Femto Fysica

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NNV Profielwerkstukreis 2021

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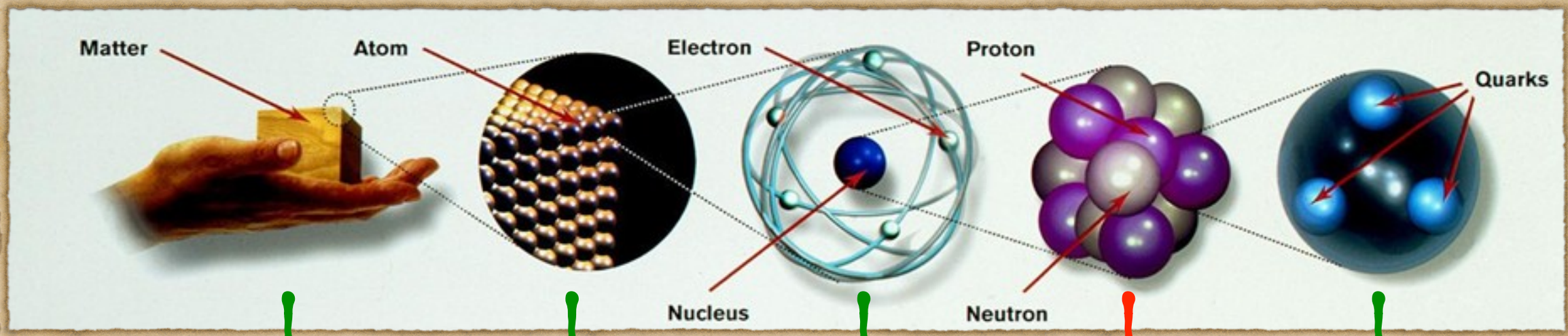
Wát voor fysica… ?



5cm (10^{-2}m)

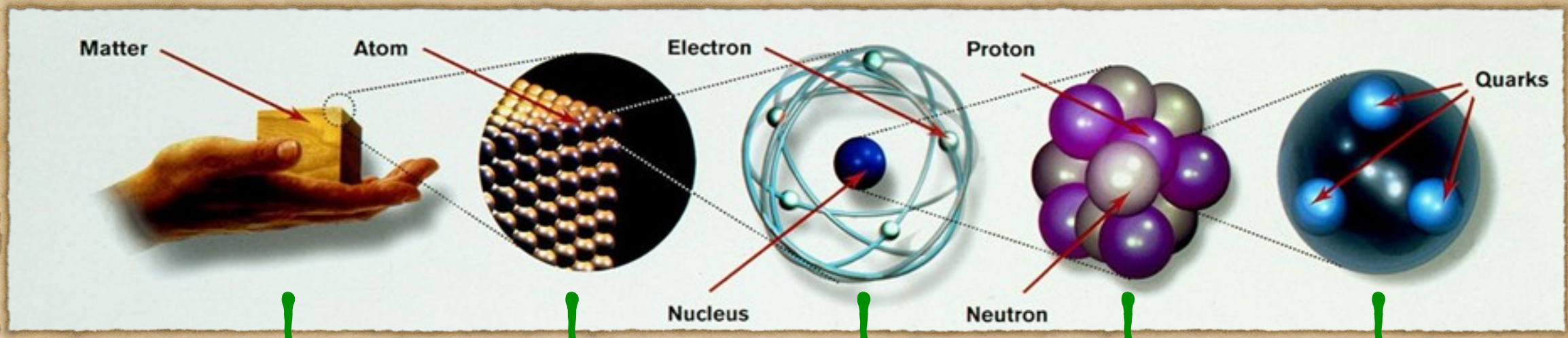
1Å (10^{-10}m)

0.01pm (10^{-14}m)

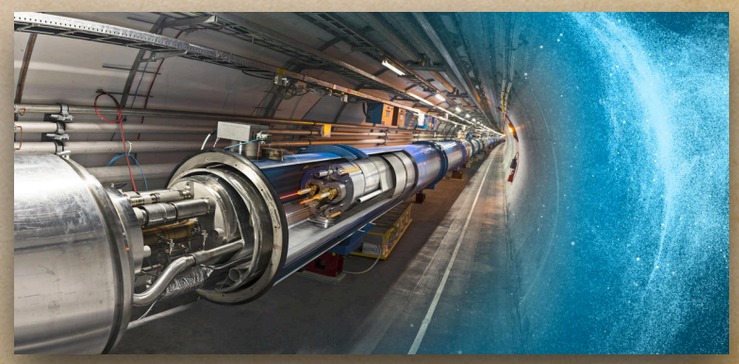
1am (10^{-18}m)

Femto!

(10^{-15}m)



Credit: CERN



Credit: CERN

enorme machines

bereiken hoge energie

door protonen te versnellen

(met femtometer grootte)

en gebruiken deze

in de zoektocht naar mini deeltjes

2

Enorme Machines

Deeltjesversnellers

Versnelling: verhoog de energie van de deeltjes

Botsing: knal twee deeltjes op elkaar om extreme energie vrij te geven

Detectie: observeer de resulterende (nieuwe?) deeltjes

Inzicht: analyseer de resultaten, om de diepe mysteries van het leven te ontrafelen

Mensen, geen machines (maar dit is aan het veranderen…)

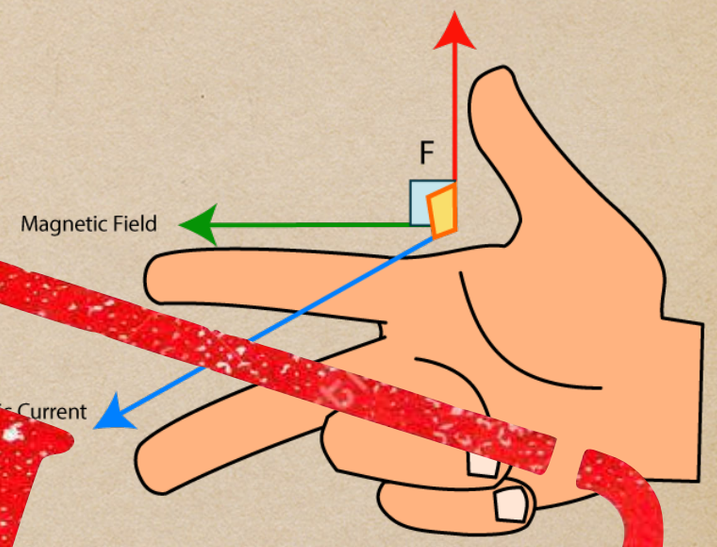
Deeltjesversnellers

Tekstboekvoorbeeld: de Large Hadron Collider

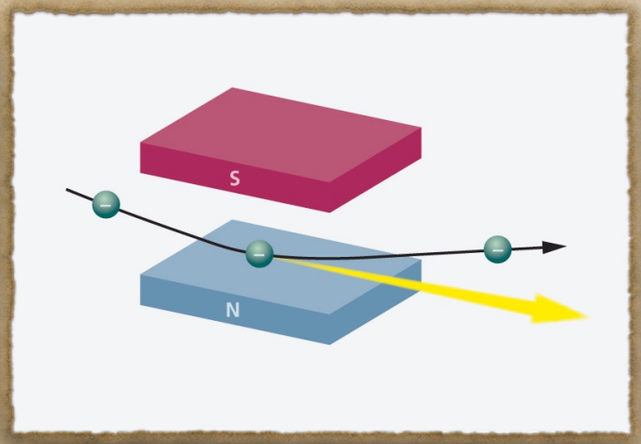
26.659 km 9593 magneten

1~2 miljard botsingen / s

Versnellers



Lorentz kracht *loodrecht* op bewegingsrichting

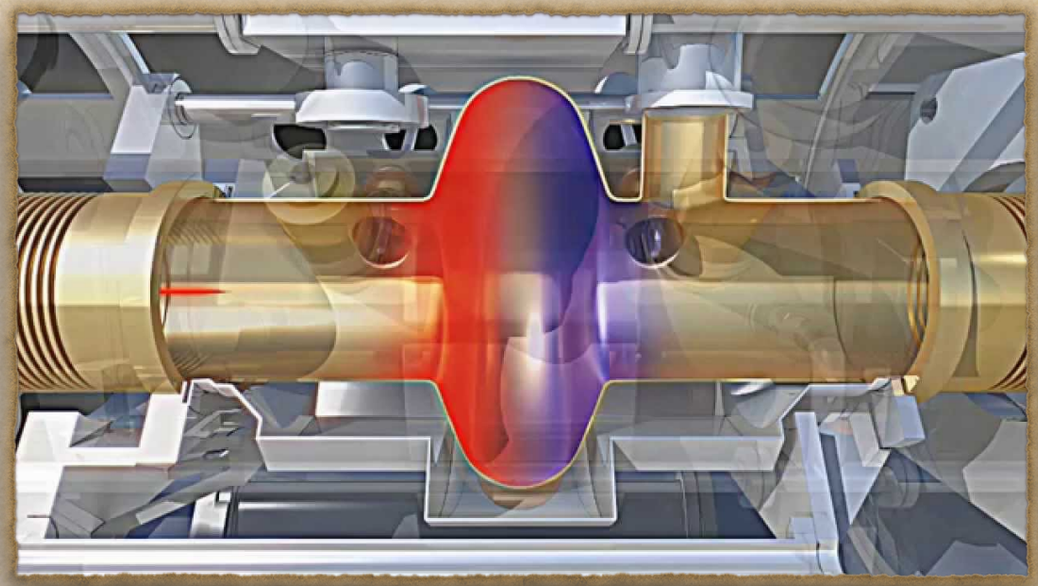


Effect van magneet is in ‘foute’ richting

Vergelijk met schommel langs zijkant te duwen

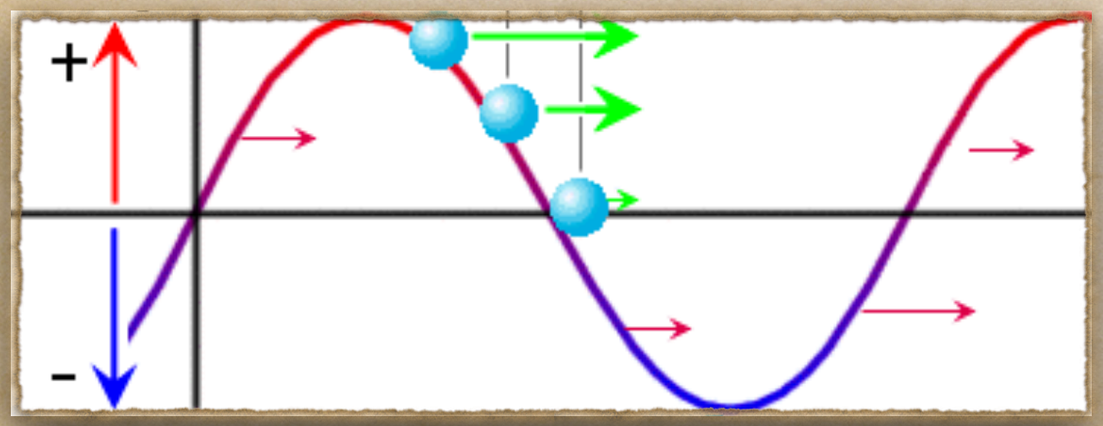
Versnellers

Elektrisch veld: caviteiten



Credit: CERN

Kracht is *longitudinaal*



Credit: JLAB

Veld moet op het juiste moment positief zijn.

Goede timing is cruciaal

Maar..

Maar..

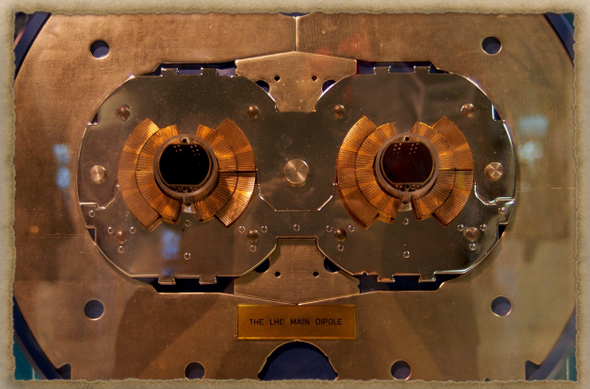
De LHC heeft 9600 magneten!

Waarom dan..?

Magneten

dipool:

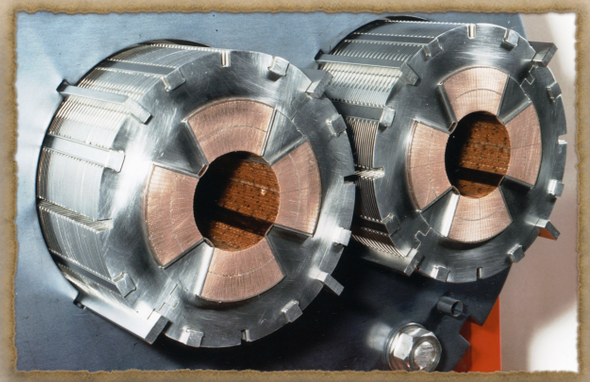
afbuiging



Credit: CERN

quadrupool:

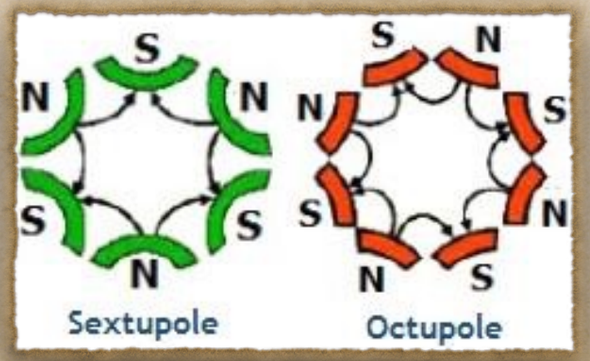
focusering



Credit: CERN

hogere ordes:

vanalles anders



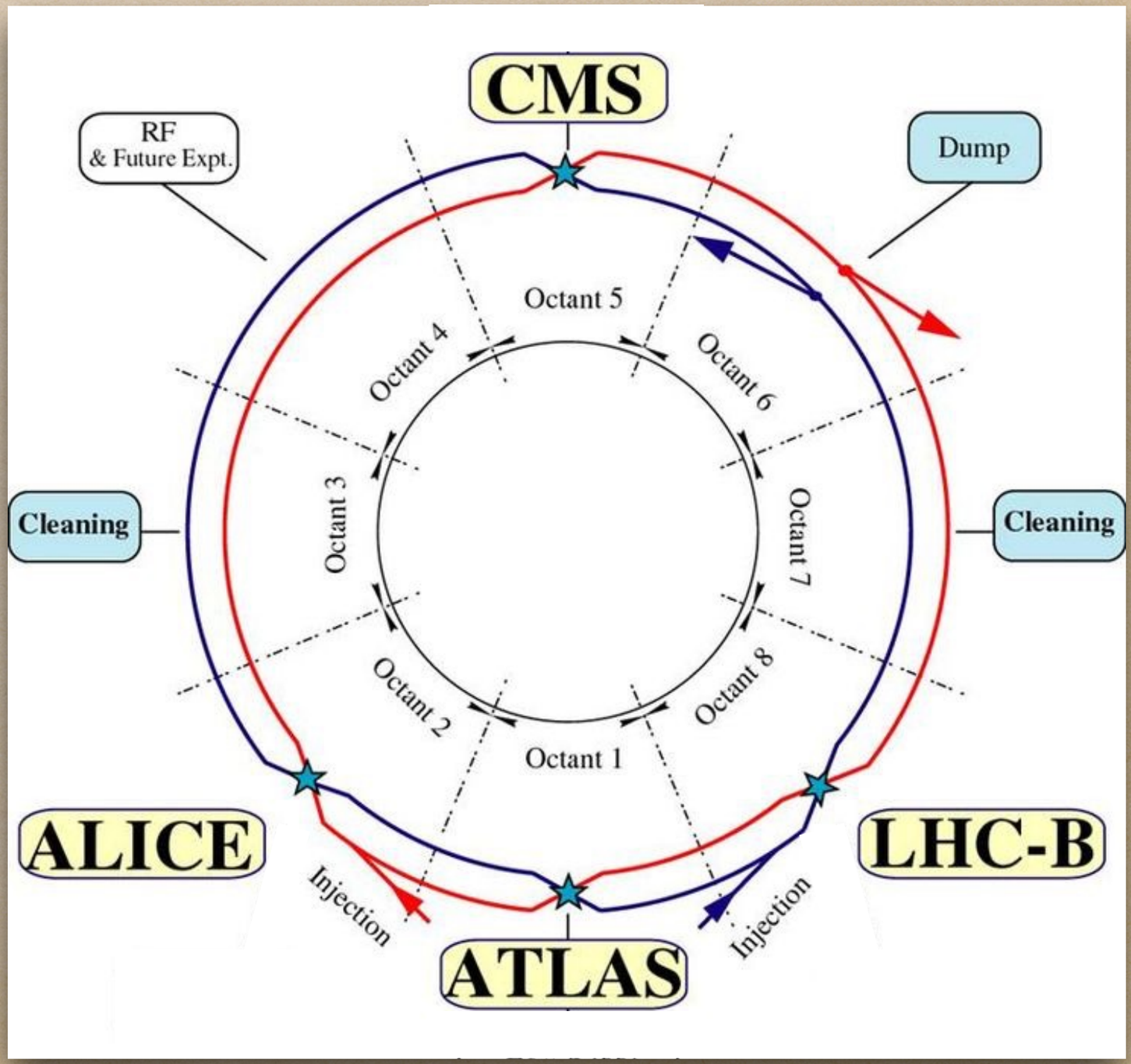
De Large Hadron Collider

Detectoren

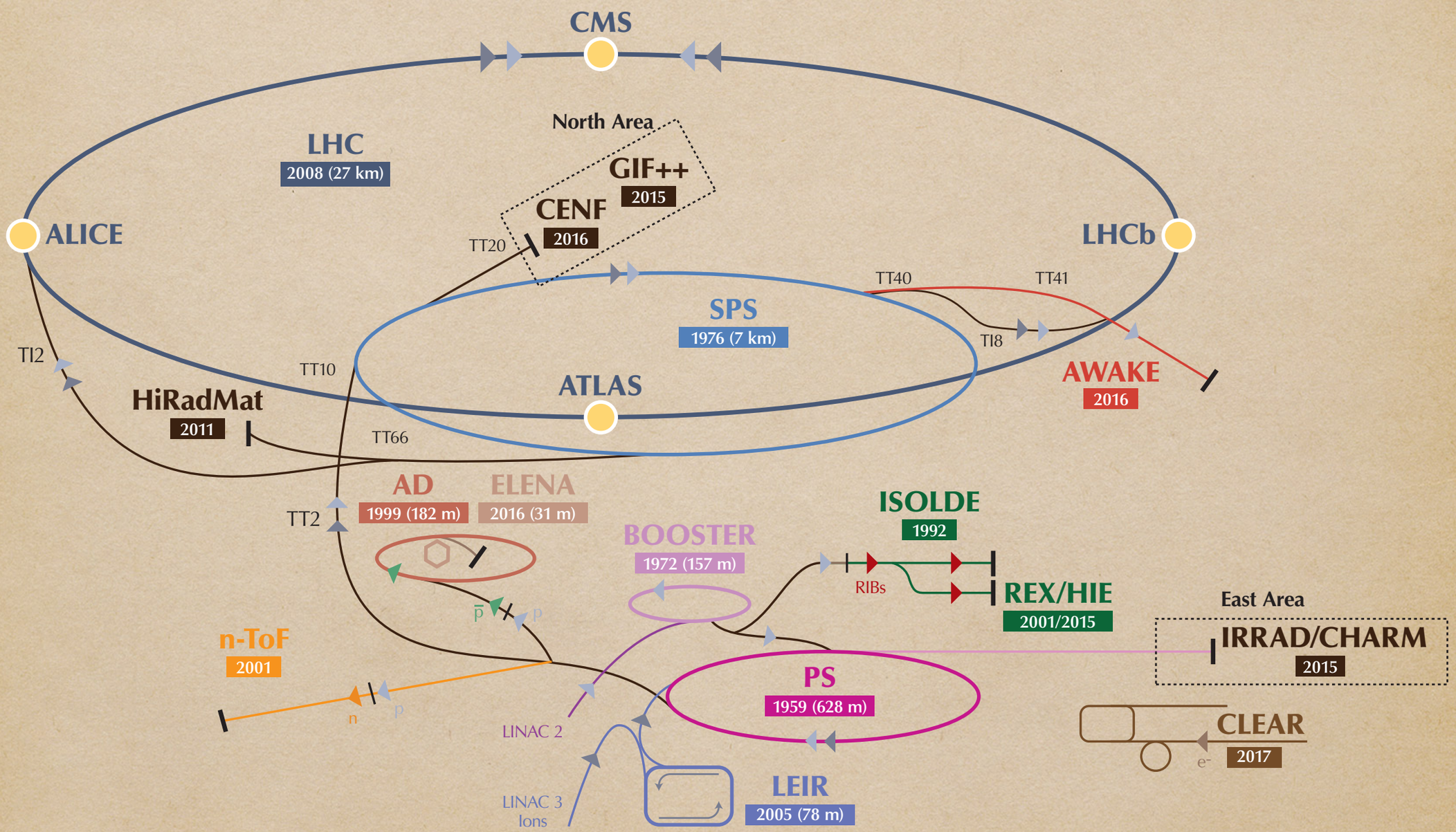
Versnelling

Beam dump

Beam cleaning



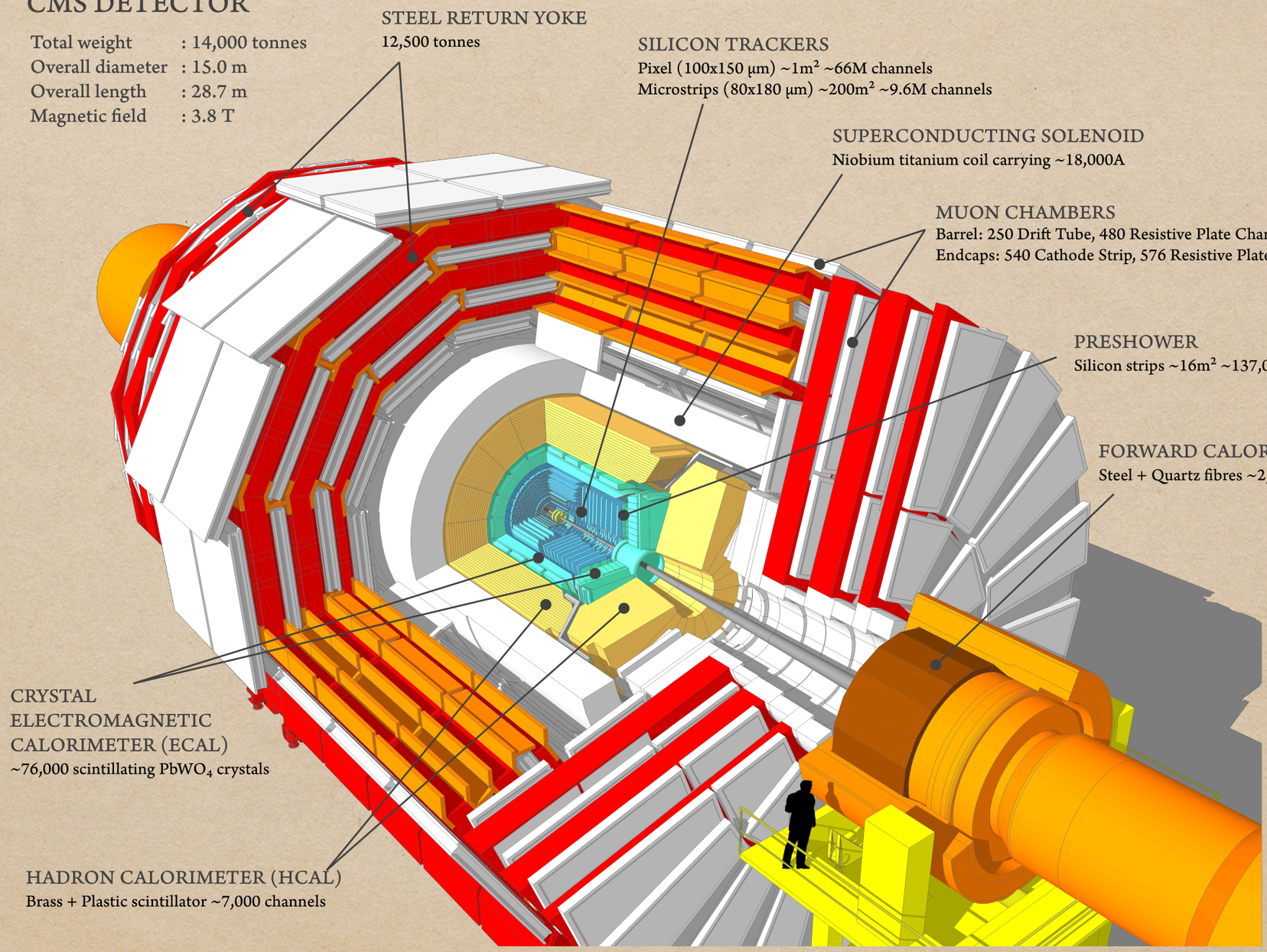
Het Versnellercomplex



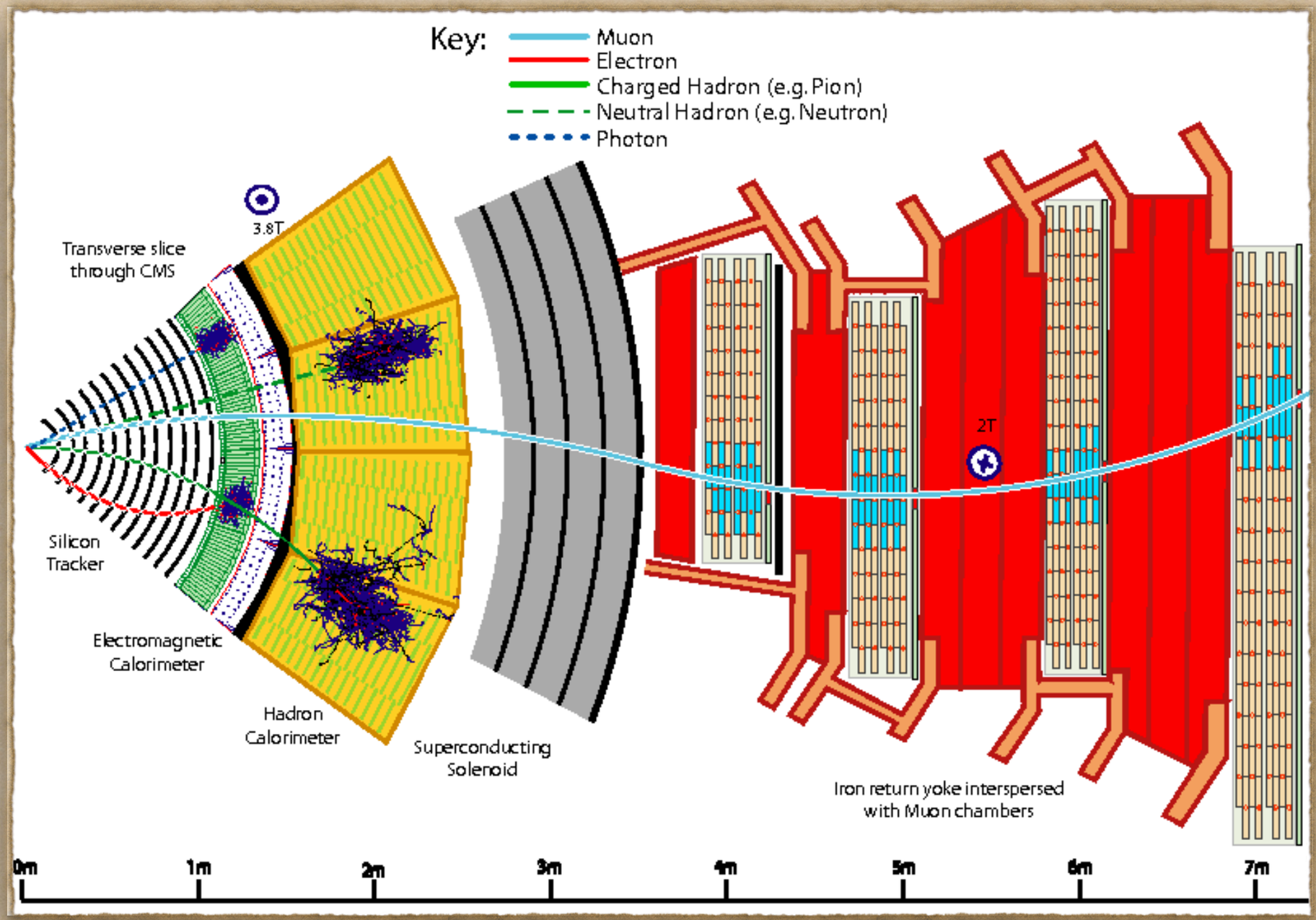
Detectoren

CMS DETECTOR

Total weight	: 14,000 tonnes
Overall diameter	: 15.0 m
Overall length	: 28.7 m
Magnetic field	: 3.8 T



Detectoren


Key:
Muon
Electron
Charged Hadron (e.g. Pion)
Neutral Hadron (e.g. Neutron)
Photon
Transverse slice through CMS
3.8T
2T
Silicon Tracker
Electromagnetic Calorimeter
Hadron Calorimeter
Superconducting Solenoid
Iron return yoke interspersed with Muon chambers
0m
1m
2m
3m
4m
5m
6m
7m

3

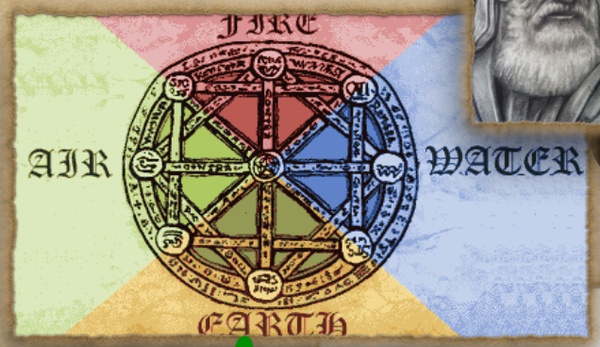
Mini Deeltjes

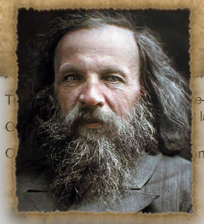
Waarvan zijn we gemaakt?

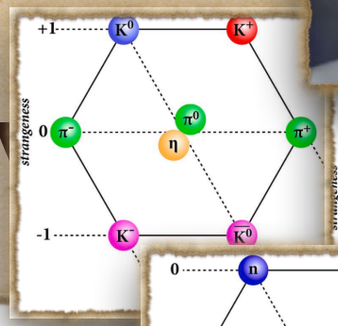
Waarvan is het heelal gemaakt?

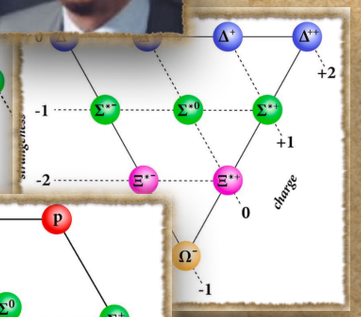
Hoe komt het dat alles gewoon ... “werkt”?

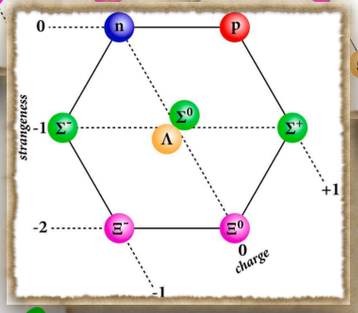
... ?

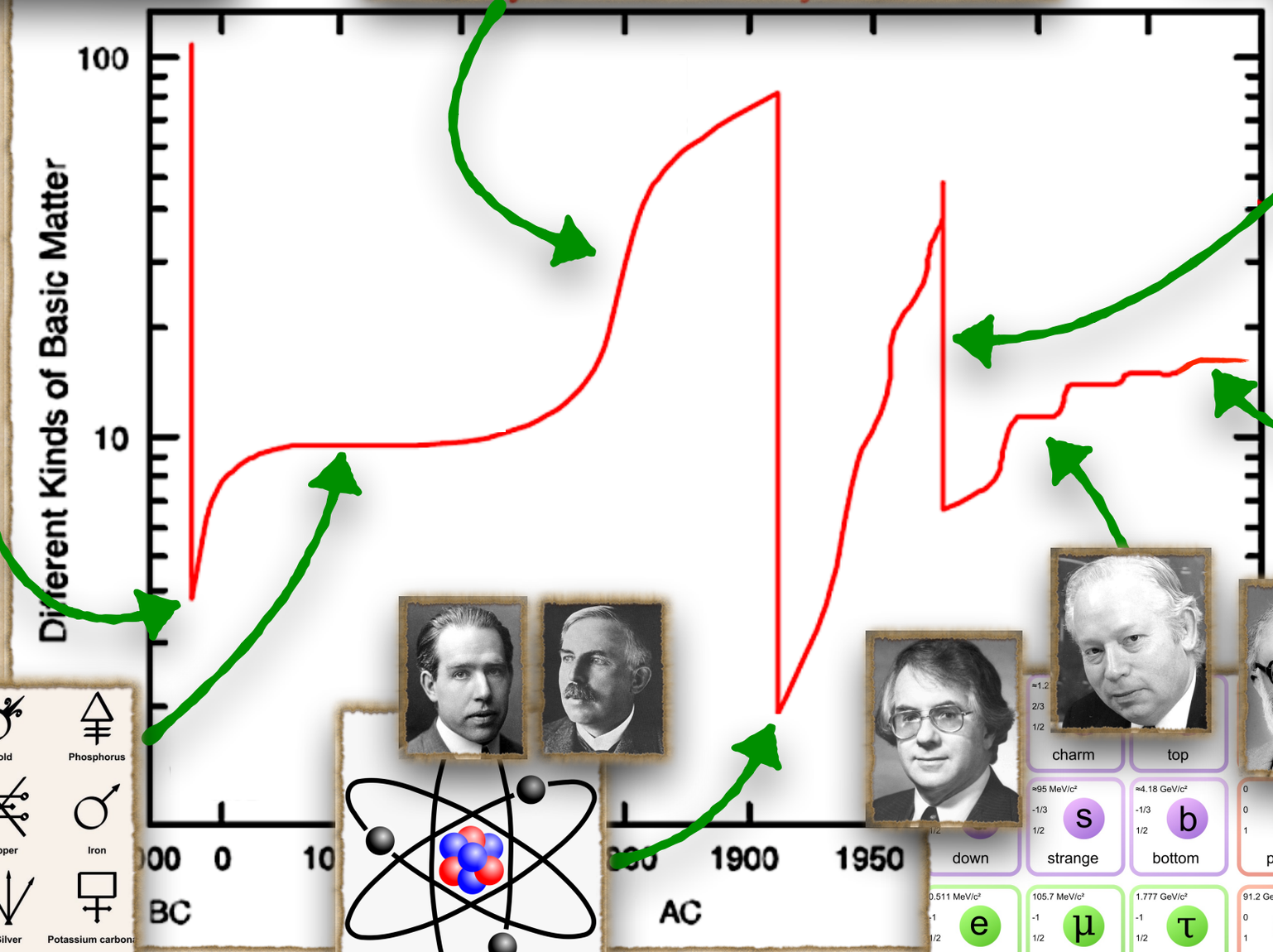


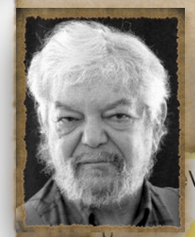


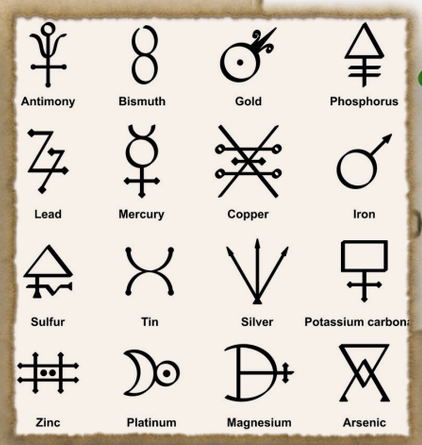


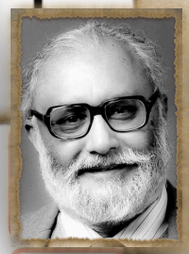








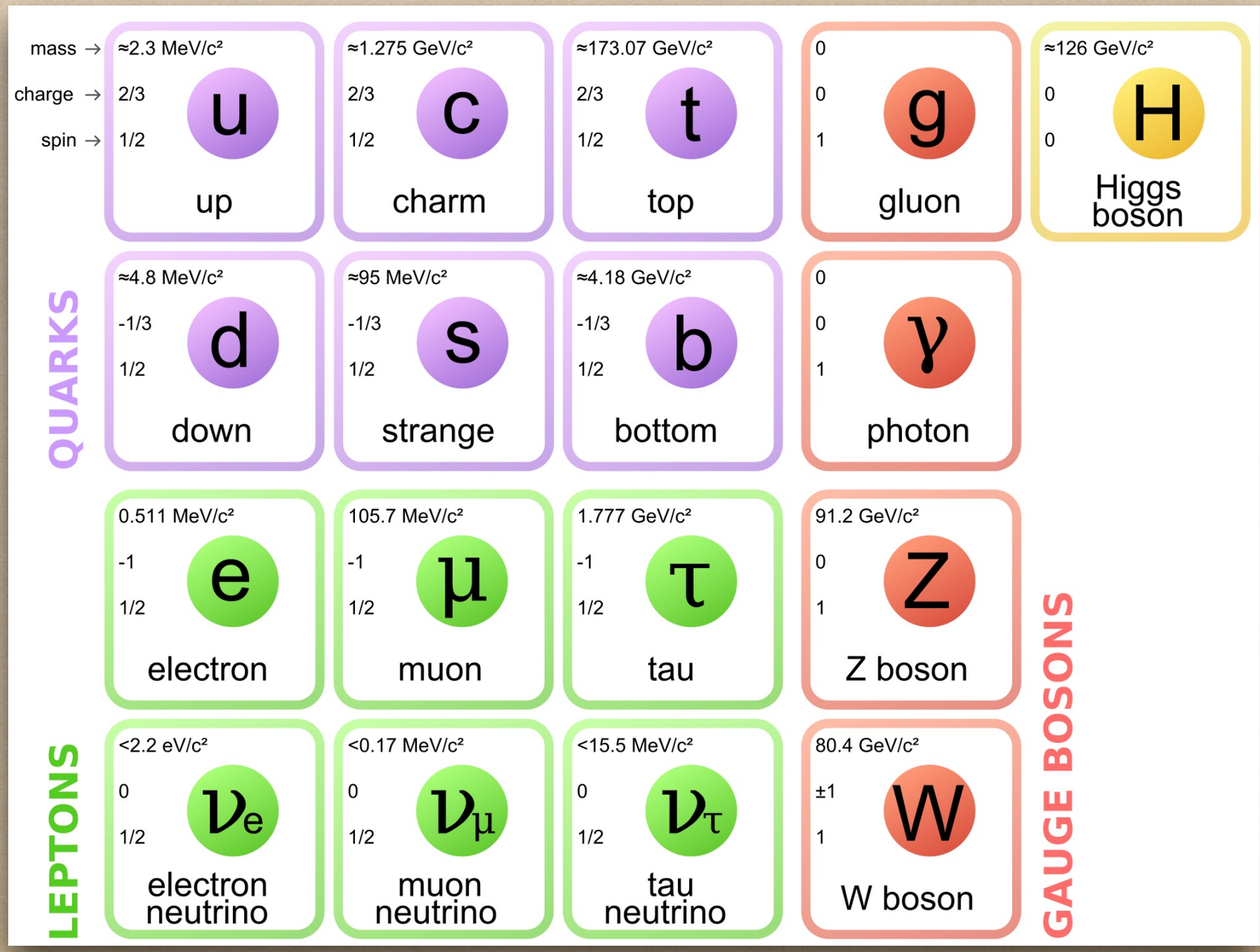




//arxiv.org/abs/1311.1769

17 deeltjes

Het Standaard Model



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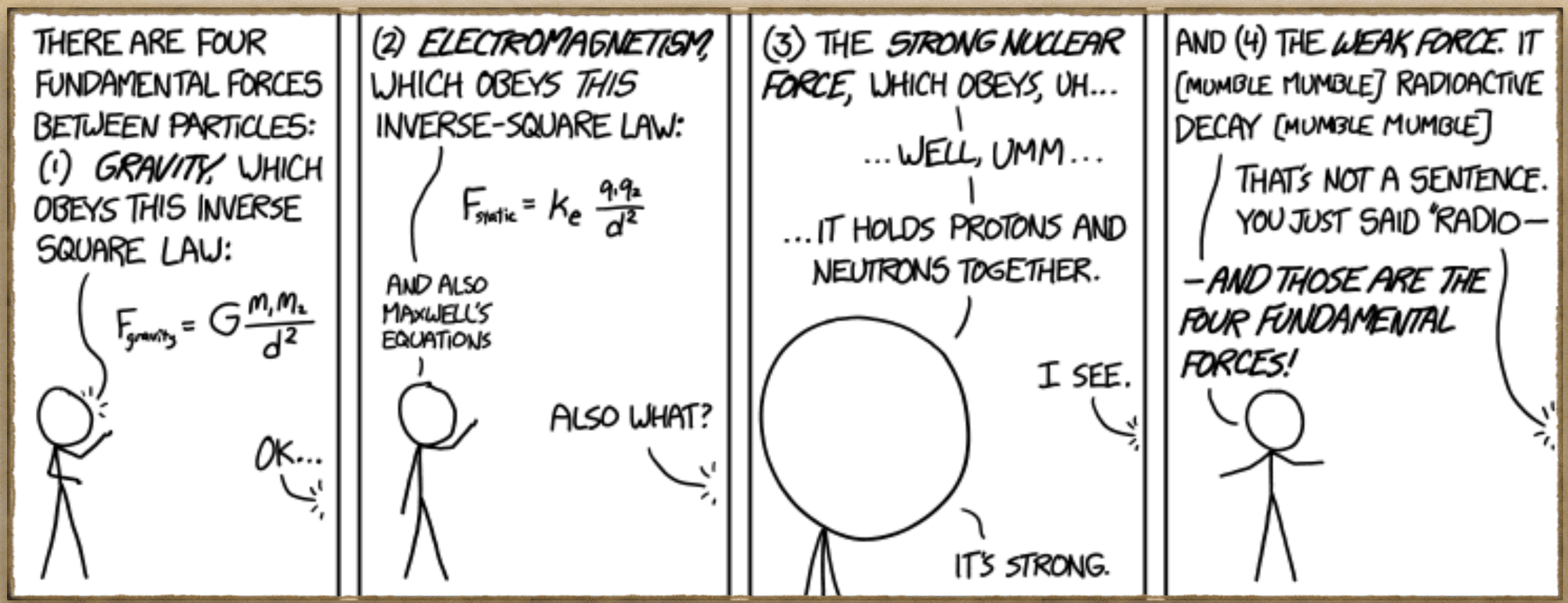
Hoge Energie

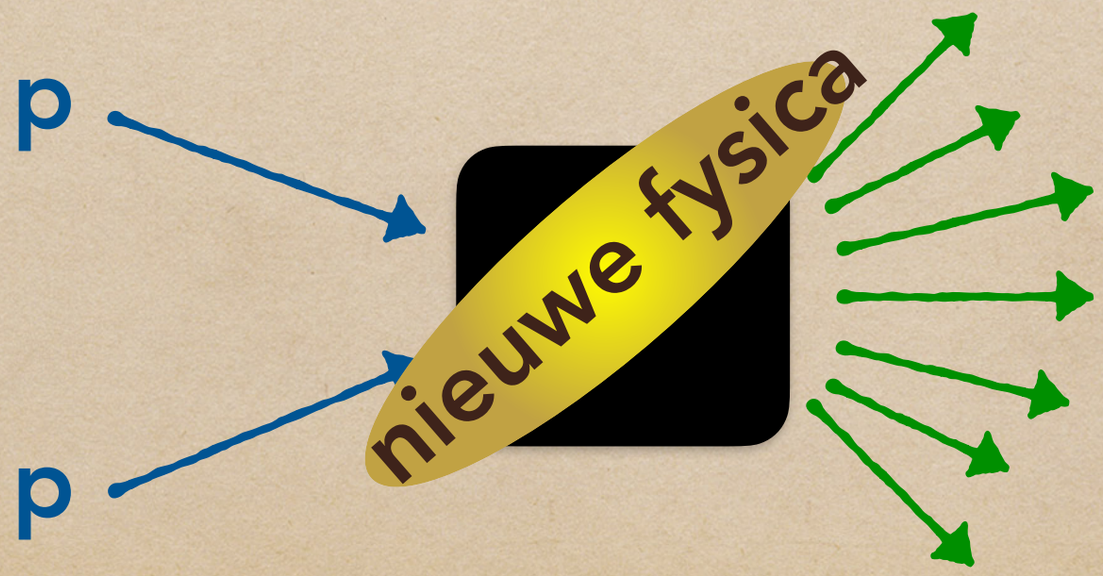
Hoge-Energiefysica



Hoe werkt deeltjesfysica?

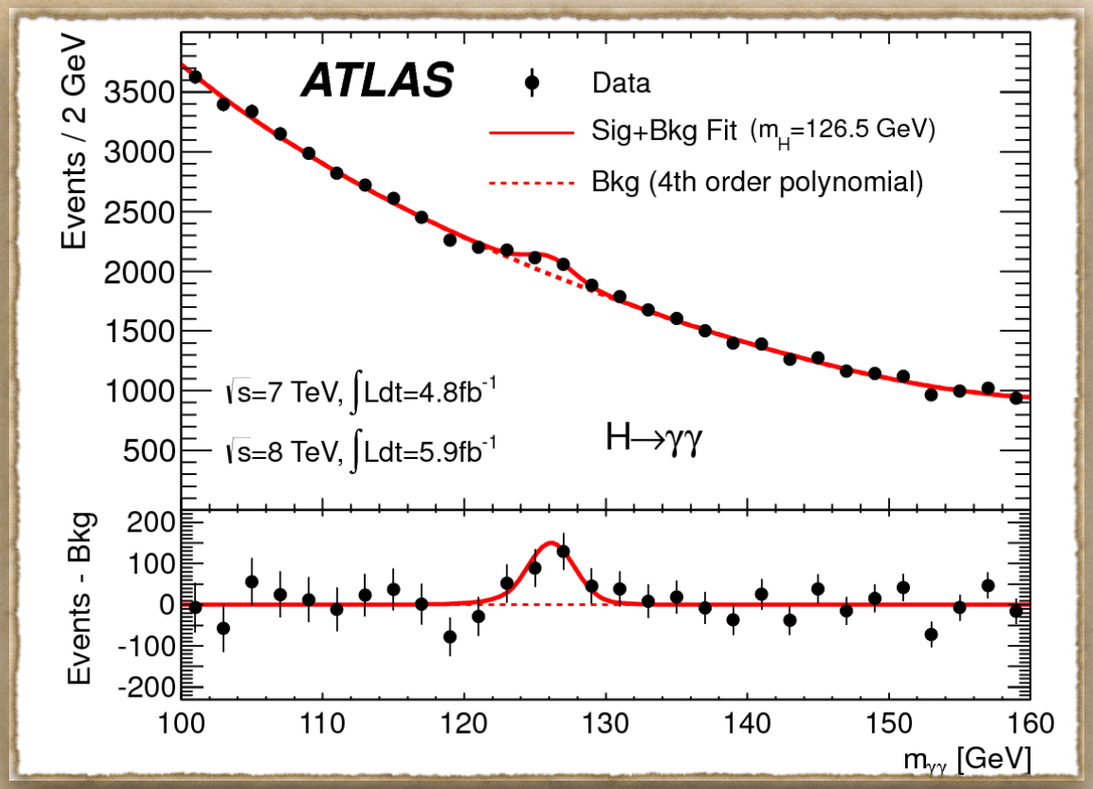
Black-Box mechanisme:

- we weten wat we er insteken
- we meten wat er uitkomt
- we gebruiken statistiek om af te leiden wat er onderweg gebeurd is

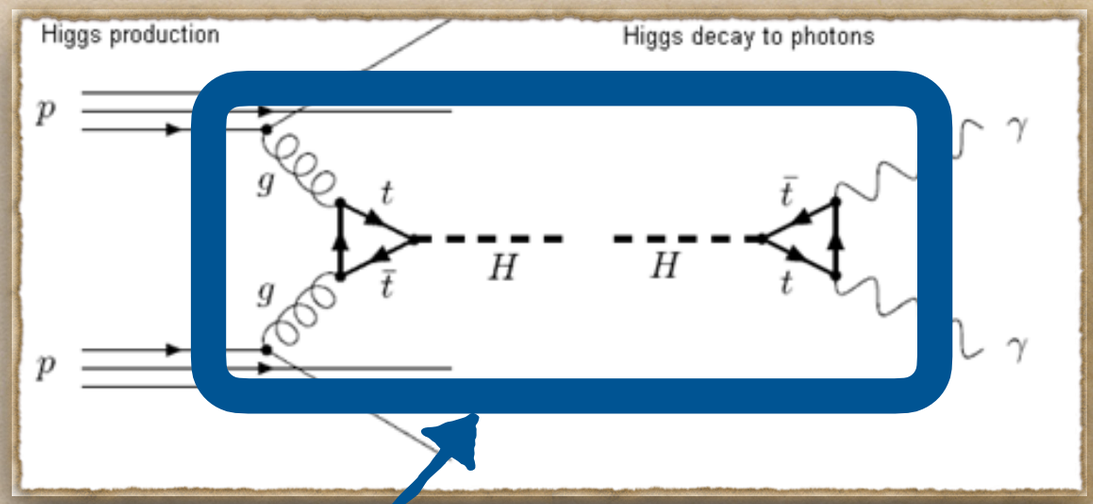


Statistiek!

Higgsdeeltje is gevonden!



Voorbeeld interactie

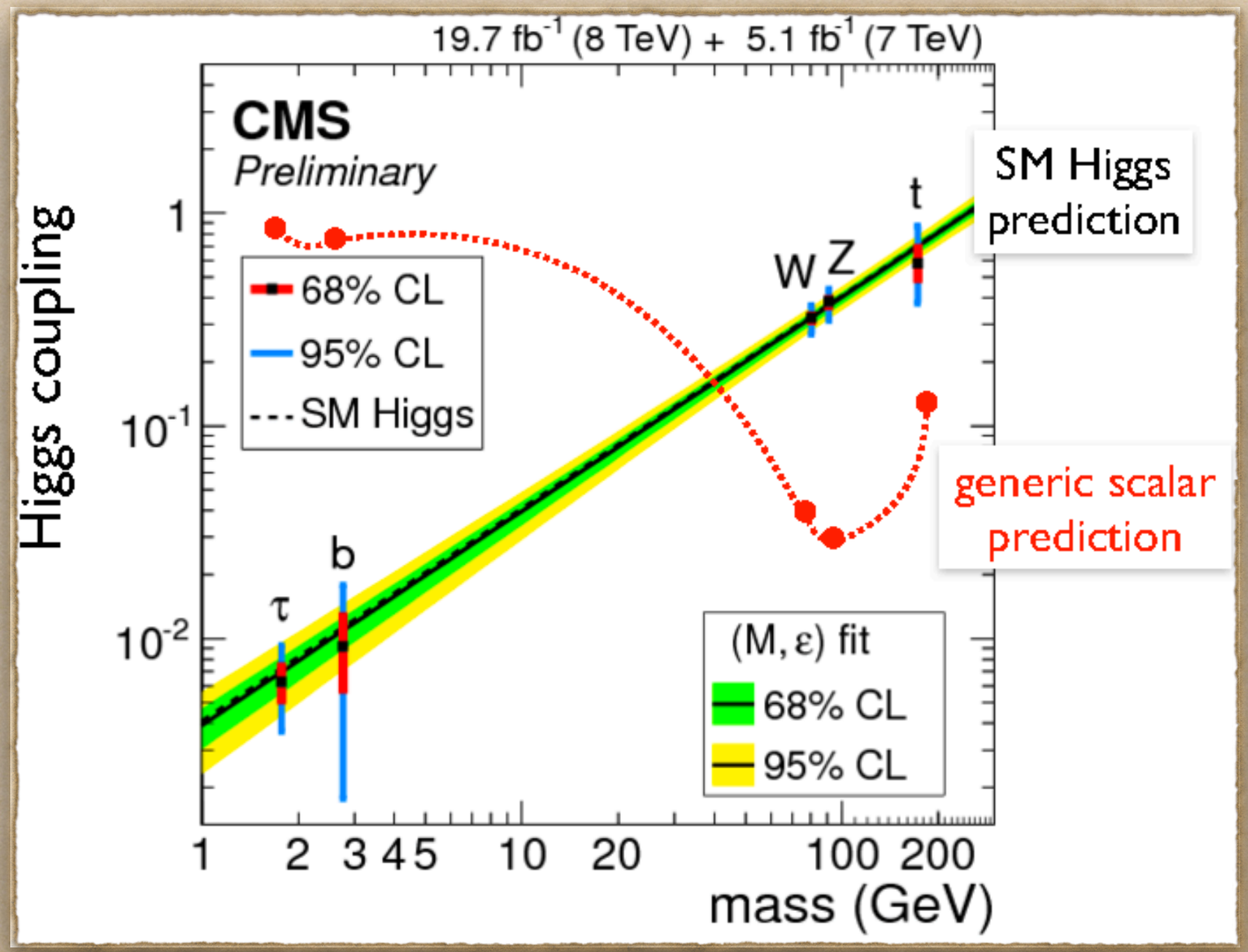


Black Box:

Kan om het even wat zijn (Higgs, photon, gluon, ….)

Gebruik **statistiek** en **waarschijnlijkheid** om een schatting te maken

Het beweegt zoals een Higgs...



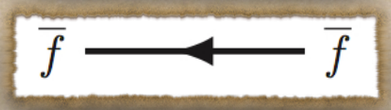
Binnenin de Black Box

Feynman diagrammen

Notatie

quark, lepton

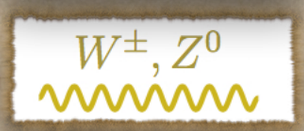
antiquark, antilepton



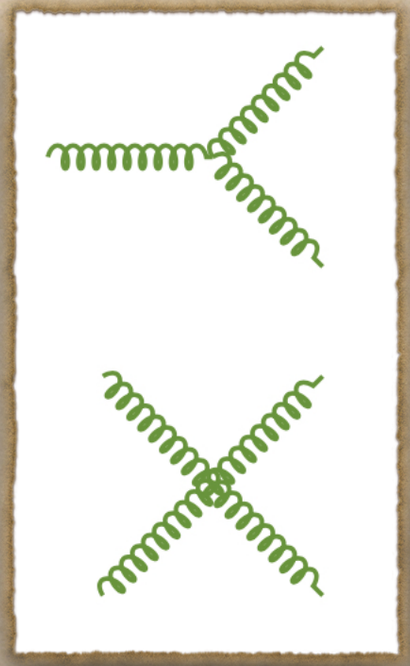
photon

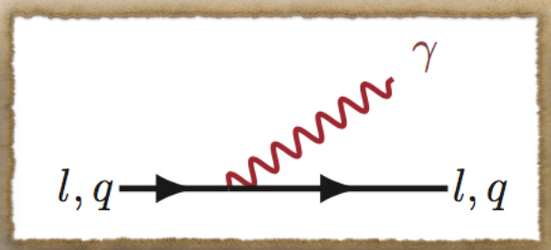
gluon

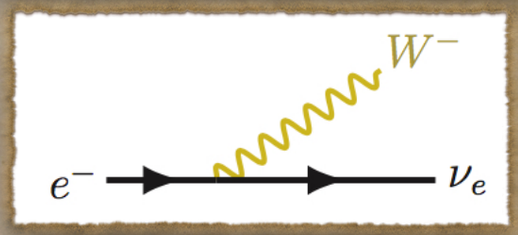
zwak boson

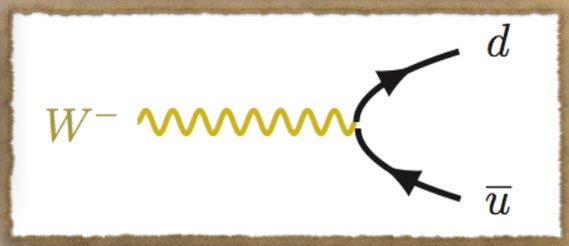


Interactie







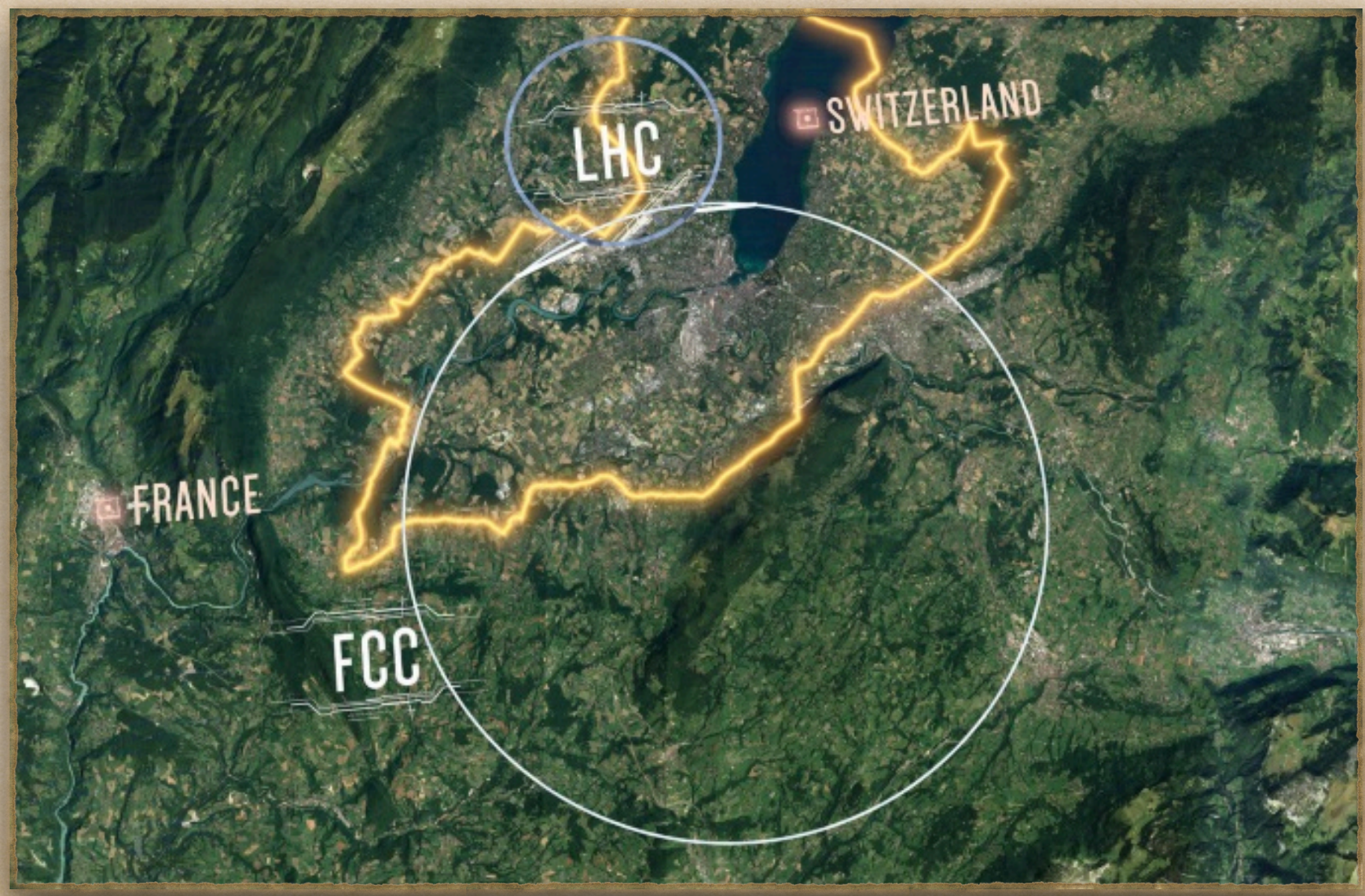


5

De Toekomst

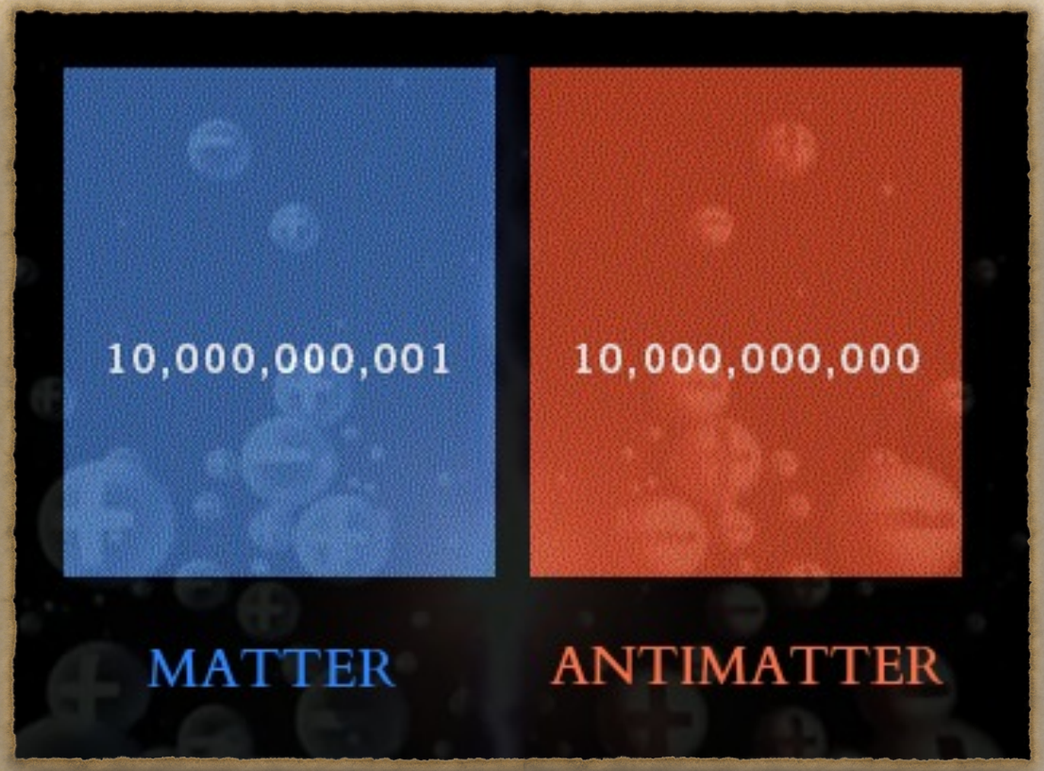
Verbreding van de zoektocht...

groter, breder, beter



(Anti)Materie Asymmetrie

(Anti)Materie Asymmetrie

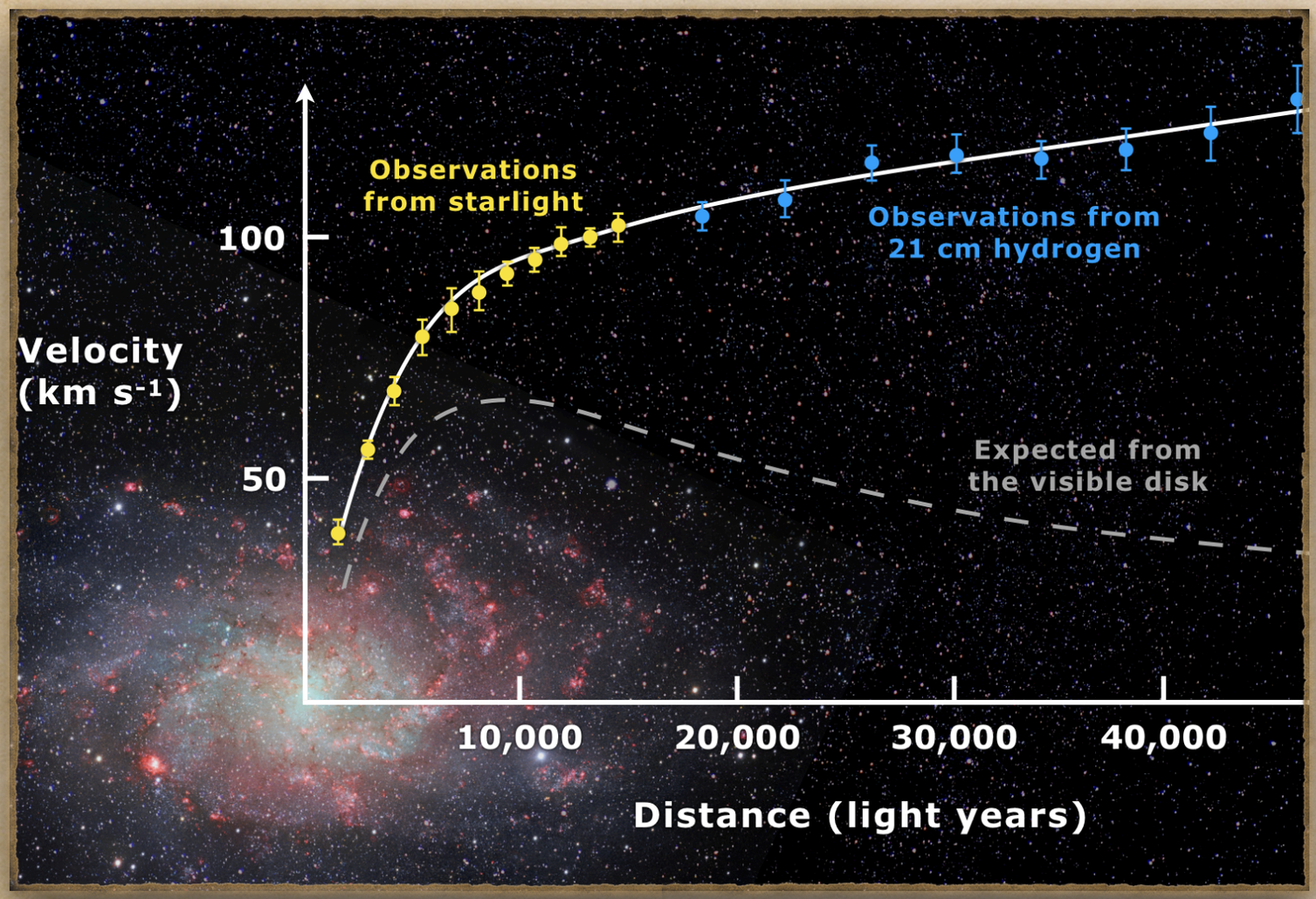


Ergens ver weg verborgen?

Asymmetrisch gecreëerd?

Asymmetrisch verval?

Donkere Materie



~~zwarte gaten?~~

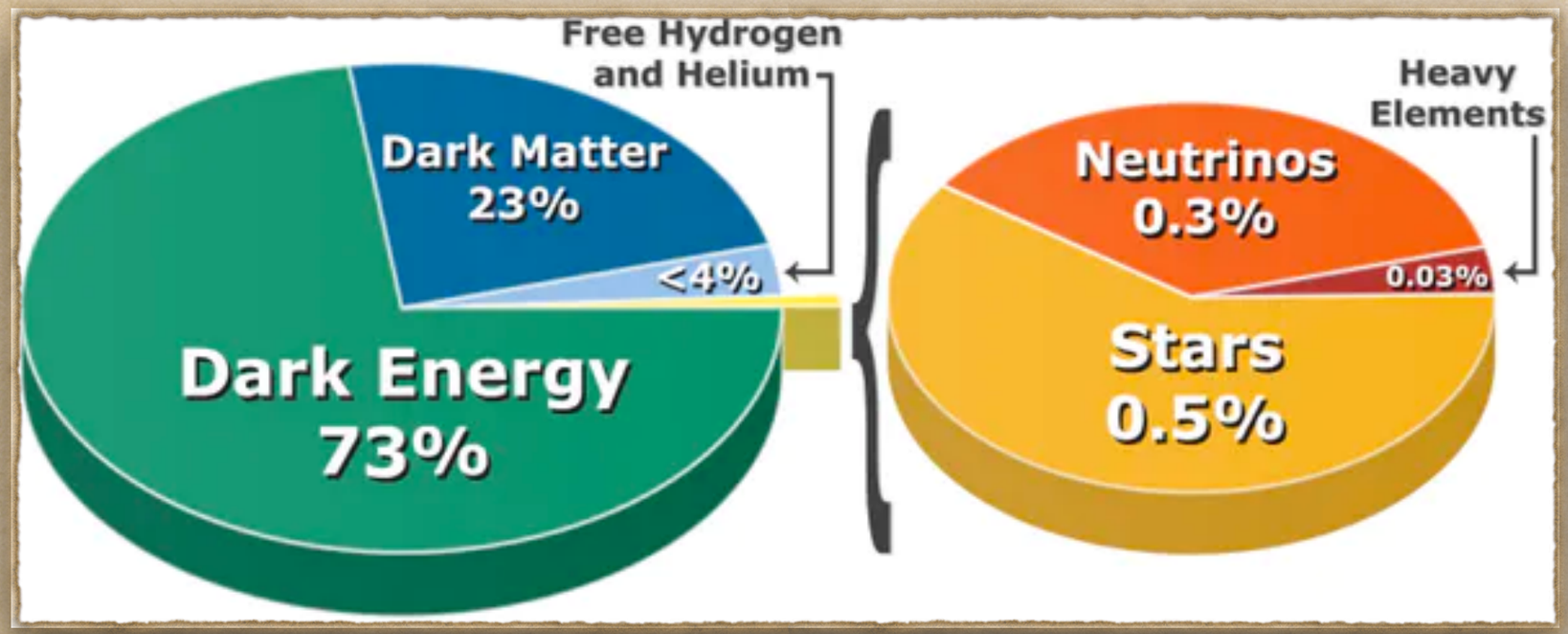
WIMPs?

steriele neutrinos?

Werkt zwaartekracht anders op grote schaal?

Donkere Energie

Variabel-energie veld?

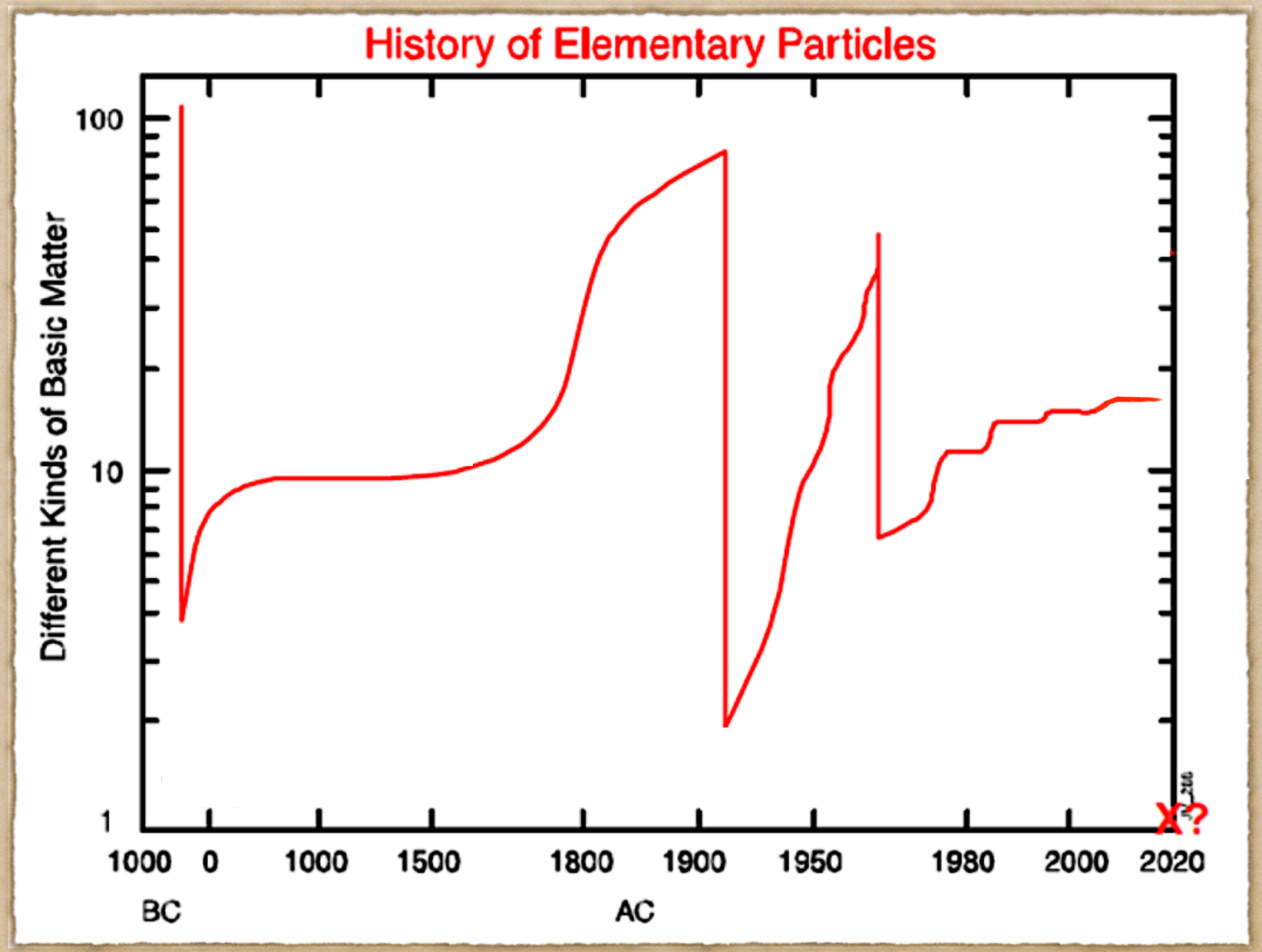


Fundamentele eigenschap van tijdruimte?

Werkt zwaartekracht anders op grote schaal?

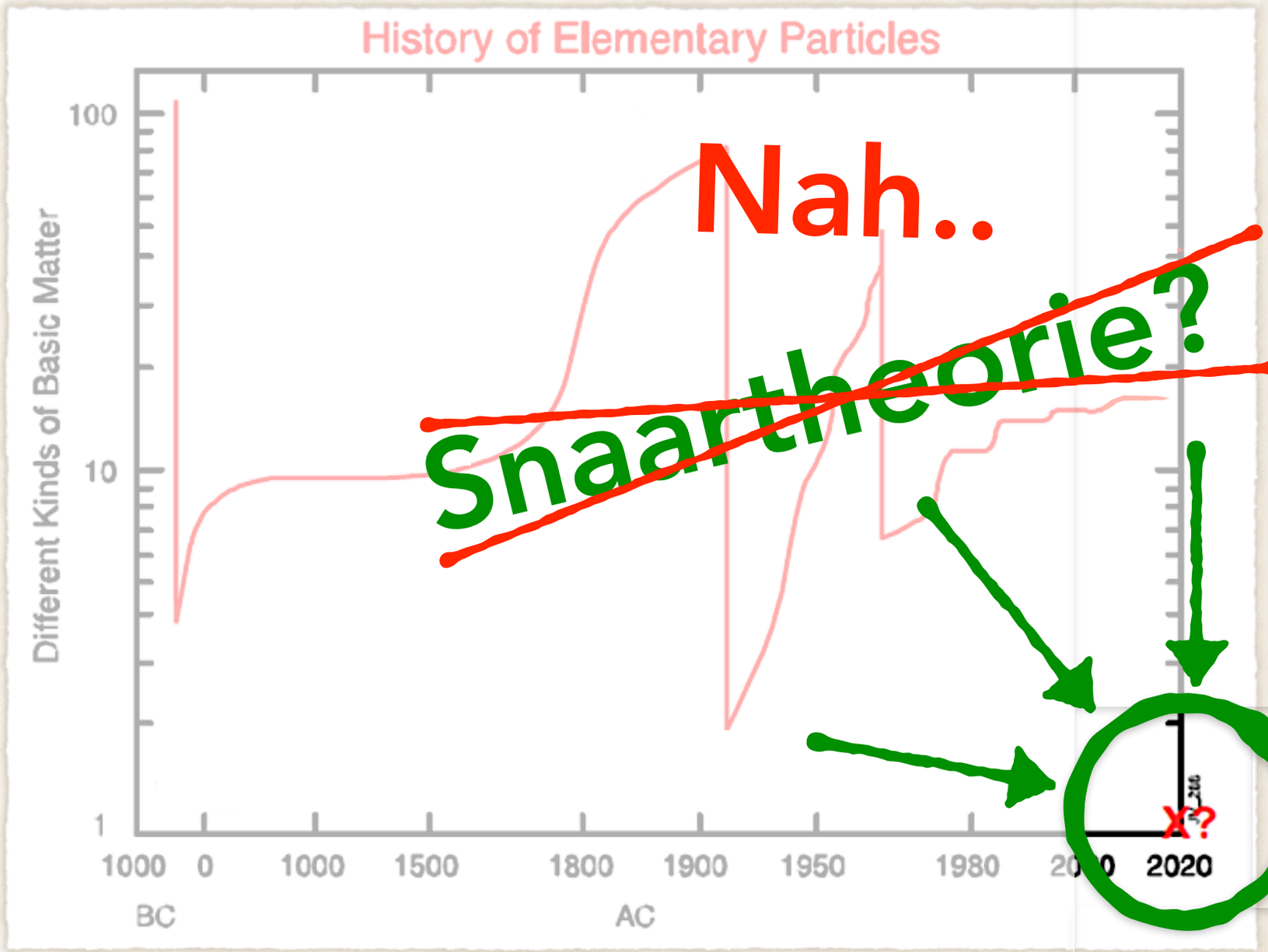
Oh en nog iets..

Bouwstenen van het universum



Credit: http://arxiv.org/abs/1311.1769

Basic Bricks of the Universe



Credit: http://arxiv.org/abs/1311.1769

Dit zijn vragen die nog steeds openstaan..

Klaar om verkend te worden…

Dankjewel voor je aandacht!

Vragen?

=> frederikvanderveken@gmail.com