

Letter of Intent presentation: ChETEC-INFRA

Axel Boeltzig, ChETEC-INFRA project manager
(Daniel Bemmerer, ChETEC-INFRA PI)

ChETEC-INFRA – where do we come from, 2021-2025
Science case



Proposed TA (transnational access) – small accelerators and telescopes

Proposed VA (virtual access) – nuclear astrophysics databases (reaction rates)

Proposed service improvement – jet gas targets

Proposed NA (networking activity) – nuclear astrophysics schools for PhD students

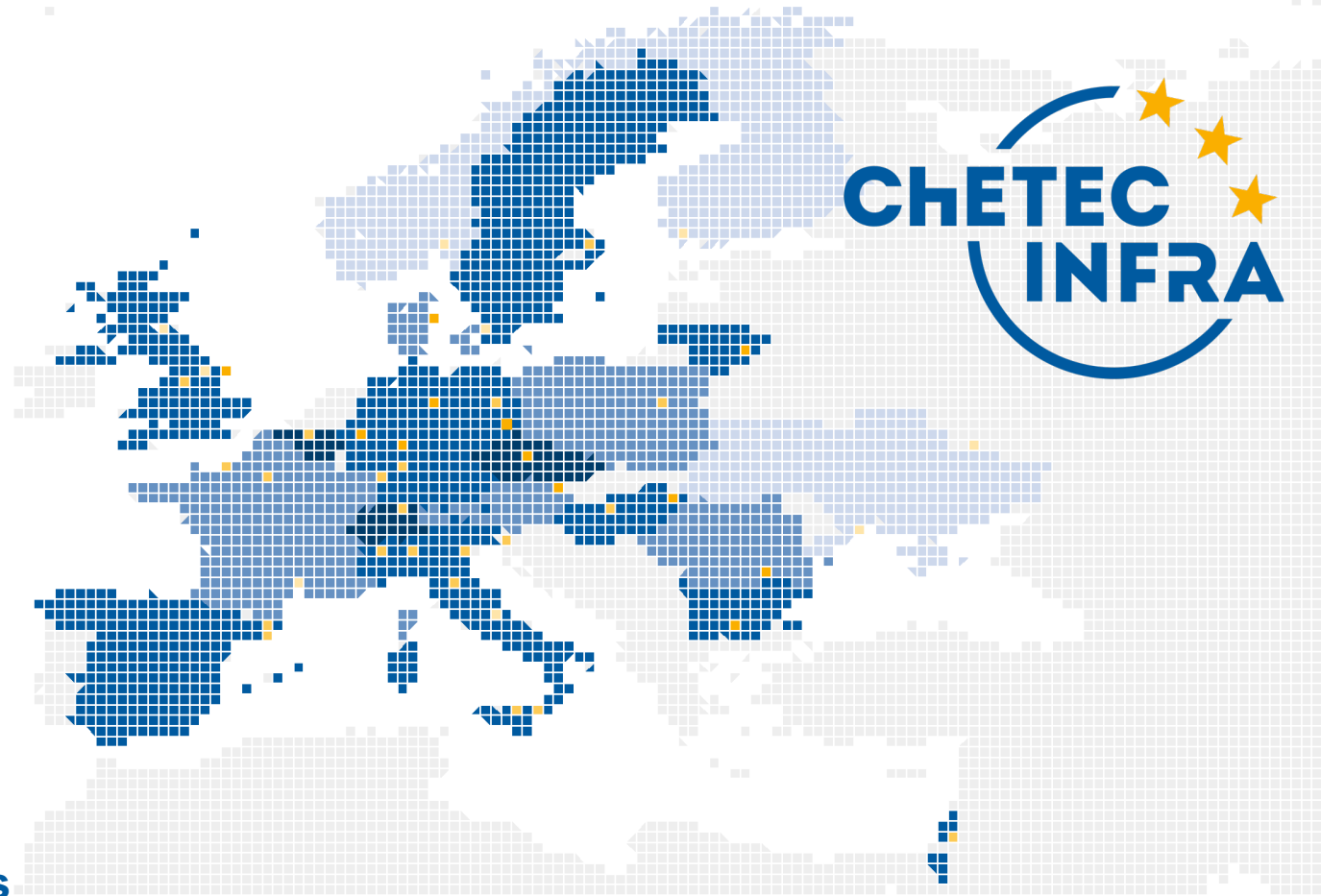
Proposed NA (networking activity) – outreach to high school students

Proposed NA (networking activity) – outreach to meteoritic / planetary science

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- ♦ **C**hemical **E**lements as **T**racers for the **E**volution of the **C**osmos – **I**nfrastructures for Nuclear Astrophysics
- ♦ EU Horizon 2020 **Starting Community of Research Infrastructures**
- ♦ H2020-INFRAIA-2020-1
- ♦ **31 partners** in 17 EU+ countries
- ♦ 1 May 2021 – 31 October 2025
- ♦ 5.0 M€ support by European Union
- ♦ **14 research infrastructures** offer EU-supported transnational access, selection based on scientific merit
- ♦ **Outreach** to PhD students, high school students
- ♦ ChETEC-INFRA legacy: many **online databases**

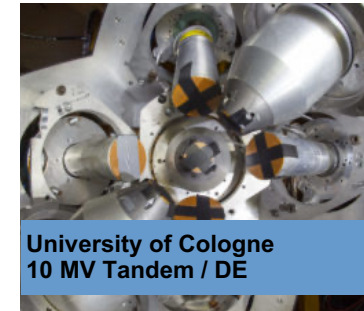
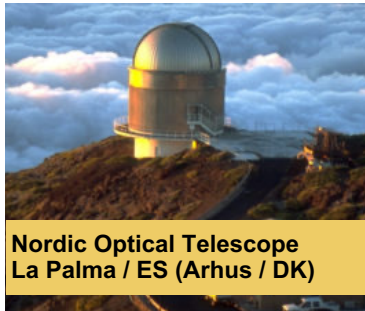


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Coordination:
HZDR, Germany

HZDR
HELMHOLTZ ZENTRUM
DRESDEN ROSENDORF

ChETEC-INFRA: 14 nuclear astrophysics research infrastructures



accelerators

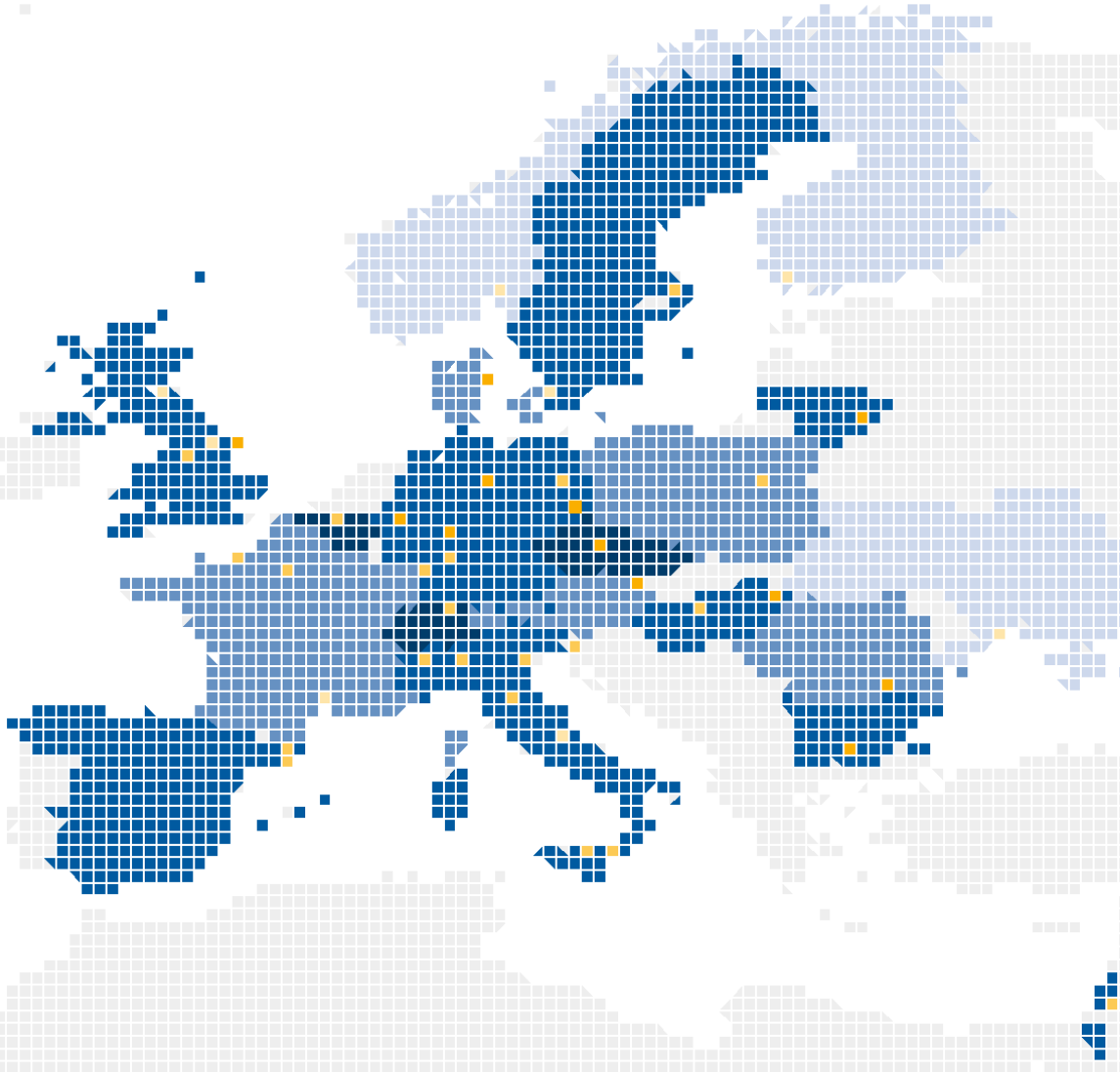
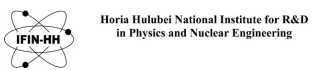
telescopes

supercomputer



5039 beam hours at accelerators, 39 nights at telescopes, 3.9 M cpu-hours

31 funded partners in EU, UK, Israel



Science – overlap between nuclear astrophysics and hadron physics

- Experiment MAGIX @ MESA Mainz on the $^{12}\text{C}(\alpha,\gamma)^{16}\text{O}$ reaction – stellar helium burning (NuPECC LRP, p. 28)
- χ EFT (Chiral Effective Field Theory) based calculations for $^3\text{He}(\alpha,\gamma)^7\text{Be}$ – Big Bang & solar neutrinos (Box 2.5 in NuPECC LRP, p. 29)
- Equation of State of neutron star matter – link to gravitational waves and neutron star mergers (Einstein Telescope) and to their multimessenger observations (nuclear astrophysics)
- Joint technical developments: Gas jets, and their characterization
- ECT* as a hub for theory in hadron physics and nuclear astrophysics

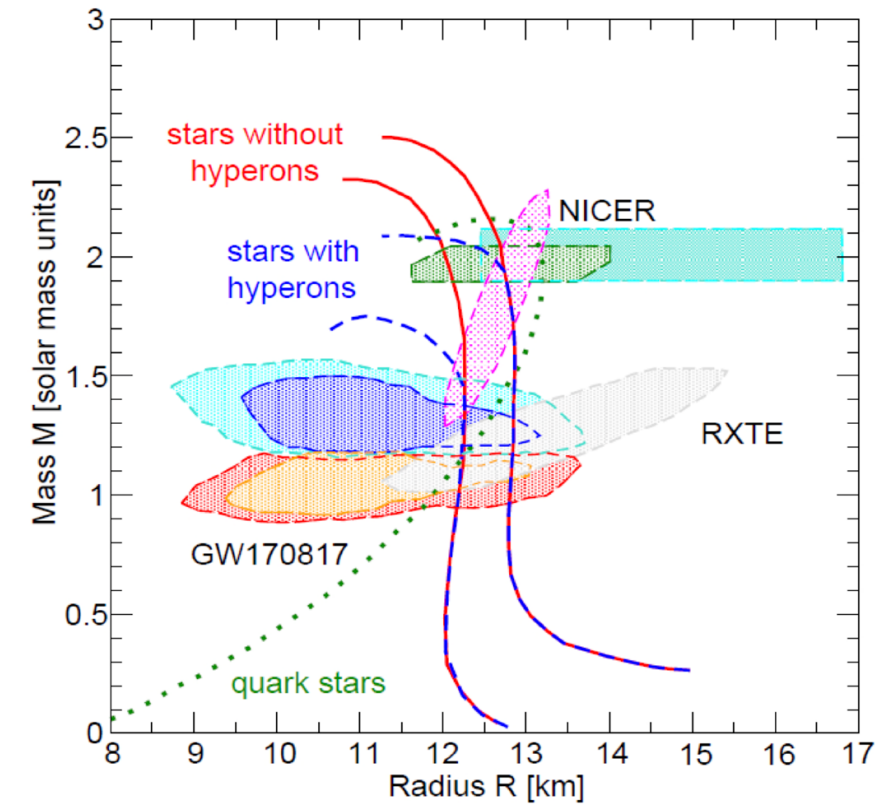


Fig. 2.9: The blobs represent the mass and radius constraints from the gravitational wave detectors LIGO and Virgo, as well as NASA's Neutron star Interior ExploreR (NICER), while the dashed and solid lines represent the predictions obtained with various EoS models, with and without hyperons. Picture credit I. Vidana (Universita di Catania).

Proposed TA (transnational access) – small accelerators and telescopes

0.8 M€ transnational access (including travel) for small labs and medium size telescopes

- | | |
|---------------------------|---|
| • HZDR/DE Felsenkeller | Underground ion beam for cross section measurements |
| • INFN/IT Bellotti | Underground ion beam for cross section measurements |
| • HZDR/DE HAMSTER | Accelerator Mass Spectrometer (AMS) for rare astrophysical isotopes |
| • UNIVIE/AT VERA | Accelerator Mass Spectrometer (AMS) for rare astrophysical isotopes |
| • PTB/DE PIAF | Neutron and ion beams for detector calibrations |
| • IFIN/RO Tandem | Tandem for cross section measurements |
| • Atomki/HU Accel. Center | Accelerator laboratory for cross section measurements |
| • ASU/CZ Perek | 2m telescope for stellar observations |
| • IANAO/BG | 2m telescope for stellar observations |
| • UNIVIL/LT Moletai | 2m telescope for stellar observations |
| • AU/DK NOT | 4m Nordic Optical Telescope (La Palma) |

Proposed VA (virtual access) - nuclear astrophysics databases

Databases and datasets	Weblink
Barium Star Repository	https://github.com/Milne-Centre/Barium-Star-Repository
Reaction Network Generator – NetGen	http://www.astro.ulb.ac.be/Netgen/
New Generation of Solar Models	https://doi.org/10.5281/zenodo.10822316
Nuclear Reaction Rates – ChANUREPS	https://chanureps.chetec-infra.eu/
Stellar Trajectories – ORChESTRA	https://zenodo.org/communities/chetec-infra-wp4
s-process Library – ASTRAL	https://exp-astro.de/astral
Solar Fusion Library (Solar Fusion III)	https://doi.org/10.5281/zenodo.13945119
3D NLTE Abundance Correction Grid	https://www.chetec-infra.eu/3DNLTE/
Database of stable isotope anomalies in bulk meteoritic materials	https://chetec.csfk.org/

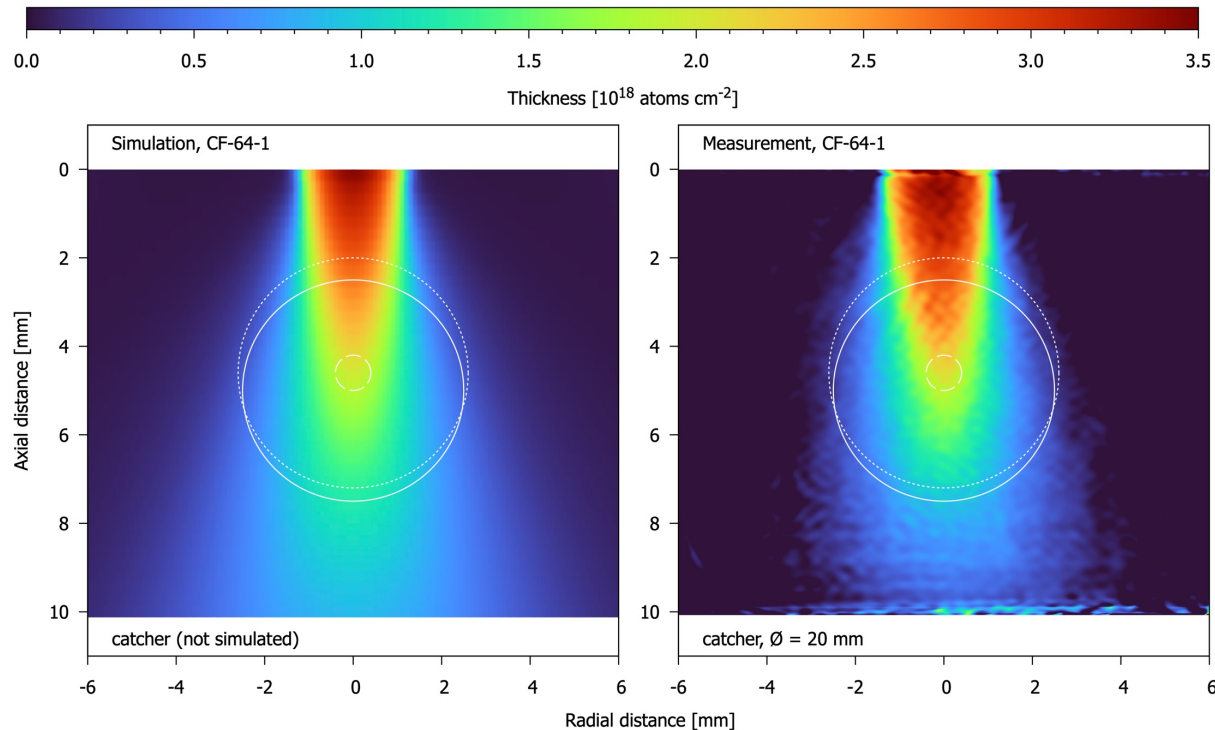
Virtual access: Make these databases (all were created by EU funds in the ChETEC-INFRA project) accessible via one common, long term sustainable interface, and grow them further.

Resources: 0.3 M€

Proposed JRA / service improvement – jet gas targets

Jet gas targets are important for many areas of nuclear and particle physics, including hadron physics and nuclear astrophysics

- Development of a wall – type gas jet target with on-line interferometric density measurement
- Application to rare and corrosive gases



Contributors:

Uni Münster
(A. Khoukaz)

HZDR
(K. Schmidt,
interferometer)

...and others

0.3 M€ resources



Proposed NA / networking activity – outreach to high school students

Outreach tool = so-called Masterclass

- A Masterclass is a full-day teaching unit deployed in high schools, by PhD students as teachers.
- ChETEC-INFRA developed and deployed two Masterclasses, with scientific background (didactics PhD thesis)
- So far available in twelve languages, more on the way: Bulgarian, Czech, **English**, French, German, Italian, Lithuanian, Polish, Romanian, Upper Sorbian, Spanish, and Swedish

Proposed Networking Activity

- Develop two more Masterclasses, and deploy them
- One on hadron physics
- One on nuclear astrophysics

Partner and resources

- TU Dresden (Uta Bilow) coordinated ChETEC-INFRA Masterclasses 2021-2025, stands ready again
- Ample experience in science communication (German "Netzwerk Teilchenwelt") for particle physics et al.
- **0.2 M€ resources**



Proposed NA / networking activity – outreach to PhD students

Supported
by
ChETEC-
INFRA

- **18th Nuclei in the Cosmos school 2025**

- Place: Barcelona
- Dates: June 10 – 13, 2025

Organized
by
ChETEC-
INFRA

- **2nd ChETEC-INFRA Observational School 2025**

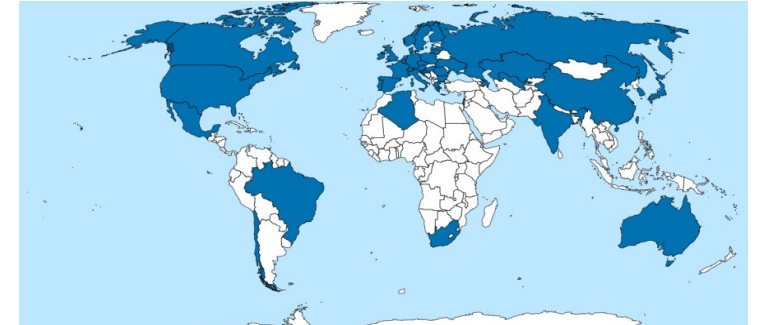
- Place: Prague, Czech Republic
- Dates: June 20 – 26, 2025

Organized
by
ChETEC-
INFRA

- **22nd Carpathian Summer School of Physics 2025**

- Place: Sinaia, Romania
- Dates: June 22 – July 3, 2025

0.2 M€ resources



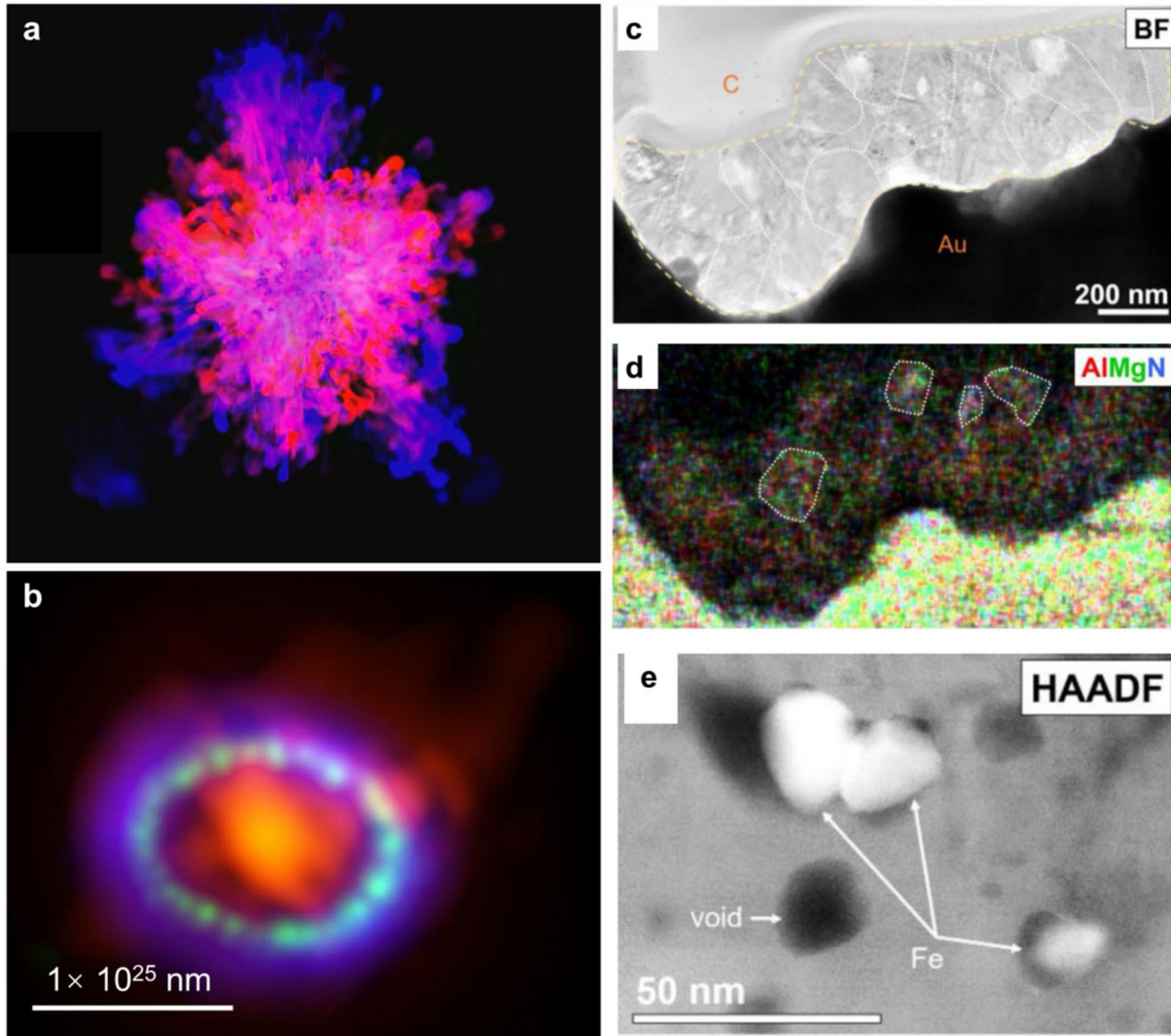
Schools on Nuclear Astrophysics Questions (SNAQs), as COVID-19 response

- from Feb 2021 to May 2022, 12 editions
- 1243 participants, 34% female

**Nuclei in the Cosmos
School 2025**



Proposed NA / networking activity – outreach to meteoritic science



Meteorites as connectors between nuclear astrophysics, geoscience, climate science, and the early universe.

Interdisciplinary bridge, based on highly successful NA in ChETEC-INFRA

Possible partners:

ETH Zürich
Konkoly Observatory, Budapest

0.2 M€ resources

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Acknowledgment



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101008324 (ChETEC-INFRA).