# Evaluation of measurement devices for radioactive and nuclear material

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# Introduction

- Fraunhofer INT has **long lasting experience** in the assessment of devices
- **Several devices of different device classes available on the market**
  - PRD: Personal Radiation Detector (also spectroscopic SPRD)
  - RIID: Radiation Isotope Identifiers Device
  - RPM: Radiation Portal Monitor (also spectroscopic SRPM)
- **Evaluation of measurement devices**
  - comparability is difficult
  - no well established standard or quality label
  - test environments for qualification measurements are necessary
- Development of **INT testing facility** to verify instrument's compliance regarding test methods / standards

# Experience

Conference paper INMM annual meeting

- 2006: Detection and Identification of Radioactive Sources Covert Under Water
- 2007: Identification of Nuclear Material with Different Gamma Spectroscopic Devices
- 2009: Searching and identifying radioactive material with hand-held high-resolution Gamma detectors
- 2010: Identification of nuclear material with hand-held and portable gamma and neutron measuring devices
- 2012: Identification Measurements of nuclear material – Detective EX versus Falcon 500
- 2013: The influence of shielding - measurements of nuclear material







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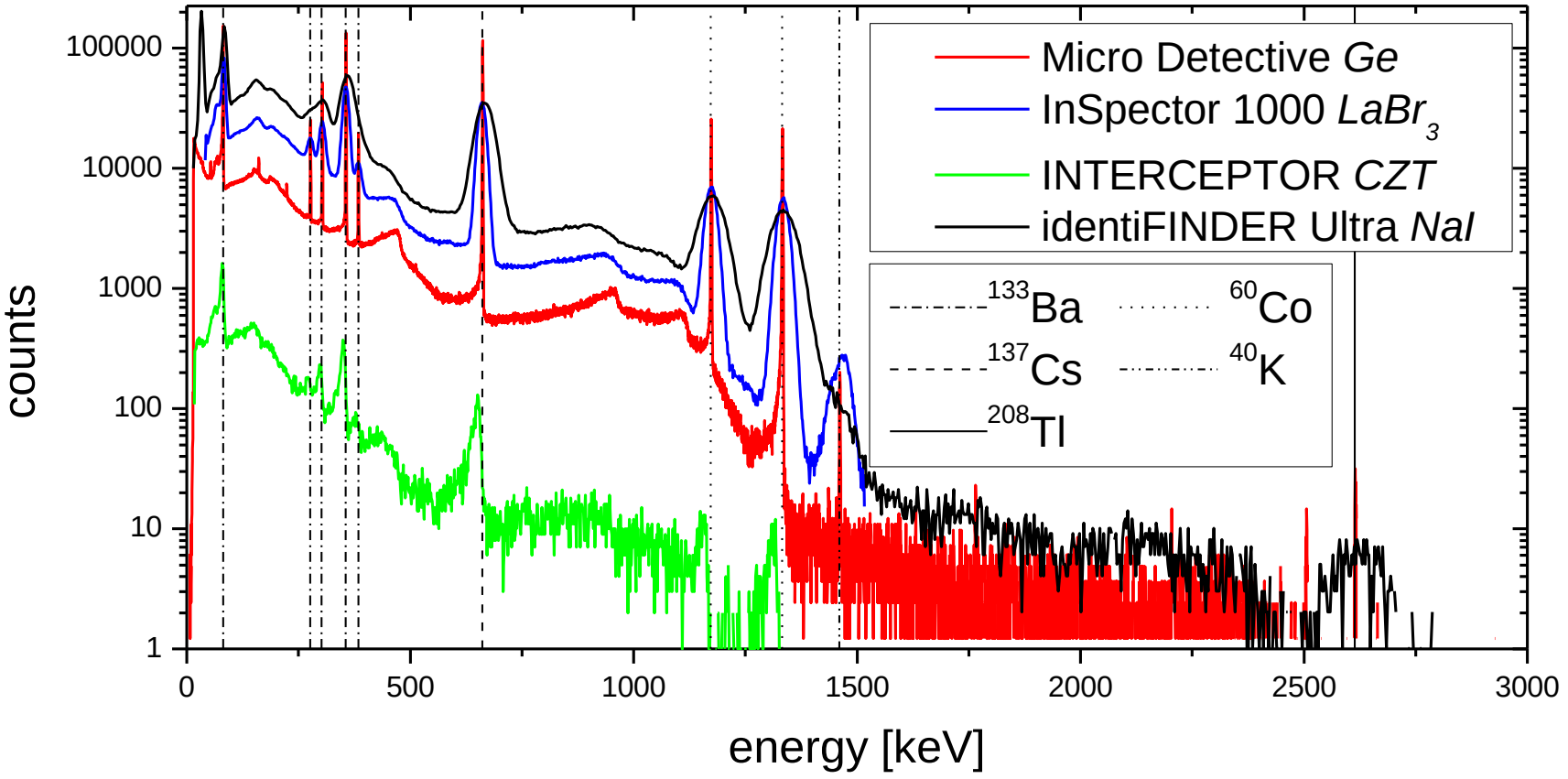
# Identification of nuclear material with hand-held and portable gamma and neutron measuring devices

- measurements at the European joint research centre JRC in ISPRA
- gamma and neutron measurements
- 5 detectors with different detector materials
- nuclear material:
  9 uranium and plutonium sources
- automatic identification
- handling of the detection systems

# Gamma detection systems

| | Micro Detective ORTEC  | Inspector 1000 Canberra  | INTERCEPTOR Thermo  | IdentiFINDER Ultra  |
|---|---|---|---|---|
| crystal material | HPGe | $LaBr_3$ | CZT | NaI(Tl) |
| crystal size [cm] | length 3<br>ø 5 | length 3.8<br>ø 3.8 | 0.7 x 0.7 x 0.35 | length 5.1<br>ø 3.6 |
| weight [kg] | 6.9 | 2.4 (complete) | 0.27 | 1.25 |
| size of device [cm] | 37.4 x 14.6 x 27.9 | 19 x 16.5 x 6.4 (body) | 11.2 x 6.1 x 2.5 | 24.8 x 9.4 x 7.6 |
| battery life [h] | >3 | 9 | 10 | 8 |
| energy resolution [keV] at 662 keV | 1.5 | 23.2 | 19 | 45 |
| relative efficiency | 10.7 % | 12.6 % | 0.02 % | 8.0 % |

# Gamma Energy Spectra – $^{133}$Ba, $^{137}$Cs and $^{60}$Co sources





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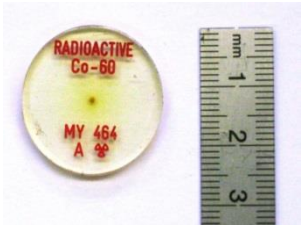
# Results

- Uranium:
  - identified by all gamma measurement devices with good quality
  - but partly additional isotopes are identified
    ➡ altogether 7 of 19 measurements ✓
- Plutonium:
  - identification is more difficult
  - one device could not identify plutonium at all
    ➡ altogether 7 of 20 measurements ✓
- Different manufactures use different display depiction of the results
- Some manufacturers use unusual definitions for high enriched uranium
- Other measurements: one device always identified Plutonium without presence

➡ necessary to familiarize oneself with the device being used, experience for assessment of the result needed

# Searching and Identifying radioactive material with hand-held gamma detectors


- 6 investigated detection systems
- Search parcours for performance testing in a lab
- $^{60}$Co source was hidden
  - 4 different heights
  - 7 persons searching, partly not knowing the devices in advance
  - 24 runs for each person
- Search strategy chosen by the seeker
- Time until finding measured





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# Results of all Measurements

- The “best device” does not exist
- Assessment of the devices are often  a matter of taste and the experience of the user, e.g. acoustic signals
- Localization: 3 Detectors have shown to be significantly superior to the others
  (µ-Detective, IdentiFinder, InSpector 1000),
  mean search times about half  or less than the others’
- Resulting strategy for tasks without preliminary knowledge of suspicious area:

  1. first: medium-weight detector with reliable identification mode
  2. second: depending on information needed, high resolution detector

# Experts in the ITRAP+10 Program

ITRAP: Illicit Trafficking Radiation Assessment Program

- **Aim**: Evaluation and comparison of the performance of available radiation detection equipment relevant to nuclear security.
- JRC **developed** in cooperation with IAEA and DNDO **test procedures** for testing of Border Monitoring Equipment.
- Working group Researcher participated as **European nuclear security experts.**
- **Task** of the expert: **validation of the test methods** which are based on the ANSI and / or IEC standards.
- Test methods exist for different device classes.
- **Phase II (work package 2) of the ITRAP + 10 Program:** laboratories in Europe are enabled to perform the corresponding tests.

➡ INT Measurement system is developed

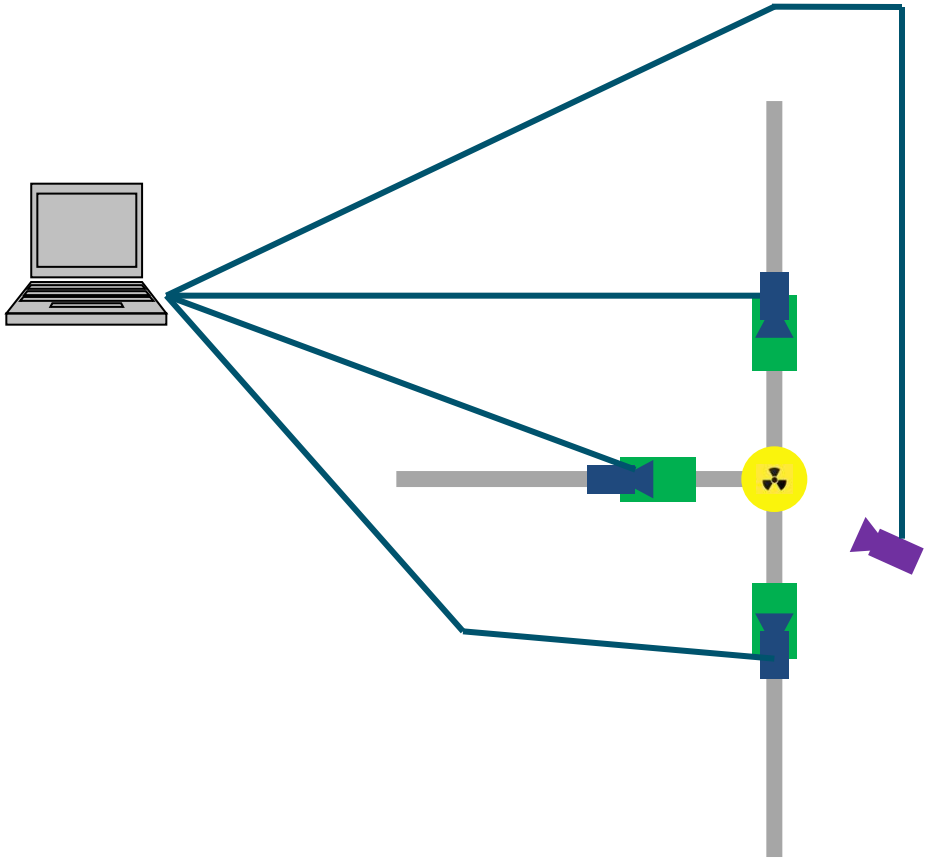
# Evaluation categories

- False identification rate
- Time to alarm; Photons
- Time to alarm; Neutrons
- Accuracy tests for photons
- Over range characteristics for ambient dose equivalent rate indication
- Gamma response of neutron detector and neutron response in the presence of gammas
- Single radionuclide identification - RIID
- Overload characteristics for identification – RIID
- Dynamic sensitivity to gamma and neutron radiations

**static measurements**

**dynamic measurements**

# INT Static Measurement System – Scheme Top View



guide rail

detector

video camera

source





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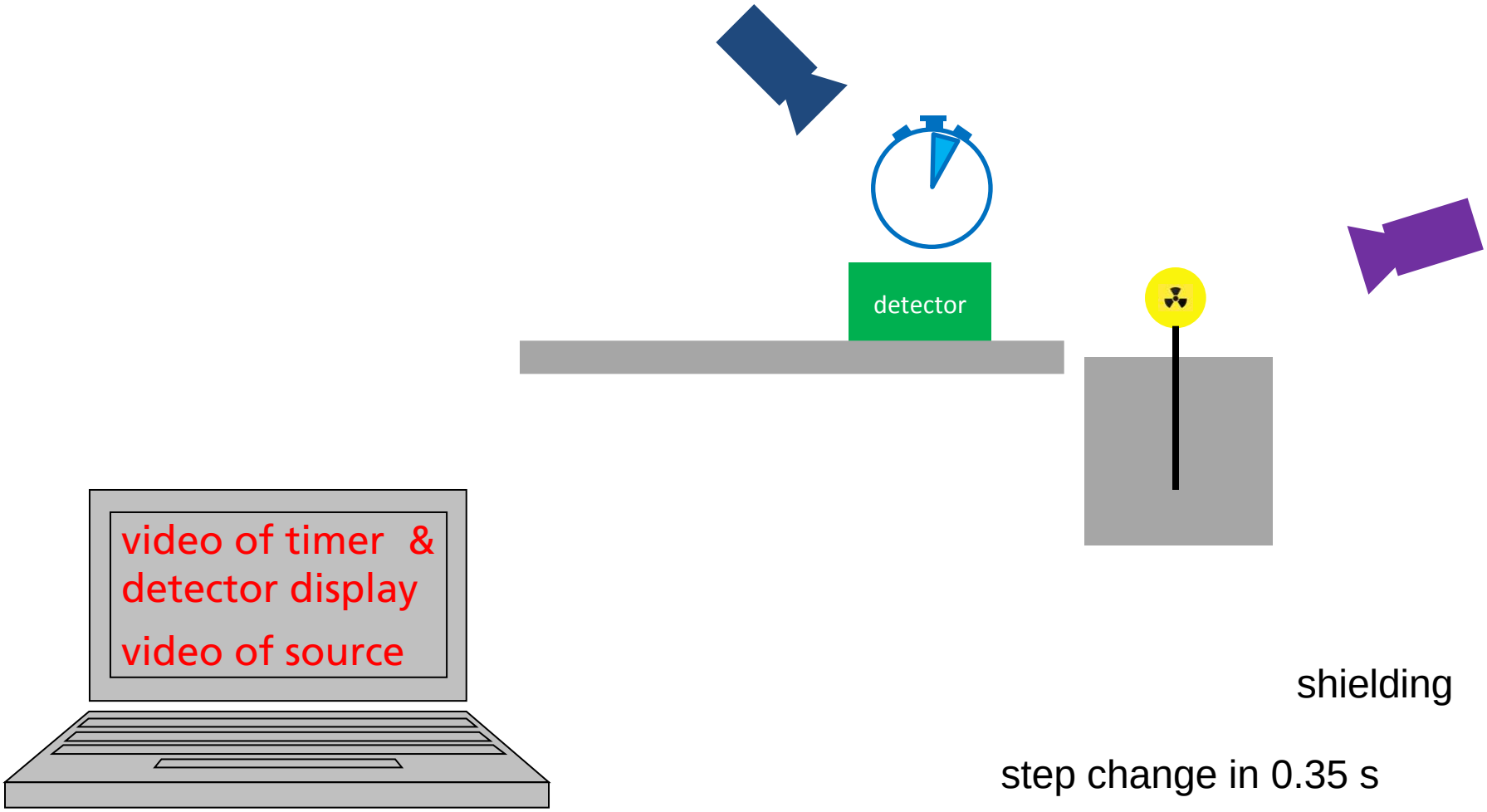
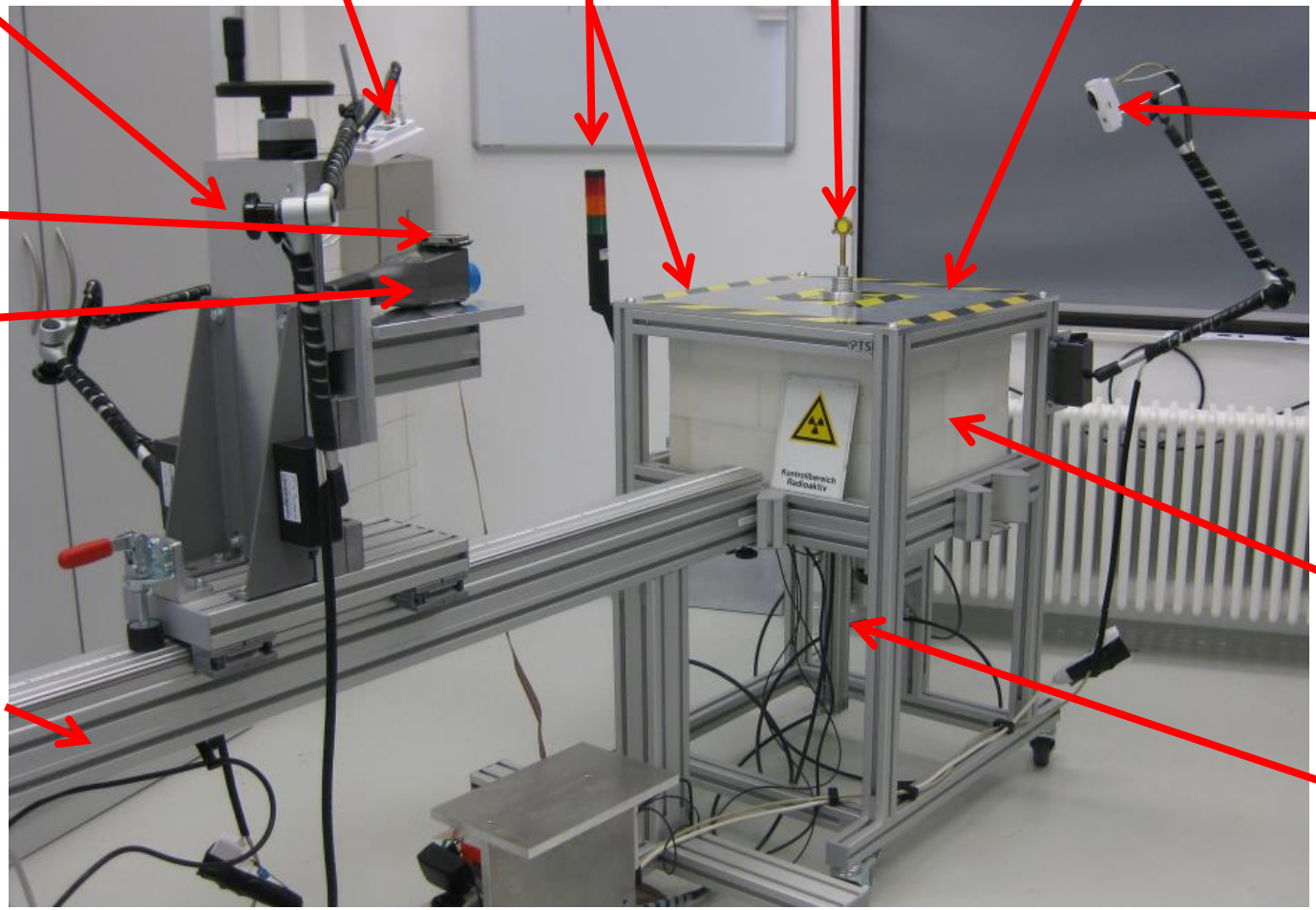
# Scheme of INT Static Measurement System – Side View



# INT Static Measurement System





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# Video System

detector display view and timer


source view





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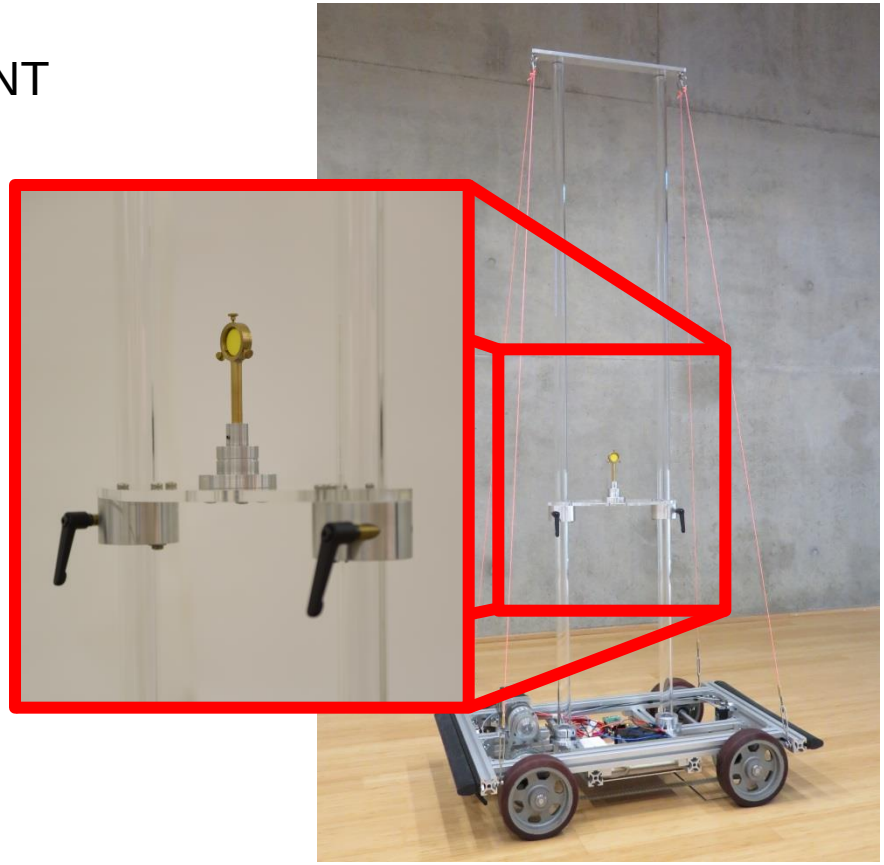
# INT dynamic measurement system

- Designed and constructed at the INT
- Trolley carries a source
  - variable height
  - source holder of static system
- Automated drive, velocity and acceleration can be chosen (0.02 m/s – 2.2 m/s as requested)
- Video observation system
- Rail to guide the trolley
- Mobile, can be transported on a trailer



rail sections on base plates





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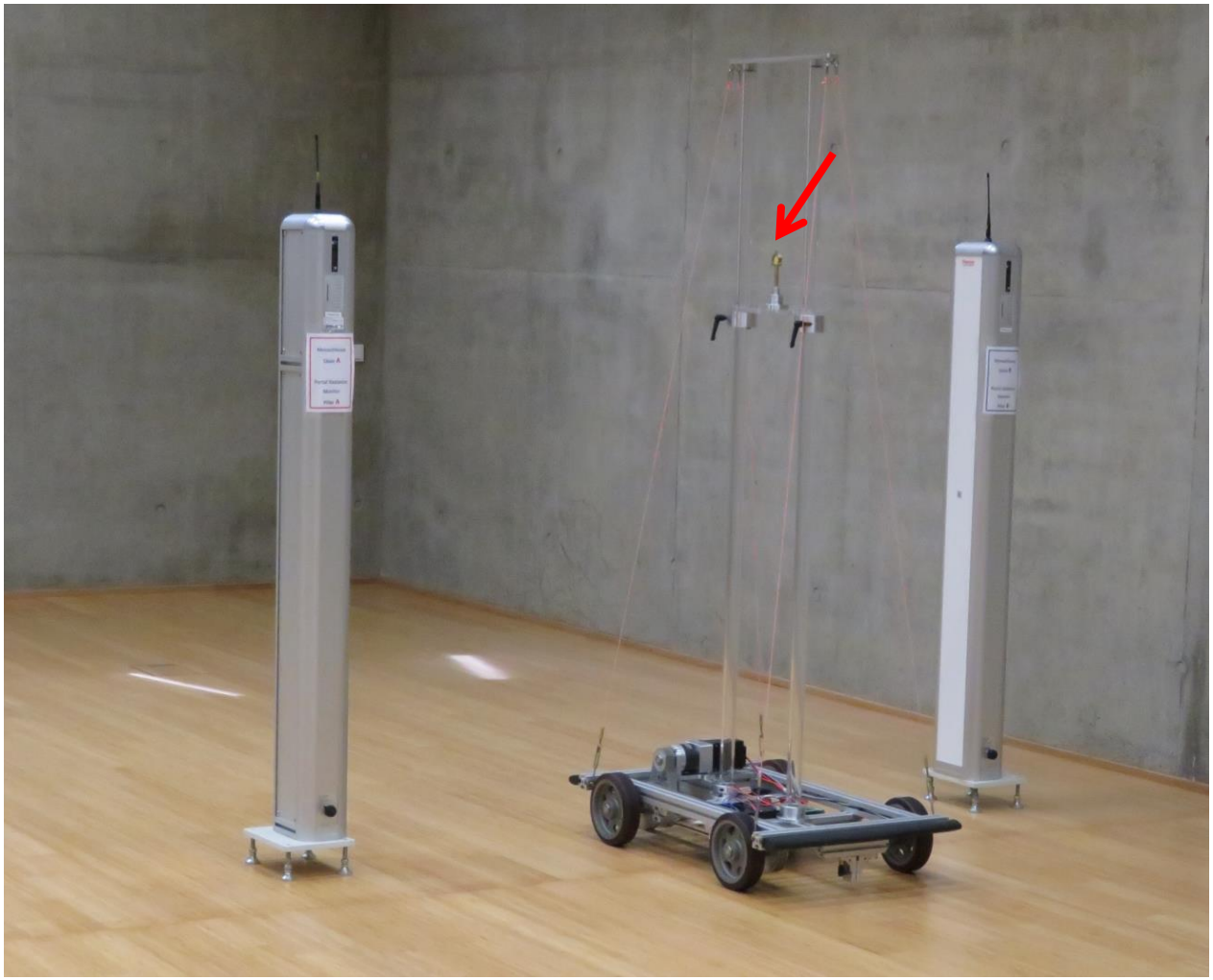
# INT dynamic measurement system

## Application situation: Radiation Portal Monitor RPM



# Summary

- Fraunhofer INT has developed a static and dynamic test environment
- Qualification measurements in the framework of a project have already been done successfully
- New measurement devices for radioactive or nuclear material can be qualified
- Already deployed devices can be qualified, too
- Comparison of different devices is possible and can be the basis for the procurement of additional or new components for replacement, e.g., in the field of military detection equipment
- Both systems are mobile and can be brought where needed

Visit us at **booth A6**
We have brought our **static measurement system** and a video of the **dynamic system**!