High energy physics in Hungary

(particle and nuclear physics, astroparticles)

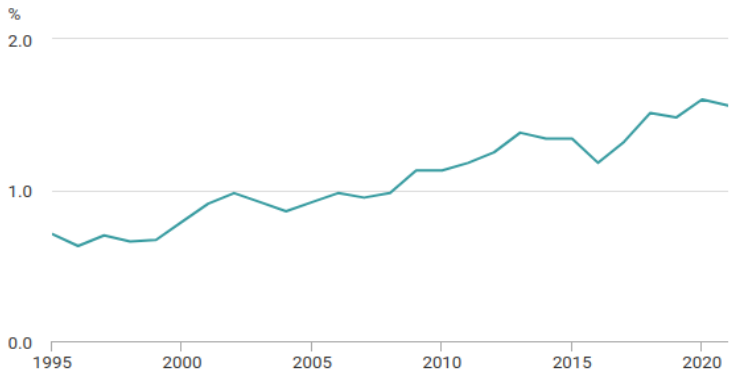
Hungary became a CERN member state in 1992.
[Thirty years of Hungarian membership of CERN]

Hungary in numbers

Parliamentary republic
Capital and largest city: Budapest
Official language: Hungarian
Area: 93,030 km^2
Population: 9.7 million
Ethnic groups: 98.3% Hungarians, 3.2% Romani (up to 8%), 1.8% Germans
Joined the European Union: 2004
Currency: Hungarian forint; 1 EUR is about 400 HUF
GDP per capita: $36,848 (on purchasing power parity), $18,527 (nominal)

Some recent (2021) numbers from the Hungarian Central Statistical Office:

- R&D expenditure as a percentage of GDP: 1.56%. It continuously increased through the past decades:



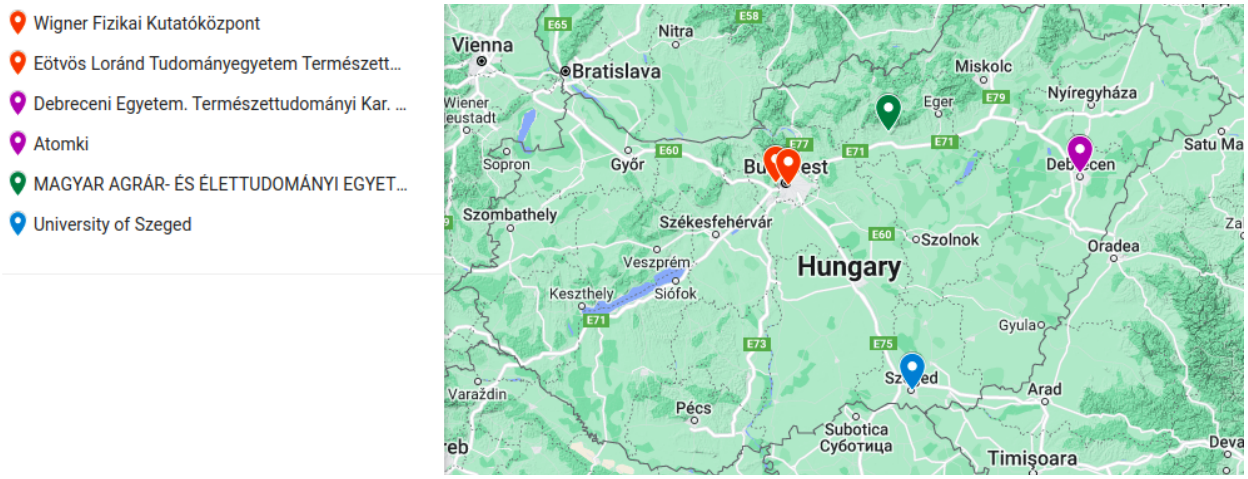
- Number of staff performing R&D activities, as a percentage of total employment: 1.09%
- R&D capital expenditure as a percentage of investments in the national economy: 0.68%

Institutions

High energy physics (experiment and theory) is concentrated in Budapest, with smaller groups in Debrecen, Szeged, Pécs, and in Gyöngyös [a map is below]:

- Wigner RCP, Institute for Particle and Nuclear Physics, Budapest [webpage]
- Eötvös Loránd University, Institute of Physics, Budapest [webpage]
- Institute for Nuclear Research (ATOMKI), Debrecen [webpage]
- University of Debrecen, Physics Institute, Debrecen [webpage]
- MATE Károly Róbert Campus, Gyöngyös [webpage]
- University of Szeged, Szeged

The research institutes, formerly under the Hungarian Academy of Sciences, are since 2019 part of the Eötvös Loránd Research Network. The universities are controlled through asset management foundations governed by a board of trustees since 2021, with some notable exceptions: e.g. the Eötvös University is still state-owned.



Funding

Funding and support is provided through various channels, they are listed in the order of importance below.

- National Research, Development and Innovation Office [webpage]
  - Most importantly, the funding agency disburses the CERN membership contribution (7 MCHF/year, 0.6% of total), and also supports M&O A for 15 experimentalists in CMS and ATLAS (altogether 150 kCHF/year).
  - The “OTKA” (former National Scientific Research Fund) grants have calls for thematic research (30 kEUR/year for 4 years, for travel, equipment, M&O B), young researchers, and postdoctors. Usually a thematic grant is essential to carry out experimental research; most Hungarian experimental groups have one

(or two) such grants available. One has to apply again once the 4 years term is over (there is no roling-grant scheme available). The average success rate is quite small (20-30%), depending on the topic.
    - The Thematic Excellence Programme provides support for university knowledge centres and research centres for their research, development and innovation activities. We have a recent winner (imaging with cosmic muons, 1 MEUR).
    - The New National Excellence Programme provides wide support for undergraduate, graduate, PhD students, doctoral candidates and postdocs, higher education teachers and researchers with several, mostly doctoral students in the particle physics area.
    - The goal of the programme Support for summer internships for Hungarian students studying abroad is to bring back the best students from abroad (mostly from UK) for the summer in order to reintegrate them to domestic research.
    - In the past years an inventory of Excellent Research Infrastructures in Hungary, a list of high quality open laboratories, was set up with the aim to provide them with targeted support in the future. Among them are the Vesztergombi Laboratory for High Energy Physics and the Wigner Scientific Computing Laboratory (both at Wigner RCP), and the ATOMKI Accelerator Centre in Debrecen.
    - Under the umbrella of the funding agency, the task of the Hungarian CERN Committee is to oversee and follow the Hungary–CERN relations; it is composed of officials from the Office and researchers representing the major research institutes and universities.
- Ministry of Culture and Innovation [webpage]
    - universities
- Eötvös Loránd Research Network [webpage]
    - institutes
- The Hungarian Academy of Sciences [webpage] supports outstanding researchers in establishing new research groups, but also aids excellent postdocs through extra salary.
    - The "Momentum" grants are the local equivalent of ERC Starting or Consolidator grants. On average 100 kEUR/year for 5 years is provided. There are 15-20 winners each year, 1-2 out of them are in physics. In the past decade there were 2 winners from experimental particle physics.
    - The Bolyai research scholarship supports individuals, young researchers. There are 10-12 winners in physics each year, about 500 EUR/month extra salary for 3 years.

Experiments and people at CERN

The Hungarian experimental community concentrates on two major LHC experiments: CMS and ALICE, with individual participation in ATLAS, TOTEM, LHCb, and also in ASACUSA. There is a notable activity in NA61/SHINE at SPS, while people from Szeged participate in ISOLDE. In the field of research and development, and preparations for future colliders, there are groups in RD51, AWAKE and FCC. Altogether, as of today, there are 99 participants active in CERN experiments (users: 73, external participants: 24, others: 2), with 24 teams and 59 authors.

CMS. Several physics topics, including study of the strong interaction, hadronization, correlations, exclusive processes; quantum correlations, femtoscopy; search for new physics, anomalous couplings; luminosity measurement. Taking part in the Phase-2 Upgrade:

- design and manufacture of the front-end data acquisition electronics of the Chromie test beam telescope for the CERN SPS test beam (Wigner)
- development of the FPGA-based data collection system of the CMS Phase-2 tracking detector (Wigner)
- development of the Phase-2 BRIL luminosity measurement system (Eötvös U)
- development of the ZDC zero-angle calorimeter (Eötvös U)
- development of positioning systems for muon detectors (ATOMKI)
- testing the SiPM sensors of the MIP Timing Detector reader (U of Debrecen)

ALICE. Several physics topics within heavy-ion physics including jet structure, nuclear effects, heavy quarks, comparisons to elementary collisions, modelling. Various ongoing R&D projects (Wigner):

- participation in ALICE Inner Tracking System (ITS2 and ITS3) detector developments: DAQ and cooling design
- participation in the research development of CERN's next generation detector ALICE3
- construction and operation of the ALICE Analysis Facility in the Wigner Scientific Computational Laboratory of the Wigner Data Centre.
- development of ALICE's time projection chamber with GEM technology, the GEM laboratory is currently developing and building GEM and multi-wire gas-filled detectors in cooperation with the Innovative Gas Detectors Group (2016-2021).
- the LHC Interface Project (LHC_IF) ensures the data flow between the Large Hadron Collider (LHC) and ALICE and thus the safe operation of the experiment (2016-2022).
- data collection, data compression and data transmission system of the ALICE detector: development is a new 4 TBps bandwidth data transmission system during the 2nd Long Shutdown period for data collection after 2020.
- ALICE Analysis Facility: research and development of a specialised hybrid (GPU and FPGA-based) analysis system with large-scale and high data density, data-intensive computing capacity, jointly with the Wigner GPU Laboratory and the Wigner Data Centre (2021-)

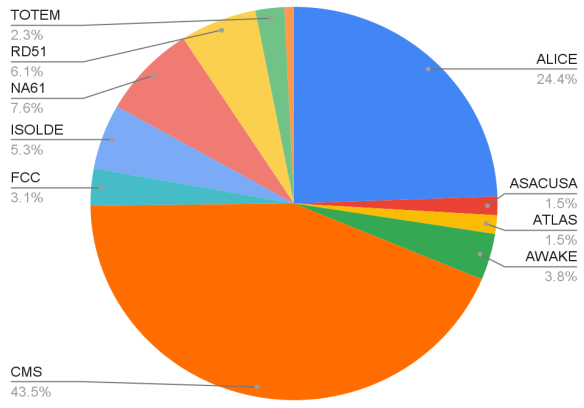
NA61. ?
RD51. ?

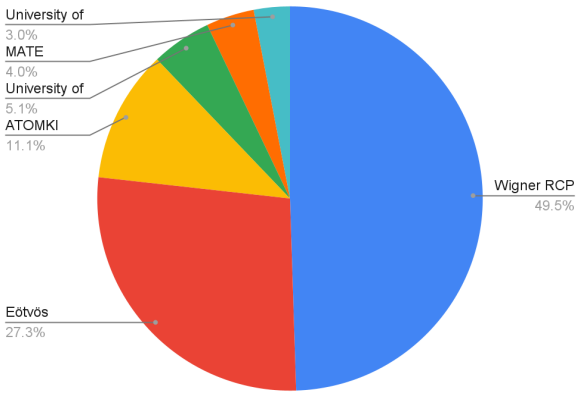
The volume of Hungarian industrial deliveries fluctuates in the range of 4-7 MCHF/year. In this respect, Hungary counts as a balanced country. There are 17 staff at CERN (0.64%), 13 researchers or engineers, 3 technicians, 1 administrative; out of these 3 women. On average there are 3-4 students taking part in the Technical Student Programme, one in the Doctoral Programme, while there are 3-5 active in the Summer Student Programme. Each year we have 30-40 physics teachers in the Hungarian Teachers Programme, taking part in a study tour at CERN.

Structure of personnel

Most people are active in CMS and ALICE, followed by NA61, RD51, ISOLDE, AWAKE. The large groups have students, while for smaller ones it is not always the case. Close to half of the people work at Wigner RCP, more than a quarter are at Eötvös University, followed by ATOMKI, University of Szeged, MATE Gyöngyös and University of Debrecen. About 15% of them are women, mostly students.

Experiment	*Sum*	As 1st exp.	As 2nd exp.	Staff	Post-doc	PhD stud.	MSc stud.	BSc stud.	Emer.
ALICE	*32*	26	6	6	2	4	5	2	
ASACUSA	*2*		2						
ATLAS	*2*	2		2					
AWAKE	*5*	5		2					
CMS	*57*	56	1	12	2	10	10	6	3
FCC	*4*	4		1	1	1		1	
ISOLDE	*7*	7		4					
NA61	*10*	6	2	1		2	1		2
RD51	*8*	4	4		1				
TOTEM	*3*	3							
WLCG	*1*		1						





Institution	*Sum*	Re-searcher	PhD stud.	MSc stud.
Wigner RCP	*49*	24	9	6
Eötvös University	*27*	7	7	13
ATOMKI	*11*	10	1	
University of Debrecen	*5*	4		1
MATE Gyöngyös	*4*	4		
University of Szeged	*3*	3		

Priorities and issues

- LHC
- ?

Contacts

- Council: Dr István Szabó, Prof Péter Lévai
- ECFA: Ferenc Siklér (restricted), Gábor Veres (plenary), Péter Major (young)
- LHC RRB: Gabriella Pásztor
- Industrial Liaison Officers: Dániel Barna, Tivadar Kiss
- Knowledge Transfer: Balázs Ujvári
- International Particle Physics Outreach Group: Dezső Horváth
- European Particle Physics Communication Network: Barbara Vizkelety