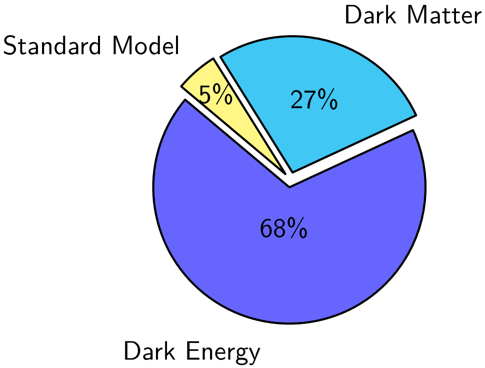
Dark Matter

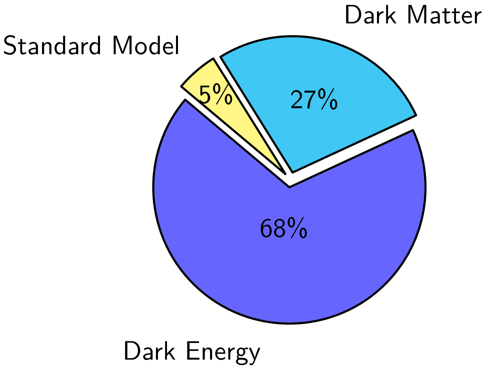
$\simeq 5\%$ of the mass and energy content of the universe can be described by Standard Model.
$\Longrightarrow$ Dark Matter



Dark Matter

$\simeq$ 5% of the mass and energy content of the universe can be described by Standard Model.
$\Longrightarrow$ Dark Matter

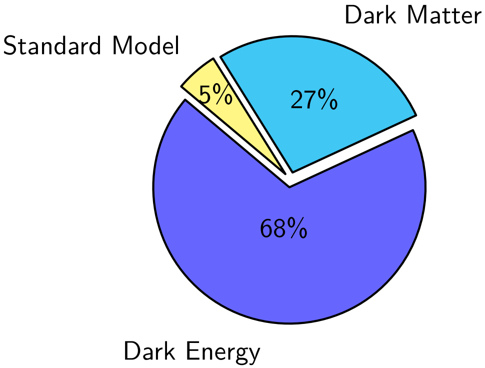
- dark sector



Dark Matter

$\simeq 5\%$ of the mass and energy content of the universe can be described by Standard Model.
$\Longrightarrow$ Dark Matter

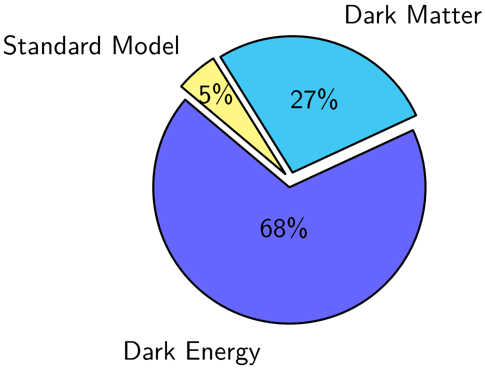
- dark sector
- weak interaction with SM



Dark Matter

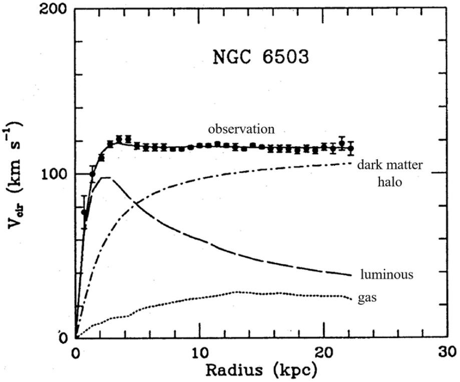
$\simeq 5\%$ of the mass and energy content of the universe can be described by Standard Model.
$\Longrightarrow$ Dark Matter

- dark sector
- weak interaction with SM
- interaction through a portal



Evidences of Dark Matter

- Rotational curves of galaxies



Evidences of Dark Matter

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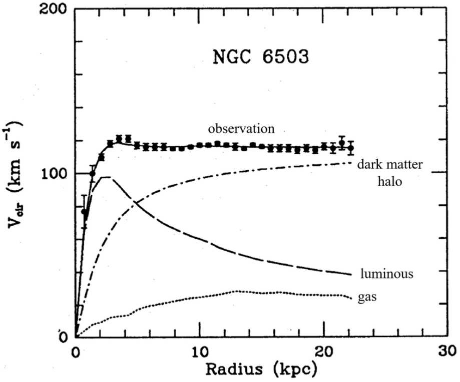
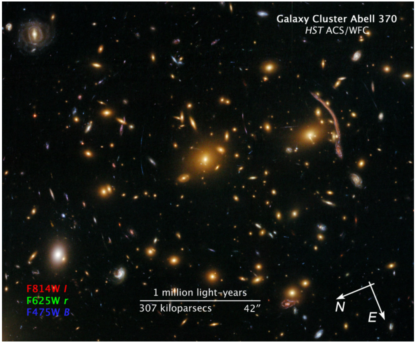


- Gravitational lensing

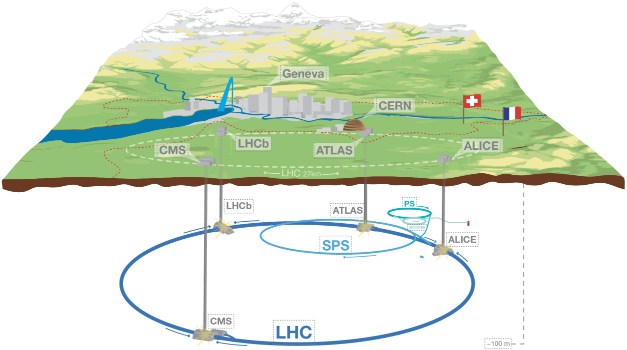


Evidences of Dark Matter

- Bullet Cluster

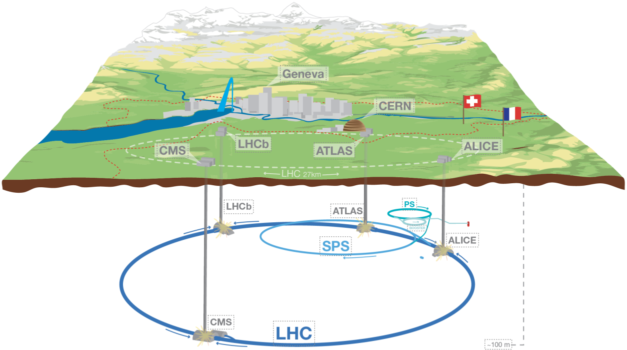
Large Hadron Collider

$\Longrightarrow p$ -p collider at CERN



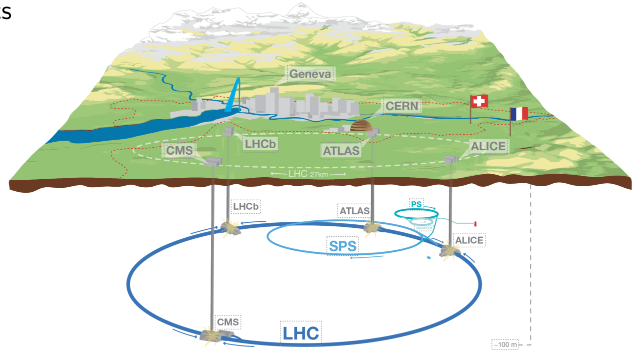
Large Hadron Collider

- p -p collider at CERN
  - 27km ring



Large Hadron Collider

- p-p collider at CERN
- 27km ring
- superconducting magnets



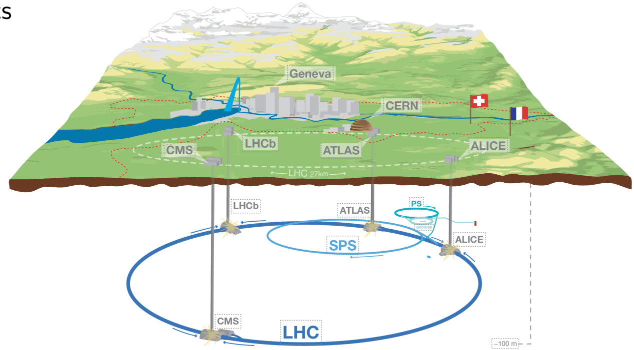
Large Hadron Collider

=p -p collider at CERN

27km ring

superconducting magnets

accelerator chain



Large Hadron Collider

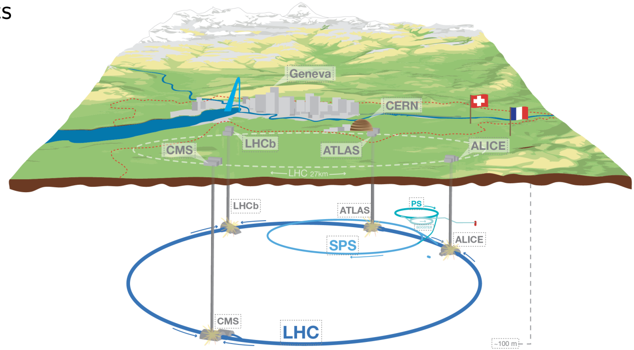
=p -p collider at CERN

27km ring

superconducting magnets

accelerator chain

$\sqrt{s} = 13$ TeV



Large Hadron Collider

$=p$ -p collider at CERN

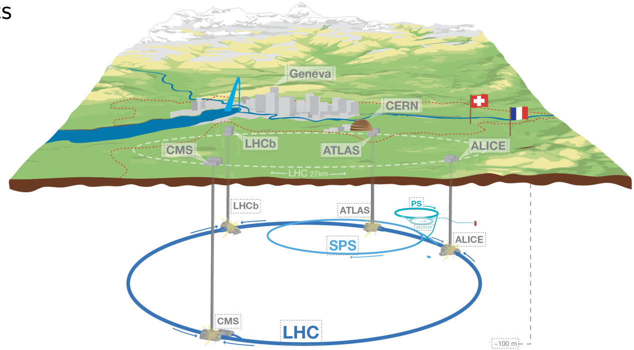
27km ring

superconducting magnets

accelerator chain

$\sqrt{s} = 13\,\text{TeV}$

$f = 40\,\text{MHz}$



Large Hadron Collider

$=p$ -p collider at

27km ring

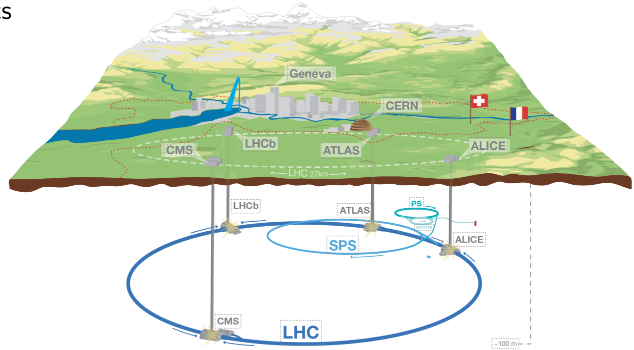
superconducting magnets

accelerator chain

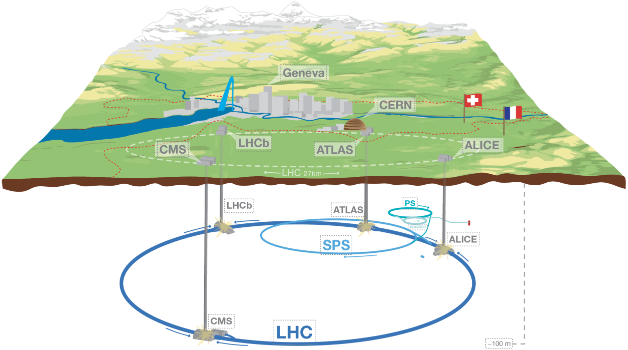
$\sqrt{s} = 13\,\text{TeV}$

$f = 40\,\text{MHz}$

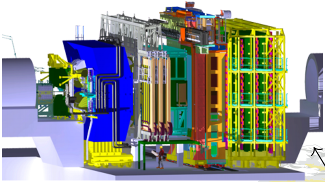
10^{11} protons per bunch

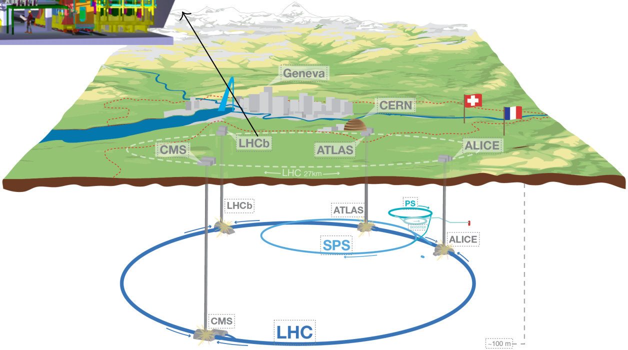


Large Hadron Collider

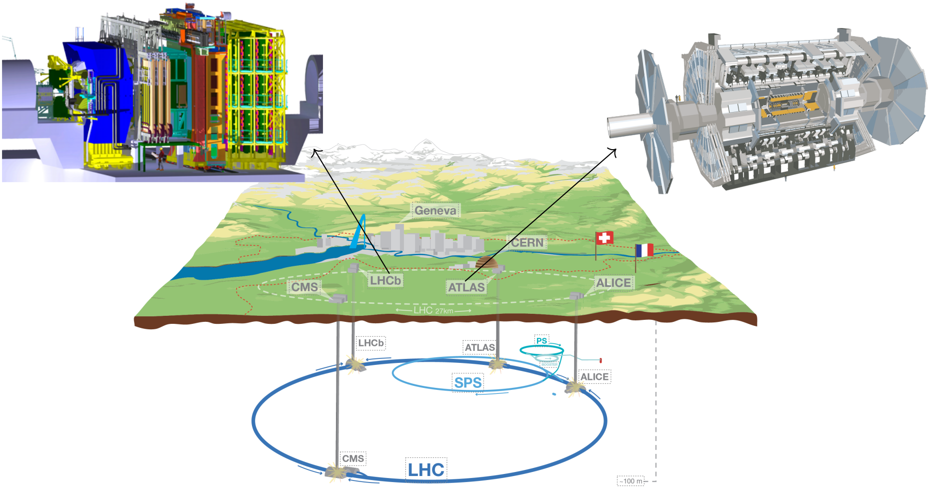


Large Hadron Collider

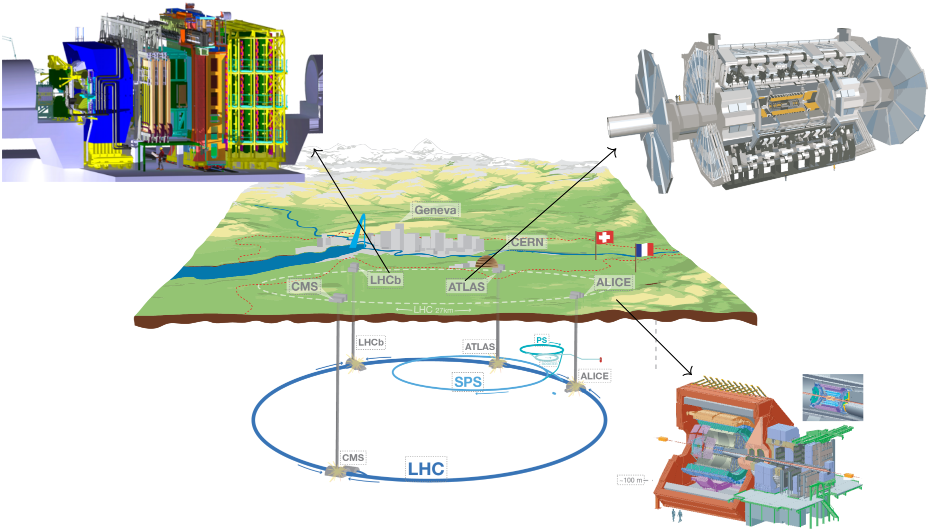




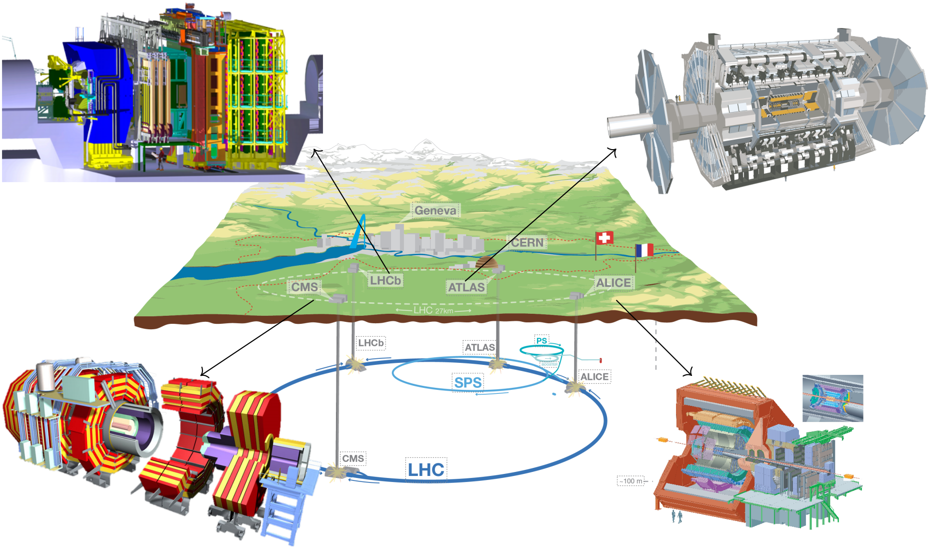
Large Hadron Collider



Large Hadron Collider



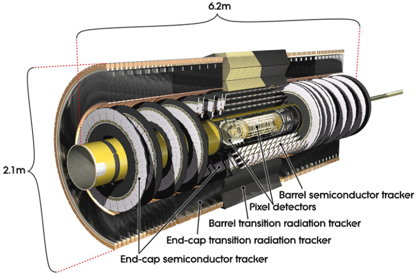
Large Hadron Collider



A Toroidal LHC ApparatuS

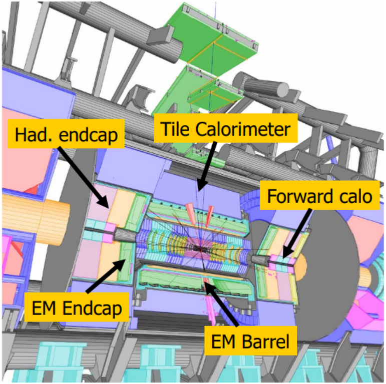
Inner Detectors

- direction, momentum and charge
- only charged particles
- pattern recognition



Calorimeters

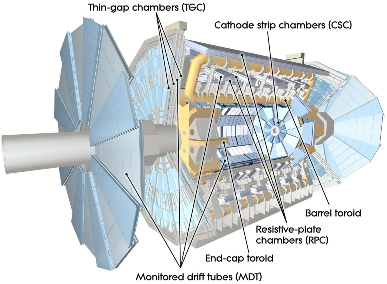
- energy measurement
- sampling calorimeter
- ECal and HCal



A Toroidal LHC ApparatuS

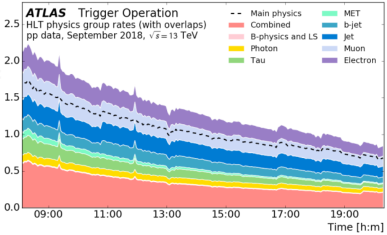
Muon Spectometer

- high energetic muons
- only to escape calos



Trigger System

- not possible to store all data
- two levels of trigger



Luminosity and pile-up

$$\frac{dN}{dt} = L\sigma$$

N : number of interactions

L : istantaneous luminosity

σ : cross section

Luminosity and pile-up

$$\frac{dN}{dt} = L\sigma$$

$$L = \frac{N_1 N_2 N_b f}{\Sigma}$$

N_1, N_2 : particles per bunch

N_b : number of bunches

f : frequency

Σ : transverse area

Luminosity and pile-up

$$\frac{dN}{dt} = L\sigma$$

$$\mathcal{L} = \int_0^T L(t)dt \qquad L = \frac{N_1 N_2 N_b f}{\Sigma}$$

$\mathcal{L}$: integrated luminosity

Luminosity and pile-up

$$\frac{dN}{dt} = L\sigma$$

$$\mathcal{L} = \int_0^T L(t)dt \qquad L = \frac{N_1 N_2 N_b f}{\Sigma}$$

$$N = \mathcal{L}\sigma$$

Luminosity and pile-up

$$\frac{dN}{dt} = L\sigma$$

$$\mathcal{L} = \int_0^T L(t)dt \qquad L = \frac{N_1 N_2 N_b f}{\Sigma}$$

$$N = \mathcal{L}\sigma$$

higher frequency

$\Downarrow$

higher luminosity

$\Downarrow$

more **pile-up**