engineering & the future of accelerators @ CERN

Pushing LIMITS and boundaries in materials AND TECHNOLOGY

	Staff		Fellows & MPA (excl. users)		Total	
Professional Category	**No.**	**%**	**No.**	**%**	**No.**	**%**
Research physicists	**86**	**3.27**	1.079	40.52	**1,165**	**22.00**
Scientific and engineering work	**1,143**	**43.41**	1,325	49.76	**2,468**	**46.60**
Technical work	890	33.80	147	5.52	1,037	19.58
Manual work	57	2.16	19	0.71	76	1.44
Prof. admin work	175	6.65	45	1.69	220	4.15
Office and admin work	280	10.63	46	1.73	326	6.16
Office work	2	0.08	2	0.08	4	0.08
Total	**2,633**	**100**	**2,633**	**100**	**5,296**	**100**

2017 CERN DATA

Scientific and Engineering Work

2,468 out of 5,296

46.60 % of CERN professionals

Research Physicists

1,165 out of 5,296

22 % of CERN professionals

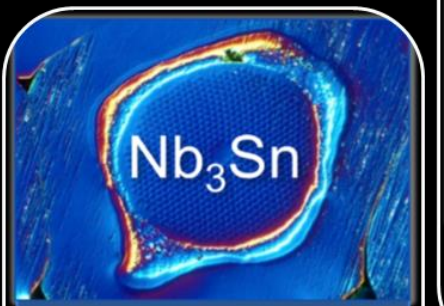
Dark energy

Dark matter

Anti matter

Revolutionary engineering

revolutionary engineering



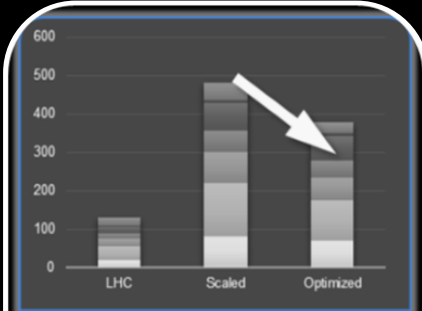
Novel Materials and Processes

16 T

High-field Magnets

Large-scale Cryogenics

FCC



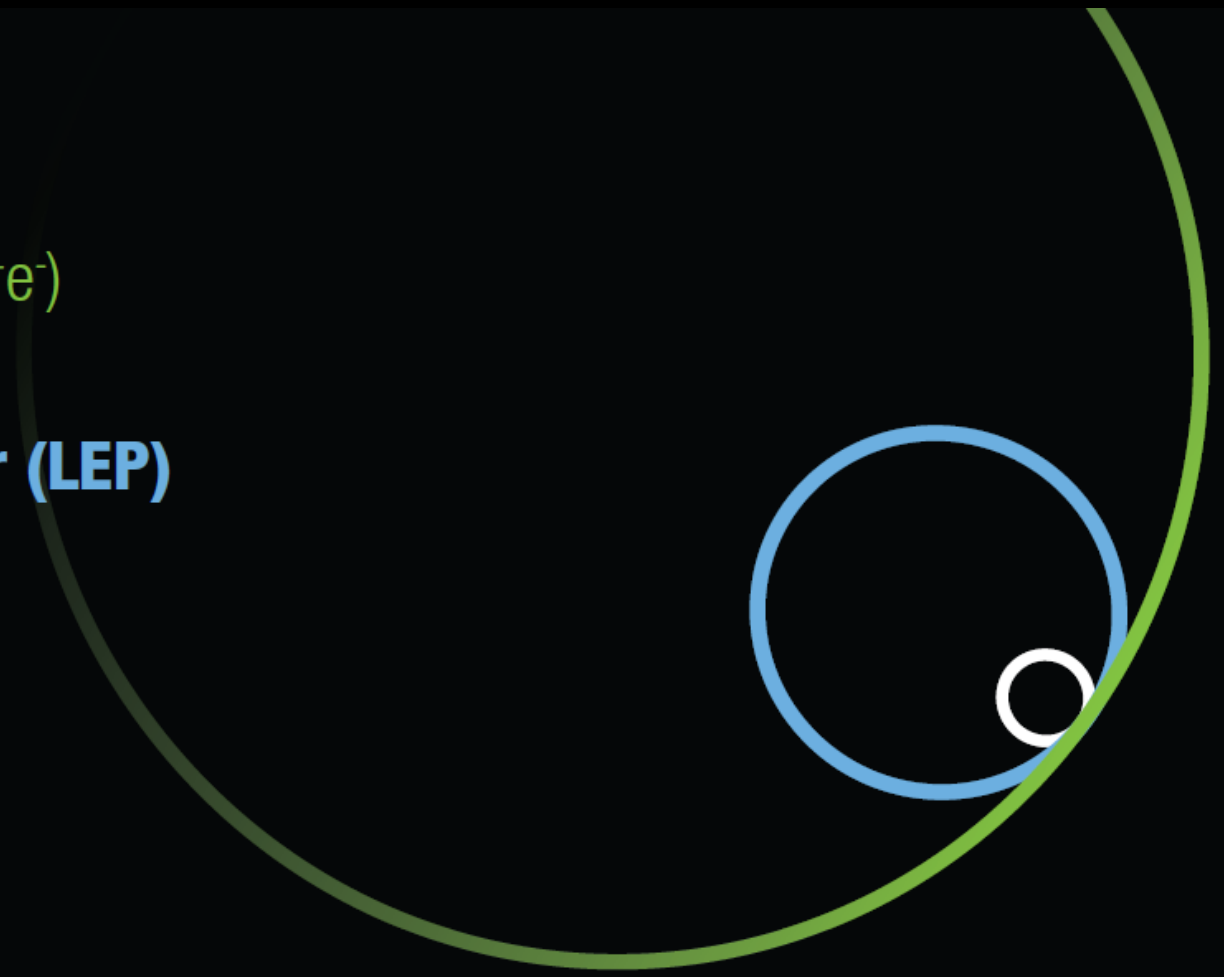
Power Efficiency

2.0

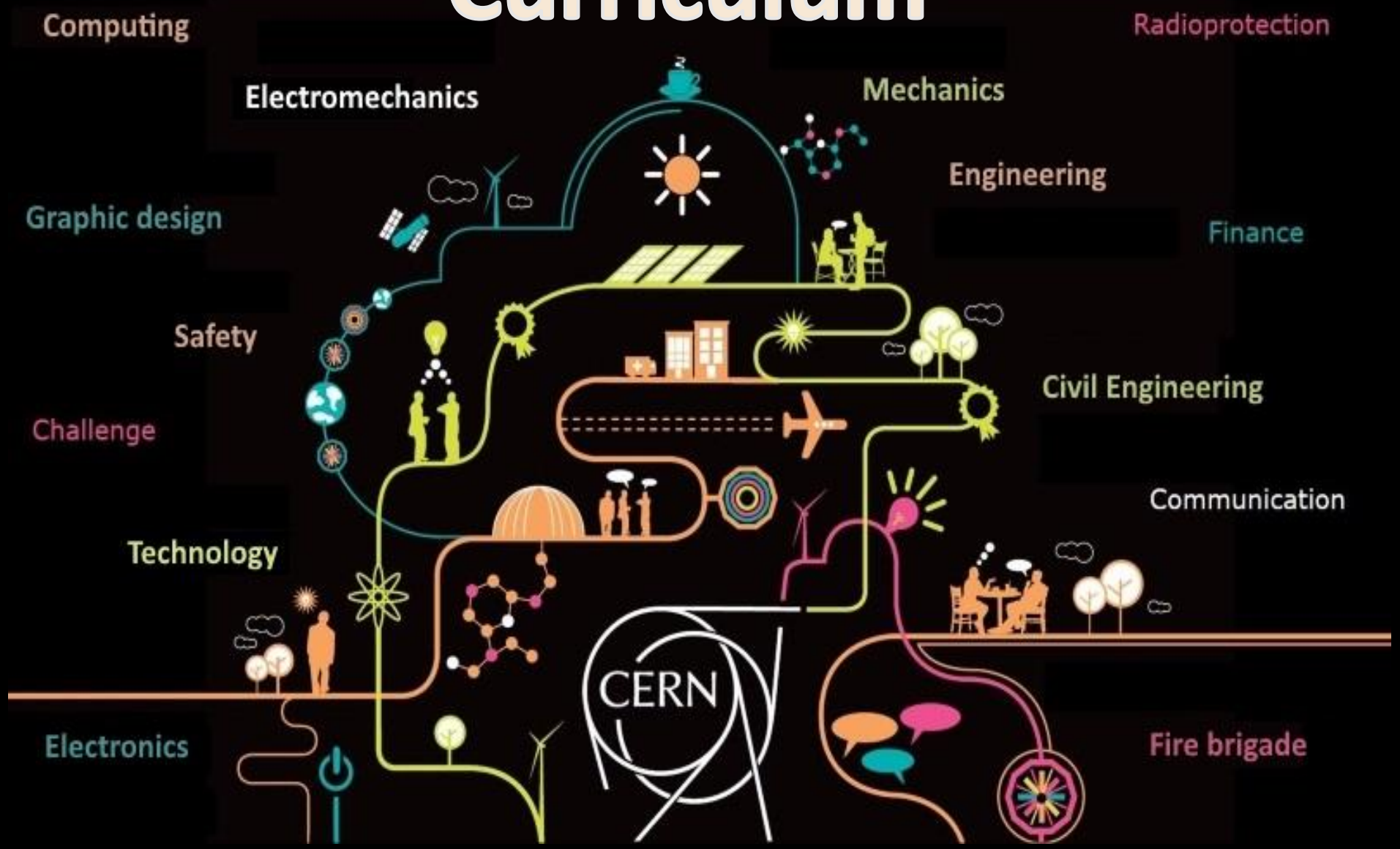
Global Scale Computing

Reliability & Availability

- **Future Circular Collider (FCC)**
  Circumference: 90 -100 km
  Energy: 100 TeV (pp) 90-350 GeV (e^+e^-)
- **Large Hadron Collider (LHC)**
  Large Electron-Positron Collider (LEP)
  Circumference: 27 km
  Energy: 14 TeV (pp) 209 GeV (e^+e^-)
- **Tevatron**
  Circumference: 6.2 km
  Energy: 2 TeV ($p\bar{p}$)

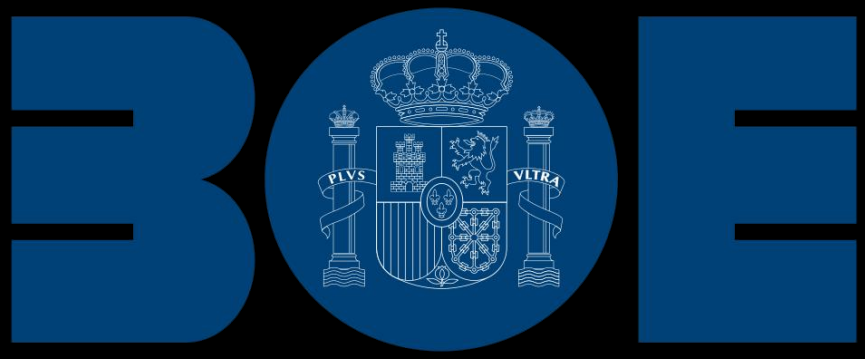


Curriculum


Computing
Radioprotection
Electromechanics
Mechanics
Engineering
Graphic design
Finance
Safety
Civil Engineering
Challenge
Communication
Technology
CERN
Electronics
Fire brigade

Curriculum

- Depends on every country
- 10th - 12th grades
- Different subjects

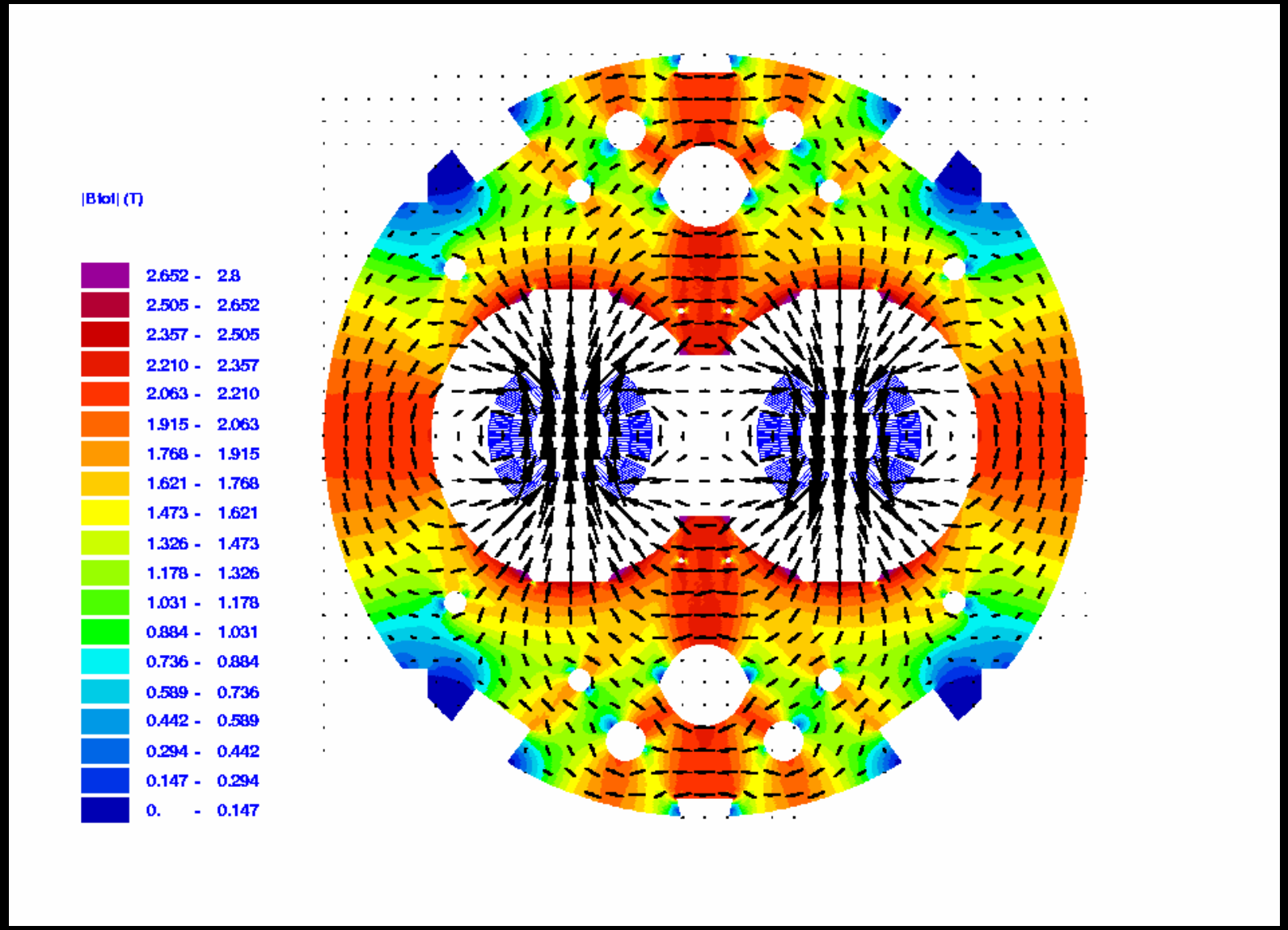


Agriculture	Fundamentals and Applications of Aquaculture and Food Processing in a Philippine Setting	AGRI
Computer Science	Data Structures and Algorithm	CS5
Engineering Science	Special Topics in Engineering	ENGG
Technology	Design and Make Technologies	TECH
Science, Technology, Engineering, and Mathematics (STEM) Research 2	Knowledge Integration, Application and ExtensionResearch for a Sustainable Development	RES2

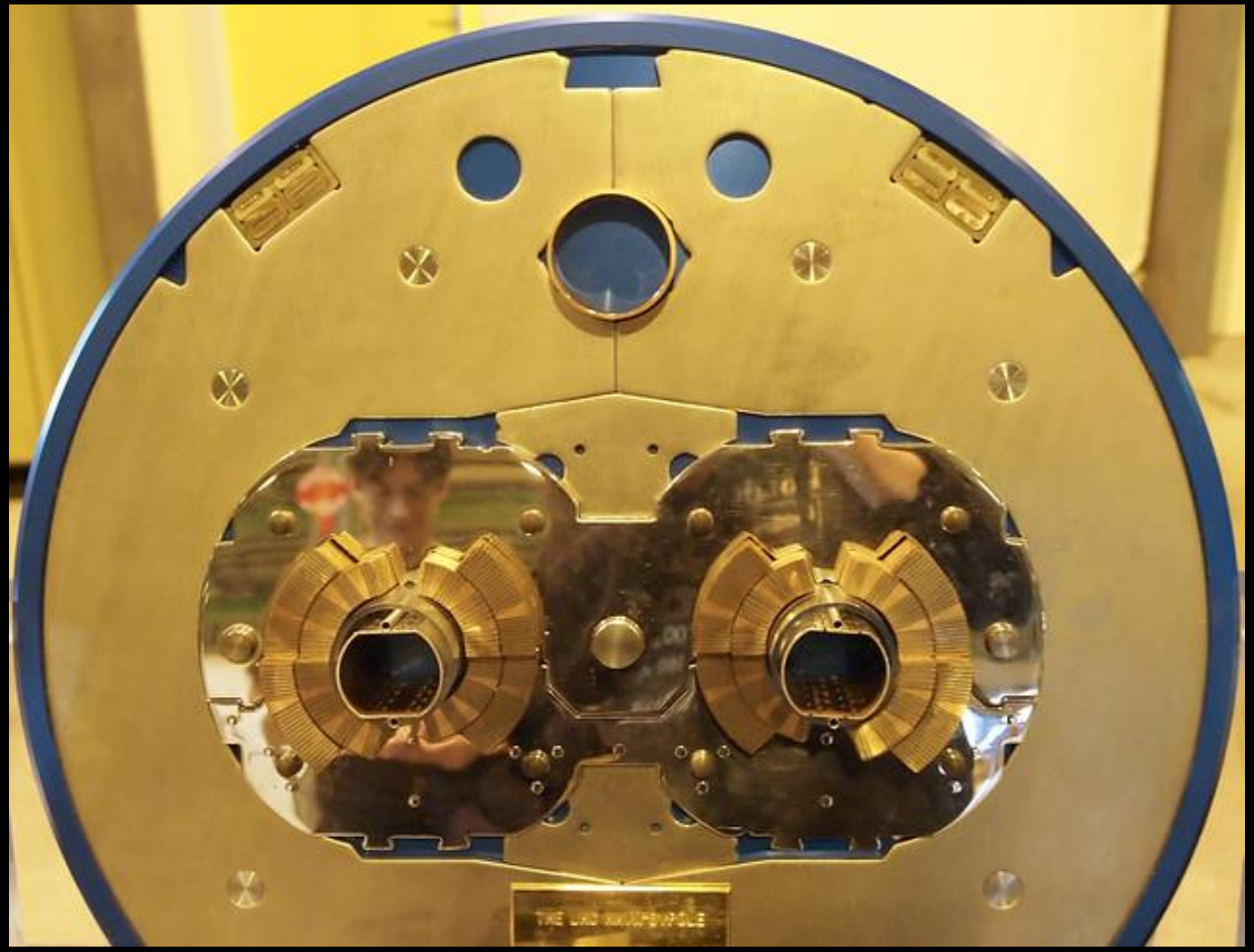
Problems we could find:

- Lack of time
- Lack of materials and resources
- Lack of motivation of our students
- Lack of mathematical skills

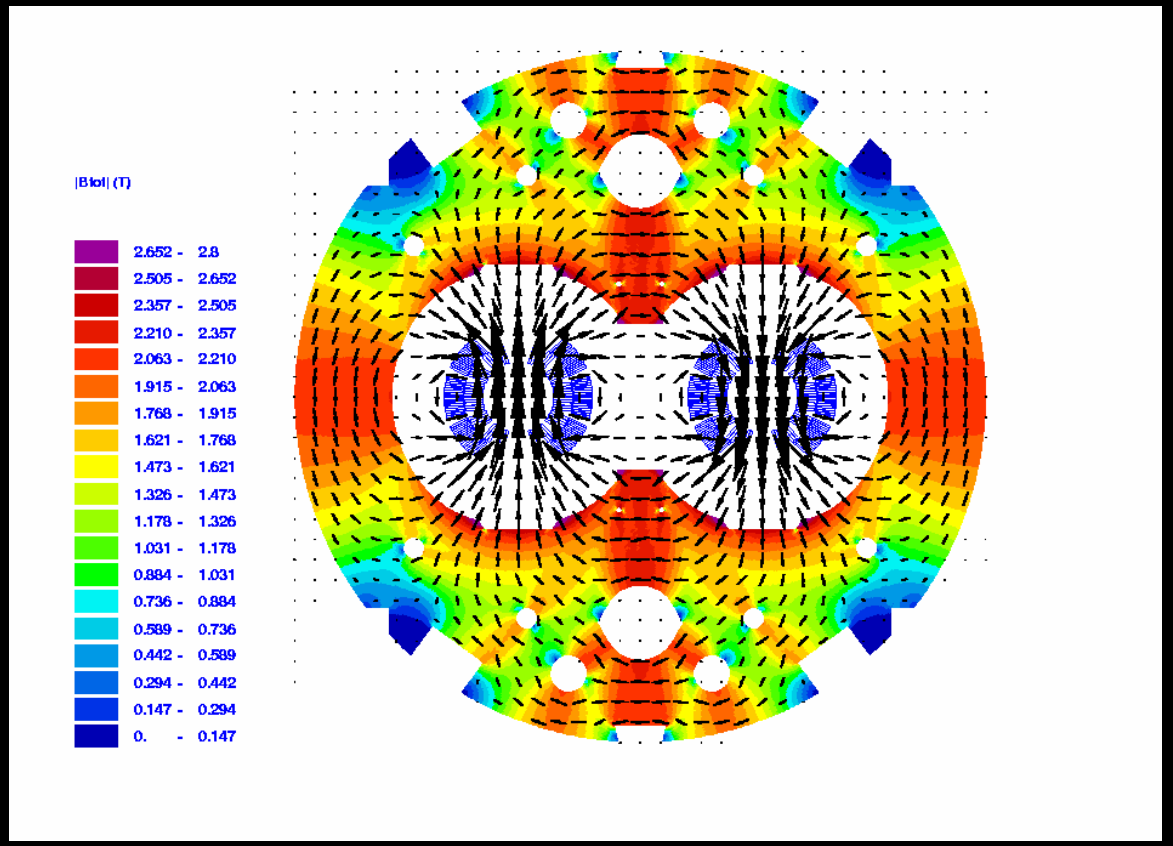
Abstract concepts

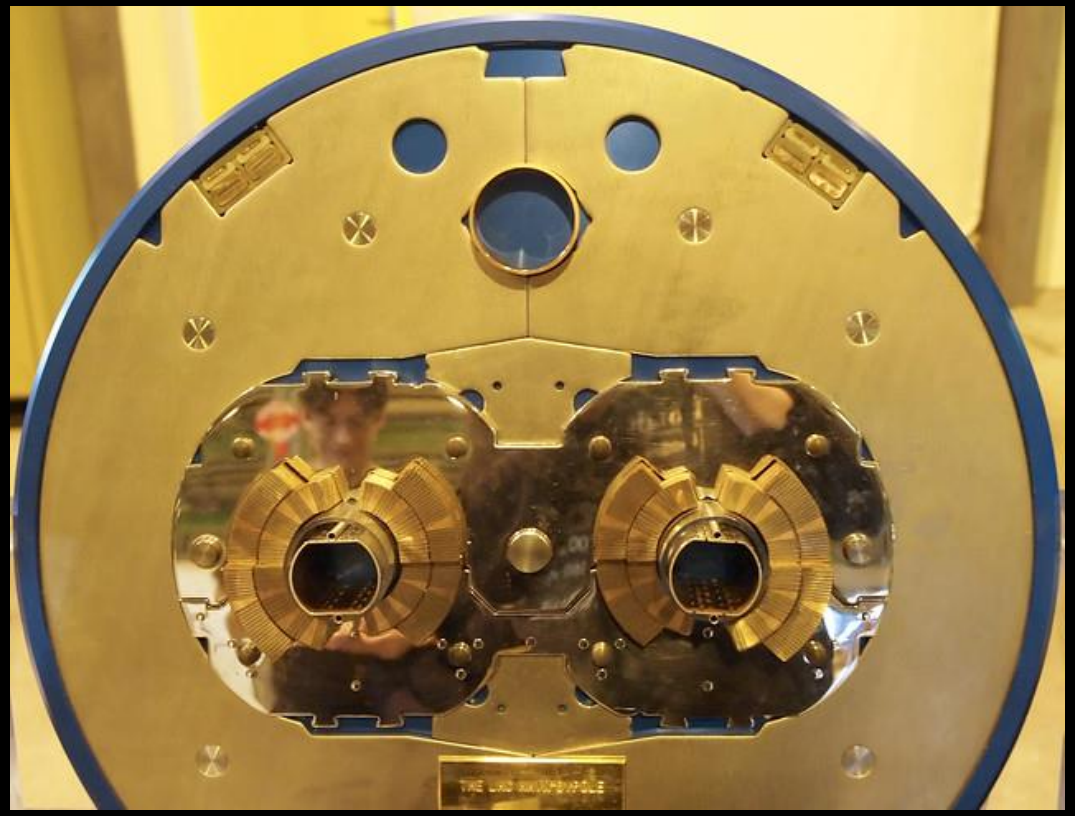


Physical world



Abstract concepts vs. physical world



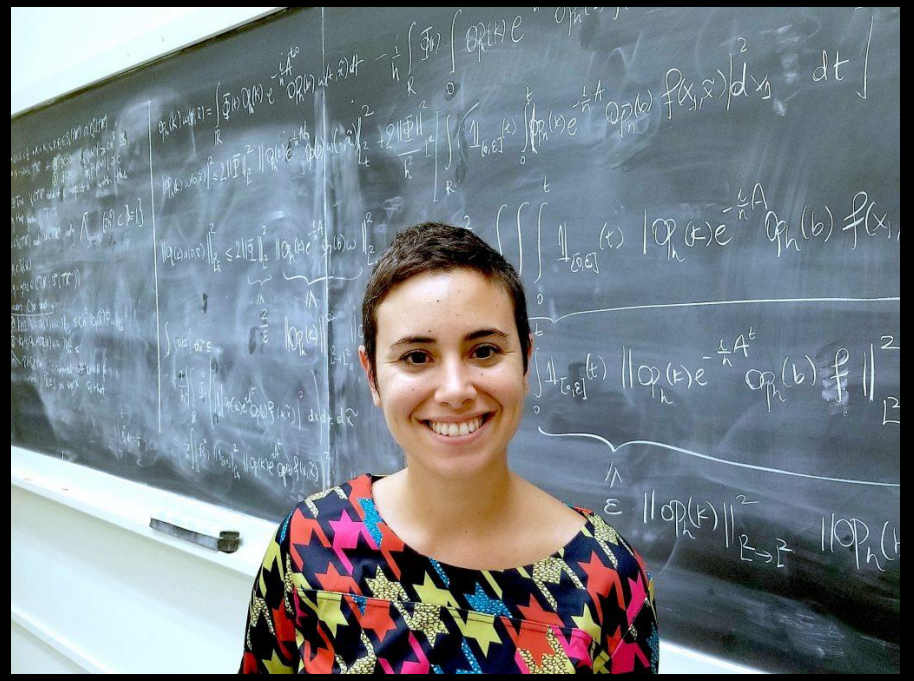


But in reality…

How could we implement engineering and physics concepts in classroom?

A hands-on activity:

- Check prior knowledge
- Calculate parameters
- Construct and test a prototype
- Take and analyze data
- Make modifications to improve it
- Make connections to engineering and physics



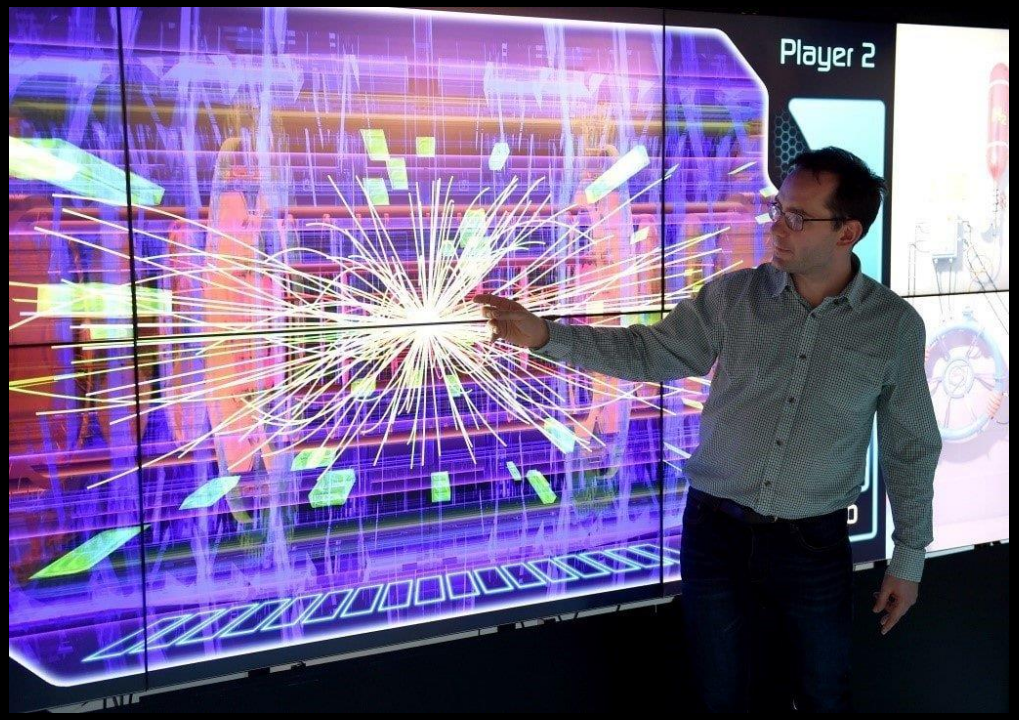
Some useful links

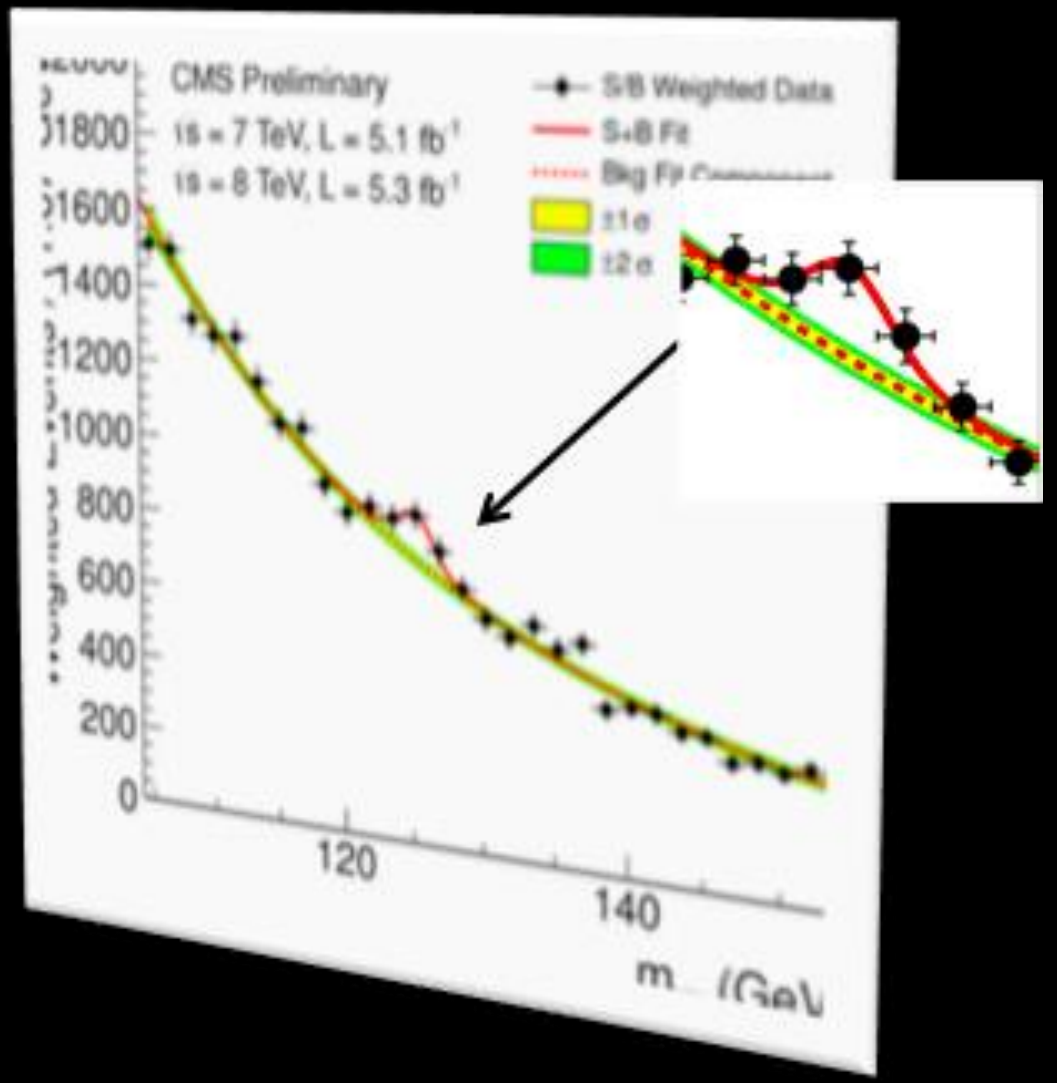
https://www.teachengineering.org/
http://www.discovere.org/
http://teachers.egfi-k12.org/
https://tryengineering.org/
https://nscl.msu.edu/public/index.html

The Future of Accelerators

2012 Discovery of Higgs boson

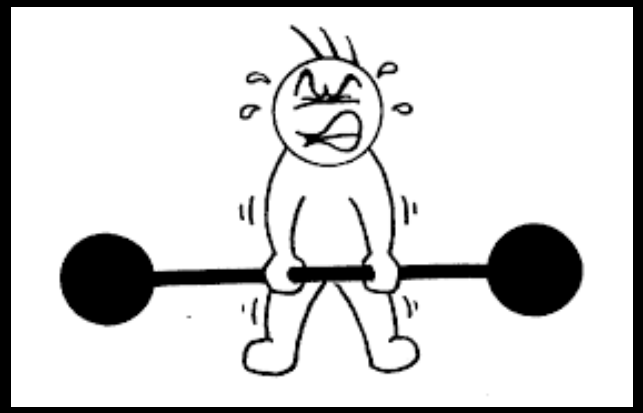
2013 Studies for higher energy accelerators



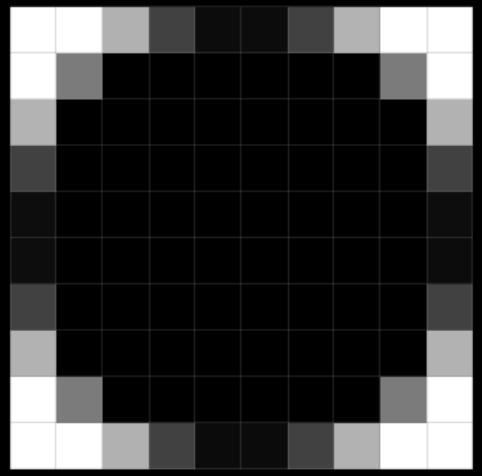


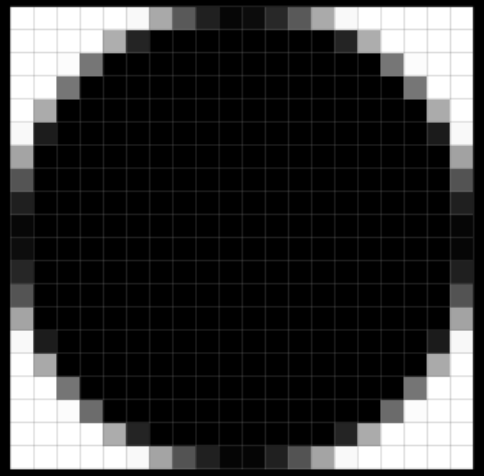
Why a bigger accelerator?

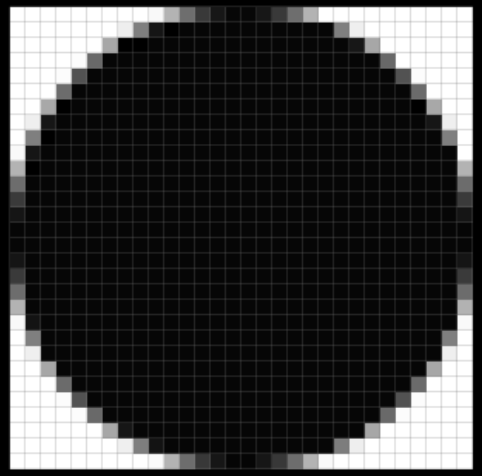
- Find new heavier particles



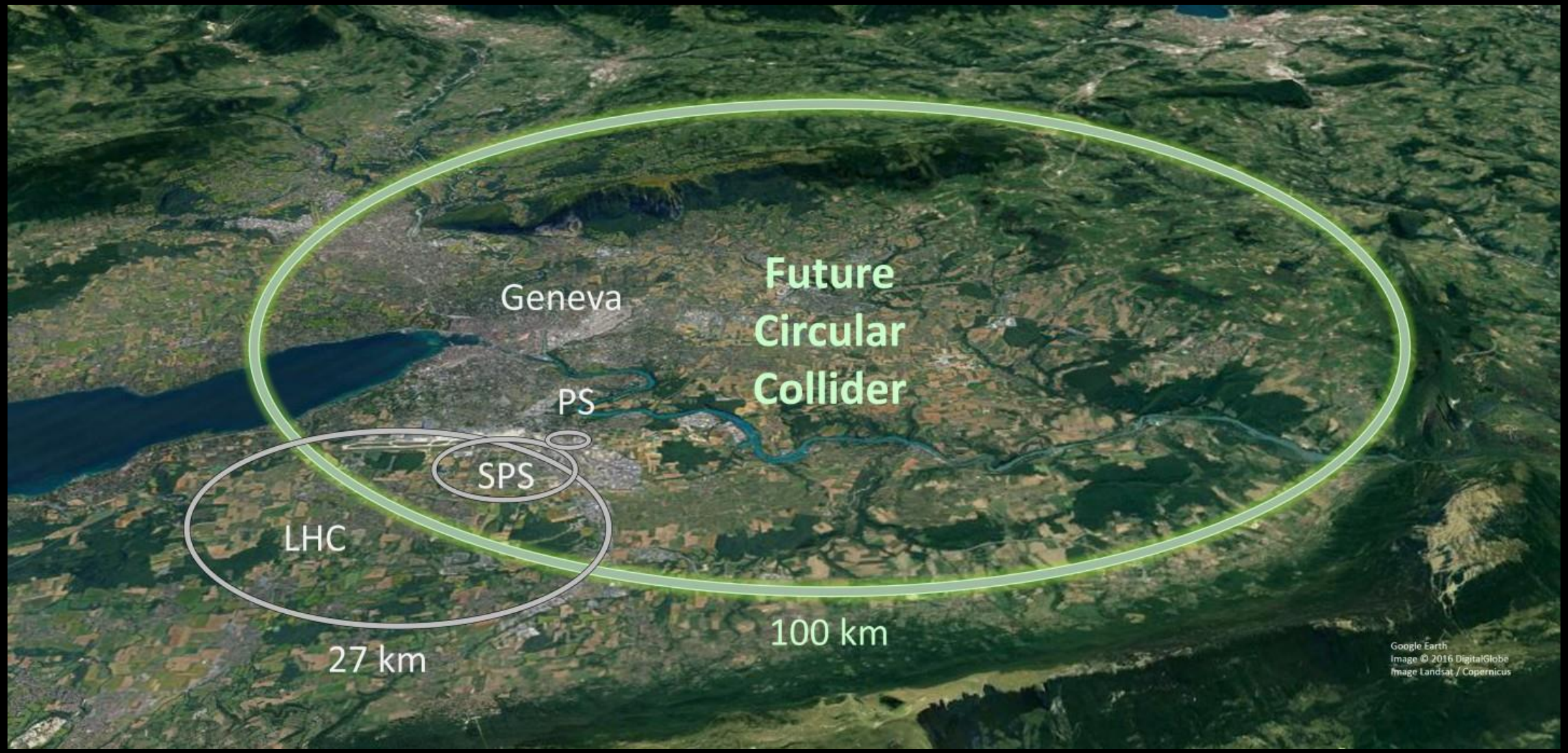
- Improving resolution







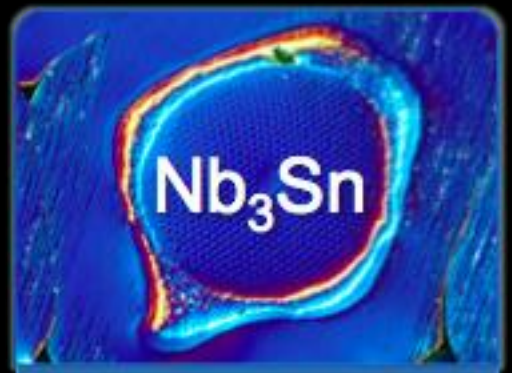
How is it going to look?



Key technologies

16 T

High-field Magnets

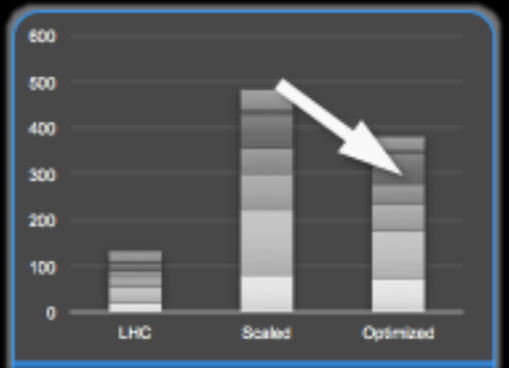


Novel Materials and Processes

Large-scale Cryogenics

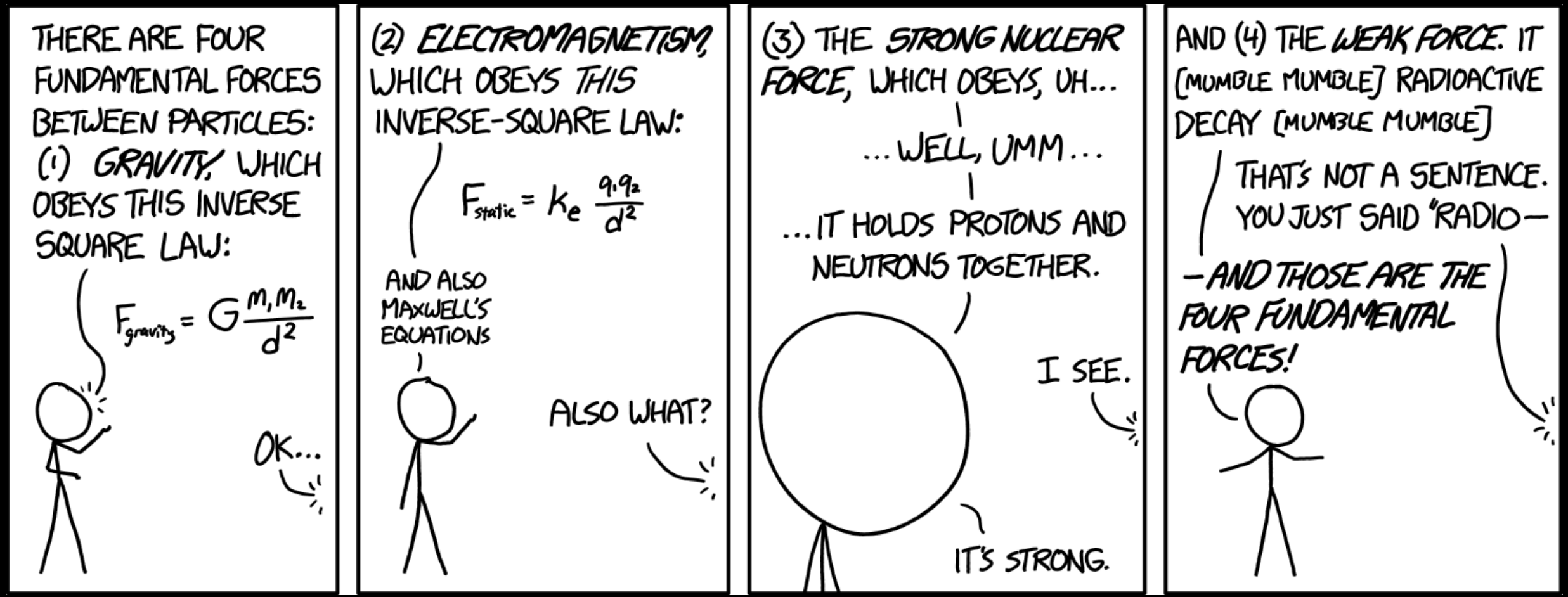
2.0

Global Scale Computing



Power Efficiency

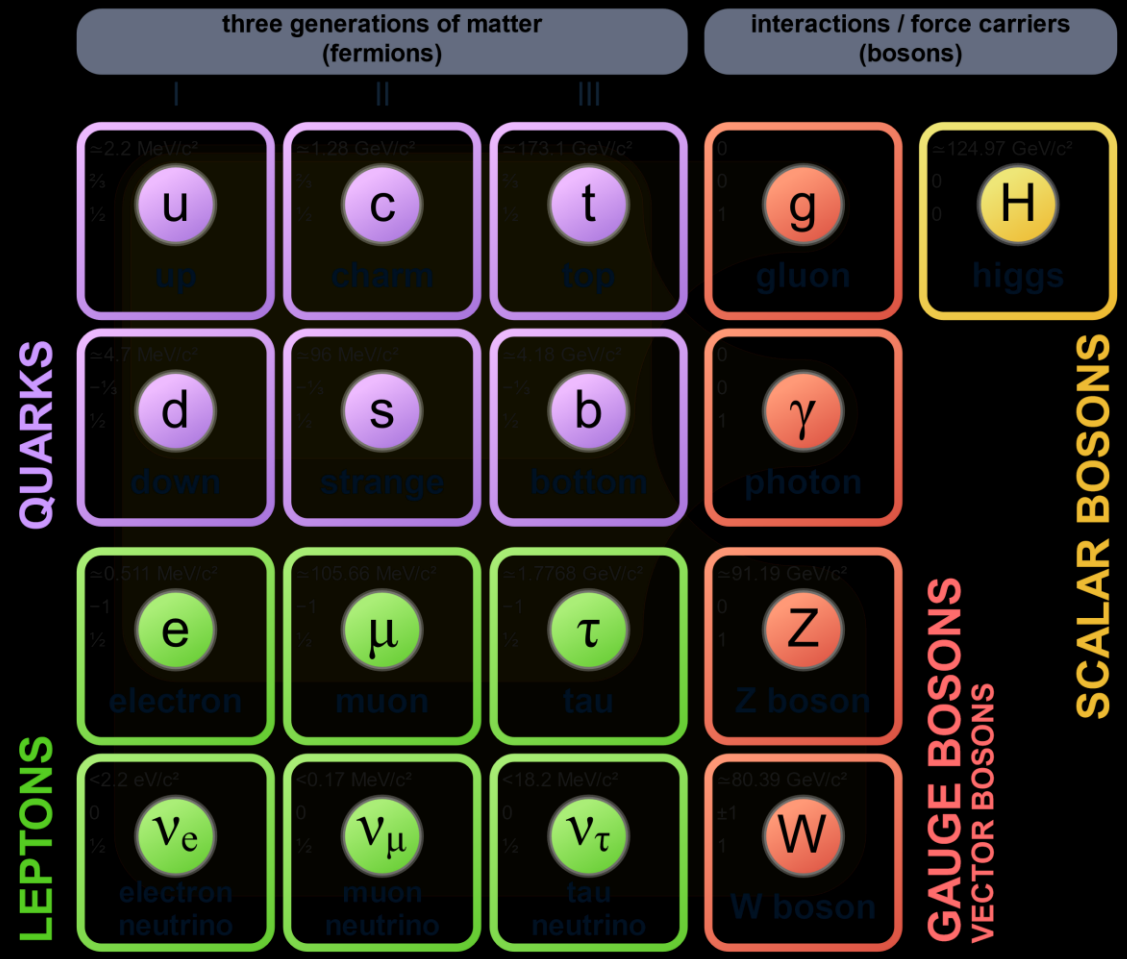
What can be done with future colliders?



"Of these four forces, there's one we don't really understand."

"Is it the weak force or the strong--" "It's gravity."

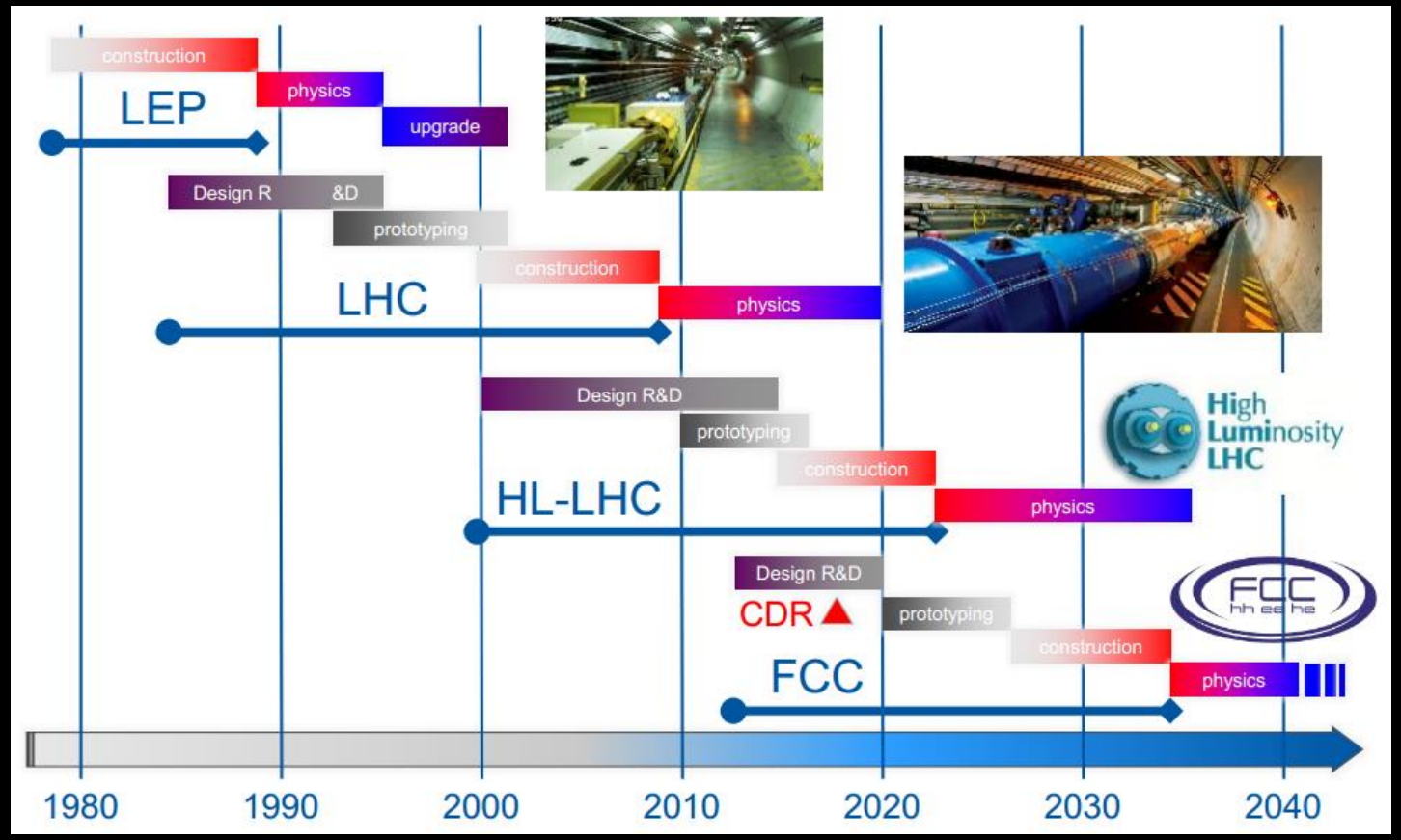
Physics with Future Colliders



- The standard model is considered "complete", but there are still questions to be answered
- Future colliders may produce new particles which help us answer these questions

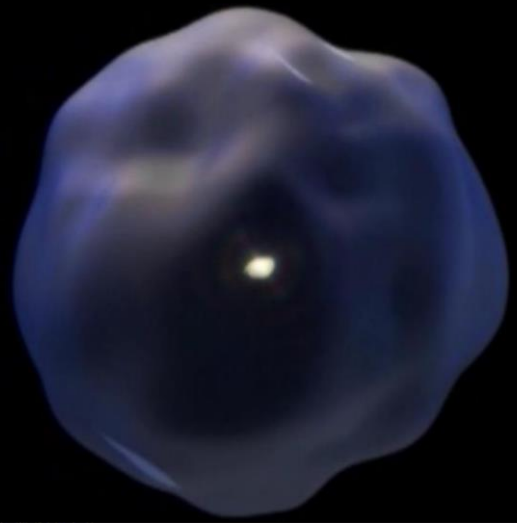
Physics with Future Colliders

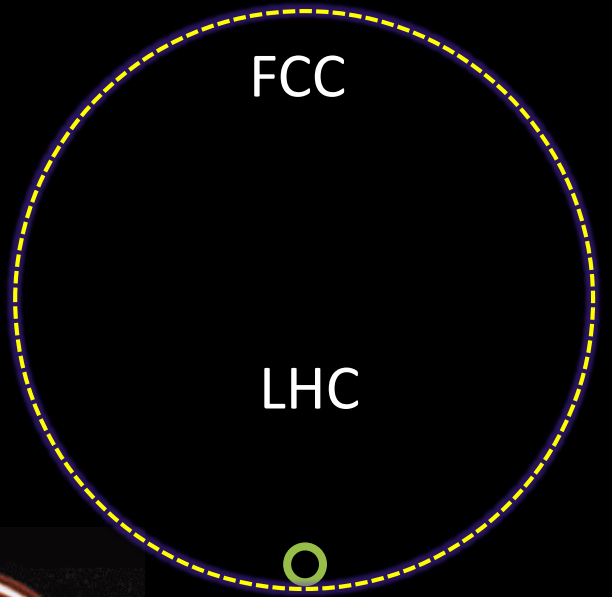
- LHC has a maximum beam energy of 14 TeV
- FCC could have maximum beam energy of 100 TeV
- This may reveal new particles!

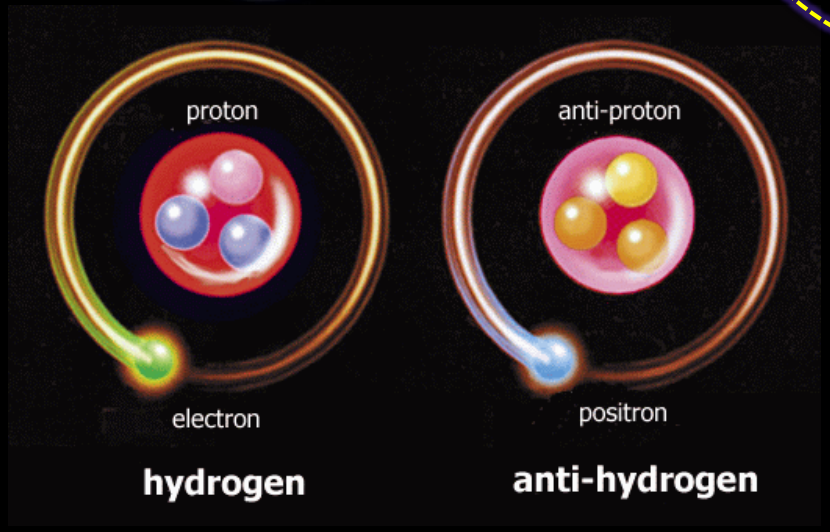


What questions can we answer with future accelerators?

- What is dark matter?
- What is dark energy?
- Where is all the antimatter?







Albert A. Michelson
1852 - 1931

“The more important fundamental laws and facts of physical science have all been discovered...”

- Albert A. Michelson 1894

Should you go into physics today?

Should you go into physics today?

Engineering

Should you go into physics today?

Understanding how things work

Should you go into physics today?

Unraveling the mysteries of the universe

What has been achieved in the last few years:

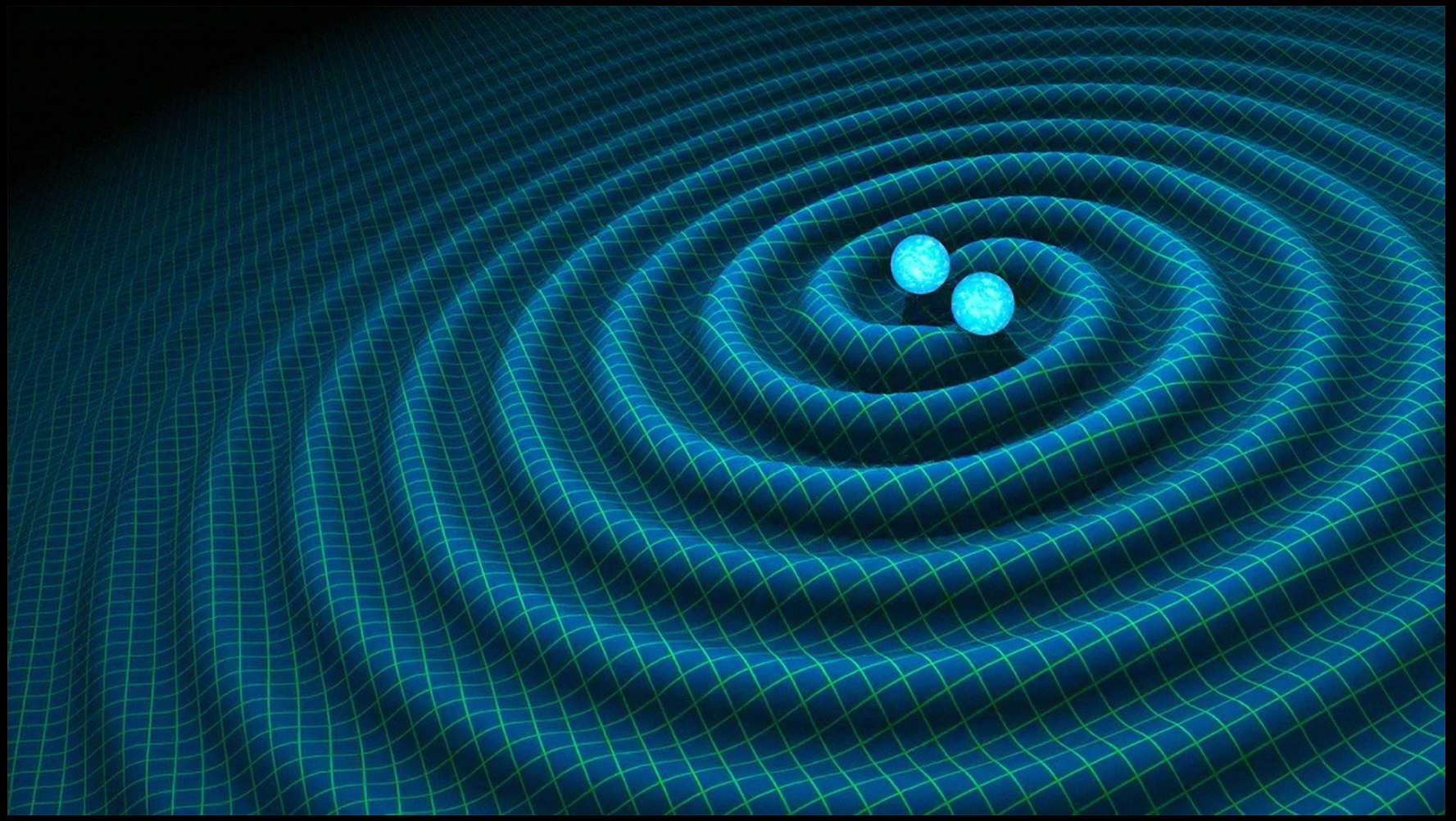
Direct observation of a black hole

Actual image

Artistic rendering

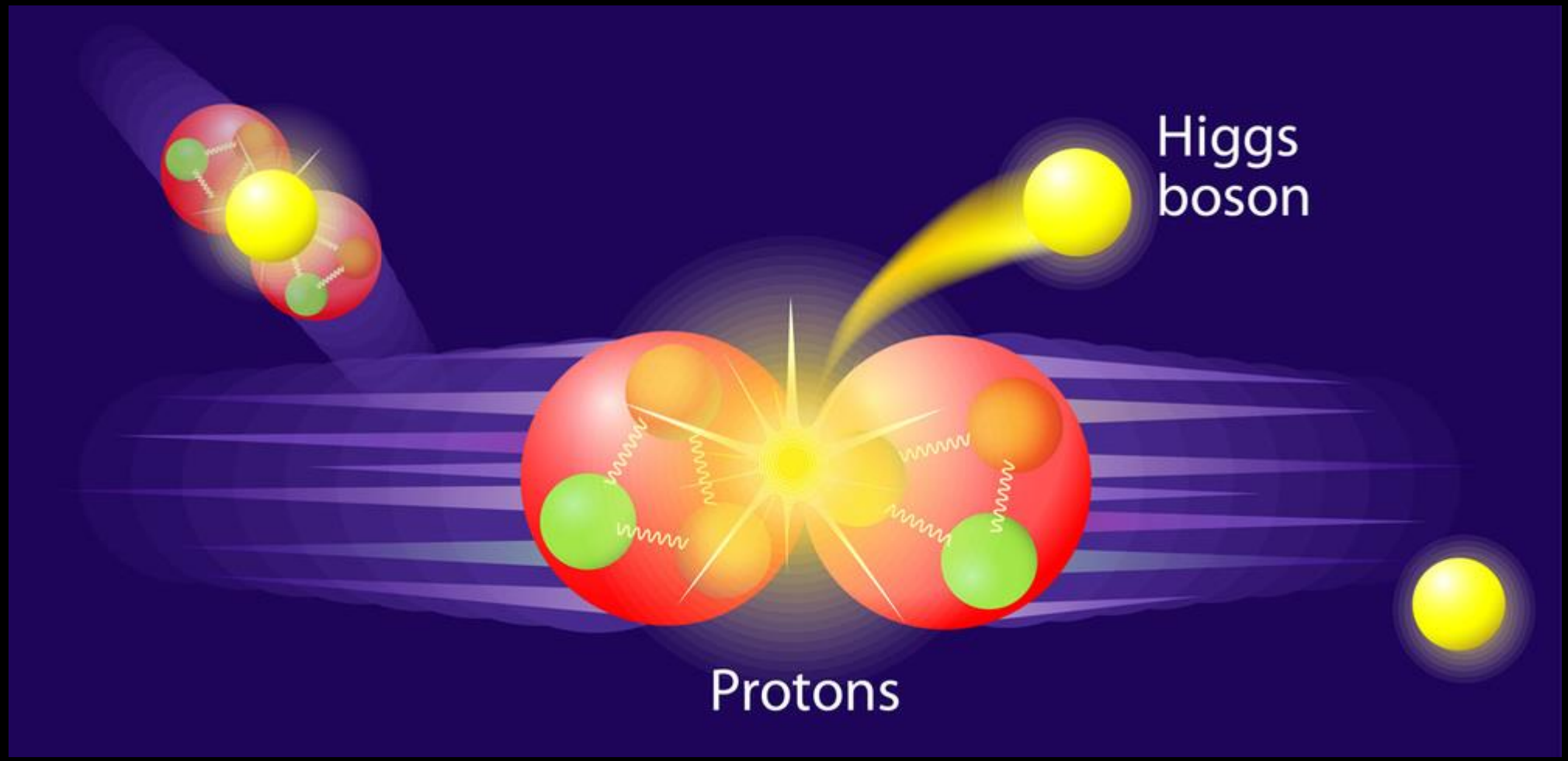
What has been achieved in the last few years:

Measuring gravitational waves



What has been achieved in the last few years:

Discovering the Higgs boson



Albert A. Michelson
1852 - 1931

I am sorry to say, but professor Albert Michelson was wrong.

We are now manufacturing Anti-Matter

At cern Geneva

We are building magnets that were thought impossible before

We are curing cancer

Anti-proton cancer treatment,
This is Not science fiction, this is really happening!

Physics is advancing now more than ever.

Join us and change the world!


thank you
danke
謝謝
ngiyabonga
شكراً جزيلاً
рахмат
teşekkür ederim
Баярлалаа
спасибо
gracias
tapadh leat
dank je
mauruuru
hvala
bedankt
dziękuję
obrigado
sukriya
kop khun krap
go raibh maith agat
sagolun
terima kasih
merci
arigatô
dakujem
mochchakkeram
mersi
barka
welalin
tack
spas
faafetai lava
vinaka
blagodaram
misaotra
matondo
paldies
grazzi
mahalo
kiitos
dankie
nanni
nandri
dhanyavad
köszönöm
bayarlalaa
gràcie
enkosi
akun
dankon
aciù
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gratias ago
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obrigada
asante
manana
tenki
murakoze
chokrane
хвала
sobodi
dèkuji
mèsi
didi madloba
kam sah hamnida
rahmat
তোমাকে ধন্যবাদ
감사합니다
xièxie
ευχαριστώ
najis tuke
ありがとう
tanemirt
rahmet
grazie
diolch
dhanyavadagalu
shukriya
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