

SIMULATION OF “KAMENNA-EXPERIMENTS” WITH THE DECISION SUPPORT MODEL LASAIR

**IAEA, EMRAS II
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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

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

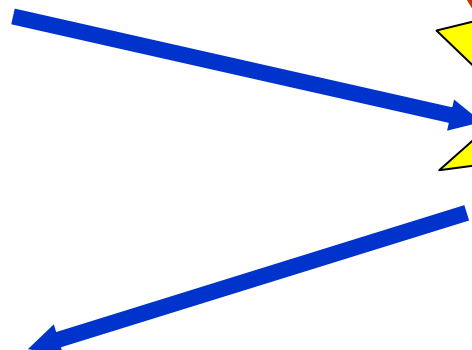
public scene



dirty bomb

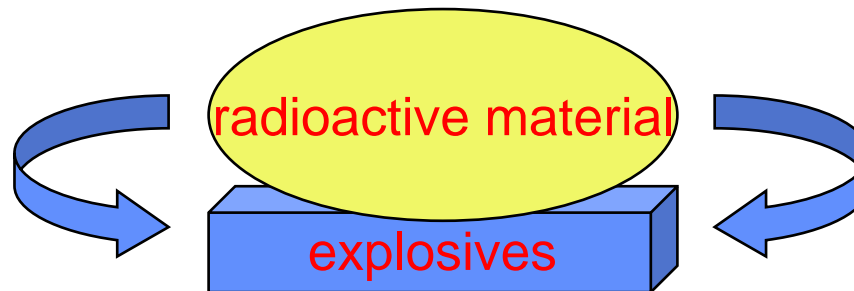


radiation exposure

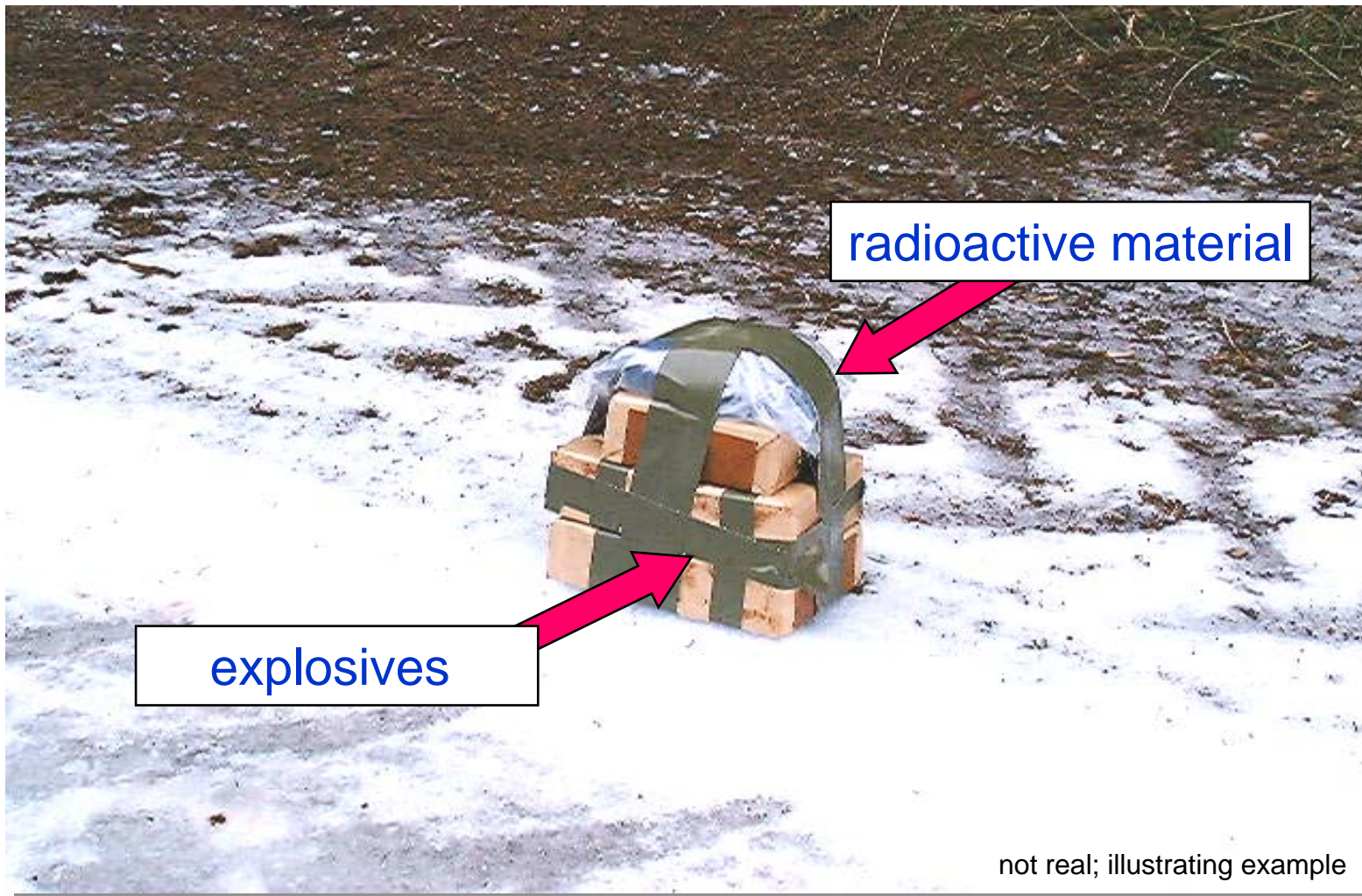


LASAIR background: “dirty bomb”

- **IED** **Improvised Explosive Device**
- **RDD** **Radiological Dispersal Device** ← LASAIR
- **RED** **Radiological Exposure Device**
- **IND** **Improvised Nuclear Device**



Example of a “dirty bomb”



not real; illustrating example

picture: Thielen, GRS

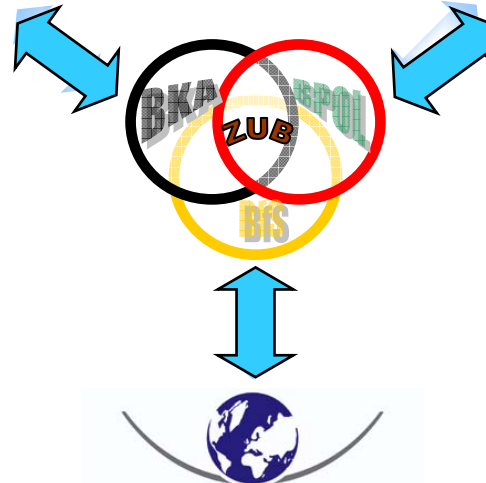
German Federal Central Support Group for Serious Radiological and Terroristic Events „CSG“



Federal Criminal Police Office



Federal Police



Bundesamt für Strahlenschutz

Federal Office for Radiation Protection

Further information
is confidential



LASAIR Task and Aim

Task use of an expert system 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

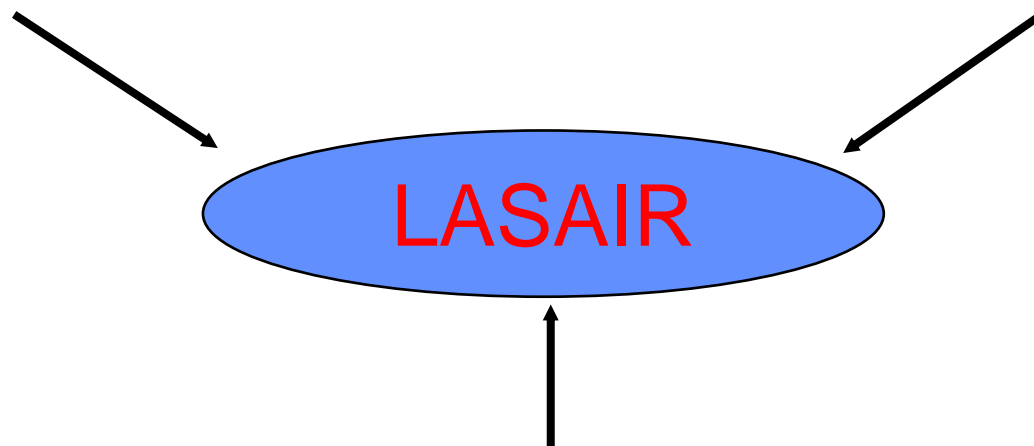
LASAIR input

Meteorology

- wind speed
- wind direction
- stability class

Release to the atmosphere

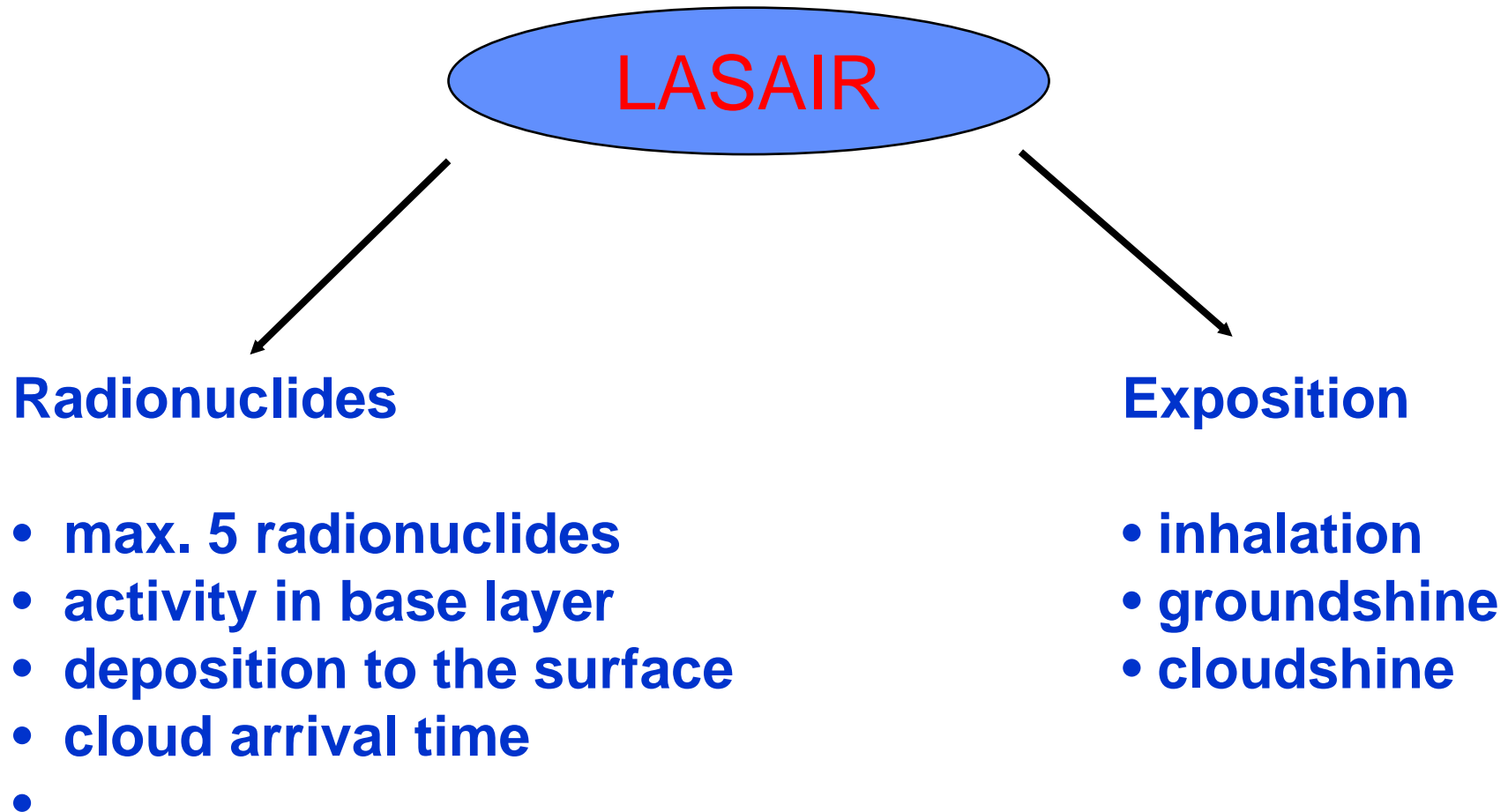
- short term release
or
- continuous release



Topography

- individual roughness length
- 2 dimensional simulation

LASAIR output



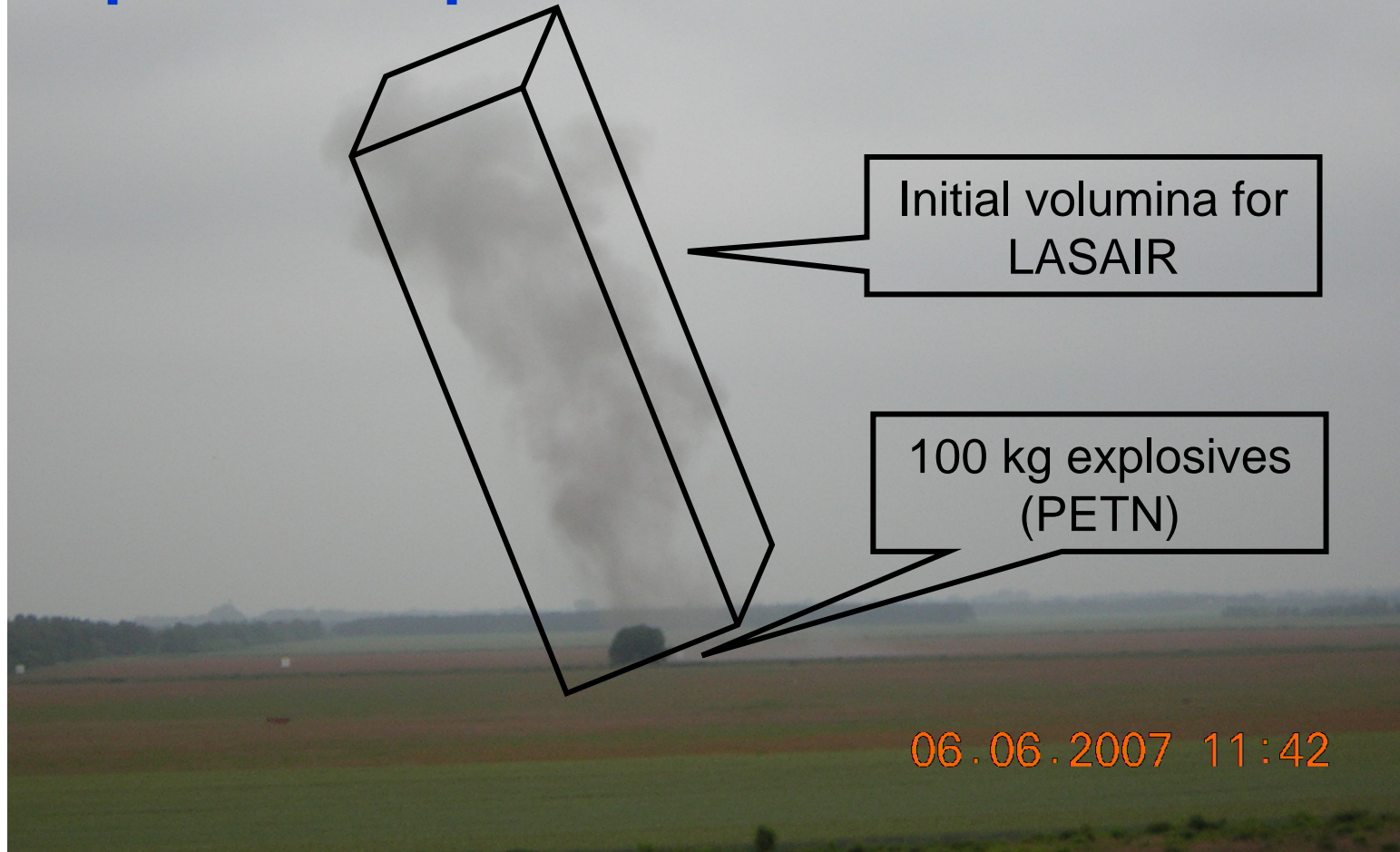
LASAIR features

- Lagrange particle model with 60.000 particles
- individual characterisation of the roughness length
- 2-dimensional flow model (no orographic structure)
- 5 radionuclides can be computed simultaneously
- user can choose out of approx. 860 radionuclides
- very quick response time (1 – 8 minutes)

LASAIR special feature

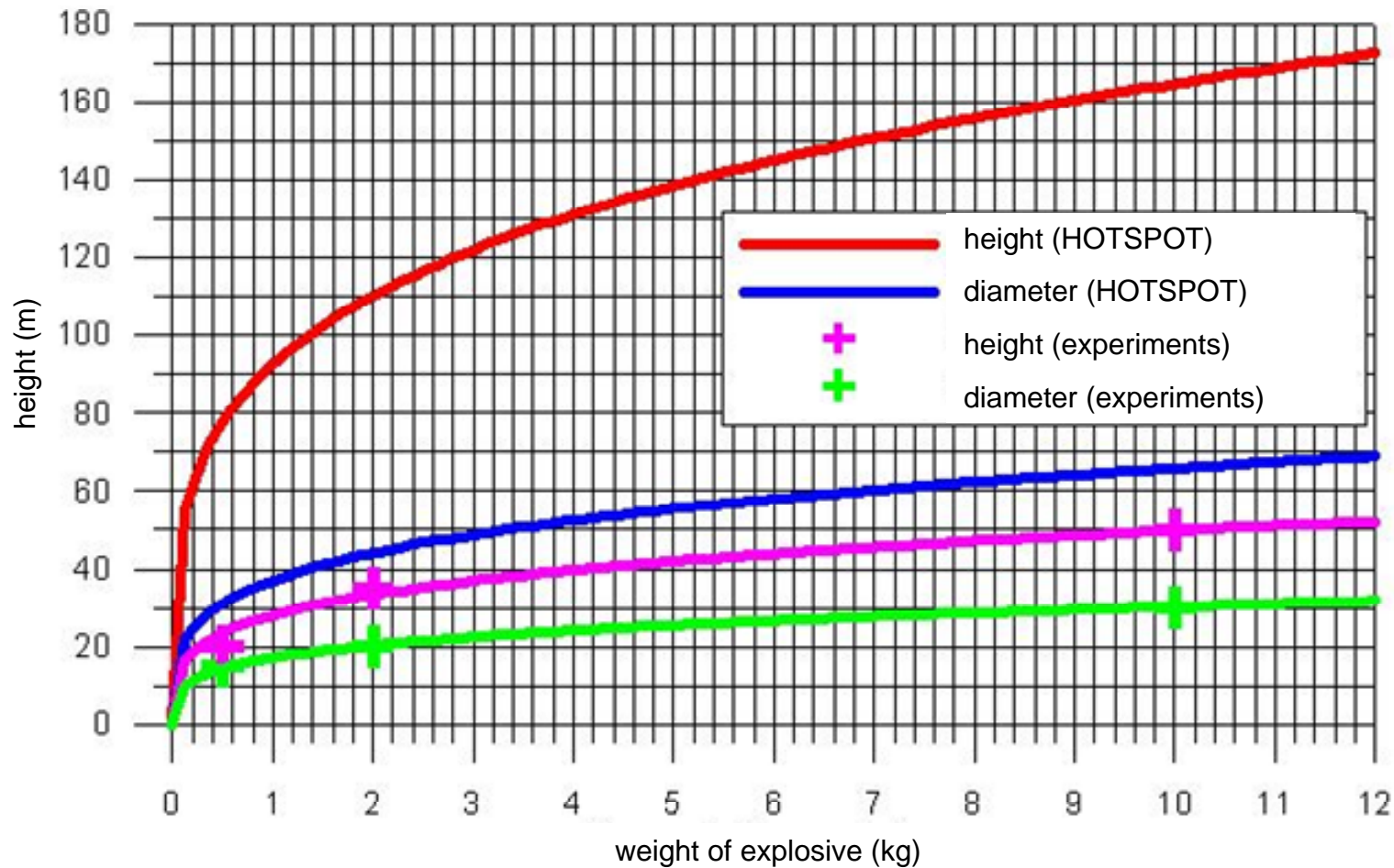
- **parameterisation of the individual cloud as initial volumina (LASAIR source term)**

Initial cloud volumina, explosive experiments 2007



Initial cloud volumina

Parametrisation after experiments



source: Thielen, GRS

Comparison of explosives for LASAIR

LASAIR

Kamenna



PETN

PERMON VESUVIT

TNT

Comparison of explosives for LASAIR

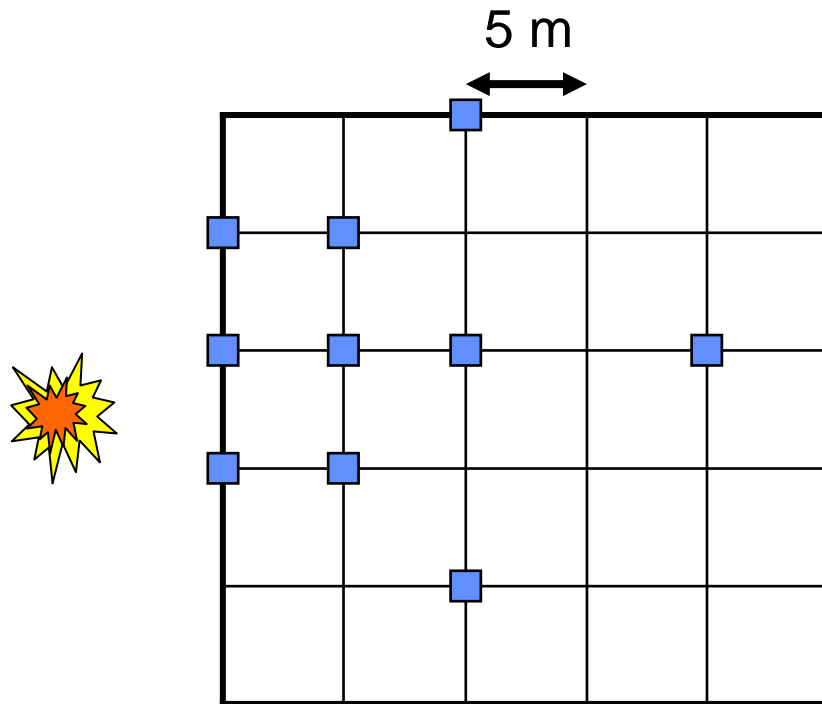
		LASAIR	Kamenna		TNT
		PETN	PERMON	VESUVIT	
Explosion heat	kJ/kg	6300	4079	3050	3725
Volume of explosion products	dm ³ /kg	780	928	280	740
Velocity of detonation	m/s	8400	4000	500	6900
Temperature of explosion	°C	3930	2749	2250	2550
Density	kg/m ³	1773	1050	900	1600
Trauzl lead block test	cm ³	530	400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

Comparison of explosives for LASAIR

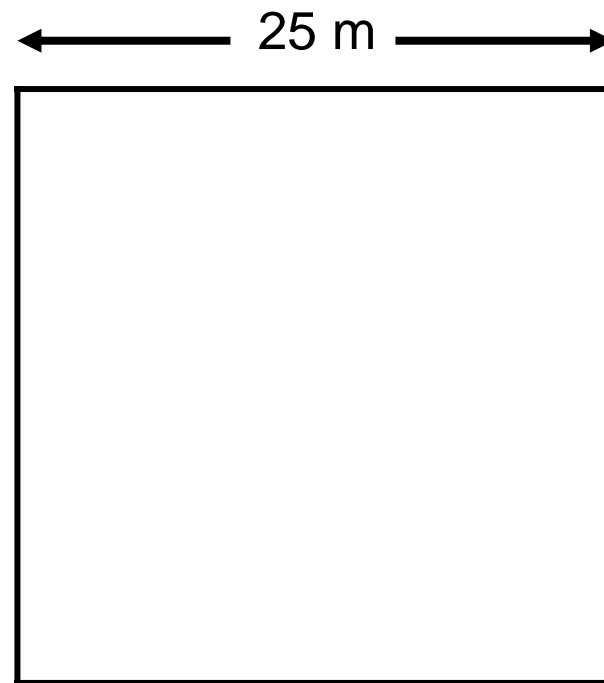
Relationship		PETN	to PERMON	to VESUVIT	to TNT	
Explosion heat	kJ/kg	1	0,65	0,48	0,59	
Volume of explosion products	dm ³ /kg	1	1,19	0,36	0,95	
Velocity of detonation	m/s	1	0,48	0,06	0,82	
Temperature of explosion	°C	1	0,70	0,57	0,65	
Density	kg/m ³	1	0,59	0,51	0,90	
Trauzl lead block test	cm ³	1	0,75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

LASAIR grid compared to „Kamenna-Experiments“

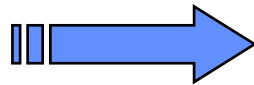
Kamenna grid size



LASAIR grid size
inner grid



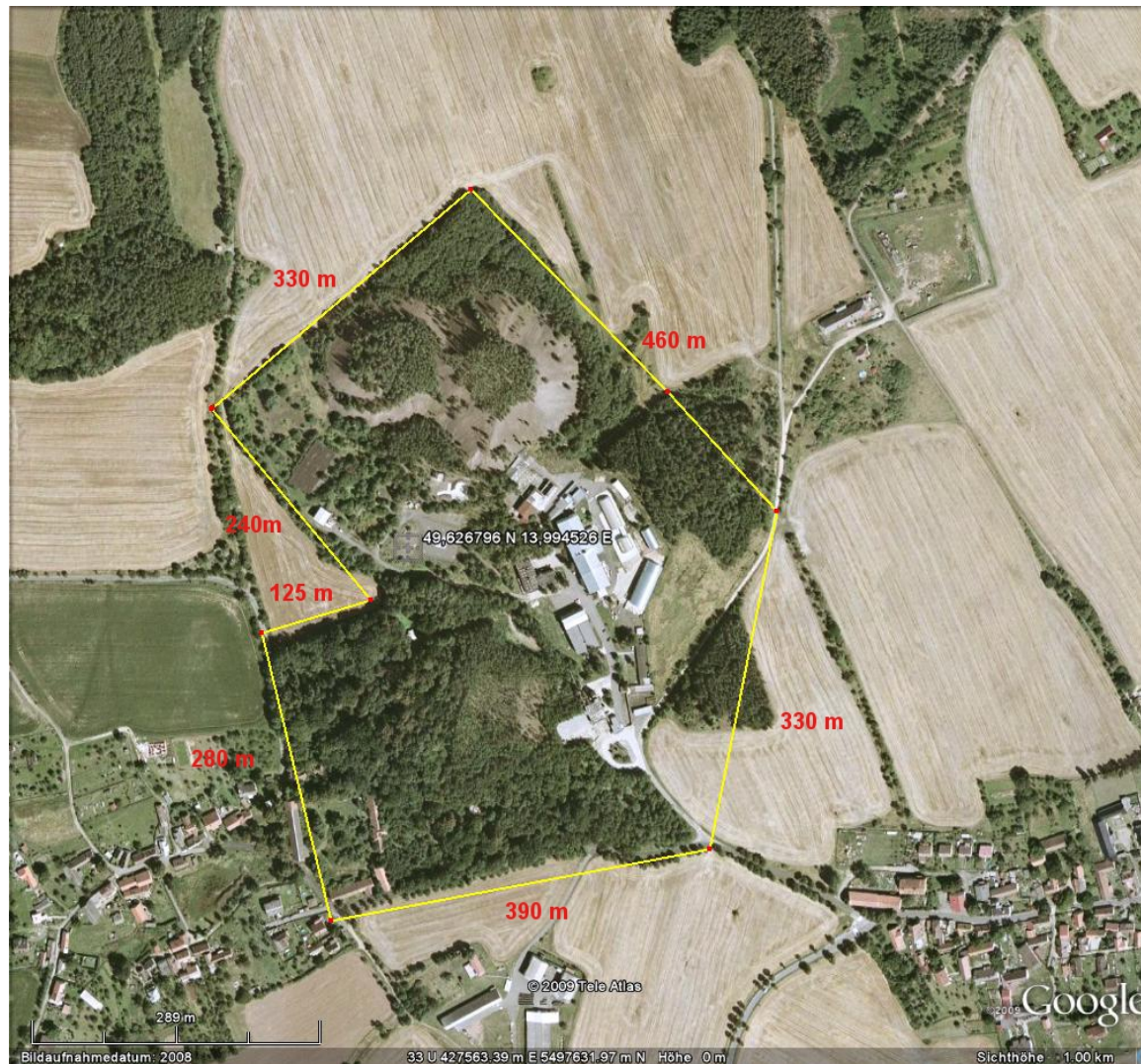
LASAIR results for „Kamenna-Experiments“



**Application of LASAIR in this study
not so much helpfull**

**Comparison of field and model data
only for deposition
(by averaging the field data)**

LASAIR preparation for „Kamenna-Experiments“



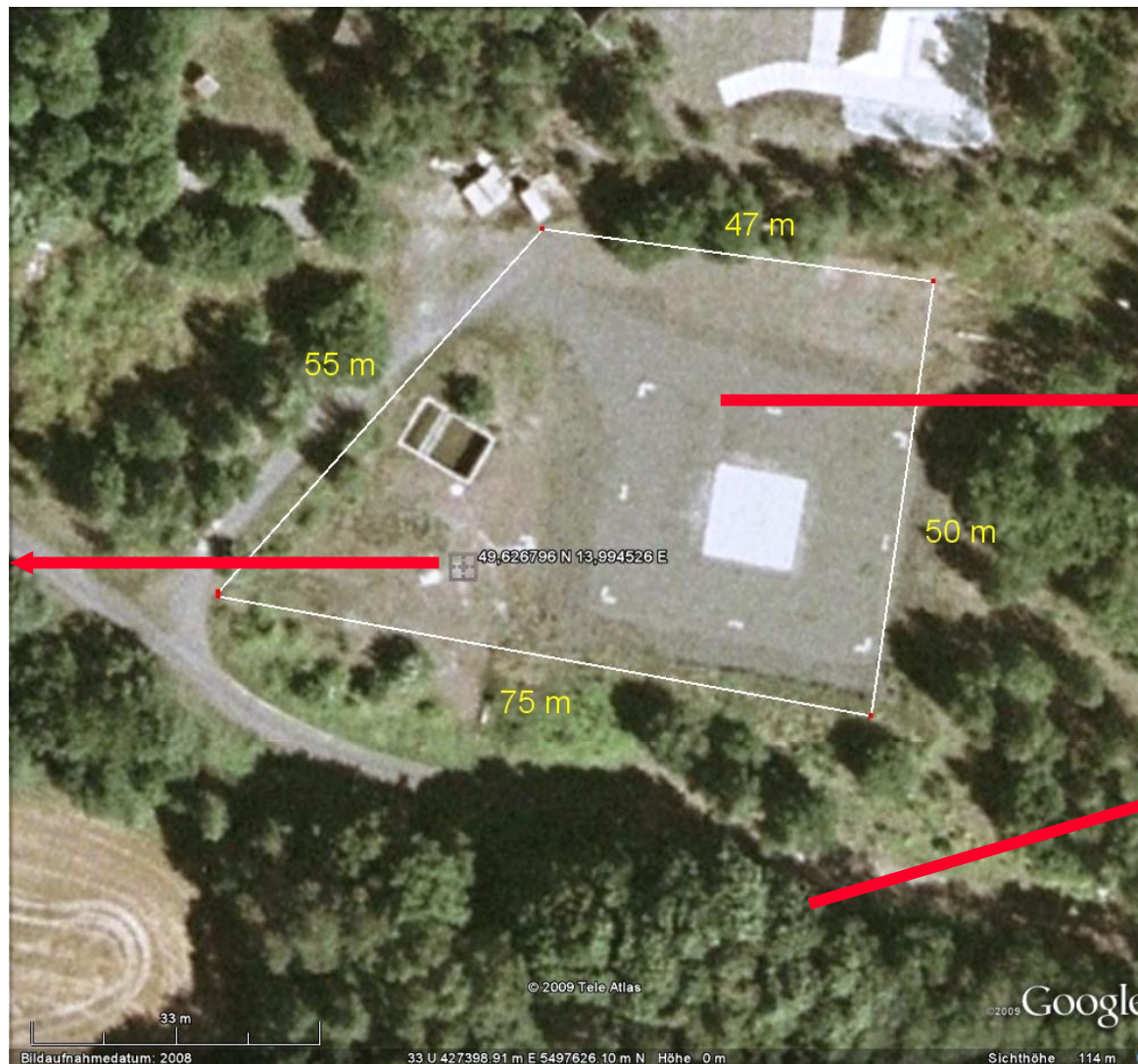
site (birds eye)

[Google Earth]

dimension in
meters

LASAIR preparation for „Kamenna-Experiments“

release
position
49,626796° N
13,994526° E
(explosion)



roughness length
2 areas
 $z_0 = 0,1$ m
(center and far vicinity)

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

LASAIR results Test 01, model Deposition (Bq/m²)



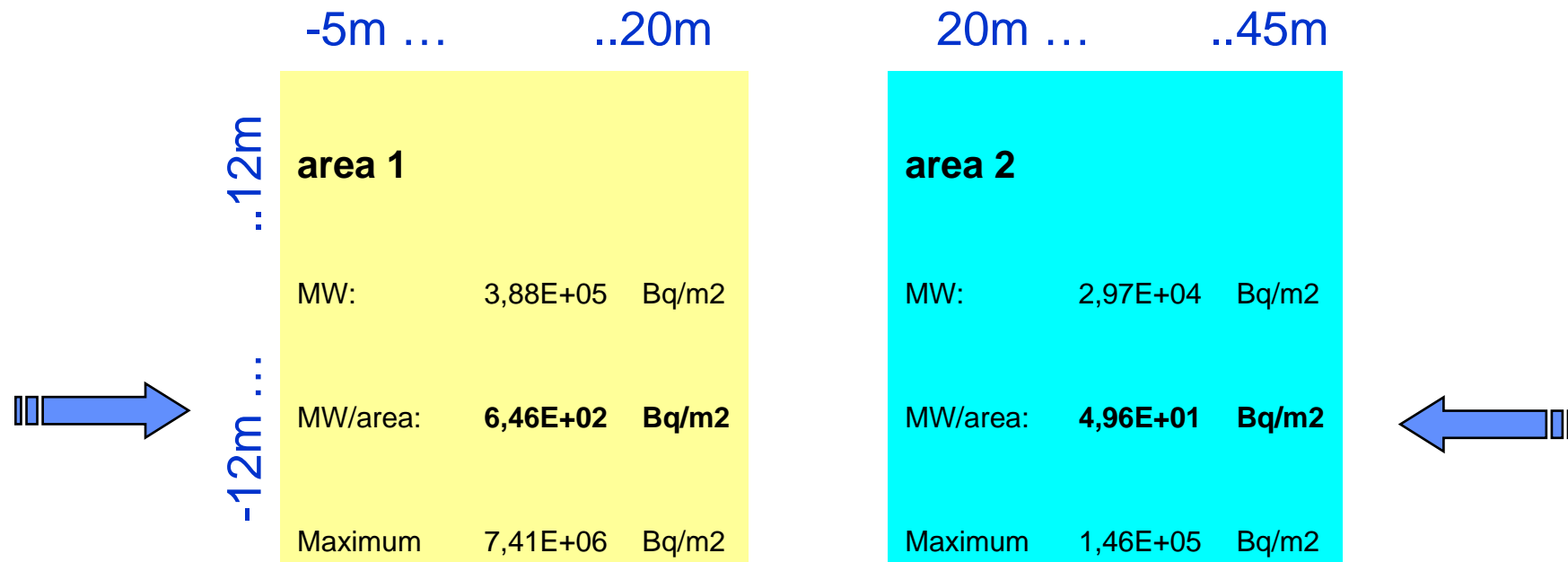
site (birds eye)

[Google Earth]

LASAIR results Test 01, model Deposition (Bq/m²)

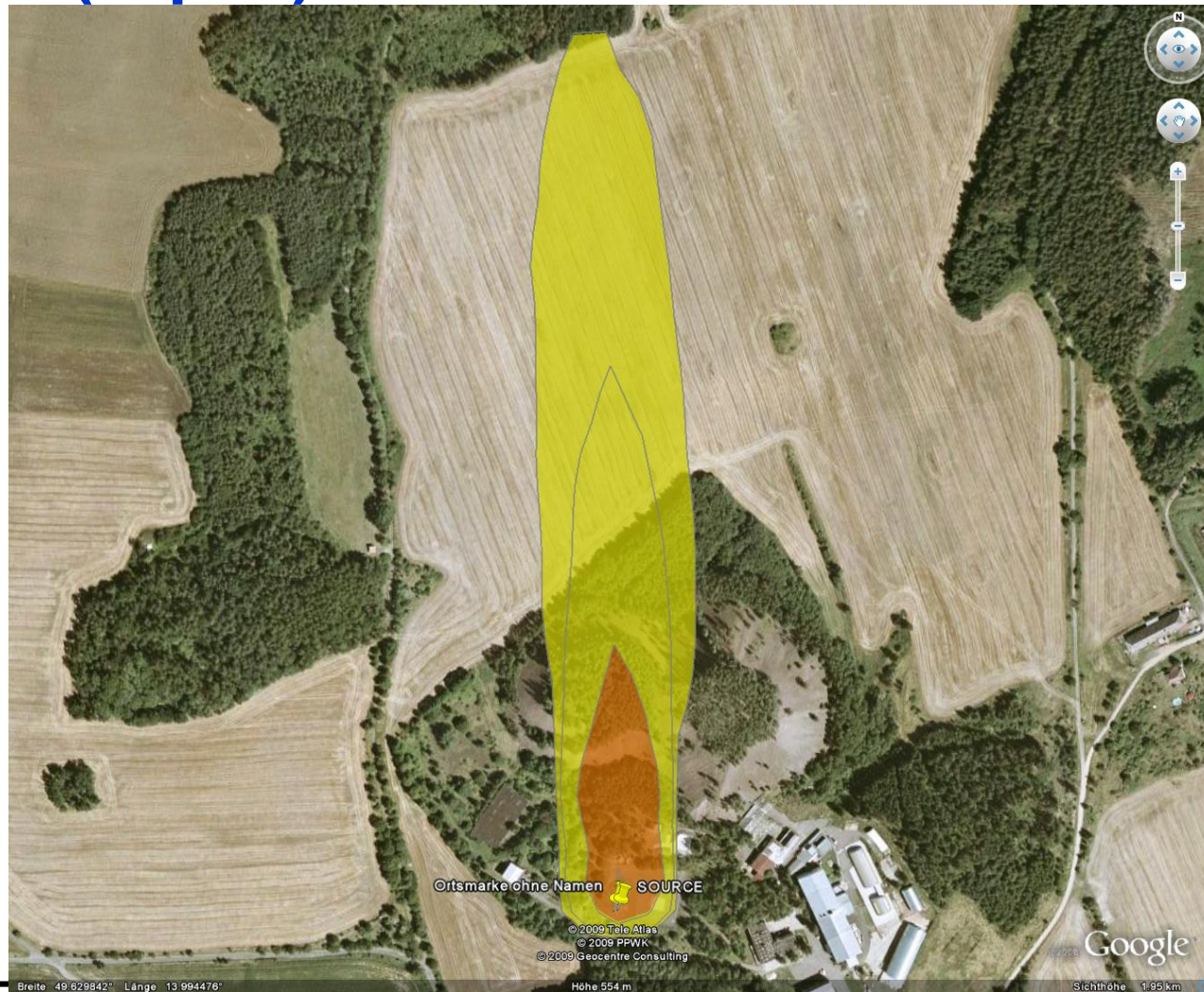
	150	- 25	0	25	50	75
125	1,29E-02		1,19E-01	1,28E+00	1,70E+01	1,07E+02
100	3,03E-02		4,14E-01	7,16E+00	9,15E+01	2,50E+02
75	1,55E-01		1,49E+00	6,45E+01	2,75E+02	3,26E+02
50	1,21E+00		3,05E+01	2,69E+02	3,97E+02	1,79E+02
25	4,85E+00		1,95E+02	3,86E+02	2,14E+02	1,97E+01
0	5,93E+00		1,71E+02	1,80E+02	1,56E+01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

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	

LASAIR results Test 02, model Deposition (Bq/m²)



site (birds eye)
[Google Earth]

LASAIR results Test 02, model 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

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

	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV
19																							
20																							
21																							
22				25,11		182,67		78,67		46,67					54,22				13,33		77,78		
23																							
24				64		291,11		10		67,78					25,78				19,56				
25																							
26				40,22		76,67		9,56		109,11					25,56		80		142,89		14,22		
27												91,56				80,67	188,89				127,78		
28	113,11			21,78		65,11		108,67		154,89	69,78	91,33			21684,61		43,78		45,56	172,44	459,78		
29												165,78					343,11				6151,56		
30	107,33			41,11		15,11		79,11		5614,22	562,67	4477,33			58872,44	4659,78	21791,11		29524,44		28846,67		
31												4231,11					53130,67				44271,33		
32								182		8946,89					146699,22				137215,56				
33	76,89			40,89		598,22		322,22	465,11	35669,3	8937,78	48084,22	67708,67		37295,56	161428,89	120071,11	144702,22		100433,33	58722,89	170435,6	
34						737,78				22454,22					53718,89				161282,22				
35											16922,22						105702,22				113162,44		
36	135,78			20,44		84,89		16,89		412,44	1713,78	126,67			2059,78	81542,22	24742,67		104904,44		69686,44		
37											138,44						7618,67				10014,44		
38	39,56			68,67		12,44		14		65,33	66,44	23,33			221,78		457,56		207,11	262,44	222,89		
39												118,89				97,78	67,56				40,89		
40						10		59,56		23,56					36,44		482,67		16,89		287,56		
41																							
42				40,44		14,67		14,22		79,33					332						157,78		
43																							
44				109,78		205,11		88,44		218,67					145,78				75,33		13,78		
45																							
46	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV
47	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV	#NV



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

area 1

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

area 2

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

area 3

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

area 4

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

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



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

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

Conclusion for test 02

- measurement data reveal strong inhomogeneity
- application of a model with larger grid size is not wise

Summary

- **In general**
results are not too bad....



**for your interest
in this presentation**