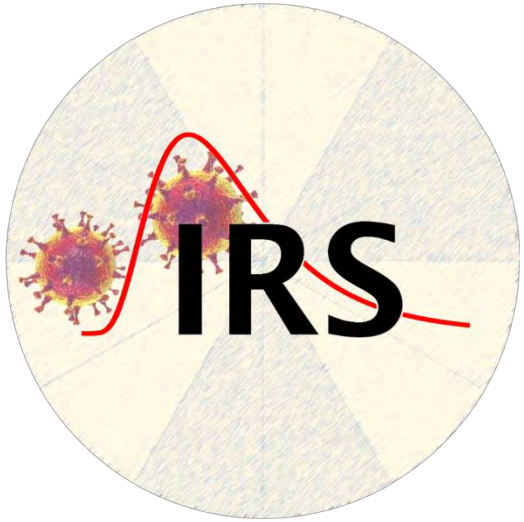
Approaches to practical exercises in the virtual laboratory



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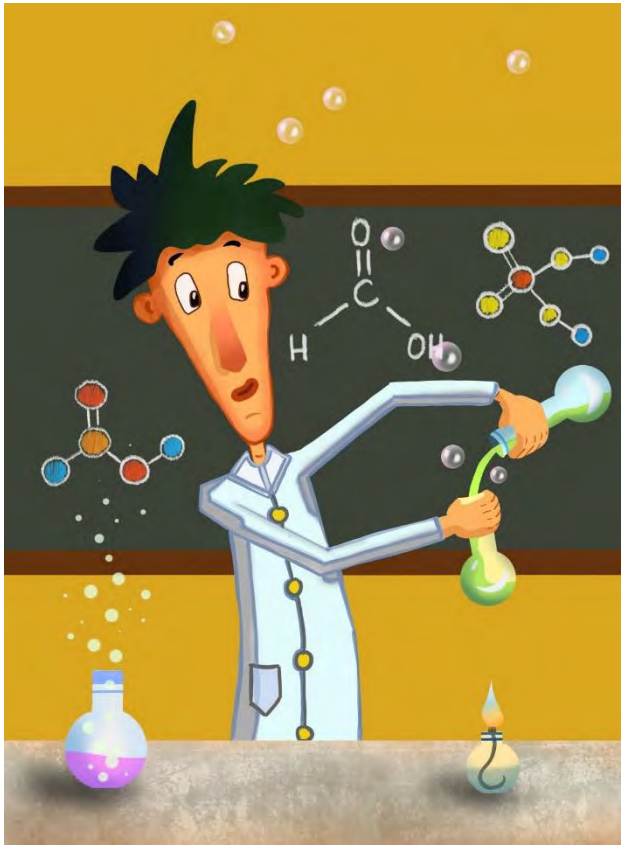
Practical lab courses

- Real experiments…
  - illustrating theory by practical application
  - deepen the knowledge
  - allow errors
  - promote problem-oriented action
  - encourage critical questioning
  - stimulate discussions
  - practicing procedures in the laboratory

  ➢ are essential for scientific education, but have limited access



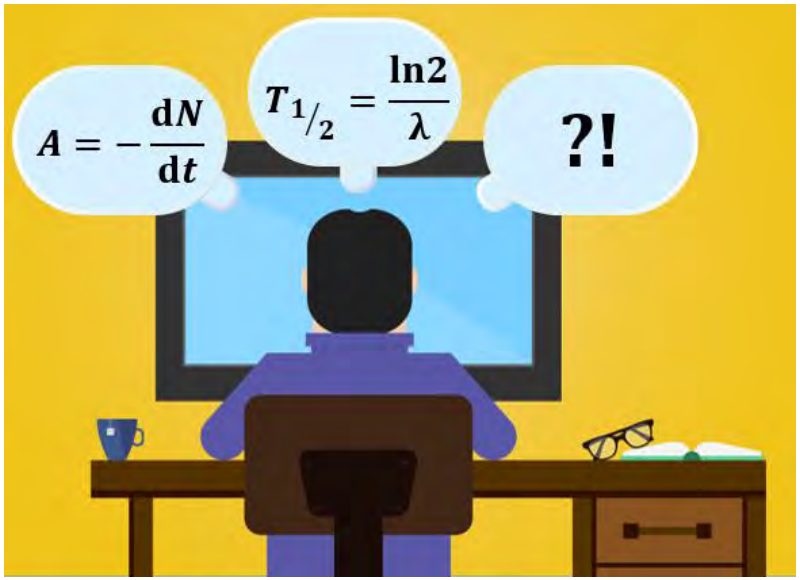
➢ Online/virtual experiments

Online experiments

- Available at any time
- Accessible to anyone who cannot work in radionuclide laboratory
  - underage students/pupils
  - Pregnant women
- Experiment can be executed by several students at the same time
- Experiments can be repeated

Lab course during lockdown

- Practical lab course “Radiation protection”
- BSc/MSc Physics & teacher trainee, MSc Chemistry
- 6 Credits ≈ 90 hours
- 8 online experiments:
  - Video demonstrations
  - Interactive screen experiments
  - Virtual experiments
  - RoboLabs
- Spread over one semester



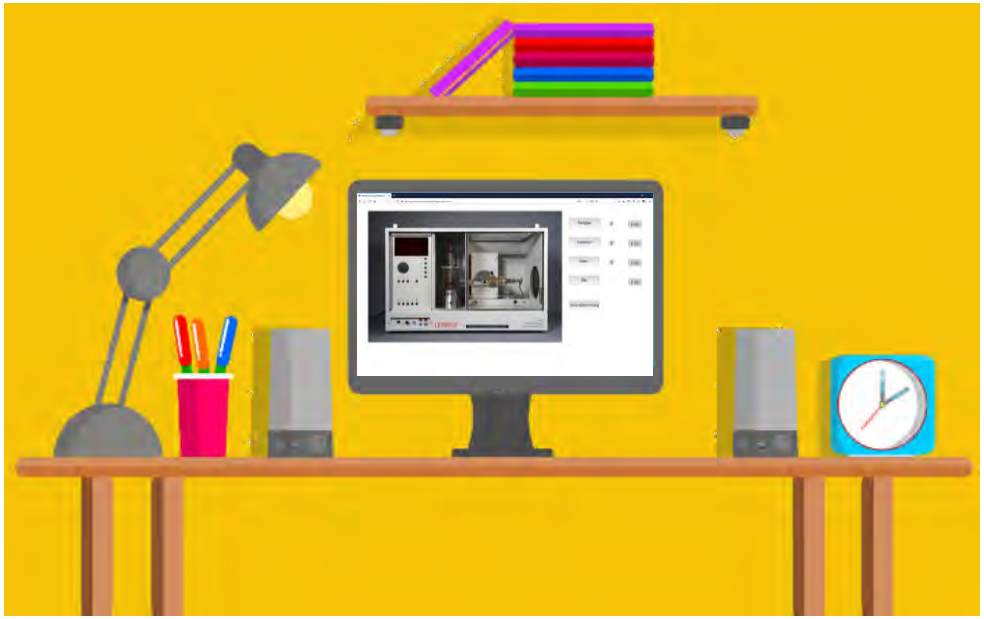
Video demonstrations

- Experimental procedure is filmed
- Linear execution, no interaction
- Generic data set for calculation exercise
- Two experiments with Geiger-Müller counter:
  - Counter tube characterisation
  - Beta attenuation

➢ Didactically not the best alternative, but the easiest and fastest to implement

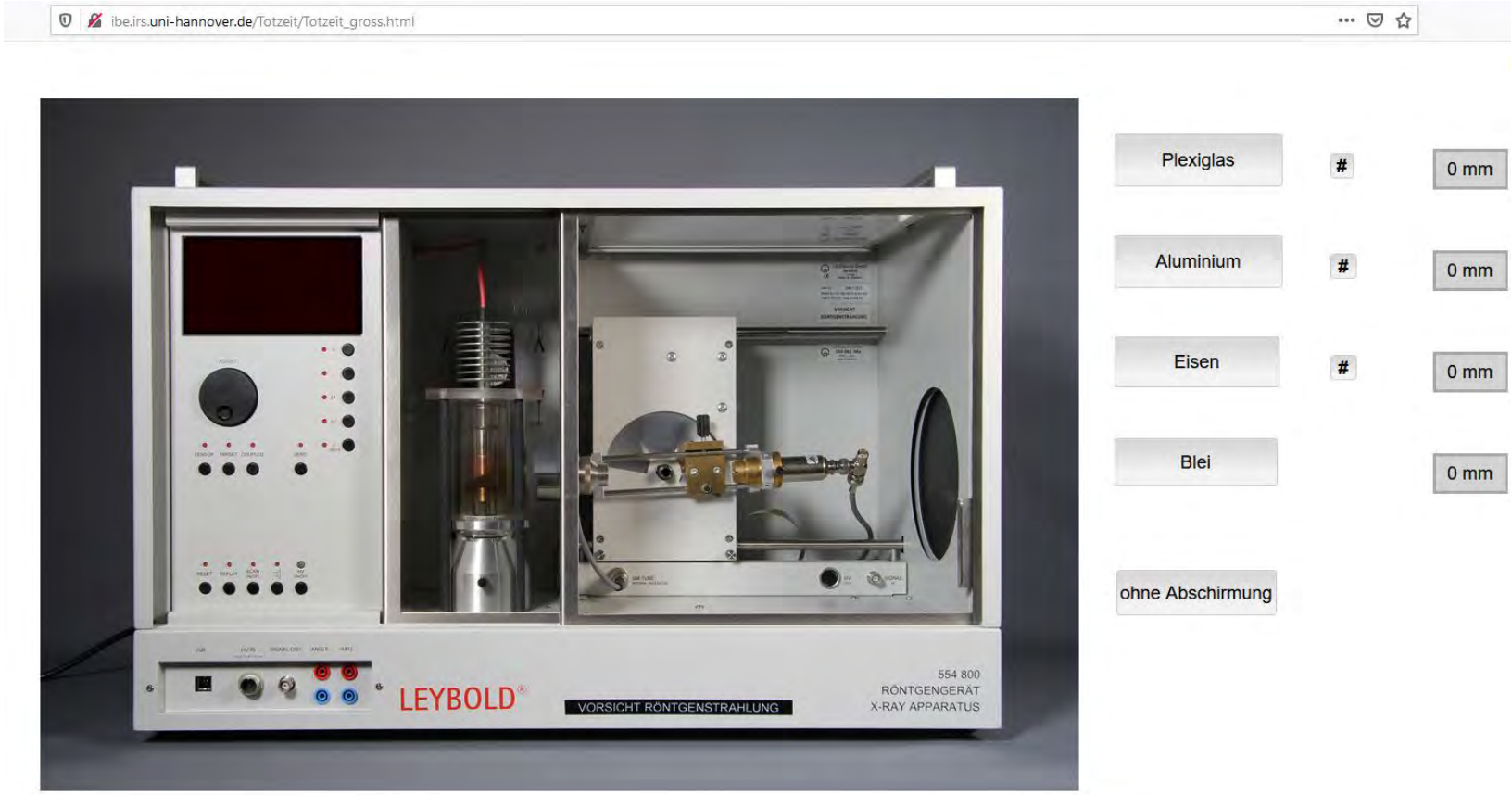
Interactive screen Experiments (ISE)

- Photographic representation of a real experiment
- Goal: Operation of the experiment close to reality
- Not equally suitable for all kind of experiments
- Major effort (filming & programming)



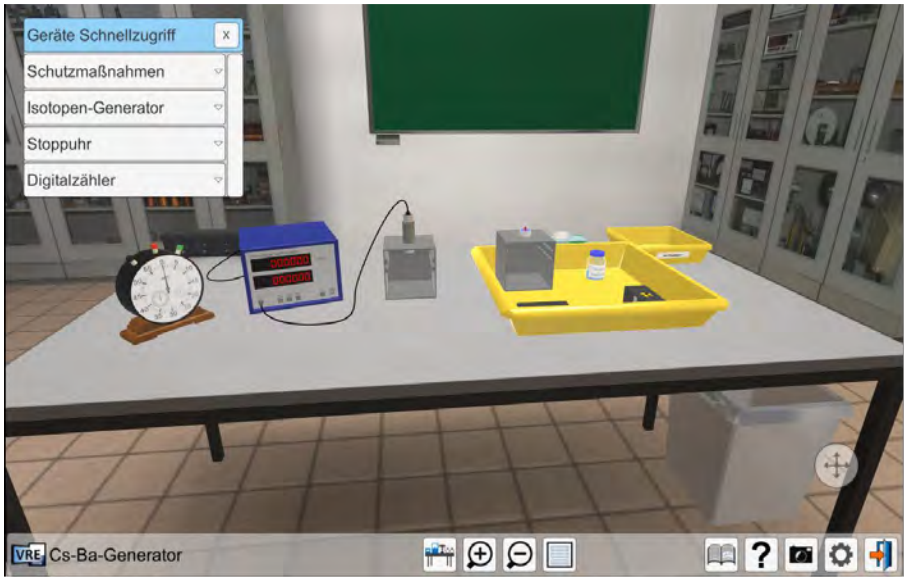
ISE: X-ray tube

- Browser application, available via ISE X-ray tube
- Task Dead time characterisation of GEIGER-MÜLLER counter



Virtual experiments (VE)

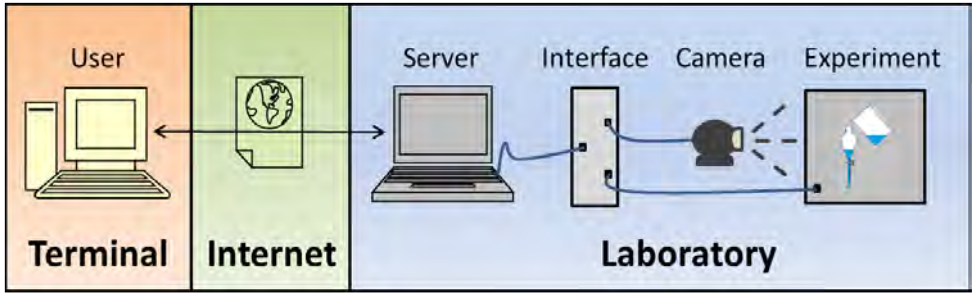
- Virtual representation of a real experiment
- First person view on experiment
- Complex experimental procedure possible
  - Including use of personal protection equipment
- Only limited by programming skills



Virtual experiments (VE)

RoboLabs

- Real, robotic experiments controlled remotely
- Expensive setup
  - Robot in the real lab
  - Video system
  - Controlling software
  - Continues maintenance

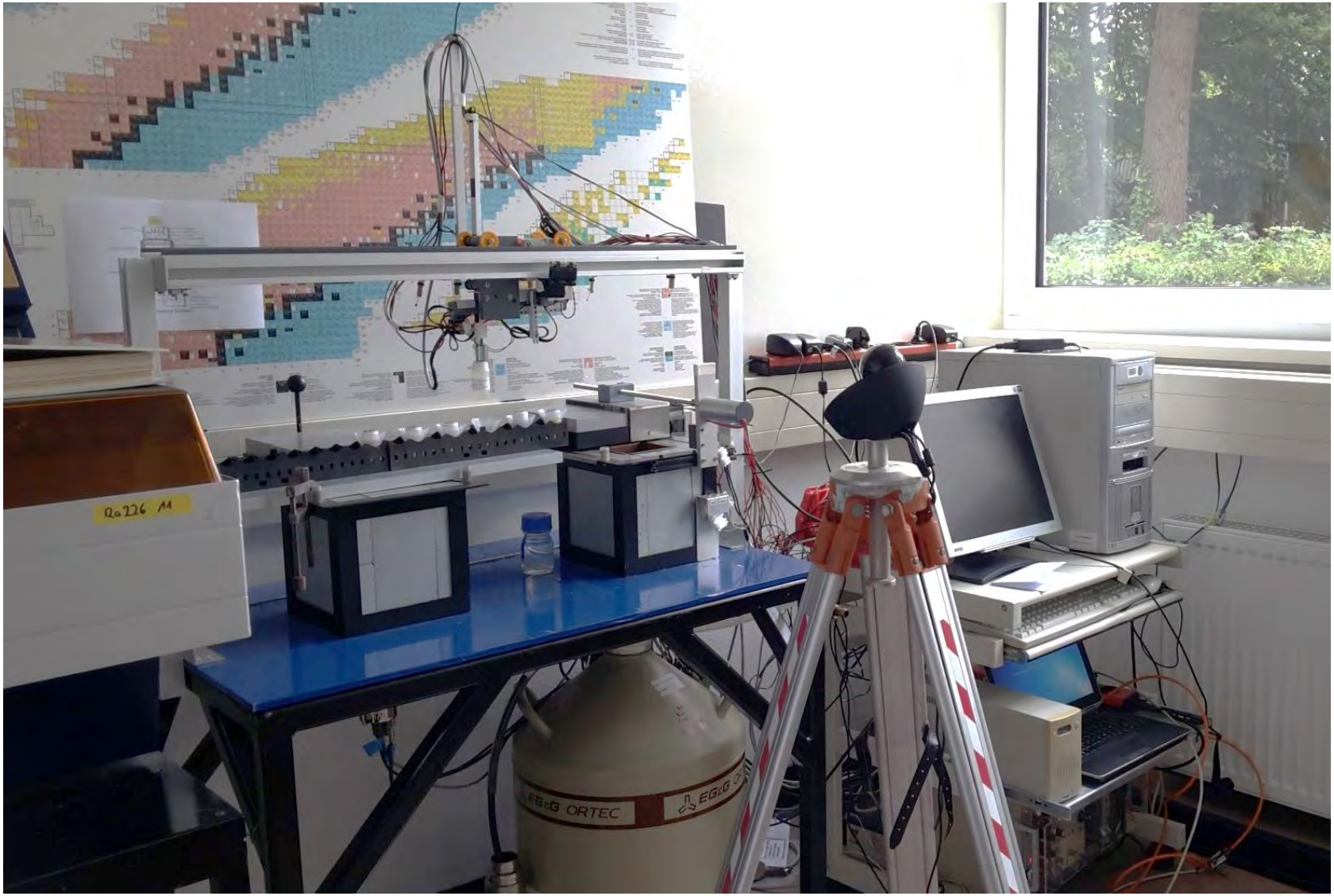


- Comes closest to a real experiment
- ➢ Users actually move things in the lab and see a live stream of it

GammaLab

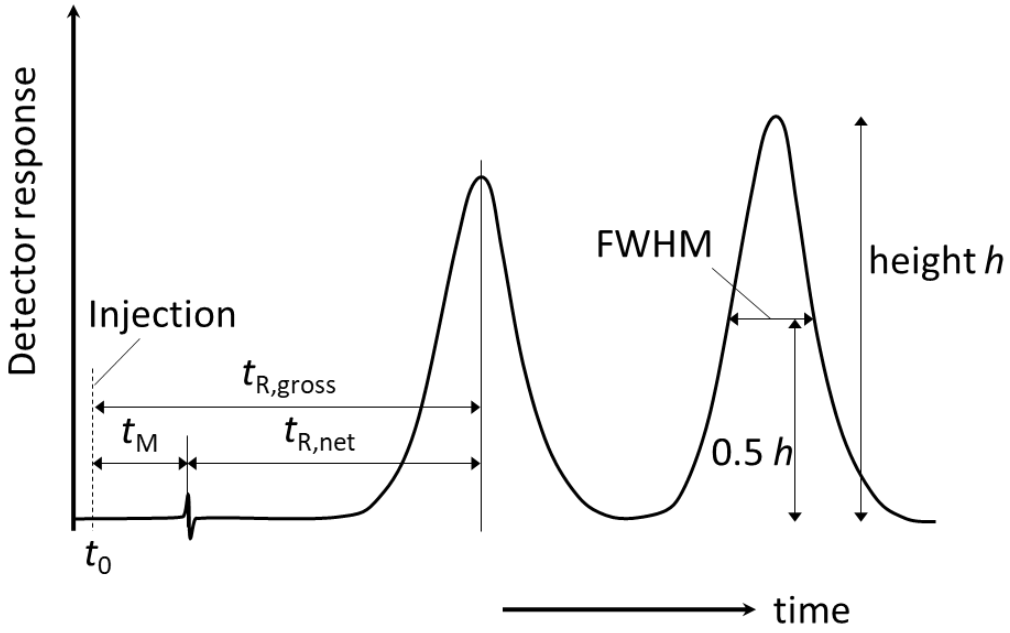
- Examination of environmental and anthropogenic samples with HPGe detector
- Learning goals:
  - Interpretation of gamma spectra
  - Identification and quantification of samples
  - Determination of characteristic limits
- Samples
  - Calibration standard
  - Sample of Cs-134
  - Soil sample from Chernobyl
  - Depleted Uranium pellet
  - Monazite sand
  - Soil sample from Fukushima

GammaLab – Experimental setup

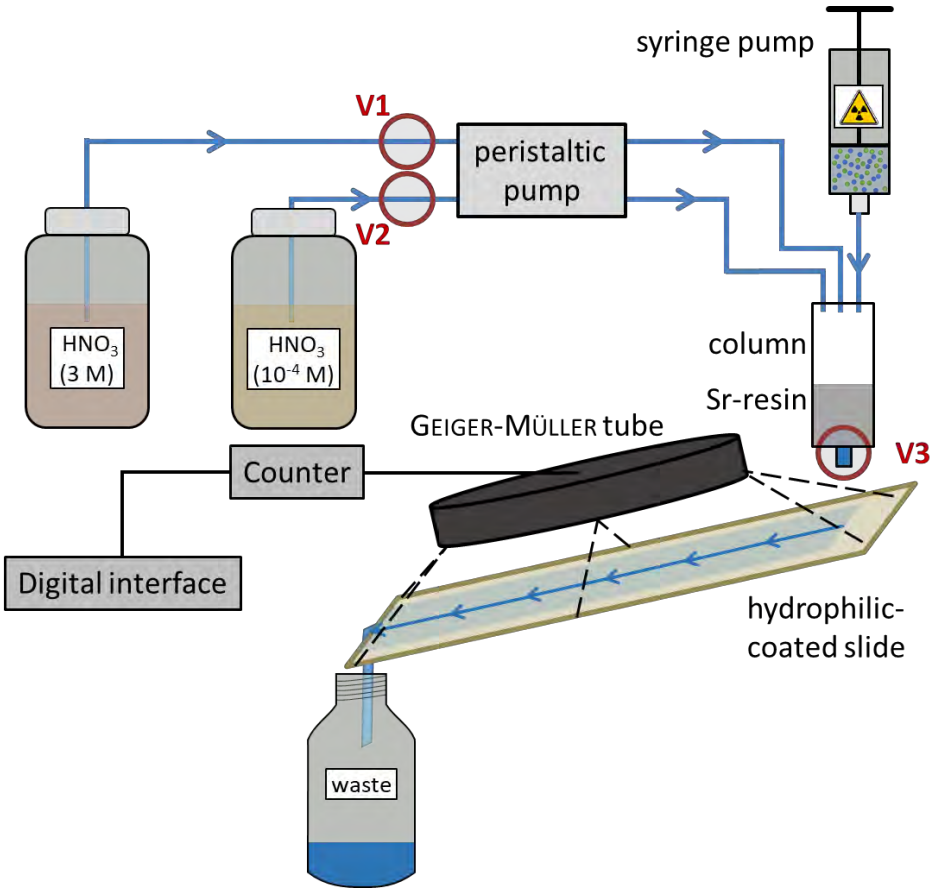


GammaLab – User interface

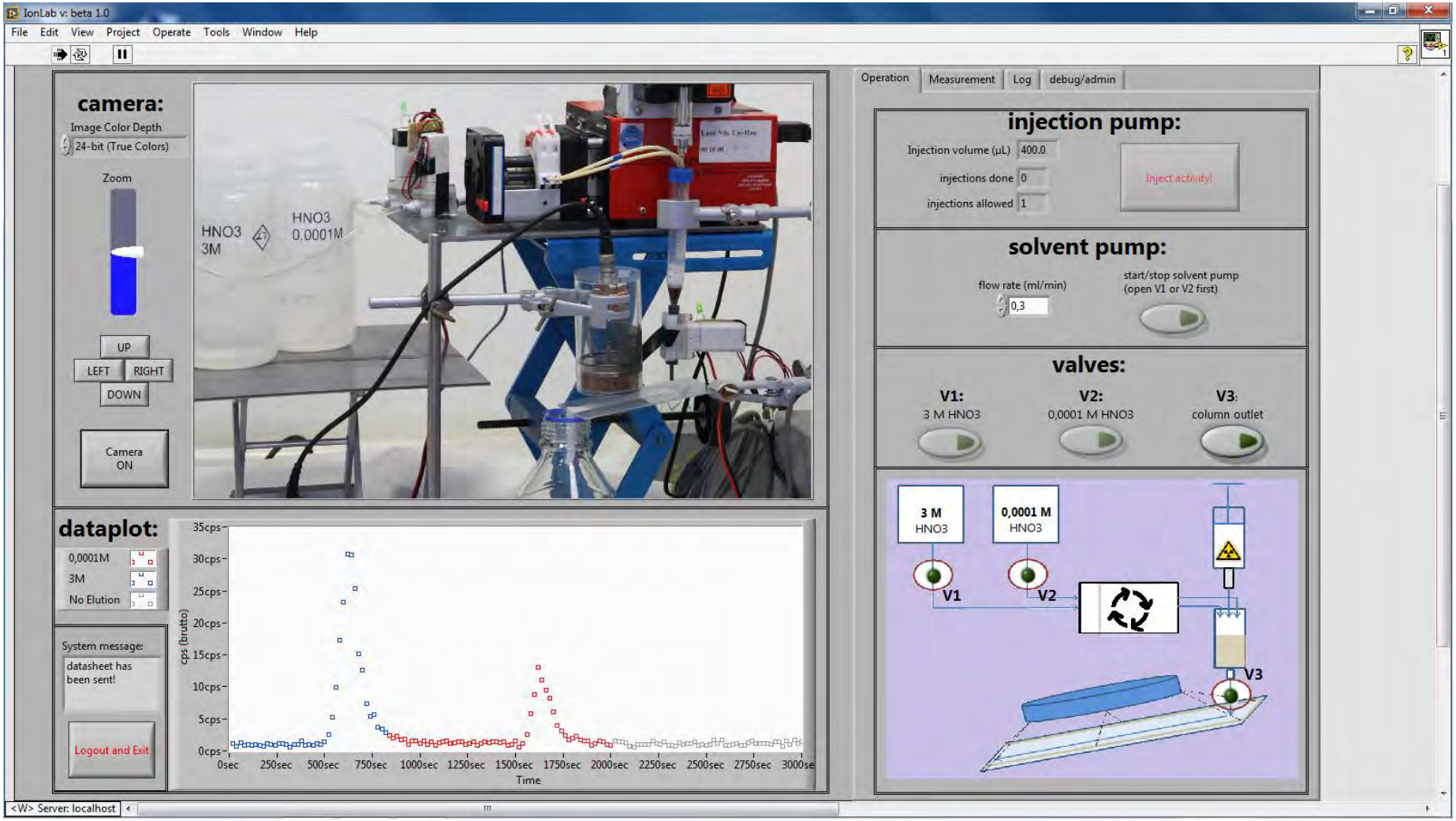
- Separation of Sr-90/Y-90 by extraction chromatography
- Learning goals:
  - Understanding of beta decay and secular equilibrium
  - Detection of beta radiation
  - Determination of chromatographic key figures



IonLab – Experimental setup



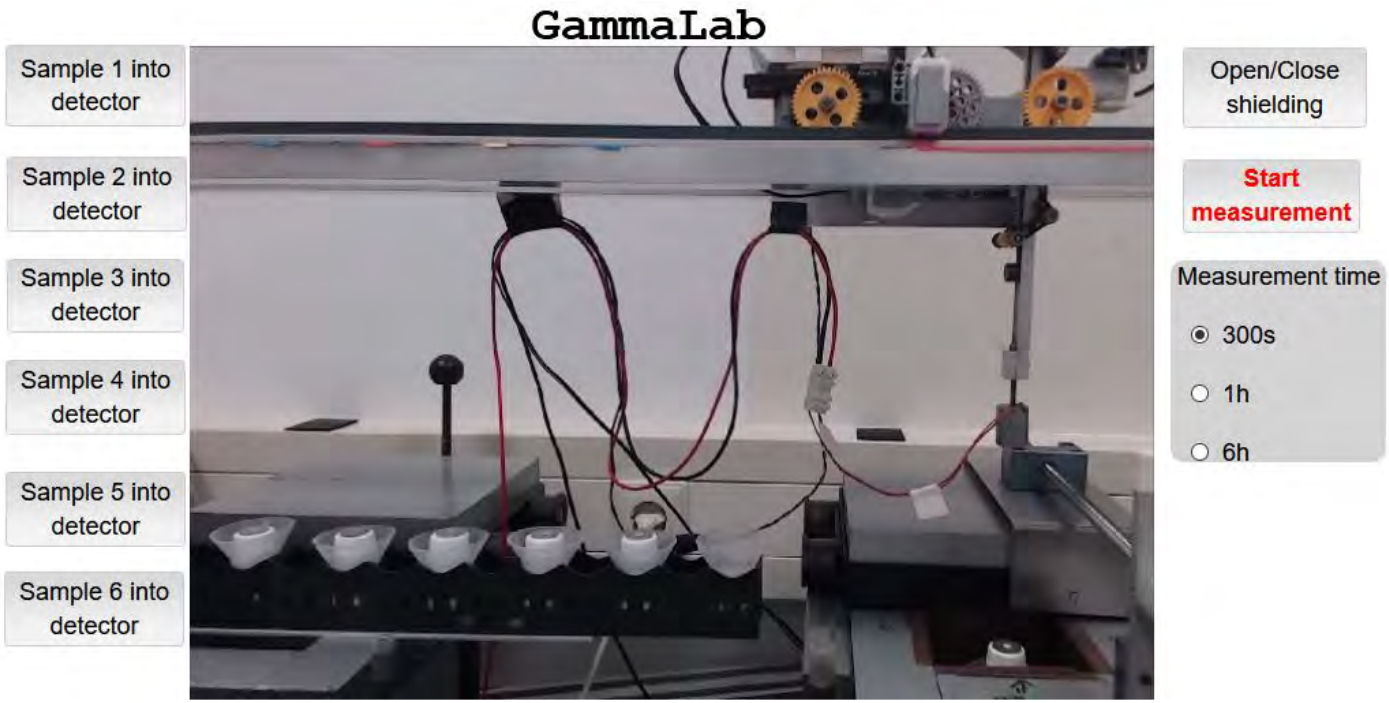
IonLab – User interface



Back-up ISE

- RoboLabs can only be operated by one person/group at a time
- Operation via the web interface is failure prone

➢ Back-up ISEs base on GammaLab and IonLab



Summary virtual lab course

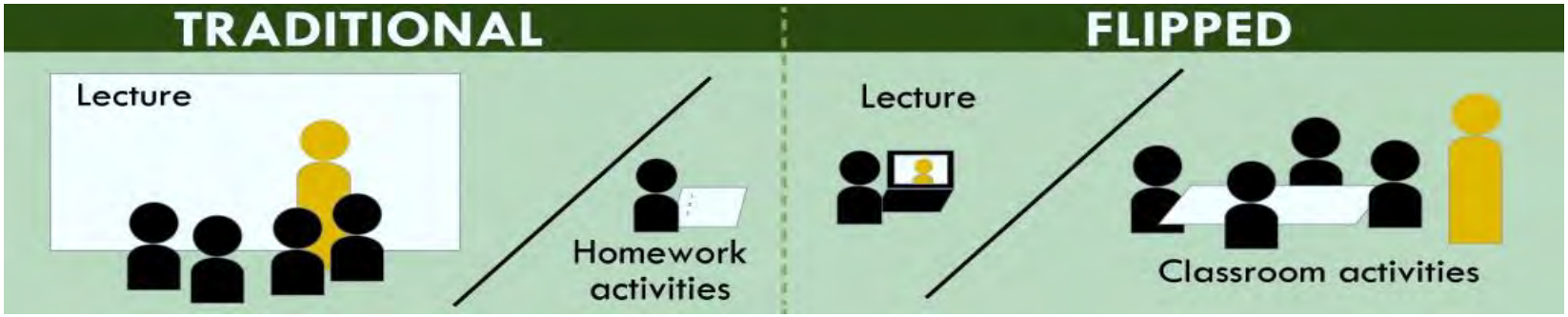
Online experiments can not replace real hands-on training, but

- might serve as a substitute for target group with limited access to laboratories
- are a contemporary step towards improving the accessibility of specialized laboratory infrastructure
- can be used as preparation for real experiments
- serve as Back-up for exceptional situations

Flipped classroom

Flipped classroom: Concept

- Classical teaching mode is inverted:



- Students receive course content in a self-determined manner and at one's own pace
- Teacher moderates presence phase, students apply content from lecture
- Classroom events promote active learning: Quizzes, discussions, mutual explaining, activating games

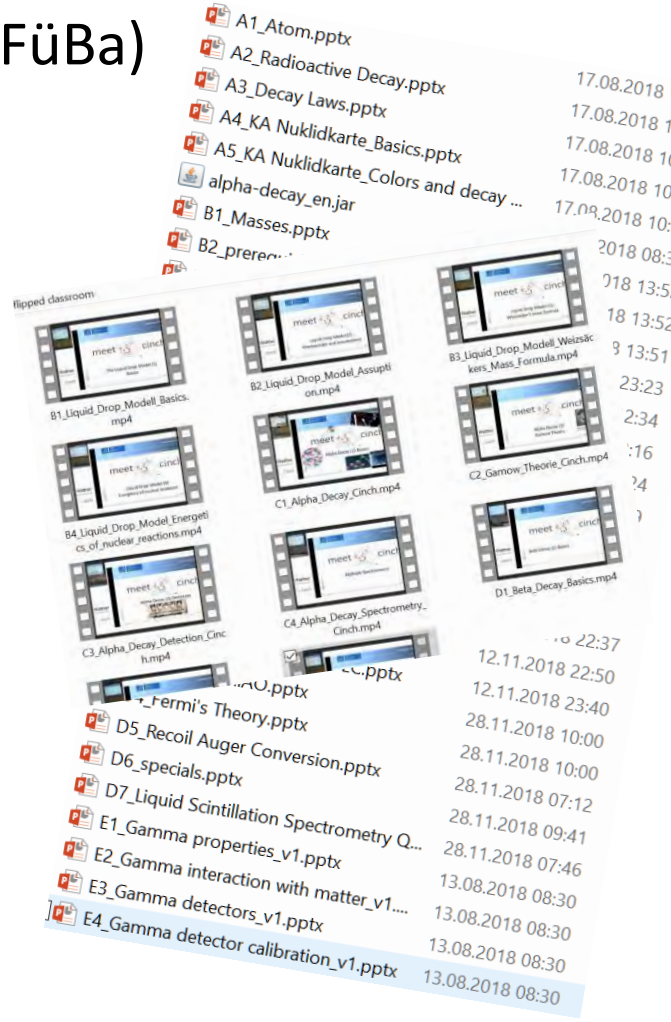
Picture: https://educationaltechnology.net/flipped-classroom/

Flipped classroom: Challenges

- Proper scheduling of the course
  - Videos lectures should be divided in several short videos (max. 15-20 min)
  - Accompanying tasks for video lectures to guide students through content and prepare for presence phase
  - No mere repetition of the content in presence phases
  - ➢ Preparation of didactically valuable activities
- Small groups in presence phase
  - ➢ Need of more tutors
- Students receptive to the concept
  - Instead of consuming lectures in presence, they must become active and be prepared for the presence phase

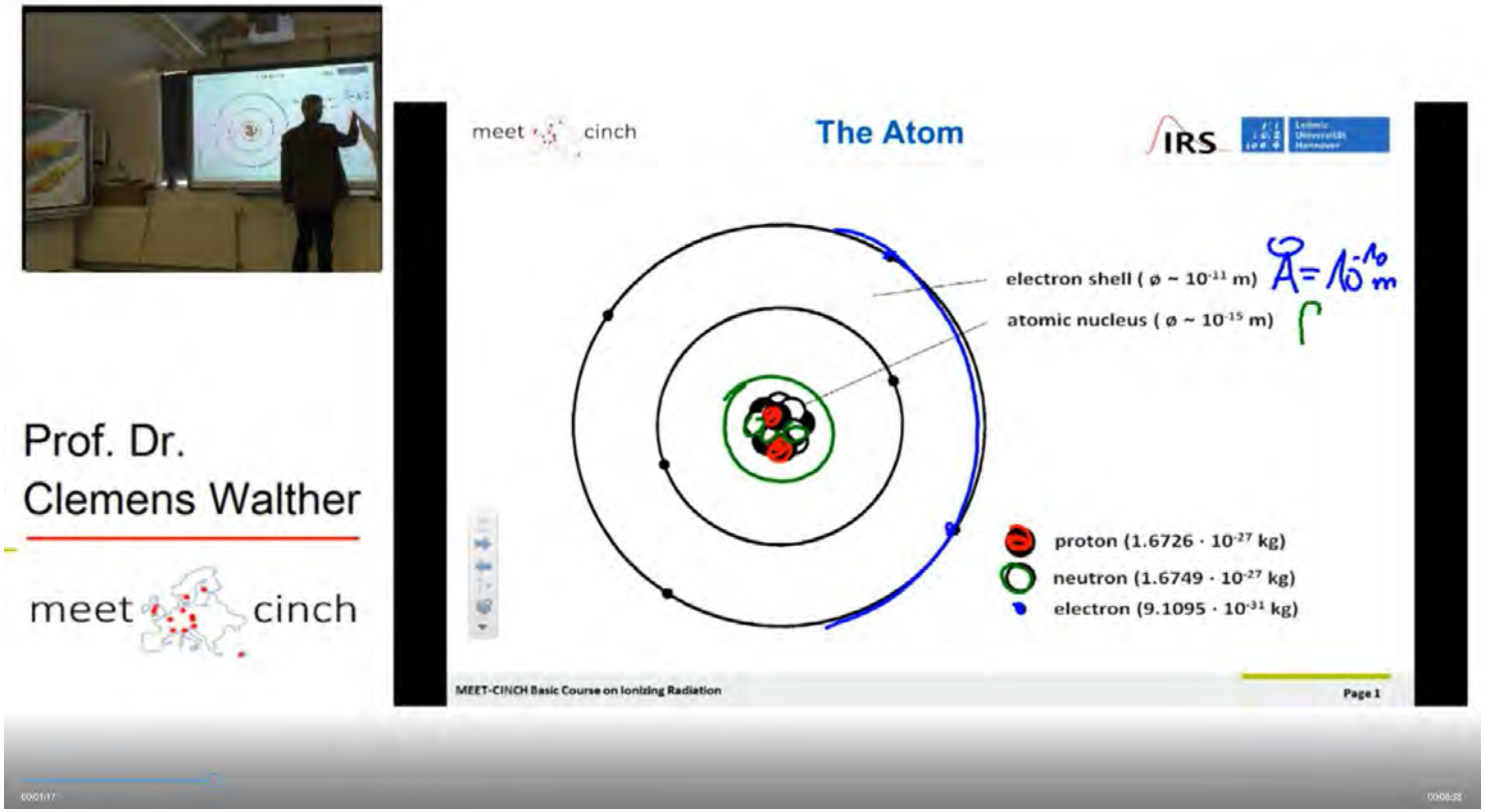
Flipped classroom at LUH/IRS

- “Basic course on Ionising Radiation” part of Physics IV
- B.Sc. Physics & teacher training students (FüBa)
- 10 topics in FC design (nuclear physics)
  - 36 videos (about 12.4 hours of video footage)
  - 7 presence phases of 90 minutes each
  - Approx. 100 students
  - 7 groups divided into “FüBa” and B.Sc.
  - Use of 1 RoboLab and 1 ISE
- Pilot run in summer semester 2019
- Developed and accompanied by a physics didactic including pre and post survey



Video lectures

- Two video feeds
  - Lecturer in front of smartboard
  - Slides with implemented comments from the smartboard



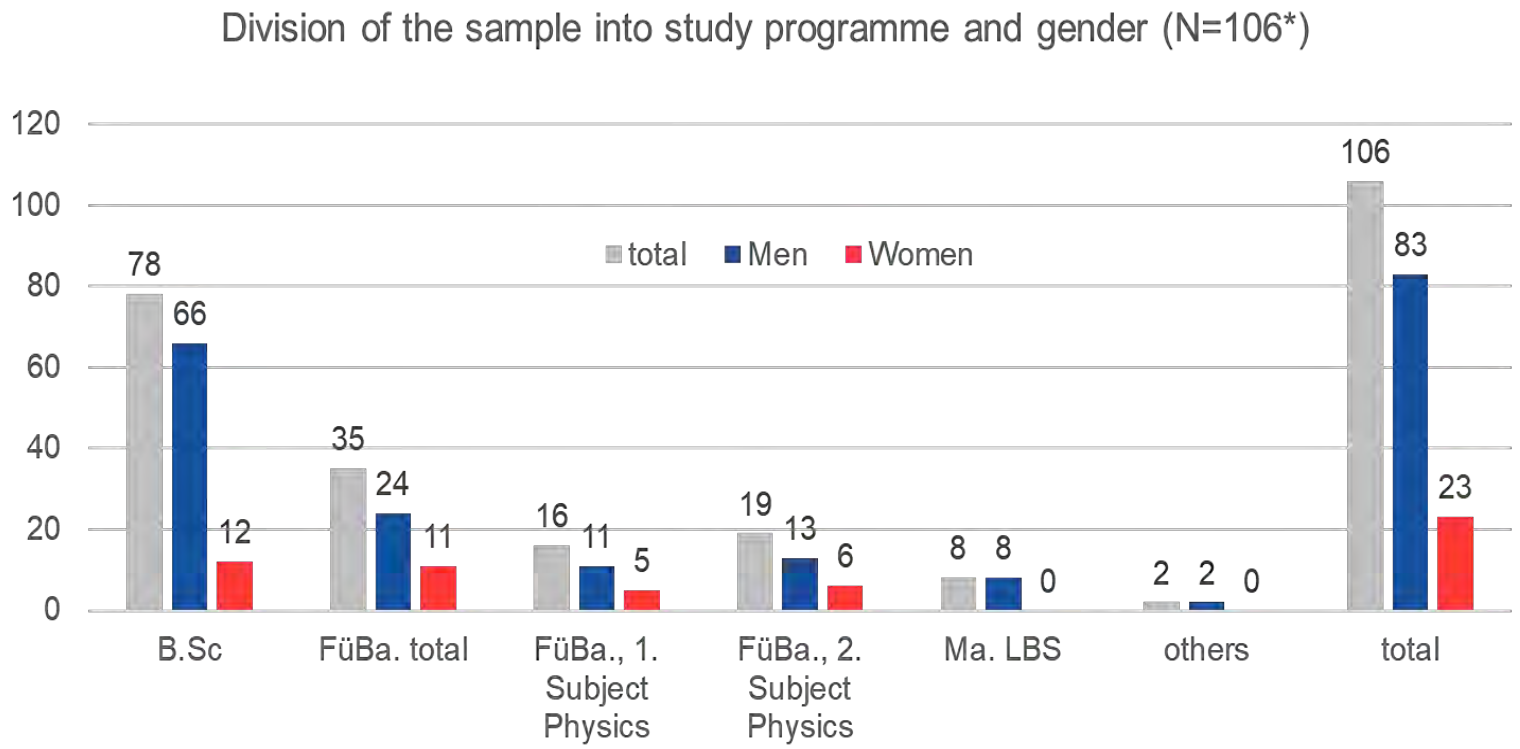
Presence phase preparation

- Materials for the tutors
  - Audio response questions
  - AO: additional PowerPoint slides
  - Materials for activating didactic elements
  - Description of method, not all tutors have background in didactics
- Pre-meetings to bring all tutors to the same level of knowledge
- Schedule with rough estimation of timing

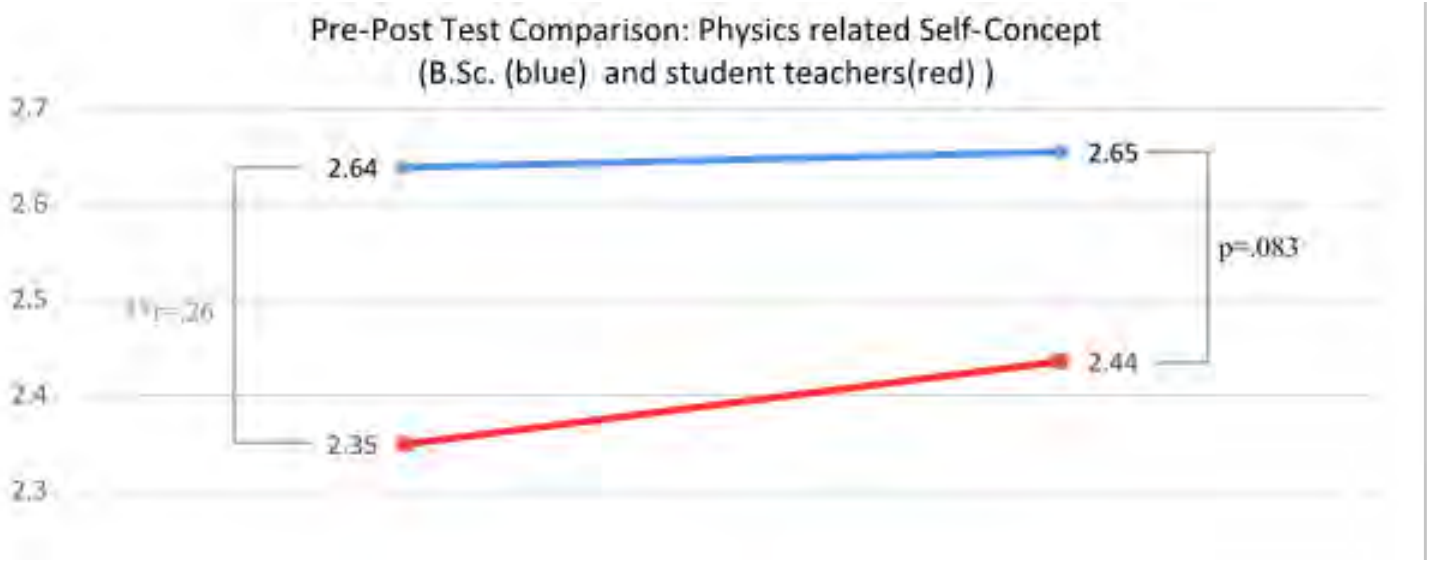
Time	Topic	Method	Remarks
20min	**Quiz on topics taught in videos** A1) – A5	**Audience response system**	
5min	Gap identification in understanding the videos	Class Discussion	First approach: attempt to find the correct answer amongst students
20 min	Chart of the nuclides	Think pair share	Some challenging entries in the KCN are presented and shall be discussed
40 min total:	**Radioactive decay equilibria**	**Group puzzle**	
3 min	Explanation of method formation of expert groups		3 different work sheets available
10 min	Discussion / solving diff. Eq. in groups 1,2 and 3		Tutor is observing / moving from group to group / giving hints
2 min	Team formation		
10 min	Explanation within team		
15 min	Solution in plenum		
5 min	Wrap up / summary		By tutor

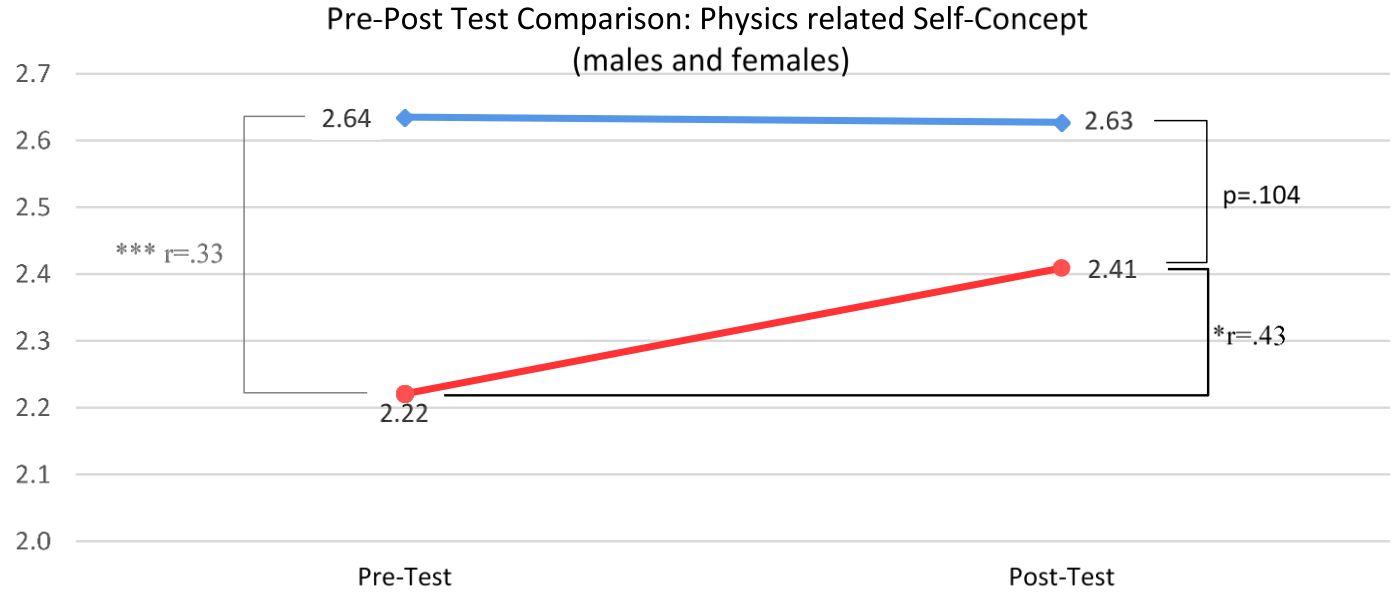
Evaluation pilot run

- Evaluation has shown differences between male and female and between B.Sc. and teacher training students



Physic related self-concept

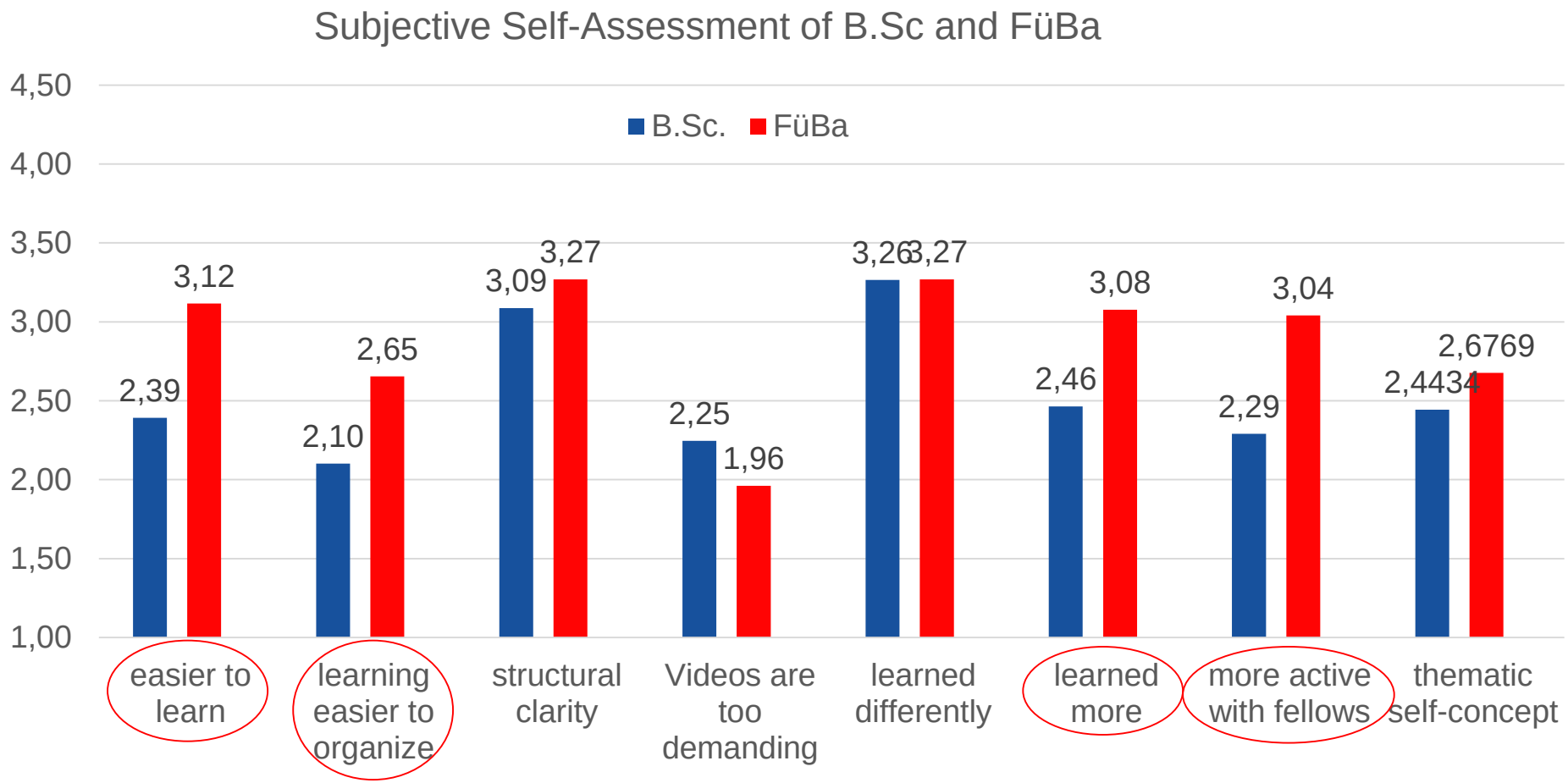




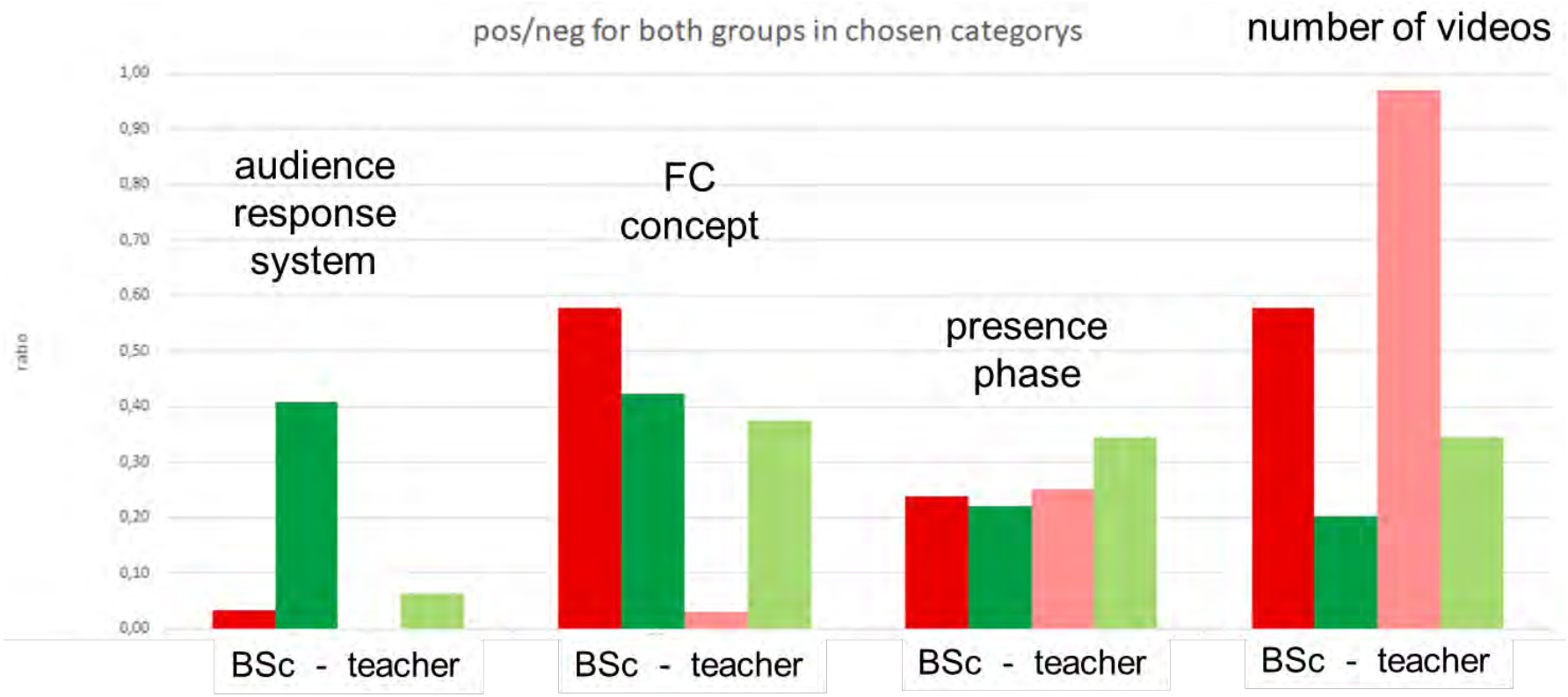
Physic related self-concept

- There is no significant change in motivation and physics related self concept regarding the whole group
- ➢ But: self-concept of females increases significantly after the flipped classroom intervention
- Overall FüBa have a significantly lower self concept regarding physics as compared to B.Sc. students
- ➢ But: FüBa students topic related self concept (nuclear physics) is higher than B.Sc. students, after flipped classroom (but not significantly)

Self assesment



Free text comments



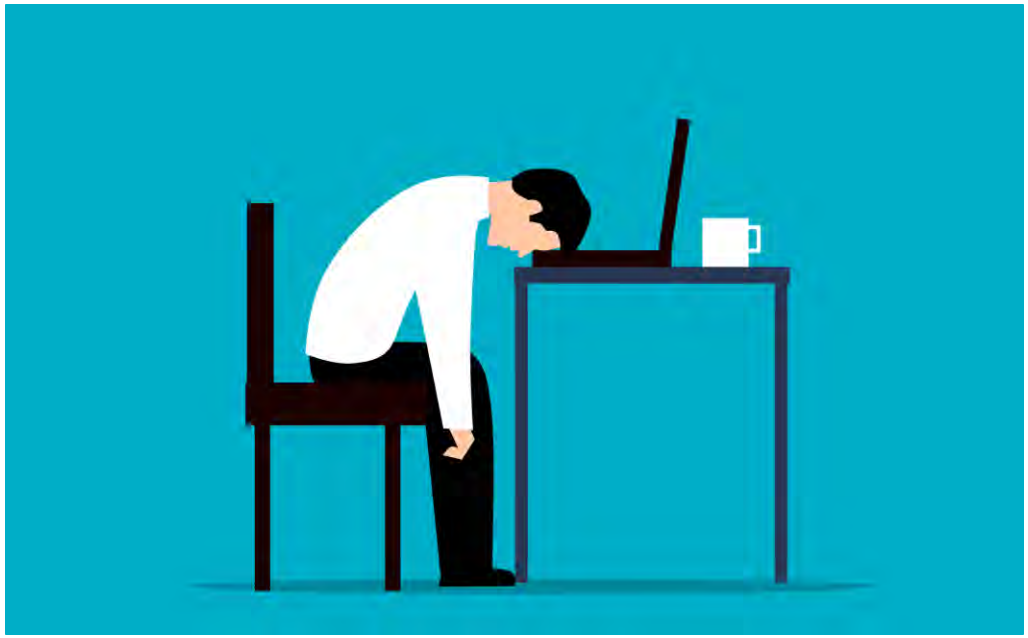
Self assessment FüBa vs B.Sc.

- FüBas (compared to B.Sc.) report that they:
  - have worked significantly more with fellow students
  - have learned significantly more (compared to traditional teaching)
  - found it significantly easier to organize there learning
- B.Sc. students evaluated flipped classroom concept more critically
  - too many inefficient methods (activating elements)
- Final written exam showed no significant differences between the achieved performances of B.Sc. students and student teachers
- The more presence phases attended, the better the exam

Flipped classroom summary

- Conversion of a lecture to flipped classroom design requires time and didactic design
- Students can adapt the lecture to their level of ability
- Application of the learning content takes place in guidance of a tutor
- New experience to the vast majority of students
- Higher acceptance of students when they are used to methodology
- Lecture could be easily adapted to the corona restrictions

Thank you for your attention!

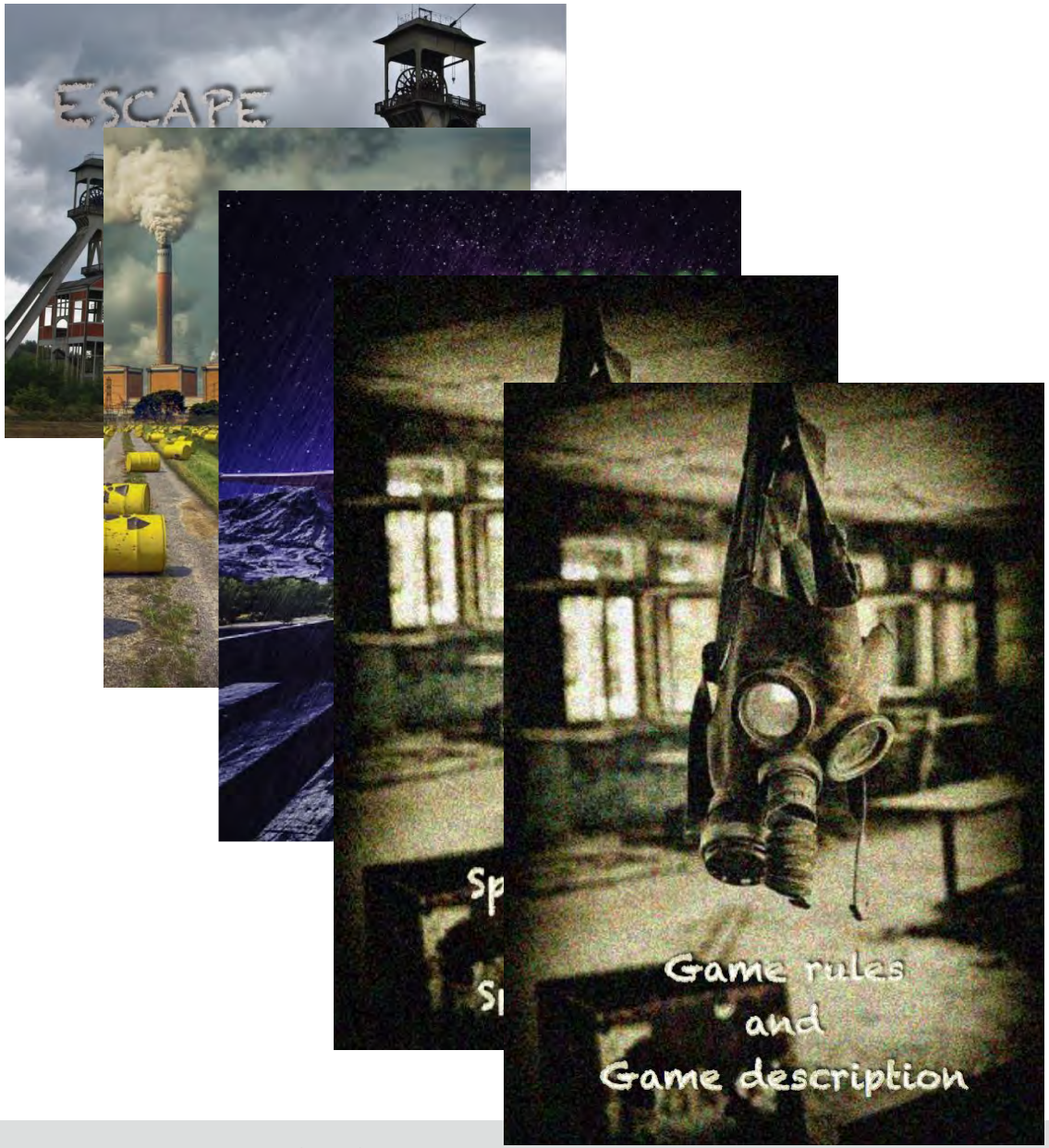


Encore ?

You probably know Escape Rooms

As a board game: Exit Games

There are more (German AND English)



1. Basic Nuclear Physics
2. Dosimetry and Radiation Protection
3. Natural Radioactivity including Radon