

Center of Accelerators and Nuclear Analytical Methods and other infrastructures

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Nuclear Physics Institute of the CAS

Jan Dobeš

Nuclear Physics Board EPS meeting, June 13, 2017, Řež



EUROPEAN UNION
European Structural and Investment Funds
Operational Programme Research,
Development and Education



Nuclear Physics Institute of the CAS

www.ujf.cas.cz

major Czech institution in nuclear physics field

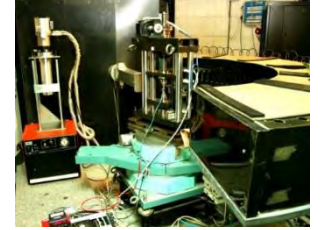
~ 290 employees ~ 100 scientists ~ 30 PhD student
(220 FTE) (80 FTE)

annual budget 8.5 MEUR
(50% institutional support CAS, 50% targeted support)



mission

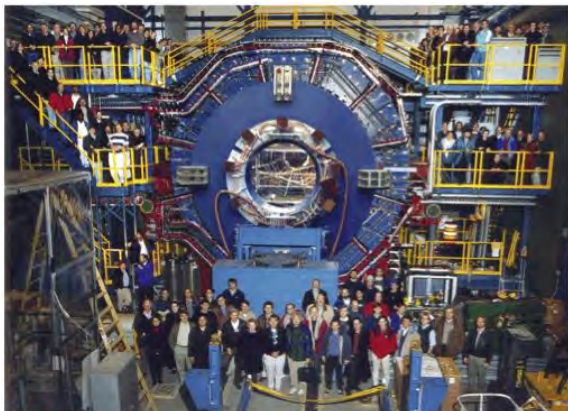
- basis research in nuclear physics and related disciplines
- use of nuclear physics methods in interdisciplinary scientific and research areas
- participation in large-scale international projects
- employment of home facilities and equipment





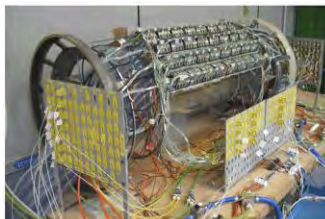
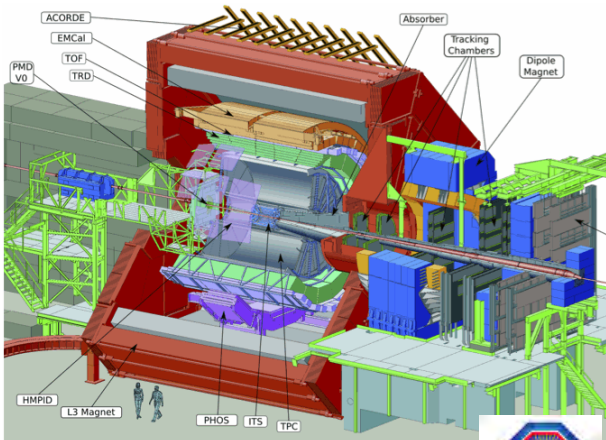
Phases of Nuclear Matter

STAR Solenoidal Tracker At RHIC @



- Silicon Vertex Tracker
- Heavy Flavor Tracker
- Distributed data management

ALICE A Large Ion Collider Experiment @

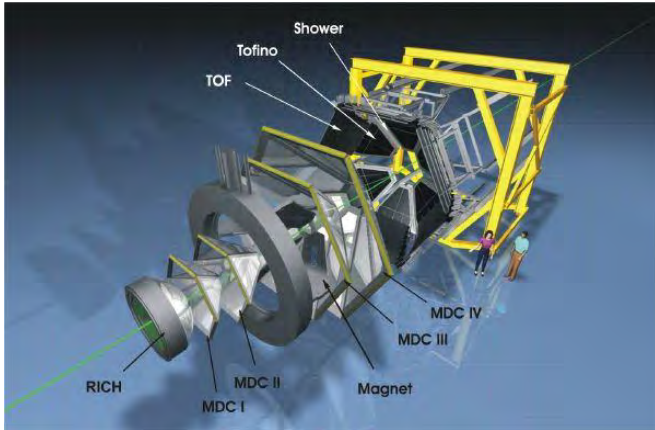


- Inner Tracking System
- GRID processing

Physics:

- Bulk correlations (Femtoscopy)
- Jet-like correlations
- Heavy flavor
- Nuclear suppression at large x

HADES High Acceptance Di-Electron Spectrometer @ GSI

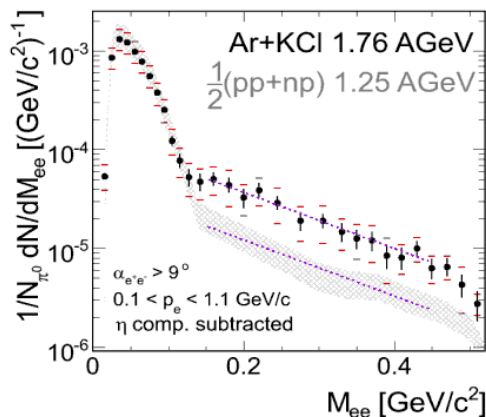


TOF manufacturing & installation

FW installation

Electromagnetic Calorimeter

CBM Compressed Baryonic Matter @ FAIR Projectile Spectator Detector



Physics:

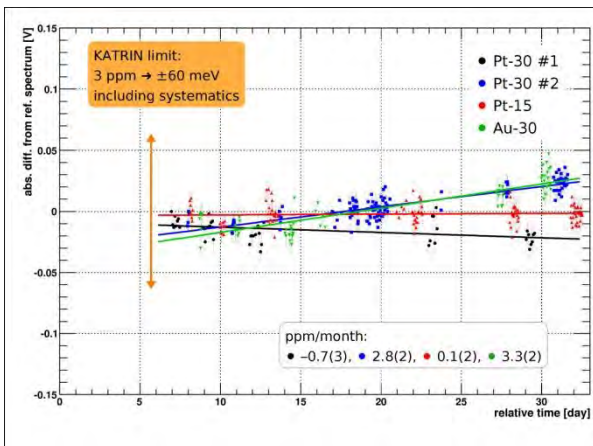
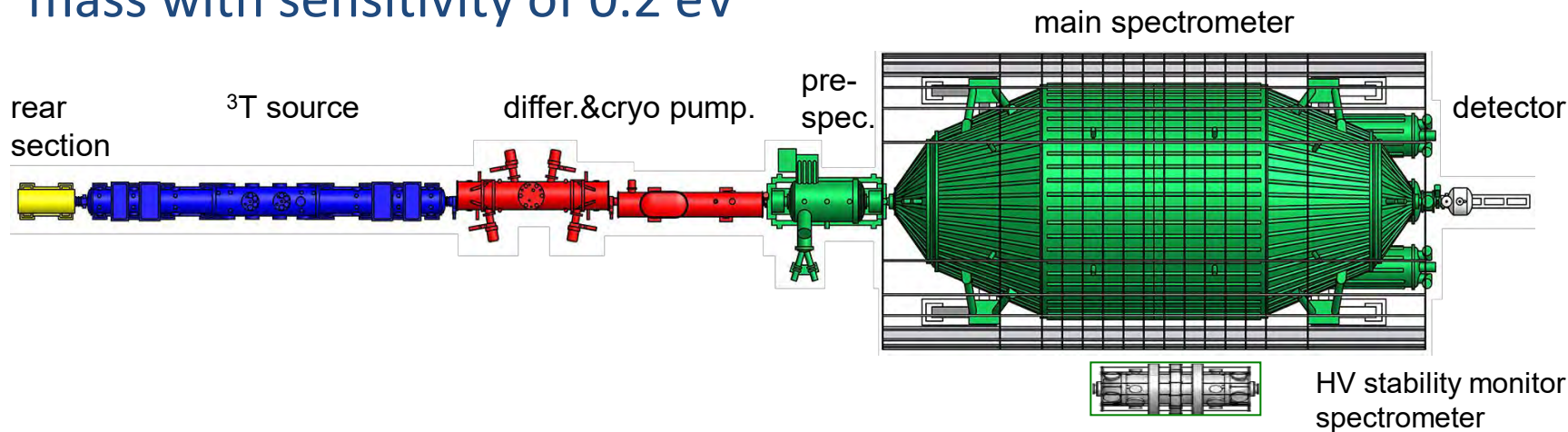
inclusive $e^- e^+$ pair production

inclusive electron-positron pair production

KATRIN (Karlsruhe Tritium Neutrino experiment) @



determination of the neutrino mass with sensitivity of 0.2 eV



calibration & monitoring task

source of conversion electrons with energy uncertainty $\sigma/E = 3\text{ppm} / (2 \text{ month exper. run})$

ESS is a partnership of 17 European Nations

Sweden, Denmark, Spain, Norway, Estonia, Latvia, Lithuania, Poland, Italy, Germany, France, Czech Republic, Switzerland, Iceland, Hungary, Netherlands, UK



the world's leading facility for research using neutrons

- ❑ brightest source of neutrons, long pulse
- ❑ neutrons – excellent instrument for probing matter
- ❑ field of research

energy, climate, health
chemistry, new materials
environment, archeology
engineering

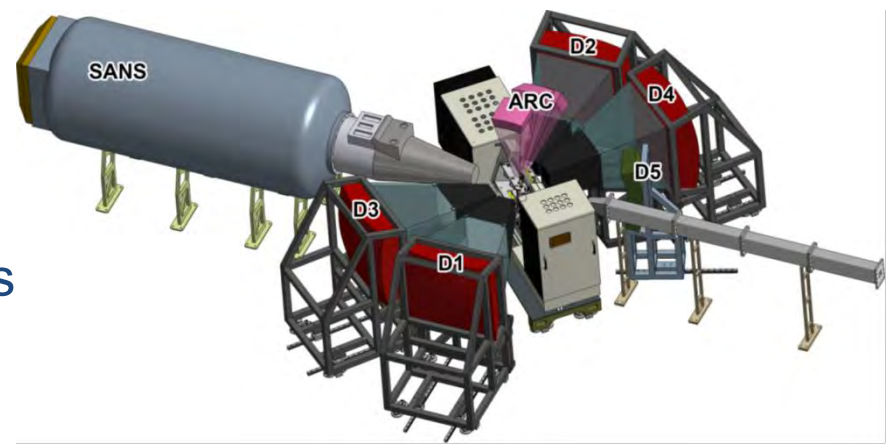


2% contribution, 36.86 M€

NPI task

BEER

Beamline for **E**uropean **M**aterials
Engineering **R**esearch



Czech contribution

ESS Target Station: Helium cooling system

Primary Water Cooling System

Intermediate Water Cooling System

HVAC Target Station Systems

Center of Accelerators and Nuclear Analytical Methods canam.ujf.cas.cz

**Laboratory of
Cyclotron and Fast
Neutron Generators
(LC & FNG)**

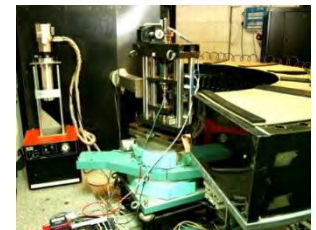
Operating the cyclotrons
U-120M & TR-24

**Laboratory of
Tandetron (LT)**

Operating an accelerator
Tandetron 4130 MC

**Neutron Physics
Laboratory (NPL)**

Providing facilities at the
reactor LVR-15



- 58 research infrastructures approved by MEYS
- operational costs funded by the MEYS
- investment costs - European Structural and Investment Funds



10.1 Physical Sciences

Center of Accelerators and Nuclear Analytical Methods

Acronym:
CANAM

Hosting institution:
Nuclear Physics Institute,
Academy of Sciences of the Czech Republic

Responsible person:
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Website:
canam.ujf.cas.cz



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Background description

The CANAM operates several different types of accelerators and neutron facilities, which are used in a wide range of scientific and technological disciplines. The ions are prepared at the isochronous cyclotron accelerator U-120M and at the electrostatic linear Tandemron 4130M accelerator. The facilities for studies with thermal neutrons are installed at the irradiation channels of the LV8-15 research reactor operated by the Rez Research Center. Fast neutrons are obtained from production targets at the cyclotron U-120M. The possibilities and scope in combination with different techniques using the ion and neutron beams which can be implemented in synergic combination in the CANAM laboratories are unique, even at the international level. The production, modification and complex characterization methods of CANAM are offered with employment for basic and applied studies in various R&D fields such as physics, materials sciences, chemistry, biology, biomedicine, energetics, microelectronics, environmental sciences, archaeology, cultural heritage, etc.

Future development

Permanent effort is devoted to developing, upgrading and modernizing the CANAM laboratories. At present, the most important enlargement is the purchase of the new TR-24 cyclotron, which substantially increases the possibilities in the research of radioactive production, with applications mainly in medicine and life sciences, and in fast neutron studies, with an impact on the development of future fission and fusion technologies. Other significant developmental step is considered, namely the purchase of an Accelerator Mass Spectrometry (AMS) system, presently not available in the Czech Republic.

Socio-economic impact

Both ion and neutron beams are important for their performance in various targeted applications, which are important not only for the scientific community, but also for the commercial sector, as the development of new materials and technologies, nanostructure synthesis, ion beam microanalysis, radiation hardness of electronic elements, and nuclear data for fusion and advanced fission systems. Cooperation between CANAM and the commercial sector concentrates not only on solving common R&D projects and tasks, but also on providing services at the CANAM facilities and expertise.

CANAM Center of Accelerators and Nuclear Analytical Methods

FAIR – CZ Facility for Antiproton and Ion Research

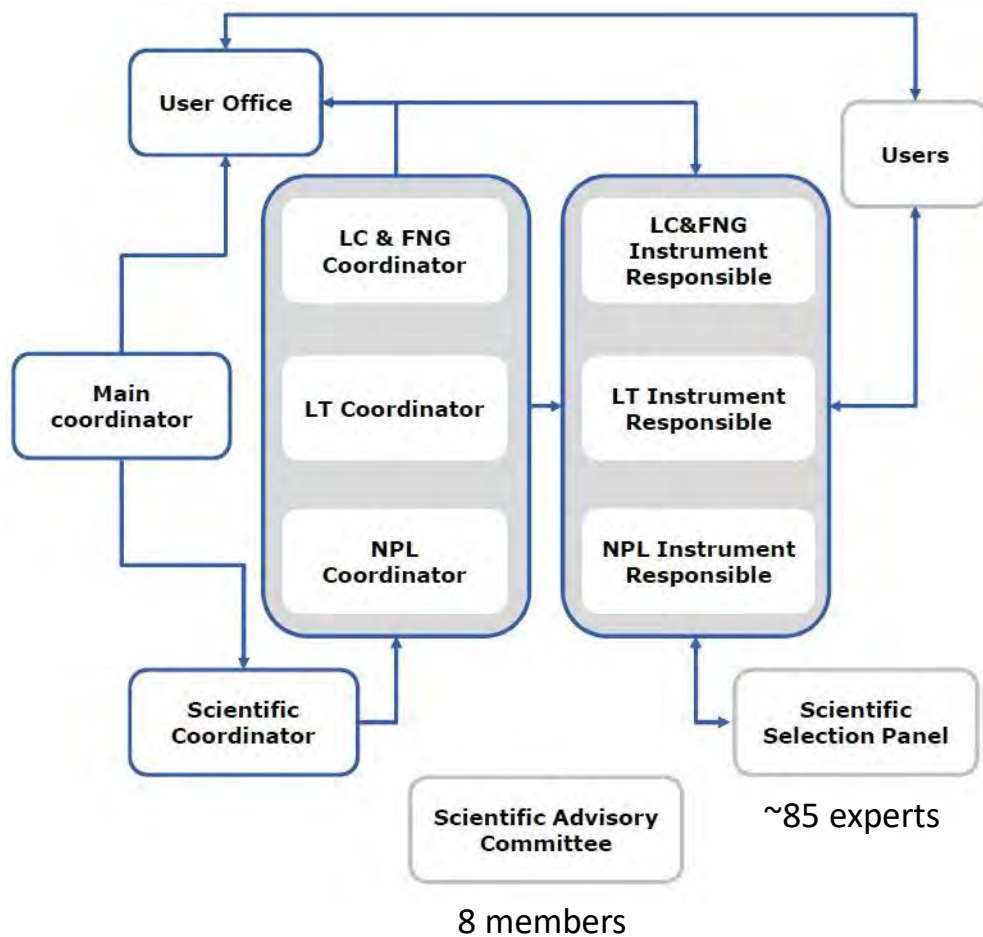
SPIRAL2 – CZ Systeme de Production d'Ions RAdioactifs en Ligne
(nuclear astrophysics, Neutrons For Science – NFS)

ESS Scandinavia – CZ European Spallation Source

CERN – CZ

BNL – CZ Brookhaven National Laboratory

EATRIS - CZ European Infrastructure for Translation Medicine



open access procedure

proposals via Users Portal

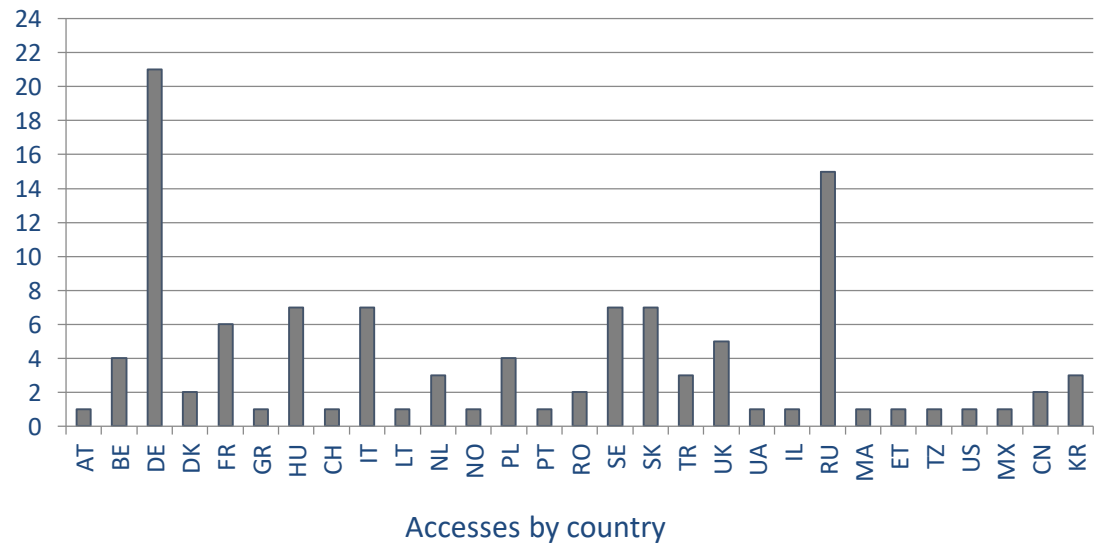
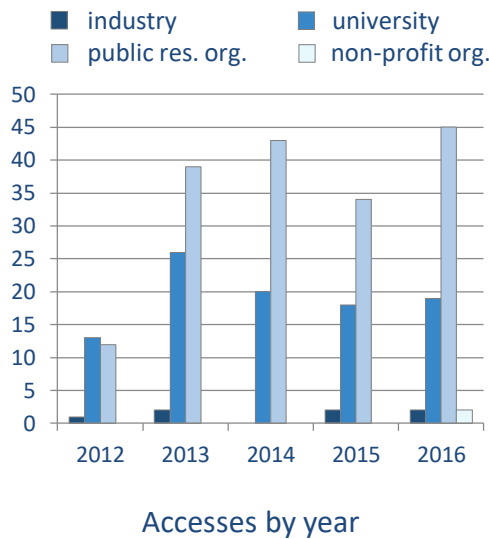
reviewed by 2 experts from SSF

technical feasibility by IR

- user community (2012 – 2016):**

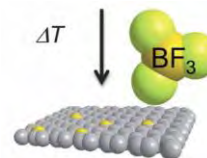
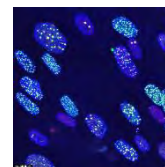
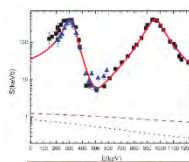
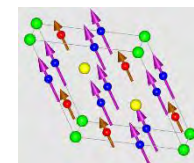
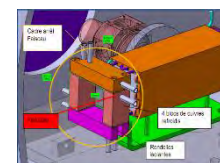
users (proposers and co-proposers of experiments) – 776 from abroad – 259

accesses (experiments performed) – 278 (CZ – 167, ERA – 86, others – 25)



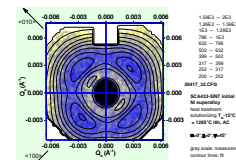
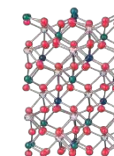
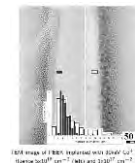
in 2012 – 2016 210 publications in impacted journals
concerned with 22 scientific disciplines

- Archaeology, anthropology, ethnology
- Elementary particle theory and high energy physics
- Nuclear, atomic and molecular physics, accelerators
- Optics, masers and lasers
- Plasma physics and discharge through gases
- Solid-state physics and magnetism
- Astronomy and celestial mechanics, astrophysics
- Biophysics
- Inorganic chemistry
- Analytical chemistry, separation
- Organic chemistry
- Macromolecular chemistry
- Biochemistry
- Physical chemistry and theoretical chemistry
- Electrochemistry
- Nuclear and quantum chemistry, photochemistry
- Geochemistry
- Pollution and air control
- Genetics and molecular biology
- Microbiology, virology
- Botany
- Biotechnology and bionics
- Food industry
- Electronics and optoelectronics
- Sensors, detecting elements, measurement and regulation
- Composite materials
- Other materials
- Corrosion and material surfaces
- Fatigue and fracture mechanics



Detection limits INAA, g

Element	Limit (g)
Al	0.001
As	0.001
B	0.001
Br	0.001
Ca	0.001
Cd	0.001
Co	0.001
Cu	0.001
Fe	0.001
Ga	0.001
Hg	0.001
I	0.001
K	0.001
Mn	0.001
Ni	0.001
P	0.001
Pb	0.001
S	0.001
Se	0.001
Si	0.001
Sr	0.001
Ta	0.001
Tb	0.001
Tl	0.001
V	0.001
Zn	0.001
Zr	0.001



ESS - European Spallation Source - testing of instrumentation at NPL

SPIRAL2 - Systeme de Production d'Ions RAdioactifs en Ligne / Neutrons for Science - development of neutron sources, radioactive ion production reactions

FAIR - Facility for Antiproton and Ion Research
detector response to real particles and radiation fields

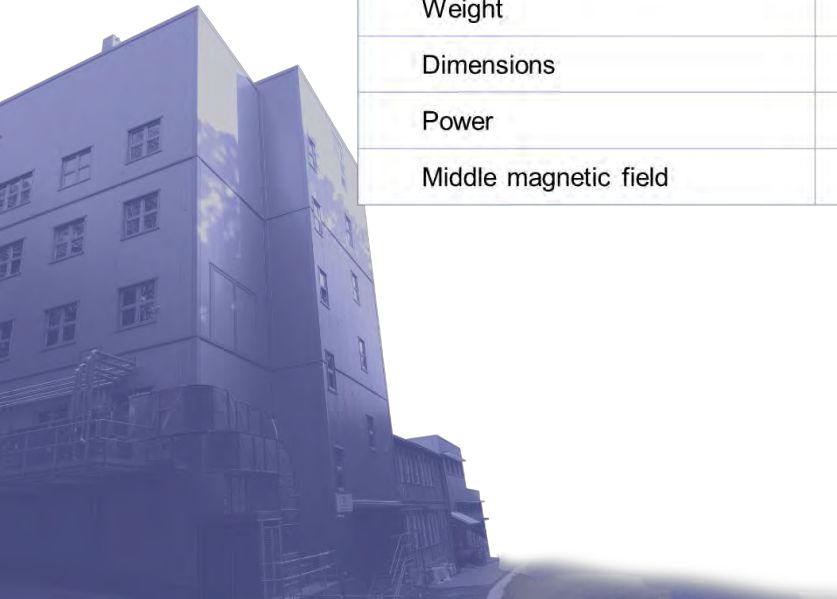
HL-LHC - High-Luminosity Large Hadron Collider
radiation hardness tests of silicon sensors and readout electronics

EATRIS - European Advanced Translational Research Infrastructure in Medicine
production of radionuclides for labelling and testing automated systems

KATRIN - Karlsruhe Tritium Neutrino experiment
production of calibration sources

2013 – 2015 investment (CAS, MEYS, NPI)

TR 24 – Advanced Cyclotron System Inc. (Canada)	
Proton energy range	18–24 MeV
Max. proton beam current	300 μ A
Acceleration frequency	85 MHz
Acceleration voltage	50 kV
H ⁻ Ion source	Multi-CUSP
Simultaneous beams	2
Weight	25 t
Dimensions	1.8×1.8×2.5 m
Power	180 kW
Middle magnetic field	1.4 T



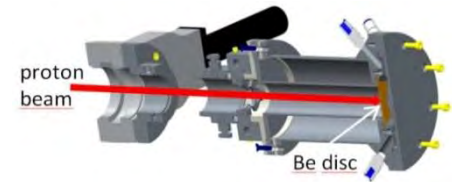
Installations and methodological development:

2017 – 2019

- high-intensity neutron source at TR-24
- n-TOF method, modernization of the detection system at FNG
- upgrade LT - ion microprobe and external analytical end-stage
- upgrade NPL - supermirror neutron guide

2020 and beyond:

- TR-24 - dual beam regime, neutron lines with TOF
- Accelerator Mass Spectrometry (AMS)





Thank you for
attention
canam.ujf.cas.cz

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