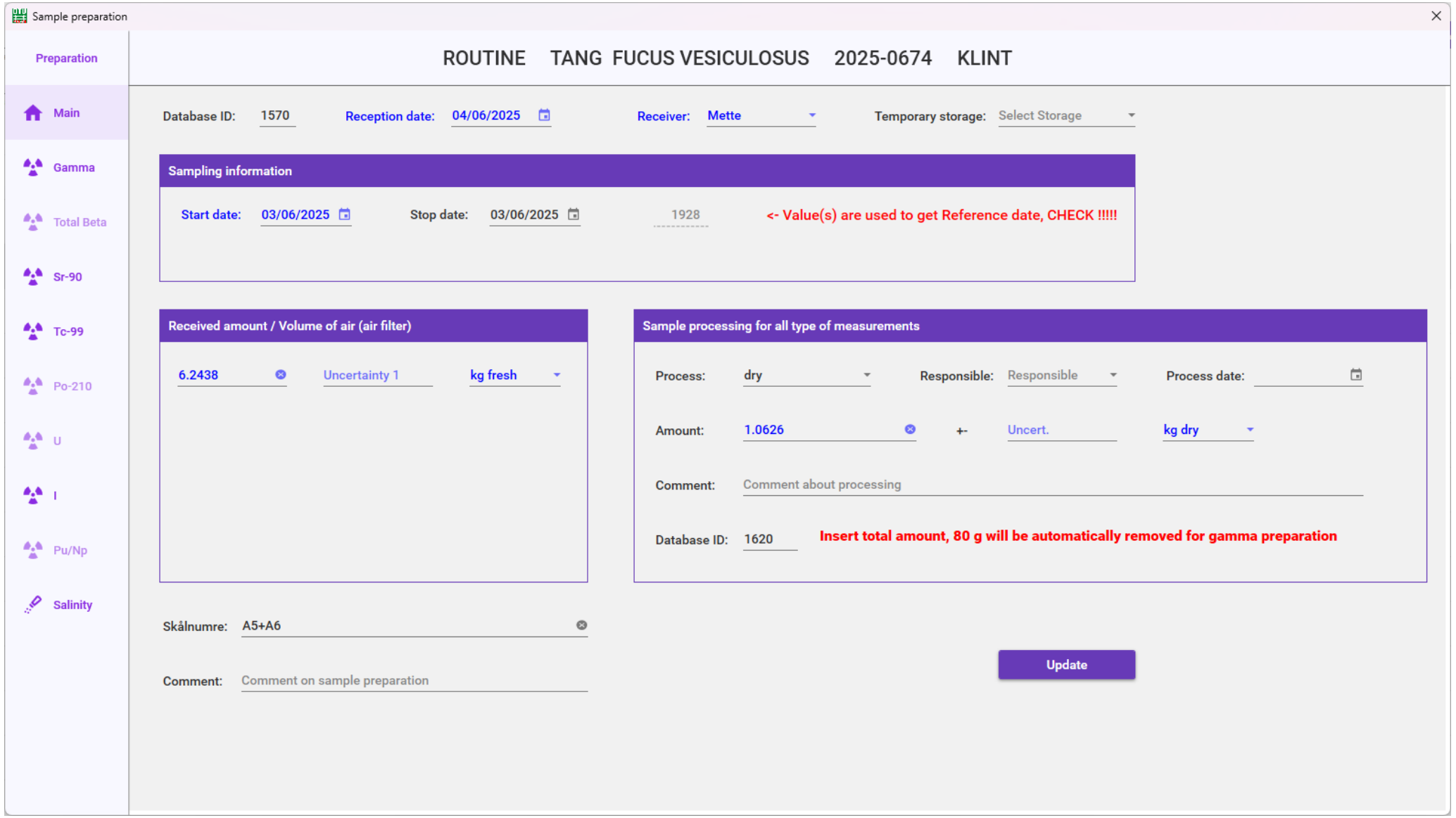
Sample registration

Project	Type	SubType	Year	Number	Place	Info	Prep	Result(s)	Status	Gamma	TotalBeta	Tc99	Sr90	Po210	Iodine	Pu+Np	Ur	Cl
routine	tang	fucus vesiculosus	2025	671	Risø	X	X	X	ongoing	analysed gamma		to do Tc99	to do Sr90		to do iodine			to do salinity
routine	tang	fucus vesiculosus	2025	673	Klint	X	X	X	ongoing	checked gamma		to do Tc99	to do Sr90		to do iodine			done salinity
routine	tang	fucus vesiculosus	2025	674	Klint	X	X	X	ongoing	checked gamma		to do Tc99	to do Sr90		to do iodine			done salinity
routine	tang	fucus vesiculosus	2025	675	Klint	X	X	O	ongoing	ready for gamma		to do Tc99	to do Sr90		to do iodine			to do salinity
routine	tang	fucus vesiculosus	2025	676	Klint	X	O	O		to do gamma		to do Tc99	to do Sr90		to do iodine			to do salinity
routine	tang	fucus vesiculosus	2025	677	Svenskehavn	X	X	X	ongoing	checked gamma		to do Tc99	to do Sr90		to do iodine			to do salinity
routine	tang	fucus vesiculosus	2025	678	Svenskehavn	X	X	X	ongoing	analysed gamma		to do Tc99	to do Sr90		to do iodine			to do salinity
routine	tang	fucus vesiculosus	2025	679	Svenskehavn	X	X	O	ongoing	ready for gamma		to do Tc99	to do Sr90		to do iodine			to do salinity
routine	tang	fucus vesiculosus	2025	680	Svenskehavn	X	O	O		to do gamma		to do Tc99	to do Sr90		to do iodine			done salinity
routine	tang	fucus vesiculosus	2025	681	Svenskehavn	X	O	O				to do Tc99						
routine	tang	fucus vesiculosus	2025	683	Hvide sande	X	X	X	ongoing	checked gamma		to do Tc99	to do Sr90		to do iodine			to do salinity
routine	tang	fucus vesiculosus	2025	684	Hvide sande	X	X	X	ongoing	analysed gamma		to do Tc99	to do Sr90		to do iodine			done salinity
routine	tang	fucus vesiculosus	2025	685	Hvide sande	X	X	O	ongoing	ready for gamma		to do Tc99	to do Sr90		to do iodine			to do salinity
routine	tang	fucus vesiculosus	2025	686	Hvide sande	X	O	O		to do gamma		to do Tc99	to do Sr90		to do iodine			to do salinity

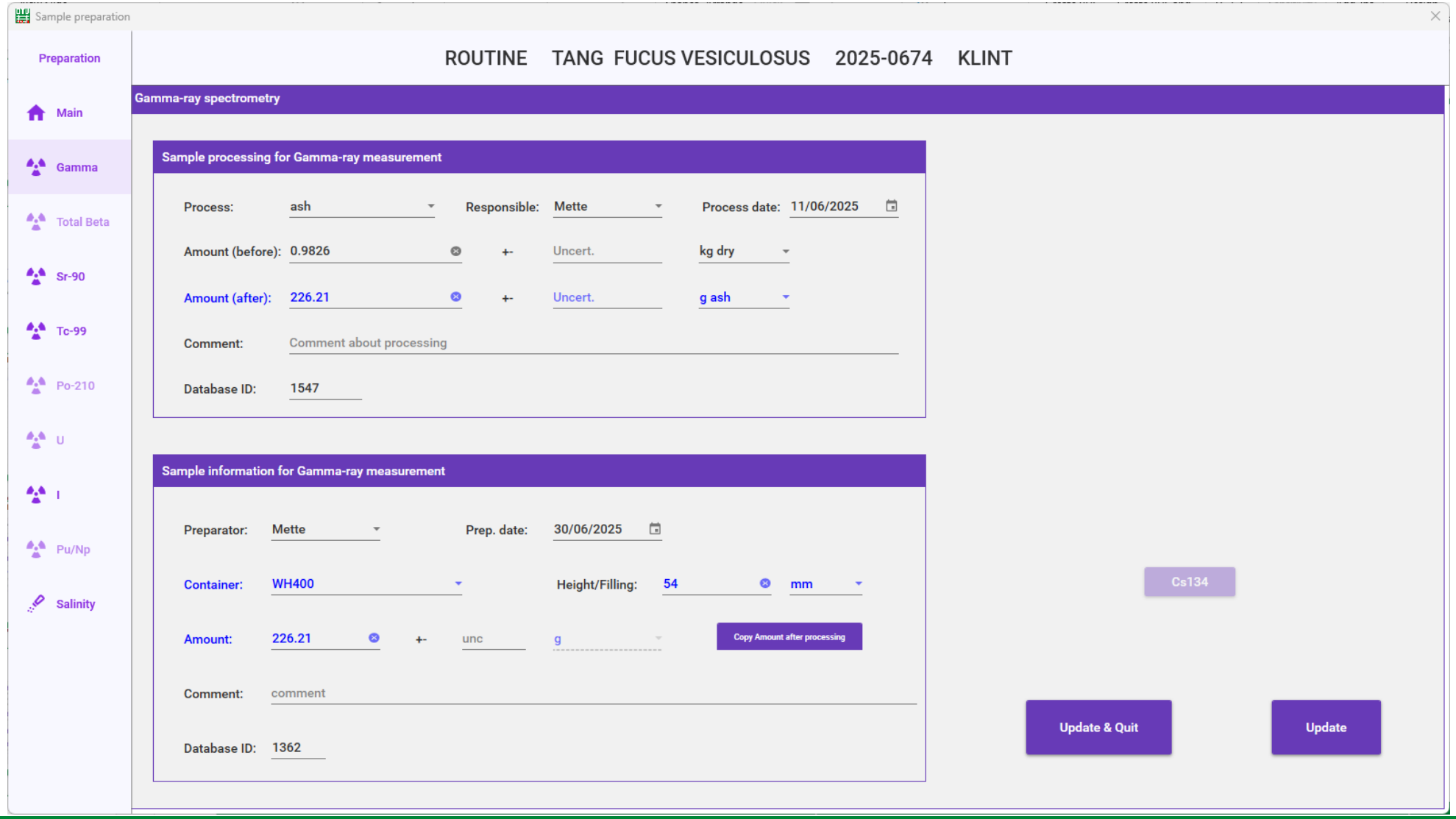
Sampling information



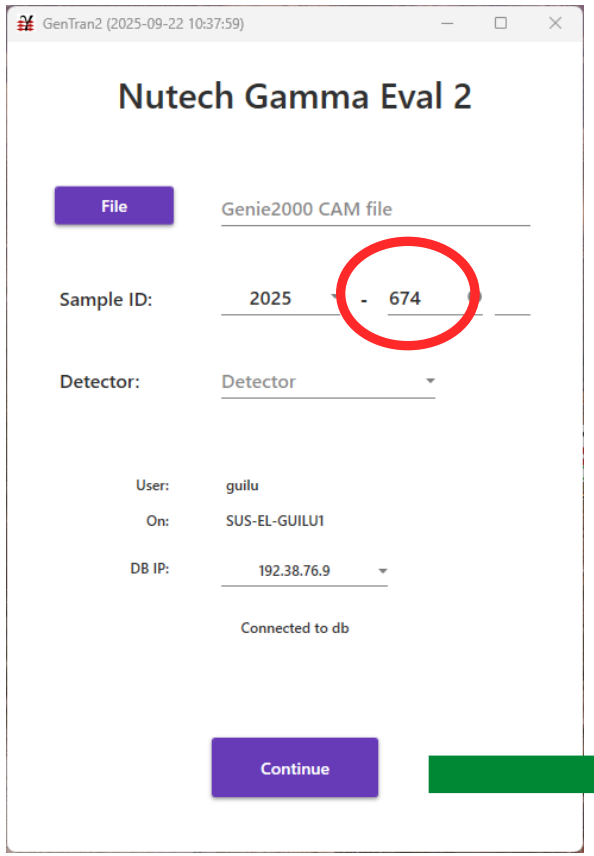
Sample registration at arrival



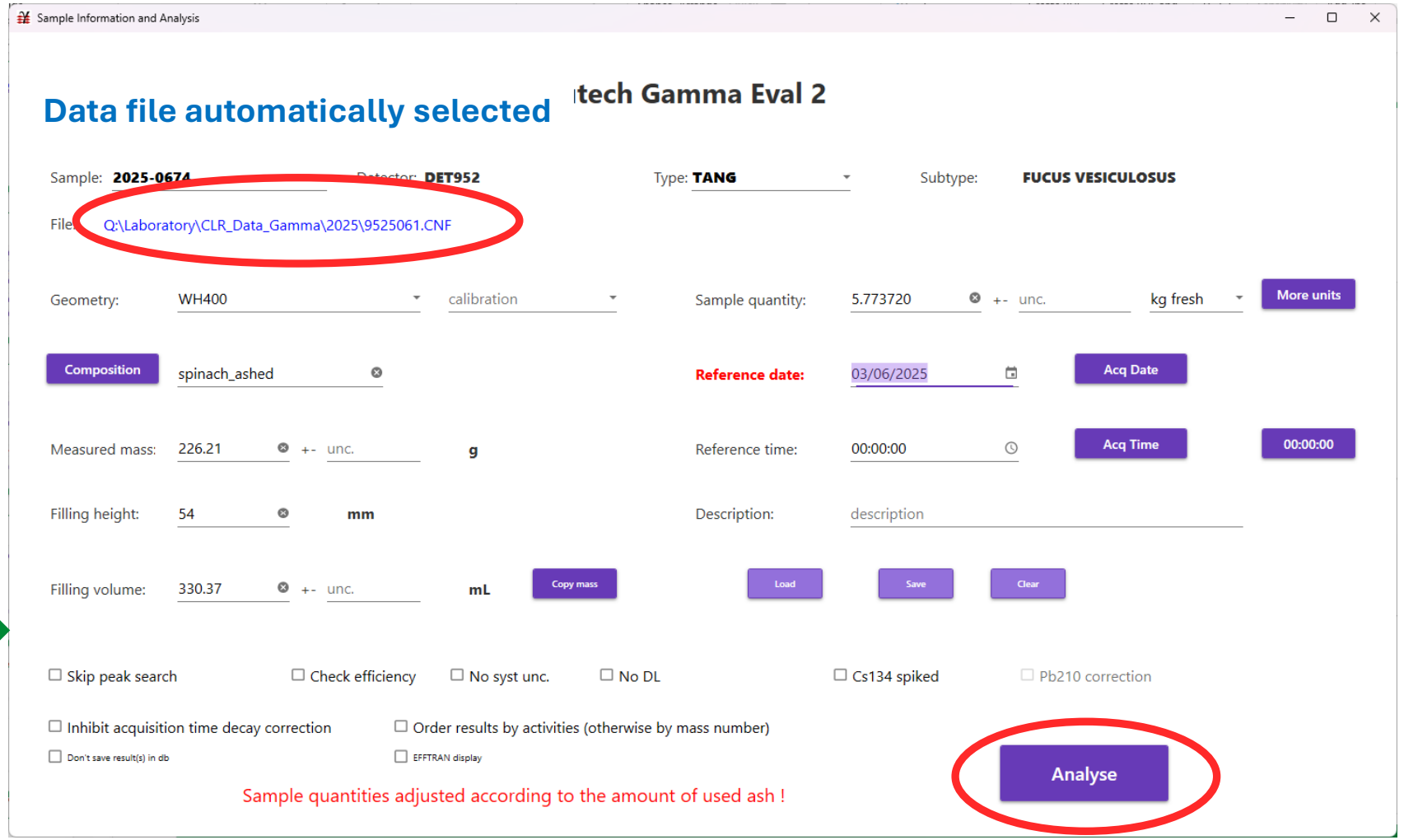
Sample preparation



GenTran 2



Sample data from DB



The process is very similar to the original GenTran

Check + ‘Analyse’

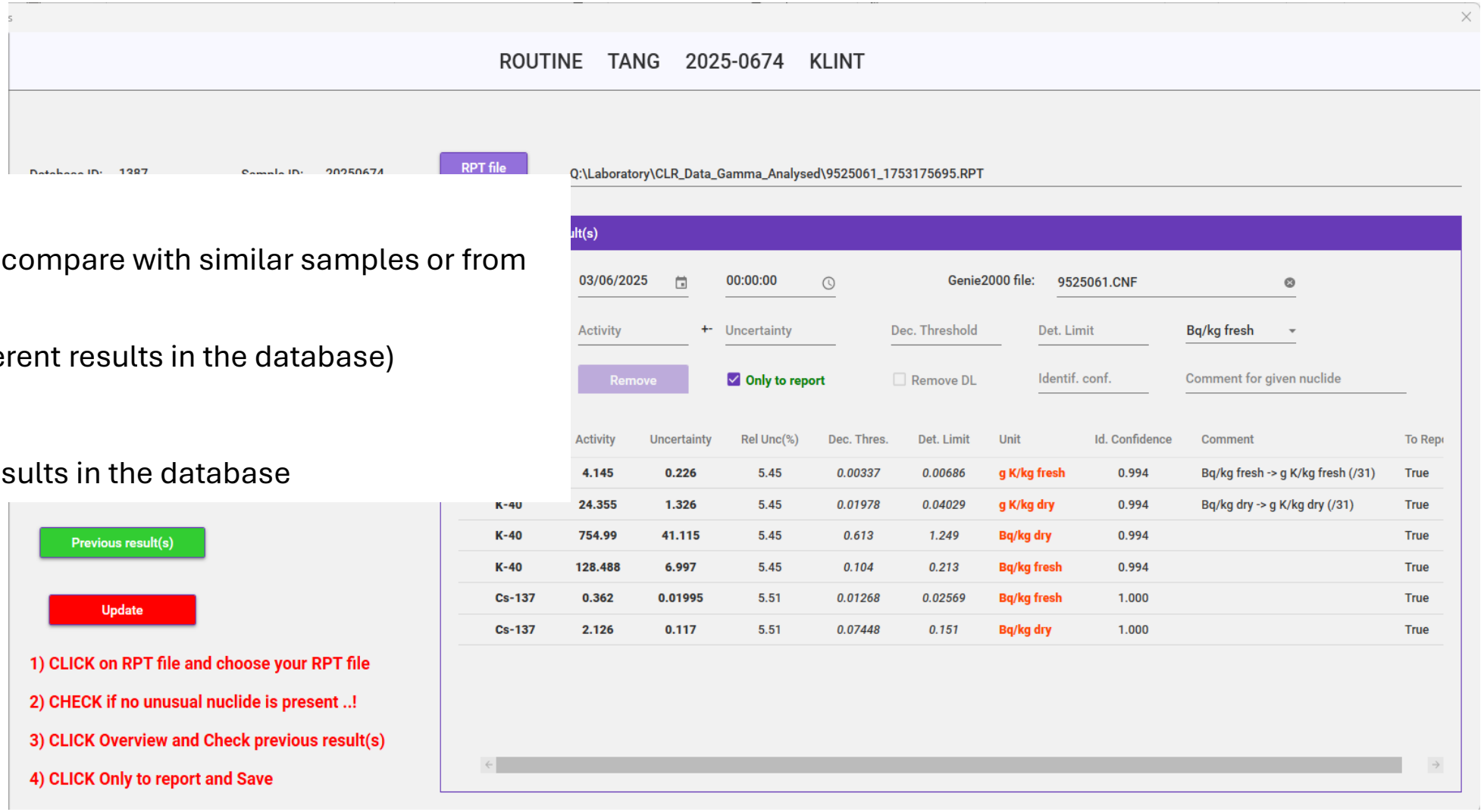
GenTran 2: Results

Analyst must check:

List of nuclides present and compare with similar samples or from previous years

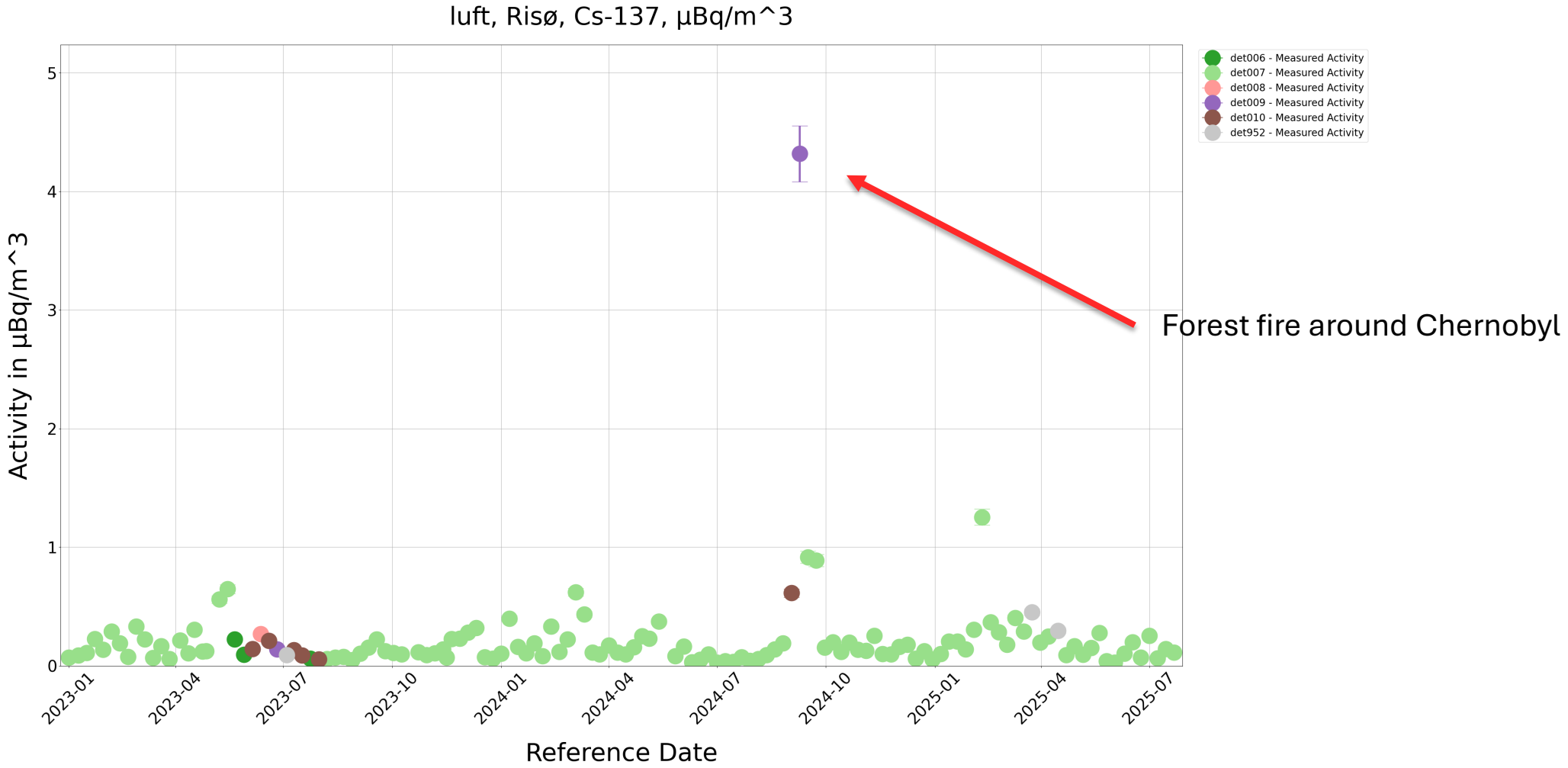
(Excel file generate with different results in the database)

Then analyst can save the results in the database



How to use data ?

Basic python script to display data:



Special setup for special samples

→ None routine sample

Coaxial detector with ‘high’ background (Cs-137 contaminated)

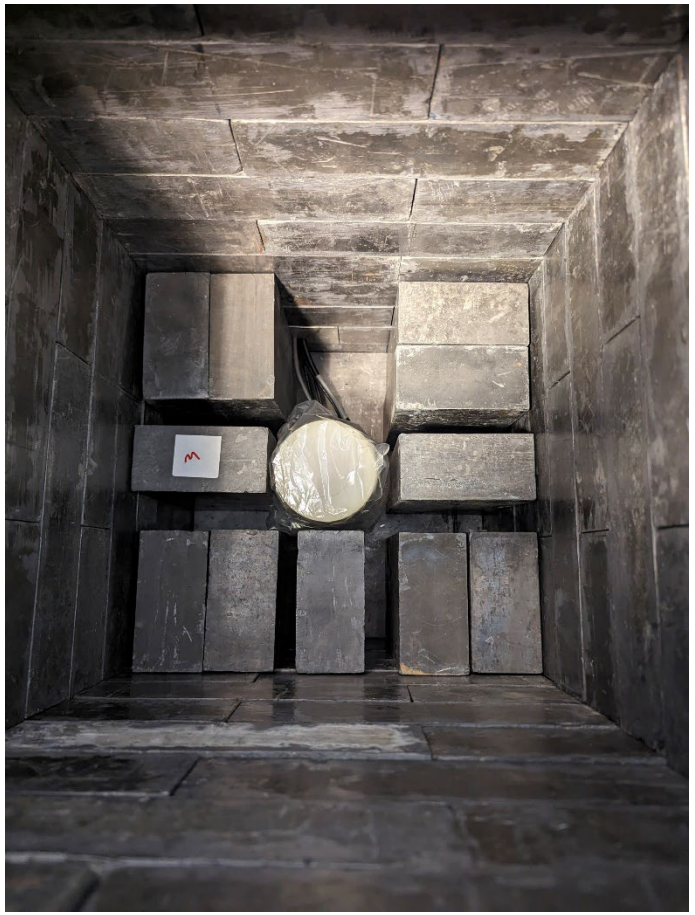
Shield 10 cm Pb only

Wide space inside the shield:

30 cm x 30 cm x 40 cm

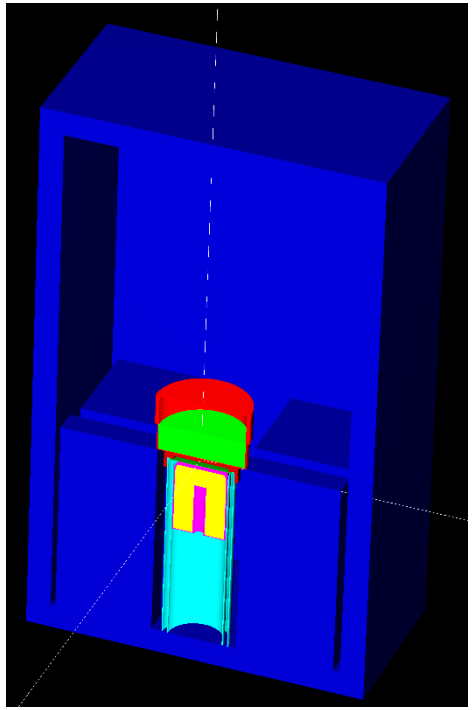
Sample holders

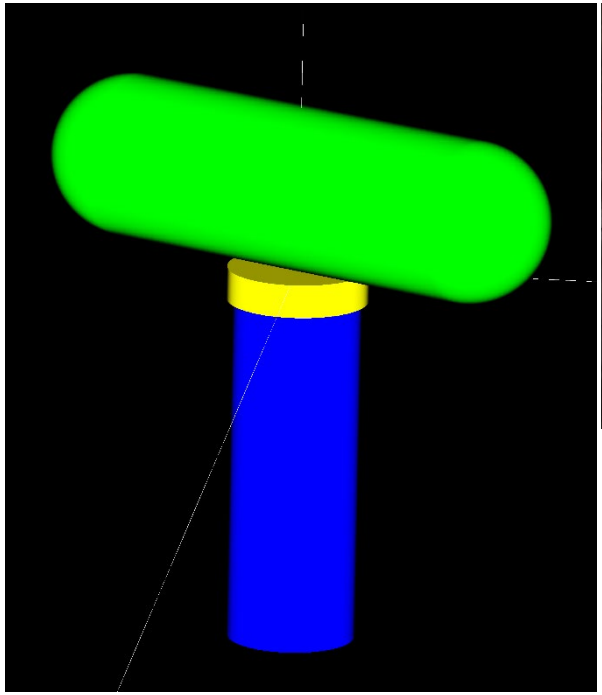
Special shield



Special setup: Monte Carlo Model

- Based on EGSnrc
- Validated using point sources, multinuclides standard, previous proficiency test samples at different distances endcap-sample





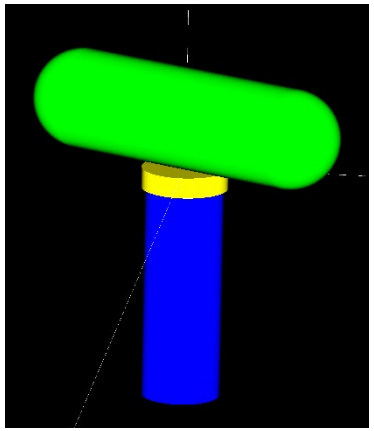
(Pb not displayed)

Special setup: Monte Carlo performance, Gas bottle

Point source placed at the top of the sample

Relative differences between the experimental setup and the associated MC model:

- Cs-137 point source: -3%
- Co-60 point source: 0.2%
- Ba-133 point source: -7%
- Ra-226 point source: -15%



Future

- Increase/improve measurement capacity ☺

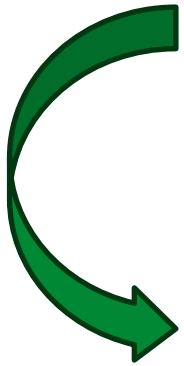
- GenTran 3:

  GenTran 2 with command line

  → automatic analysis

  Software partly written and test started

BUT



Need to check and validate automatic results !

Include possibily of ‘detection’ of none usual nuclides

Traditional check by software ?

Check using local AI ?

(Still) all samples need to be checked by the responsible after analysis ?