CERN

#askCERN

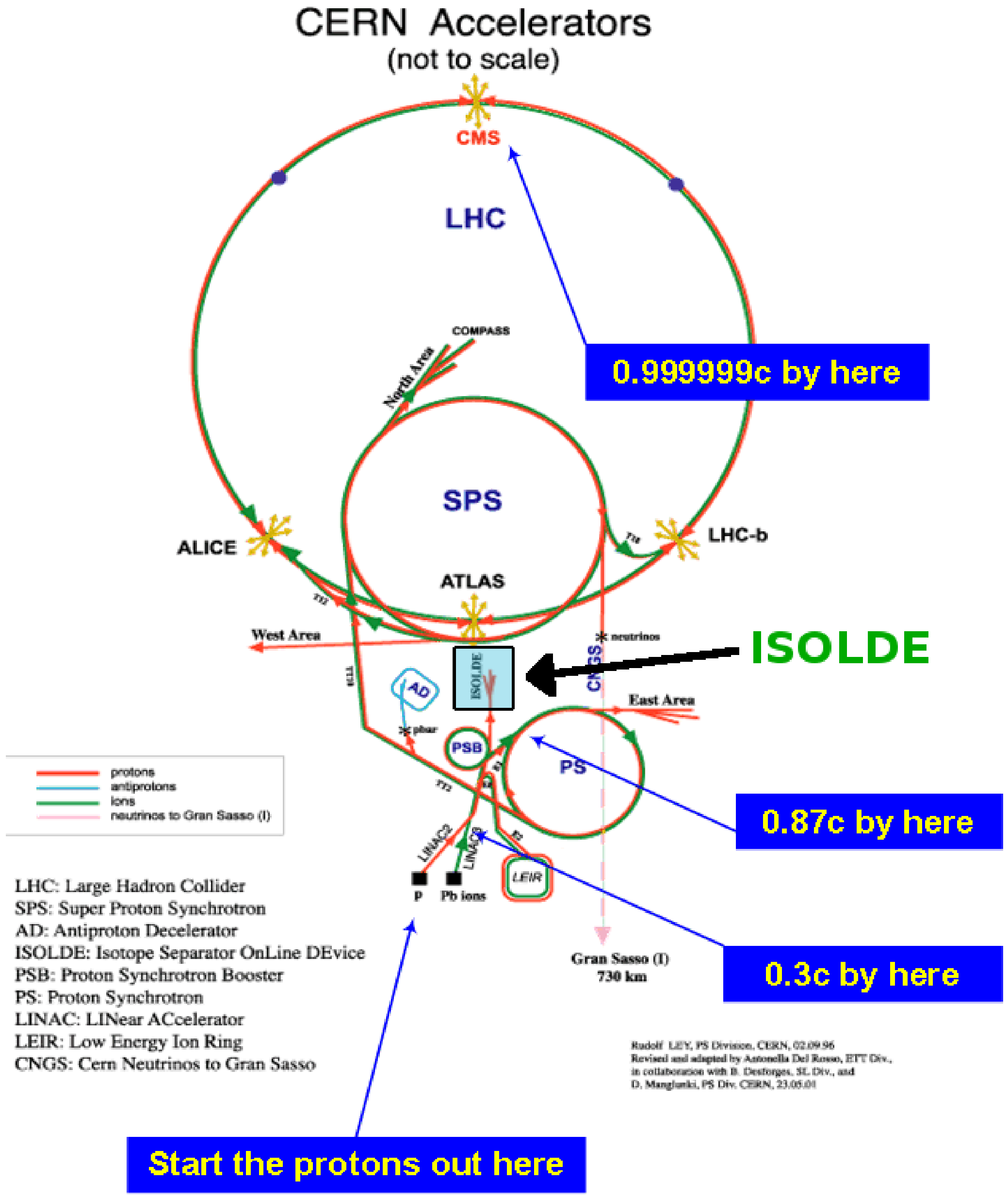
Hangout with CERN: ISOLDE – the dream of the alchemists

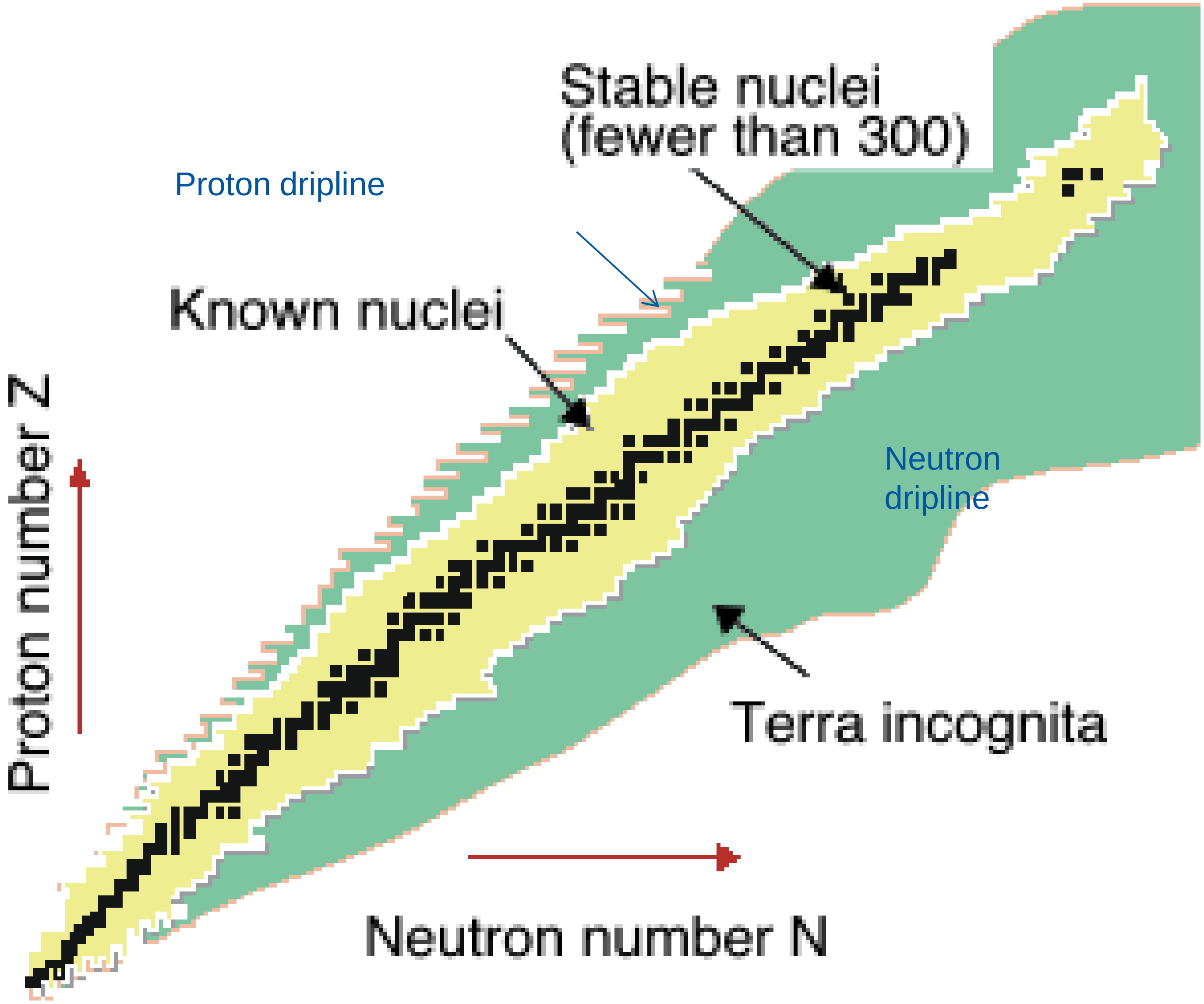
30 May 2013

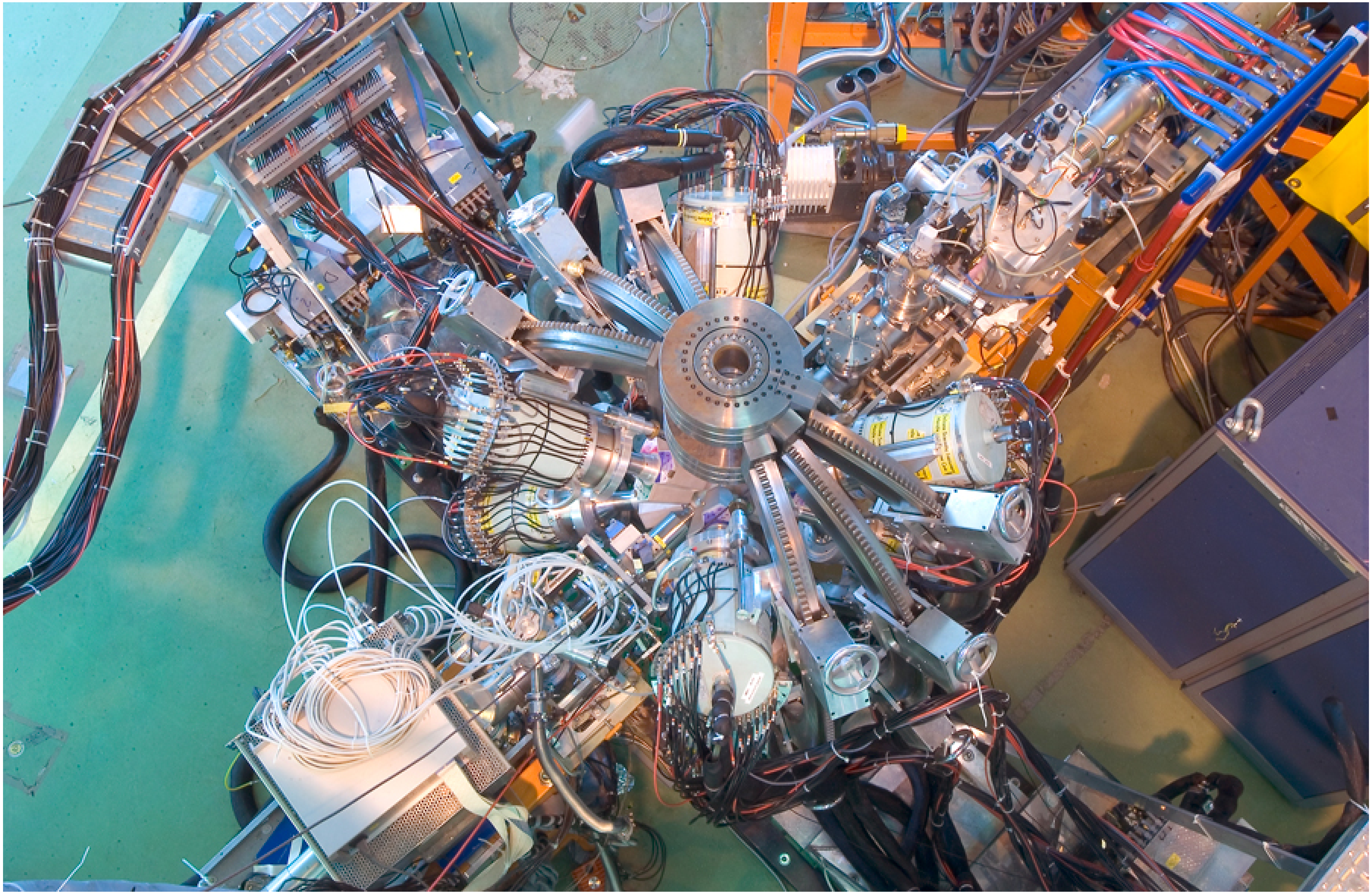
Today's trivia question

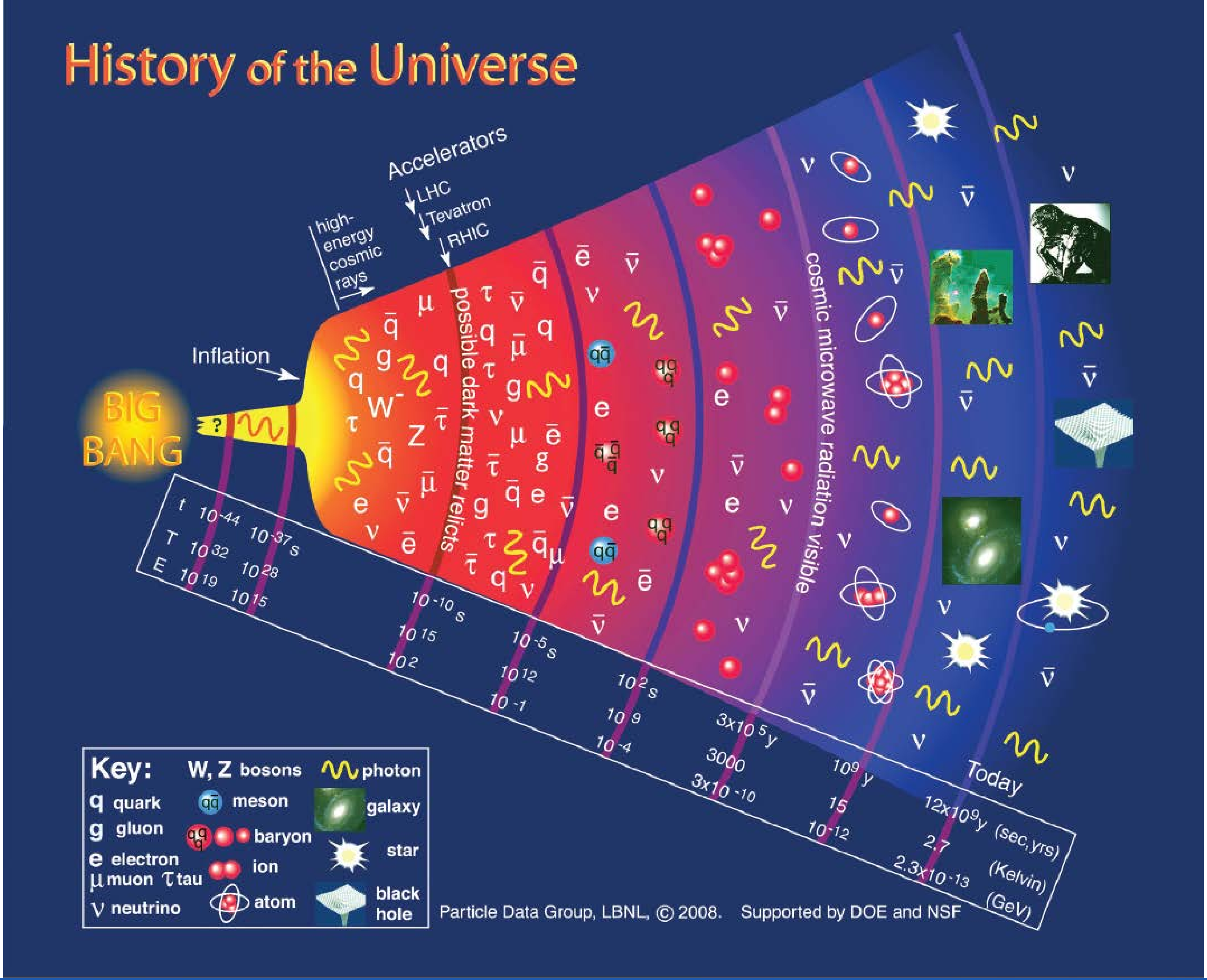
30 years ago this Saturday, CERN formally announced the discovery of something.

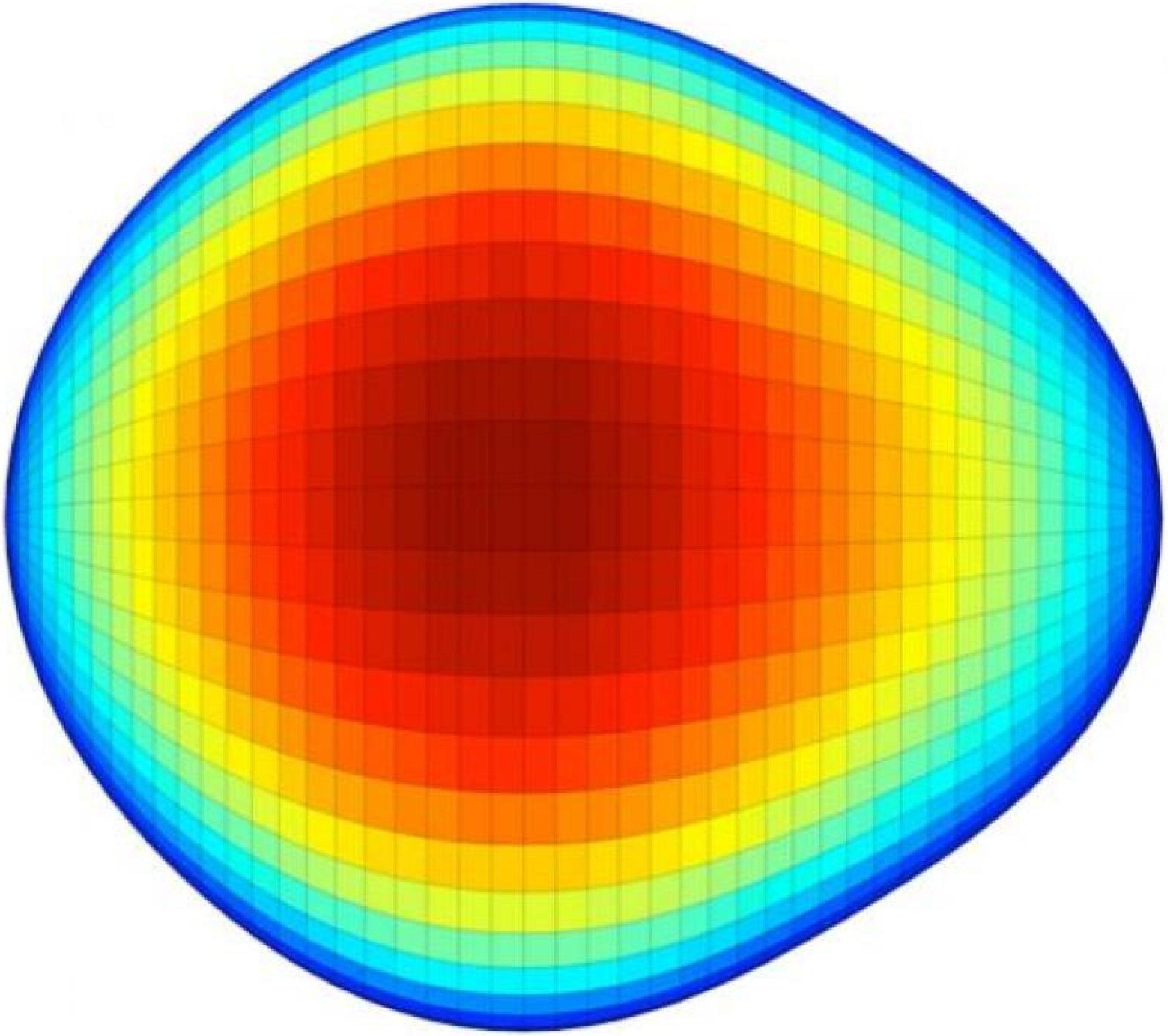
What was it?


CERN Accelerators
(not to scale)
CMS
LHC
COMPASS
North Area
SPS
ALICE
ATLAS
LHC-b
West Area
neutrinos
ISOLDE
CNGS
AD
East Area
pbar
PSB
PS
LINAC2
LINAC3
LEIR
P
Pb ions
Gran Sasso (I)
730 km
protons
antiprotons
ions
neutrinos to Gran Sasso (I)
LHC: Large Hadron Collider
SPS: Super Proton Synchrotron
AD: Antiproton Decelerator
ISOLDE: Isotope Separator OnLine DEvice
PSB: Proton Synchrotron Booster
PS: Proton Synchrotron
LINAC: LINear ACcelerator
LEIR: Low Energy Ion Ring
CNGS: Cern Neutrinos to Gran Sasso
Rudolf LEY, PS Division, CERN, 02.09.96
Revised and adapted by Antonella Del Rosso, ETT Div.,
in collaboration with B. Desforges, SL Div., and
D. Manglunki, PS Div. CERN, 23.05.01
0.999999c by here
0.87c by here
0.3c by here
Start the protons out here


Stable nuclei
(fewer than 300)
Proton dripline
Known nuclei
Proton number Z
Neutron
dripline
Terra incognita
Neutron number N




History of the Universe
Accelerators
LHC
Tevatron
RHIC
high-energy cosmic rays
Inflation
BIG BANG
possible dark matter relicts
cosmic microwave radiation visible
t 10^-44 10^-37 s
T 10^32 10^28
E 10^19 10^15
10^-10 s
10^15
10^2
10^-5 s
10^12
10^-1
10^2 s
10^9
10^-4
3x10^5 y
3000
3x10^-10
10^9 y
15
10^-12
Today
12x10^9 y (sec,yrs)
2.7 (Kelvin)
2.3x10^-13 (GeV)
Key:
W, Z bosons
photon
q quark
meson
galaxy
g gluon
baryon
star
e electron
ion
μ muon τ tau
atom
black hole
ν neutrino
Particle Data Group, LBNL, © 2008. Supported by DOE and NSF



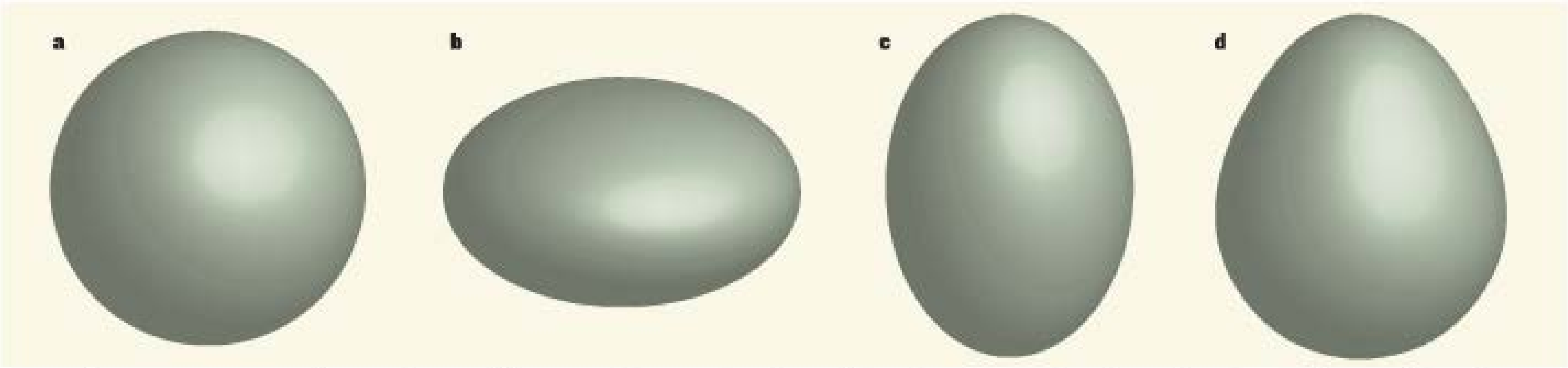
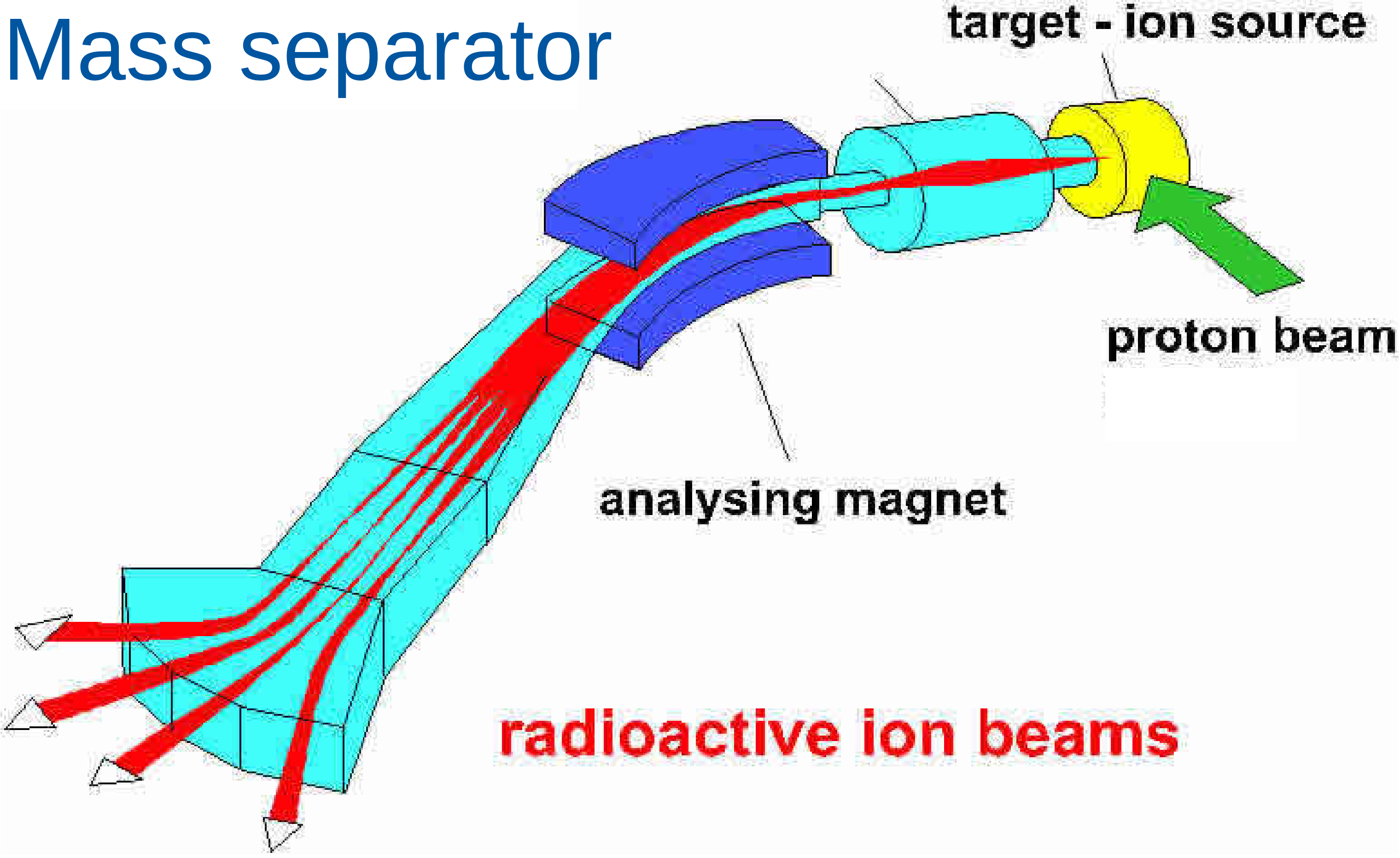
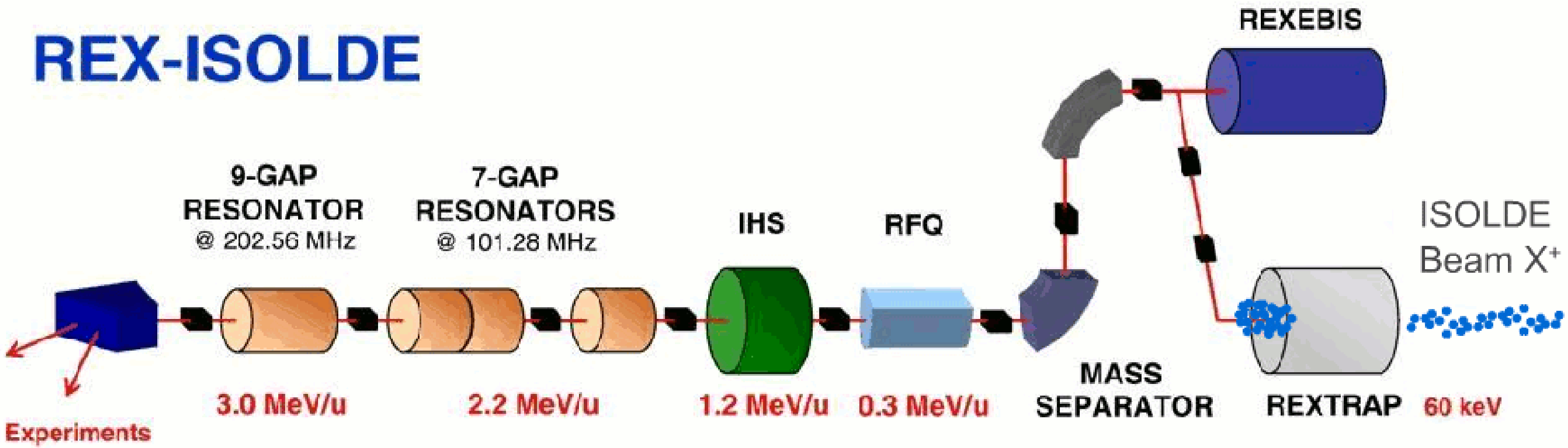
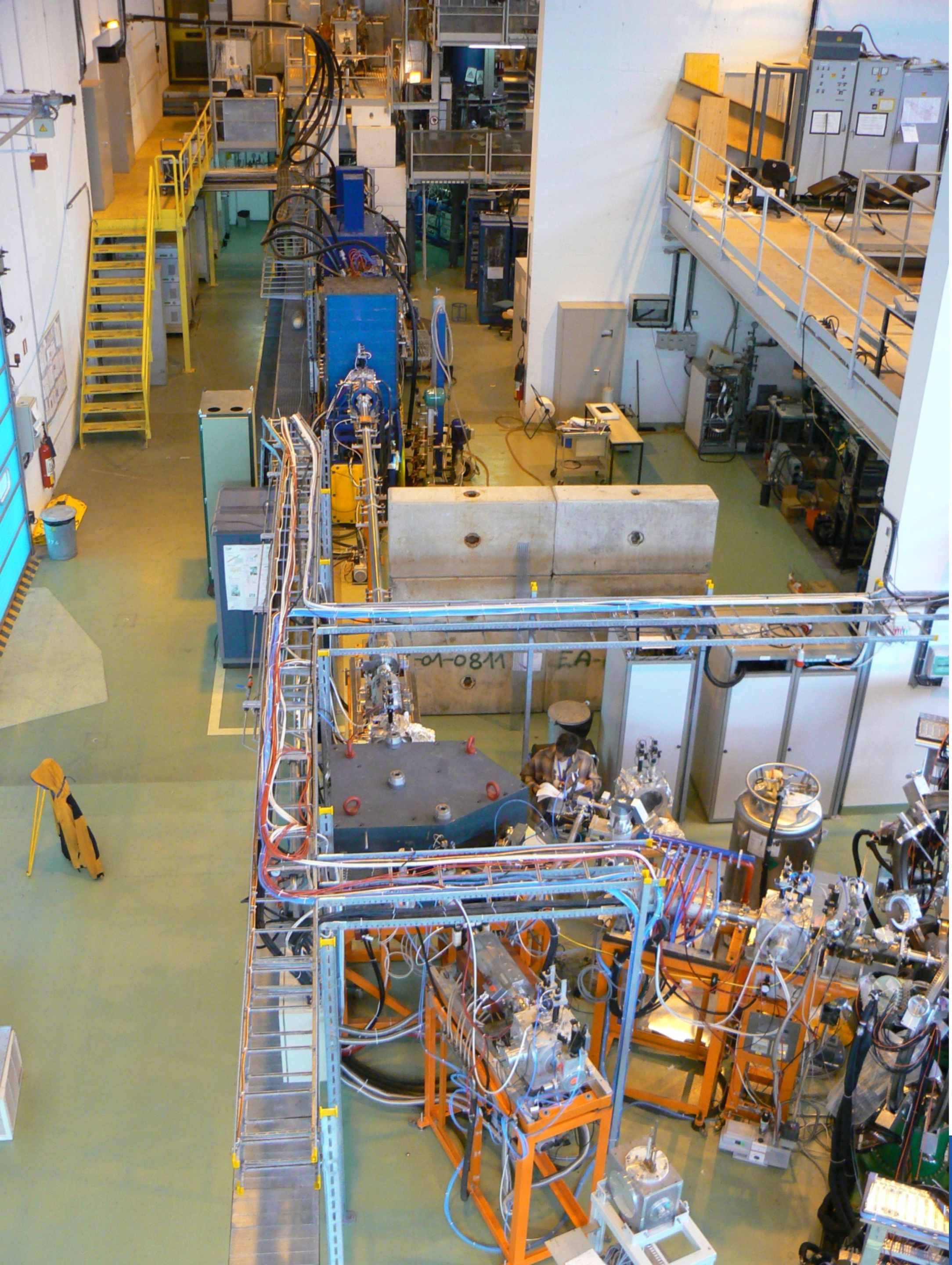


Figure 1 | Nuclear shapes. Nuclei can take several shapes, including a sphere (**a**), an oblate spheroid (**b**) and a prolate spheroid (**c**). Gaffney *et al.*[1] have observed the more exotic pear shape (**d**).

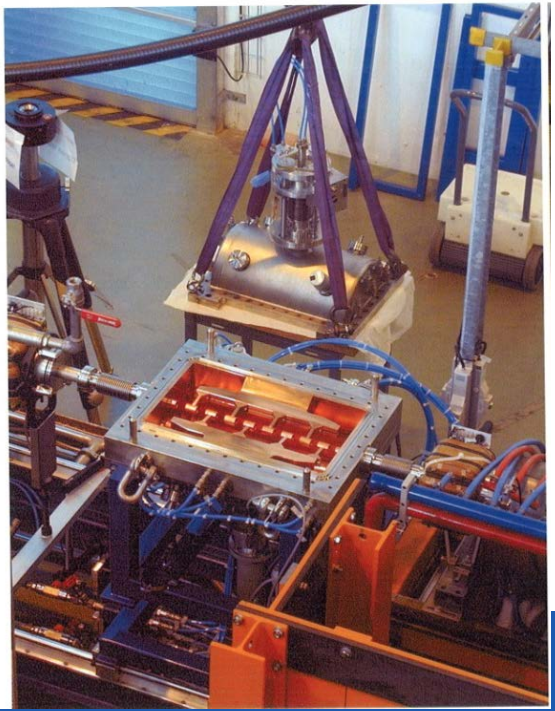
Mass separator

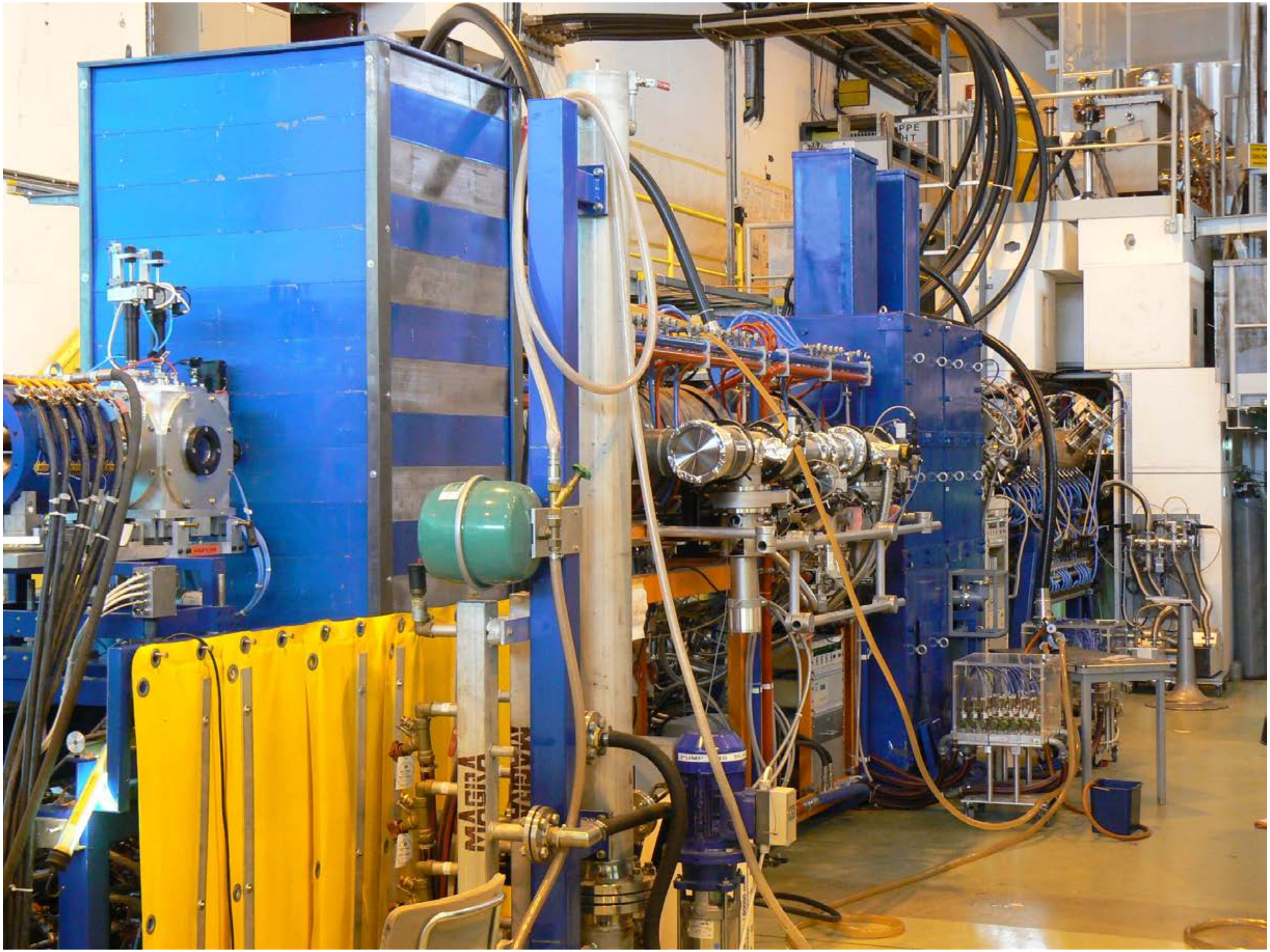


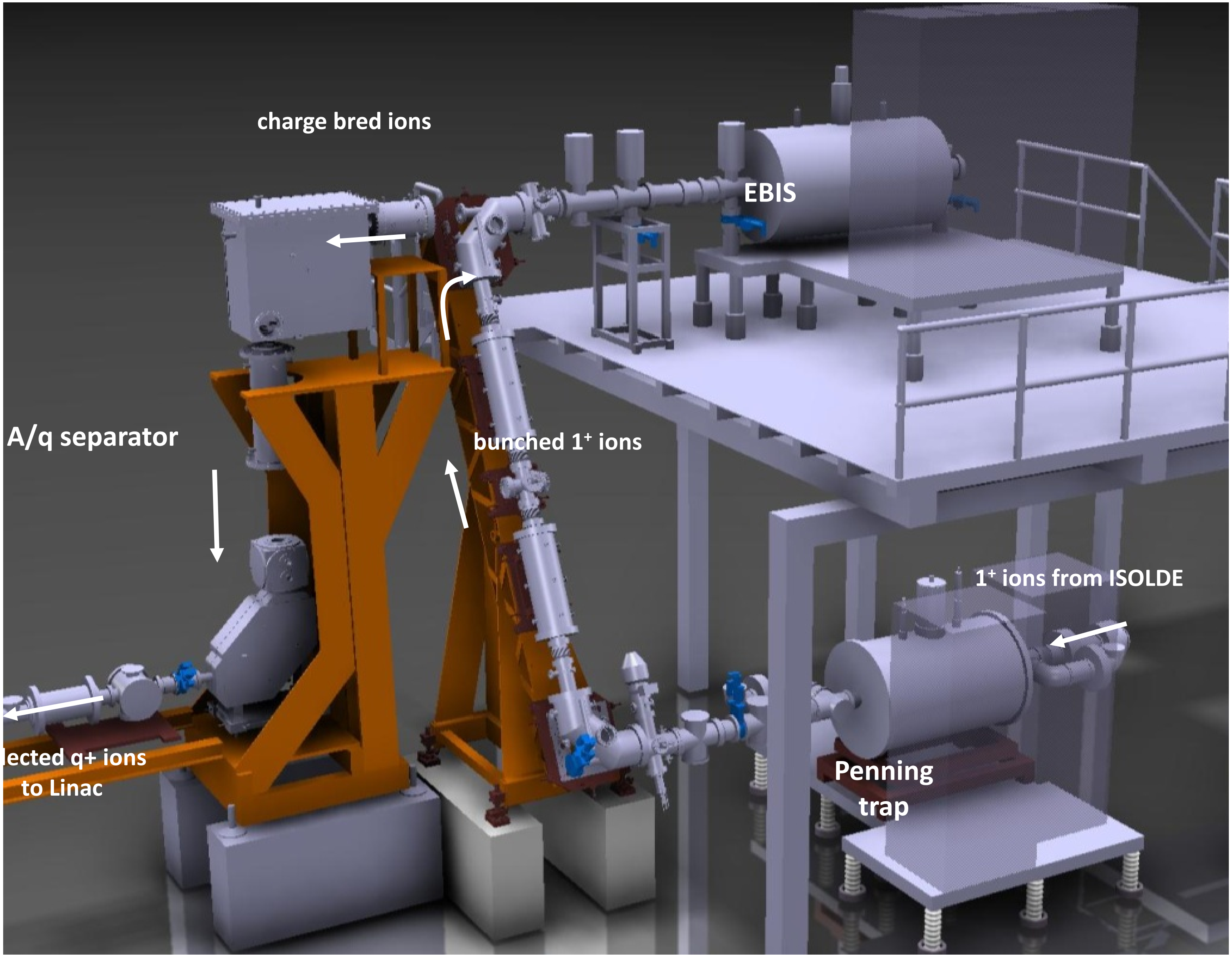

REX-ISOLDE
REXEBIS
9-GAP
RESONATOR
@ 202.56 MHz
7-GAP
RESONATORS
@ 101.28 MHz
IHS
RFQ
ISOLDE
Beam X+
Experiments
3.0 MeV/u
2.2 MeV/u
1.2 MeV/u
0.3 MeV/u
MASS
SEPARATOR
REXTRAP
60 keV


-01-0811
E.A-

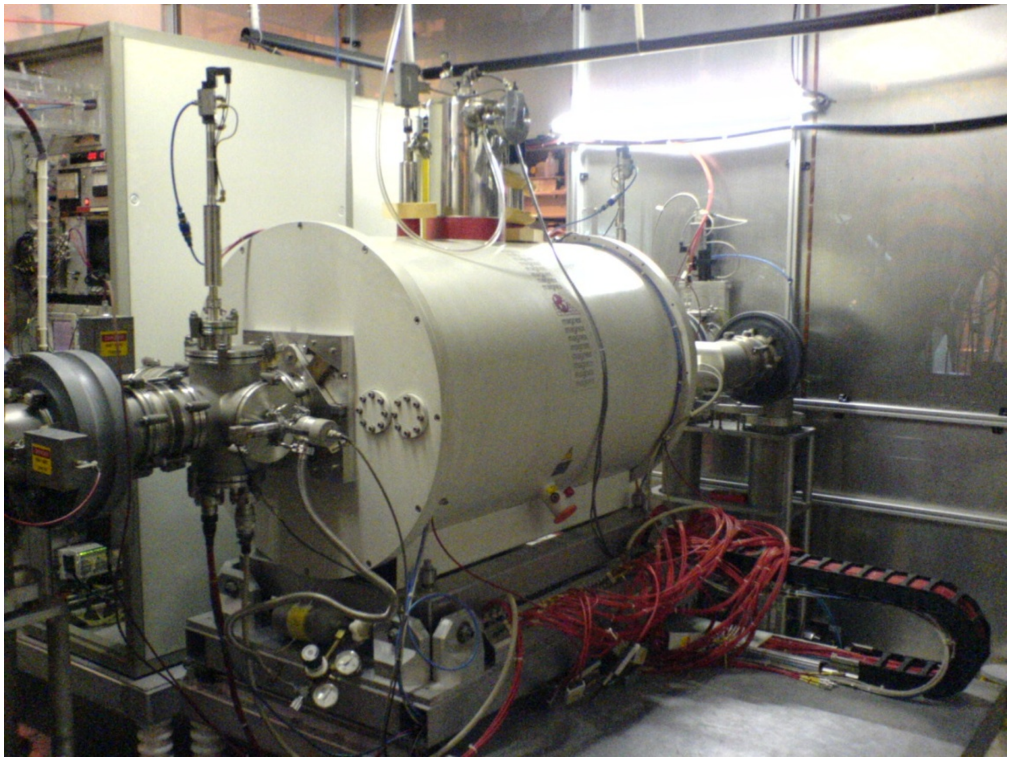

X-Ray



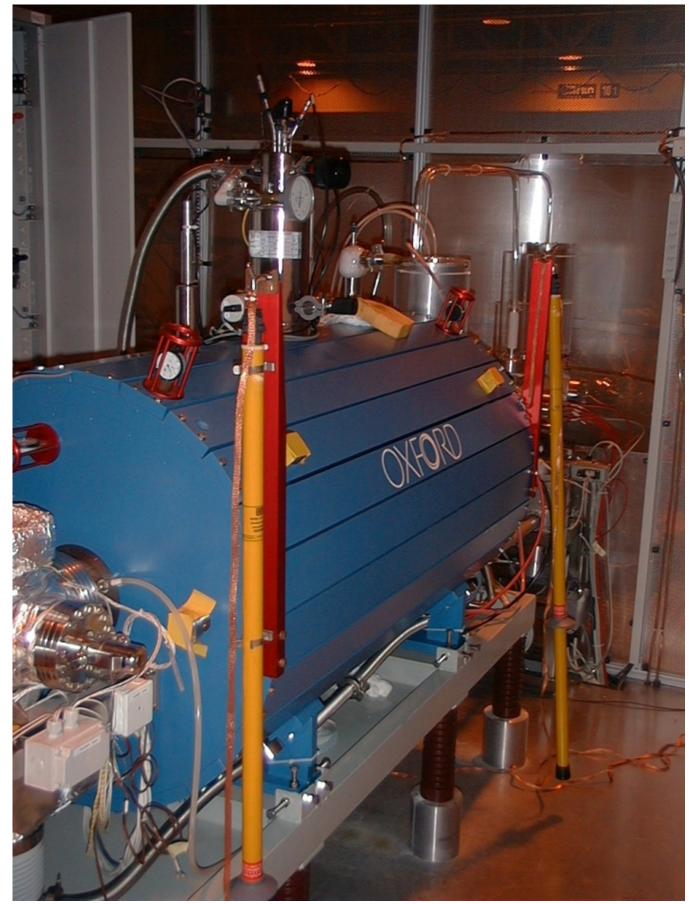

MAGRA

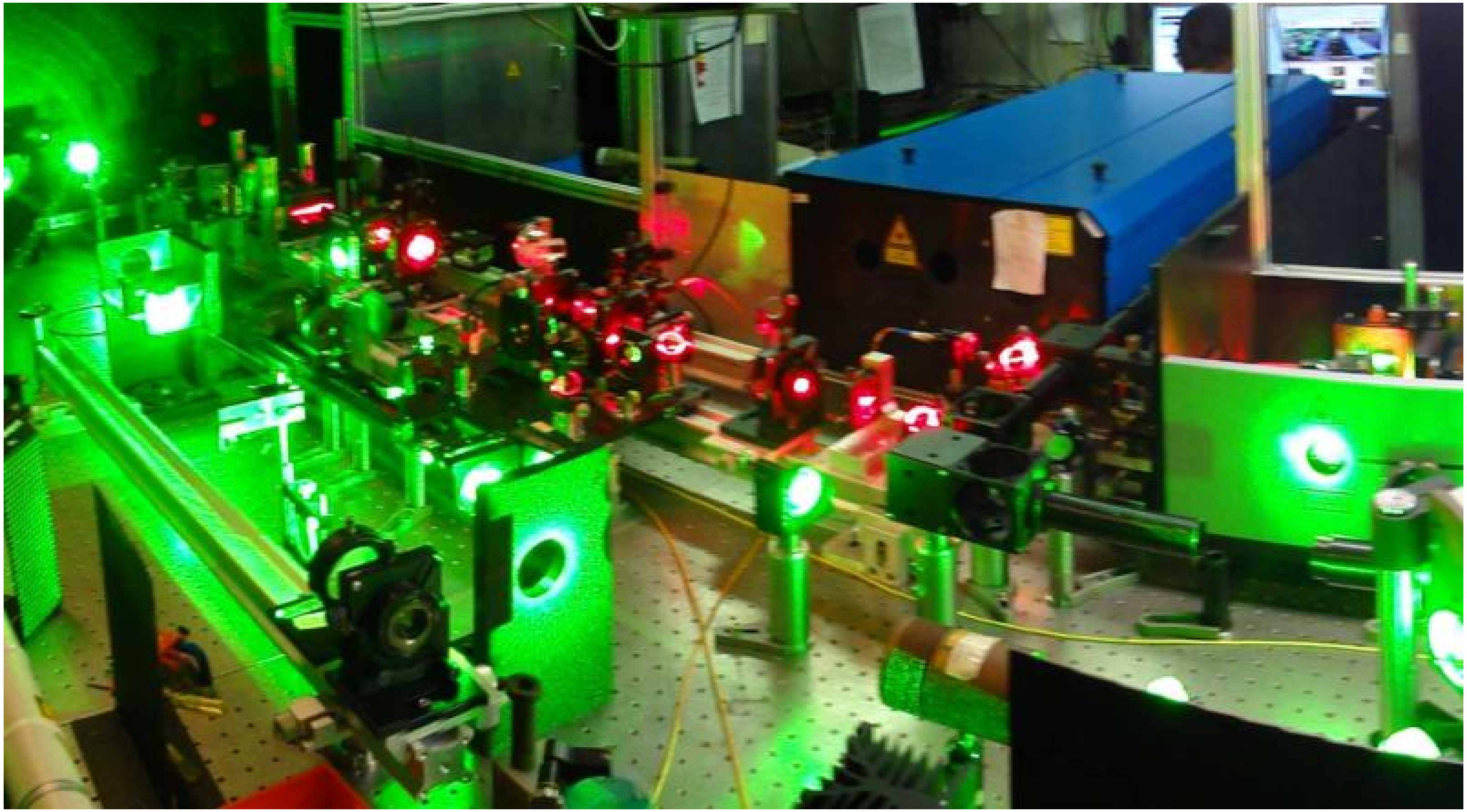

charge bred ions
EBIS
A/q separator
bunched 1+ ions
1+ ions from ISOLDE
lected q+ ions
to Linac
Penning
trap

REXTRAP



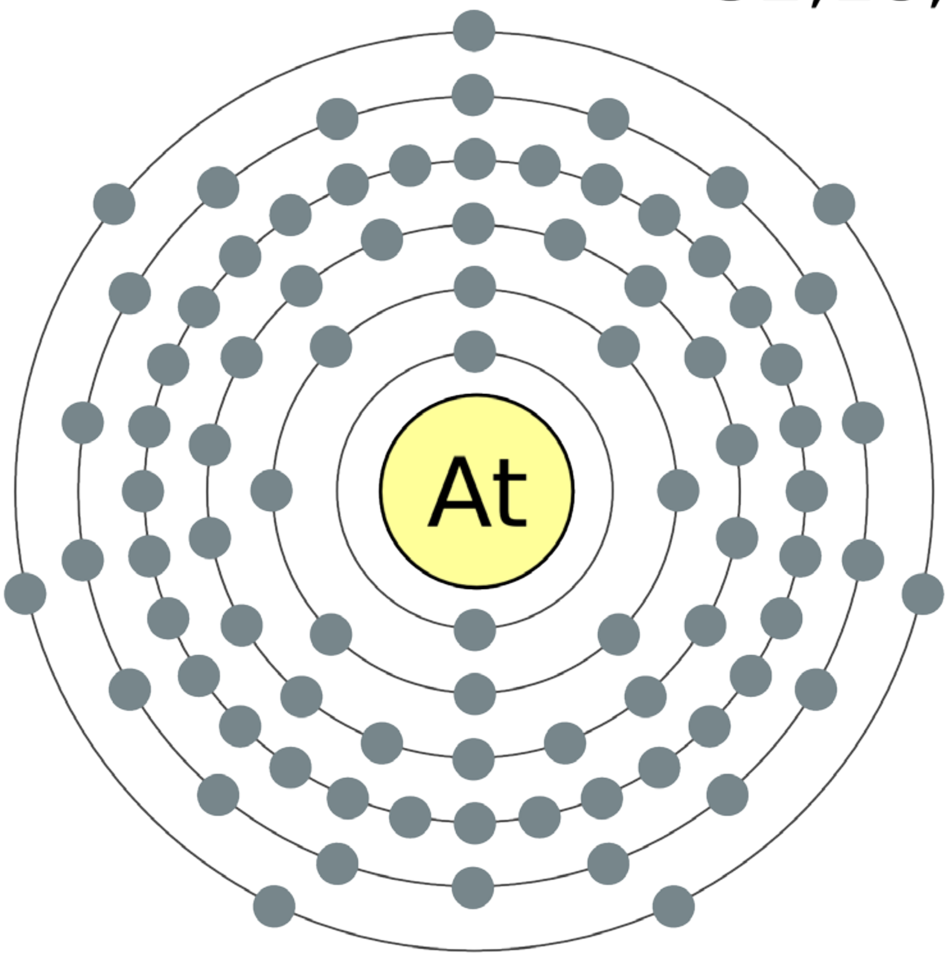
REXEBIS





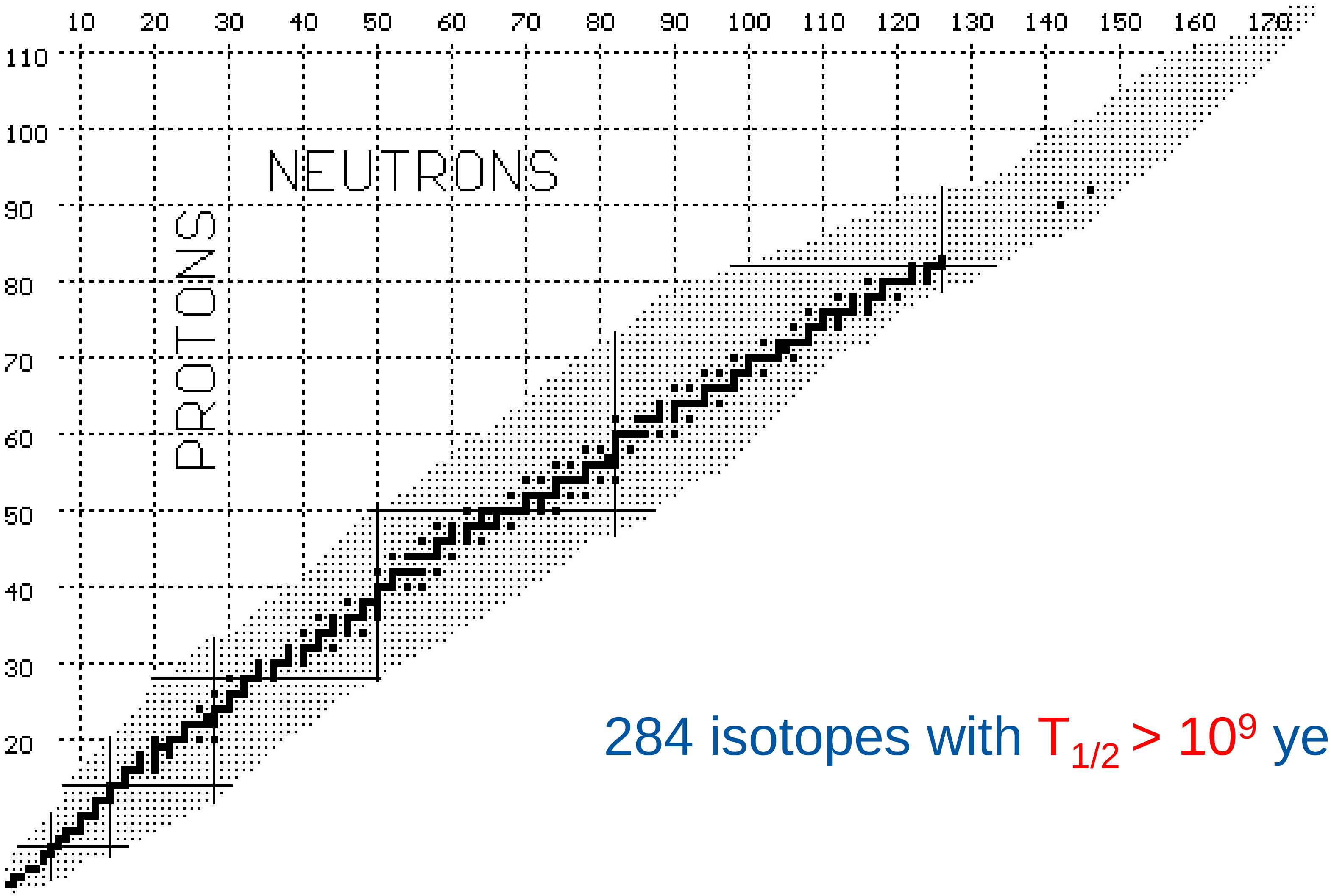
85: Astatine

2,8,18,
32,18,7

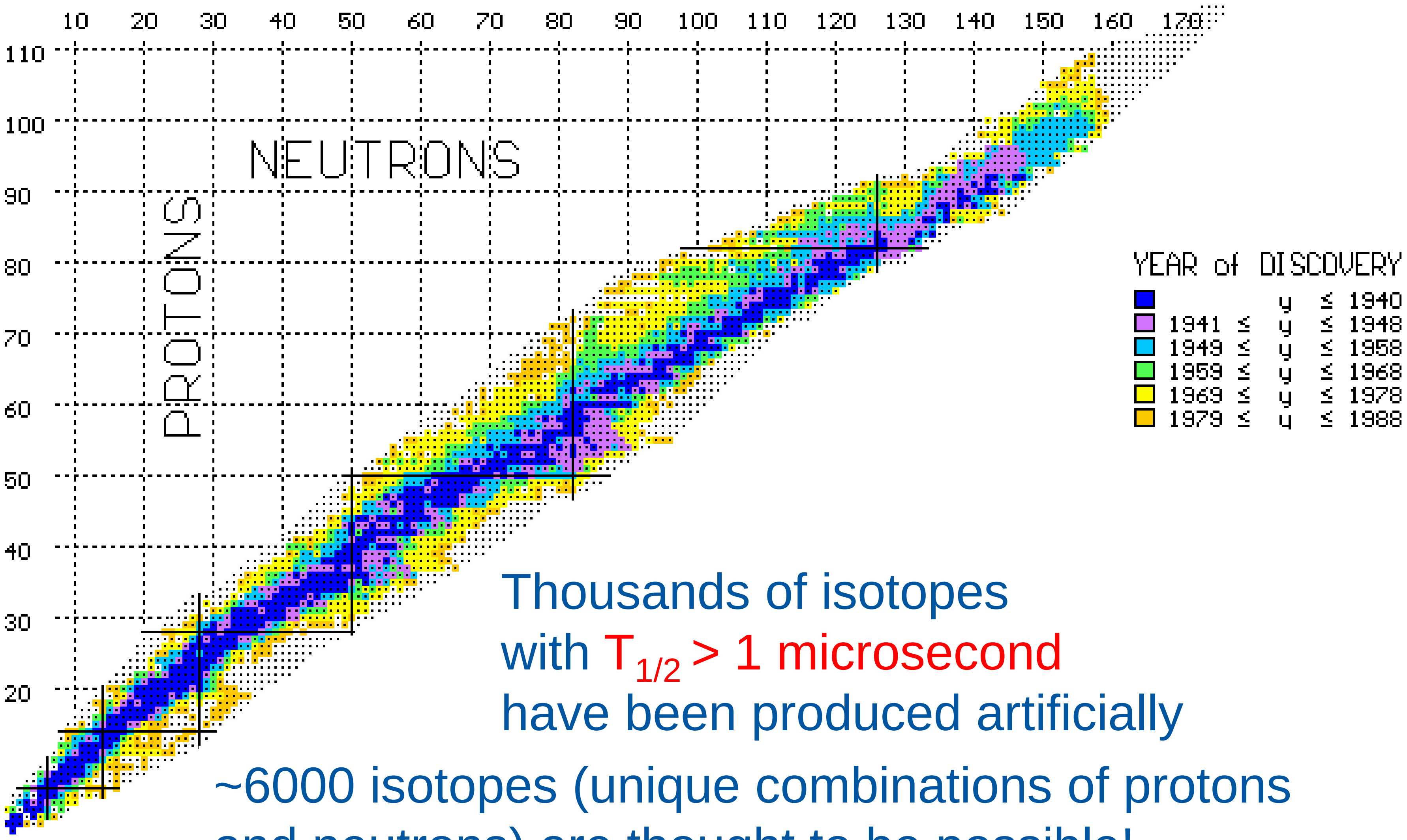


Group → / ↓ Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo

Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

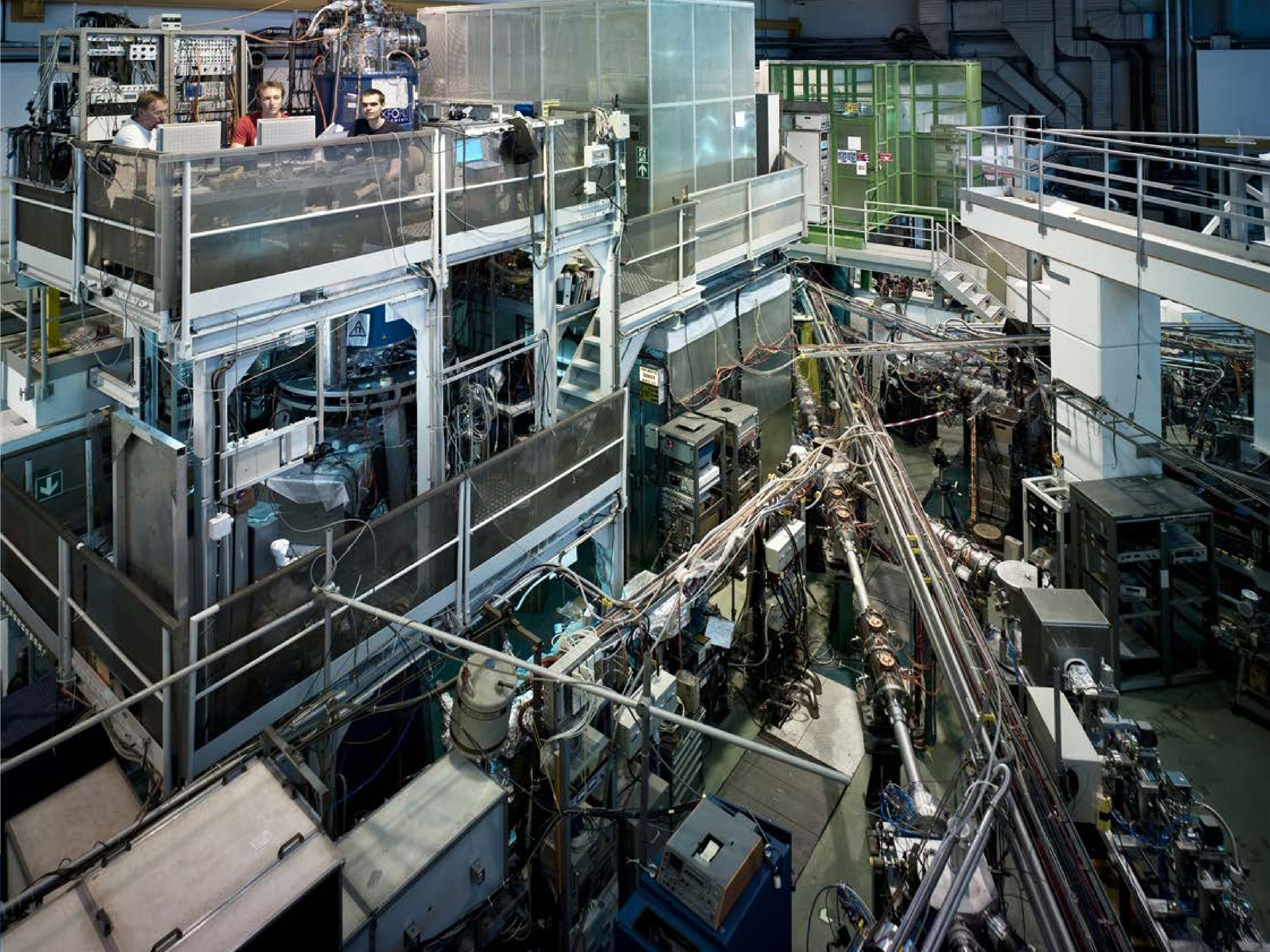


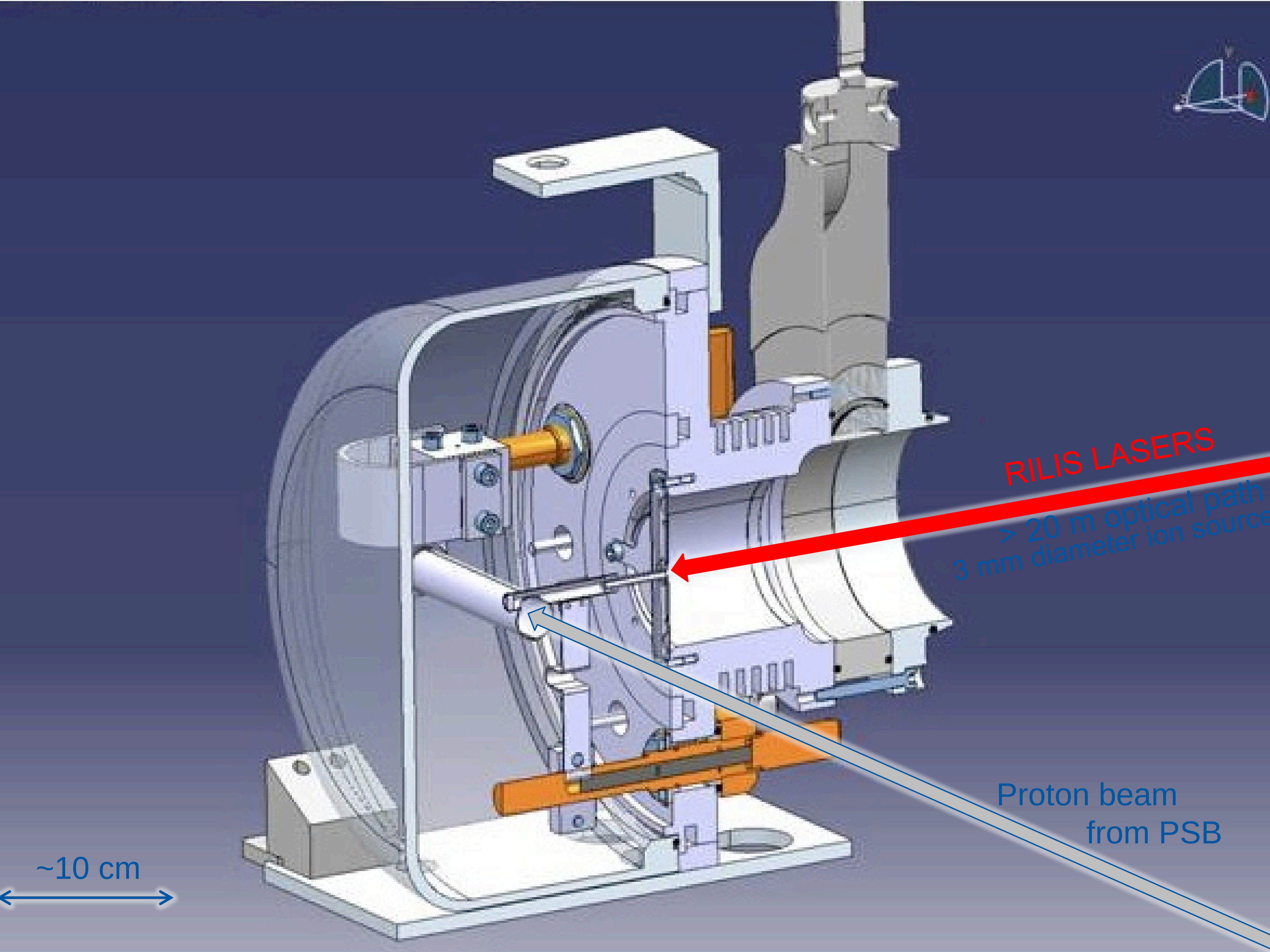
284 isotopes with $T_{1/2} > 10^9$ year



Thousands of isotopes
with $T_{1/2}$ > 1 microsecond
have been produced artificially

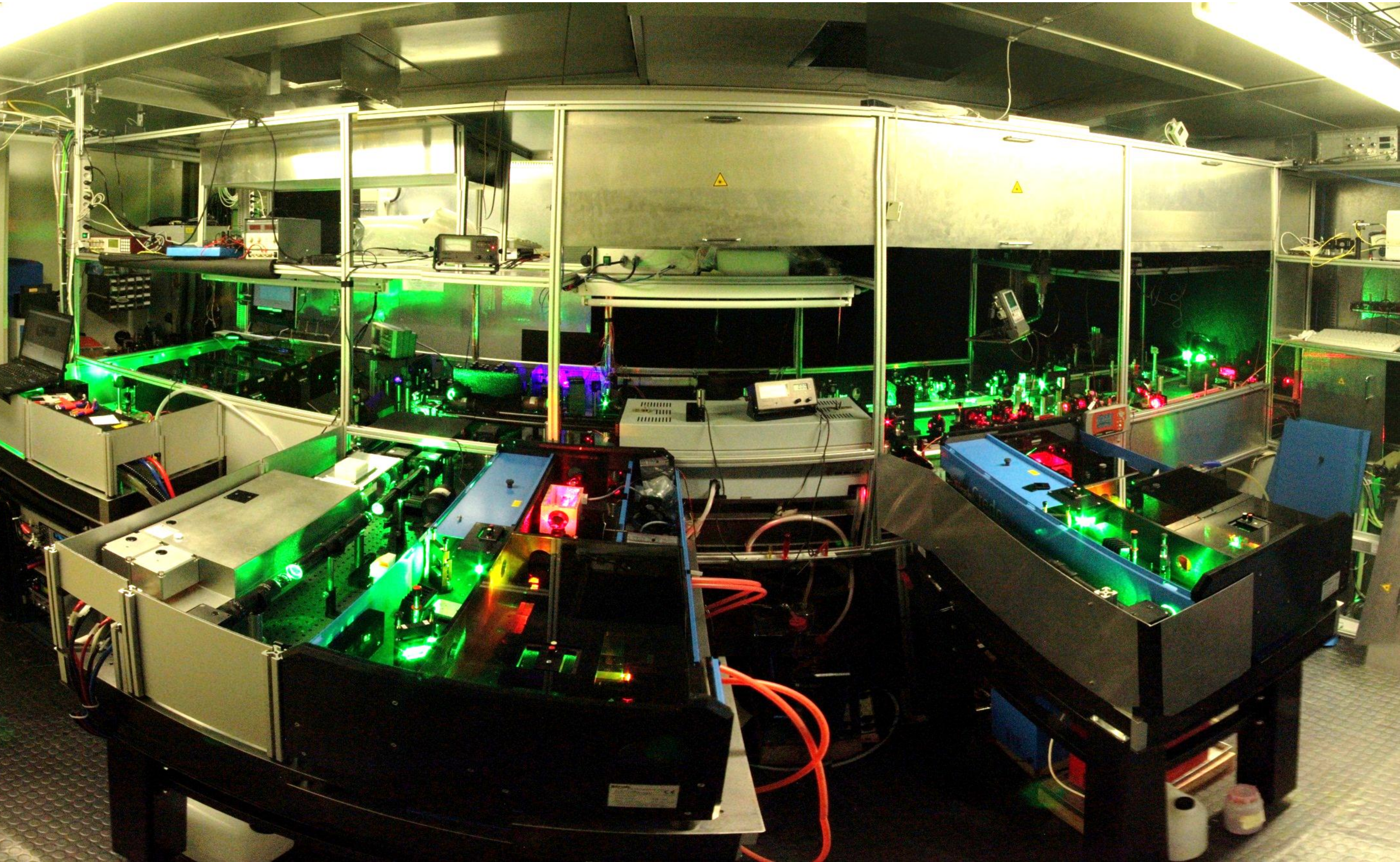
~6000 isotopes (unique combinations of protons and neutrons) are thought to be possible!



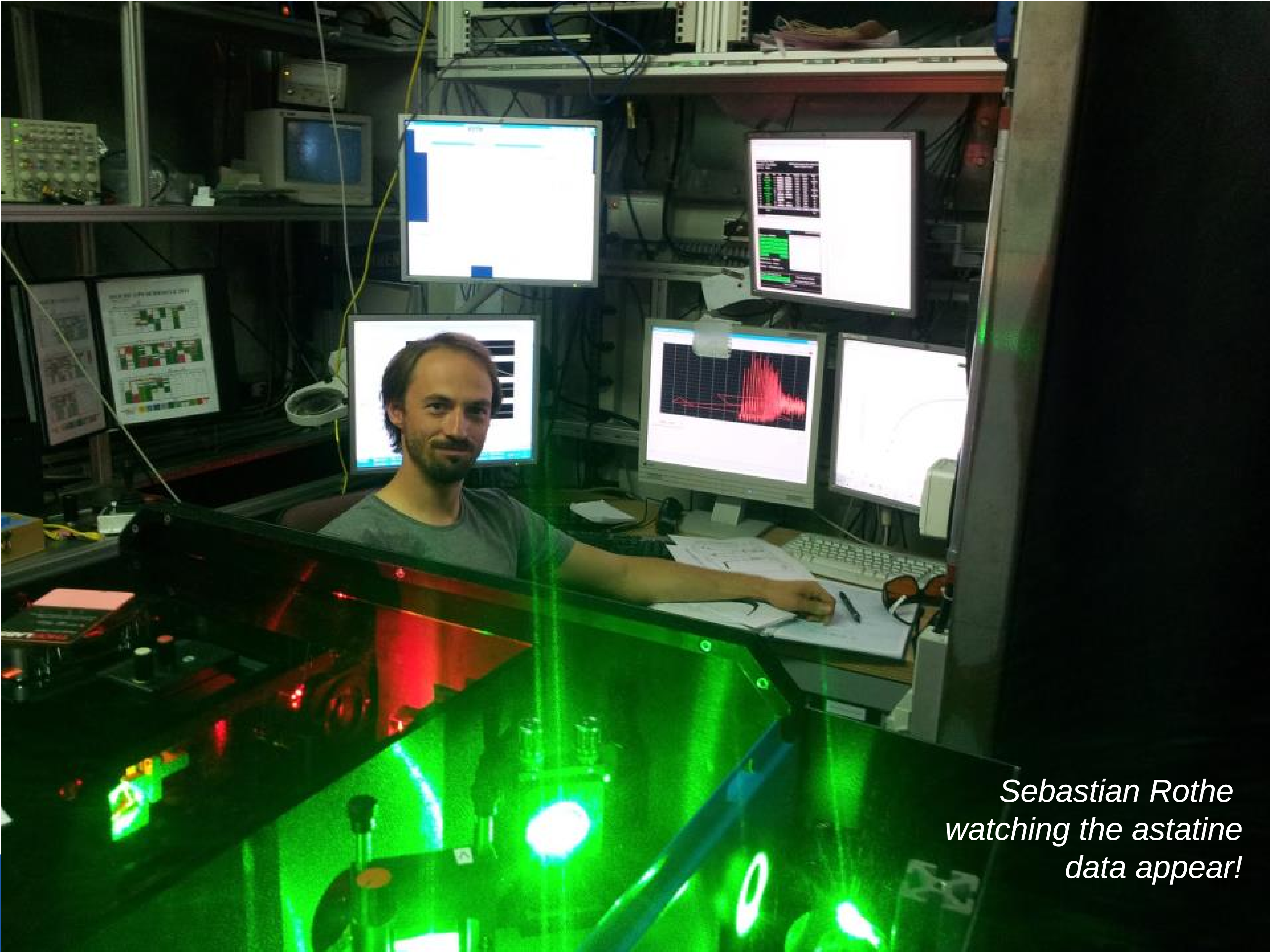


RILIS LASERS
> 20 m optical path
3 mm diameter ion source
Proton beam
from PSB
~10 cm

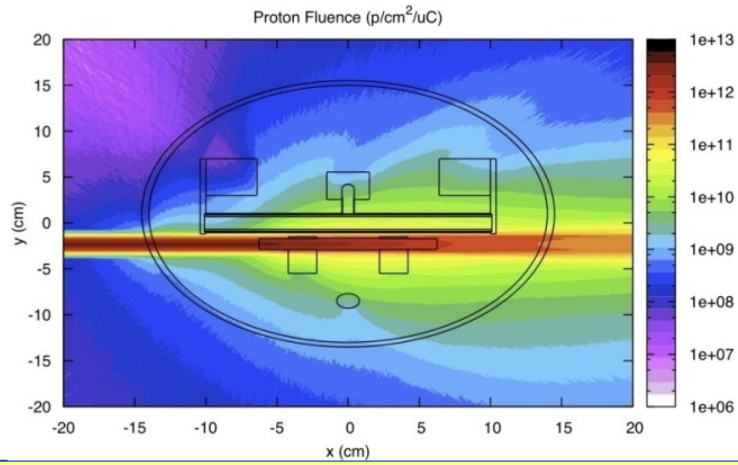
RILIS in action

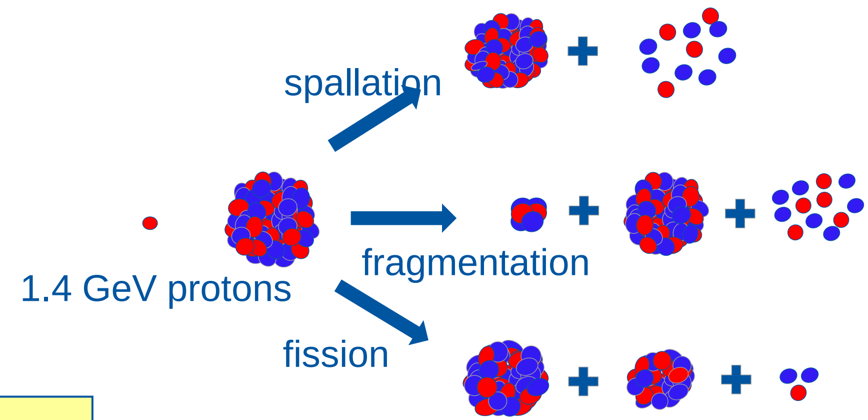


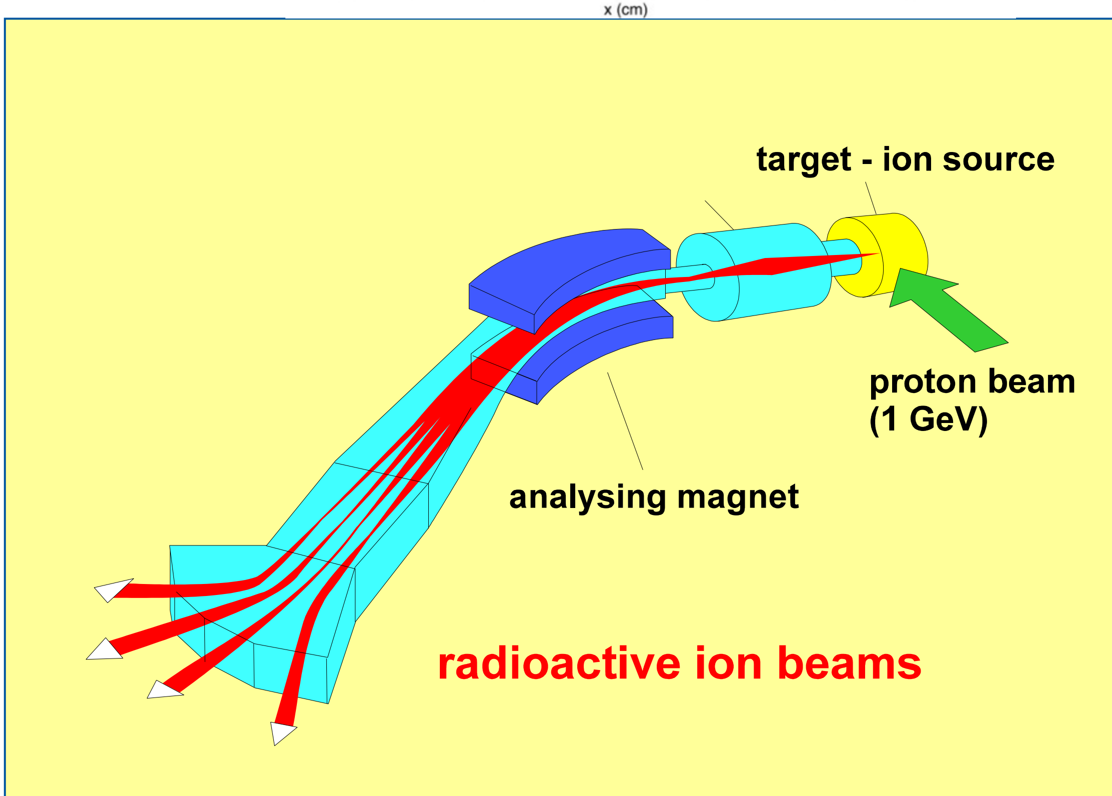
RILIS in action

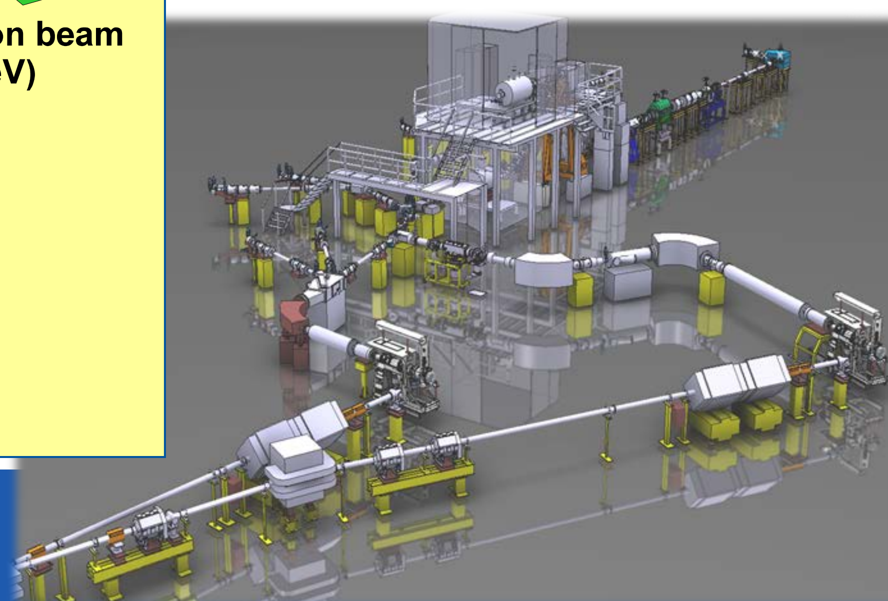


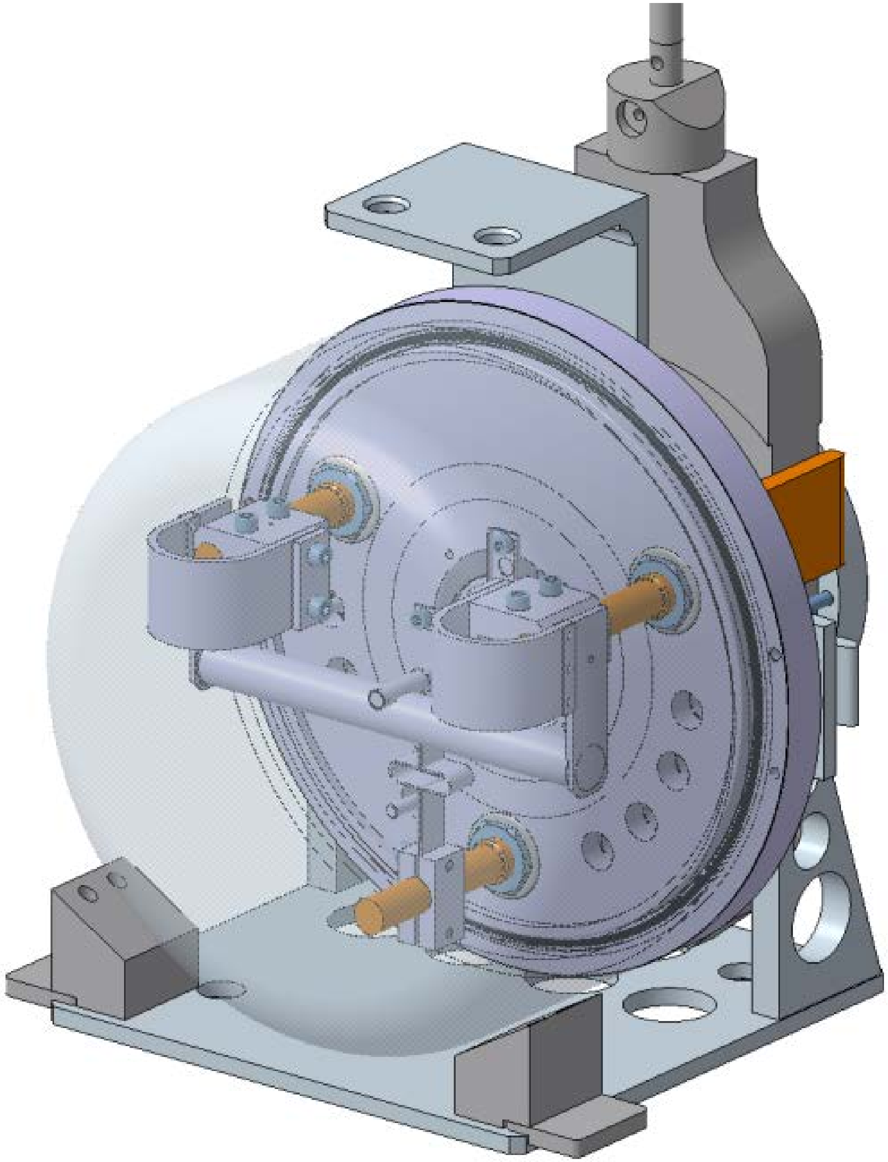
Sebastian Rothe watching the astatine data appear!

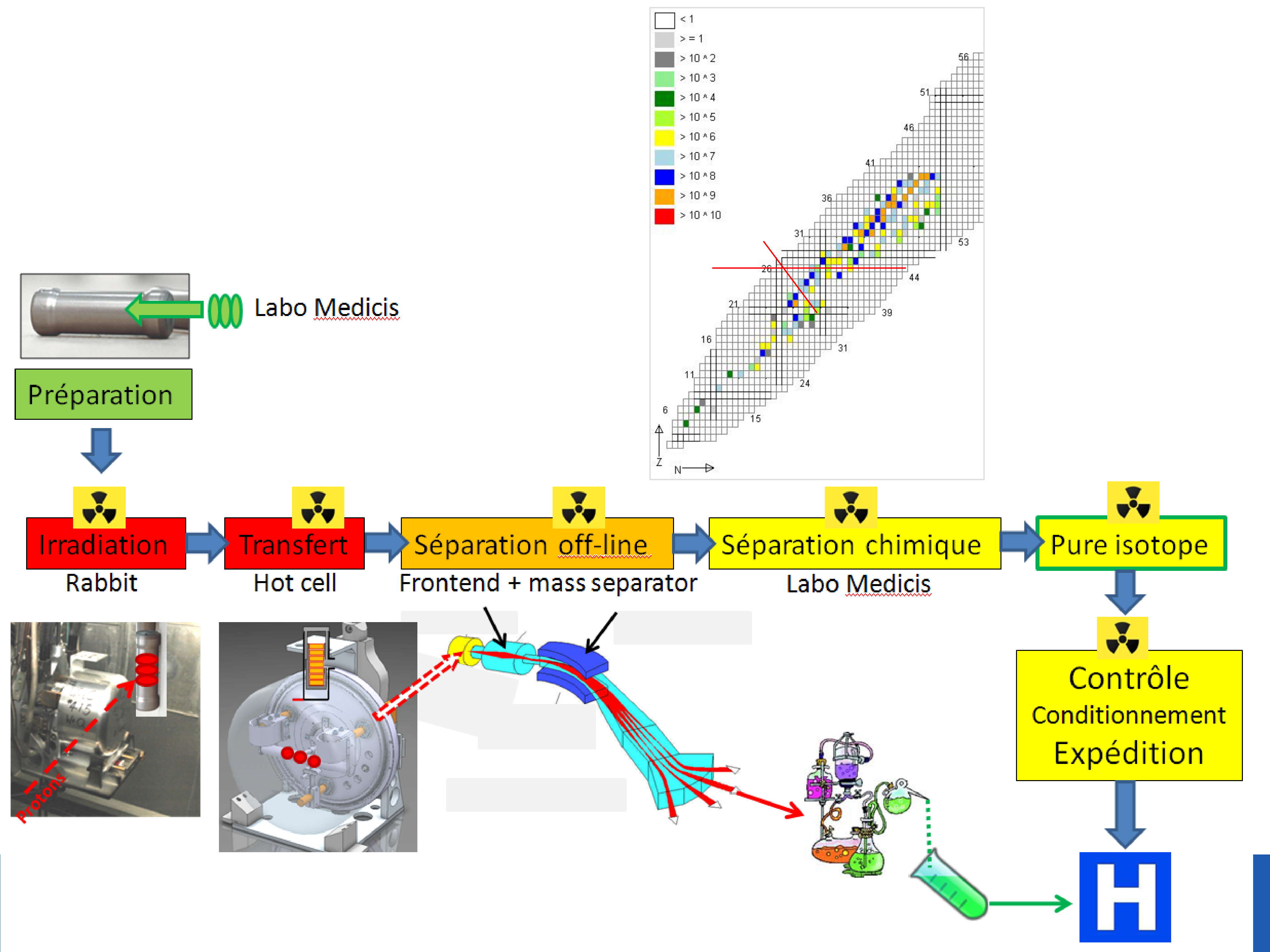

Proton Fluence (p/cm²/uC)
y (cm)
x (cm)
20
15
10
5
0
-5
-10
-15
-20
1e+13
1e+12
1e+11
1e+10
1e+09
1e+08
1e+07
1e+06

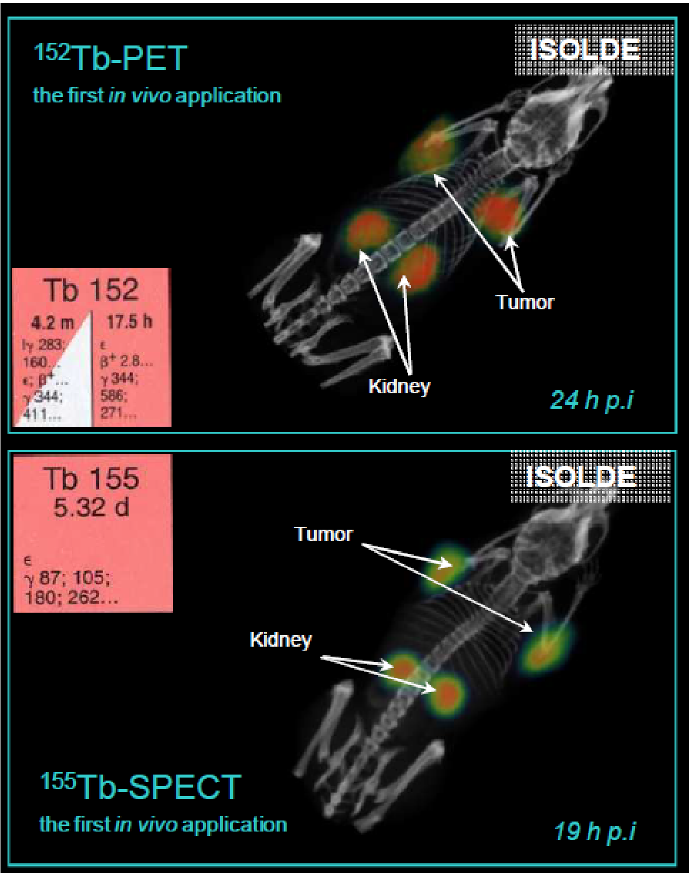

spallation
1.4 GeV protons
fragmentation
fission


target - ion source
proton beam
(1 GeV)
analysing magnet
radioactive ion beams



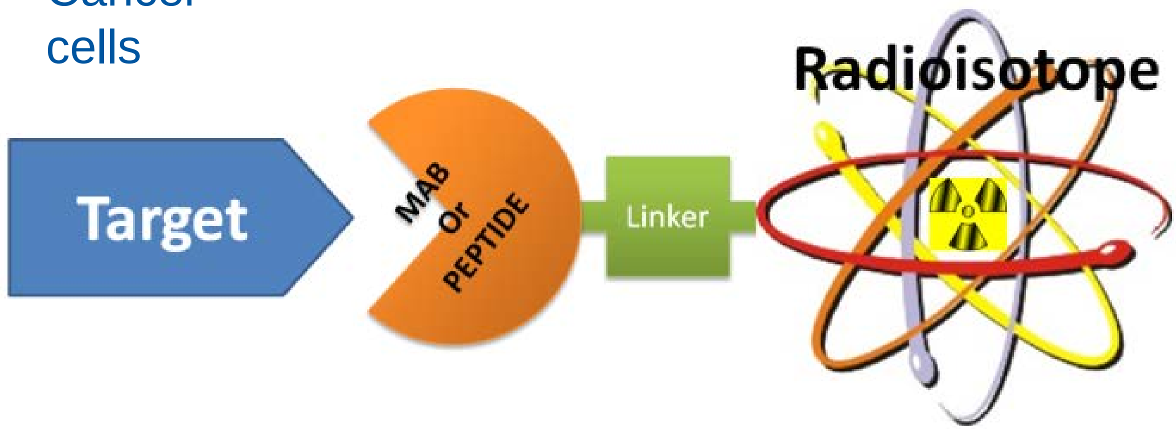


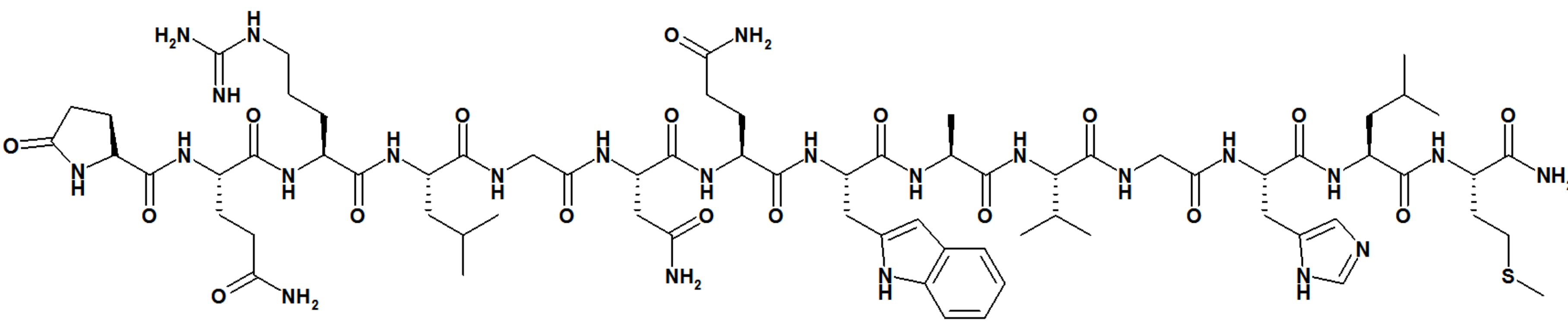

Labo Medicis
Préparation
< 1
> = 1
> 10 ^ 2
> 10 ^ 3
> 10 ^ 4
> 10 ^ 5
> 10 ^ 6
> 10 ^ 7
> 10 ^ 8
> 10 ^ 9
> 10 ^ 10
Z
N
Irradiation
Rabbit
Transfert
Hot cell
Séparation off-line
Frontend + mass separator
Séparation chimique
Labo Medicis
Pure isotope
Contrôle
Conditionnement
Expédition
Protons



Prostate
Cancer
cells

^{152}Tb
From
ISOLDE



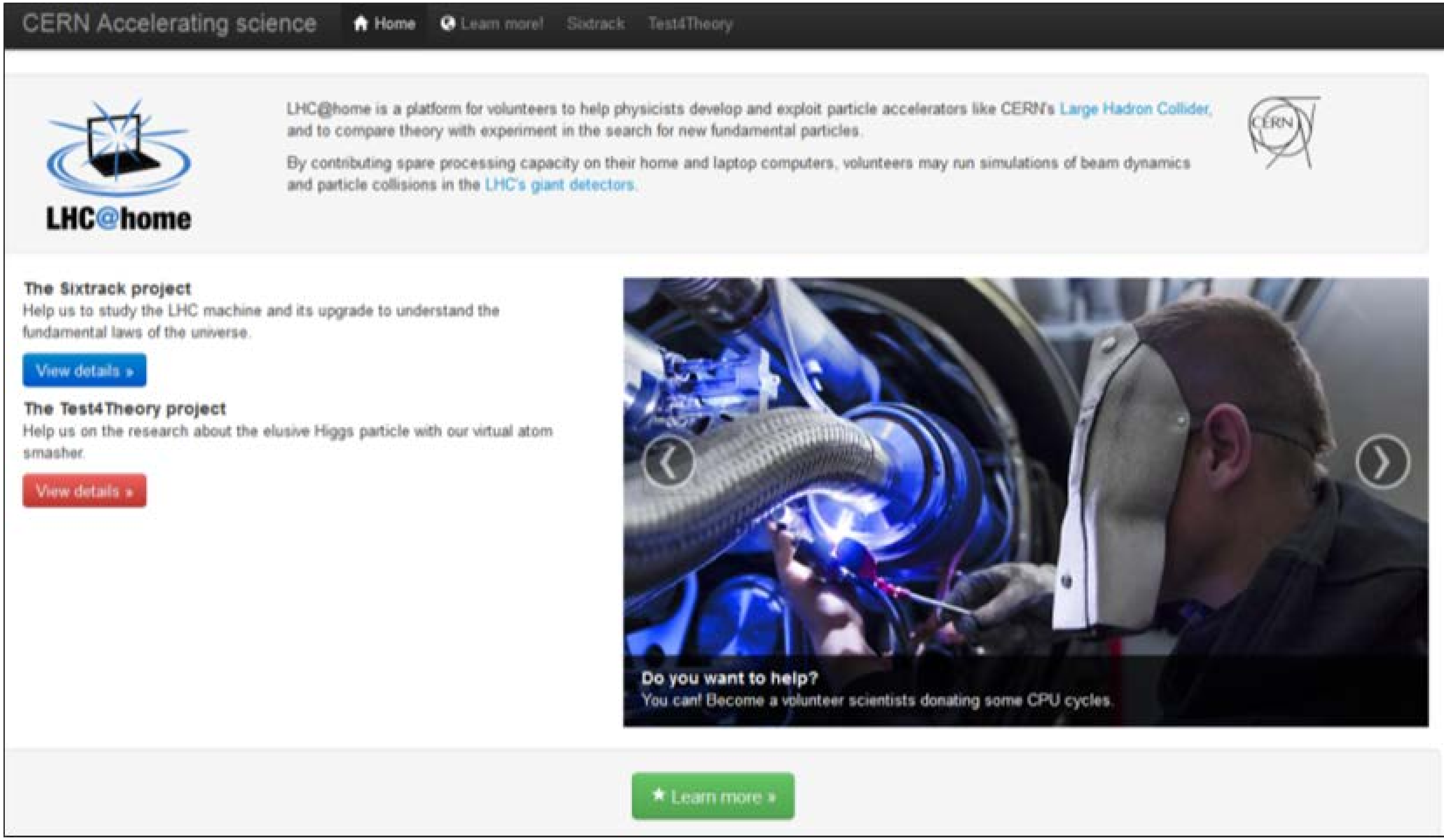


Today’s trivia answer

Q. 30 years ago this Saturday, CERN formally announced the discovery of something.
What was it?

A. The Z boson

cern.ch/LHCathome



http://www.quantumdiaries.org/author/cern/

QUANTUM DIARIES

Thoughts on work and life from particle physicists from around the world.

journal diario

Home

« Impact majeur pour une toute petite mesure | Mixing it up »

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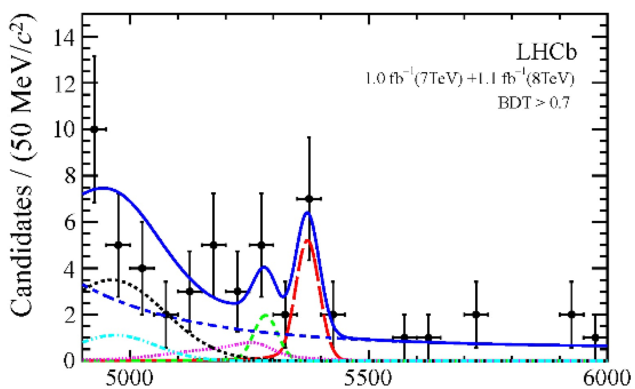
Huge impact from a tiny decay

The Hadron Collider Physics Symposium opened on November 12 in Kyoto on a grand note. For the first time, the LHCb collaboration operating at the Large Hadron Collider (LHC) at CERN showed evidence for an extremely rare type of events, namely the decay of a B_s meson into a pair of muons (a particle very similar to the electron but 200 times heavier). A meson is a composite class of particles formed from a quark and an antiquark. The B_s meson is made of a bottom quark *b* and a strange quark *s*. This particle is very unstable and decays in about a picosecond (a millionth of a millionth of a second) into lighter particles.

Decays into two muons are predicted by the theory, the Standard Model of particle physics, that states it should occur only about 3 times in a billionth of decays. In scientific notation, we write $(3.54\pm0.30)\times10^{-9}$ where the value of 0.30 represents the error margin on this theoretical calculation. Now, the LHCb collaboration proudly announced that they observed it at a rate of $(3.2^{+1.5}_{-1.2})\times10^{-9}$, a value very close to the theoretically predicted value, at least within the experimental error.



QUANTUM DIARIES

Thoughts on work and life from particle physicists from around the world.

journal diario

Home

« Mixing it up | Le mystère plane toujours sur le boson de Higgs »

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The mystery remains on the Higgs boson

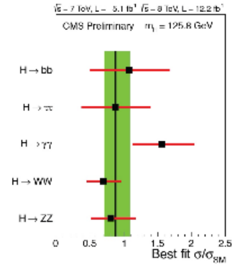
Ever since the discovery of what might be the Higgs boson last July, physicists from the CMS and ATLAS experiments have been trying to pinpoint its true identity. Is this the Higgs boson expected by the Standard Model of particle physics or some "Higgs-like boson" befitting a different theoretical model?

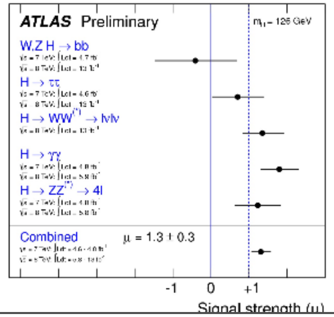
To tell the difference, we must check all its properties, like how often this boson decays into different types of particles, and determine its spin and parity, two properties of fundamental particles.

Since the new boson has a short lifetime, it breaks apart immediately after being created. There are five ways a Standard Model Higgs boson should decay that we can study at the Large Hadron Collider (LHC): breaking into two photons, two W or two Z bosons, two b quarks or two tau leptons in well defined proportions. We must check both the presence of and the rate at which each decay mode occurs.

Last summer, just after the discovery of the new boson, both experiments reported unambiguous observations in only three channels. Unfortunately, the data sample was still too small to really be able to check if the new boson could decay into a pair of b quarks or tau leptons.

With more data available, the two experiments have just shown results for all channels today at a conference held in Kyoto as shown on the two figures below.





Next week's Hangout with CERN

- Thursday 6 June, same time 17:00 CEST
  - Possibly Penguins!

Participants

Thierry Stora, CERN

Bruce Marsh, CERN

Carla Babcock, CERN

Tim Chupp, University of Michigan

Maria Jose Garcia Borge, CERN

Ruth Cook, Student

Credits

Steven Goldfarb — Host

Kate Kahle — Q&A from Social Media

Kate Kahle and Achintya Rao — Production

Thank you for watching!

www.cern.ch