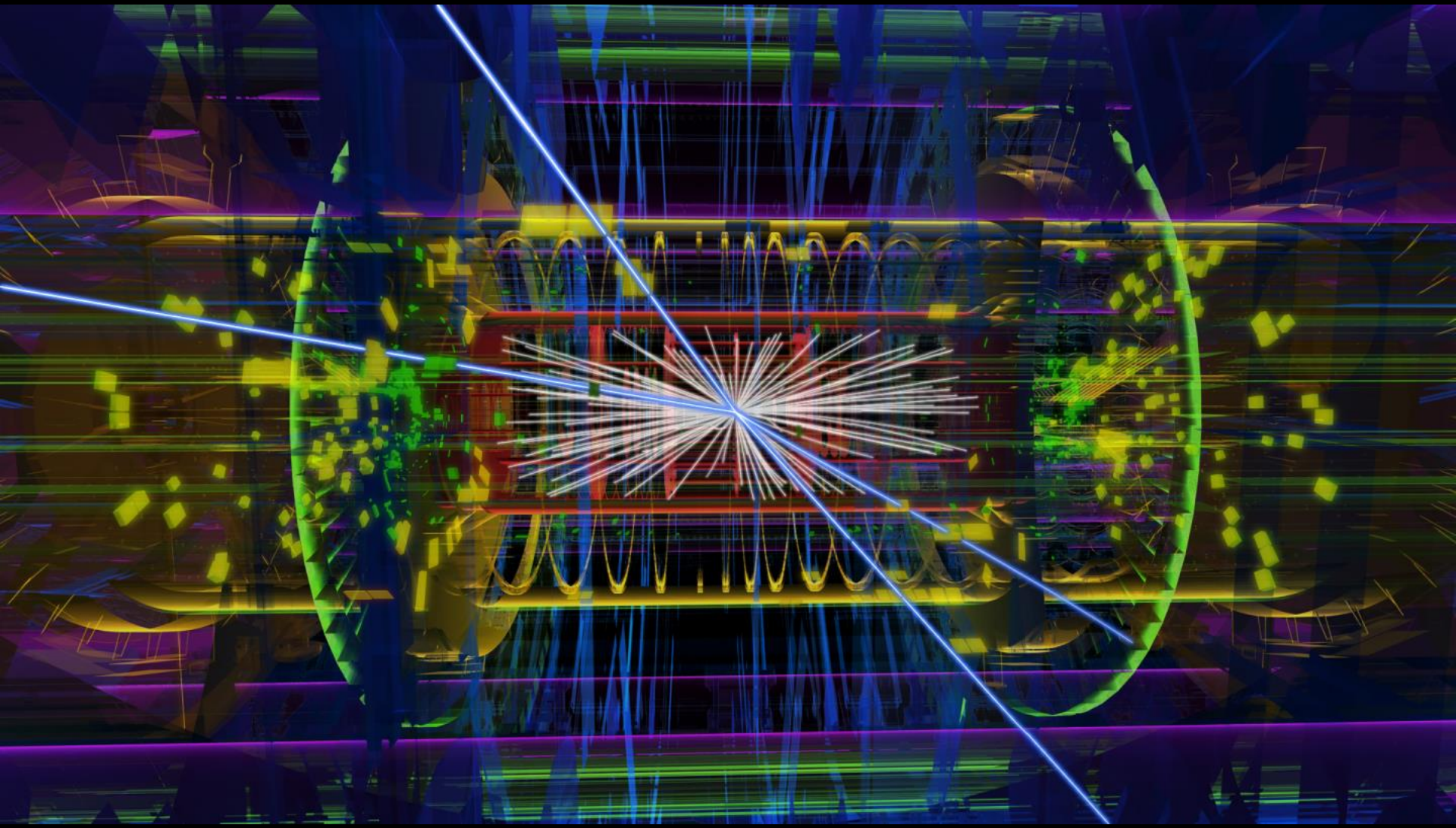
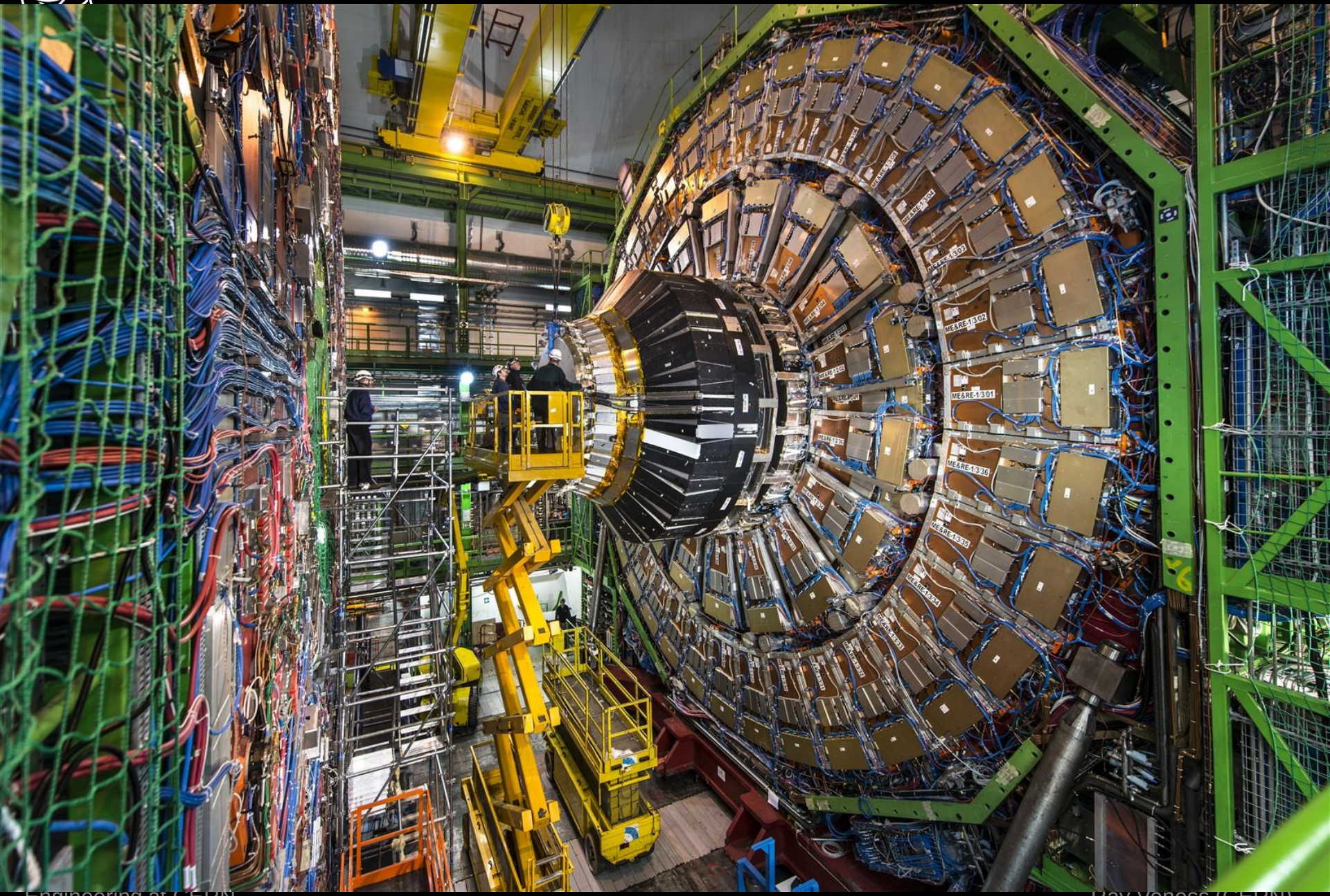
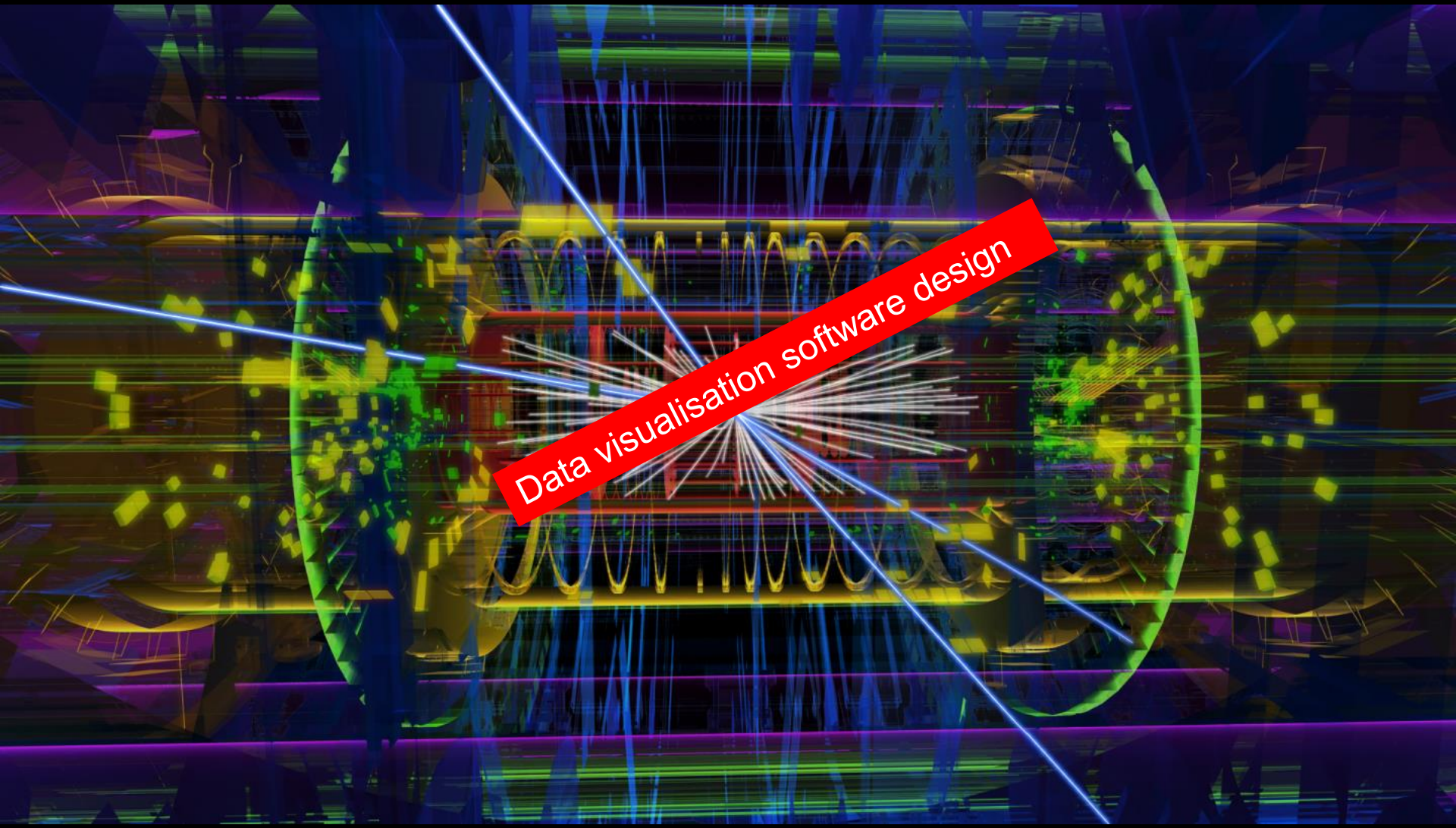
An Introduction to Engineering at CERN

Ray Veness

CERN

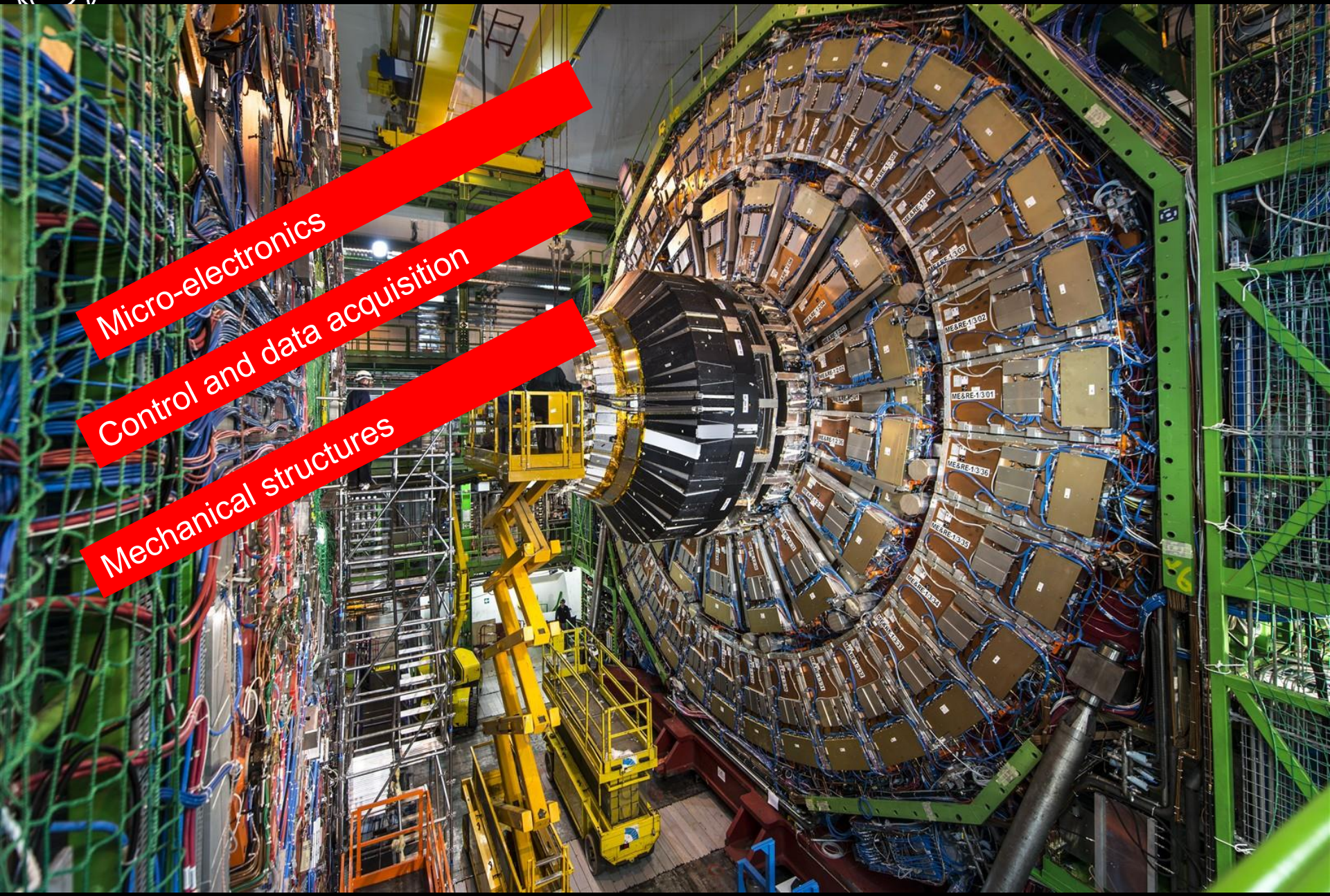



ME&RE-1/3/02
ME&RE-1/3/01
ME&RE-1/3/36


Data visualisation software design

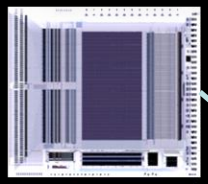

Computer hardware
Databases
Network Infrastructures


Running jobs: 259835
Transfer rate: 6.15 GiB/sec
3/4/2013 4:10:16 pm
4:10 pm
4:20 pm
UKI-NORTHGRID-LIV-HEP
UKI-NORTHGRID-SHEF-HEP
UKI-SOUTHGRID-BHAM-HEP
UKI-SOUTHGRID-CAM-HEP
UKI-SOUTHGRID-OX-HEP
UKI-SOUTHGRID-BRIS-HEP
EFDA-JET
RAL-LCG2
UKI-LT2-IC-HEP
UKI-LT2-QMUL
UKI-SOUTHGRID-SUSX
RUG-CIT
NIKHEF-ELPROD
SARA-MATRIX
GOEGRID
UNI-DORTMUND
WUPPERTALPROD
UNI-SIEGEN-HEP
UNI-BONN
MAIGRID
ITWM
FZK-LCG2
GRIF
IN2P3-IRES
LRZ-LMU
MPPMU
UNI-FREIBURG
IN2P3-SUBATECH
HEPHY-UIBK
UNIBE-LHEP
CERN-PROD
UNIGE-DPNC
CSCS-LCG2
IN2P3-CC
IN2P3-LAPP
IN2P3-LPC
Grid computing
WLCG
CMS
LHCb
dashboard
Google earth

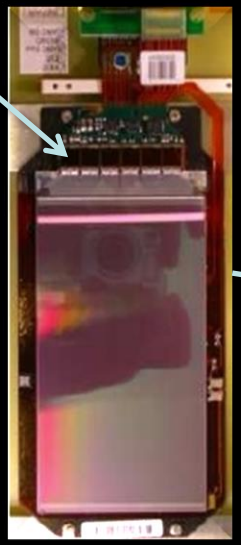

Micro-electronics
Control and data acquisition
Mechanical structures

Microchips for Megastructures

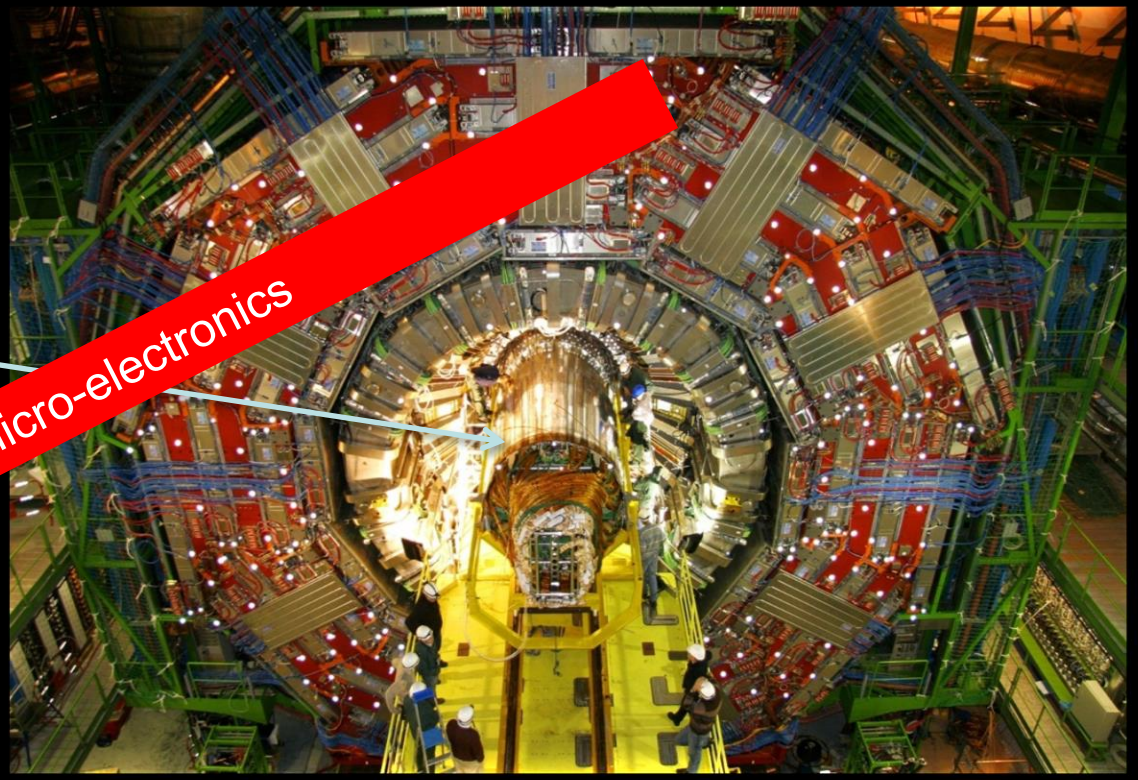
Front-End ASIC

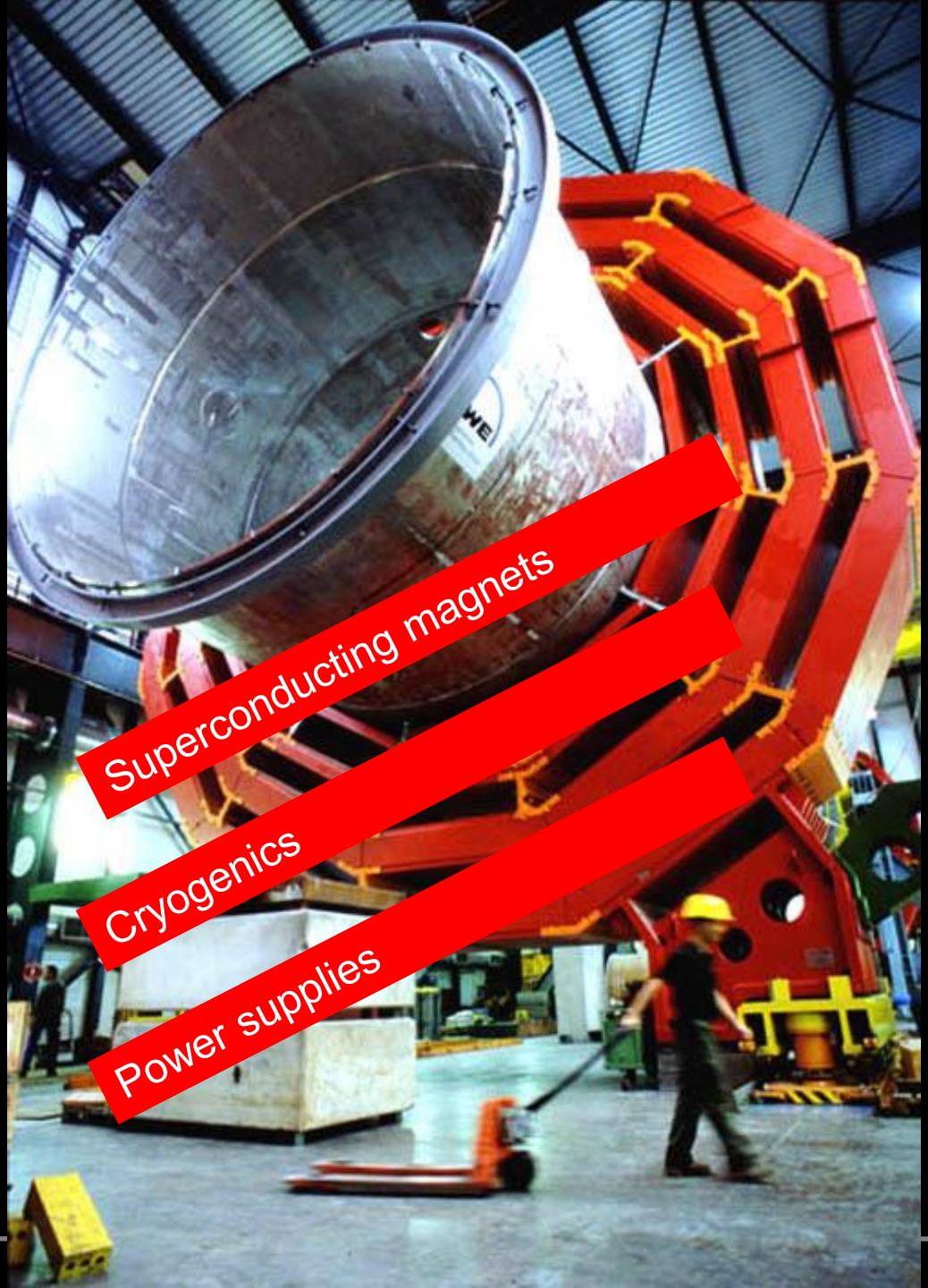


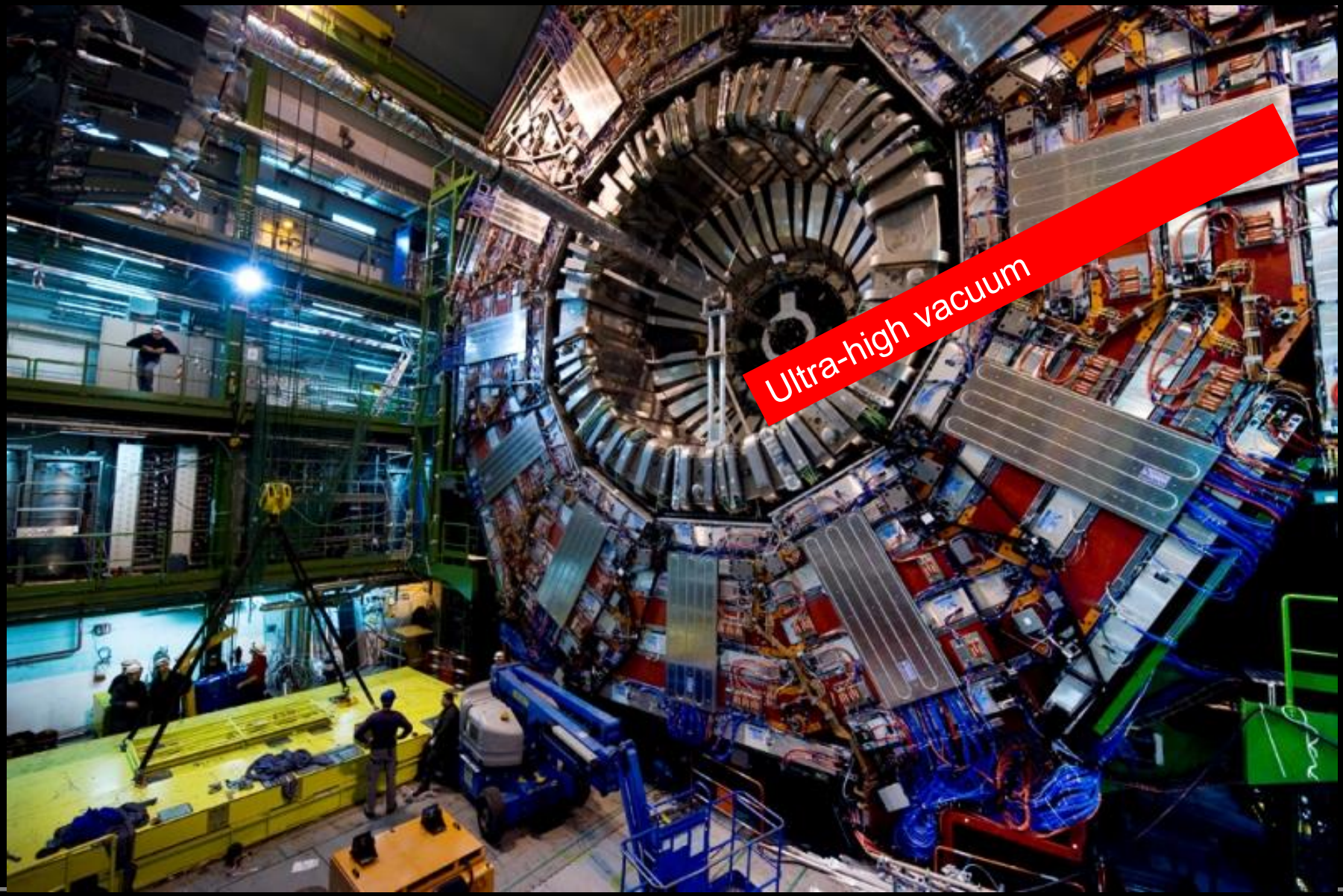
Silicon Tracker Hybrid



CMS experiment on the LHC accelerator at CERN



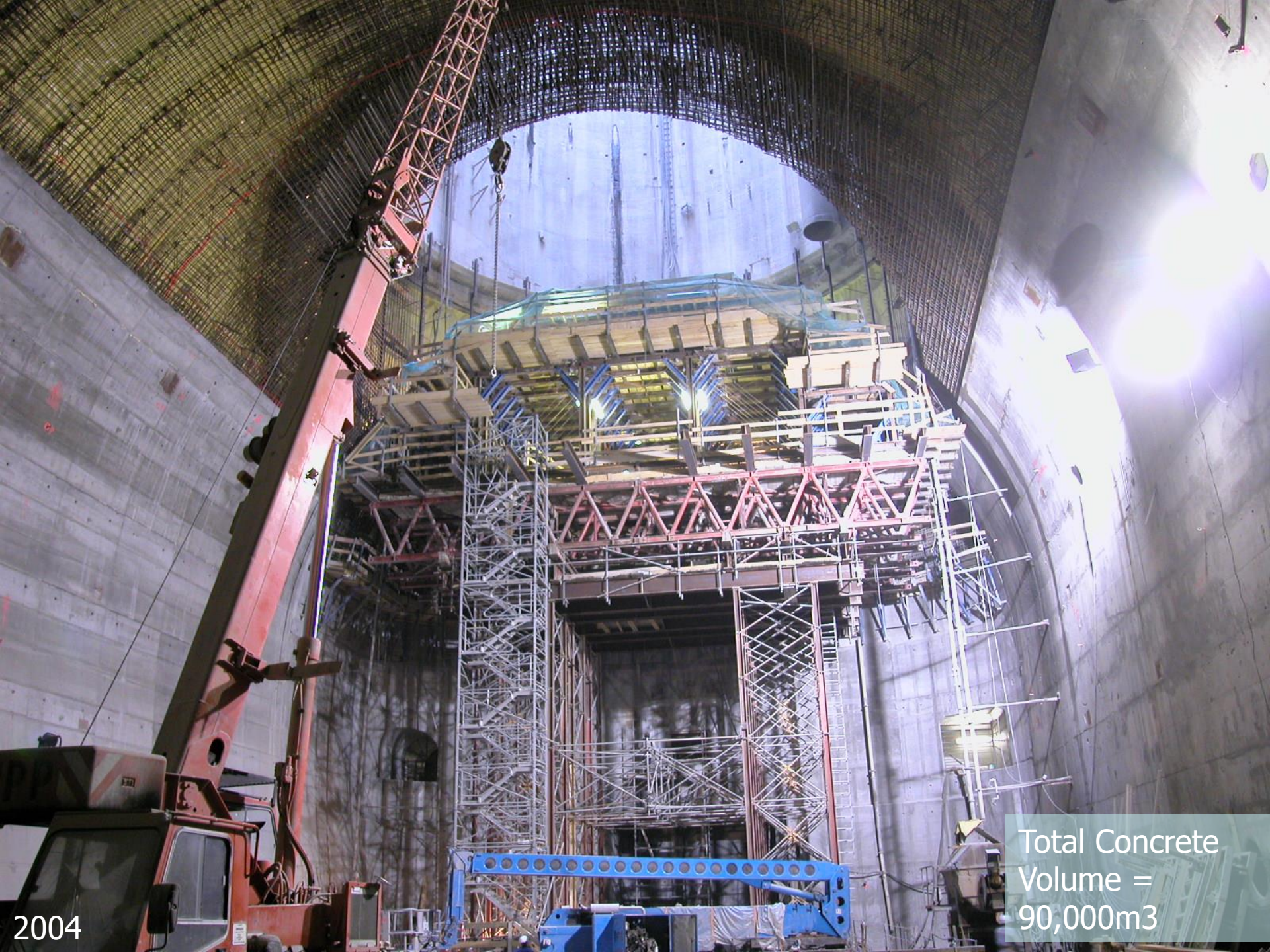

Superconducting magnets
Cryogenics
Power supplies


Ultra-high vacuum


Underground Civil structures
Cooling and ventilation
Heavy handling

Point 5 -Excavation commencement of PM54 shaft - July 09, 1999 - CERN ST-CE

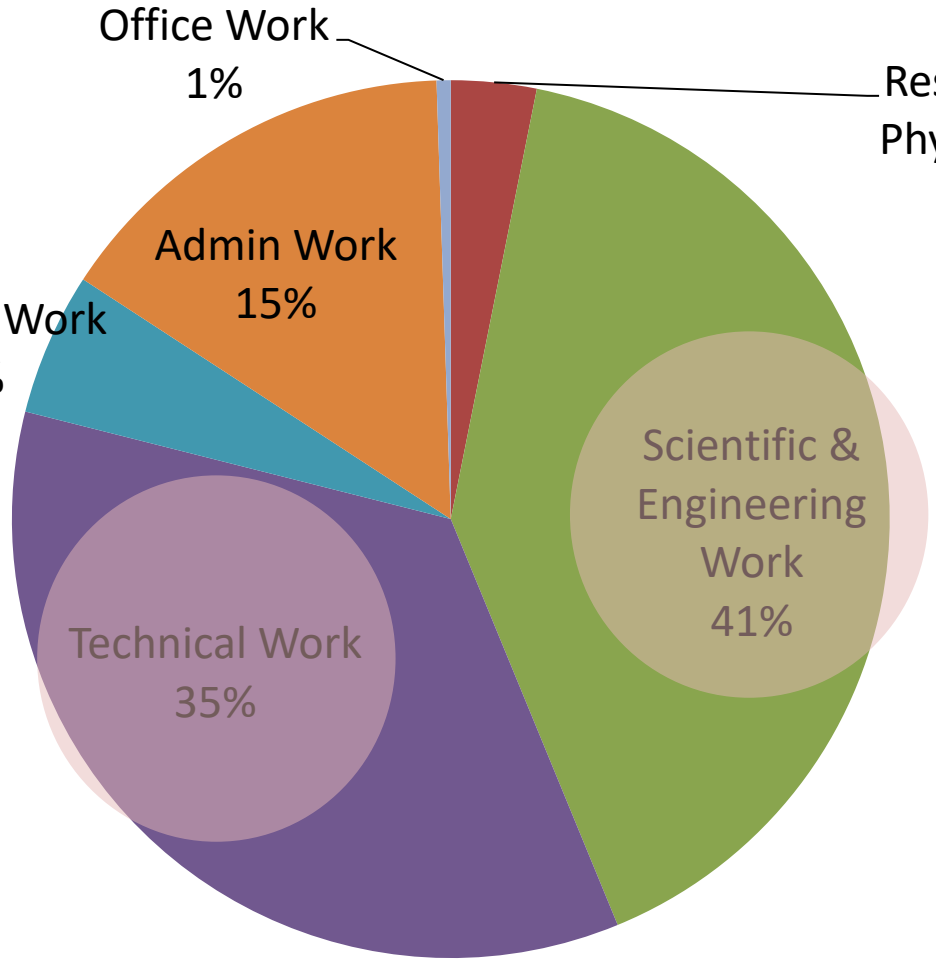

PAOLO DE NICOLA


Total Concrete Volume = 90,000m3
2004

Ray Veness (CERN)

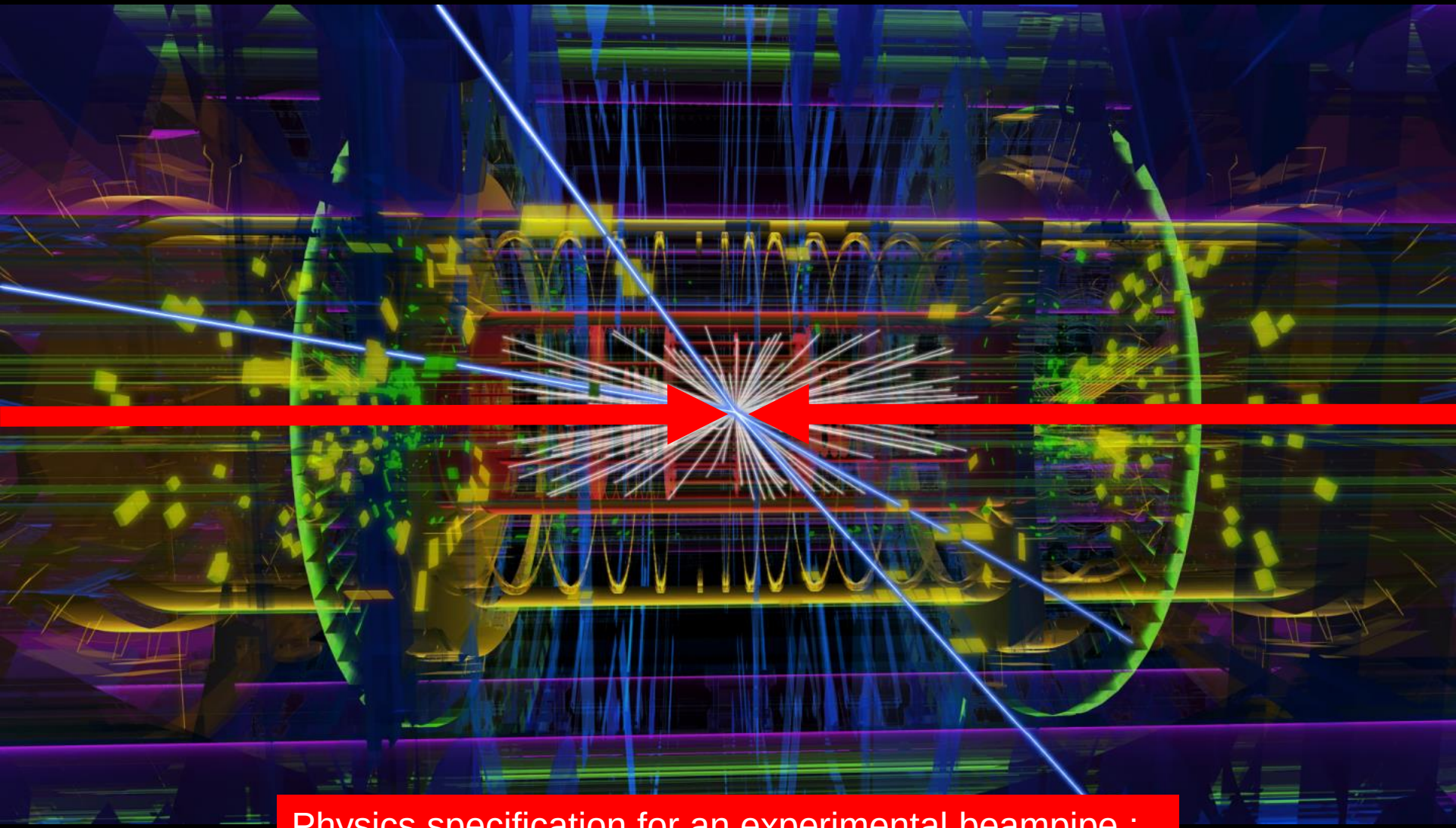
Image courtesy British Gas

CERN Staff by job description

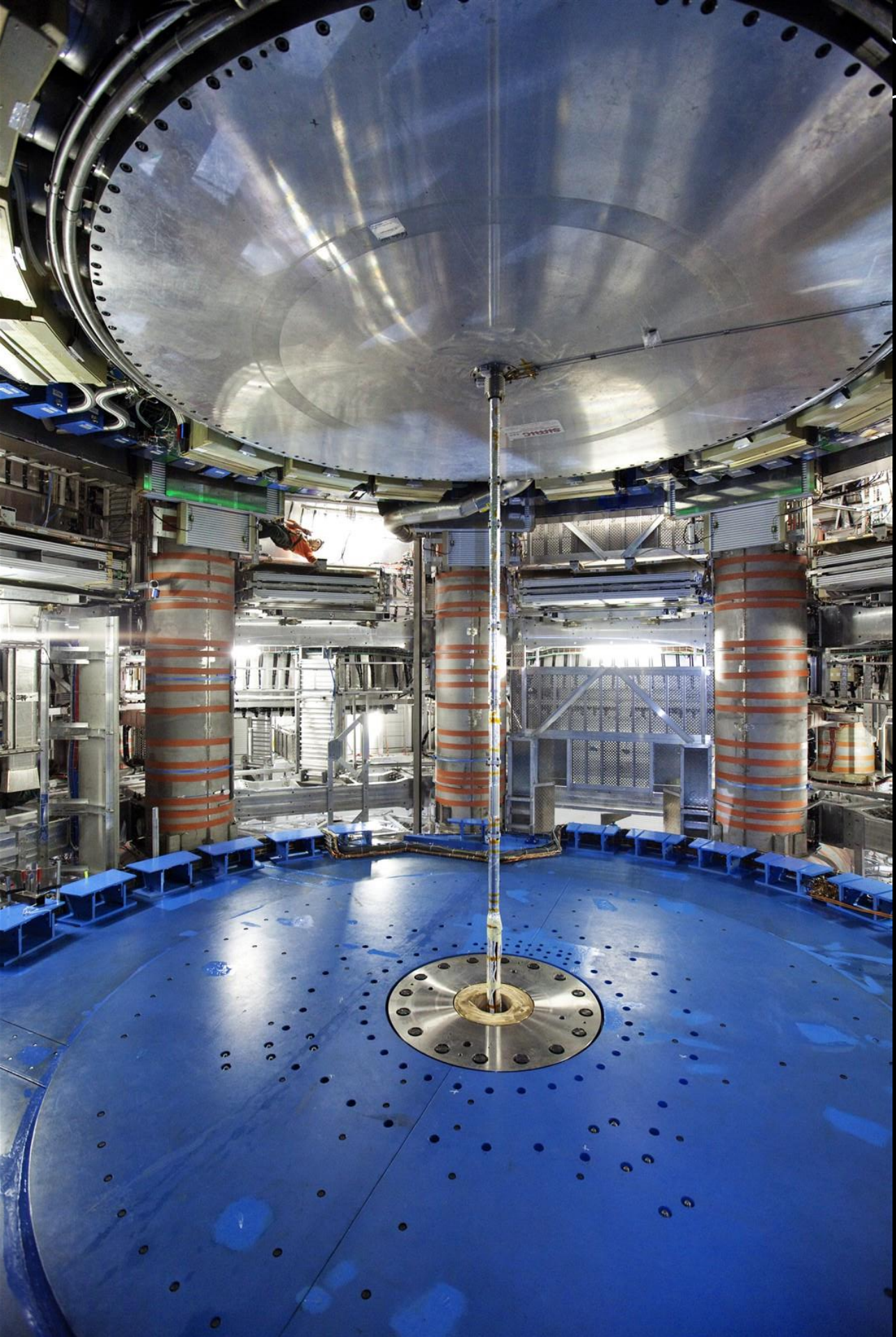


Engineers
-Electrical/Electronic
-Mechanical
-Civil
-Computing
Applied physicists

Technicians
Programmers
Accelerator operators



Physics specification for an experimental beampipe :
Nothing, contained by nothing!



Nothing, contained by nothing!

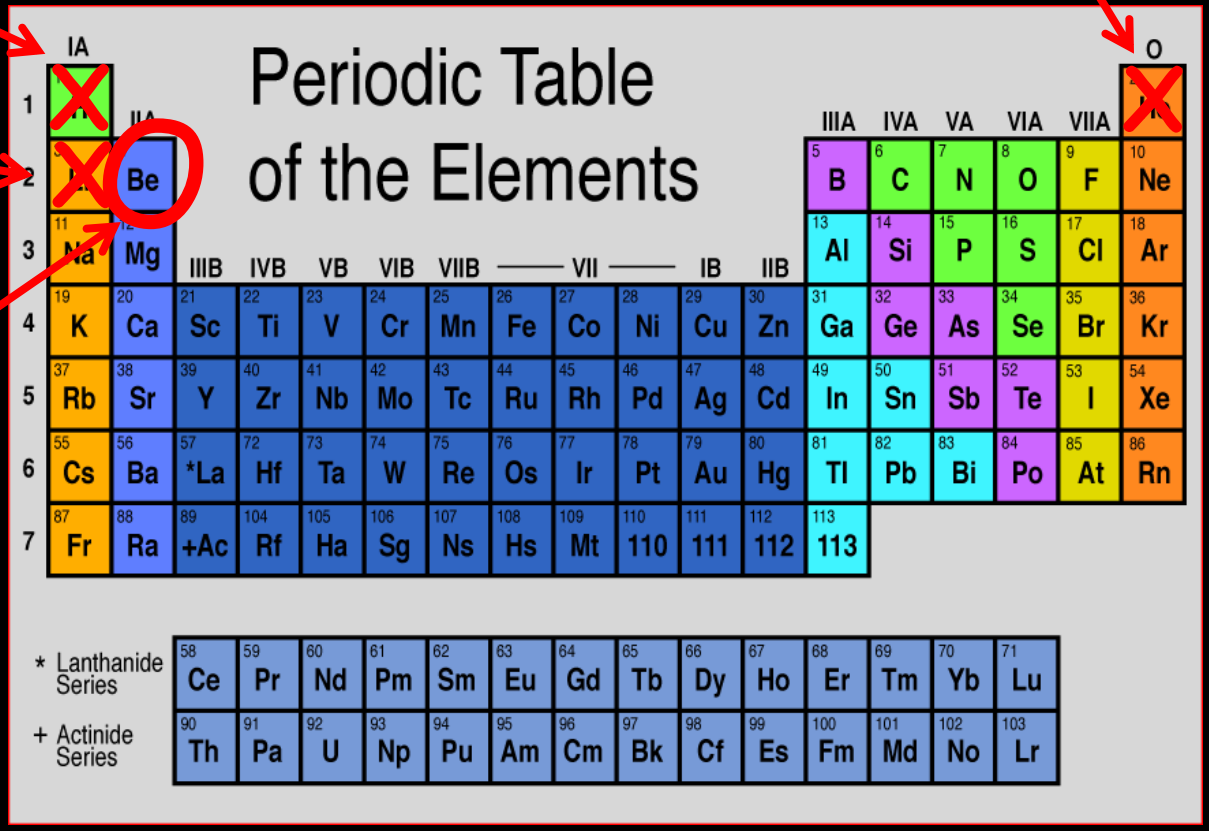
Hydrogen is a gas at room temperature!

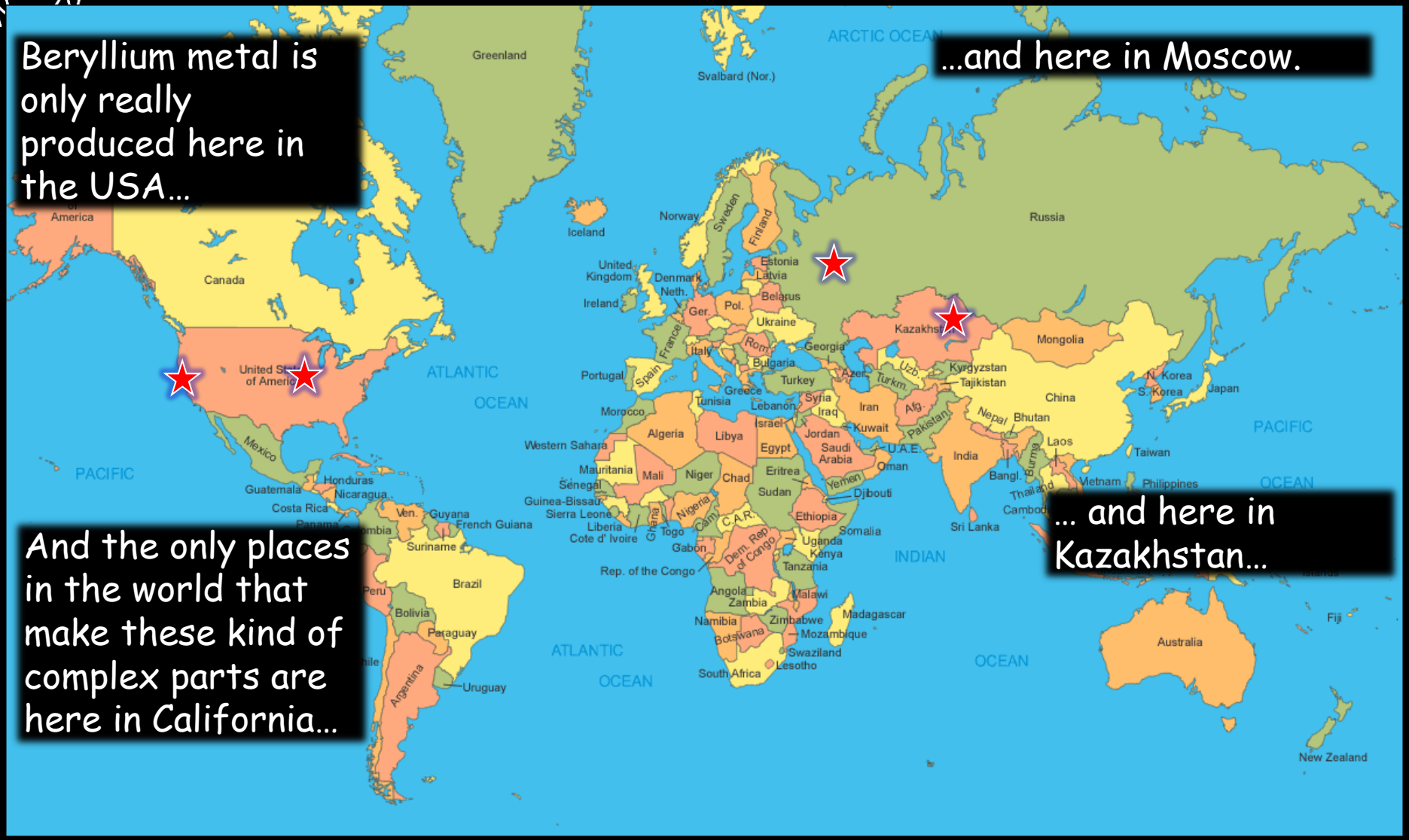
So is helium…

Lithium explodes in air… not so good

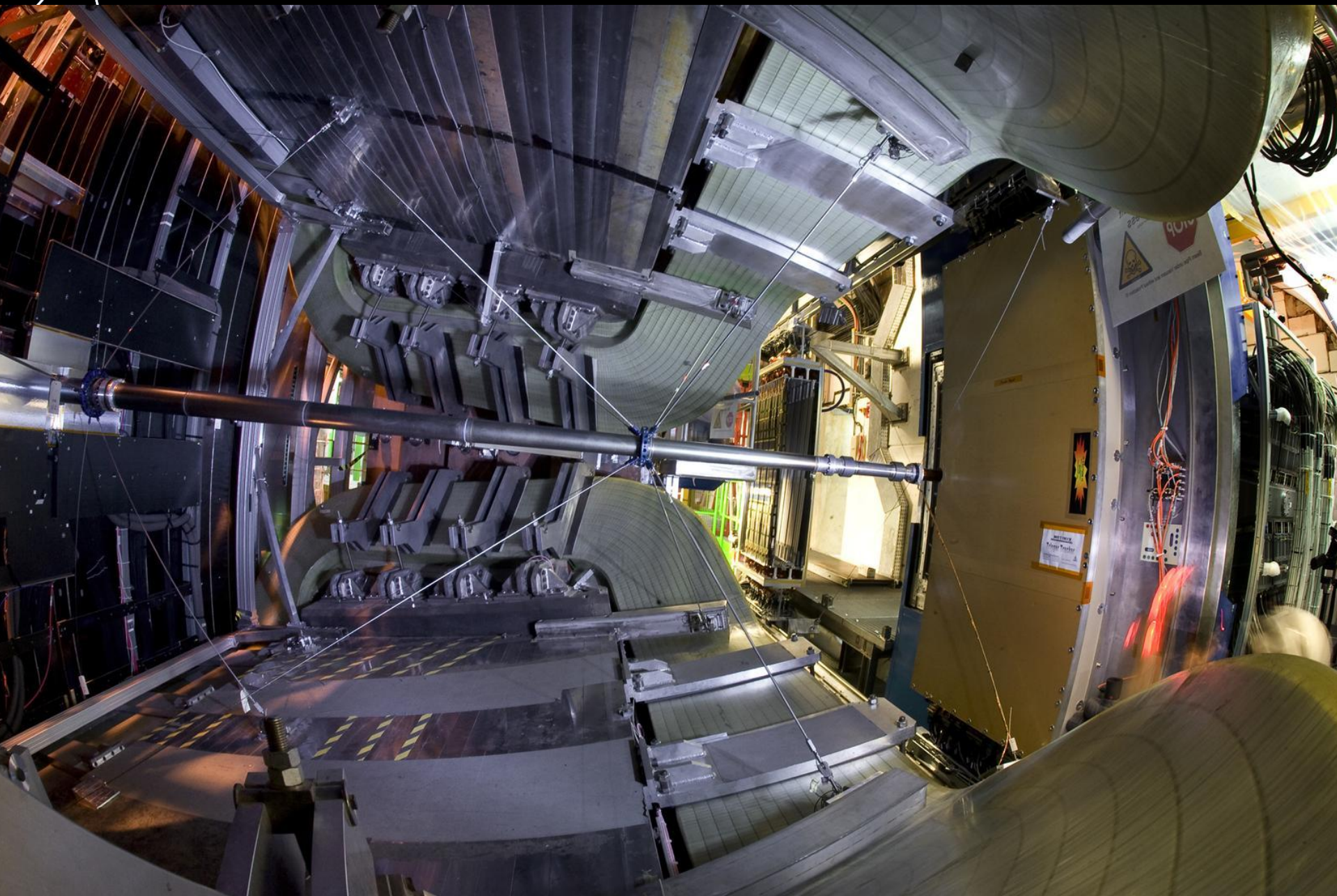
Beryllium… that would be good!

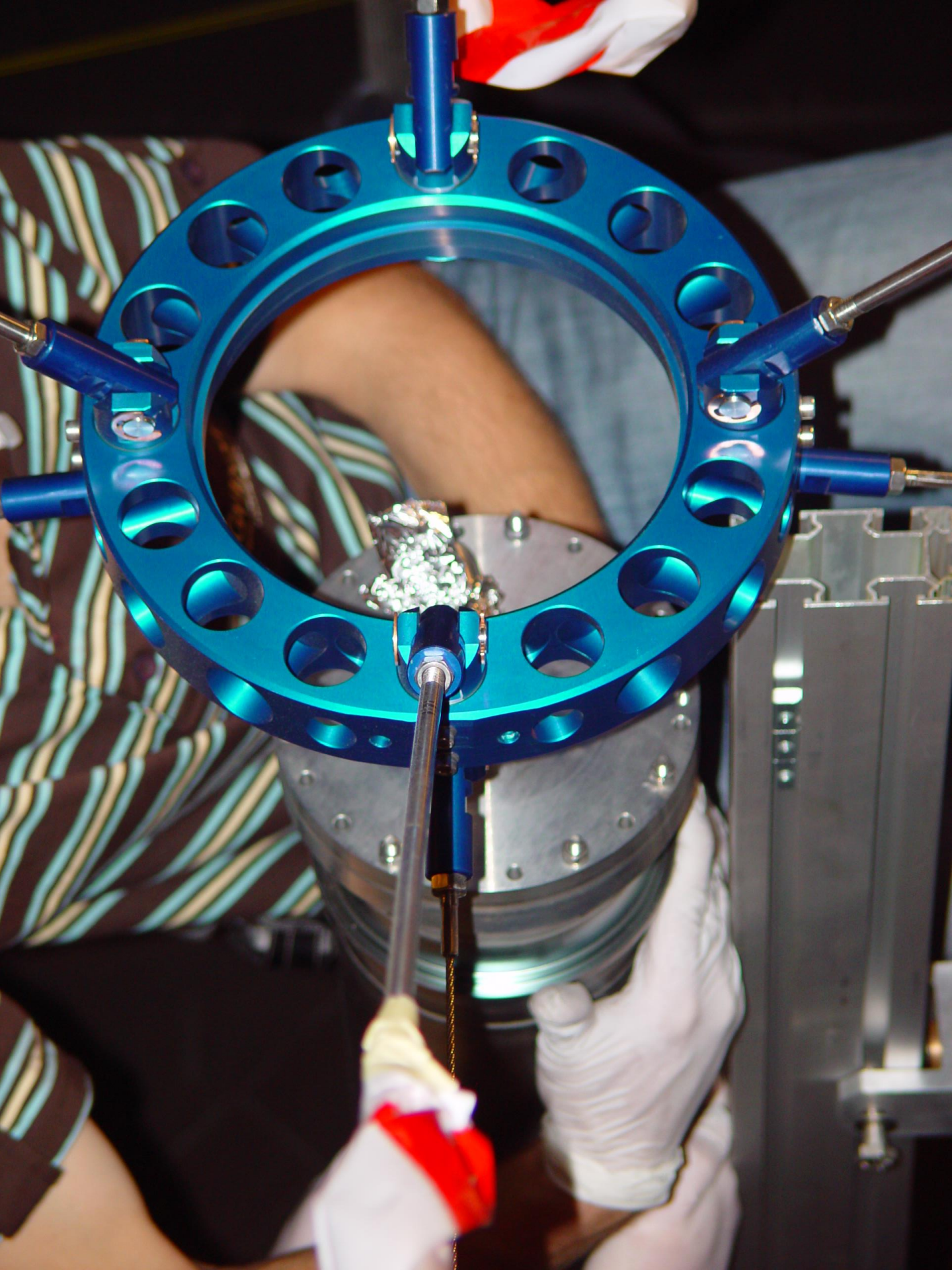
…except that it is pretty hard to get hold of!



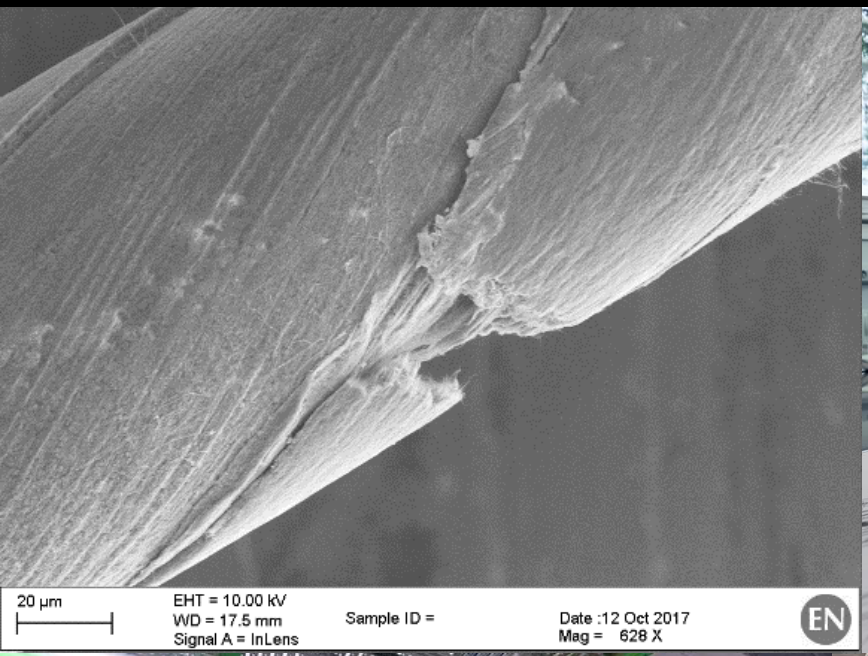

Beryllium metal is only really produced here in the USA…
…and here in Moscow.
And the only places in the world that make these kind of complex parts are here in California…
… and here in Kazakhstan…
Greenland
Svalbard (Nor.)
ARCTIC OCEAN
Russia
Iceland
Norway
Sweden
Finland
Canada
United States of America
Mexico
Guatemala
Honduras
Nicaragua
Costa Rica
Panama
Cuba
Jamaica
Haiti
Dominican Rep.
Ven.
Guyana
Suriname
French Guiana
Colombia
Peru
Brazil
Bolivia
Paraguay
Chile
Argentina
Uruguay
PACIFIC
ATLANTIC
OCEAN
United Kingdom
Ireland
Denmark
Neth.
Ger.
Pol.
Belarus
Ukraine
Estonia
Latvia
France
Spain
Portugal
Italy
Rom.
Bulgaria
Greece
Turkey
Georgia
Azer.
Kazakhstan
Mongolia
Uzb.
Turkm.
Kyrgyzstan
Tajikistan
China
N. Korea
S. Korea
Japan
Afg.
Pakistan
Nepal
Bhutan
India
Laos
Taiwan
Bangl.
Burma
Thailand
Cambod.
Vietnam
Philippines
Sri Lanka
Tunisia
Lebanon
Syria
Iraq
Iran
Kuwait
Israel
Jordan
Saudi Arabia
U.A.E.
Oman
Yemen
Djibouti
Morocco
Western Sahara
Algeria
Libya
Egypt
Mauritania
Mali
Niger
Chad
Eritrea
Sudan
Senegal
Guinea-Bissau
Sierra Leone
Liberia
Cote d' Ivoire
Ghana
Togo
Nigeria
Cam.
C.A.R.
Ethiopia
Somalia
Gabon
Dem. Rep. of Congo
Uganda
Kenya
Tanzania
Rep. of the Congo
Angola
Zambia
Malawi
Namibia
Zimbabwe
Mozambique
Madagascar
Botswana
Swaziland
Lesotho
South Africa
INDIAN
OCEAN
Australia
Fiji
New Zealand

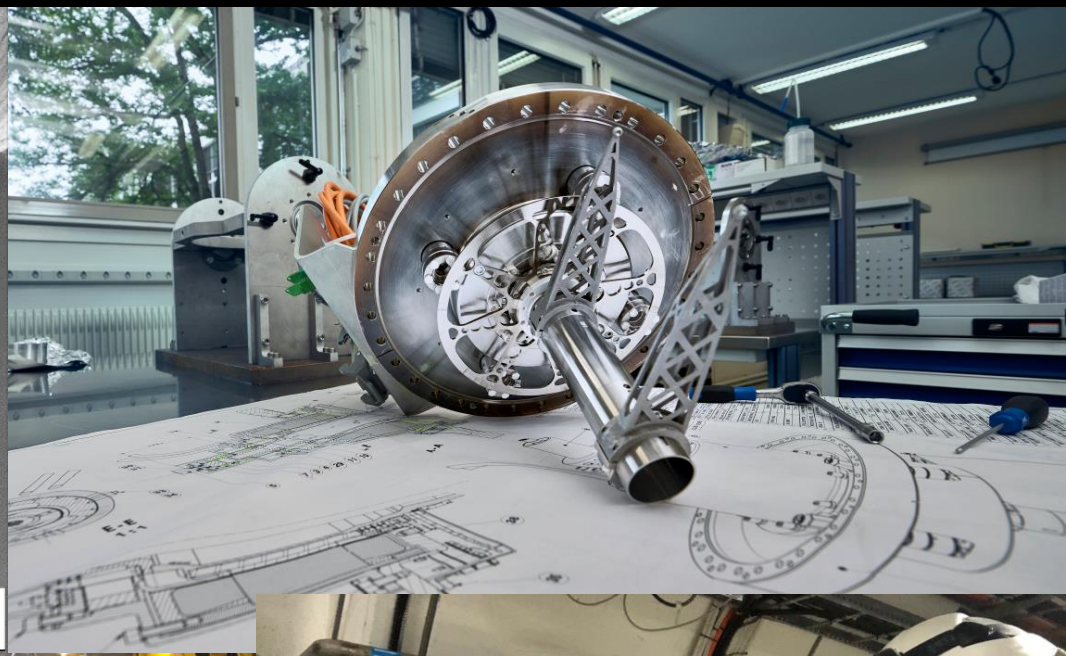
A photo I took of a CERN colleague, as we waited to cross the Khasakh-Russian border in 2004…

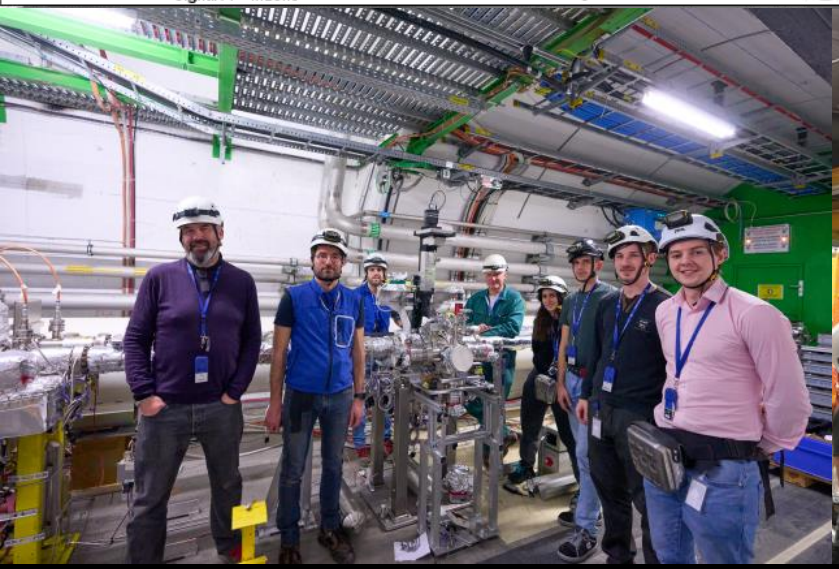




One slide on some of my more recent projects







Engineering is about people

Technician (France)

Technician (Portugal)

Technical Engineer (France)

Engineer (Poland)

Engineer (Germany)

Technician (UK)

Engineer (UK)

Technical Engineer (Italy)

Engineer (Spain)

Designer (UK)

Mechanic (France)

Trainee (Italy)

Doctoral Student (France)

Technician (France)

Missing: Engineer (Pakistan); Technician (Swiss); Engineer (Russia); Engineer (Ukraine)…

Beam Instrumentation Mechanics Section BBQ, June 2023

"…It's my job to install your boiler and help with any boiler problems you may have…"

What is Engineering?

Oxford English Dictionary, 3rd Ed.

The branch of science and technology concerned with the development and modification of engines (in various senses), machines, structures, or other complicated systems and processes using specialized knowledge or skills, typically for public or commercial use…

Wikipedia

(from Latin ingenium, meaning "cleverness" and ingeniare, meaning "to contrive, devise") is *the application of scientific, economic, social, and practical knowledge in order to invent, design, build, maintain, research, and improve structures, machines, devices, systems, materials and processes.*

So engineering means…

- Make something real out of dreams
  - Creativity!
- Discussion, negotiation, consensus:
  - Communication! Teamwork!
- Need to be ready for lifelong learning:
  - particle and accelerator physics, material science, leadership, commerce, Russian…
- Based, of course, on good science:
  - Start from first principles
  - But don’t re-invent the wheel… unless you need to!
  - Good engineering design
- Get it done, on time and on budget!

CERN

- CERN is a particle physics facility
  - But we employ very few particle physicists
  - Most theoretical and experimental scientists work for our member institutes
- …but most of what we do is “Engineering”
  - 2/3 of our staff are engineers, applied scientists or technicians
  - Work together, we can produce the most amazing, complex and beautiful things

…and can I just ask you

- You are seeing some great examples of engineering
  - SM18, CERN control centre, AD/LEIR
  - ALICE, LHCb, CMS Service cavern
- Give (all of) your students a different impression of what a career in engineering might mean
  - CERN, along with the economies of all our countries, needs more engineers, and diversity is as essential here, as everywhere

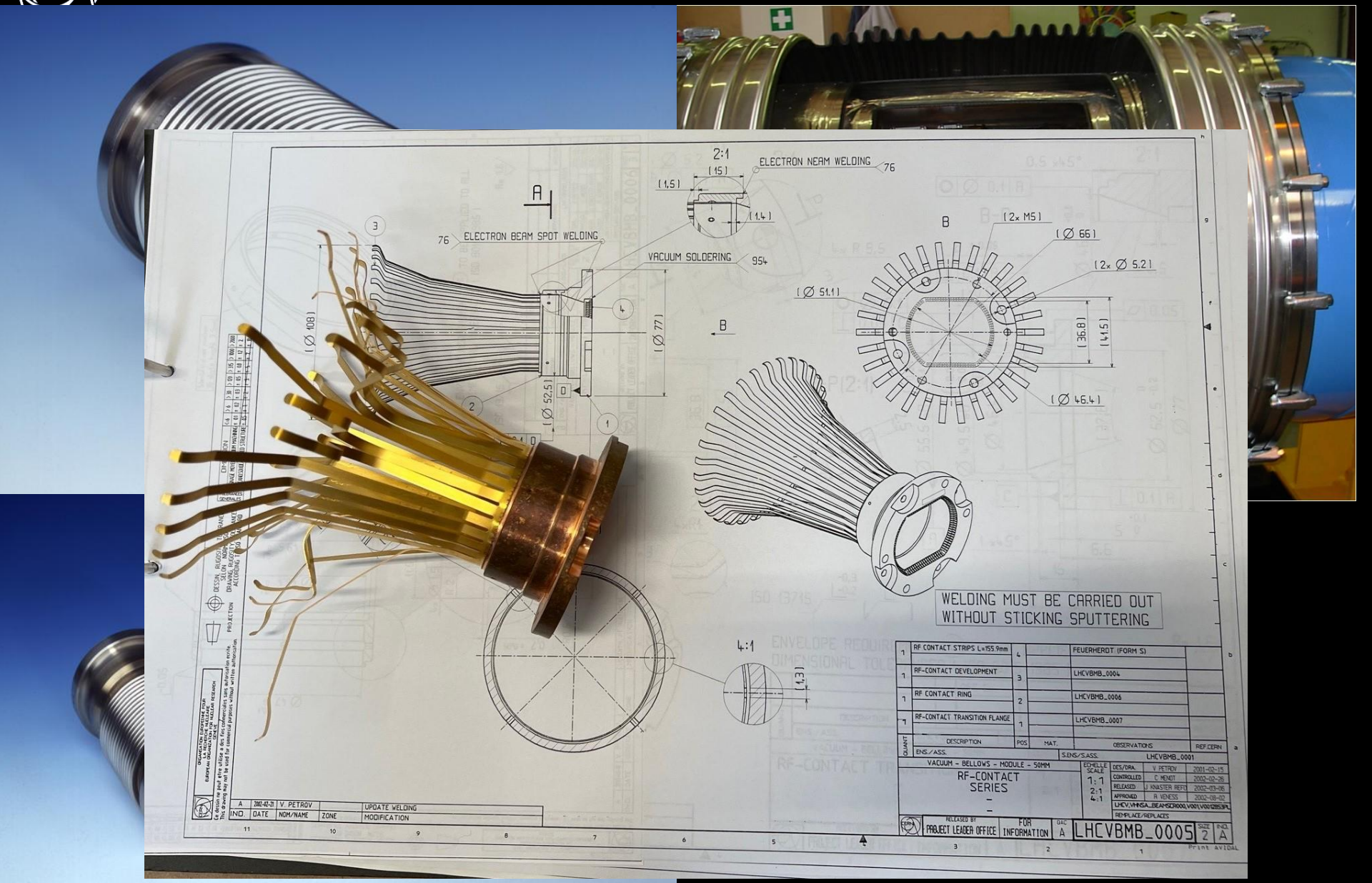
Thank you!

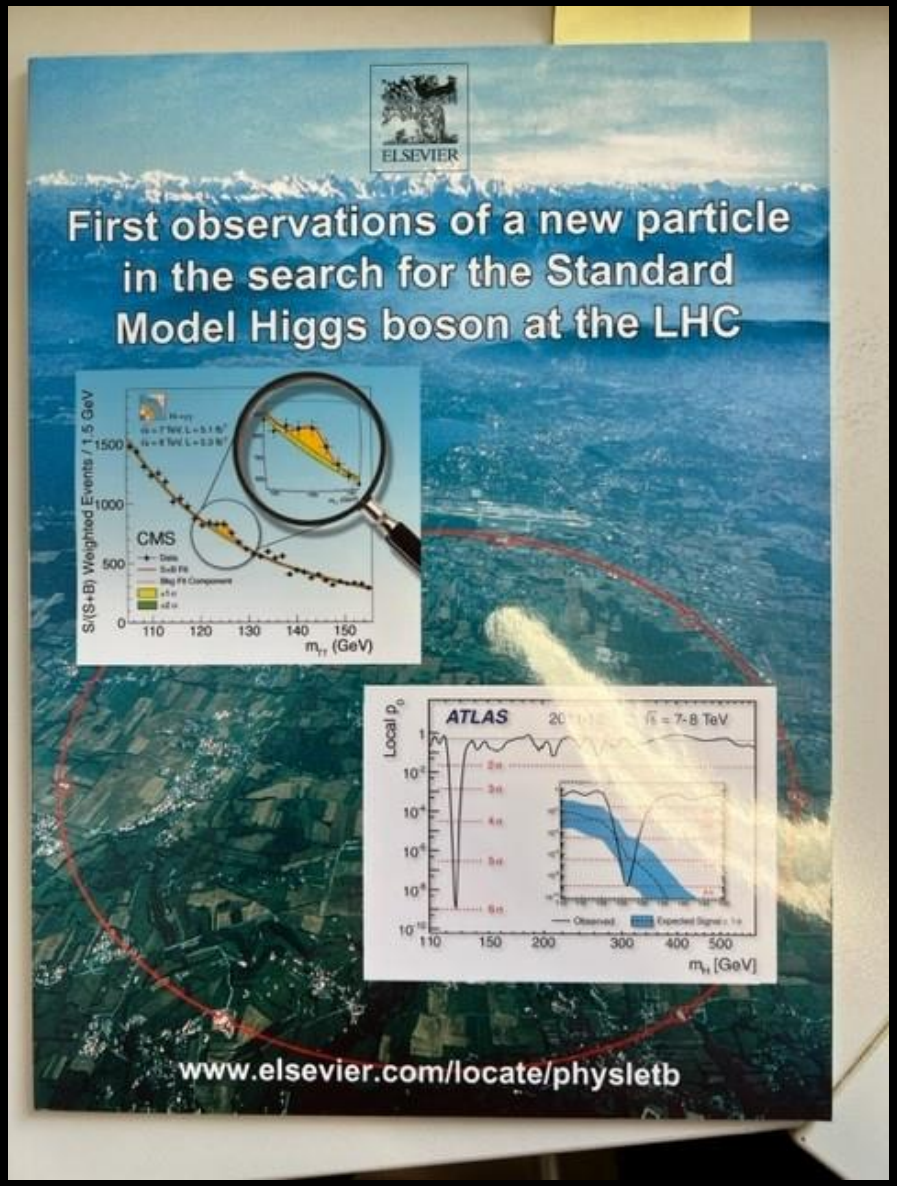
…and please feel free to take some of our enthusiasm for engineering home with you!

Backup

Ray Veness, in a nutshell

- Born and schooled in London, England
- Studied Mechanical Engineering at Leicester University
  - PhD in Solid Mechanics at Leicester University
- 2 years working on fusion energy technology at Culham Laboratory, Oxfordshire, UK
- Recruited as a CERN staff in 1992
  - Worked as a Section Leader in 5 different departments
- Responsible for many parts of the LHC design, including all experimental vacuum systems
  - Co-author of the ATLAS Higgs discovery publication(!)
- Currently Section Leader and Deputy Group Leader for Beam Instrumentation (Accelerator Systems Department)


2:1
ELECTRON BEAM WELDING
76
ELECTRON BEAM SPOT WELDING
VACUUM SOLDERING
954
(2x M5)
(Ø 66)
(2x Ø 5.2)
(Ø 51.1)
(Ø 46.4)
WELDING MUST BE CARRIED OUT
WITHOUT STICKING SPUTTERING
4:1
RF CONTACT STRIPS L=155.9mm
RF-CONTACT DEVELOPMENT
RF CONTACT RING
RF-CONTACT TRANSITION FLANGE
FEUERHERDT (FORM S)
LHCVBMB_0004
LHCVBMB_0006
LHCVBMB_0007
VACUUM - BELLOWS - MODULE - 50MM
RF-CONTACT
SERIES
LHCVBMB_0001
LHCVBMB_0005
PROJECT LEADER OFFICE
FOR INFORMATION
V. PETROV
UPDATE WELDING


ELSEVIER
First observations of a new particle in the search for the Standard Model Higgs boson at the LHC
CMS
S/(S+B) Weighted Events / 1.5 GeV
$m_{\gamma\gamma}$ (GeV)
ATLAS
$\sqrt{s}$ = 7-8 TeV
Local p_0
m_H [GeV]
www.elsevier.com/locate/physletb