



Investigando l'infinitamente piccolo: la fisica all'LHC

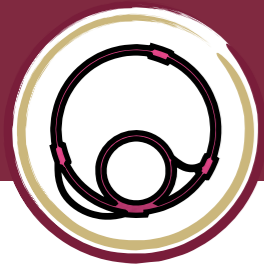


Nello Brusino

INFN Roma

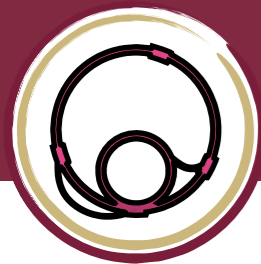


Istituto Nazionale di Fisica Nucleare



Domanda





Domanda #1

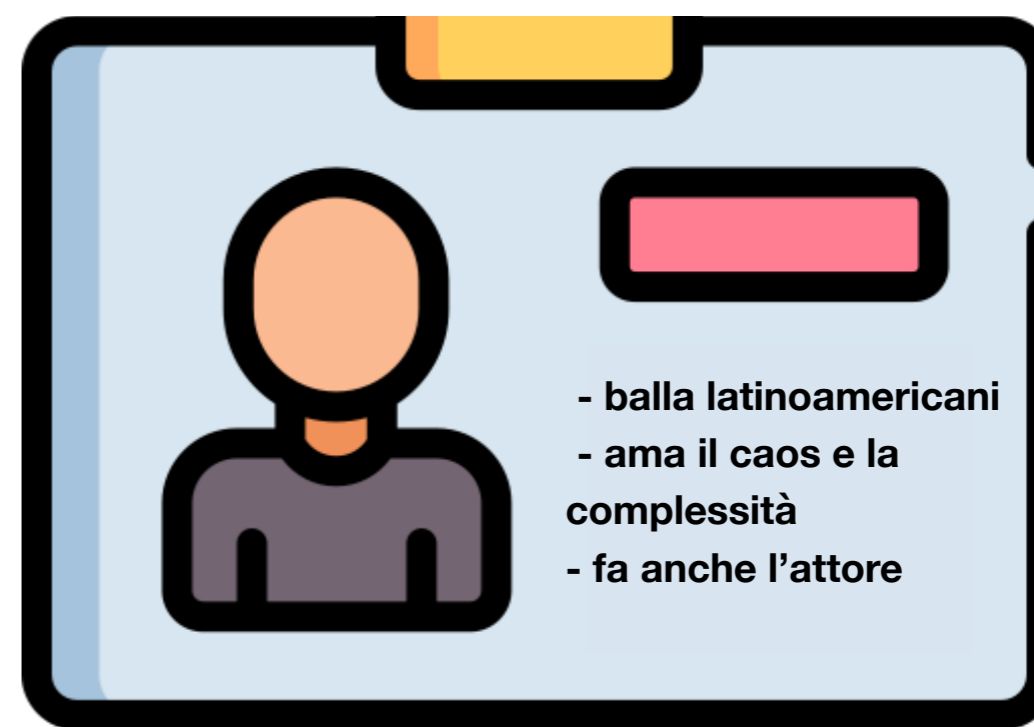


Identikit di un'e fisica*

α



γ

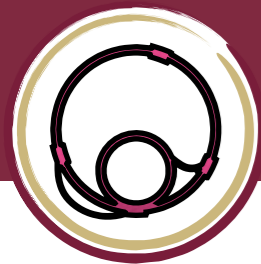


β



Chi di questi è un'e fisica?

- A. α
- B. α e β
- C. β e γ
- D. α , β e γ



Domanda #1



Identikit di un'e fisica*

α

- usa spesso carta e penna
- ha una pessima memoria
- dubita della fisica quantistica

γ

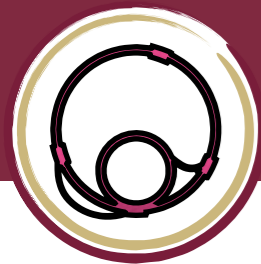
- balla latinoamericani
- ama il caos e la complessità
- fa anche l'attore

β

- si è diplomata in pianoforte
- non ha vinto il Nobel
- usa caschetto e cacciavite

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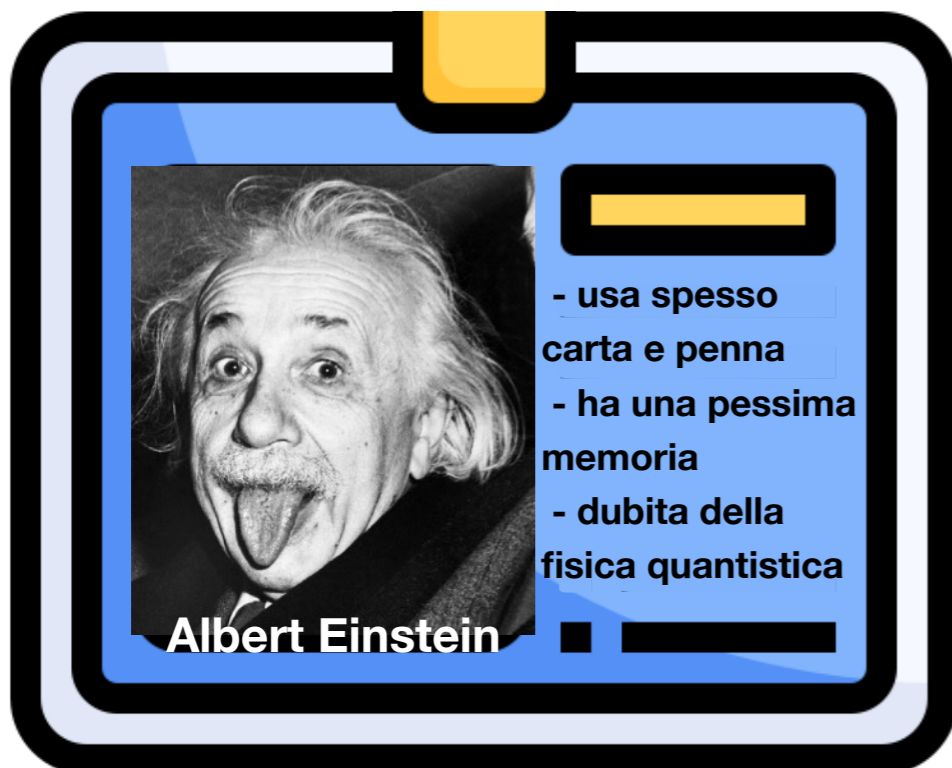


Domanda #1



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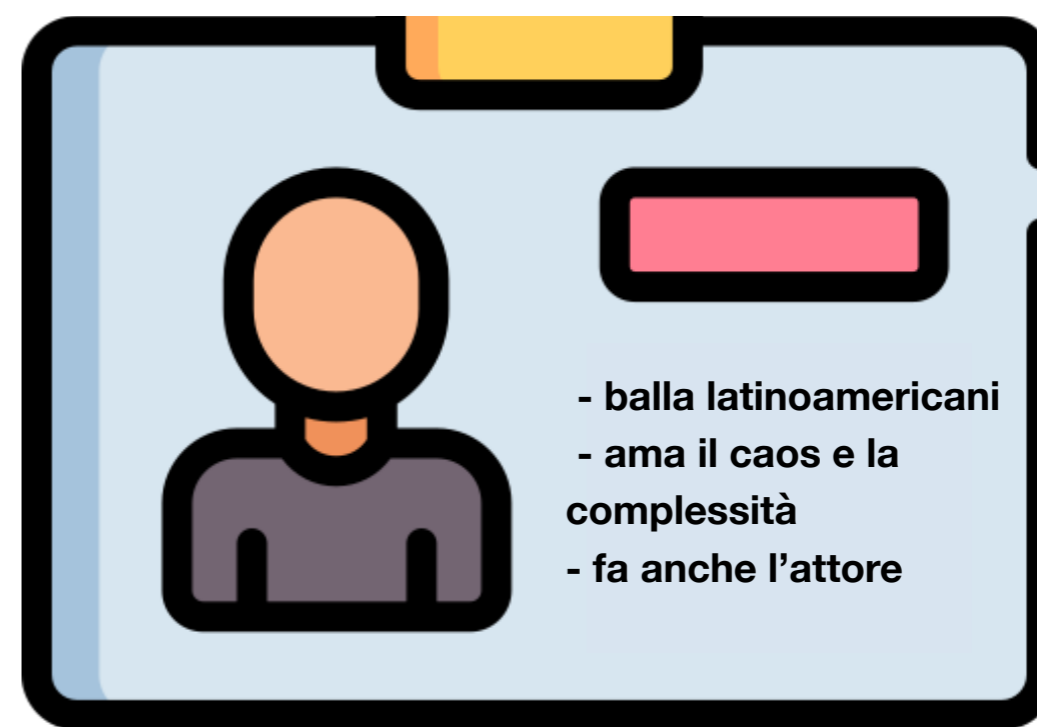
α



Albert Einstein

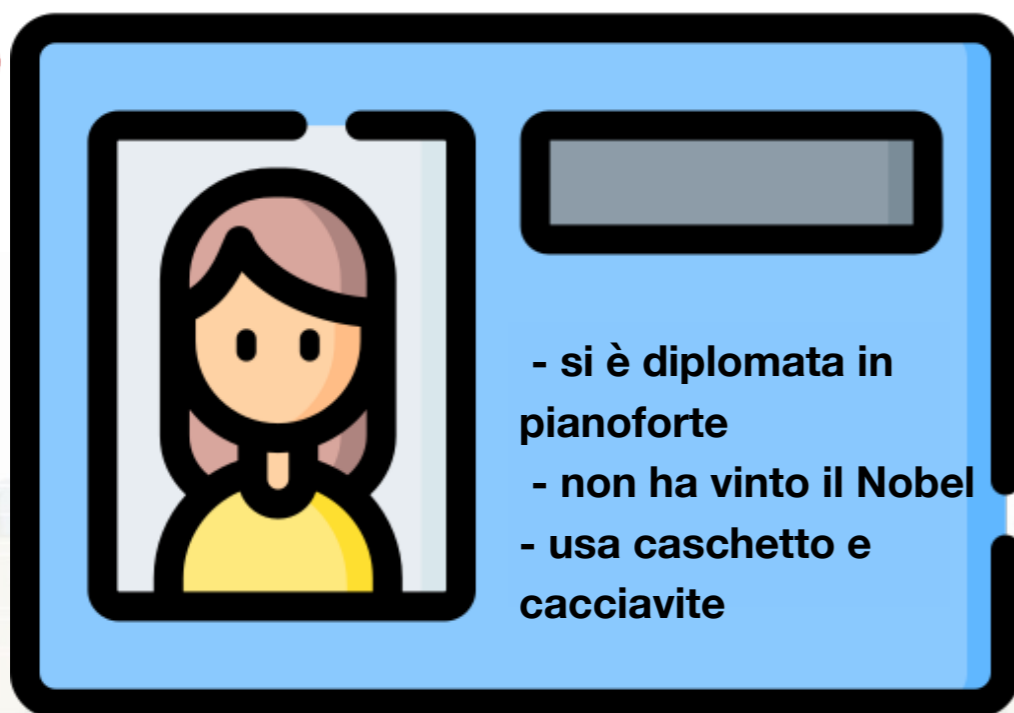
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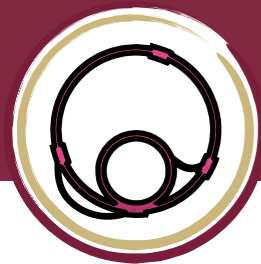
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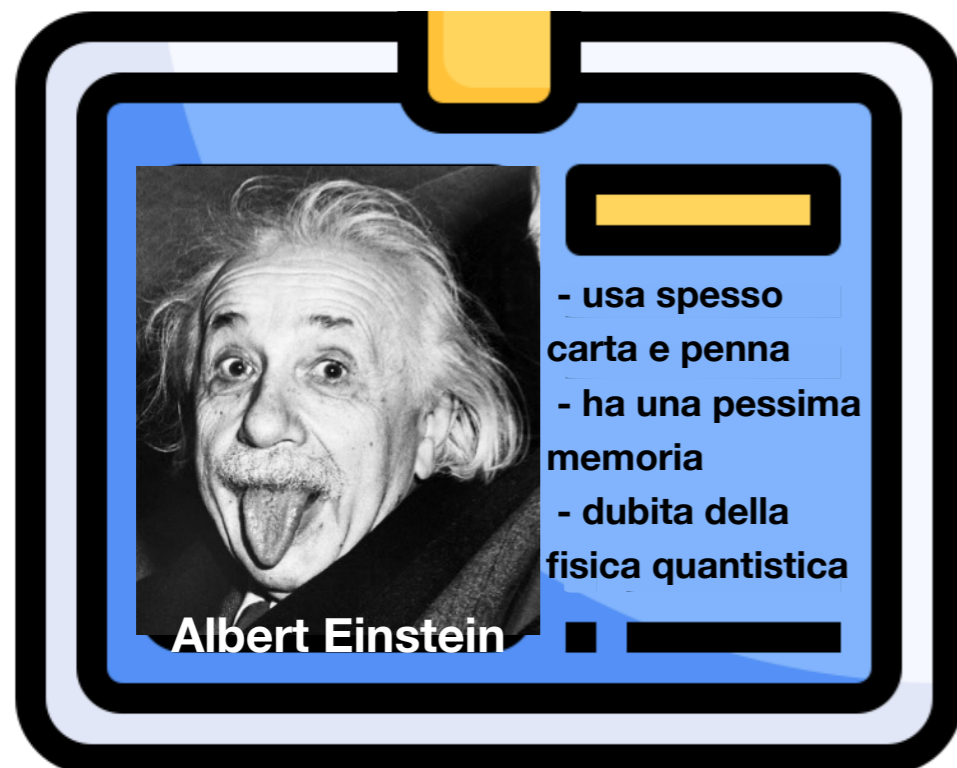


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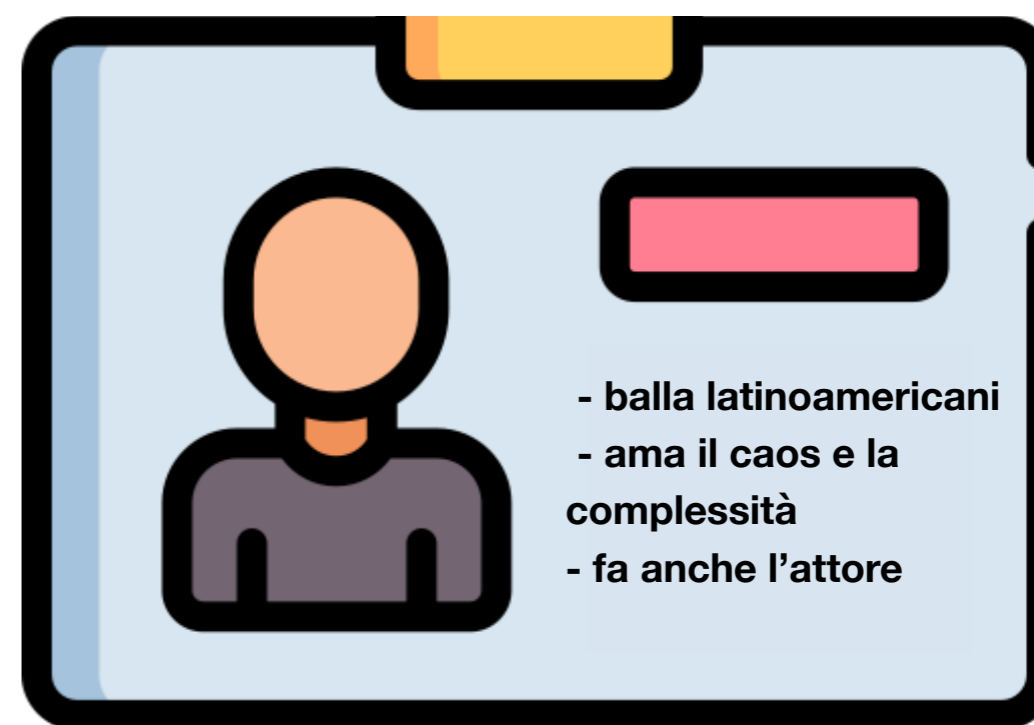
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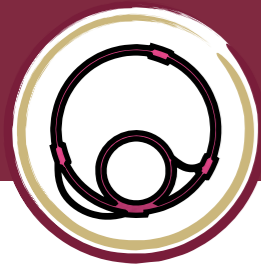


Fabiola Gianotti

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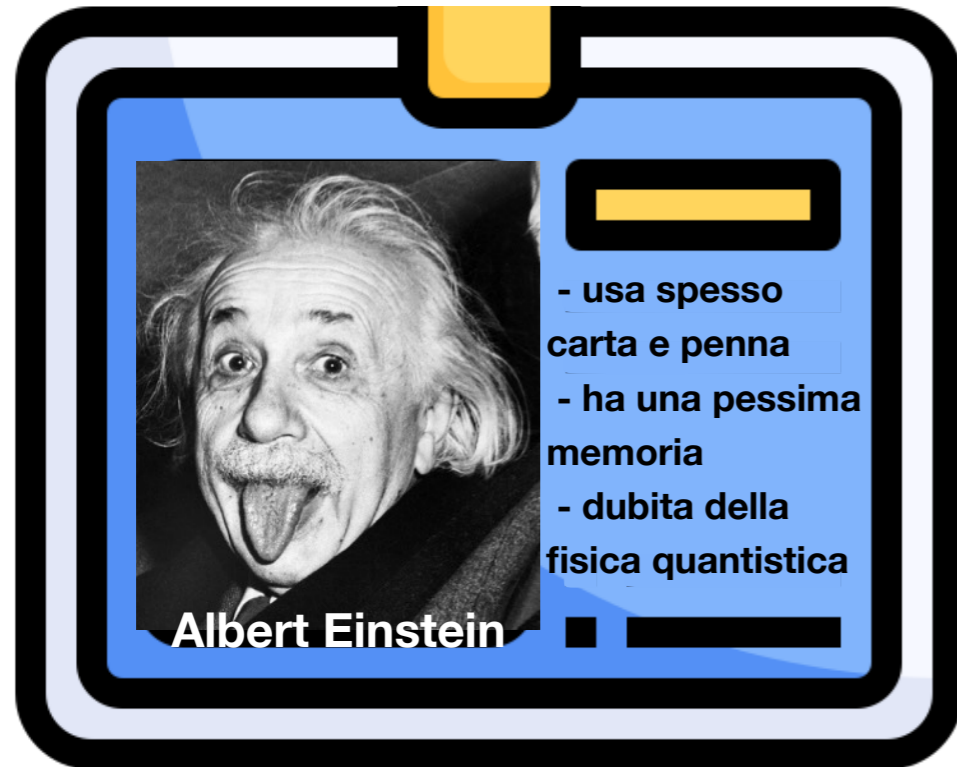


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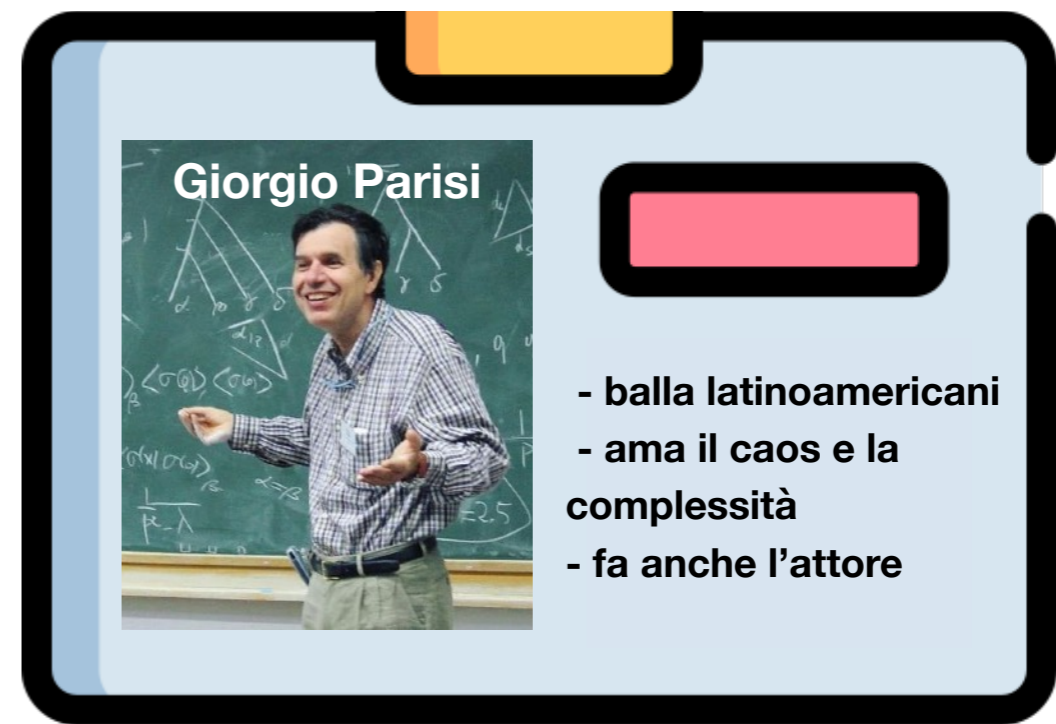
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Albert Einstein

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Giorgio Parisi

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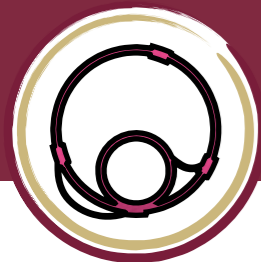


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Identikit di una fisica del CERN

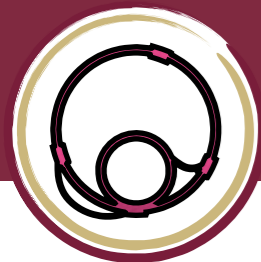
Fisica del CERN

TITOLO:
- Dottore/ssa in fisica particellare

ESPERIENZE:
- pubblicazioni
- conferenze
- seminari

INTERESSI:
- infinitamente piccolo
- fisica delle alte energie
- ...

SKILL ULTERIORI:
-
-



Identikit di una fisica del CERN

Fisica del CERN

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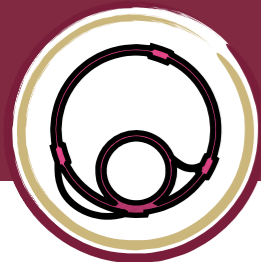
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SKILL ULTERIORI:

SEGNI PARTICOLARI:

APPROVED



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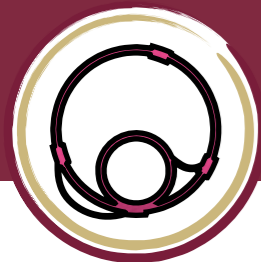
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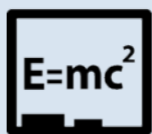


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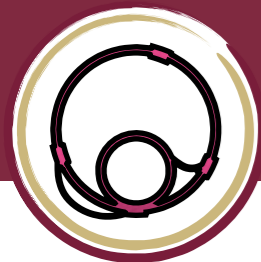
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SEGNI PARTICOLARI:
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APPROVED



Identikit di una fisica del CERN



APPROVED

Fisica del CERN

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ESPERIENZE:

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INTERESSI:

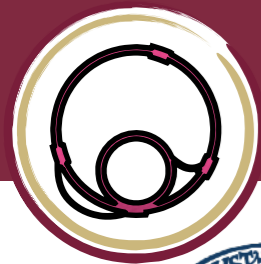
- infinitamente piccolo
- fisica delle alte energie
- ...

SKILL ULTERIORI:

-
-
-
-
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-

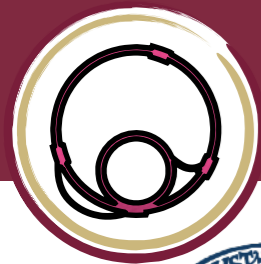
SEGNI PARTICOLARI:

- indossa un badge CERN
- ha sempre con se un PC
- ha la valigia pronta e tanti souvenir !



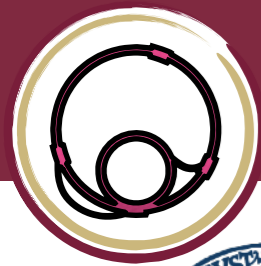
Viaggi di una fisica





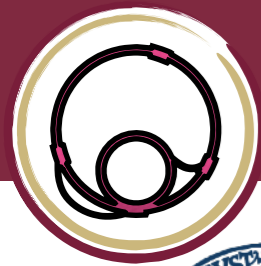
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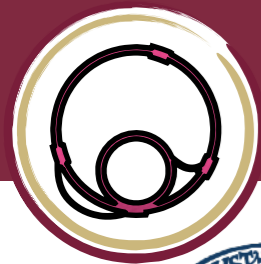
Viaggi di una fisica





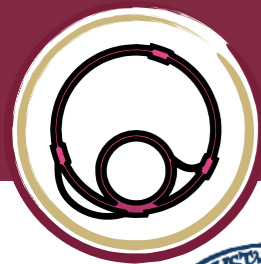
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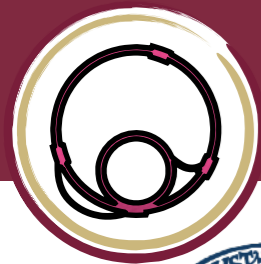
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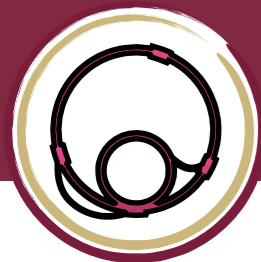
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Viaggi di una fisica

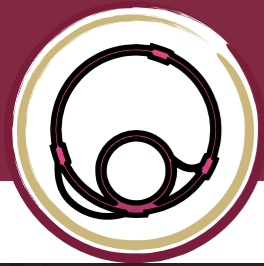




L' "infinitamente" piccolo

[The Higgs Boson Simplified Through Animation \(on Youtube\)](#)

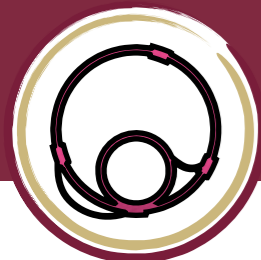




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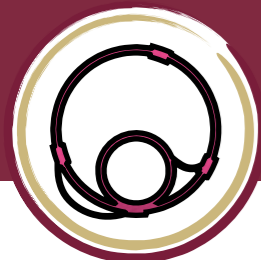
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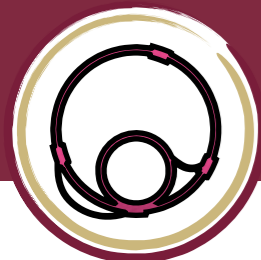
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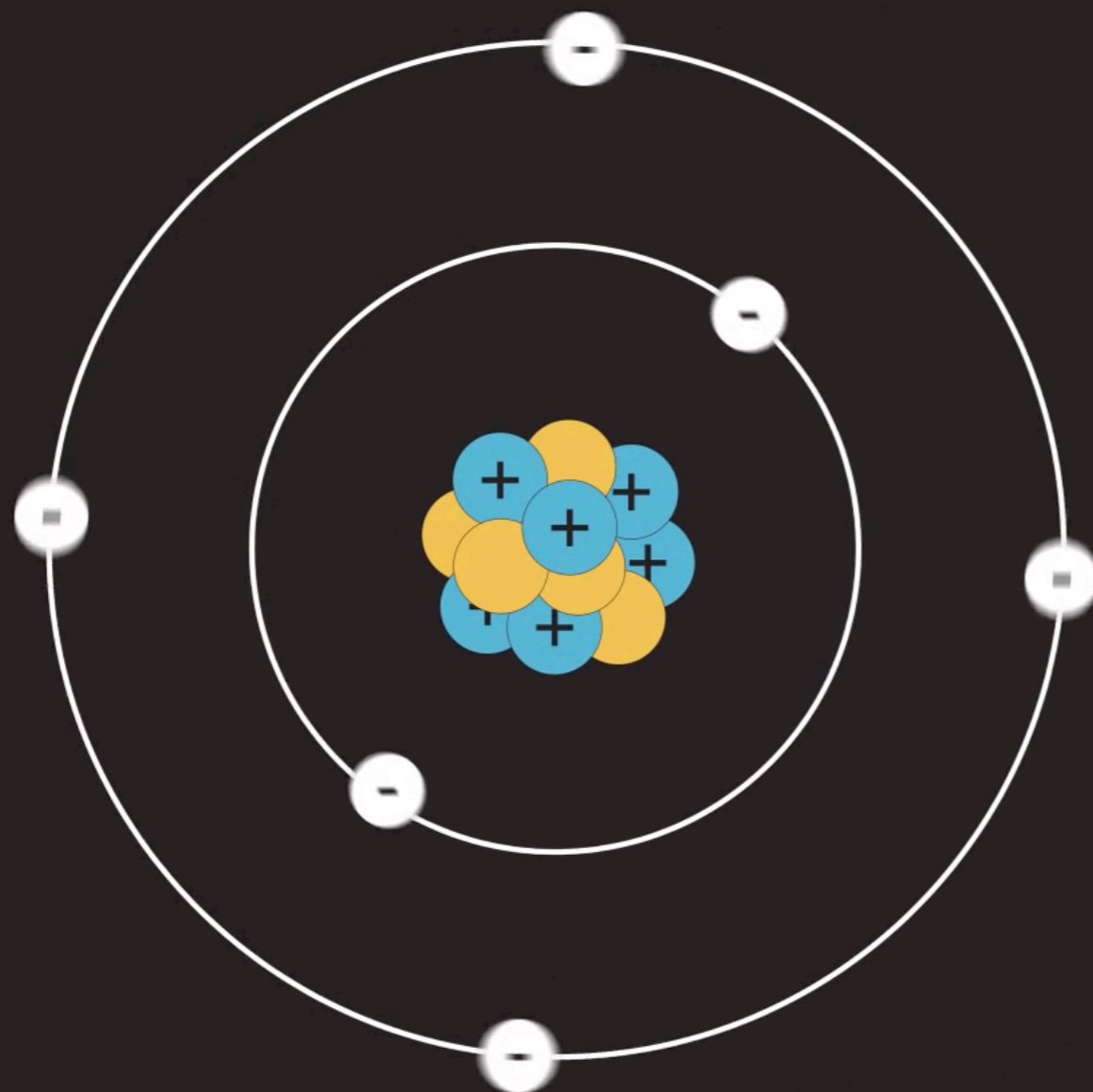
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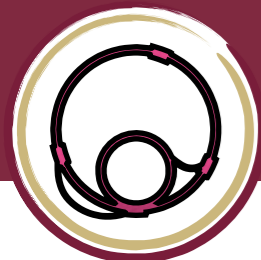


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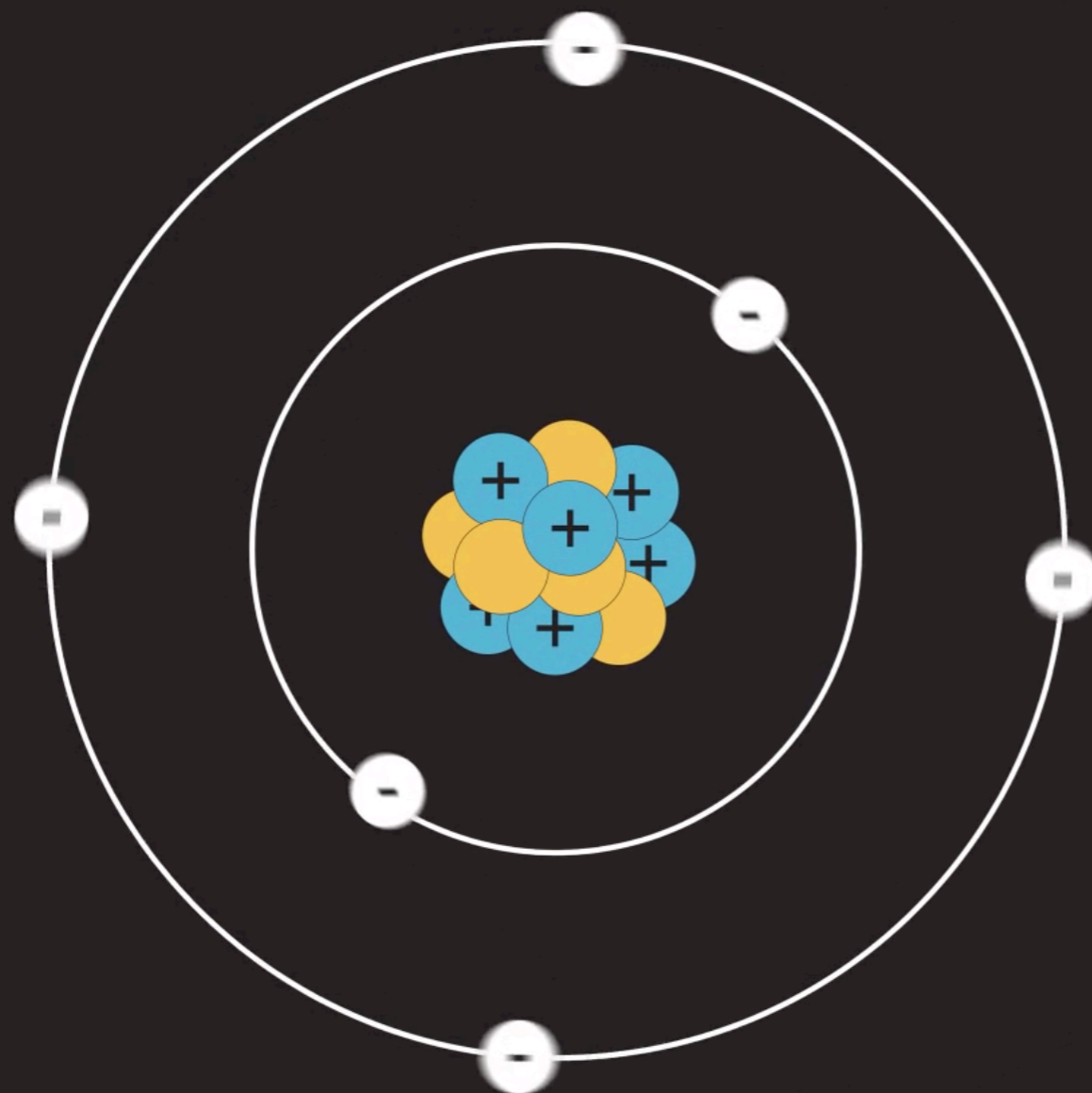


Atom

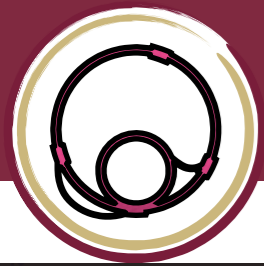


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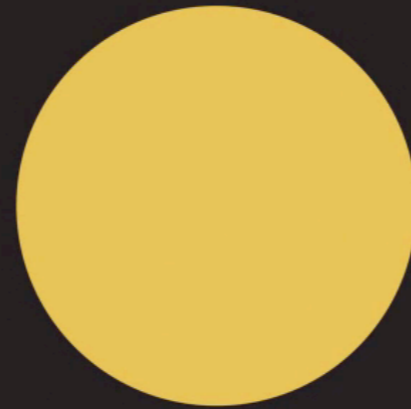


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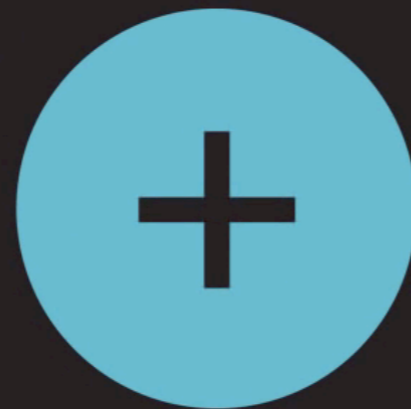


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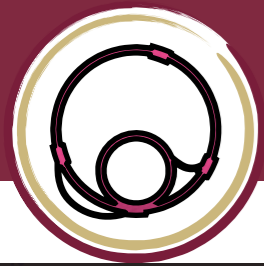
Neutron



Proton

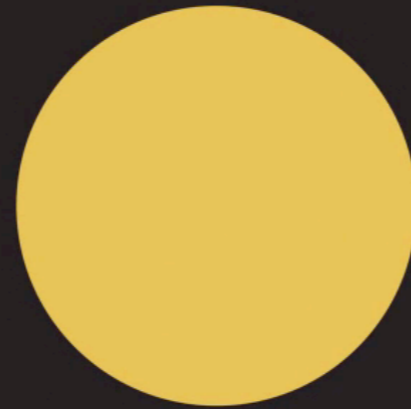


Electron

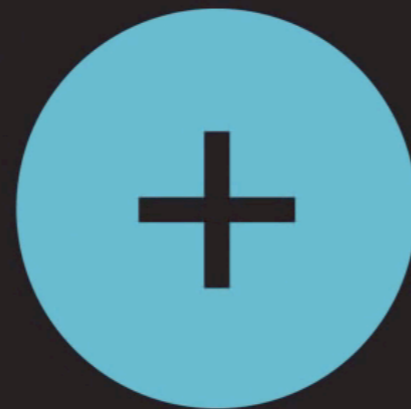


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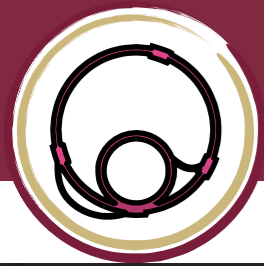
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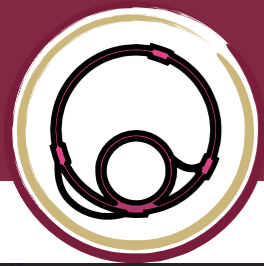
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u

d

Quarks



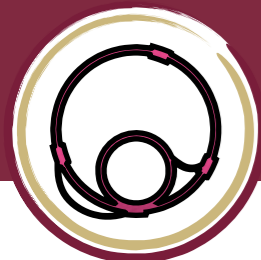
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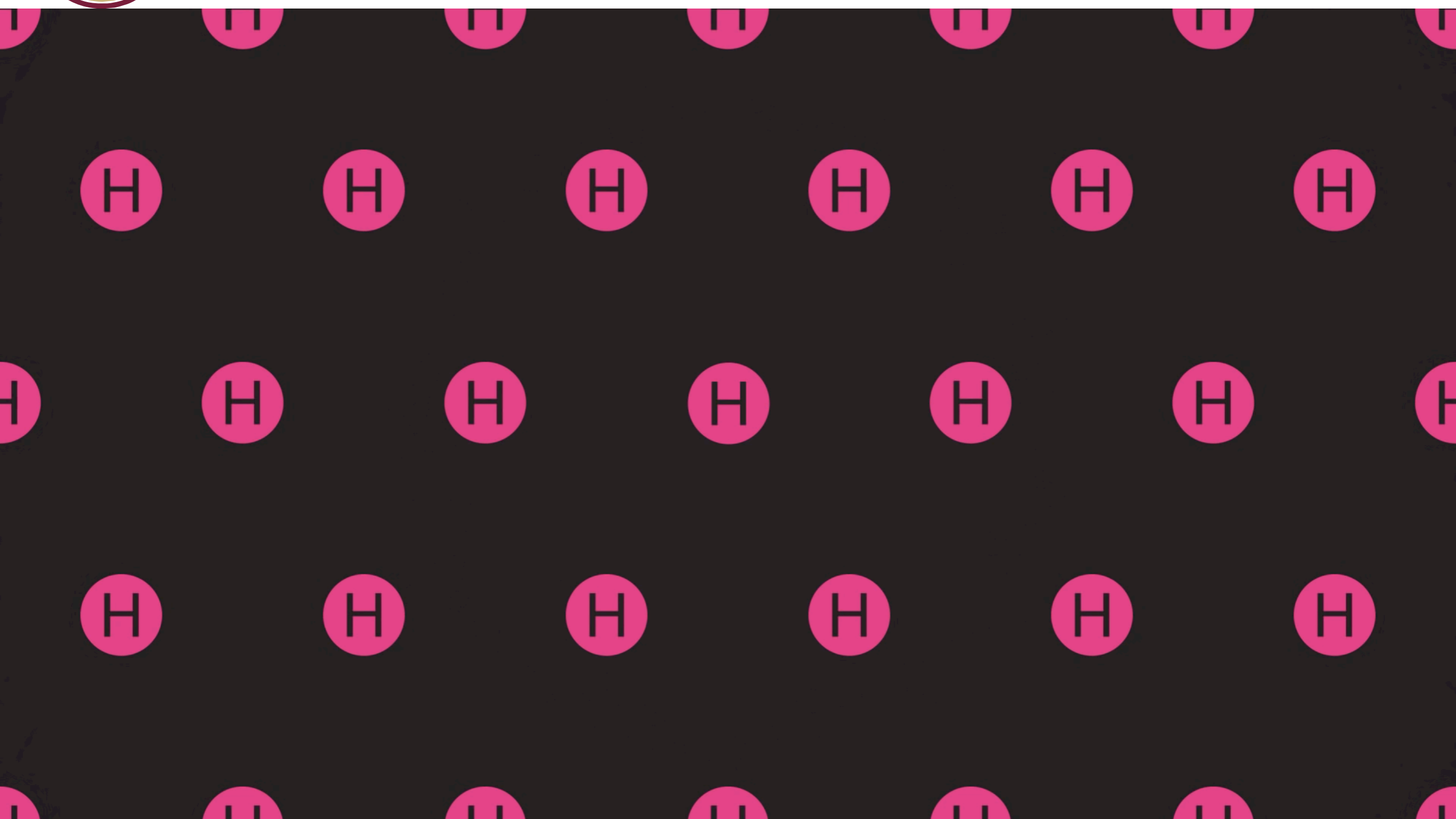
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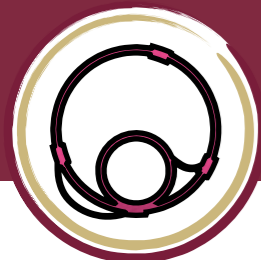
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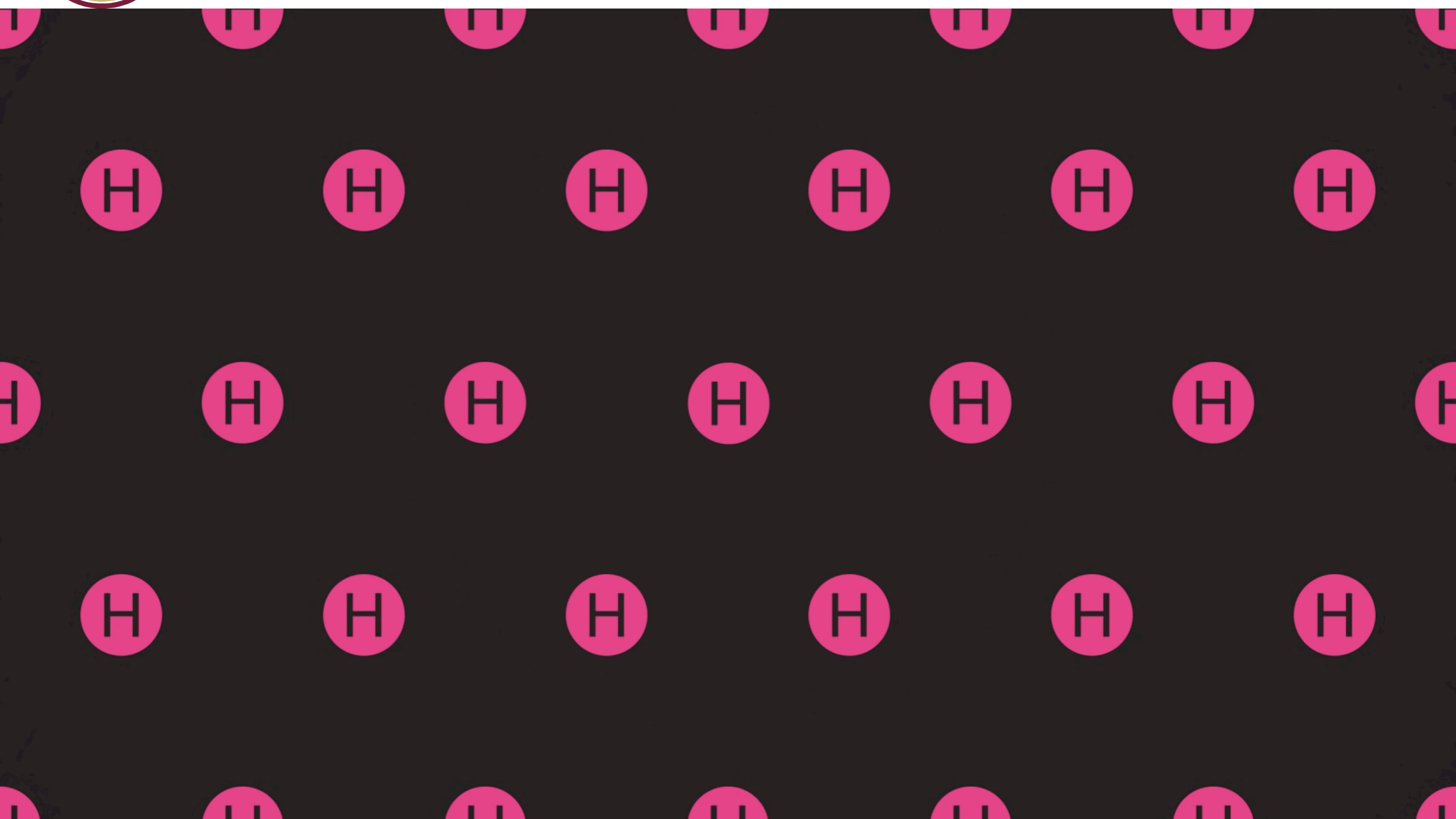
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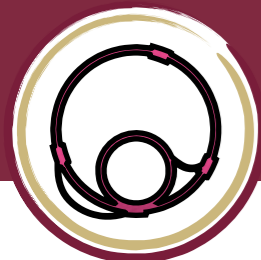




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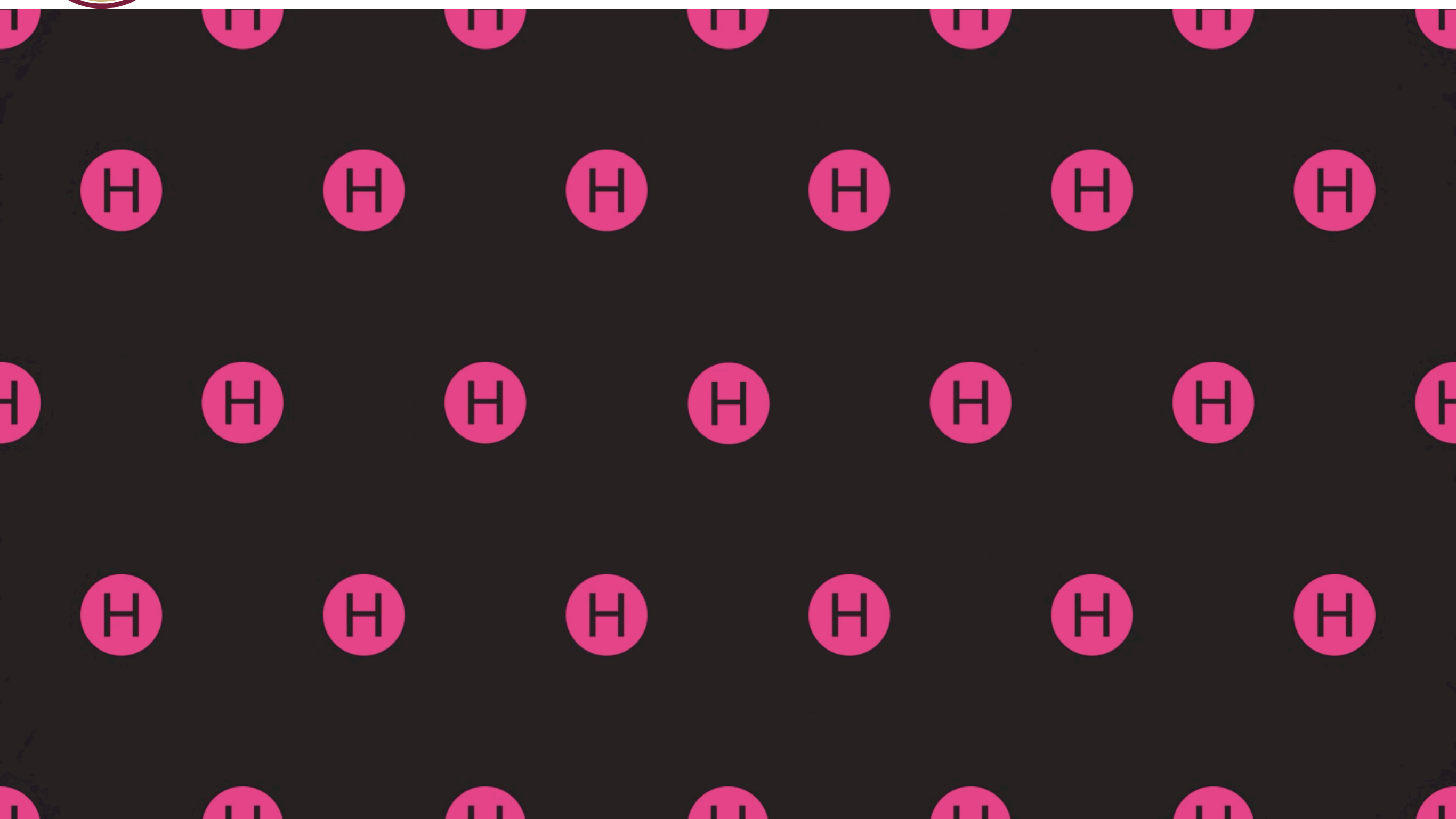
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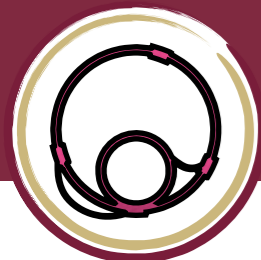




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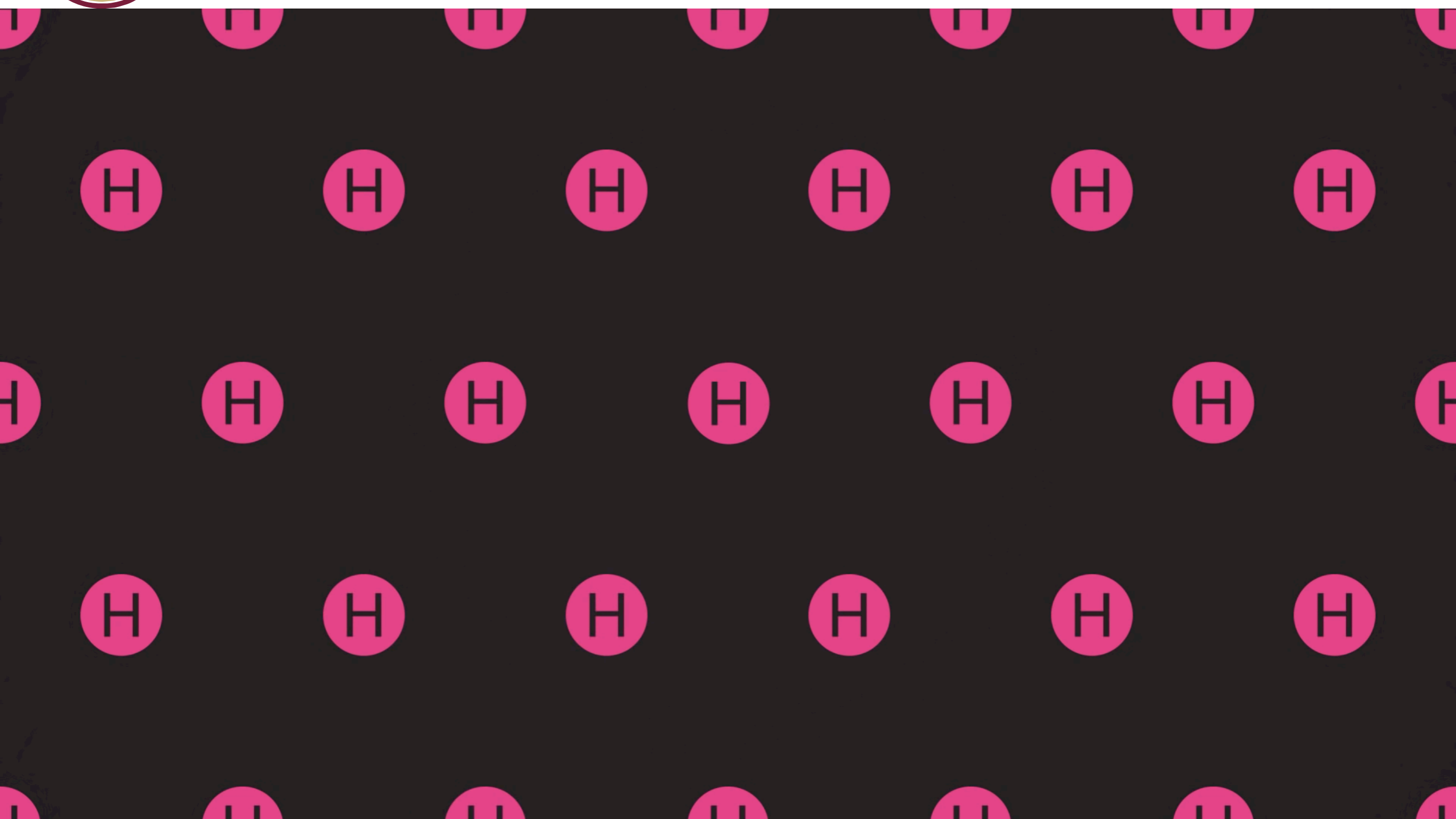
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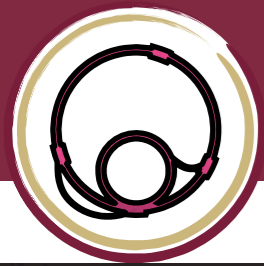




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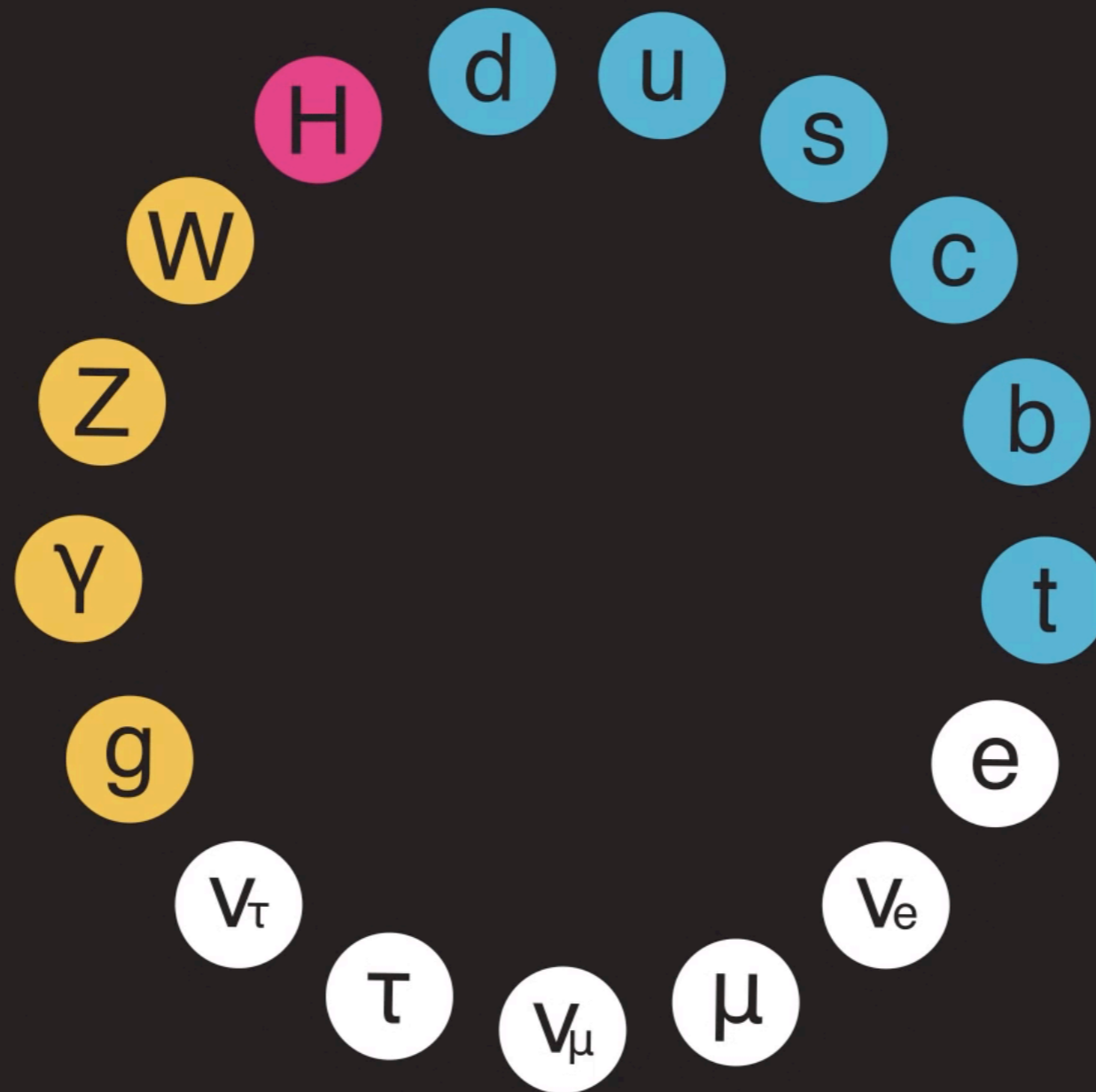
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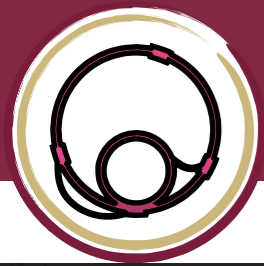




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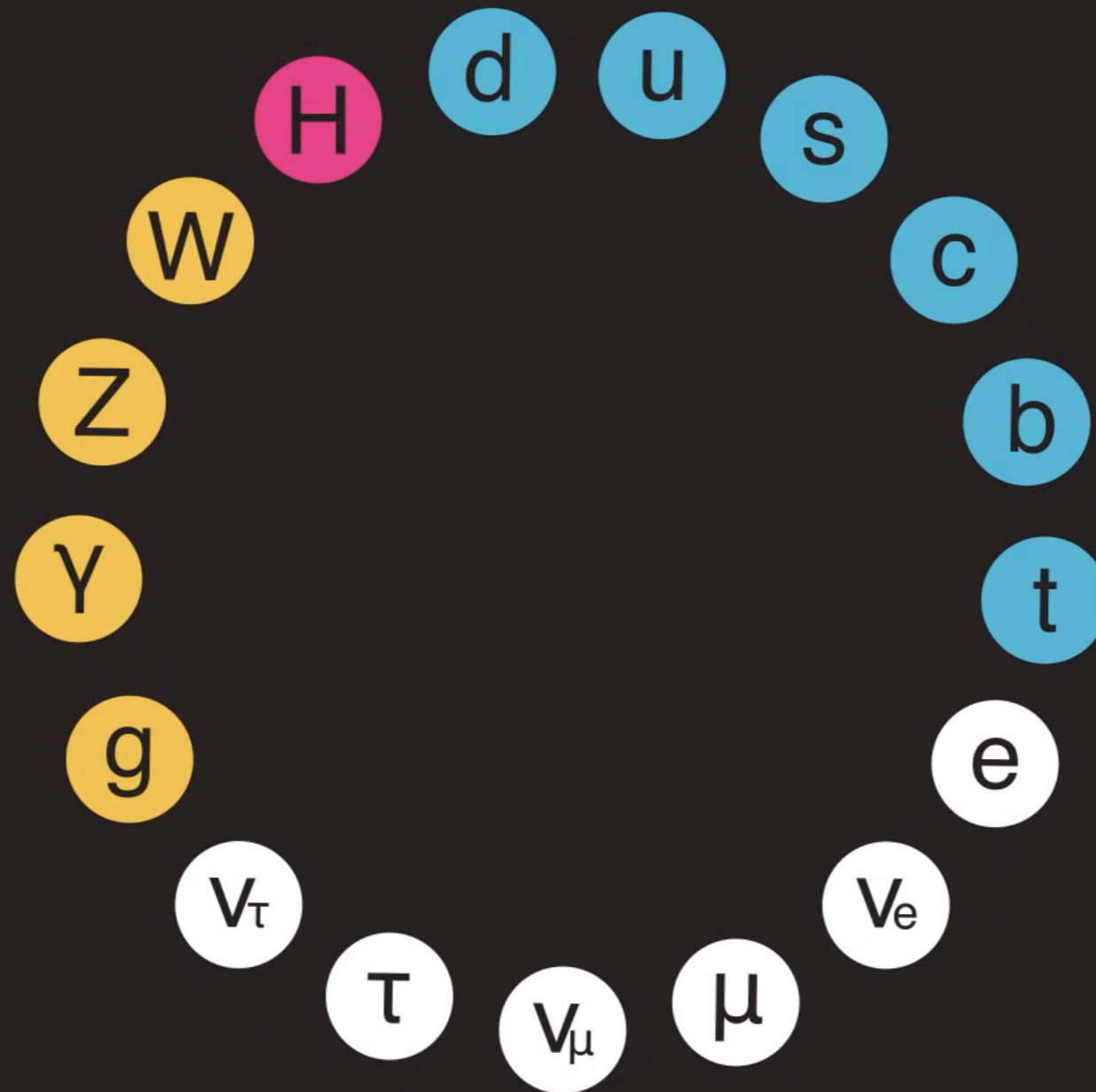
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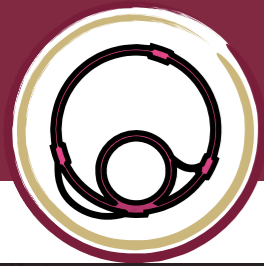




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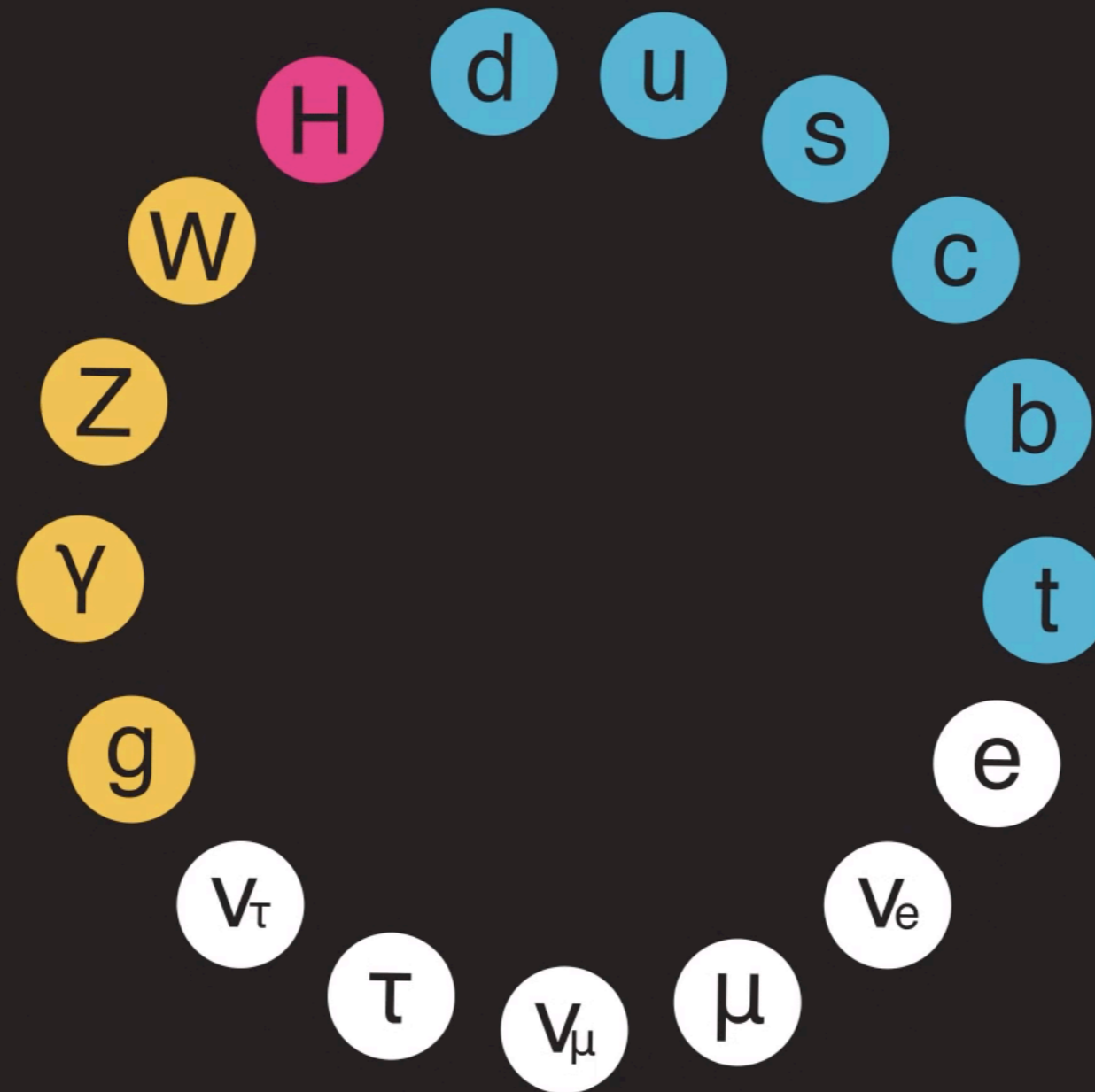
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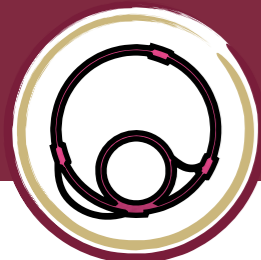


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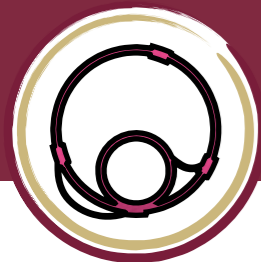
Large
Hadron
Collider



L' "infinitamente" piccolo

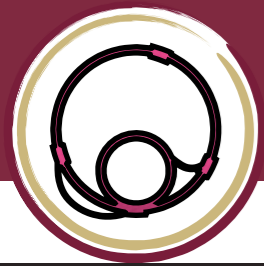
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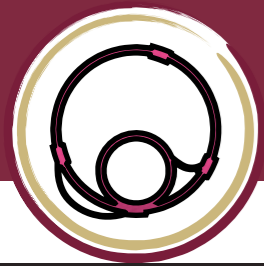


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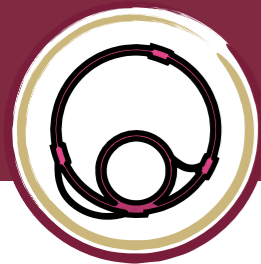


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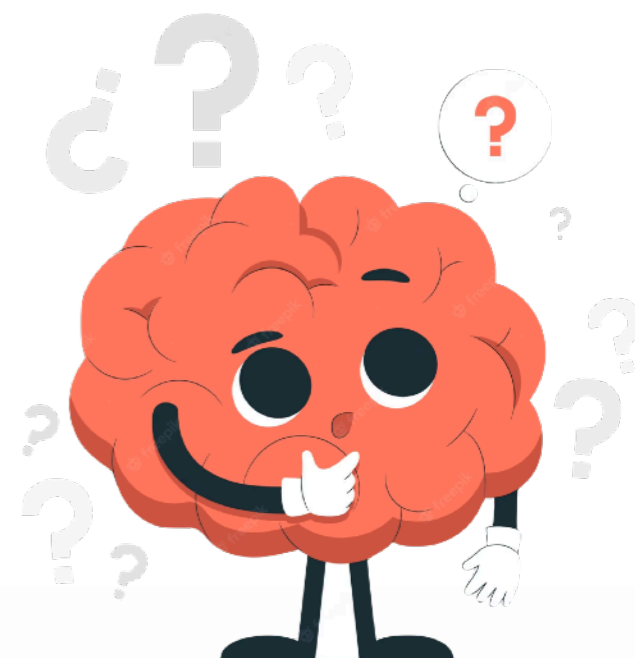


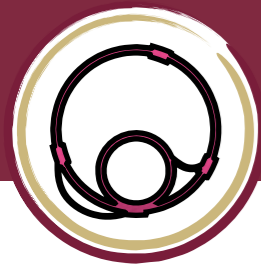
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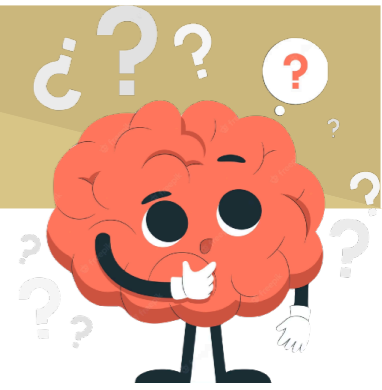


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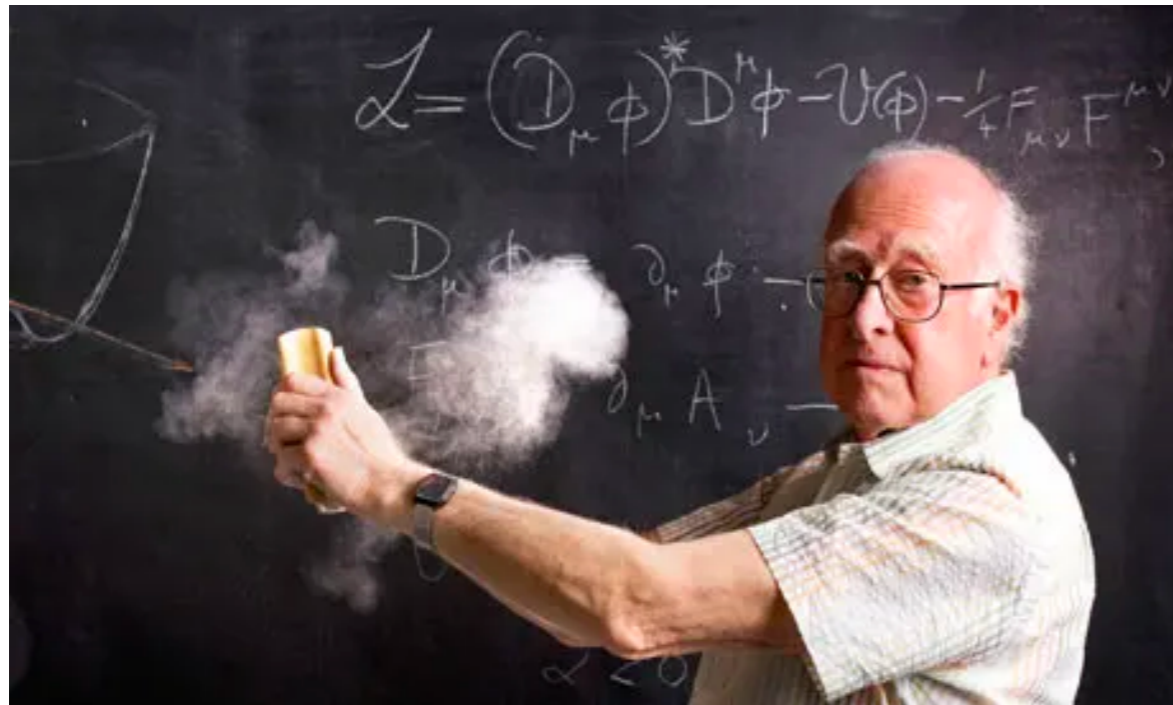


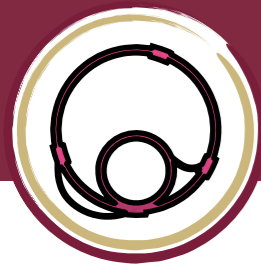


Domanda #2

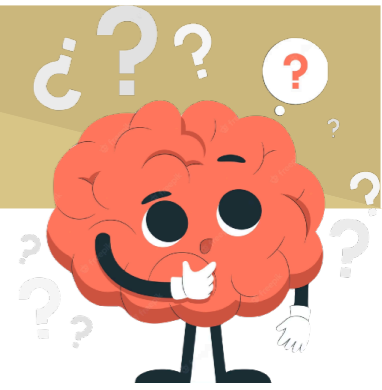


Che cos'è il bosone di Higgs e quando è stato scoperto?

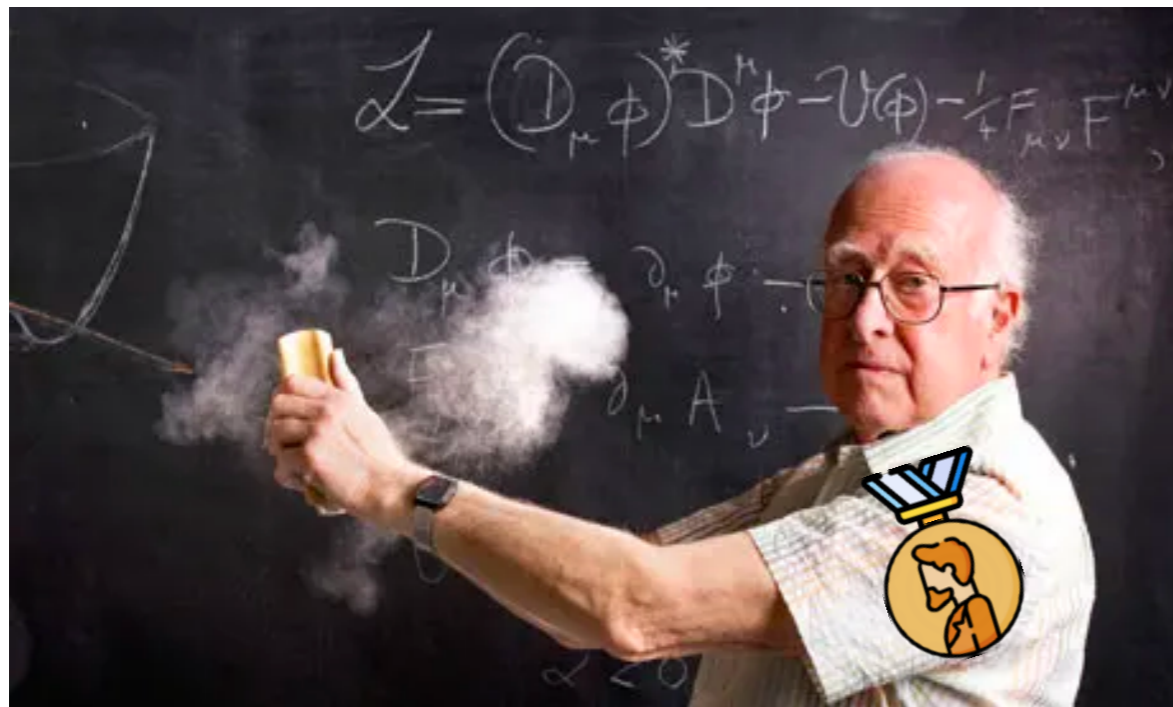




Domanda #2

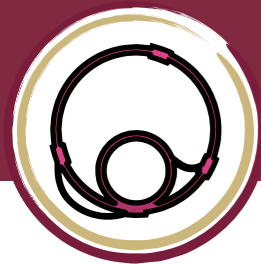


Che cos'è il bosone di Higgs e quando è stato scoperto?

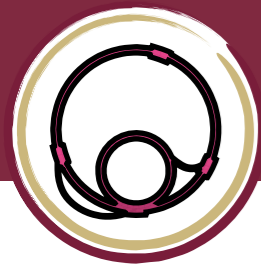


- A. È una particella responsabile della massa, scoperta nel 2012 all'LHC di Ginevra
- B. È una particella mediatrice della corrente, scoperta nel 2002 all'LHC di Genova
- C. È una particella responsabile della massa, scoperta nel 2022 all'LHC di Ginevra
- D. È una particella mediatrice della corrente, scoperta nel 2012 all'LHC di Genova



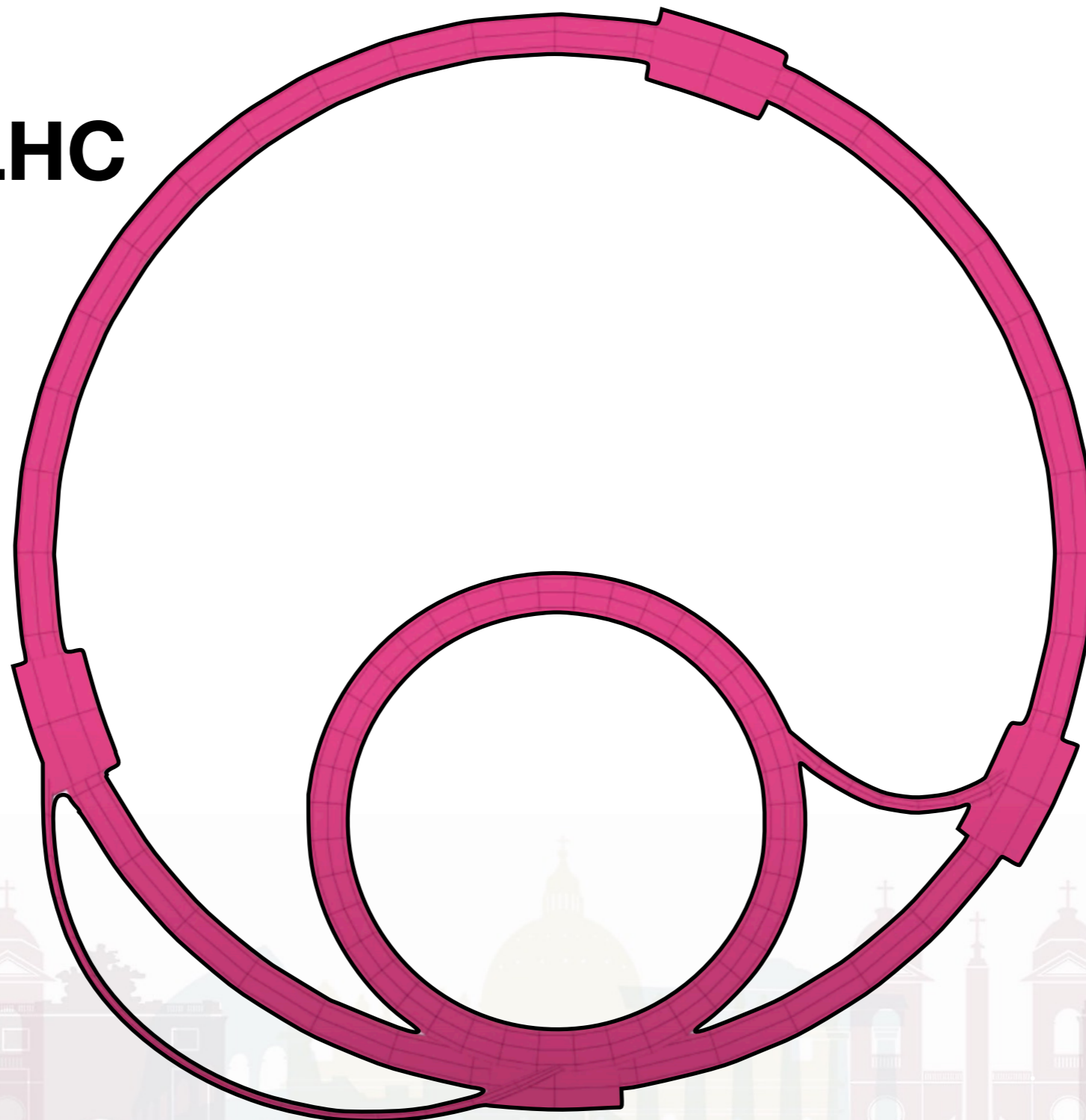


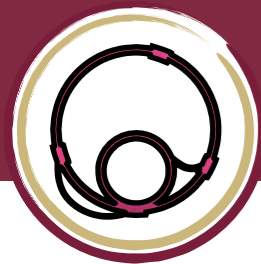
Come osservare l' ∞ -mente piccolo?



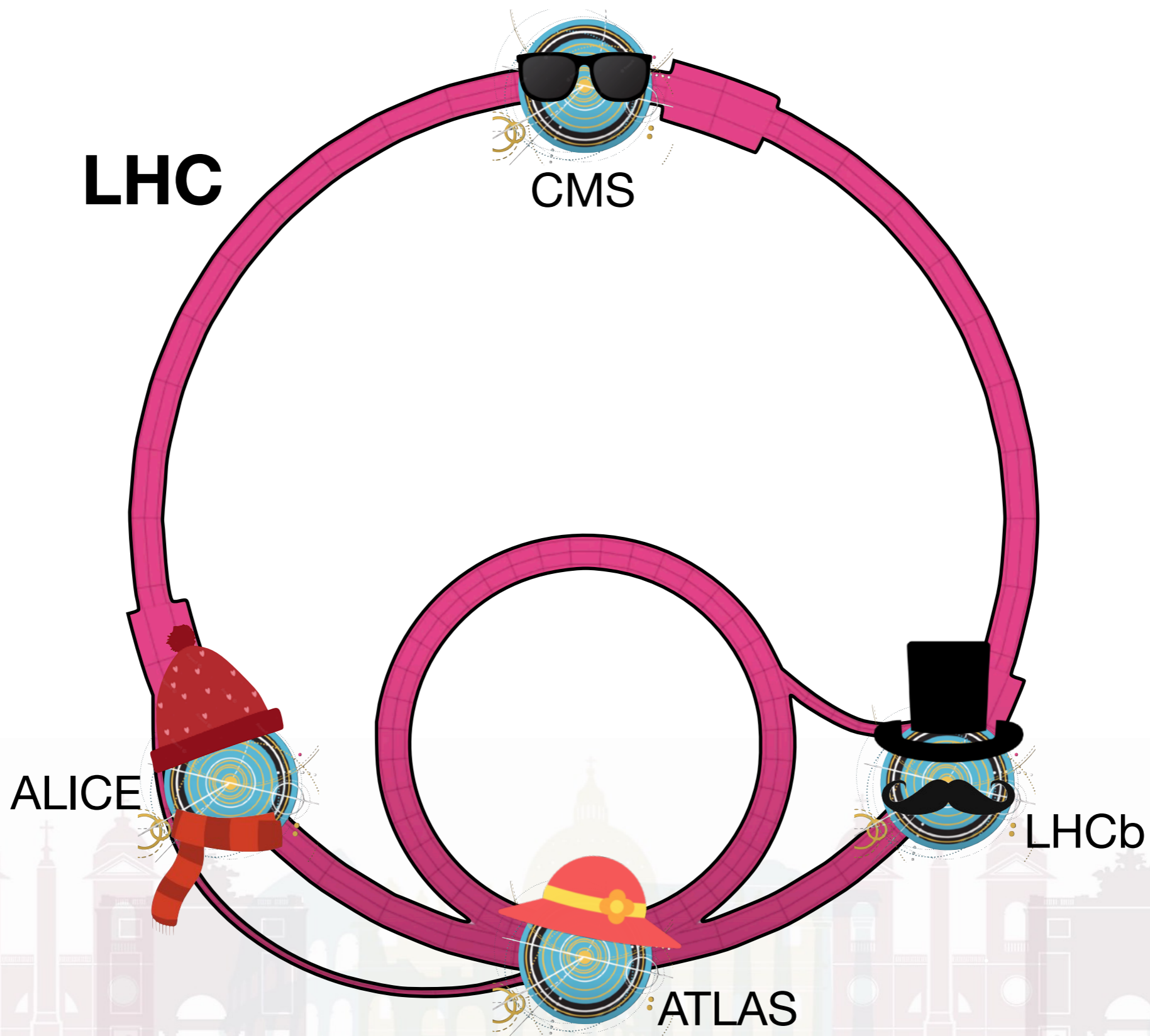
Come osservare l' ∞ -mente piccolo?

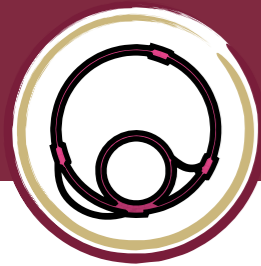
LHC





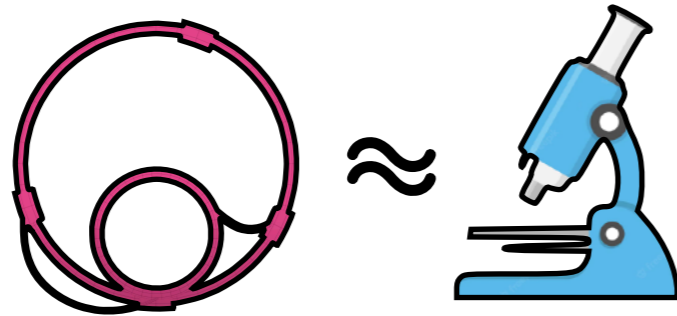
Come osservare l' ∞ -mente piccolo?



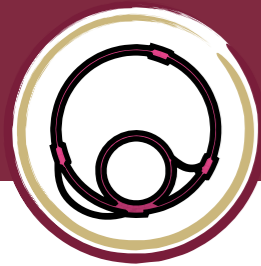


Analogie e numeri

[LHC by the numbers](#)

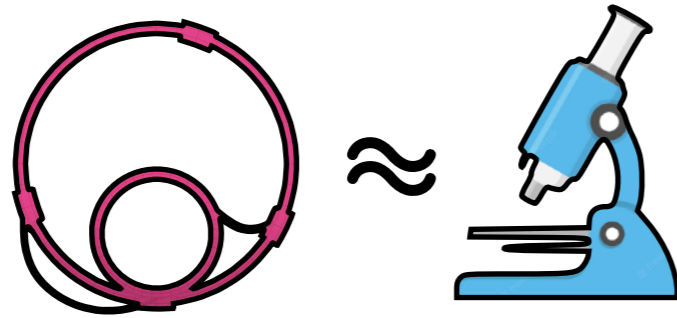


“Energia”	13.6 TeV (100 milioni x →)	200 V
Risoluzione	~1 fm (1 milionesimo di nm)	1 nm (1 milionesimo di mm)
Peso	migliaia di tonnellate	pochi kg
Profondità	100 m (sottoterra)	—
Temperatura	-271 °C	—
Dimensione	27 km (circonferenza)	< 1 m ²
Costo!	4 Miliardi €	500-3000 €

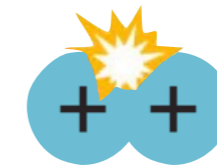


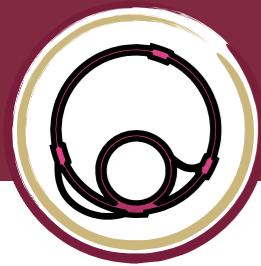
Analogie e numeri

[LHC by the numbers](#)



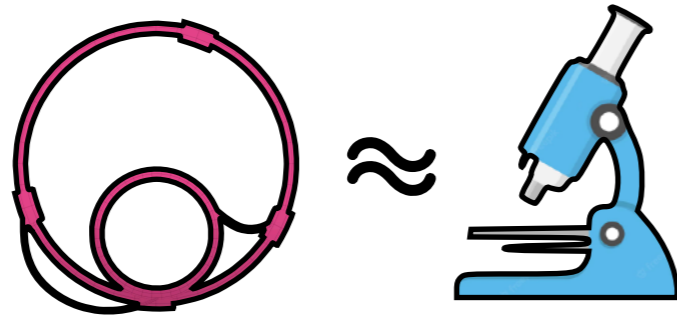
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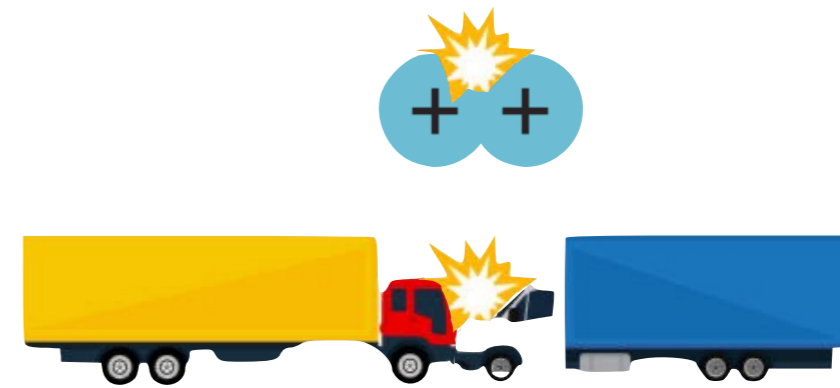


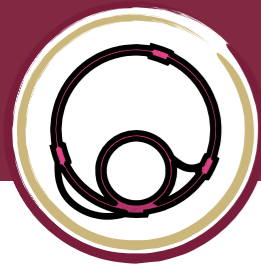
Analogie e numeri

LHC by the numbers



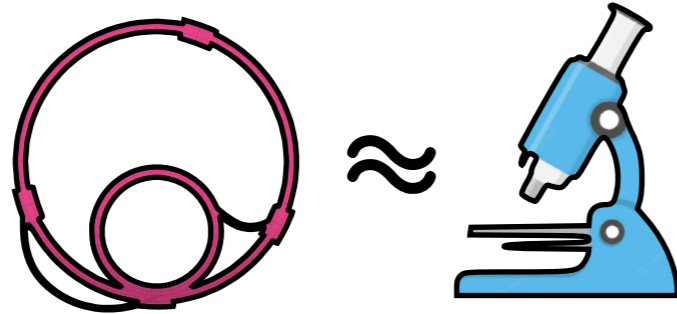
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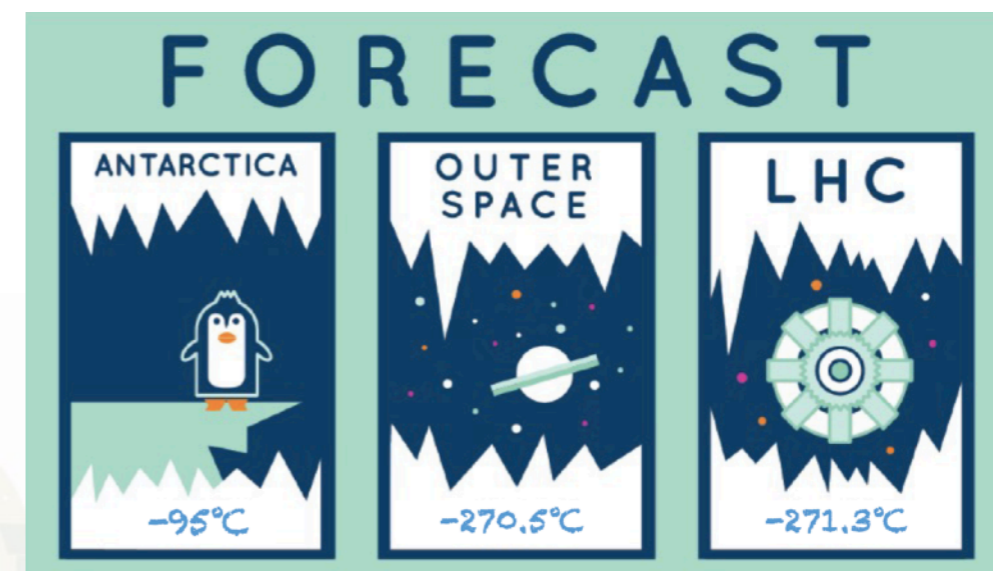
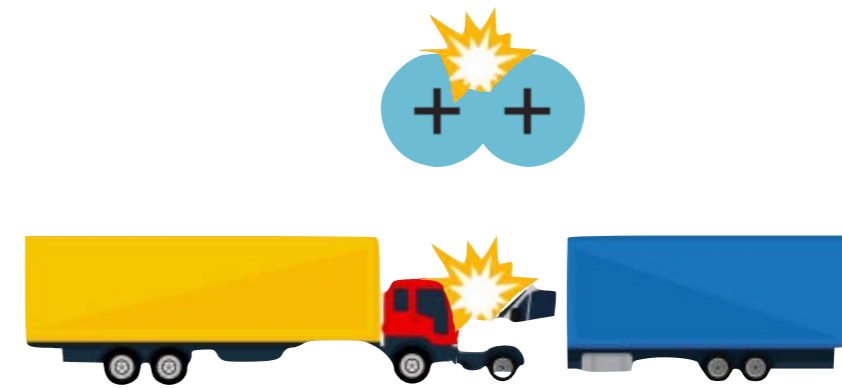


Analogie e numeri

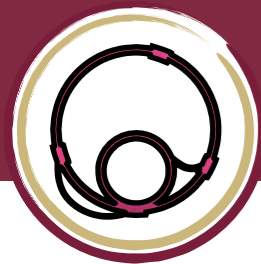
LHC by the numbers



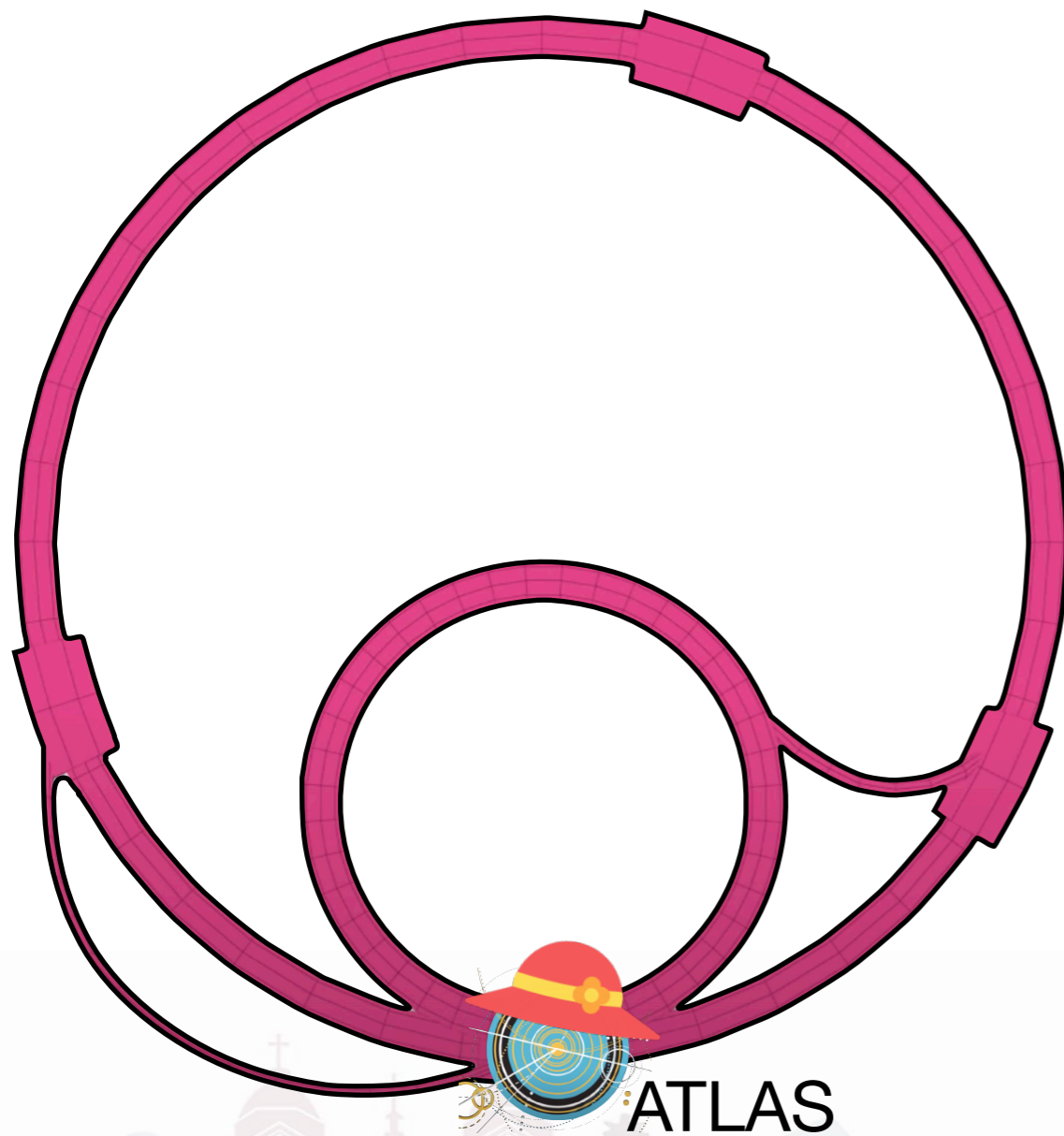
“Energia”	13.6 TeV (100 milioni x →)	200 V
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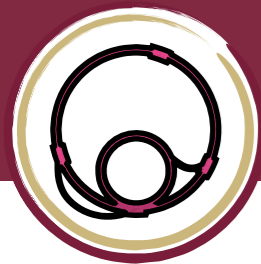


Vuoto più spinto del vuoto interstellare! (~10⁻¹⁰ mbar)

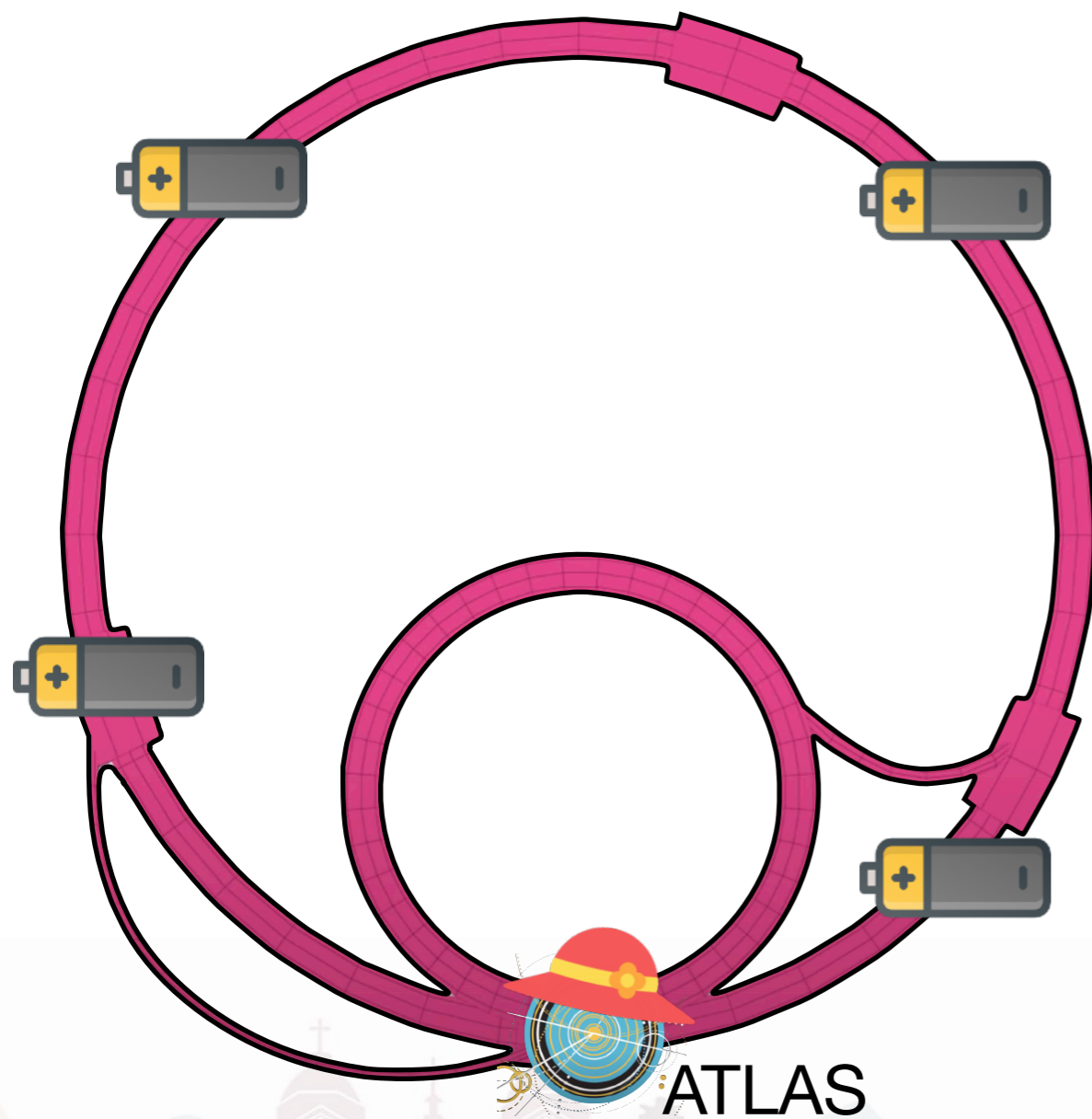


Elementi principali di ATLAS

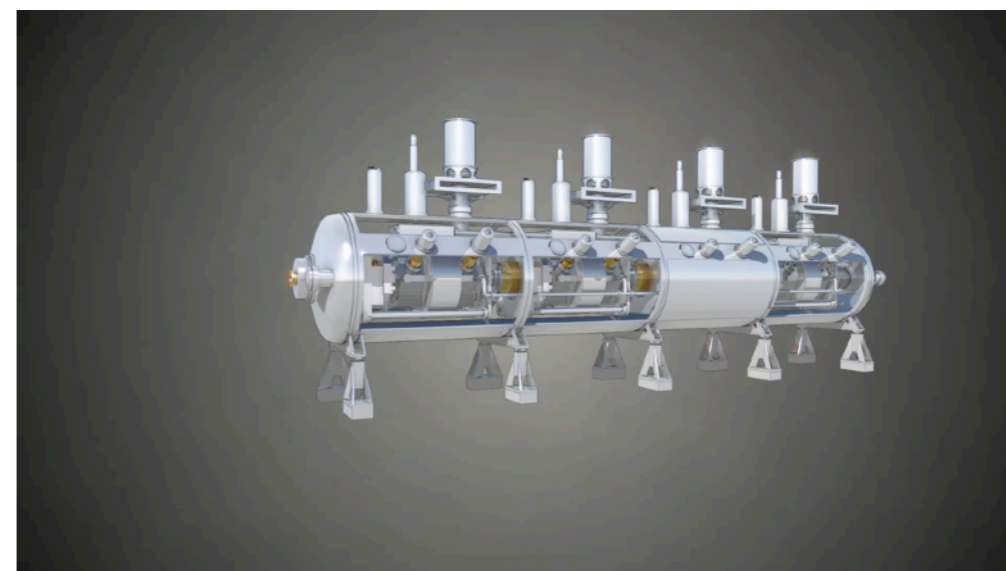




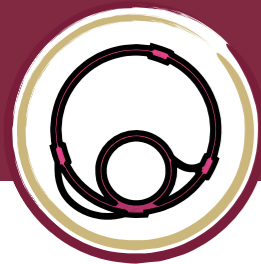
Elementi principali di ATLAS



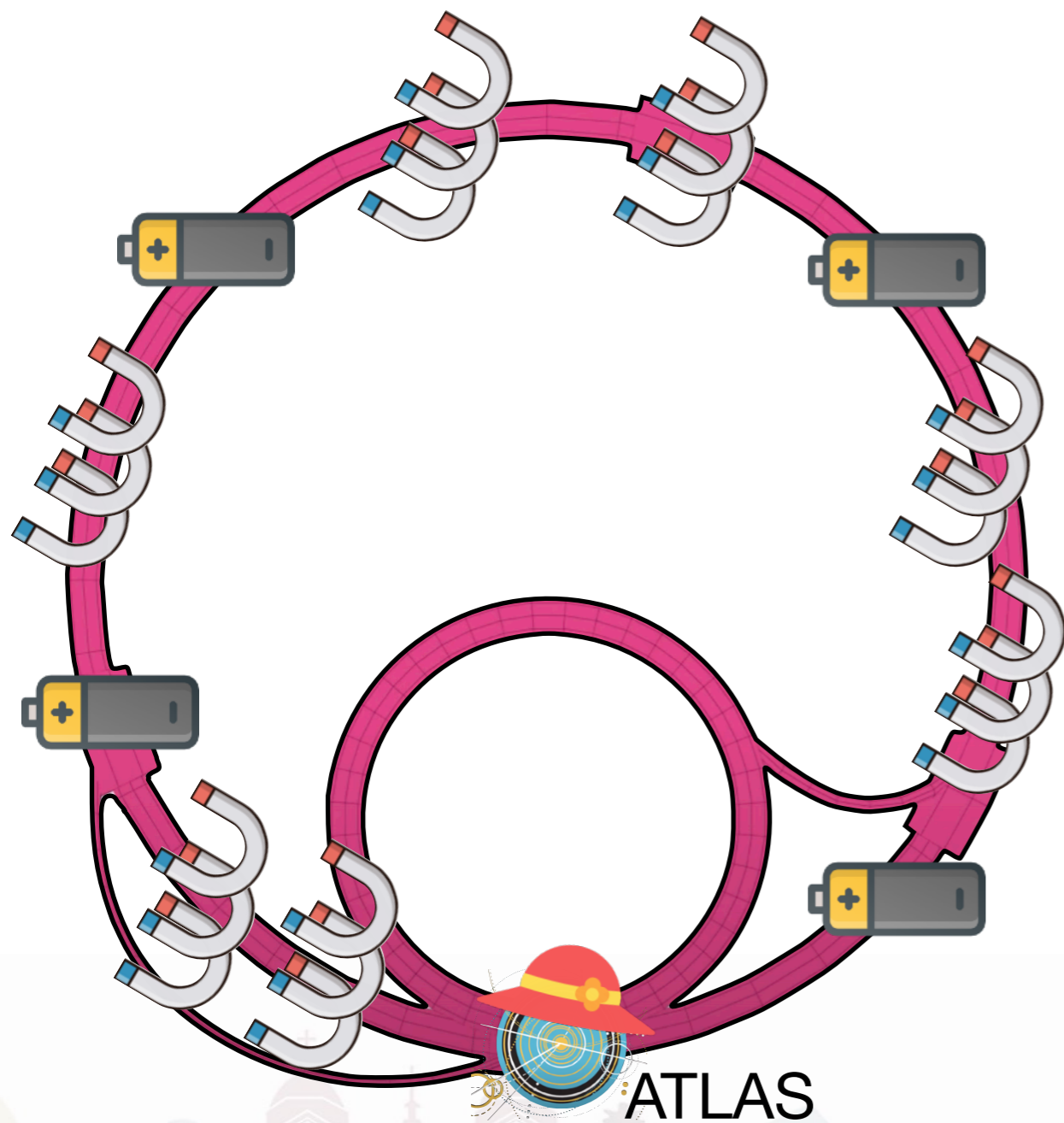
Cavità RF superconduttrici



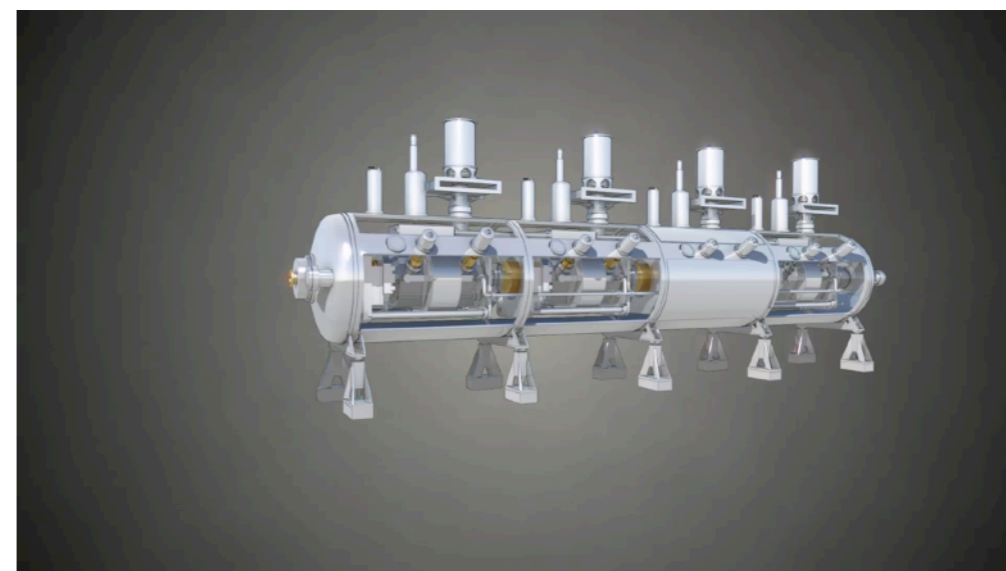
[DOI: 10.17181/cds.1750707](https://doi.org/10.17181/cds.1750707)



Elementi principali di ATLAS

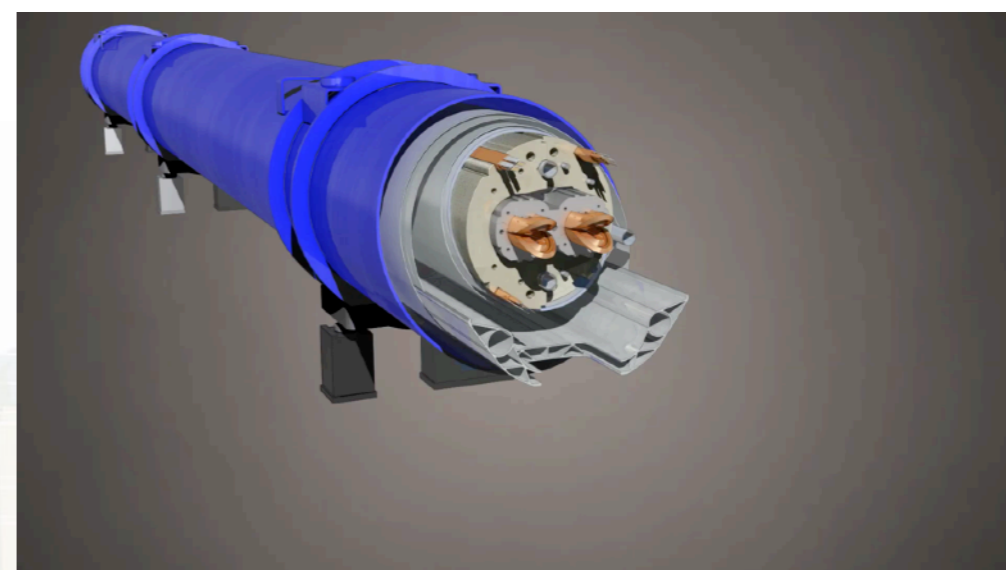


Cavità RF superconduttrici

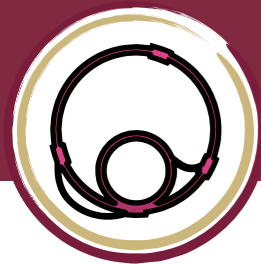


[DOI: 10.17181/cds.1750707](https://doi.org/10.17181/cds.1750707)

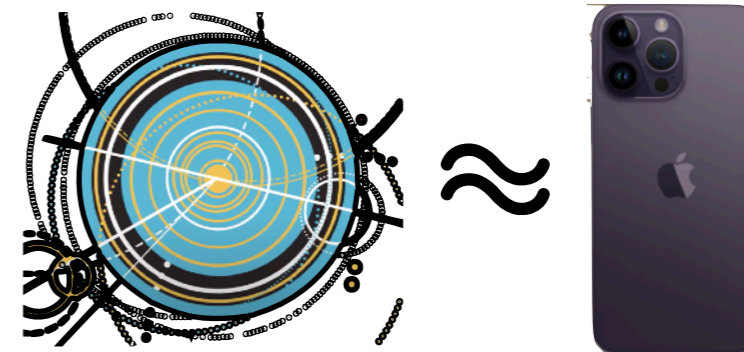
Magneti superconduttori



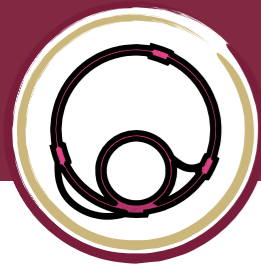
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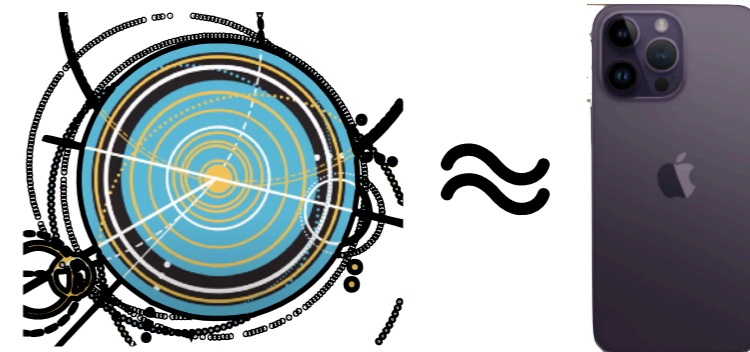
Analogie e numeri



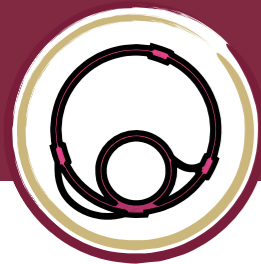
Risoluzione	100 MP	100 MP 
Framerate	40 MHz (40 milioni fps)	250 fps 
Peso	10 tonnellate	< 1 kg
Dati	1 PB/s (1 milione x →)	~5 GB/s
Dimensione	50m x 20m x 20m	pochi cm ³
Costo!	~2 milioni €	1000-6000 €



Analogie e numeri

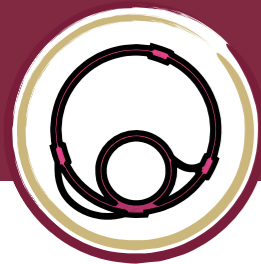


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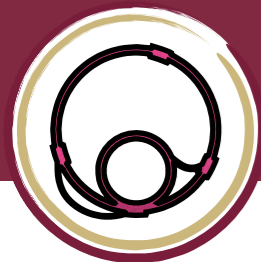
Rivelatore di particelle: la macchina fotografica più potente al mondo



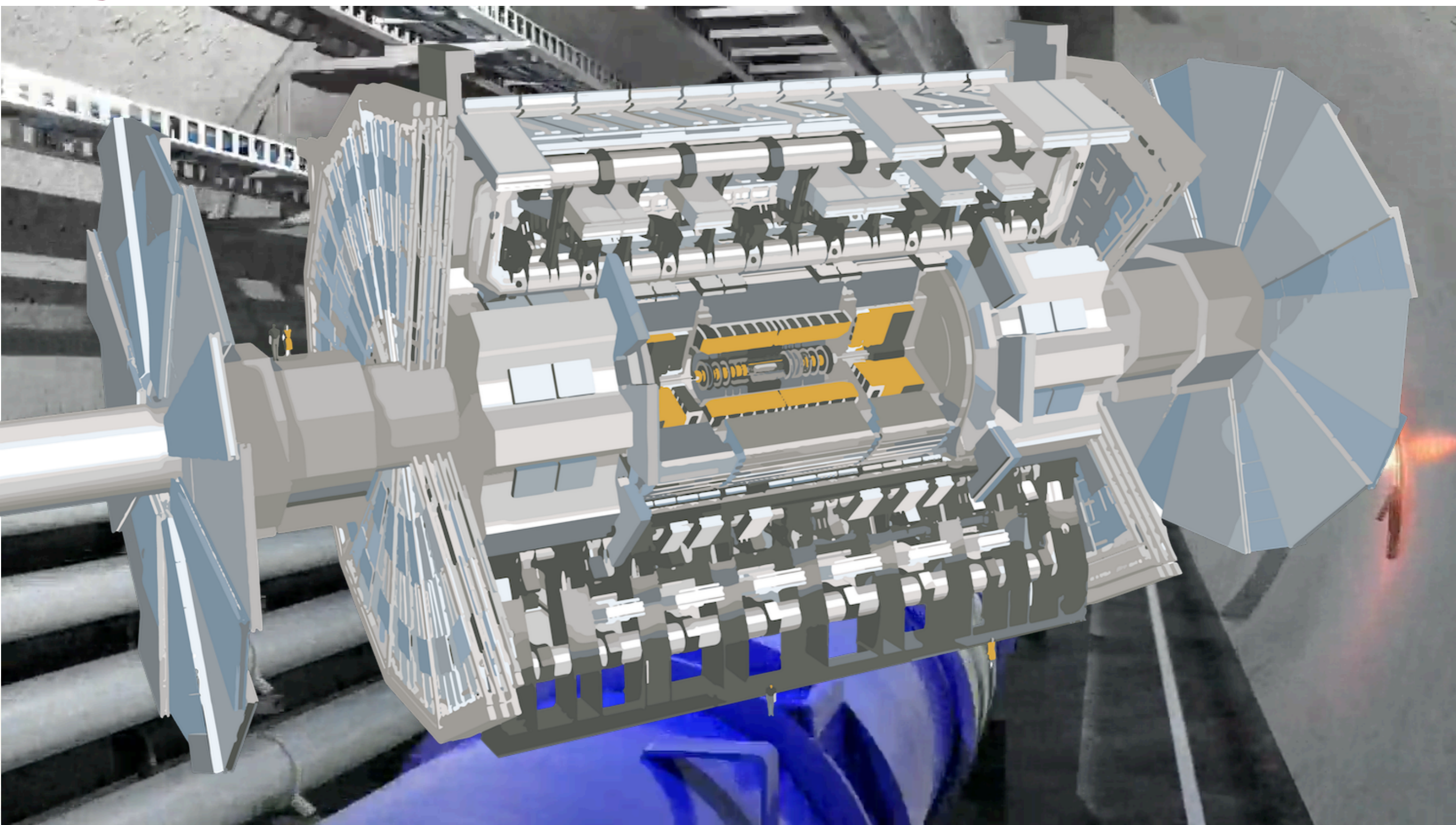


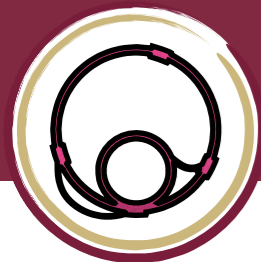
Rivelatore di particelle: la macchina fotografica più potente al mondo



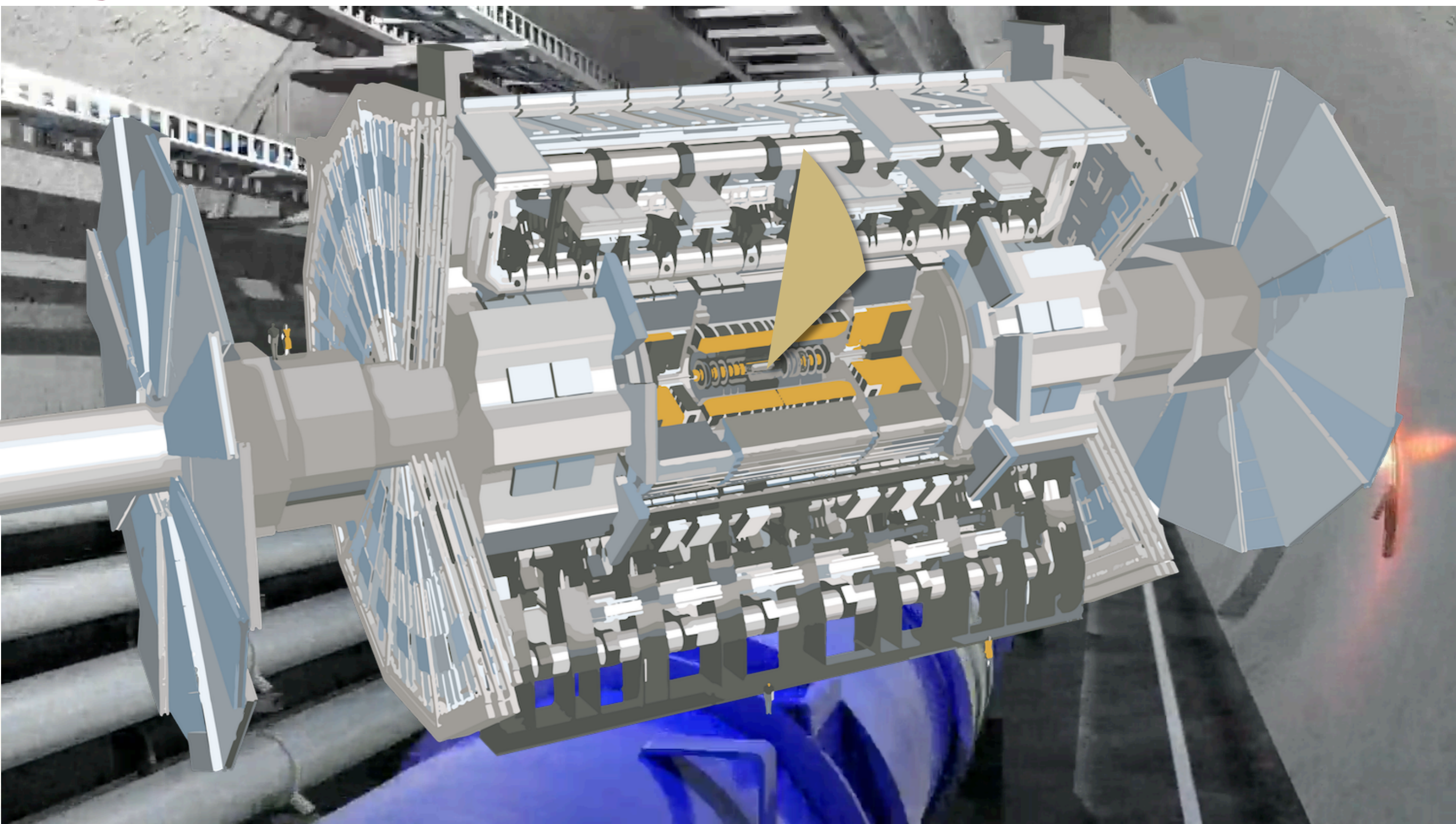


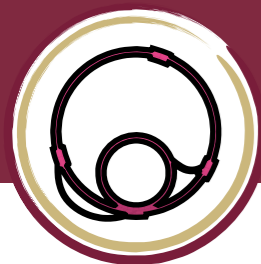
Rivelatore di particelle: la macchina fotografica più potente al mondo



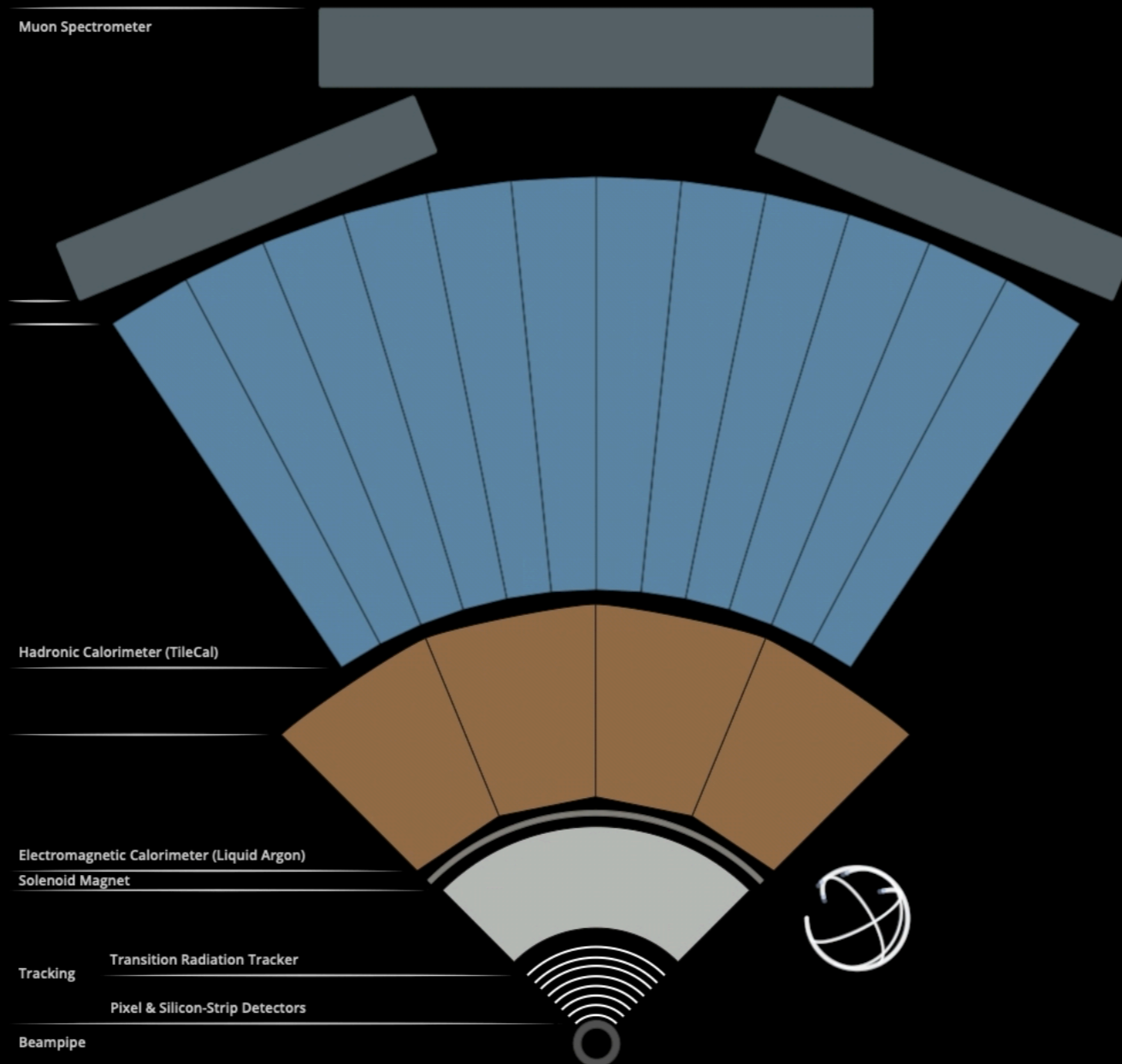


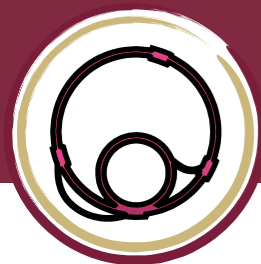
Rivelatore di particelle: la macchina fotografica più potente al mondo



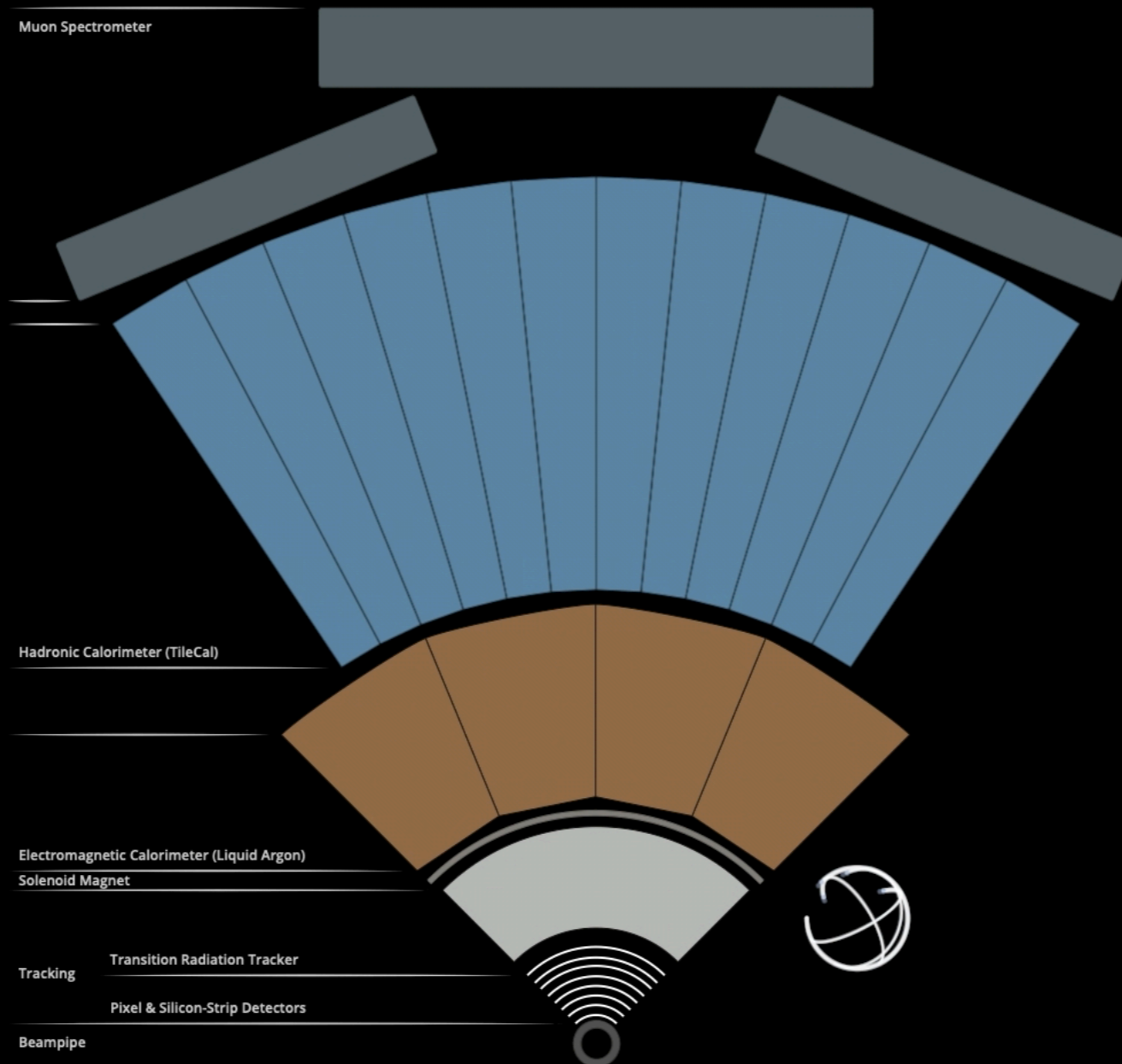


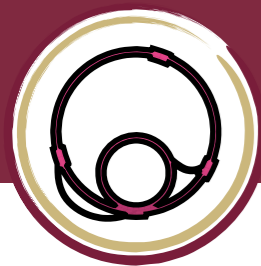
Elementi principali di un rivelatore





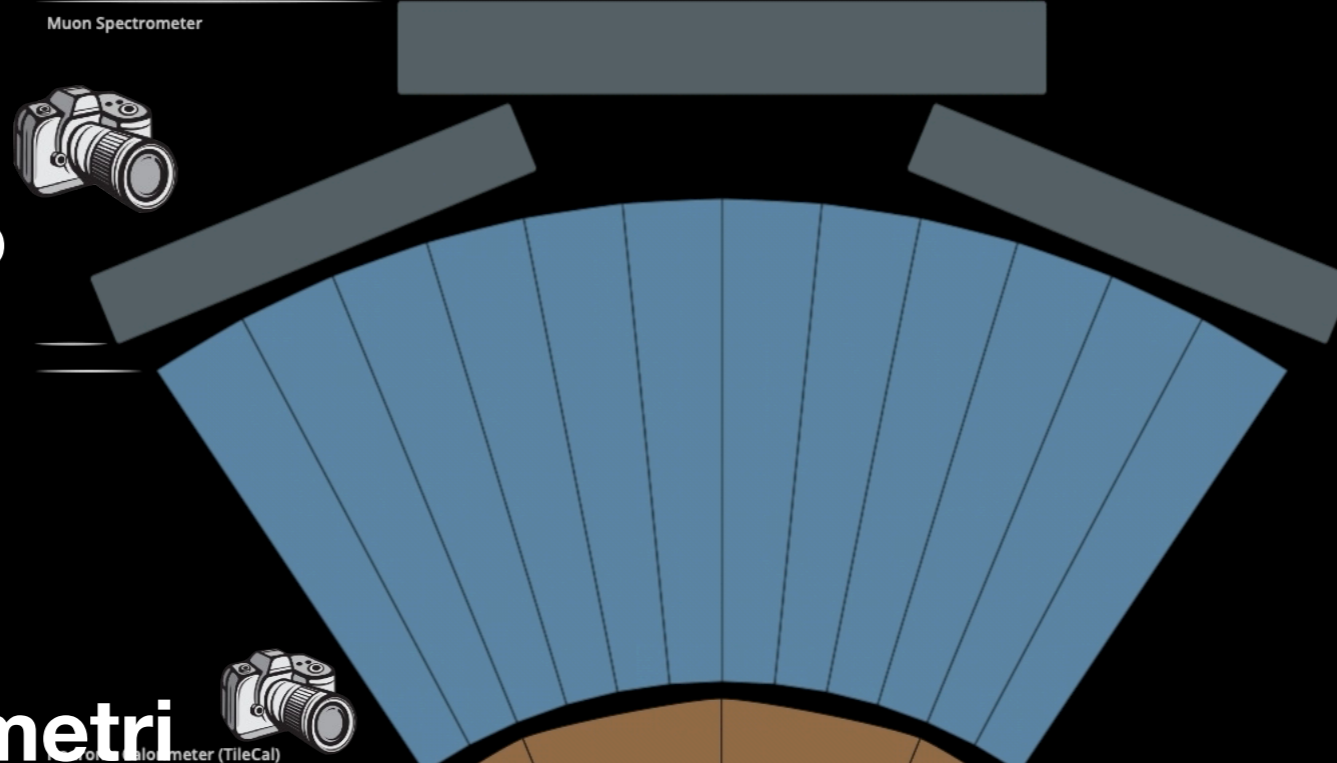
Elementi principali di un rivelatore





Elementi principali di un rivelatore

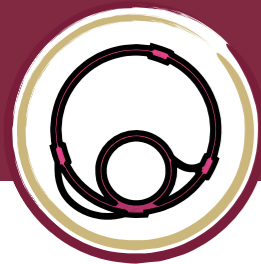
Spettrometro



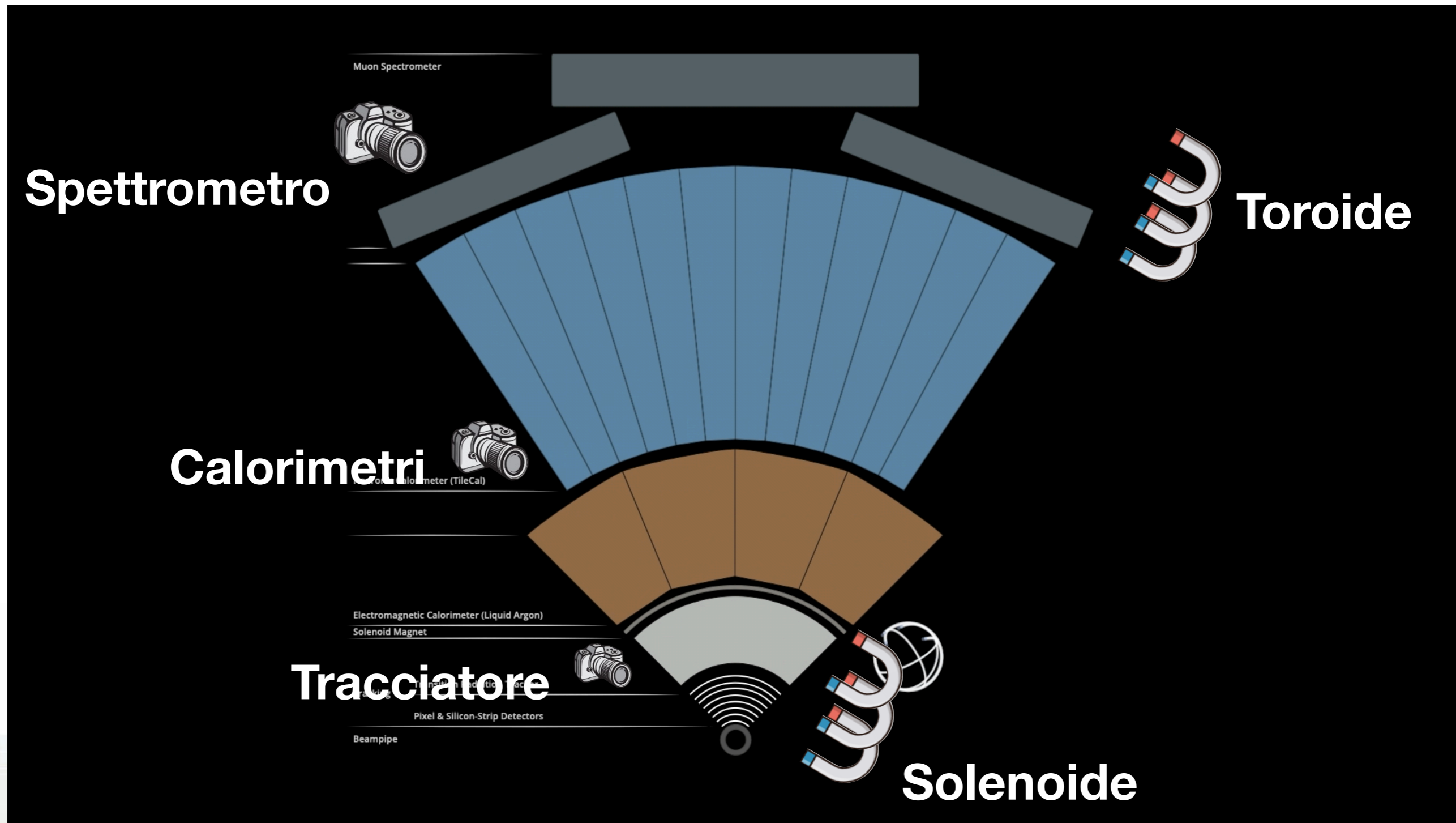
Calorimetri

Tracciatore

Muon Spectrometer
Electromagnetic Calorimeter (TileCal)
Solenoid Magnet
Transverse Hadronic Calorimeter (THC)
Pixel & Silicon-Strip Detectors
Beampipe

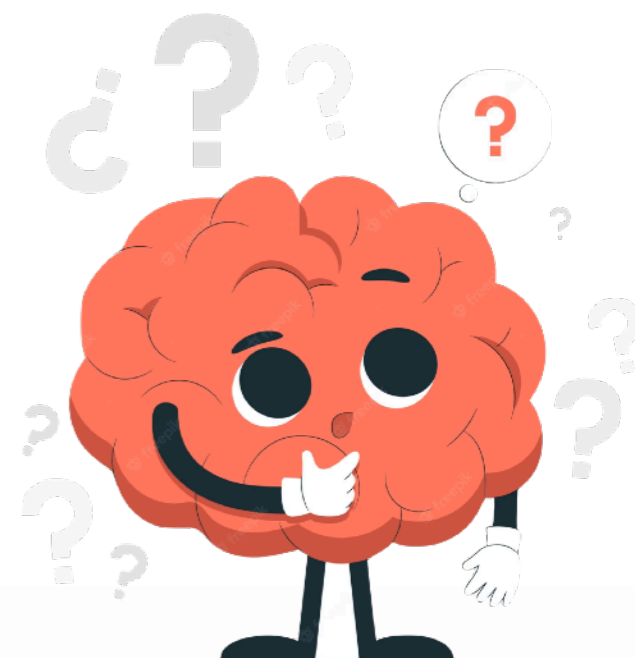


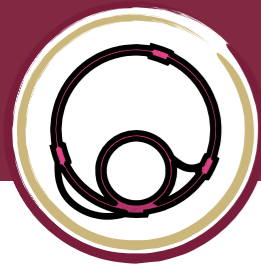
Elementi principali di un rivelatore



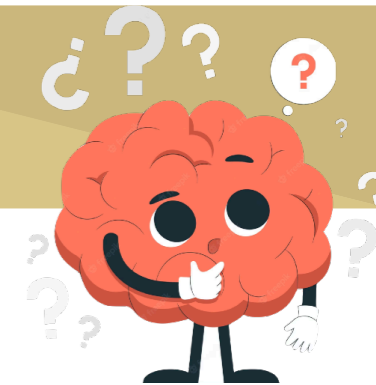


Domanda

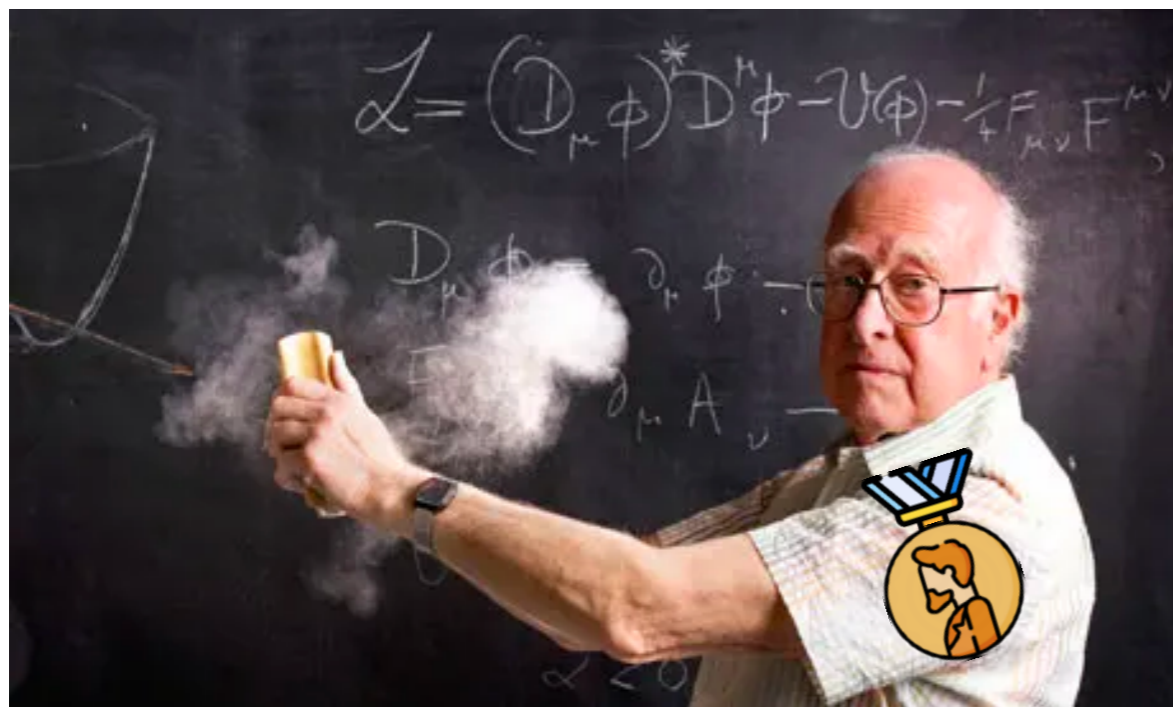




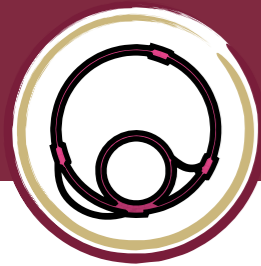
Domanda #3



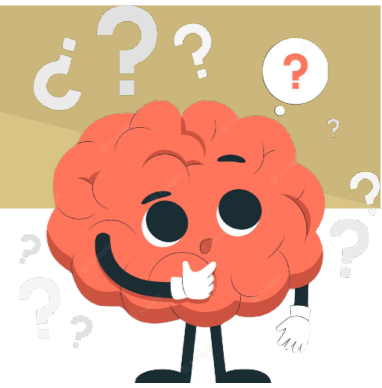
A che profondità si trova l'LHC?



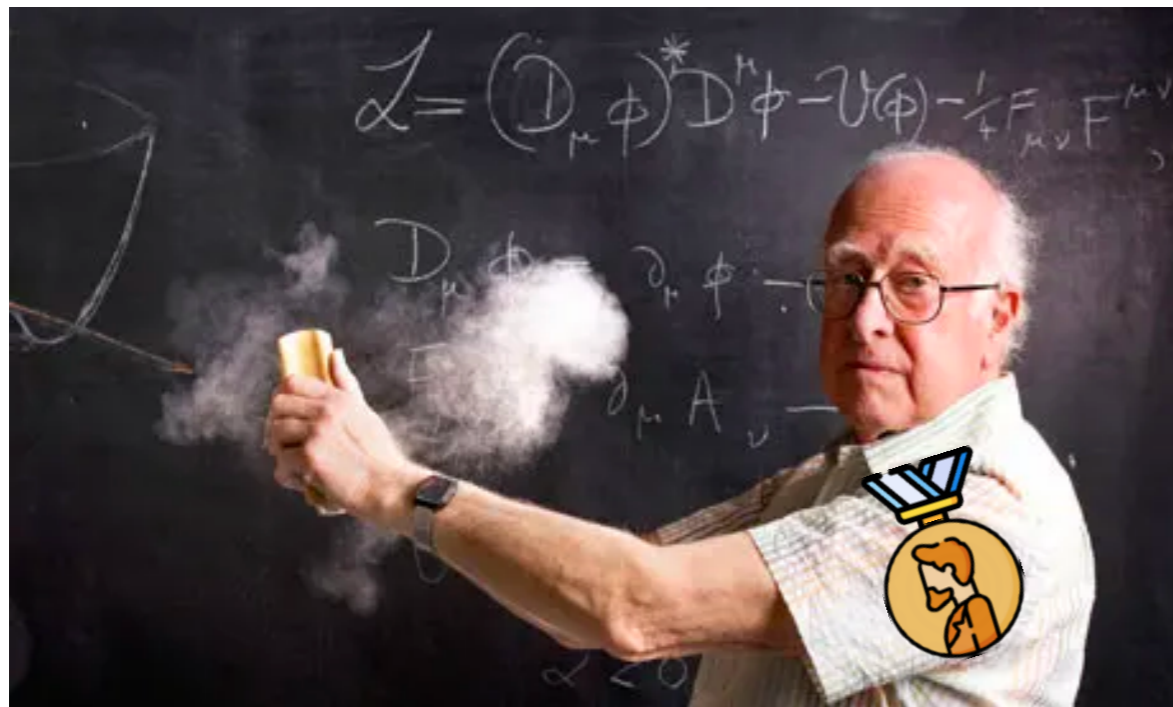
- A. 10 m
- B. 100 m
- C. 1000 m
- D. Non si trova sottoterra



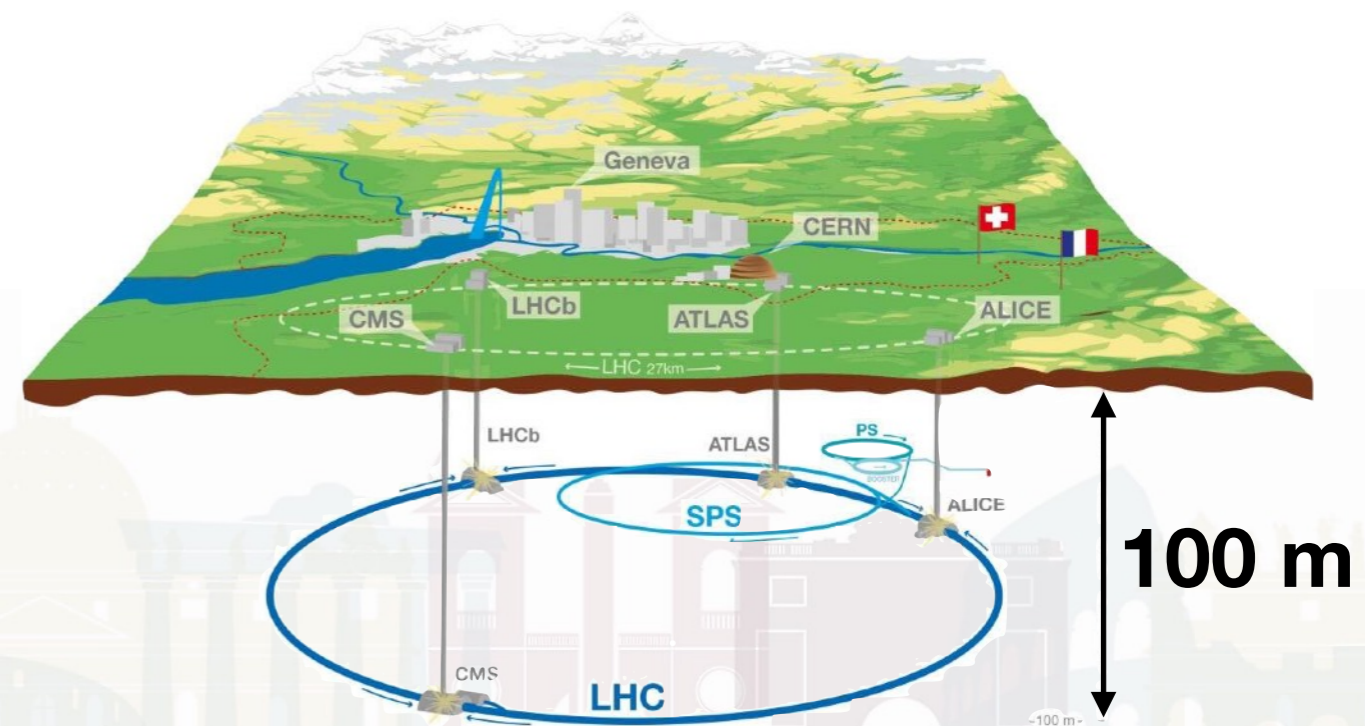
Domanda #3



A che profondità si trova l'LHC?

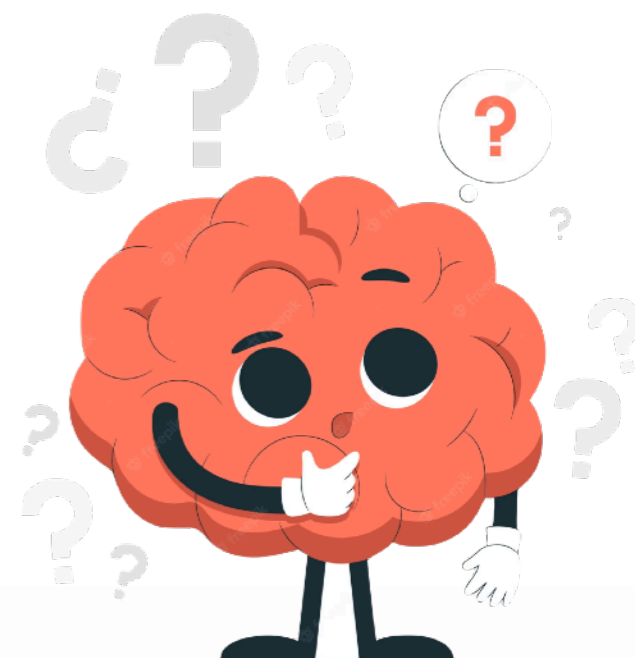


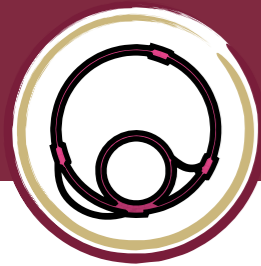
- A. 10 m
- B. 100 m
- C. 1000 m
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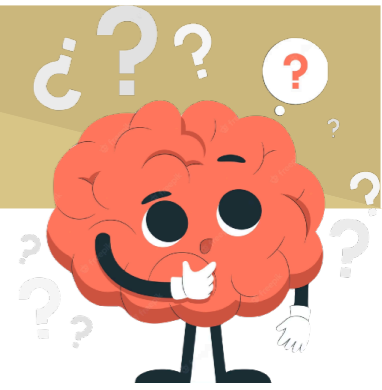


Domanda

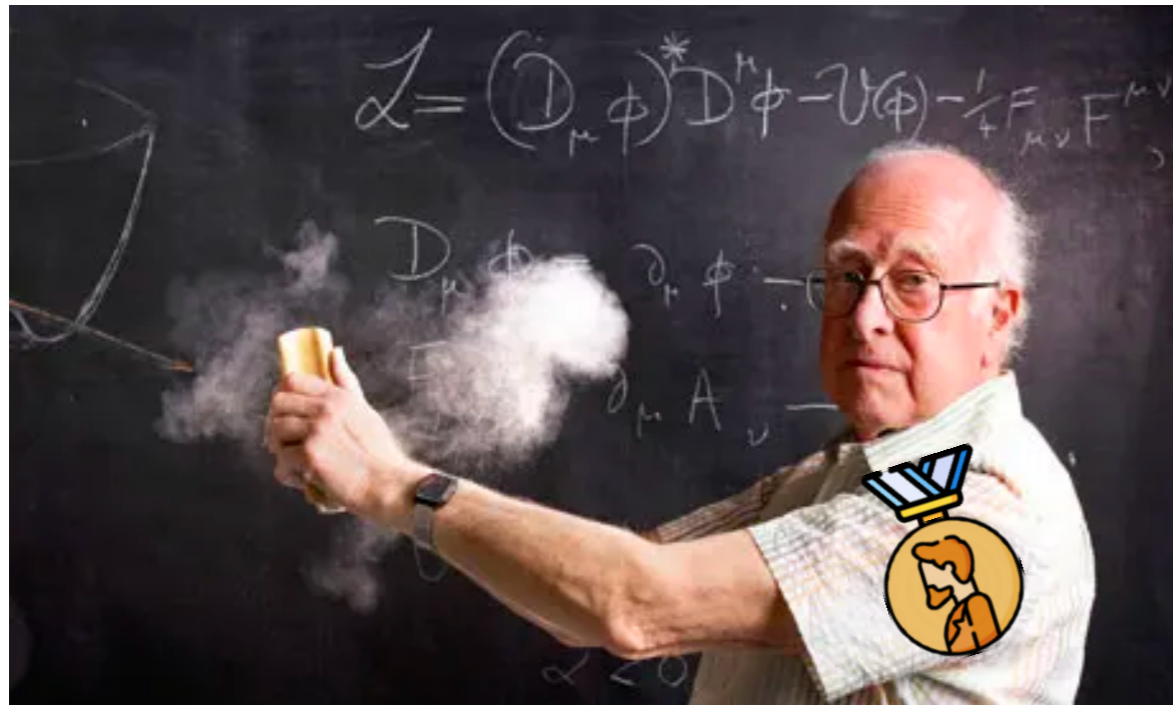




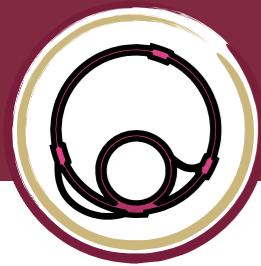
Domanda #4



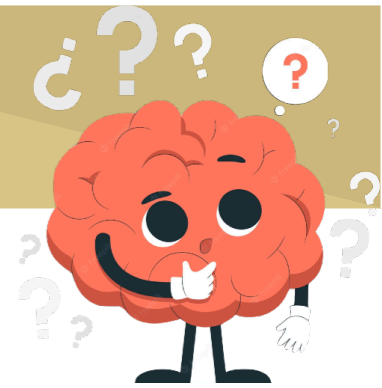
Che temperature raggiungono i magneti dell'LHC?



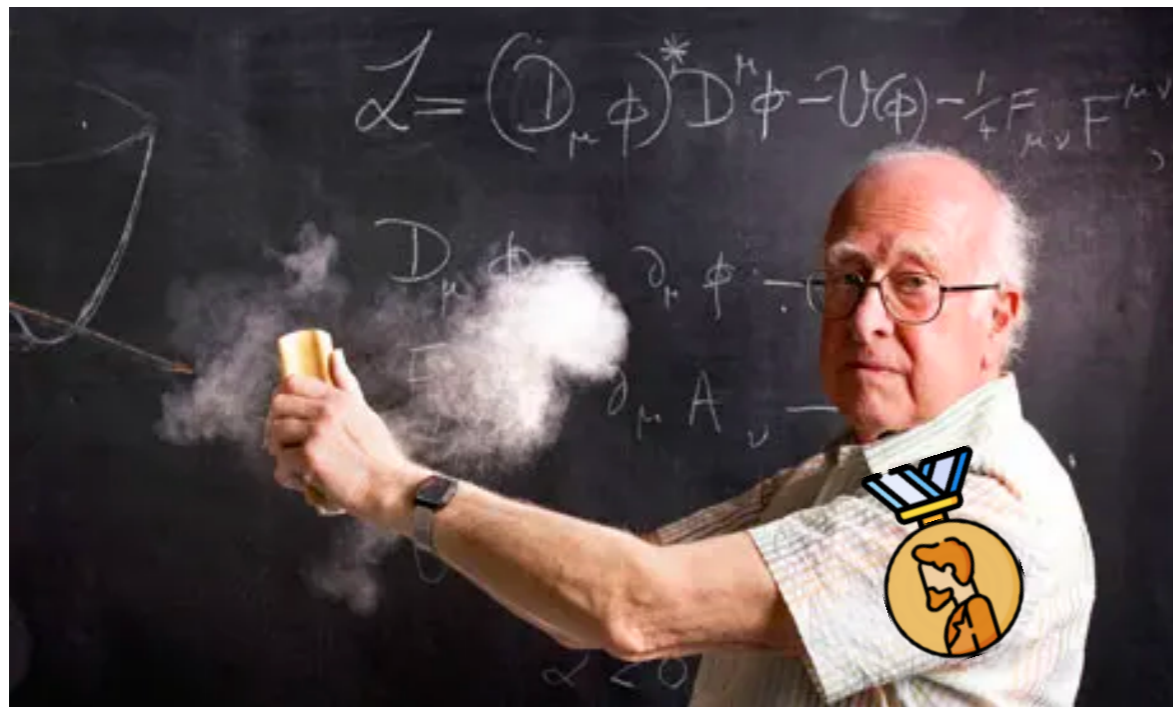
- A. circa $-270\text{ }^\circ\text{C}$
- B. circa $-70\text{ }^\circ\text{C}$
- C. $0\text{ }^\circ\text{C}$
- D. nessuna delle 3



Domanda #4

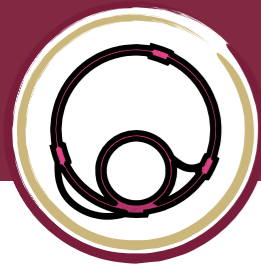


Che temperature raggiungono i magneti dell'LHC?



- A. circa $-270\text{ }^{\circ}\text{C}$
- B. circa $-70\text{ }^{\circ}\text{C}$
- C. $0\text{ }^{\circ}\text{C}$
- D. nessuna delle 3

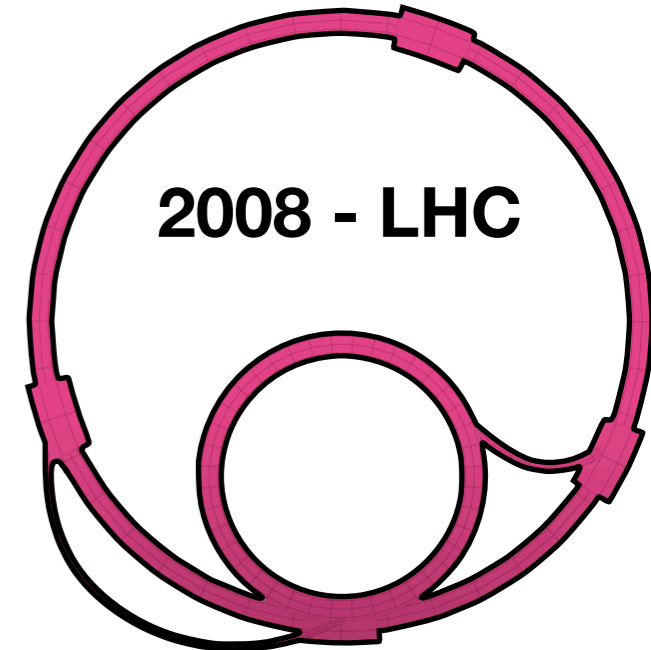
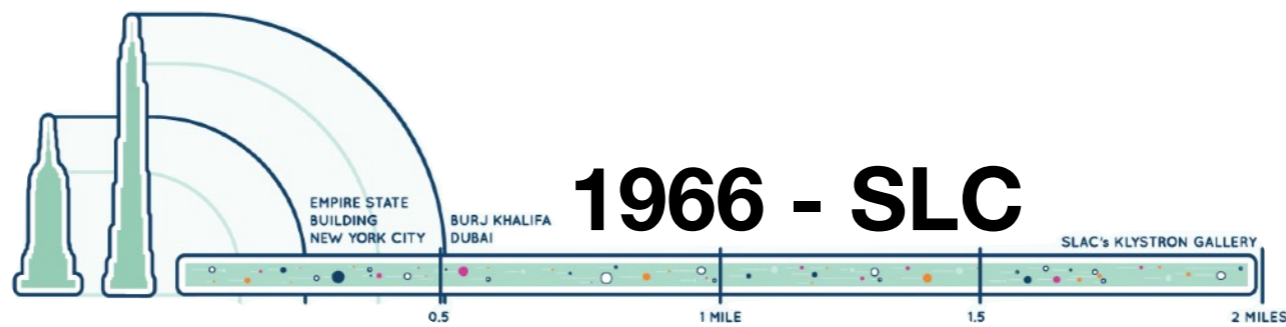


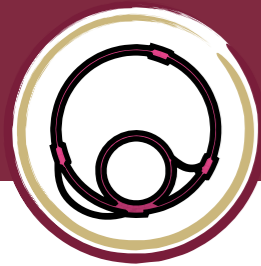


Non solo al CERN



1930 - Lawrence

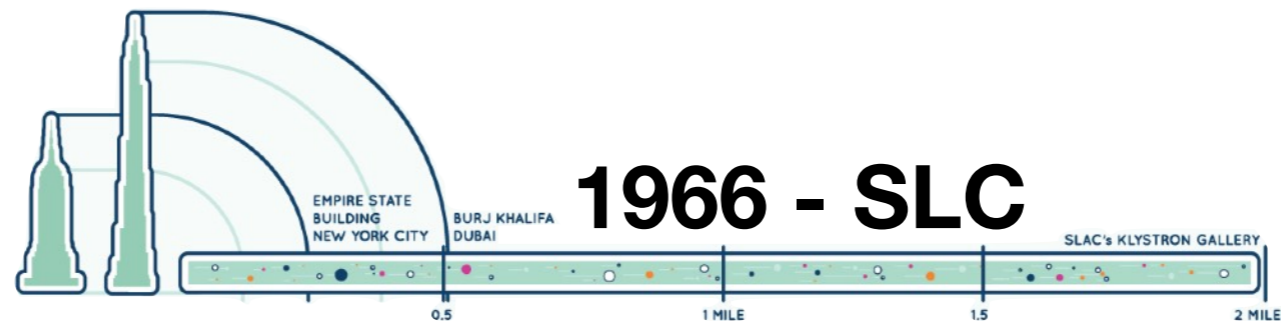




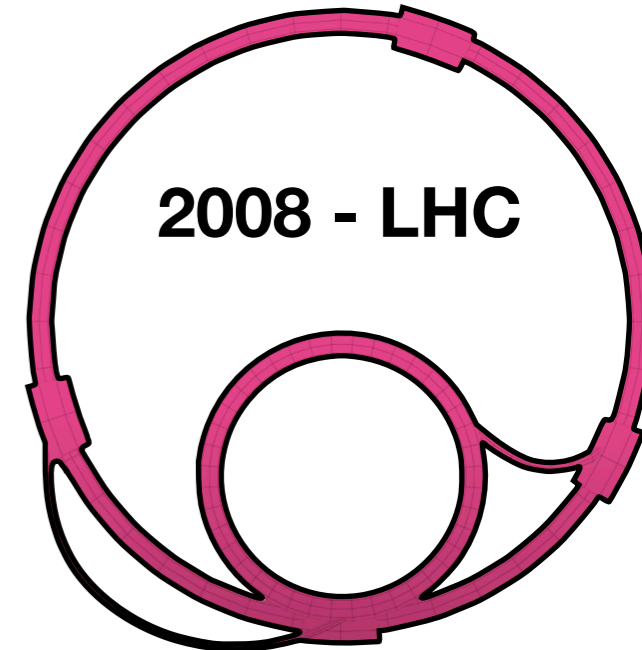
Non solo al CERN



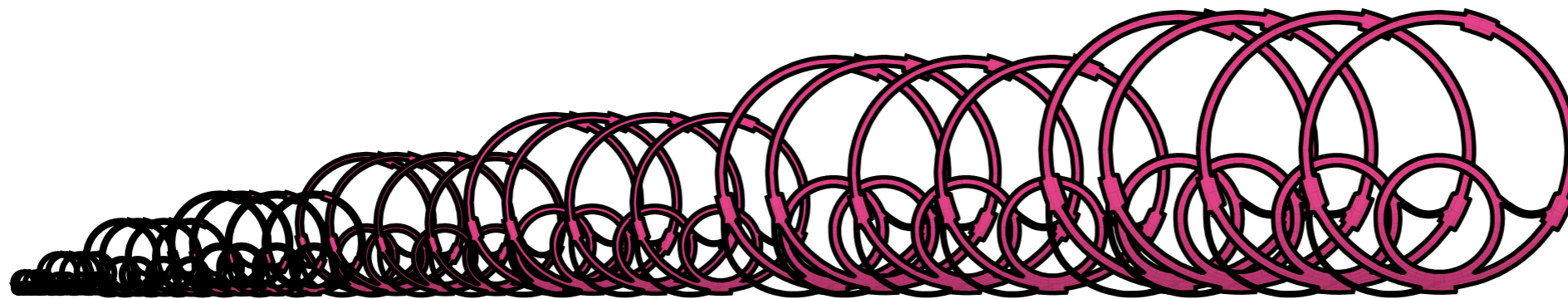
1930 - Lawrence



1966 - SLC



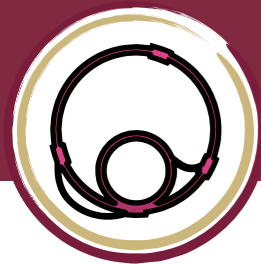
2008 - LHC



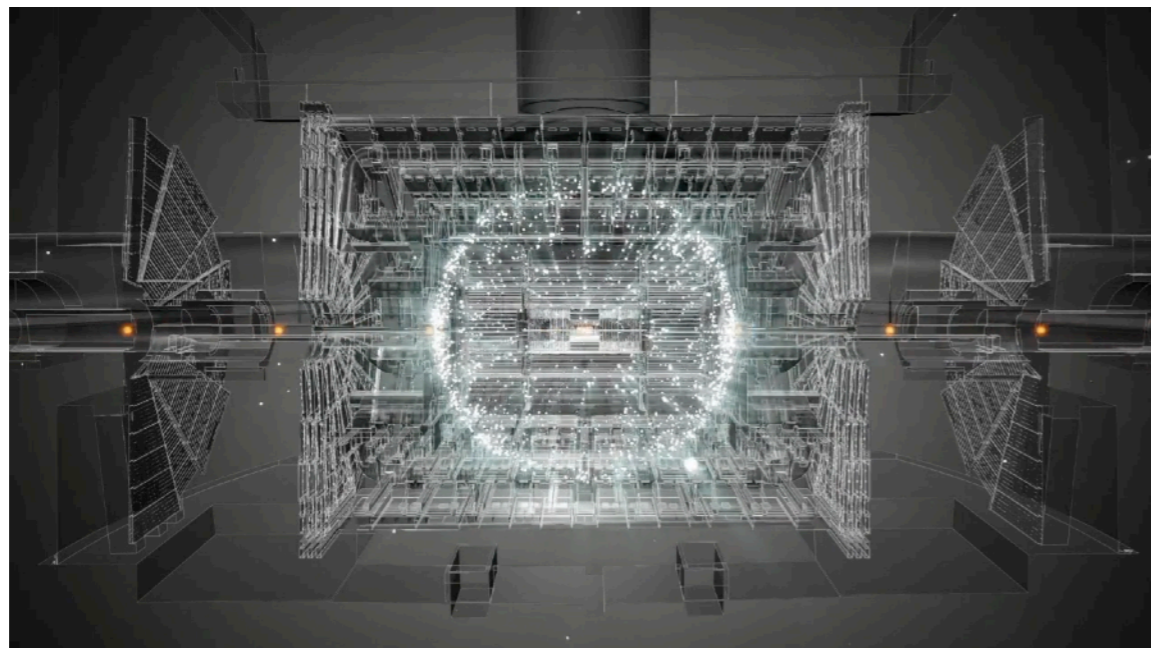
Non solo al CERN...non solo per la ricerca!

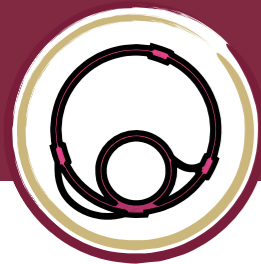
- oggi giorno esistono più di 30mila acceleratori operativi in tutto il mondo
- acceleratori per curare tumori
- acceleratori per sterilizzare cibi e materiali
- acceleratori per analizzare la struttura delle proteine (COVID19)
- acceleratori per produrre polimeri super-assorbenti
 - + per realizzare pannolini per i bambini e mascherine protettive!
- acceleratori per testare carburanti innovativi



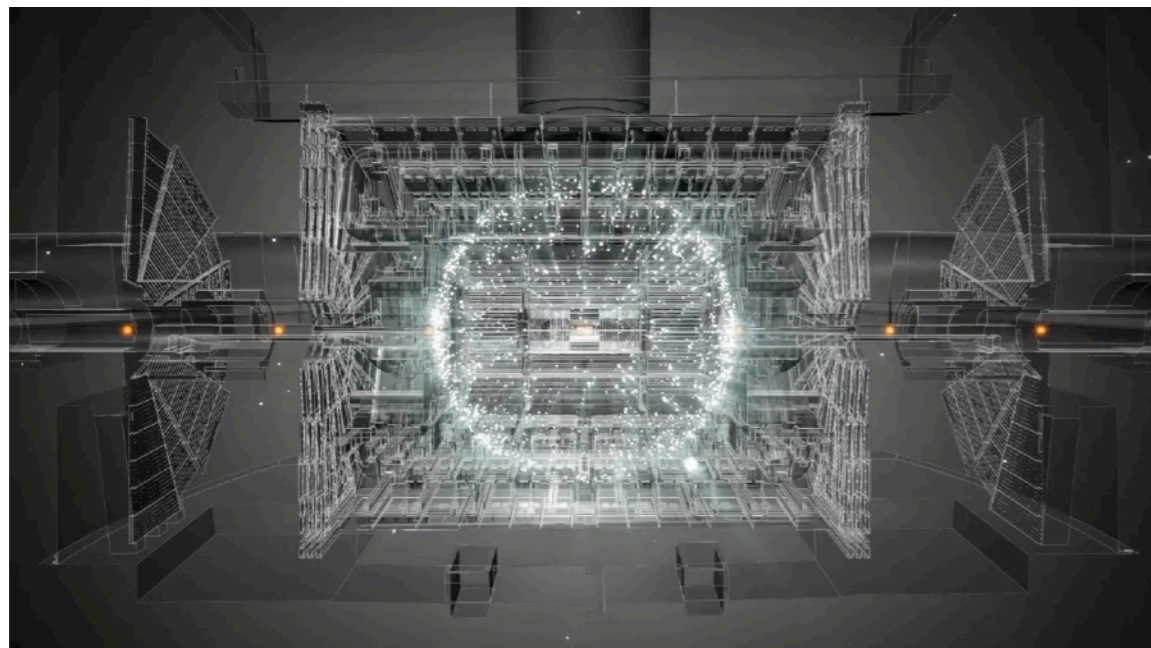


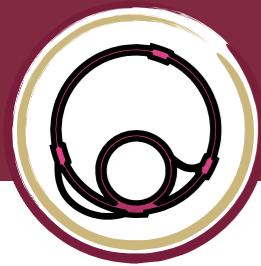
LHC d.H. (dopo Higgs)



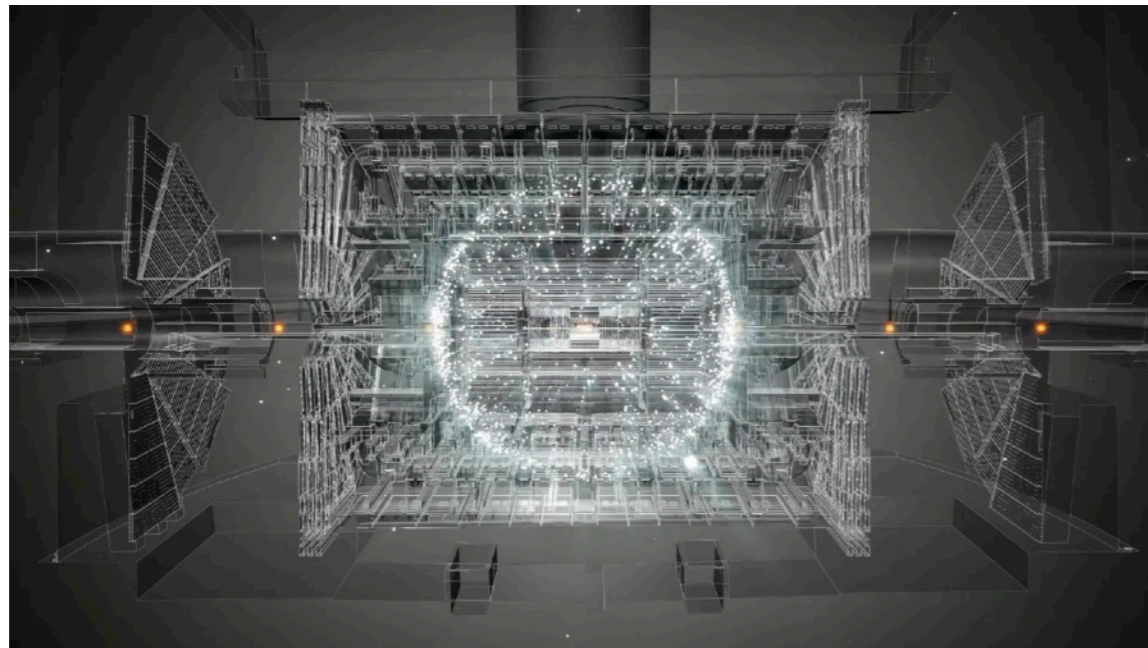


LHC d.H. (dopo Higgs)

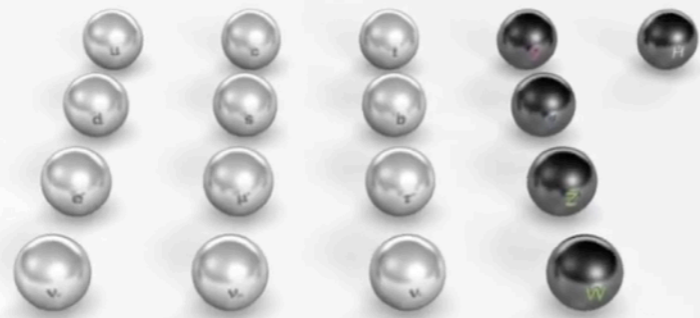




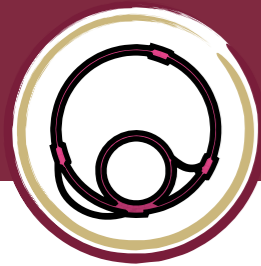
LHC d.H. (dopo Higgs)



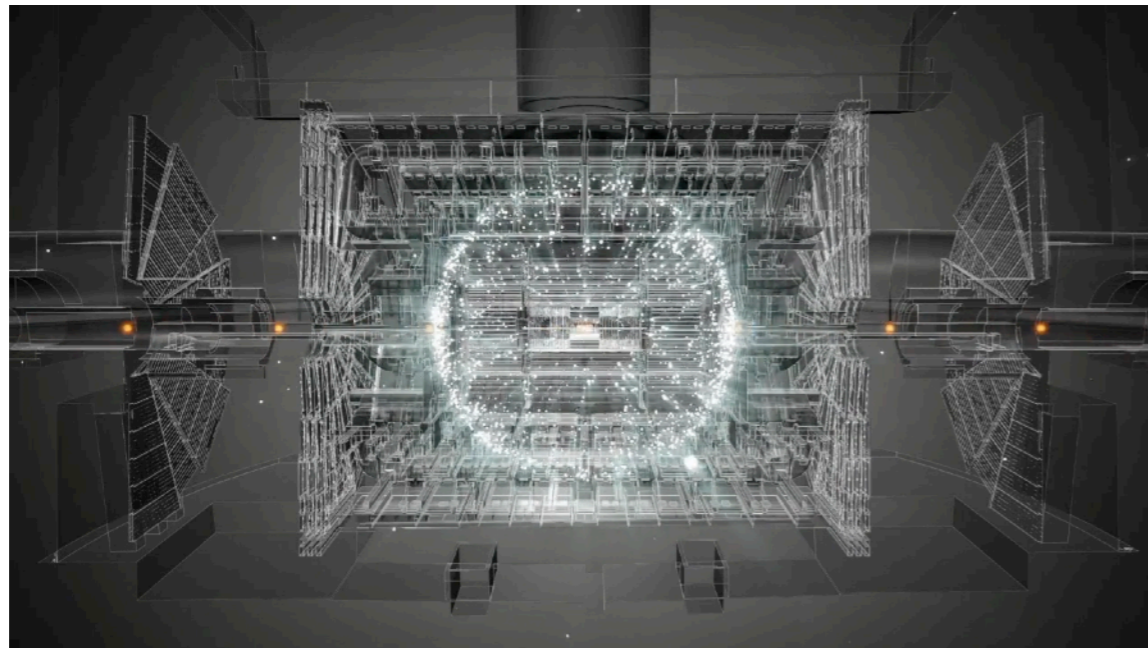
Cosa si fa all'LHC da 10 anni?



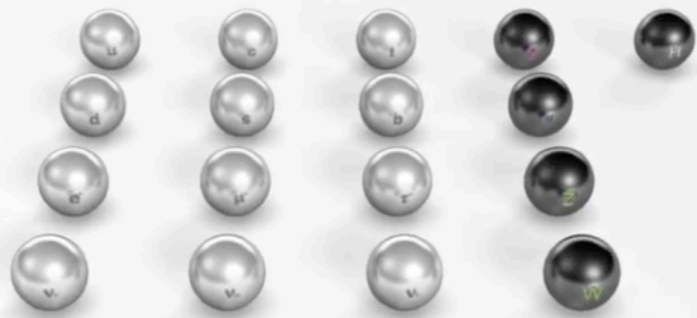
Standard Model



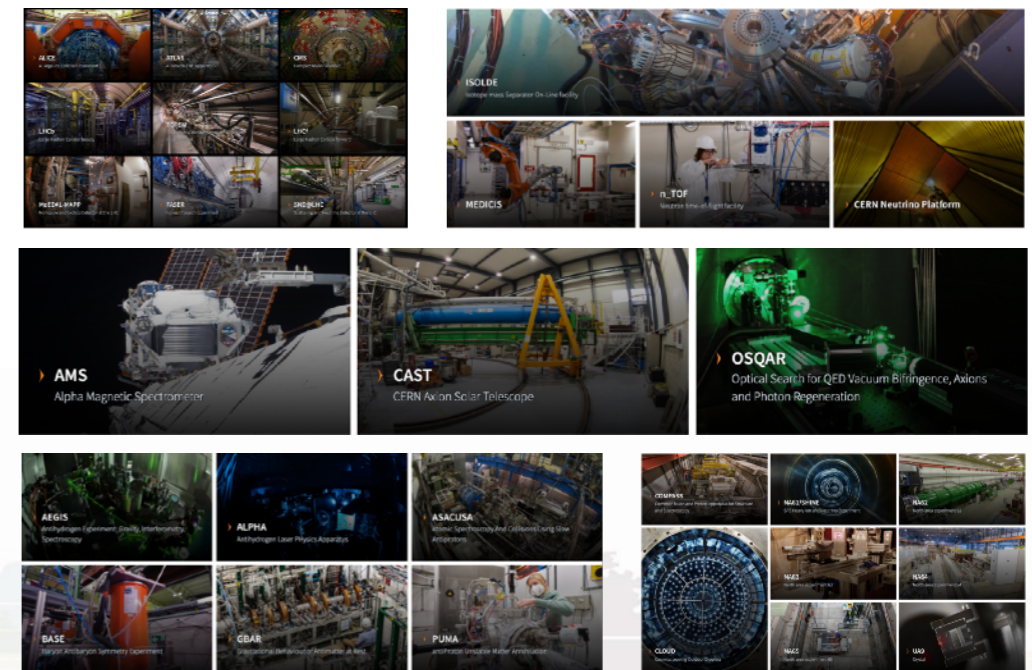
LHC d.H. (dopo Higgs)

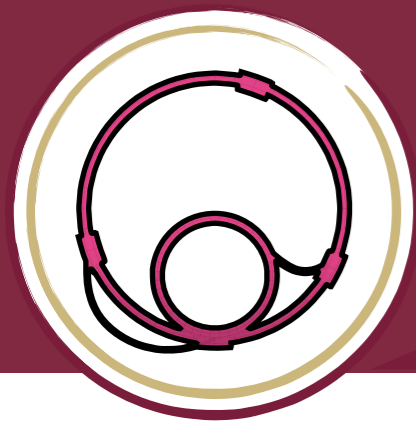


Cosa si fa all'LHC da 10 anni?



Standard Model





Grazie!

