Experience with different methods for on- and off-line detection of small releases of fission products from fuel elements at the HOR

T.V. Delorme, A.C. Groenewegen, A. van der Kooij, W.J.C. Okx

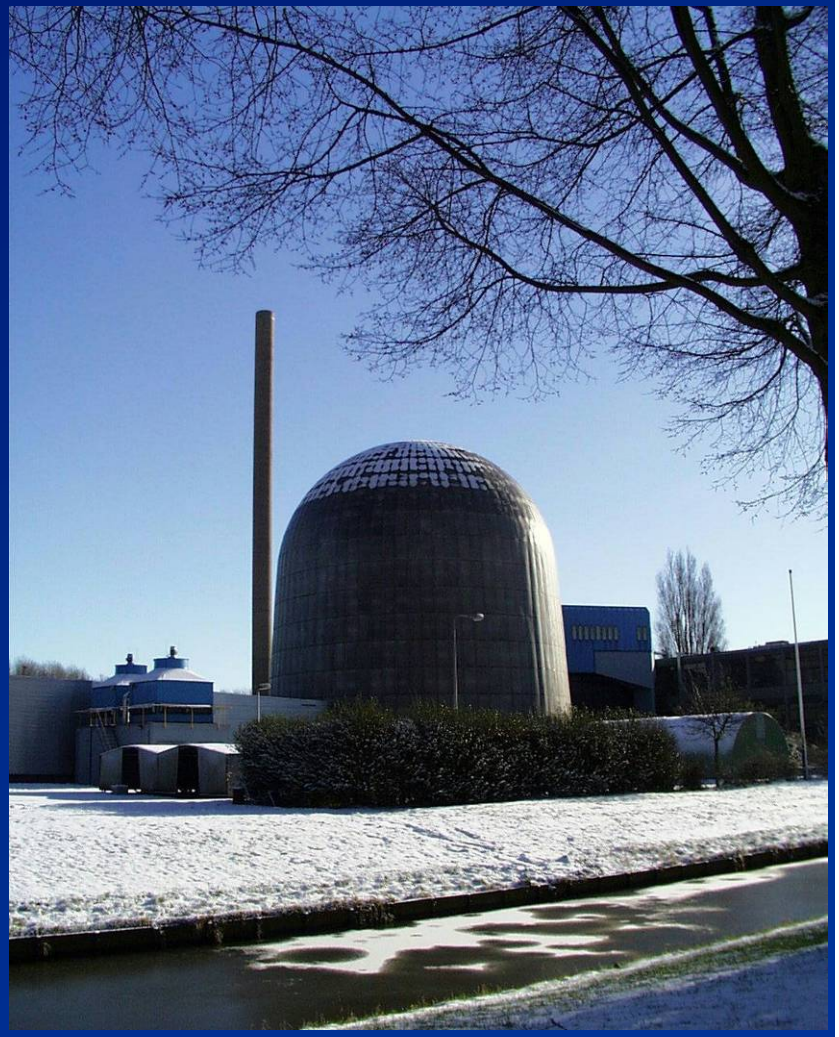
T.V.Delorme@tudelft.nl, HOR-Operation

Delft University of Technology, Reactor Institute Delft

Mekelweg 15, NL 2629 JB, Delft – The Netherlands

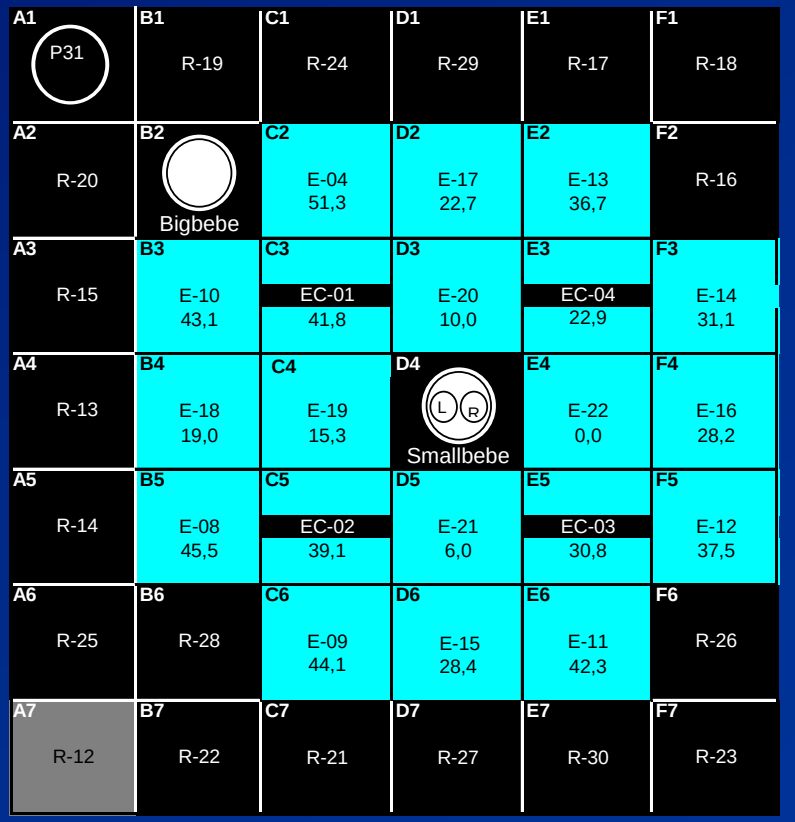
Presentation overview

- The Hoger Onderwijs Reactor
- Experience with detection of small releases of fission products
- New developed instruments
- Conclusions



HOR General Data

- Pool type research reactor
- Max. licensed power 3 MW
- Steady operating power 2 MW
- MTR fuel type, 19 fuel plates
- First criticality 1963



HOR Site View

Reactor Institute Delft – HOR
Faculty of Applied Sciences

TU Delft

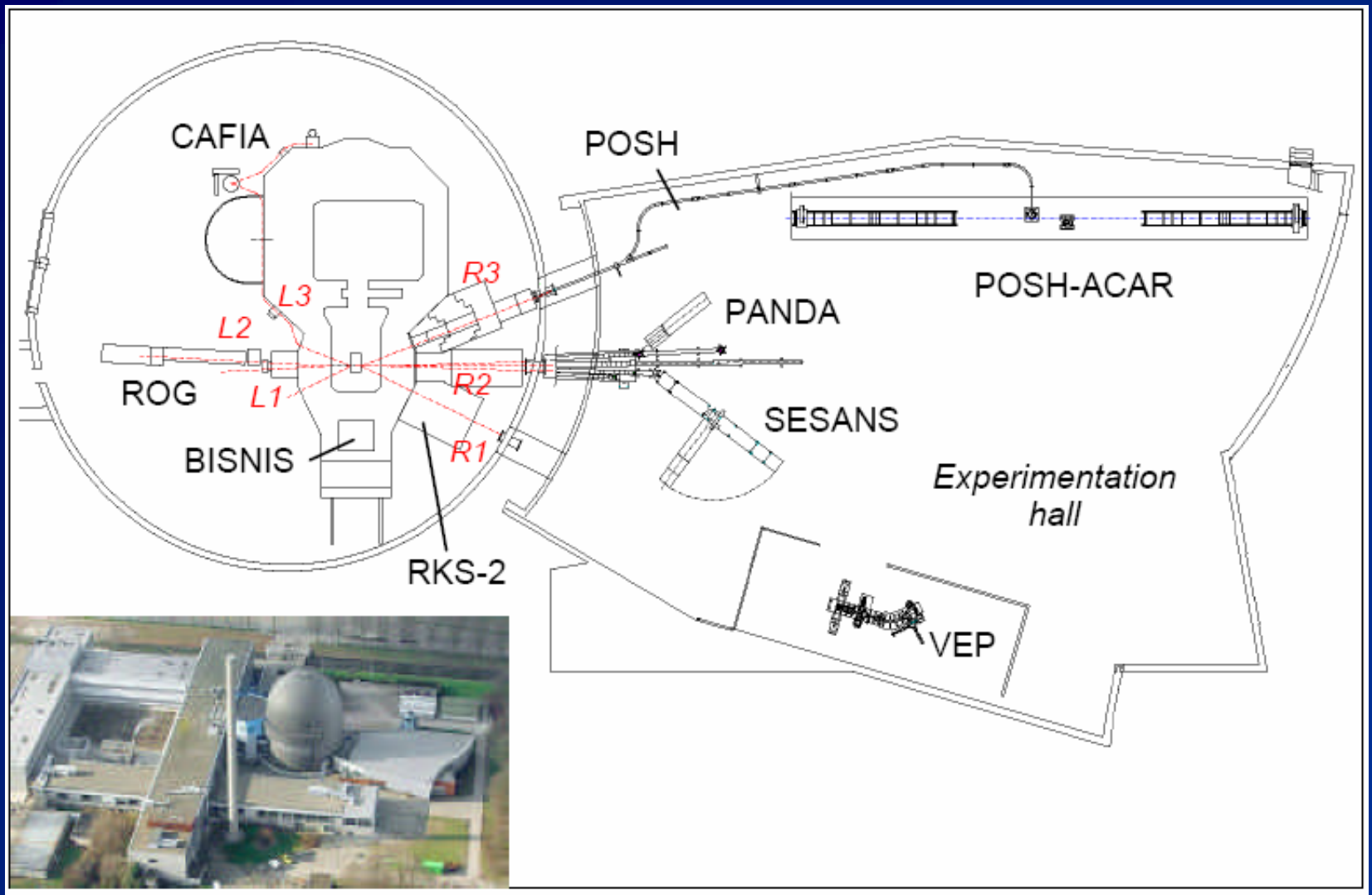


Figure 2: Aerial photo and schematic outline of the current reactor facility including experimentation hall, core grid and beam lines R1-3, L1-3.

Exp. detection small releases of fission products

- Experience gained mainly from 2001 until June 2005
- During HEU to LEU fuel conversion five cases in which fission product concentration in the pool increased significantly
- 1 HEU element and 4 LEU elements from the first batch

Exp. detection small releases of fission products

Already available instruments f.e.:

- Direct measurement of fission product activity in the pool true small ion exchanger system
- Measuring delayed neutron activity
- Direct measurement of air-borne activity above the pool
- Direct measurement of air-borne activity in the stack
- Et cetera ...

Examples already available instruments

Reactor Institute Delft – HOR
Faculty of Applied Sciences

TU Delft

Exp. detection small releases of fission products

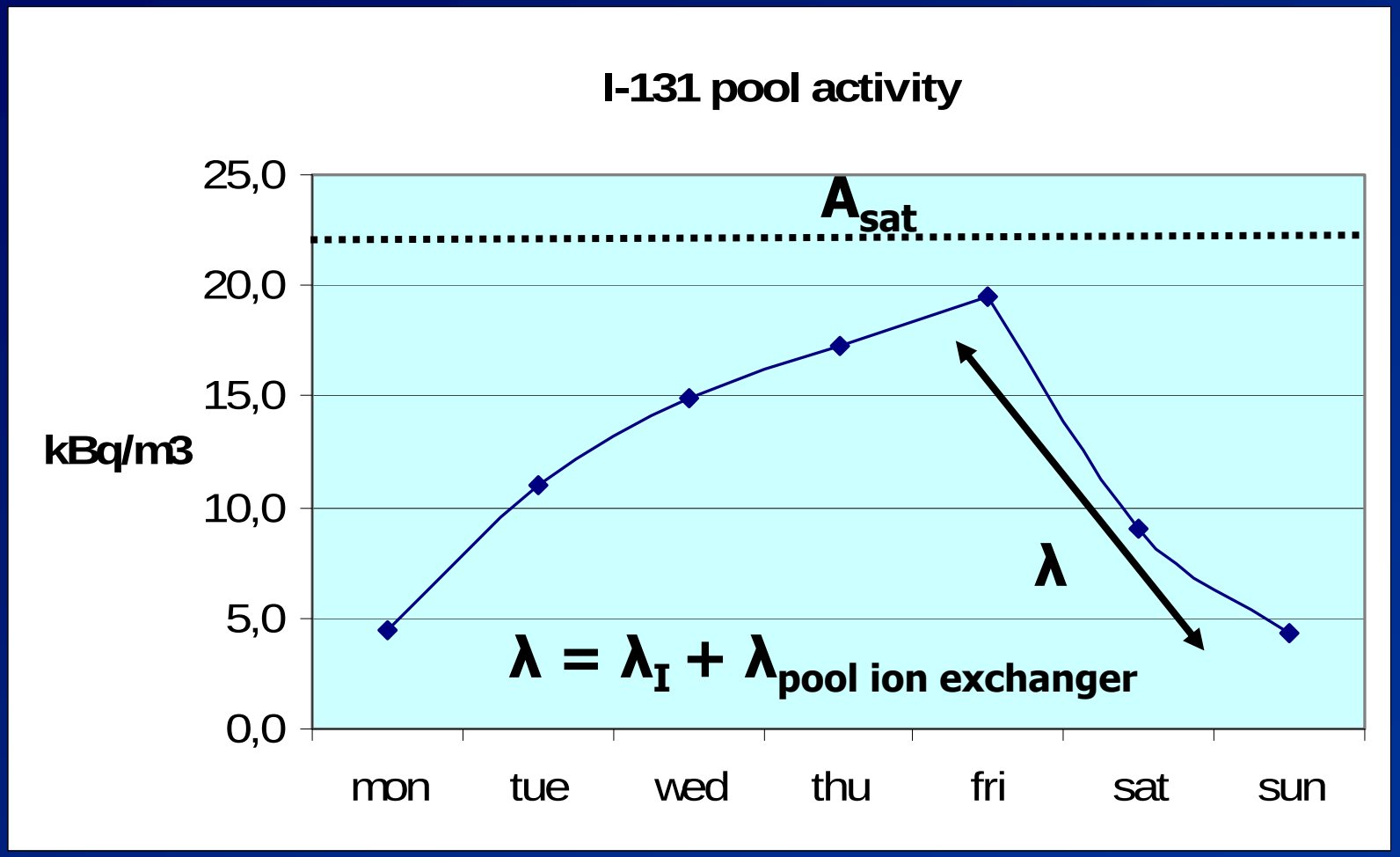
New developed instruments:

1. Model for core fission products release constant
2. Wet sipping device
3. RID-cascade

Reactor Institute Delft – HOR
Faculty of Applied Sciences

TU Delft

Core fission products release constant



Release constant = $\lambda / \lambda_I * A_{sat}$

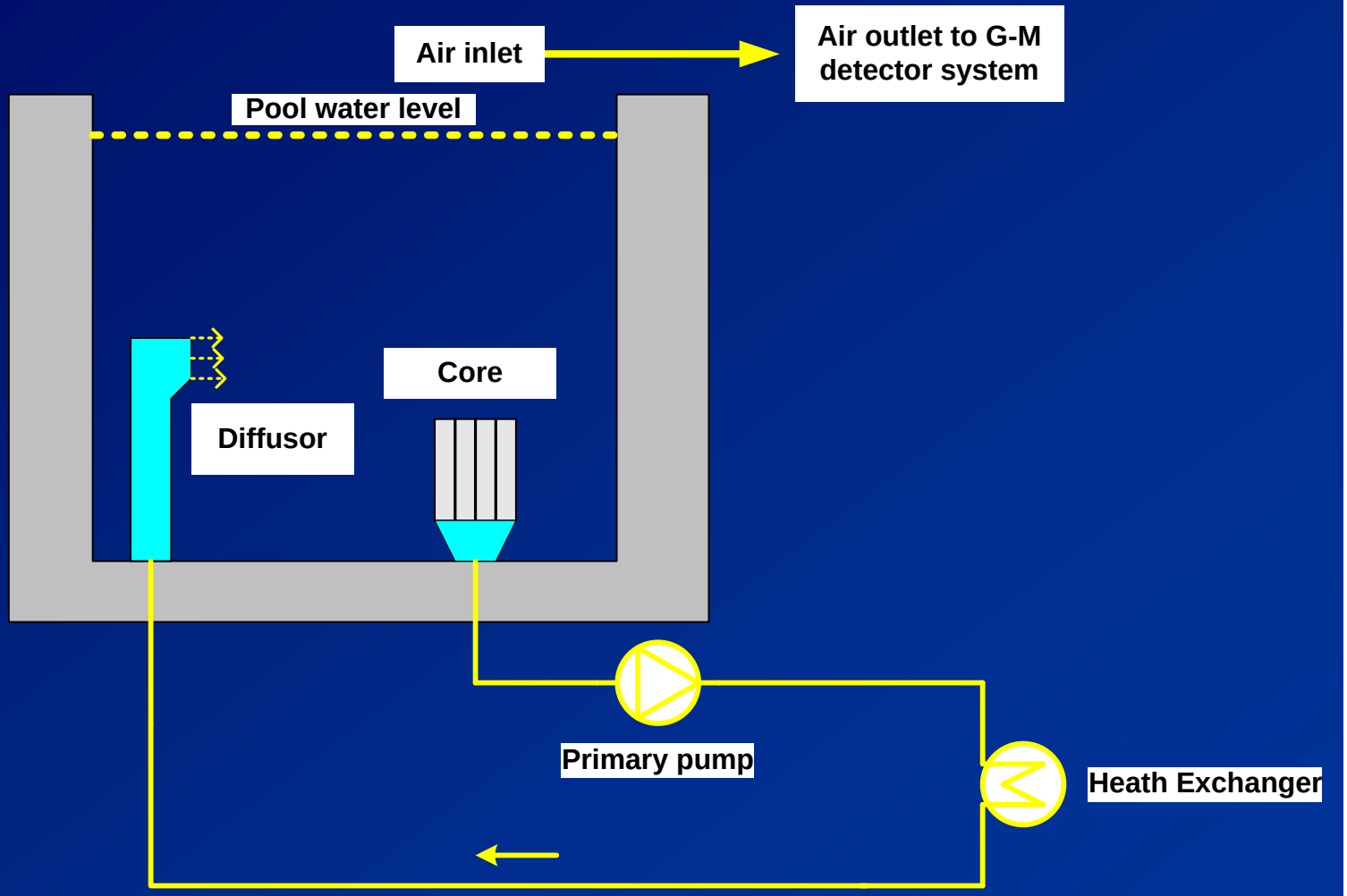
Reactor Institute Delft – HOR
Faculty of Applied Sciences

TU Delft

Air-born activity monitor & RID-cascade design

Overview

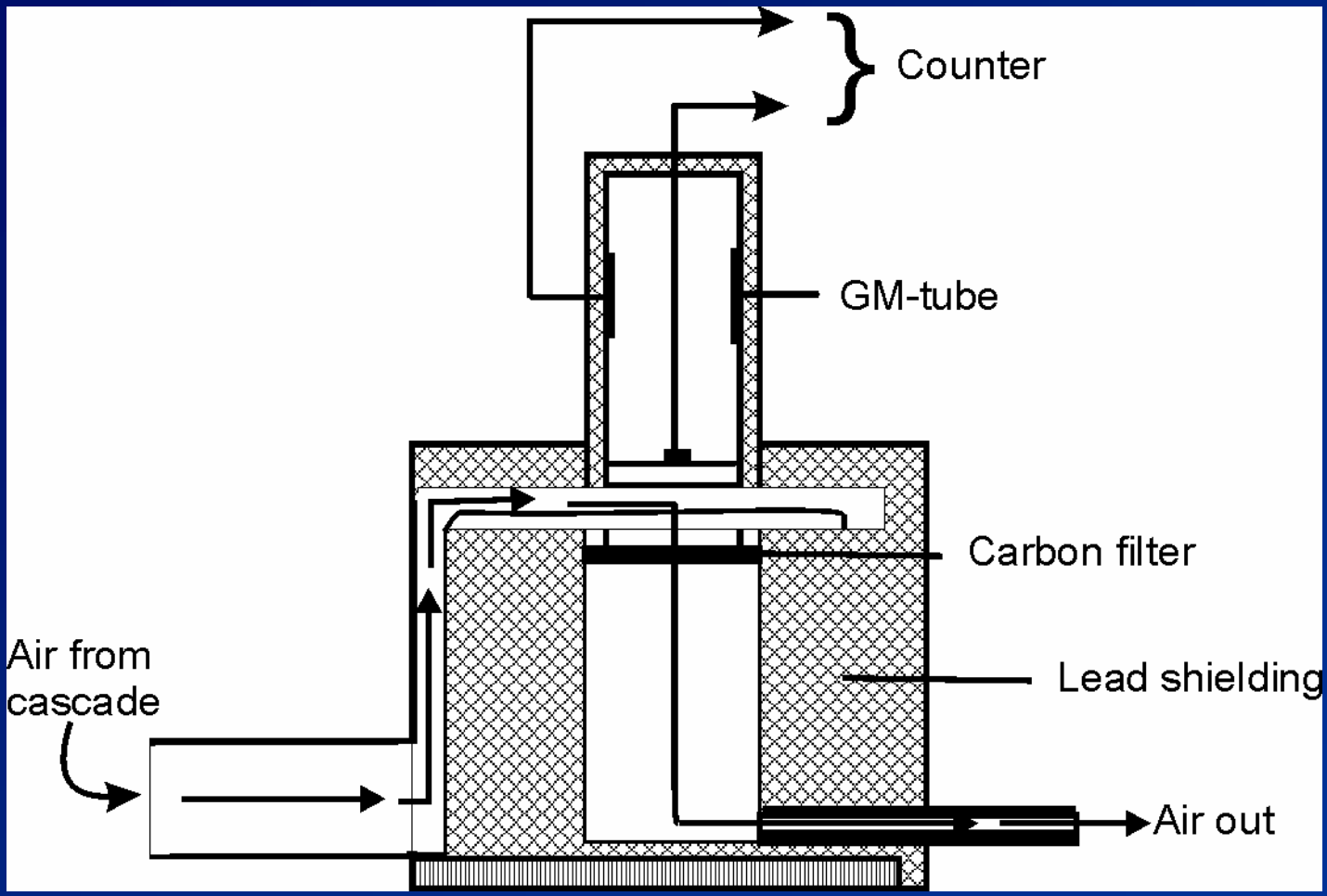
Air born activity monitor



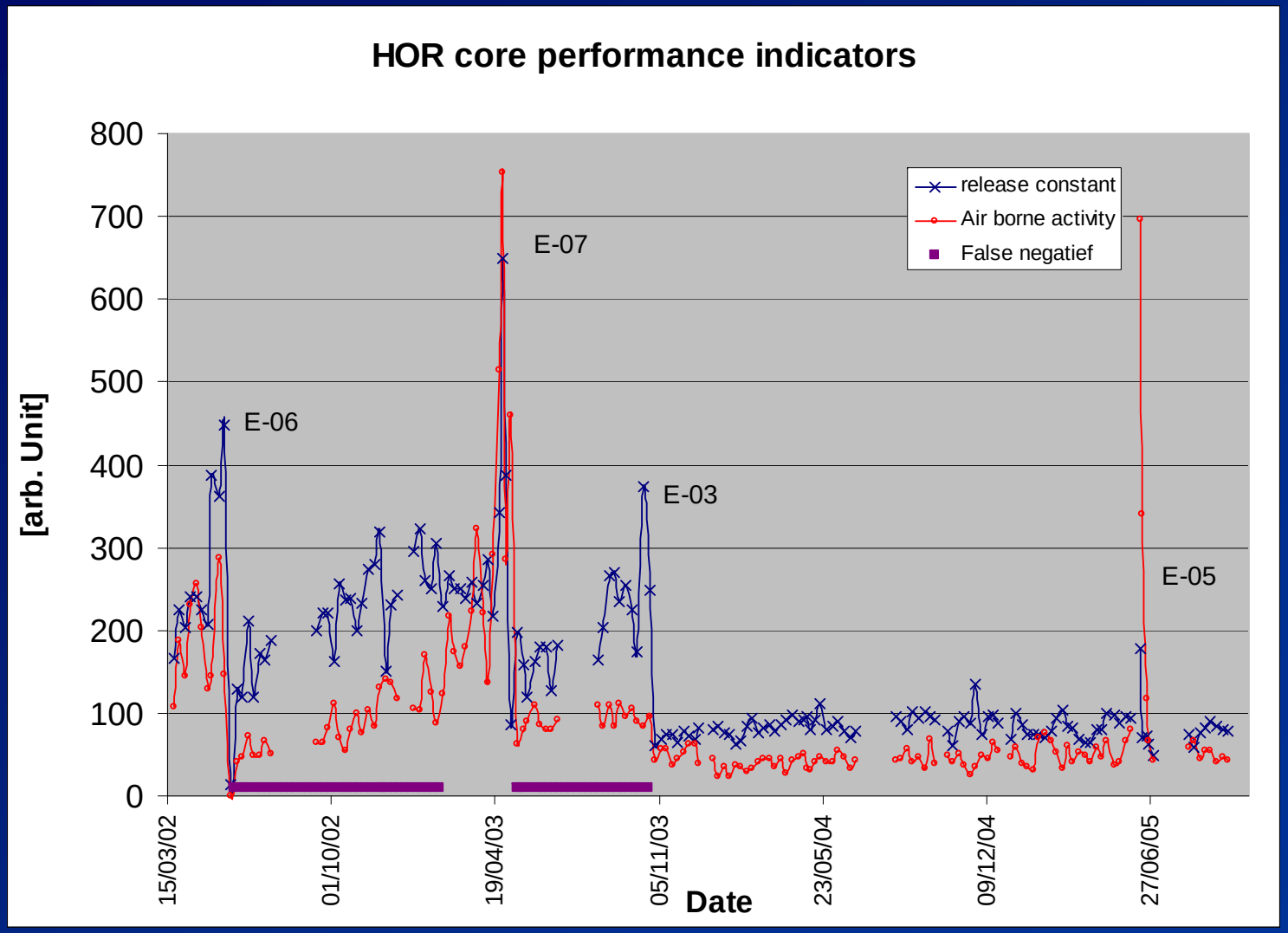
Reactor Institute Delft – HOR
Faculty of Applied Sciences

TU Delft

Air-borne activity monitor & RID-cascade design



Air-borne activity monitor & RID-cascade design



Reactor Institute Delft – HOR
Faculty of Applied Sciences

TU Delft

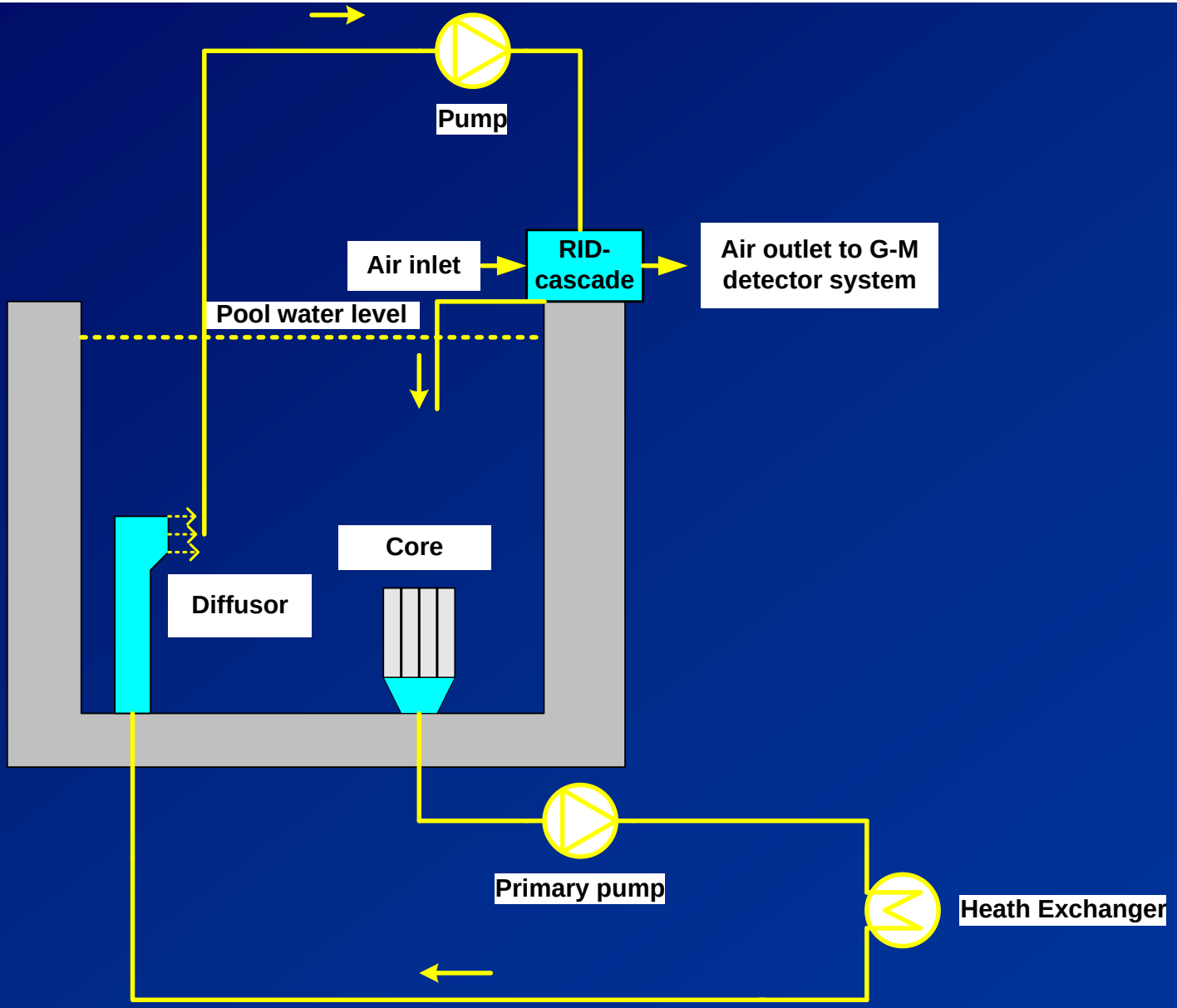
Air-borne activity monitor & RID-cascade design

Boundary conditions for improved air-born activity monitor:

1. Signal should not be influenced by natural ‘hot’ water layer
2. Sensitivity for small fuel defects as high as possible
3. Influence background activity as Na-24 as low as possible
4. Maintenance and calibration time should be as low as possible
5. Simple interpretation and analysis
6. Reliable over time

Schematic overview

improved air-born activity monitor



Reactor Institute Delft – HOR
Faculty of Applied Sciences

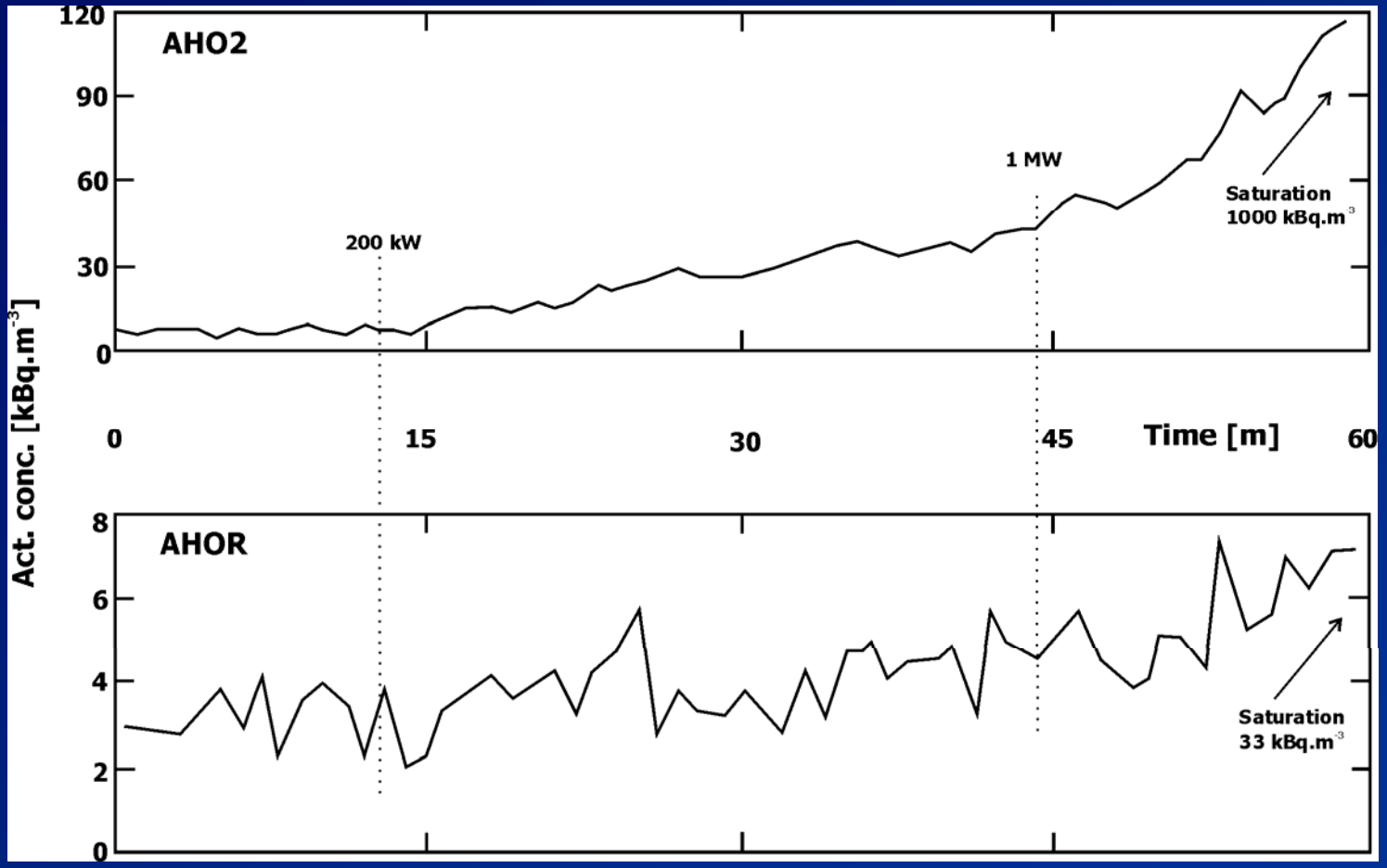
TU Delft

RID-cascade

Reactor Institute Delft – HOR
Faculty of Applied Sciences

TU Delft

First measurements with RID-cascade



Reactor Institute Delft – HOR
Faculty of Applied Sciences

TU Delft

Conclusions

- Experience gained during LEU fuel element defects let to 3 new instruments
- Release constant turned out to be sensitive and reliable performance indicator even at operation times of a few hours
- The RID-cascade gives a stable indication but it still must be tested with an element with a defect