Discharges of (nuclear) medical facilities

Monitoring campaign at water treatment plants with immersed gamma spectrometry

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Monitoring campaign at Water Treatment Plants (WTPs)

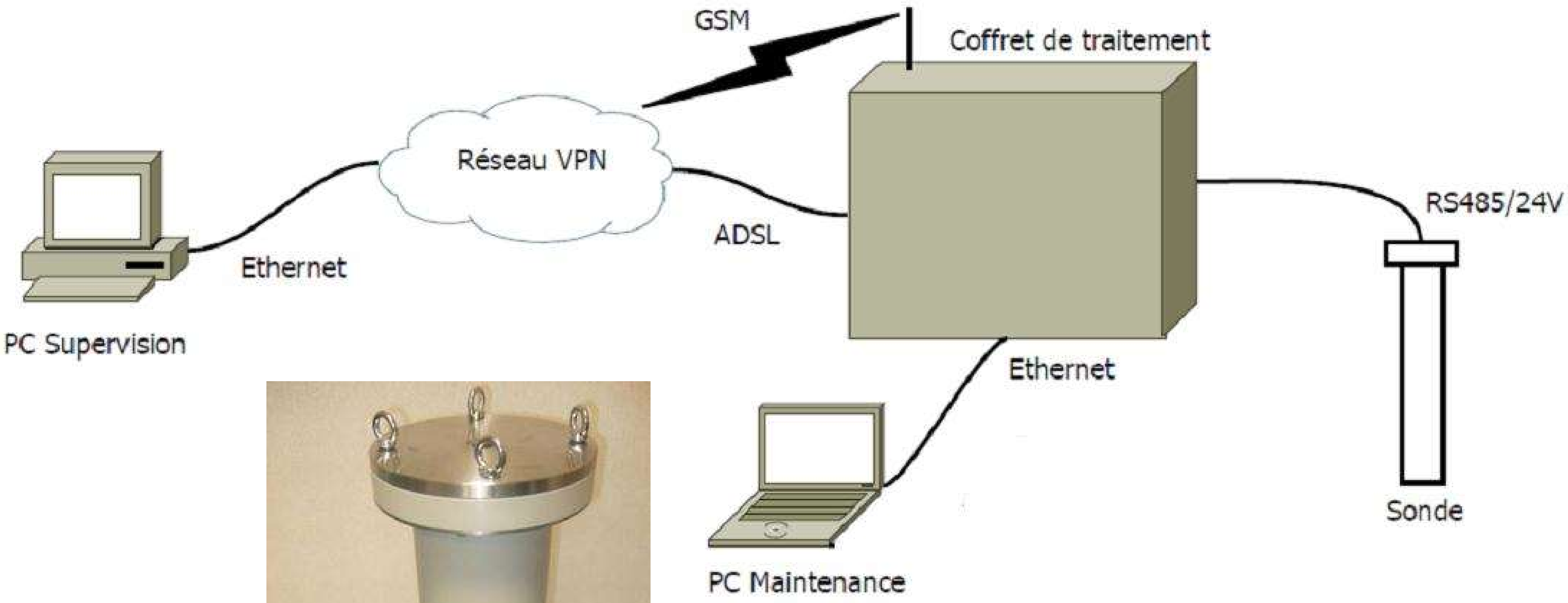
- Introduction
- Equipment, workflow & Installation
- Results and analyses
- Conclusions
- What's Next
- Annexes

Introduction

- **Goal:** study of the impact of discharges of medical radionuclides (hospitals/nuclear medicine, R&D…)
- **Why:**
  - Strong increase in nuclear medicine
  - Little or no data available
  - Increasing international interest (EC, OSPAR…)
- **How:** monitoring influents / effluents into WTP with automatic gammaspectrometry probes (+ lab measurements)
- **Analyses and reporting:**
  - Report with conclusions to WTP
  - « Sharing » the information with our colleagues (responsible for the medical sector etc), EC, OSPAR… …

Equipment

Aquascan probes (Saphymo)



- **Detection of 10 radionuclides with alarm notification level**
- **Unidentified peak notification**
- **10' and 1h count**

Workflow

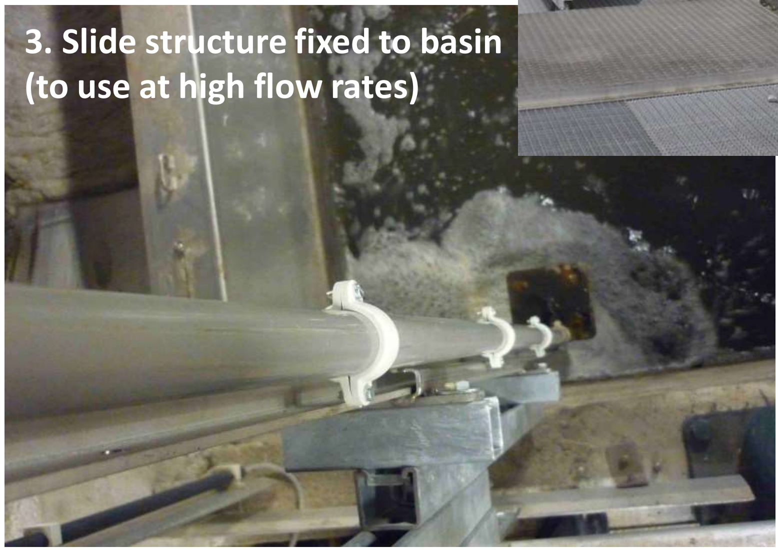
- Operational phase about 3 months for each WTP
- Following WTPs were investigated:
  - Roselies
  - Montignies-sur-Sambre
  - Antwerpen-Zuid
  - Leuven
  - Gent
- It includes **continuous measurements** of radioactivity
  - of water entering / leaving WTP by **immersed probes**,
  - of ambient air by **mobile dose rate probes**

- It includes **punctual / occasional samples**:
  - of **effluent WTP** (in & out) to validate the automatic measurements,
  - of **sludge** (search radionuclides present and determination of their concentrations)..

Installation


1. Drop down with chain and weight


2. Drop down with chain and weight + external support structure


3. Slide structure fixed to basin (to use at high flow rates)


4. Ambient dose rate probe at sludge facility


5. External container with pump and overflow (when impossible to mount probe in channel)

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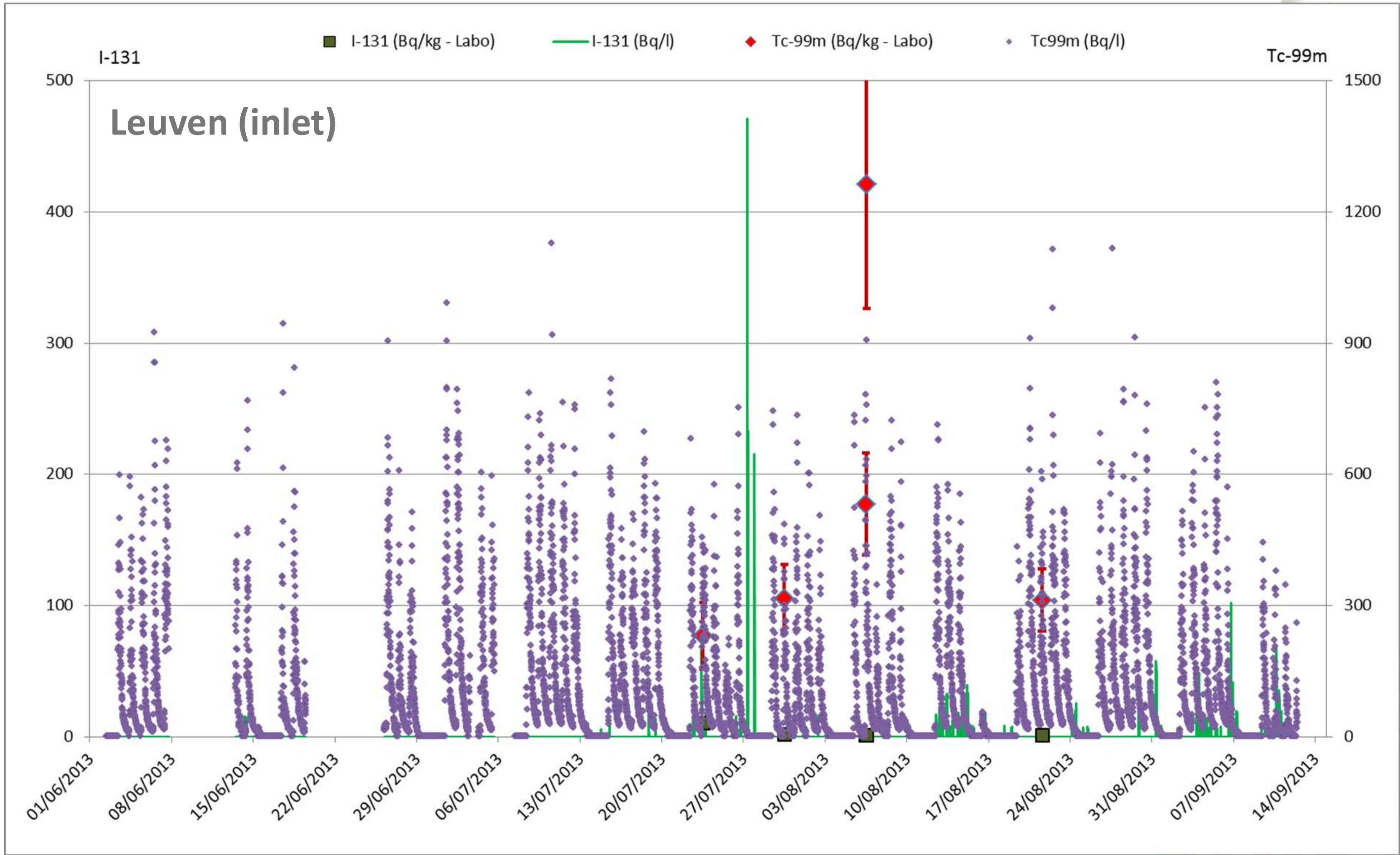
Results & Analyses (WTP inlet)



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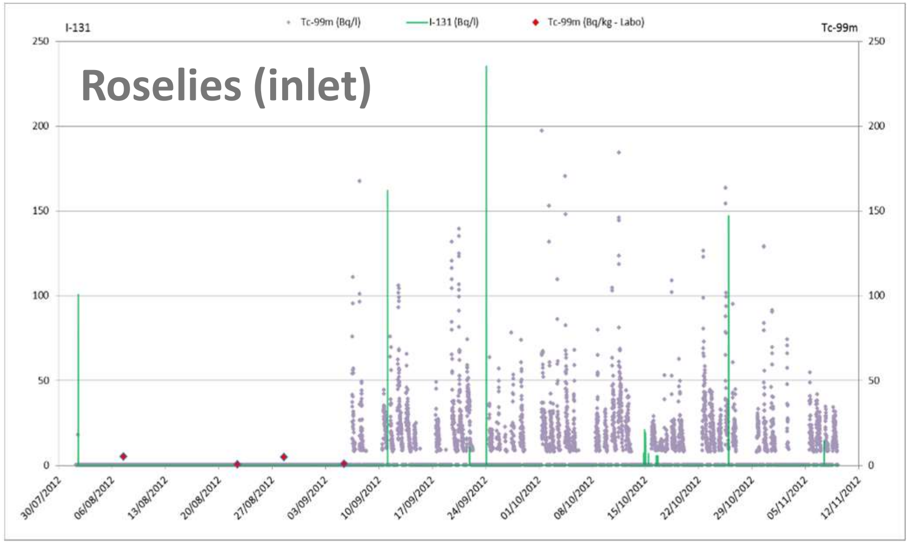

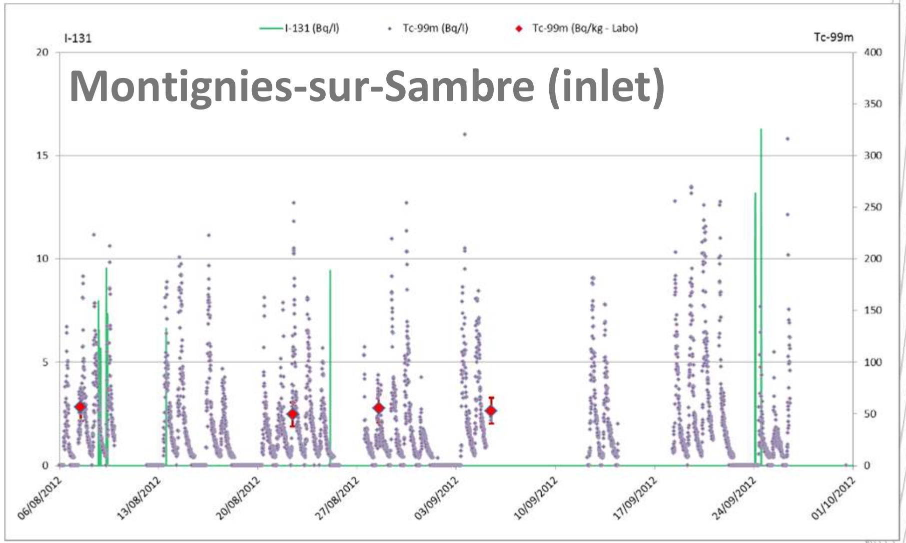

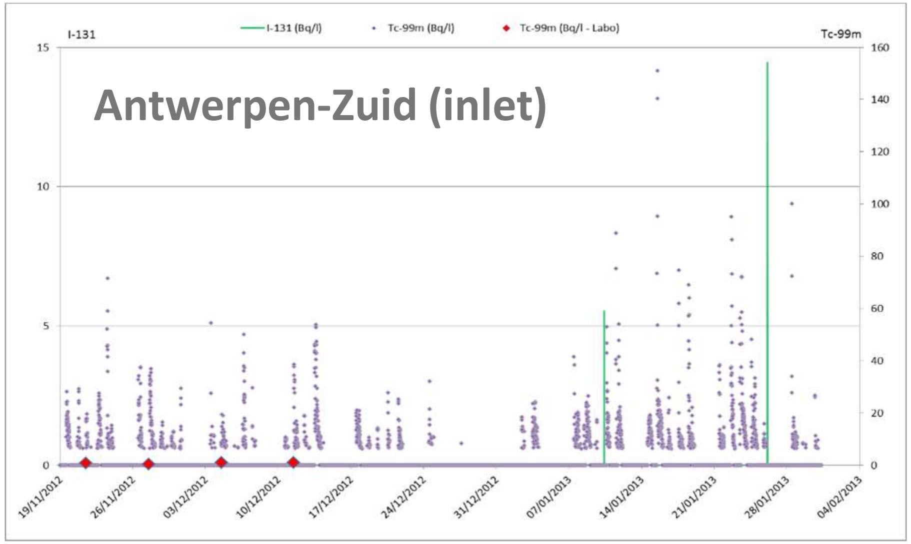

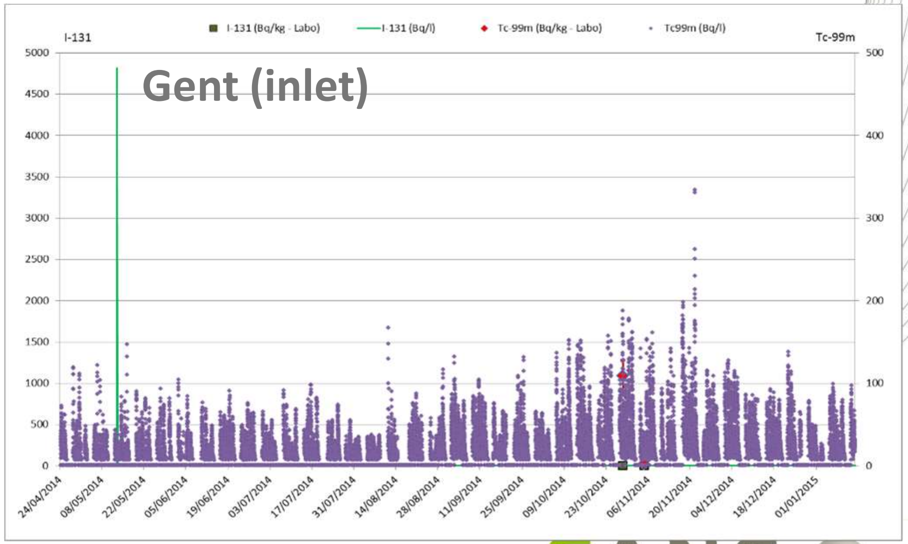

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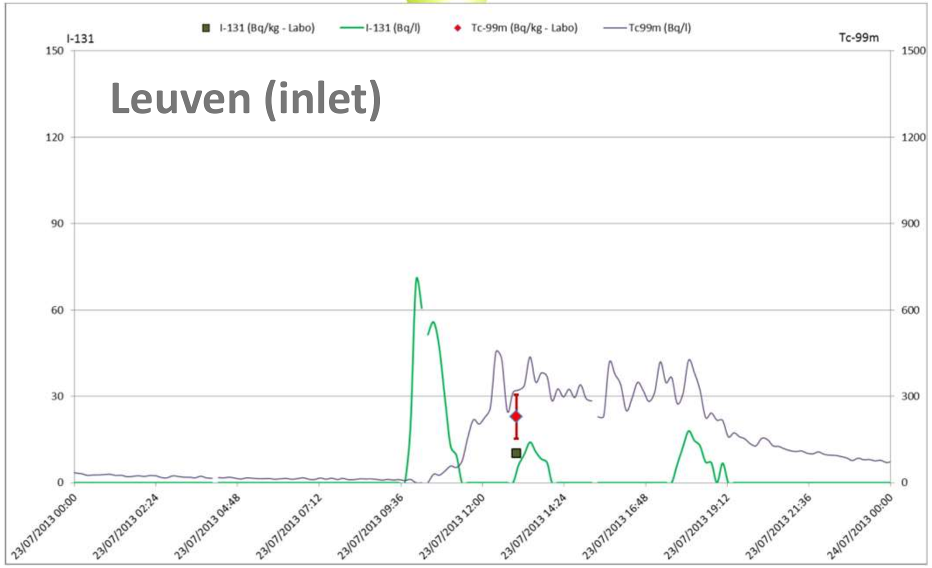
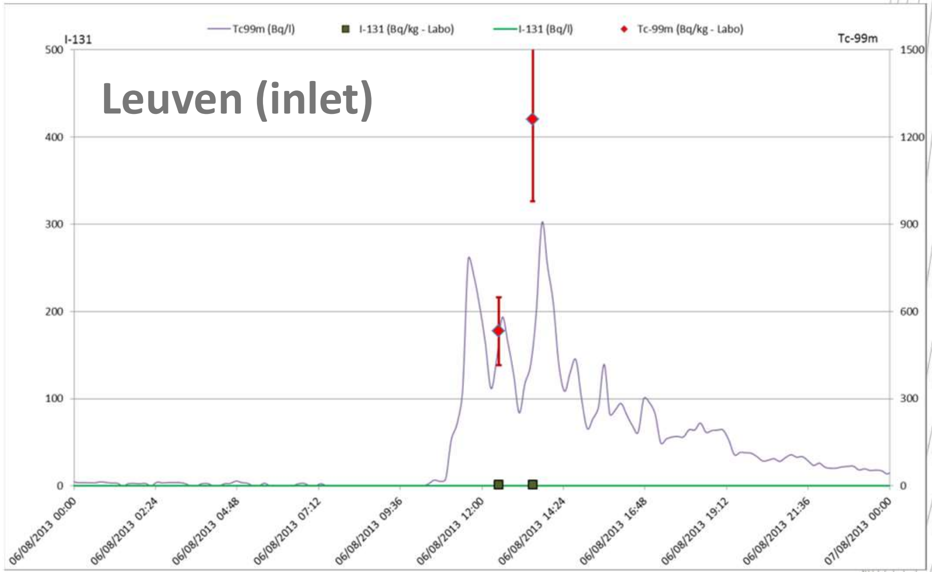
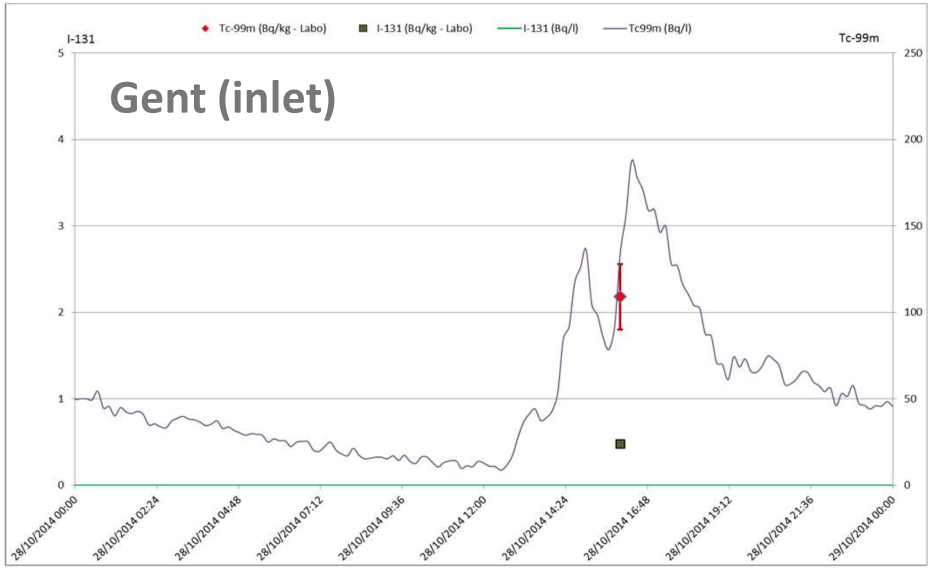
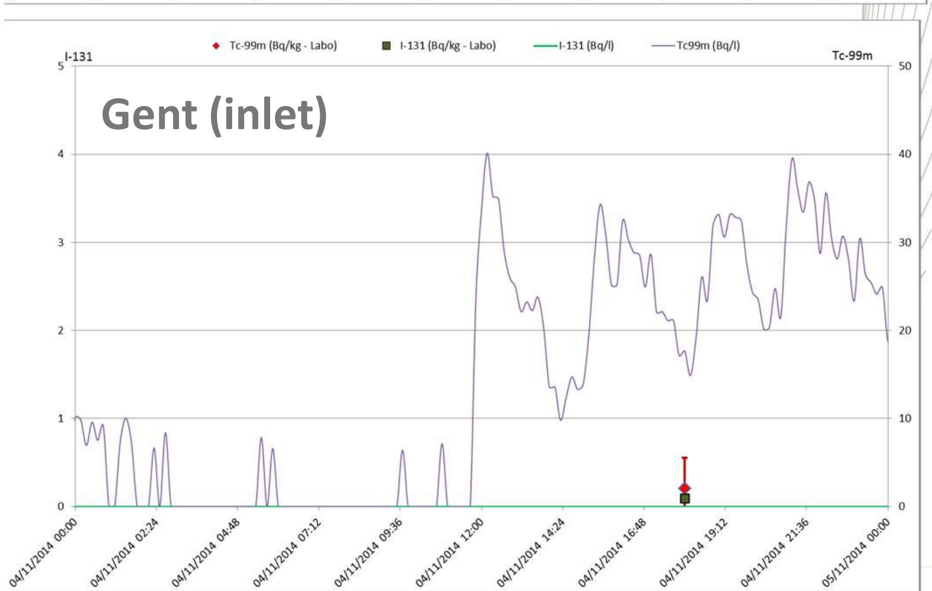








Results & Analyses (WTP inlet)

GRPIR-2001

Radionuclide	Half-life	Max concentration (Bq/litre)
Iodine-123	13 hours	4800
Iodine-131	8 days	45
Technetium-99m	6 hours	45,000
Samarium-153	2 days	1300
Fluorine-18	1.83 hours	20,000
Iridium-192	73.83 days	710

- **Tc-99m detected frequently: < 300 Bq/l, max 1100 Bq/l**
- **I-131 detected regularly: < 45 Bq/l, max 4800 Bq/l**
- **I-123, Sm-153, Ir-192 and F-18 detected occasionally**
- **In general, concentrations in compliance with GRPIR-2001, with exception of I-131 (exceeds limit of 45 Bq/l):**
  - 8x I-131 violations at Roselies with a maximum of 235 Bq/l
  - 0 violations at Montignies-sur-Sambre and Antwerpen-Zuid
  - 23x I-131 violations at Leuven with a maximum of 471 Bq/l
  - 5x I-131 violations at Gent with a maxmimum of 4817 Bq/kl

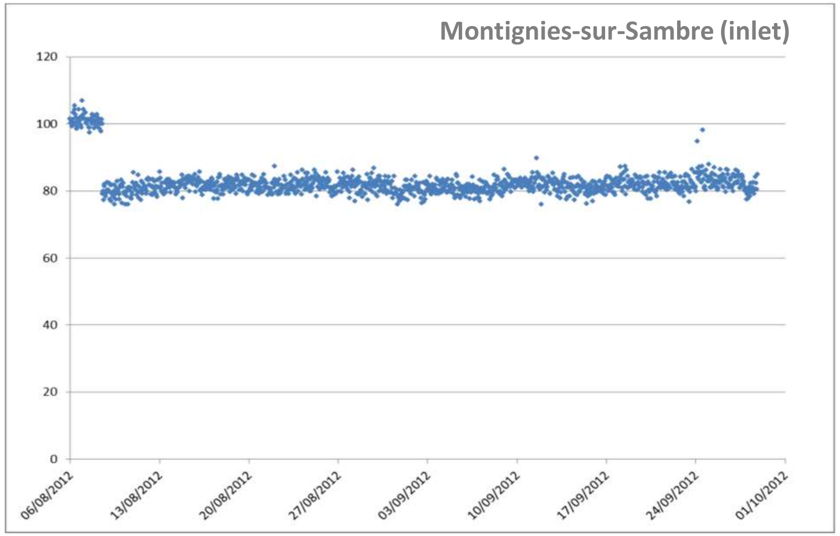
Results & Analyses (WTP sludge)

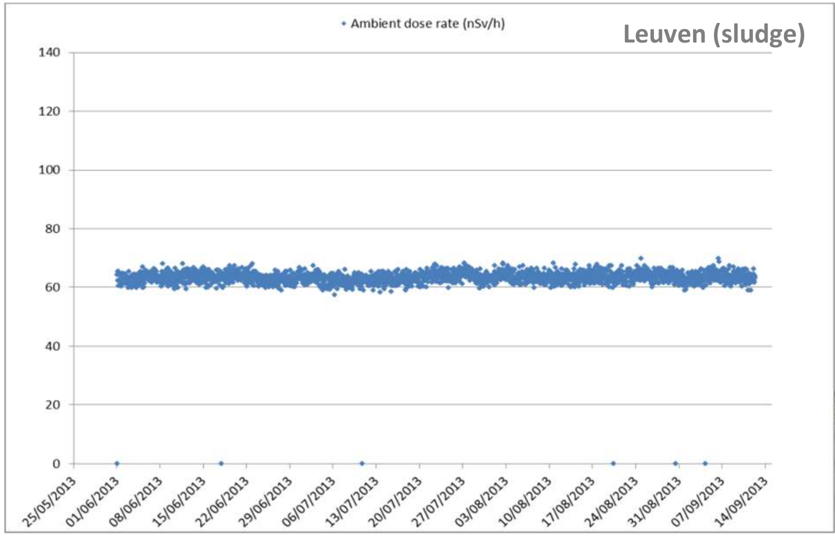
WTP	Fresh Sludge (Bq/kg)		Dry Sludge (Bq/kg)	
	Tc-99m	I-131	Tc-99m	I-131
Roselies	< DL to 22	< DL to 22	< DL	170
Montignies-sur-Sambre	5 to 150	< DL to traces	< DL	5
Antwerpen-Zuid	< DL to 2	5 to 10	< DL	22
Leuven	< DL to 21	10 to 22	70	50
Gent	11	6	55	20

- Medical **radionuclides present in sludge** (Tc-99m and I-131)
- In general, more I-131 in dried then fresh sludge (fixation)
- For Tc-99m, concentration sometimes higher in fresh, sometimes higher in dried sludge:
  - Radionuclides intend to concentrate in dried sludge
  - Higher transit time for dried sludge (≠ WTP processes, weather influence/amount of rain,…)
  - Short half-life can offset the concentration effect (Tc-99m ~ 6 hours)
- **Concentrations in compliance with GRPIR-2001** (for solids)

Results & Analyses (WTP ambient DR)

- In general, incoming activity of **radionuclides at the inlet of WTP has no effect on ambient (long term) dose rate.**
- Ambient **measured dose rate is in general lower then natural background** level and attributed to structure and environment of the facilities:
  - Probes located inside building (when outside Dose rate ≈ background level)
  - Shielding effect due to presence of water, concrete
  - Reduces natural radioactivity component
- In general, presence of **radionuclides in sludge little effect on ambient dose rate**:
  - In general **dose rate is lower (or slightly lower) then natural background level** (shielding effect)
  - Effect depending on different factors: treatment process, open /closed sludge transport, degree of dryness…





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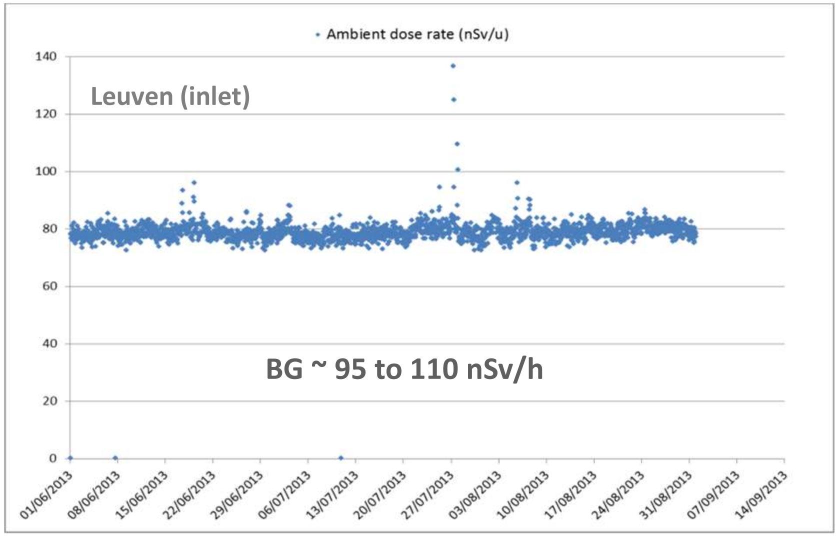
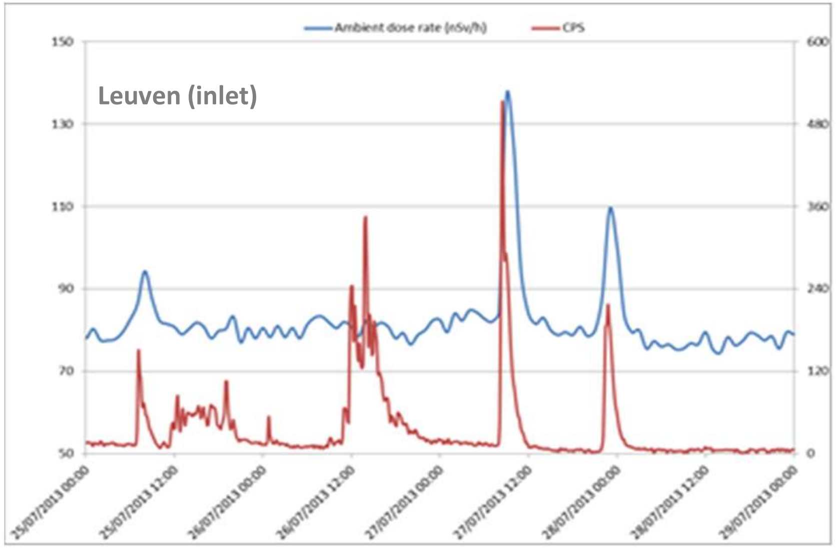
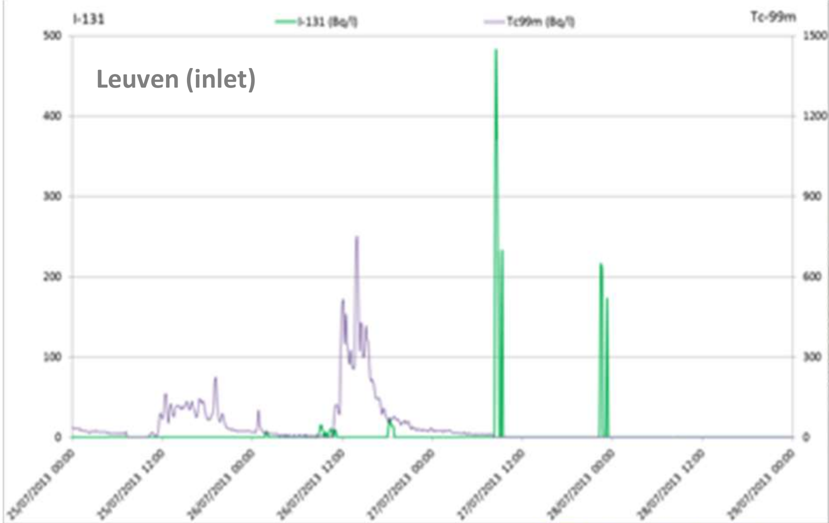
Results & Analyses (WTP ambient DR)





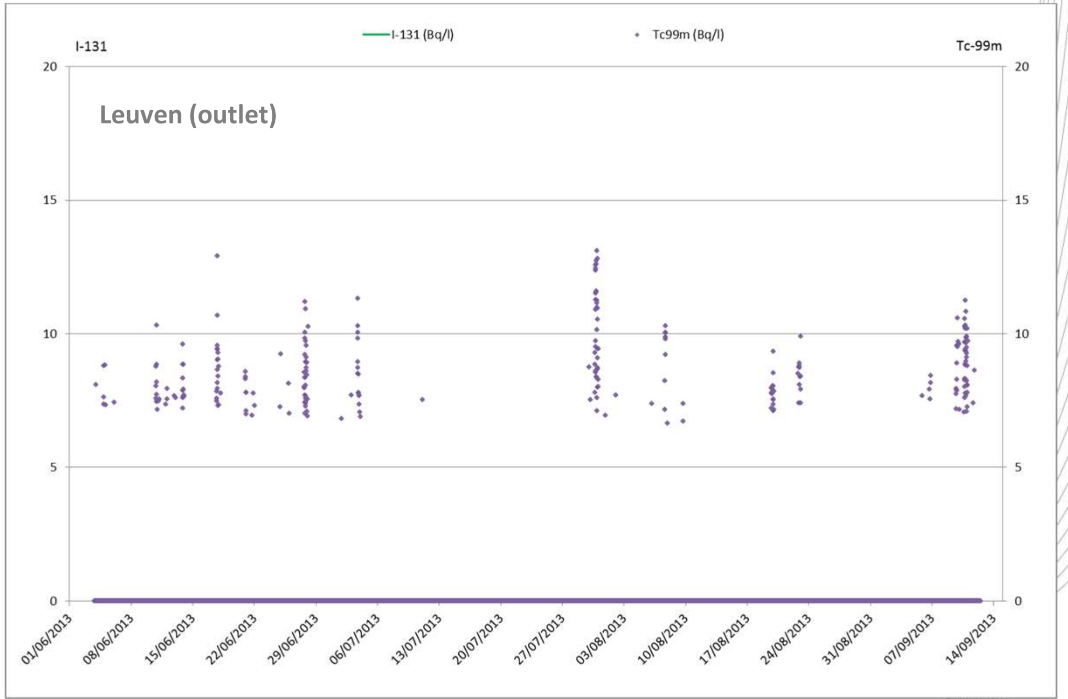


- **Gamma probe inlet Leuven was located outside**
- **Less or no shielding of metal and concrete**
- **Ambient dose rate fluctuations (peaks) observed**
- **Peaks are due to (high concentration of) I-131; no influence of Tc-99m on ambient dose rate**
- **Radionuclides with higher energy gamma rays can increase temporary ambient dose rate**
  - **I-131: 95% gamma in range of 280 to 640 keV**
  - **Tc-99m: 89% gamma of 140 keV**

Results & Analyses (WTP outlet)

At the outlet of WTP, the immersed probe in general can not detect any of the previously observed (medical) radionuclides anymore.

- With exception of Tc-99m in 1 water treatment plant
- In WTP Leuven, occasionally trace amounts (< or ~ 10 Bq/l)



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Conclusions of the WTP campaign

- Detection of different isotopes at the entrance to the station
  - Tc-99m frequently
  - I-131 regularly
  - I-123, Sm-153, Ir-192 and F-18 occasionally
- I-131 sometimes exceeds (strongly) the limit of the “liberation level”
- Traces/presence of I-131 and Tc-99m detected in sludge
- No detection of the isotopes at the outlet of the station (sometimes traces of Tc-99m
- (small) influence of I-131 on the ambient dose rate (of influents/sludge)
- **Despite observed exceedances of the “liberation” level for the I-131 at the inlet of the WTP and its influence on the ambient dose rate, there is no radiological risk for the employees ...**
- **I-131 concentrations at the inlet is too high…** (investigation ongoing)

What's next?

New internal policy "Radiological Monitoring" (end 2018)

- A **more transversal view** on monitoring of discharges & environment
- Graded approach between domains and within each domain
- Initially **joint inspections** between environmental Surveillance of the Territory and the licensing services.
- Internal exercise with regard to **more routine monitoring of discharges from (nuclear)**, both at source (procedures for release and discharge, monitoring of the discharge) and in the environment (monitoring and sampling of rivers).
- **Any data / practices that you see fit and usefull in establishing a better control**, taking into account the operational context within medical facilities, **are always welcome**!

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Discharges of (nuclear) medical facilities
WTP Campaign

Thank you for your attention
Questions?

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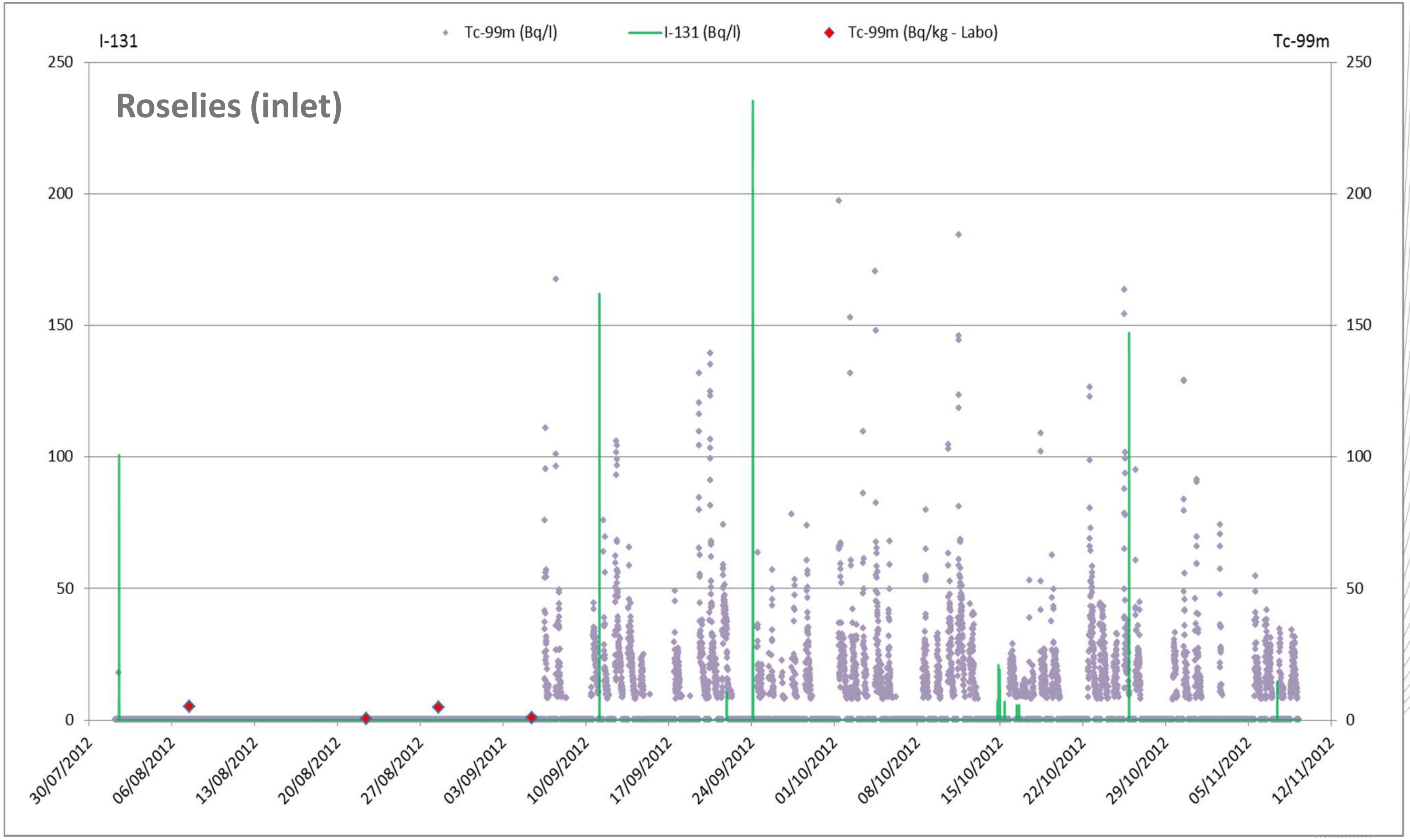
Monitoring campaign at water treatment plants with immersed gamma spectrometry

Annexes

Annex WTP: Online measurements



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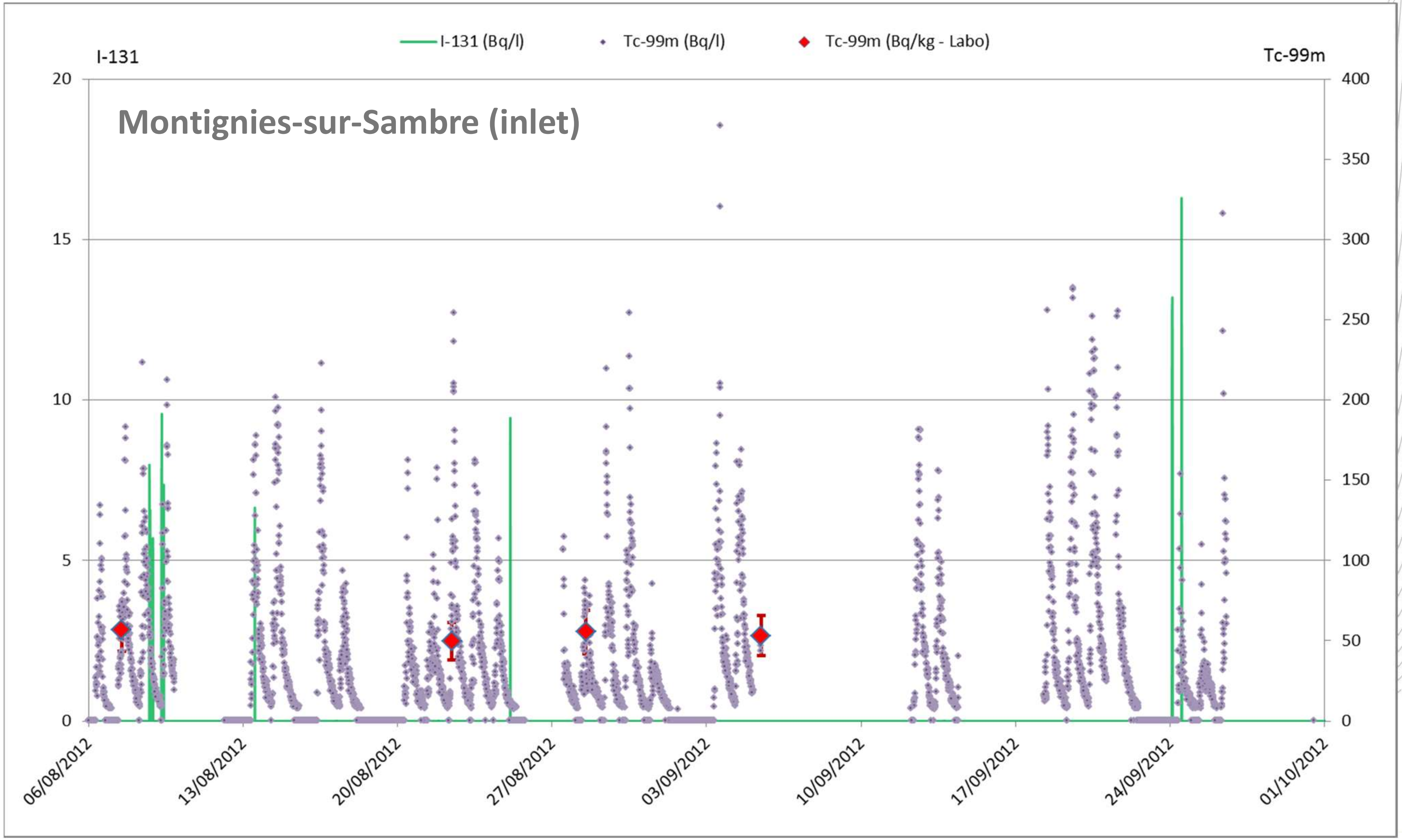

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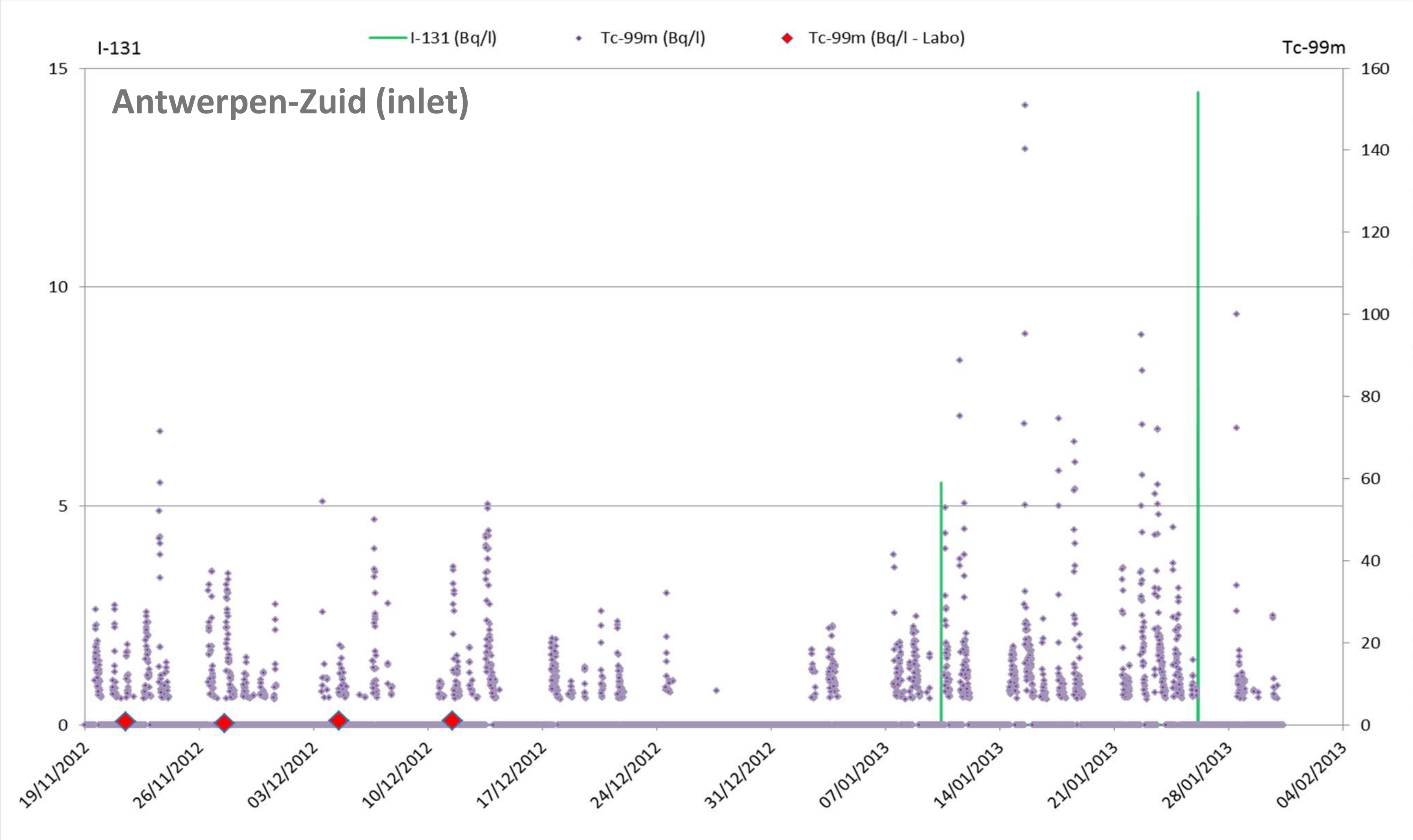

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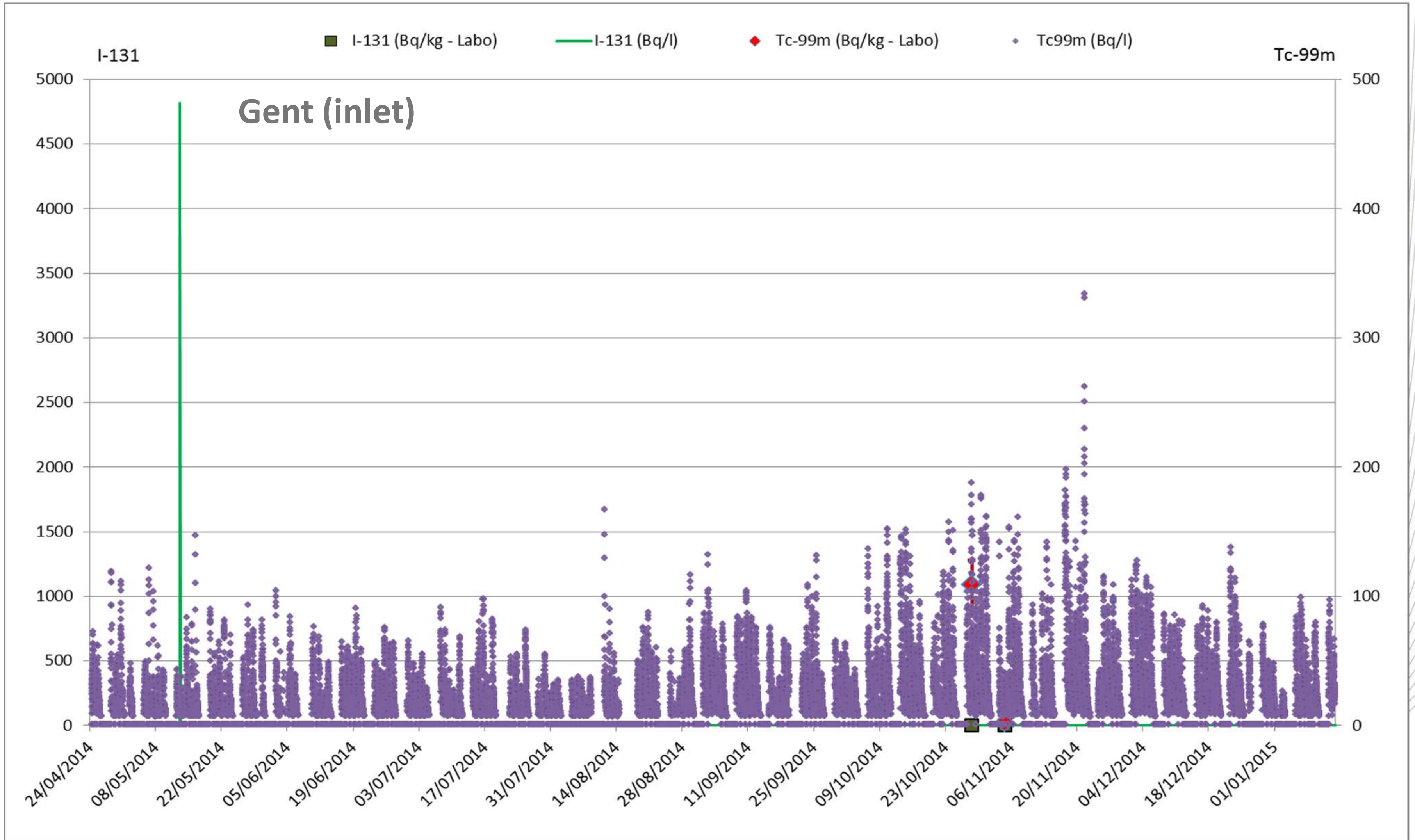

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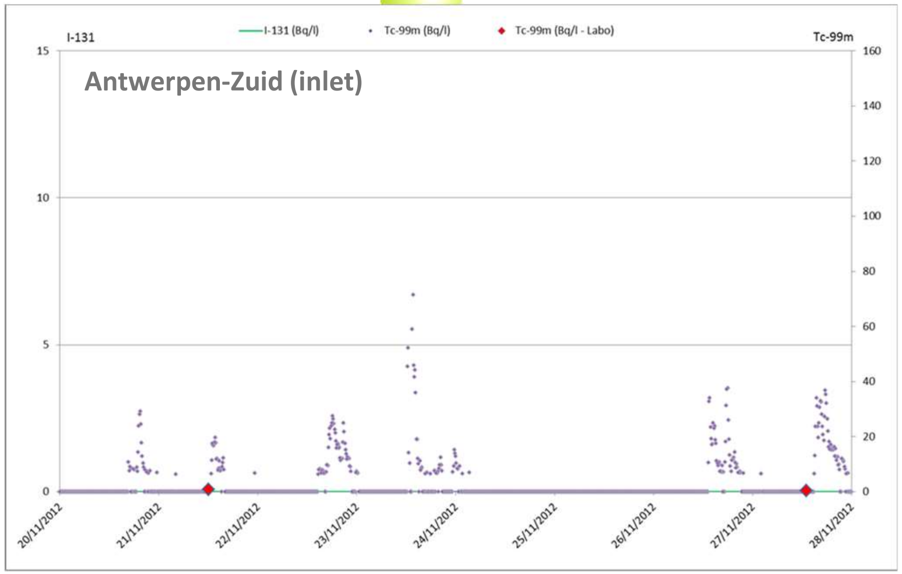
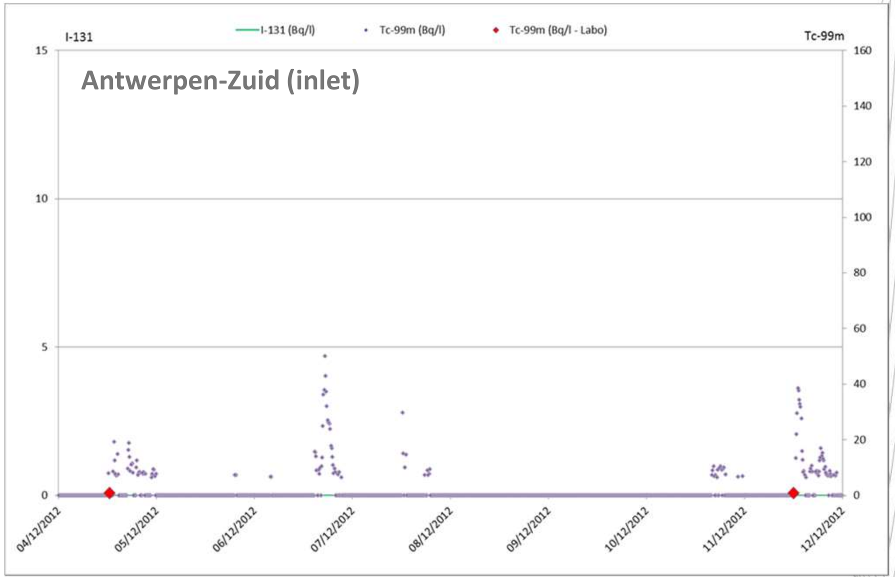
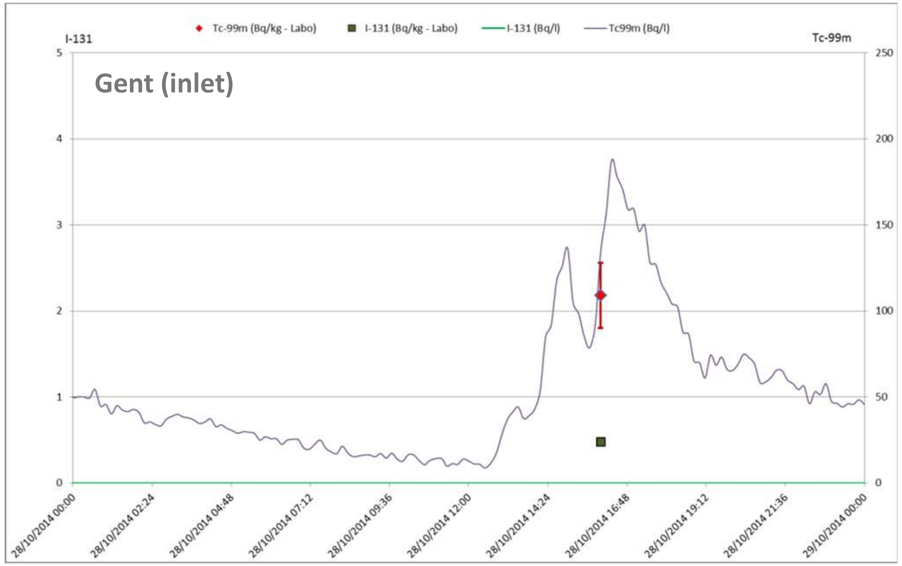
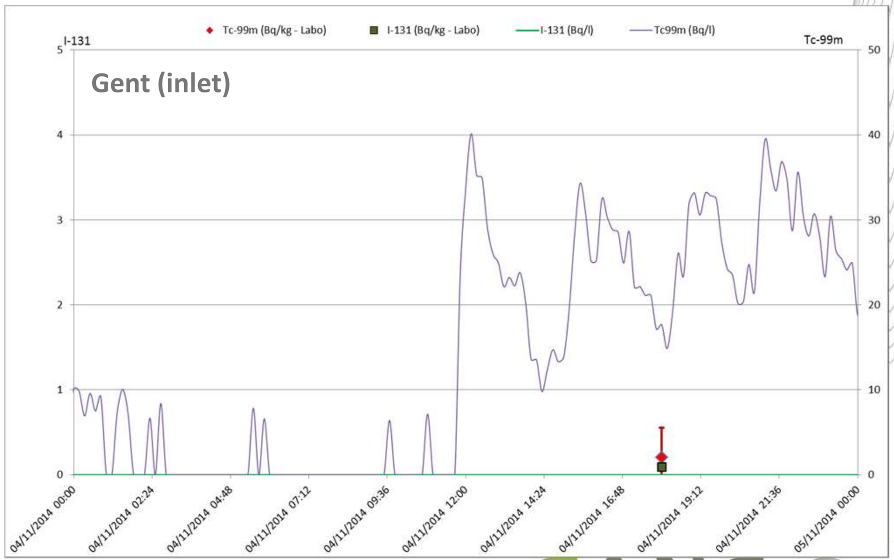
Annex WTP: Lab/online measurements









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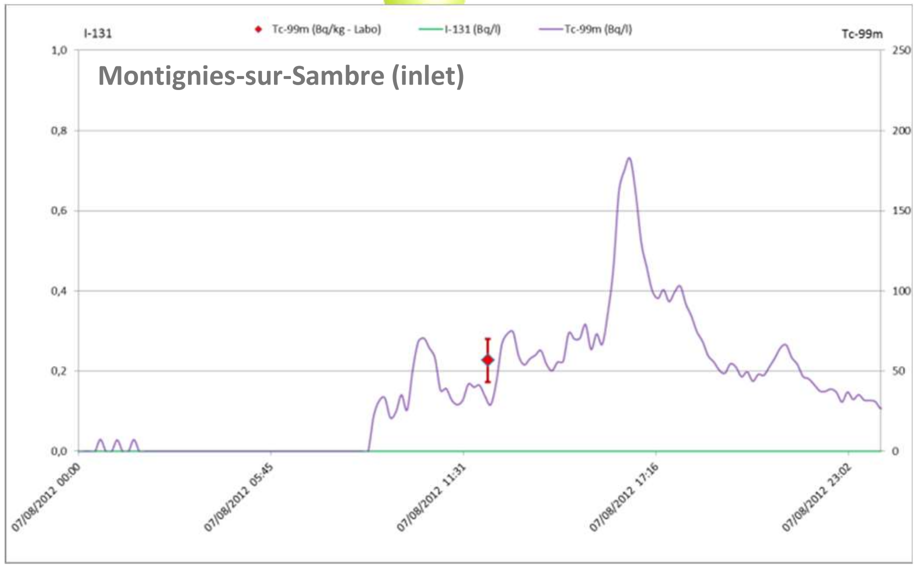

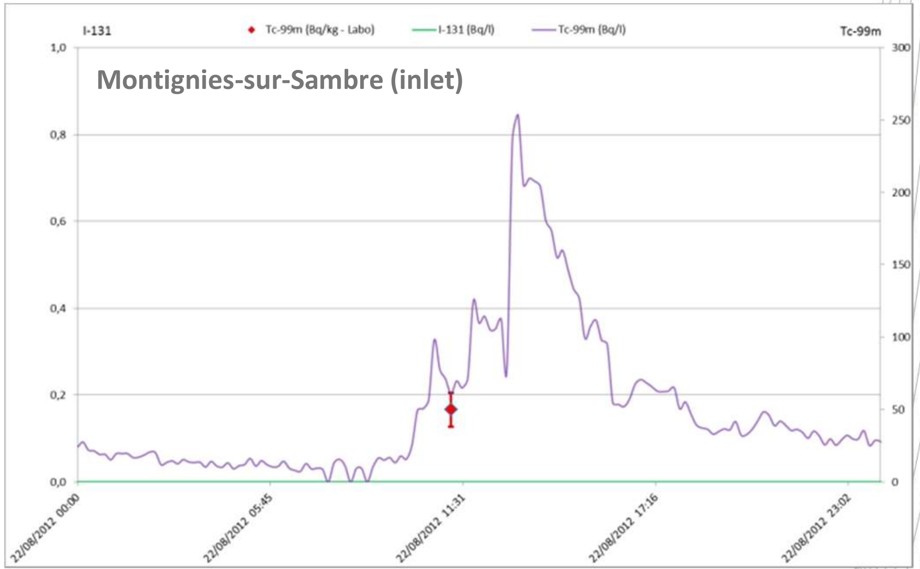

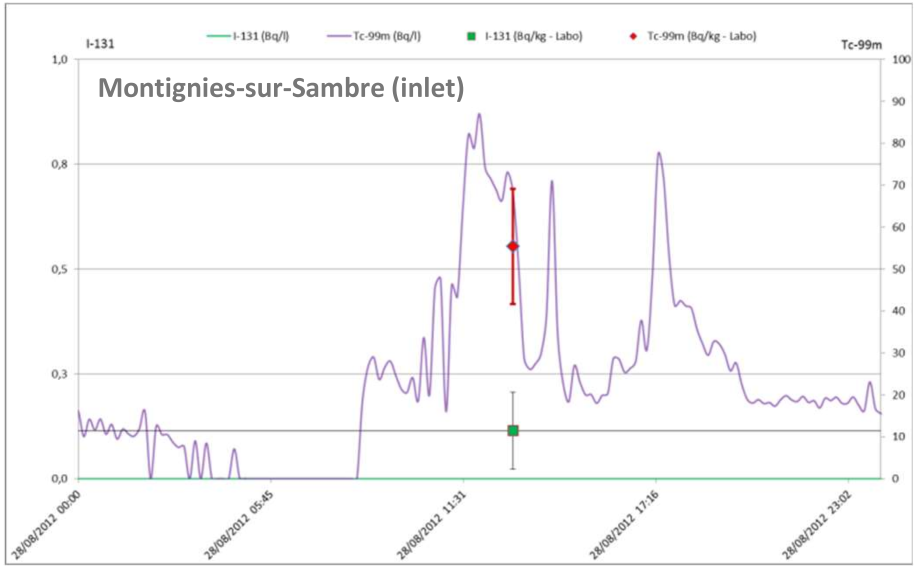

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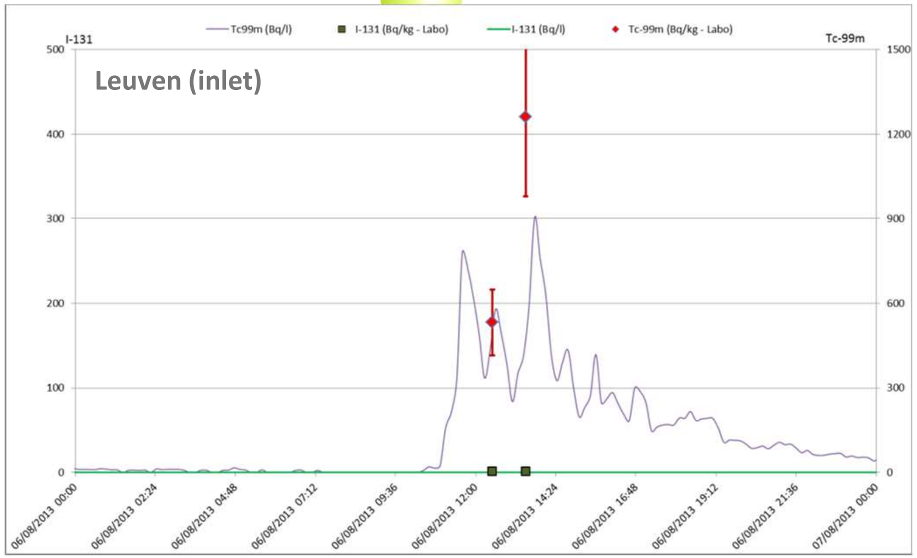

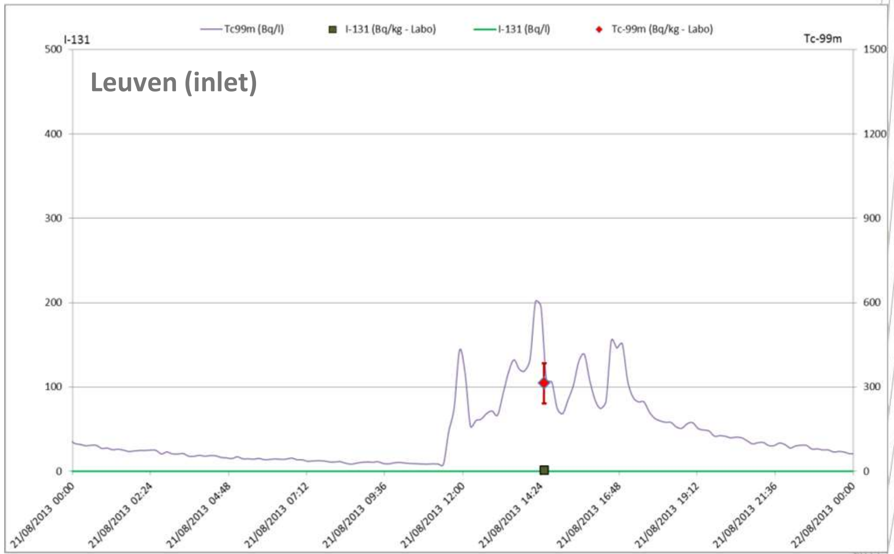

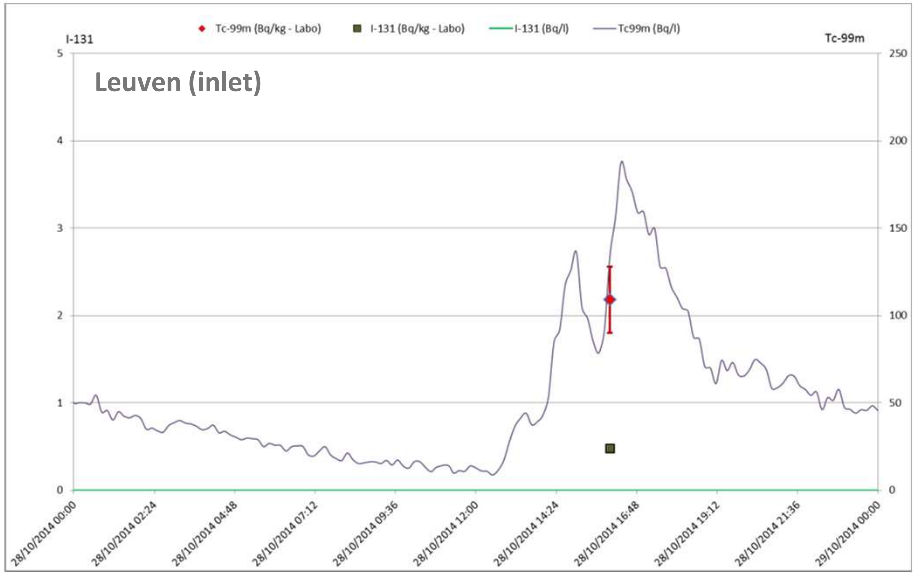

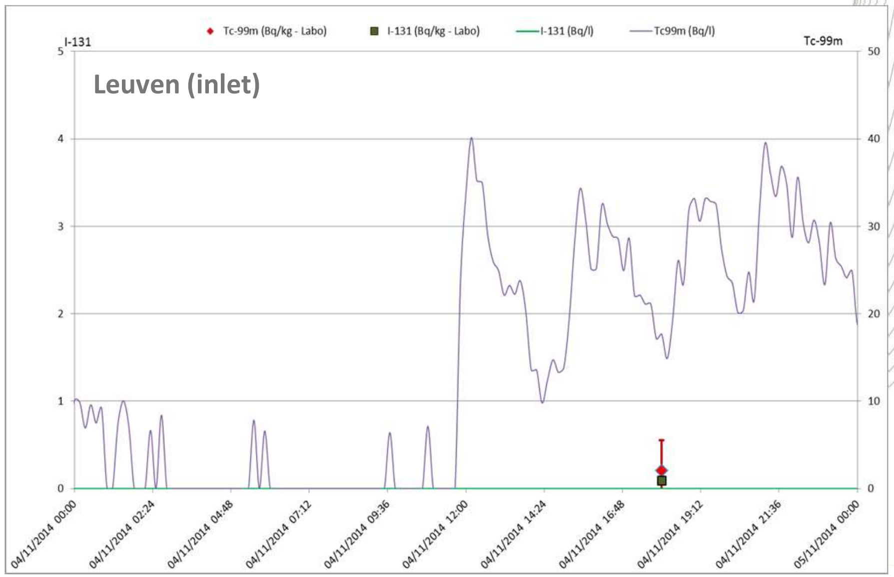

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Annex WTP: Ambient dose rate