NKS EPHSOGAM: Early Phase Source Term Estimation From Gamma Spectra

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Stockholm, 15-16 January, 2019

Statens strålevern
Norwegian Radiation Protection Authority

www.nrpa.no

Background

Dagbladet INNHOLD VIDEO PLUSS SNARVEIER BLINDERN 3°C

NYHETER Innenriks Utenriks Politikk

MULIG KILDE: Russland sa ikke nøyaktig hva som var kilden til radioaktivitet, men de høyeste nivåene ble funnet i regionen Tsjeljabinsk sør i Uralfjellene. I nærheten ligger byen Majak, som har et av Russlands største atomanlegg. Samtidig nekter russiske myndigheter for at det har vært en ulykke. Her et bilde av Techa-elva, som har blitt kraftig forurenset av atomavfall fra anlegget. Området er nærmest totalt ødelagt som følge av radioaktivitet. Foto: AP Photo/Katherine Jacobsen/NTB Scanpix

Mystisk sky traff Norge. Russland melder om «ekstrem» radioaktivitet, men nekter for atomulykke

Meldt om radioaktiv forurensning i hele Europa, men de vet ennå ikke hvor det kommer fra.

Like 13.3M

Friday, Nov 24th 2017 1PM 6°C 4PM 6°C 5-Day Forecast

MailOnline Science & Tech

Deadly radioactive particles are found across Europe, and scientists have no idea where they came from

- Spike in the levels of radioactive Iodine-131 in Europe was detected in January
- Radioactive particles have moved from Eastern Europe towards the UK
- The particles could have come from a nuclear incident or an iodine plant

By DAISY DUNNE FOR MAILONLINE

PUBLISHED: 14:13 GMT, 20 February 2017 | **UPDATED:** 14:15 GMT, 20 February 2017

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TELEPOLIS > ENERGIE & KLIMA > RUTHENIUM-106: WIEDER EINMAL ERHÖHTE RADIOAKTIVE STRAHLUNG ÜBER EUROPA

Ruthenium-106: Wieder einmal erhöhte radioaktive Strahlung über Europa

12. Oktober 2017 – Florian Rötzer

AKW in Smolensk. Nach Angaben von Rosatom soll die Strahlung nicht aus Russland kommen. Bild: Rosatom

Das BfS nennt als Quelle Russland, dort weist man die Vermutung empört zurück

Vor einigen Tagen meldete das Bundesamt für Strahlenschutz (BfS), dass leicht erhöhte Werte von radioaktivem Ruthenium-106 in Deutschland und in anderen europäischen Ländern wie in der Schweiz, Österreich und Italien seit dem 29. September gemessen wurden.

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News 30.10.2016 11:02 | updated 30.10.2016 11:08

Radiation safety watchdog hunts source of radioactive iodine tagged in air samples

The Finnish Radiation and Nuclear Safety Authority STUK has begun efforts to trace the origin of small quantities of radioactive iodine detected across the country. STUK said that within a one-week period, sensors picked up traces of I-131 in Rovaniemi, Helsinki and Loviisa, but the source of the radioactive substance is still unknown.

STARS AND STRIPES

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Air Force clears the air around specialized 'nuke sniffer' plane deployment

One of the two WC-135 Constant Phoenix jets in the U.S. Air Force parked at RAF Mildenhall, England, Thursday, March 2, 2017. The planes are equipped to sniff out particles in the air such as Iodine-131, which results from nuclear explosions. WILLIAM HOWARD/STARS AND STRIPES

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By WILLIAM HOWARD | STARS AND STRIPES

Published: March 9, 2017

twitter.com/Straalevernet

Background

- October 2016 – application sent to NKS
- January 2017 – project start
- February 2017
- March 2017 – simulation period
- September 2017 – EPHSOGAM
- October 2017
- November 2017 - reporting

I-131

The Independent Barents Observer

Small amounts of the radionuclide iodine-131 of anthropogenic origin was measured in the Pasvik valley in January. Photos: Thomas Nilsen

Radioactive Iodine over Europe first measured in Finnmark

Finland and France went public with information, but Norwegian authorities argue the measurements had no news value.

I-131

The Barents Observer

Small amounts of the radioactive iodine of anthropogenic origin was measured in the Pasvik valley in January. Photos

Another tiny measurement of radioactive iodine at Svanhovd

Norwegian Radiation Protection Authorities (NRPA) without any suspected source.

Читать по-русски | Read in Russian

By Thomas Nilsen

March 23, 2017

The very small amount of radioactive iodine was measured in week 10, between March 6 to 13, by the authorities' instruments at Svanhovd, a few hundred meters from Norway's border to the Kola Peninsula in the north.

Ru-106

PHYS ORG Nanotechnology Physics Earth Astronomy & Space

Home » Earth » Environment » October 5, 2017

Spike in airborne radioactivity detected in Europe

October 5, 2017

German officials say that a spike in radioactivity has been detected in the air in Western and Central Europe but there's no threat to human health.

The Federal Office for Radiation Protection said Thursday that elevated levels of the isotope Ruthenium-106 have been reported in Germany, Italy, Austria, Switzerland and France since Sept. 29.

Spokesman Jan Henrik Lauer told The Associated Press the source of the Ruthenium-106 isn't known but calculations indicate it may have been released in eastern Europe.

Ruthenium-106 is used for radiation therapy to treat eye tumors, and sometimes as a source of energy to power satellites.

Plan

- Develop a number of simulated situations involving unknown releases amenable to back trajectory analysis

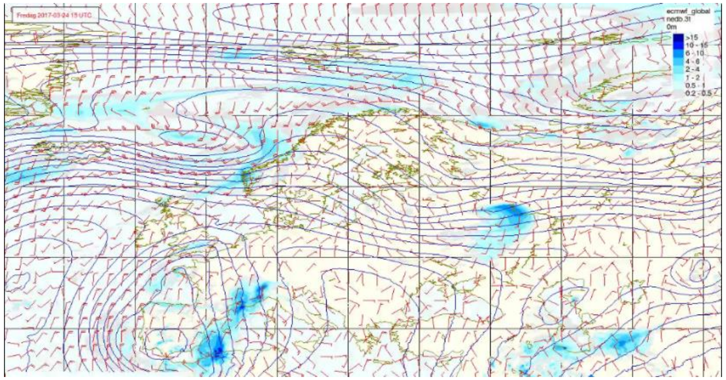
- Develop synthetic measurement data for each scenario

- Disseminate data to participants with the objectives:

  1. identify where the release originated,
  2. determine when the release occurred,
  3. determine how long the release continued,
  4. determine which isotopes were released,
  5. determine air concentrations,
  6. estimate how much activity was released

Development

- All simulated releases were based around March 2017 and within an area covering all of continental Europe
- Participants were asked to store meteorological data for their dispersion systems for that month
- This stored data formed the basis for the activity in September 2017
- The release simulations were conducted based on the data for March 2017



Development

- 4 locations were selected and releases from these locations were simulated as having happened at four different times during March 2017
- 3 simulated monitoring stations (air filters) for each release point «sampling» for different periods
- A source term was developed for each scenario and the dispersion for each scenario was calculated using ARGOS
- Air concentrations and doserates for each isotope were then calculated for each monitoring station and each scenario
- HPGE gamma spectra were then simulated (Monte Carlo) for each station and for each scenario

Development

- Participants were provided with the spectra and limited information on the location of the stations and the period during which they were operating

- Participants were asked to provide a quantitative and qualitative spectral analysis and use the data to determine the nature of the release

- Time limited to 7 days to report as much as possible

- 15 participants from 12 countries recieved data ……. 7 participants from 7 countries were in a position to provide data within 7 days

Example

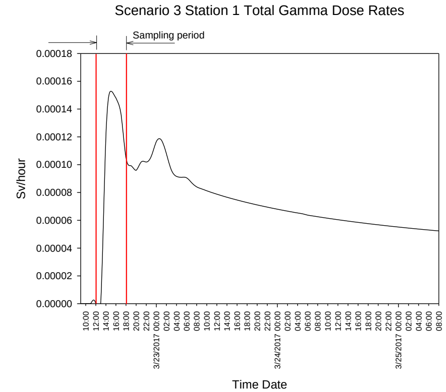
Scenario 3

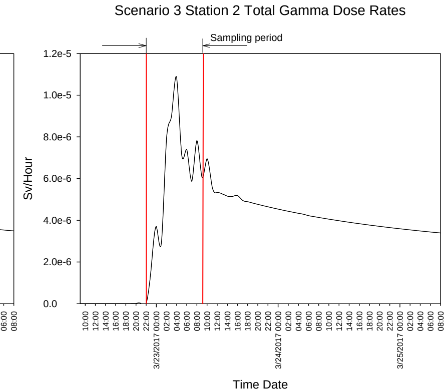
Scenario 3 stations

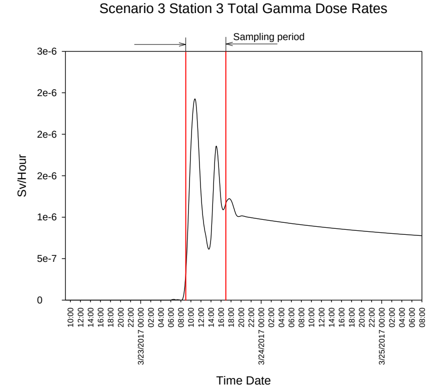
Station 1
- Location: 08 41' 16" E 50 11' 44" N
- Sampling start: 3/22/2017 12:00
- Sampling stop: 3/22/2017 18:00
- Sampling duration: 6 hours
- Sampling rate: 100 m³/hour

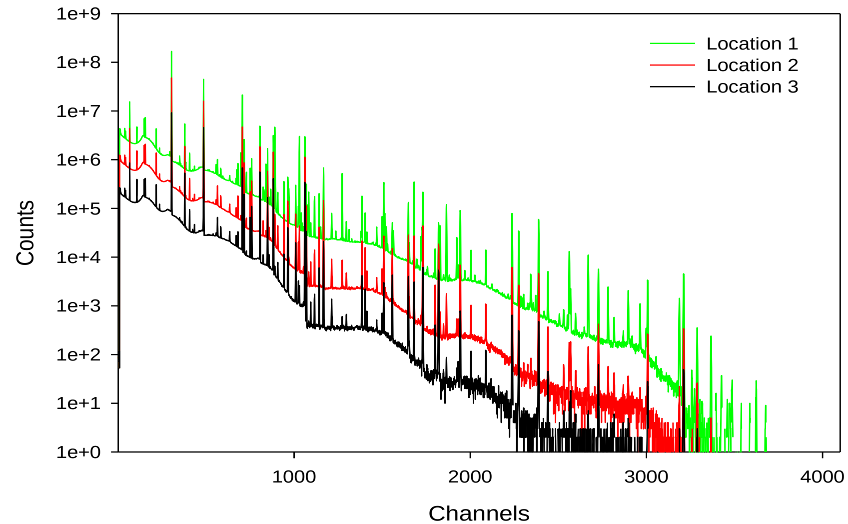
Station 2
- Location: 05 59' 29" E 51 08' 05" N
- Sampling start: 3/22/2017 22:00
- Sampling stop: 3/23/2017 9:00
- Sampling duration:11 hours
- Sampling rate: 150 m³/hour

Station 3
- Location: 03 18' 30" E 51 06' 31" N
- Sampling start: 3/23/2017 9:00
- Sampling stop: 3/23/2017 17:00
- Sampling duration:8 hours
- Sampling rate: 200 m³/hour



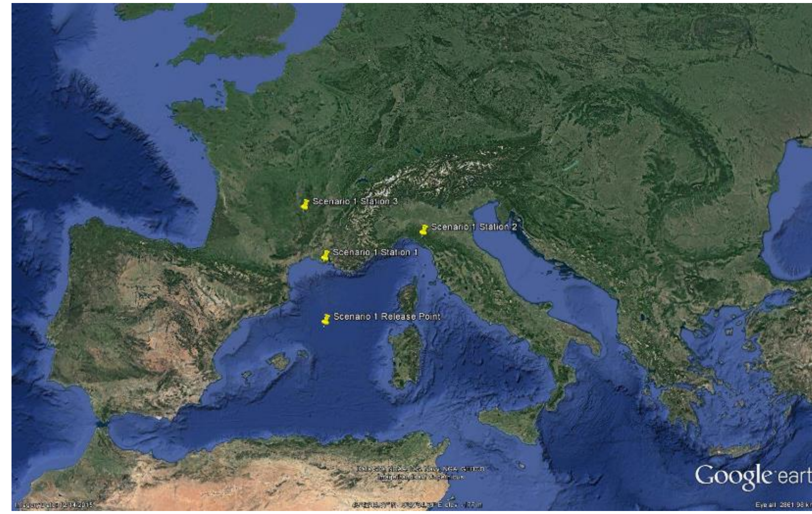




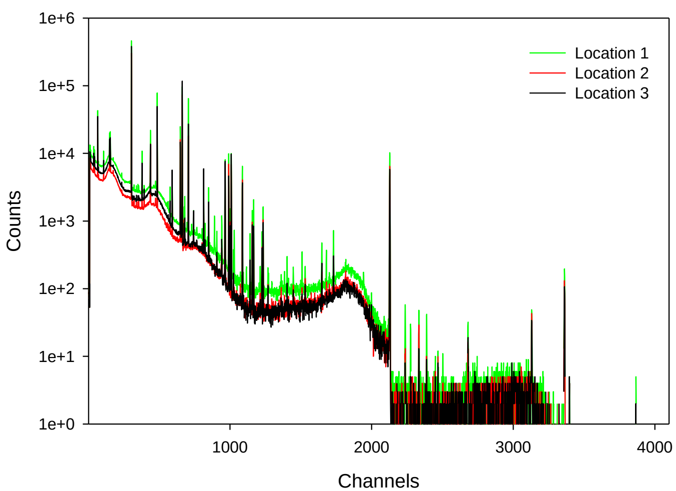


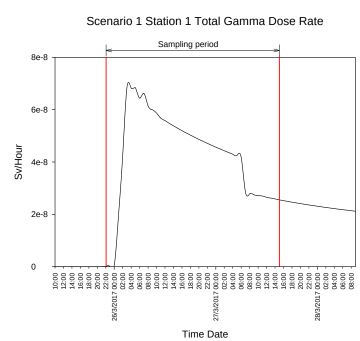
Scenario 1

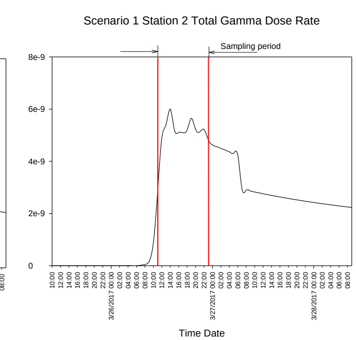
- Relatively small release from a submarine in the Meditteranean
- Steady release over 6 hours from 09.00 on 25 March 2017
- Challenging location and difficult meteorology

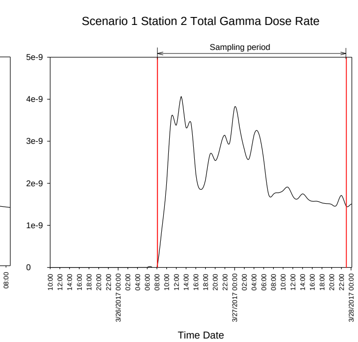


Isotope	Total Release Bq	Hour 1 Bq	Hour 2 Bq	Hour 3 Bq	Hour 4 Bq	Hour 5 Bq	Hour 6 Bq
I-133	9.16E+14	1.53E+14	1.53E+14	1.53E+14	1.53E+14	1.53E+14	1.53E+14
I-132	4.75E+14	7.92E+13	7.92E+13	7.92E+13	7.92E+13	7.92E+13	7.92E+13
La-140	1.5E+14	2.51E+13	2.51E+13	2.51E+13	2.51E+13	2.51E+13	2.51E+13
Te-132	4.61E+14	7.68E+13	7.68E+13	7.68E+13	7.68E+13	7.68E+13	7.68E+13
I-131	3.49E+14	5.82E+13	5.82E+13	5.82E+13	5.82E+13	5.82E+13	5.82E+13
Ru-103	2.43E+14	4.05E+13	4.05E+13	4.05E+13	4.05E+13	4.05E+13	4.05E+13
I-135	8.77E+13	1.46E+13	1.46E+13	1.46E+13	1.46E+13	1.46E+13	1.46E+13
Zr-97	6.8E+13	1.13E+13	1.13E+13	1.13E+13	1.13E+13	1.13E+13	1.13E+13
Zr-95	7.2E+13	1.2E+13	1.2E+13	1.2E+13	1.2E+13	1.2E+13	1.2E+13
Nb-97	6.94E+13	1.16E+13	1.16E+13	1.16E+13	1.16E+13	1.16E+13	1.16E+13
Nb-97m	6.44E+13	1.07E+13	1.07E+13	1.07E+13	1.07E+13	1.07E+13	1.07E+13









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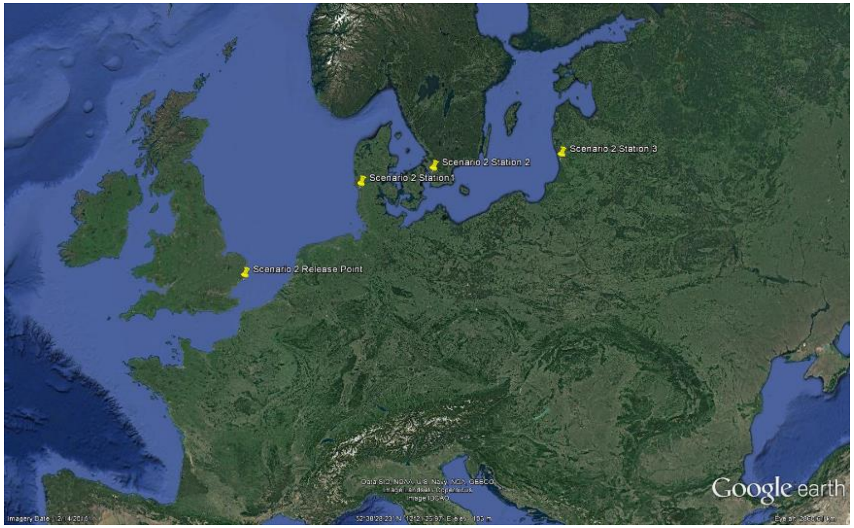
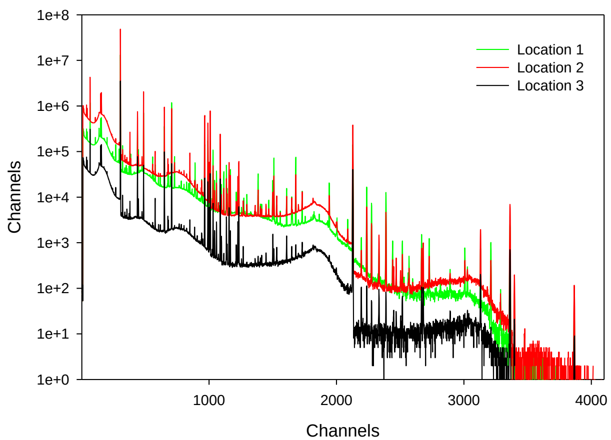
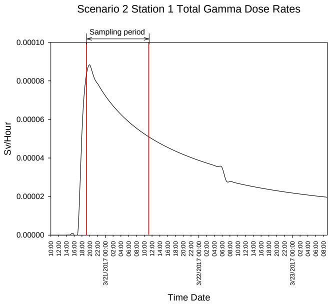
Scenario 2

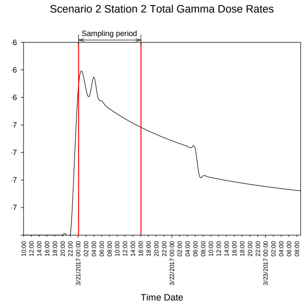
- Large, short release from Sizewell B in the UK
- Release started at midnight on the 20th of March and lasted until 01:00
- Simple meteorology
- Difficult due to number of candidate points in the UK and along the dispersion route

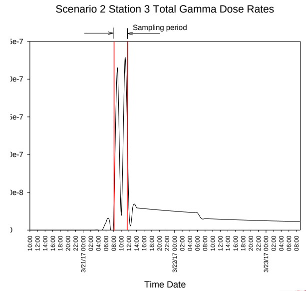


Isotope	Total Inventory Bq	Total release Bq
I-134	7.4996E+18	4.4998E+18
I-132	4.8597E+18	2.9158E+18
I-135	6.4491E+18	3.8695E+18
I-133	6.9241E+18	4.1545E+18
I-131	3.3159E+18	1.9895E+18
Te-132	4.7866E+18	1.9146E+18
La-140	6.2299E+18	2.4920E+17
Zr-97	5.8280E+18	2.3312E+17
Te-131m	4.8414E+17	1.9366E+17
Zr-95	5.8645E+18	2.3458E+17





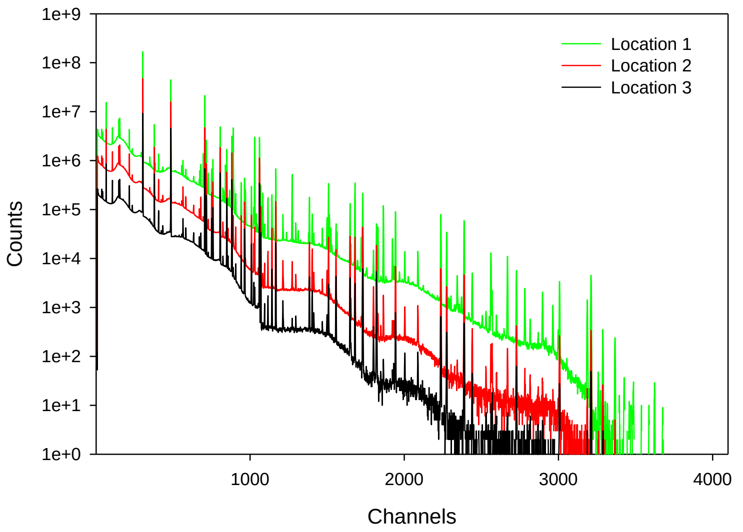


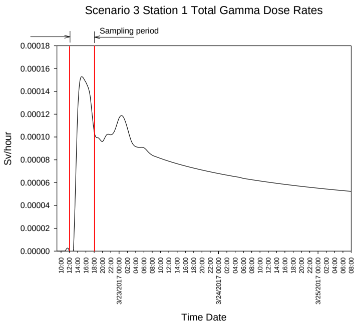


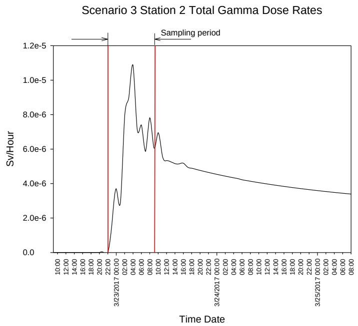
Scenario 3

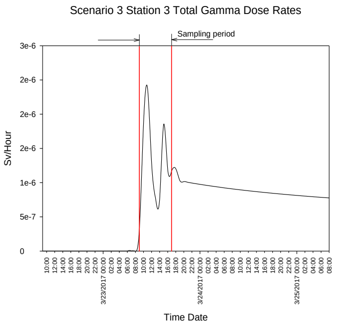
- Large, complex release from Grafenrheinfeld NPP in Germany over 12 hours
- Started on the 22nd of March at 08:00
- Participants informed of the origin of the release

Isotope	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	Total Bq
I -132	5.17E+16	2.87E+16	2.79E+16	8.38E+15	1.57E+16	1.65E+16	5.03E+16	9.66E+16	6.15E+16	3.49E+15	4.39E+15	6.95E+15	3.72E+17
I-133	4.53E+16	2.38E+16	2.22E+16	6.45E+15	1.18E+16	1.20E+16	3.55E+16	6.60E+16	4.07E+16	2.21E+15	2.71E+15	4.15E+15	2.73E+17
I -131	3.94E+16	2.21E+16	2.16E+16	6.62E+15	1.26E+16	1.34E+16	4.19E+16	8.21E+16	5.31E+16	3.08E+15	3.92E+15	6.31E+15	3.06E+17
I-135	1.22E+16	5.02E+15	3.61E+15	1.05E+15	1.91E+15	1.94E+15	5.71E+15	1.06E+16	6.49E+15	3.51E+14	4.29E+14	6.53E+14	5.00E+16
Te-132	4.38E+16	1.87E+16	2.31E+16	9.42E+15	1.12E+16	1.63E+15	2.99E+15	3.76E+15	3.94E+15	2.42E+15	1.89E+15	4.43E+15	1.27E+17
Cs-134	3.85E+15	2.30E+15	2.16E+15	8.09E+14	1.31E+15	1.42E+15	4.08E+15	8.49E+15	7.37E+15	3.76E+14	4.46E+14	7.43E+14	3.34E+16
Cs-137	3.30E+15	1.97E+15	1.85E+15	6.94E+14	1.13E+15	1.21E+15	3.50E+15	7.28E+15	6.32E+15	3.23E+14	3.82E+14	6.37E+14	2.86E+16
Ba-140	4.69E+14	6.41E+14	1.58E+16	1.76E+15	3.19E+15	2.20E+15	6.74E+14	4.81E+13	9.59E+05	5.87E+12	2.80E+05	2.95E+05	2.48E+16
I-134	3.89E+14	9.09E+13	1.14E+09	3.31E+08	6.04E+08	6.13E+08	1.80E+09	3.34E+09	2.05E+09	1.11E+08	1.35E+08	2.06E+08	4.79E+14
Zr-95	3.53E+09	2.17E+10	1.35E+15	3.86E+12	3.76E+05	1.93E+05	6.39E+11	4.71E+04	3.74E+04	1.33E+04	1.14E+04	6.32E+11	1.36E+15
Sb-127	1.20E+11	1.10E+09	1.51E+14	6.83E+13	1.67E+13	1.36E+13	1.95E+13	1.68E+13	1.29E+13	4.75E+12	3.81E+12	8.74E+12	3.16E+14
La-140	0.00E+00	0.00E+00	4.40E+13	8.58E+11	2.66E+10	1.19E+04	7.83E+10	3.23E+10	3.45E+03	1.27E+10	2.53E+10	1.61E+10	4.51E+13
Ce-144	2.26E+09	1.39E+10	8.68E+14	2.48E+12	2.42E+05	1.24E+05	4.11E+11	3.04E+04	2.42E+04	8.60E+03	7.37E+03	4.09E+11	8.71E+14
Ru-103	2.56E+10	5.49E+10	2.27E+09	5.53E+07	3.13E+01	1.03E+01	4.36E+00	5.43E+07	5.41E+07	7.00E-01	5.37E+07	6.07E-01	8.30E+10









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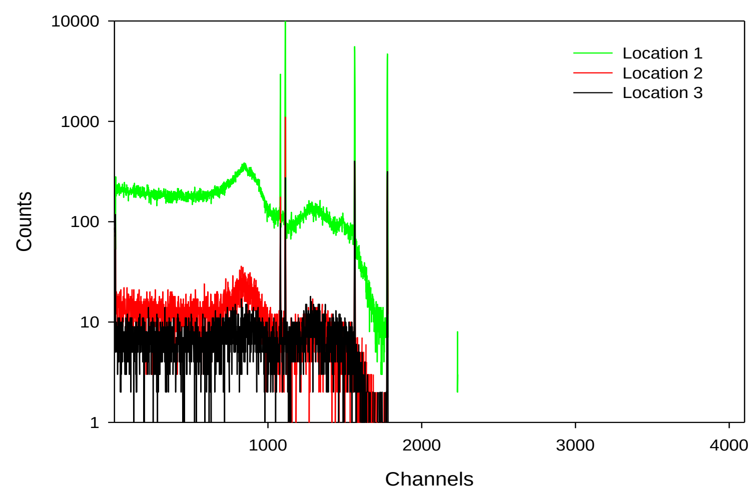
Scenario 4

- Based on a real situation from 2016 with detection of three isotopes over Braunschweig in Germany. Assumed to have originated at Rivne in Ukraine.
- No doserate informasjon (too low)
- Short release or limited amounts
- 06:00 21 mars
- Simple meteorology

Isotope	Total release Bq
Mn-54	1.0E+12
Co-58	1.54E+11
Co-60	5.19E+11

Isotope and releases for Scenario 4.



Tools

- For analysis of dispersion/back trajectory calculations:

  ARGOS

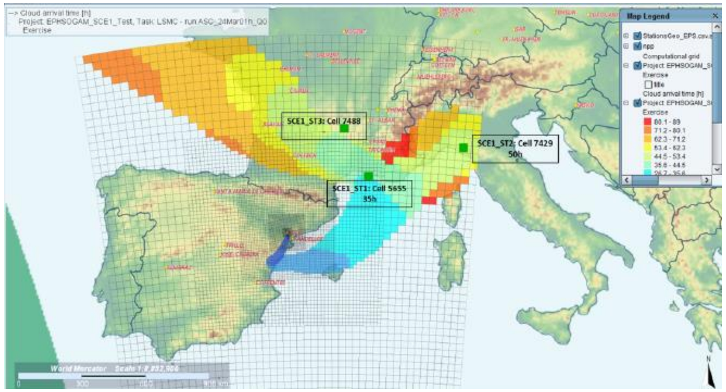
  RODOS

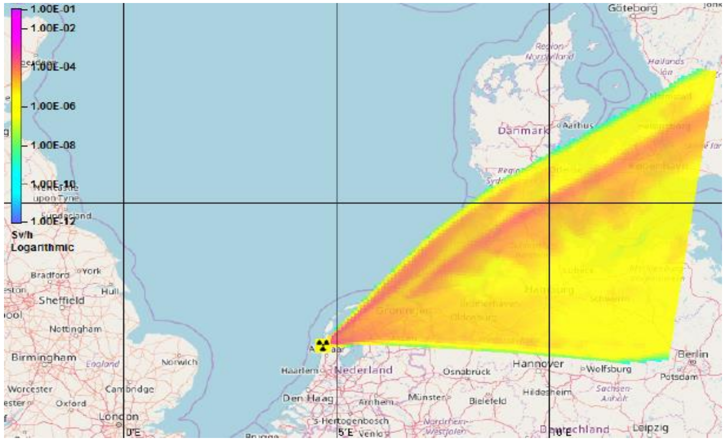
  HYSPLIT

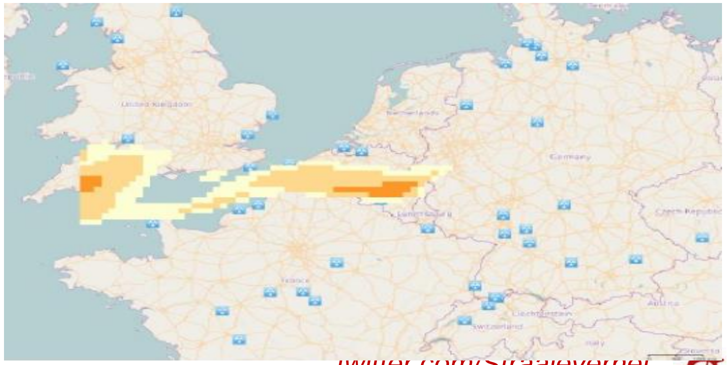
  In-house

- Gamma analysis:

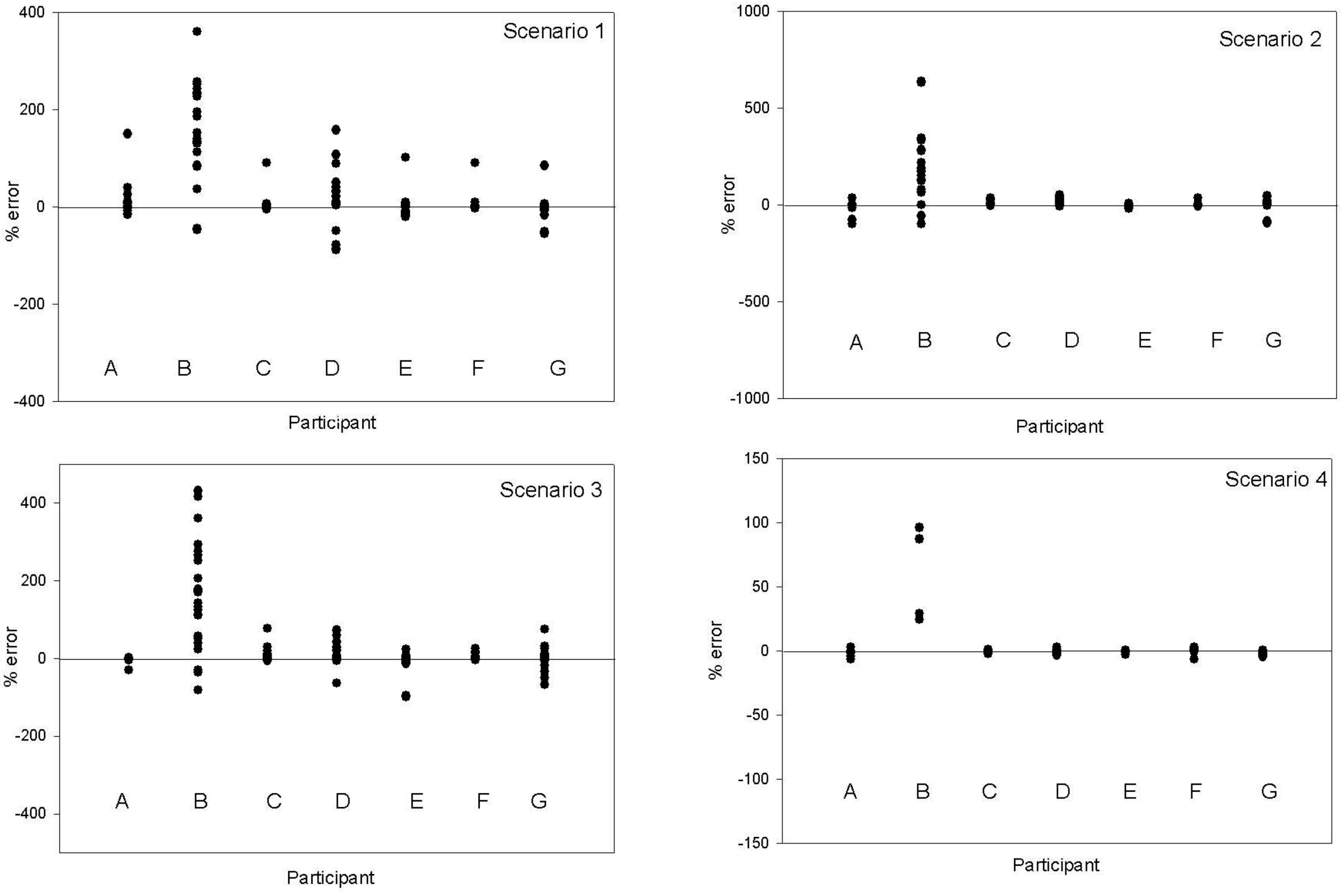
  Usual range of commercial and in-house







Air concentrations



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Scenario 1- when and where

Simulated Date and Time	Submarine south of Spain	6 hours starting at 09:00 on the 25th of March 2017
A	Cofrentes NPP, Spain	30 hours starting at 00:00 on the 25th of March 2017
B	Spainish NPP, Cadarache	Unknown duration starting at 06:00 25th of March 2017
C	No location estimated	No estimate provided
D	Cartagena naval port, Vandellos NPP, Toulon naval port, Asco NPP	> 48 hour release starting at 04:00 on the 25th of March 2017
E	Ascó NPP and Tricastin NPP	For Asco NPP: unknown duration starting at 01:00 on the 24th of March 2017 For Triscatin NPP: unknown duration starting at 02:00 on the 20th of March 2017
F	along the East to South coast of Spain, Western part of the Mediterranean Sea	between 22:00 on the 22nd of March and 22:00 on the 23rd of March 2017
G	No estimate	No estimate provided

Scenario 2- when and where

Simulated Date and Time	Sizewell B, UK	1 hour starting at 09:00 on the 20th of March 2017
A	Sizewell Nuclear Power Plant, UK	36 hour release starting at 20:00 on the 19th of March 2017
B	British NPP: Wylfa NPP Hartlepool NPP Torness NPP	Wylfa NPP : 03:00 – 06:00 on 20th of March 2017, Hartlepool NPP : 09:00 – 12:00 on 20th of March 2017, Torness NPP: 09:00 -13:00 on 20th of March 2017
C	Sizewell NPP UK	6 hour release starting at 06.00 on the 20th of March 2017
D	Brest naval port France NPP Gravelines France NPP Sizewell UK La Hague France	Brest: 07:00 on the 19th to 18:00 on the 19th of March 2017 Gravelines NPP: From 22:00 on 19th to 12:00 on the 20th of March 2017, Sizewell NPP: From 05:00 to 07:00 on the 20th of March 2017 La Hague: 04:00 on the 21st of March 2017
E	Hartlepool UK, Sizewell UK, Bradwell UK, Oldbury UK and Hinkley Point UK, Gravelines France, Borsselle The Netherlands	4 hour release starting at 02:00 on the 20th of March 2017
F	North Sea, South-East part of UK or (less likely) North-West part of France. Bradwell NPP UK.	Bradwell: starting 07:00 on the 20th of March 2017
G	Petten Reactor, Netherlands	18 hour release starting at 14:00 on the 20th of March 2017

Scenario 3- when

Simulated Date and Time	12 hour release starting at 08:00 on the 22nd of March 2017
A	5 hour release starting at 08:00 on the 22nd of March 2017 with a second release period from 9 to 15 hours after the start.
B	unestimated release duration but starting at 09:00 on the 22nd of March 2017
C	No estimate
D	5 hour release starting at 10:00 on the 21st of March 2017
E	releases between 07:00 and 15:00 on 22nd of March 2017
F	> 10 hour release starting at 05:00 on the 22nd of March 2017
G	4 hour release starting at 08:00 on the 22nd of March 2017

Scenario 4- where and when

Simulated Date and Time	Rivne NPP, Ukraine	1 hour release starting at 06:00 on the 21st of March 2017
A	Ursus iron foundry, Eastern Poland	Not estimated
B	very close to Station 1	“no more than a few hours before sampling” (first sampling occurred at 11:00 on the 21st of March 2017)
C	Rivne NPP	No estimate
D	NPP Rivne Kunice Ostrava CZ (large industrial area)	20 hour release staring at 15:00 on the 20th of March 2017
E	Rivne NPP	release at 07:00 on the 21st of March 2017
F	Rivne NPP	3 hour release starting at 04:00 on the 21st of March 2017
G	Rivne NPP	release starting at 07:00 on the 21st of March 2017

How much– Scenario 1

Isotope	Total release Bq	A	B	C	D	E	F	G
I-133	9.16E+14	1E+17	-	-	1.65E+16 / 5.21E+17		-	-
I-132	4.75E+14	1E+17	-	-		-	-	-
La-140	1.5E+14	1E+17	-	-	1.28E+15 / 1.75E+17	-	-	-
Te-132	4.61E+14	1E+17	-	-	2.00E+15 / 2.77E+17	-	-	-
I-131	3.49E+14	1E+17	-	-	7.14E+14 / 2.42E+16	-	-	-
Ru-103	2.43E+14	1E+17	-	-	7.89E+14 / 1.11E+17	-	-	-
I-135	8.77E+13	1E+17	-	-		-	-	-
Zr-97	6.8E+13	1E+17	-	-	3.09E+15 / 4.00E+17	-	-	-
Zr-95	7.2E+13	1E+17	-	-	1.74E+14 / 2.46E+16	-	-	-
Nb-97	6.94E+13	1E+17	-	-		-	-	-
Nb-97m	6.44E+13	1E+17	-	-		-	-	-

How much– Scenario 2

Isotope	Total release Bq	A	B	C	D	E	F	G
I-134	4.4998E+18	1E+19	-	-	-	-	-	-
I-132	2.9158E+18	1E+19	-	-	-	-	-	4.5E+16
I-135	3.8695E+18	1E+19	-	-	7E+15	-	-	5.9E+17
I-133	4.1545E+18	1E+19	-	-	3E+15	-	-	1.1E+18
I-131	1.9895E+18	1E+19	-	1E+18	4E+14	-	4E+16	2.9E+17
Te-132	1.9146E+18	1E+19	-	-	4E+15	-	5E+17	2.0E+17
La-140	2.4920E+17	1E+19	-	-	1E+15	-	7E+16	4.6E+17
Zr-97	2.3312E+17	1E+19	-	-	6E+14	-	-	2.7E+17
Te-131m	1.9366E+17	1E+19	-	-	8E+14	-	4E+16	3.0E+17
Zr-95	2.3458E+17	1E+19	-	-	5E+14	-	5E+16	3.2E+17

How much – Scenario 3

Isotope	Actual Bq	A	B	C	D	E	F	G
I -132	3.72E+17	1E+17	-	-	-	-	-	9.0E+16
I-133	2.73E+17	1E+17	-	-	1.17E+17	-	-	2.5E+17
I -131	3.06E+17	1E+17	-	-	3.15E+16	-	4E+16	2.4E+17
I-135	5.00E+16	1E+17	-	-	-	-	-	4.2E+16
Te-132	1.27E+17	1E+17	-	-	5.29E+16	-	-	6.0E+17
Cs-134	3.34E+16	1E+17	-	-	3.66E+15	-	2E+15	4.8E+16
Cs-137	2.86E+16	1E+17	-	-	2.97E+15	-	2E+15	3.8E+16
Ba-140	2.48E+16	1E+17	-	-	7.11E+15	-	7E+15	2.7E+16
I-134	4.79E+14	1E+17	-	-	-	-	-	-
Zr-95	1.36E+15	1E+17	-	-	1.67E+14	-	-	5.8E+15
La-140	4.51E+13	1E+17	-	-	-	-	-	-

How much – Scenario 4

Isotope	Total release Bq	A	B	C	D	E	F	G
Mn-54	1.0E+12	-	-	-	2.E+11	-	6E+11	-
Co-58	1.54E+11	-	-	-	3.E+10	-	1E+11	-
Co-60	5.19E+11	1E+13	-	-	9.E+10	-	3.6E+11	-

Scenario 1

Scenario 2

Scenario 4

Observations

Quantifying the isotopes – same pattern as for other exercises (evidence of systematic errors for at least one participant), usual patterns of false positives etc.

Finding the general area a release may have arisen in was no problem – more precise pinpointing of the release point was, for some, more difficult.

While the data is limited, there was some evidence that it was how the tool was used, rather than the tool, that determined the probability of a more precise estimate of location.

The date of a release was within the grasp of most participants – the precise time and length of the release was less clear in the responses.

Few participants were willing to estimate the amount of activity released – estimates that were provided were within an order of magnitude or so. There was no evidence that knowing teh location of the release in advance served to improve the estimates.