Courses for Natural-Science Students

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1. **My own Teaching**
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My own Teaching

Lecture *Physics and Technology of the Verification of Arms-Limitation Agreements*

Audience: physics students (3-8)

Topics: NTM ... satellites ... radar ... CTBT verification ... co-operative verification ... research ... outlook

2 h / week   2-3 short exercises / week

Oral exam. (20 min.) 3 credit points (CP) – counts as elective course

Seminar *Science, Armament and Disarmament*

Audience: students from all disciplines (15-25, 3-5 non-physics)

Students could choose from list of about 30 topics: nuclear weapons ... ballistic missiles ... CTBT ... satellite verification ... military robots ... chemical weapons ... cyber war ... J. Rotblat/Pugwash ...

2 h / week

1 student presentation / week, distribute overview in week before

Support in preparation; presentation is reviewed before uploaded as material

Presence and presentation: 2 CP, with oral exam. (20 min.) 3 CP

Physics: counts as physics seminar, needs physics-based topic

Other disciplines: some accept/demand „studium fundamentale“

Teaching Goals (Lecture on Verification)

Explicit description in „Module Handbook“

Teaching contents
Use of physics for the verification of compliance with arms-limitation agreements
Actual and our own research for verification and IAEA safeguards is included
With introduction in arms limitation and the importance of verification

Competences
Physical bases for the various verification technologies, derivation of elementary equations, compute numerical examples from practice
For national technical means of verification: satellite trajectories, optical imaging with diffraction limit of image resolution and sensor technologies, radar with radar equation and principle of imaging with synthetic aperture

For co-operative verification: nuclear-radiation detectors, seismic and acoustic (underwater sound, infrasound) detection of nuclear explosions, technologies for checking missile containers and for monitoring of missile launches, tags and seals, ground sensors

Examples of actual research: acoustic-seismic detection of land and air vehicles, monitoring of an underground final repository, noble-gas detection.
Actual treaty negotiations, proposals, political problems of verification

Discuss relationship between science and society/international relations
Strengthen interdisciplinary abilities, awareness for responsibility of scientists

Natural-Science Students

After basic courses:

Much knowledge, many competences (mathematical methods, physics approaches)

Goal: Capability to work with scientific publications, solve (simple) problems, do (some) quantitative analyses in relevant fields on their own - achievable

Examples:

Estimate nuclear-weapon yield

Estimate soot/dust density from mass fires

Compute fission-product quantities

Design satellite trajectories for different purposes

Locate seismic source from wave-arrival times

Starting from basic laws of physics, students can be led up to technological applications

Derive equations, step by step, e.g. on blackboard

Final equation: input example values, compute results, discuss consequences and applications

Main Problem 1

Different subdisciplines involved

Nuclear weapons/nuclear disarmament:
nuclear physics, thermodynamics/acoustics/shock waves, optics, radiation biology; overhead imagery, isotope measurement

Each usually treated for 1-2 semesters in a systematic sequence
Here covered in only 1-3 weeks → leaps in substance

Probably unavoidable

Main Problem 2

No (solid) background in history, political science/international relations, international law, arms control
- needs to be provided in basic form

In my case 2-h lecture:

International law, international humanitarian law
War/armed conflict
Just war
UN Charter
Security dilemma
Collective security
Arms control
Disarmament
Verification – by national technical means - coooperatively
Arms control agreements: examples PTBT, CTBT

More time would be better, but will remain superficial

Questions

How to increase students‘ motivation to take such a course?

How much time is available, is accepted in the respective curriculum?

How to create space for such a course?

Relative weight of „warning“ versus constructive uses of natural science/engineering?

How to stimulate student activity?

Numerical exercises versus writing assignments?

Involve other teaching personnel from natural sciences/engineering, from social/political sciences, humanities?

If this is difficult: Which media to recommend to natural scientists to feel comfortable with teaching contents from other disciplines?