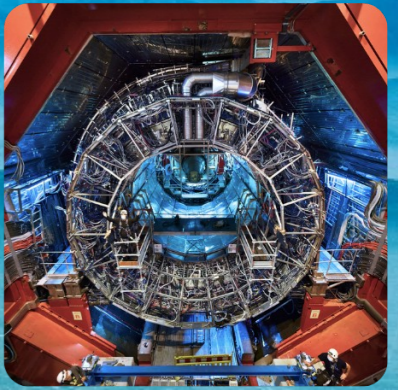
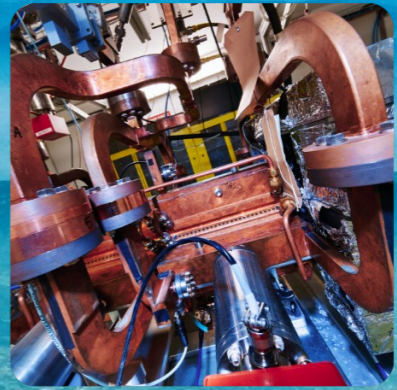
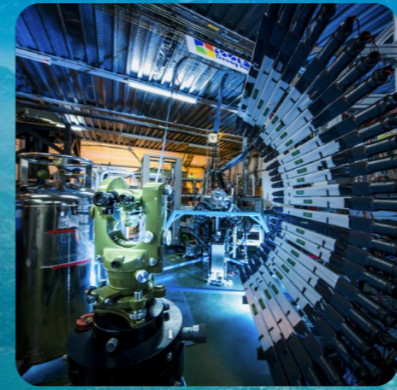
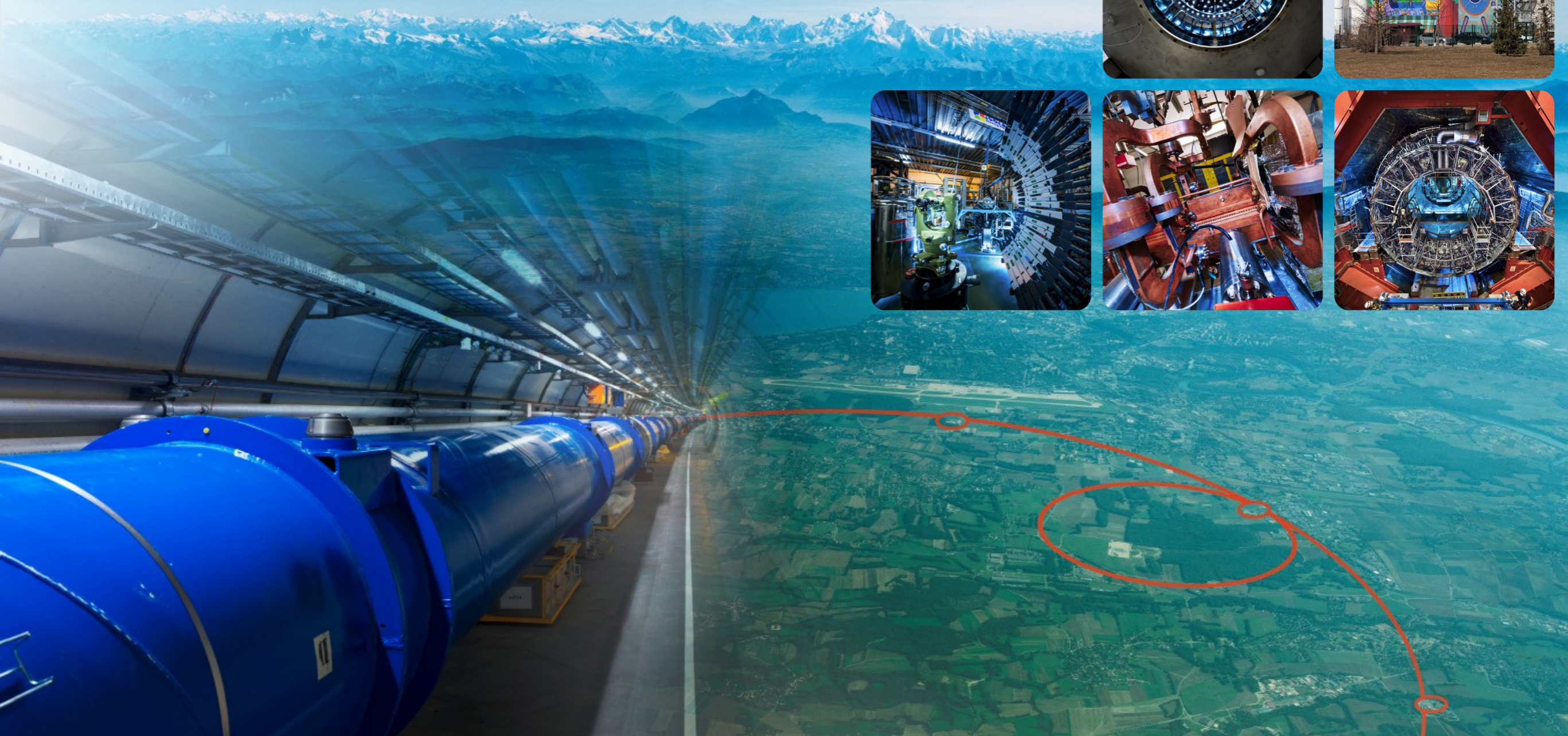


# CERN-related research in Sweden



LUND UNIVERSITY



Stockholm University



UPPSALA UNIVERSITET

Sara Strandberg, RECFA visit 16/5 2024

# CERN at Swedish Universities

- Sweden is one of the 12 founding members of CERN.
- Swedish groups run a diverse research program in particle, nuclear, atomic, environmental and accelerator physics.

<b>Number of Experiments:</b>	44
<b>Number of Institutes:</b>	9
<b>Number of Teams:</b>	56
<b>Number of Authors:</b>	84
<b>Total number of participants:</b>	149
<b>Users:</b>	110
<b>External Participants:</b>	37
<b>Other Participants:</b>	2

Numbers include also e.g. emerita and master students

Source: [CERN Greybook](#)

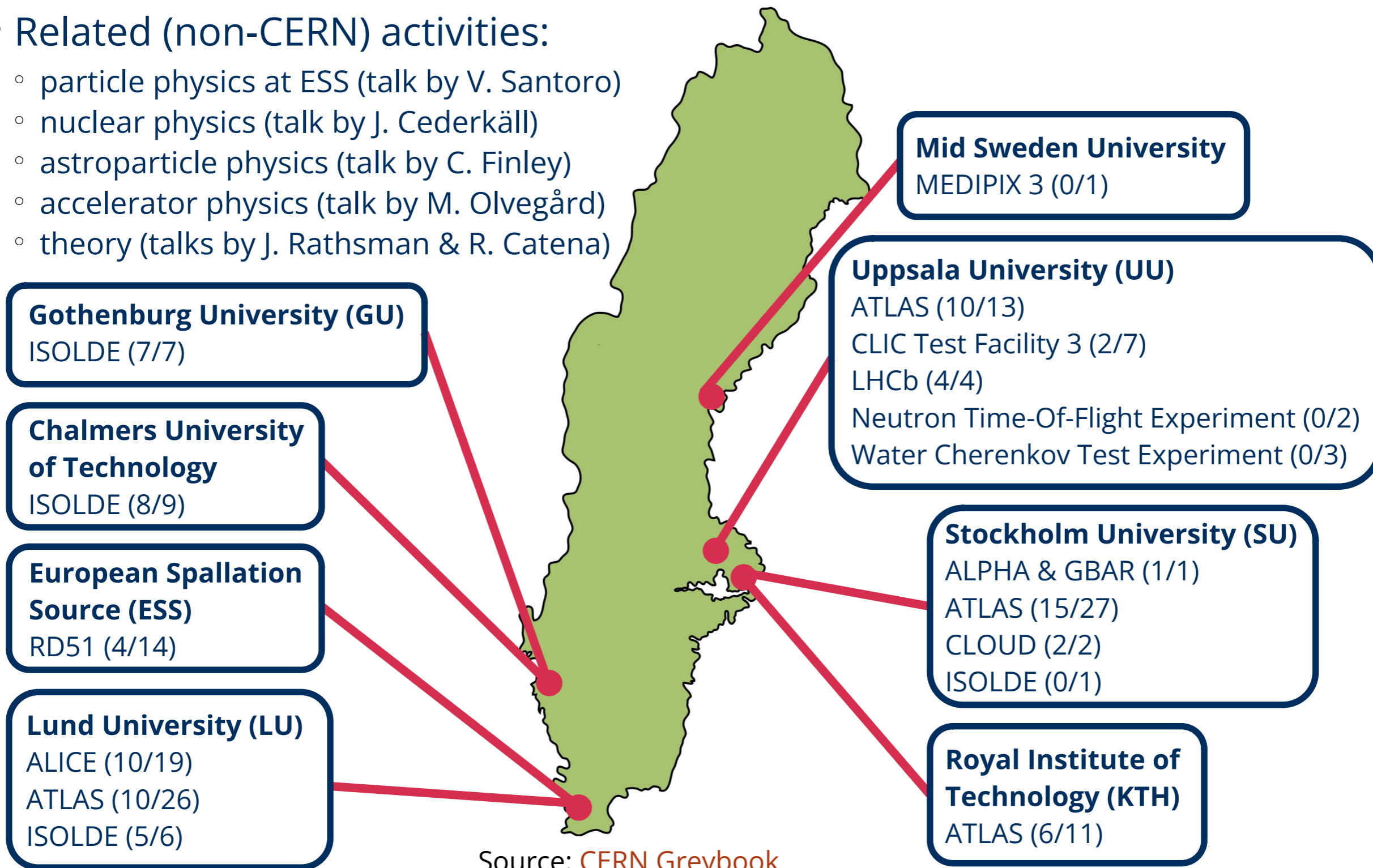
- Involved in ALICE, ATLAS and ISOLDE since their foundations.
  - Significant funding from the Swedish Research Council (VR) and the Knut and Alice Wallenberg (KAW) Foundation.
- Sweden also participating in ALPHA, AWAKE, CLIC, CLOUD, GBAR, HL-LHC and LHCb.

# CERN at Swedish Universities

- 9 institutes are engaged in CERN experiments (authors/all).

- Related (non-CERN) activities:

- particle physics at ESS (talk by V. Santoro)
- nuclear physics (talk by J. Cederkäll)
- astroparticle physics (talk by C. Finley)
- accelerator physics (talk by M. Olvegård)
- theory (talks by J. Rathsman & R. Catena)



Source: CERN Greybook

- **ATLAS - KTH, LU, SU, UU (41 authors, 77 members)**

- Broad program focusing on Higgs and BSM physics.

- KTH and SU contributed to the construction of the calorimeter system and calorimeter trigger electronics.

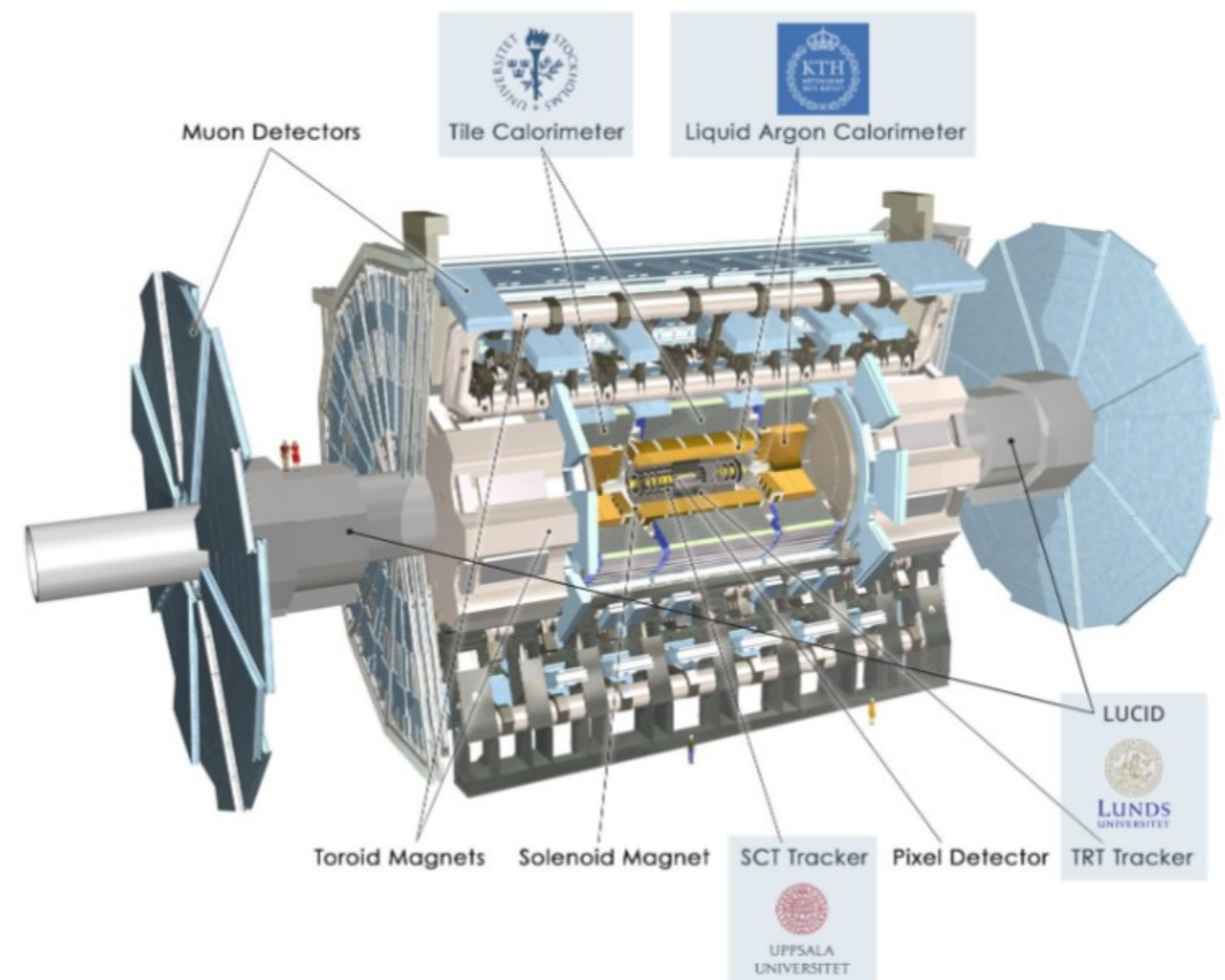
- LU and UU built part of the tracking system.

- LU built part of the LUCID luminosity detector.

- Phase-II upgrade commitments to ITk (LU and UU), HGTD (KTH) and TileCal (SU) projects.

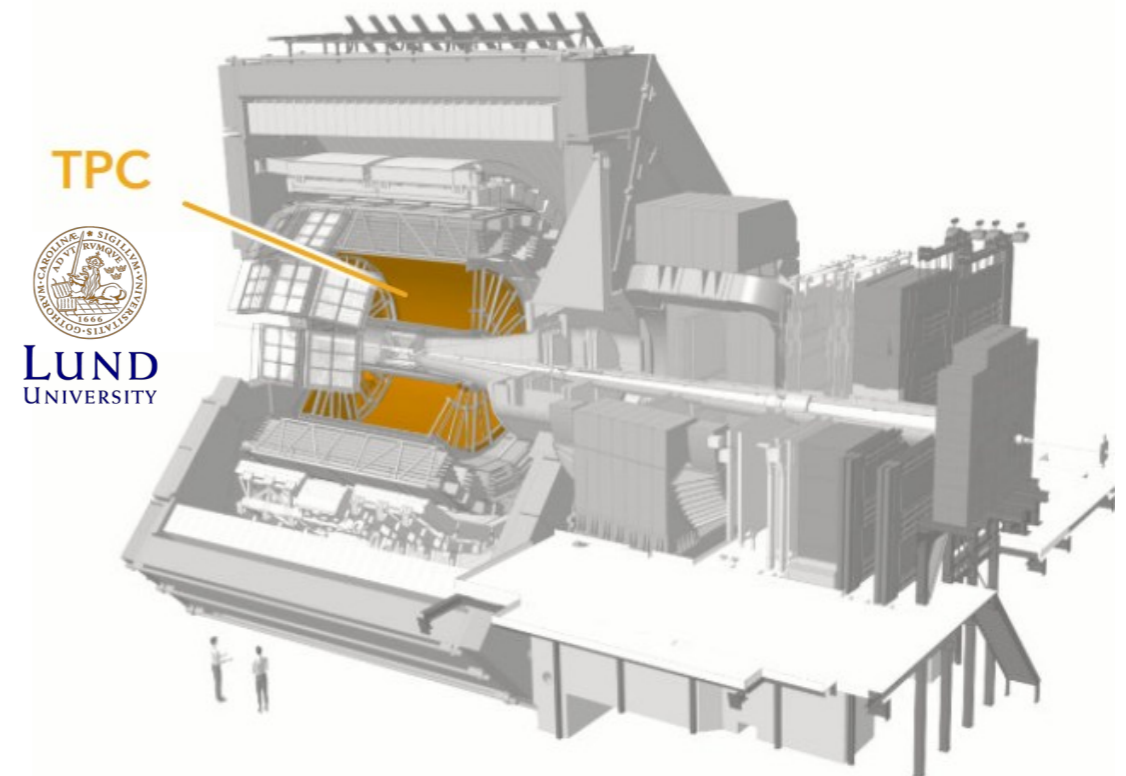
- Committed to operations and data preparation through e.g. trigger, data quality, luminosity, reconstruction software, ...

See talks by  
J. Strandberg  
and R. Brenner



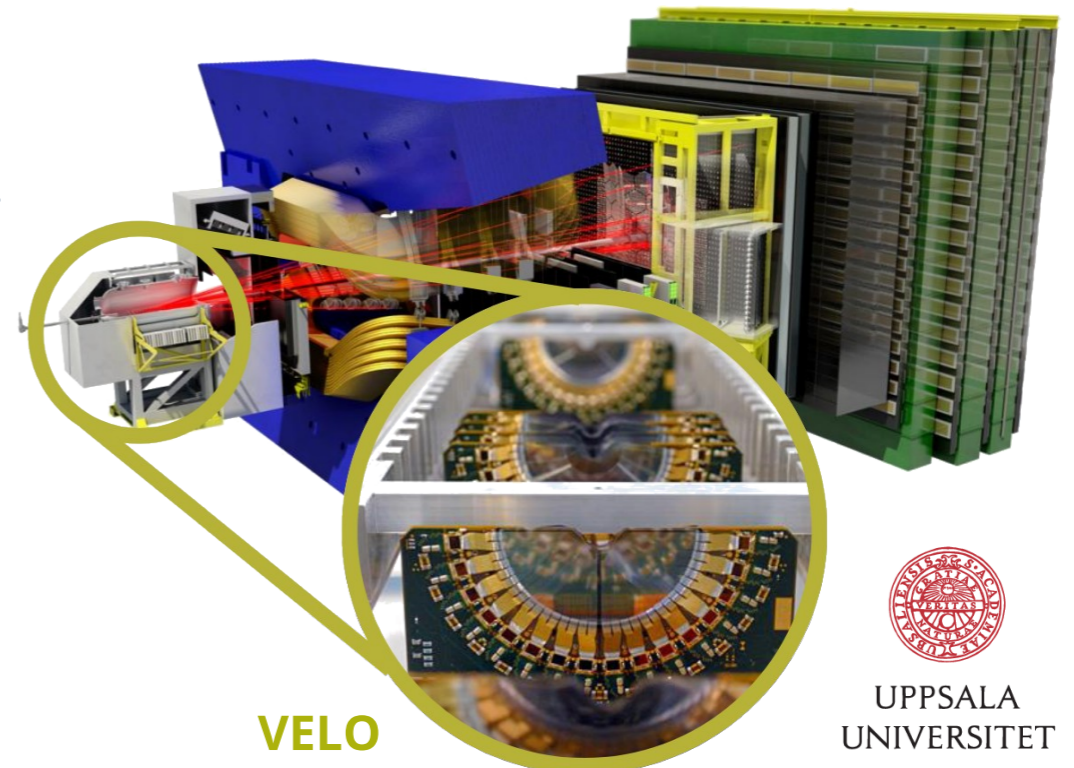
- **ALICE - LU (10 authors, 18 members)**

- Study hadronic processes and the quark-gluon plasma.
- Participated in the construction and upgrades of the TPC readout electronics.
- Involved in development of the inner tracker system (ITS3) upgrade project.

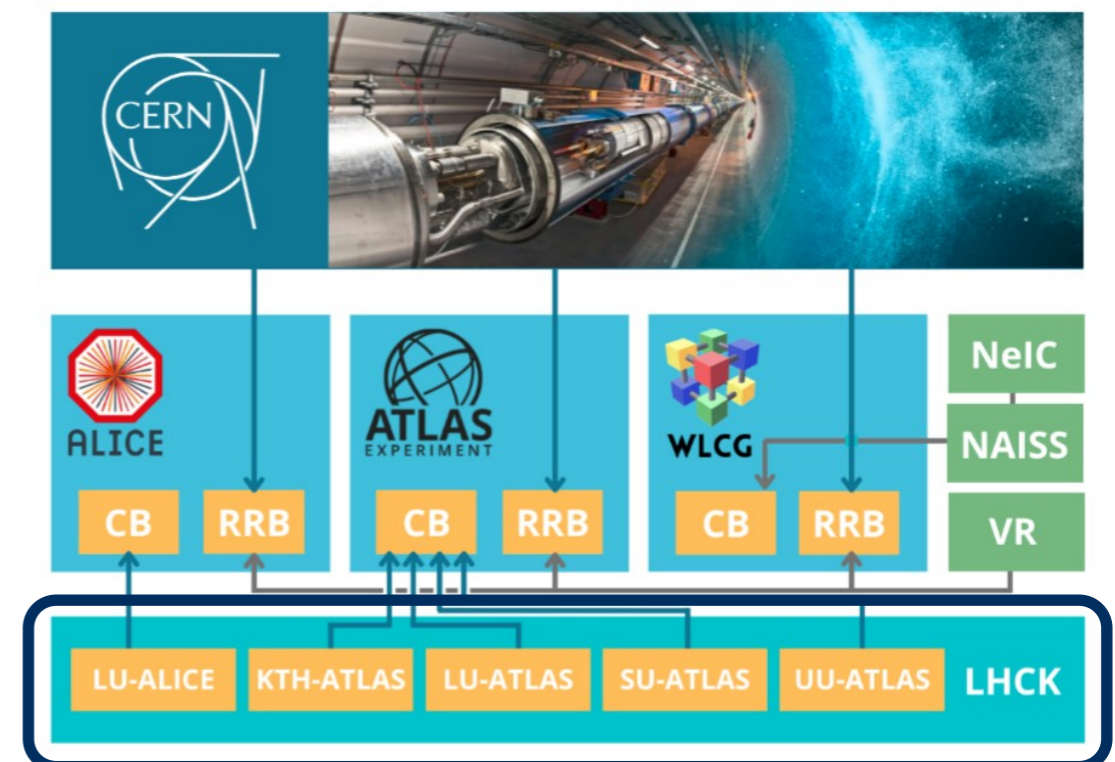


- **LHCb - UU (4 authors, 4 members)**

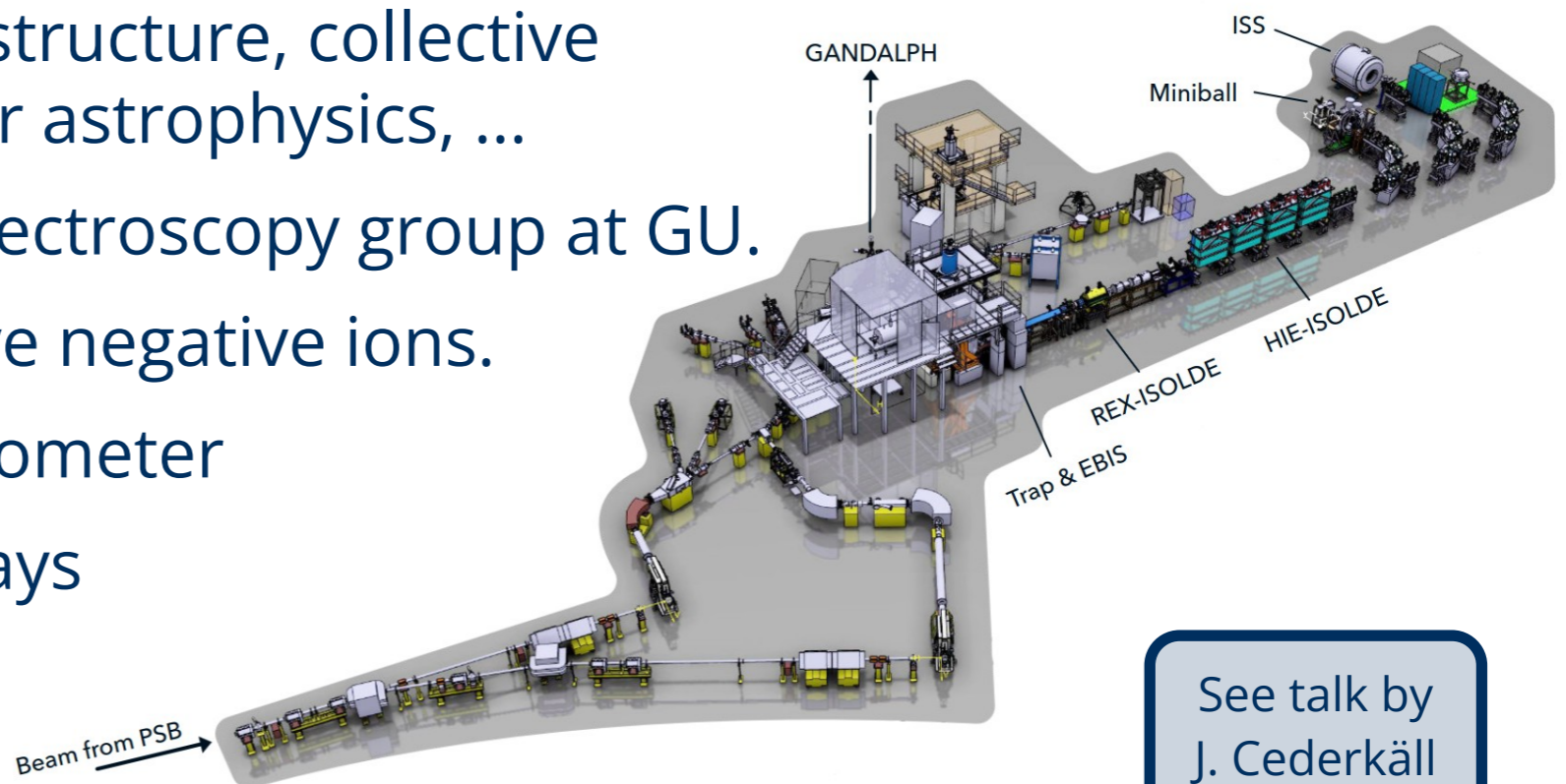
- New initiative among Swedish scientists.
- Study heavy-flavour hadrons and CP violation.
- Contribute to maintenance and operation for the vertex locator (VELO).



- Since the 1990's, the Swedish involvement in the LHC experiments has been coordinated through the LHC consortium (LHCK).
- Composed of one representative from each of the Swedish LHC groups (KTH, LU, SU, UU in ATLAS and LU in ALICE).
  - LHCb does not have national infrastructure support from VR (two-step application process in competition with other proposals) and is thus not represented in LHCK.
- Beneficial to collaborate and coordinate between Swedish groups and act together towards funding agencies.
- Common funding requests for:
  - construction
  - CORE and non-CORE upgrade
  - maintenance and operation
    - now including also the Swedish share for grid computing



- **ISOLDE - Chalmers, GU, LU (20 authors, 22 members)**
- Isotope separator initiated by Denmark, Norway and Sweden, to study exotic atomic nuclei.
- Swedish physicists involved in development of the **REX-ISOLDE** post-accelerator and the upgrade of the Resonance Ionization Laser Ion Source (RILIS) as part of the High Intensity and Energy ISOLDE (**HIE-ISOLDE**) project.
- ISOLDE Solenoidal Spectrometer (**ISS**) (Chalmers and LU).
  - Evolution of nuclear shell structure, collective nuclear properties, nuclear astrophysics, ...
- **GANDALPH**, led by laser spectroscopy group at GU.
  - Spectroscopy of radioactive negative ions.
- **Miniball** gamma-ray spectrometer
  - Detect outgoing gamma-rays and charged particles from nuclear reactions.



See talk by J. Cederkäll

- **ALPHA - SU (1 author, 1 member)**
  - The first experiment to trap antihydrogen atoms, to observe the 1S-2S transition in antihydrogen, and to measure its hyperfine spectrum.
- **GBAR - SU (1 author, 1 member)**
  - Makes and traps antihydrogen ions (antiproton + 2 positrons) to study antimatter gravity as it falls.
- **CLOUD - SU (2 authors, 2 members)**
  - Swedish contribution is focused on connecting molecular observations from the CLOUD chamber with the real atmosphere, through numerical modeling and comparisons to field observations.





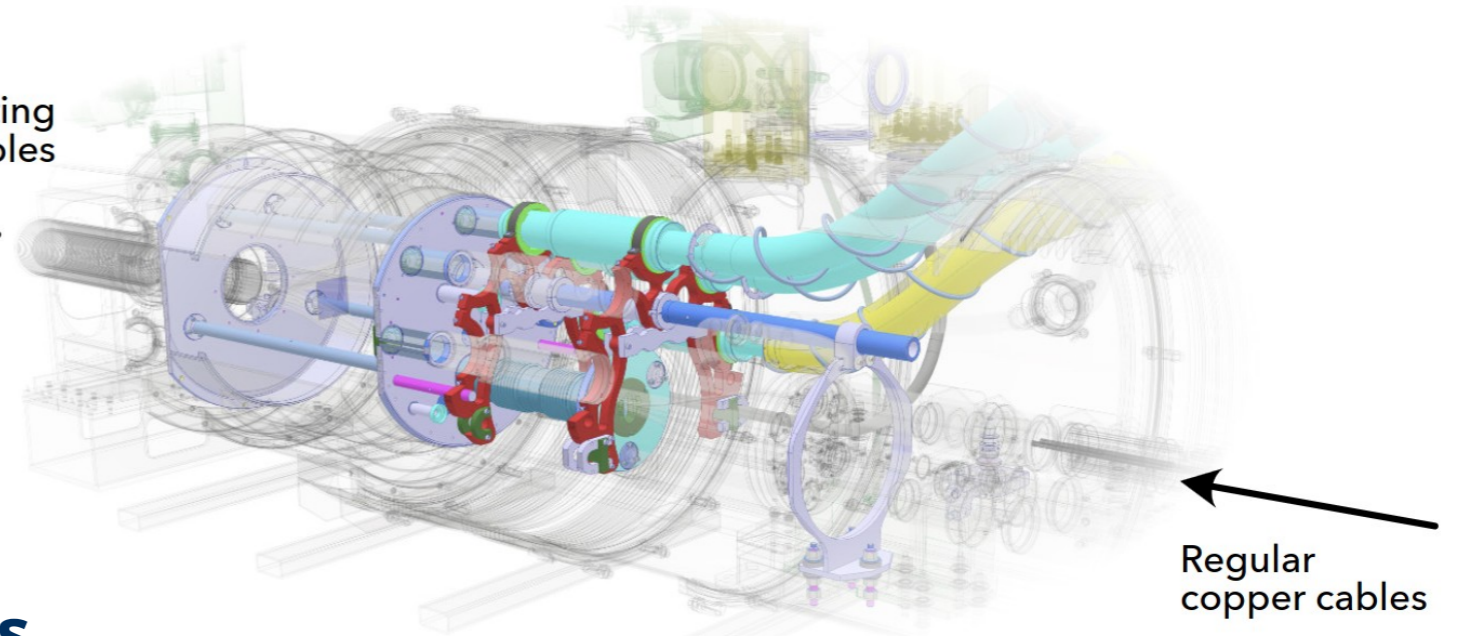
- **HL-LHC**

- UU is involved in accelerator development and tests for HL-LHC.
- Coupling cryostats for connecting regular and superconducting cables, anti-cryostats for high-precision magnetic measurements and tests of superconducting magnets.

See talk by  
M. Olvegård



Superconducting  
MgB<sub>2</sub> cables



Regular  
copper cables

- **Other accelerator activities**

- UU is working on the test facility for CLIC.
- UU is also involved in development of the radio frequency system for AWAKE.

- Part of the LHC data flow is managed by the Nordic Tier1 activity (NT1) of the Nordic e-Infrastructure Collaboration (NeIC).
  - The Swedish share of CPU, disk and tape is provided by national data centres in Linköping and Umeå.



The infrastructure's need for supporting e-infrastructure					
	2024	2025	2026	2027	2028
Computation [kHS06]	388.4	480.2	553.4	568.3	615.3
Storage, Disk [PB]	34.1	33.9	34.0	37.1	39.0
Storage, Tape [PB]	36.9	48.0	54.2	53.9	60.1
Sysadmin [FTE]	3.4	3.4	3.4	3.4	3.4
Network [Gbit/s]	20	100	100	100	100

See talk by  
O. Smirnova

**Table E1:** Computing needs for the Swedish share of the WLCG infrastructure.

- The LU and UU groups contribute to the operation of NT1 and work with development of grid middleware ARC used at NT1.
- Sweden has also hosted a Tier2 facility that will be phased out.



- Sweden pays ~2.5% of the CERN budget.
- Our industrial return is significantly lower.
  - Industrial return coefficient of 0.37 in 2023 (down from 0.61 in 2019-2022). → Very poorly balanced country.
  - Industrial service index even worse at 0.02.
    - Expected since tends to go to nearby countries.

- Sweden pay
- Our industr
  - Industrial (2022). → V
  - Industrial s
  - Expected

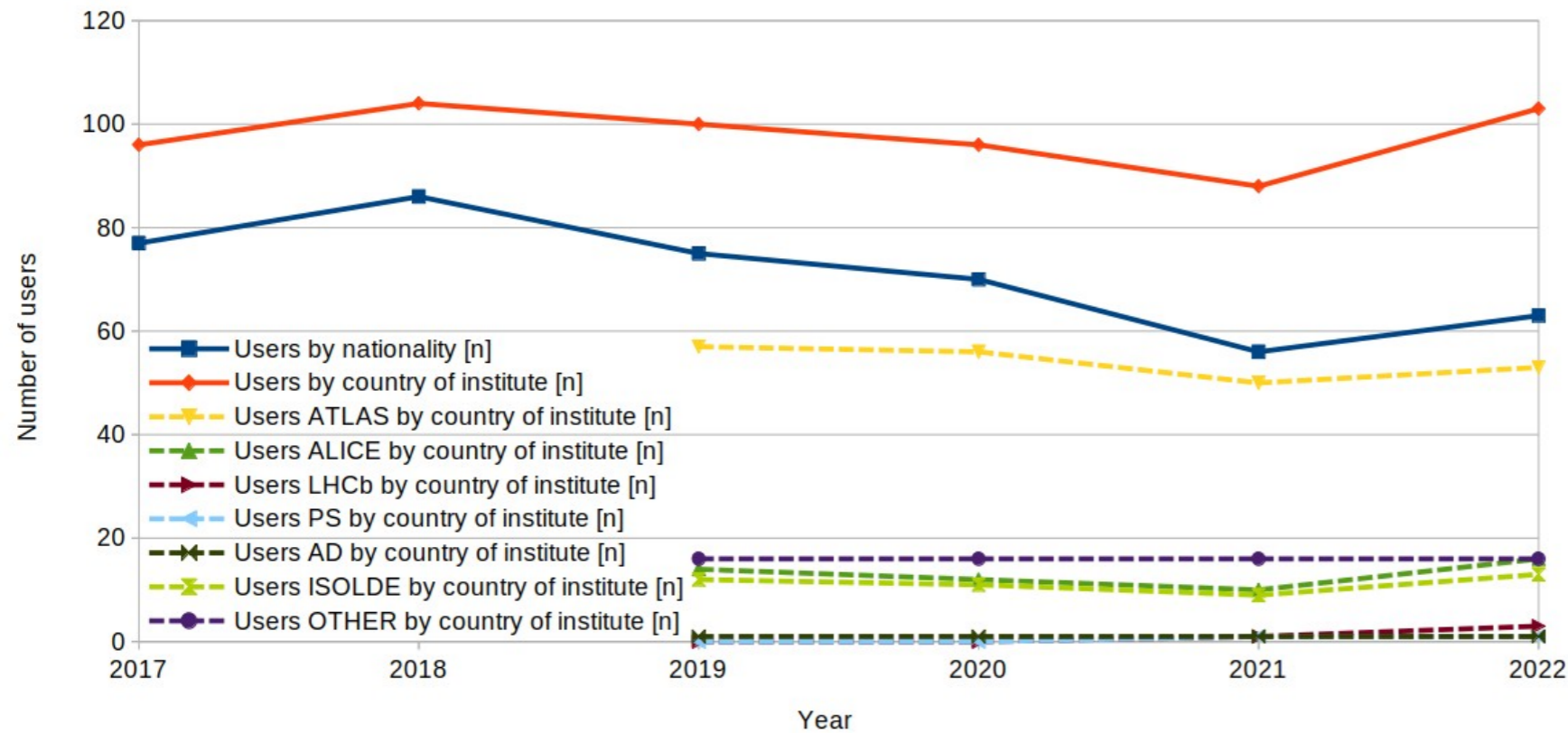


Table 5: Status of Member States for the period 1st of March, 2024 - end of February 2025

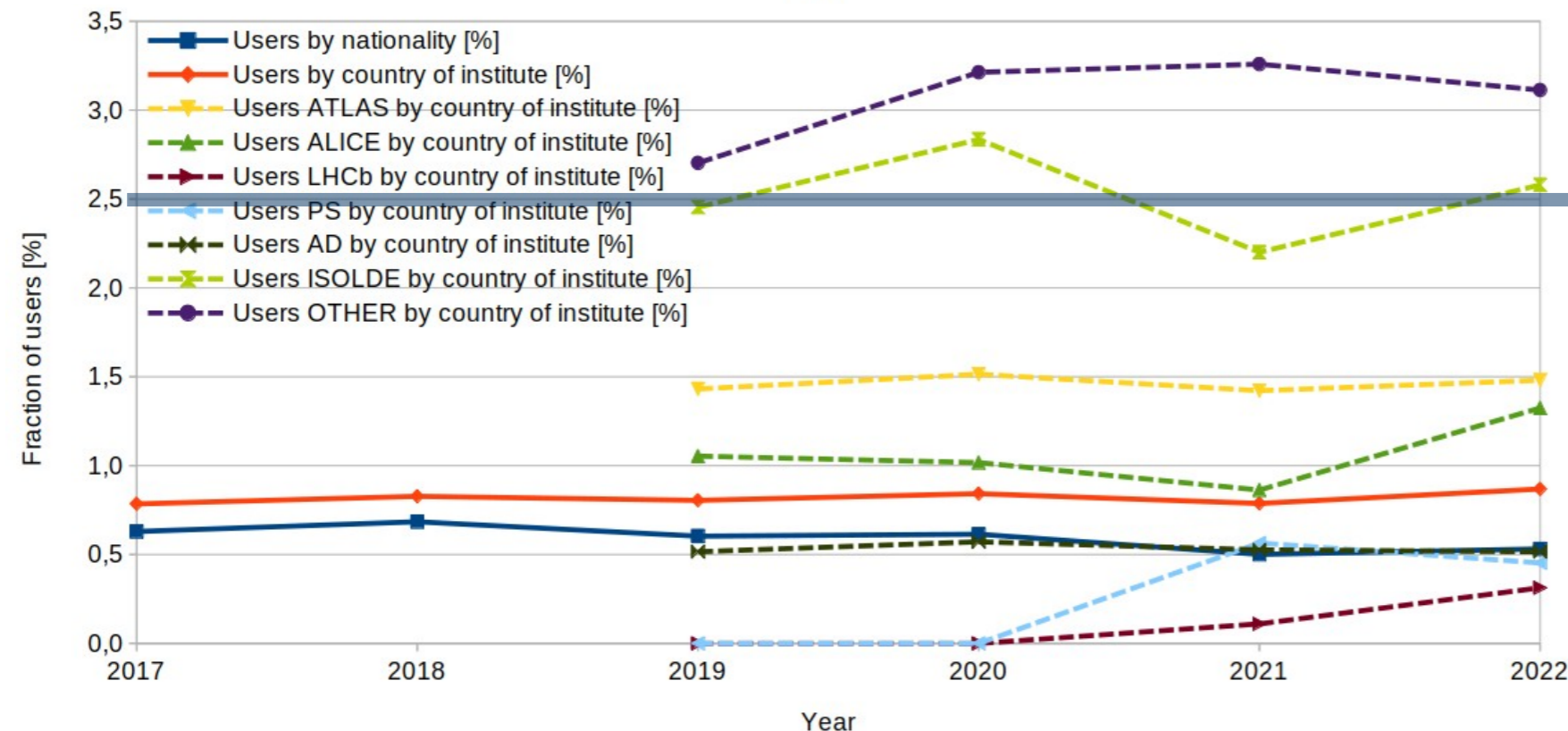
Year:  Country:

Country	IF	IF	Supplies			Industrial Services		
			Well balanced	Poorly balanced	Very poorly balanced	Well balanced	Poorly balanced	
Austria	AT		1.06	-	-	-	0.11	
Belgium	BE		-	0.42	-	-	0.05	
Bulgaria	BG		-	0.75	-	-	-	
Switzerland	CH		5.22	-	-	10.85	-	
Cyprus	CY		-	0.41	-	-	-	
Czech Republic	CZ		-	0.81	-	-	-	
Germany	DE		-	0.85	-	-	0.11	
Denmark	DK		-	0.42	-	3.29	-	
Estonia	EE		1.51	-	-	-	-	
Spain	ES		-	0.72	-	1.35	-	
Finland	FI		-	0.56	-	-	-	
France	FR		1.36	-	-	2.3	-	
United Kingdom	GB		-	0.5	-	0.47	-	
Greece	GR		-	0.47	-	-	0.31	
Croatia	HR		-	0.89	-	0.49	-	
Hungary	HU		-	0.78	-	-	-	
Israel	IL		-	-	0.31	-	-	
India	IN		-	0.53	-	-	-	
Italy	IT		1.34	-	-	-	0.11	
Lithuania	LT		1.13	-	-	-	-	
Latvia	LV		-	0.84	-	-	-	
Netherlands	NL		-	0.71	-	-	0.03	
Norway	NO		-	0.44	-	-	-	
Pakistan	PK		-	-	0.22	-	-	
Poland	PL		-	0.74	-	-	0.08	
Portugal	PT		-	0.78	-	-	-	
Romania	RO		-	-	0.35	-	-	
Serbia	RS		-	0.53	-	-	-	
Sweden	SE		-	-	0.36	-	-	
Slovenia	SI		-	0.9	-	-	-	
Slovakia	SK		-	0.64	-	0.99	-	
Republic Of Turkiye	TR		1.65	-	-	-	-	
Ukraine	UA		-	-	0.27	-	-	

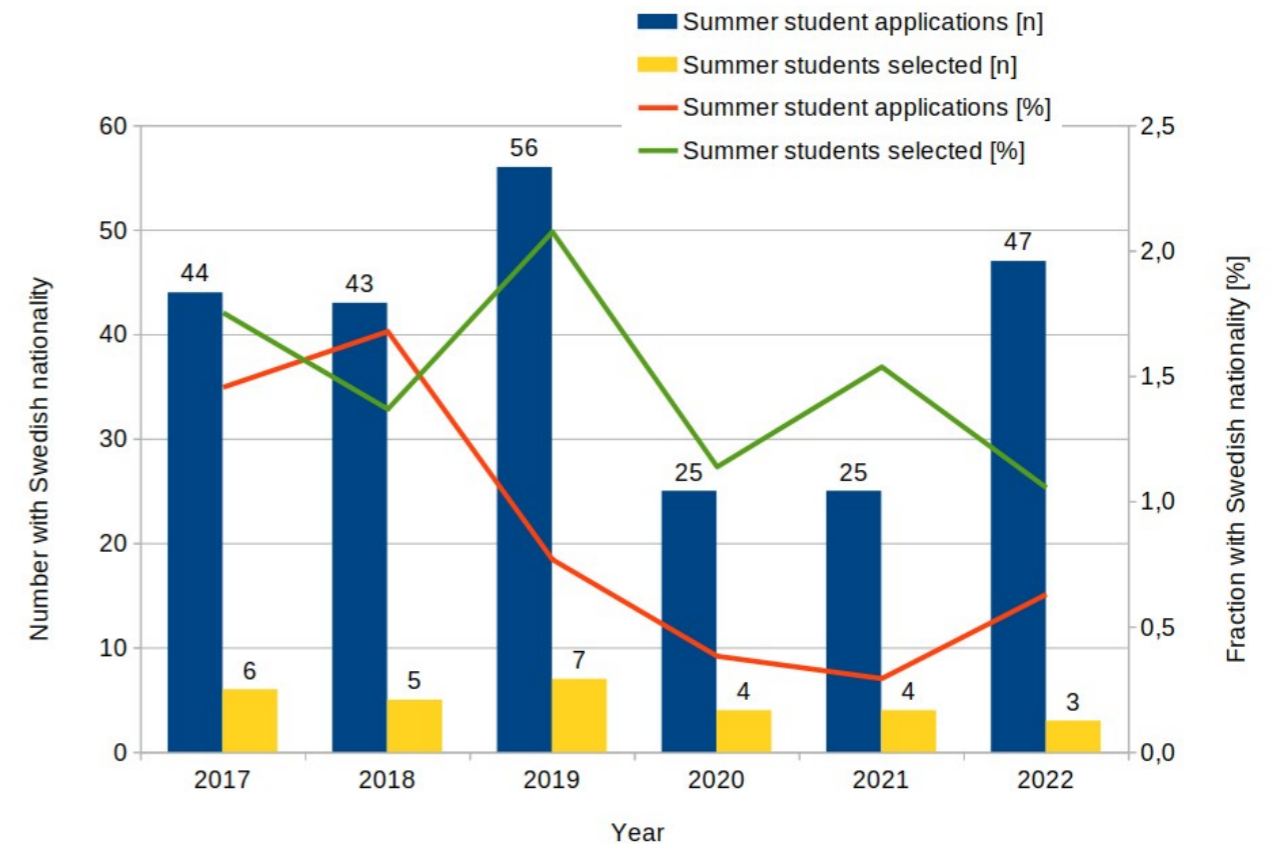
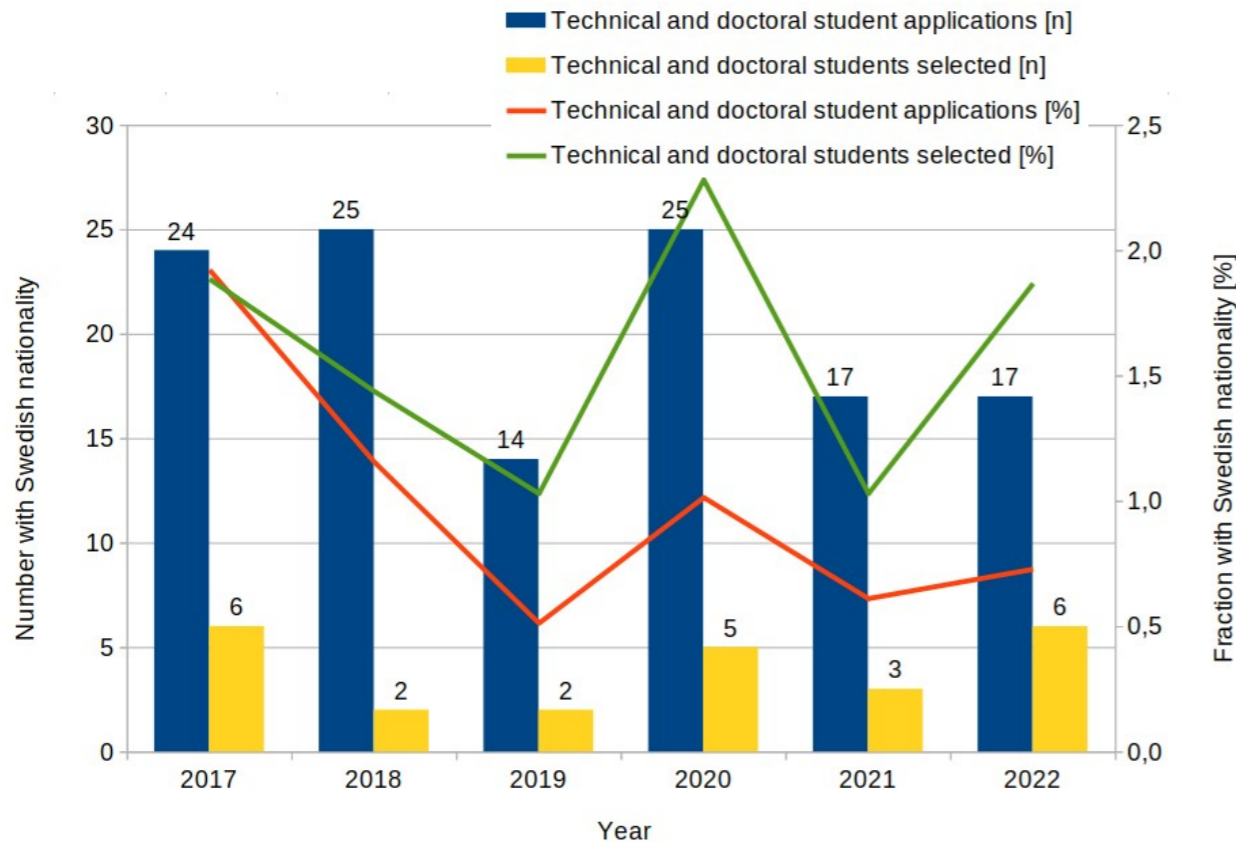
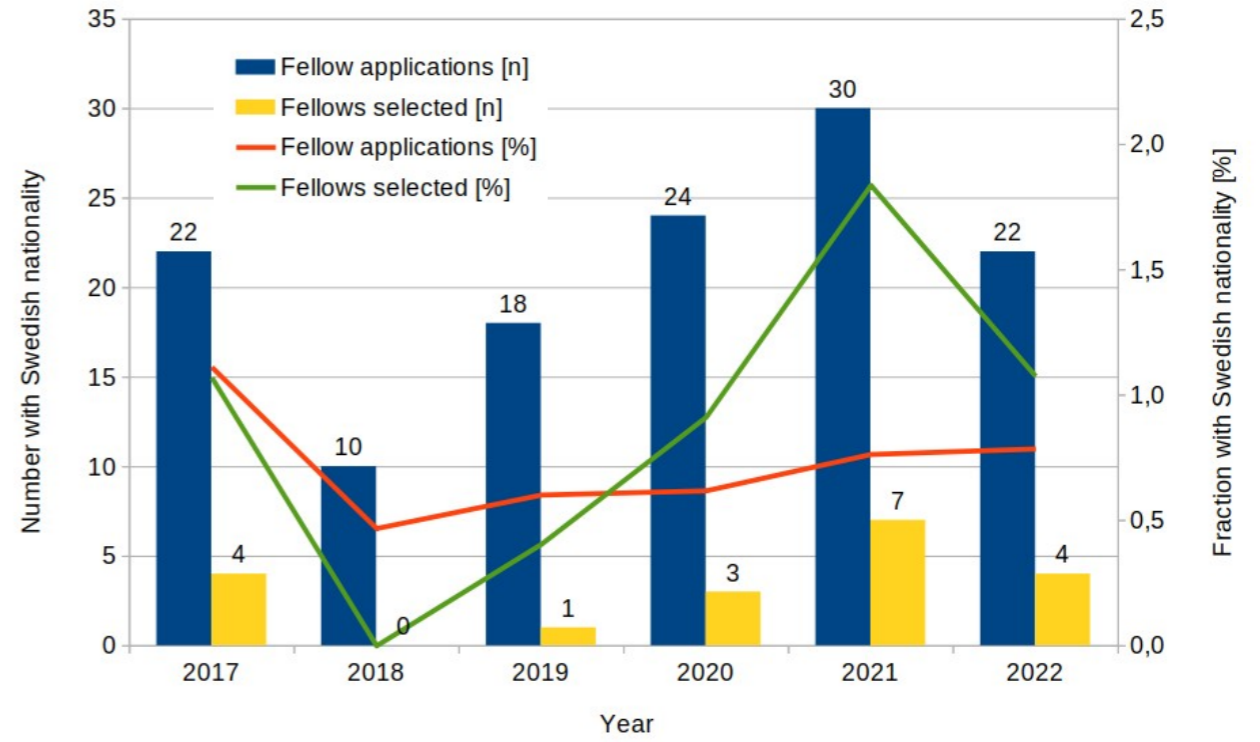
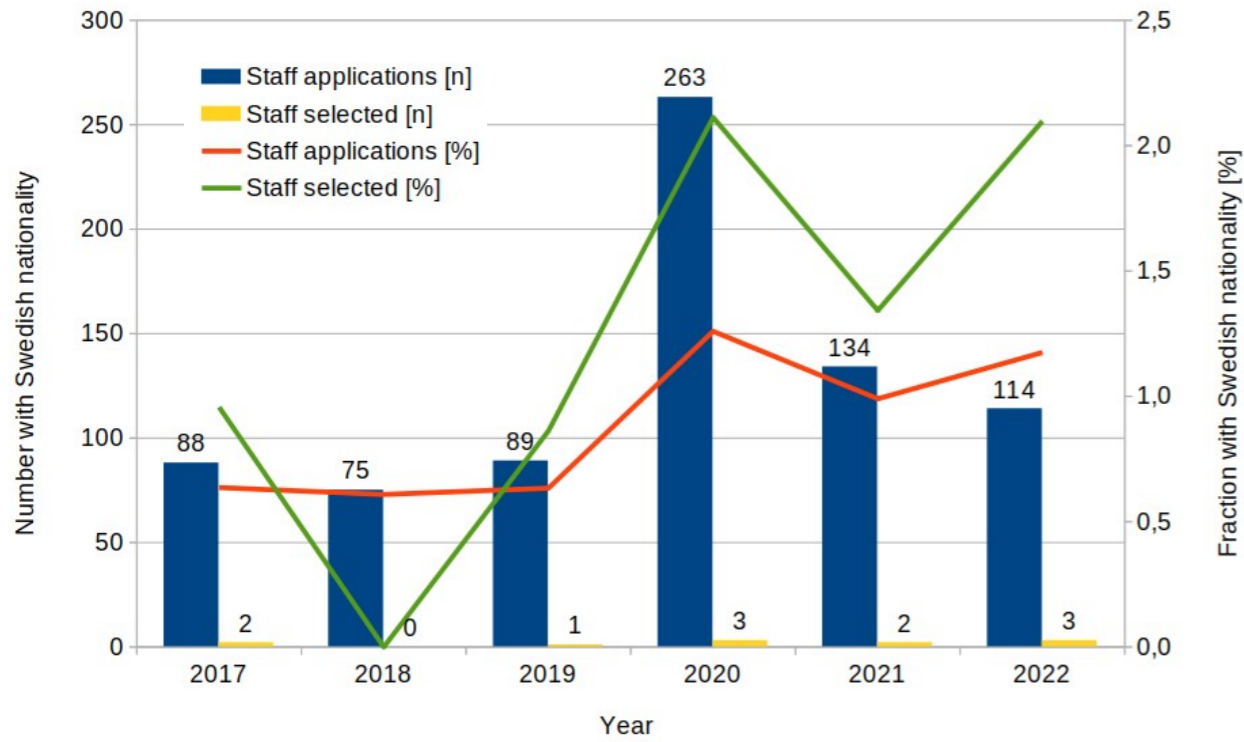
- Sweden pays ~2.5% of the CERN budget.
- Our industrial return is significantly lower.
  - Industrial return coefficient of 0.37 in 2023 (down from 0.61 in 2019-2022). → Very poorly balanced country.
  - Industrial service index even worse at 0.02.
    - Expected since tends to go to nearby countries.
- Also under-represented among staff, fellows, students and users.
  - 0.9% of CERN staff, 1.2% of CERN fellows and 0.5% of CERN users with a Swedish nationality at the end of 2022.
  - 1.3% of staff, 1.0% of fellow, 1.6% of technical/doctoral student, 1.4% of summer student and 0.6% of administrative student applications went to candidates with Swedish nationality in the period 2018-2022.
  - Similar numbers over many years.



- The number of Swedish users, by nationality or institute, have been stable over time, but low relative to the Swedish CERN share.



Swedish CERN share



- Launched in 2017, co-funded by VR and the innovation agency Vinnova.
- Industrial Liaison Office (ILO) and Knowledge Transfer Office (KTO) towards CERN.
- Monitor CERN procurements, match with Swedish companies and provide support throughout the process.
- Organize outreach events targeting students.
- Inform about jobs and career opportunities at CERN.
- Continued support to BiSS - for ILO, KTO and outreach - is important.
- More stakeholders should be included.
  - Currently involve Chalmers, Luleå, Lund, Uppsala and Research Institutes of Sweden (RISE) but e.g. no institutes in Stockholm.



Connecting Swedish industry, universities and research institutes with large-scale research facilities

#### ABOUT US

Big Science Sweden

Funding

Steering Committee

Industrial Liaison Office (ILO)

Knowledge Transfer Office (KTO)

Outreach

#### BUSINESS OPPORTUNITIES

How to Register and Submit Bids (BiSS Lathund)

Procurement & tenders +

Collaboration

Proposals and financial support +

Research facilities +

#### OUTREACH

Student programmes and job opportunities in Big Science



- Industry contracts

Significant order from CERN for more than 400 km of wire



**Luma Metall**  
Luma Metall in Kalmar has developed into a specialist in the plating of fine and ultrafine wire in tungsten and molybdenum, two materials traditionally used for filaments in light bulbs. From being Sweden's most well-known brand of incandescent lamps, Luma is now a high-tech supplier of fine wire products and precious metal plating technologies to research facilities and industry.  
In 2019 Luma received a significant order from CERN for more than 400 km of wire, to be used in the upgrade of a detector in the Atlas experiment at CERN. The material that Luma is supplying consists of 50-micron (= 0.05 mm) base tungsten wire on which a gold plating is added (about 0.35-micron pure gold).

Global leader in development and production of high-voltage pulse generators

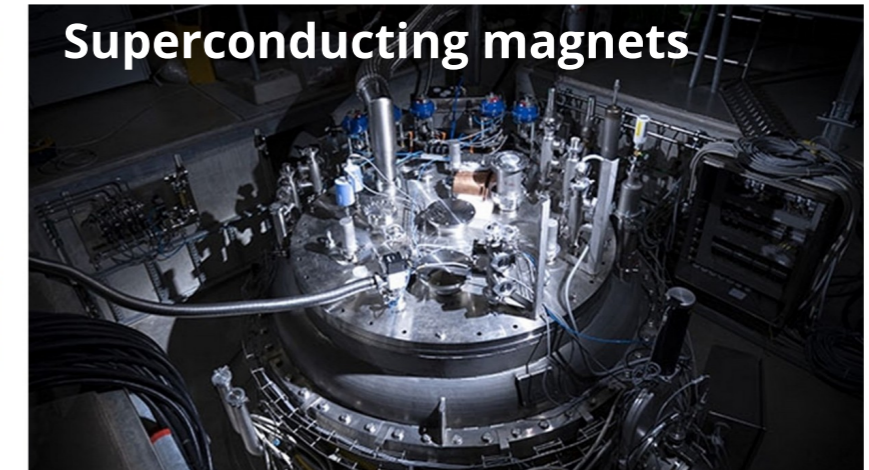


**ScandiNova**  
ScandiNova is a global leader in development and production of high-voltage pulse generators. Today, the company has a key function in radiation therapy, cancer treatment and research accelerators, and has supplied nearly 500 systems to around a hundred customers all over the world. One of these is CERN in Geneva.

18 February 2021

Swedish cutting-edge technology with global competitiveness

A cluster of technology companies in Småland are collaborating with Uppsala University and Linnaeus University in an EU research and innovation project on superconducting magnets with uses in, for example, Big Science. The project aims to develop environmental-friendly and energy efficient superconducting magnets, where research and technical development can be combined to boost global competitiveness.



www.u.se/en/news February 2021 - Top of the five-metre-deep thermos (vertical cryostat), which will be used to cool down the magnet prototype to -270 degrees Celsius during the tests at FREIA laboratory. Photograph: Mikael Wallerstedt

- Outreach events

See talk by C. Ohm

29 NOVEMBER

**CERN: en plats för mig!**  
Kim Albertssons erfarenheter som forskare på CERN.

**LULEÅ, LUNCHSEMINARIUM** CERN, världens mest avancerade forskningsinfrastruktur. Här jobbar människor från hela världen för att utmana gränserna för...

02 FEBRUARI

**LUND - LTH**  
**Karriärväg: Big Science**  
Lunchseminarium med Elias Walter Waagaard som doktorerar i acceleratorfysik på CERN

**LUND** Kan CERN vara nästa steg i din karriär? Ja, absolut! Här jobbar människor från hela världen...

NYHETER

## CELEBRATE CERN 70 YEARS

<p><b>GÖTEBORG CHALMERS</b> Exhibition 10:00-16.00 Lunch seminar 12.15 About CERN, and the opportunities available to Swedish students Evening lecture 19.00 Pitchers sports bar in Majorna</p>	<p><b>LUND UNIVERSITY ASTRONOMIHUSET</b> Exhibition 10:00-16.00 Lunch seminar 12.15 About CERN, and the opportunities available to Swedish students Evening event 18.00 Science Showcase at Stadshallen</p>	<p><b>MALMÖ UNIVERSITY ORKANEN</b> Exhibition 13:00-16.00 Lunch seminar 12.15 About CERN, and the opportunities available to Swedish students Evening lecture 17.30 The Wisdome Malmö Teknikens och Sjöfartens hus</p>
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www.bigsciencecareer.se

Register for the lunch seminar  
LUNCH IS INCLUDED IF YOU REGISTER IN ADVANCE

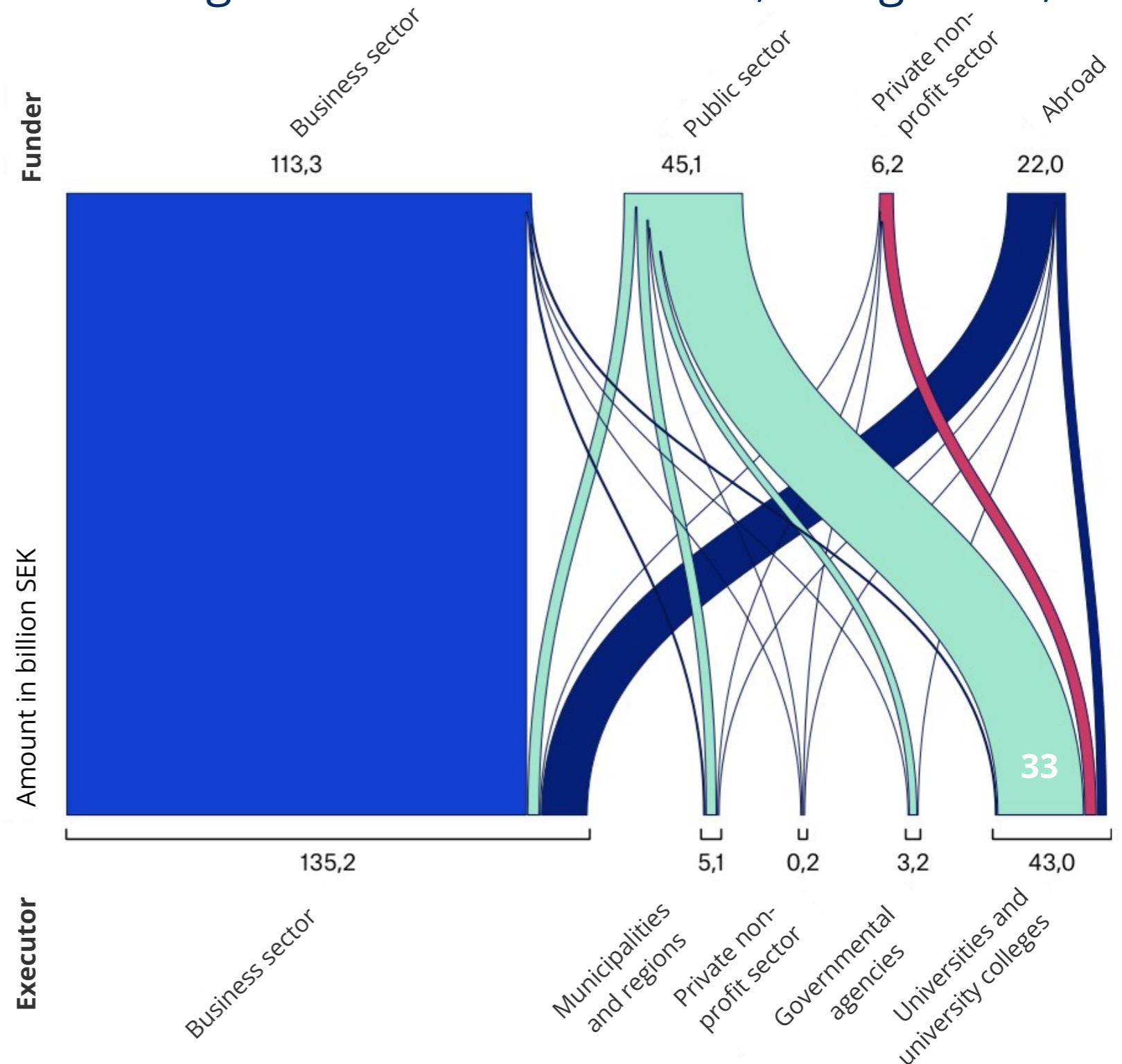
Forskningsanläggningen CERN firar 70 år!  
Passa på att träffa svenska forskare som i samband med firandet av CERN gör en liten turné för att berätta om den forskning som bedrivs vid CERN och v...

# Research funding in Sweden

- A large fraction of the R&D funding in Sweden comes from, and goes to, the business sector.
- The largest funder of R&D at universities is the public sector (i.e. government).

1 CHF = 1 € = 12 SEK

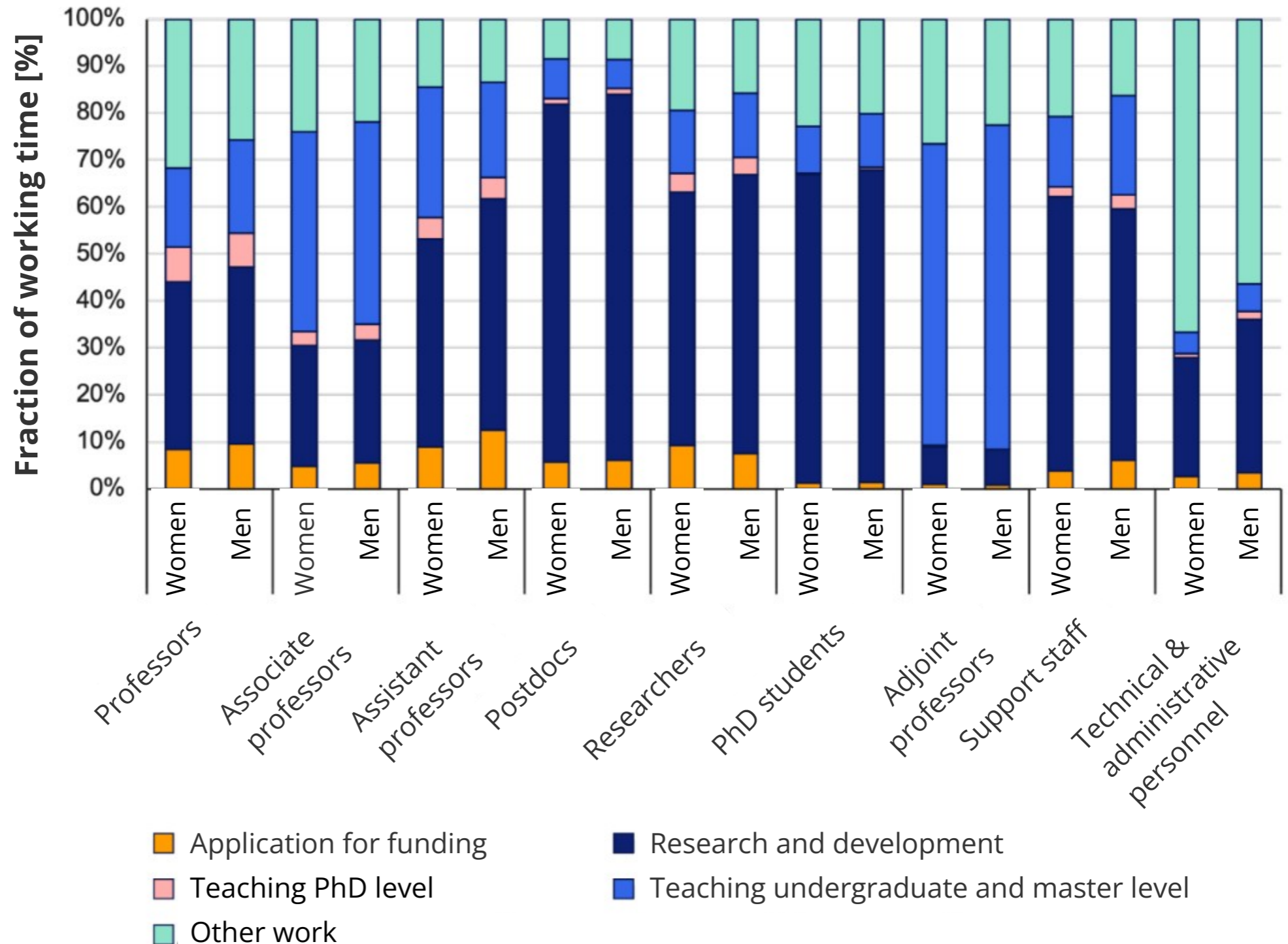
- In 2021, 33 billion SEK went from the public sector to the higher education sector (universities and university colleges).
  - 22 billion SEK of these in direct funding,
  - and 8.1 billion SEK through competitive grants from VR.



- Faculty positions are funded by the universities.
  - Number of faculty in Swedish CERN-related groups is relatively stable.
    - Exception is SU ATLAS group with no hires done since 2011.  
Faculty has reduced from 11 (2011) to 4 (2024).
  - Funding model varies between universities. Strong pressure everywhere to secure external funding (VR, KAW, ERC) to cover part of the salary or to reduce the teaching load.
    - Teaching load of up to 50-80% for faculty without external funding.
- Typically no university funding for PhD students and postdocs.
  - Still a sizeable young community thanks to individual project grants (~3 MSEK) and large project and environment grants (~20-30 MSEK).
    - This external funding is typically for research and cannot be used to pay postdocs focusing on instrumentation, maintenance or operations.
- Some permanent technical staff at universities, but many of them were hired long ago and are close to retirement.
  - New hires difficult in prevailing excellence-centric, individualistic model.

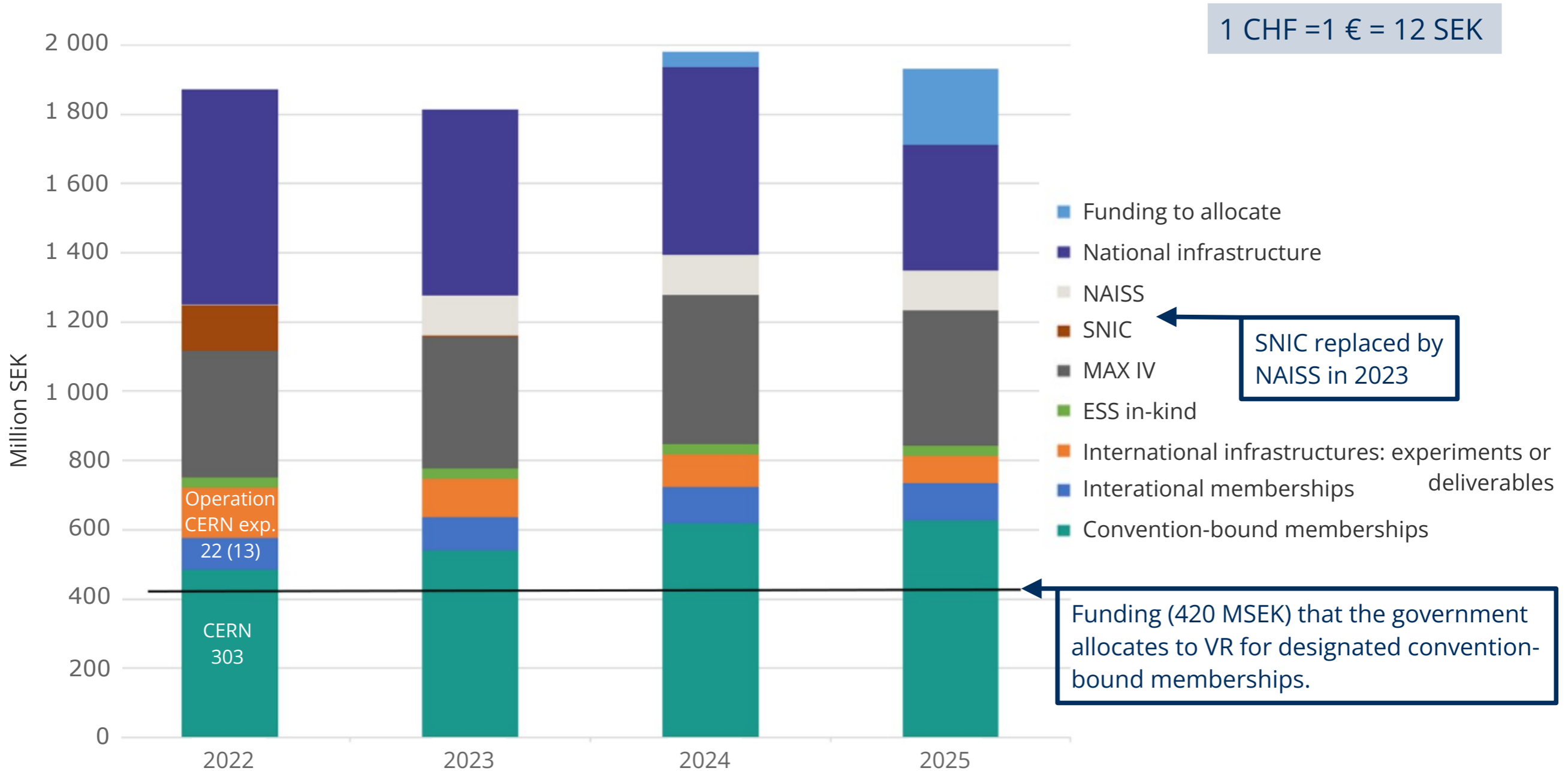
# Research funding in Sweden

- Relative time spent on different tasks:



# Swedish infrastructure funding

- Of the 8.1 billion SEK from VR, 3 billion SEK go to research infrastructures.



- Direct grants to ESS are not shown (they amounted to 1179 million SEK in 2022).

# Swedish infrastructure funding

- CERN-related activities that have national research infrastructure support from VR are ALICE, ATLAS and ISOLDE.
- The ongoing grants from VR for these infrastructures are:

1 CHF = 1 € = 12 SEK

Activity	Purpose	Period	Amount (granted/applied)	Comment
ALICE & ATLAS	Operations	2024-2028	(108/142) MSEK	Mainly funds for M&O fees, travel, CERN residency and computing.
ATLAS	Phase-II CORE upgrade	2015-2024	(44/81) MSEK	Only CORE costs approved. Prolongation to 2026 needed. Cost increases due to SEK/CHF exchange rate is covered by VR.
ATLAS	Phase-II non-CORE upgrade	2019-2023	(19/19) MSEK	Prolongation to 2026 needed. Cost increases due to COVID and other delays are partly covered by universities.
ALICE	ITS3 upgrade (in LS3)	2022-2027	(11.7/12.1) MSEK	
ISOLDE	Membership fee	2023-2026	(2.2/2.2) MSEK	

- Swedish researchers also hold several individual research grants, mainly from VR and KAW.
- Also two large KAW project grants spanning theory and experiment.

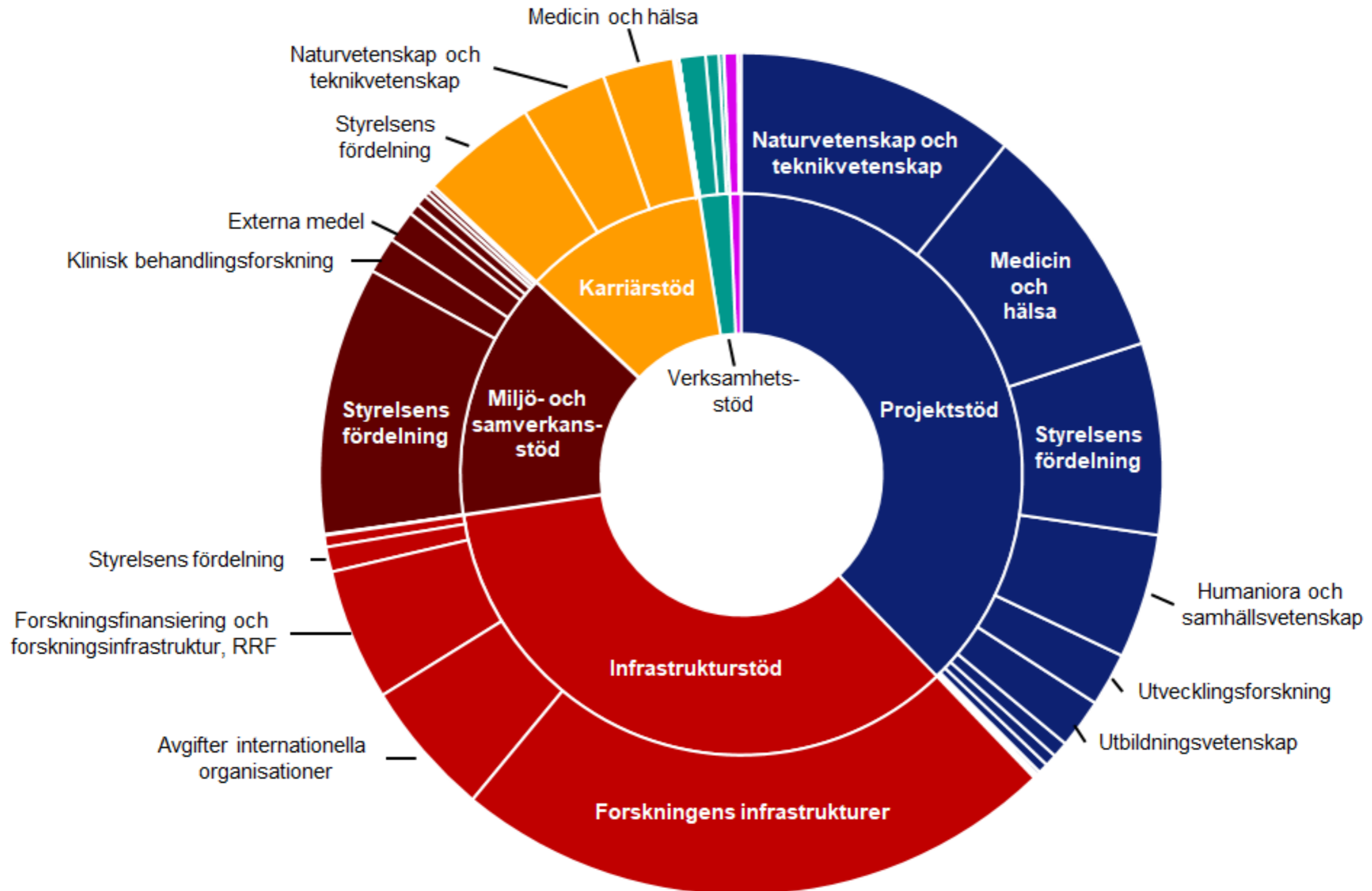
- Sweden is a founding member of CERN and has a broad and rich CERN-centred research program.
    - Particle, nuclear, atomic, environmental and accelerator physics.
  - Room for improvement in the Swedish presence at CERN.
    - Under-represented among CERN users.
      - Partly due to mismatch between infrastructure and research funding. Lack of support on group level for using the funded infrastructures.
      - Research funding is predominantly individualistic and short-term (~4y). Working in a team is considered negatively in individual applications.
    - Return on investment at CERN has been consistently low over many years, in supply/service contracts and in staff/fellow/student positions.
      - Used to have dedicated funding from VR for CERN summer and technical students, but this scheme has been ended.
      - Has lacked dedicated programs to reach out to students and young scientists about career opportunities at CERN.
- BiSS plays an important role here. Needs continued funding.

- The infrastructure funding model, with short (~5y) funding cycles and lack of contingency, is poorly suited for large-scale and long-term international projects.
  - The infrastructure funding from VR, partly used for membership fees paid yearly in CHF, is allocated in SEK at the start of a funding period.
    - Weakened SEK currency relative to CHF/EUR requires extra funding to be granted, which eats into the funding for other infrastructure projects.
- Difficult to hire permanent technical staff at universities for computing, instrumentation, maintenance, operations, due to individualistic system.
- No funding for ECFA, ACCU, IPPOG, neither for membership fees nor for travel to meetings. VR requests not granted, no flexible funding available.
  - Participation to meetings has to be paid by individual research grants while representing Sweden. Time and effort to find funding for small fees.
- Sweden does not take full advantage of the incredible opportunities that CERN presents. Room to improve the research, knowledge-building, and industrial return to Sweden from membership in CERN and experiments!



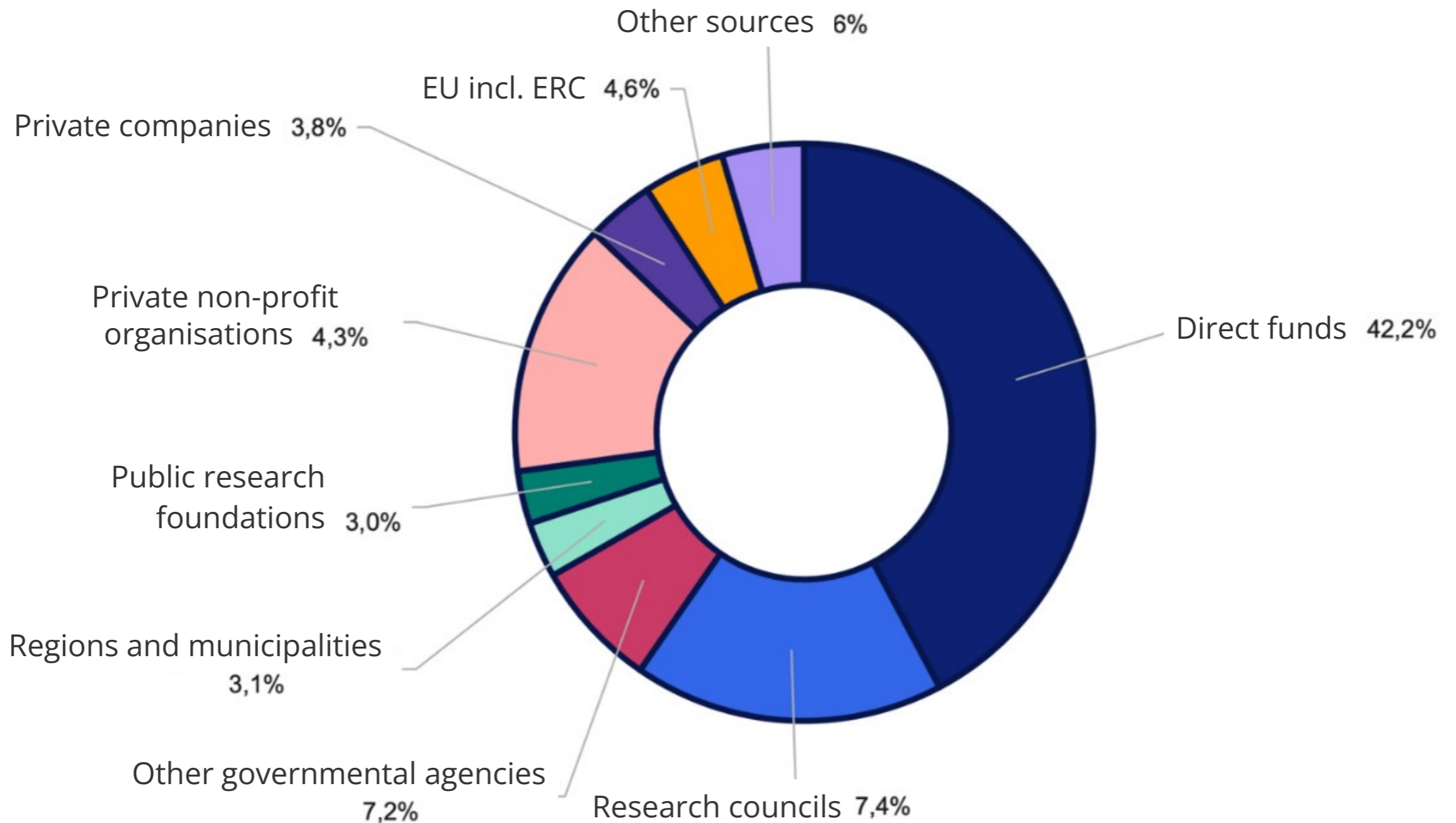


- The division of the funding from VR:

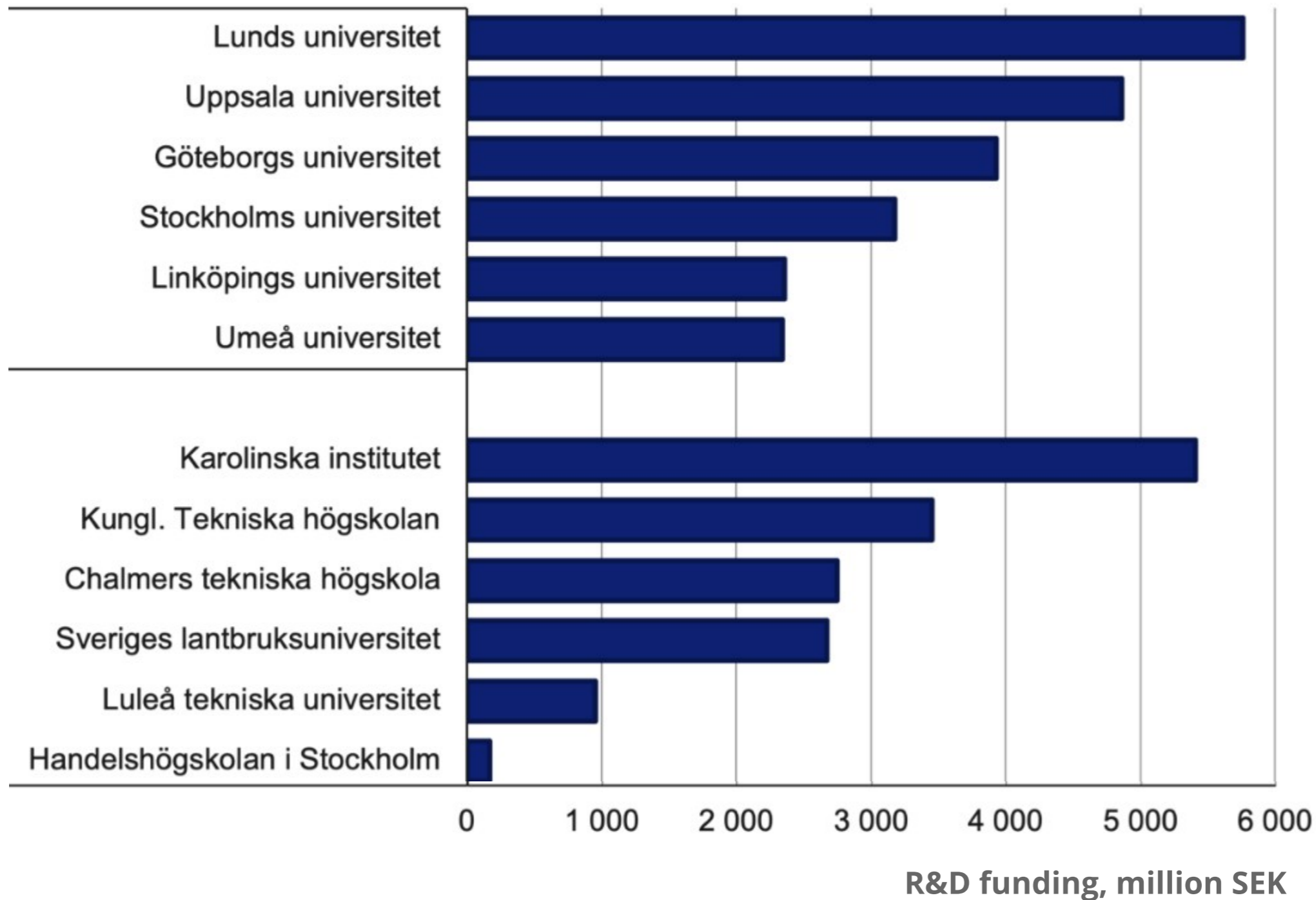


# Swedish funding system

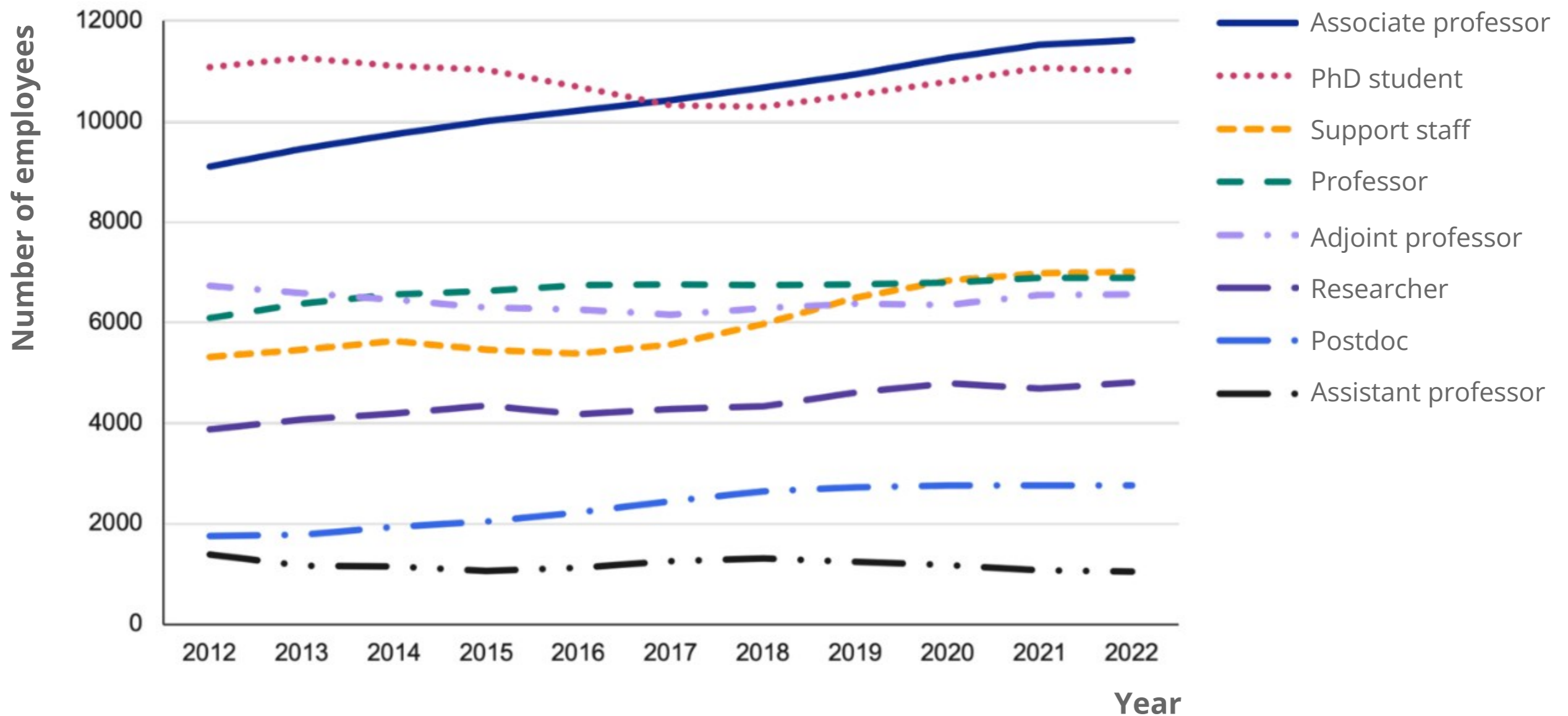
- The funding to the higher education sector comes from the following sources:



- The funding distributed over the large universities:



- Number of employees in the higher education sector:



Sweden is very poorly balanced

Sweden is poorly balanced



Table 6: Overall return coefficient for the year 2023

Year: 2023 Country: - ALL -

Name	Country		2020 - 2023		2023	
	↑↓	↑↓	CHF Amount ↑↓	Return Coefficient ↑↓	CHF Amount ↑↓	Return Coefficient ↓↑
Switzerland		CH	435 314 475	6.93	112 723 370	6.34
France		FR	513 011 713	2.34	157 835 468	2.54
Estonia		EE	1 011 996	0.81	564 371	1.6
Denmark		DK	37 049 928	1.29	12 773 799	1.57
Republic Of Turkiye		TR	6 210 109	0.89	2 852 439	1.44
Bulgaria		BG	2 116 150	0.4	1 618 191	1.09
Spain		ES	95 274 468	0.82	30 715 657	0.94
Croatia		HR	856 398	0.63	307 683	0.81
Latvia		LV	395 373	0.45	198 670	0.81
Italy		IT	123 800 495	0.76	36 144 705	0.78
Slovakia		SK	5 415 146	0.66	1 657 979	0.72
Slovenia		SI	1 055 131	0.48	396 577	0.64
Czech Republic		CZ	7 501 667	0.44	2 513 024	0.52
United Kingdom		GB	100 366 878	0.42	31 640 718	0.47
Serbia		RS	1 145 970	0.29	486 029	0.43
Finland		FI	6 420 509	0.3	2 538 248	0.42
India		IN	6 310 376	0.29	2 557 641	0.41
Hungary		HU	4 662 217	0.42	1 241 437	0.39
Germany		DE	163 718 055	0.49	36 040 301	0.38
Greece		GR	5 715 436	0.35	1 466 132	0.32
Netherlands		NL	29 033 831	0.39	6 728 795	0.32
Poland		PL	19 658 892	0.42	4 080 186	0.31
Austria		AT	21 206 982	0.61	2 935 057	0.3
Portugal		PT	7 395 768	0.42	1 498 105	0.3
Lithuania		LT	820 315	0.61	107 121	0.28
Israel		IL	5 155 675	0.16	2 266 816	0.26
Romania		RO	3 554 565	0.19	1 226 745	0.23
Norway		NO	8 485 200	0.24	1 971 819	0.19
Sweden		SE	7 984 351	0.19	2 238 475	0.19
Belgium		BE	10 601 949	0.24	2 189 394	0.18
Cyprus		CY	308 521	0.22	68 561	0.18
Ukraine		UA	192 586	0.14	45 760	0.12
Pakistan		PK	307 076	0.12	8 291	0.01
<b>Totals</b>			<b>1 632 058 201</b>	<b>1</b>	<b>461 637 561</b>	<b>1</b>



Year	2019	2020	2021	2022	2023
Supplies (MCHF)	8.2	2.9	1.3	1.6	2.2
Industrial return	1.21	0.55	0.25	0.28	0.37



Enquiry			Lowest bid			Alignment			Difference	
Year	Reference	Description	Supplier	Country	Bid (CHF)	Supplier	Country	Initial bid (CHF)	%	CHF
2014	DO-28633/TE/ MSC	Supply of H/V Corrector Magnets for the CERN LINAC 4 to Proton Synchrotron Booster Transfer Line	Sef	FR = 93 % ; DE = 7 %	161521	Scanditronix	SE = 99 % ; AT = 1 %	168739	4.47%	7218
1996	IT-2420/LHC	Hydraulic Press	Cte Sist Emi	IT = 75 % ; ES = 15 % ; DE = 10 %	1530000	Jfjellman	SE = 93 % ; DE = 7 %	1717000	12.22%	187000
2023	DO-33819/IR	Provision of students services on the CERN Science Gateway site	Adecco	CH = 100%	261 159	Academic Work Sweden	SE = 100%	308 985.6	18.31	47 826.6

Table 13: List of orders / contracts for supplies placed in 2023 for a total value exceeding 50 000 CHF

Payments and outstanding commitments, including future years

**Excluding contracts in tables 11 and 12 and excluding amounts funded by External funds (all funds other than Member State contributions).**

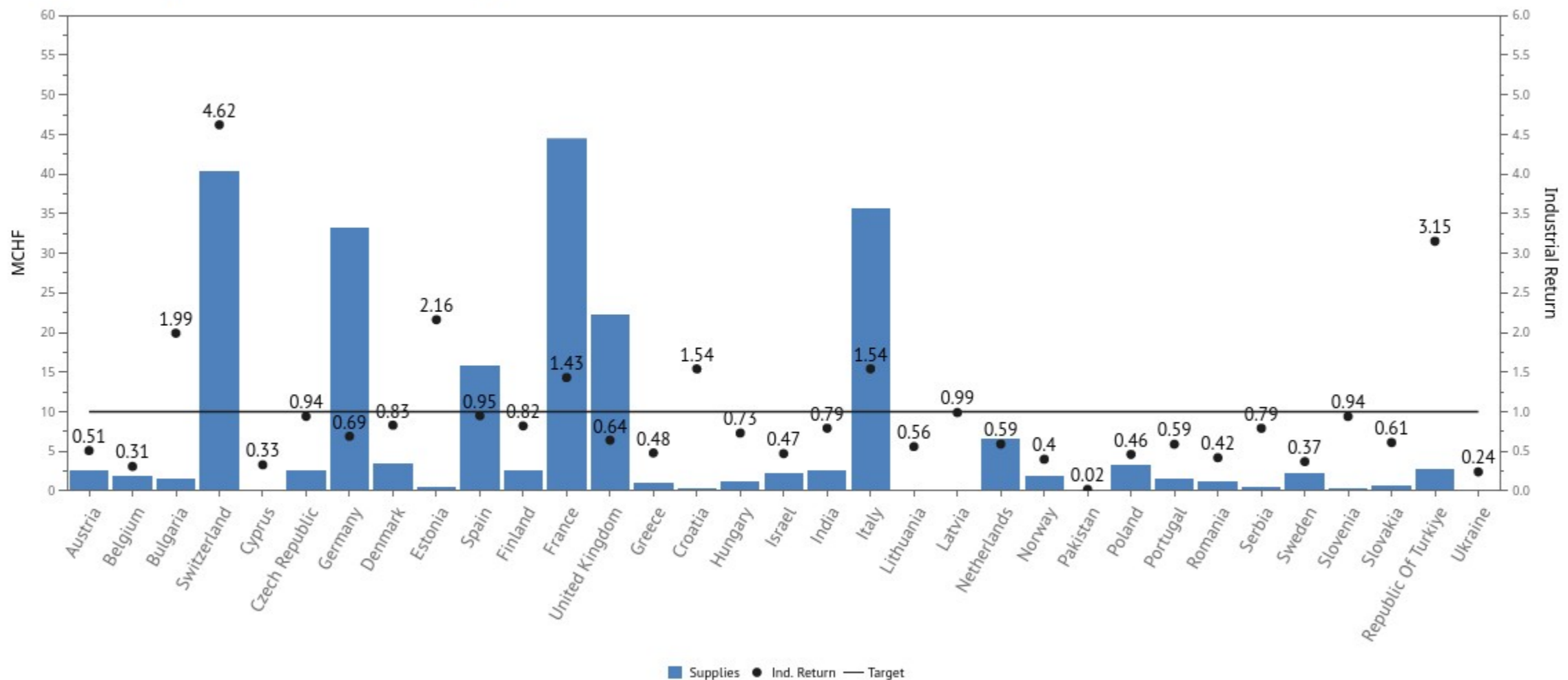
Show  entries

Search:

Contract number / Supplier	Reference	Description	Cou	Pct	Commitment
BS51/ PROLIANS SMG	IT-4558/SMB	PERSONAL PROTECTIVE EQUIPMENT	SE	12	10 774
Subtotal:					10774
CA1078321/ ELETTA INSTRUMENTATION	SINGLE SOURCE: COMPATIBILITY	14KA SERIES FLOWMETERS	SE	100	90045
Subtotal:					90045
CA1558274/ VOLVO GROUP (SUISSE)	DO-33928/EN/HE	HEAVY LOAD TRUCK	SE	72	97444
Subtotal:					97444

- Sweden is a very poorly balanced country with an industrial return coefficient in 2023 of 0.37 (down from 0.61 in 2019-2022).

Graph 1: Payments in 2023 for Supplies



- Industrial service payments to Swedish companies amounted to 58 kCHF in 2023, corresponding to an index of 0.02.
- Less of a worry since the industrial services more naturally go to countries in the CERN vicinity.

Graph 2: Payments in 2023 for Industrial Services

