

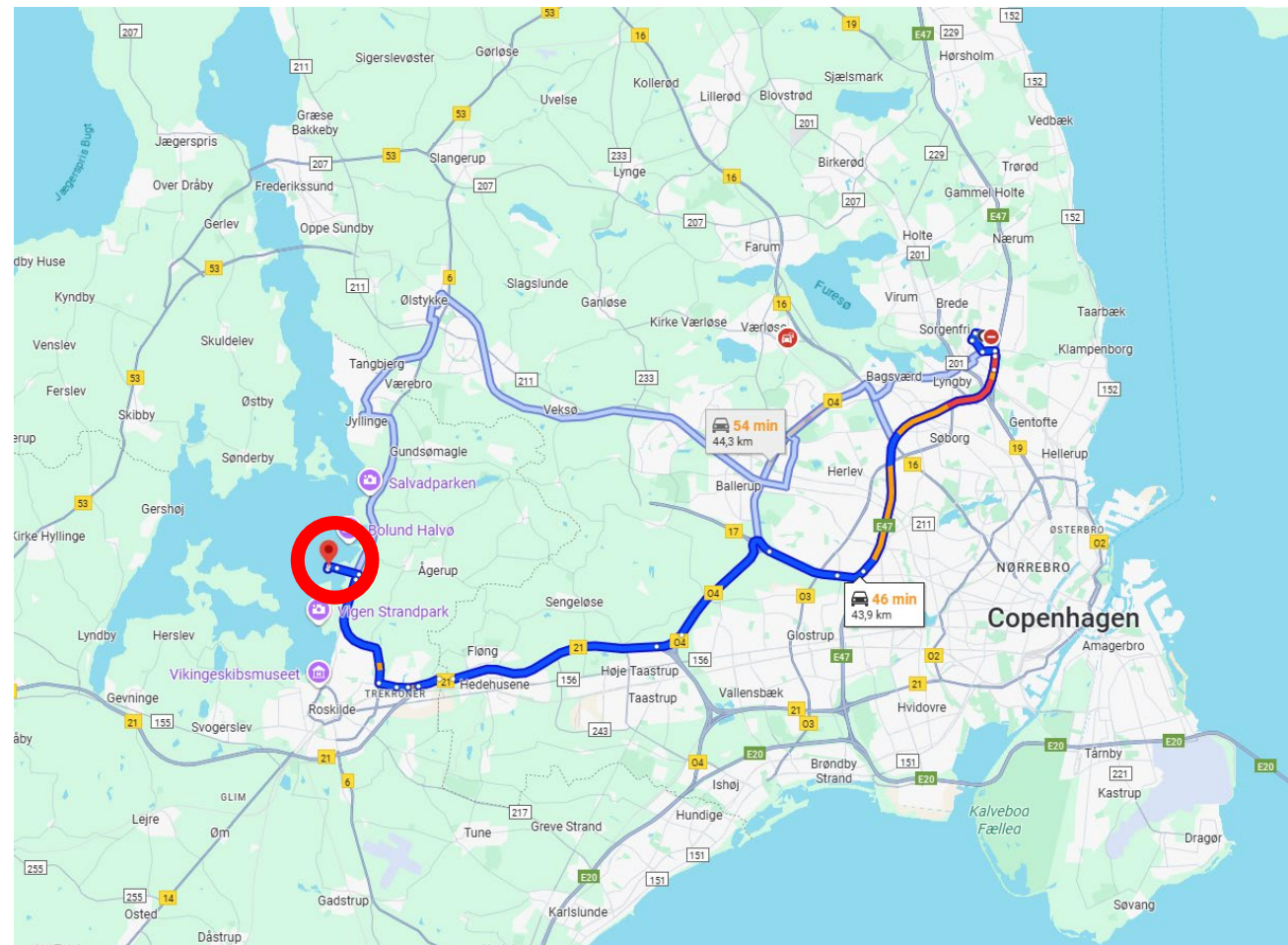
Gamma Laboratory Risø

Guillaume Lutter, DTU

NKS GammaAI 2025, 08-09 October 2025

Radioecology and Tracer Studies (RTS)

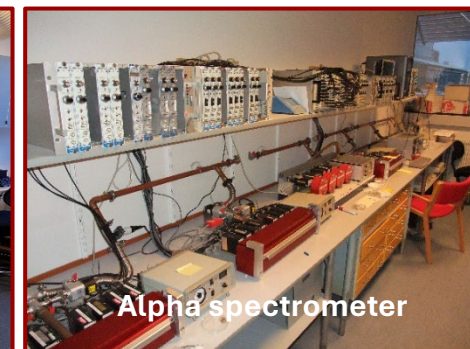
- 1956-2006: Risø National Laboratory
- 2007-2011: Risø DTU
- 2012-2019: DTU Nutech
- 2020-2022: DTU Environment
- 2022-present: DTU Sustain



Radioecology and Tracer Studies (RTS)



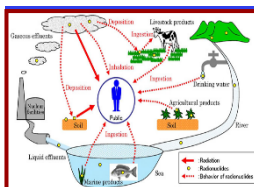
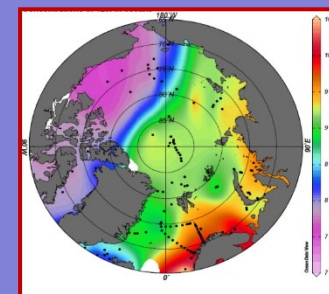
- 6 x Chemistry lab (22 fume hoods)
- 1 x seawater lab (2 fume hoods, 3 work stations)
- 1 x sample preparation building (2 fume hoods, 8 ovens, 3 drying cabinets)
- 16 x alpha spectrometers
- 12 x (low-bkg) gamma spectrometers
- 35 x low-bkg gas flow beta counters
- 2 x low-bkg LSC (Quantulus, Tricap)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



Main activities

Radioecology & Tracer study

**Development of
radioanalytical
methods**



Environment monitoring

Scientific advice

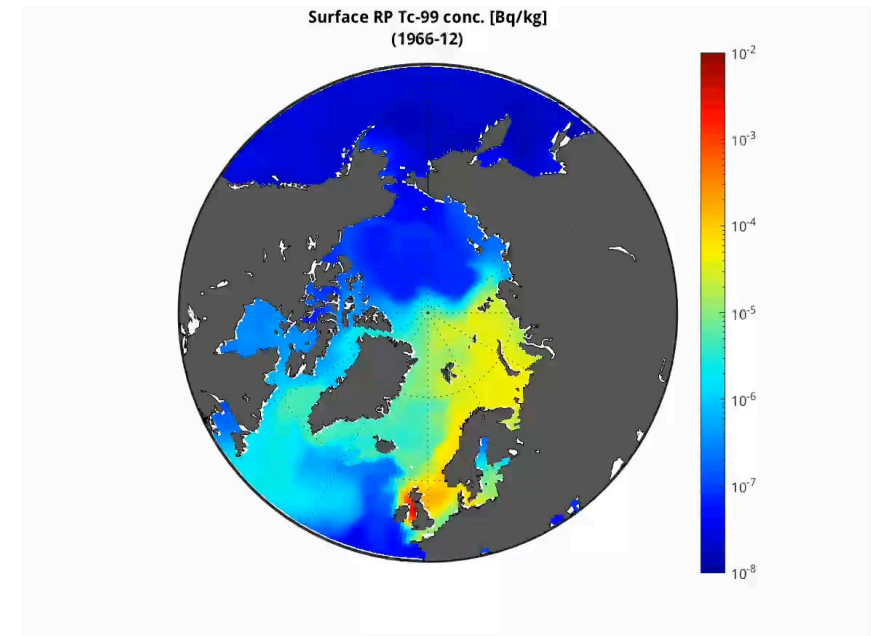
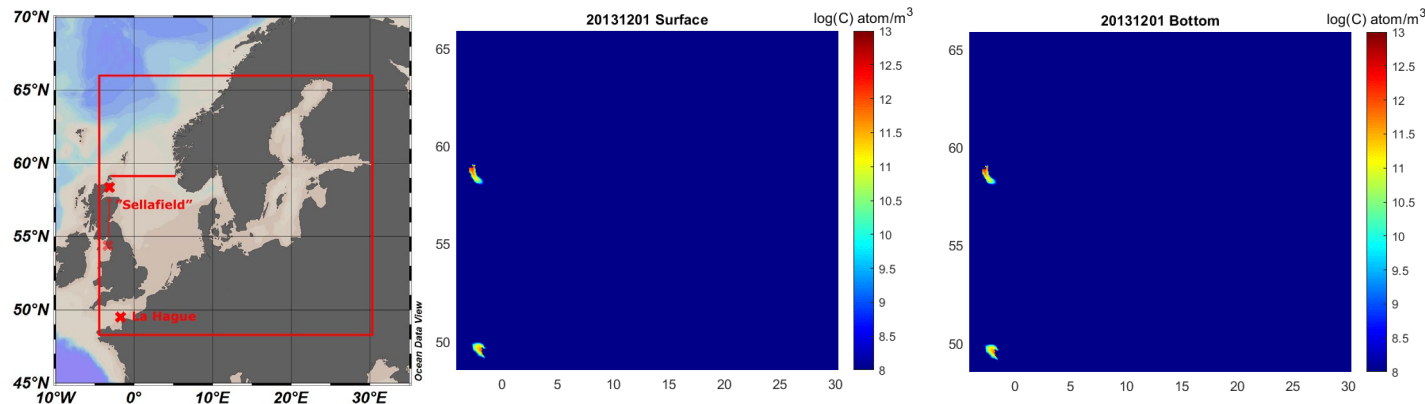
Scientific Advice (commercial service)



- 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:

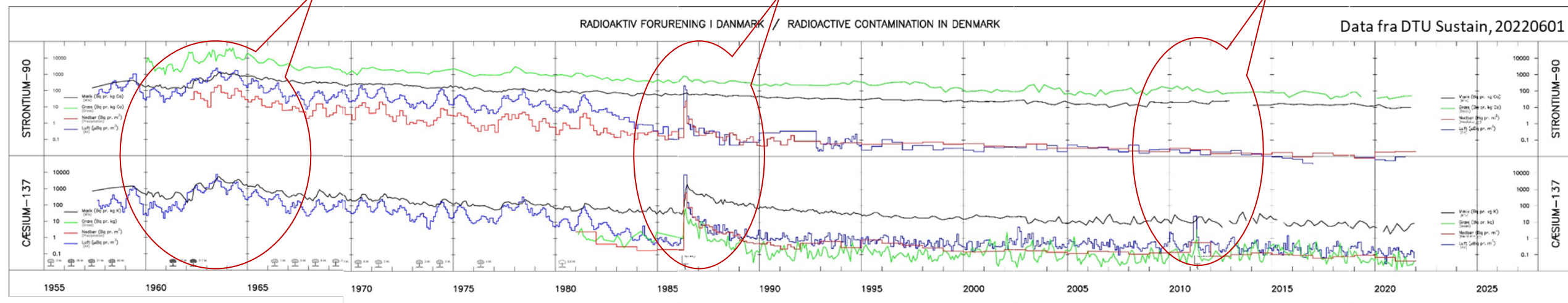
- Air, water, soil, vegetation, food
- γ , ^3H , ^{137}Cs , ^{90}Sr , ^{99}Tc , $^{239,240}\text{Pu}$, ^{237}Np
- 2000 analysis/year



Atmospheric nuclear weapon tests

Chernobyl accident

Fukushima accident



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

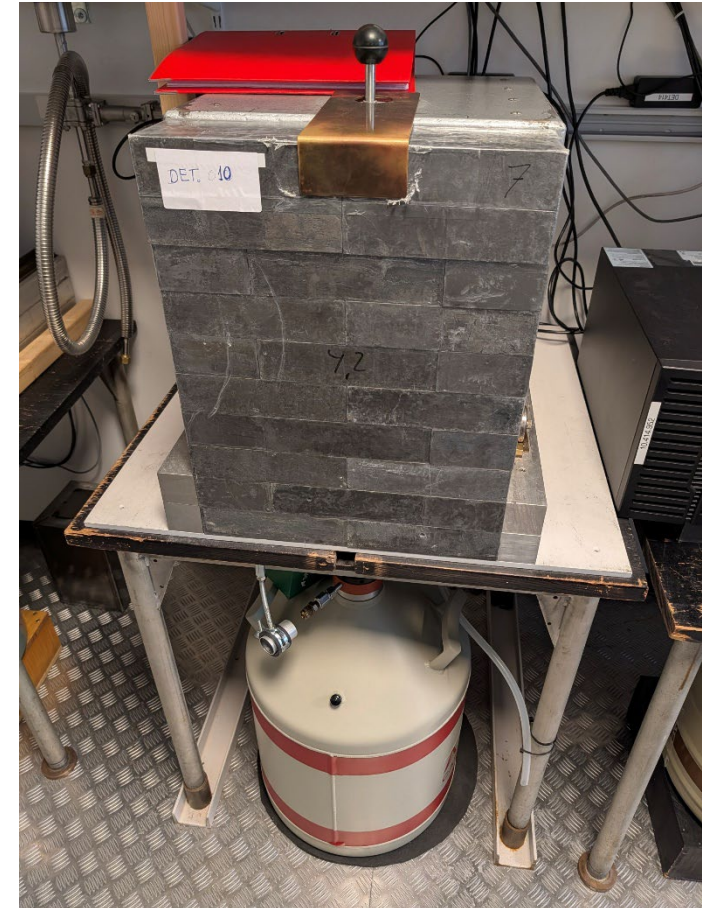
+ 2 NaI detectors

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:

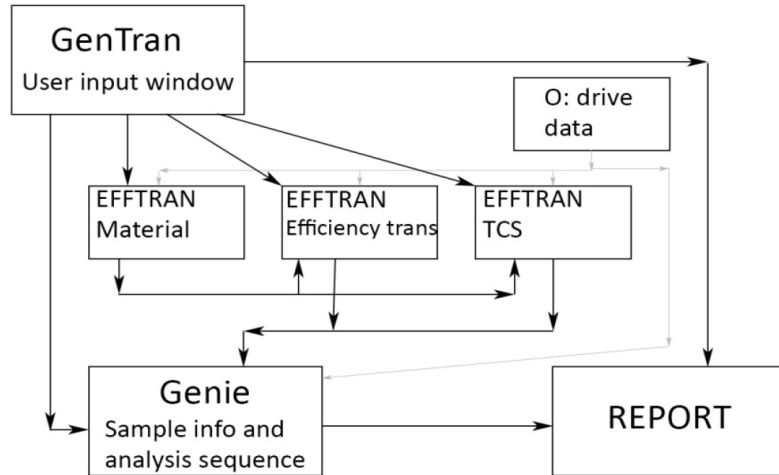
Environmental samples:

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)

- 7 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

DTU Samples

Project: routine

Sample Type: tang

Year: 2025

☐ All

Number: Number

Number

Database: rts

Main Status:

Sub. Status:

29 samples selected (0 cancelled & not shown)

Load

DB Inputs

Create Routine

New Sample

Import Old data

	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	0	ongoing	ready for gamma		to do Tc99	to do Sr90		to do iodine			to do salinity
	routine	tang	fucus vesiculosus	2025	676	Klint	X	0	0		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	0	ongoing	ready for gamma		to do Tc99	to do Sr90		to do iodine			to do salinity
	routine	tang	fucus vesiculosus	2025	680	Svenskehavn	X	0	0		to do gamma		to do Tc99	to do Sr90		to do iodine			done salinity
	routine	tang	fucus vesiculosus	2025	681	Svenskehavn	X	0	0				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	0	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	0	0		to do gamma		to do Tc99	to do Sr90		to do iodine			to do salinity

(Double-click to change items in blue)

Sampling information

Sample Information

tang

Database ID: 5

Sample info ID: 1928

Sampling year: 2025

Number: 674

Sample location

Database ID: 33

New/Edit location

Place: Klint

Latitude: 55.96666670 (DDD.DDDDD)

Longitude: 11.58333333 (DDD.DDDDD)

Zone:

Country: DK

Danmark

Comment: Comment

Validation

Checked by

Sampling

Start date: 03/06/2025

Stop date:

Sampler:

Sampler

Min depth: Min depth m

Max depth: Max depth m

(if only 1 value, fill MAX Depth and leave Min Depth empty)

Sub-sample numbers

Space separated format: ### ### ###

Archival

Storage location:

Sample information comment

Sample info comment

Update

Update & Close

Cancel & Close

Sample registration at arrival

Preparation

Main

Gamma

Total Beta

Sr-90

Tc-99

Po-210

U

I

Pu/Np

Salinity

ROUTINE TANG FUCUS VESICULOSUS 2025-0674 KLINT

Database ID: 1570

Reception date: 04/06/2025

Receiver: Mette

Temporary storage: Select Storage

Sampling information

Start date: 03/06/2025

Stop date: 03/06/2025

1928

<- Value(s) are used to get Reference date, CHECK !!!!!

Received amount / Volume of air (air filter)

6.2438

Uncertainty 1

kg fresh

Sample processing for all type of measurements

Process: dry

Responsible: Responsible

Process date:

Amount: 1.0626

+-

Uncert.

kg dry

Comment: Comment about processing

Database ID: 1620

Insert total amount, 80 g will be automatically removed for gamma preparation

Skålnumre: A5+A6

Comment: Comment on sample preparation

Update

Sample preparation

Preparation

Main

Gamma

Total Beta

Sr-90

Tc-99

Po-210

U

I

Pu/Np

Salinity

ROUTINE TANG FUCUS VESICULOSUS 2025-0674 KLINT

Gamma-ray spectrometry

Sample processing for Gamma-ray measurement

Process: ash Responsible: Mette Process date: 11/06/2025

Amount (before): 0.9826

Uncert.

kg dry

Amount (after): 226.21

Uncert.

g ash

Comment: Comment about processing

Database ID: 1547

Sample information for Gamma-ray measurement

Preparator: Mette Prep. date: 30/06/2025

Container: WH400

Height/Filling: 54 mm

Amount: 226.21

unc

g

Comment: comment

Database ID: 1362

Cs134

Update & Quit

Update

Technical University of Denmark

19

GenTran 2

GenTran2 (2025-09-22 10:37:59)

Nutech Gamma Eval 2

File Genie2000 CAM file

Sample ID: 2025 - 674

Detector: Detector

User: guilu
On: SUS-EL-GUILU1
DB IP: 192.38.76.9
Connected to db

Continue

Sample data from DB

Sample Information and Analysis

Nutech Gamma Eval 2

Data file automatically selected

Sample: **2025-0674** Detector: **DET952** Type: **TANG** Subtype: **FUCUS VESICULOSUS**

File: Q:\Laboratory\CLR_Data_Gamma\2025\9525061.CNF

Geometry: WH400 calibration Sample quantity: 5.773720 +- unc. kg fresh **More units**

Composition spinach_ashed

Reference date: 03/06/2025 **Acq Date**

Measured mass: 226.21 +- unc. g Reference time: 00:00:00 **Acq Time** 00:00:00

Filling height: 54 mm Description: description

Filling volume: 330.37 +- unc. mL **Copy mass** **Load** **Save** **Clear**

☐ Skip peak search ☐ Check efficiency ☐ No syst unc. ☐ No DL ☐ Cs134 spiked ☐ Pb210 correction

☐ Inhibit acquisition time decay correction ☐ Order results by activities (otherwise by mass number)

☐ Don't save result(s) in db ☐ EFFTRAN display

Sample quantities adjusted according to the amount of used ash !

Analyse

The process is very similar to the original GenTran

Check + 'Analyse'

GenTran 2: Results

ROUTINE TANG 2025-0674 KLINT

Database ID: 1397 Sample ID: 20250674 RPT file Q:\Laboratory\CLR_Data_Gamma_Analysed\9525061_1753175695.RPT

Result(s)

03/06/2025 00:00:00 Genie2000 file: 9525061.CNF

Activity +- Uncertainty Dec. Threshold Det. Limit Bq/kg fresh

Remove ☒ Only to report ☐ Remove DL Identif. conf. Comment for given nuclide

Activity	Uncertainty	Rel Unc(%)	Dec. Thres.	Det. Limit	Unit	Id. Confidence	Comment	To Rep
4.145	0.226	5.45	0.00337	0.00686	g K/kg fresh	0.994	Bq/kg fresh -> g K/kg fresh (/31)	True
K-40	24.355	1.326	5.45	0.01978	0.04029	0.994	Bq/kg dry -> g K/kg dry (/31)	True
K-40	754.99	41.115	5.45	0.613	1.249	0.994		True
K-40	128.488	6.997	5.45	0.104	0.213	0.994		True
Cs-137	0.362	0.01995	5.51	0.01268	0.02569	1.000		True
Cs-137	2.126	0.117	5.51	0.07448	0.151	1.000		True

Previous result(s)

Update

- 1) CLICK on RPT file and choose your RPT file
- 2) CHECK if no unusual nuclide is present ..!
- 3) CLICK Overview and Check previous result(s)
- 4) CLICK Only to report and Save

Analyst must check:

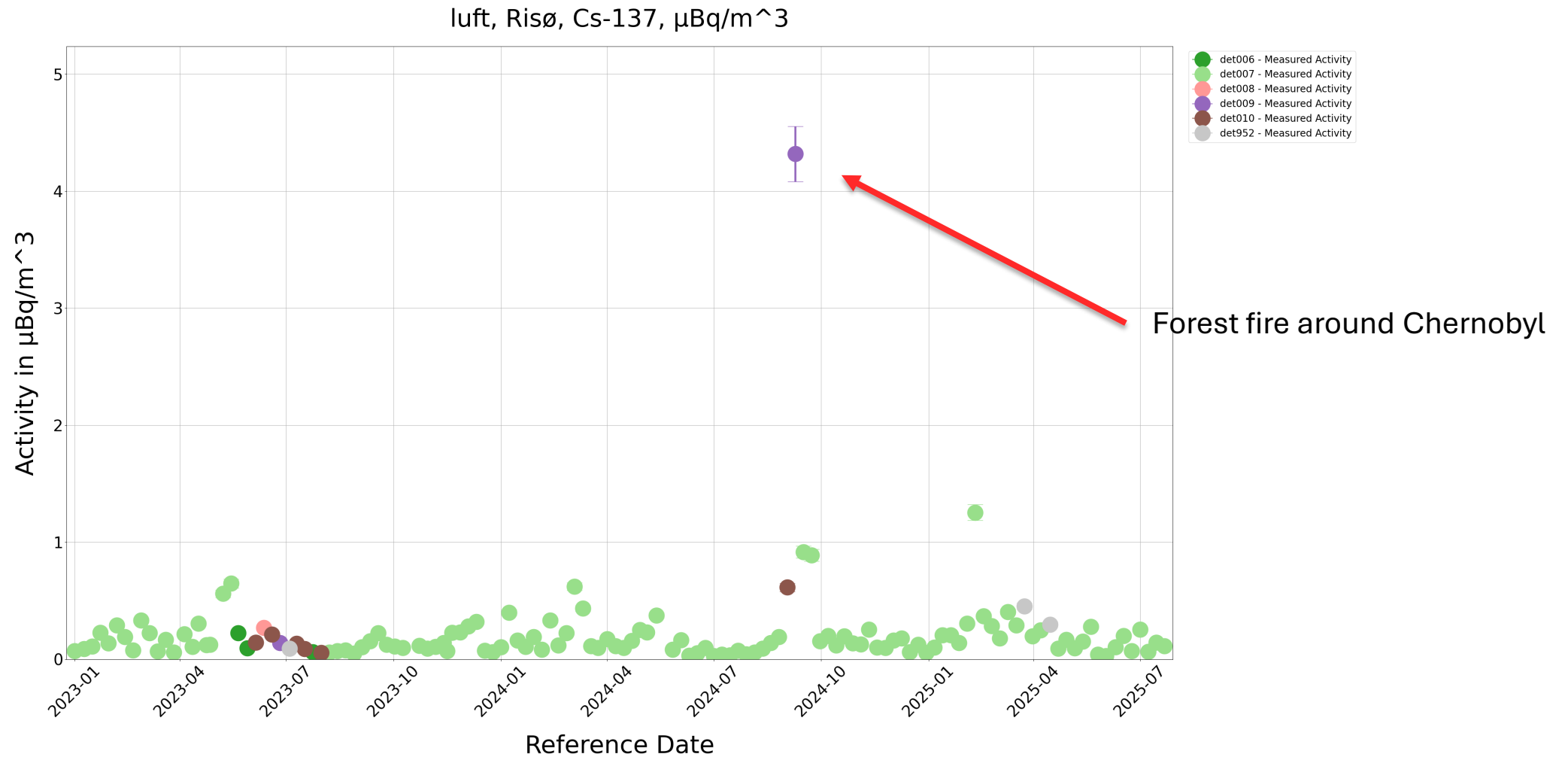
List of nuclides present and compare with similar samples or from previous years

(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

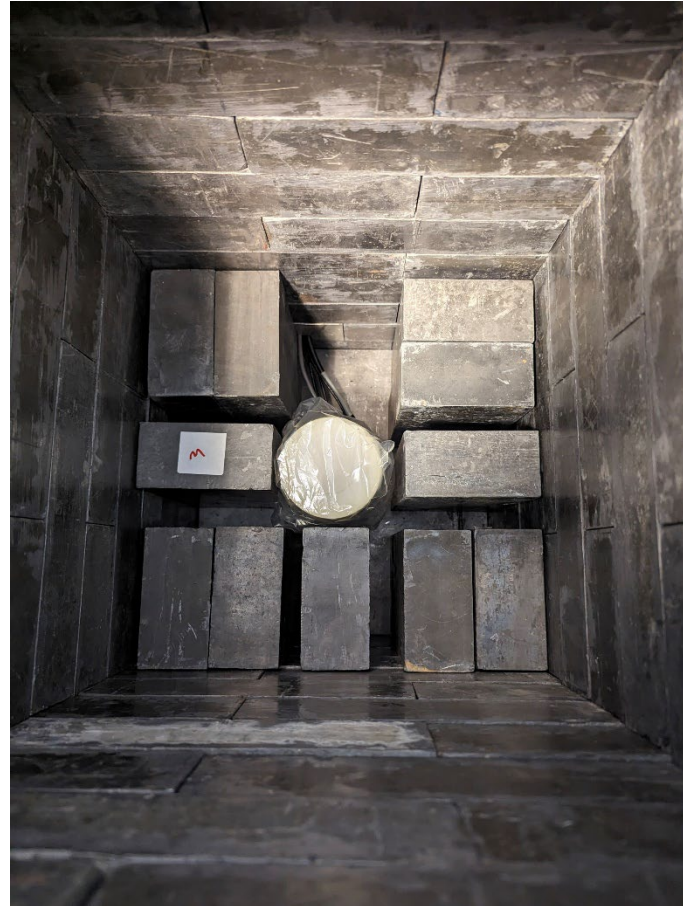
Wide space inside the shield:

30 cm x 30 cm x 40 cm

Sample holders

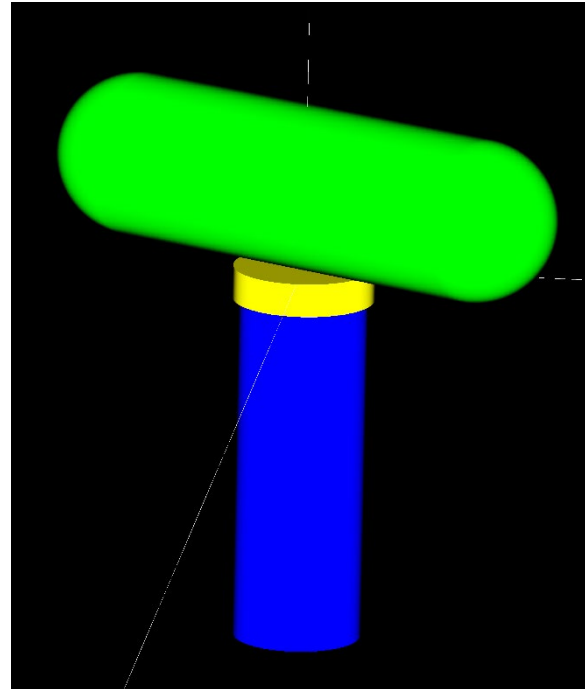
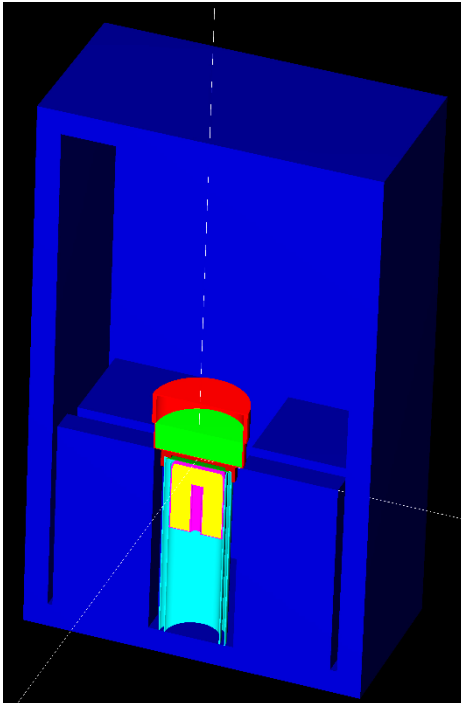


Special shield



Special setup: Monte Carlo Model

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



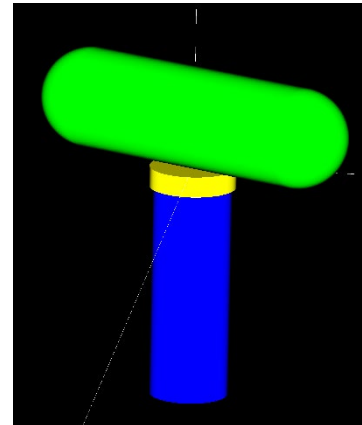
(Pb not displayed)

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 possibility of 'detection' of non usual nuclides

Traditional check by software ?

Check using local AI ?

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