1862
RIGA TECHNICAL UNIVERSITY

RTU and CERN

RTU Prof. Toms TORIMS
CERN Scientific Associate

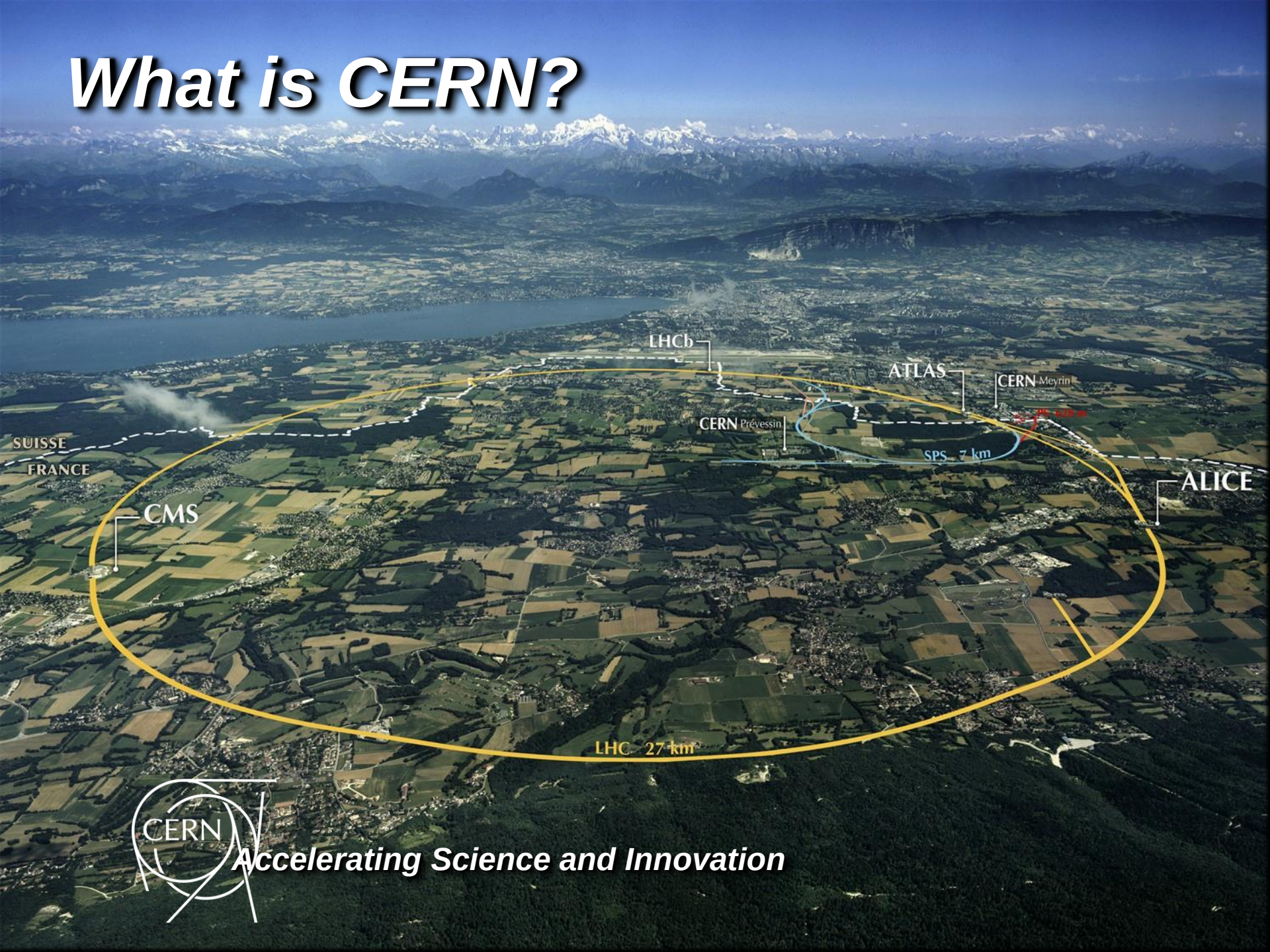
Representative of Latvia

- Dr.sc.ing. **Toms TORIMS**
- PhD in Mechanical Engineering
- Professor at the Chair of Material Processing Technology at RTU
- Advisor to the Minister of Education and Science (science)
- Advisor to the Rector of Riga Technical University
- Nominated Head of the Centre of High Energy Physics and Accelerator Technologies
- CERN Scientific Associate
- 50+ scientific publications

Content

- What is CERN and why it is important for RTU and Latvia to participate
- Where are we? – story about people – Latvians @ CERN
- EU co-financed projects?
- What are our perspectives and possibilities?

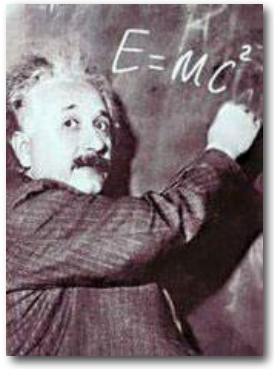
What is CERN?



CERN

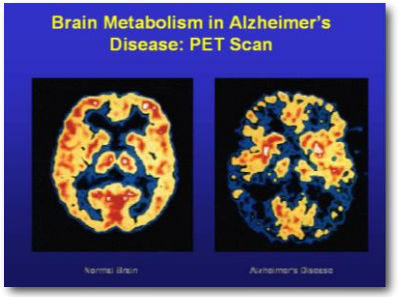
Accelerating Science and Innovation

The Mission of CERN



- Push back the frontiers of knowledge

  E.g. the secrets of the Big Bang …what was the matter like within the first moments of the Universe's existence?



- Develop new technologies for accelerators and detectors
  - Information technology - the Web and the GRID
  - Medicine - diagnosis and therapy

- Train scientists and engineers of tomorrow

- Unite people from different countries and cultures

CERN: founded in 1954: 12 European States
"Science for Peace"
Today: 22 Member States

~ 2500 staff
~ 1800 other paid personnel
~ 13000 scientific users

Budget (2017) ~ 1100 MCHF

Member States: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Romania, Slovak Republic, Spain, Sweden, Switzerland and United Kingdom

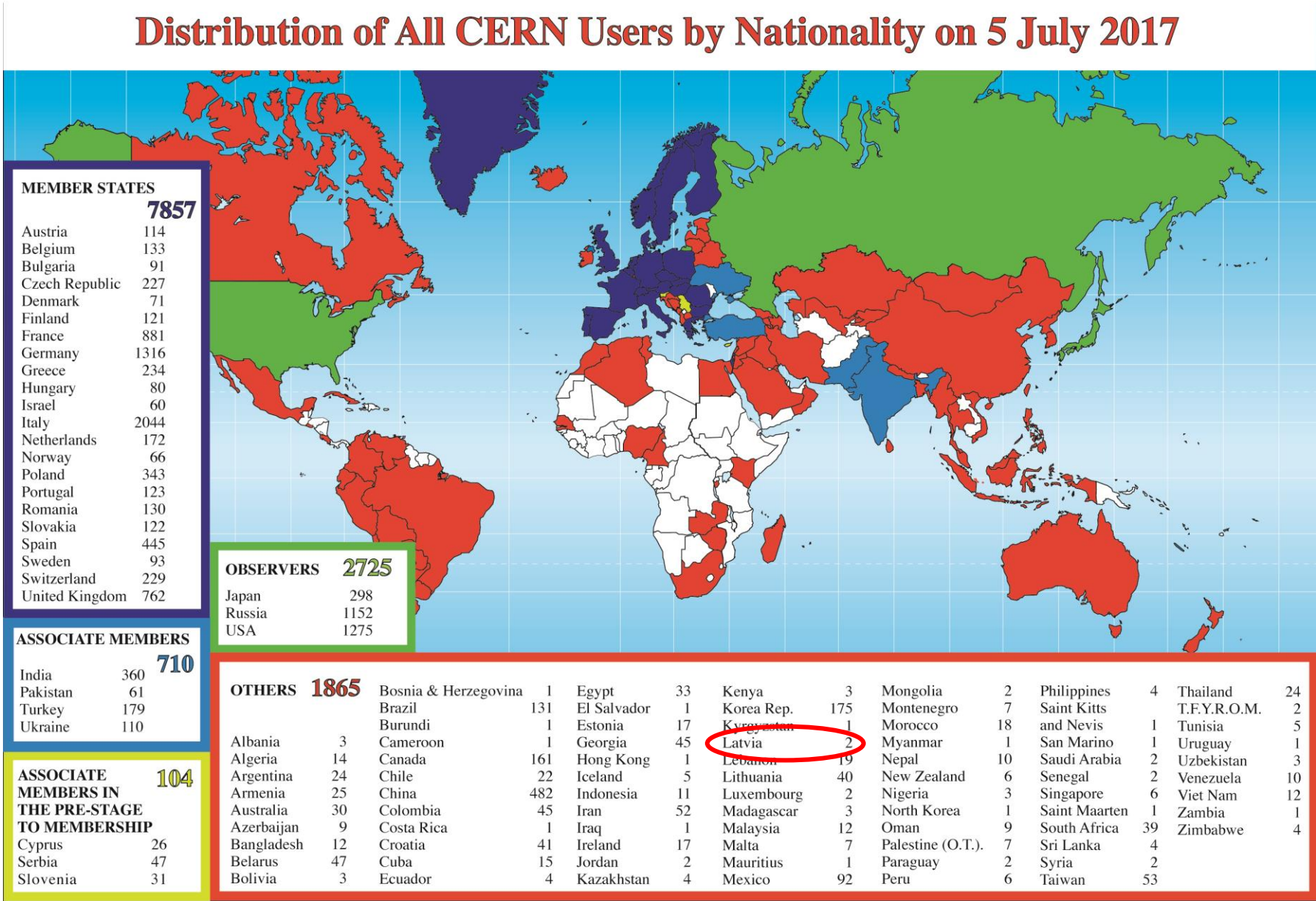
Associate Members in the Pre-Stage to Membership: Cyprus, Serbia, Slovenia

Associate Member States: India, Pakistan, Turkey, Ukraine

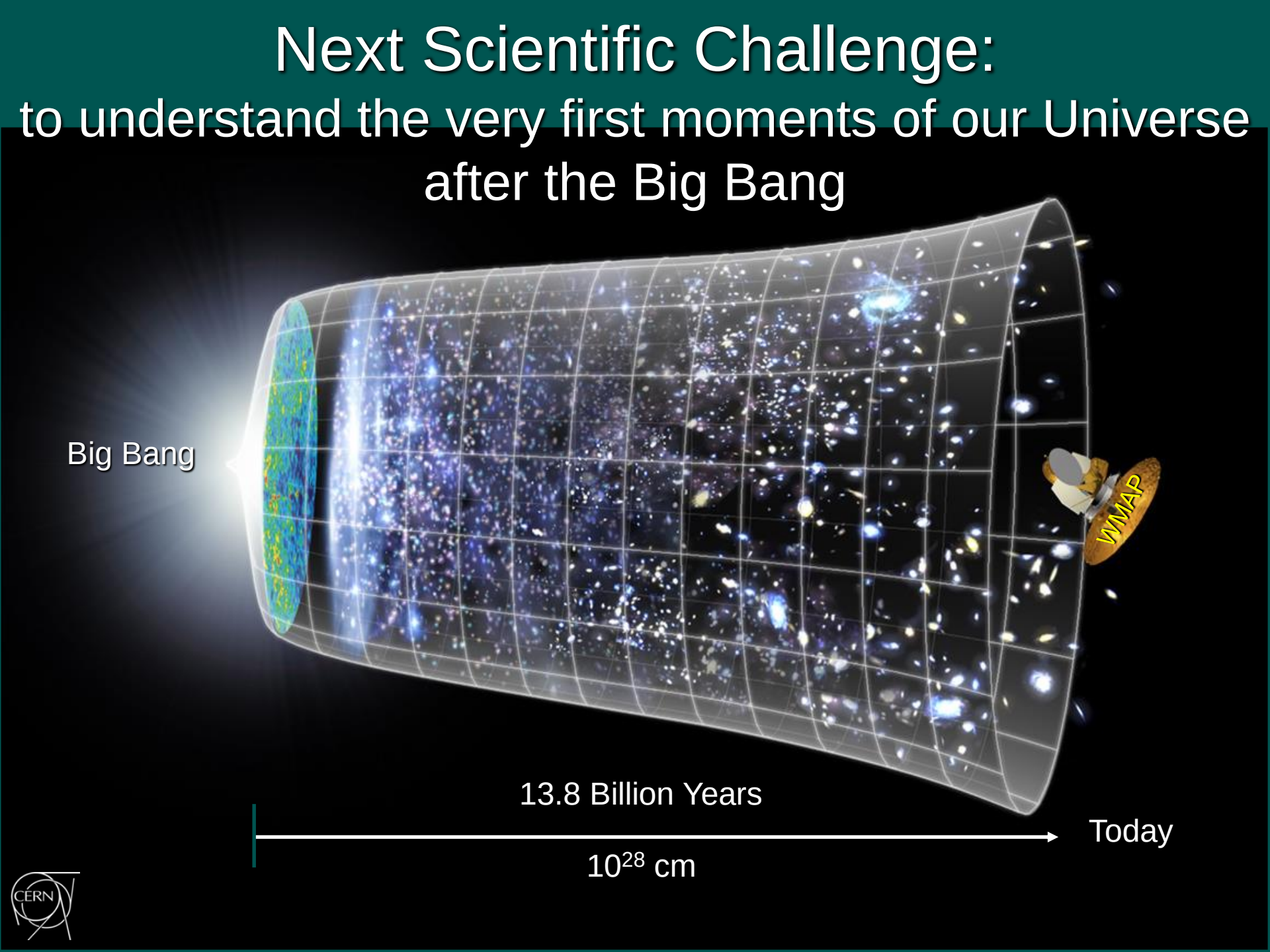
Applications for Membership or Associate Membership: Brazil, Croatia, Lithuania, Russia

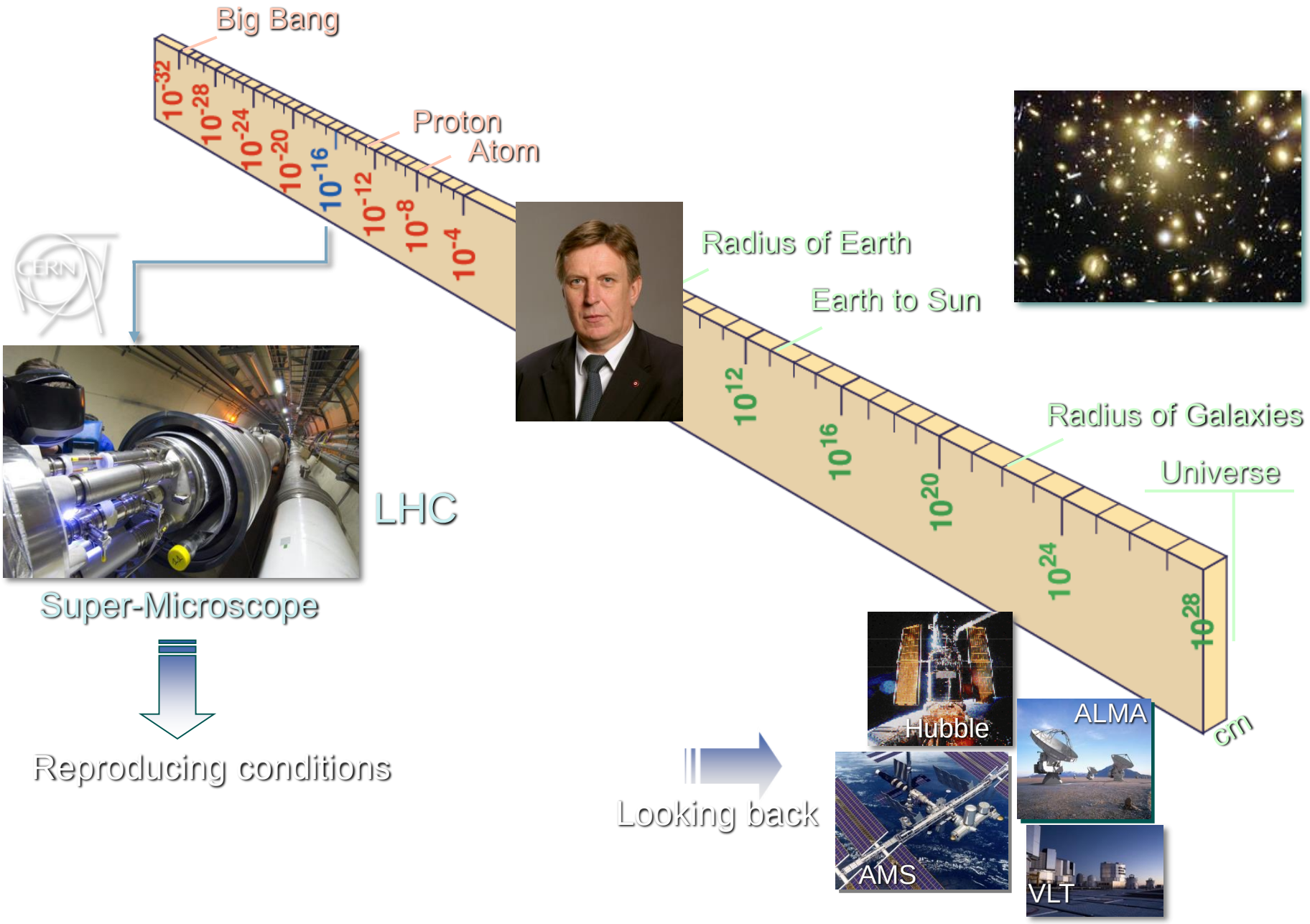
Observers to Council: Japan, Russia, United States of America; European Union, JINR and UNESCO

Science is getting more and more global

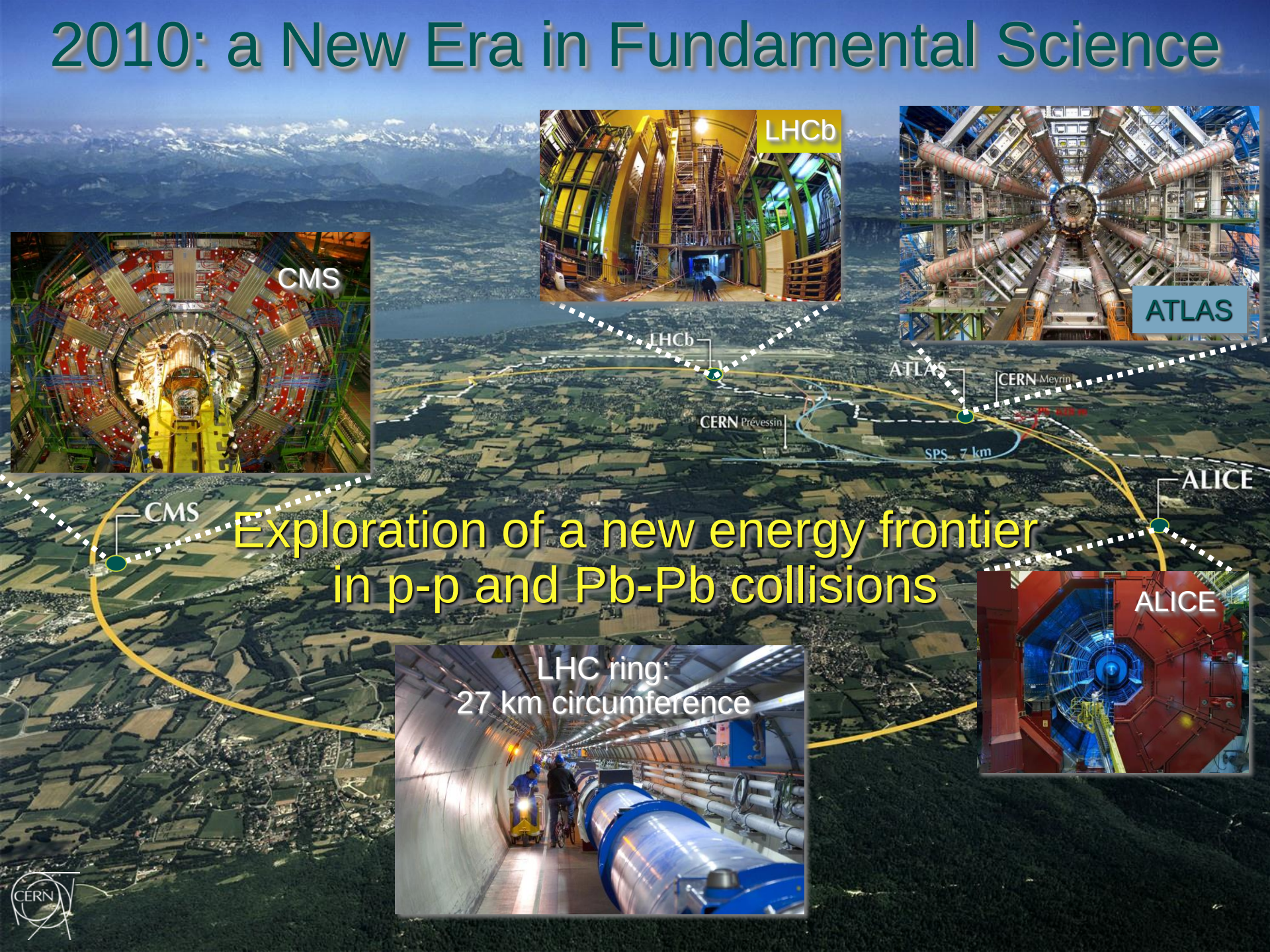


Next Scientific Challenge:
to understand the very first moments of our Universe after the Big Bang




Big Bang
Proton
Atom
Radius of Earth
Earth to Sun
Radius of Galaxies
Universe
cm
LHC
Super-Microscope
Reproducing conditions
Looking back
Hubble
ALMA
AMS
VLT

2010: a New Era in Fundamental Science



Exploration of a new energy frontier
in p-p and Pb-Pb collisions

CERN

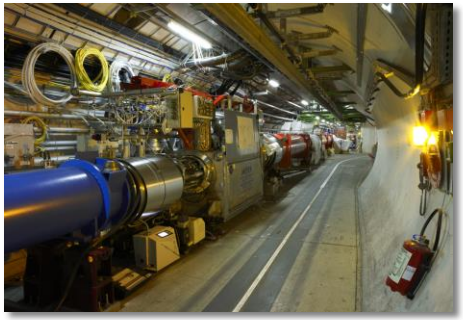
Discovery 2012, Nobel Prize in Physics 2013

The Nobel Prize in Physics 2013 was awarded jointly to François Englert and Peter W. Higgs *"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider".*

CERN: Particle Physics and Innovation

- Interfacing between fundamental science and key technological developments

- CERN Technologies and Innovation



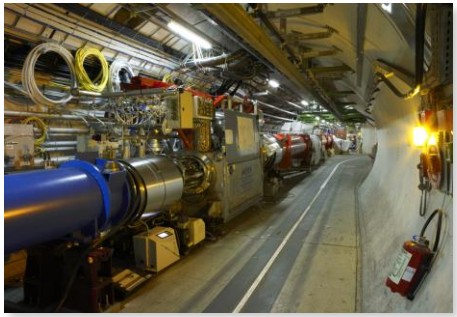
Accelerating particle beams

Detecting particles

Large-scale computing (Grid)

Medical Application as an Example of Particle Physics Spin-off

Combining Physics, ICT, Biology and Medicine to fight cancer

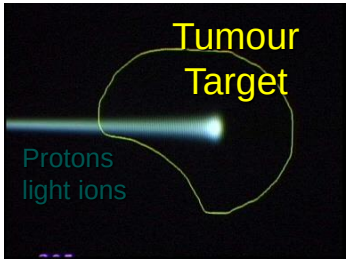


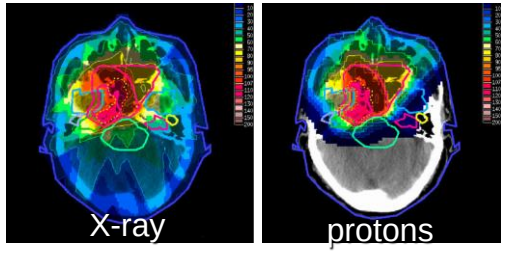
Accelerating particle beams

~30’000 accelerators worldwide

~17’000 used for medicine

Hadron Therapy

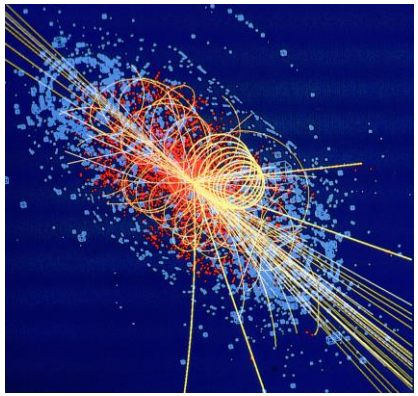




Leadership in Ion Beam Therapy now in Europe and Japan

>100’000 patients treated worldwide (45 facilities)

>50’000 patients treated in Europe (14 facilities)

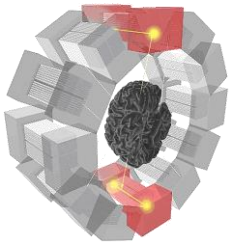


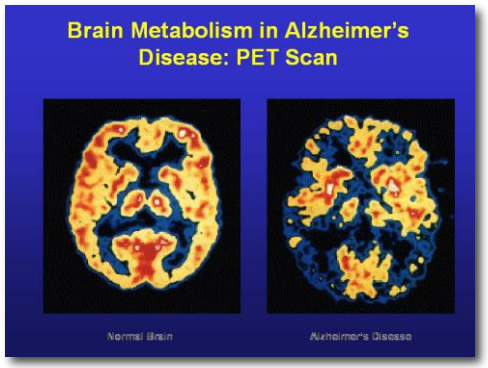
Detecting particles

Imaging

Clinical trial in Portugal, France and Italy for new breast imaging system (ClearPEM)

PET Scanner



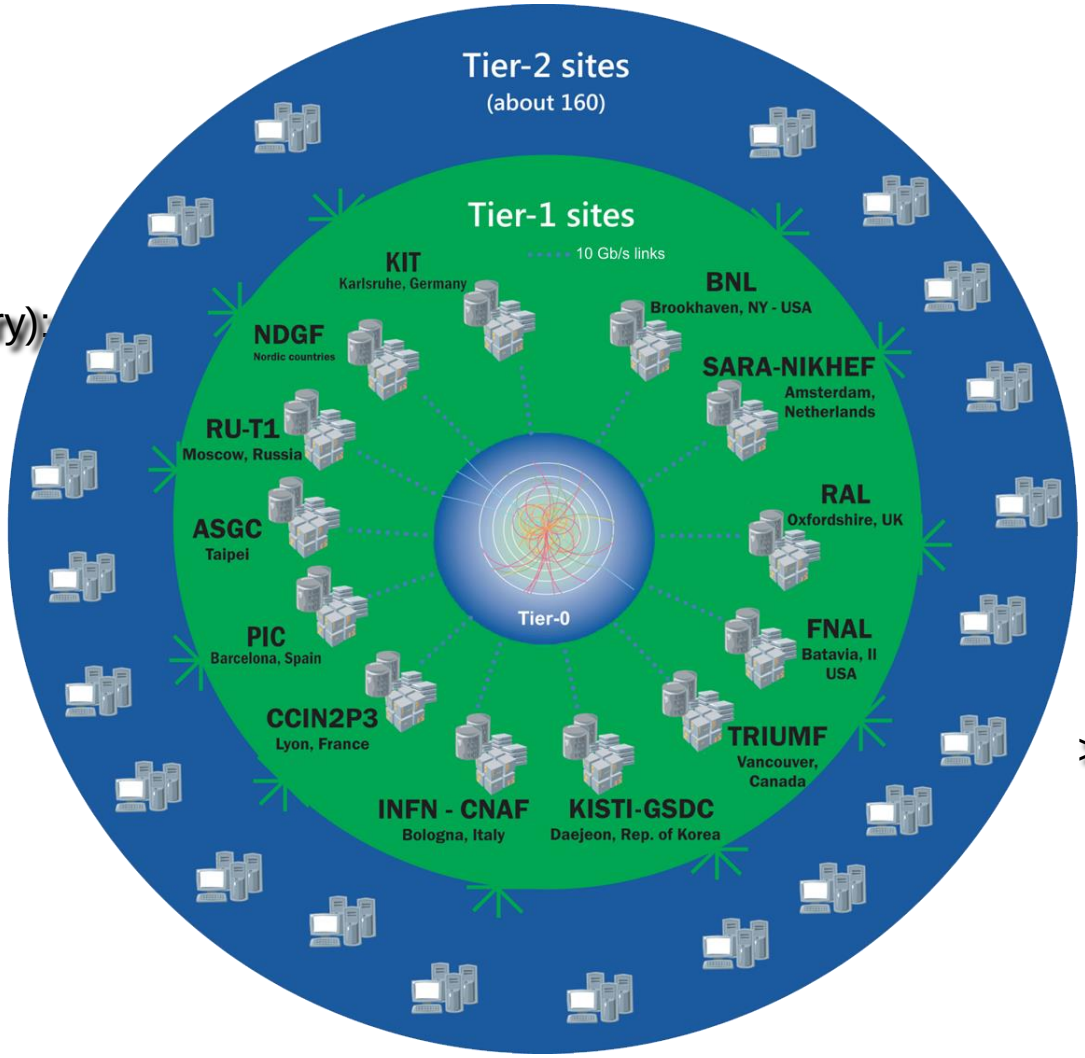


The Worldwide LHC Computing Grid

Tier-0 (CERN and Hungary): data recording, reconstruction and distribution

Tier-1: permanent storage, re-processing, analysis

Tier-2: Simulation, end-user analysis



~170 sites, 40 countries

~500k CPU cores

500 PB of storage

> 2 million jobs/day

10-100 Gb links

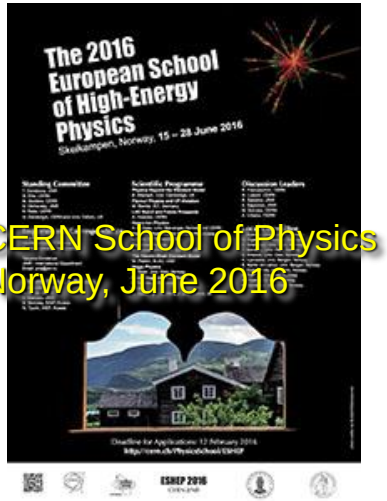
WLCG:
An International collaboration to distribute and analyse LHC data

Integrates computer centres worldwide that provide computing and storage resource into a single infrastructure accessible by all LHC physicists

CERN Education Activities

Scientists at CERN
Academic Training Programme

Young Researchers
CERN School of High Energy Physics
CERN School of Computing
CERN Accelerator School



CERN School of Physics
Norway, June 2016

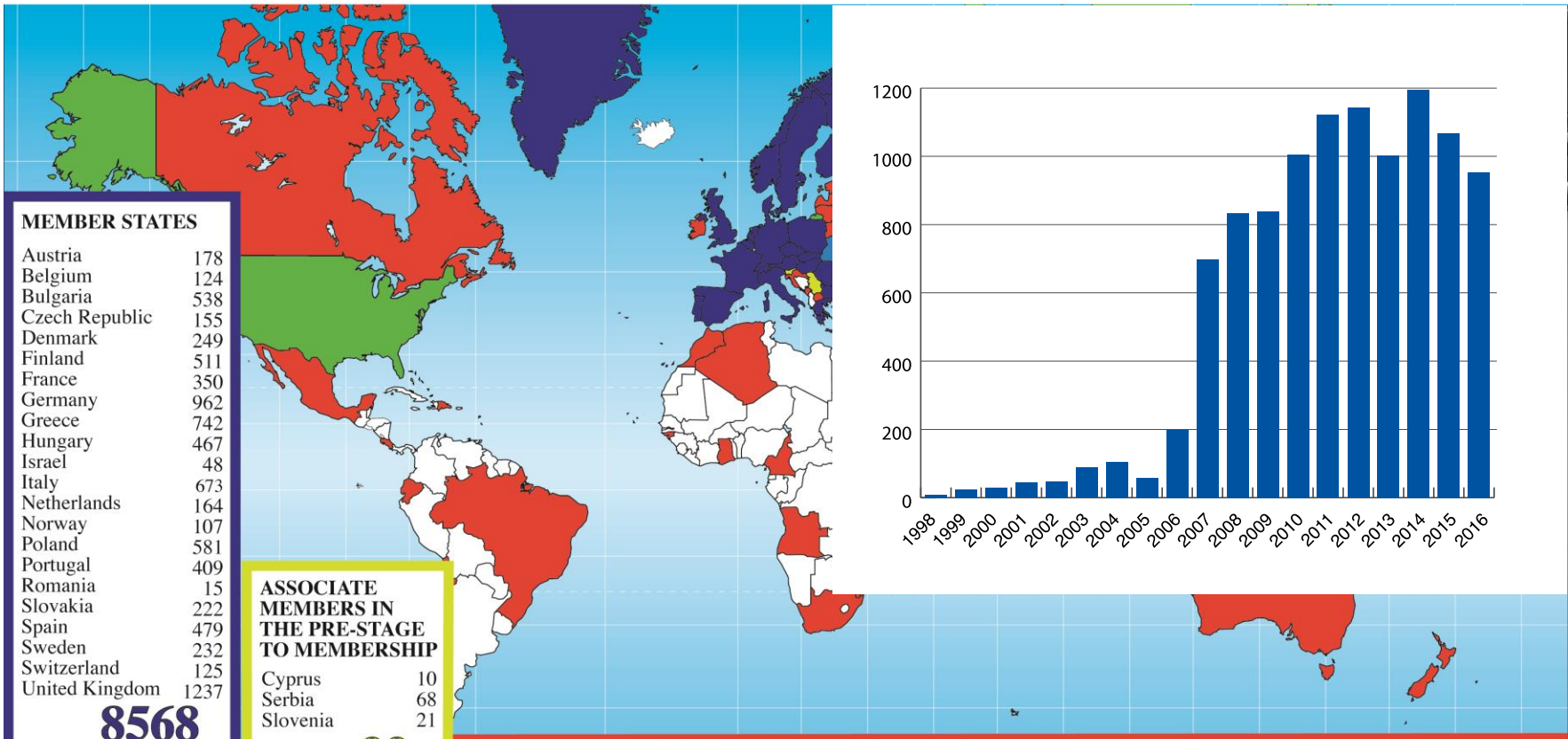
Undergraduates
Summer Students Programme

CERN Teacher Schools
International and National Programmes

Public visitors
120 thousand per year

CERN Teacher Programme

Teacher Programme Participants 1998 - 2016 (Total: 10462)



MEMBER STATES

Austria	178
Belgium	124
Bulgaria	538
Czech Republic	155
Denmark	249
Finland	511
France	350
Germany	962
Greece	742
Hungary	467
Israel	48
Italy	673
Netherlands	164
Norway	107
Poland	581
Portugal	409
Romania	15
Slovakia	222
Spain	479
Sweden	232
Switzerland	125
United Kingdom	1237

8568

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP

Cyprus	10
Serbia	68
Slovenia	21

99

ASSOCIATE MEMBERS

India	5
Pakistan	3
Turkey	241
Ukraine	150

399

OBSERVERS

Japan	8
Russia	379
USA	102

489

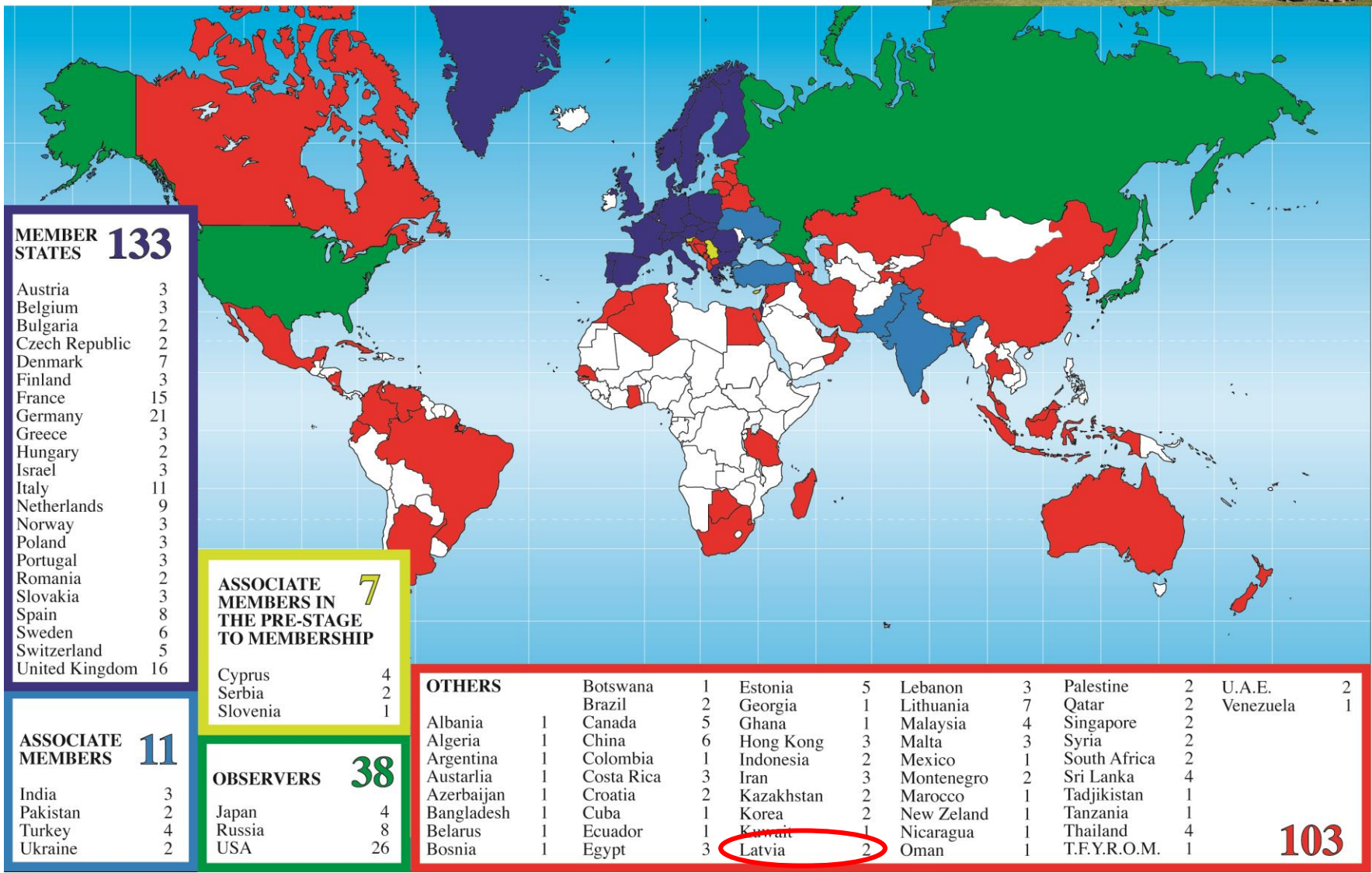
OTHERS

Algeria	8	Canada	9	Ghana	6	Malta	36	Sao Tome	7	U.A.E.	1
Angola	7	Cape Verde	4	Guinea Bissau	1	Mexico	27	Saudi Arabia	1		
Armenia	1	Chile	3	Iran	7	Mongolia	1	Singapore	2		
Australia	7	China	2	Ireland	8	Montenegro	15	South Africa	8		
Azerbaijan	1	Costa Rica	4	Jordan	12	Morocco	2	South Korea	48		
Bahrain	2	Croatia	23	Kazakhstan	8	Mozambique	22	Swaziland	1		
Belarus	3	Dominican Rep.	71	Kenya	4	Nepal	2	Taiwan	1		
Brazil	187	Ecuador	2	Latvia	25	New Zealand	2	Thailand	14		
Burundi	2	Egypt	2	Lebanon	1	Palestine (O.T.)	4	T.F.Y.R.O.M.	12		
Cameroon	5	Estonia	79	Lithuania	51	Qatar	1	Timor-Leste	9		
		Georgia	121	Madagascar	2	Rwanda	20	Uganda	3		

928

Summer Students 2017

Summer Students 2017



MEMBER STATES 133

Austria	3
Belgium	3
Bulgaria	2
Czech Republic	2
Denmark	7
Finland	3
France	15
Germany	21
Greece	3
Hungary	2
Israel	3
Italy	11
Netherlands	9
Norway	3
Poland	3
Portugal	3
Romania	2
Slovakia	3
Spain	8
Sweden	6
Switzerland	5
United Kingdom	16

ASSOCIATE MEMBERS 11

India	3
Pakistan	2
Turkey	4
Ukraine	2

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP 7

Cyprus	4
Serbia	2
Slovenia	1

OBSERVERS 38

Japan	4
Russia	8
USA	26

OTHERS

Albania	1	Botswana	1	Estonia	5	Lebanon	3	Palestine	2	U.A.E.	2
Algeria	1	Brazil	2	Georgia	1	Lithuania	7	Qatar	2	Venezuela	1
Argentina	1	Canada	5	Ghana	1	Malaysia	4	Singapore	2		
Austarlia	1	China	6	Hong Kong	3	Malta	3	Syria	2		
Azerbaijan	1	Colombia	1	Indonesia	2	Mexico	1	South Africa	2		
Bangladesh	1	Costa Rica	3	Iran	3	Montenegro	2	Sri Lanka	4		
Belarus	1	Croatia	2	Kazakhstan	2	Marocco	1	Tadjikistan	1		
Bosnia	1	Cuba	1	Korea	2	New Zeland	1	Tanzania	1		
		Ecuador	1	Kuwait	1	Nicaragua	1	Thailand	4		
		Egypt	3	Latvia	2	Oman	1	T.F.Y.R.O.M.	1		

103

Prevoius cooperation

- 1996 – Institute of Electronics and Computer Sciences of the Latvian Academy of Science participated in the *CMS* experiment
- until 2000 – The Institute of Solid State Physics, University of Latvia participated in *Cristal Clear Project*
- until 2011 – LU and RTU scientists sucecfully participated in the *Baltic Grid*

RTU – CERN co-operation

- Sine 2012 RTU has Framework Collaboration Agreement with CERN

- *Inter alia* two PhD students working on their doctoral thesis based on this agreement

Future scientists @ CERN

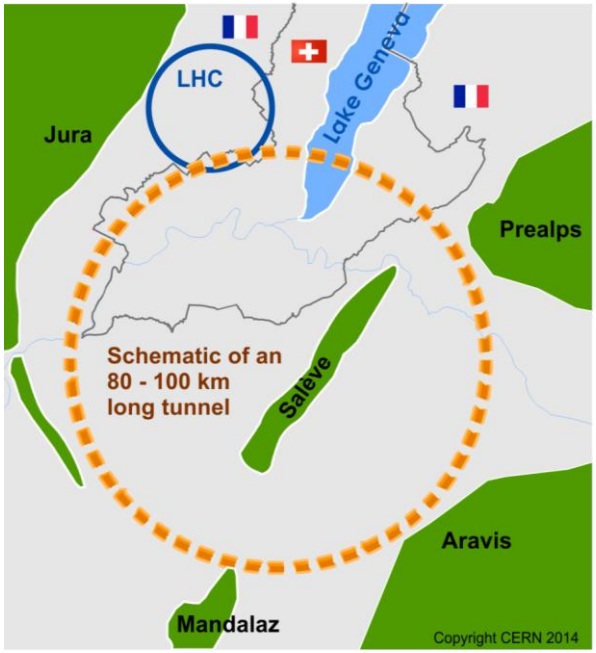
- 2013 – first Latvian PhD students visit to CERN. Participants - PhD students from RTU and other Latvian universities. Hereafter once a year such visits take place.

RTU scientists at CERN

- In January 2015 – RTU Rector and scientists delegation visited CERN. In meetings with leading specialists and group leaders particular scientific cooperation areas are being identified.
  - Power electronics and energetics
  - Material processing technologies
  - Robotics
  - Material science

RTU is partner in FCC

- 2015 – RTU signs Memorandum of Understanding with CERN about FCC (Further Circular Collider) research project



Memorandum of Understanding
for the Future Circular Collider (FCC)
Study hosted by CERN

THE INSTITUTES, LABORATORIES, UNIVERSITIES AND THEIR FUNDING AGENCIES AND OTHER SIGNATORIES OF THIS MEMORANDUM OF UNDERSTANDING AND CERN AS THE HOST LABORATORY (**"**the Participants**")**

Whereas

At a dedicated session of the CERN Council held on 30 May 2013, the Council adopted the Update of the European Strategy for Particle Physics which included *inter alia* the following statement:

"…Europe needs to be in a position to propose an ambitious post-LHC accelerator project at CERN by the time of the next Strategy update, when physics results from the LHC running at 14TeV will be available. CERN should undertake design studies for accelerator projects in a global context, with emphasis on proton-proton and electron-positron high-energy frontier machines. These design studies should be coupled to a vigorous accelerator R&D programme, including high-field magnets and high-gradient accelerating structures, in collaboration with national institutes, laboratories and universities worldwide."

The conceptual design study (the "FCC Study") must be available in time for the next update of the European Strategy for Particle Physics foreseen to take place in 2018,

RTU is partner in FCC

- Prof. Torims represents Latvia and participates in FCC konferences

- **80-100 km** tunnel/infrastructure
- unprecedented **power capacity**
- unprecedented **magnetic field**
- pp - collider (FCC-hh)
- e+e - collider (FCC-ee)
- p-e (FCC-he) option
- High energy HE-LHC ar FCC-hh technology

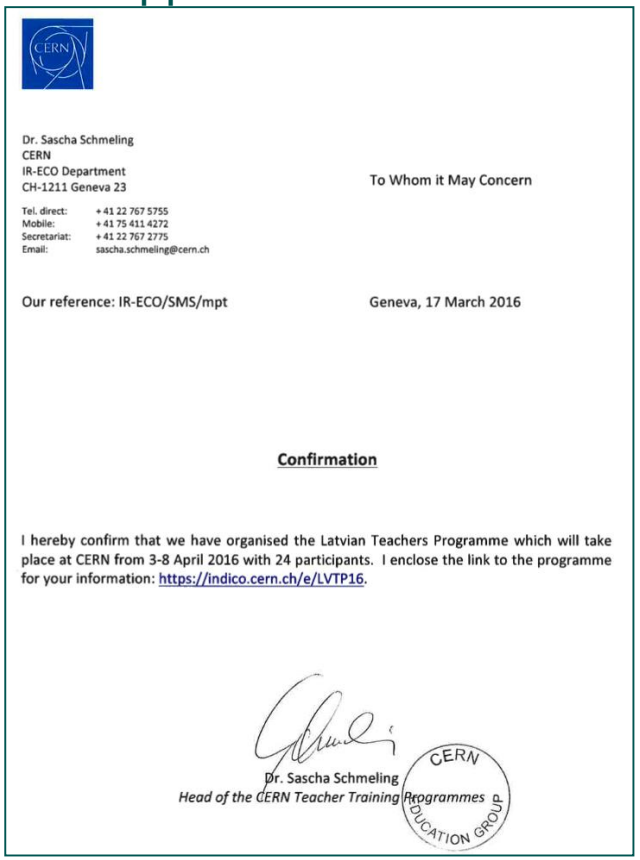
- Challenge in terms of maintenace and repairs…

RTU plays in highest league

- 2016 (march) – RTU, together with other top 40 European scientific Institutes participates in ARIES project coordinated by CERN
- RTU:
  - technologies – improved coating for particle accelerators working surfaces
  - development of innovative radio frequency modulator – energy particle accelerator beam
  - apmācības
- 2017 May 1st project started – RTU is partner in 3 WP. Total 500 000 eur.

Visi of Latvian physics teachers to CERN

- 2016 (jun) – first visit. RTU organized and covered expenses in cooperation with CERN. Visit is successful and CERN agrees to host group of physics teacher from Latvia every year.
- 2017 (feb) – second visit. Ministry of Education and Science, RTU and CERN supports the event.



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Mobile: +41 75 411 4272
Secretariat: +41 22 767 2775
Email: sascha.schmeling@cern.ch

To Whom it May Concern

Our reference: IR-ECO/SMS/mpt

Geneva, 17 March 2016

Confirmation

I hereby confirm that we have organised the Latvian Teachers Programme which will take place at CERN from 3-8 April 2016 with 24 participants. I enclose the link to the programme for your information: https://indico.cern.ch/e/LVTP16.

Dr. Sascha Schmeling
Head of the CERN Teacher Training Programmes

CERN EDUCATION GROUP

Visit of RTU IZV to CERN

- 2016 – first visit of Latvian pupils to CERN. RTU Engineering Highschool - together with visit of Minister of Education and Since
- First study-online conference with Latvia

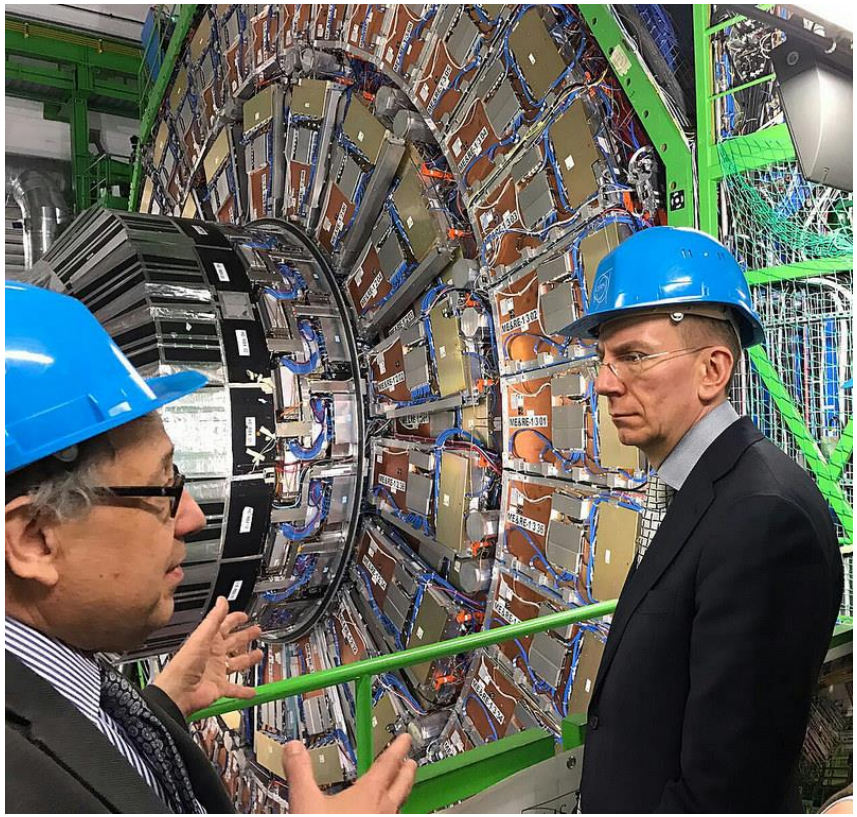
Latvia signs «*ICA*» *agreement*

- 2016 - 31 Oct. Dr. Kārlis Šadurskis Minister of Education and Science on behalf of Latvia signs international cooperation agreement with CERN
- Door to CERN is open ...

Visit of Minister of Foreign Affairs to CERN

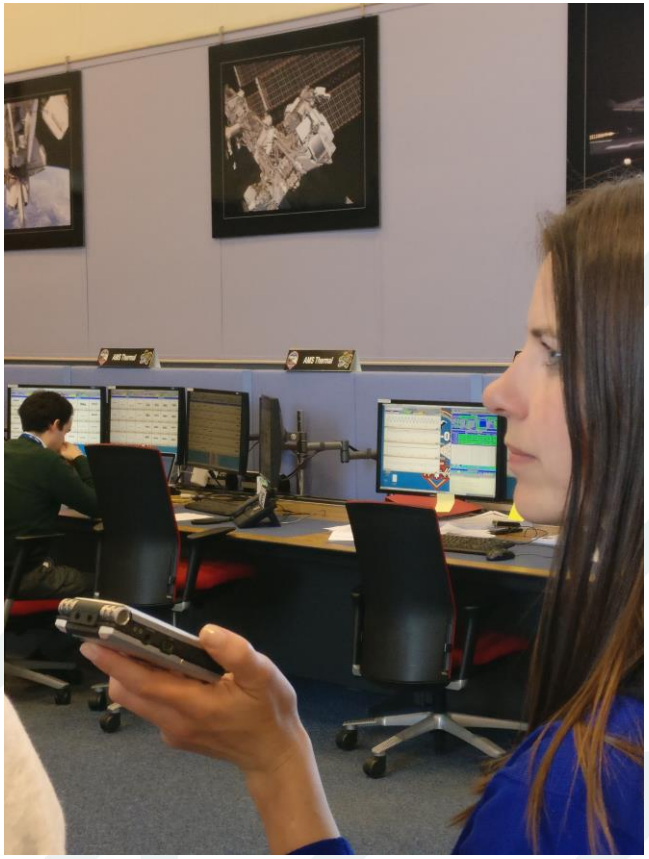
2017 - 27. Feb. Edgars Rinkēvičs Minister of Foreign Affairs visits CERN:

- Positively impressed about positive cooperation between Latvia and CERN.
- Confirmed the intention to involve Latvian scientists, companies, teaching staff and students into CERN activities.
- Underlined the importance of cooperation with CERN not only in the field of fundamental research, that would significantly contribute to the development of science in Latvia, but also practical cooperation with Latvian companies.



Latvian Radio visit to CERN

- Series of scientific radio broadcast «Zināmais nezināmajā» – in simple terms explains to the society what is CERN and tells about cooperation opopportunities



Minister of Welfare visit to CERN

2017 - 8. Jun **Jānis Reirs -** Minister of Welfare together with **Vitālijs Gavrilovs -** Head of Employers' Confederation of Latvia and **Egils Baldzēns -** Head of Free Trade Union Confederation of Latvia visited CERN

- Visits of Latvian ministers are very important due to fact, that Latvia is about to make decision regarding the accession to CERN. It is important for government representatives to see in reality the scope of research activities at CERN.

«Primekss» management at CERN

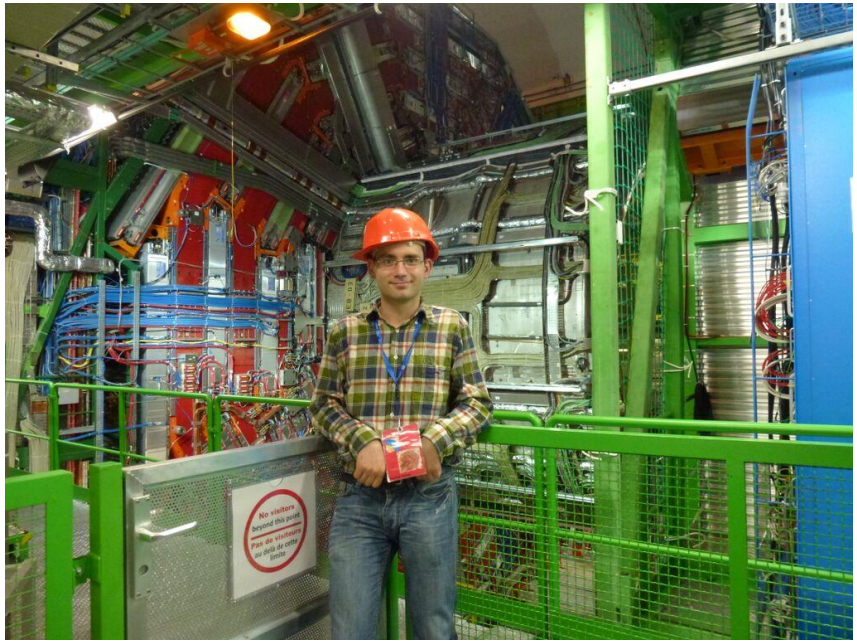
CERN orders innovative concrete technology – pilot project?

Visit of the Prime Minister

Latvian scientists who worked at CERN

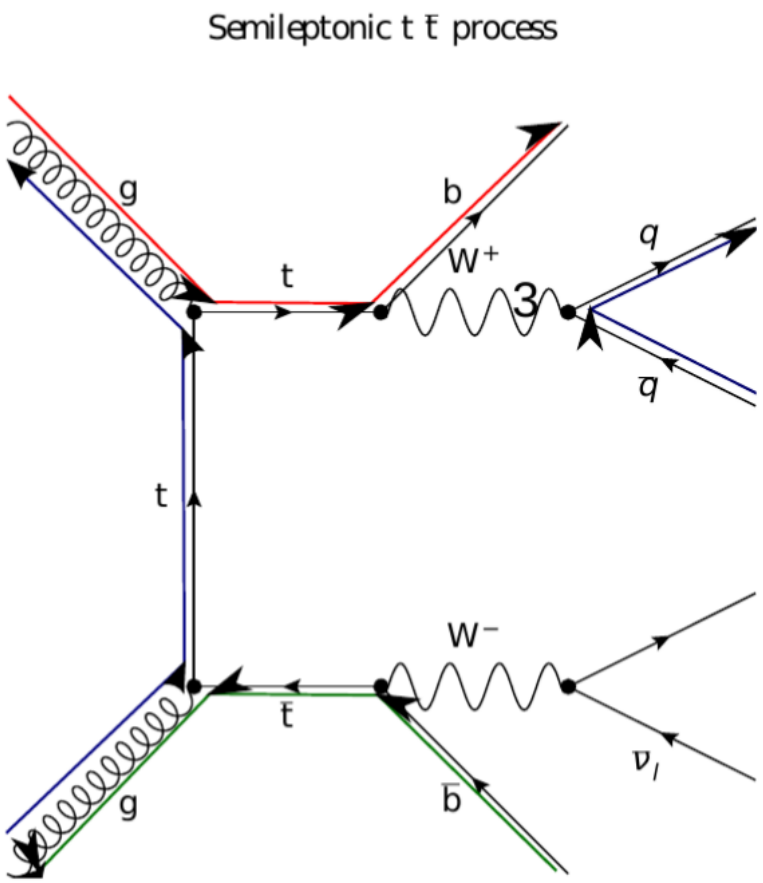
Viesturs Veckalns (RTU)

- Quoting young physician: *«We are investigating how color link between two can be observed in the CS detector».*
- Perspective after PhD defense in RTU – work at CERN (CMS experiment) as project associate – 2018.

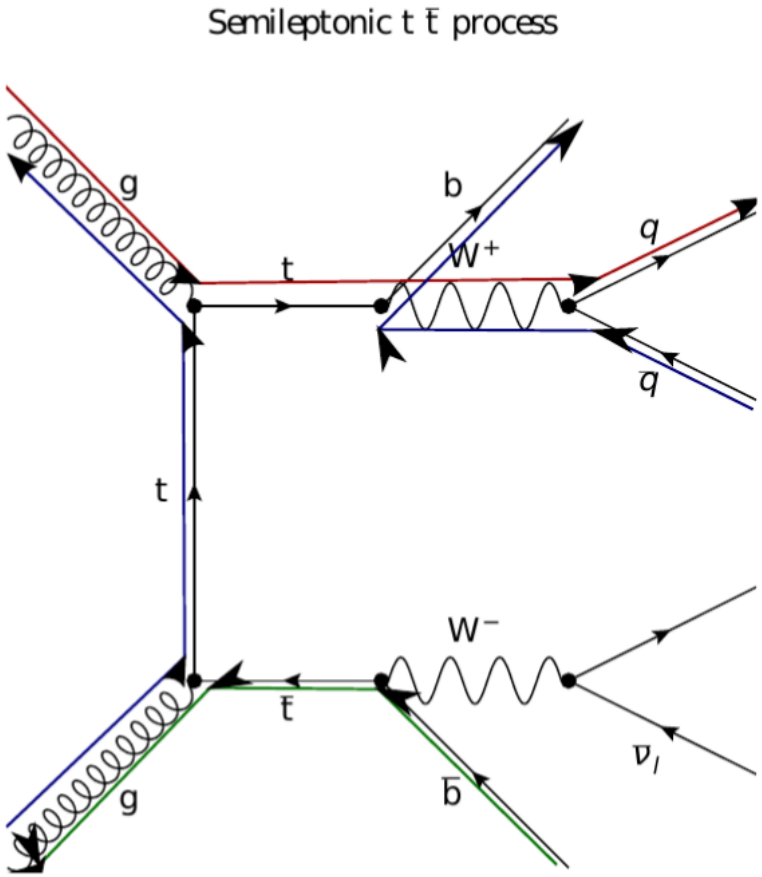


Involved in CERN CMS experiment since 2014. Represents RTU according to the agreement signed in 2012.

Viesturs Veckalns (RTU)



Standard model



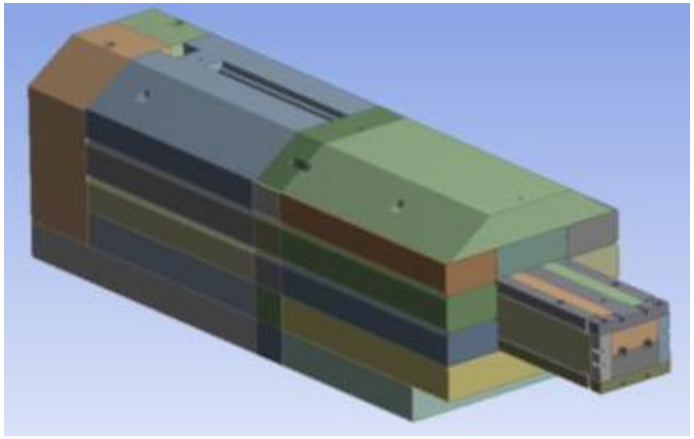
Flipped model

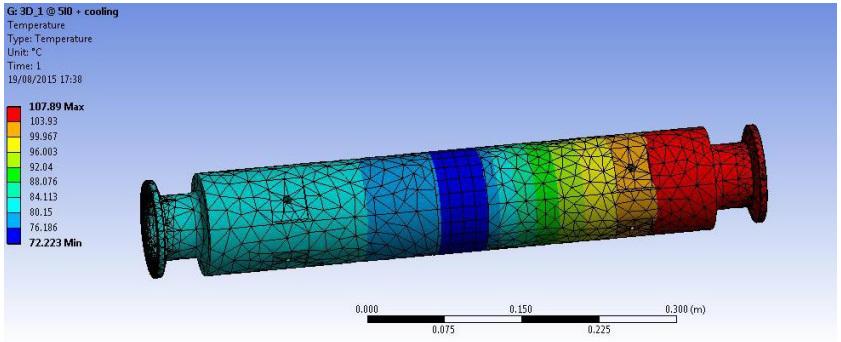
Color flow «ttbar decays»

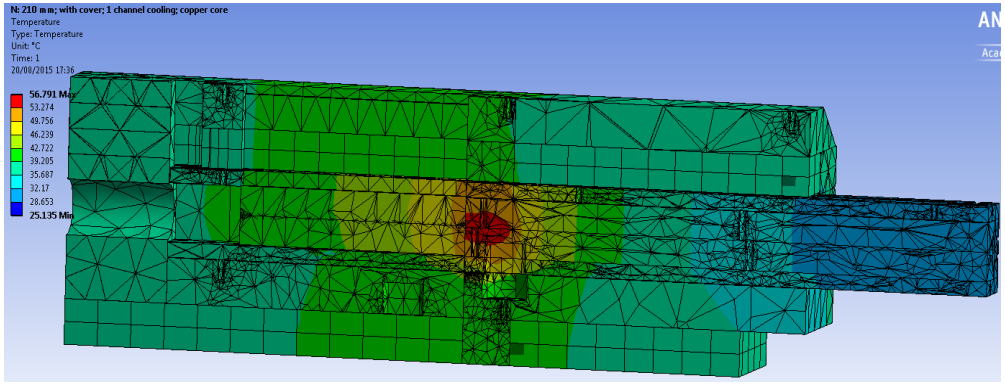
Stepans Šķļariks (RTU)

First CERN summer school participant from Latvia – 2015.

«Collimator thermal function analysis»



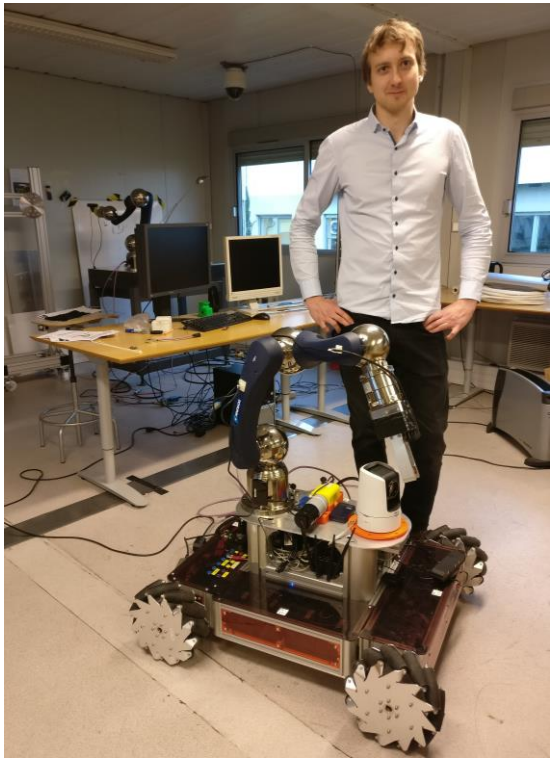




Artūrs Ivanovs (RTU)

- 15.02. - 28.04.2017 scientific internship at CERN

- Development and validation of the battery energy dynamic algorithm for LHC robotized device.
- Perspective – PhD at CERN and work ar project associate from 01.08.2017.



CERN Robotics Group

Contract type:

Project Associate for 3 years

Field of Research:

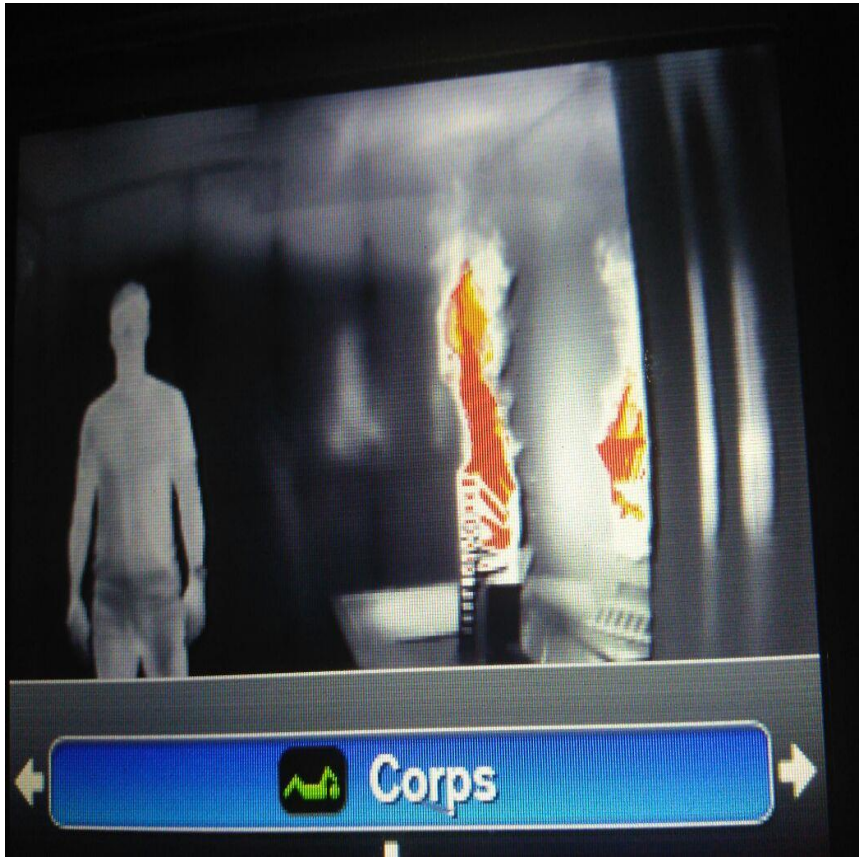
Machine Learning for Robotics Applications

PhD Thesis:

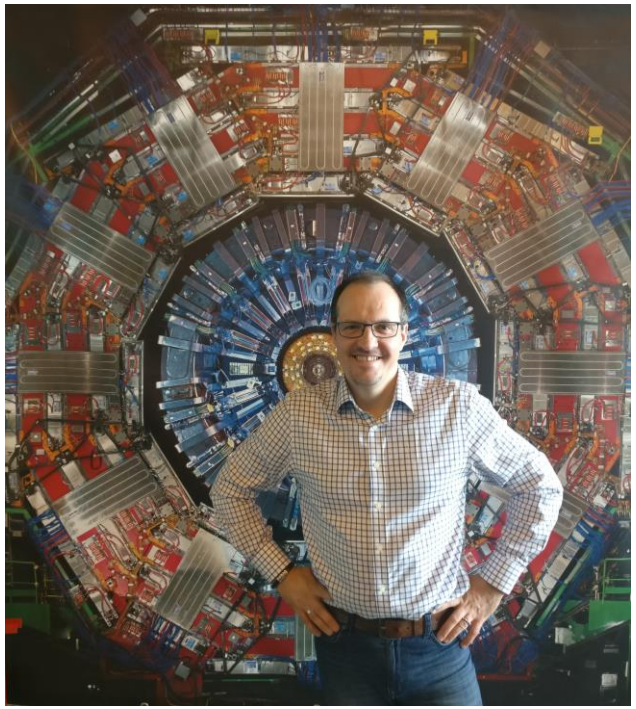
Development of a system for human recognition and wireless vital parameter monitoring in harsh environments

Expected outcome:

Robotic platform with mounted sensors used by first-response brigades to efficiently locate people and monitor their vital parameters before sending in the rescue team.



Toms Torims (RTU)



CERN scientific associate

- **Responsible for accelerator and related technology analysis. The aim is to identify fields, where these technologies can be beneficial for needs of society as well as production (i.e. medicine, mechanical engineering and machine construction)**

- Is analyzing *EuCARD2 (largest EU particle accelerator technology development project) result analysis in order to estimate the impact of project outcomes to the scientific community and society in general*

- *Is advising CERN about strategic goals of ARIES project implementation and about AMICI project scientific and communication structure development*
- ***De facto* Latvian representative at CERN**

Andris P. Stikuts (LU master)

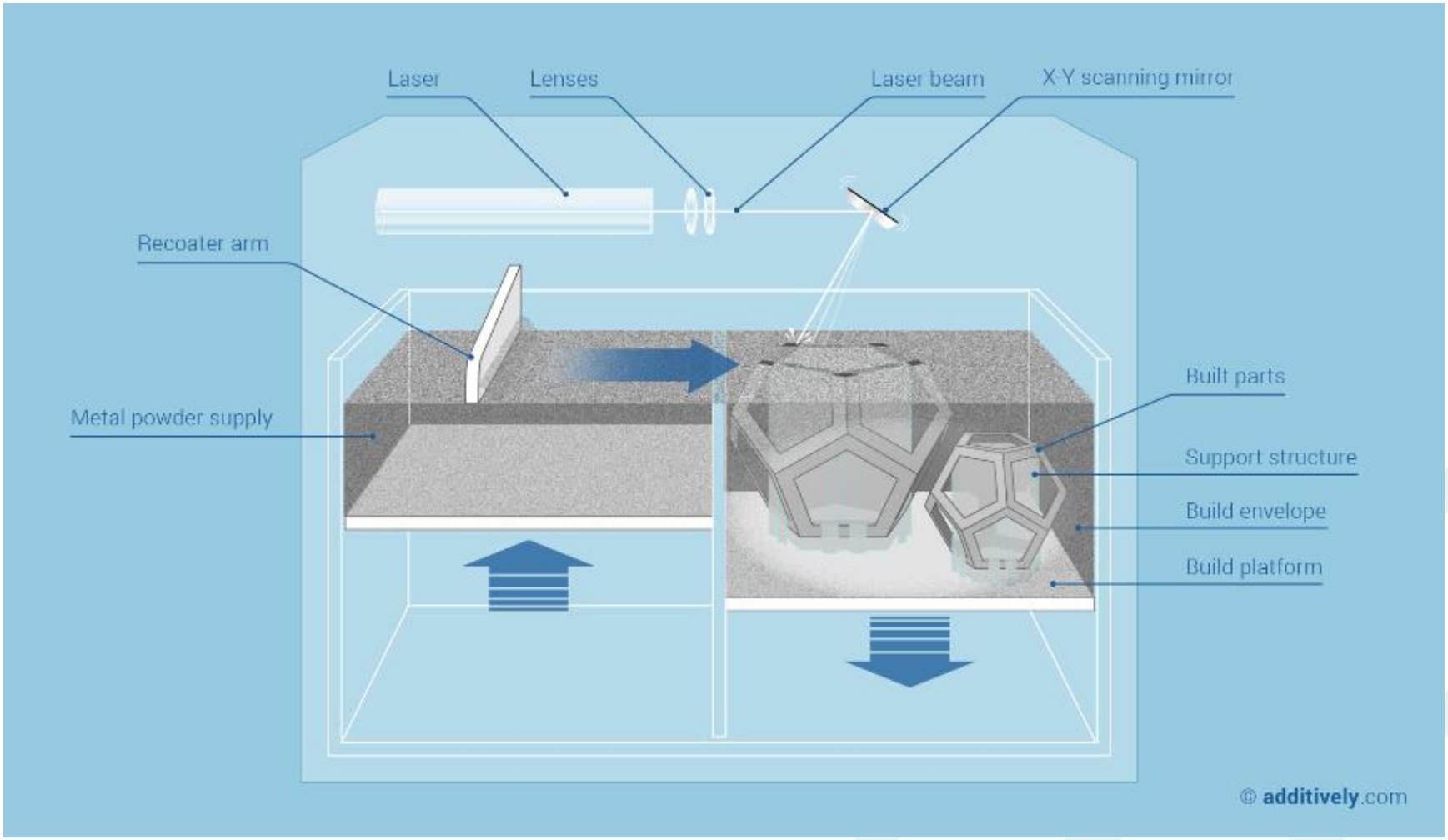
- 2017 **CERN summer school**
- Is working in CLIC (Compact Linear Collider) team, where electron-positron collision simulations are made
- Simulation are required in order to estimate potential futures perspectives of CLIC (Compact Linear Collider)

Artūrs Vēvers (RTU PhD)

- 2017 CERN **summer school**
- *Engineering Department - Mechanical & Materials Engineering Group*
- Is investigating and comparing currently available simulation programs for 3D printing process simulations
- Is developing "End spacer" part simulation and creates supporting structure, that would provide minimal deformation during the printing process
- Is assisting in plant parts 3D printing processes

What is Additive Manufacturing?

Selective Laser Melting (SLM)



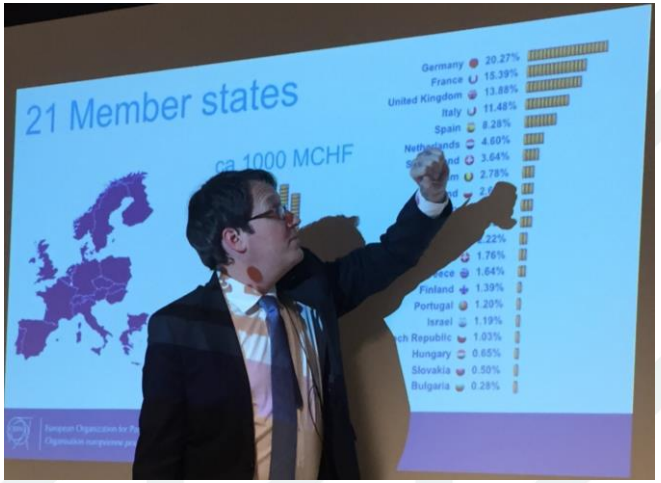
CERN scientists in Latvia

World class scientists in Latvia

- Highly appreciated and well attended guest lecturers of leading CERN scientists in RTU CERN. Students from RTU as well as other universities in 2012., 2013., 2015. un 2016.

Dr. Paul Collier

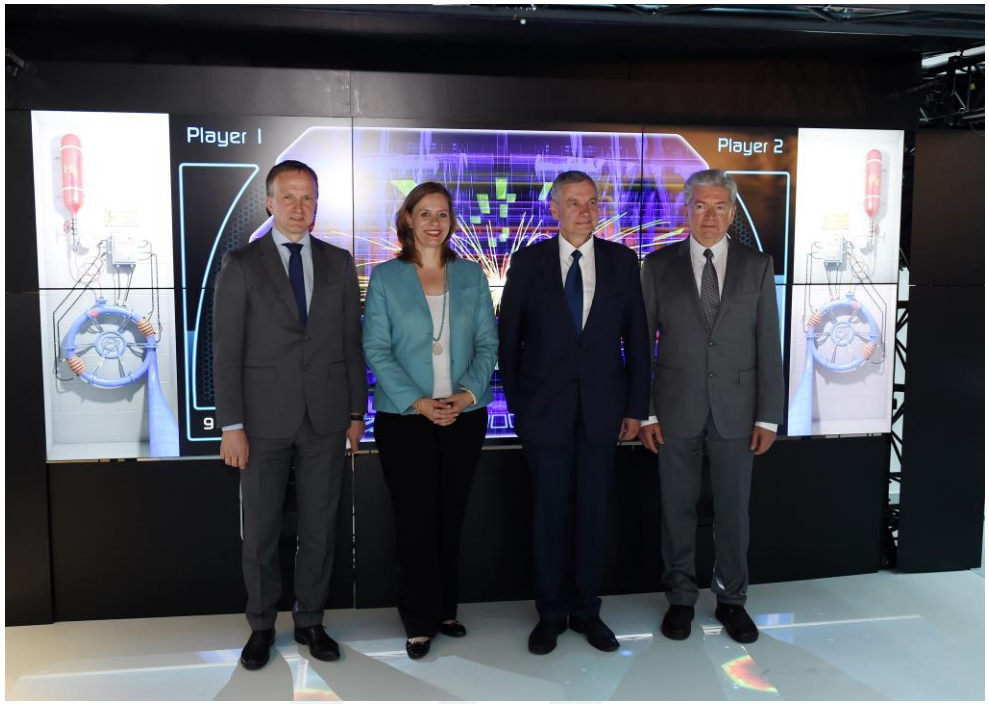
Dr. Tadeusz Kurtyka

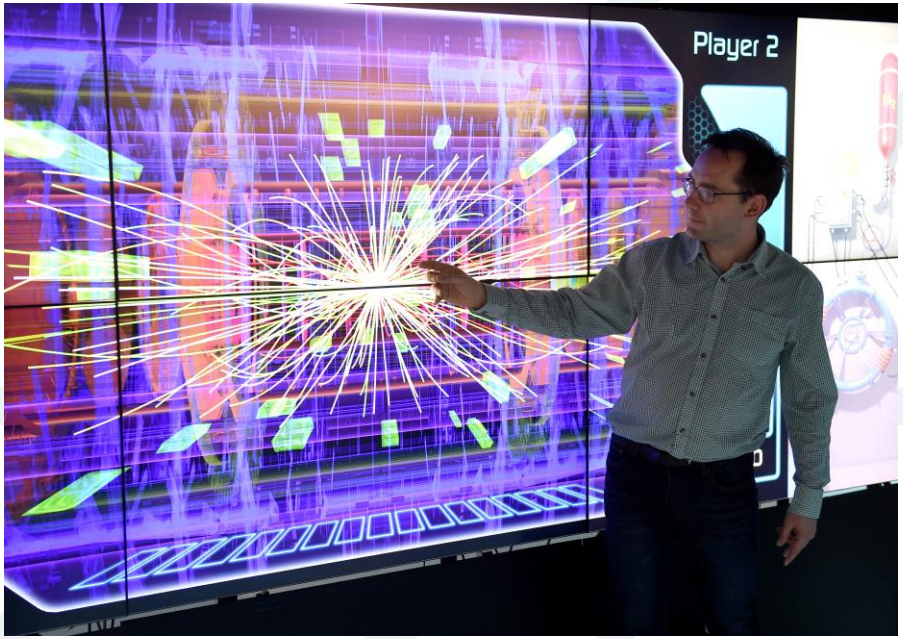


Dr. Christoph Schaefer

CERN science week in Latvia

22 - 26 May, 2017





Supported by Latvian Government

LATVIJAS REPUBLIKAS MINISTRU PREZIDENTS

Prime Minister of the Republic of Latvia

Riga, 19 May 2017

Dear Professor Sijbrand de Jong,

On behalf of the Government of the Republic of Latvia, I would like to express our satisfaction about the excellent and evolving cooperation between the European Organization for Nuclear Research (CERN) and Latvia.

In accordance with the above mentioned, I would like to inform you that Latvia is looking forward to bringing this cooperation to a higher stage in order to enjoy the partnership with CERN to the full by considering the application to its membership status at the CERN, first as an associate member, followed by full membership.

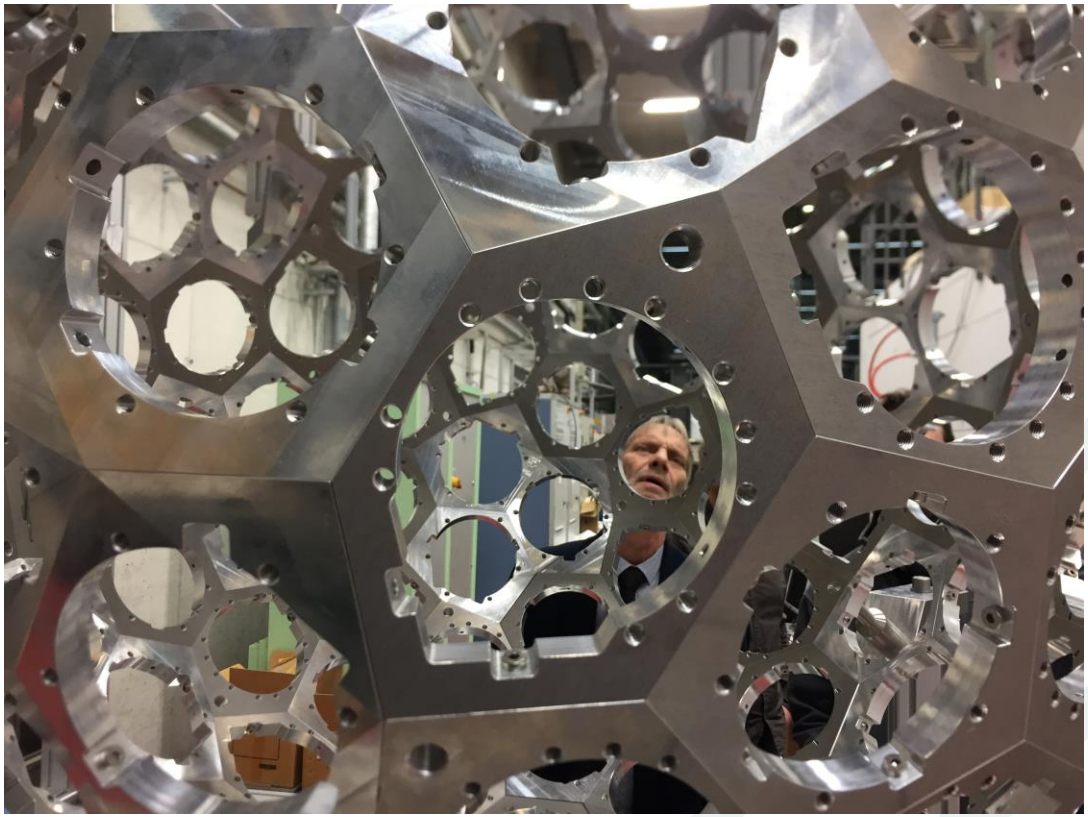
Sincerely,

Māris Kučinskis

ARIES project

ARIES projekts

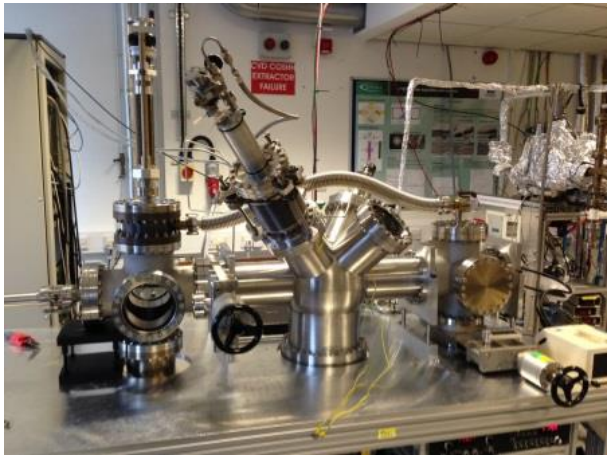
- «*Accelerator Research and Innovation for European Science and Society*» – CERN coordinated Horizon 2020 project

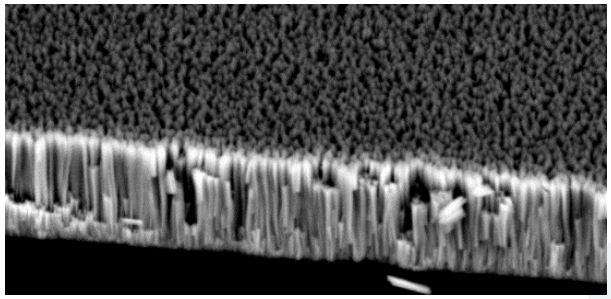


ARIES project - I

- technologies – improved coating for particle accelerators working surfaces

Riga Technical University

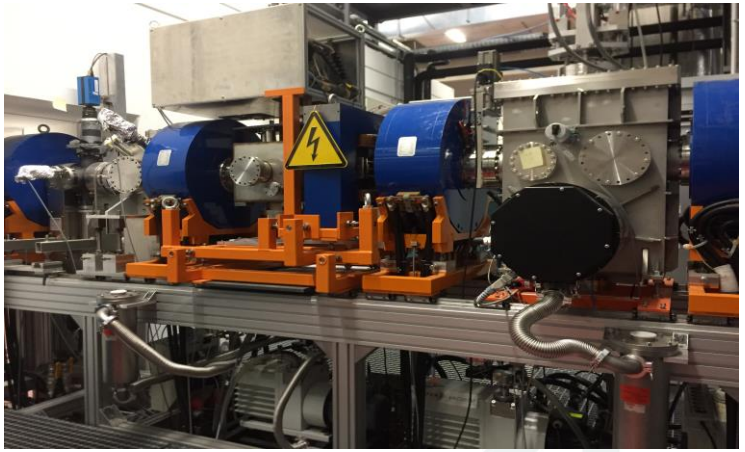


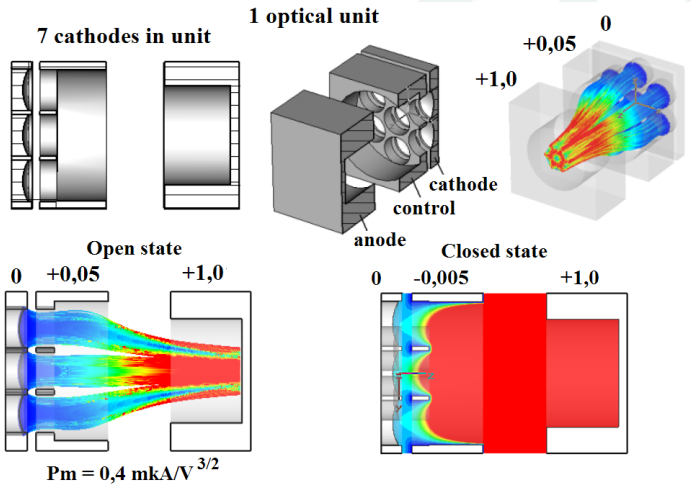


SEM image of a NbN thin film

ARIES project - II

– development of innovative radio frequency modulator – energy particle accelerator beam





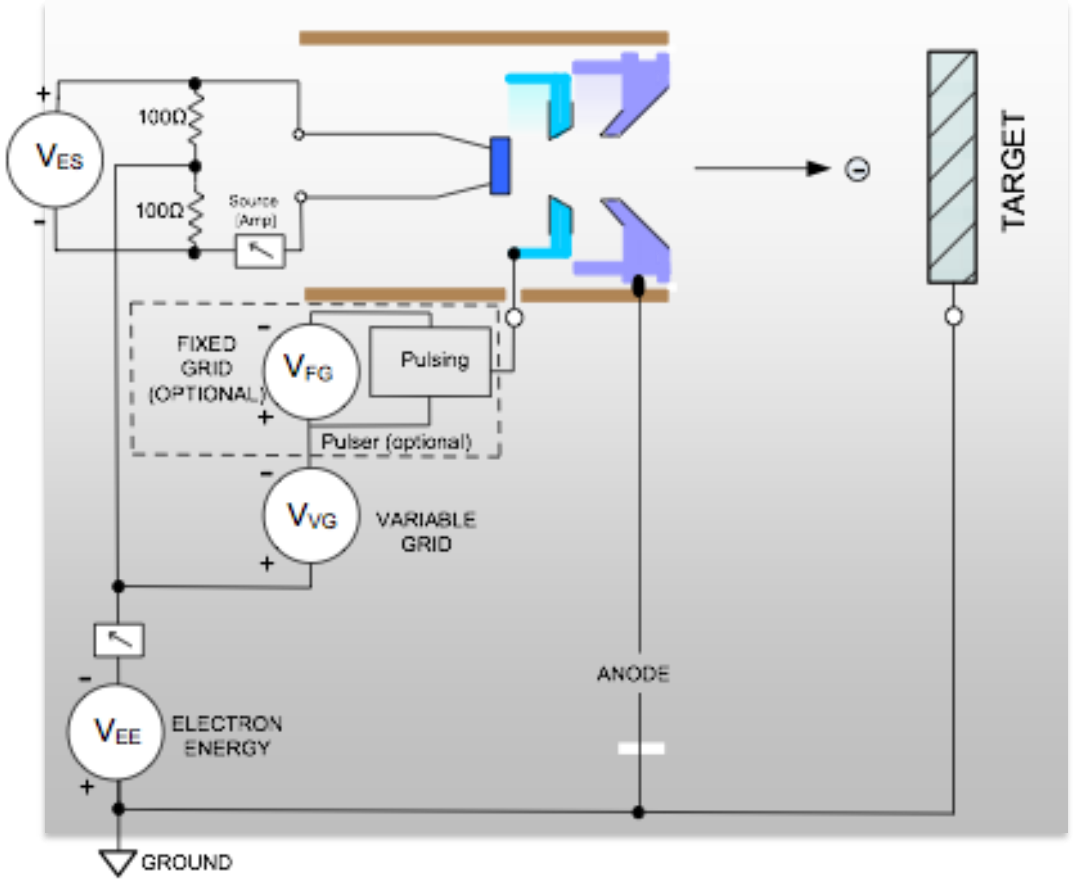
Partners: GSI – Darmstadt, Frankurt University, CERN

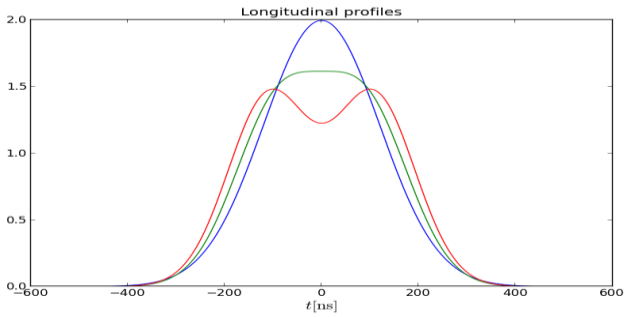
Prototype design RTU

Gen.

Power Amp

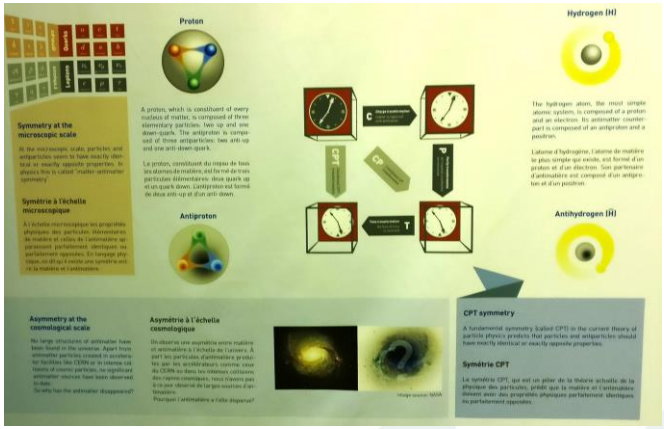
modulator plates/grid



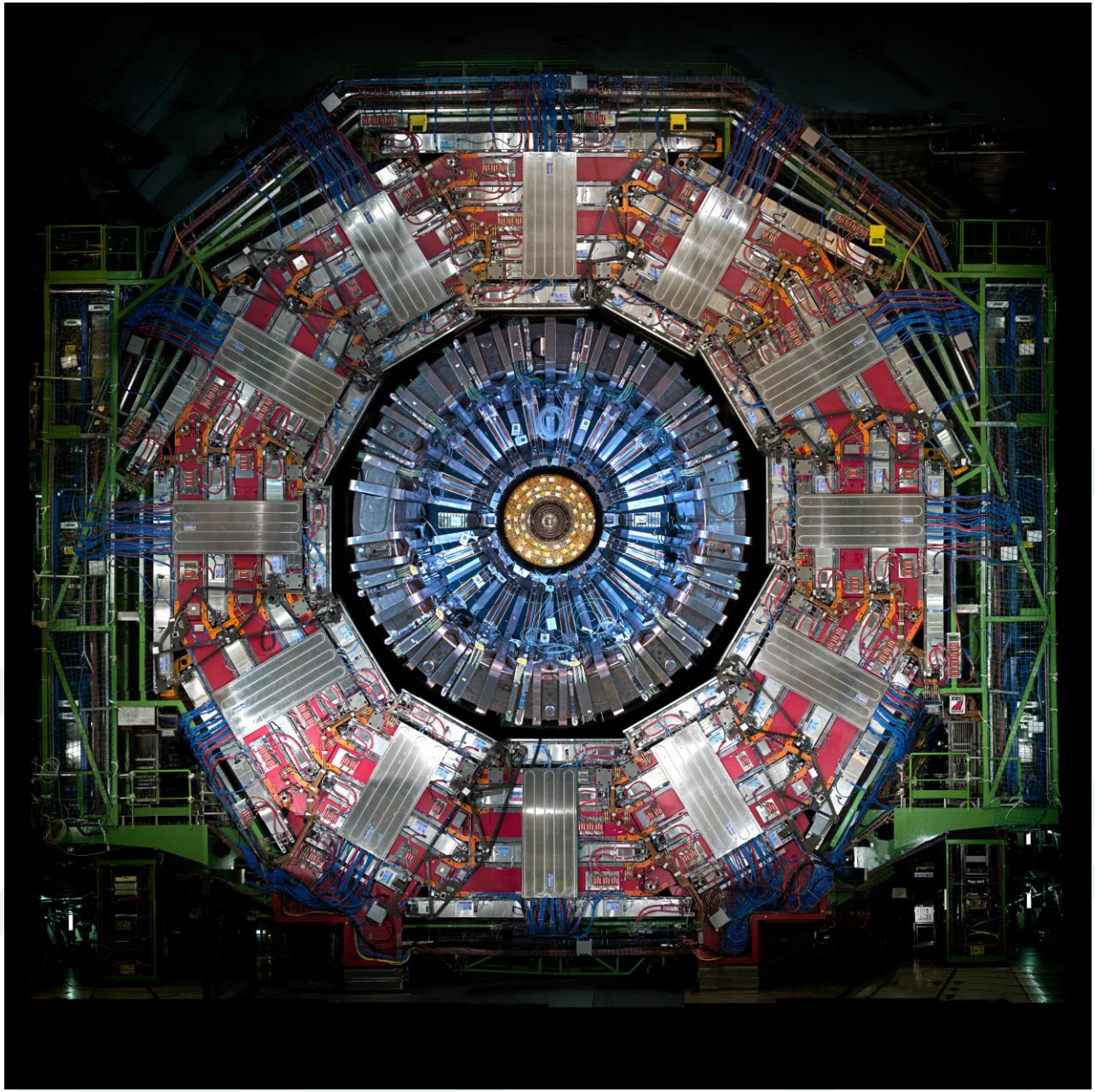


ARIES project - III

- Education and training – online course about particle accelerators
- RTU is developing online platform



CMS Collaboration



Consortium

- To join CMS as a Full Member in form of Consortium of two Universities, namely, Riga Technical University (RTU) and University of Latvia (LU).
- Two largest universities of Latvia - major players in the Baltic region
- Support from the Ministry of Education and Science
- Envisage to join CMS as from 2018
- Funding available and mechanism is established

Reasons for the application

- Consultations with the CMS management and relevant groups - identified that RTU and LU both have wide range of required experience and **could directly contribute** to the on-going and future activities of CMS

- Participation in CMS will significantly boost the competence of the RTU and LU in the fields of physics analysis, technology development and computing

- This would facilitate the on-going process of the advanced particle physics community consolidation in Latvia

- This will enhance Baltic States cooperation in the field of high energy physics

RELEVANT FACULTIES

RIGA TECHNICAL UNIVERSITY

ready to participate:

CENTRE OF HIGH ENERGY PHYSICS AND ACCELERATOR TECHNOLOGIES

COMPUTER SCIENCE & INFORMATION TECHNOLOGY

ELECTRONICS & TELECOMMUNICATIONS

POWER & ELECTRICAL ENGINEERING

MECHANICAL ENGINEERING, TRANSPORT & AERONAUTICS

POTENTIAL AREAS OF COLABORATION

- Data processing - algorithms, computing, encoding, programming, alignment, data validation and certification, Monte-Carlo simulations, data bases, etc.
- Sensors, data transmission and signal processing
- Manufacturing technology and mechanics - design, prototyping and actual manufacturing (e.g. additive manufacturing)
- Electronics and electrical engineering
- Materials and radiation hardness
- Particle physics

Future evolution

- Initially (in 2018) Consortium is envisaging to contribute to CMS with two participants, e.g.:

  Riga Technical University
  – one scientist (can be post-doc) or one PhD student/engineer

  University of Latvia
  – one scientist (can be post-doc) or one PhD student

- As it is evident from the presentation there are numerous areas of potential contribution

- Collaboration can be enhanced to the larger number of participants and faculty members – up-to four in end 2018 or 2019

Closing remark

- Latvia sees its engagement in the CMS experiment as an strategic opportunity
- It will enhance the scientific potential of RTU and LU by taking part in technology development, computing, and physics analysis
- Latvia considers its engagement in the CMS experiment as important step towards Latvia's application: for the CERN Associate Member as the pre-stage to membership.

60

Next steps

What’s next?

- Latvia - CERN associate and full member – we are on the way!
- Door to CERN is open...
- Latvian scientists work at CERN
- Participation in CERN experiments
- Regular teacher group visits
- Regular pupil group visits
- CERN organized events and «schools»

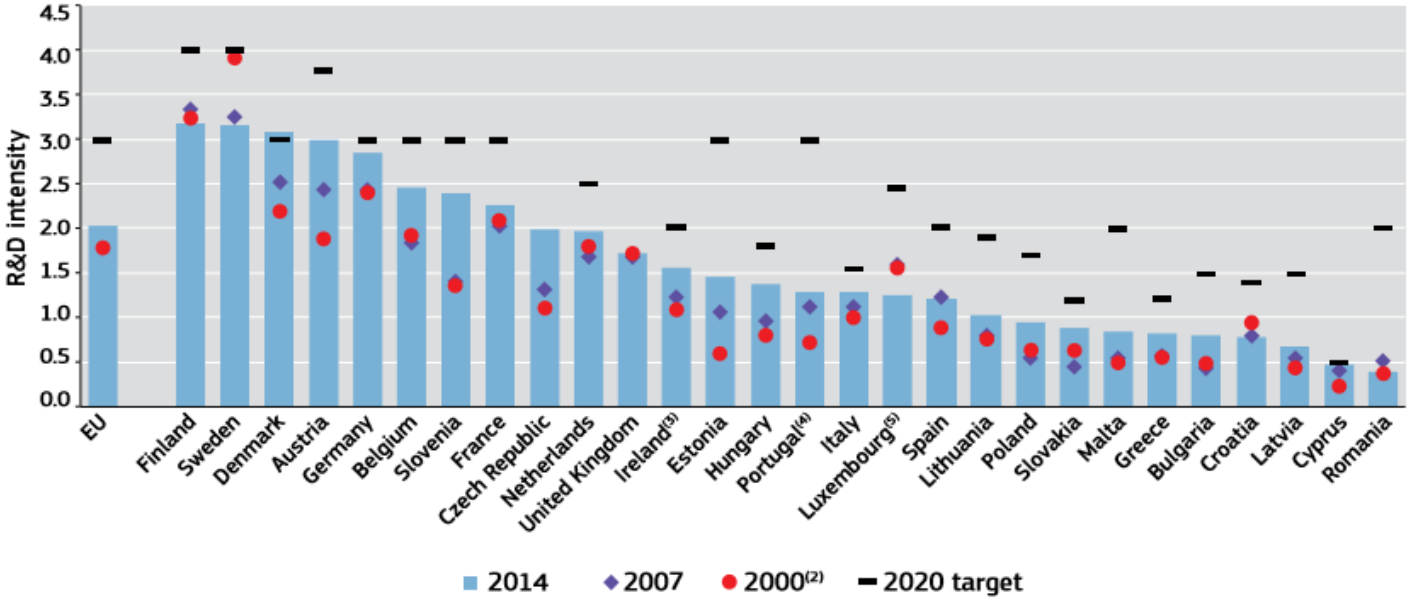
What's in it for Latvia?

- Opportunity to get support point for moving science in Latvia from the consumer level to potentialy profitable level
- Opportunity do demonstrate to EU and NATO that Latvia is not a country for low qualification work
- Opportunity to raise quality standards in exact sciences at Latvian universities with support of CERN scientific and technical infrastructure. By doing so, preventing leak of talented students abroad.
- «Interesting» orders for Latvian companies, opportunity to enter new markets, direct access to CERN innovations.

What's in it for Latvia?

- Politics: we are in NATO and EU, but science?

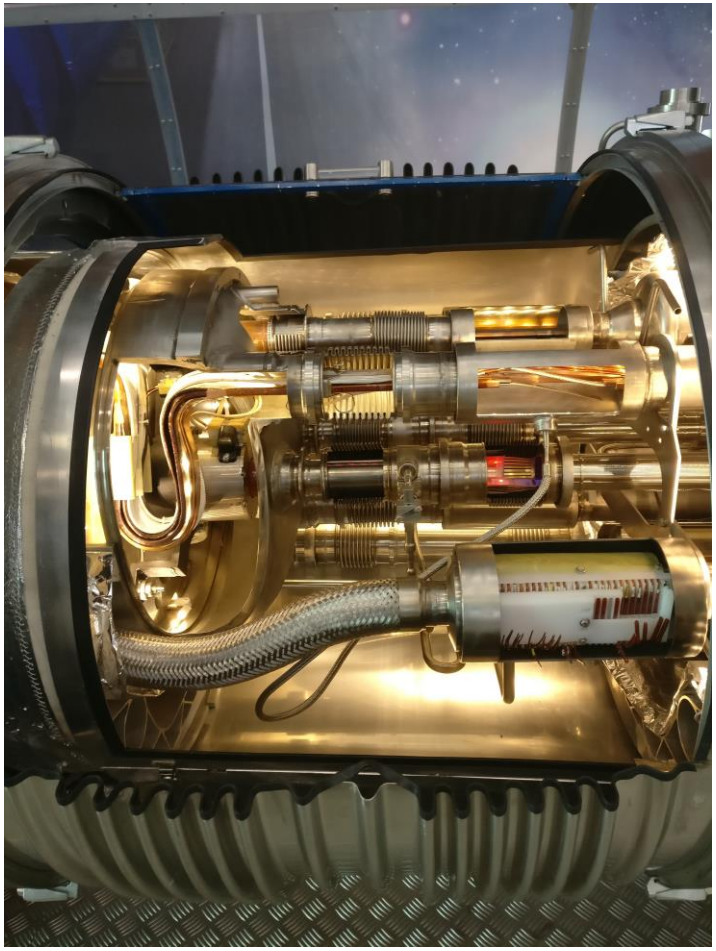
Figure I-2-10 R&D intensity 2000, 2007, 2014 and 2020 target(1)



Science, Research and Innovation performance of the EU (EK dati 2016)

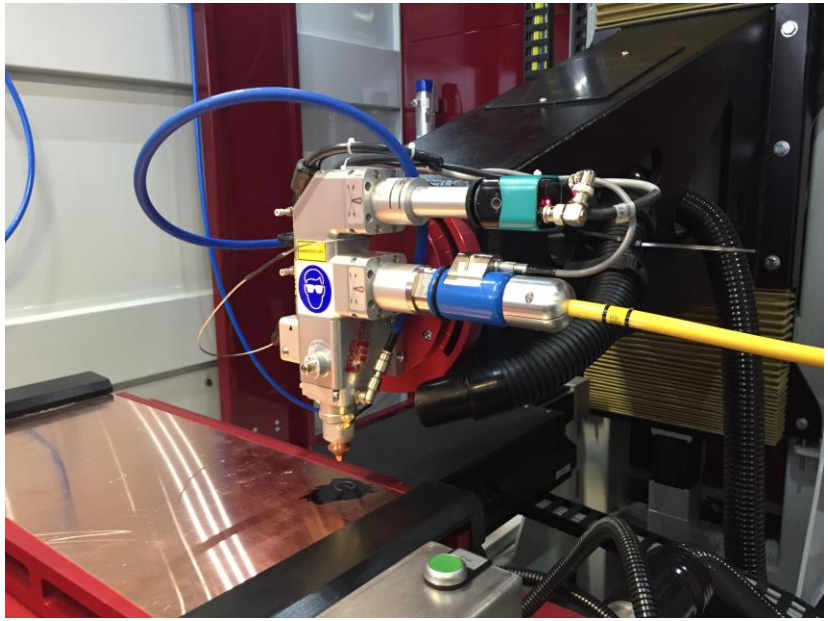
What's in it for Latvia?

- Science:
  - Breakthrough and grasp of fresh air to all fields of science (physicians, engineers, medicine etc.)
  - Free access to all experiments
  - Work at CERN for scientists
  - + all activities mentioned before, but from CERN budget
- Possibility to raise EU funds – significantly more than paid membership fee of 1.7 M euro
- Opportunity to play in highest league



What’s in it for Latvia?

- Economics: invested 1,7 M eur per year. What will be the reward?



Entrepreneurs

- **«NanoOptoMetrics»** – surface metrological analysis equipment – in contact with CERN, who showed interest in this technology and equipment
- Promissing **«Primekss»** visit to CERN 05.07.2017 – pilot project?
- start-up company **«Adaplab» is** ready to offer CERN its' *process control and PLC's (Programmable Logic Controllers)* – in touch with CERN

Next steps

- Latvian participation un CMS project – LU un RTU consortium
- Visits of high level representatives from related ministries to CERN
- CERN EXPO in Latvia April-June 2018
- Governmental Education, Culture and Science Committee visit to CERN
- Visit of entrepreneurs and associations January
- Roadmap for Latvian membership to CERN

Thank you!