A system for radwaste storage real-time monitoring: laboratory and real tests

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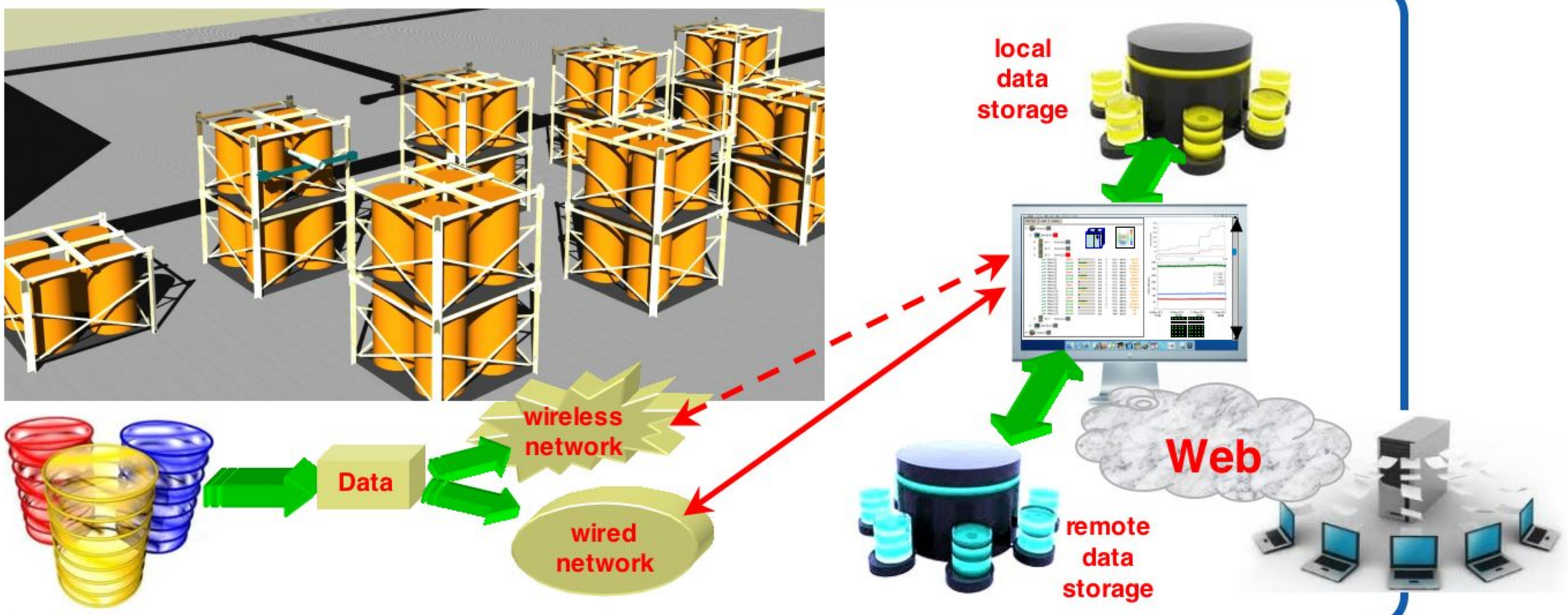


DMNR Detector Mesh for Nuclear Repositories

radioactive waste confined into long-lasting drums

DMNR project: topics

- On-line monitoring of short/medium term radioactive waste storage
- Application of non-conventional detectors for decommissioning

DMNR project: goals

- real-time monitoring: activity, mechanical stability, etc.
- real-time availability of data to control authorities, fire departments, local and national governments, etc.
- radwaste handling by means of advanced tools and procedures suitable for **reducing the risks** to the **local workers** and to the **population**

What we would never like to see...

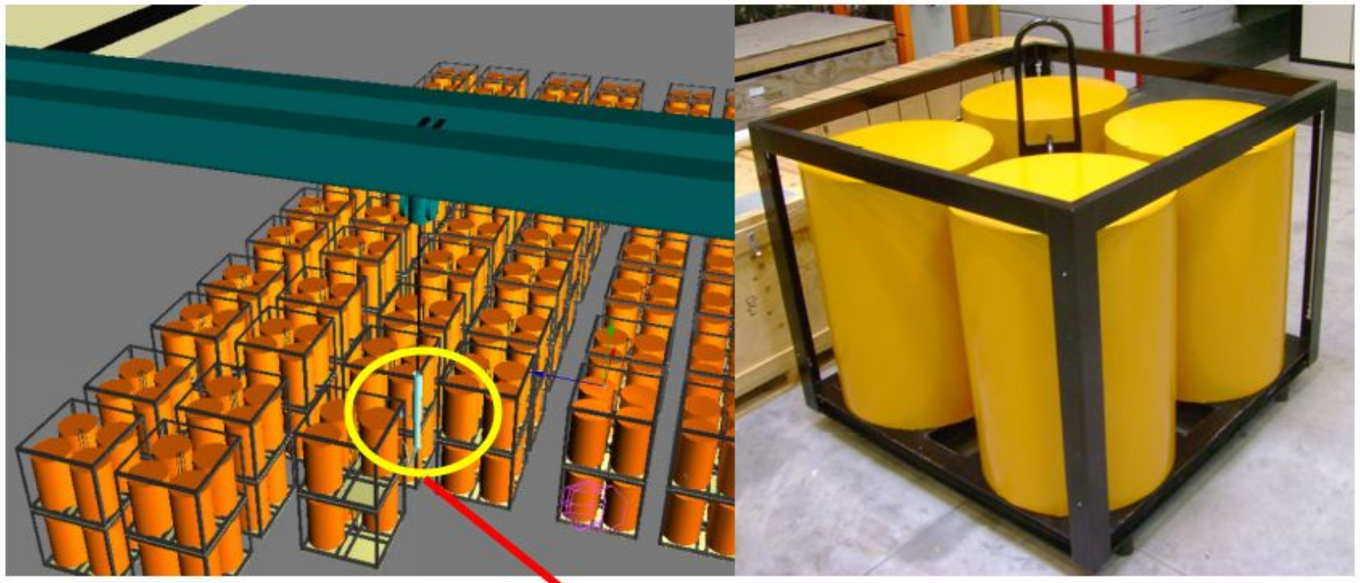
No repository with online monitoring
(to our knowledge)

On-line monitoring could minimize the need of human operators inside (ALARA)

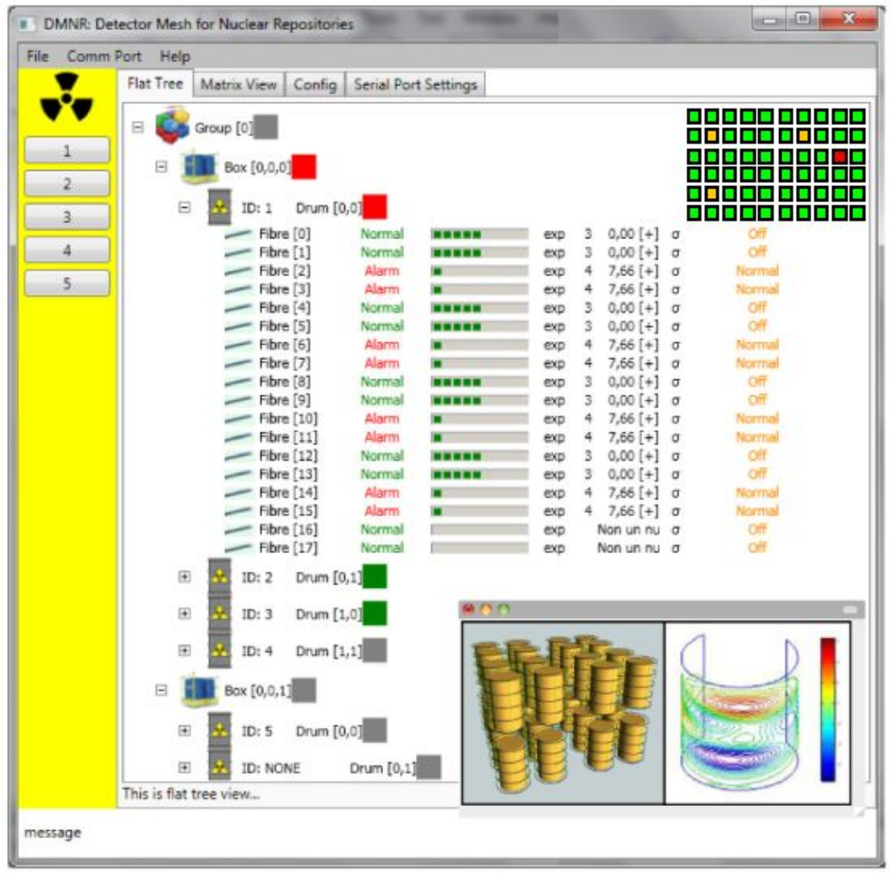
DMNR project: technical goals

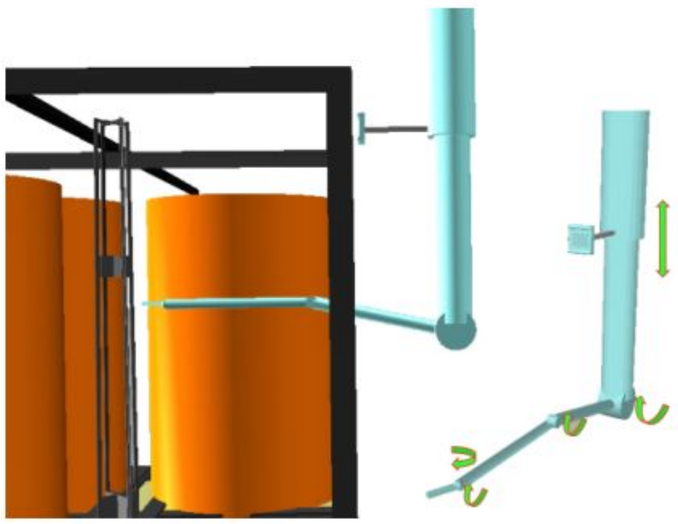
Full details about the single drum available in real time
Drum history and specifications available

- *On-line display and data check*
- *Counting rate channel by channel*
- *Programmable alarm levels*

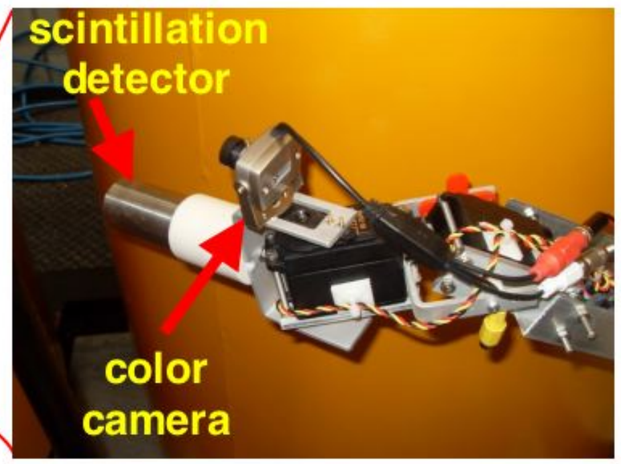


1:1 prototype platform





robotic arm for remote inspection



Why do we want to monitor?

We want to have a complete and detailed record of the history of each drum. So far there are drums around, whose content is unspecified and whose history is unclear.

Accidents may happen, most likely:

- ***drums might be damaged while being displaced (mainly for inspection!)***
- ***the concrete matrix containing the waste might crack (and leak out)***
- ***liquid waste?????***

What would be desirable?

individual and continuous online monitoring of drums, even during possible displacements
or better, never displace the drums, monitor them in place

How do we want to monitor?

Sensor requirements and goal:

radiation hardness ≈100-1000 years close to a drum with 10-100 mGy/h

robustness yes, plastic scintillators; SiPM not damaged by ambient light exposure

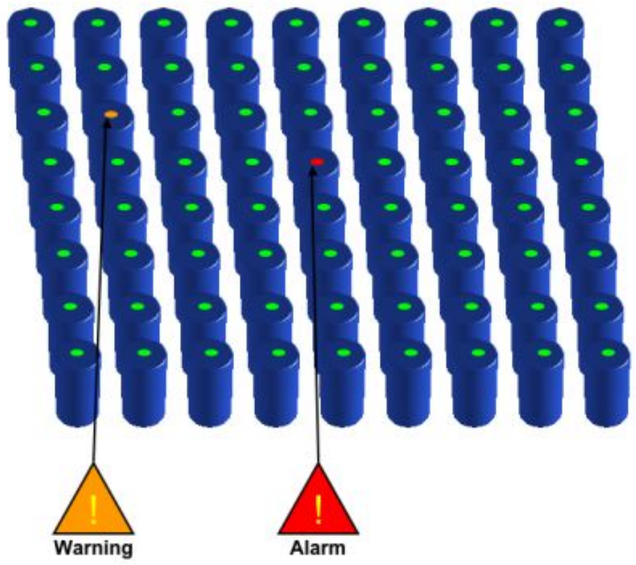
low efficiency, high sensitivity yes

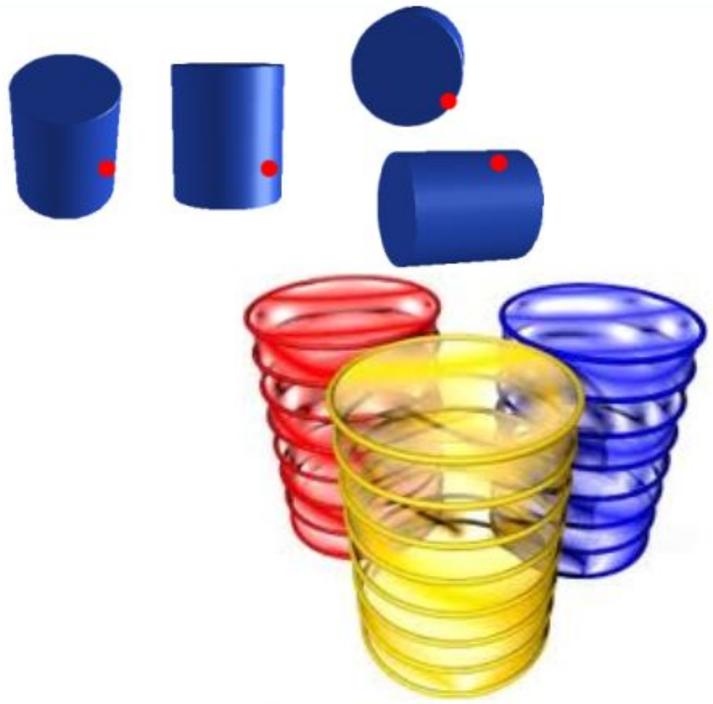
reliability yes

(possible position sensitivity) yes

ease of handling yes

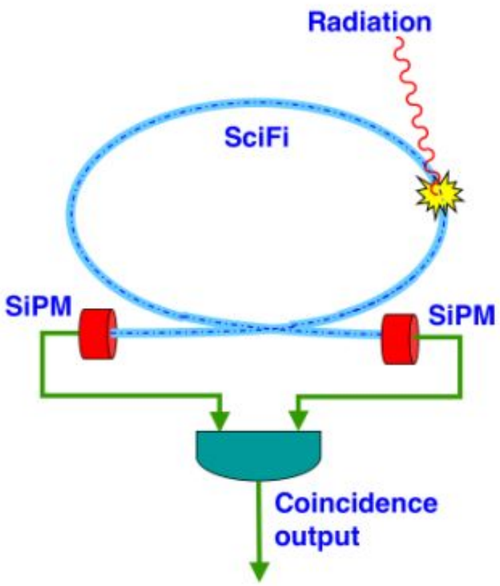
low cost yes





the solution we propose

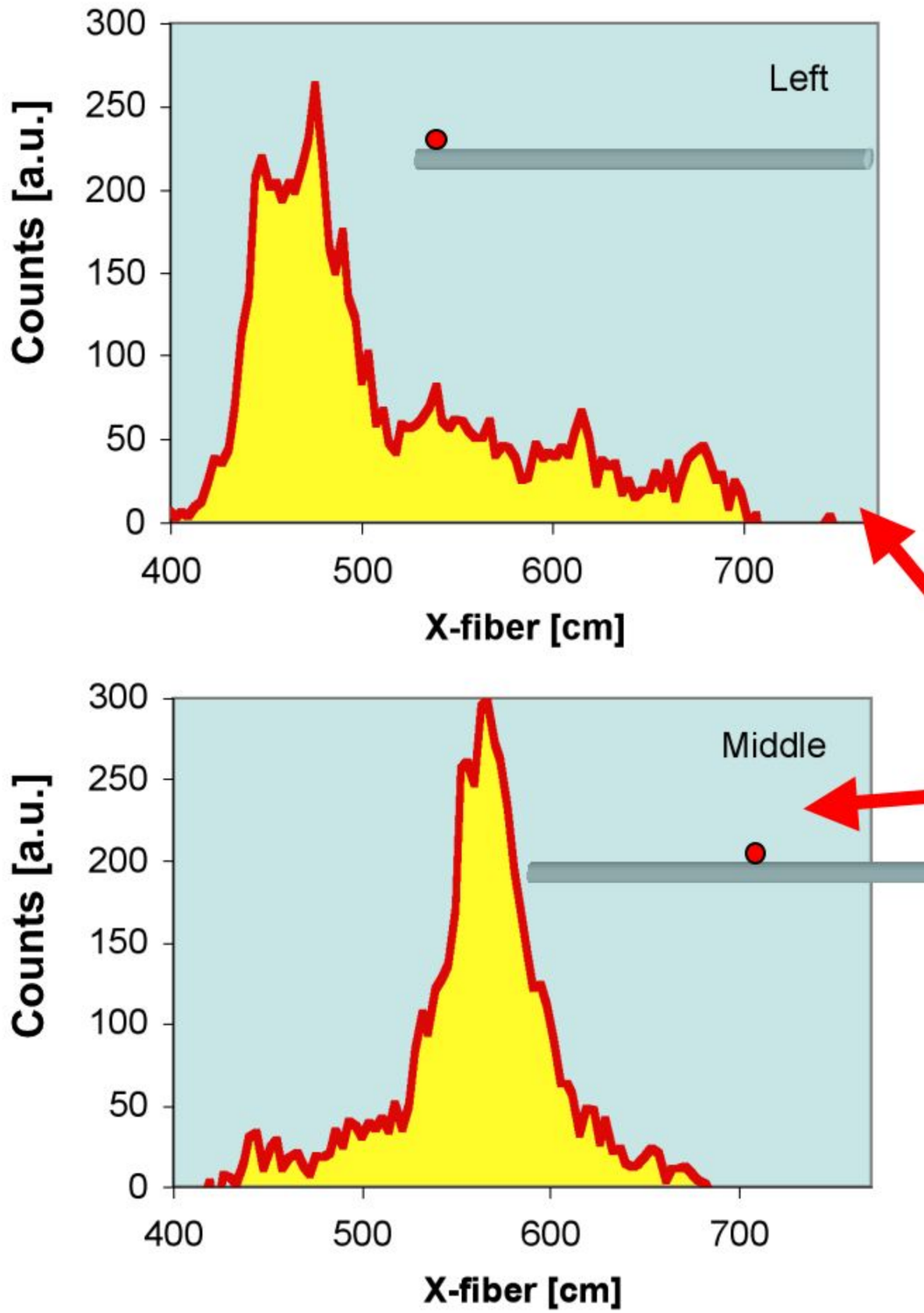
whenever radiation stimulates the fiber, a tiny light pulse is produced, and the SiPM is capable of detecting it

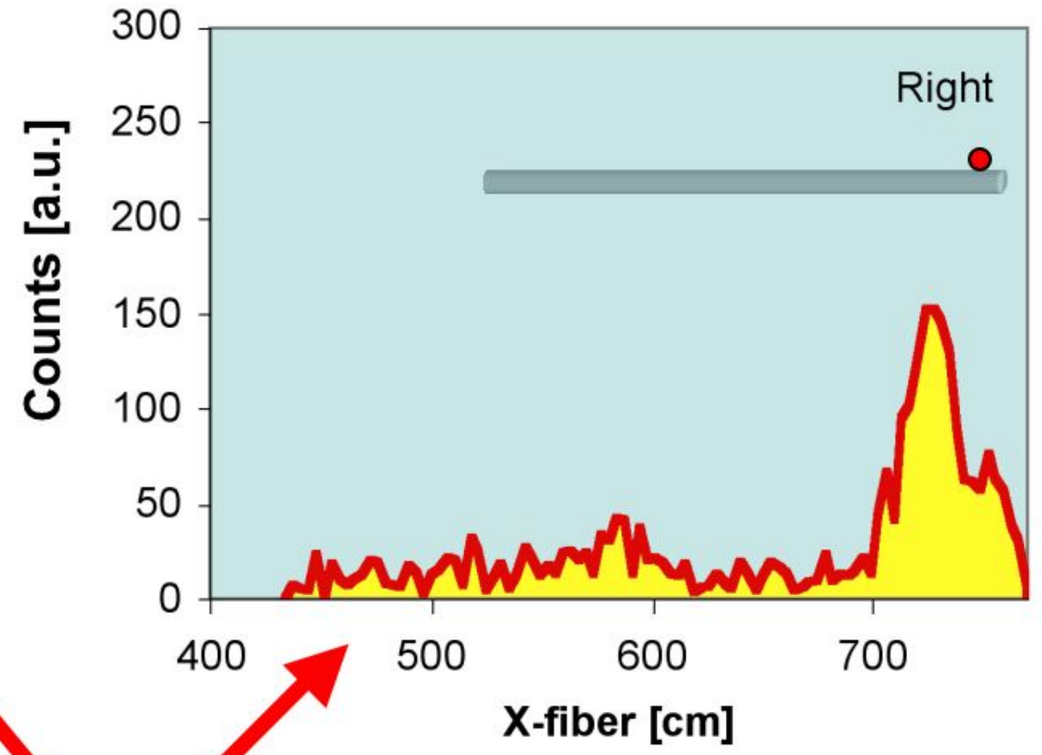


the coincidence suppresses spurious counts

A mesh of scintillating fibers readout at both ends by means of Silicon PhotoMultipliers (SiPM)

but... can we actually detect gamma rays?



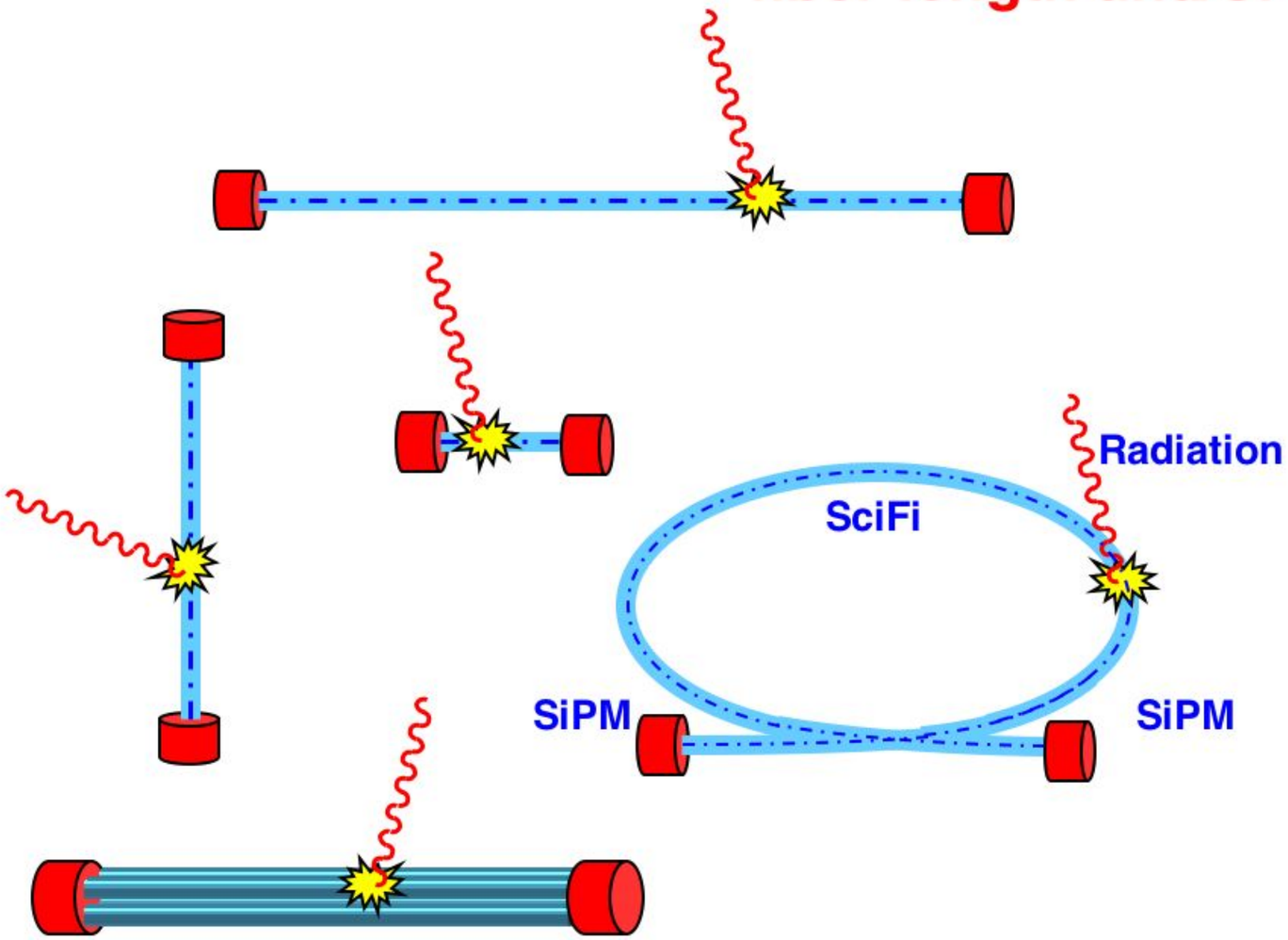


YES! Tests with ^{60}Co source in 3 positions along the fiber

the half-difference between the left and right arrival times provides the impact coordinate

$$x = v\frac{(t_{left} - t_{right})}{2}$$

geometrical efficiency: can be varied by changing fiber length and/or thickness



several fibers coupled to larger area SiPM's

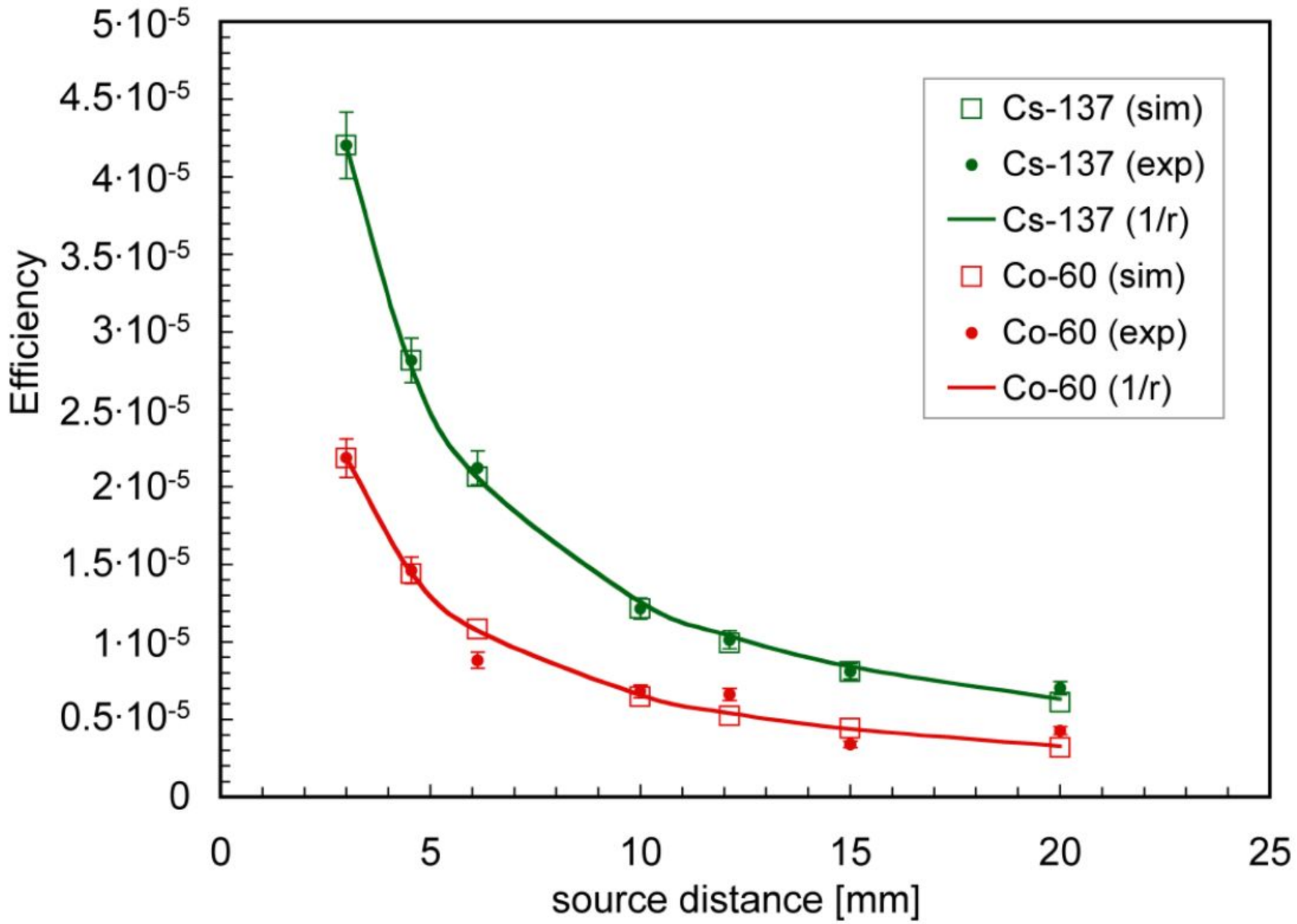
flexible sensors, both mechanically and conceptually

gamma detection efficiency (pointlike source)

calculated

simulated

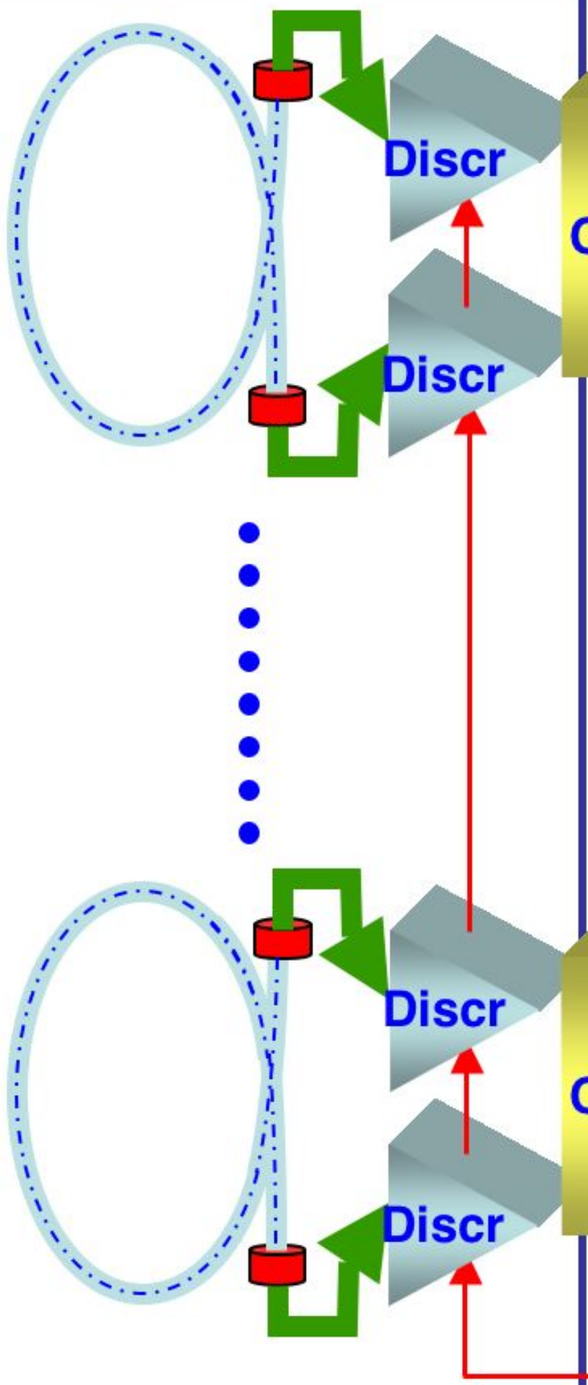
measured

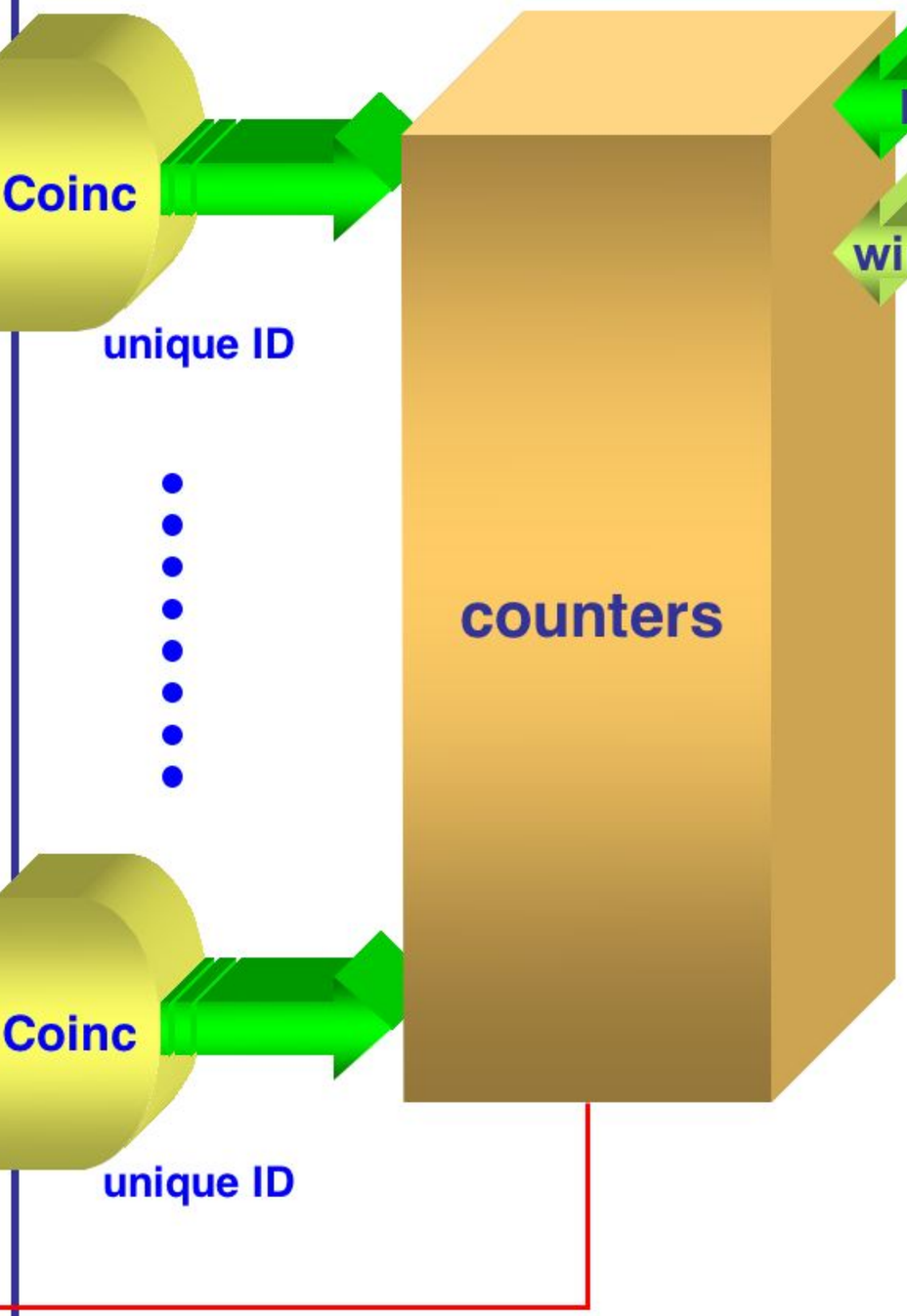


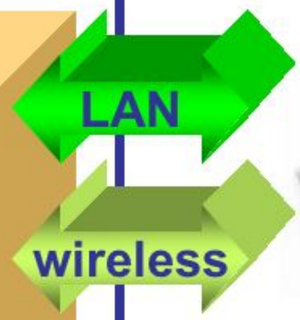
systematic normalization due to optical coupling and PDE

after normalization to the first point the data are self-consistent

Front-end and data acquisition scheme







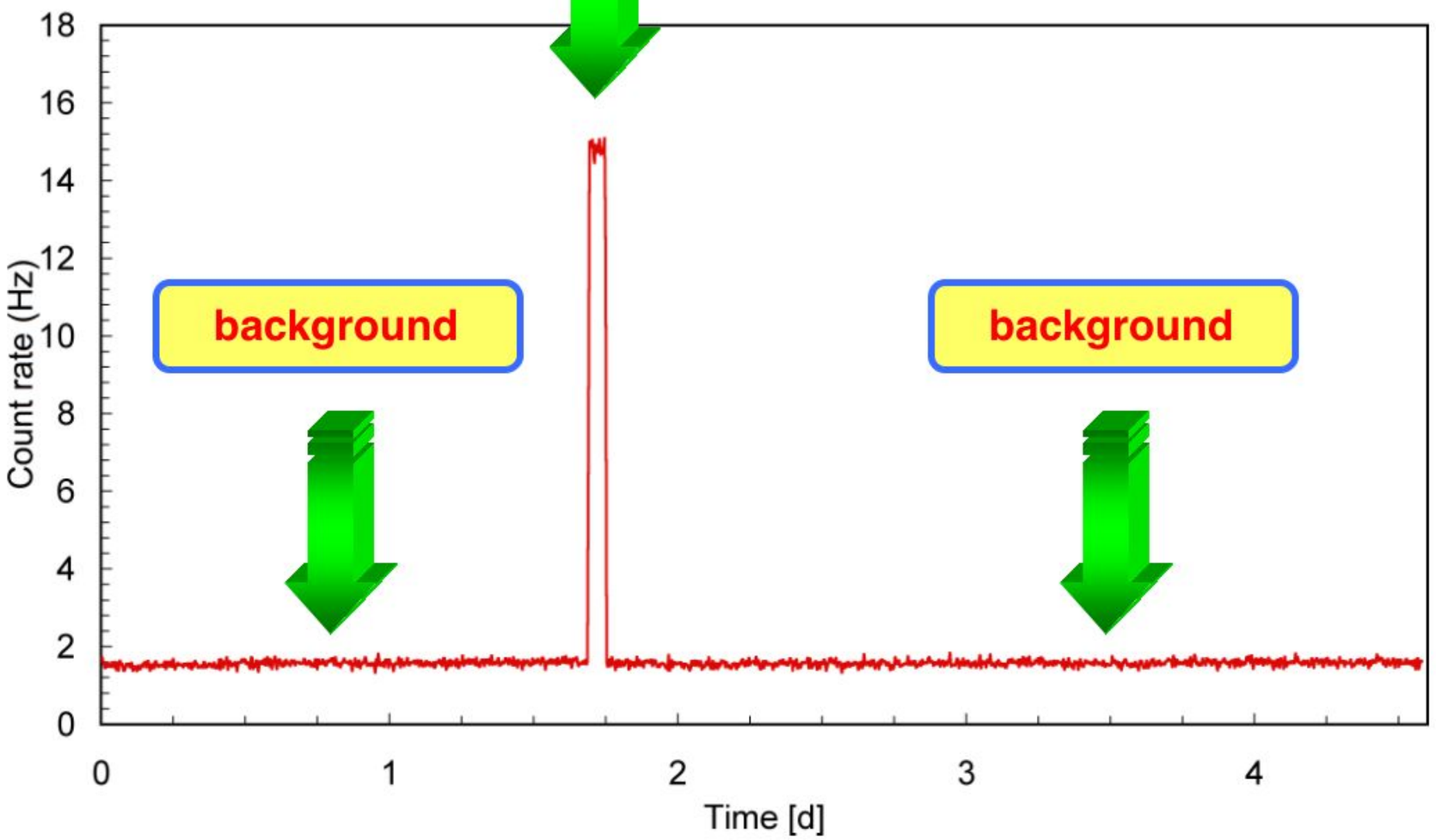
waste drum units

FPGA data acquisition and control

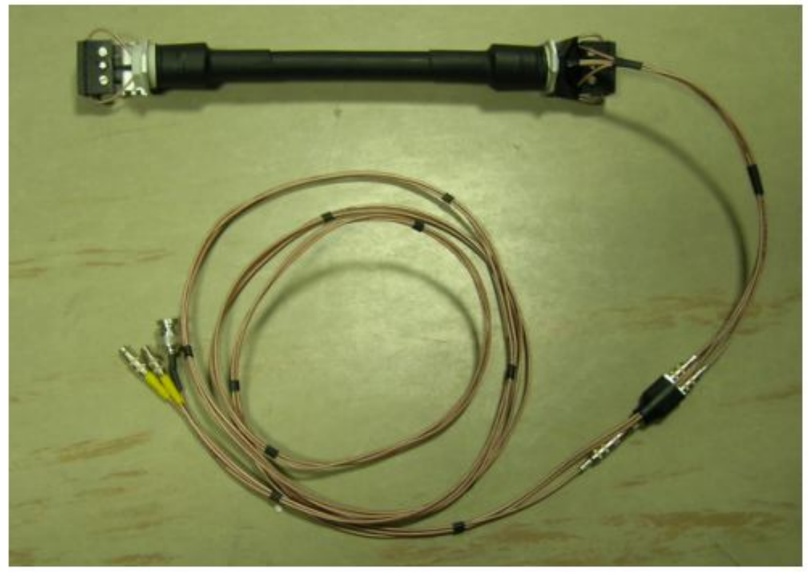
- local wireless and LAN
- global WAN

PROTOTYPE LAB TESTS

2.7MBq source at 10cm

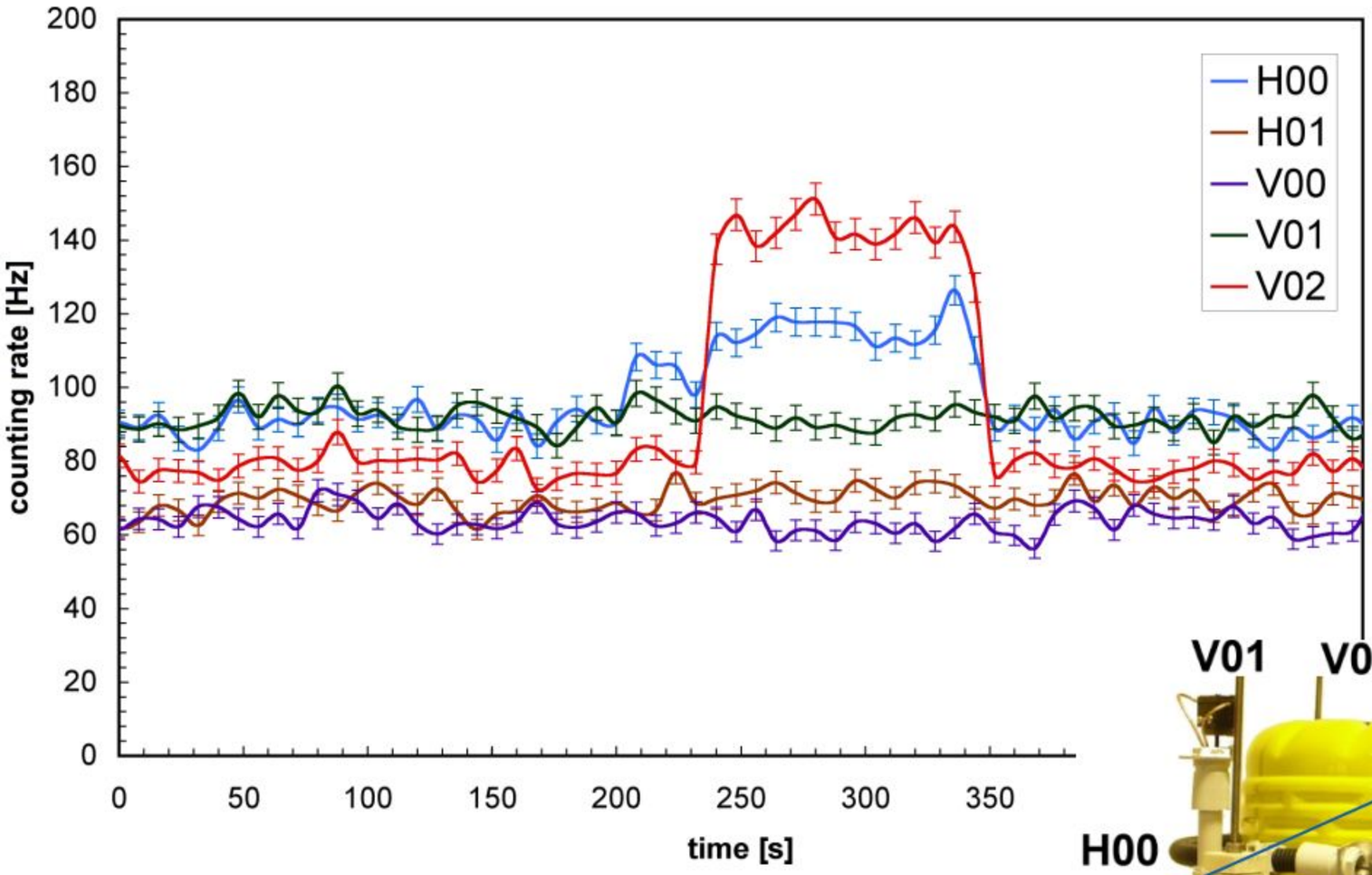


4.5 days test



the instant S/B ratio was ≈9

PROTOTYPE LAB TESTS

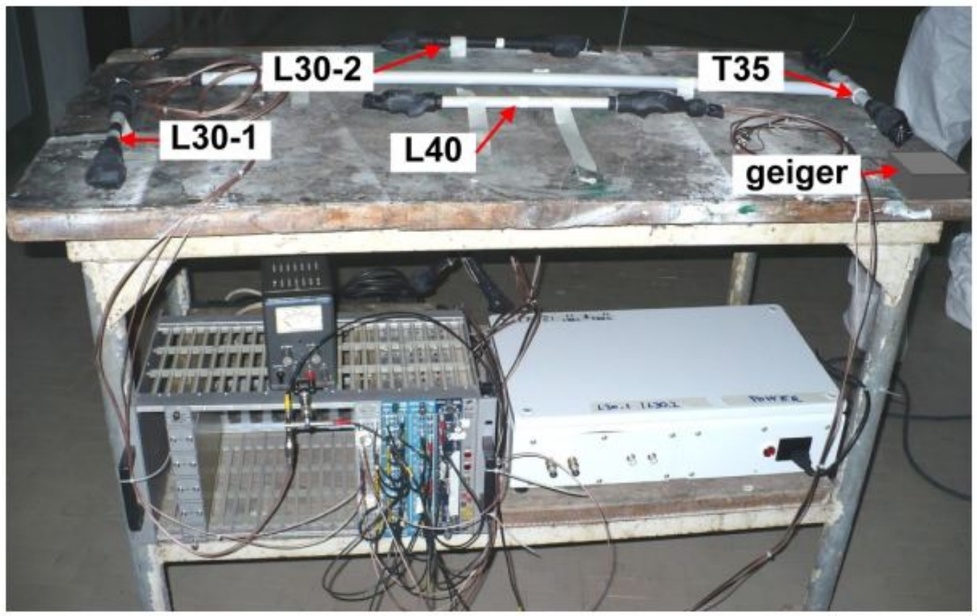


3D reconstruction by crossing fibers

test with minidrum: 5 fibers and mixed gamma sources, total 2.7MBq

test with real radwaste drums

preliminary test with real radwaste drums in a storage site inside the former nuclear power plant of Garigliano (SOGIN S.p.a.)



- 4 detectors (+geiger) on a pushcart moved at 7 positions (P0-P6) with increasing dose rates
- left in position P6 overnight
- then quickly removed

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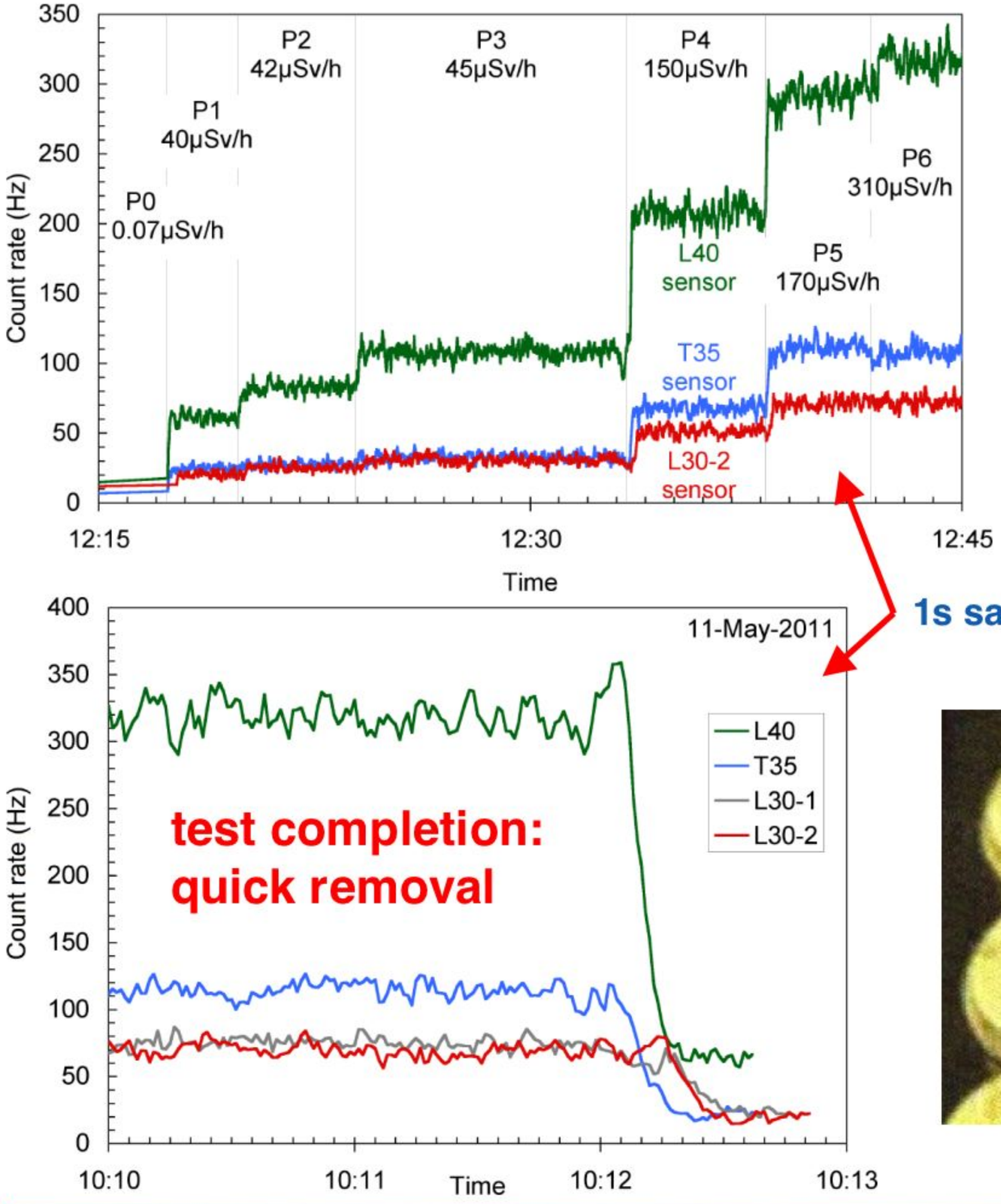
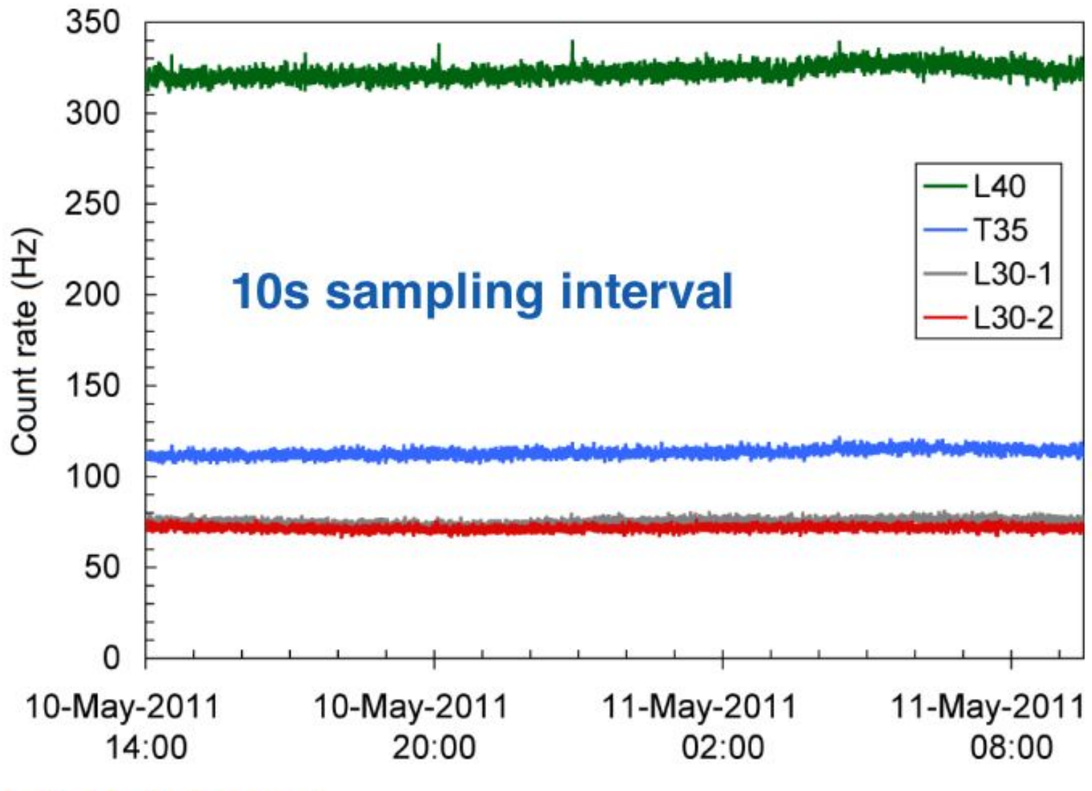
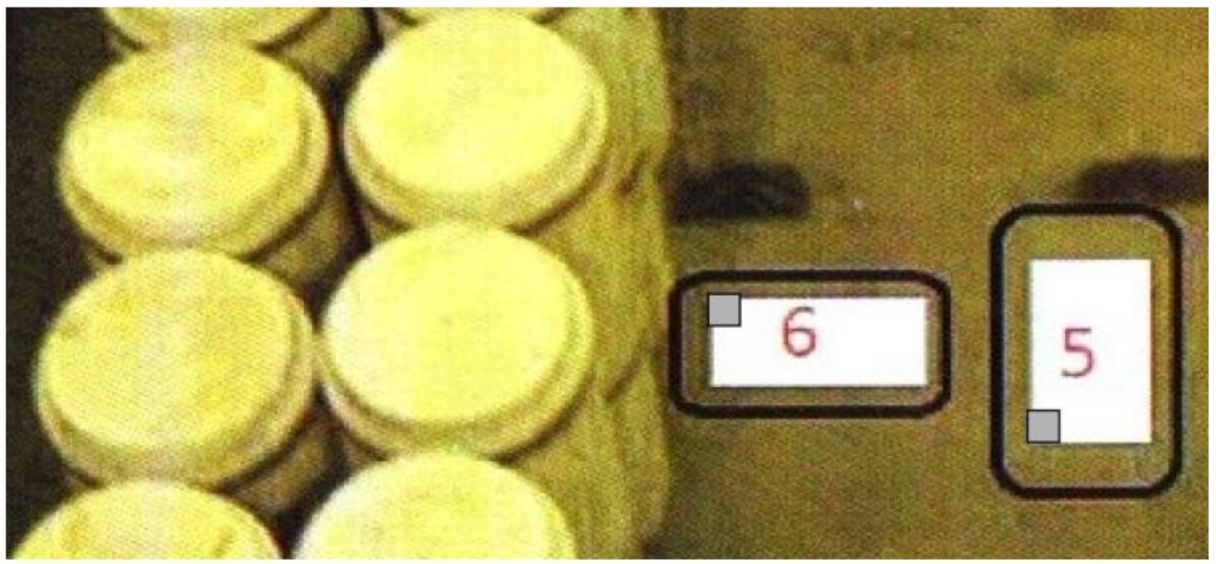
test start: P0 - P6 positions



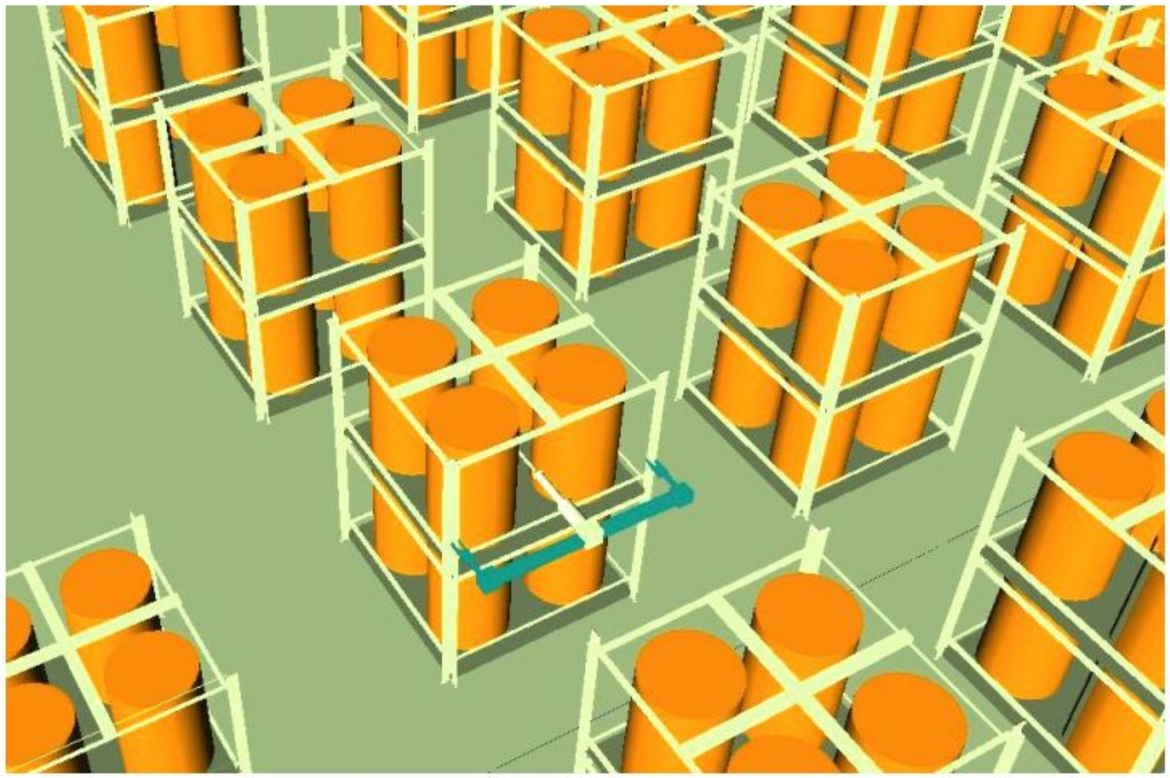
overnight



1s sampling interval



Conclusion



If we want to fully pursue the nuclear power, we must convince people (and ourselves) that we are able to handle the problem of waste repositories, in the short, medium, and long term.

to know or
not to know?

What I showed here represents, I hope, a step in the direction of making people aware of danger and advantages