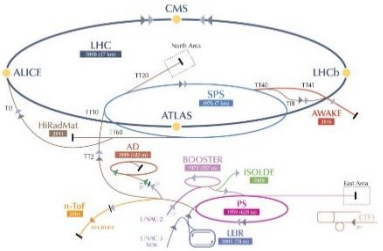
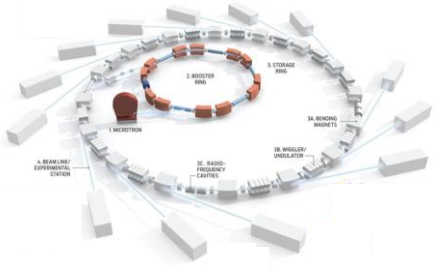
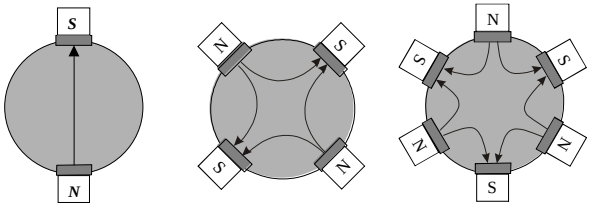
CESSAMag: magnets for SESAME

Attilio Milanese
CERN

1. short introduction

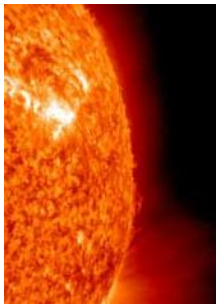






2. magnets for accelerators and SESAME in particular

3. popular questions about SESAME magnets



Questions are welcome at any time.

A few acronyms…

CESSAMag

CERN-EC Support for SESAME Magnets

CERN

Conseil Européen pour la Recherche Nucléaire

(European Council for Nuclear Research)

EC

European Commission

SESAME

Synchrotron-light for Experimental Science and Applications in the Middle East

SESAME is a synchrotron light source in construction in Jordan, built together and used by several members, like CERN.
In a nutshell, it is an electron accelerator for applied science.


Bahrain


Cyprus


Egypt


Iran


Israel

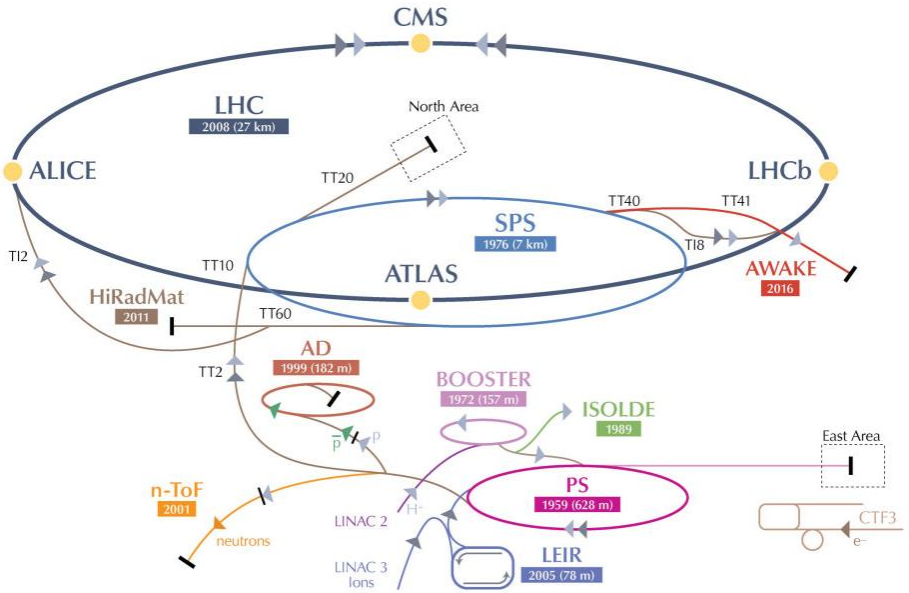

Jordan


Pakistan


Palestine

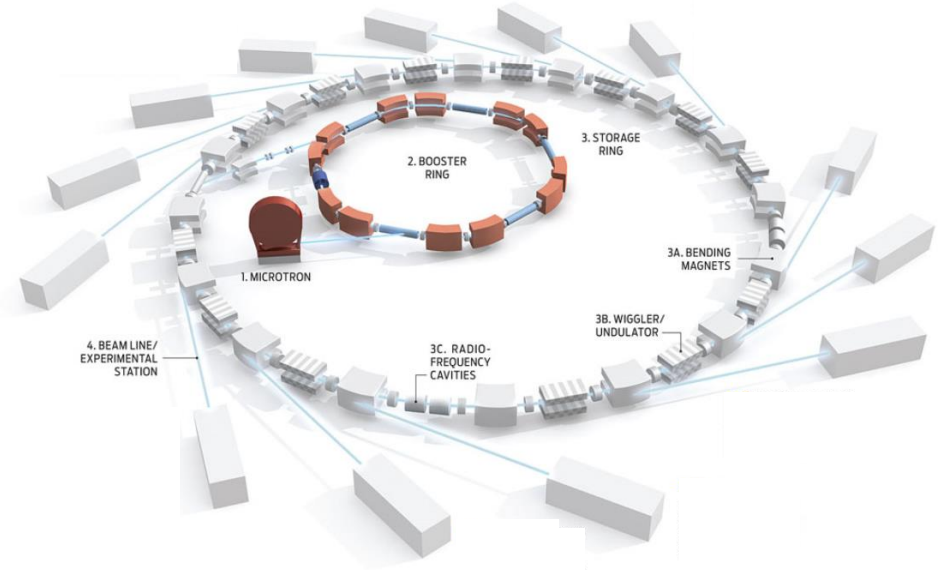

Turkey

SESAME and CERN have similar histories (tomorrow's talks) and they are based on similar technology – particle accelerators.

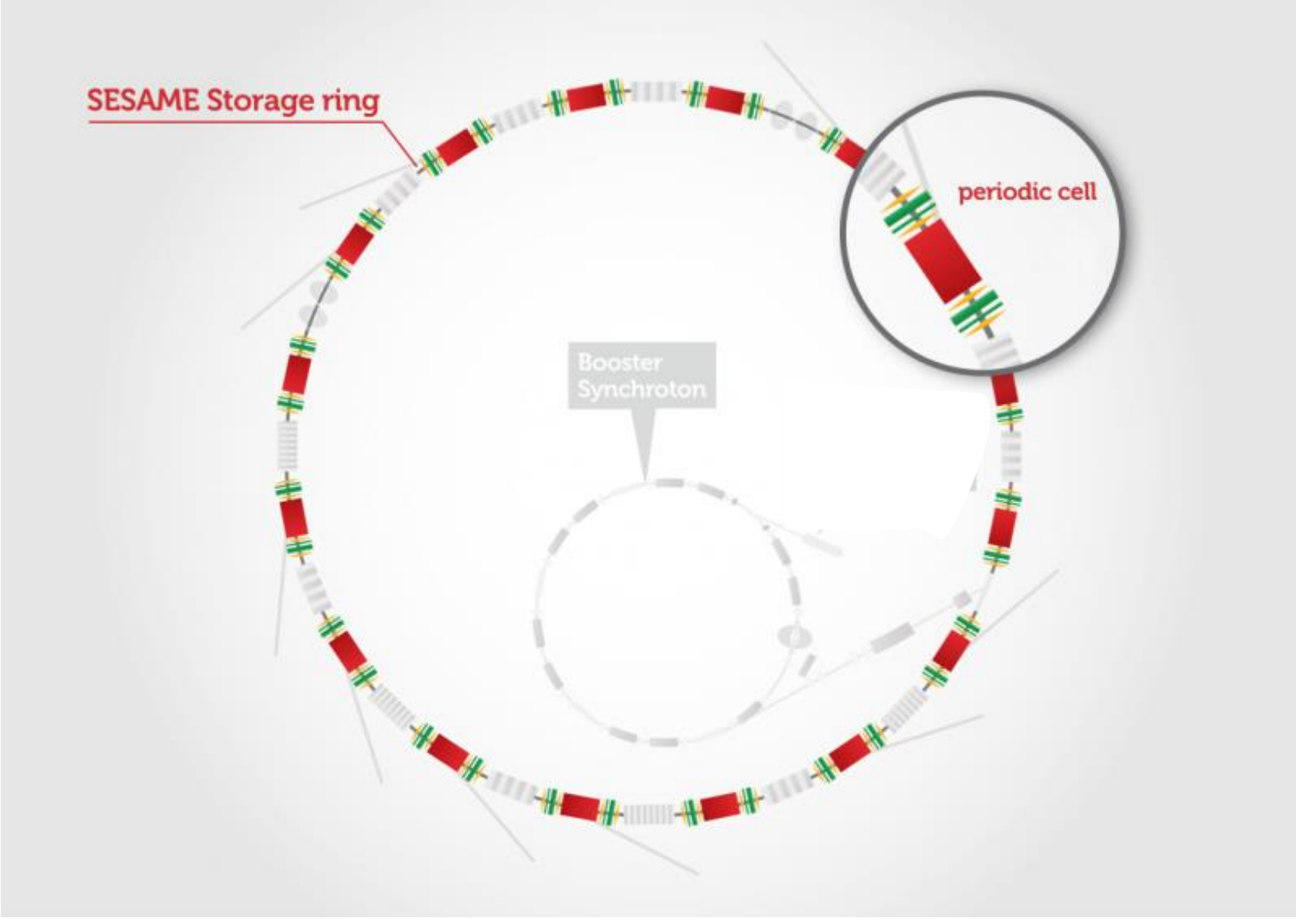


CERN

SESAME



The main accelerator at SESAME is circular – about 130 m long – with electrons emitting light when bent around.

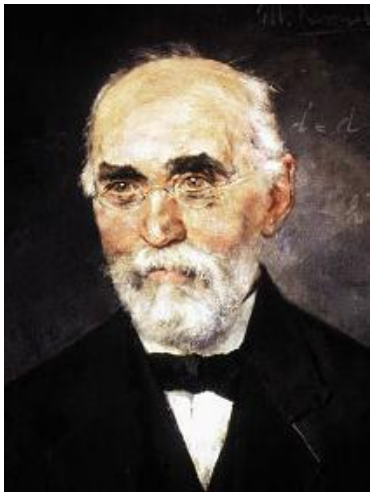


The accelerator is built with modular cells. The one below is the first for SESAME; it was assembled at CERN in spring 2015.

Magnetic field are used in accelerators to guide the beams, as moving charged particles experience a force in a magnetic field.

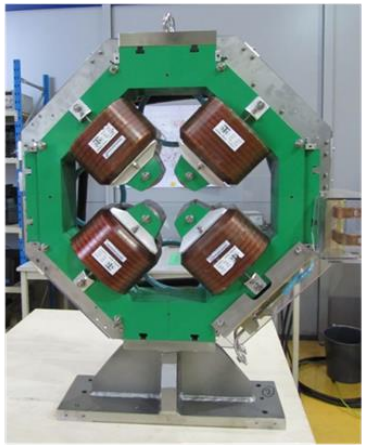
$$\vec{F} = q\vec{v} \times \vec{B}$$

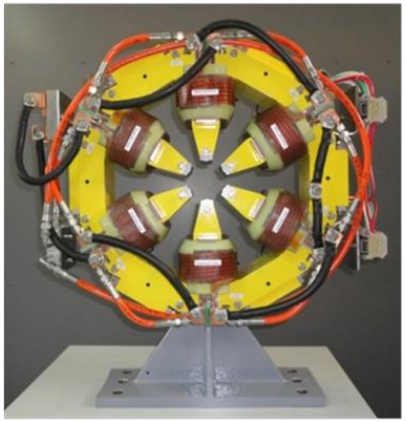
Lorentz (?) force



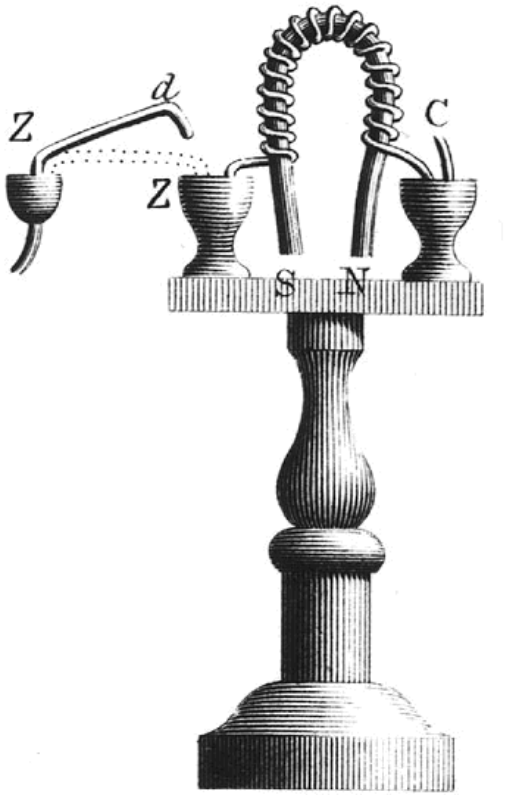
About 70% of CERN accelerators is filled with “magnets”. We are expert in this technology, with about 15 000 installed units.

We collaborate with SESAME on their magnets, power supplies and control system. EC funds this part of the project.

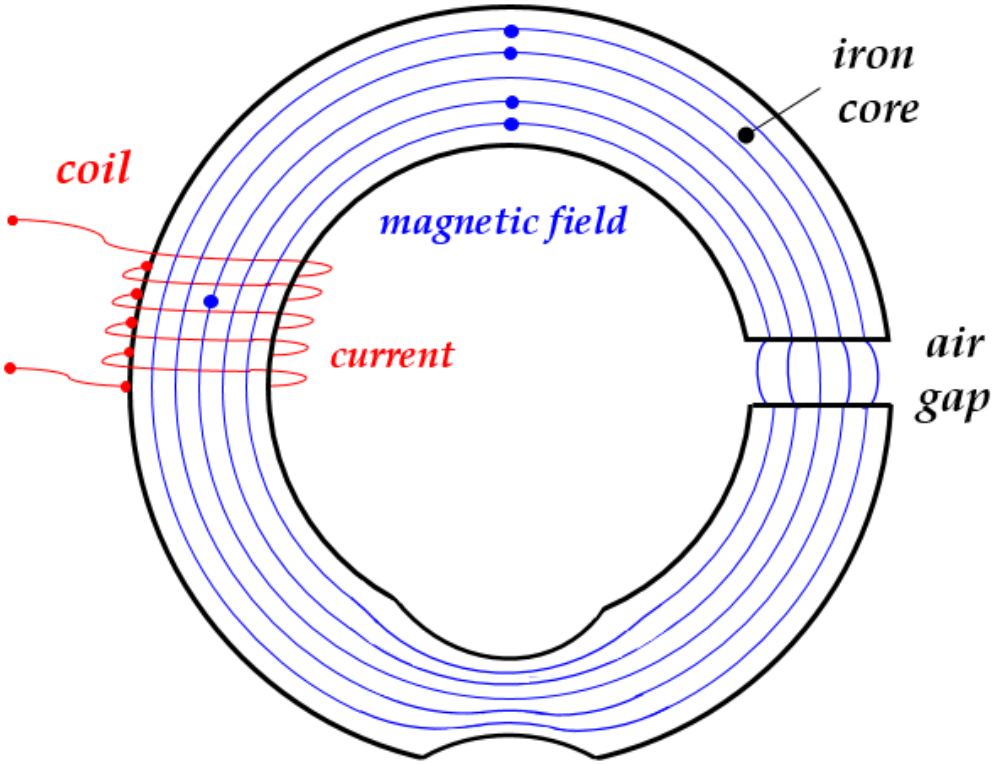




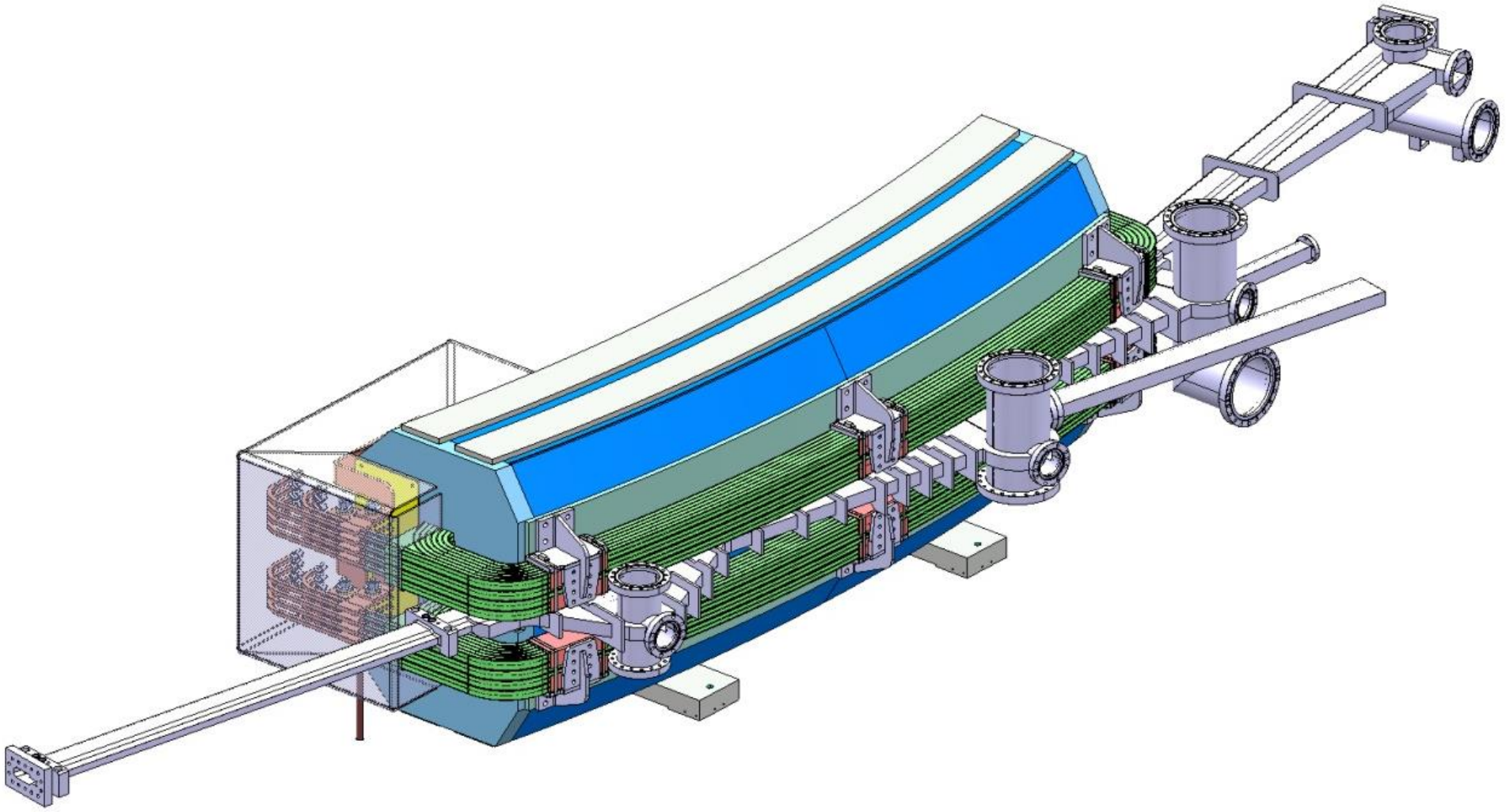
The “magnets” here are electromagnets, where the field is produced with an electrical current magnetizing an iron core.



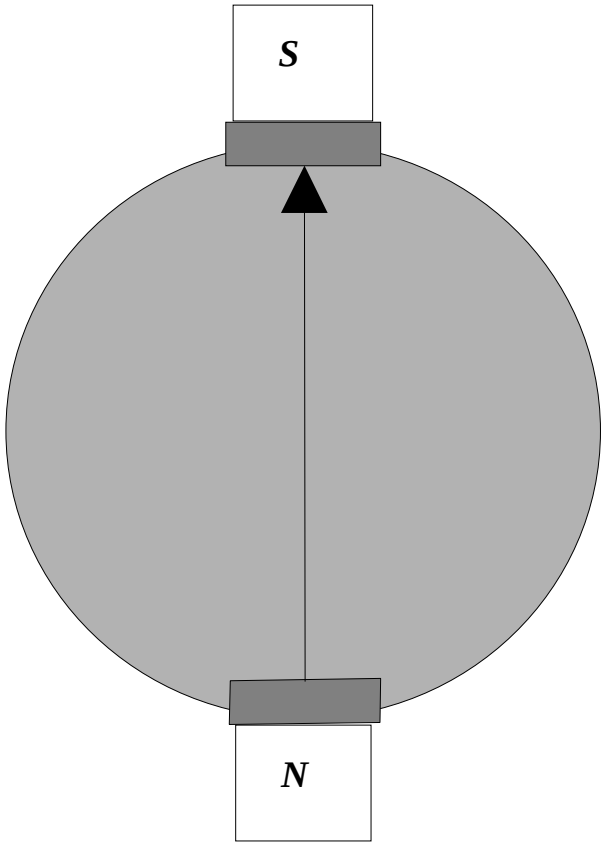
Sturgeon, 1824

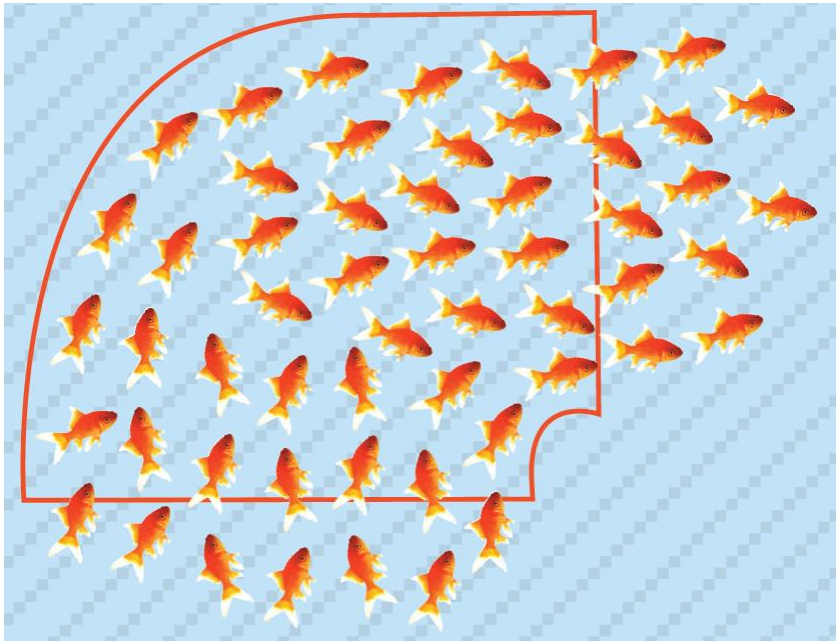


This is a model of the “dipole” magnet, with the vacuum chamber for the electron / photon beams.

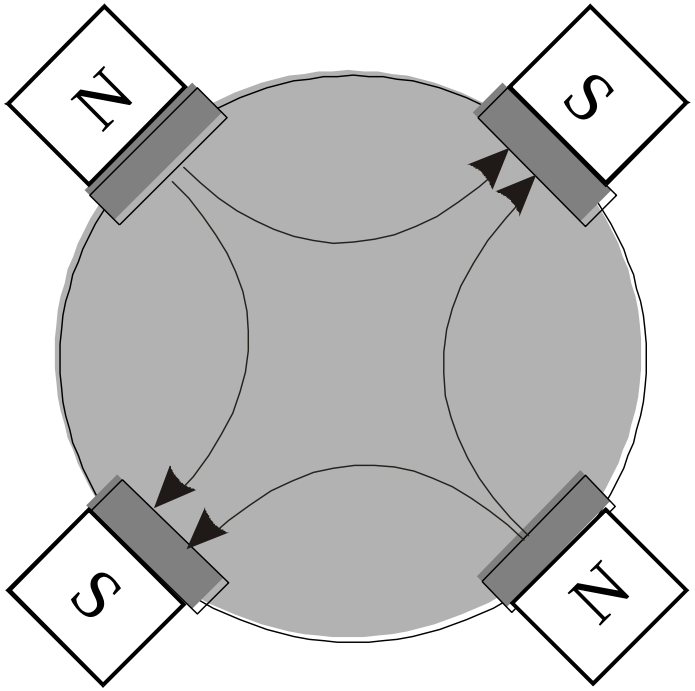


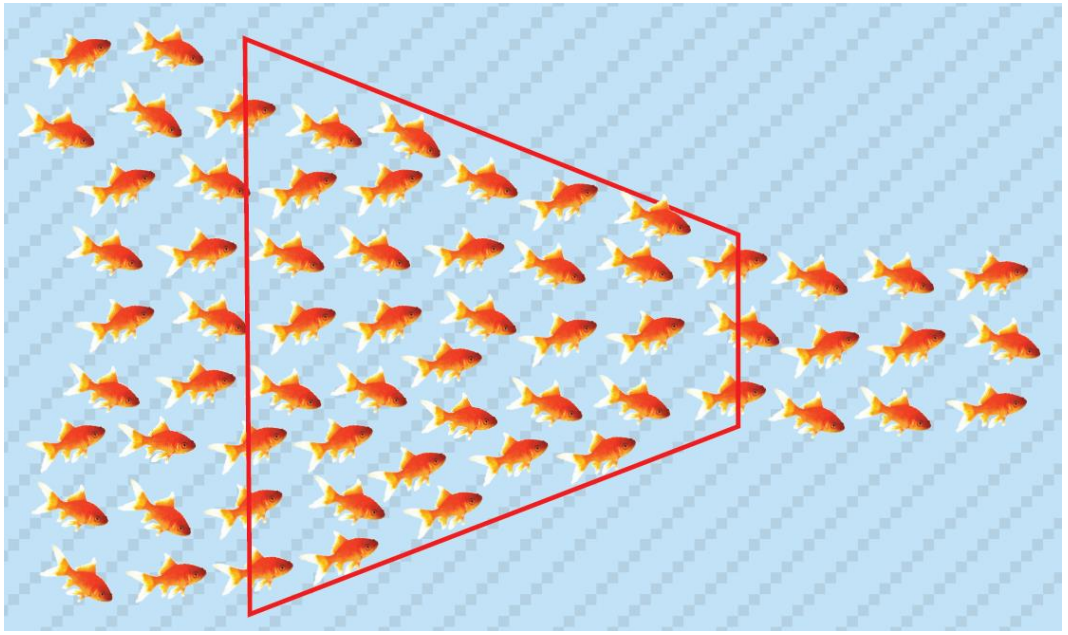
There are different types of magnets in an accelerator. A "dipole" has 2 poles and it steers (or bend) the beam.



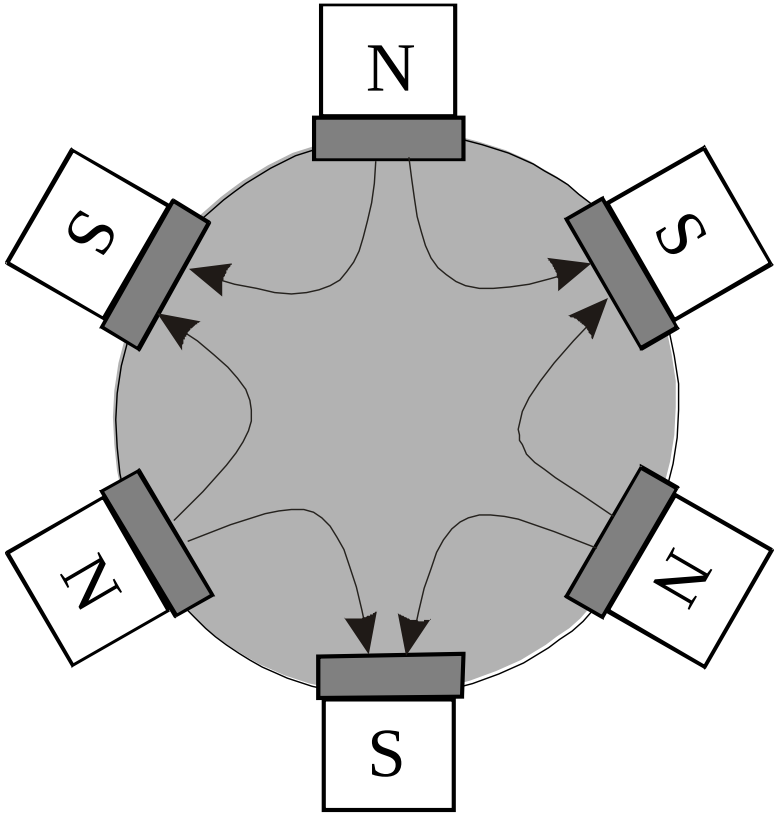


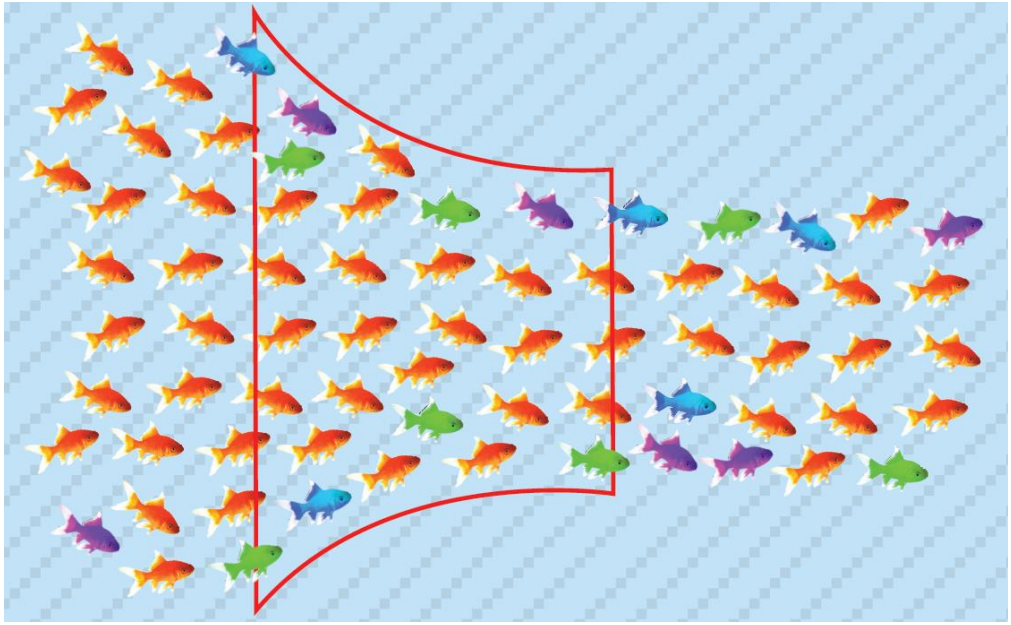
An arrangement of 4 poles makes a “quadrupole”. This kind of magnet is like a lens and it keeps the beam tight and focused.



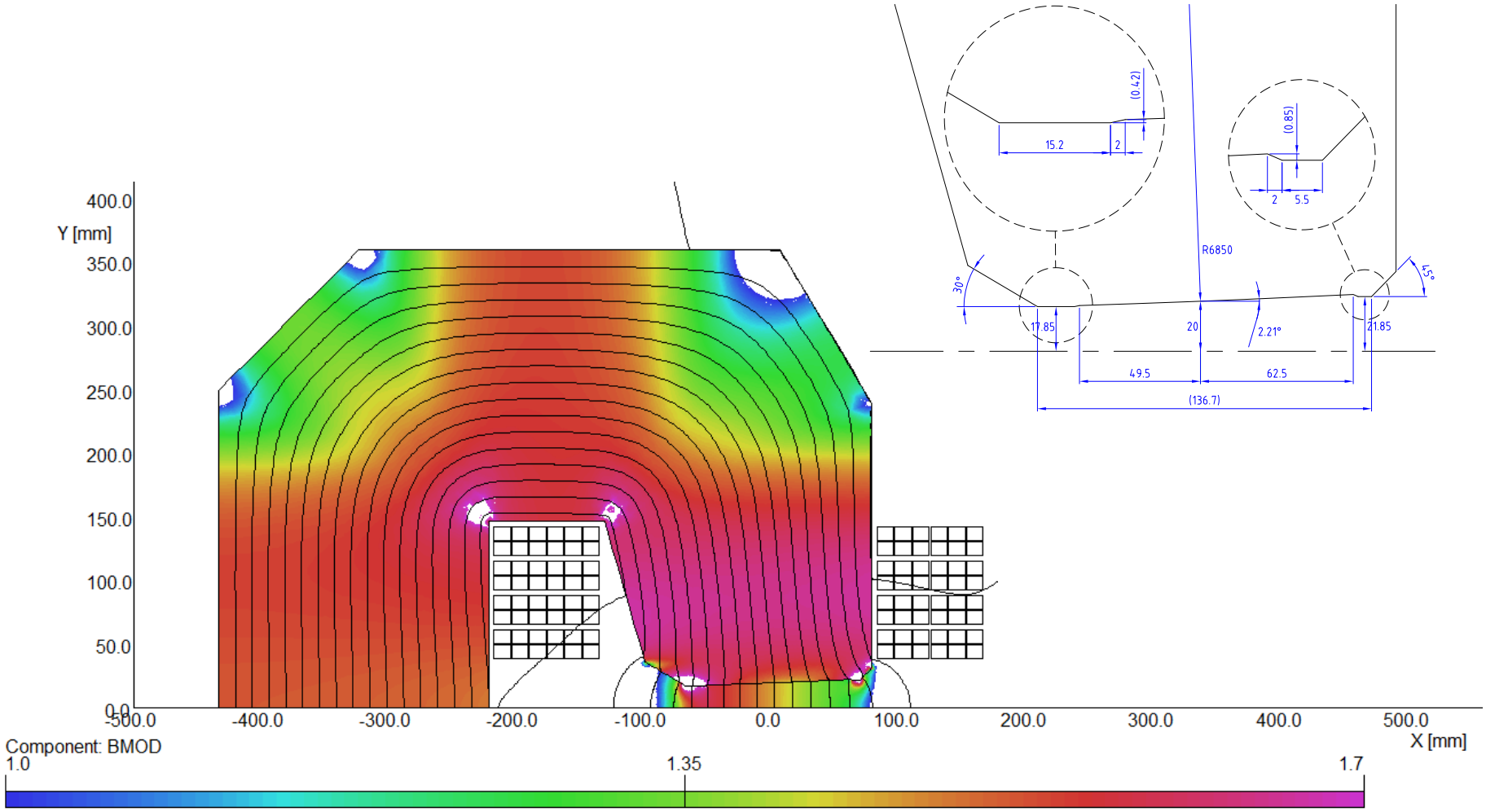


A “sextupole” has 6 poles. This magnet corrects the tendency of faster / slower particles to behave differently.



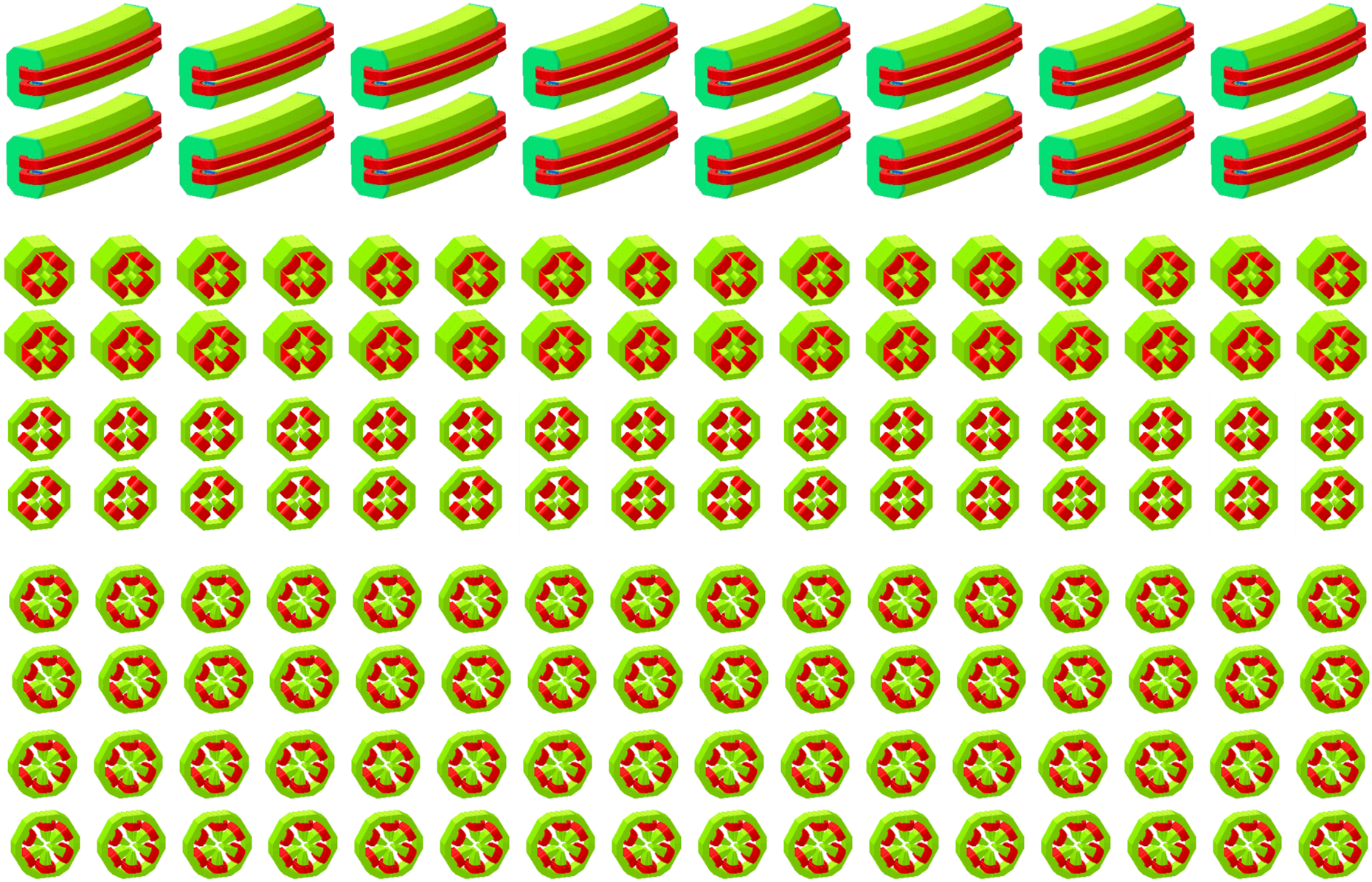


Every magnet type has been custom designed, using also computer simulations, so to meet the requirements of SESAME.

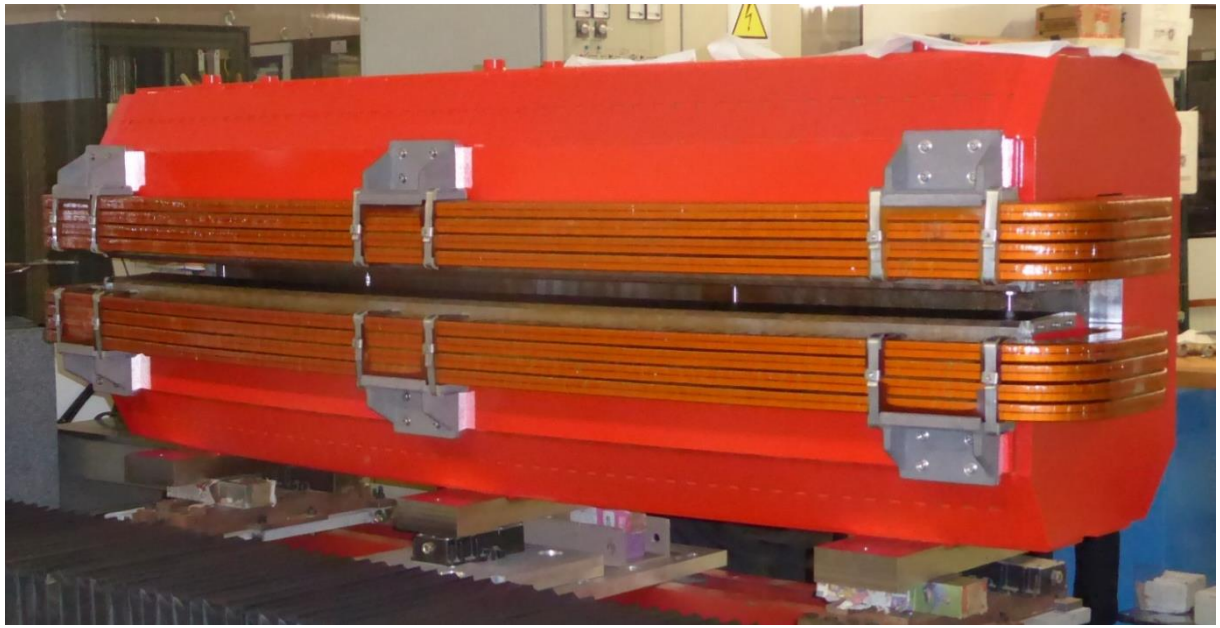


About 150 magnets are needed for the main accelerator.

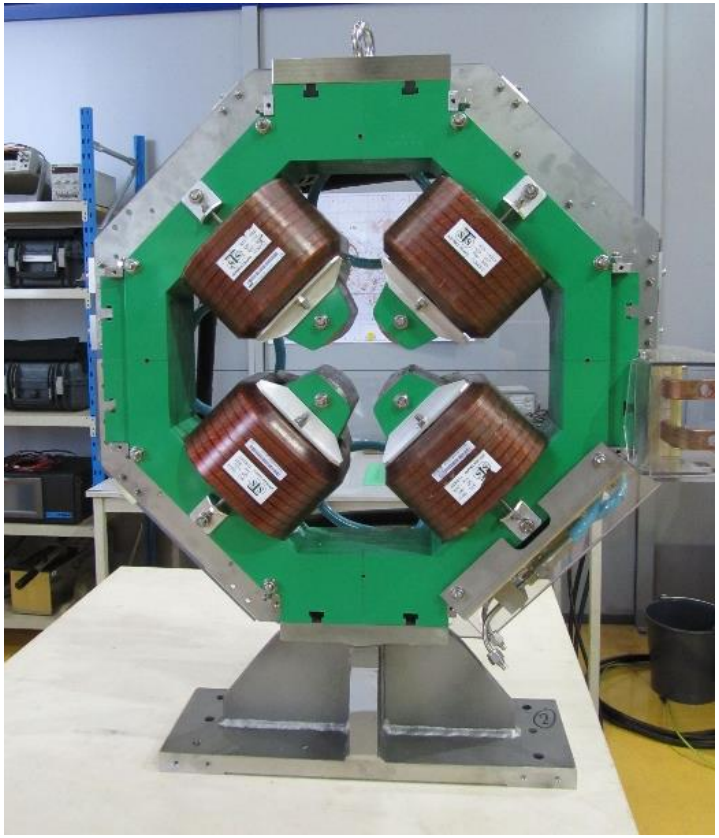
Components and magnets have been bought in the industry.



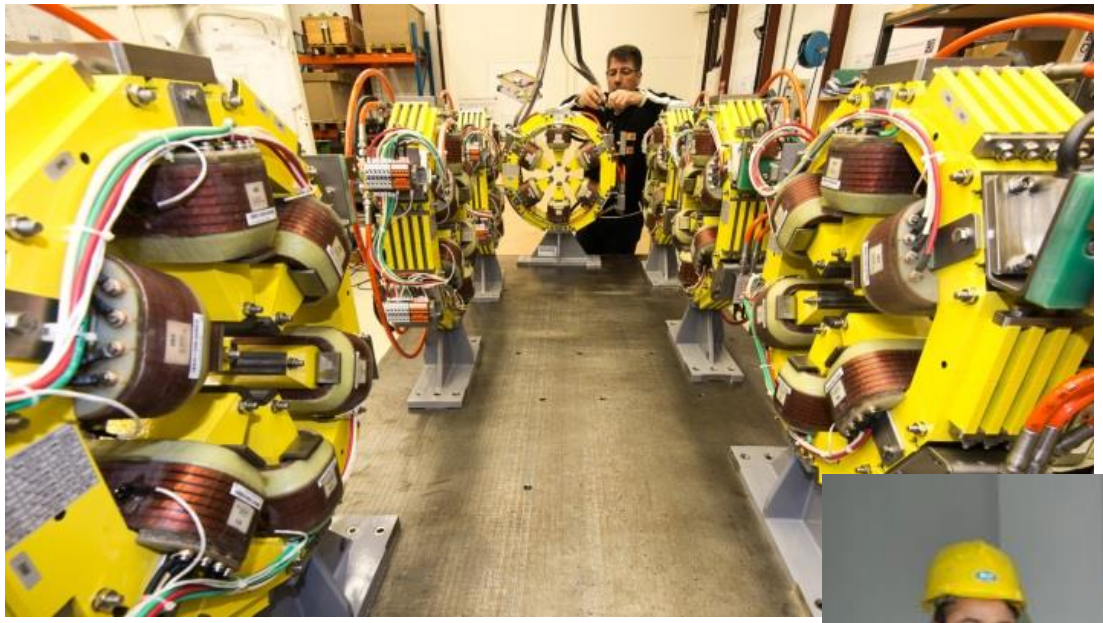
The dipoles have been manufactured in the UK.



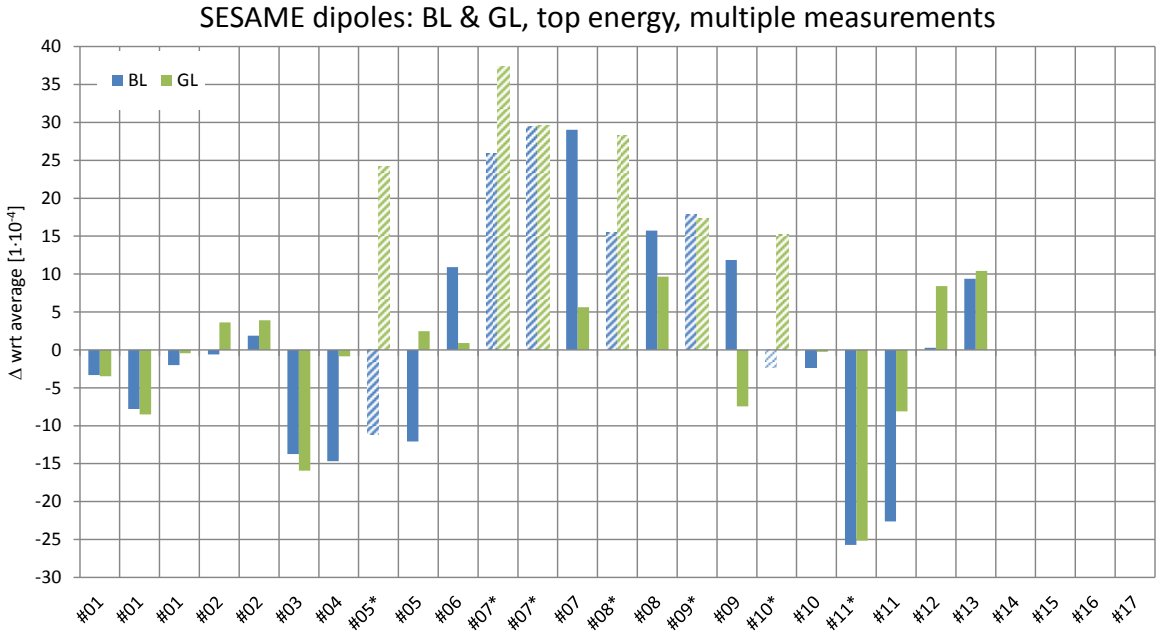
The quadrupoles have been made in Spain, with components (the coils) made in Turkey.

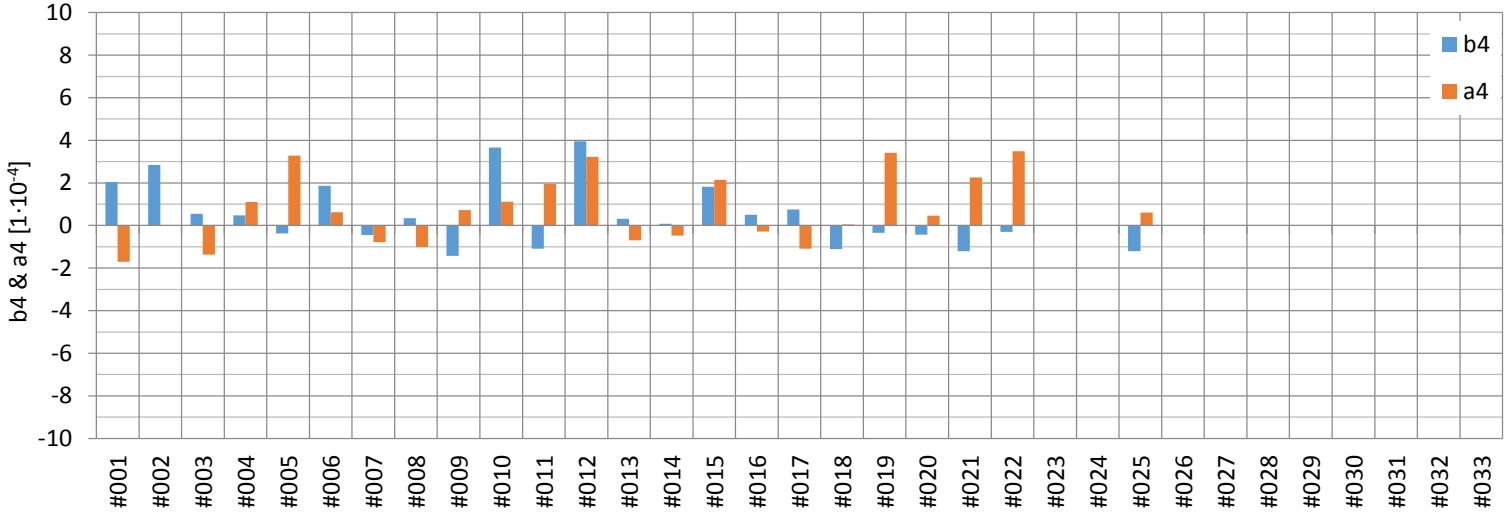


The sextupoles come from Cyprus and Pakistan, with components (the coils) made in France.

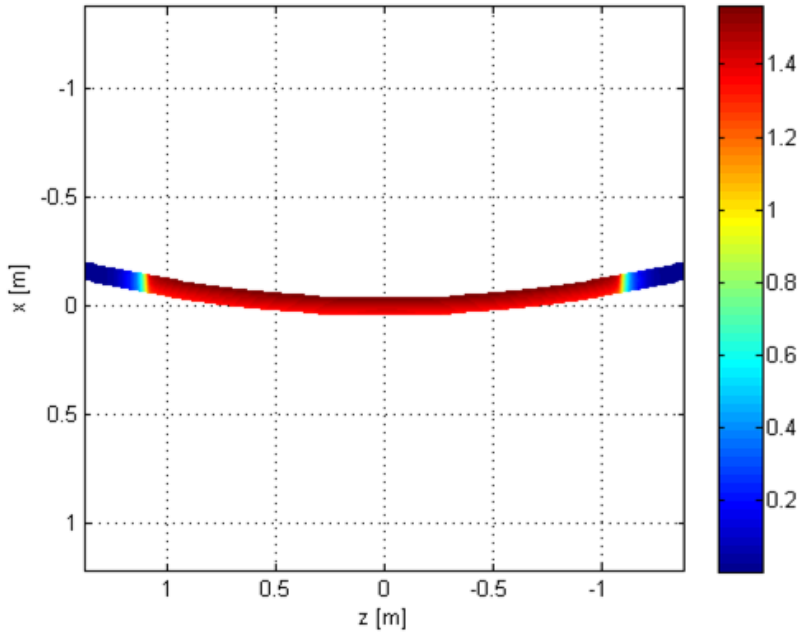


Once delivered, then every single magnet of SESAME is tested and measured as if it were installed at CERN.

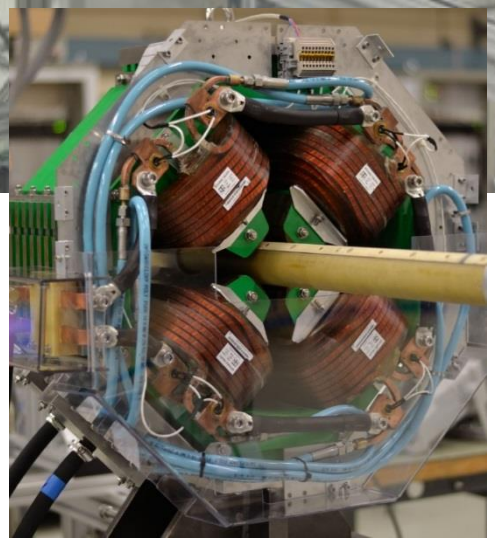


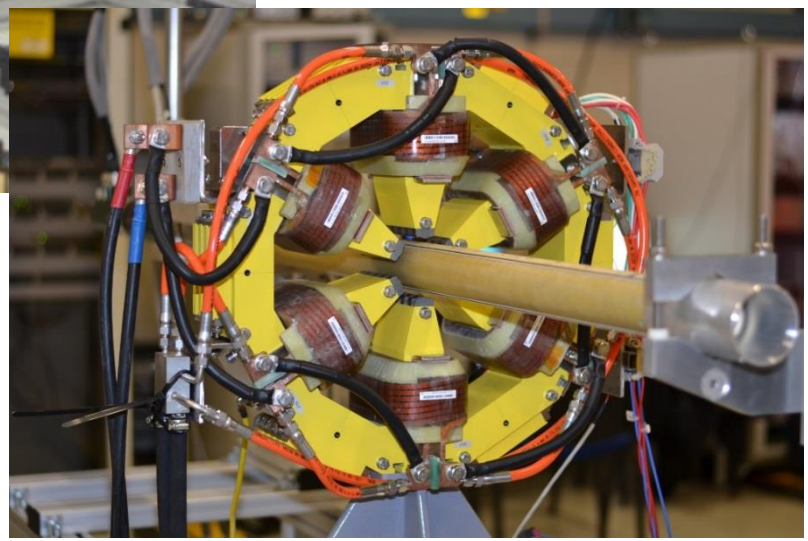


The dipoles are measured in another institute (ALBA, Spain) using a Hall probe mapping.



The other magnets are measured at CERN with a rotating coil system, which will then be transferred to SESAME.





Power supplies and controls are needed for the magnets. These have been developed together by SESAME and CERN.

What will be the typical distance travelled by electrons in the SESAME accelerator?

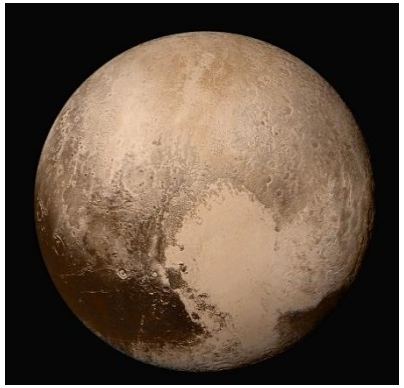
speed × time = distance

300 000 km/s × 10 h = … = 10 800 000 000 km

average distance

Sun – Pluto

5 906 380 000 000 km



What is the precision needed in these magnets?

uniformity of the magnetic field around 0.01%

tolerances on (critical) mechanical parts of 0.02 mm

0.10 mm

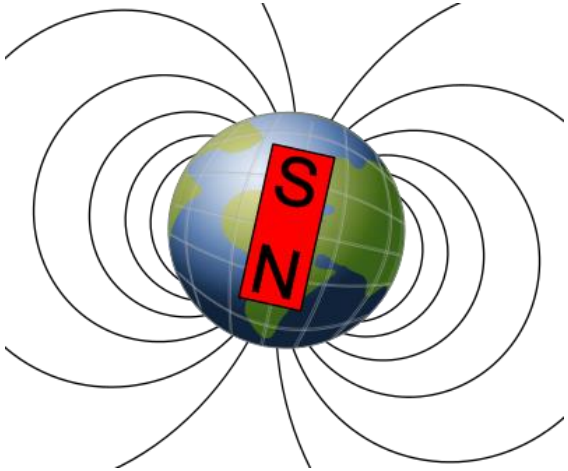
average diameter of a strand of human hair

How much money is the European Commission giving CERN / SESAME for this project?

5 000 000 EUR

How strong are these SESAME magnets?

about 1.5 T (Tesla)



0.000025 - 0.000065 T

(1/30000)

7.7 T

(5 times)

How much do these magnets weigh?

about 130 tons

(roughly 3/4 iron, 1/4 copper)

100 – 150 tons

the blue whale,
the largest animal
inhabiting our planet

How much electrical power will be needed for these magnets?

about 500 kW (at full energy)

50 m rotor diameter

wind > 10 m/s

How to work with particle accelerator magnets?

Keep studying…

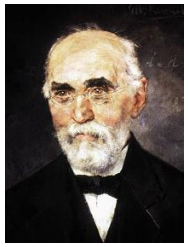
then apply for a job

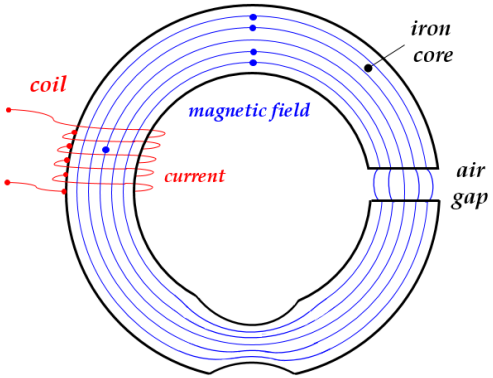
in an accelerator, maybe SESAME!

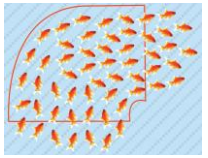
To wrap up…

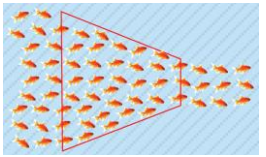
$$\vec{F} = q\vec{v} \times \vec{B}$$

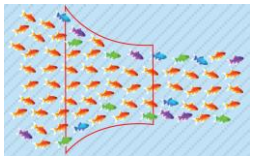
Lorentz (?) force

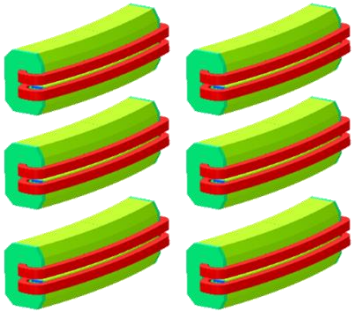












To know more…

cessamag.web.cern.ch

"Pictures" for both hardware and people

links to technical notes under "Document repository"

www.sesame.org.jo

"SESAME Publications" for technical information

cas.web.cern.ch (CERN Accelerator School)

proceedings under "Previous Schools" are a wealth of information, see the 2009 in particular for magnets

my contact Attilio.Milanese@cern.ch

thank you

شكرا (shukran)

ευχαριστώ (efharistó)

ممنون (mamnoon)

شكريه (shukriya)

teşekkür ederim

תודה (toda)