SIMULATION OF "KAMENNA-EXPERIMENTS" TEST 1 – 4 WITH THE DECISION SUPPORT MODEL LASAIR

IAEA, EMRAS II
Working Group 9 „Urban Areas"
Sevilla, Spain, 08. - 10.06. 2010

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Acronym LASAIR

LASAIR

Programme for the Lagrange-Simulation of the dispersion (*German: Ausbreitung*) and Inhalation of Radionuclides

Lagrange := meteorological mathematical procedure

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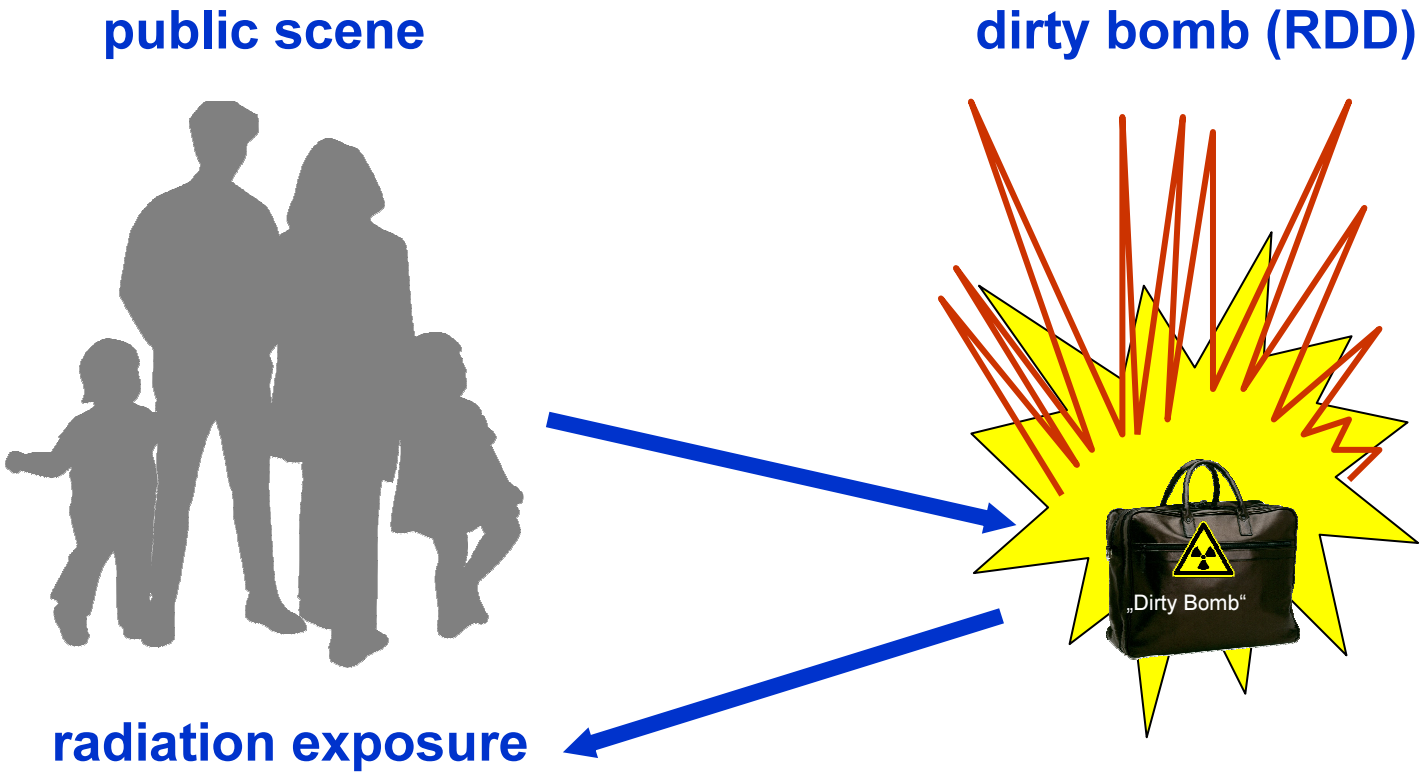
LASAIR background: Effects after a „dirty-bomb“ explosion



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LASAIR Task and Aim

Task use of an expert systeme programme
for scientific support in a „dirty bomb“ scenario

Aim easy and rapid simulation of atmospheric
dispersion of radioactive substances
with
diagnostic windfield-model
Lagrangian-Particle-Model

and the computation of the radiation exposure

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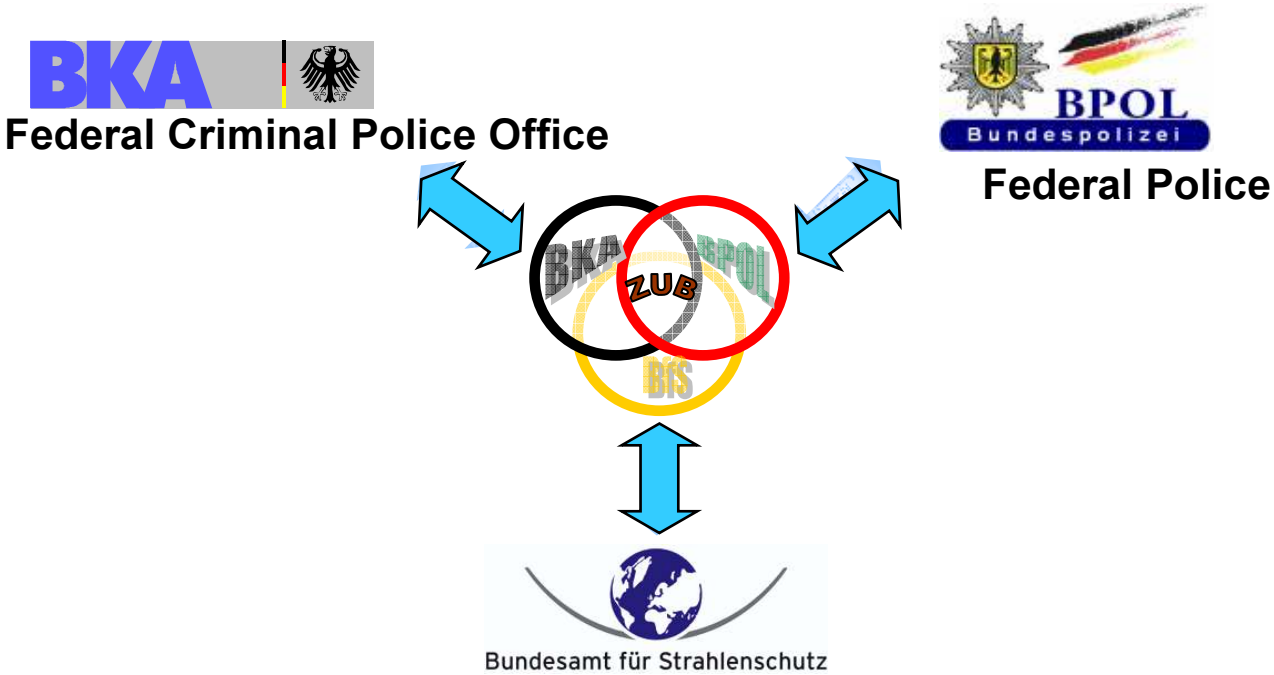
German Federal Central Support Group for Serious Radiological and Terroristic Events „CSG“



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LASAIR Area of Responsibility (Germany and its Federal States)

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LASAIR model description

- model name: LASAIR
- purpose: “dirty bomb”- scientific support for German Police
- type of model: Lagrange particle model (60.000 particles)
  model is conservative
- environm. comp.: urban or rural areas (40 x 40 km²)

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LASAIR model descriptions

- 2-dimensional flow model (no orographic structure)
- individual characterisation of the roughness length
- 5 radionuclides can be computed simultaneously
- user can choose out of approx. 860 radionuclides
- very quick response time (1 – 10 minutes)

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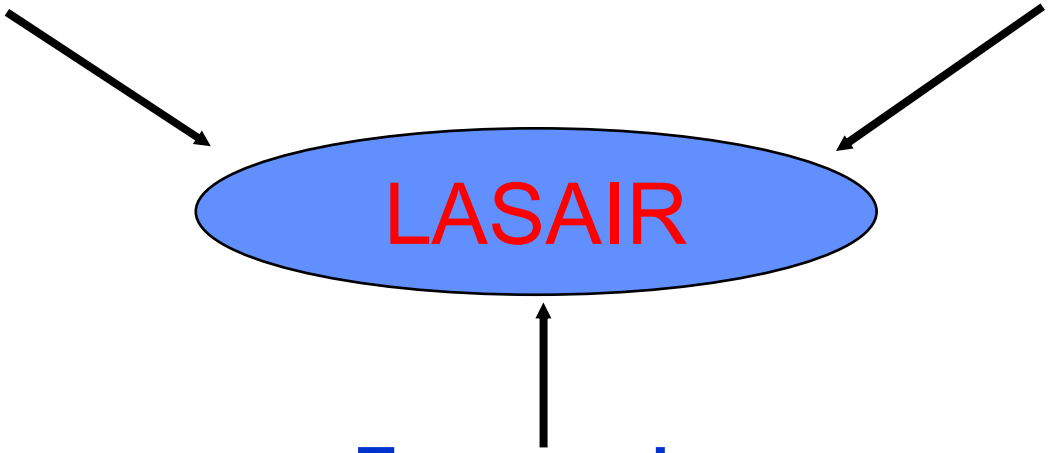
LASAIR input

Meteorology
- wind speed
- wind direction
- stability class

Release to the atmosphere
- short term release
  or
- continuous release



Topography
- individual roughness length
- 2 dimensional simulation

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LASAIR output

Radionuclides

- max. 5 radionuclides
- activity conc. in base layer
- deposition on the surface
- cloud arrival time

Exposition

- inhalation
- groundshine
- cloudshine

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LASAIR special feature

- parameterisation of the individual cloud as initial volumina (LASAIR source term)

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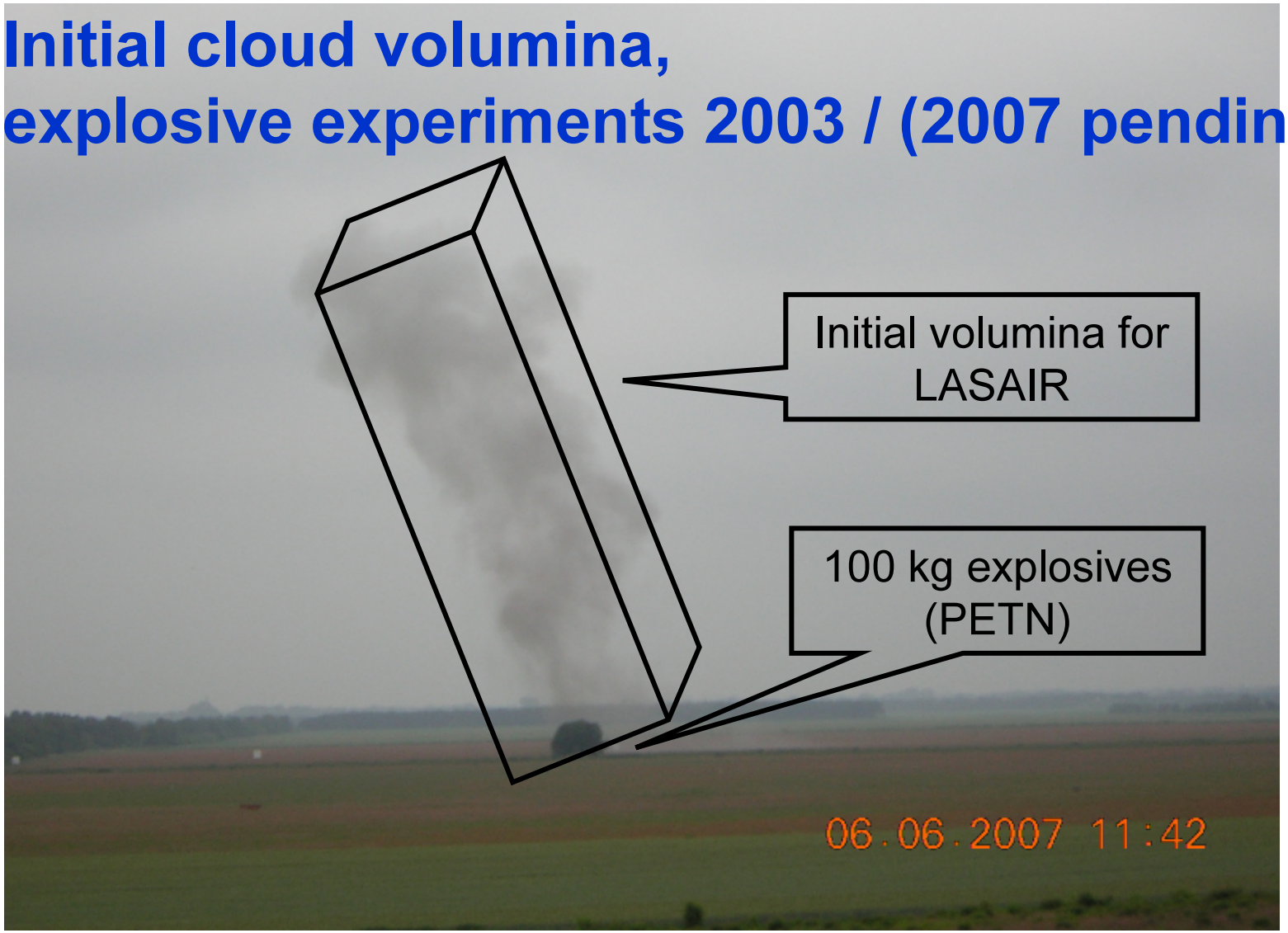
Initial cloud volumina, explosive experiments 2003 / (2007 pending)



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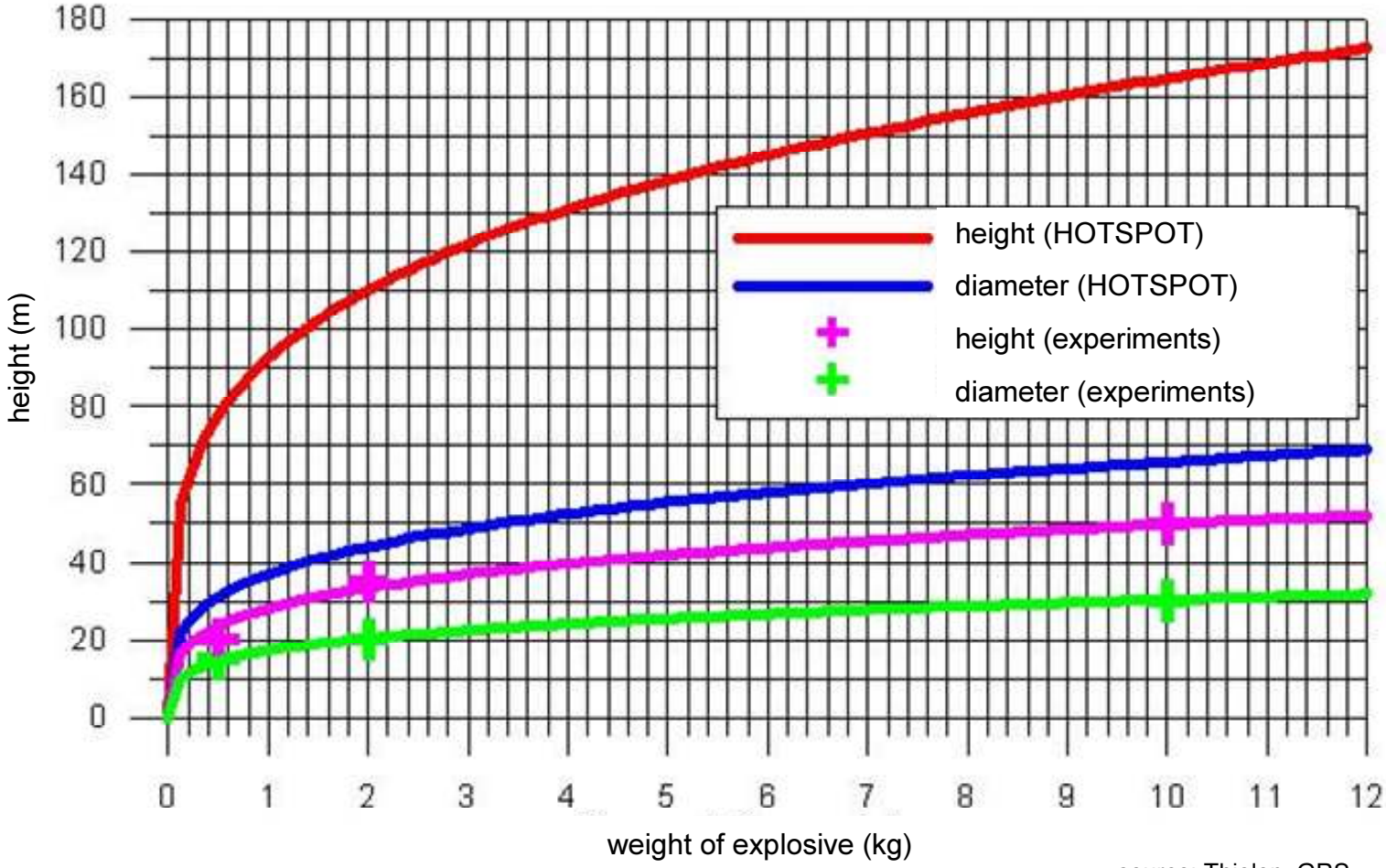
Initial cloud volumina
Parametrisation after experiments 2003 (2007 pending)



source: Thielen, GRS

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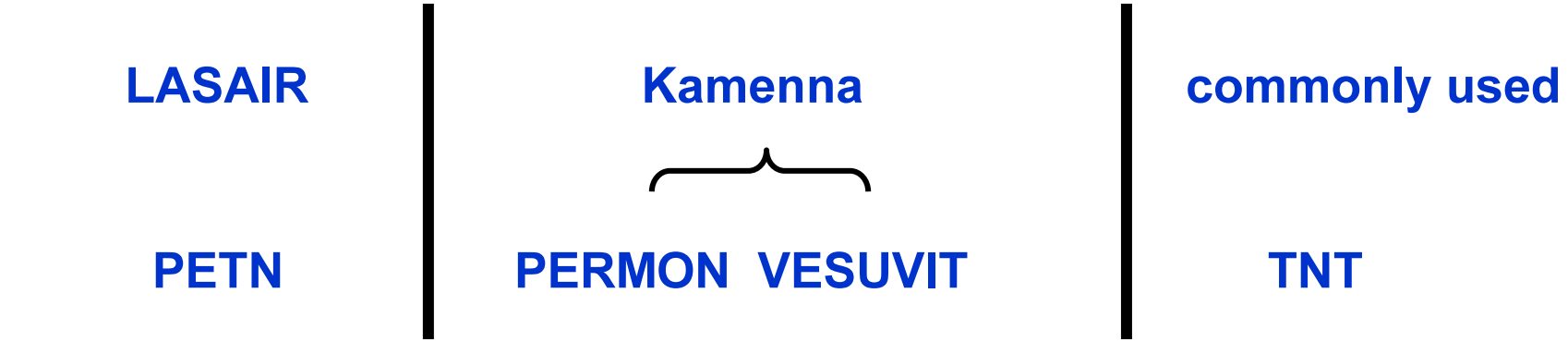
Comparison of explosives for LASAIR



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Comparison of explosives for LASAIR

		LASAIR	Kamenna		
		PETN	PERMON	VESUVIT	TNT
Explosion heat	kJ/kg	6300	4079	3050	3725
Volume of explosion products	dm^3/kg	780	928	280	740
Velocity of detonation	m/s	8400	4000	500	6900
Temperature of explosion	°C	3930	2749	2250	2550
Density	kg/m^3	1773	1050	900	1600
Trauzl lead block test	cm^3	530	400	75	300

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Comparison of explosives for LASAIR

Relationship		PETN	to PERMON	to VESUVIT	to TNT
Explosion heat	kJ/kg	1	0,65	0,48	0,59
Volume of explosion products	dm^3/kg	1	1,19	0,36	0,95
Velocity of detonation	m/s	1	0,48	0,06	0,82
Temperature of explosion	°C	1	0,70	0,57	0,65
Density	kg/m^3	1	0,59	0,51	0,90
Trauzl lead block test	cm^3	1	0,75	0,14	0,57
		1	**: 0,97**	**0,25**	**0,76**

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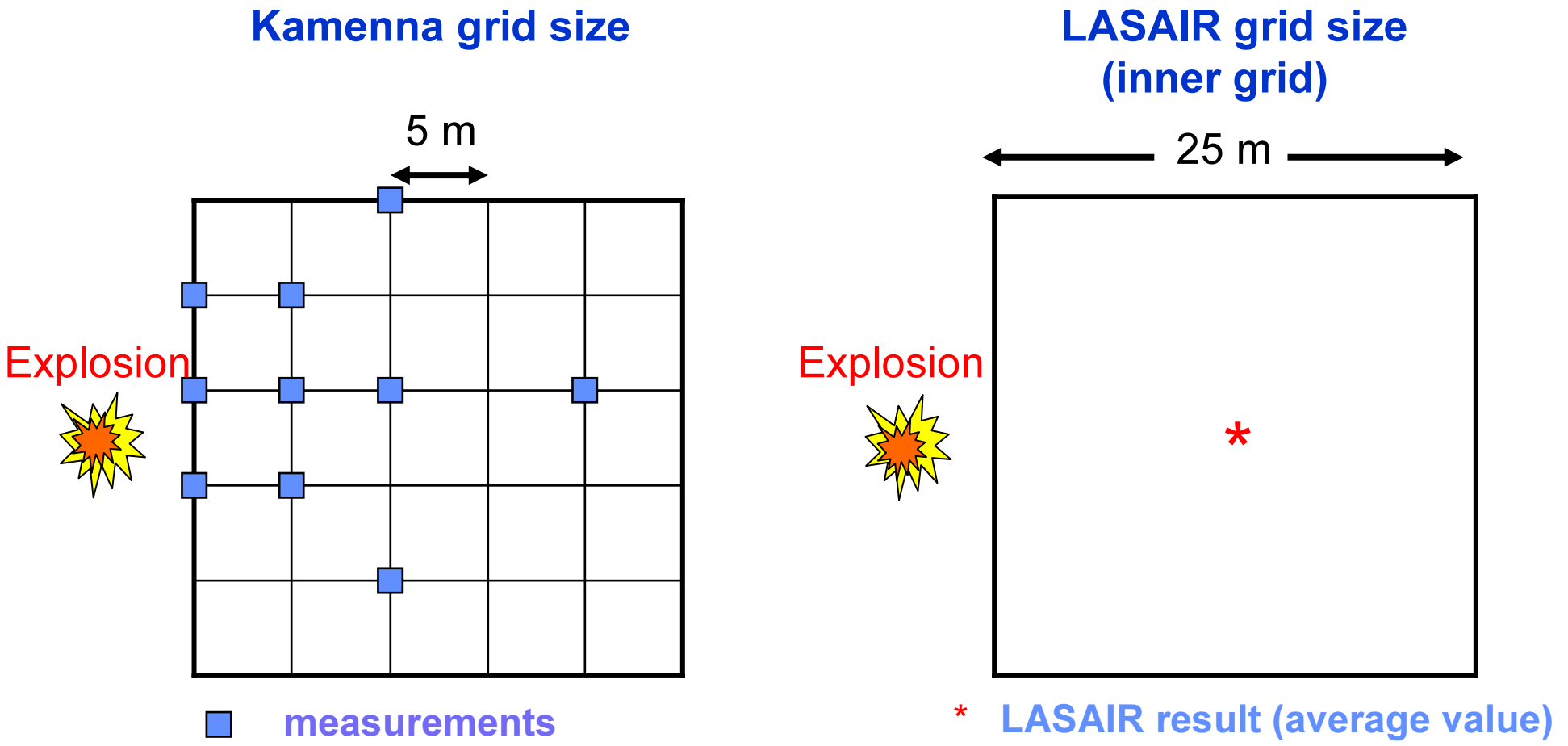
LASAIR grid compared to „Kamenna - Experiments“



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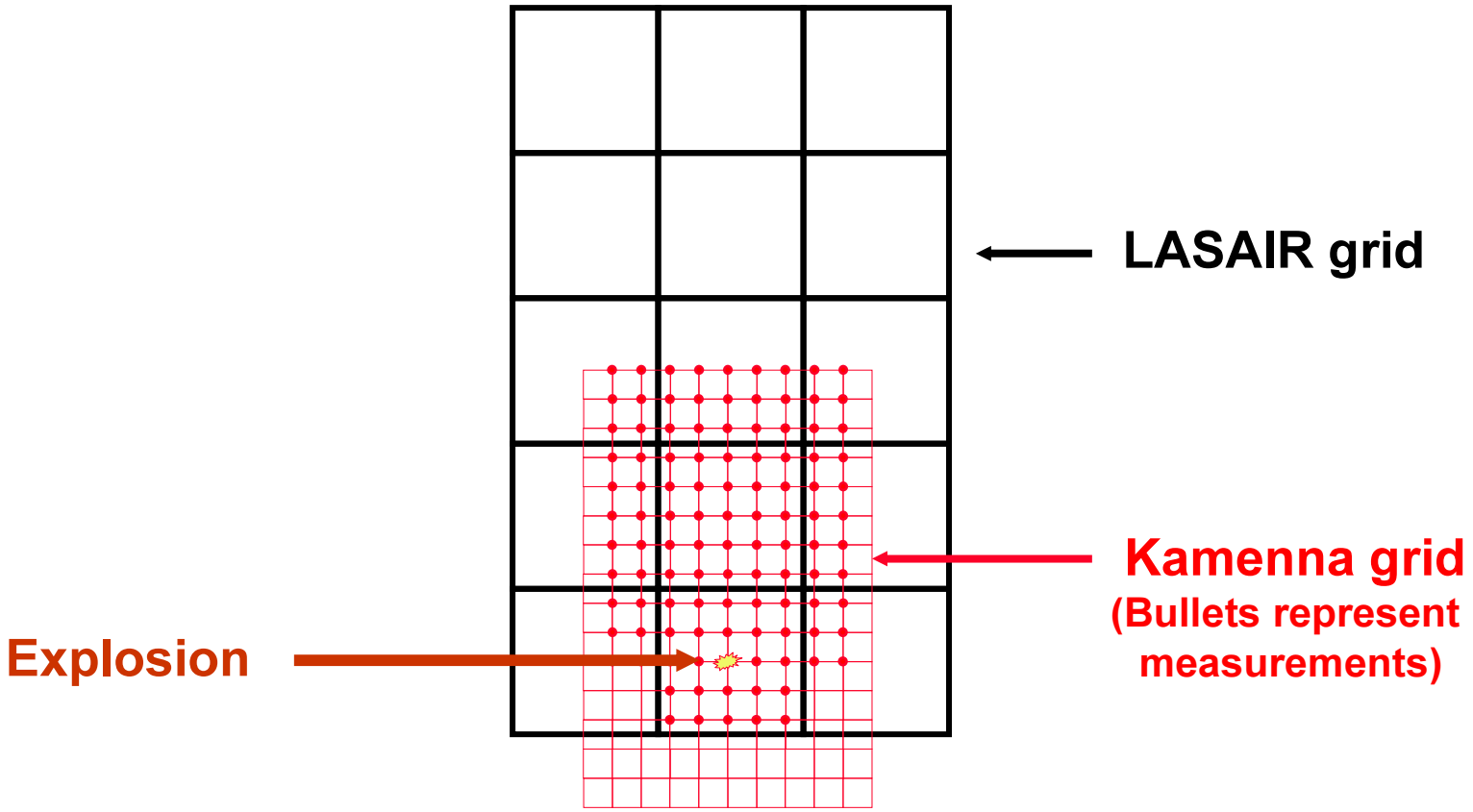
Grids Kamenna-Experiments - LASAIR



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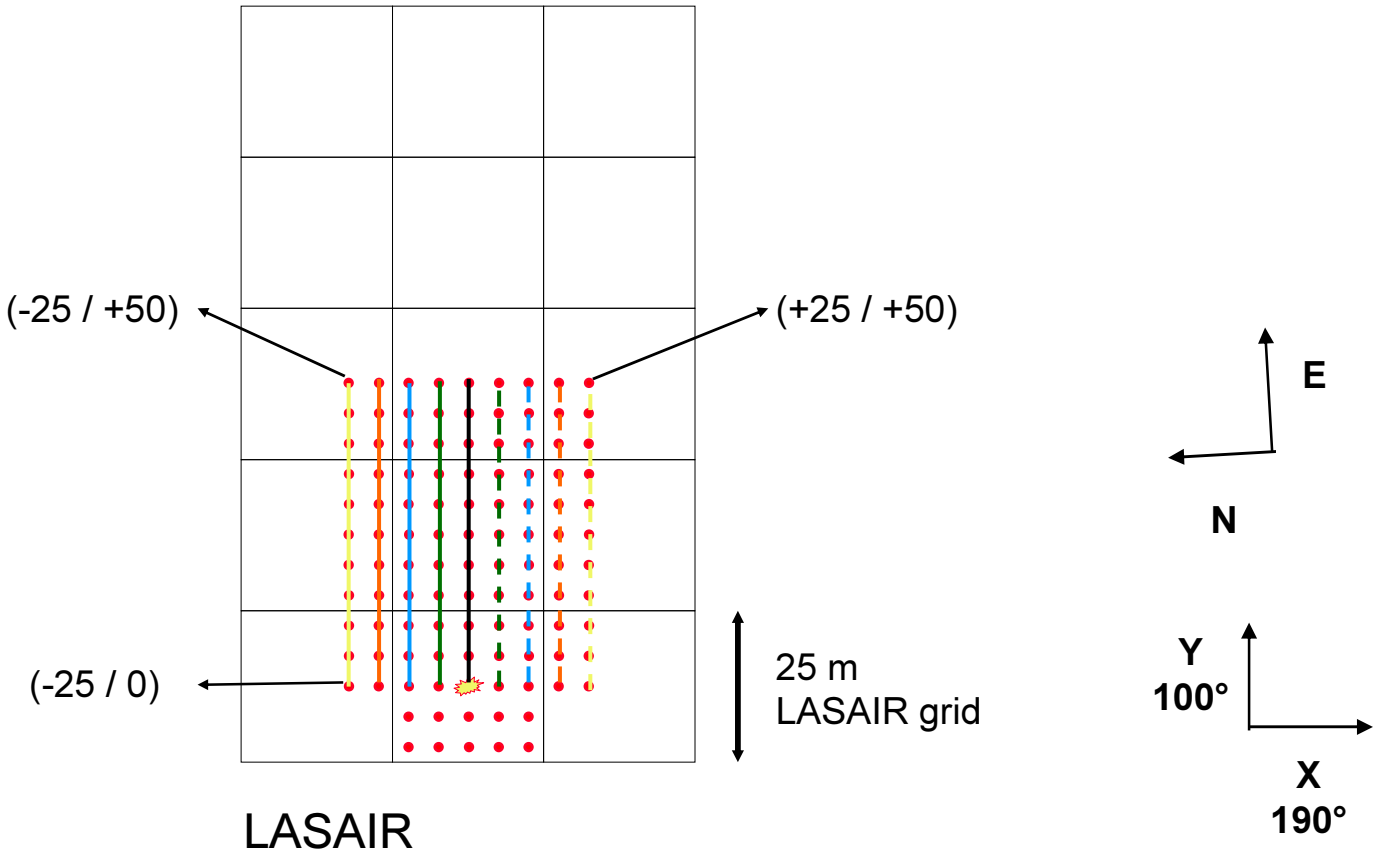
Grids Kamenna-Experiments - LASAIR



LASAIR
origin of explosion in the
center of the first grid cell

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LASAIR Input data

Input data	Test 1	Test 2	Test 3	Test 4
Date (yy/mm/dd)	2007/12/06	2008/05/15	2009/05/05	2009/07/14
explosion time	12:45	11:30	12:22	12:42
explosive	Permon 10T	Vesuvit TN	Permon 10T	Permon 10T
explosive mass	30 g	20 g	350 g	350 g
mass of PETN (size cuboid)	30 g	5 g	7 x 7 x 12 m³ (!)	7 x 7 x 12 m³ (!)
particle sizes [µm] [0-2.5 / 2.5-10 / 10-50 / 50<]	[100 / - / - / -]	[100 / - / - / -]	[100 / - / - / -]	[100 / - / - / -]
meteorology (interval)	09:33 – 14:39	11:15 – 11:56	11:30 – 13:19 at station 1	11:00 – 14:00
wind speed (height 2m)	0 – 6.3 m/s	0.28 – 1.85 m/s	0.9 – 7.2 m/s	0 – 4.9 m/s
wind direction	S - W	ESE – SSW	SW - N	SE - W
stability class	D	D	D	C
land use class roughness length	explosion test ground: 0.1 m vicinity: 1.0 m	explosion test ground: 0.1 m vicinity: 1.0 m	explosion test ground: 0.1 m vicinity: 1.0 m	explosion test ground: 0.1 m vicinity: 1.0 m obstacle 1.5 m
radionuclide half life	Tc-99m 6.01 h / 2.163E04 s	Tc-99m 6.01 h / 2.163E04 s	Tc-99m 6.01 h / 2.163E04 s	Tc-99m 6.01 h / 2.163E04 s
Activity (time of measurement) Activity (time of explosion)	780 MBq at 10:20 590 MBq at 12:45	1058 MBq at 10:10 907 MBq at 11:30	1222 MBq at 12:22 1222 MBq at 12:22	1088 MBq at 11:00 894 MBq at 12:42

(!) not consistent with explosive amount (!)

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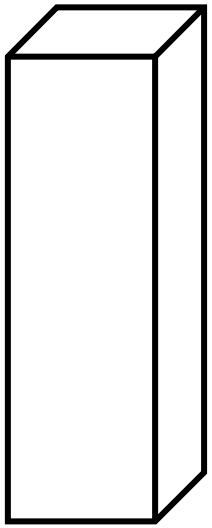
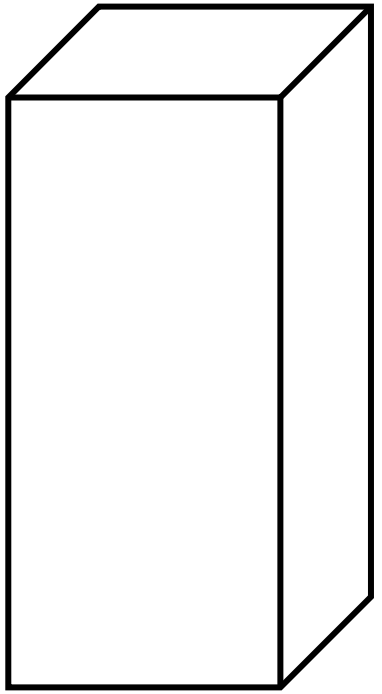
Kamenna Experiments Test 3 and 4

- parameterisation of the individual cloud as initial volumina (LASAIR source term)

Test 1
30 g Permon
↓
7 x 7 x 12 m³



Test 3, 4
350 g Permon
↓
13 x 13 x 22 m³



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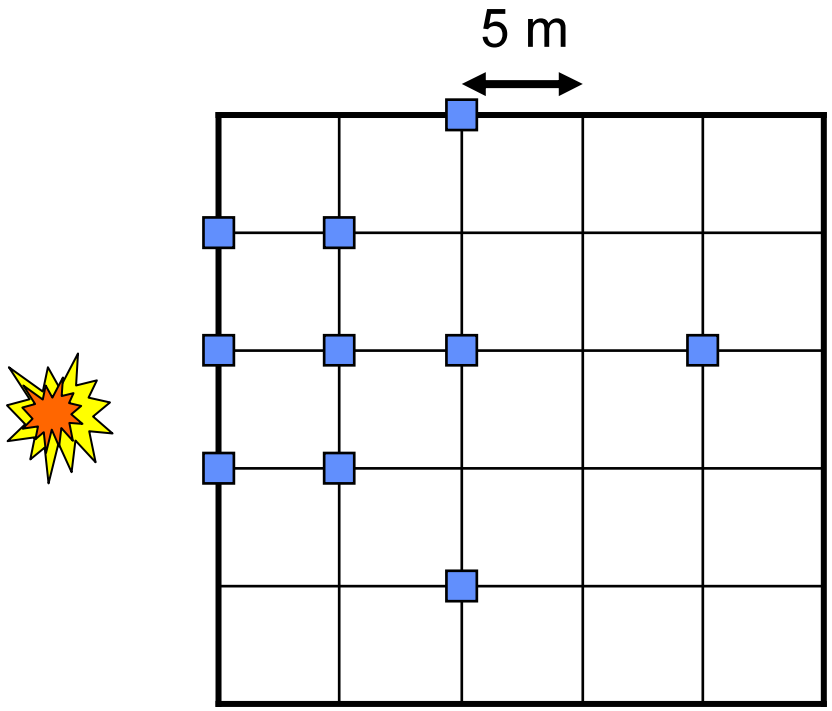
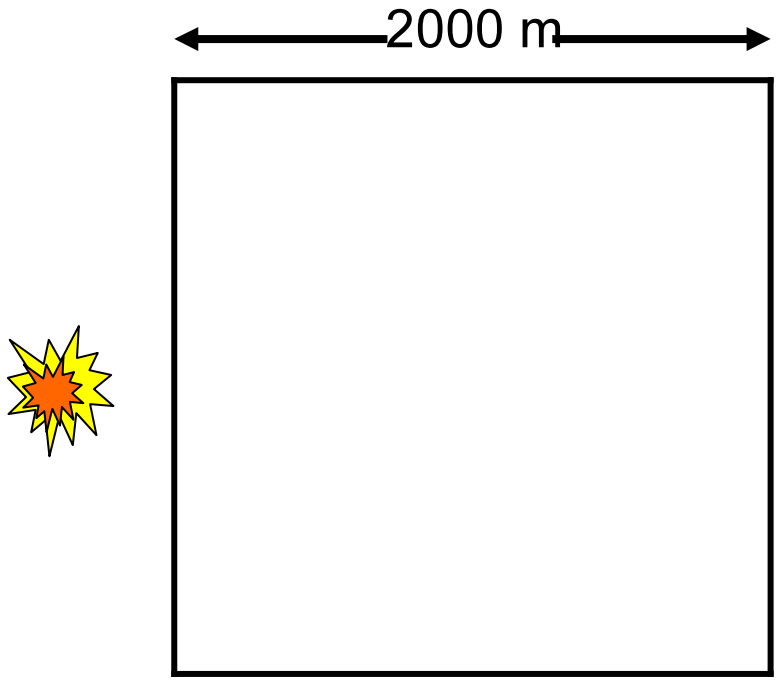
LASAIR grid compared to „Kamenna-Experiments“

Kamenna grid size



LASAIR grid size outer grid



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LASAIR results for „Kamenna-Experiments“

Comparison of field and model data
for deposition and activity

results of LASAIR
comparison after averaging of measurement data

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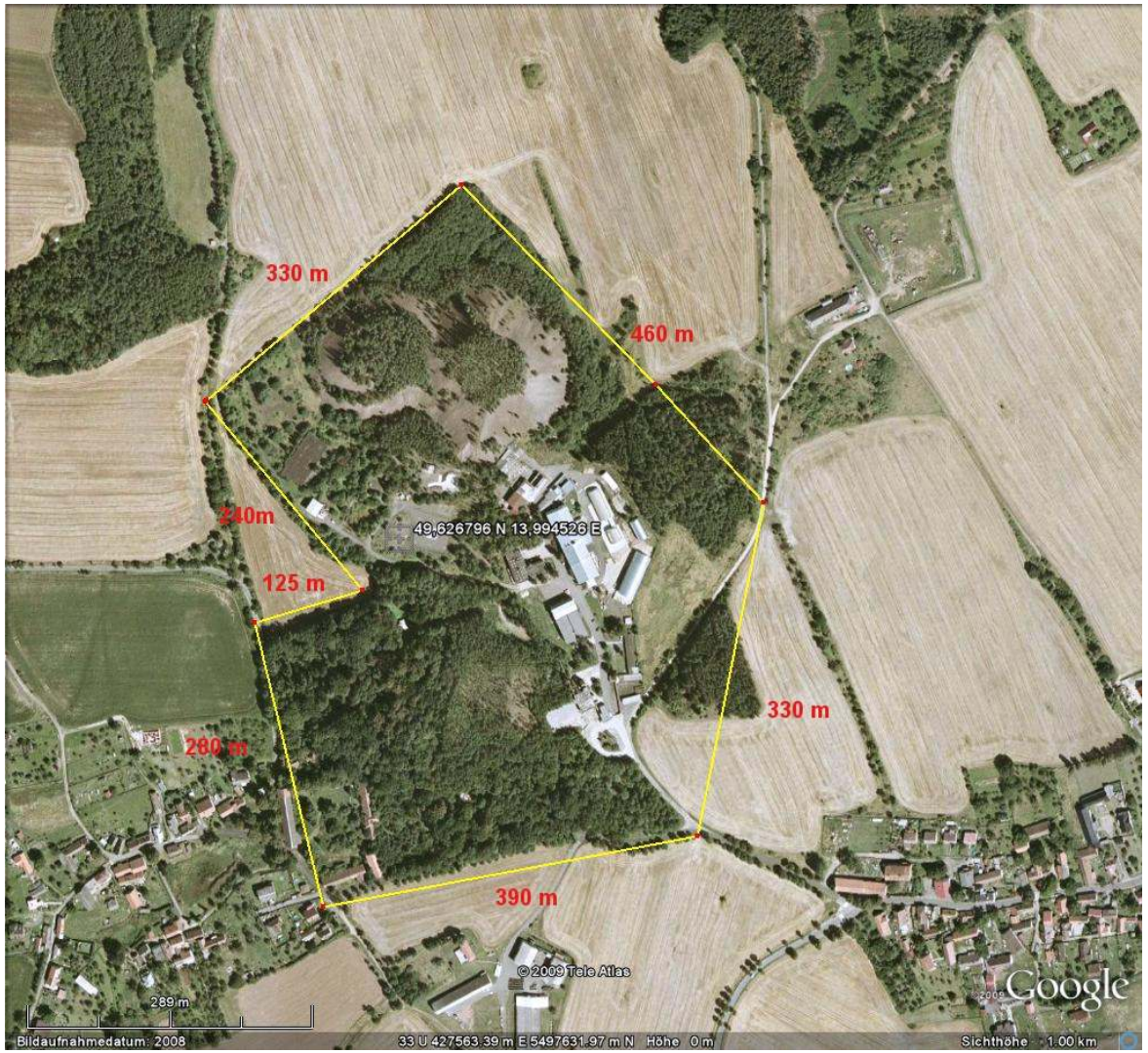
LASAIR preparation for „Kamenna-Experiments“



N

E

site (birds eye)

[Google Earth]

dimension in meters

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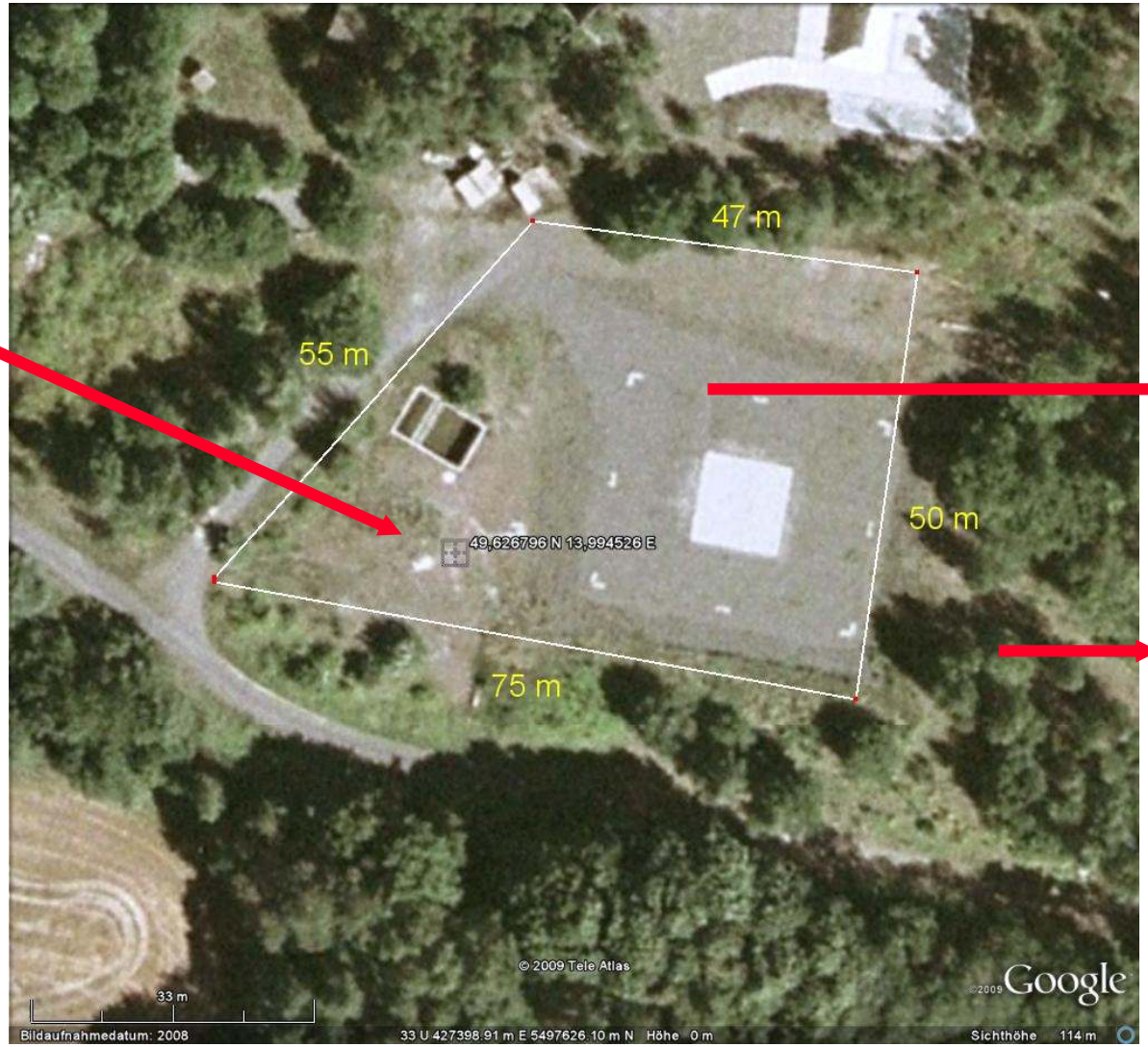
LASAIR preparation for „Kamenna-Experiments“

release position

49,626796° N

13,994526° E

(explosion)



roughness length

3 areas

z_0 = 0,1 m
(center and far vicinity)

z_0 = 1,0 m
(treas in close vicinity)

z_0 = 1,5 m
(obstacles [bus])

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LASAIR results Test 01, Deposition (Bq/m²)

site (birds eye)

[Google Earth]

N

E

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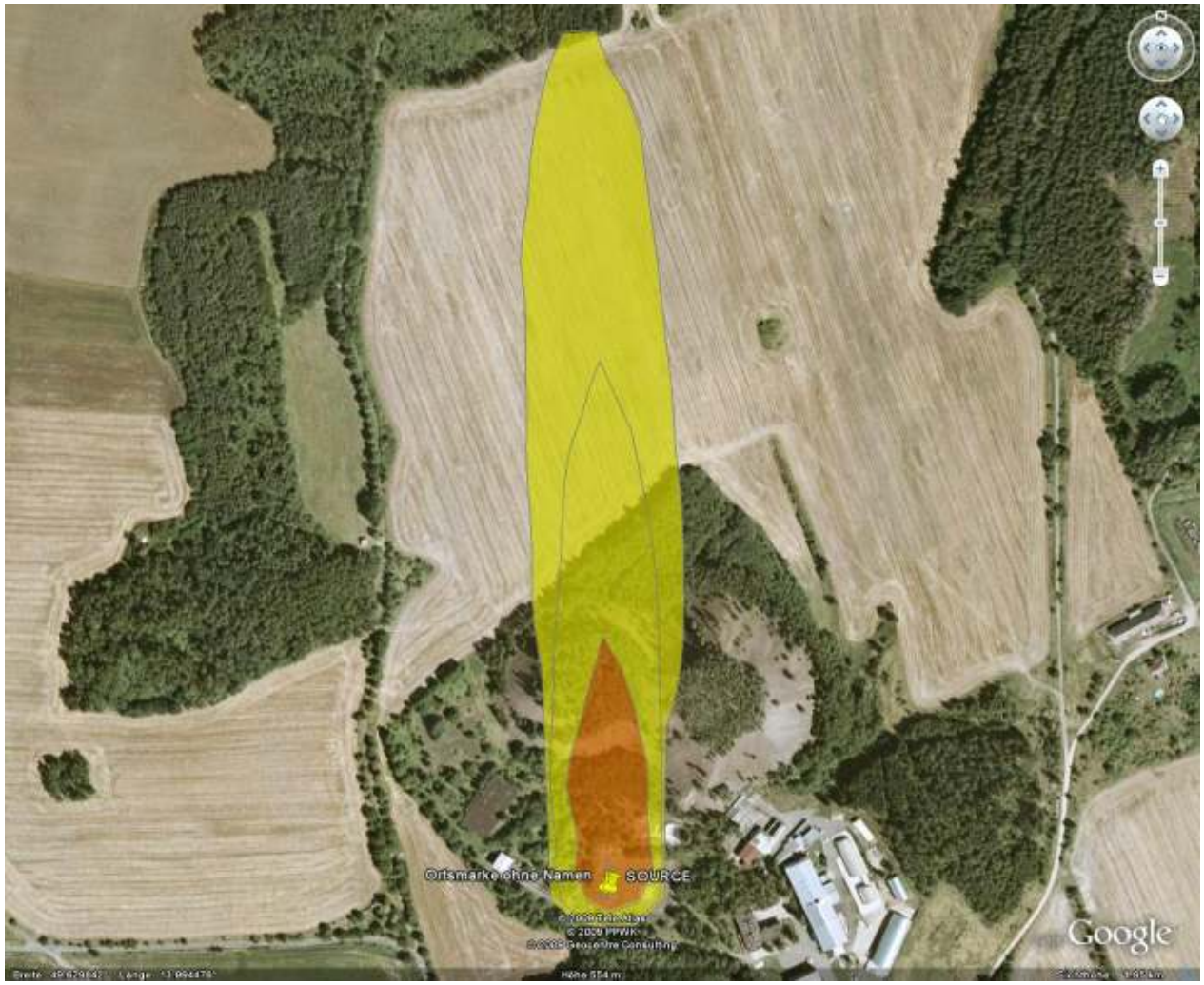
LASAIR results Test 02, Deposition (Bq/m²)



site (birds eye)

[Google Earth]

N

E

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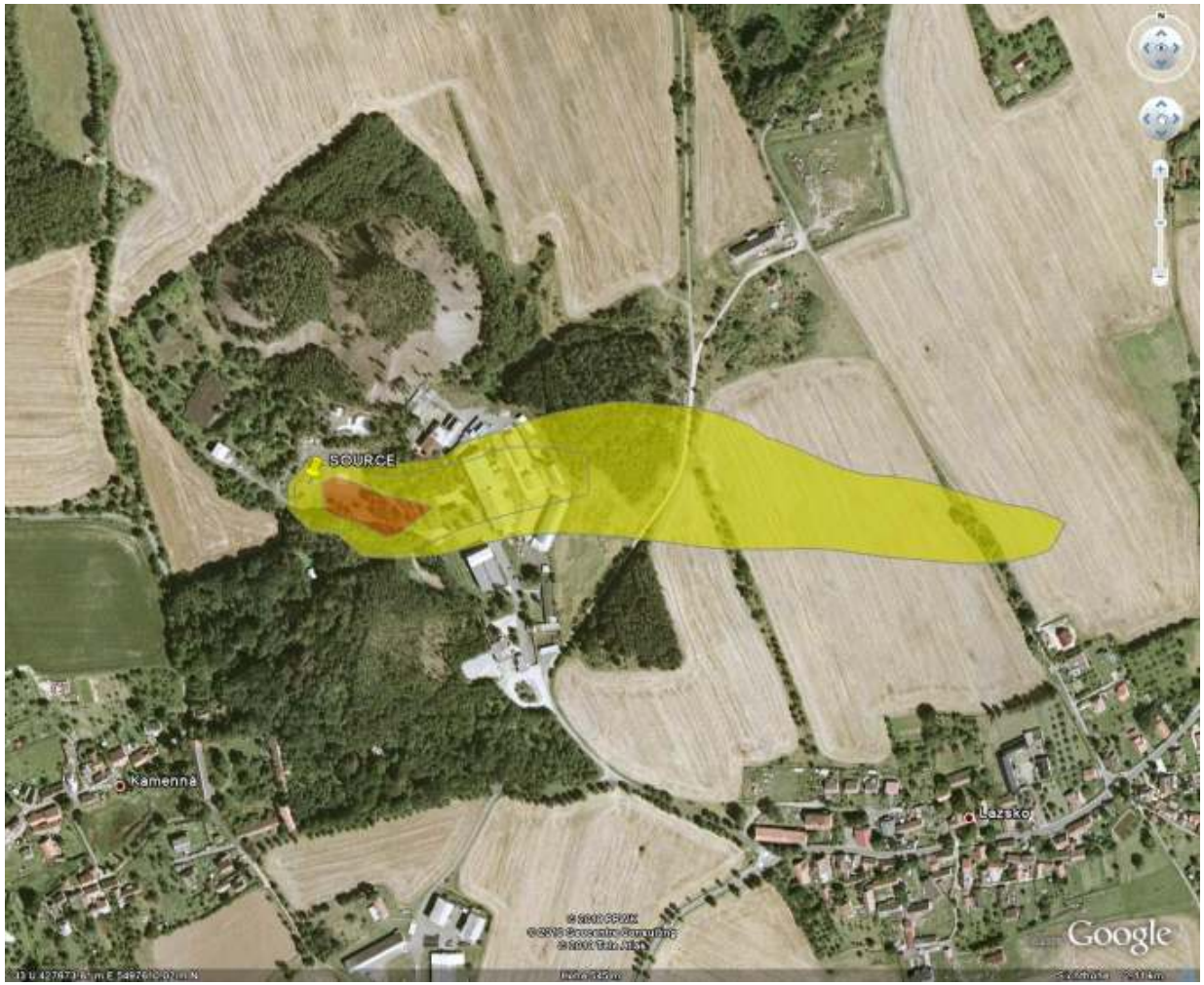
LASAIR results Test 03, Deposition (Bq/m²)



site (birds eye)

[Google Earth]

N

E

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LASAIR results Test 04, Deposition (Bq/m²)

site (birds eye)

[Google Earth]

N

E

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LASAIR results Test 04, Deposition (Bq/m²), close view

site (birds eye)

[Google Earth]

N

E

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LASAIR results Test 01, Deposition (Bq/m²)

150	- 25	0	25	50	75
125	1,29E-02	1,19E-01	1,28E+00	1,70E+01	1,07E+02
100	3,03E-02	4,14E-01	7,16E+00	9,15E+01	2,50E+02
75	1,55E-01	1,49E+00	6,45E+01	2,75E+02	3,26E+02
50	1,21E+00	3,05E+01	2,69E+02	**3,97E+02**	1,79E+02
25	4,85E+00	1,95E+02	3,86E+02	2,14E+02	1,97E+01
0	5,93E+00	1,71E+02	1,80E+02	1,56E+01	5,80E-01
-25	2,31E+00	5,64E+00	4,55E+00	1,11E+00	6,39E-02
-50	1,45E-01	1,40E-01	7,12E-02	2,09E-02	0,00E+00
- 75	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00
	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00

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LASAIR results Test 02, Deposition (Bq/m²)

	- 75	- 50	- 25	0	25	50	75
175	1,04E+01	8,76E+01	6,78E+02	1,42E+03	9,43E+02	1,36E+02	1,39E+01
150	5,91E+00	7,23E+01	8,35E+02	1,77E+03	1,09E+03	9,91E+01	6,16E+00
125	2,65E+00	5,41E+01	1,13E+03	2,47E+03	1,45E+03	6,65E+01	2,29E+00
100	1,21E+00	3,29E+01	1,36E+03	2,96E+03	1,68E+03	4,13E+01	8,07E-01
75	3,20E-01	1,75E+01	1,12E+03	2,62E+03	1,55E+03	2,58E+01	3,19E-01
50	6,09E-02	9,53E+00	8,74E+02	2,69E+03	1,84E+03	1,92E+01	1,18E-01
25	7,89E-03	6,35E+00	1,05E+03	3,25E+03	2,22E+03	1,39E+01	2,67E-02
0	0,00E+00	5,67E+00	6,14E+02	1,70E+03	1,10E+03	9,22E+00	0,00E+00
-25	0,00E+00	2,96E+00	8,31E+00	1,10E+01	9,37E+00	3,68E+00	0,00E+00
-50	0,00E+00	2,94E-01	5,41E-01	4,63E-01	4,38E-01	2,21E-01	0,00E+00

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LASAIR results Test 03, Deposition (Bq/m²)

Bq/m**2	-25	0	25	50	75	100	125	150
-100	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,70E-03	9,36E-03	3,56E-02	1,39E-01
-75	0,00E+00	0,00E+00	0,00E+00	0,00E+00	1,45E-02	8,56E-02	2,98E-01	1,80E+00
-50	6,72E-01	8,12E-01	5,88E-01	2,98E-01	1,96E-01	1,08E+00	4,50E+00	1,87E+01
-25	9,51E+00	4,16E+01	3,79E+01	8,96E+00	5,64E+00	1,50E+01	6,31E+01	1,82E+02
0	2,10E+01	6,60E+02	1,30E+03	9,62E+02	4,20E+02	4,35E+02	6,60E+02	6,77E+02
25	1,49E+01	6,26E+02	1,31E+03	1,53E+03	1,52E+03	1,22E+03	9,48E+02	6,85E+02
50	2,76E+00	7,67E+00	4,42E+01	5,89E+02	1,14E+03	8,52E+02	3,93E+02	2,08E+02
75	0,00E+00	4,75E-01	3,58E+00	1,44E+01	3,51E+01	5,28E+01	5,23E+01	4,30E+01
100	0,00E+00	1,22E-02	6,78E-02	3,69E-01	1,45E+00	3,77E+00	6,33E+00	7,29E+00
125	0,00E+00	0,00E+00	0,00E+00	3,18E-02	1,30E-01	2,79E-01	3,90E-01	4,06E-01

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LASAIR results Test 04, Deposition (Bq/m²)

Bq/m**2	-50	-25	0	25	50	75	100	125	150
-100	2,77E+01	9,24E+01	2,45E+02	4,73E+02	5,82E+02	5,06E+02	3,63E+02	2,28E+02	1,35E+02
-75	4,85E+01	1,88E+02	5,86E+02	1,03E+03	1,02E+03	6,33E+02	3,19E+02	1,68E+02	9,20E+01
-50	6,16E+01	5,54E+02	2,26E+03	3,49E+03	2,26E+03	6,98E+02	2,51E+02	1,18E+02	6,35E+01
-25	5,37E+01	1,63E+03	5,13E+03	5,59E+03	2,47E+03	5,45E+02	1,73E+02	7,84E+01	4,00E+01
0	3,44E+01	1,33E+03	3,59E+03	3,09E+03	1,02E+03	2,85E+02	1,03E+02	4,40E+01	2,10E+01
25	1,48E+01	1,31E+02	3,23E+02	3,33E+02	2,05E+02	1,13E+02	4,99E+01	2,15E+01	1,13E+01
50	4,44E+00	1,29E+01	3,20E+01	5,29E+01	5,18E+01	3,57E+01	2,14E+01	1,07E+01	5,77E+00
75	9,61E-01	2,93E+00	6,46E+00	1,12E+01	1,34E+01	1,07E+01	6,78E+00	3,79E+00	1,67E+00
100	2,08E-01	9,15E-01	2,25E+00	3,58E+00	4,61E+00	4,04E+00	2,06E+00	8,01E-01	3,32E-01

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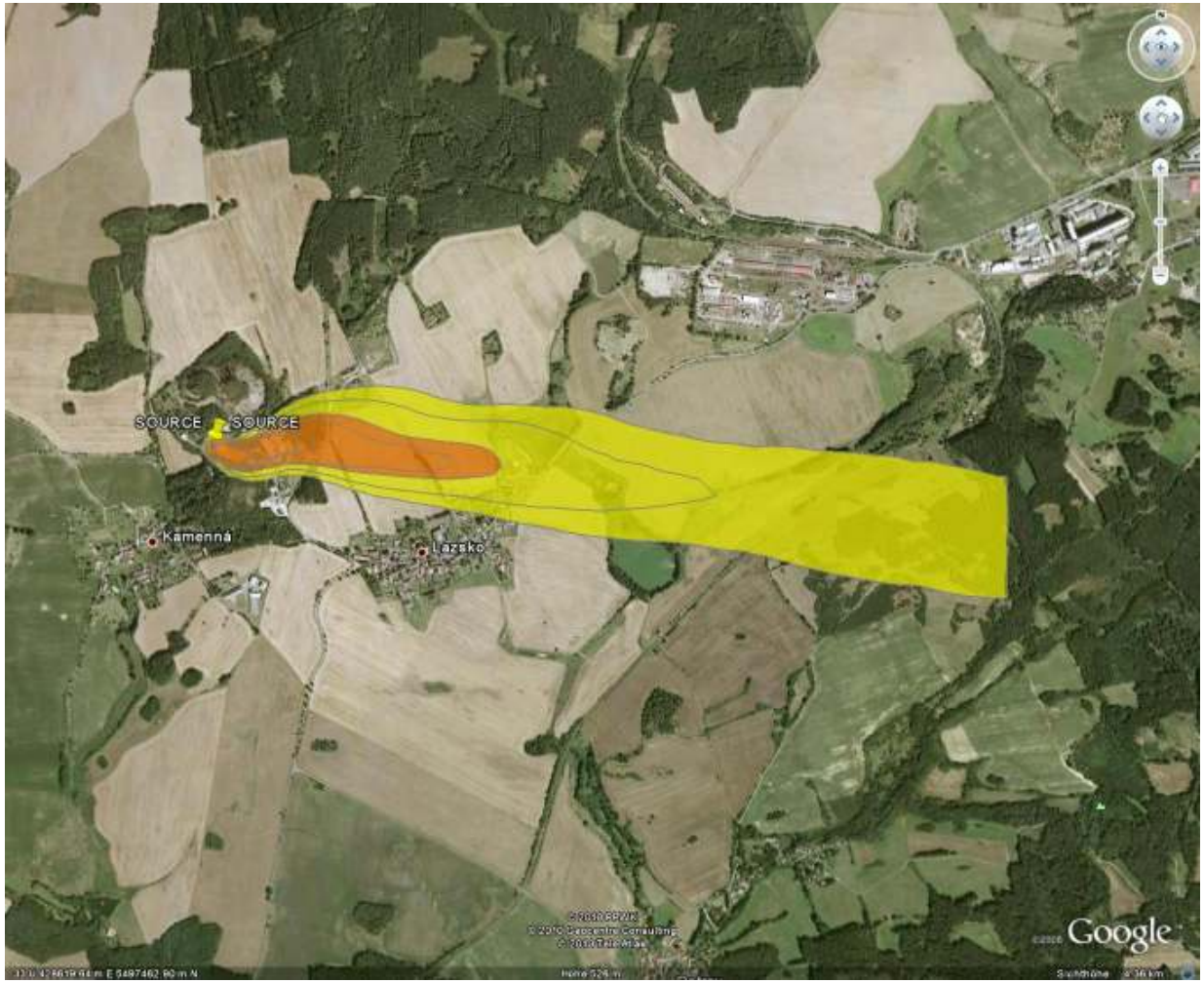
LASAIR results Test 03, mean activity (Bq/m³, 00 – 05 min.)



site (birds eye)

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LASAIR results Test 04, Mean activity (Bq/m³, 00 – 05 min.)

site (birds eye)

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LASAIR results Test 03, Mean activity (Bq/m³ , 00 - 05 min.)

(Bq/m**3)	-25	0	25	50	75	100	125	150
-125	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,09E-02	1,69E-01
-100	0,00E+00	0,00E+00	0,00E+00	0,00E+00	2,90E-03	1,90E-02	1,10E-01	8,65E-01
-75	0,00E+00	0,00E+00	0,00E+00	6,77E-03	3,83E-02	1,60E-01	1,35E+00	7,61E+00
-50	4,32E-01	5,89E-01	3,90E-01	2,82E-01	4,21E-01	3,01E+00	1,71E+01	6,80E+01
-25	1,23E+01	1,20E+02	1,19E+02	1,85E+01	1,57E+01	5,06E+01	2,15E+02	5,84E+02
0	3,12E+01	2,07E+03	4,00E+03	2,87E+03	1,32E+03	1,22E+03	1,82E+03	2,00E+03
25	2,20E+01	1,96E+03	4,10E+03	4,63E+03	4,50E+03	3,55E+03	2,75E+03	2,09E+03
50	2,74E+00	9,84E+00	2,27E+02	1,86E+03	3,39E+03	2,65E+03	1,37E+03	7,87E+02
75	4,10E-02	4,81E-01	9,74E+00	7,41E+01	2,10E+02	2,99E+02	2,78E+02	2,12E+02
100	2,51E-03	6,73E-02	6,26E-01	4,36E+00	1,53E+01	3,09E+01	3,97E+01	3,68E+01
125	0,00E+00	8,13E-03	5,98E-02	2,71E-01	7,83E-01	1,67E+00	2,22E+00	2,05E+00
150	0,00E+00	0,00E+00	8,29E-03	3,64E-02	8,02E-02	1,17E-01	1,27E-01	1,15E-01

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LASAIR results Test 04, Mean activity (Bq/m³ , 00 – 05 min.)

(Bq/m**3)	-50	-25	0	25	50	75	100
-225	1,12E-02	3,47E-02	5,63E-02	6,15E-02	5,07E-02	4,91E-02	5,63E-02
-200	4,07E-02	1,92E-01	3,99E-01	4,52E-01	3,32E-01	3,28E-01	6,06E-01
-175	1,06E-01	5,52E-01	1,99E+00	2,88E+00	2,28E+00	1,69E+00	1,60E+00
-150	4,74E-01	2,34E+00	6,74E+00	1,22E+01	1,41E+01	1,05E+01	6,05E+00
-125	2,74E+00	1,11E+01	2,81E+01	5,47E+01	6,37E+01	4,16E+01	1,94E+01
-100	1,38E+01	6,71E+01	1,60E+02	2,29E+02	2,02E+02	1,11E+02	4,40E+01
-75	5,03E+01	3,65E+02	9,73E+02	1,18E+03	7,33E+02	2,74E+02	8,70E+01
-50	1,12E+02	2,00E+03	6,06E+03	6,71E+03	3,02E+03	5,67E+02	1,17E+02
-25	1,37E+02	5,32E+03	1,42E+04	1,23E+04	3,89E+03	6,38E+02	1,10E+02
0	1,00E+02	4,07E+03	1,01E+04	7,52E+03	1,74E+03	3,66E+02	8,25E+01
25	4,24E+01	4,92E+02	1,19E+03	9,96E+02	3,63E+02	1,36E+02	4,49E+01
50	7,76E+00	4,77E+01	1,13E+02	1,28E+02	8,98E+01	4,64E+01	1,69E+01
75	1,57E+00	5,89E+00	1,39E+01	2,03E+01	1,96E+01	1,20E+01	4,10E+00
100	1,68E-01	6,90E-01	2,03E+00	3,41E+00	3,07E+00	1,71E+00	7,16E-01

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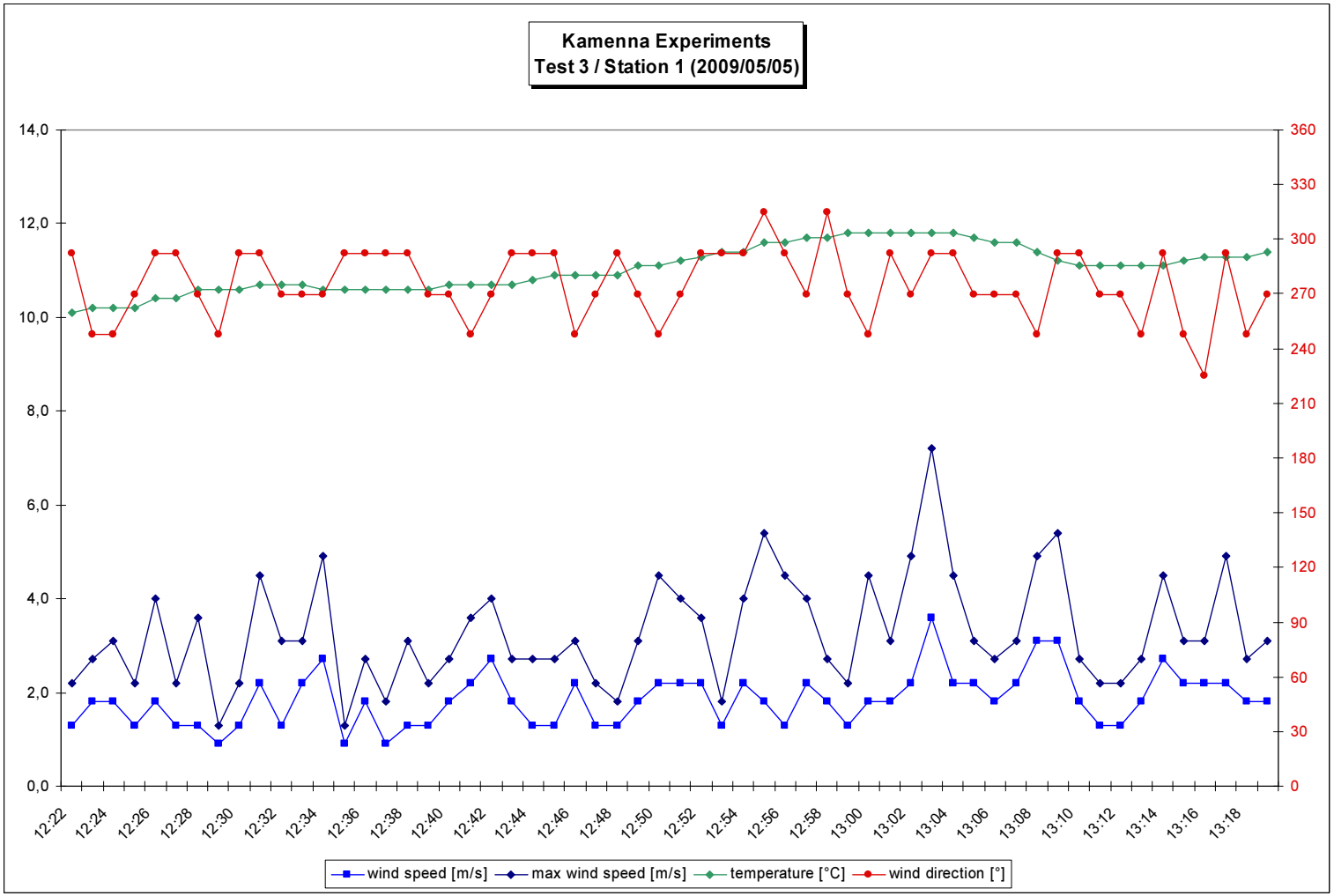
Met. Data Kamenna: Test 3, Station 1



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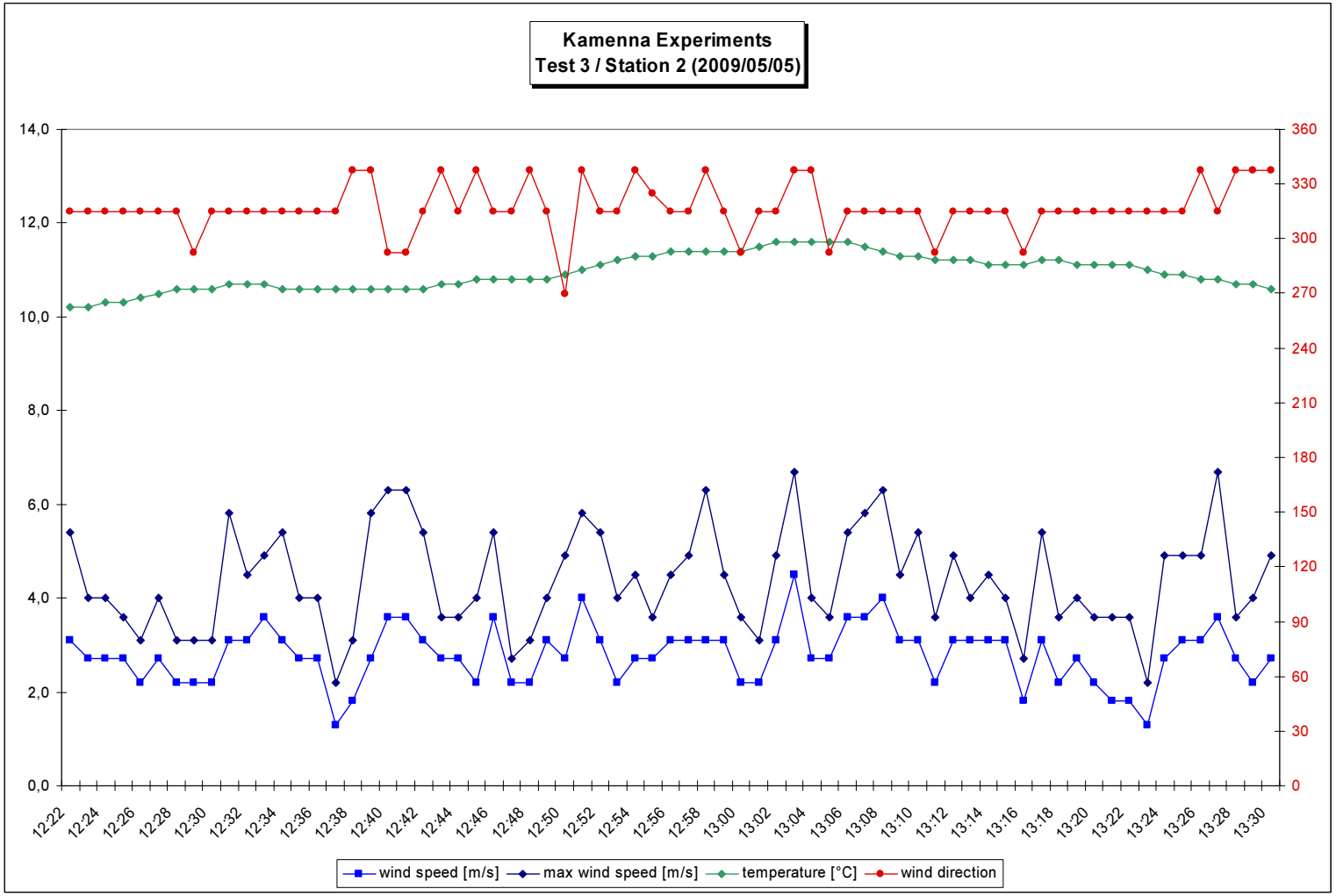
Met. Data Kamenna: Test 3, Station 2



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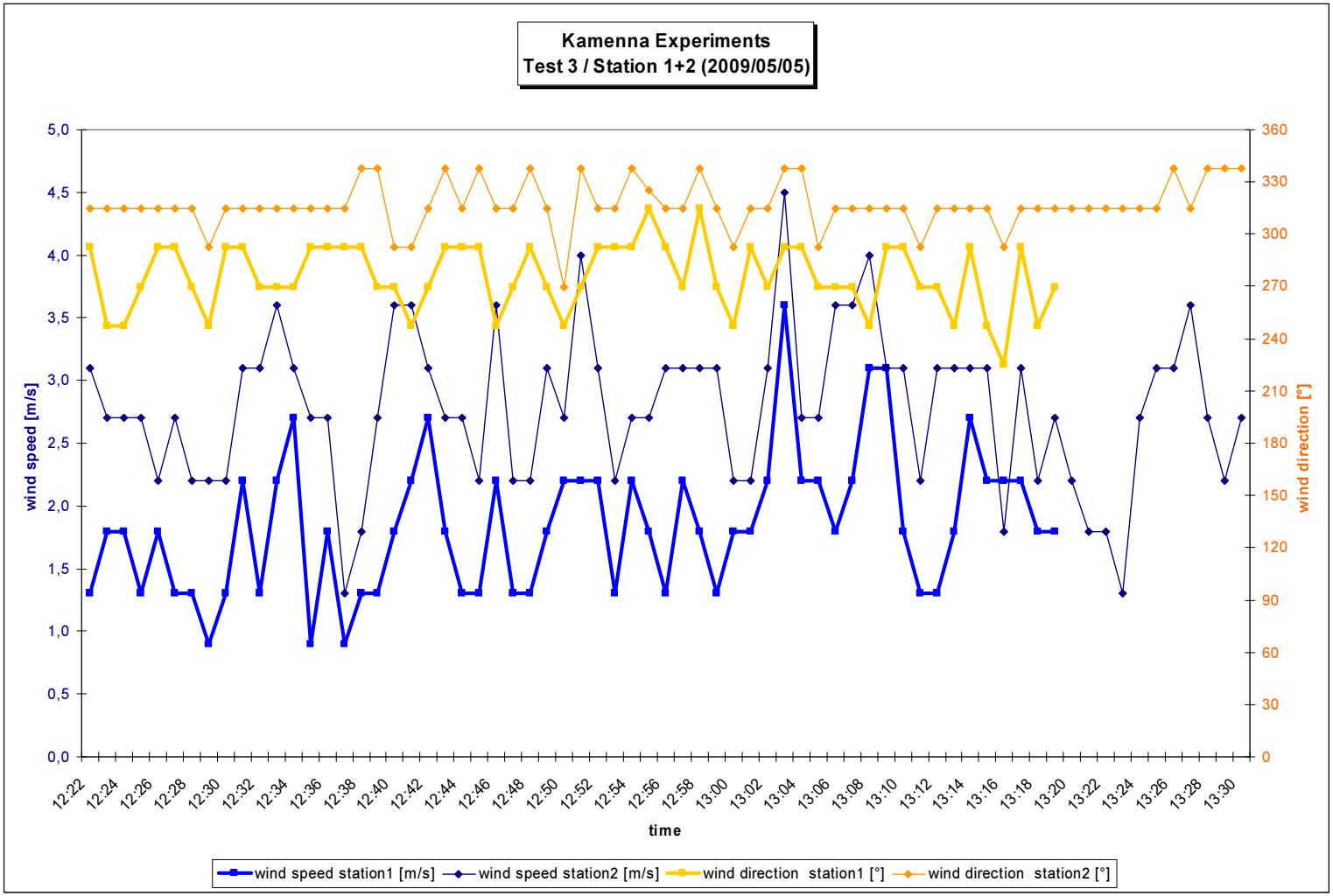
Met. Data Kamenna: Test 3, Station 1 + 2, wind only



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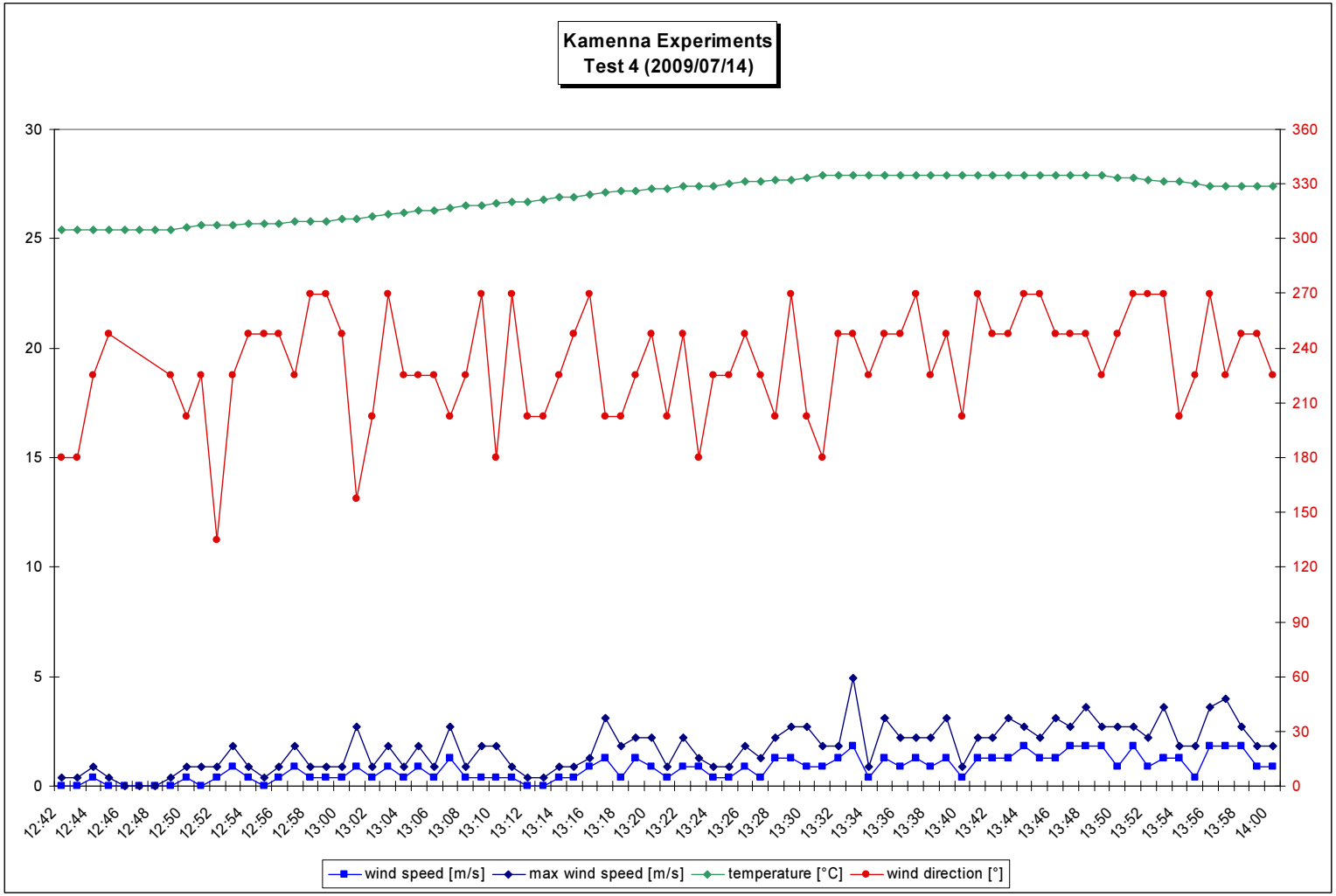
Met. Data Kamenna: Test 4



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Results

Conclusion

- Comparison of LASAIR deposition data possible only after averaging of measurement data
- Comparison of activity data is possible (line?)
- Comparison to measurement data (test 3 and 4) doubtful (initial volume for 30 g PERMON instead of 350 g)
- time integrated activity (definition of the time intervall?)
- percentage of activity ?

Summary

- **In general**

  results are not too bad….

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for your interest in this presentation

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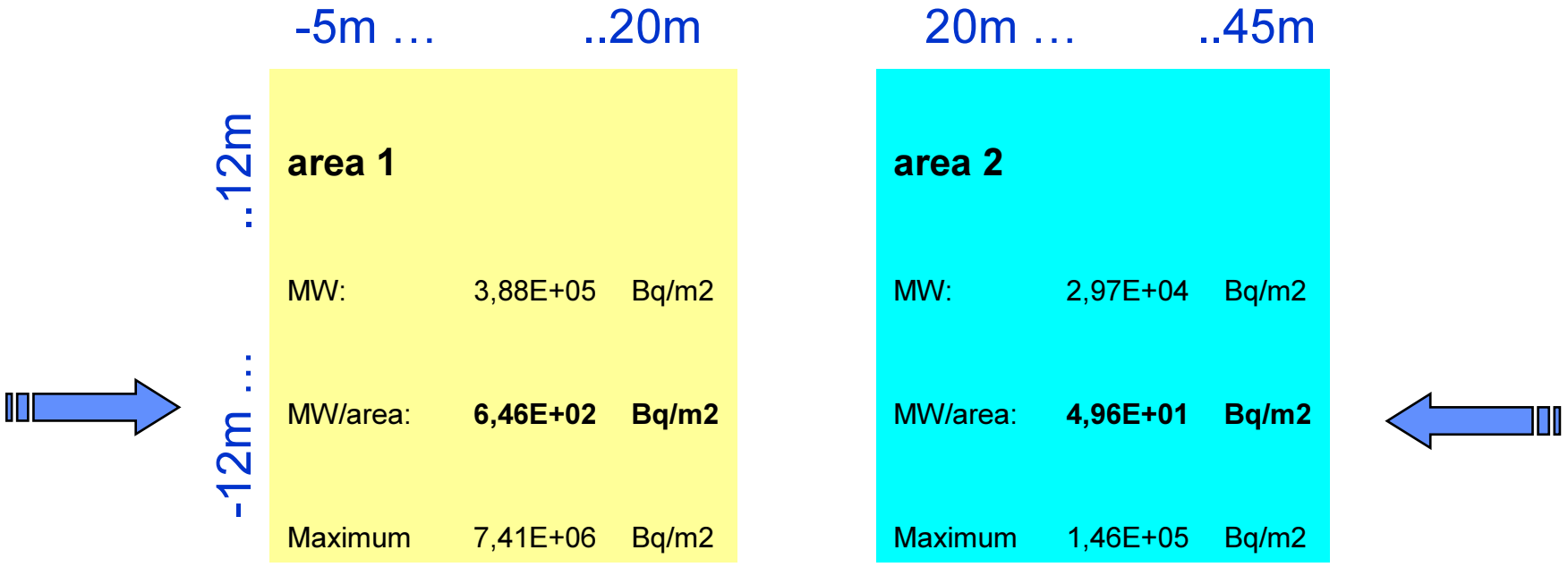
Results Test 01, experiment, average Deposition (Bq/m²)



Experiment	**646 Bq/m²**	**1,67 : 1**	**496 Bq/m²**	**1,24 : 1**
LASAIR approx.:	**386 Bq/m²**		**397 Bq/m²**	

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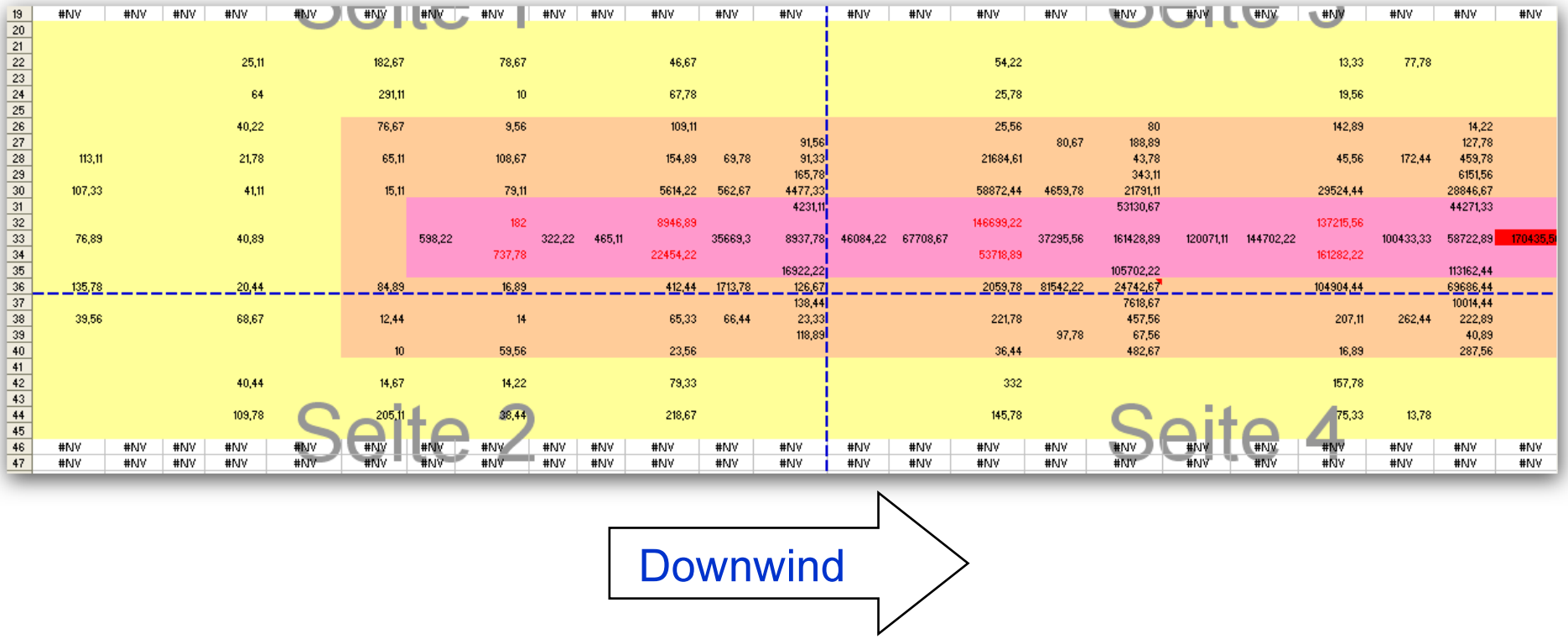
Test 02, experiment, average Deposition (Bq/m²)



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Test 02, experiment, average Deposition (Bq/m²)

area 1			
MW:	1,78E+04	Bq/m2	600 m²
MW/area:	**2,96E+01**	**Bq/m2**	
Maximum	1,70E+05	Bq/m2	

area 2			
MW:	7,62E+03	Bq/m2	600 m²
MW/area:	**1,27E+01**	**Bq/m2**	
Maximum	8,72E+04	Bq/m2	

area 3			
MW:	2,46E+04	Bq/m2	240 m²
MW/area:	**1,03E+02**	Bq/m2	
Maximum	1,70E+05	Bq/m2	

area 4			
MW:	6,46E+04	Bq/m2	38 m²
MW/area:	**1,70E+03**	Bq/m2	
Maximum	1,70E+05	Bq/m2	

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Test 02, experiment, average Deposition (Bq/m²)

Area	mean value / area
600 m²	29,6
240 m²	103
38 m²	1700

Experiment	29,6 Bq/m²	103 Bq/m²	1700 Bq/m²
LASAIR approx.:	1700 Bq/m² grid 1	3250 Bq/m² grid 2	xx

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