TECHNISCHE UNIVERSITÄT DRESDEN

NETZWERK TEILCHENWELT

Science Communication & Nuclear Astrophysics Masterclasses

CHETEC INFRA

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Masterclasses online @
http://mc.chetec-infra.eu

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Who am I ?

- **2021**: State examination for Teaching (Computer Science & Physics)
- **PhD Student** @ Technische Universität Dresden, Germany
  - Chair of Didactics of Physics
  - Outreach Group of the Institute for Nuclear & Particle Physics
- I'm doing …
  - **Educational Research** regarding Nuclear Astrophysics
  - Giving **Masterclasses** around Germany
  - **Teaching** as much as possible

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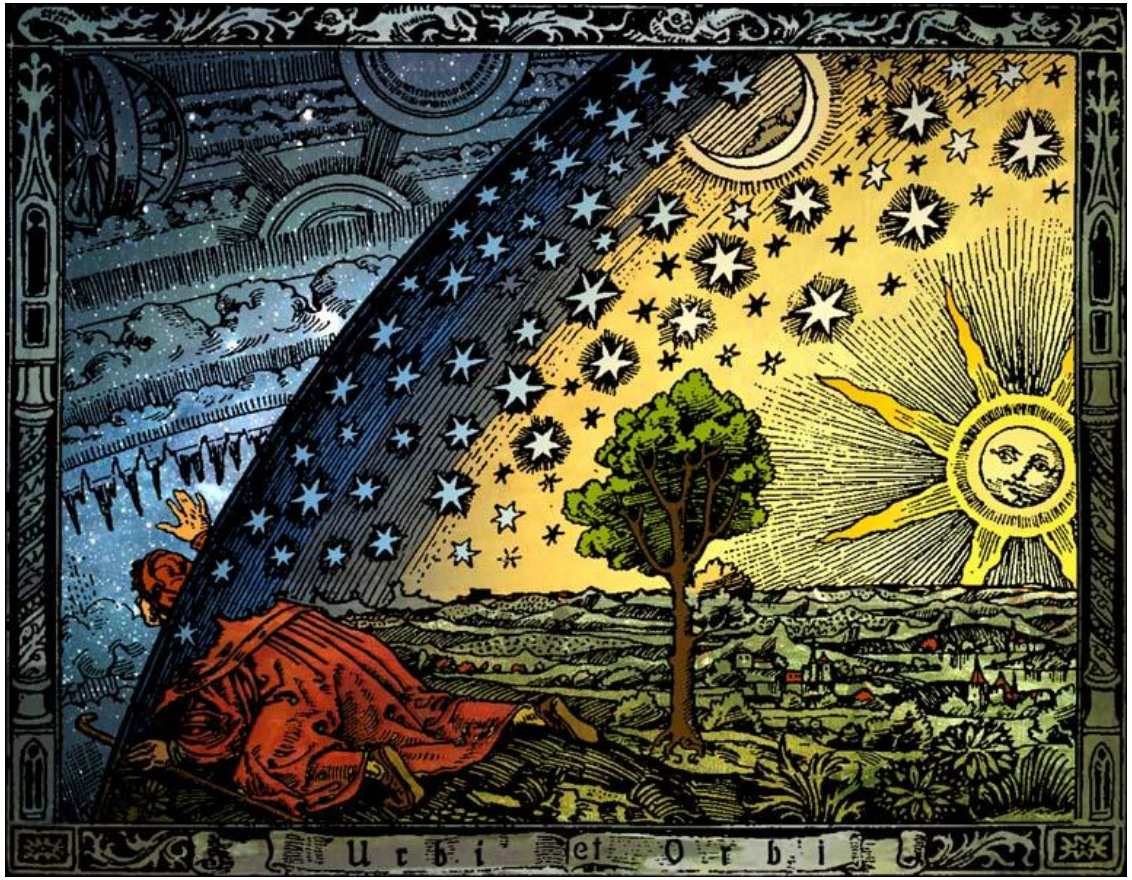
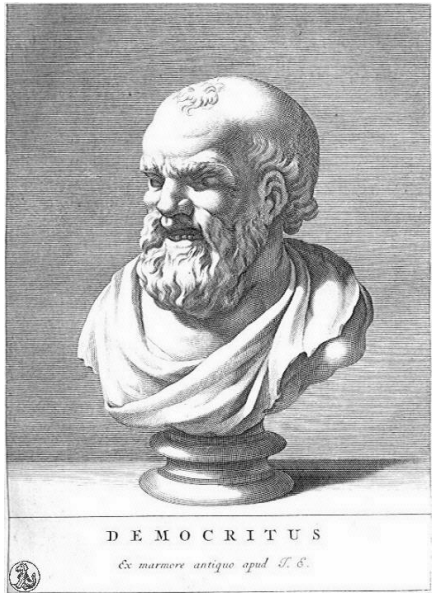
Outreach
Why and How?

Outreach





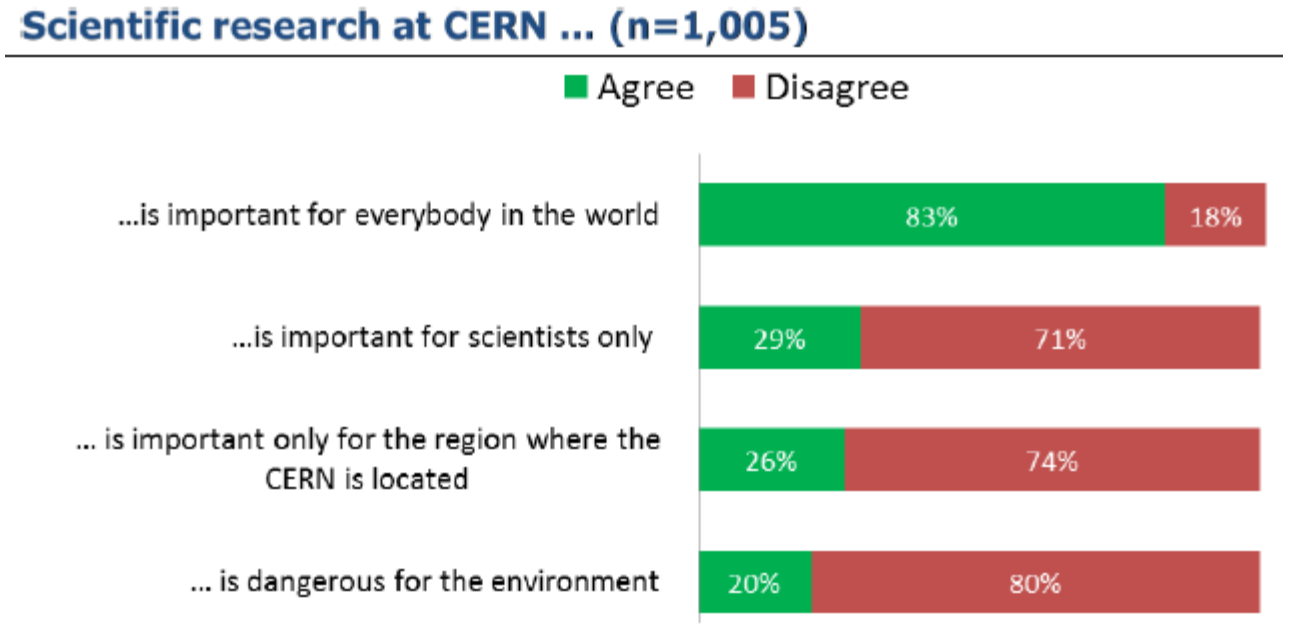
- Where do we come from?
- What are we made of (and the things around us?)
- What are the rules behind all this?

Explanation

Outreach

Taxpayer **Fundamental research**

A price worth paying R. Heuer (2020)
https://cerncourier.com/a/a-price-worth-paying/



From: Scientific Research at CERN as a Public Good: A Survey to French Citizens M. Florio et al. (2018)
http://cds.cern.ch/record/2635861

Explanation **Legitimation**

Outreach

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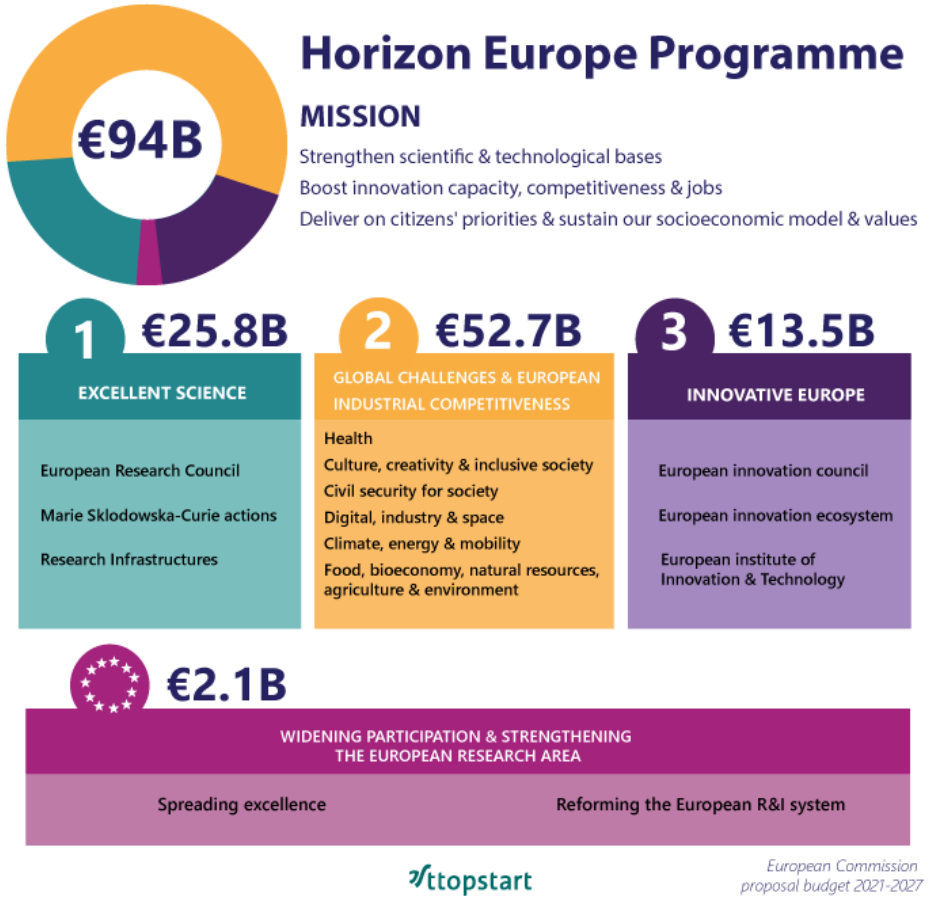
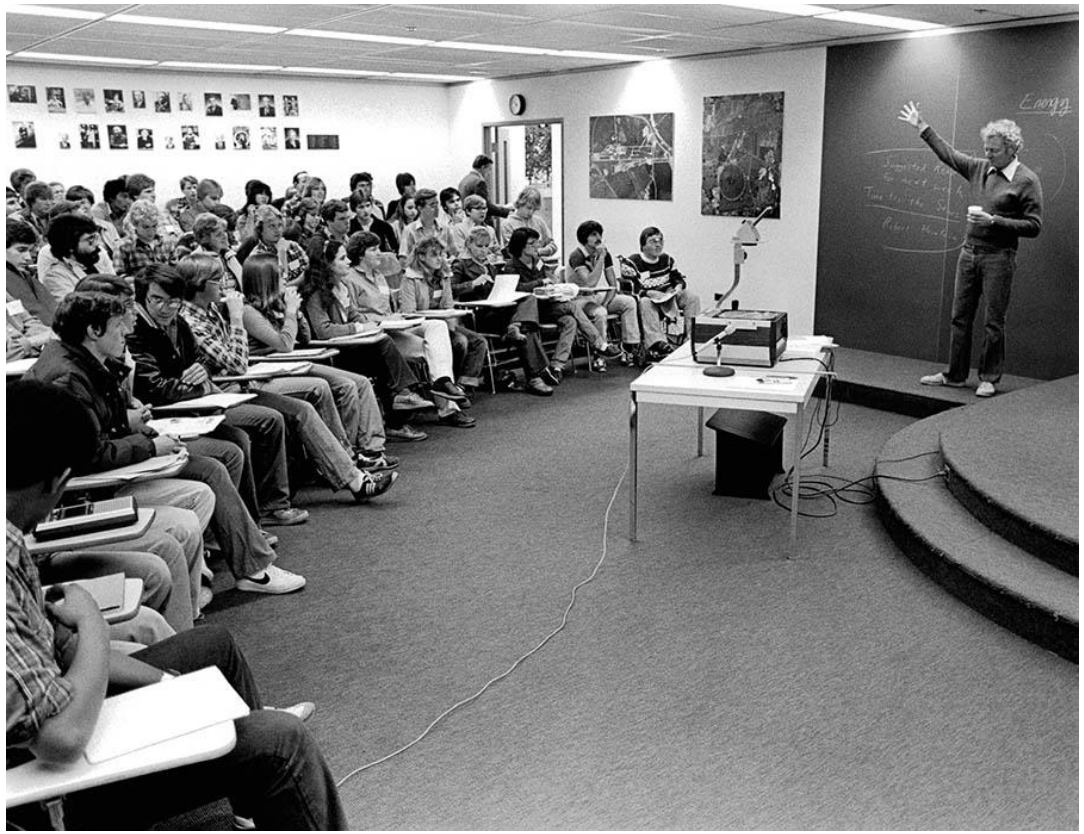


Explanation Legitimation **Visibilty**

Outreach



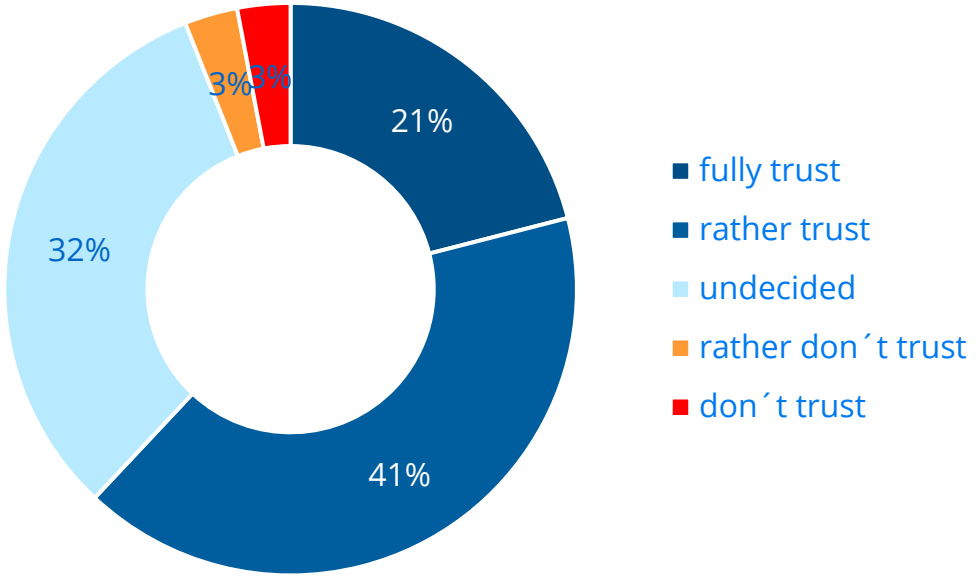
Leon Lederman, 1980ies

Explanation Legitimation Visibilty **Next generation**

Outreach

"How much do you trust science and research?"

Wissenschaftsbarometer 2021



Source: Wissenschaft im Dialog/Kantar

Outreach

QAA Podcast on Twitter: "Tonight's epi...
twitter.com

CERN AND THE GATES OF HELL | ВКонтакте
vk.com

Pin on For the Home
pinterest.com

CERN Concern News - Home | Facebook
facebook.com

LHC
pinterest.com

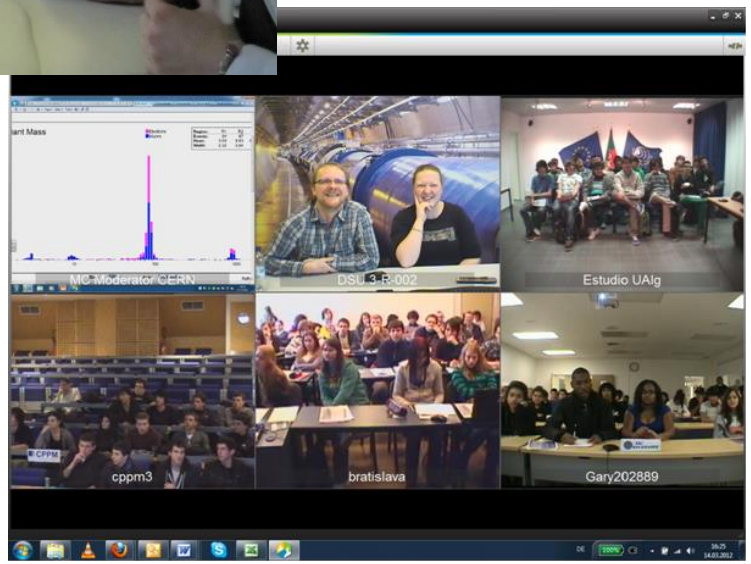
JULY 5, 2022. WILL A PORTAL TO HELL WILL ...
theworldhour.com

Explanation Legitimation Visibilty Next generation **Trust in science**

Outreach

Concept of Masterclasses

- High school students (15 – 19) are „scientists for one day“
- Lectures & Hands-on activities
- Held by (young) physicists, e.g. PhD students
- At a research institute or university or classroom



Outreach

The idea behind Masterclasses

Act as a "scientist for a day"

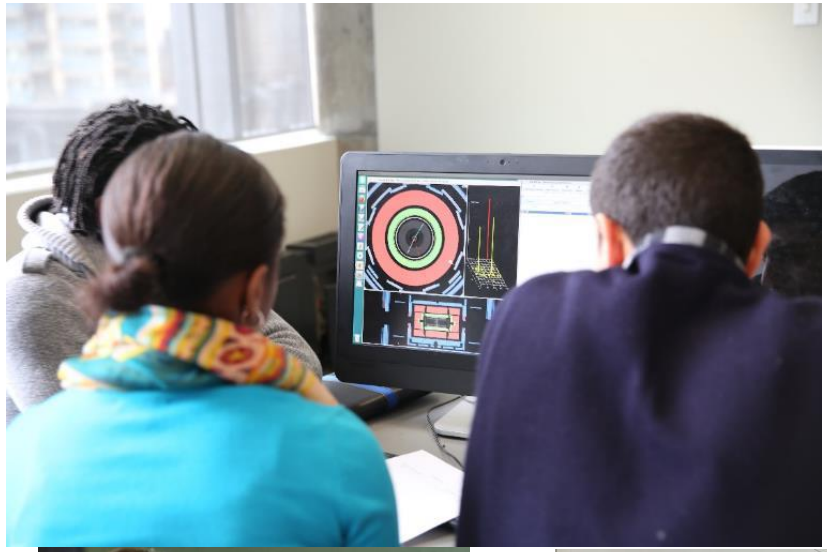
- Close to current research
- Own "hands-on" activities (listen = forget, see = remember, do = understand)

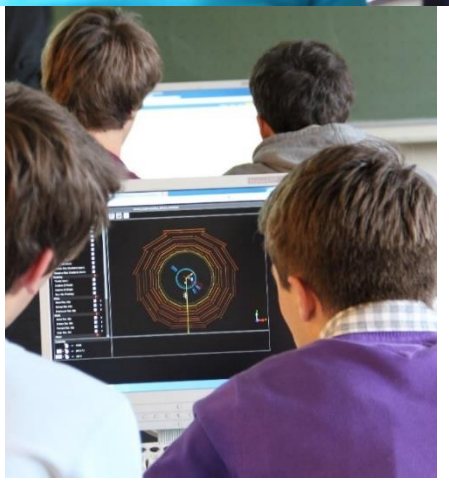
Authentic experiences

- Analysis of real scientific data
- Meeting and discussion with scientists

Get insight into the research process

- Use of relevant methods and tools
- Comparisons between experiment and theory



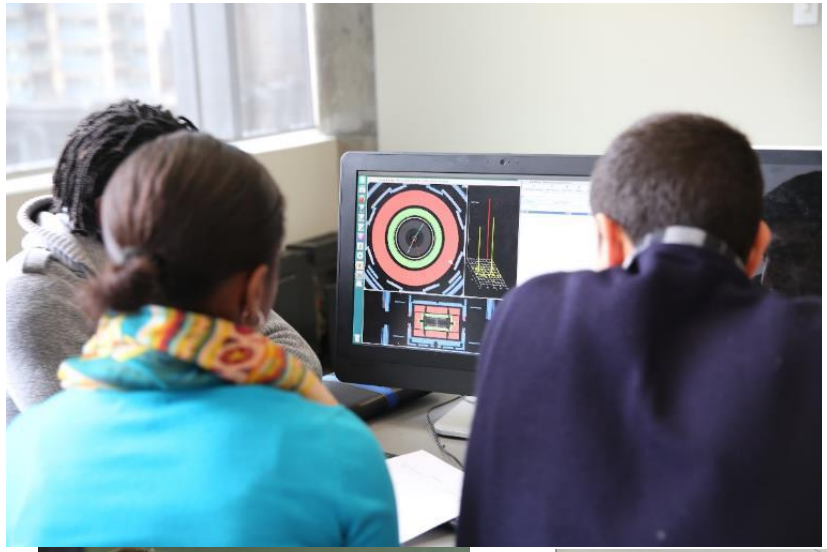


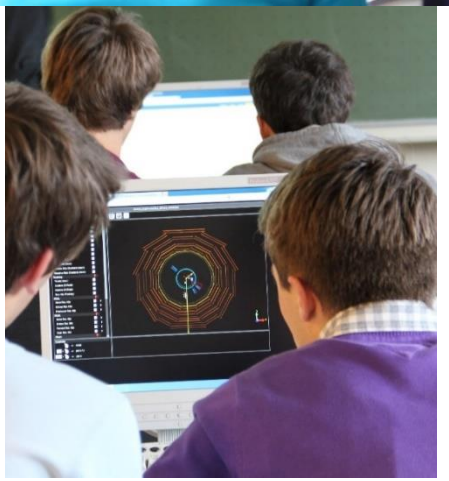
Outreach

The idea behind Masterclasses

Existing programs and structures create **multiple benefit**

- win for **high school students**:
  ´experience modern research first-hand
- win for **facilitators/PhD students**:
  train their communication skills,
  participate in a rewarding activity,
  learn more about their own science
- win for **physicists**: get young talents for the research groups





NUCLEAR ASTROPHYSICS
MASTERCLASSES

What are we working on?

- Development of two Nuclear Astrophysics Masterclasses
  - First Masterclass available @ mc.chetec-infra.eu
  - Second Masterclass coming End of 2023
- Languages
  - **German**, **English**, **French**, **Italian**, **Czech**, **Bulgarian**, **Sorbian**
  - Spanish, Romanian, Swedish, Hungarian, Lithuanian, Hebrew, *Hindi, Catalan*, *Welsh*

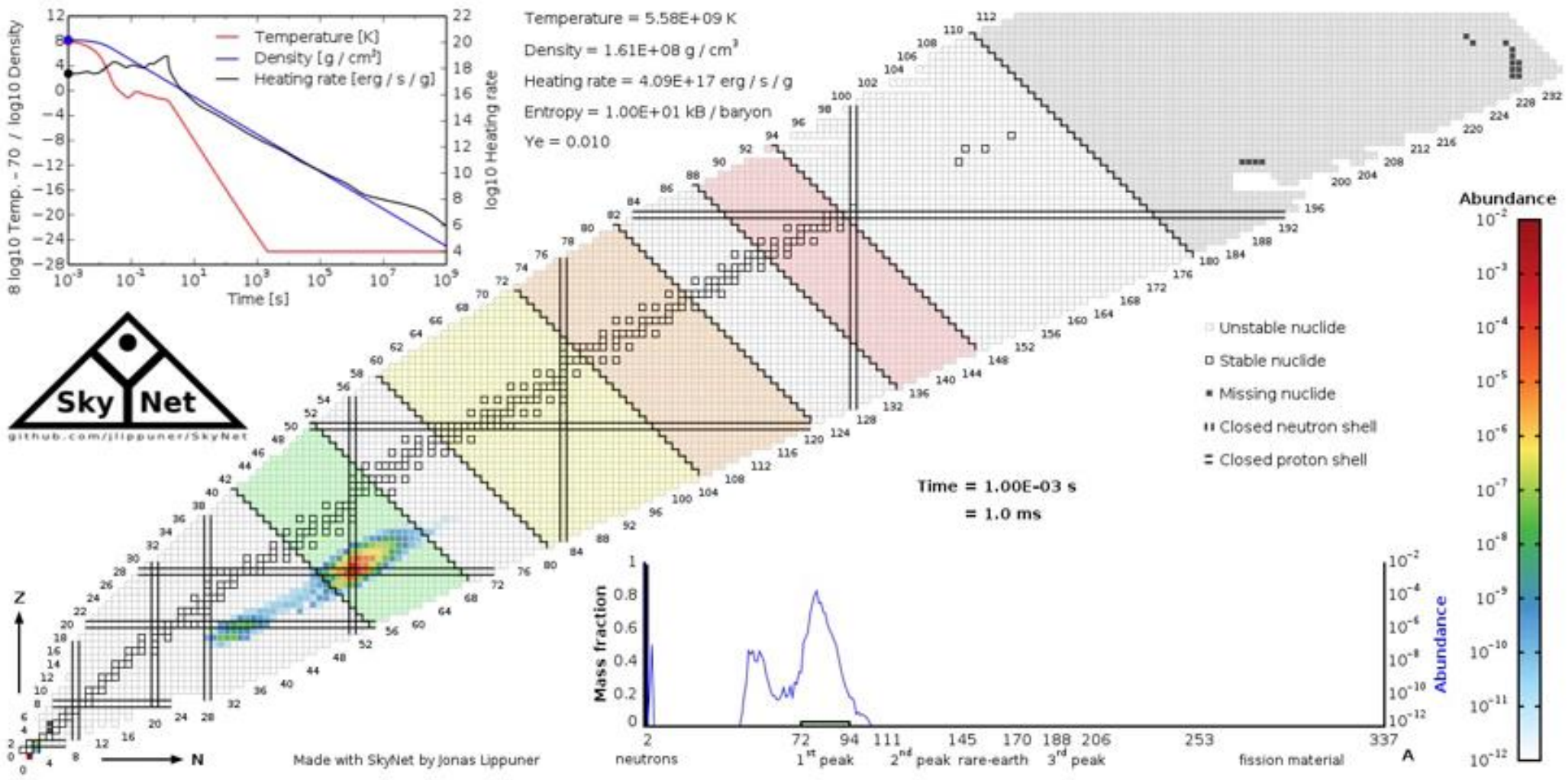
What are we working on?

- **Centerpiece** of the Masterclasses: Analysis & evaluation of a **physical experiment**
  - ➢ Current Measurements carried out by nuclear physicists / Astrophysicists
- **Learning Goals**
  - Teaching the basic principles of nuclear physics & astrophysics
    Nuclei Structure, Nuclear Reactions, Nucleosynthesis, Stellar Evolution, Cross Sections etc.
  - Conveying the basic idea of this science field
    What questions does nuclear astrophysics ask itself and how does it work to answer them?
  - Depicting how physical knowledge develops
    Dynamics, evolution & open questions of nuclear astrophyiscs
  - Insight into the work of nuclear astrophysicists
  - ➢ Create interest in Nuclear Astrophysics

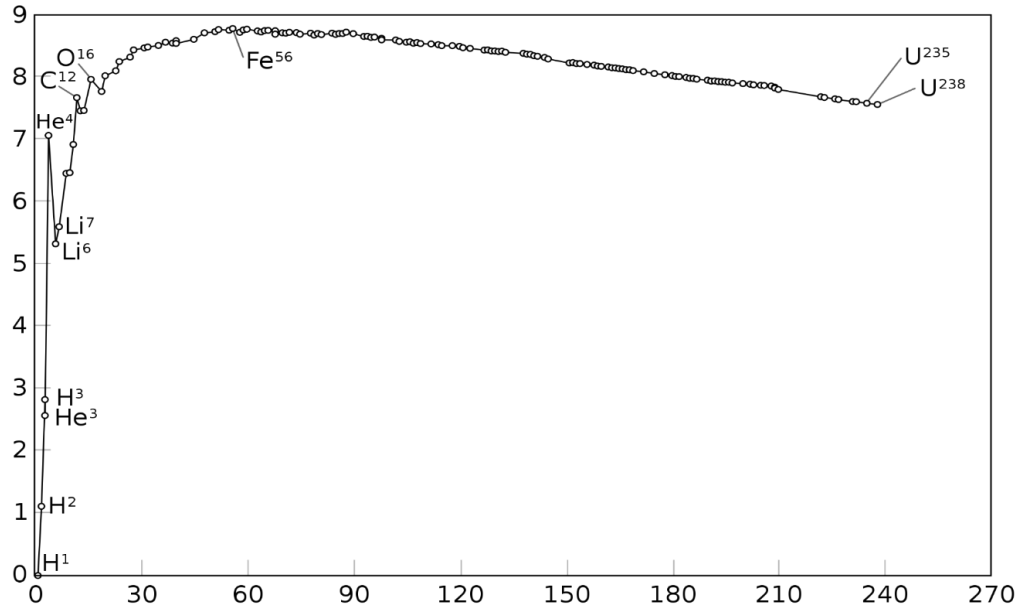
Education is that which remains when one has forgotten everything he learned in school.

Insight into the **Content** and **Materials**

R-Process in Action

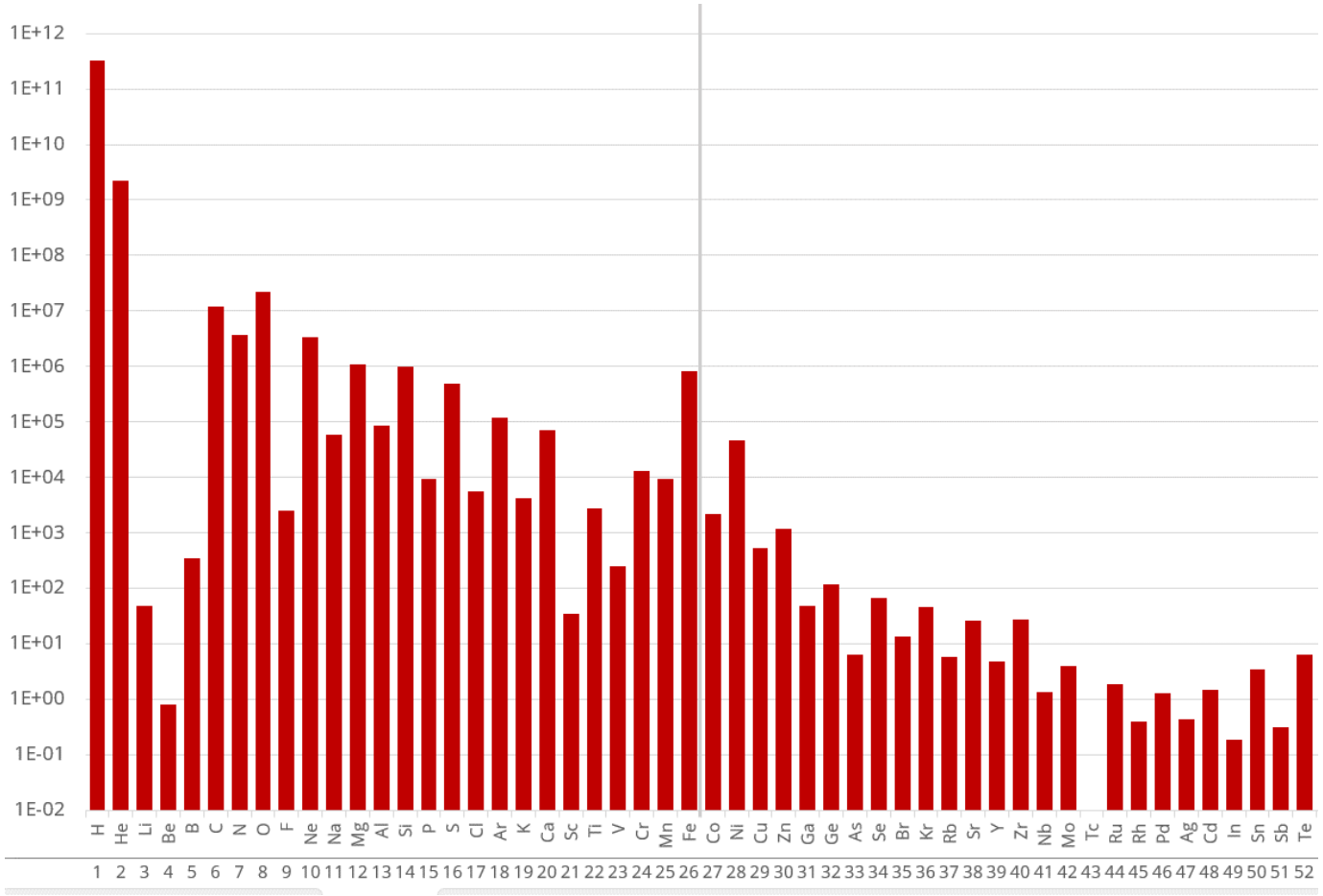


S- & R-Process



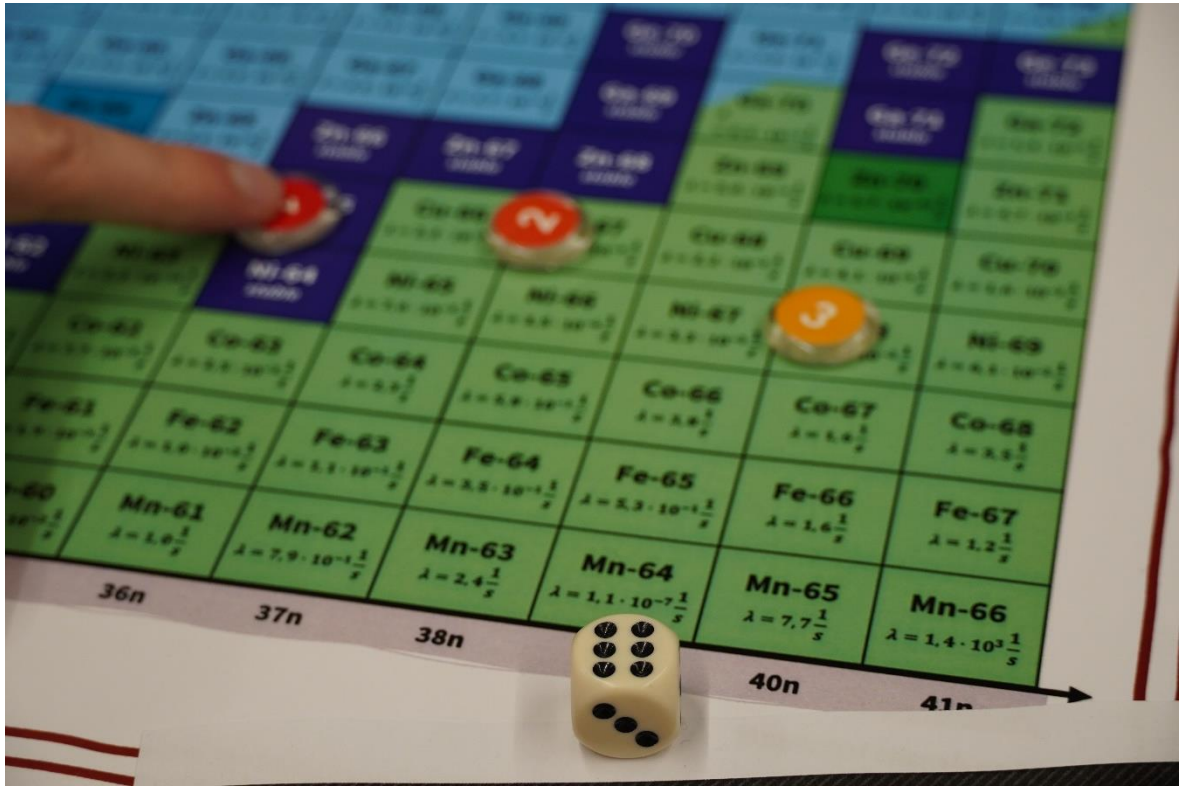
Binding Energies

Abundances of the chemical elements



S- & R-Process

- **The Nuclei Race**:
  Recreating s- and r-processes in a board game
  - Calculate the probability ratio between neutron capture and beta conversion
  - Tracing the steps on a nuclide map
  - Clarify the difference between the s- & r-process as well as the stochastic character



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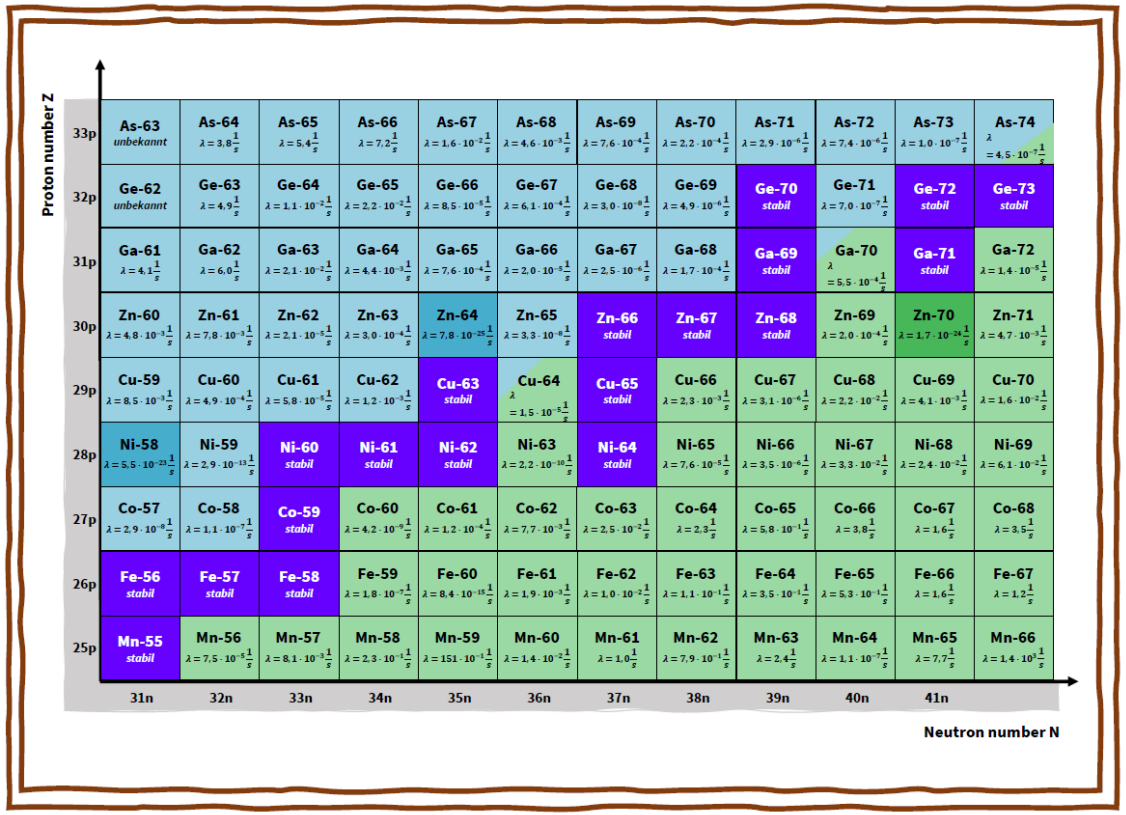

Content & Materials

- **Various Lectures** linking the activities
- **Videos & Visualizations**
- **Multiple Activities** with Gamification Elements, e.g. …
  - Nuclei Race
  - Primordial nucleosynthesis puzzle
  - Playful Challenges
  - Building a Hertzsprung–Russell diagram together

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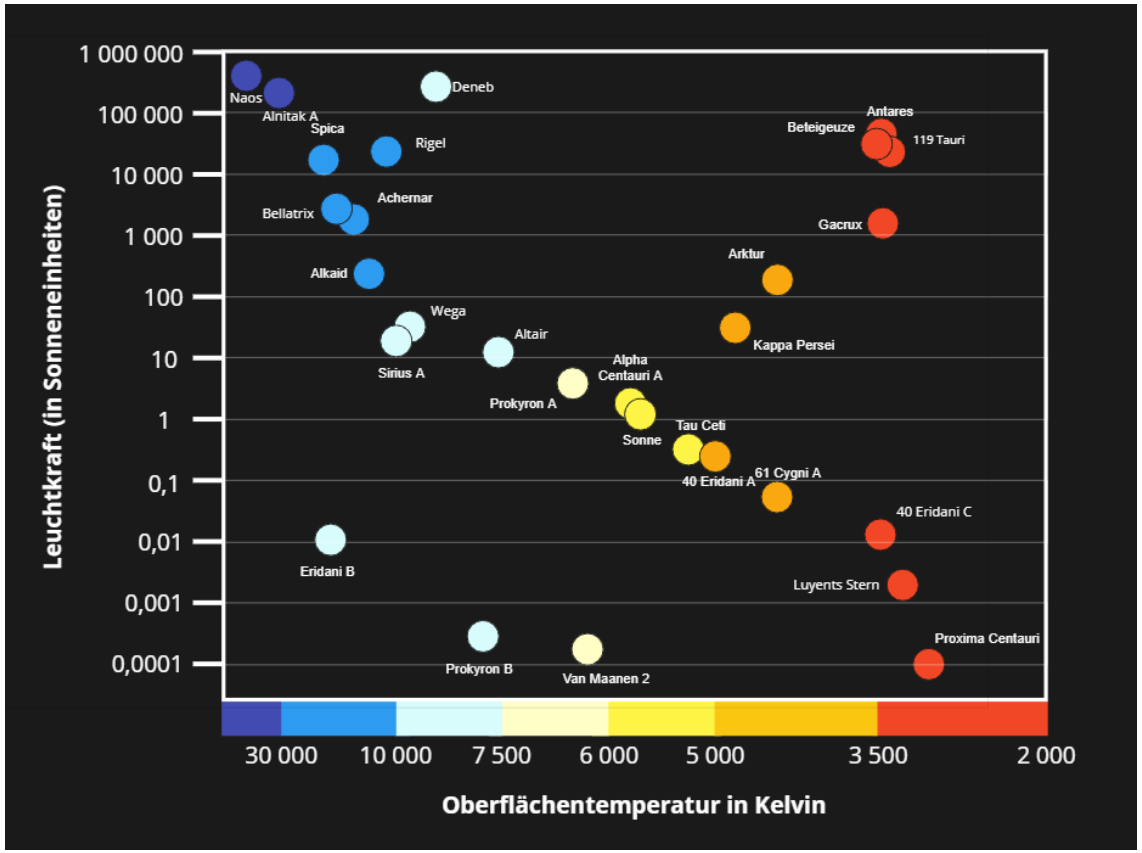

Content & Materials

Nuclides	Stars	Universe
$ 100	$ 100	$ 100
$ 200	$ 200	$ 200
$ 300	$ 300	$ 300

Content & Materials

Nuclides	Stars	Universe
Why is the earth's core composed mainly of Iron & Nickel?	Why are stars spinning?	How do we know how old the universe is?
Why are Lithium and Beryllium so rare?	Why do stellar spectra have absorption lines?	How does the expansion of the universe work?
Why is there radioactivity at all?	What is a star?	What was before the Big Bang?

Content & Materials

Centerpiece of the Masterclass:
Analysis & evaluation of a **nuclear astrophysics experiment**

1. Masterclass

- Nuclear Reaction Measurements carried out at the Felsenkeller Laboratory
- Data analysis of $^{14}\mathrm{N}(\alpha,\gamma)^{18}\mathrm{F}$
  - Gamma spectroscopy & peak measurements
  - usage of a term diagram
  - Consideration of the underground
  - Determination of the cross section & reaction rate

2. Masterclass

- Stellar Spectra provided by Andreas
- Analysis of **Lithium Abundances**
  - Astronomical Spectroscopy
  - Deriving stellar parameters
  - Calculating Abundances with WebSME
  - Reconstructing the cosmological lithium problem

Goals:

- Working as a Physicist for one day
- Gain an Insight into the Laboratory and the working methods of Nuclear & Astrophysicists

Content & Materials

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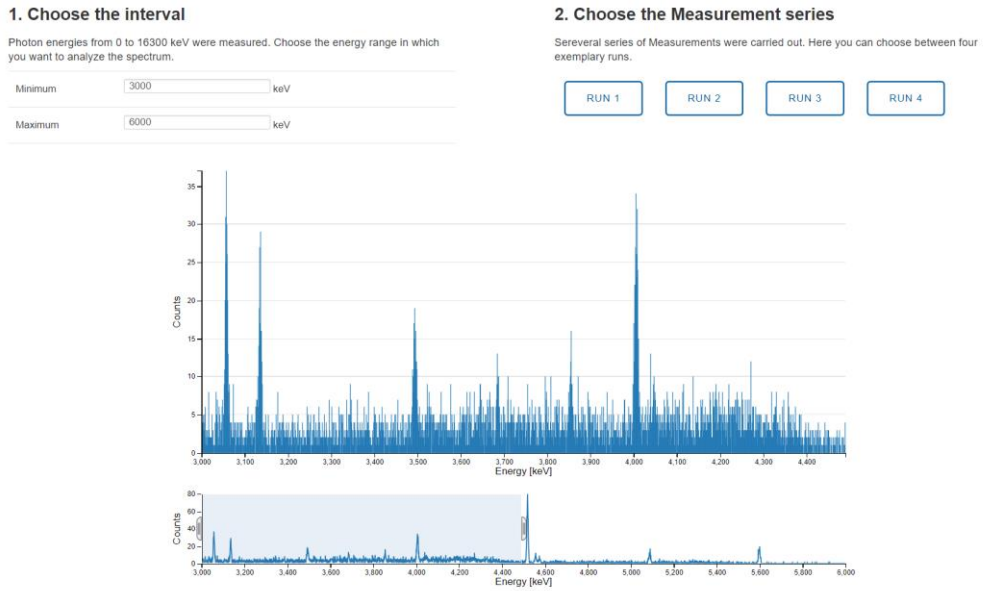
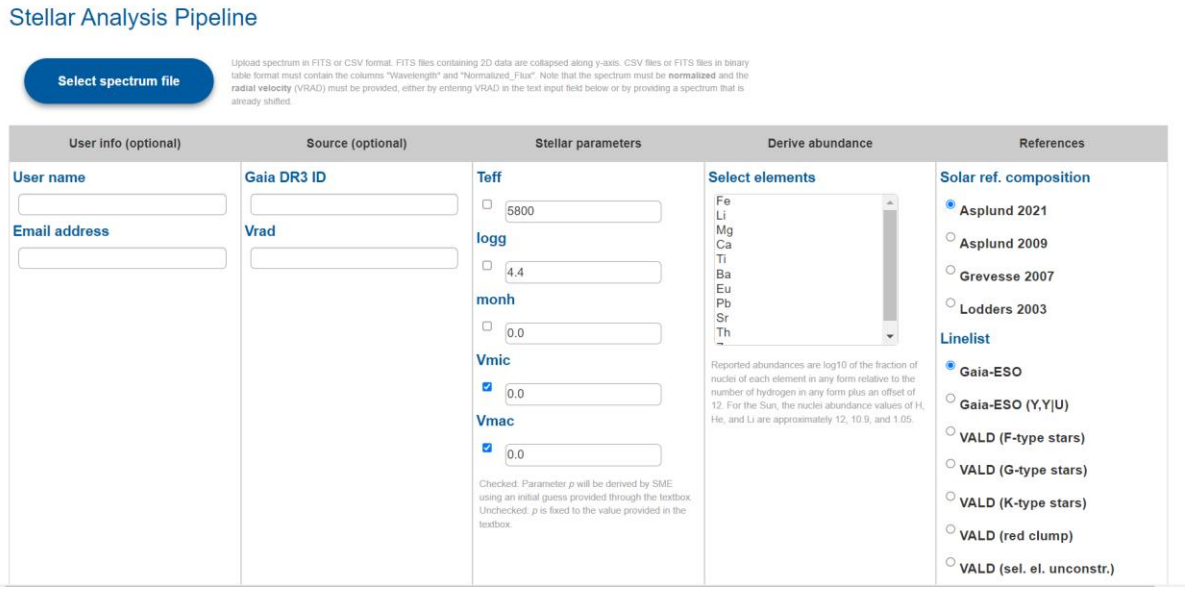


2. Masterclass



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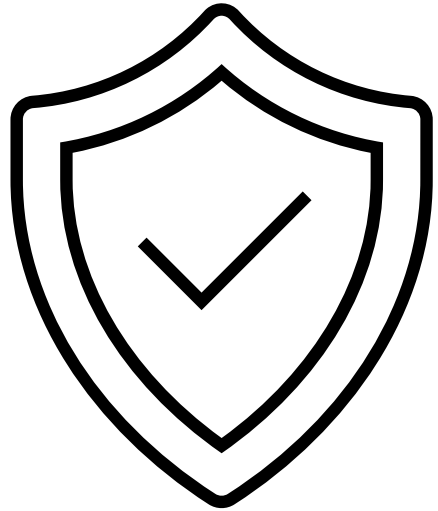
General **Design Aspects** of the Masterclasses

General Design Aspects

1. Low Threshold

- Previous knowledge in astrophysics and nuclear physics not mandatory
- Target Group: Age 15+



General Design Aspects

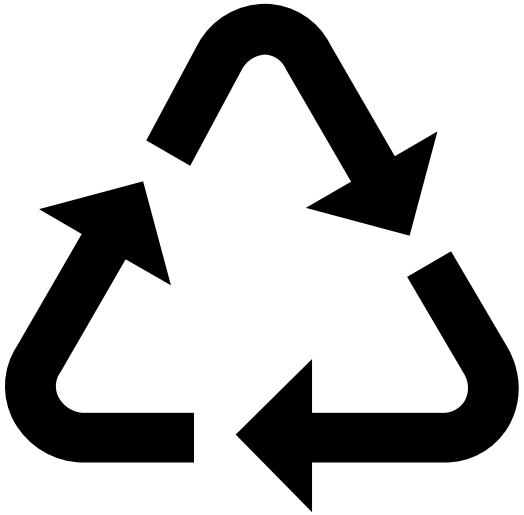
1. **Low Threshold**
2. **Accessability**

- Masterclass available in both online and live formats
- Open Access to all materials online
- No software installations necessary
- Analog materials can be recreated easily

General Design Aspects

1. **Low Threshold**
2. **Accessability**
3. **Reproducibility**

- Complete materials & instructions for educators open access
- Making it as easy as possible, to be a Nuclear Astrophysics Facilitator



General Design Aspects

1. **Low Threshold**
2. **Accessability**
3. **Reproducibility**
4. **Two different Masterclasses**

- Access to nuclear astrophysics with different Points of View
- No Necessity to visit the first Masterclass to understand the second
- Two independent Masterclasses
  - Each Scientist can choose their preferred topic

1. Masterclass
Nuclear Physics Experiments

Nuclear Astrophysics

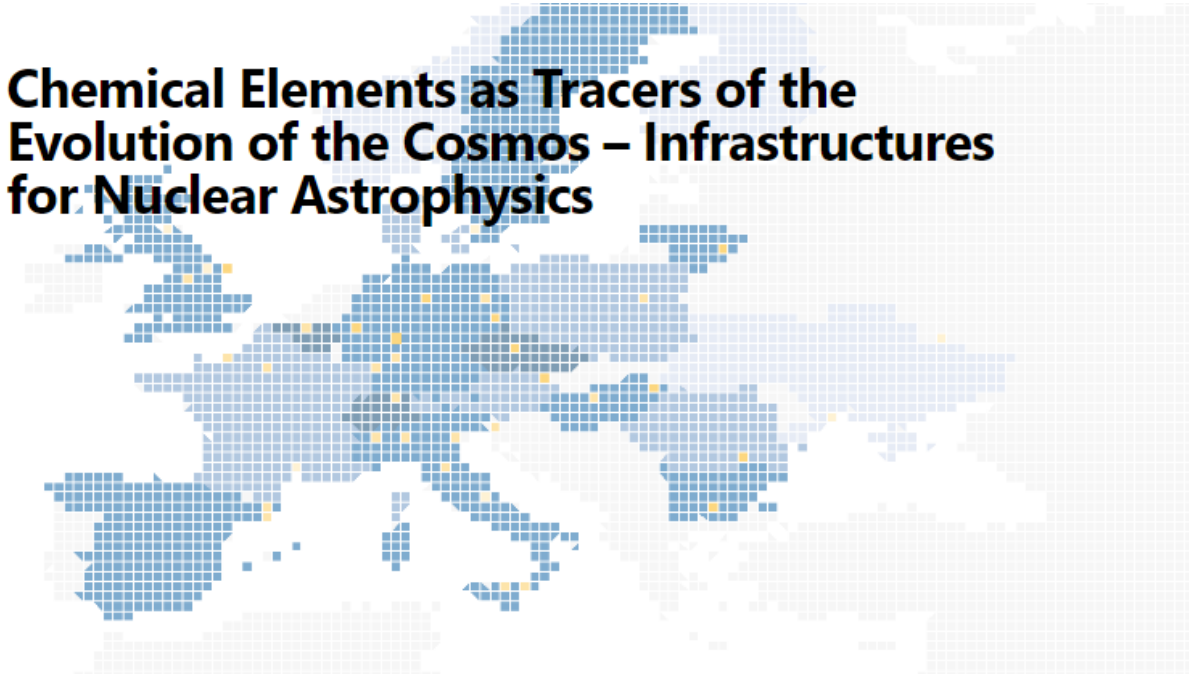
2. Masterclass
Astronomical Observations

How can you contribute?

How can you Contribute?

We are aiming for…

- Creating a Network of Nuclear Astrophysics **Facilitators**
- Giving every Physicist the opportunity to be a Educator
- Mediate Nuclear Astrophysics around the Globe



ChETEC-INFRA Masterclasses

mc.chetec-infra.eu

How can you Contribute?

We are looking for…

Science Communicators who want to give Nuclear Astrophysics Masterclasses

- Anyone who works in this field, can be an **Educator & Facilitator**
- **Open Access Teaching Materials** including
    - Presentation
    - Guide for the whole Masterclass
    - Guided Masterclass Run Through

If you're interested, get in touch:

hannes.nitsche@tu-dresden.de

How can you Contribute?

Connecting with Schools & Students

- Talk to your supervisor
- Masterclass contacts at your institute? Outreach / public engagement officer at your institute or faculty?
- Check out NuPECC, PANS (Public Awareness of Nuclear Science)
- School contact office, Newsletter, mailing, social media, Contact your former school
- Cooperation with a school lab, or networks, e.g STEM schools
- Contact Hannes!

If you're interested, get in touch:

hannes.nitsche@tu-dresden.de

Masterclass can be found online @

http://mc.chetec-infra.eu

Thank you for your attention.