

SIMULATION OF “KAMENNA-EXPERIMENTS” TEST 1 – 4 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

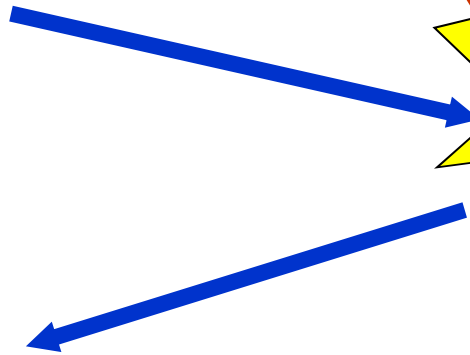
public scene



dirty bomb (RDD)



radiation exposure



LASAIR model descriptions

- **2-dimensional flow model (no orographic structure)**
- **type of model: Lagrange particle model (60.000 particles)**
- **individual characterisation of the roughness length**
- **5 radionuclides can be computed simultaneously**
- **approx. 860 radionuclides available**
- **very quick response time (1 – 10 minutes)**

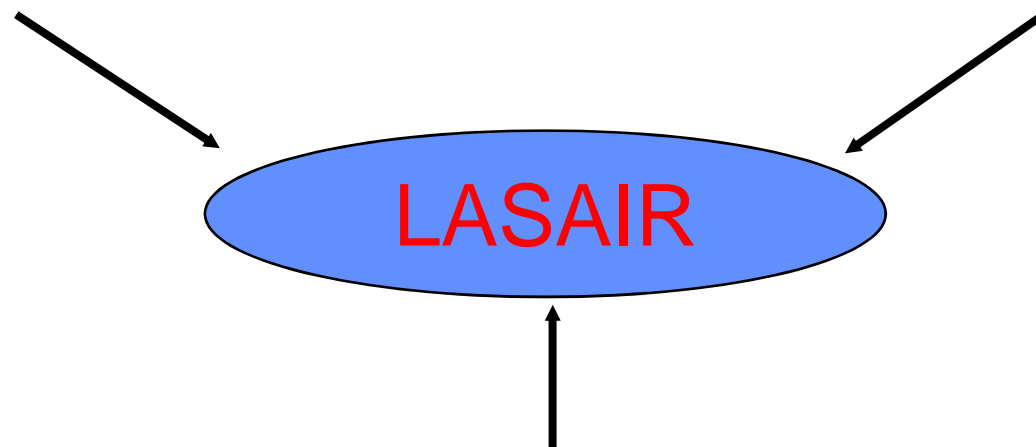
LASAIR input

Meteorology

- wind speed
- wind direction
- stability class

Release to the atmosphere

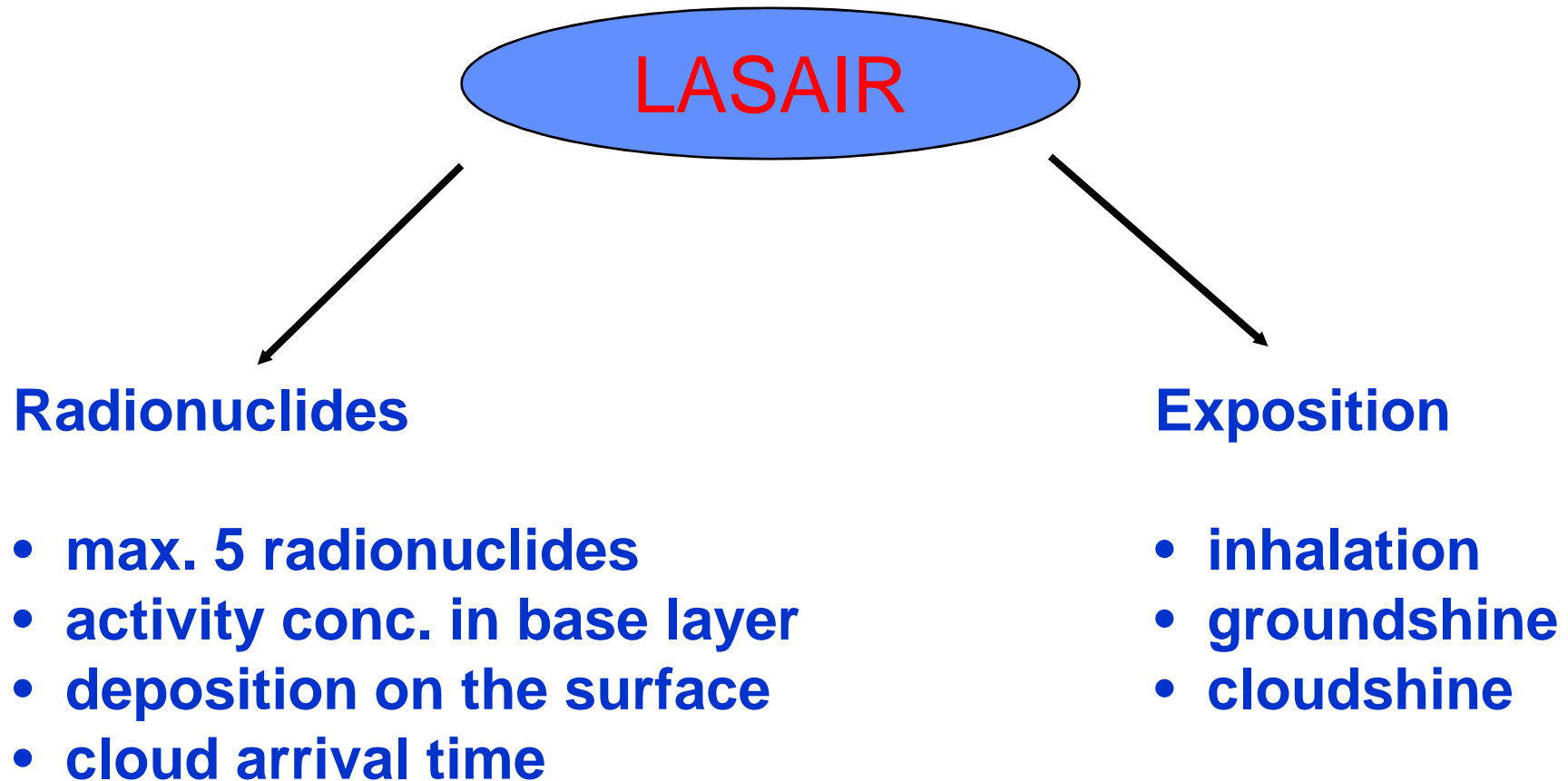
- short term release
or
- continuous release



Topography

- individual roughness length
- 2 dimensional simulation

LASAIR output



LASAIR deposition computation

- computation

$$D_r = V_g \cdot C_{Lu,r}^*$$

D_r	deposition of nuclide r	[Bq m ⁻²]
V_g	deposition velocity	[m / sec]
$C_{Lu,r}^*$	time-integrated activity in air	[Bq min m ⁻³]

LASAIR deposition velocities and size range

- **deposition velocities**

Suggested values for aerosol diameters and deposition velocities for the short-range scenario
[Kasper & Govert, email Kathy 02.08.2010]

Size range (μm)	Average diameter (μm)	Deposition velocity (10^{-4} m/s)
< 0.39	0.2	0.5
0.39 - 1.3	1	1.5
1.3 - 10.2	8	10
> 10.2	20	80

LASAIR values for deposition velocities for the short-range scenario (standard values in brackets)

Size range (μm)		Deposition velocity (10^{-4} m/s)
0 – 2,5		1 (10)
2,5 – 10		10 (100)
10 -50		80 (500)
> 50		80 (2000)

LASAIR deposition velocities and size range

- size range for aerosols in LASAIR spectral distribution

Size range (μm)	Percentage %
0 – 2,5	40
2,5 – 10	40
10 -50	10
> 50	10
	100

LASAIR integrated activity computation

- computation

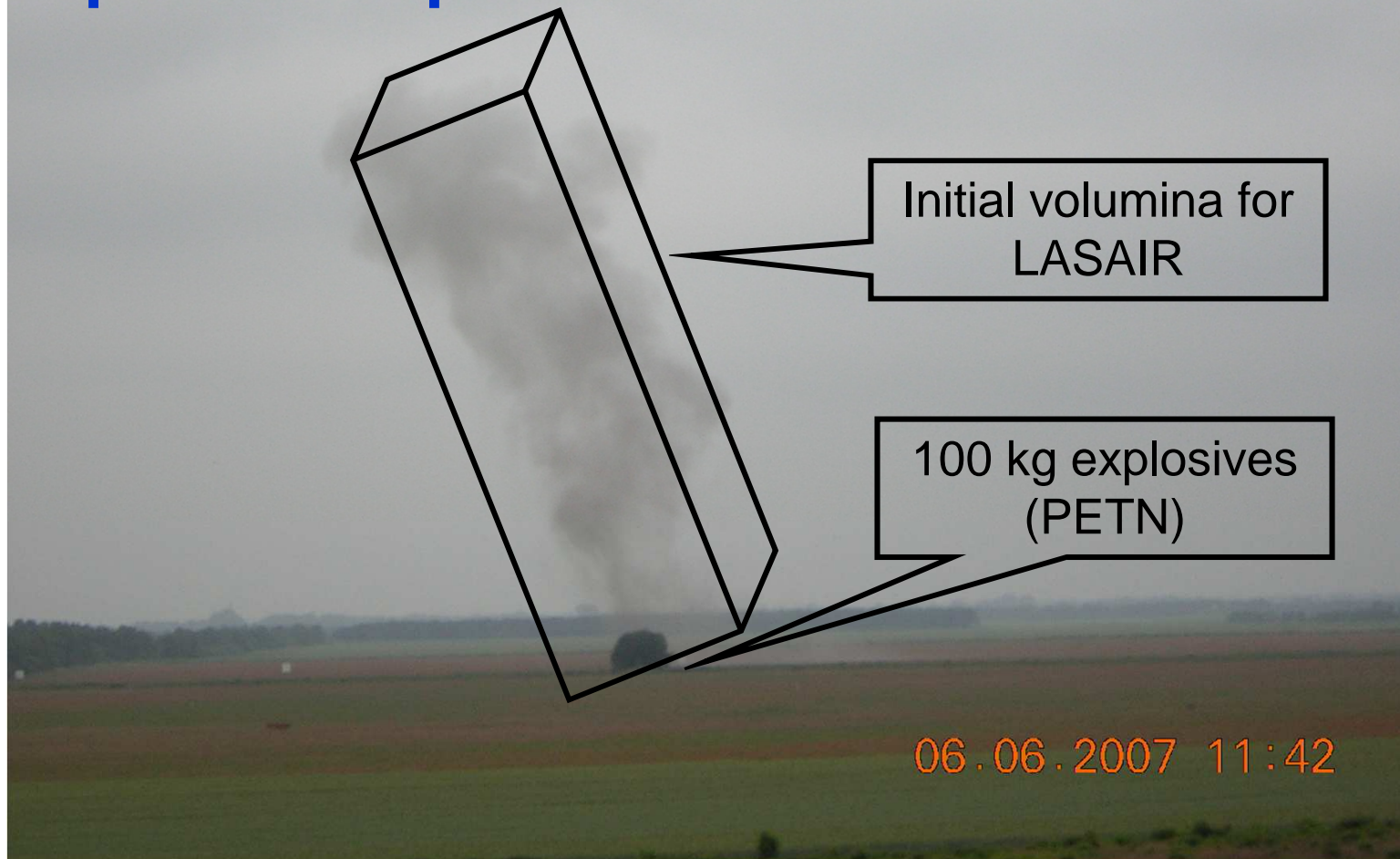
$$C_{Lu,r}^* = C_{Lu,r} \cdot T$$

$C_{Lu,r}^*$	time-integrated activity in air	[Bq min m ⁻³]
$C_{Lu,r}$	activity in air	[Bq m ⁻³]
T	time period	[min]

LASAIR special feature

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

Initial cloud volumina, explosive experiments 2003 / 2007



Comparison of the initial volume





A

B

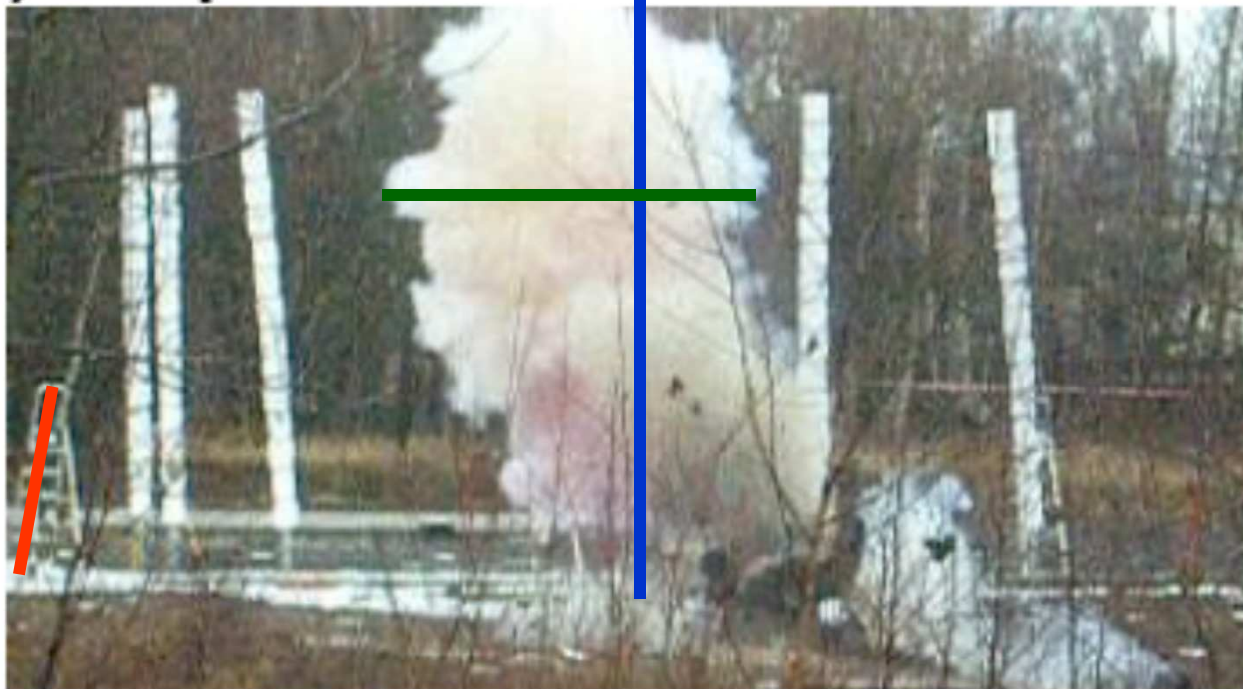
C

Certificate
EN 131
Norm

Arbeitshöhe bis	ca. m A	2,65	2,85	3,05	3,25	3,50	3,75
Standhöhe	ca. m B	0,65	0,85	1,05	1,25	1,50	1,75
Gesamtlänge	ca. m C	1,45	1,65	1,85	2,05	2,25	2,45
Stufenzahl		3	4	5	6	7	8
Gewicht	ca. kg	3,0	3,6	4,5	5,2	6,2	7,2
Transport- maße	Länge ca. m	1,45	1,65	1,85	2,05	2,25	2,45
	Breite ca. m	0,41	0,44	0,46	0,49	0,52	0,54
	Höhe ca. m	0,13	0,13	0,13	0,13	0,13	0,13
Art.-No.		120212	120274	120281	120298	120304	120311

Comparison of the initial volume



3

Test 1, 2007/12/06, picture 3

$h = 2,48 \text{ cm}$
equates to $1,85 \text{ m}$

$h = 8,34 \text{ cm} \Rightarrow$
 $8,34 / 2,48 * 1,85 \text{ m}$

$\triangleq \underline{\underline{6,2 \text{ m}}}$

$w = 4,94 \text{ cm} \Rightarrow$
 $4,94 / 2,48 * 1,85 \text{ m}$

$\triangleq \underline{\underline{3,7 \text{ m}}}$

Comparison of the initial volume



4 Test 2, 2008/05/15, picture 4

$h = 2.89 \text{ cm}$ equates to 1.85 m

$h = 8.15 \text{ cm} \Rightarrow 8.15 / 2.89 * 1.85 \text{ m}$

$\triangleq \underline{5.2 \text{ m}}$

$w = 3.6 \text{ cm} \Rightarrow 3.6 / 2.89 * 1.85 \text{ m}$

$\triangleq \underline{2.3 \text{ m}}$

Comparison of the initial volume

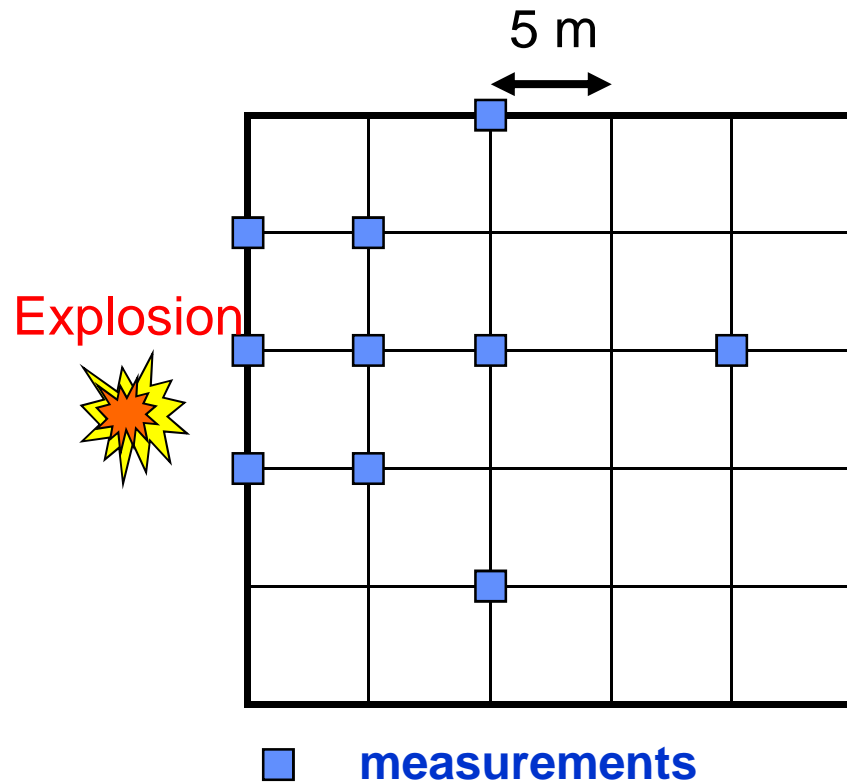
Suggestion from Dejan / Hartmut / LASAIR formula

		Test 1 suggested	used	Test 2 suggested	used	Test 3 suggested	used	Test 4 suggested	used
Cloud height	m	7 / 6,2 / 8	7	5 / 5,2 / 4	5	12,9 / n.a. / 18	13	12,9 / n.a. / 18	13
Cloud base	m	2,8 / 3,7 / 5	3	2 / 2,3 / 3	2	5,2 / n.a. / 12	5	5,2 / n.a. / 12	5

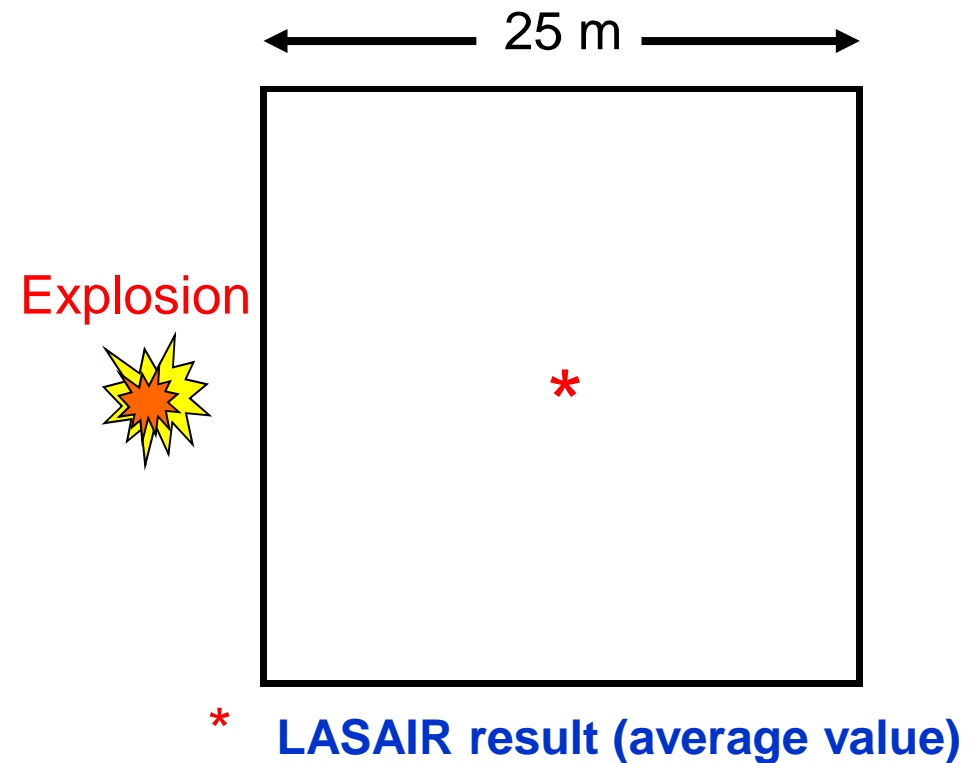
n.a.: not available

Inner LASAIR grid vs. „Kamenna - Experiments“

Kamenna grid size

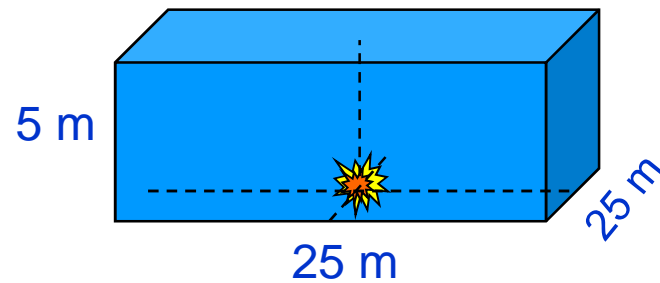


LASAIR grid size
(inner grid)



Inner LASAIR grid vs. „Kamenna - Experiments“

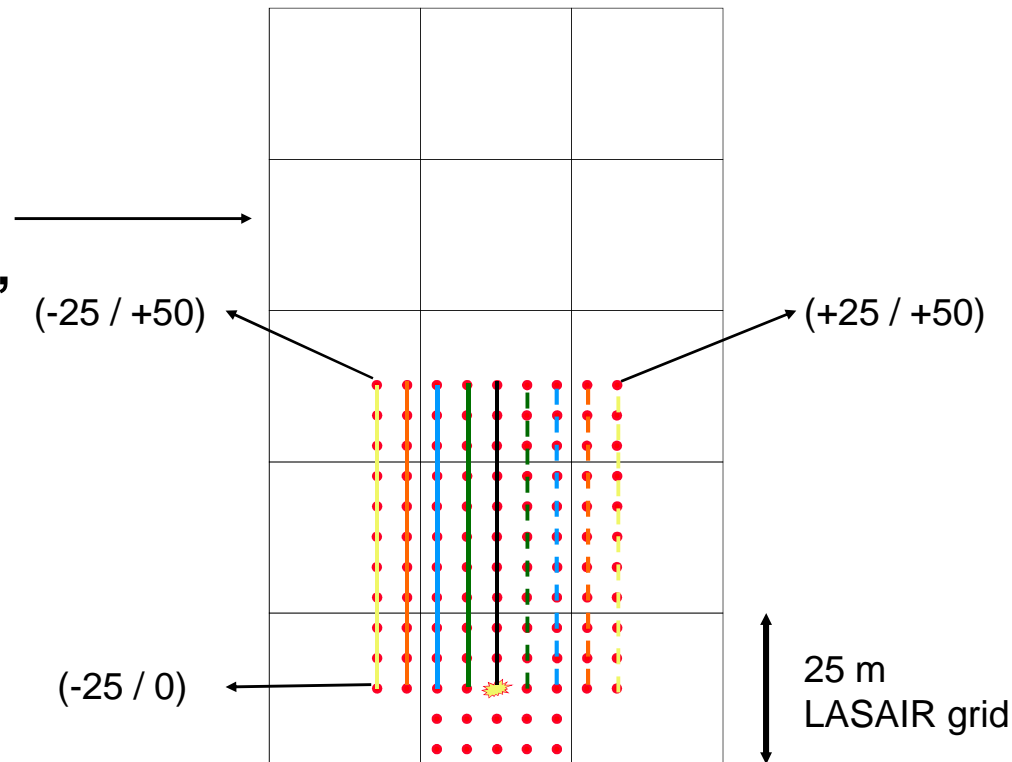
LASAIR volume grid size
(inner grid)



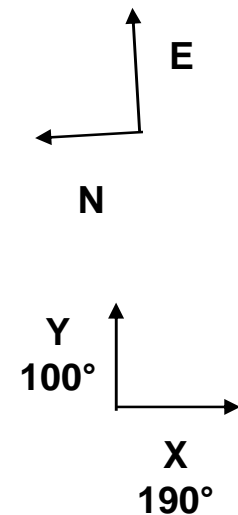
Grids Kamenna-Experiments - LASAIR

LASAIR grid
mostly 25 m, 50 m,
(100 m, only few)

Kamenna grid
(Bullets represent
measurements)



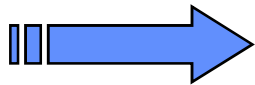
LASAIR
origin of explosion in the
center of the first grid cell



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
defined cloud height (m)	7	5	13	13
defined cloud base (m)	3	2	5	5
particle sizes [μm] [0-2.5 / 2.5-10 / 10-50 / 50<]	[40 / 40 / 10 / 10]	[40 / 40 / 10 / 10]	[40 / 40 / 10 / 10]	[40 / 40 / 10 / 10]
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
stability class	D	B - C	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

LASAIR results for „Kamenna-Experiments“

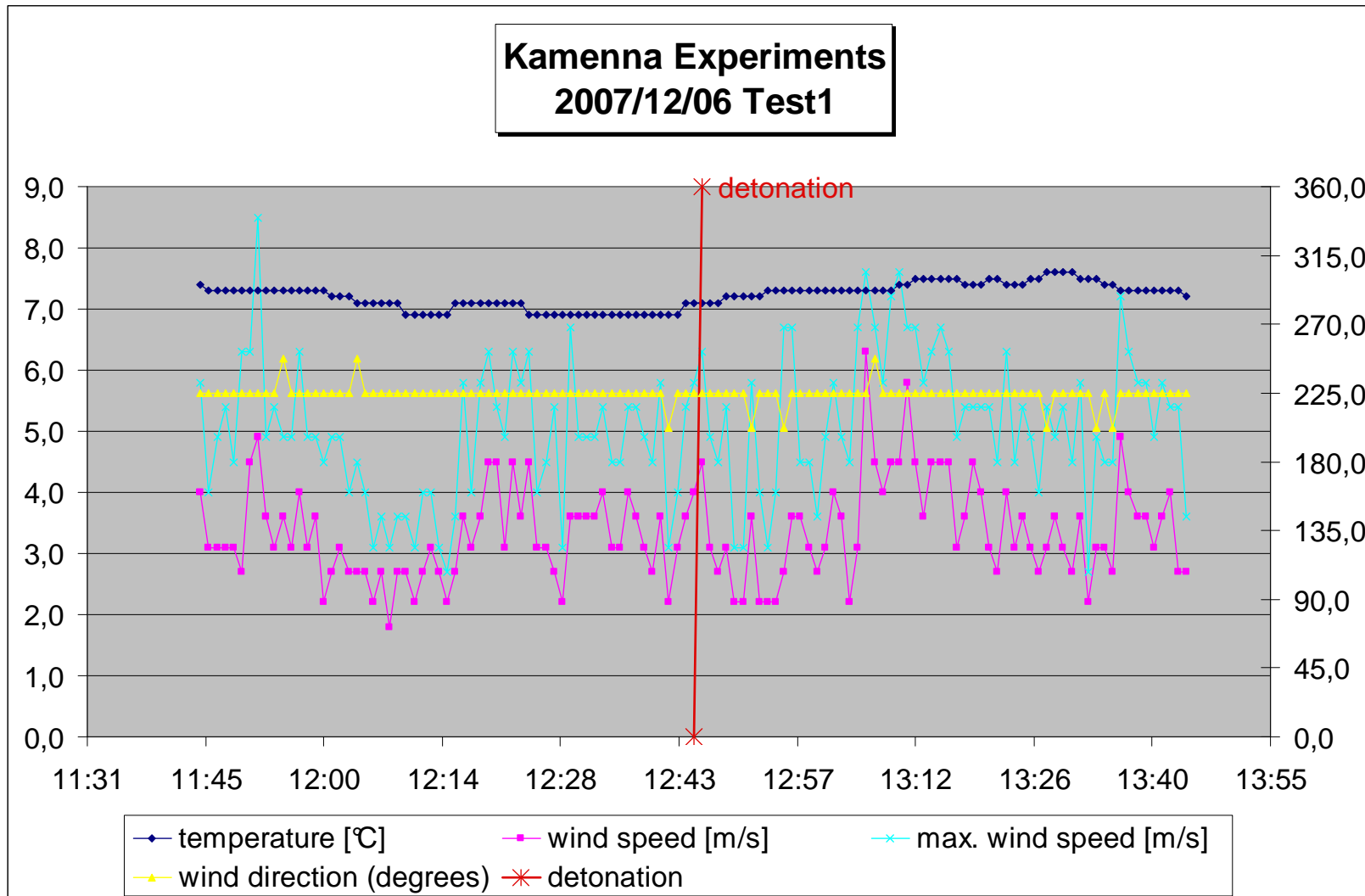


**Comparison of field and model data
for time-integrated activity,
maxima downwind and
deposition**

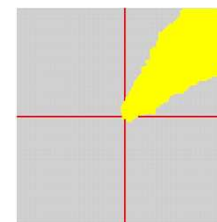
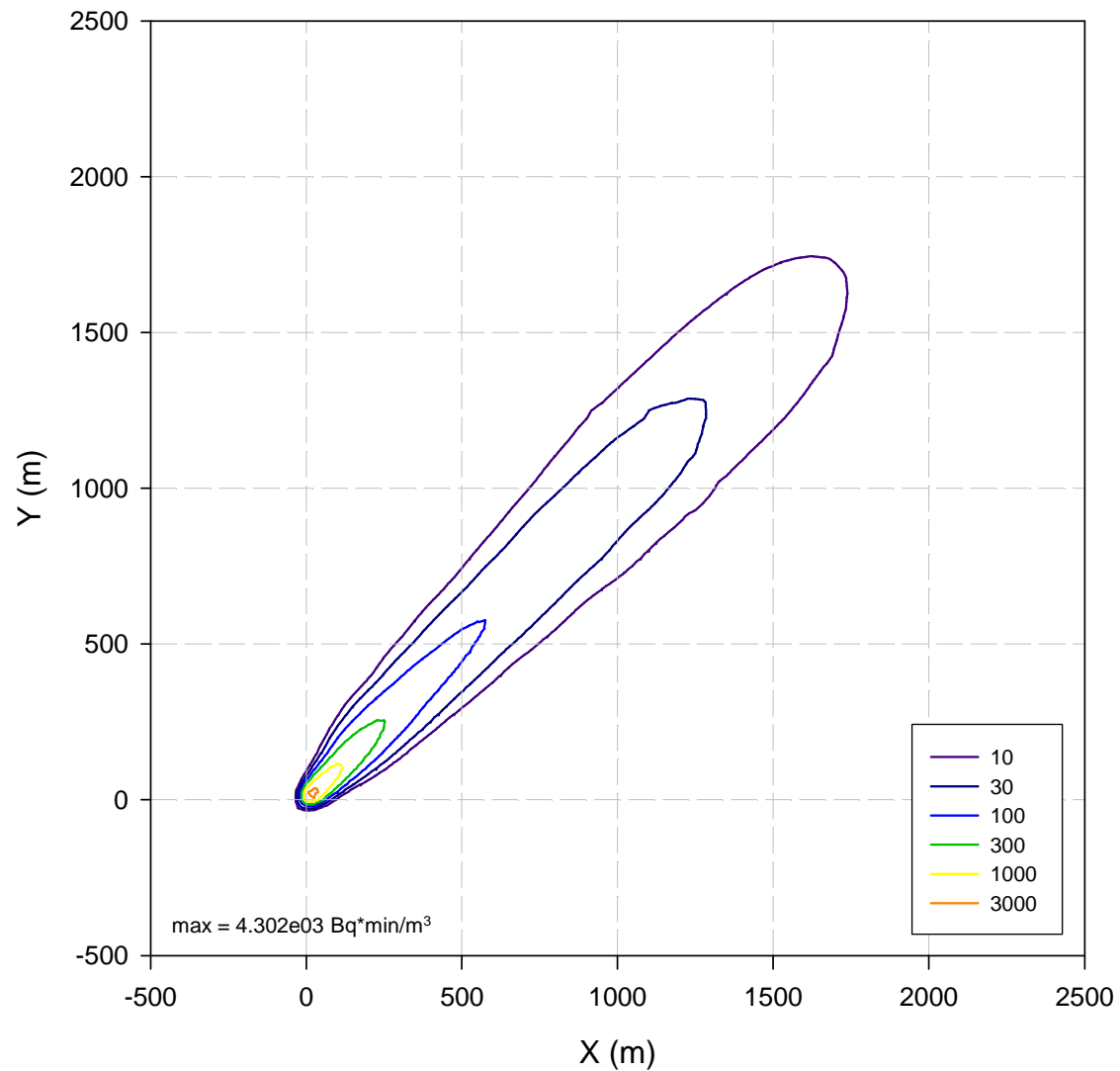
results from LASAIR



Meteorology Test 1

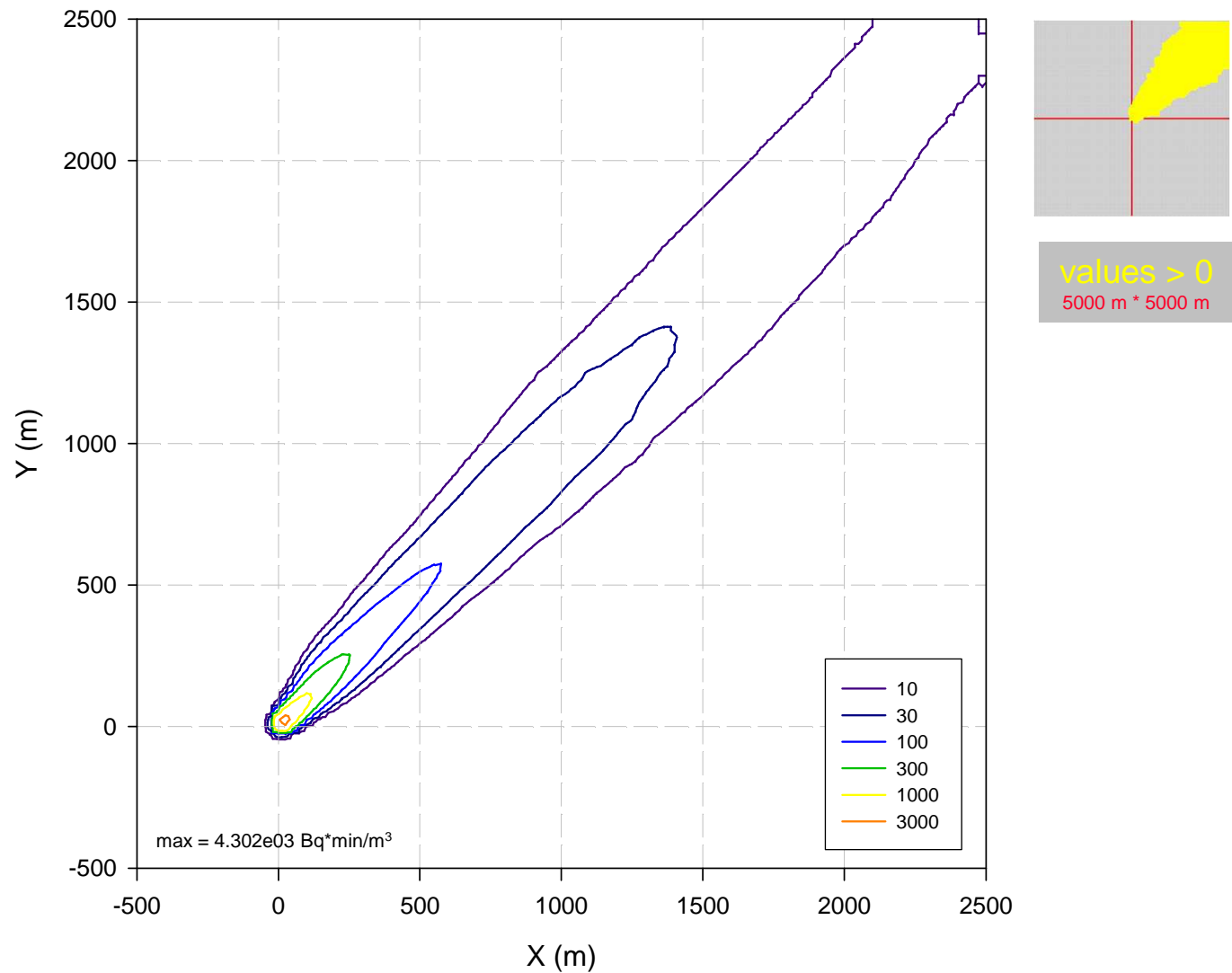


Experiment 1, time integrated activity [Bq*min/m³], 05 min

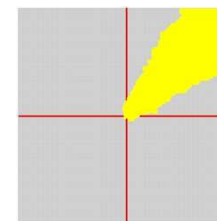
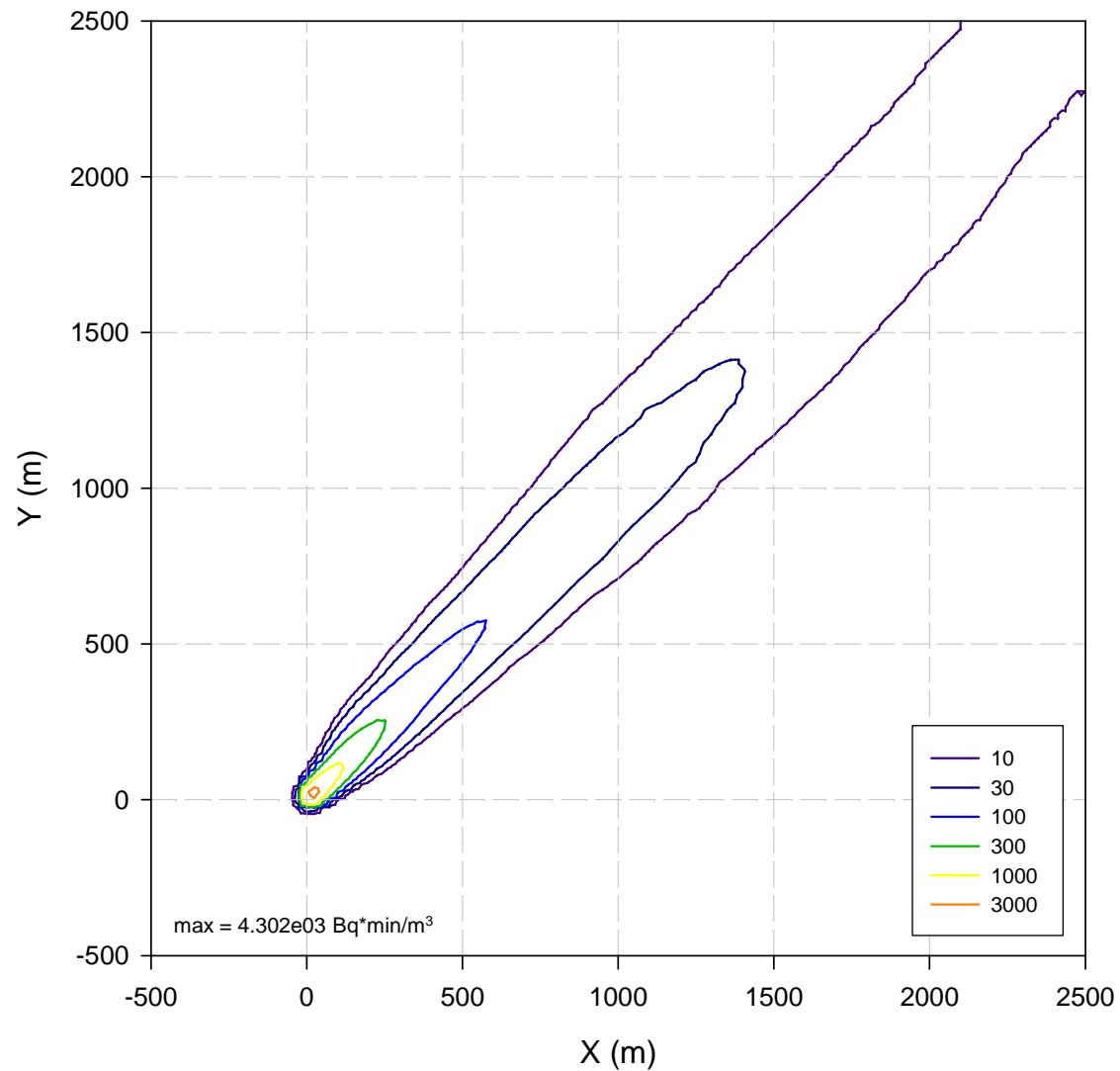


values > 0
5000 m * 5000 m

Experiment 1, time integrated activity [Bq*min/m3], 10 min

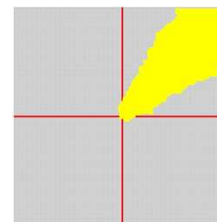
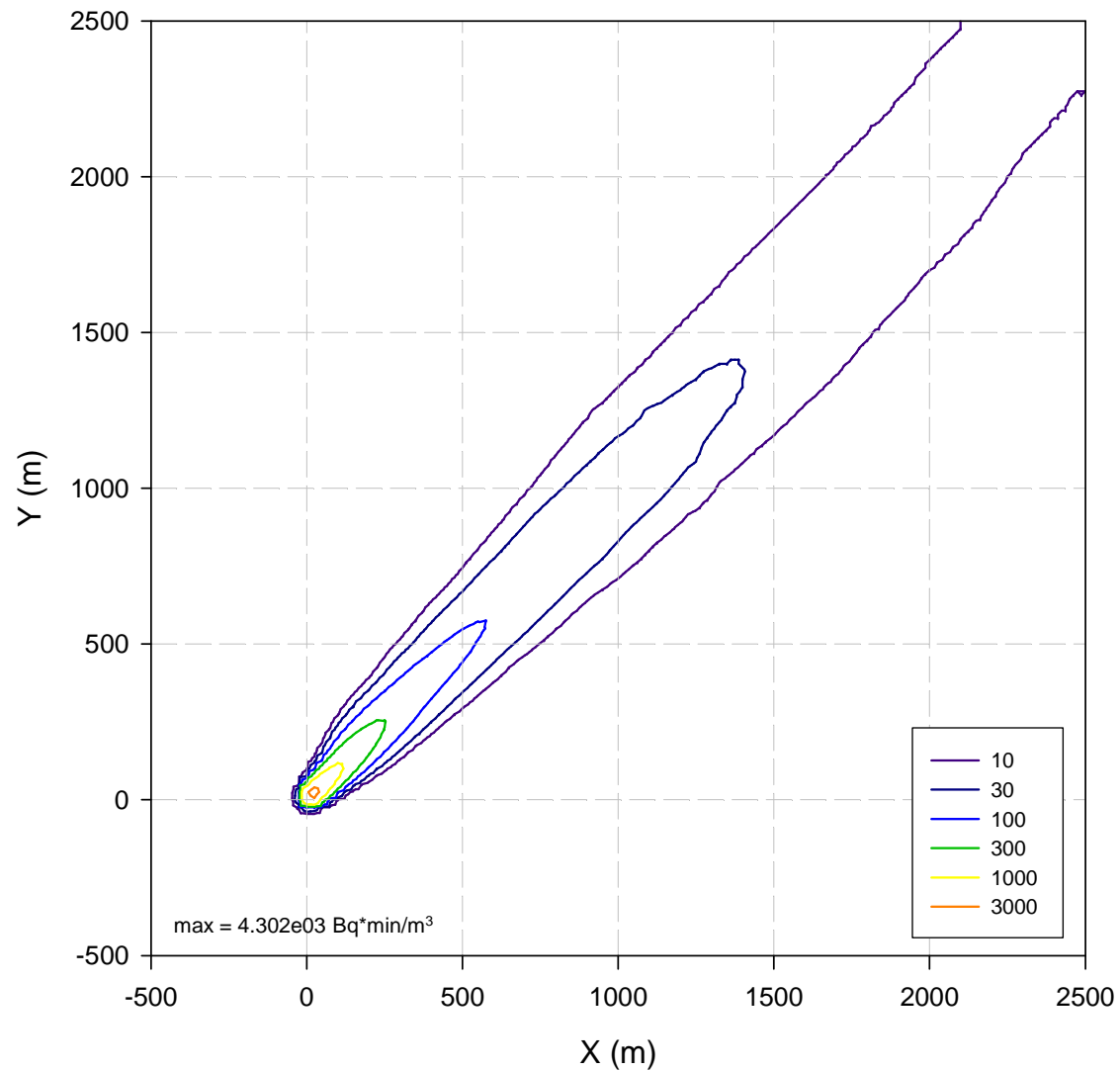


Experiment 1, time integrated activity [Bq*min/m3], 15 min



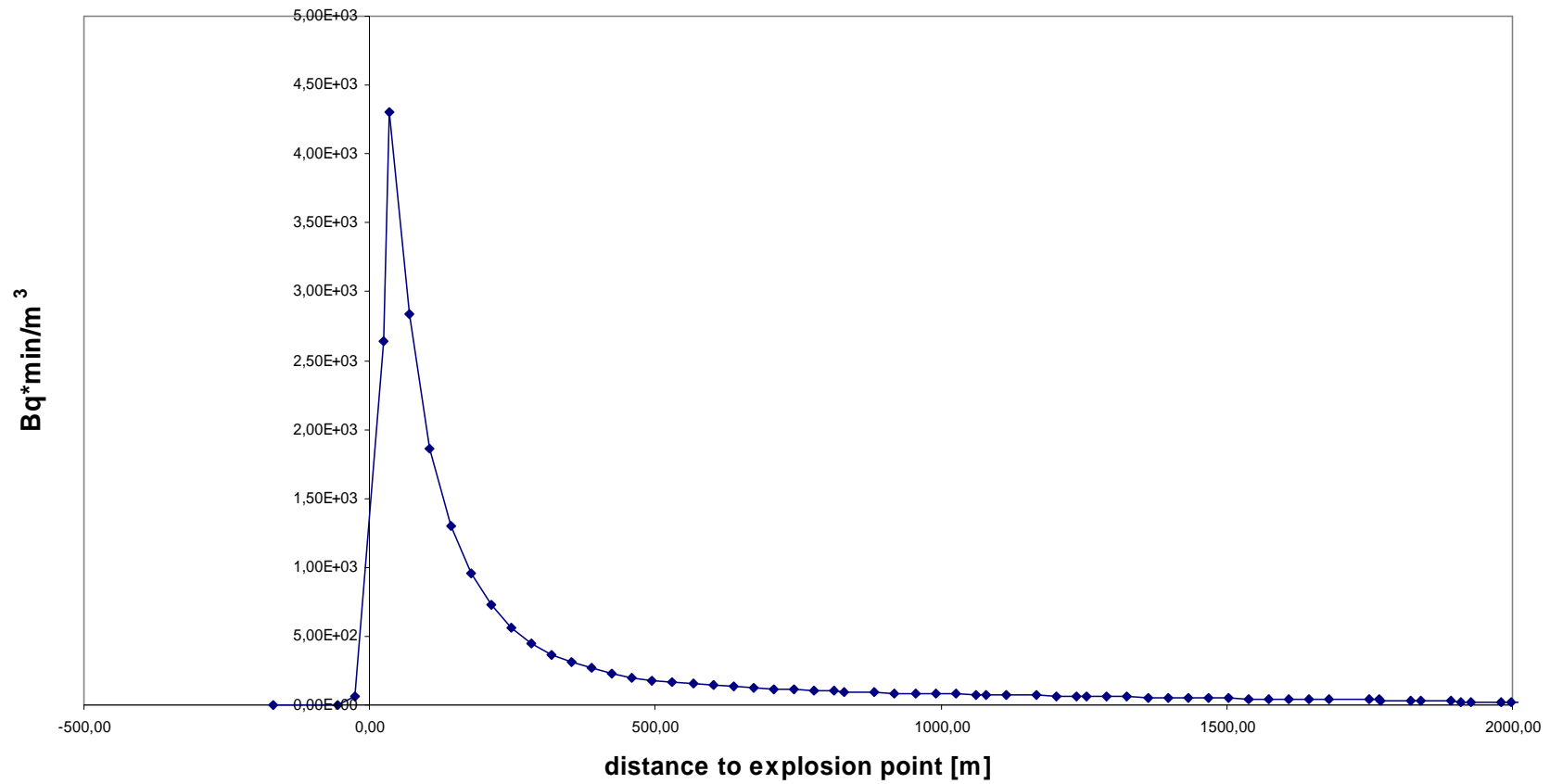
values > 0
5000 m * 5000 m

Experiment 1, time integrated activity [Bq*min/m³], 60 min

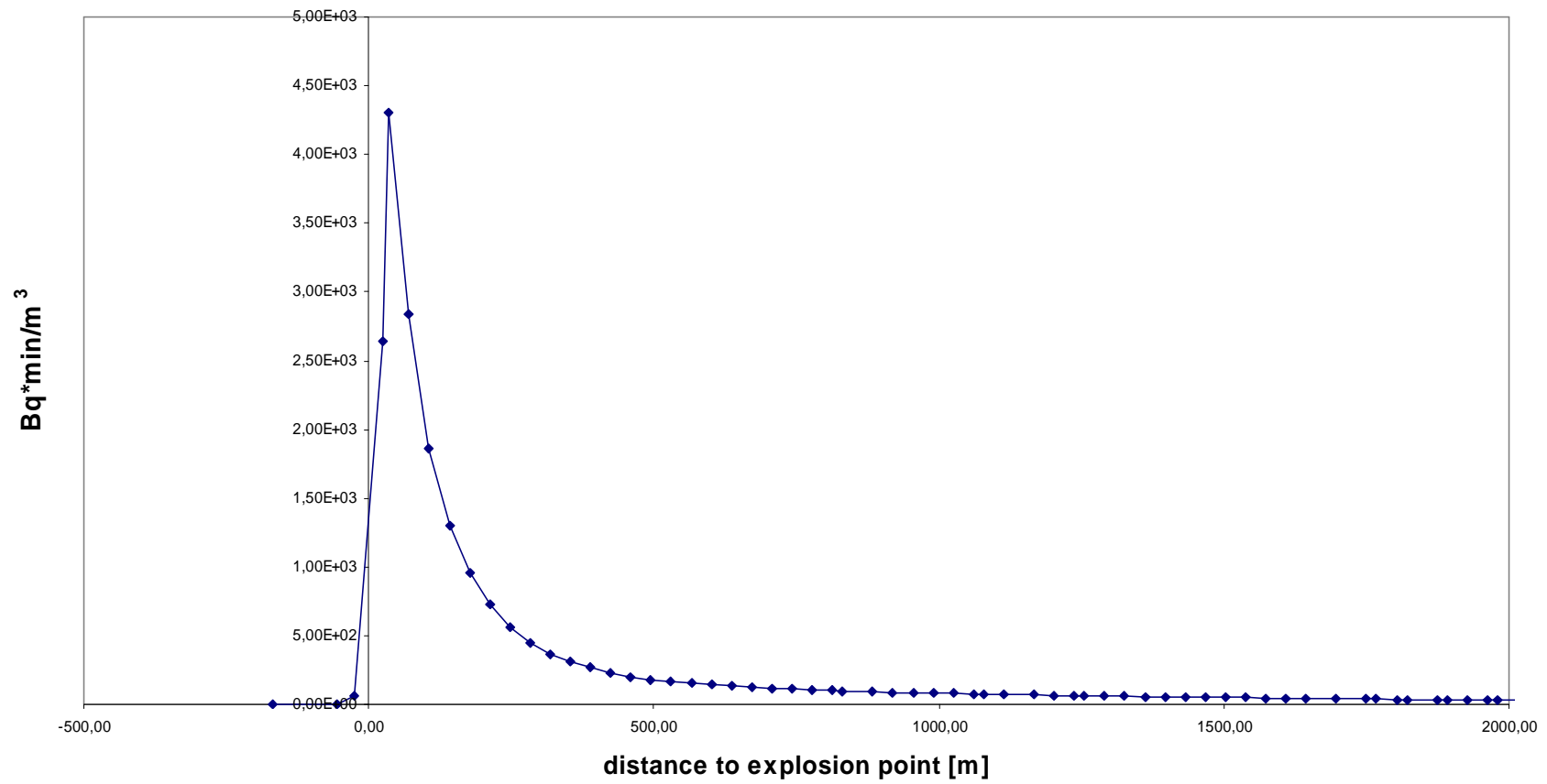


values > 0
5000 m * 5000 m

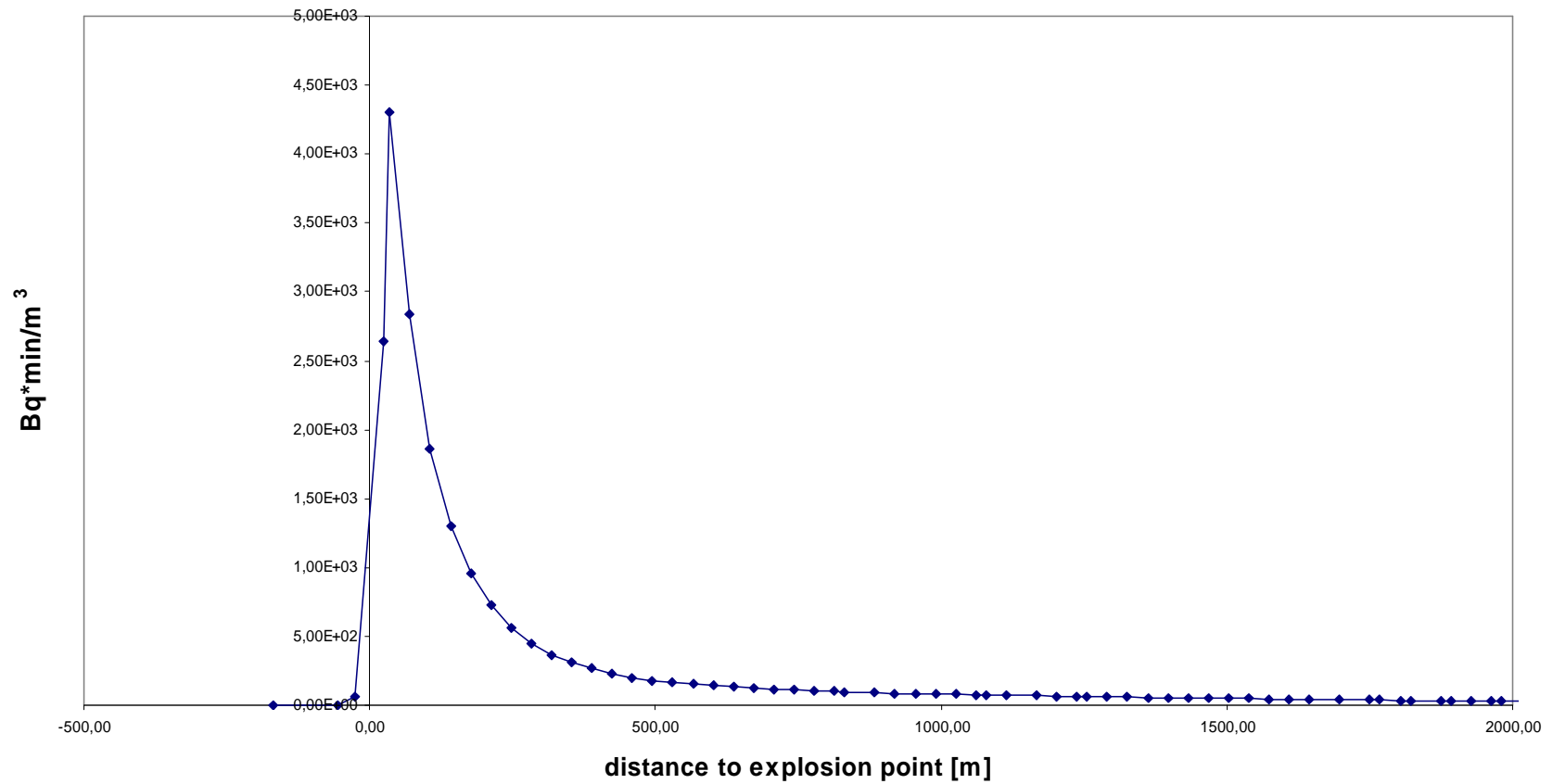
**Experiment 1, time integrated activity [Bq*min/m³], 05 min
Maxima downwind**



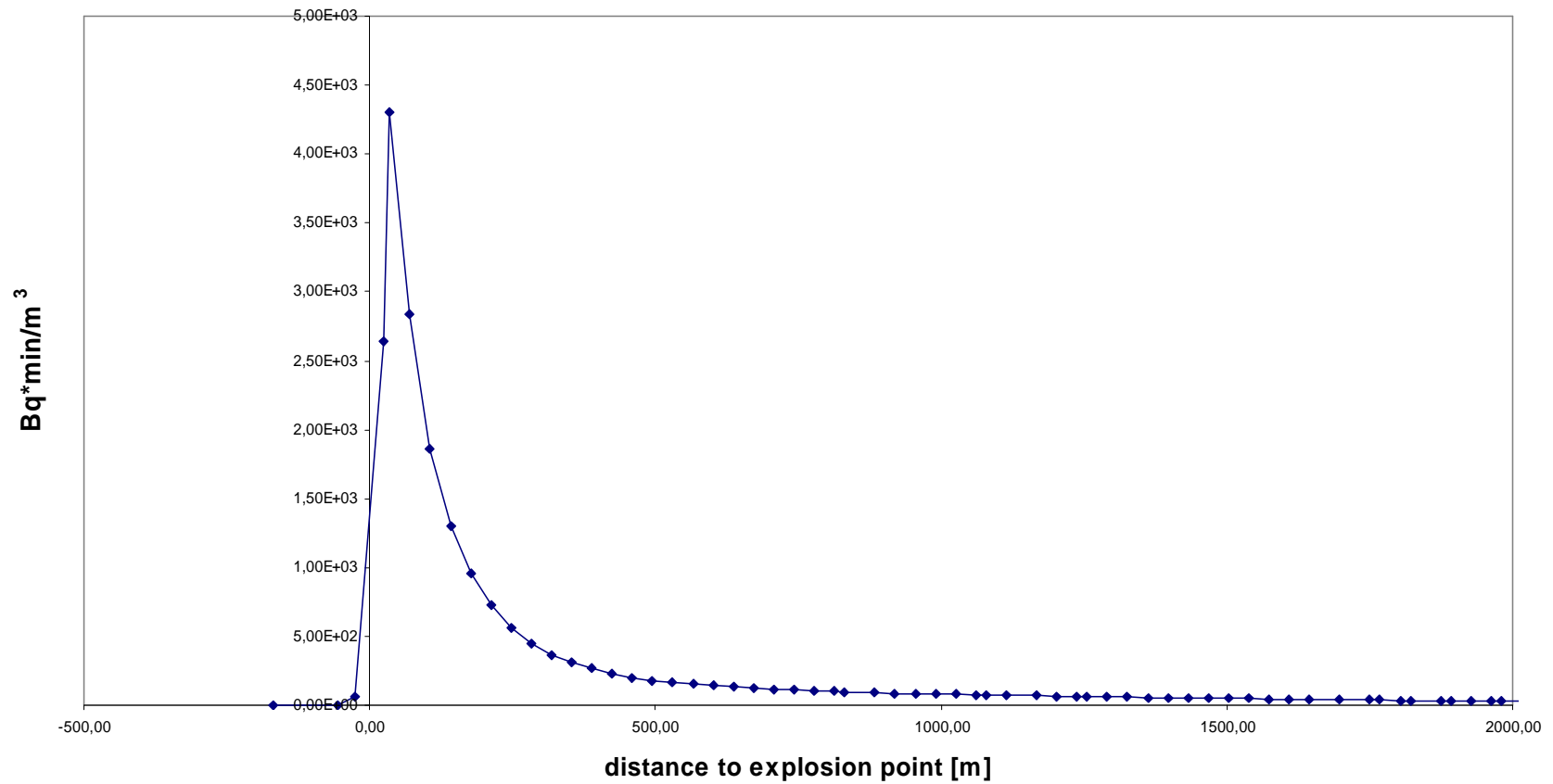
**Experiment 1, time integrated activity [Bq*min/m³], 10 min
Maxima downwind**



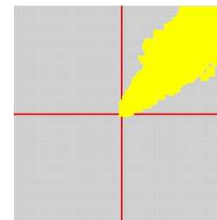
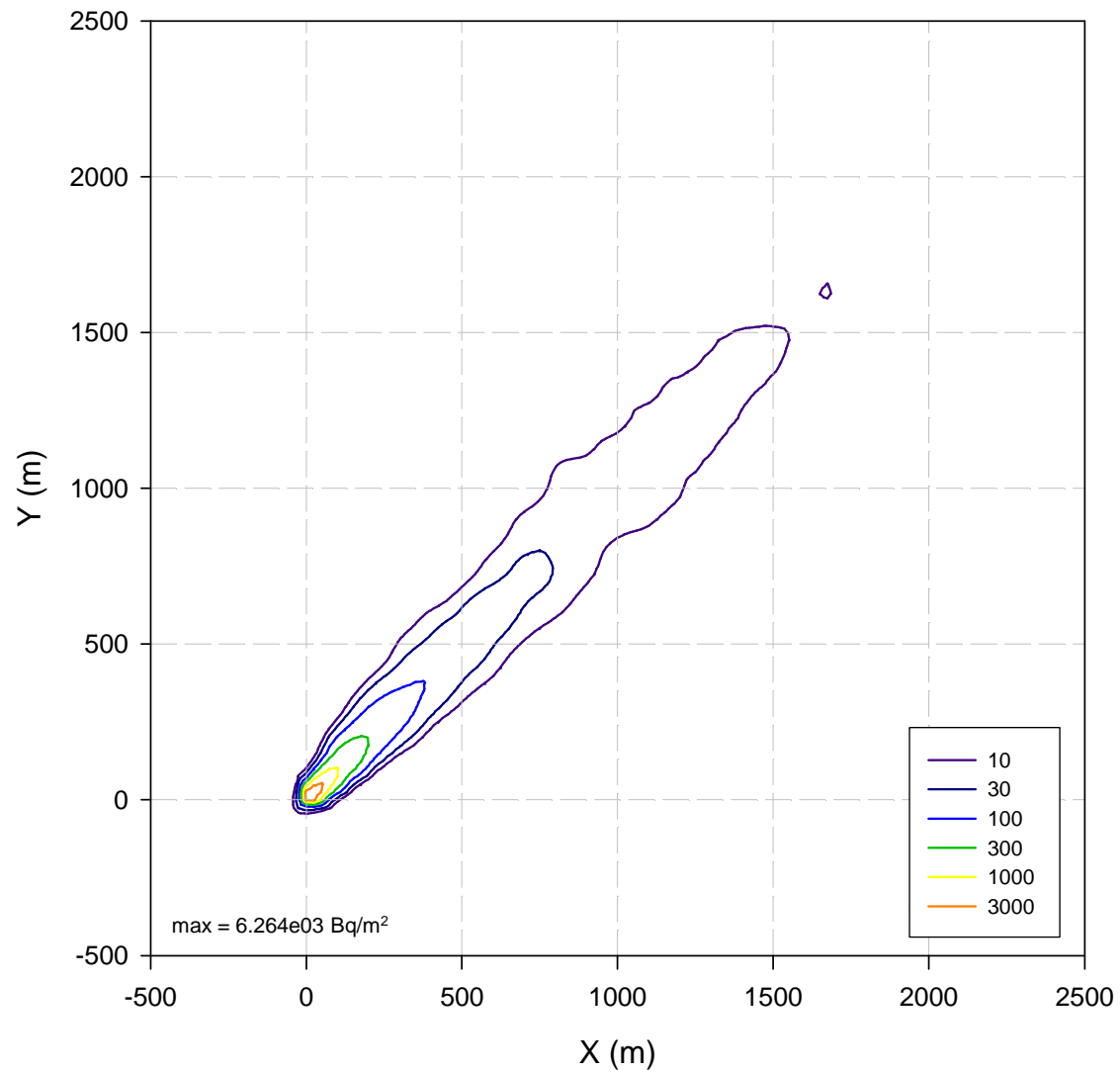
**Experiment 1, time integrated activity [Bq*min/m³], 15 min
Maxima downwind**



**Experiment 1, time integrated activity [Bq*min/m³], 60 min
Maxima downwind**



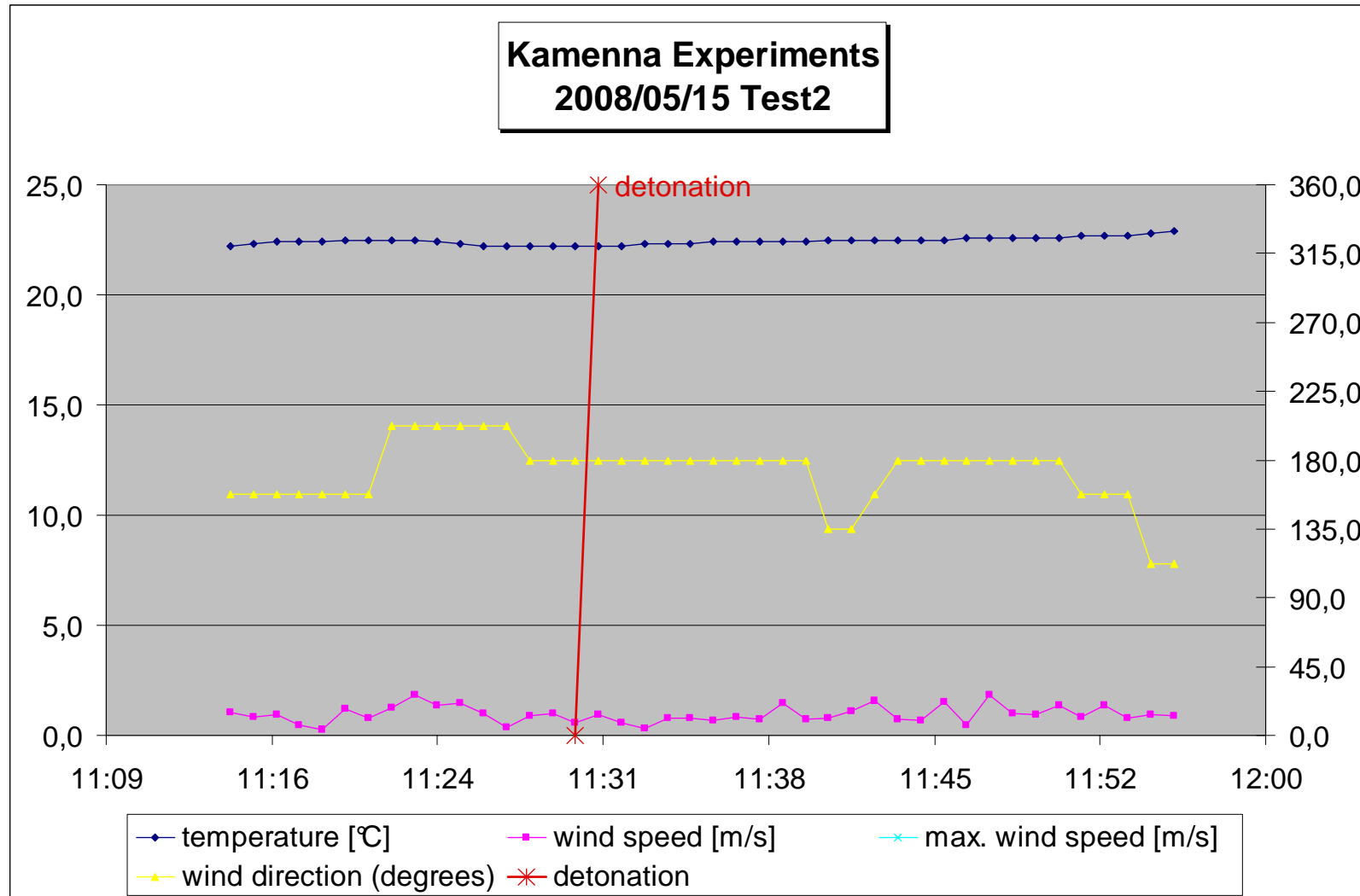
Experiment 1, Deposition [Bq/m²], 60 min



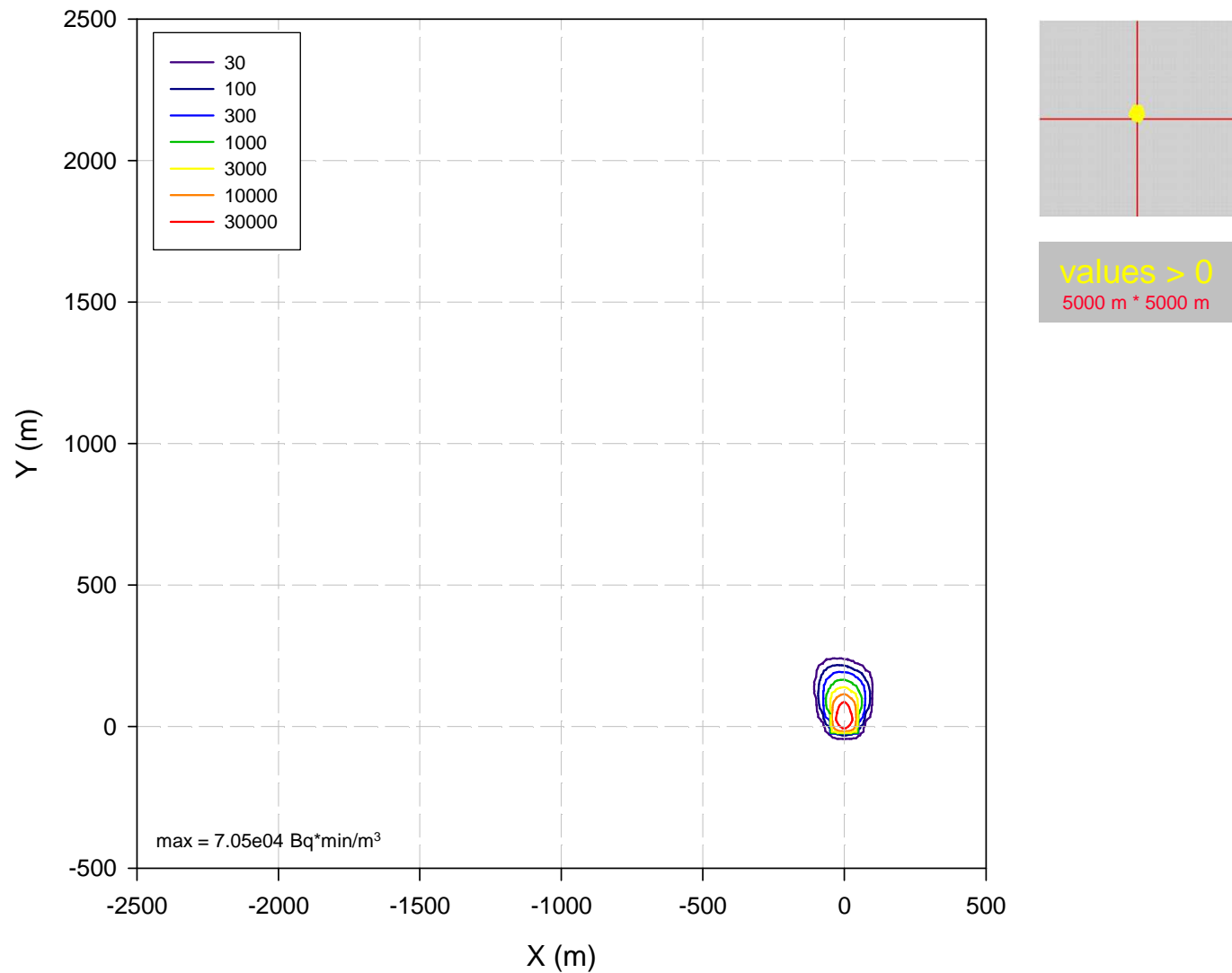
values > 0
5000 m * 5000 m



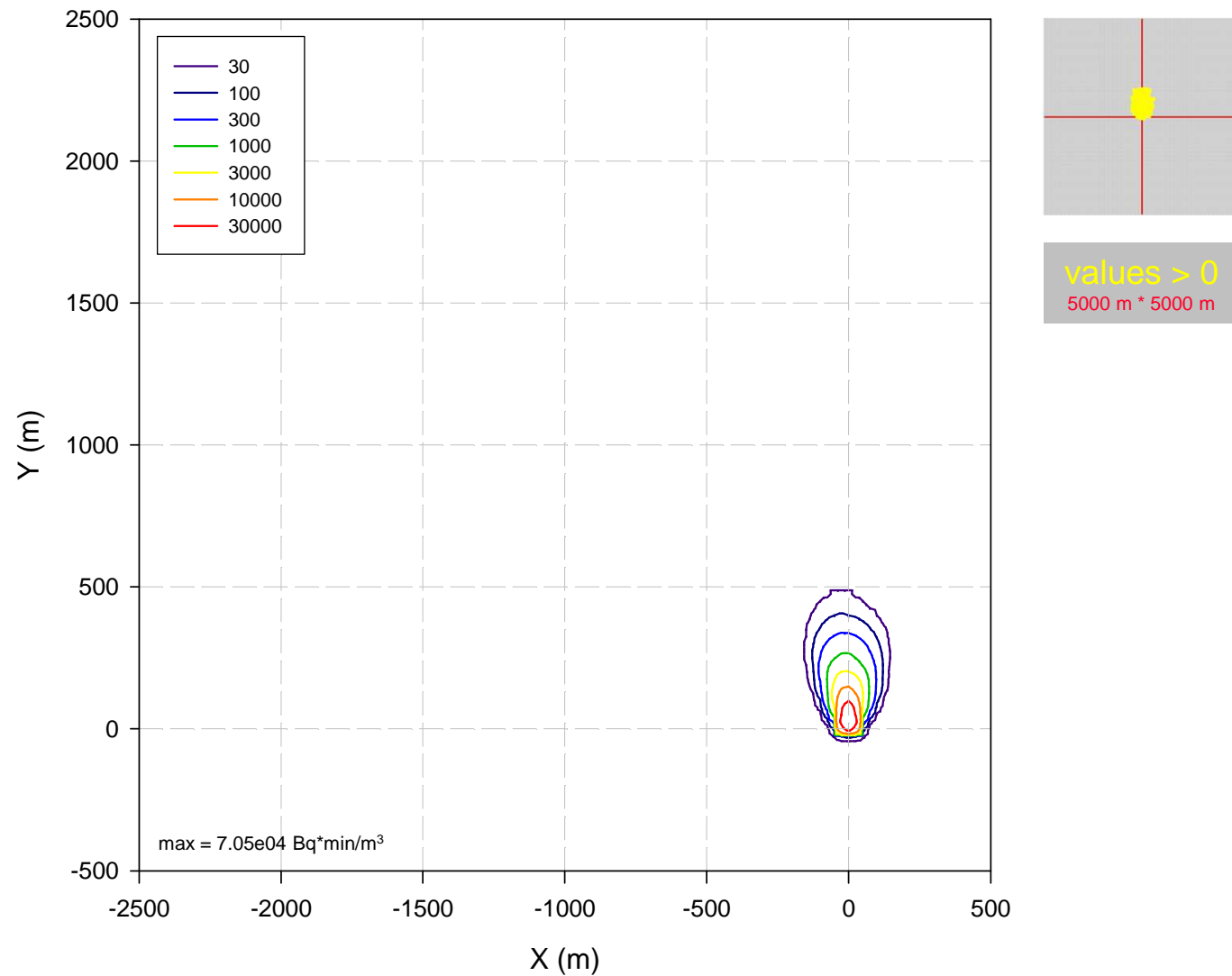
Meteorology Test 2



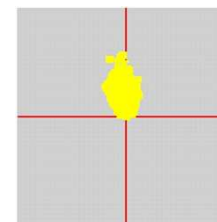
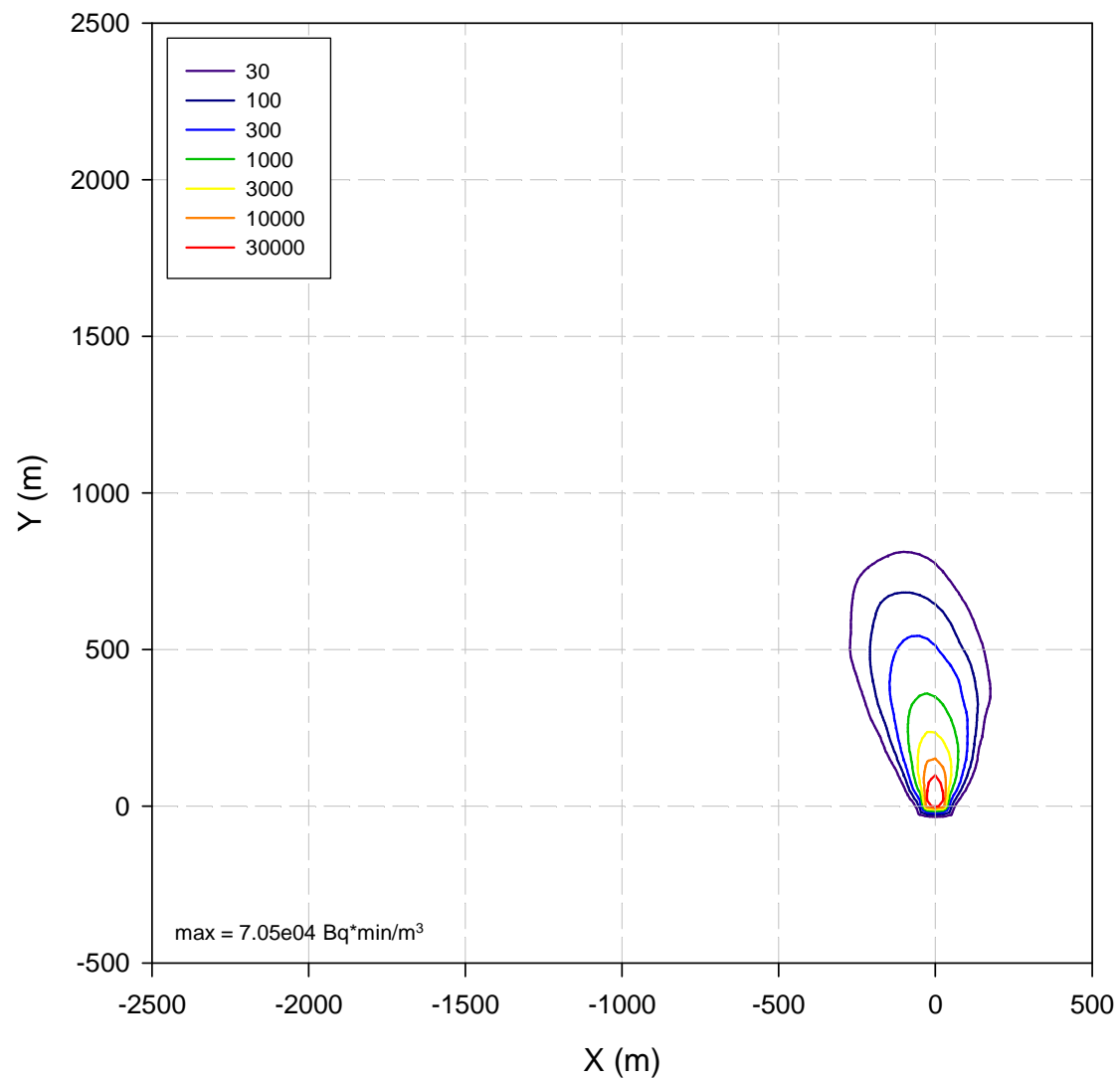
Experiment 2, time integrated activity [Bq*min/m3], 05 min



Experiment 2, time integrated activity [Bq*min/m3], 10 min

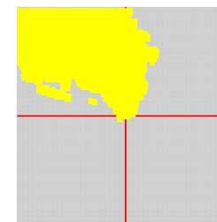
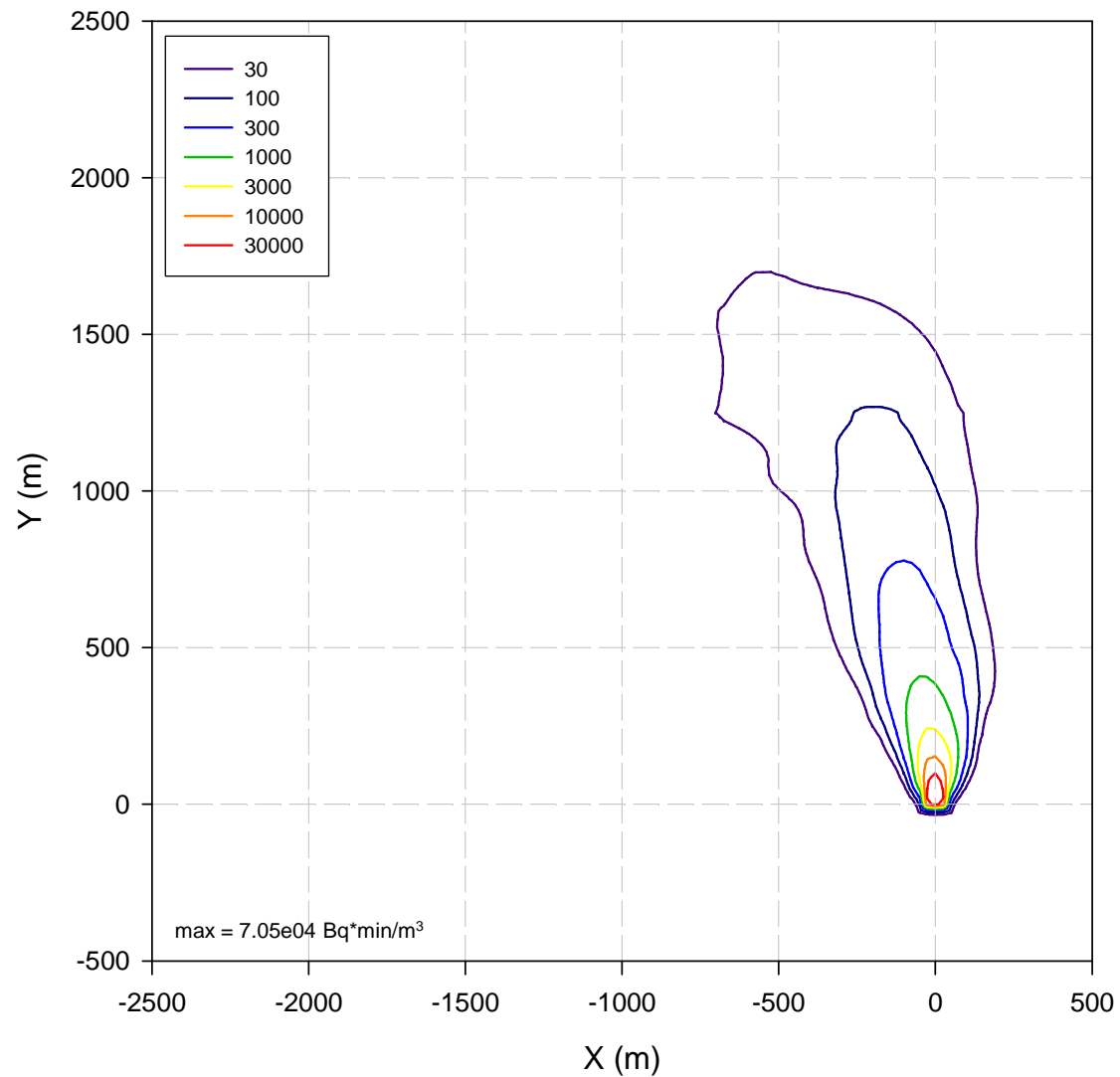


Experiment 2, time integrated activity [Bq*min/m³], 15 min



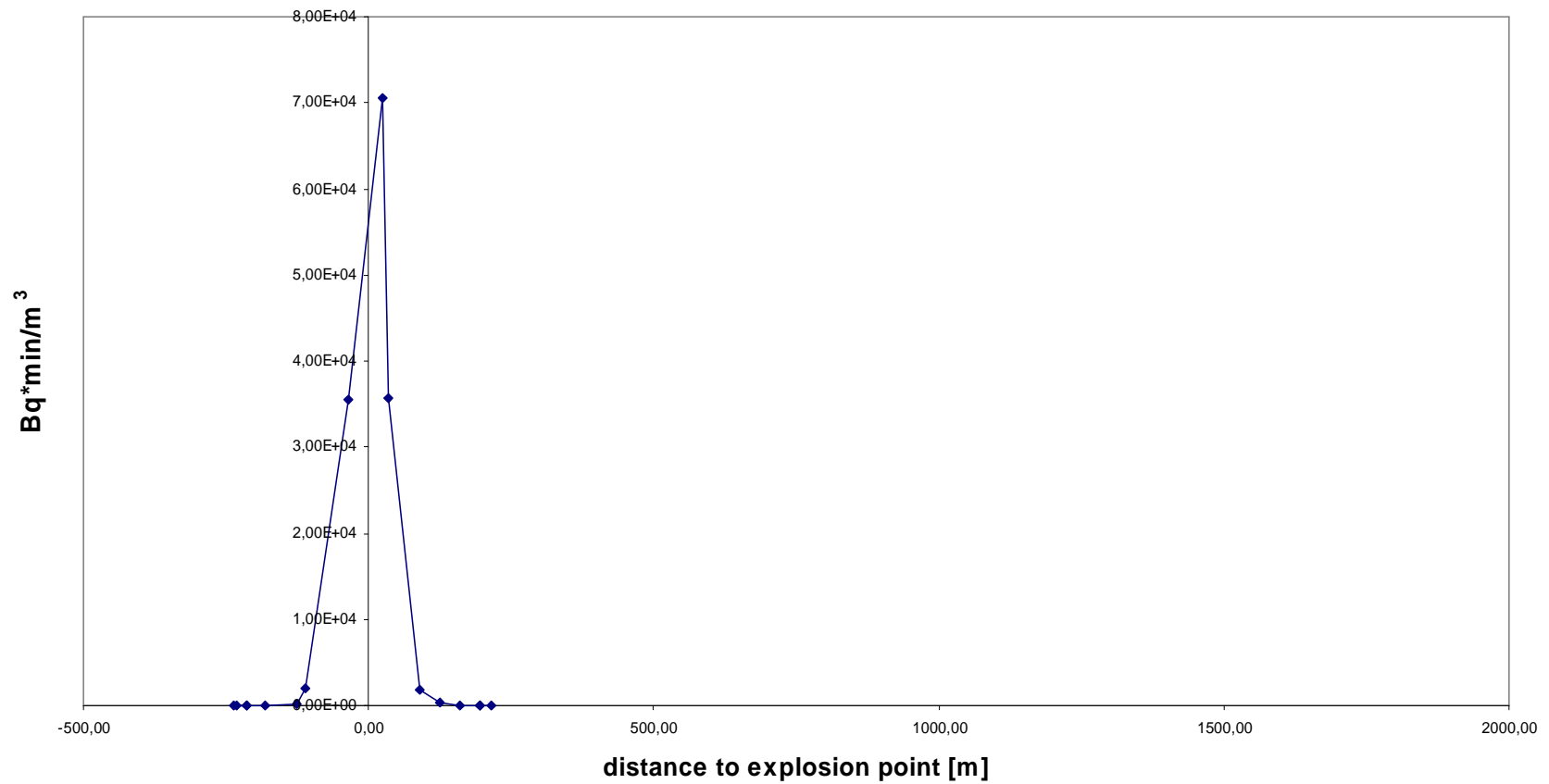
values > 0
5000 m * 5000 m

Experiment 2, time integrated activity [Bq*min/m³], 60 min

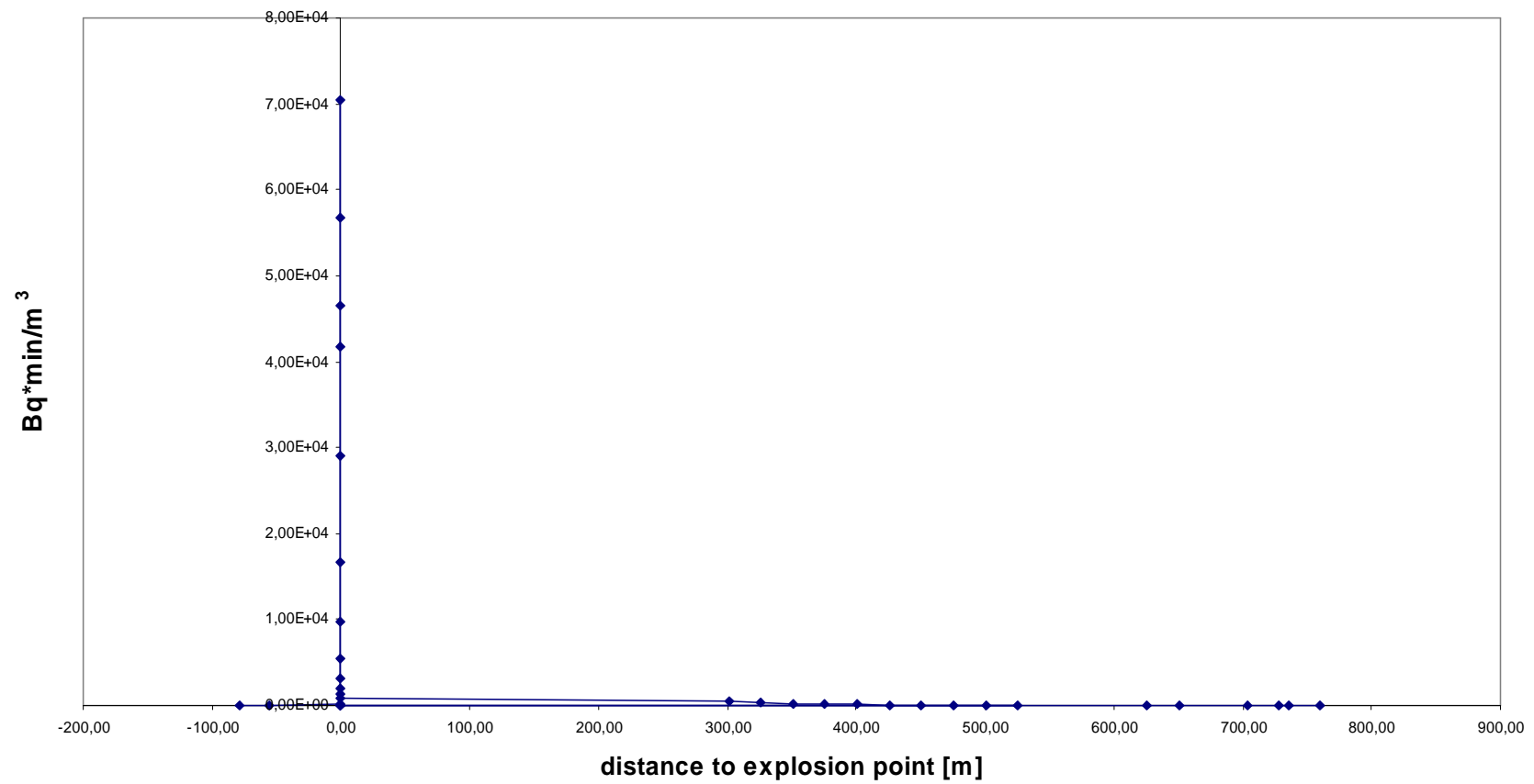


values > 0
5000 m * 5000 m

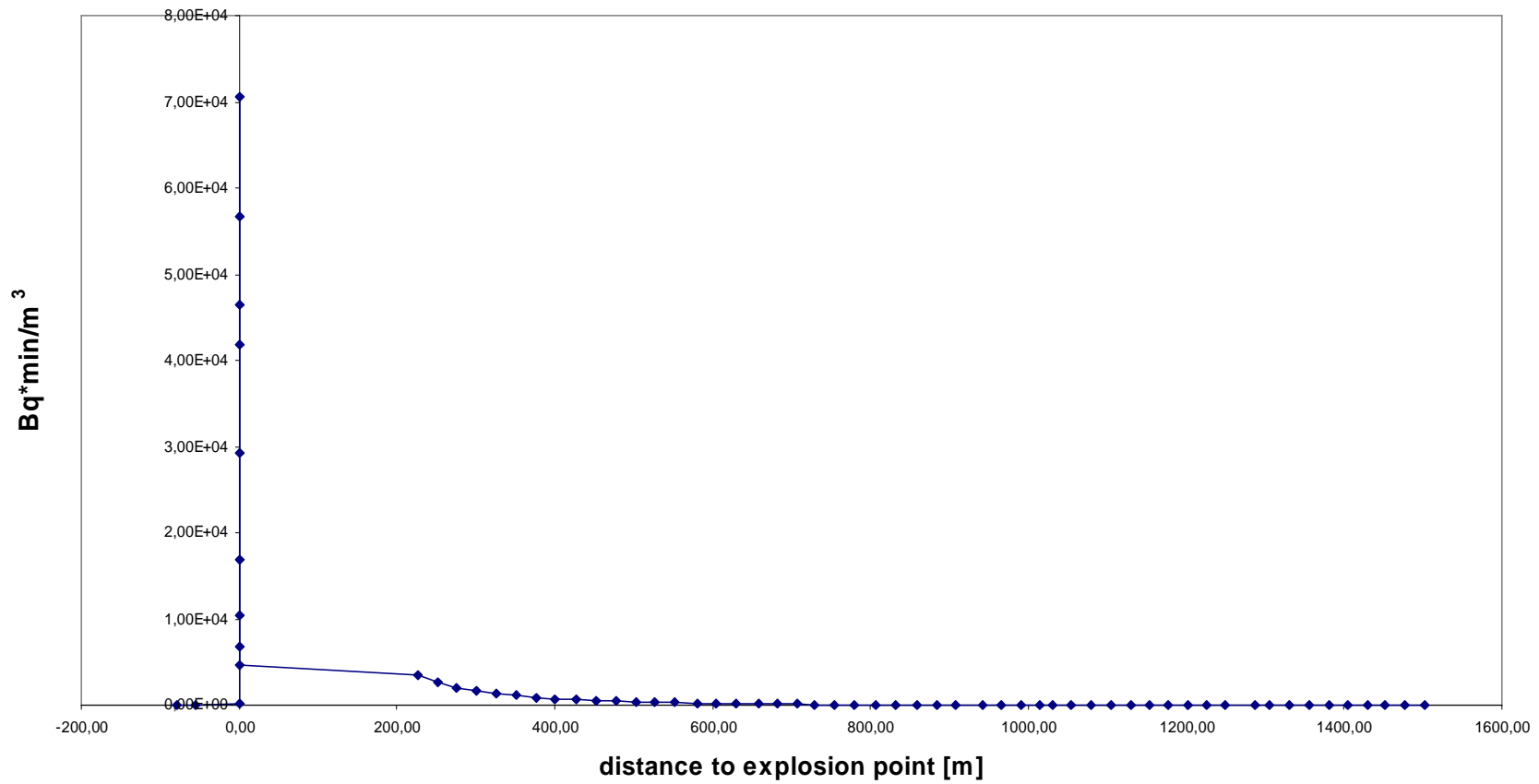
**Experiment 2, time integrated activity [Bq*min/m³], 05 min
Maxima down wind**



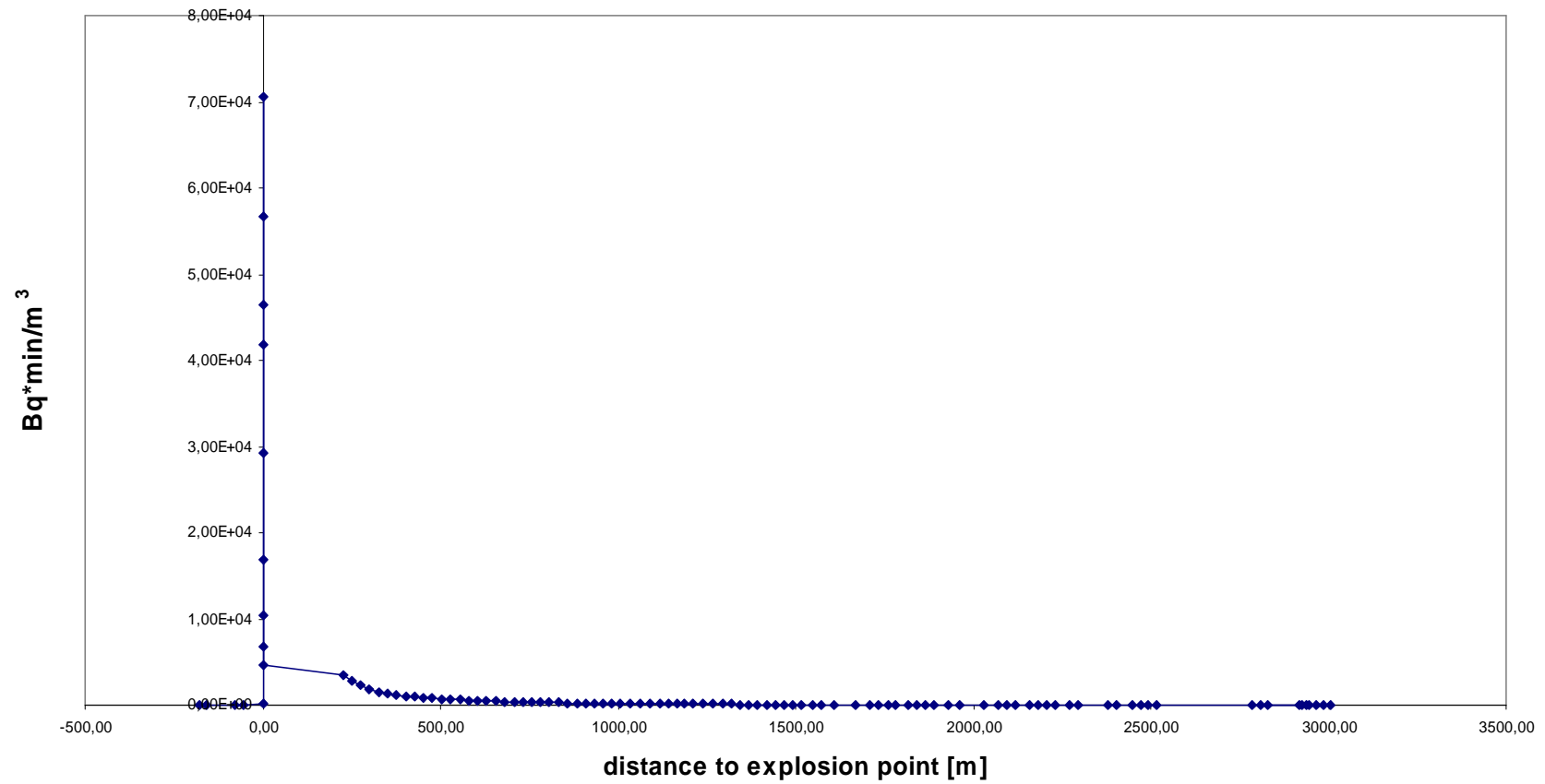
**Experiment 2, time integrated activity [Bq*min/m³], 10 min
Maxima downwind**



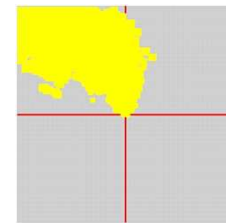
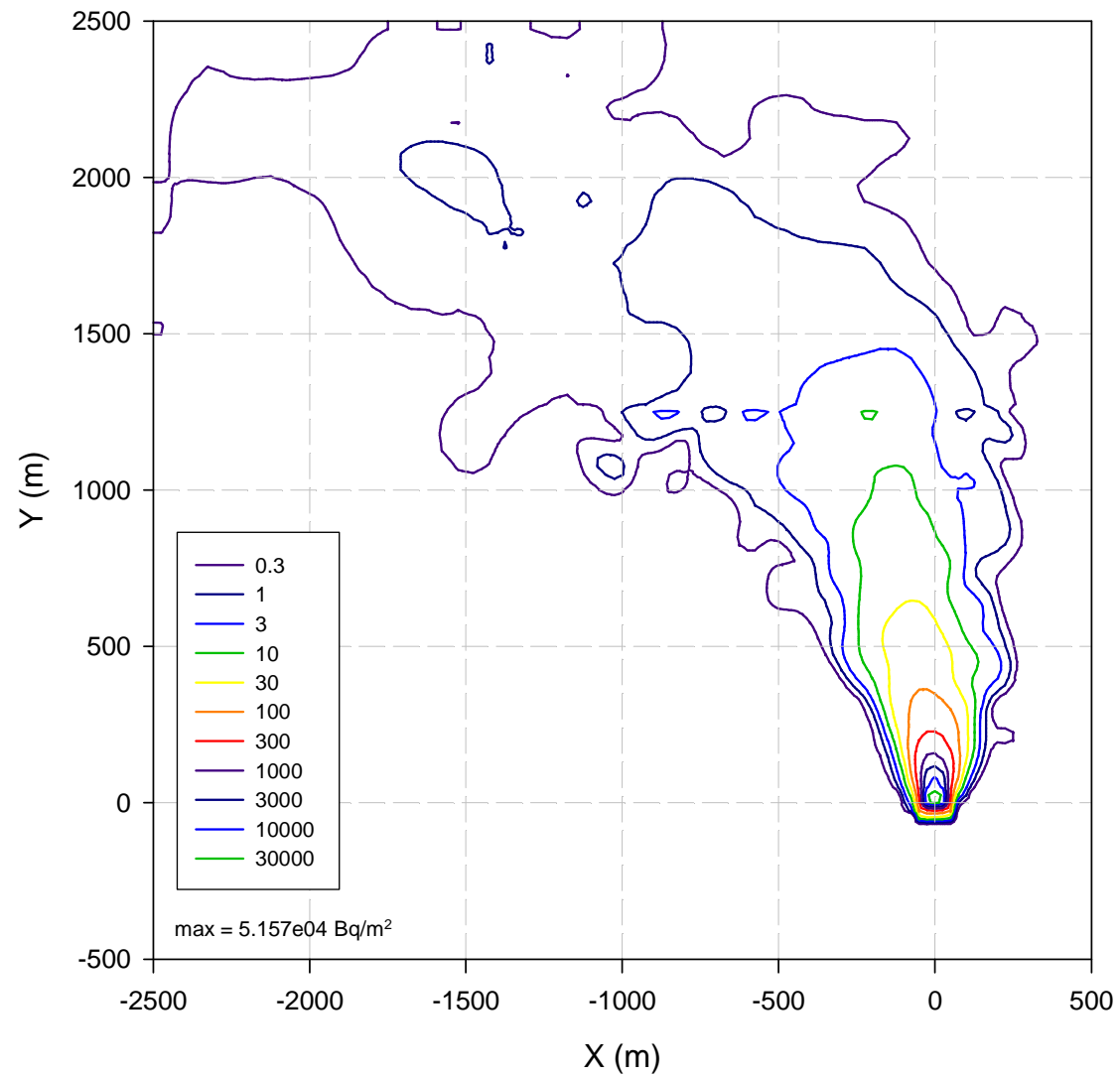
**Experiment 2, time integrated activity [Bq*min/m³], 15 min
Maxima downwind**



**Experiment 2, time integrated activity [Bq*min/m³], 60 min
Maxima downwind**



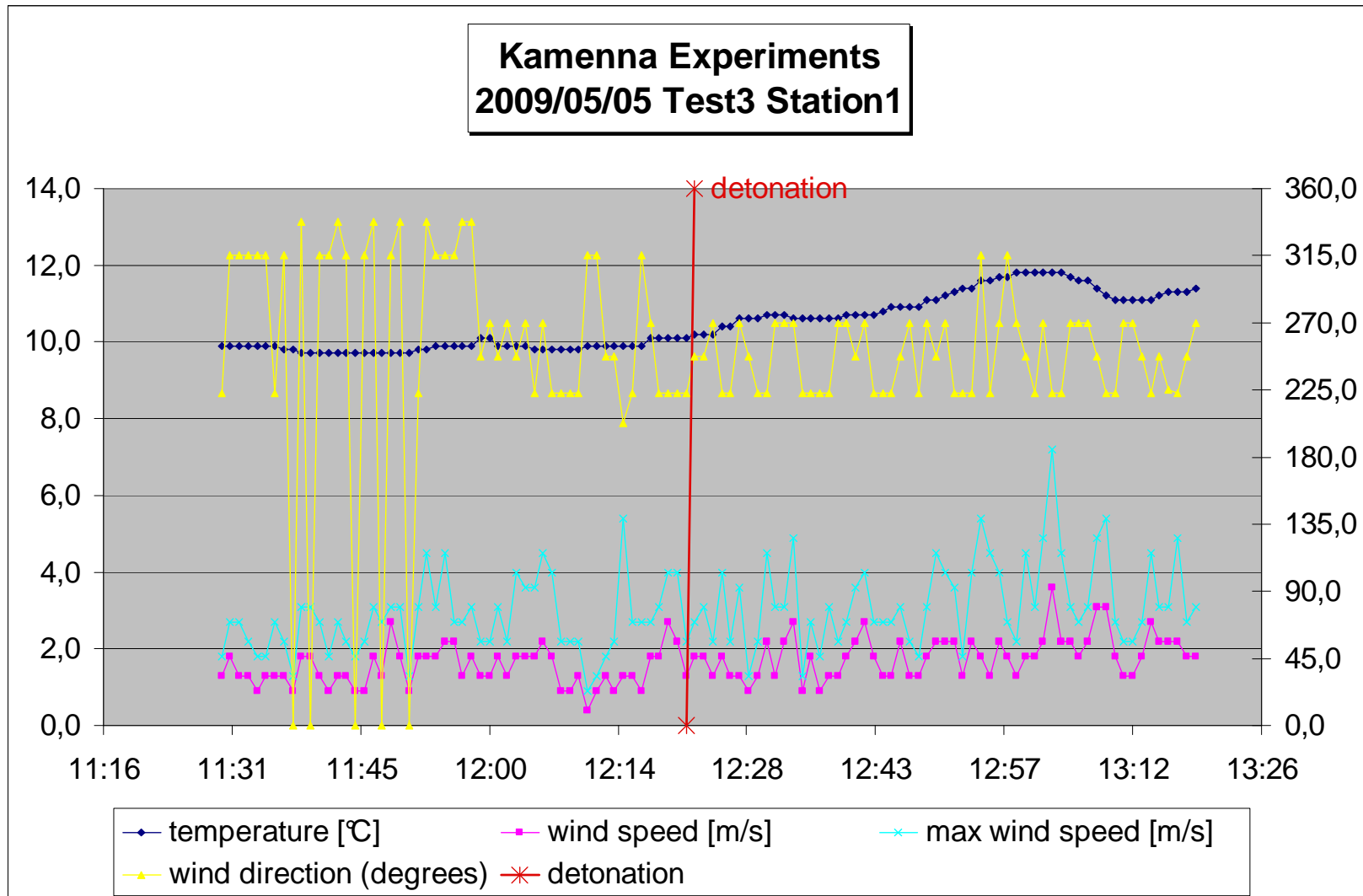
Experiment 2, Deposition [Bq/m²], 60 min



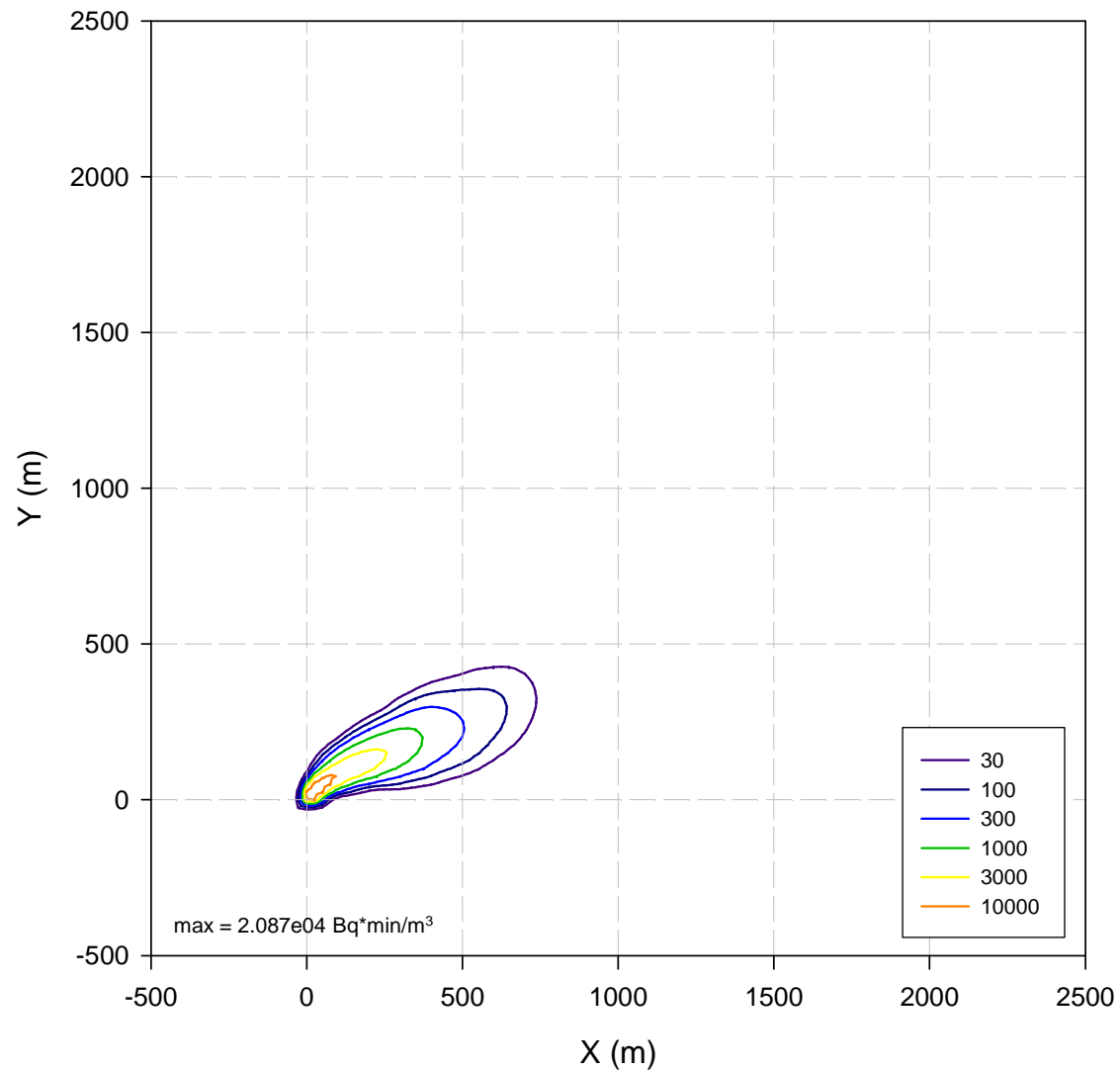
values > 0
5000 m * 5000 m



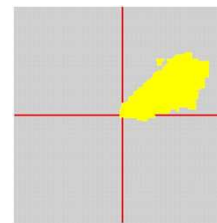
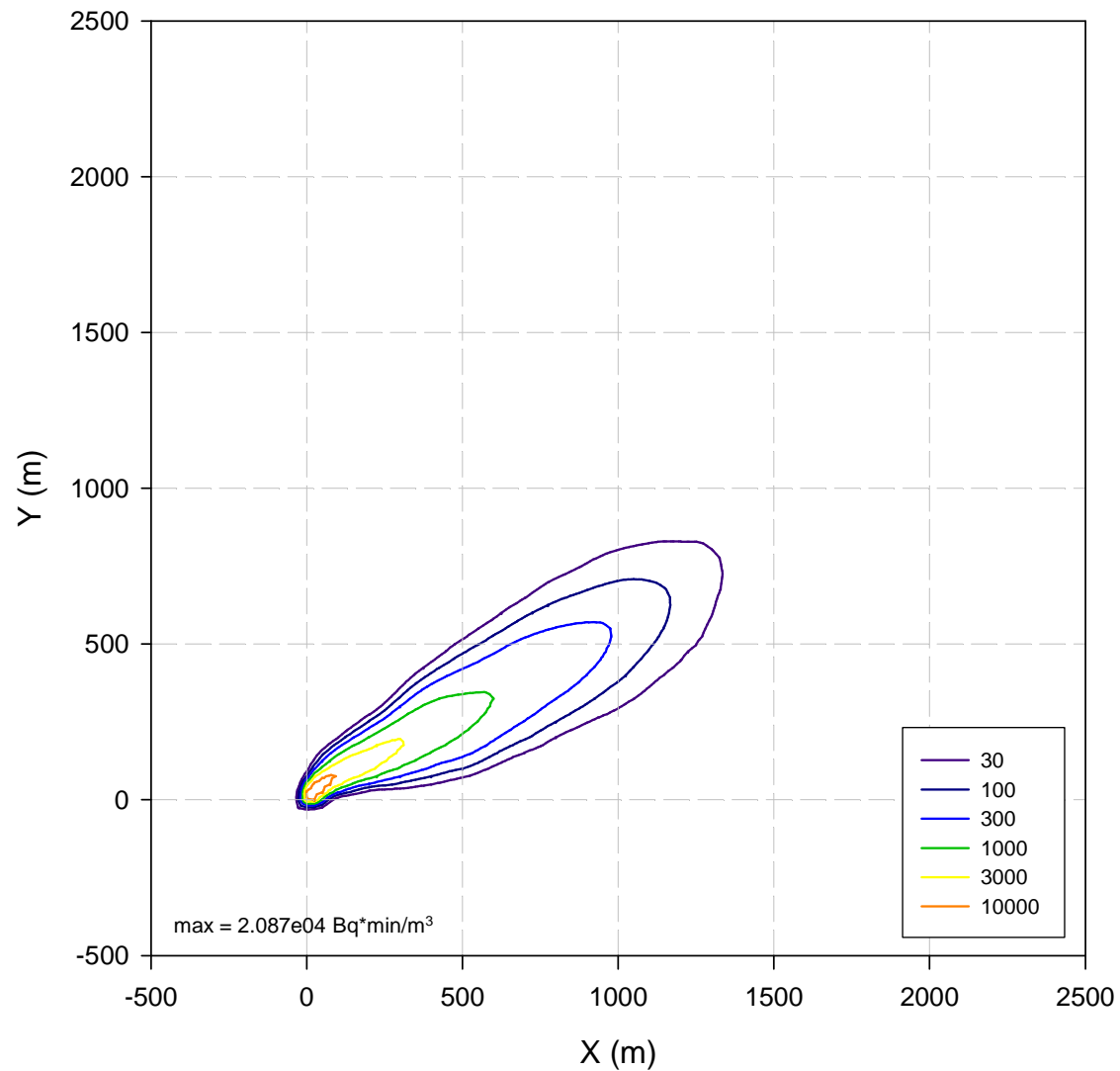
Meteorology Test 3



Experiment 3, time integrated activity [Bq*min/m3], 05 min

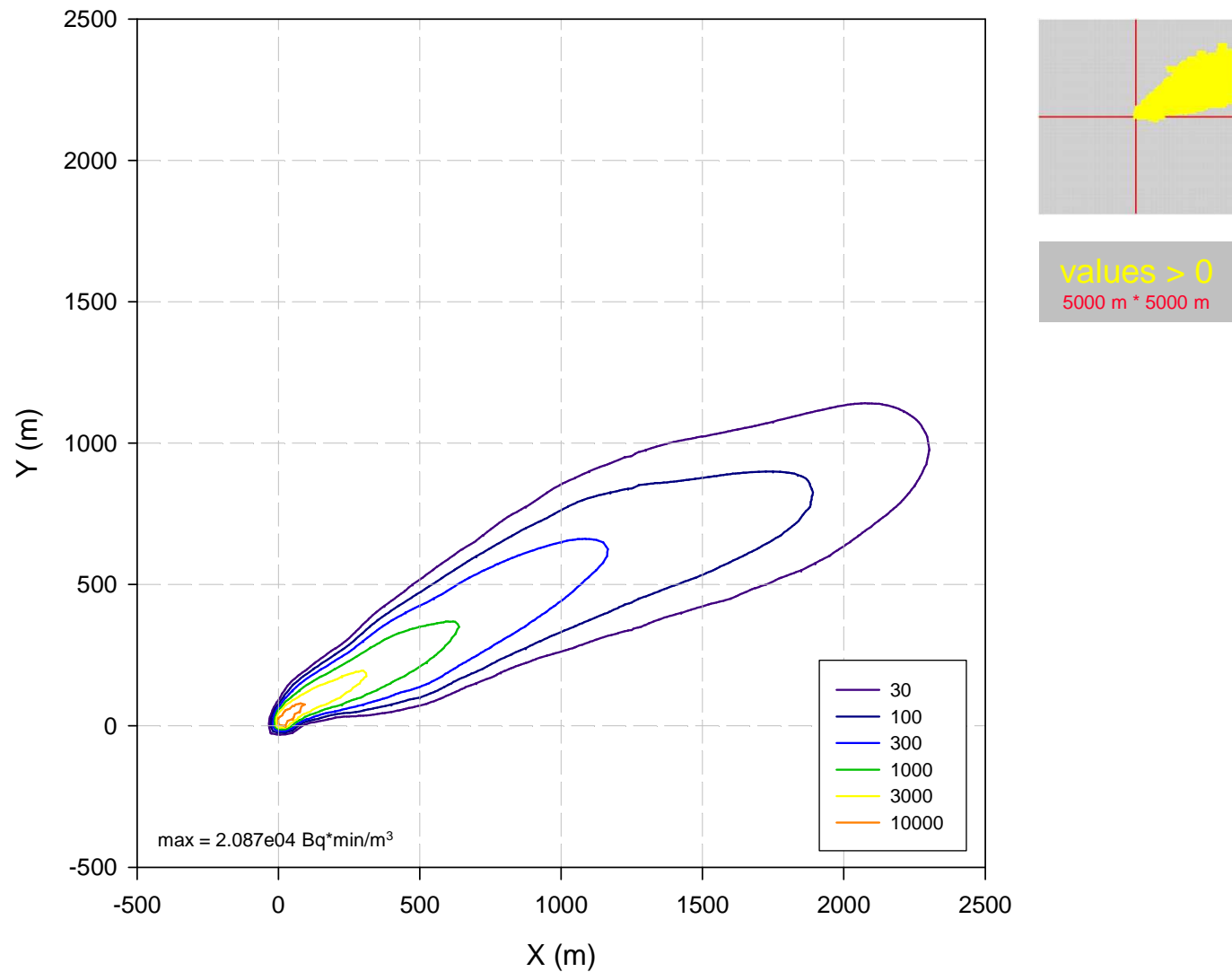


Experiment 3, time integrated activity [Bq*min/m³], 10 min

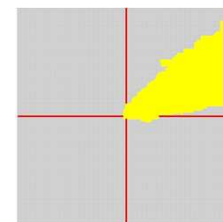
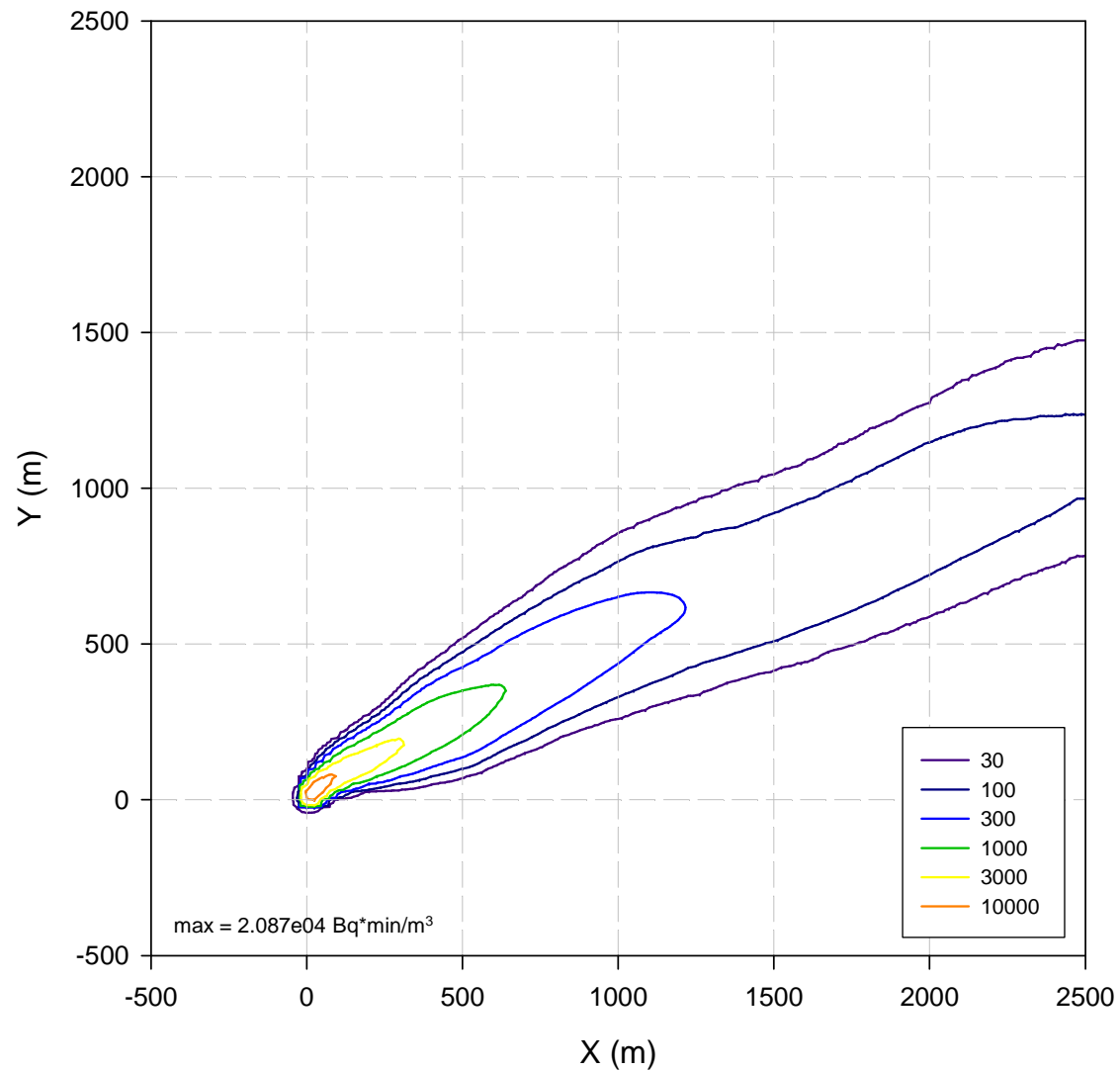


values > 0
5000 m * 5000 m

Experiment 3, time integrated activity [Bq*min/m3], 15 min

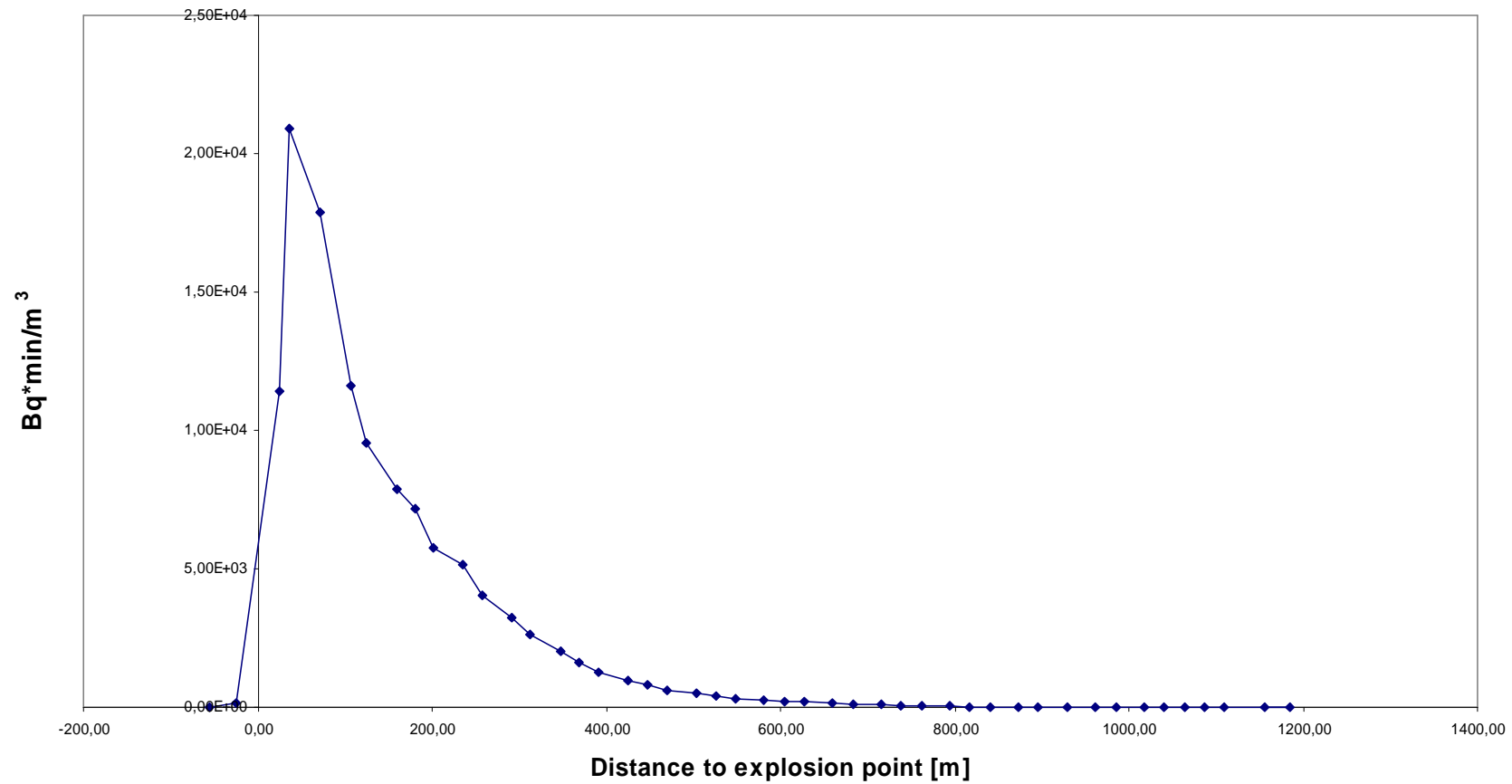


Experiment 3, time integrated activity [Bq*min/m³], 60 min

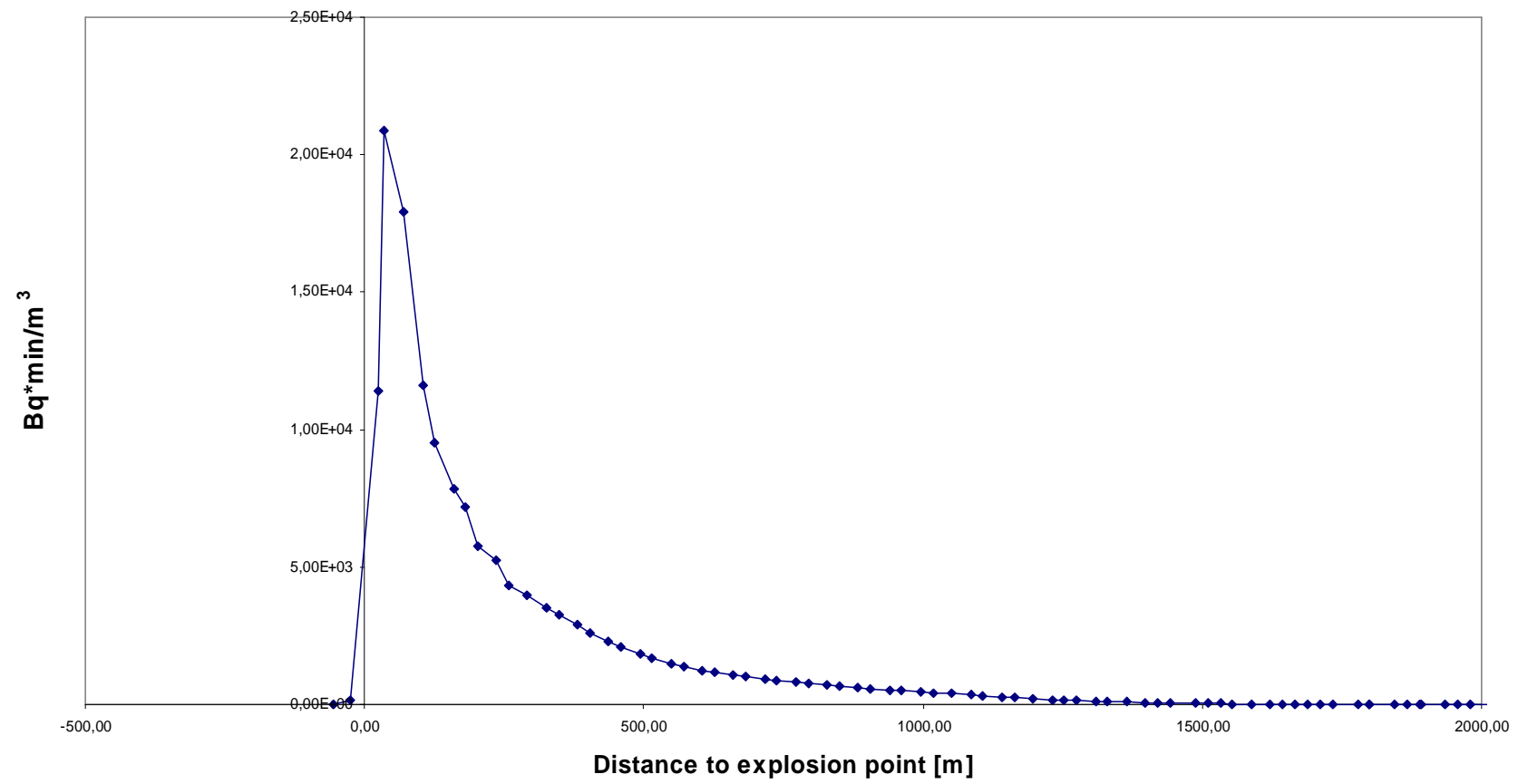


values > 0
5000 m * 5000 m

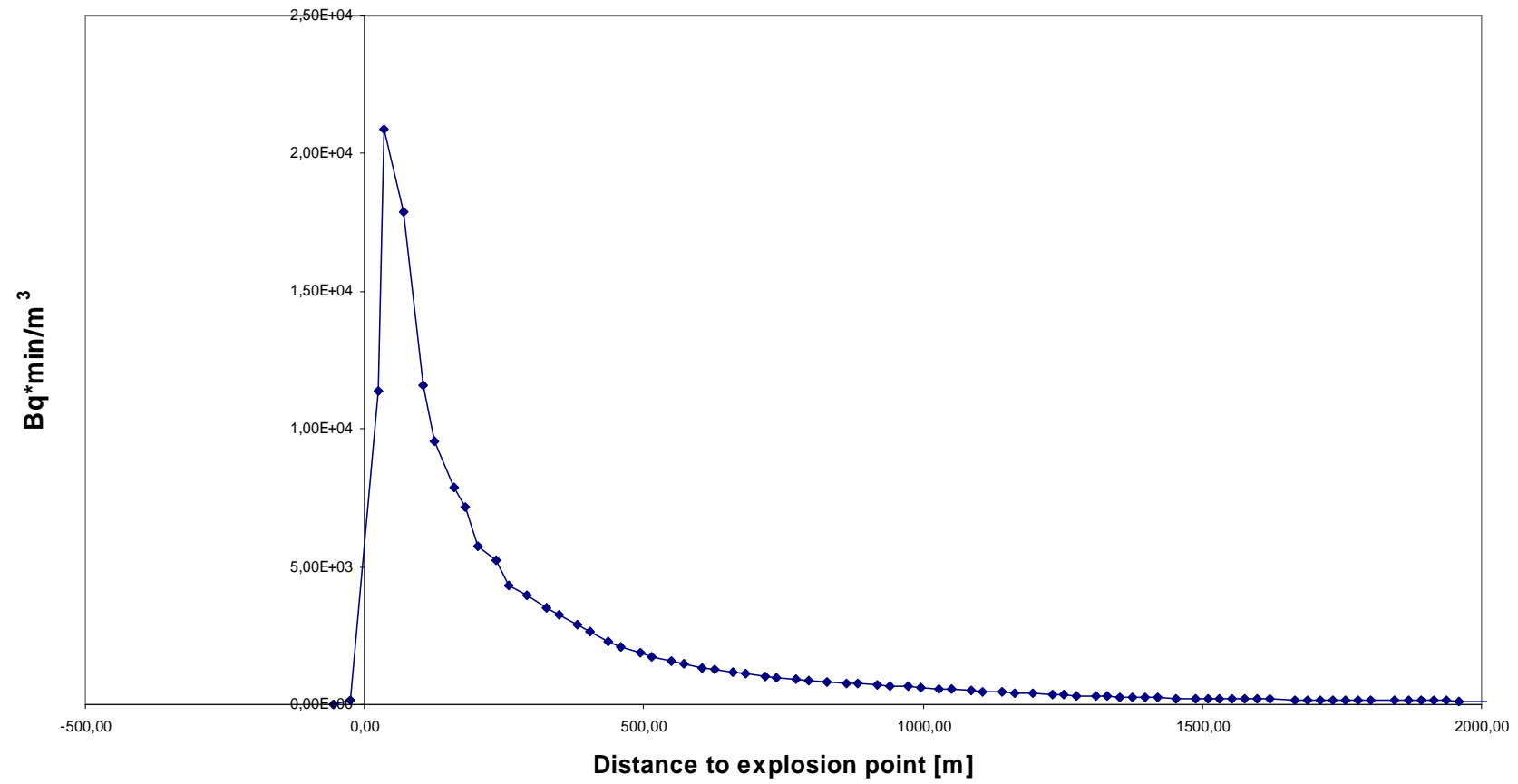
Experiment 3, Activity [Bq*min/m³], 05 min
Maxima downwind



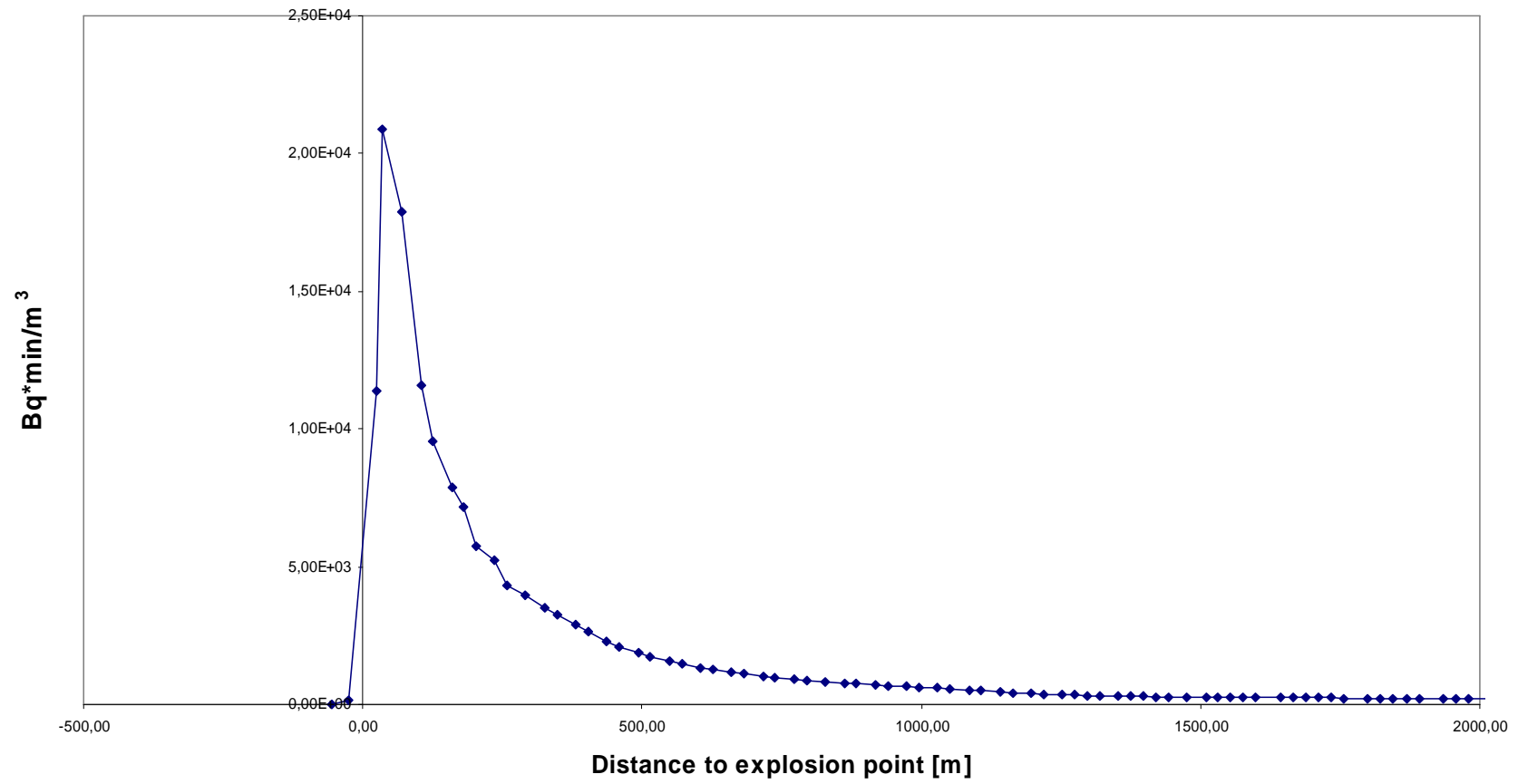
Experiment 3, time integrated activity [Bq*min/m³], 10 min
Maxima downwind



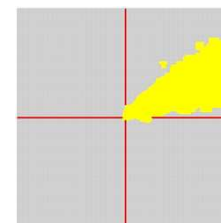
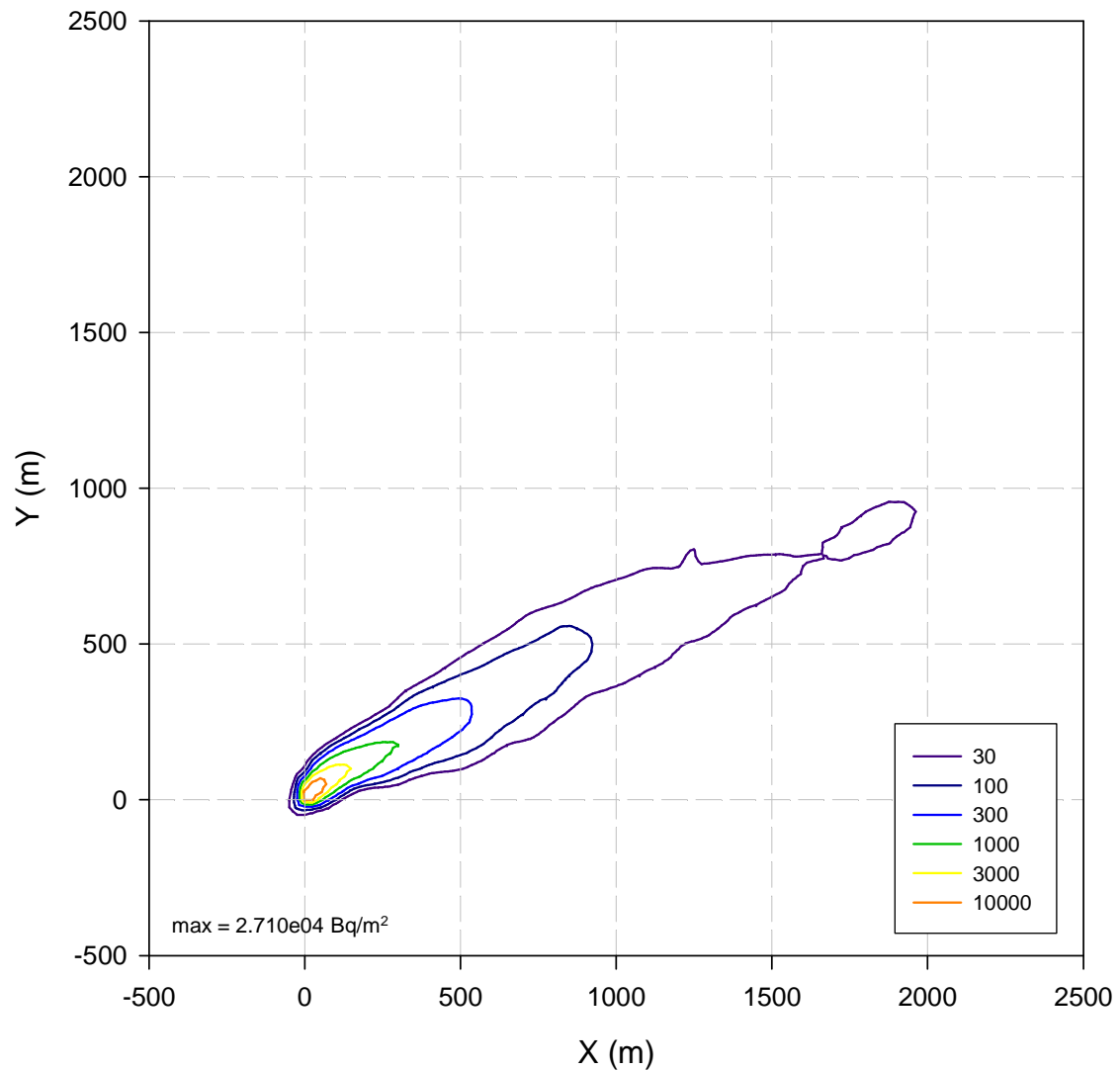
Experiment 3, time integrated activity [Bq*min/m³], 15 min
Maxima downwind



Experiment 3, time integrated activity [Bq*min/m³], 60 min
Maxima downwind



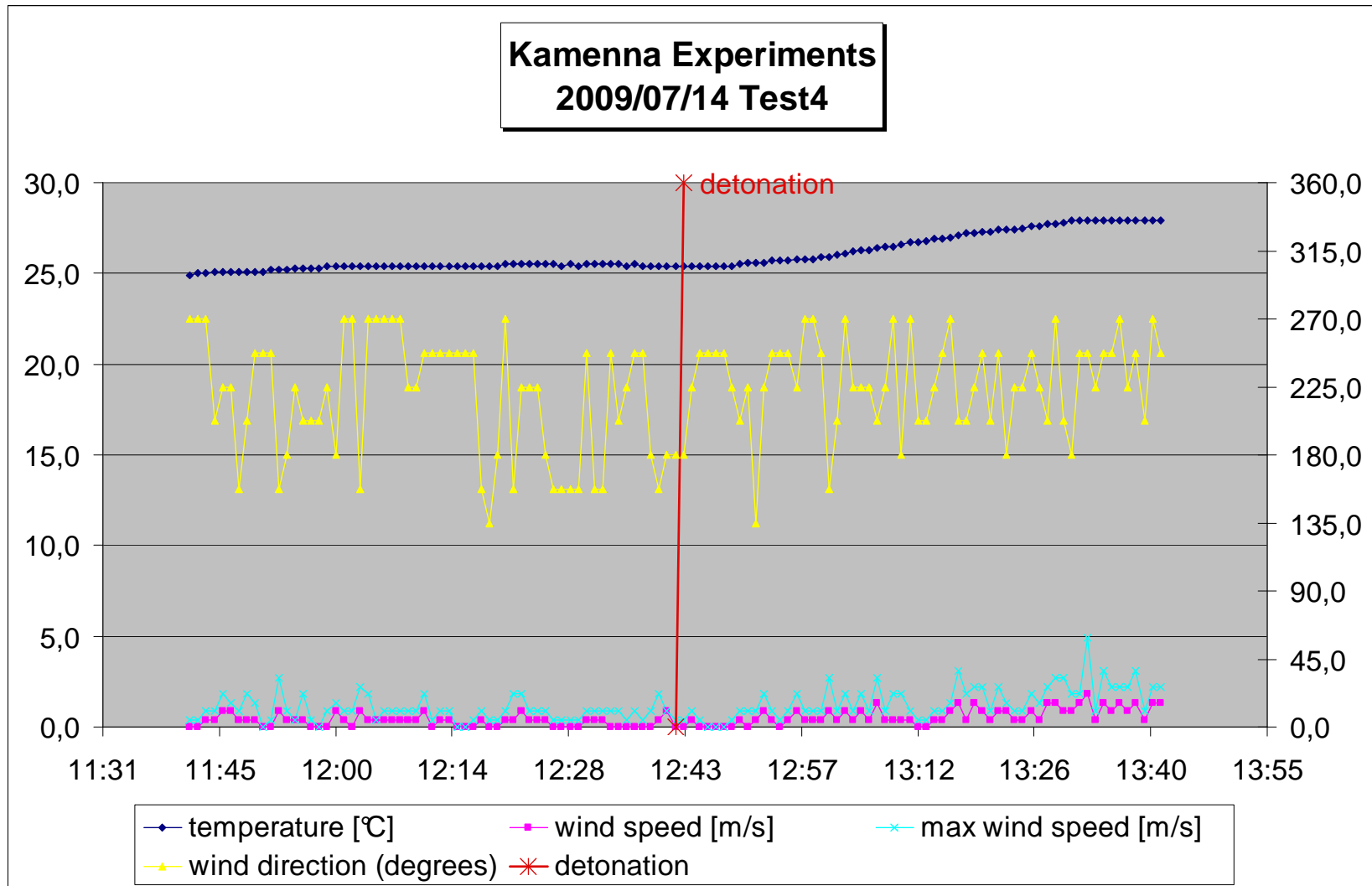
Experiment 3, Deposition [Bq/m²], 60 min



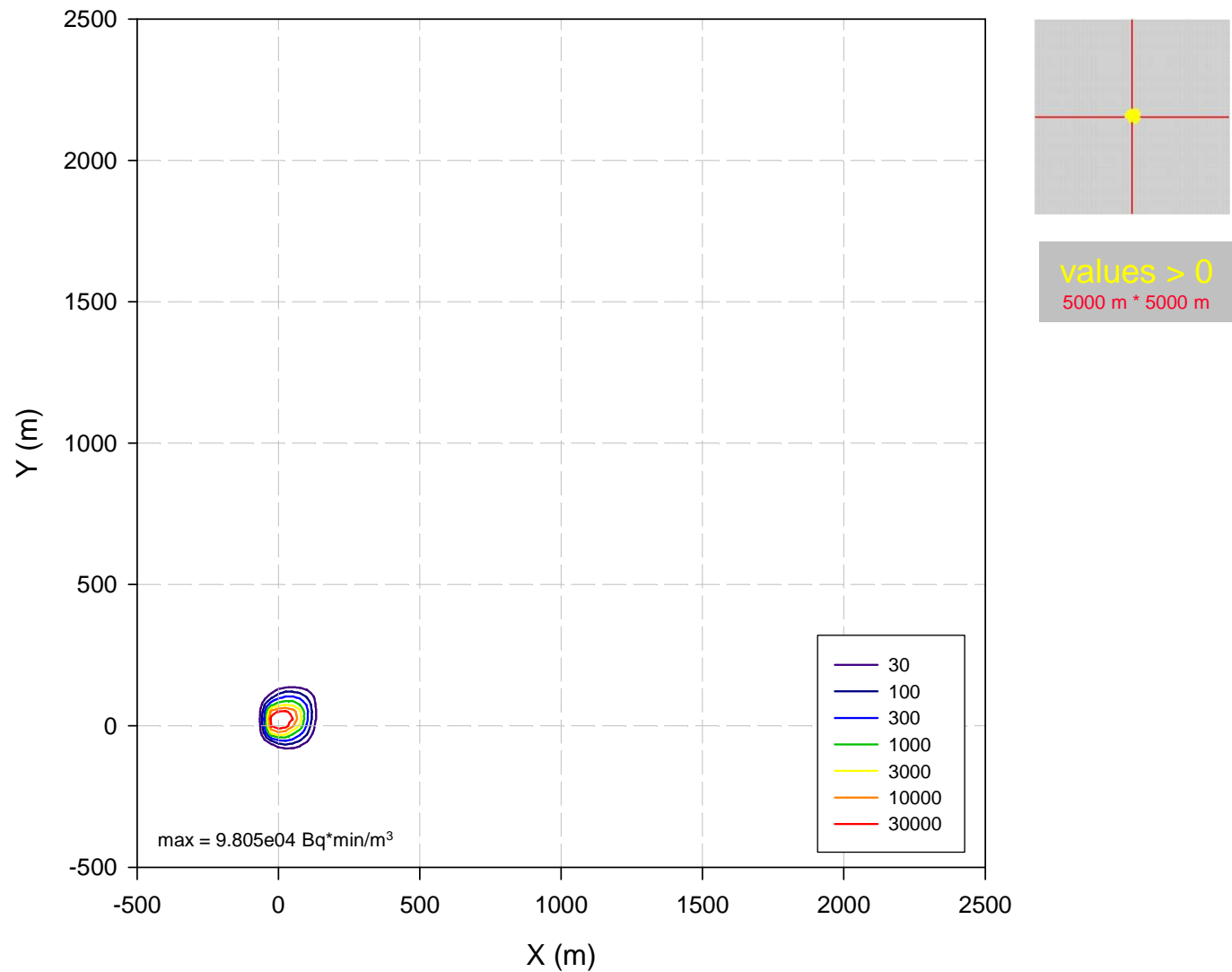
values > 0
5000 m * 5000 m



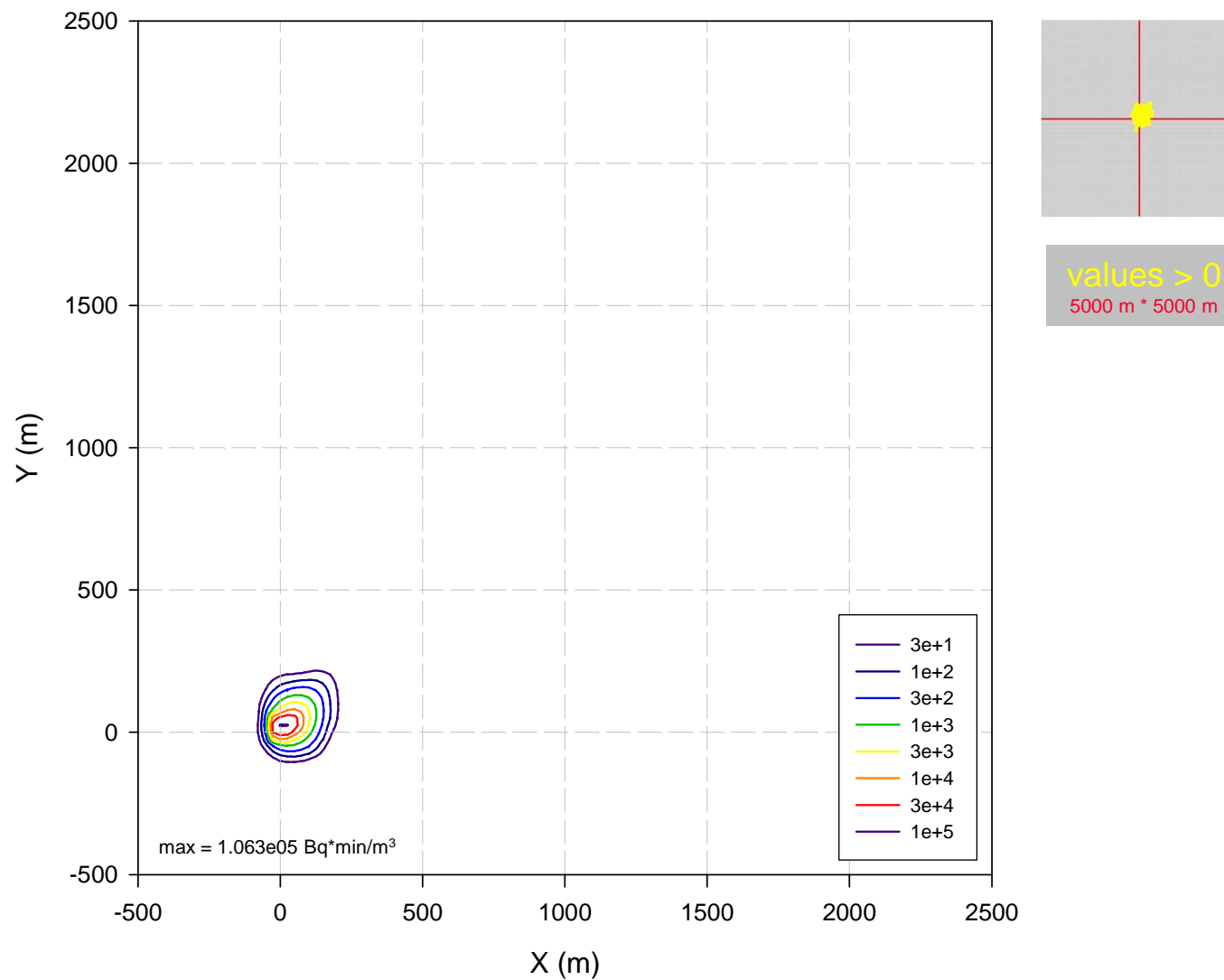
Meteorology Test 4



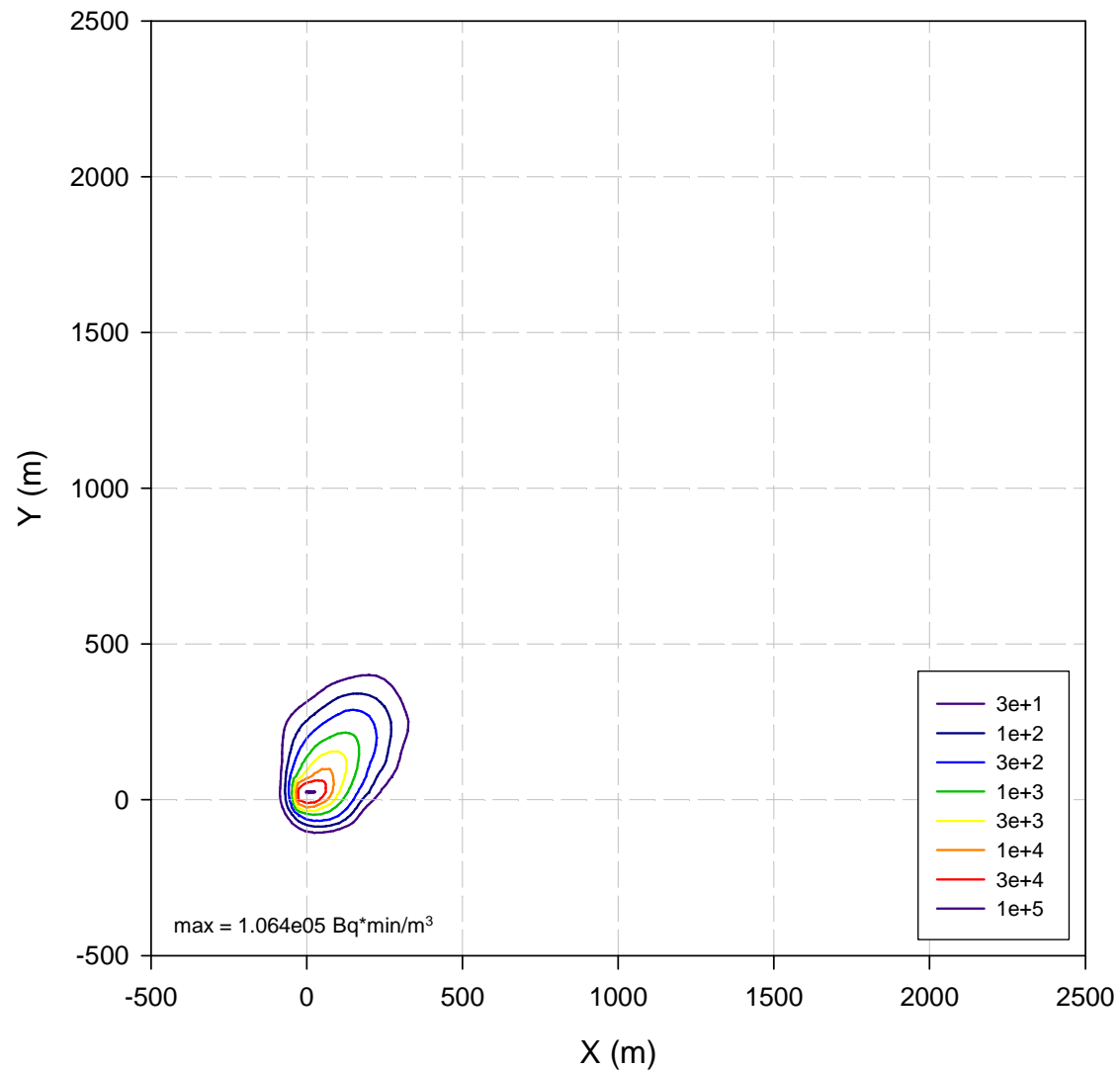
Experiment 4, time integrated activity [Bq*min/m³], 05 min



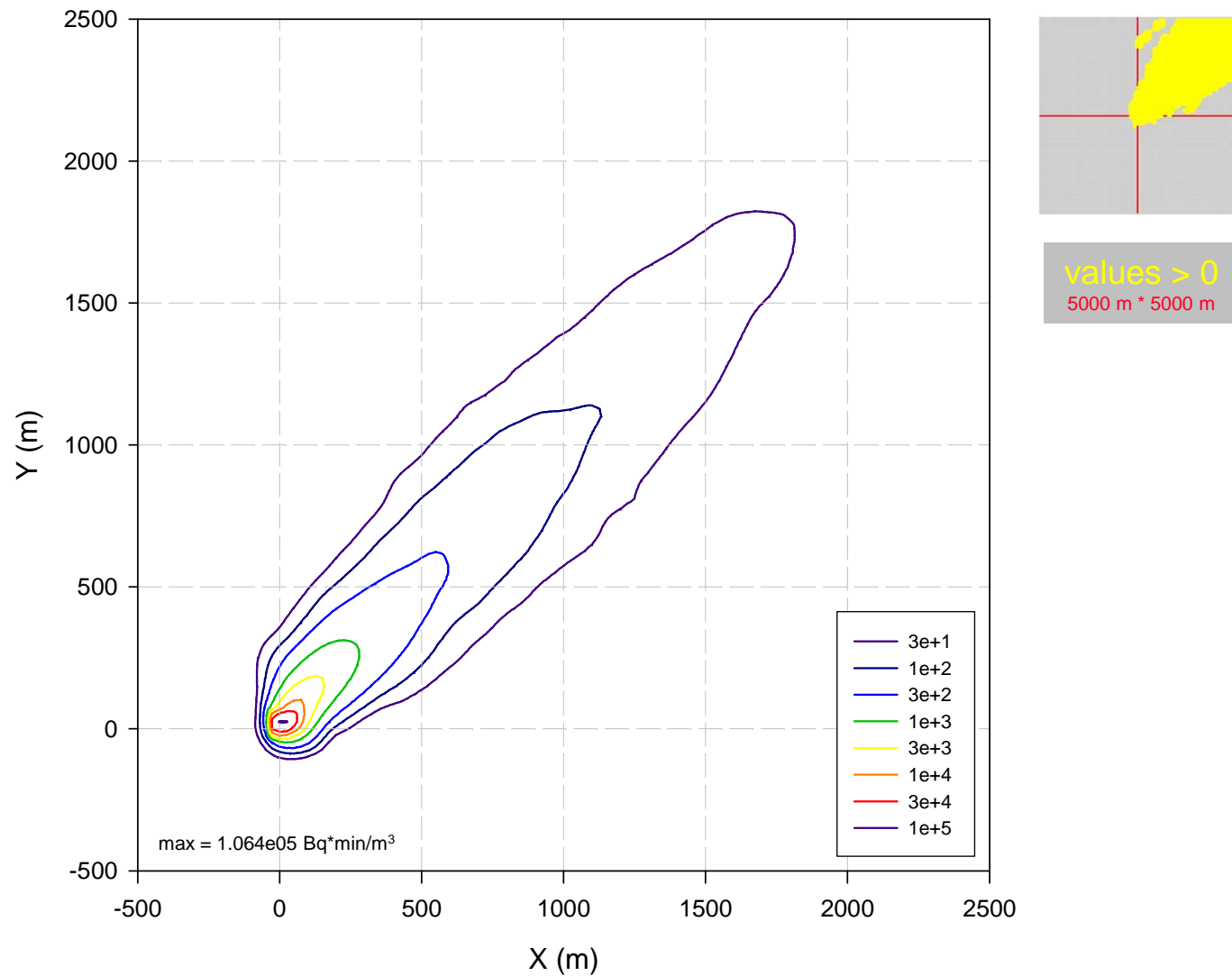
Experiment 4, time integrated activity [Bq*min/m³], 10 min



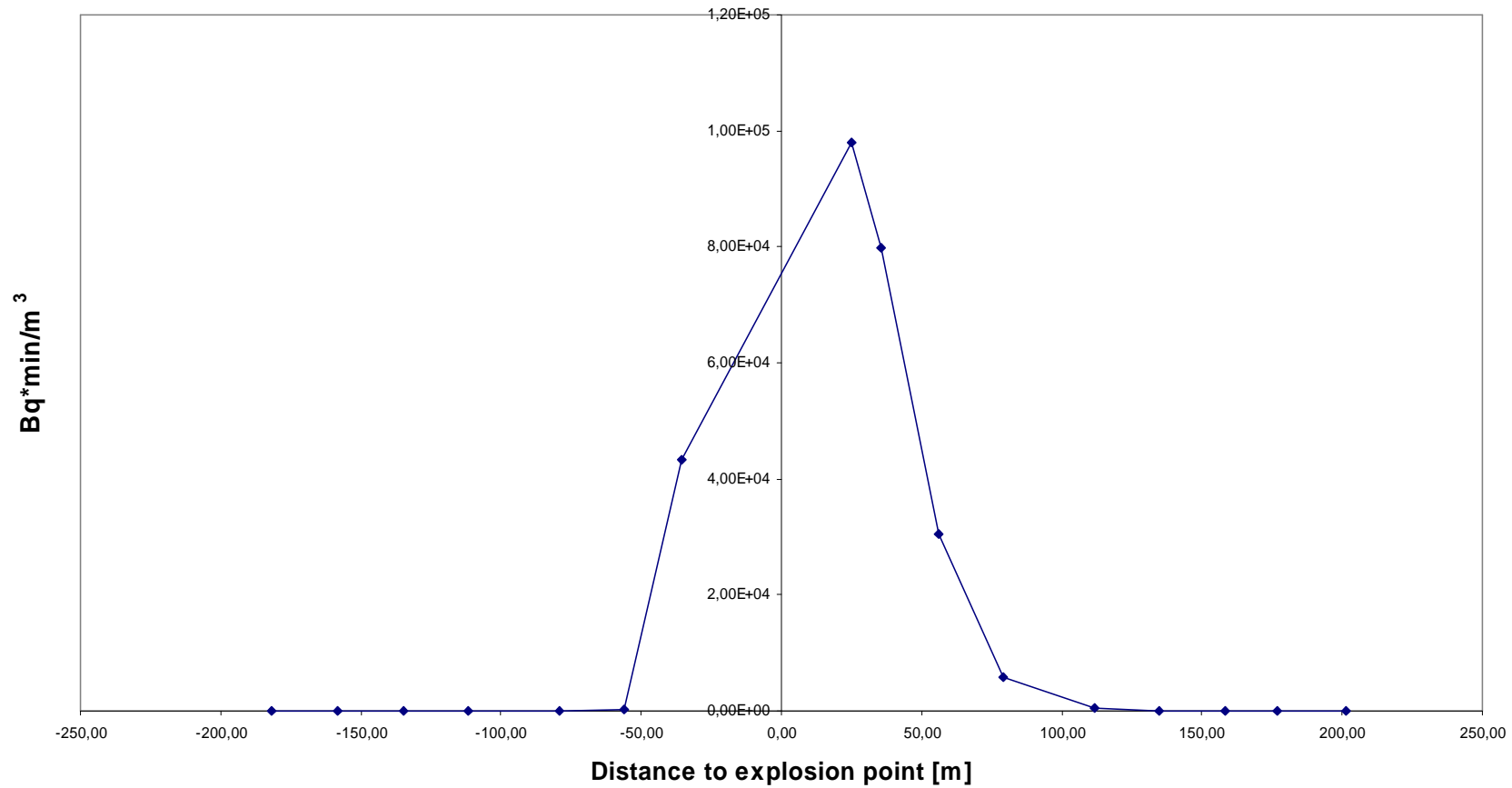
Experiment 4, time integrated activity [Bq*min/m³], 15 min



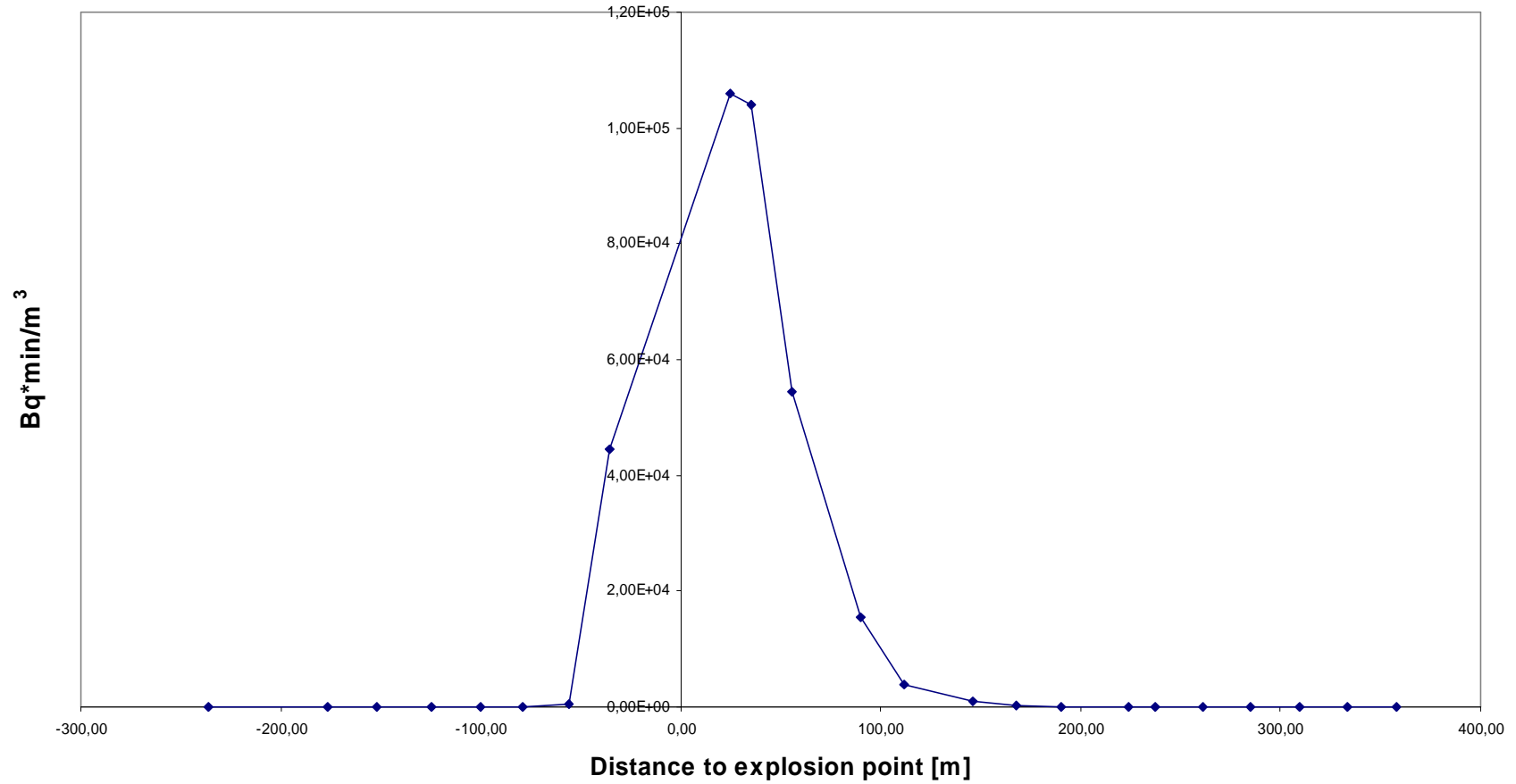
Experiment 4, time integrated activity [Bq*min/m3], 60 min



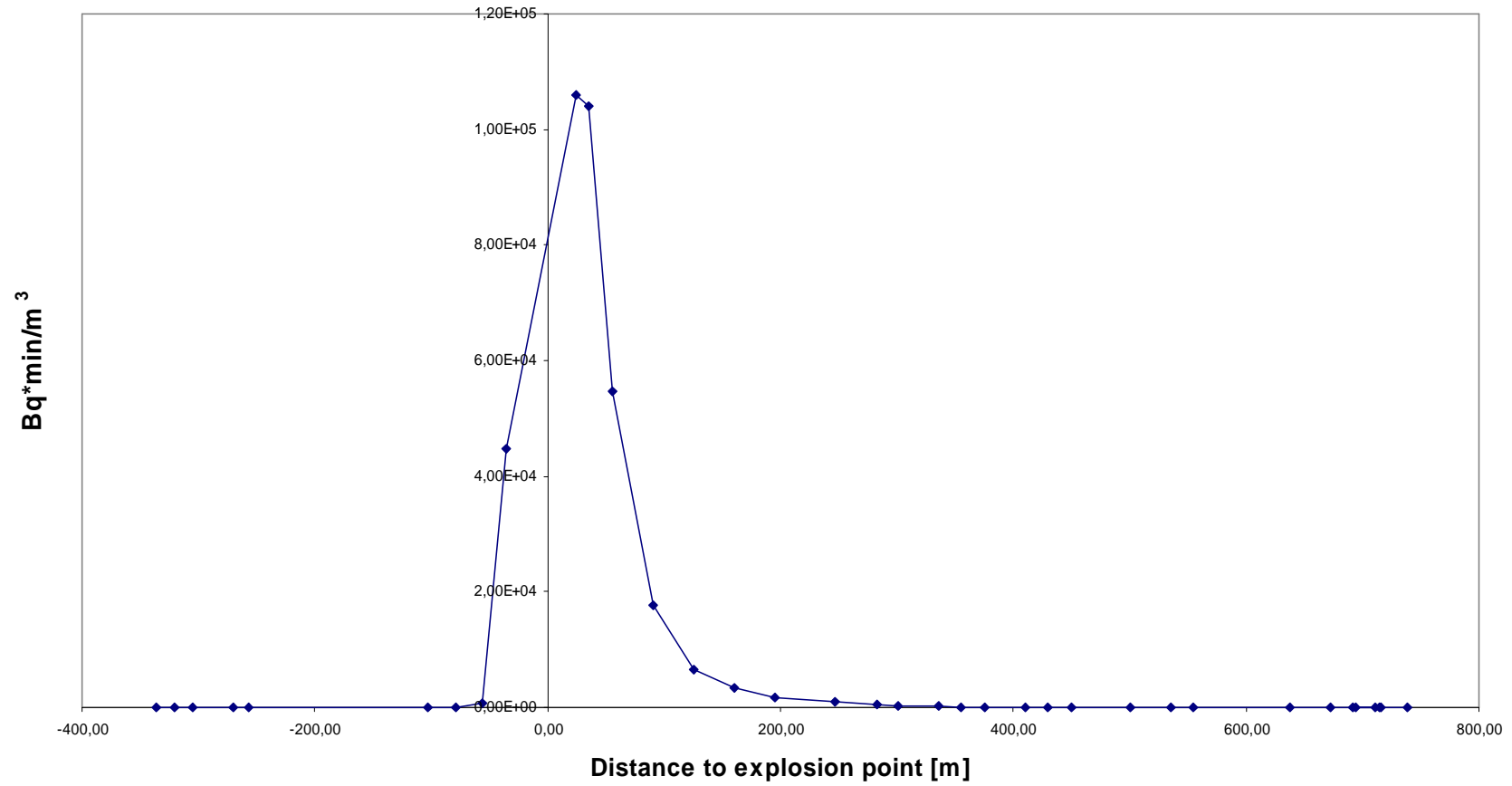
Experiment 4, time integrated activity [$\text{Bq}\cdot\text{min}/\text{m}^3$], 05 min
Maxima downwind



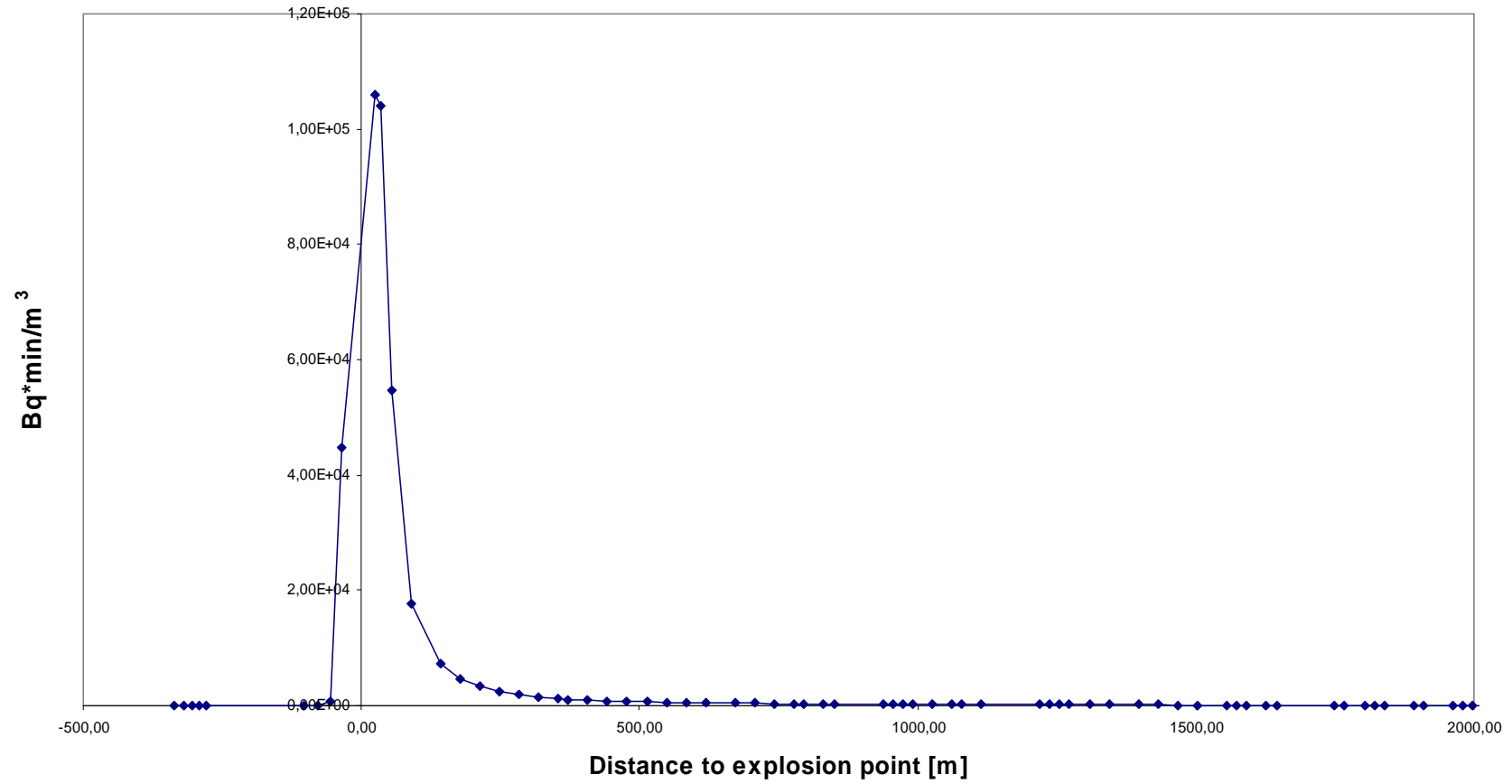
Experiment 4, time integrated activity [Bq*min/m³], 10 min
Maxima downwind



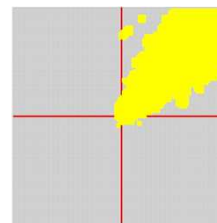
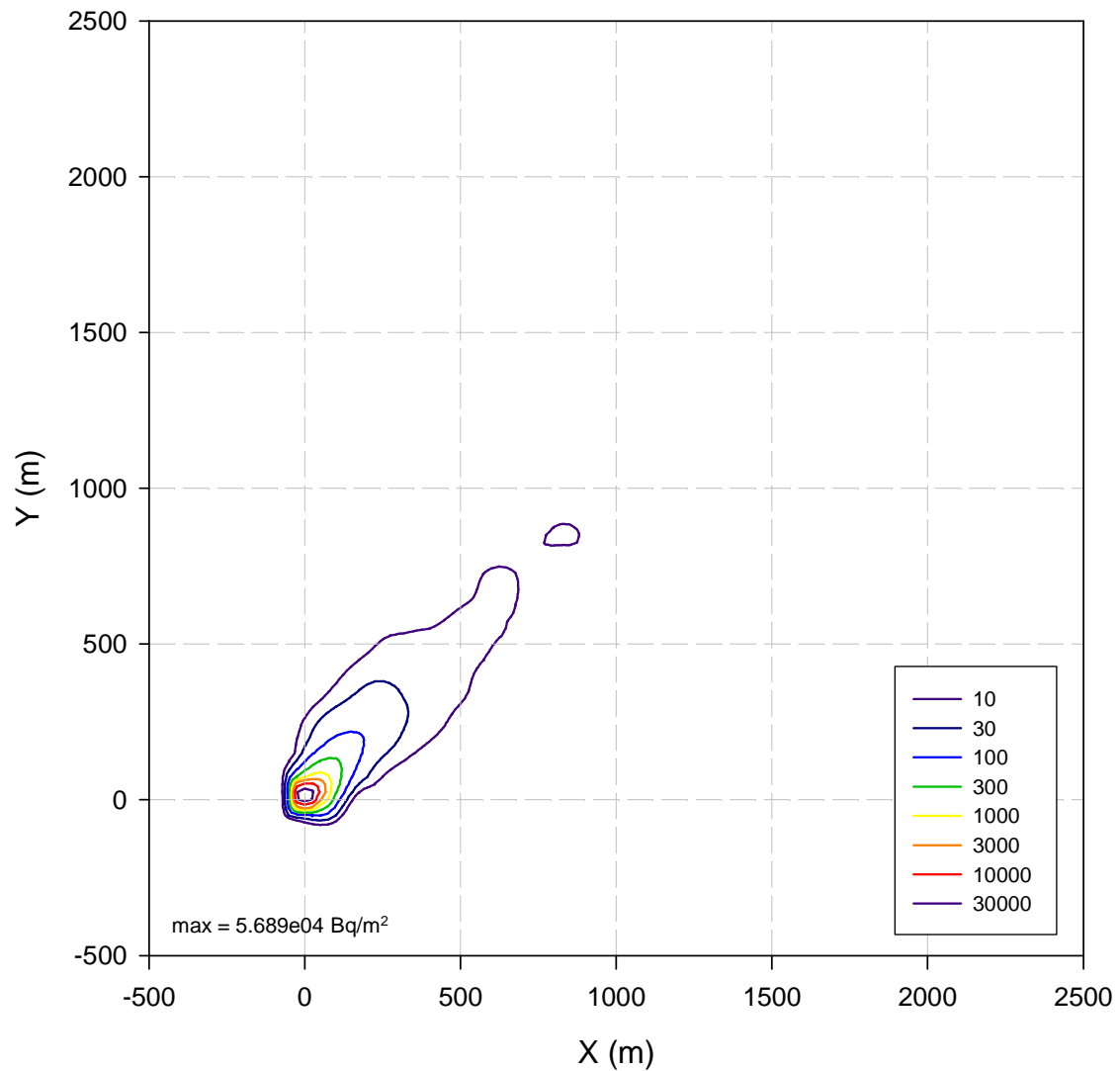
Experiment 4, time integrated activity [Bq*min/m³], 15 min
Maxima downwind



Experiment 4, time integrated activity [Bq*min/m³], 60 min
Maxima downwind



Experiment 4, Deposition [Bq/m²], 60 min



values > 0
5000 m * 5000 m

Results, Summary

Conclusion

- mesh size in LASAIR is too coarse
- results are consistent
- low windspeeds are challenging for the models
- comparison to measurements and/or to other models is difficult (mesh size, LASAIR data has a different scope)



**for your interest
in this presentation**