

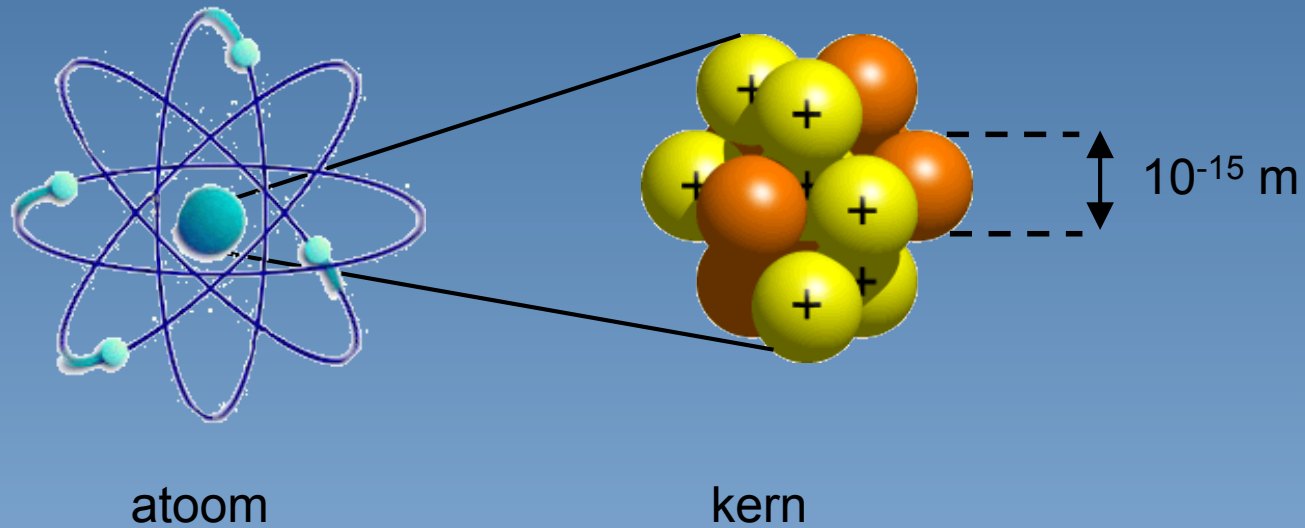


DE ONTDEKKING VAN HET HIGGS BOSON

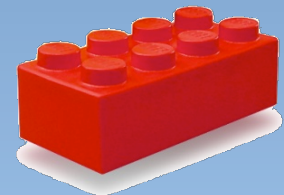
KIJK Live, 2 oktober 2013, Amsterdam

Ivo van Vulpen (UvA / Nikhef)

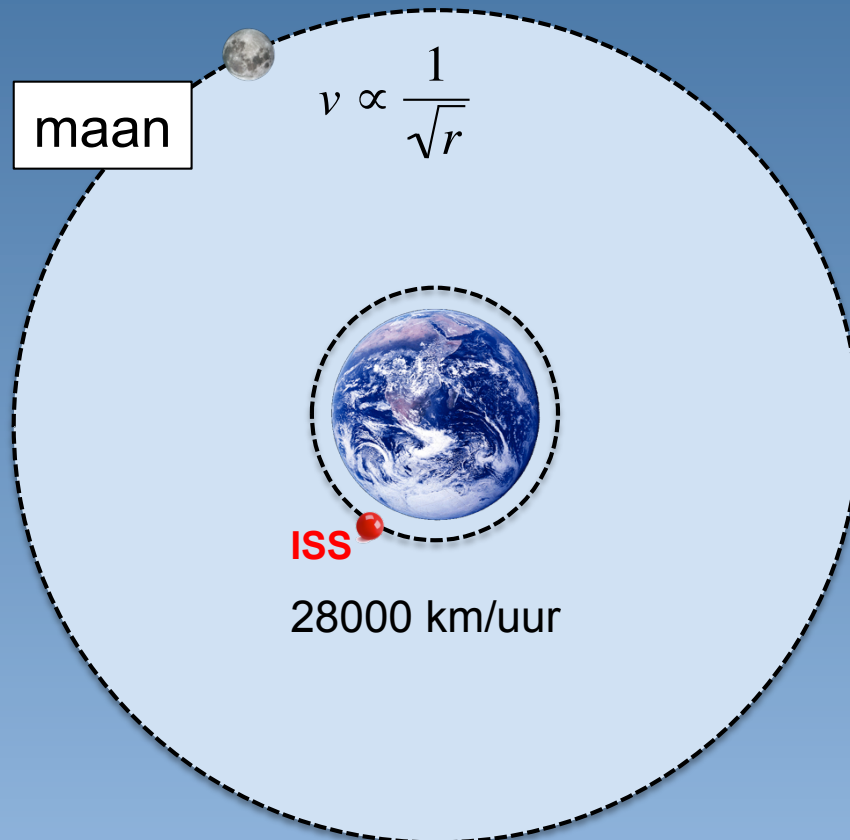
Deeltjesfysica



Wat zijn de bouwstenen van de dingen om ons heen ?

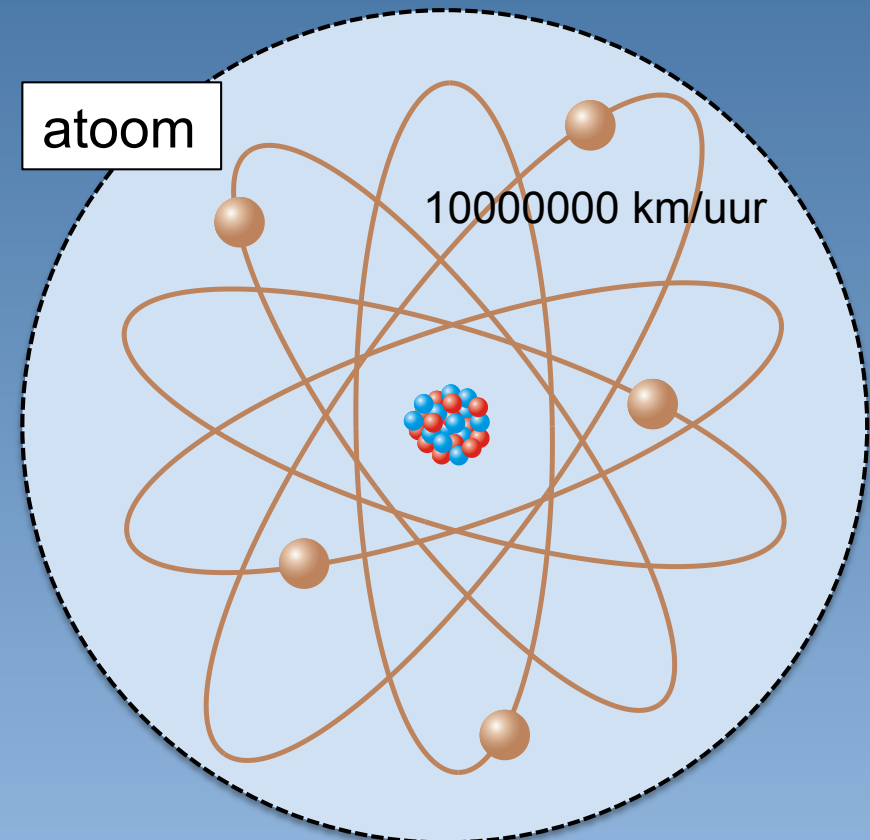


Klassieke mechanica



400.000.000 [m]

Quantummechanica



0.0000000001 [m]

De atoomwereld

1) De elektronen vallen niet op de kern

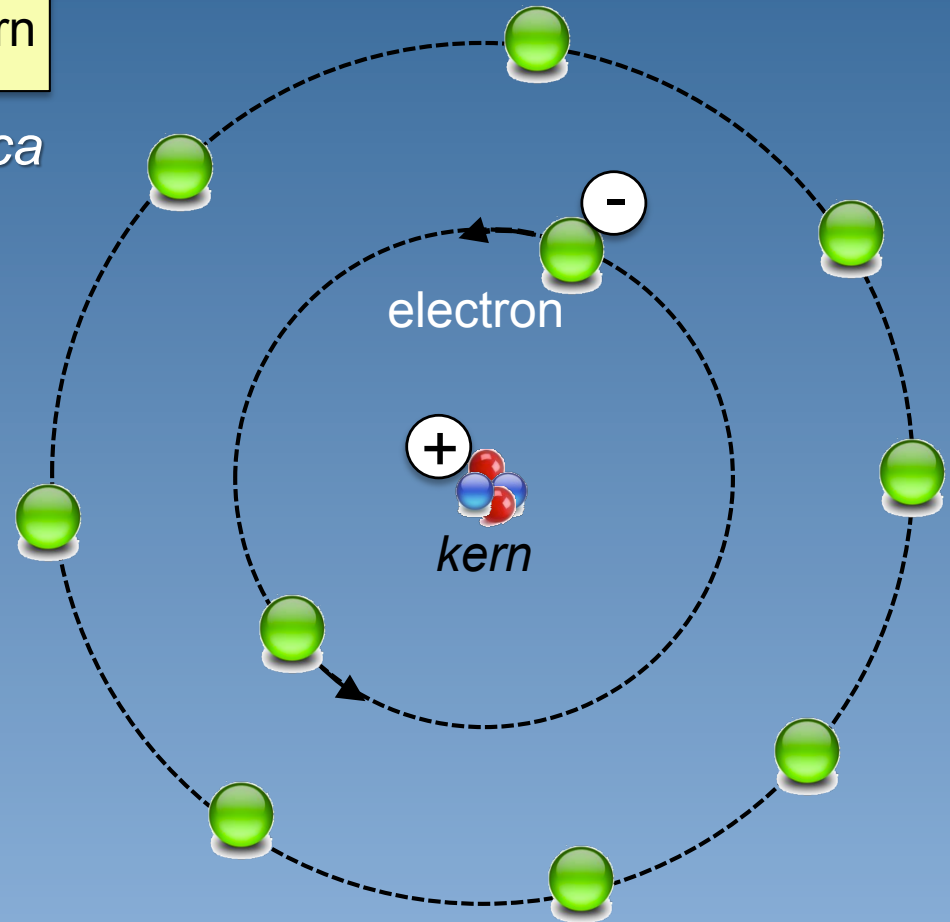
Natuurwet: *quantummechanica*

2) De kerndeeltjes kleven aan elkaar

Natuurkracht: *de kernkrachten*

3) Maar 2 electronen in de 1^e baan

Fenomenen: *spin en Pauli's uitsluitingsprincipe*



De stand van zaken op 2 oktober 2013



De elementaire deeltjes



up

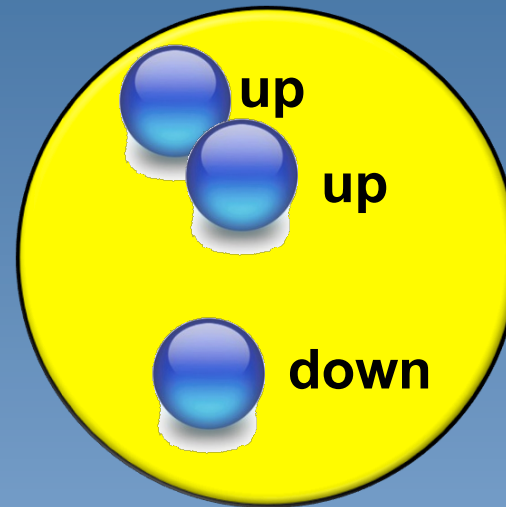


down

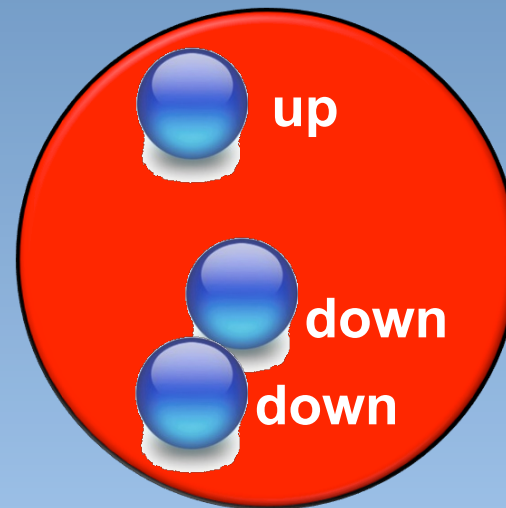


elektron

+ 4 natuurkrachten



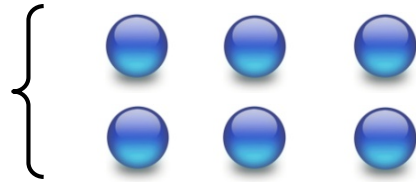
Proton



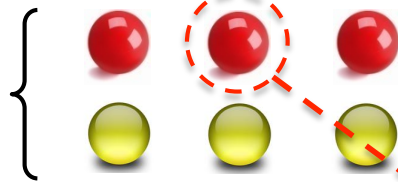
Neutron

Deeltjes

Quarks



Leptonen

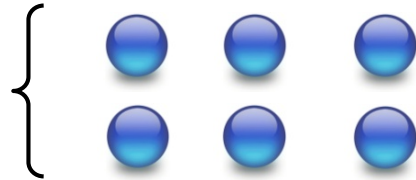


Krachten

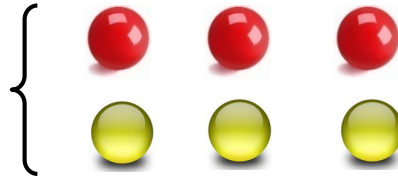
- 1) Electromagnetisme
- 2) Zwakke kernkracht
- 3) Sterke kernkracht
- 4) Zwaartekracht

Anti-deeltjes

Anti-
Quarks



Anti-
Leptonen



muon

deeltjes



Het Standaard Mod



Theorie

Realiteit

Het Standaard Model

$$SU(2)_L \otimes U(1)_Y \otimes SU(3)_C$$

+ Higgs boson

≠



Deeltjes hebben *geen*

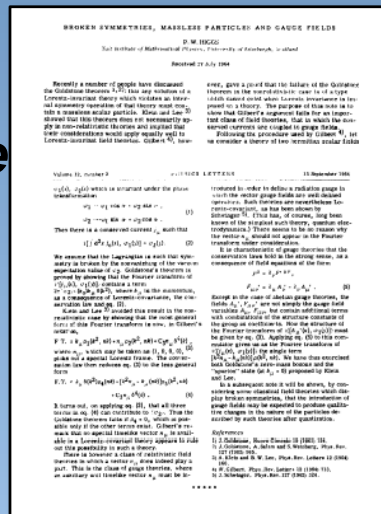


Het Higgs mechanisme

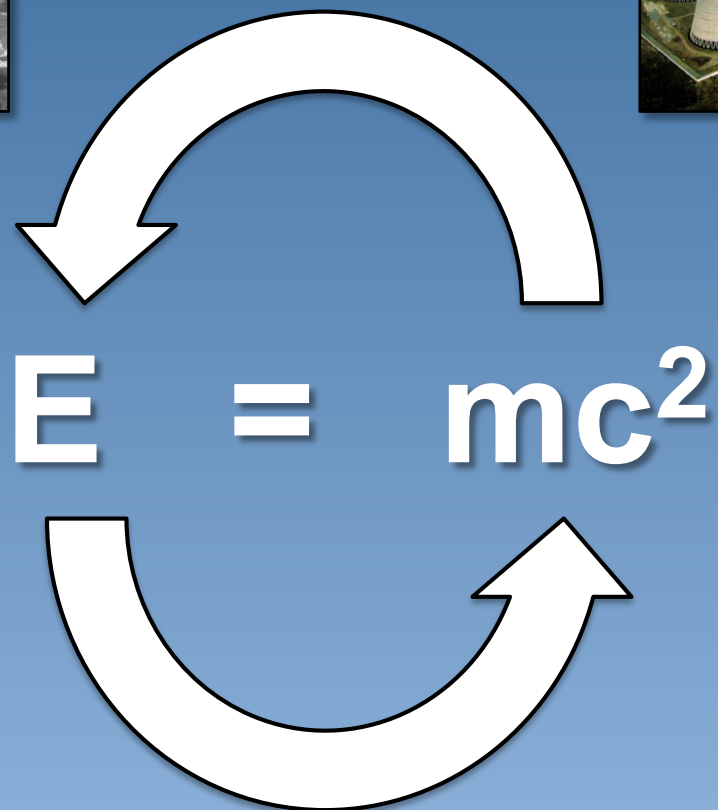
Deeltjes hebben *wel* massa

Higgs veld in het vacuum

“Als ik gelijk heb moet er ook een nieuw deeltje bestaan: **het Higgs boson**”



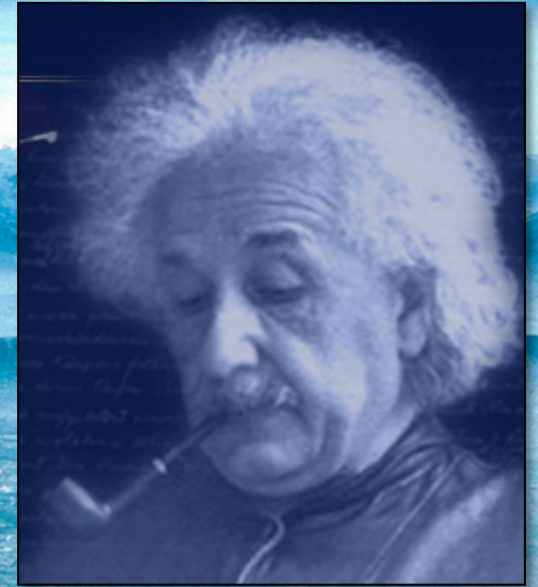
- September 1964 -

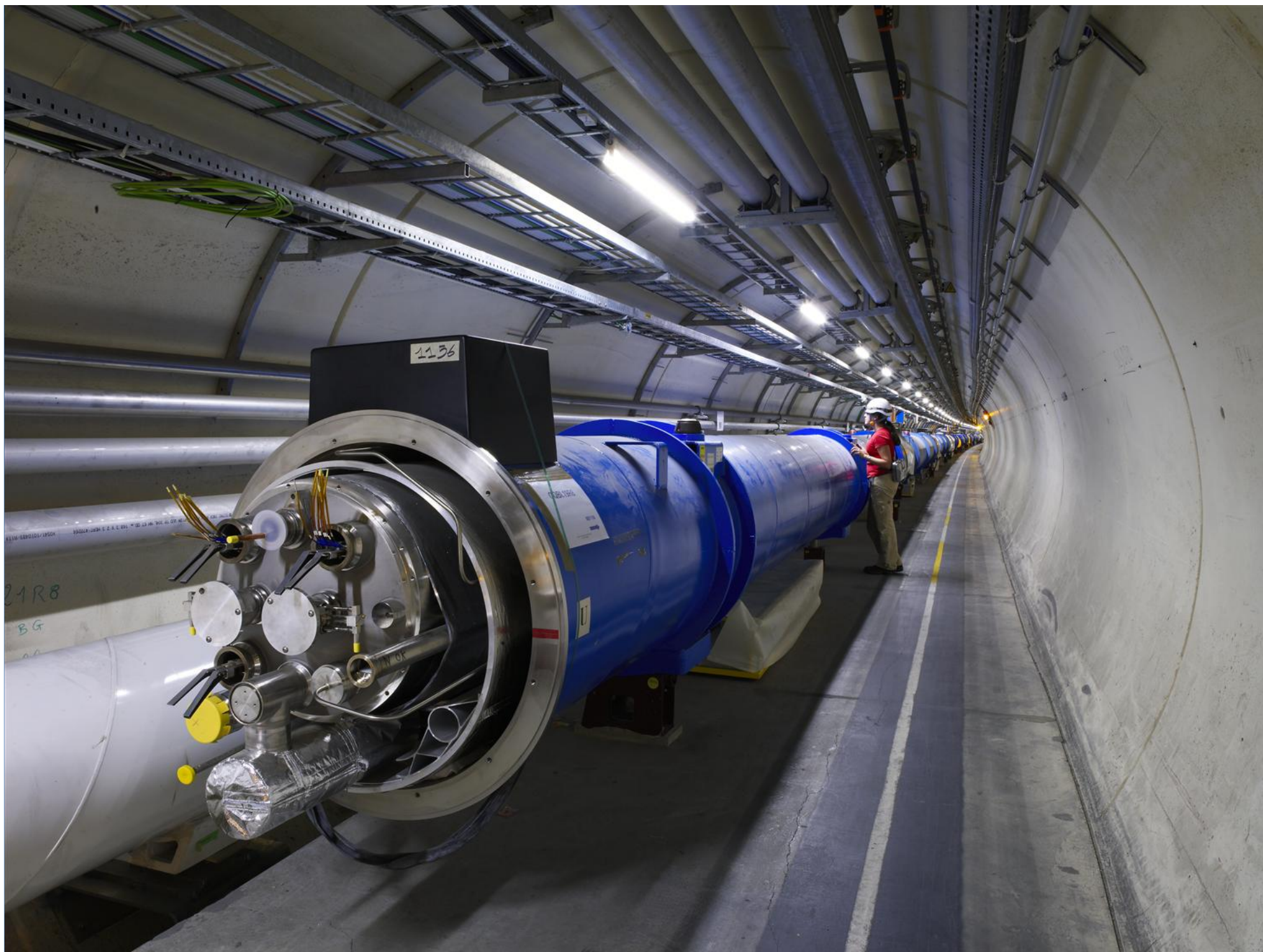


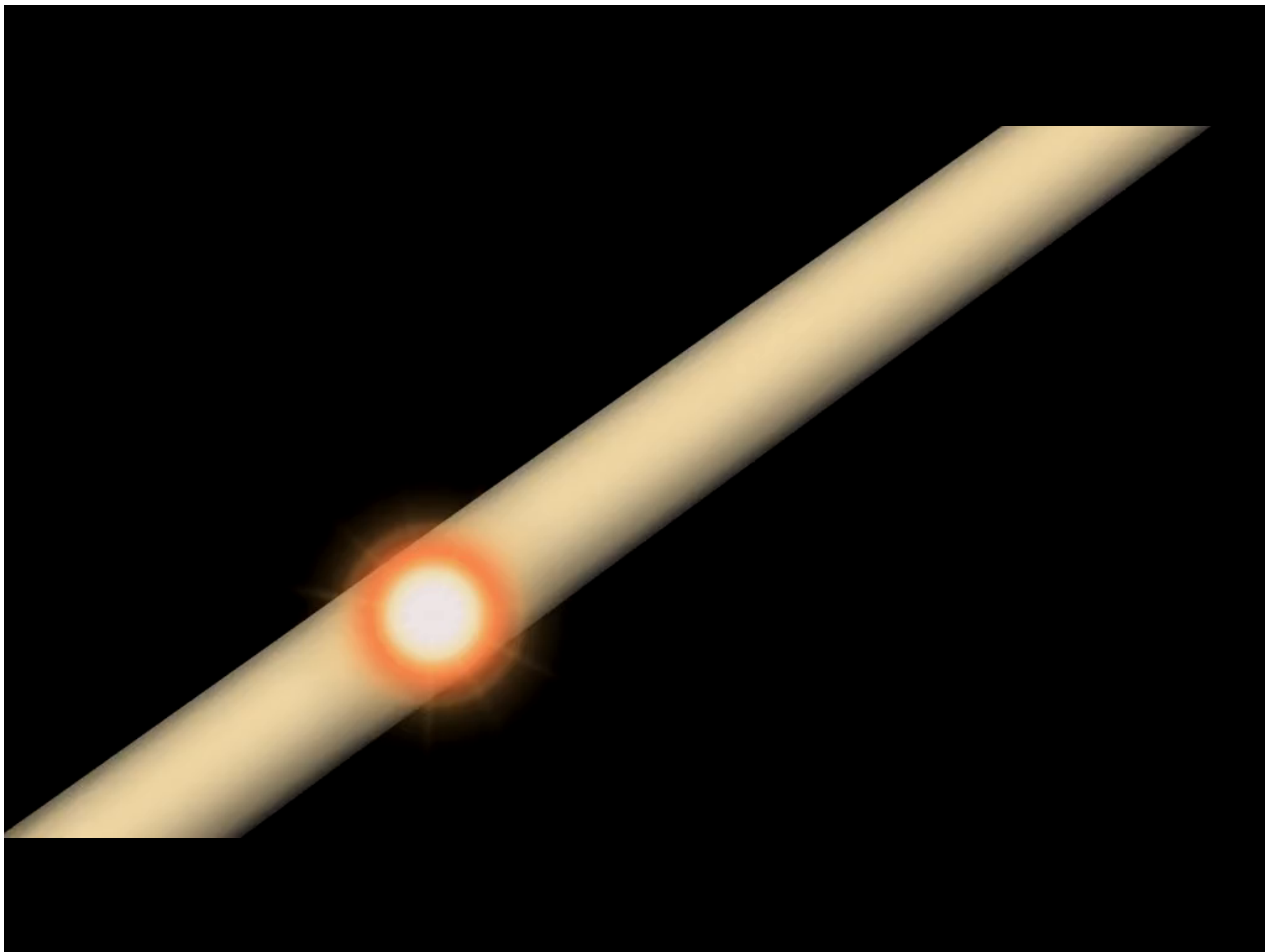
An aerial photograph of the Geneva region in Switzerland. The foreground shows a patchwork of green and brown agricultural fields. In the middle ground, the city of Geneva is visible, surrounded by a lake. In the background, there are rolling hills and a range of snow-capped mountains under a clear blue sky. A red oval is drawn over the landscape, representing the path of the Large Hadron Collider (LHC).

Nieuwe deeltjes maken

De Large Hadron Collider (LHC)
op CERN bij Genève



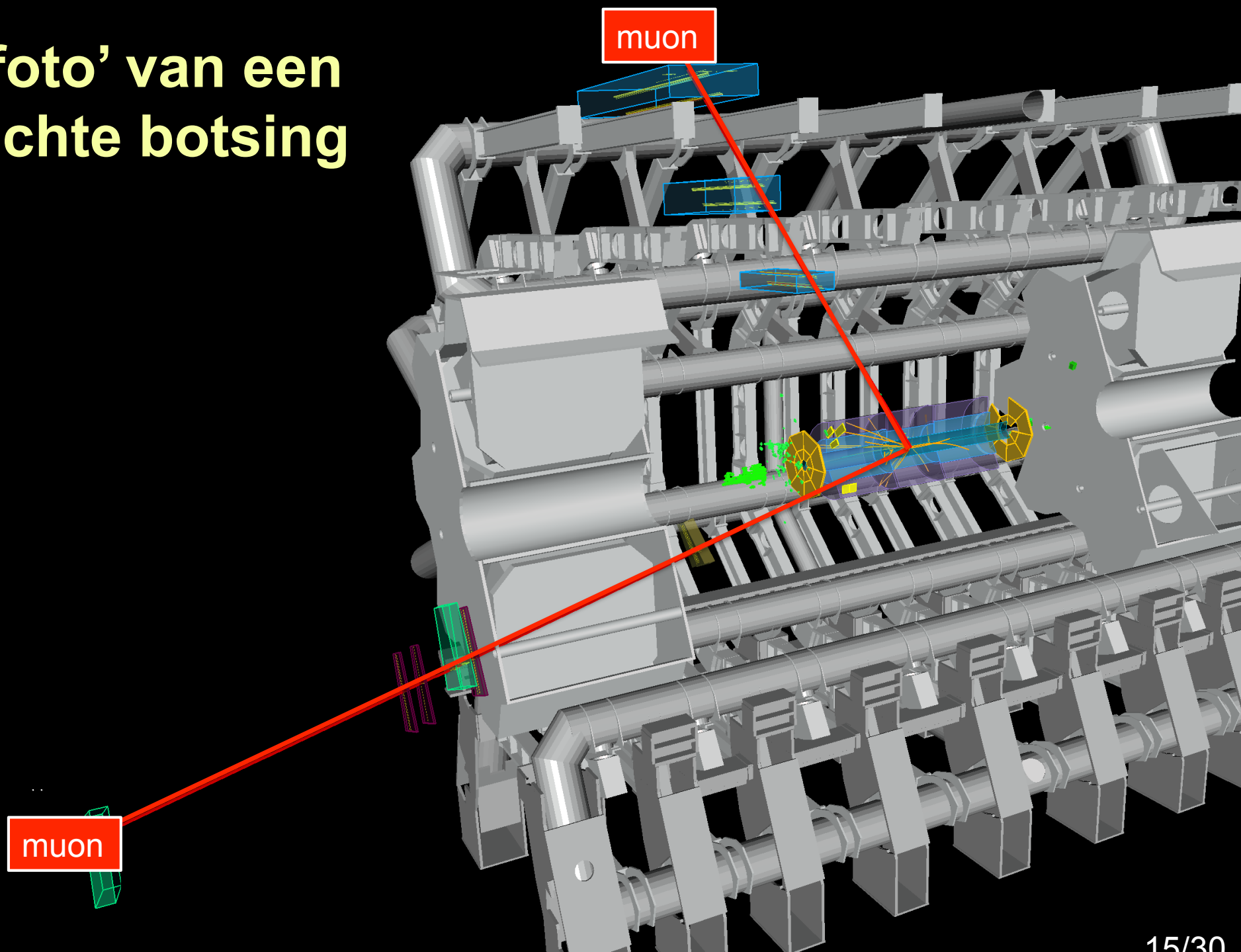




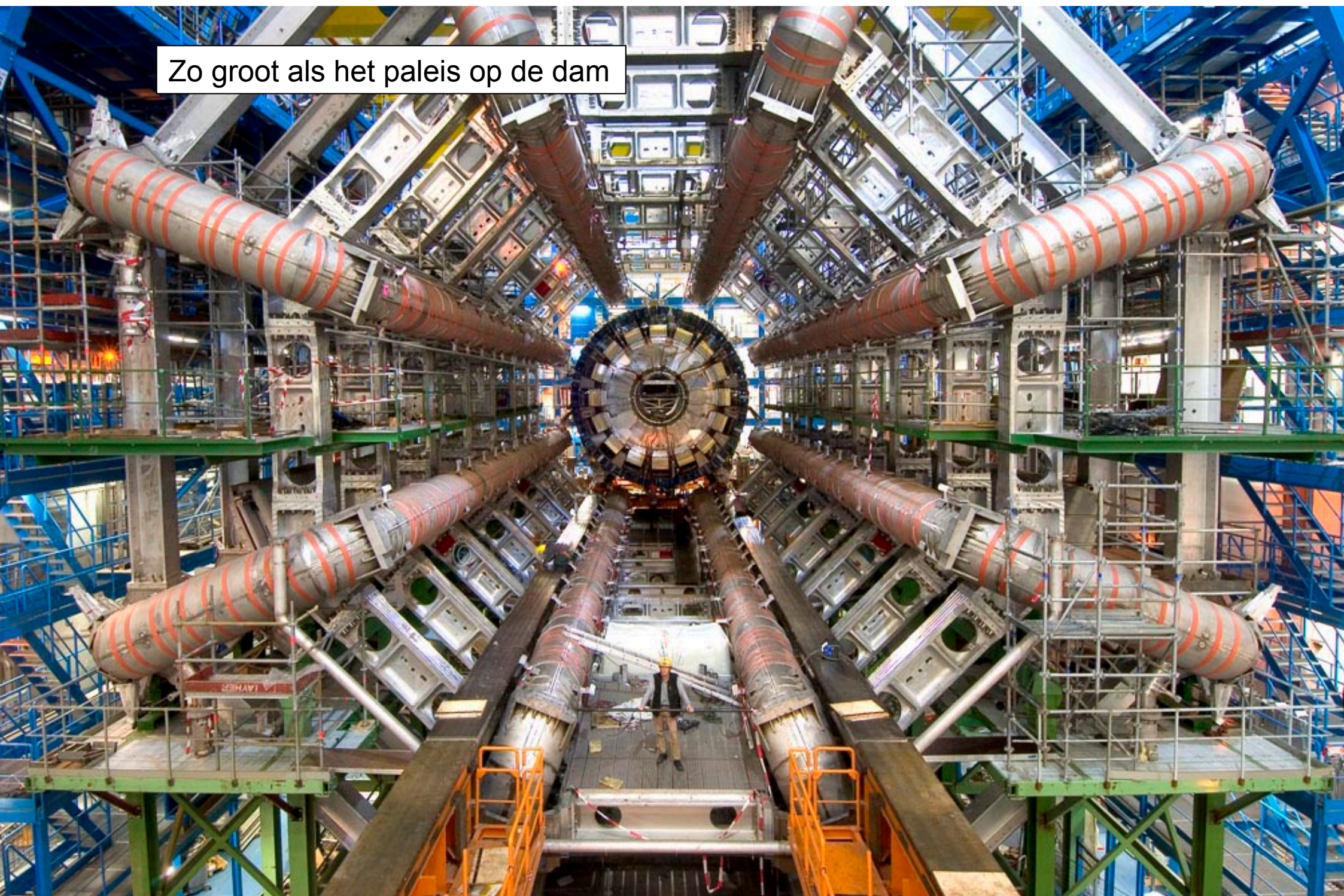
Onze 'fototoestellen'



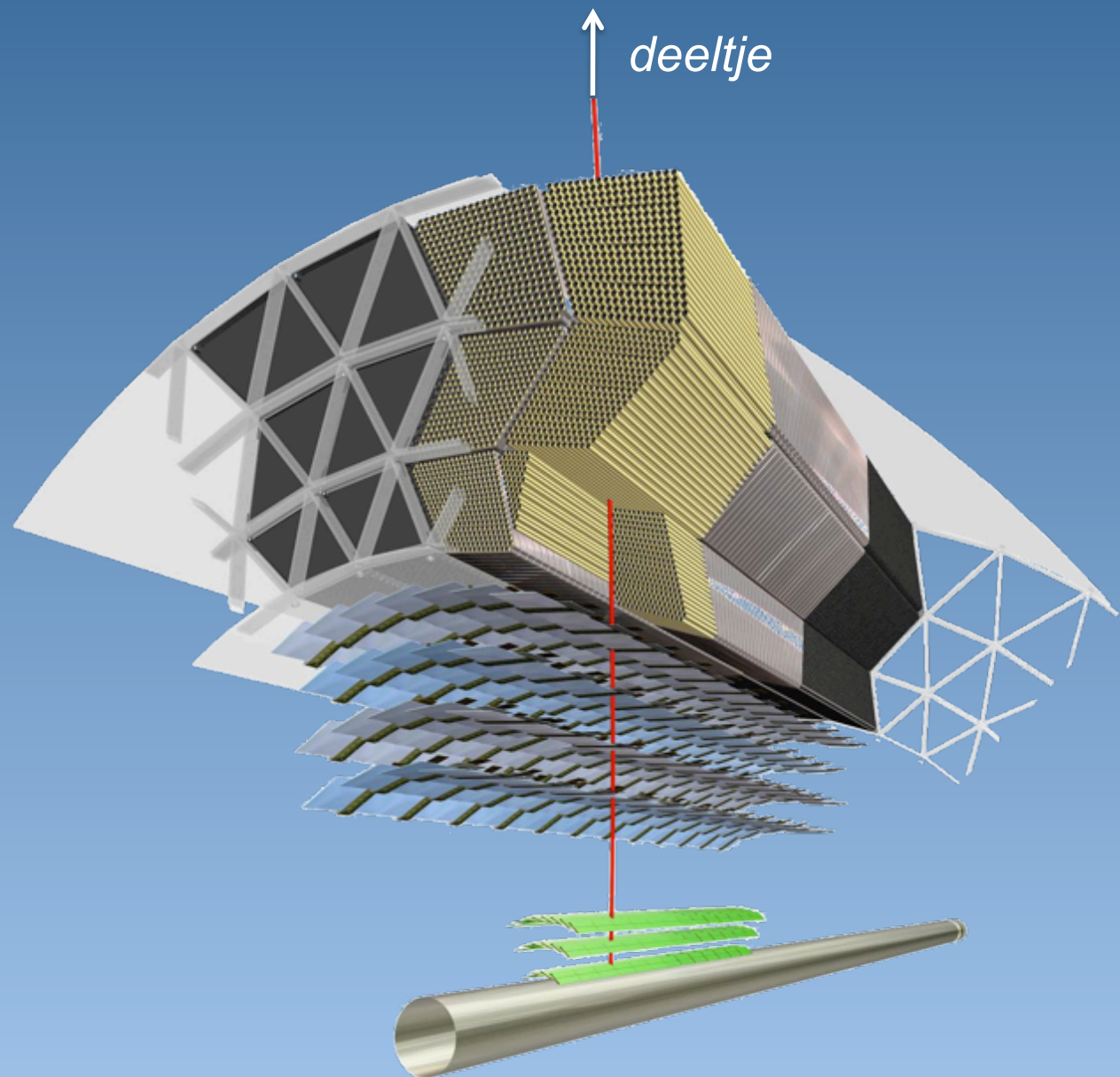
‘foto’ van een echte botsing



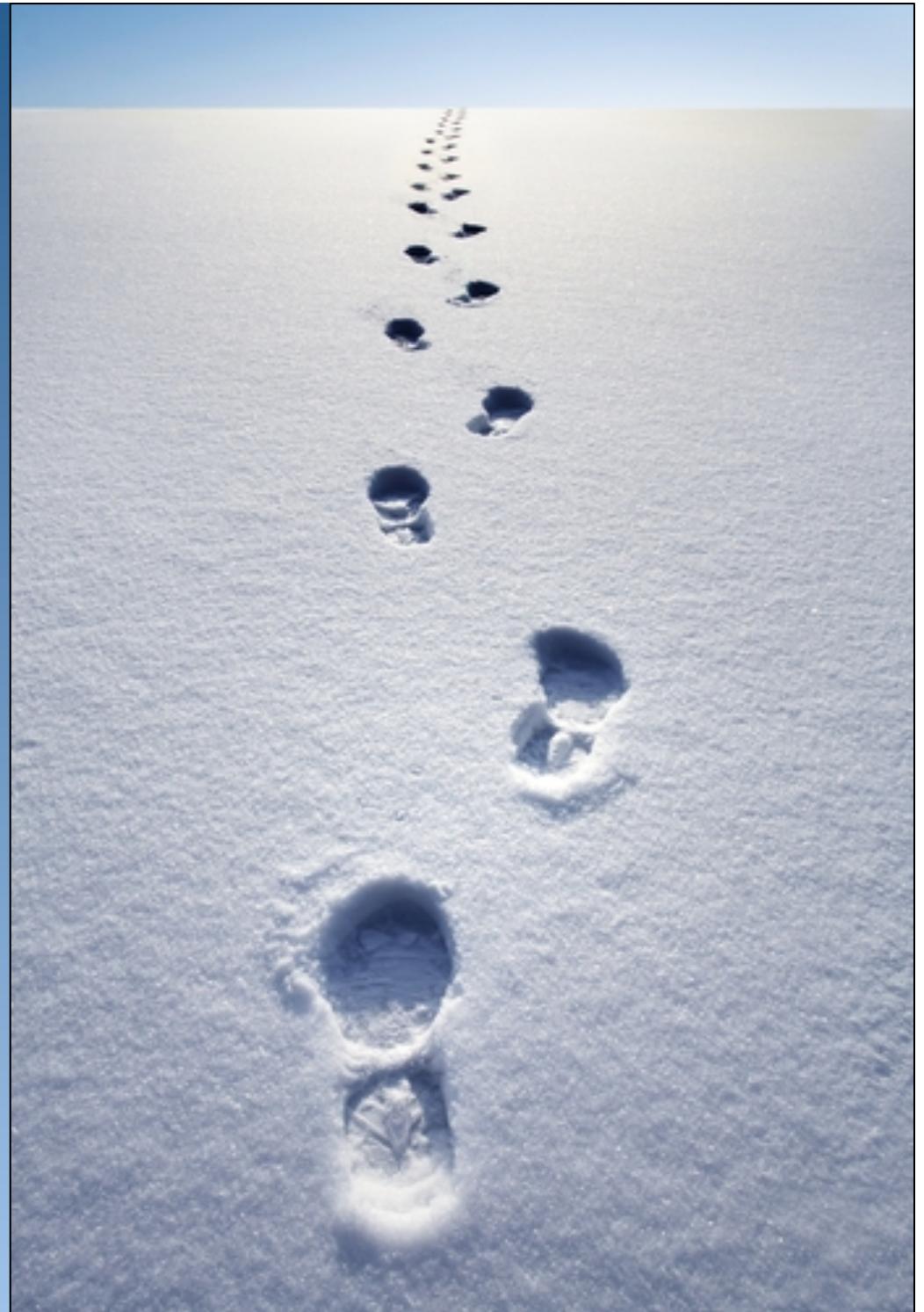
Zo groot als het paleis op de dam



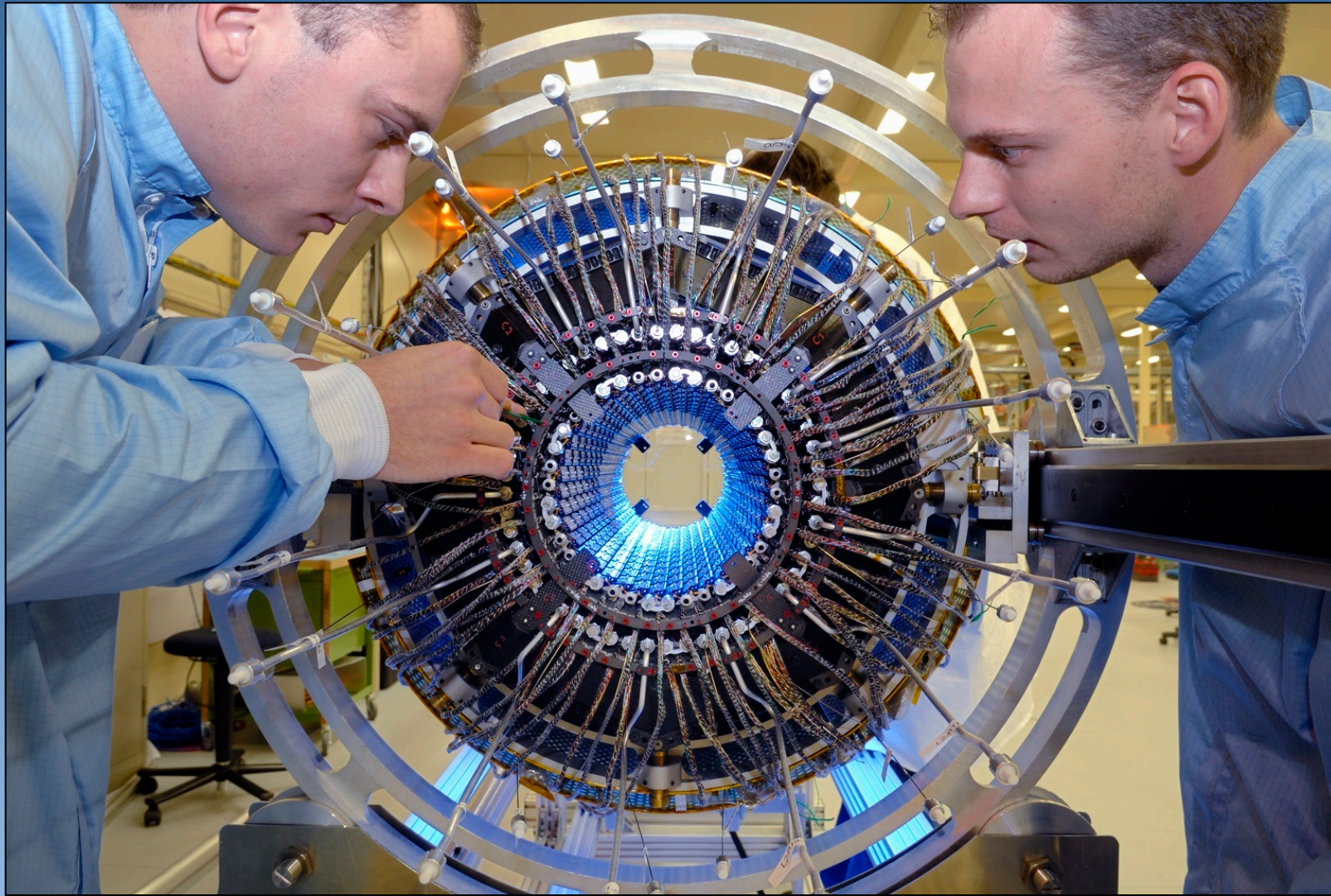
Waarom is die ATLAS detector nou zo complex ?



Konijn, auto of mens ?



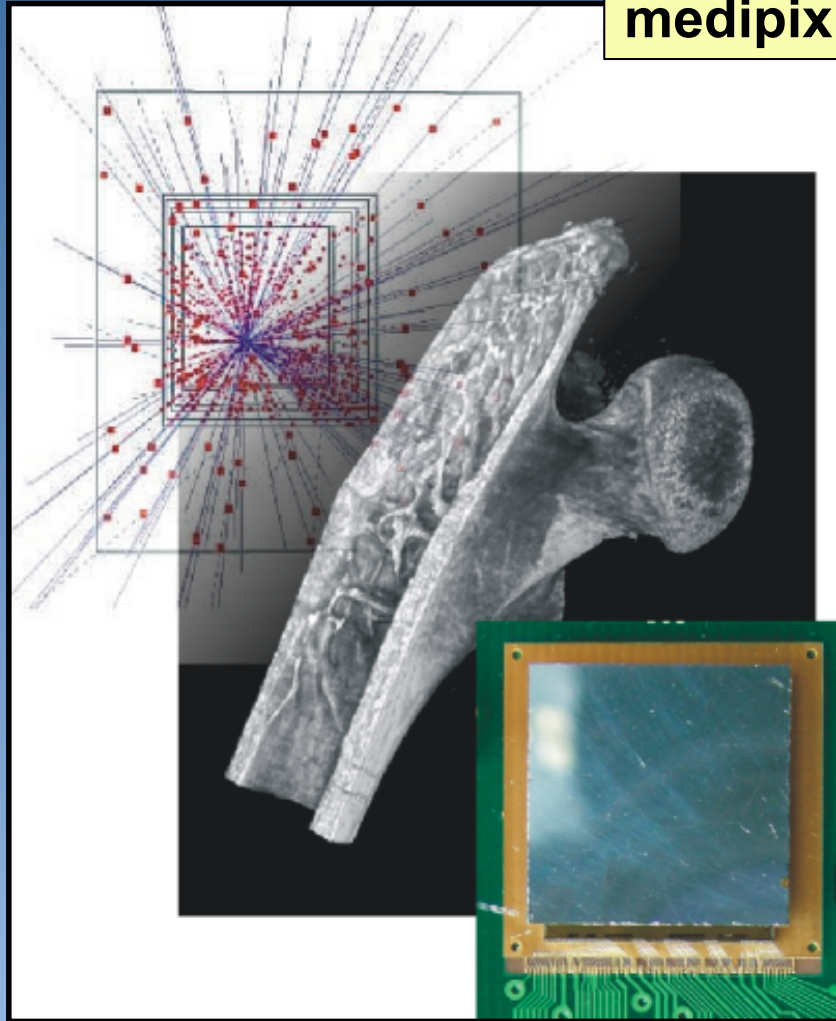
De Atlas pixel detector



80 MegaPixel camera 40.000.000 foto's per seconde

Medische toepassingen

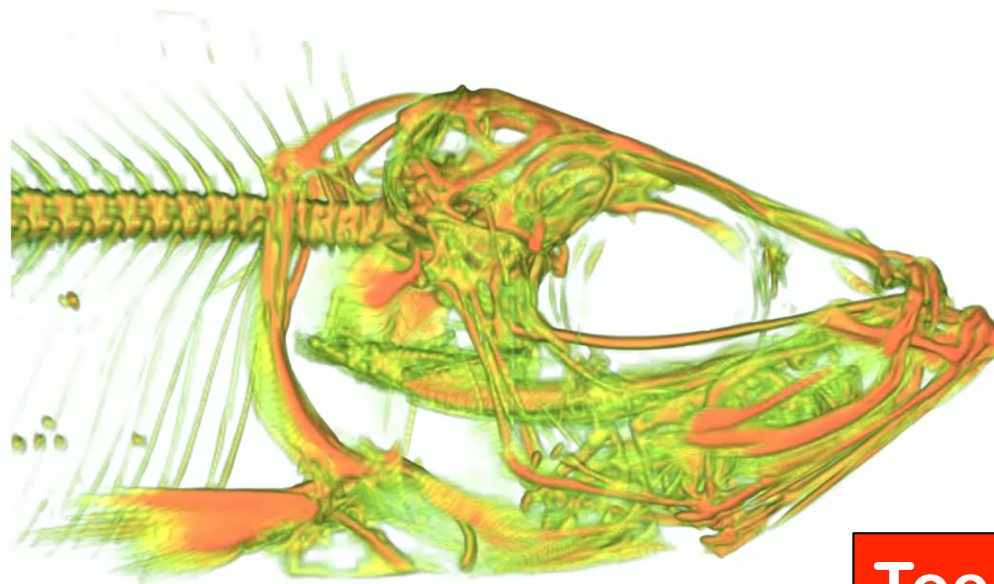
medipix



Normale CT scan ~ 200 Röntgen foto's

Kleinere pixel grootte: 1 mm $\rightarrow$ 50 μ m

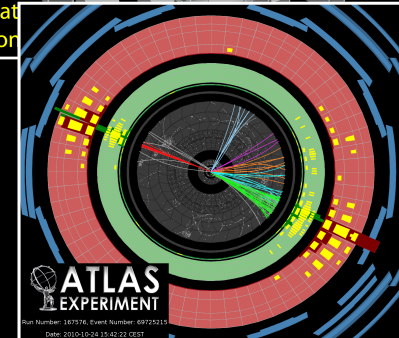
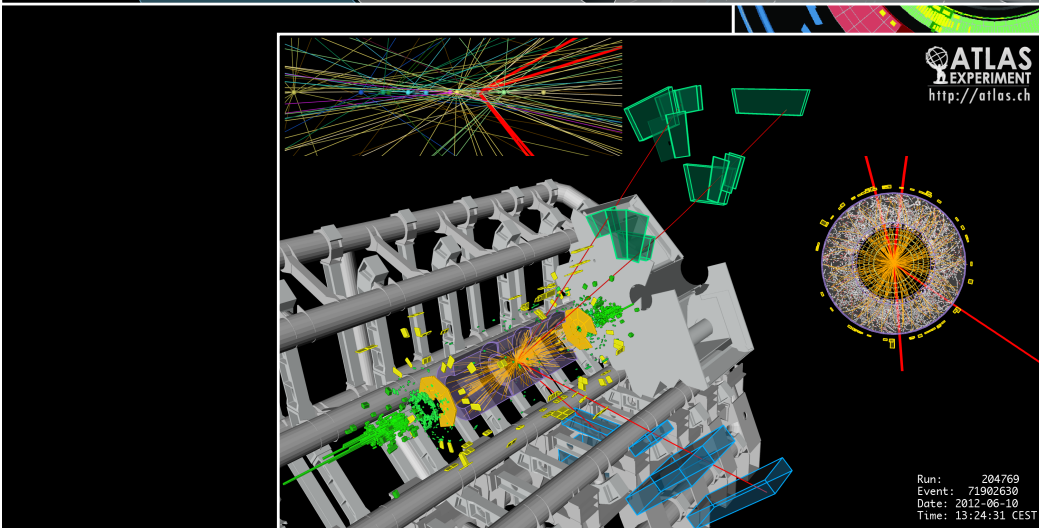
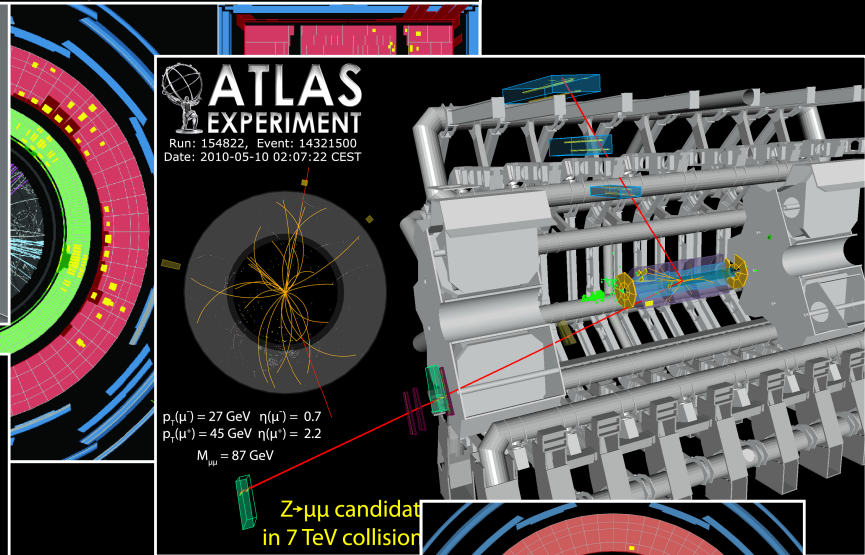
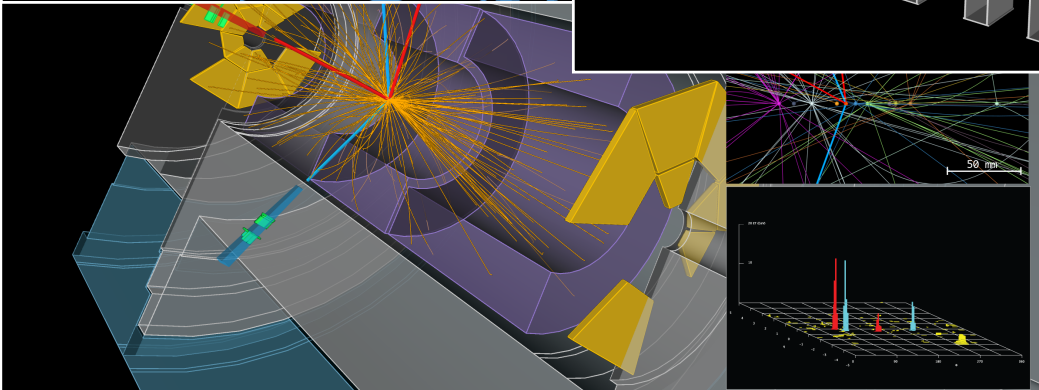
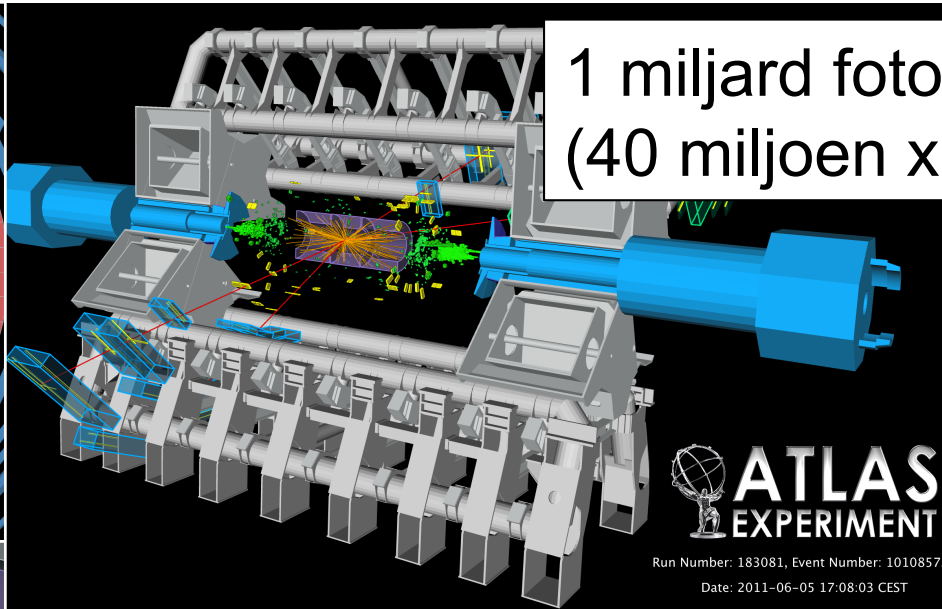
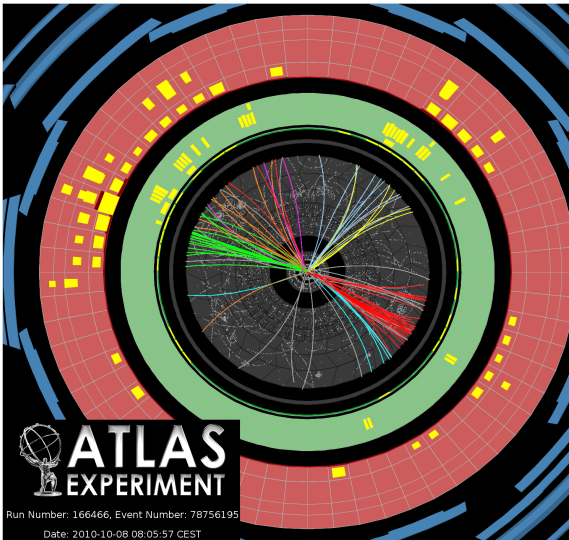
CT scan of a (spiering) of 2.4 cm length using MedPix



**Toekomst:
kleuren-Xrays**

Toepassing: minder X-rays voor zelfde resolutie

1 miljard foto's per seconde
(40 miljoen x 20 botsingen)



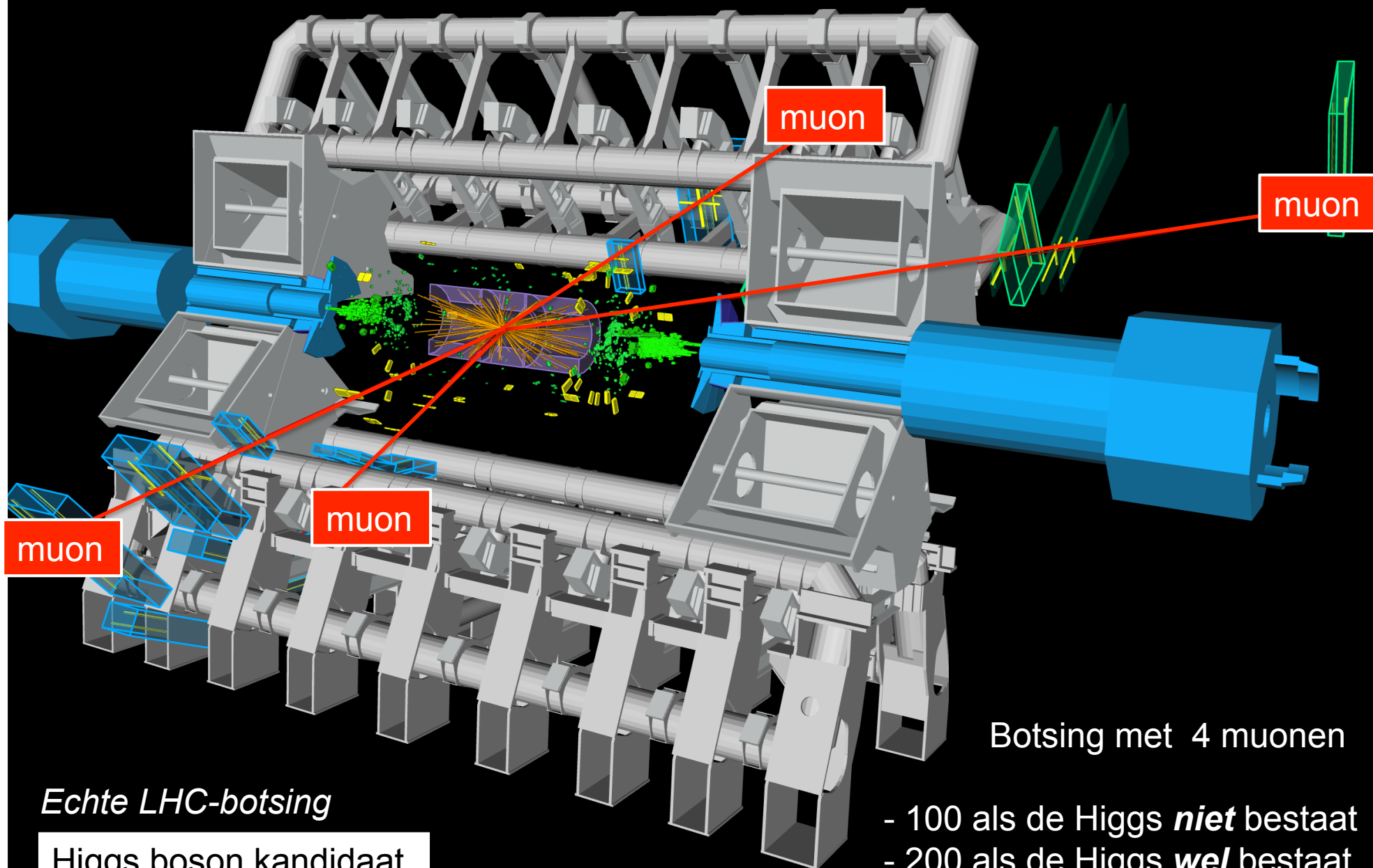
Computing

Lastig: 1 miljard foto's per seconde
... en je mag er maar 200 bewaren (diskruimte)

Big data: 15 Peta Bytes en 100,00 CPU's

... het echte werk!





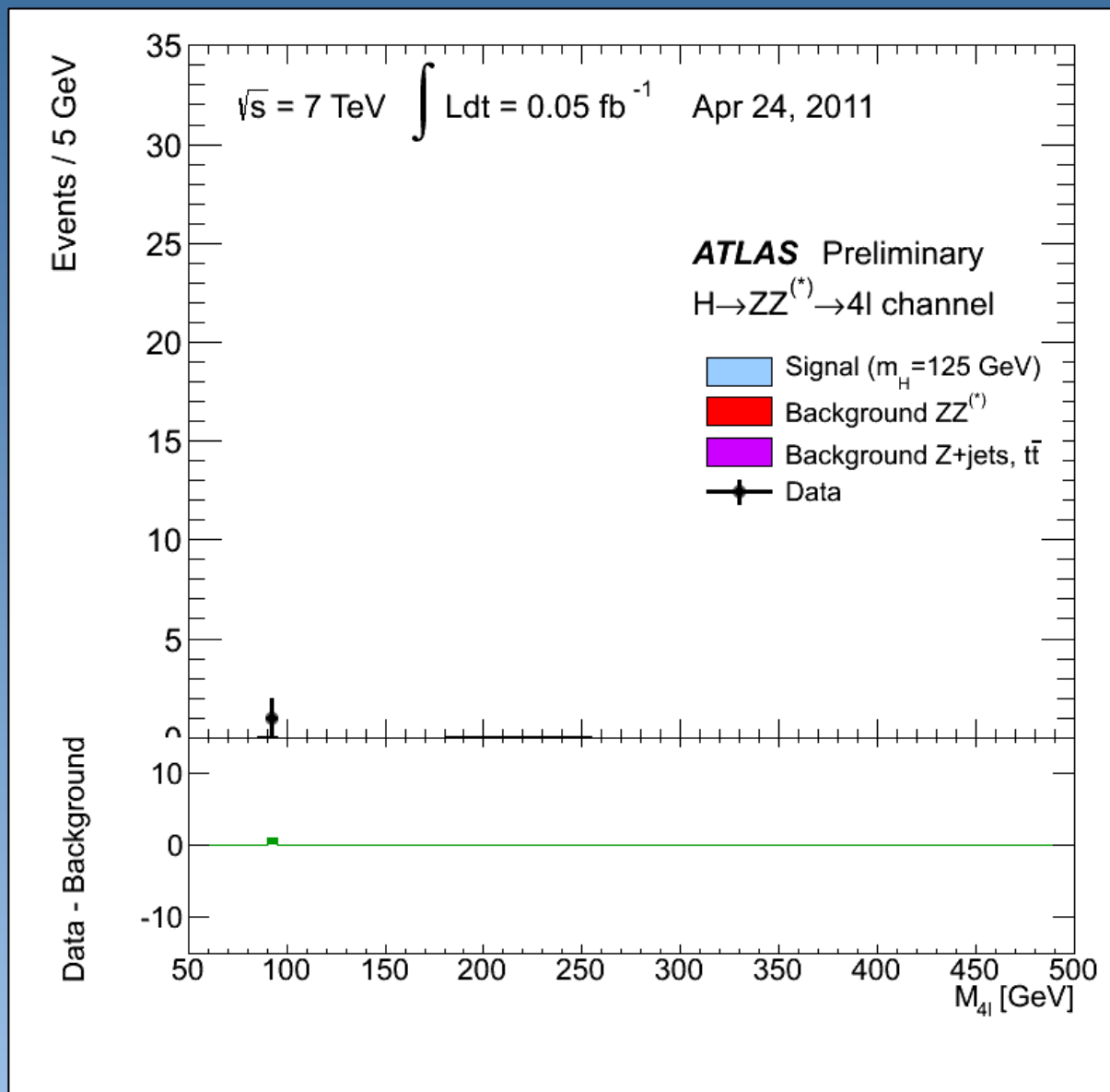
Echte LHC-botsing

Higgs boson kandidaat

Botsing met 4 muonen

- 100 als de Higgs *niet* bestaat
- 200 als de Higgs *wel* bestaat

Kijk hier ($m_h = 125$ GeV)



4 juli 2012: feest !!



Dinsdag 8 oktober 11:45 uur

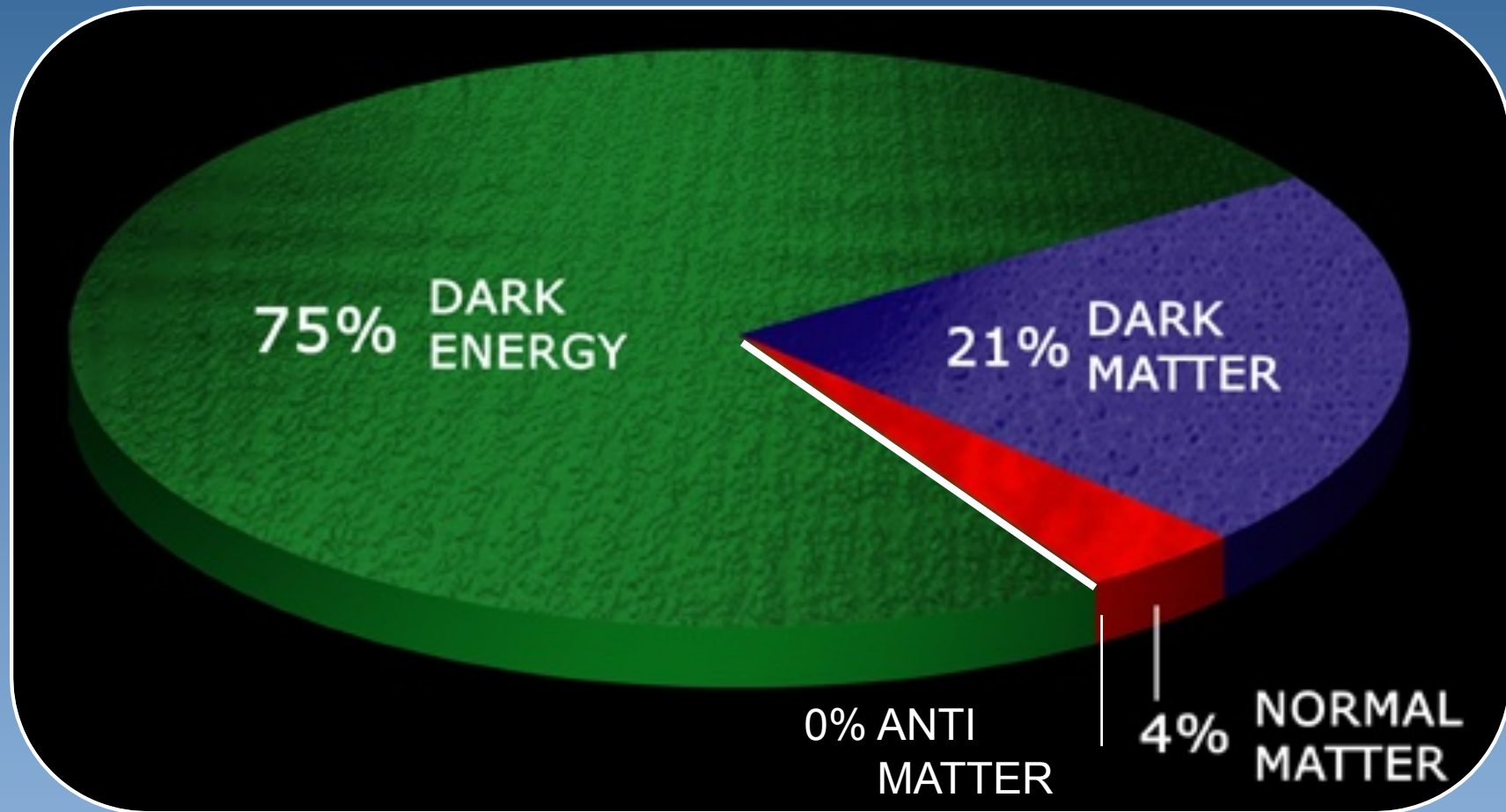
bekendmaking Nobelprijs natuurkunde



Wat snappen we nog niet:



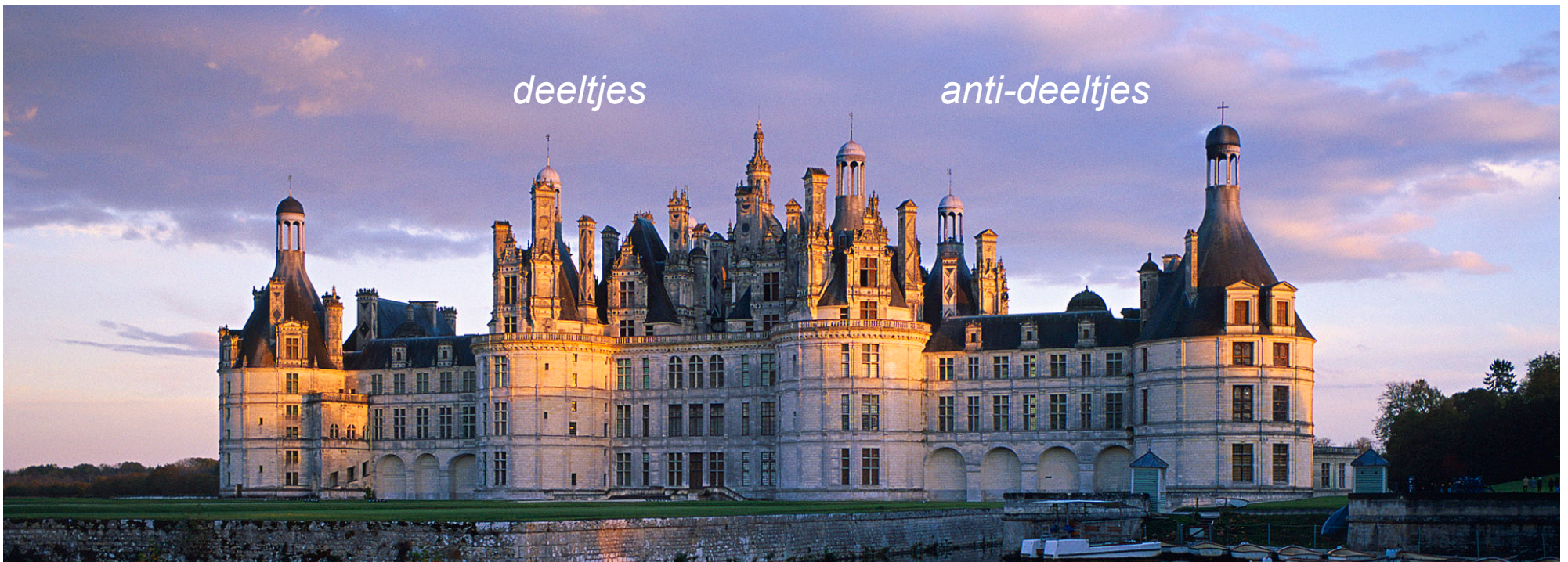




Wat is de donkere materie ?

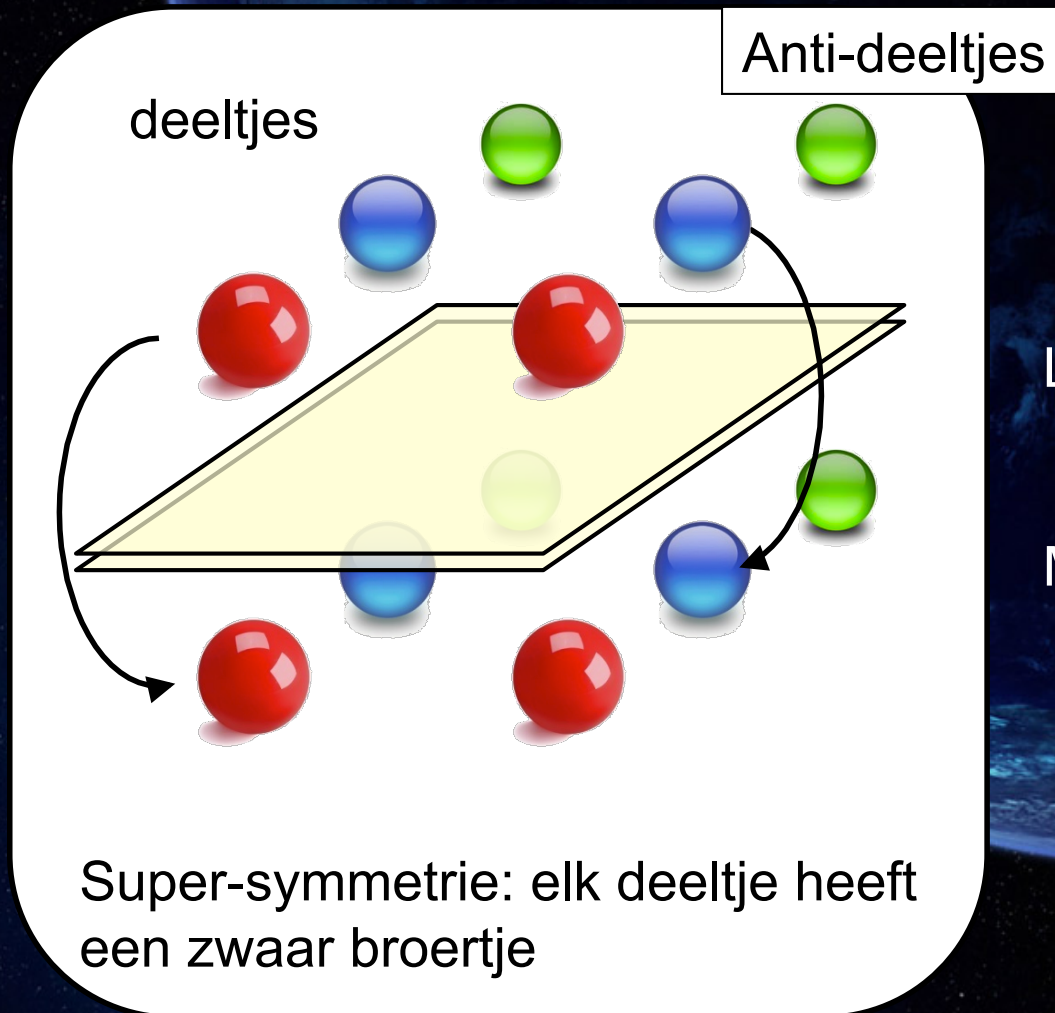
deeltjes

anti-deeltjes



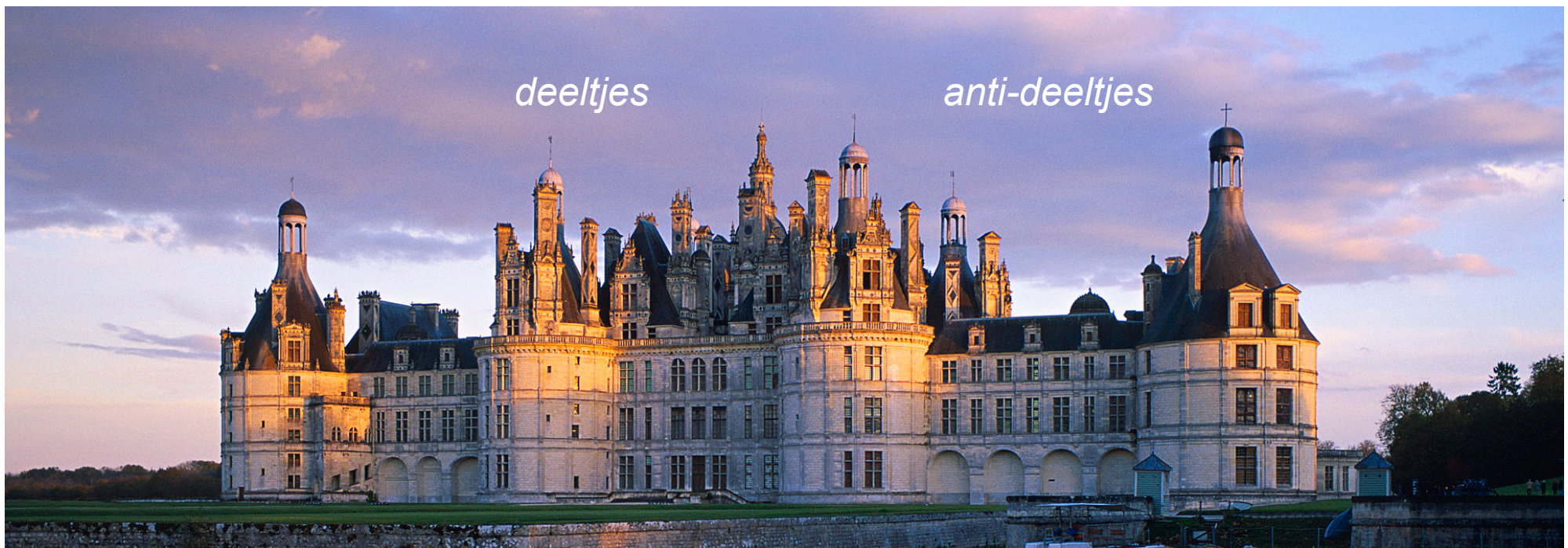
Donkere Materie zelf maken

Theoretisch idee: Supersymmetrie:



Lichtste is donkere materie deeltje ?

Maak ze bij de LHC !



deeltjes

anti-deeltjes

Natuurkunde

De natuur zit vol vreemde spelregels

Het Higgs boson bestaat

Wat is donkere materie / energie ?

Waarom is de zwaartekracht zo raar ?

Spin-off

Slimme jonge mensen voor de industrie

Computing, sensors, versnellers

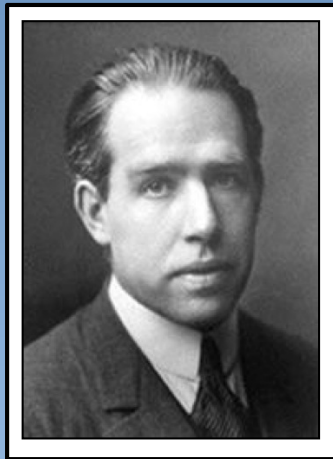
Medische apparatuur

avontuur

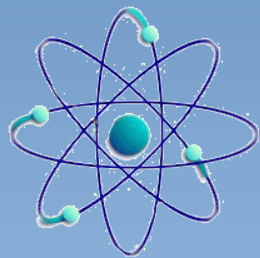
BACKUP

Quantummechanica ... nuttig ?

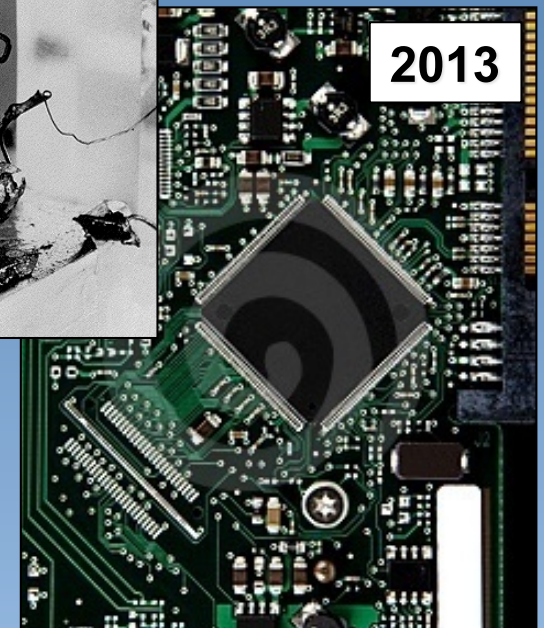
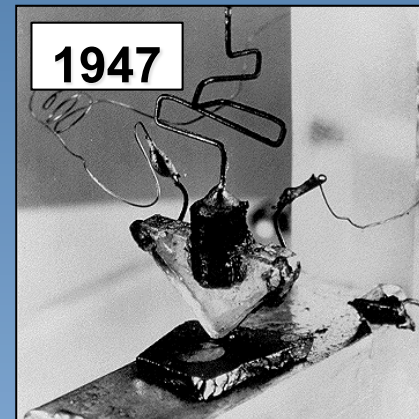
Quantummechanica



Niels Bohr



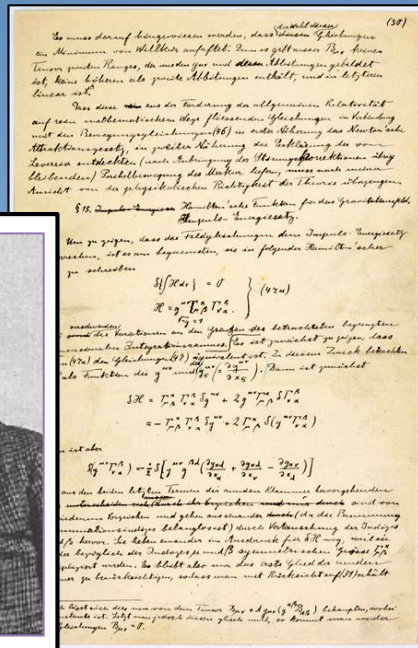
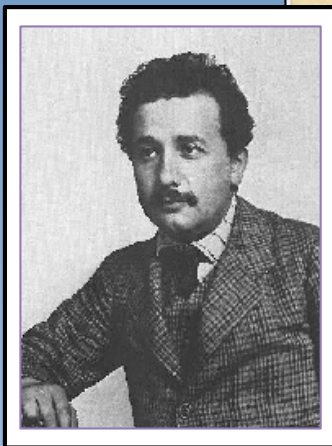
“Quantum mechanica en begrip van atomen cruciaal voor transitors.”



Relativiteitstheorie ?

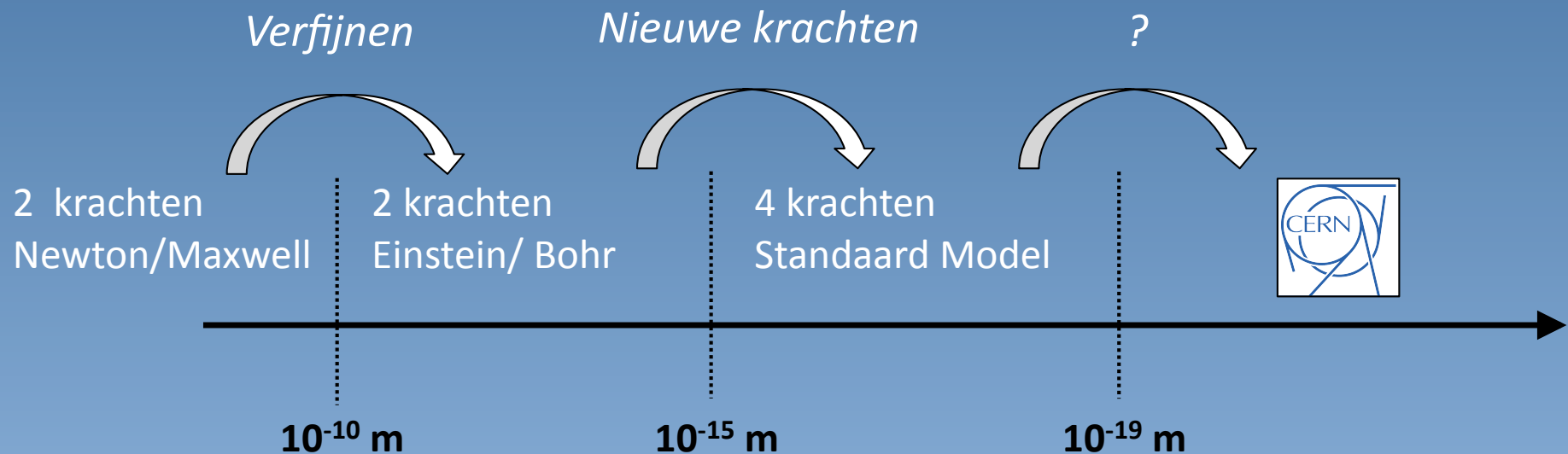
Net zo raar en onlogisch als de quantummechanica

- tijd gaat langzamer als je hard beweegt
- tijd gaat sneller als je verder weg bent van de aarde



“Zonder relativiteitstheorie zit de GPS er 10 km per dag naast!”

Nieuwe fenomenen, nieuwe krachten ??



CERN in Genève, Zwitterland



Wat zijn de spelregels ?

