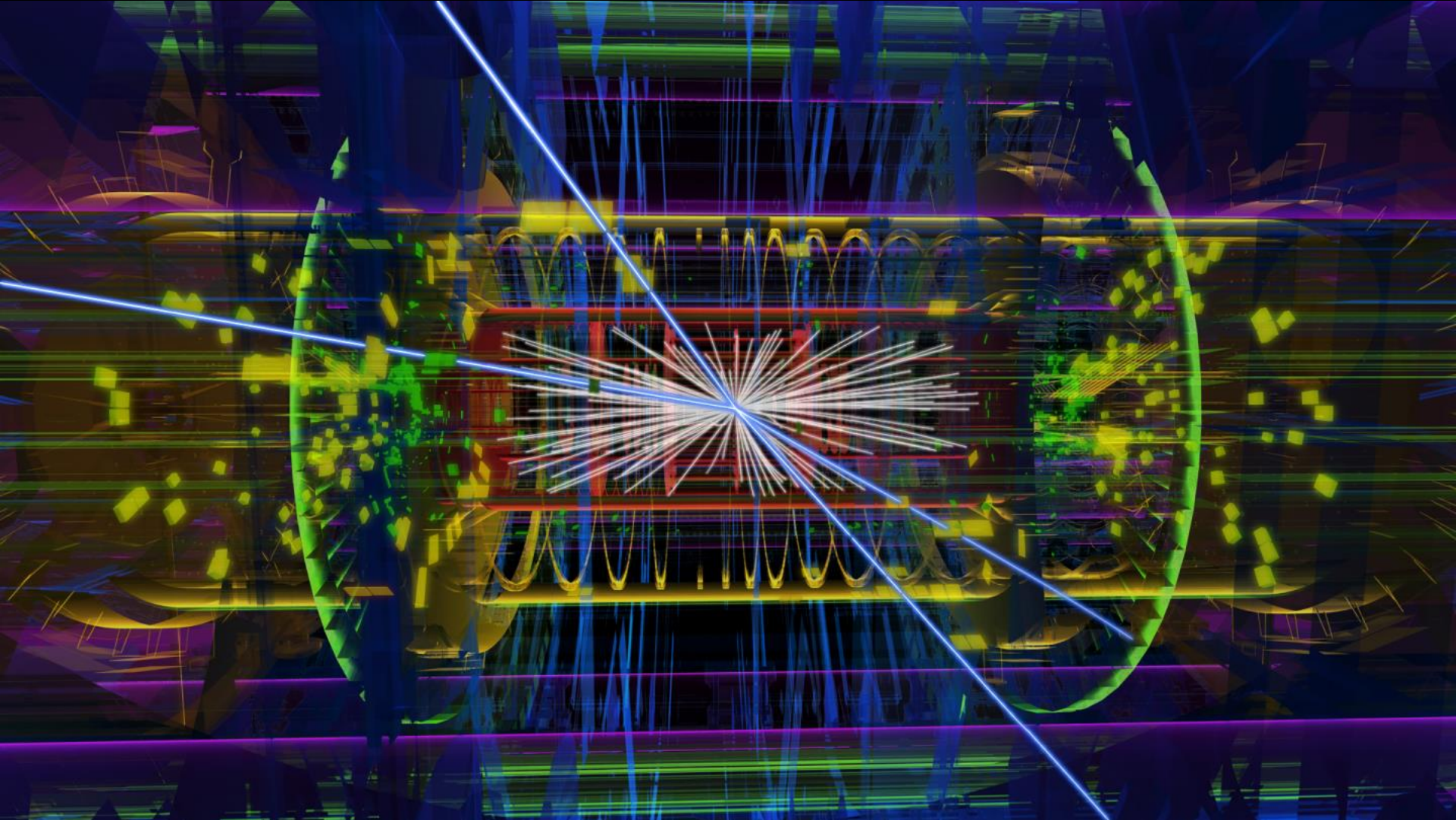
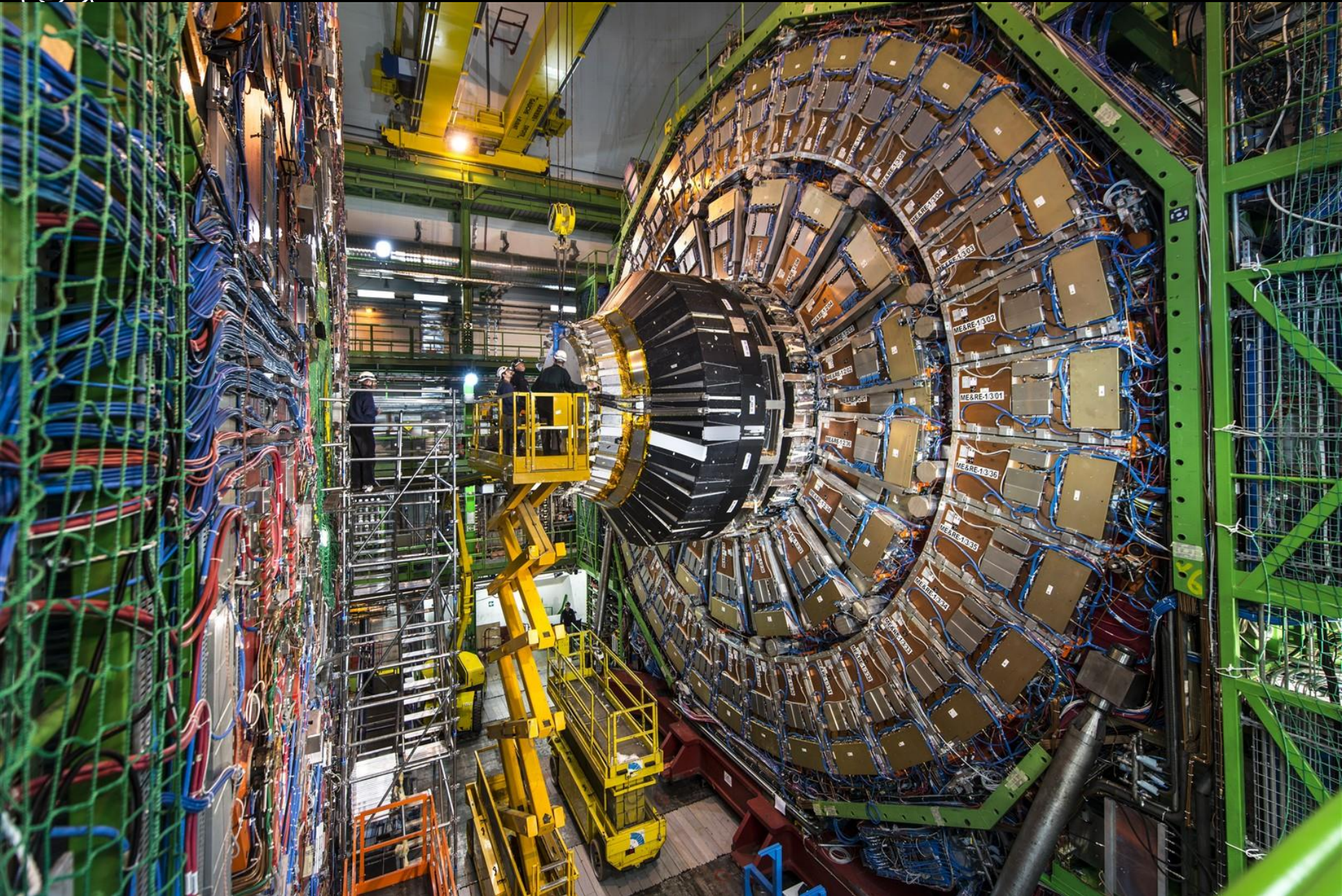


# An Introduction to Engineering at CERN

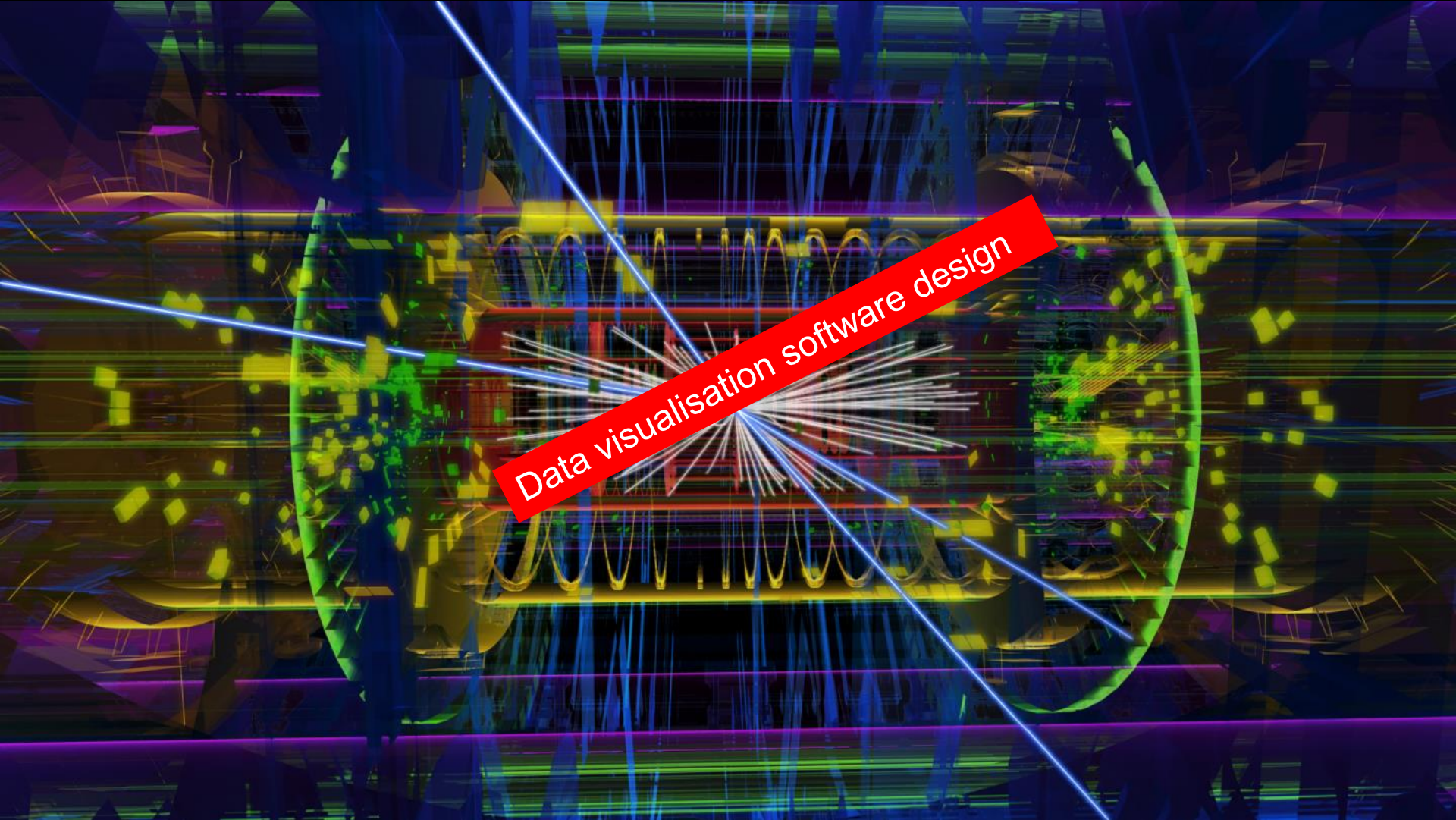
Ray Veness  
CERN













Computer hardware

Databases

Network Infrastructures



3/4/2013 4:10:16 pm  
4:10 pm 4:20 pm

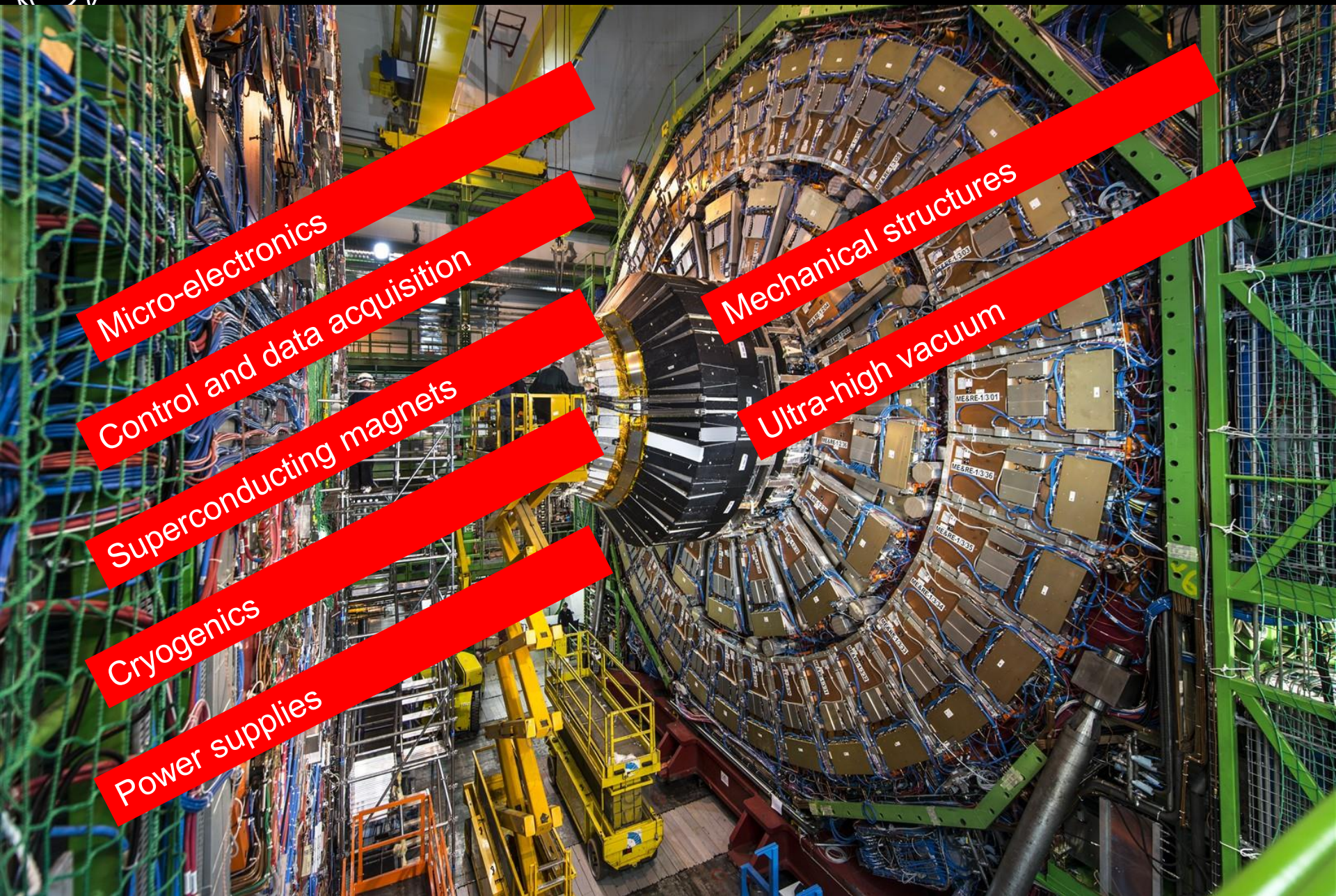
Running jobs: 259835  
Transfer rate: 6.15 GiB/sec



© 2013 Ches/Spot Image  
Image © 2013 GeoContent!  
Image © 2013 TerraMetrics  
Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
ERGRID







Micro-electronics

Control and data acquisition

Superconducting magnets

Cryogenics

Power supplies

Mechanical structures

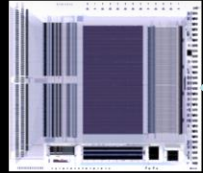
Ultra-high vacuum



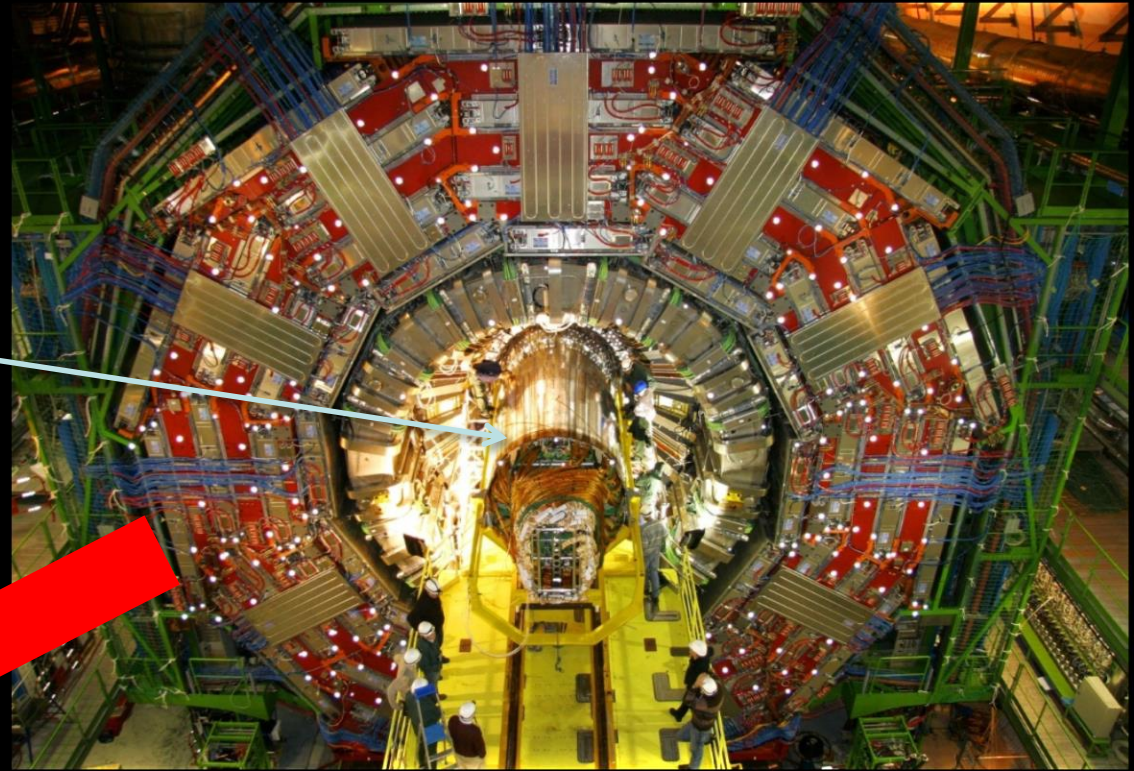
# Microchips for Megastructures

Front-End ASIC

CMS experiment on the LHC accelerator at CERN



Silicon Tracker Hybrid



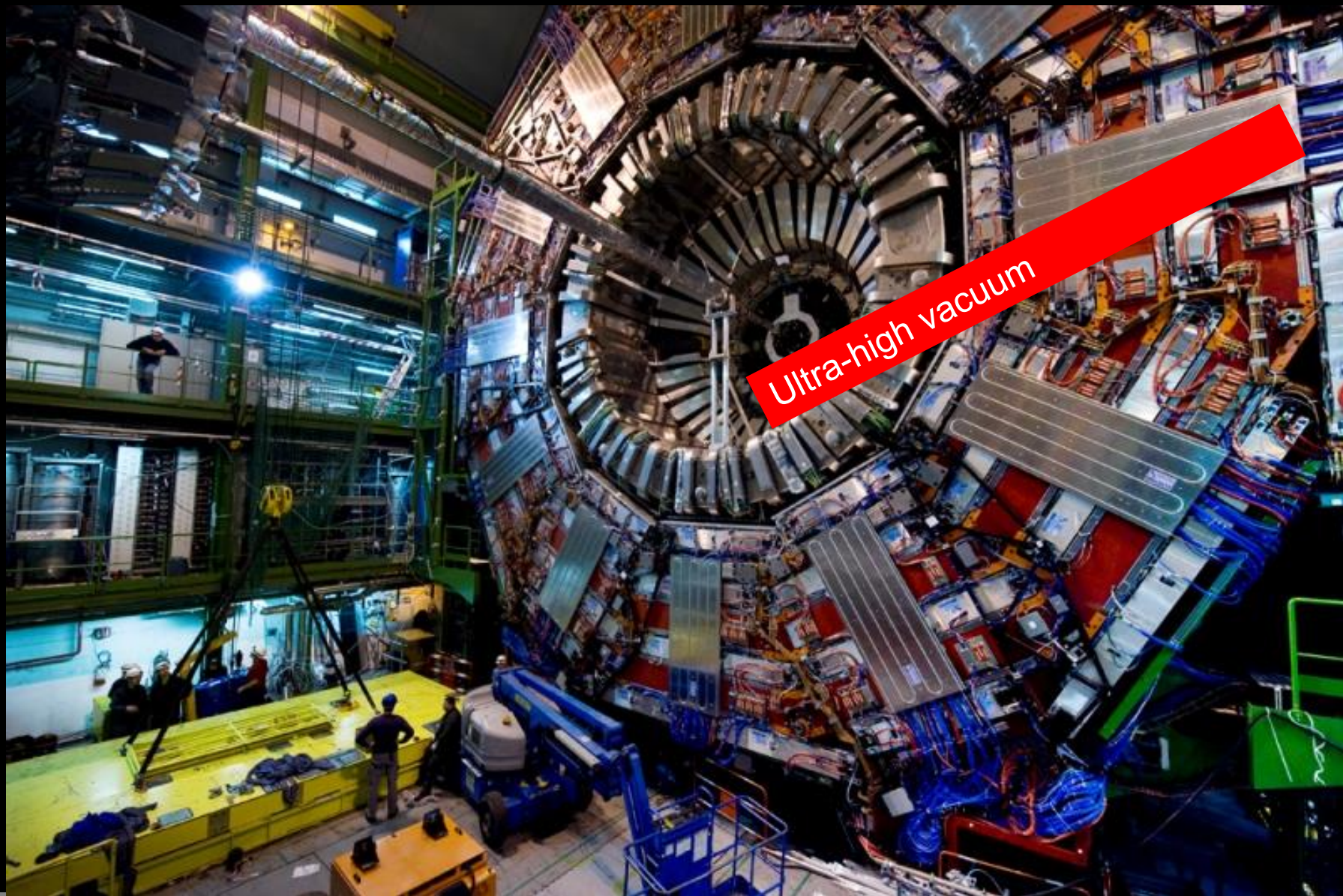
Micro-electronics

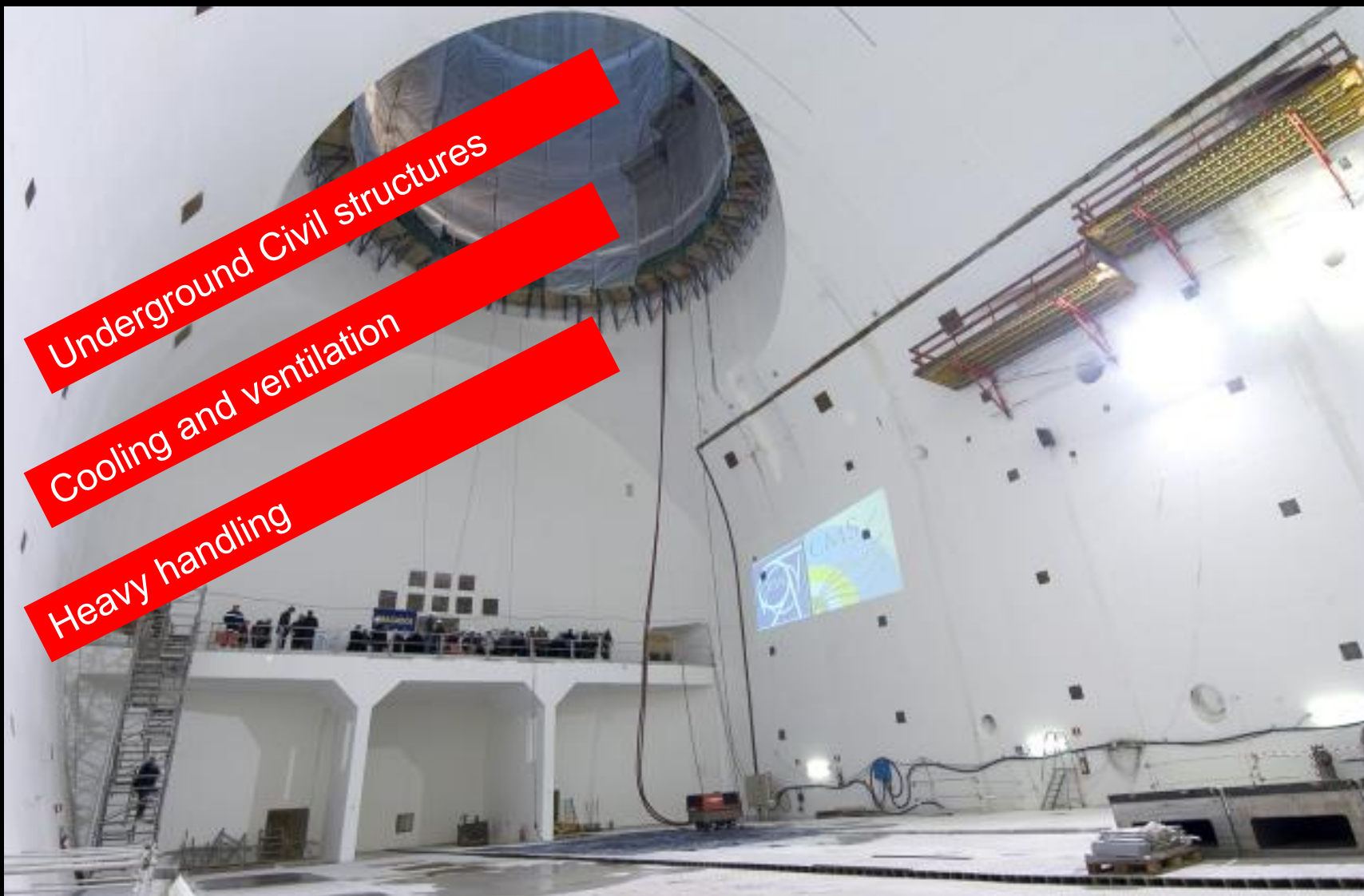


Superconducting magnets

Cryogenics

Power supplies

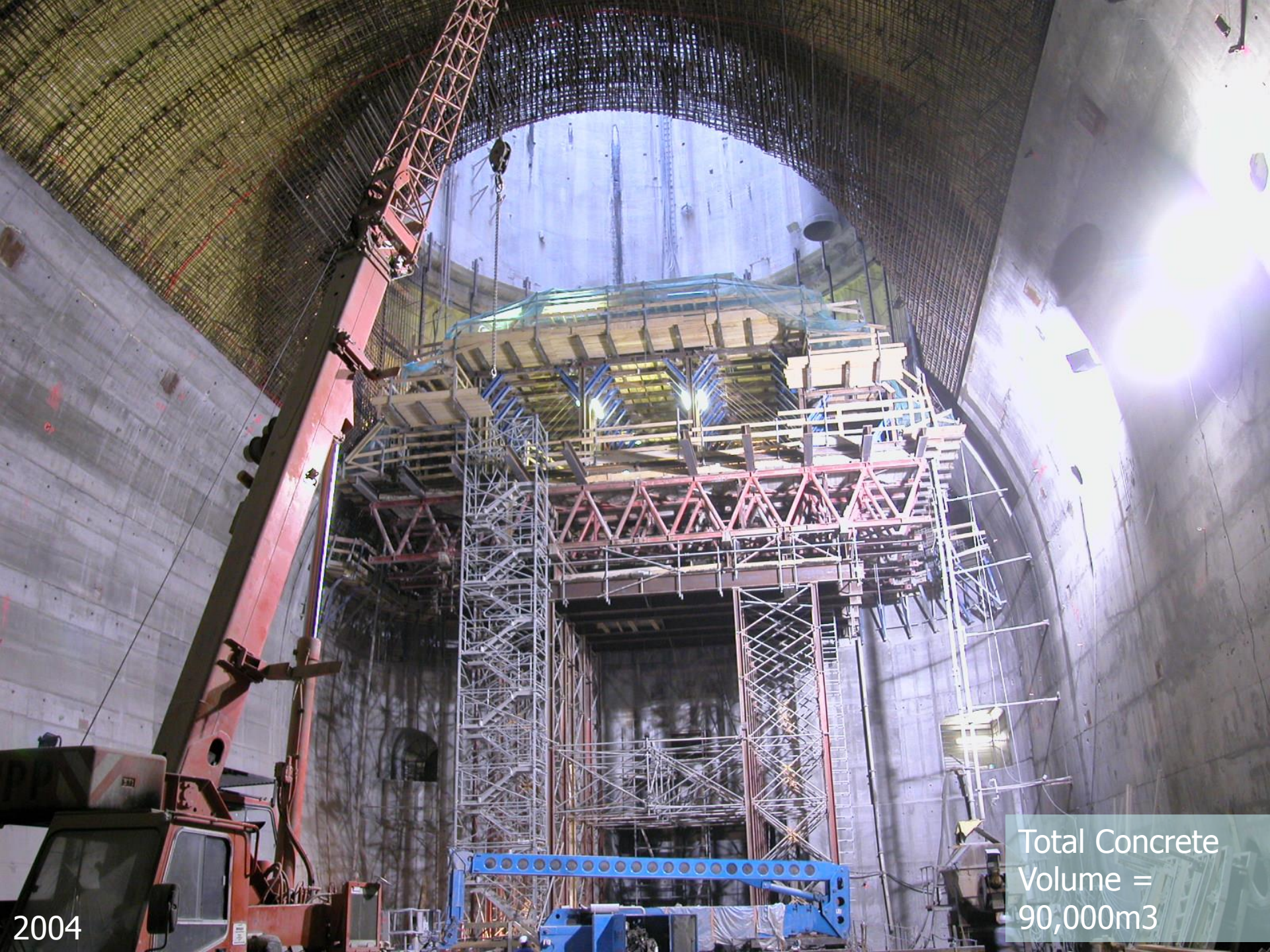






**Point 5 -Excavation commencement of PM54 shaft - July 09, 1999 - CERN ST-CE**





Total Concrete  
Volume =  
90,000m<sup>3</sup>

2004









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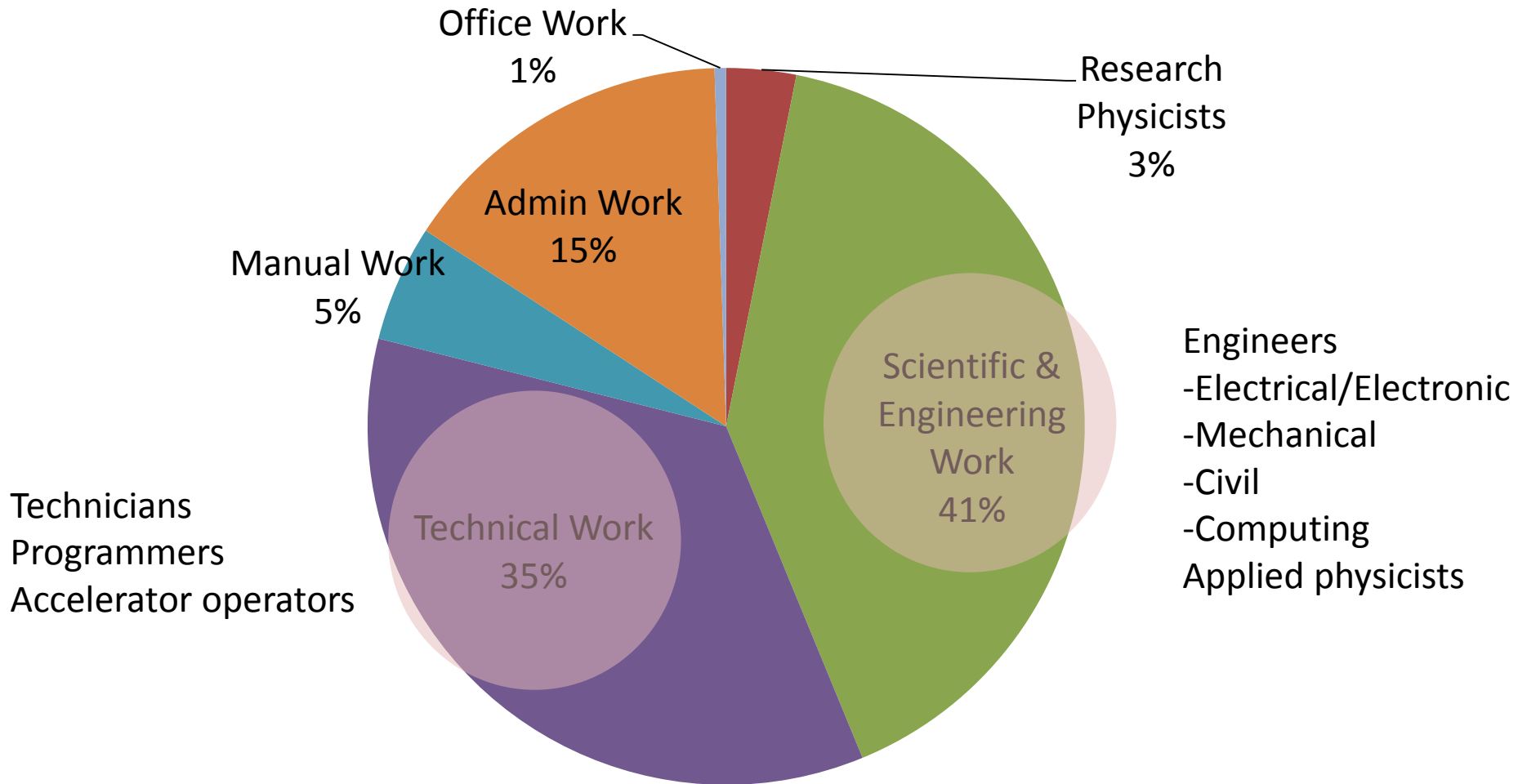
Ray Veness (CERN)

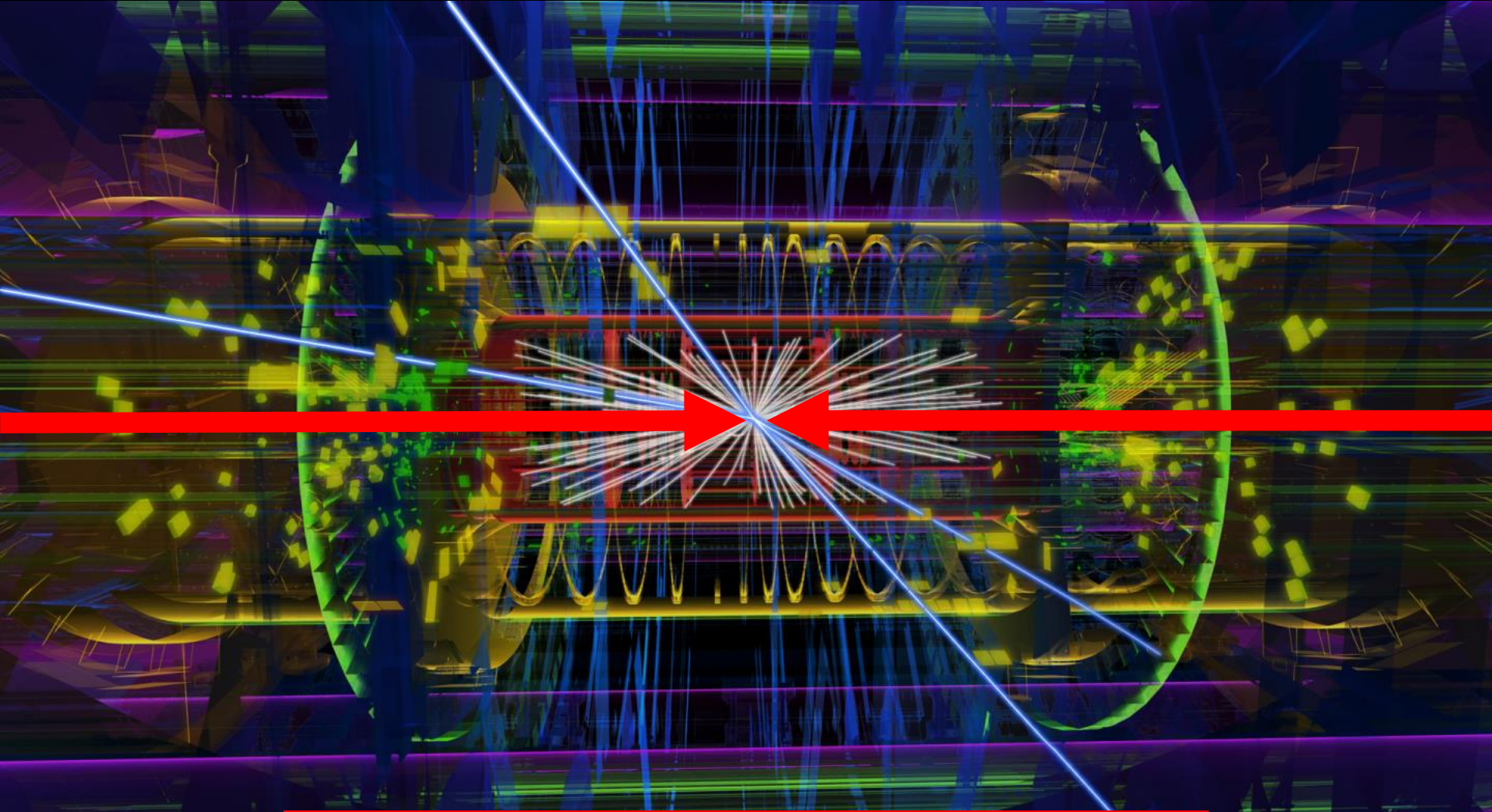


**ROSS**  
**THE BOILER**  
**ENGINEER**

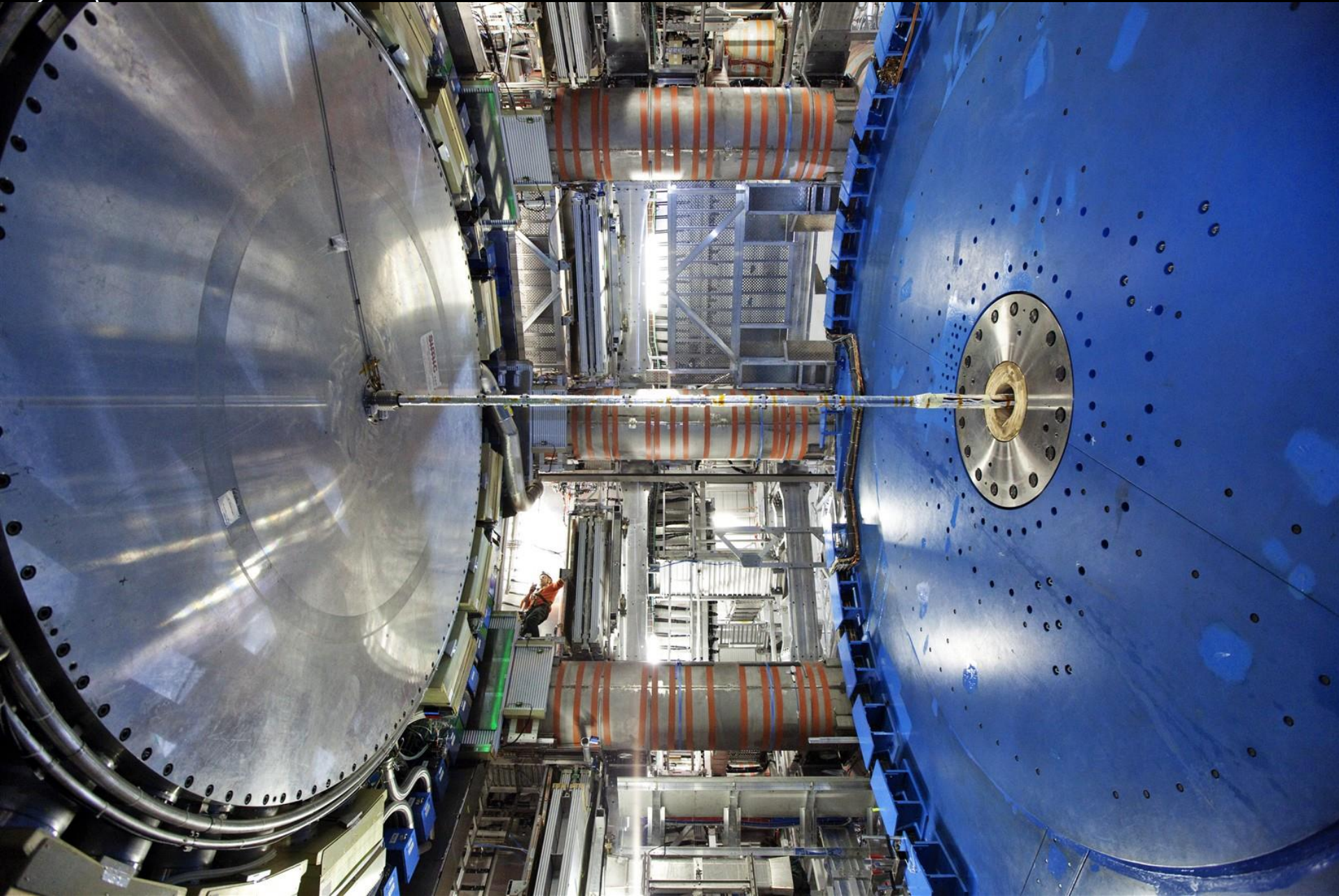
Image courtesy British Gas

# CERN Staff by job description





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!

Periodic Table of the Elements

1	IA	<del>H</del>																	0	<del>He</del>	
2	IIA	<del>Li</del>	Be																	10	Ne
3		11	12	IIIB	IVB	VB	VIB	VII B	VIII	IB	IIB	13	14	15	16	17	18				
4		19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
5		37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54		
6		55	56	*La	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		
7		87	88	+Ac	104	105	106	107	108	109	110	111	112	113							

* Lanthanide Series	58	59	60	61	62	63	64	65	66	67	68	69	70	71
	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
+ Actinide Series	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

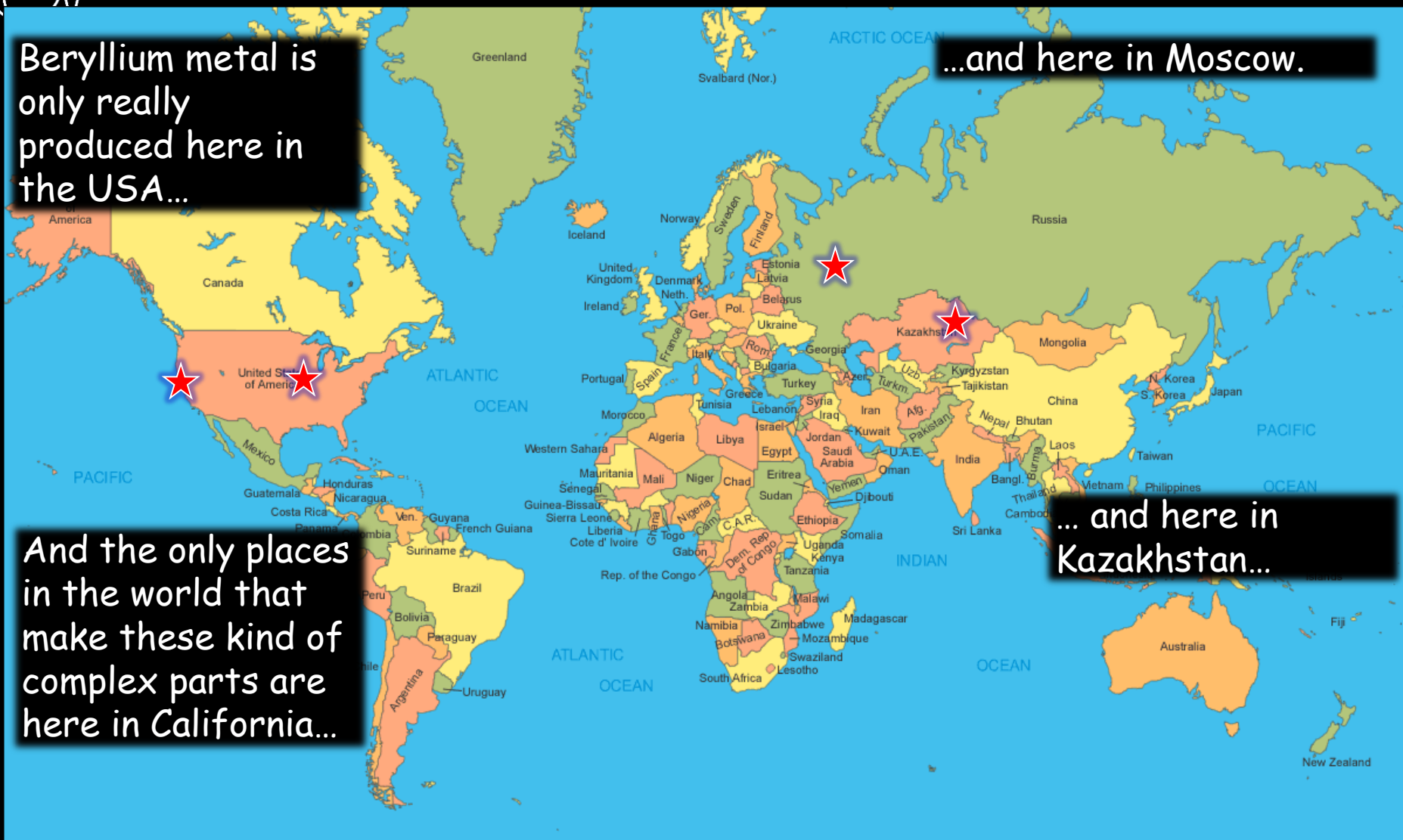


Beryllium metal is only really produced here in the USA...

...and here in Moscow.

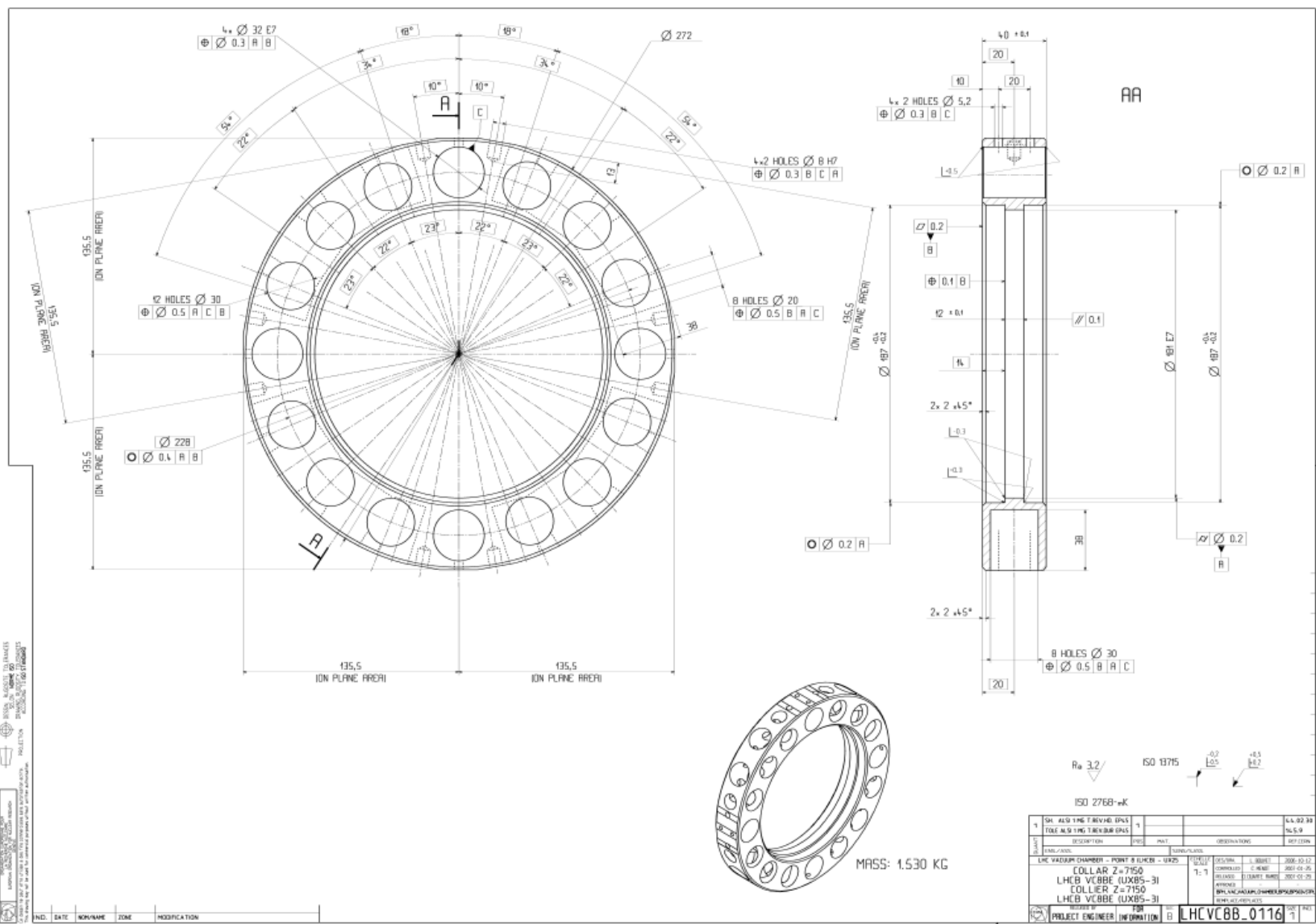
And the only places in the world that make these kind of complex parts are here in California...

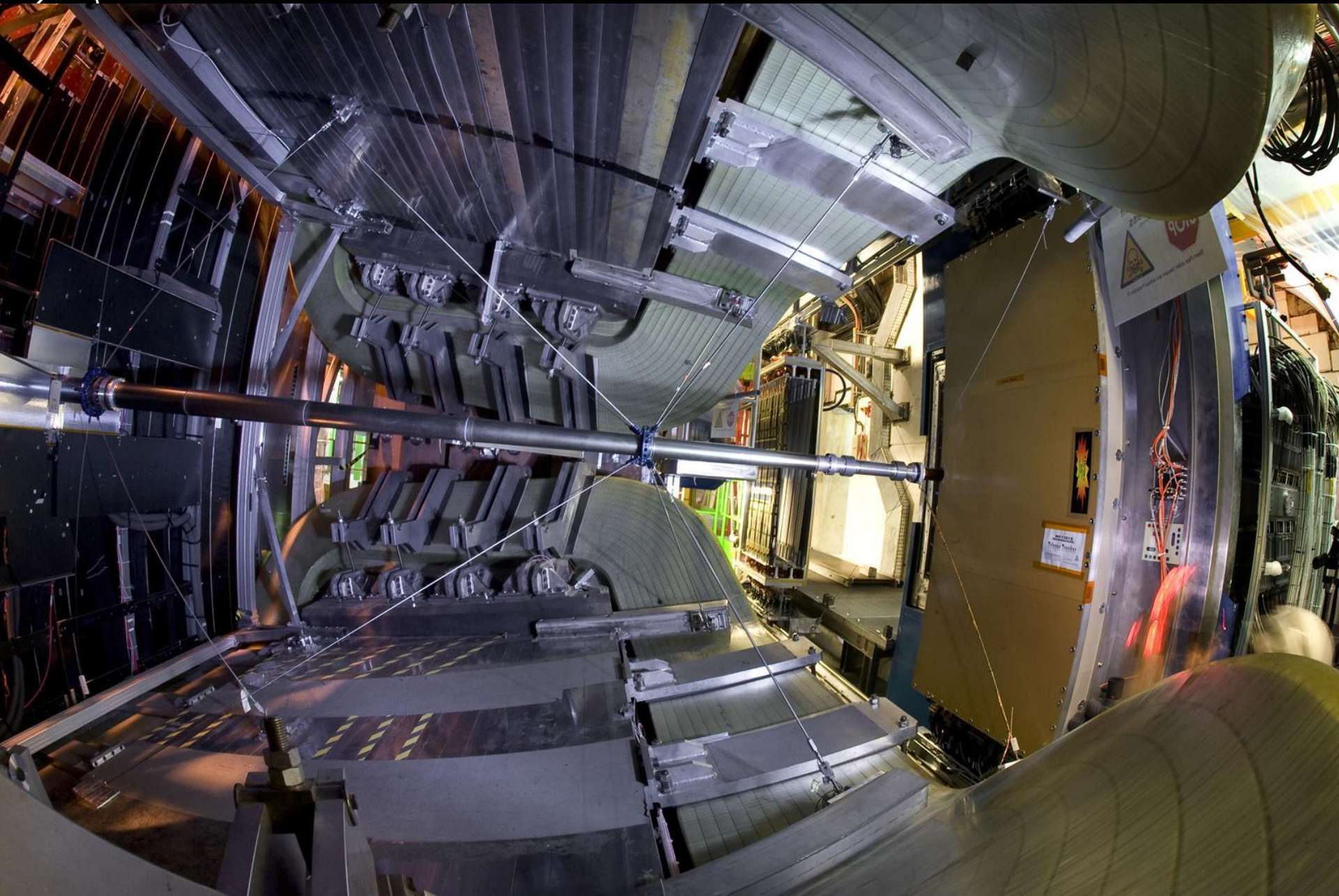
... and here in Kazakhstan...





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







Engineering at CERN



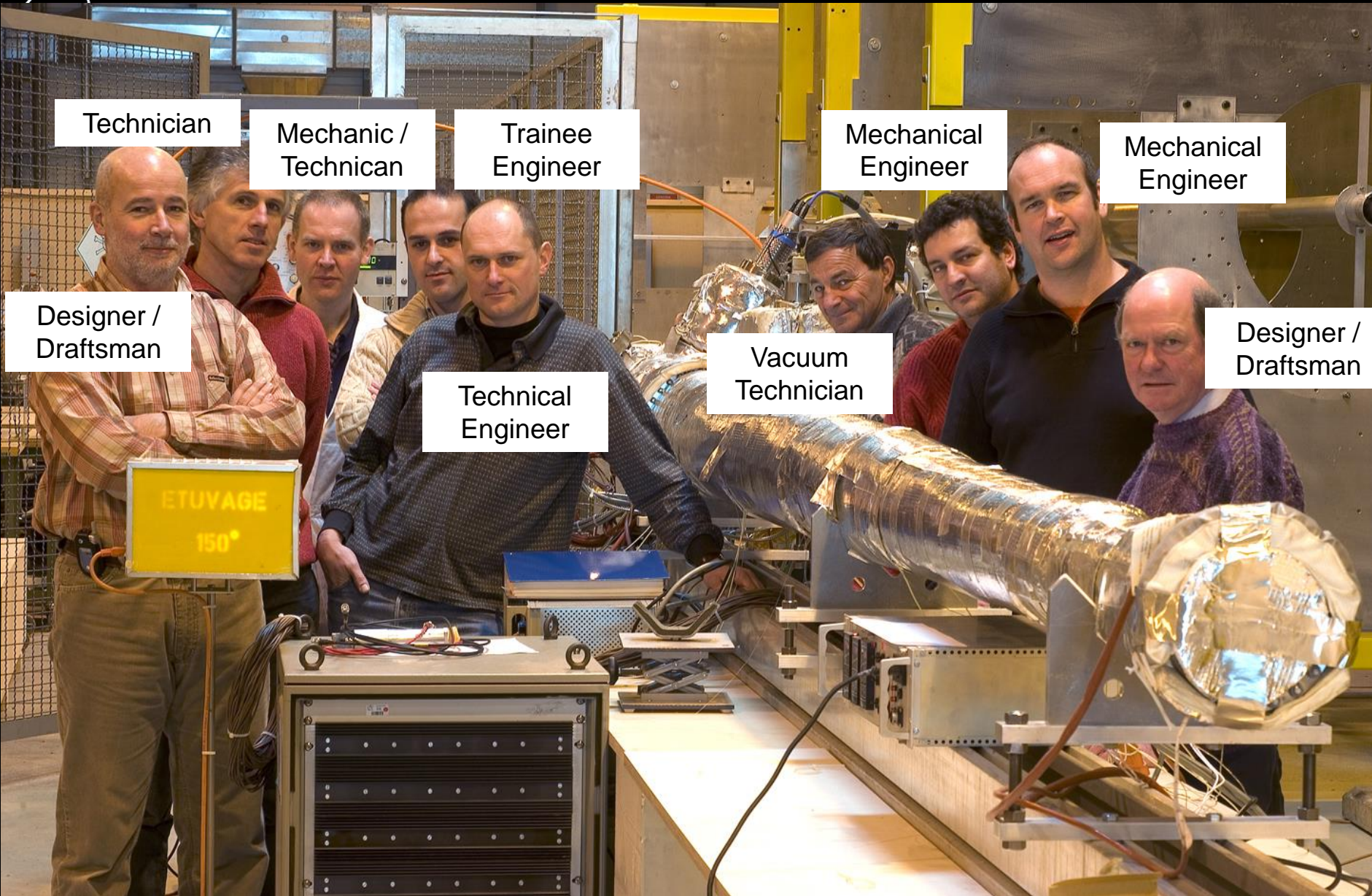
Ray Veness (CERN)



“...It’s my job to install your boiler and help with any boiler problems you may have...”



# Experimental beampipes team (2008)



Technician

Mechanic /  
Technician

Trainee  
Engineer

Mechanical  
Engineer

Mechanical  
Engineer

Designer /  
Draftsman

Technical  
Engineer

Vacuum  
Technician

Designer /  
Draftsman

ETUVAGE  
150°



# Beam instrumentation (2018)







# What is Engineering?

OED, 3<sup>rd</sup> 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...

- **Discussion, negotiation, consensus:**
  - Communication!
- **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

- I hope you have enjoyed your visits over the 10 days
- You have seen some incredible examples of engineering
  - Magnet test facility (SM18), Data centre,
  - Antimatter factory,
- Give 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...



Thank you!

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