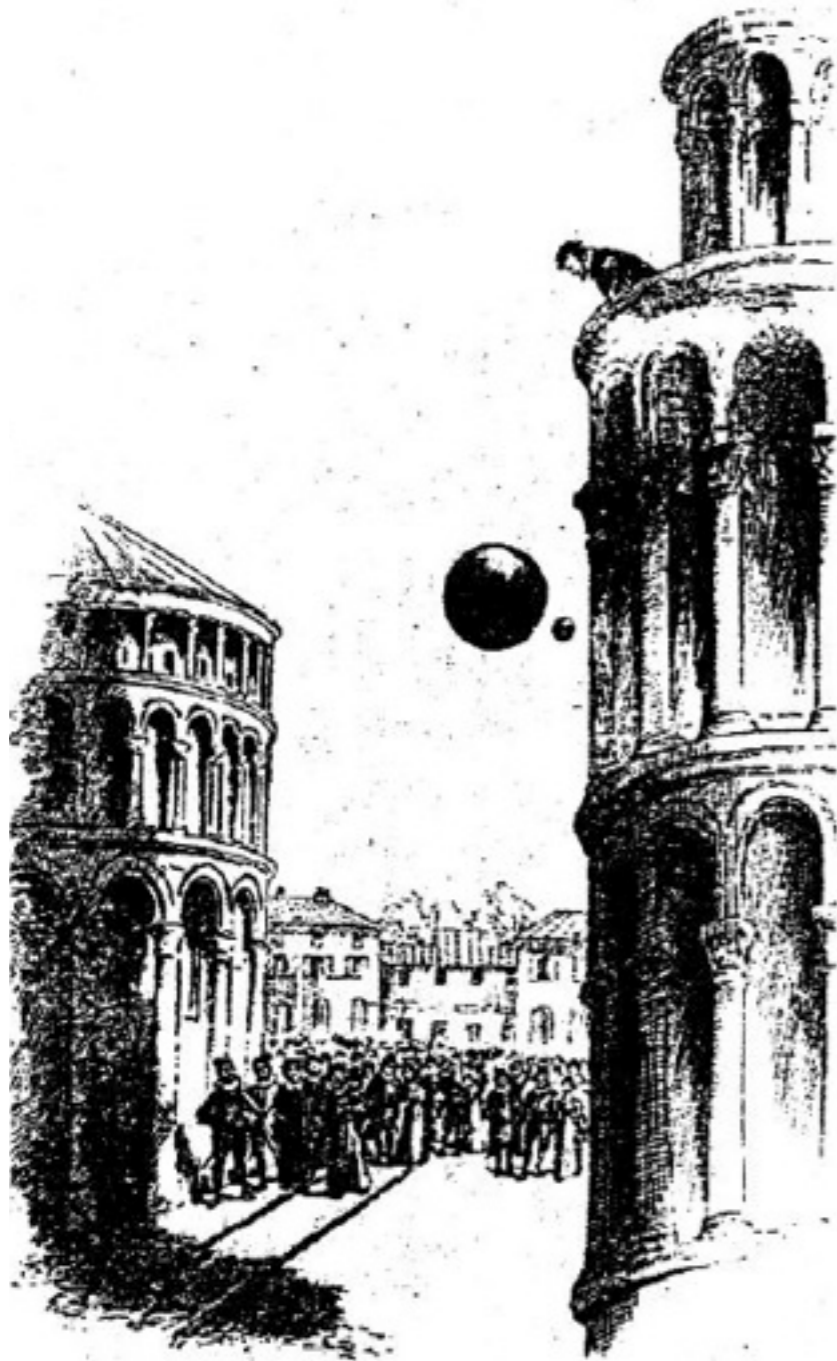


# The AEGIS Experiment

## Measuring the Gravitational Interaction of Antimatter

Michael Doser / CERN



# AEgIS Experimental Goal

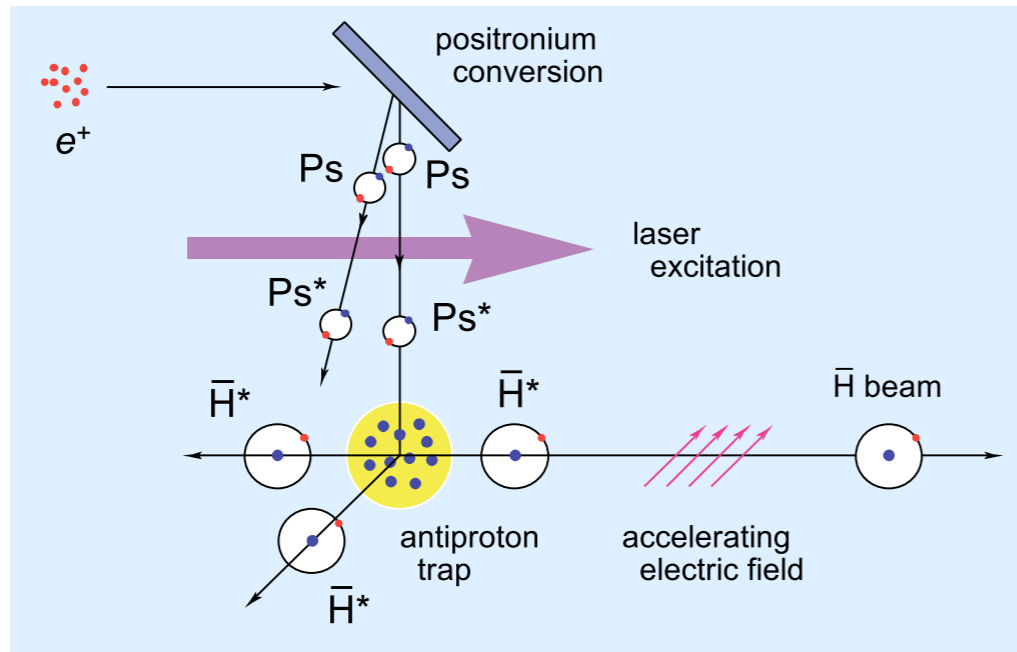
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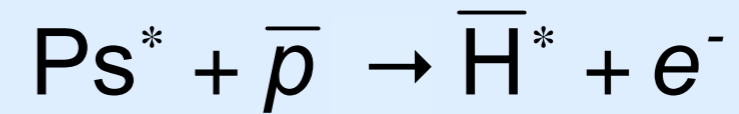
- ⊙ Primary goal:
  - ⊙ Measurement of gravitational acceleration  $g$  for antihydrogen with 1% accuracy
  
- ⊙ Secondary goals:
  - ⊙ Spectroscopy of antihydrogen
  - ⊙ Study of Rydberg atoms
  - ⊙ Positronium physics: formation, excitation, spectroscopy
  - ⊙ PALS with different materials

# 3 steps:

## 1) pulsed antihydrogen formation

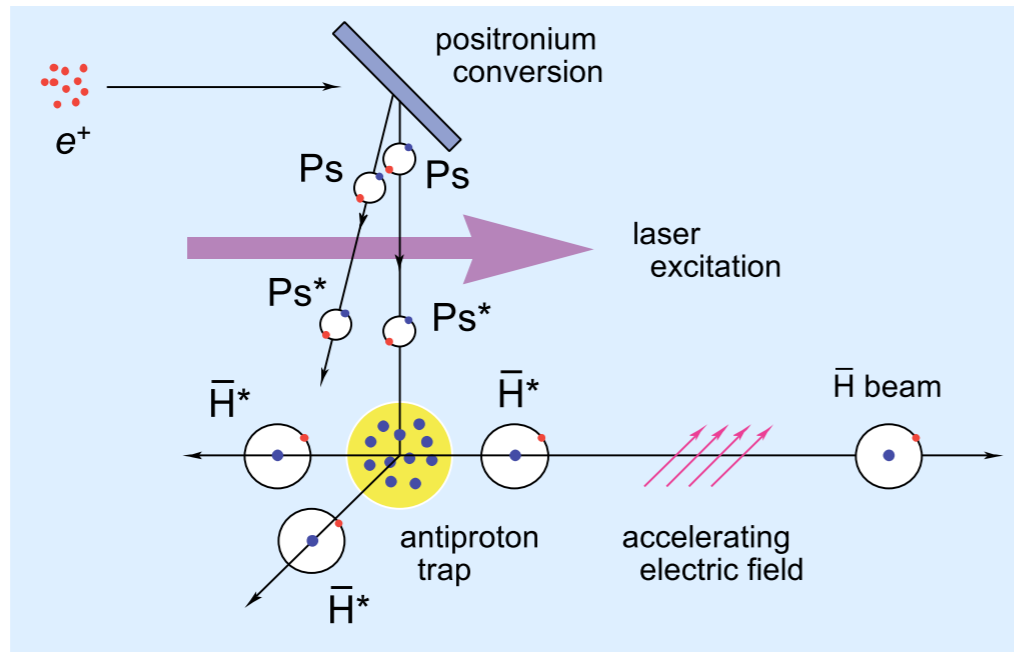


- ⊙ Produce ultra cold antiprotons
- ⊙ Form positronium by interaction of positrons with a porous target (pulsed)
- ⊙ Laser excite  $Ps$  to get Rydberg  $Ps$  (pulsed)
- ⊙ Form Rydberg cold antihydrogen (pulsed) by
- ⊙ Stark accelerate the antihydrogen with inhomogeneous electric fields

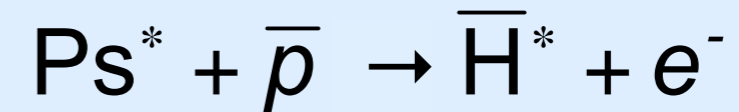


# 3 steps:

## 1) pulsed antihydrogen formation



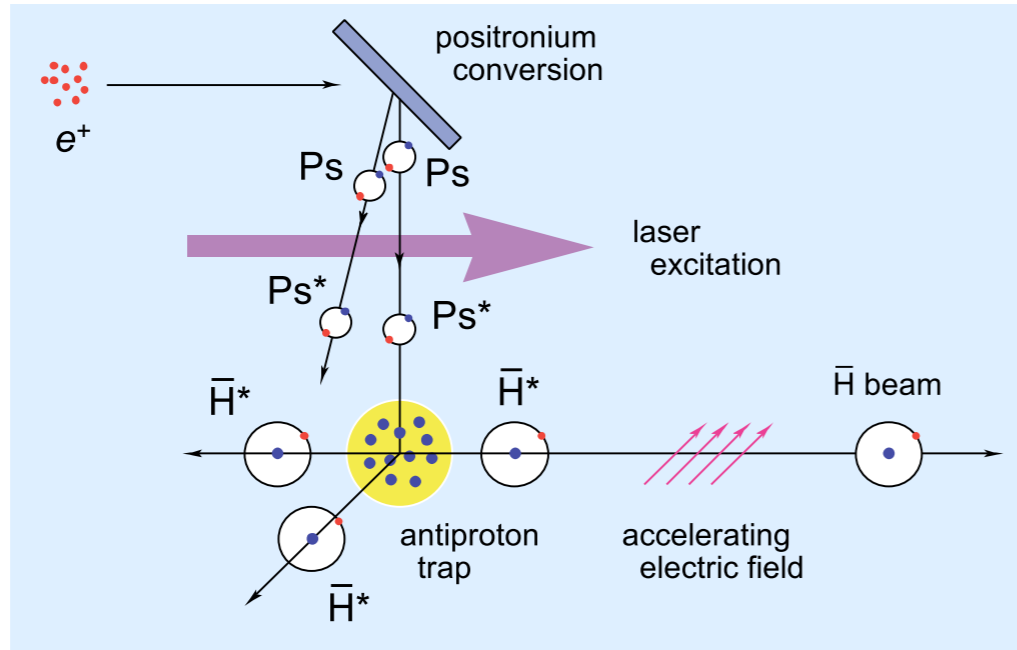
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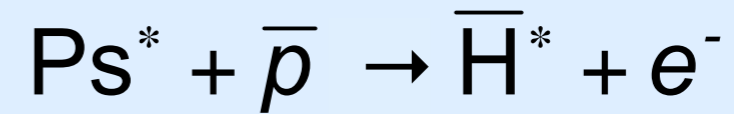
## 2) horizontal antihydrogen beam formation (method from physical chemistry)

# 3 steps:

## 1) pulsed antihydrogen formation

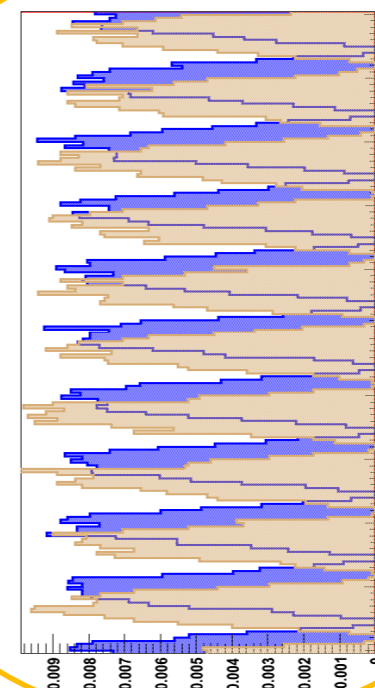
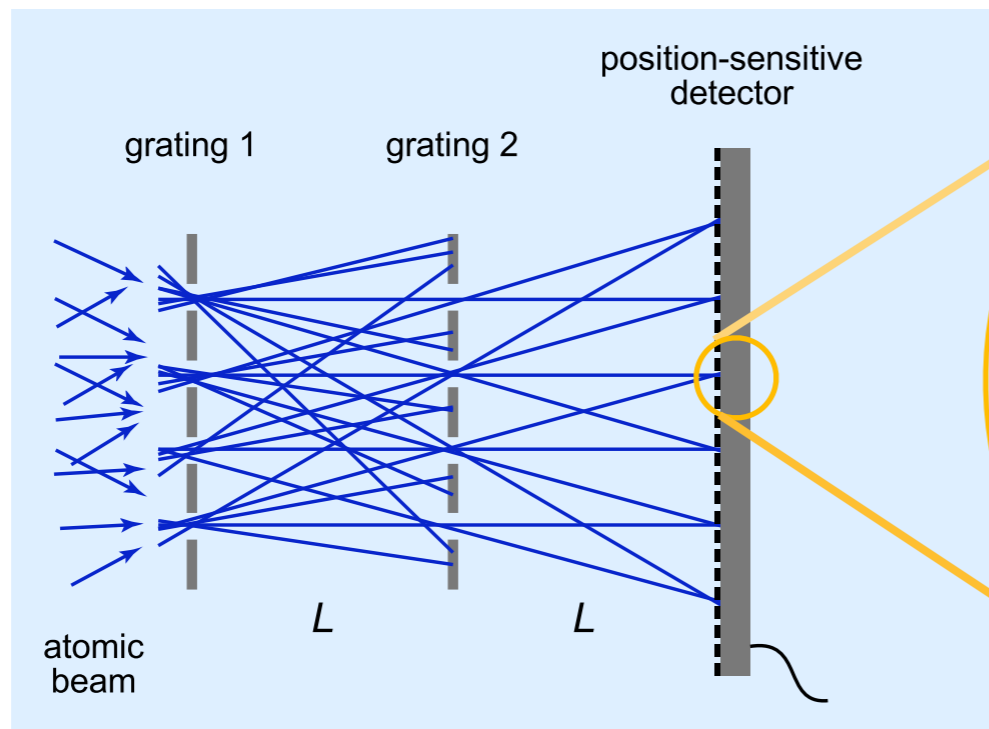


- ⦿ Produce ultra cold antiprotons
- ⦿ Form positronium by interaction of positrons with a porous target (pulsed)
- ⦿ Laser excite Ps to get Rydberg Ps (pulsed)
- ⦿ Form Rydberg cold antihydrogen (pulsed) by
- ⦿ Stark accelerate the antihydrogen with inhomogeneous electric fields



## 2) horizontal antihydrogen beam formation (method from physical chemistry)

## 3) measurement of parabolic trajectory (classical atom “interferometer”)

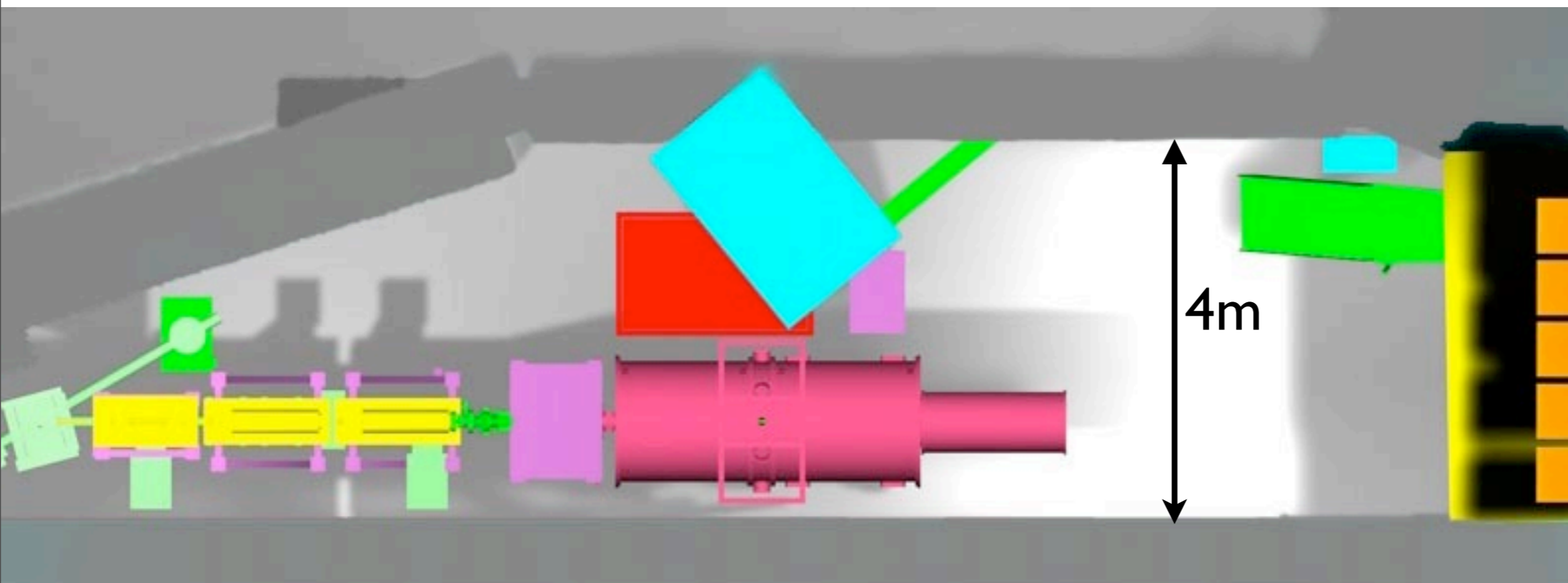
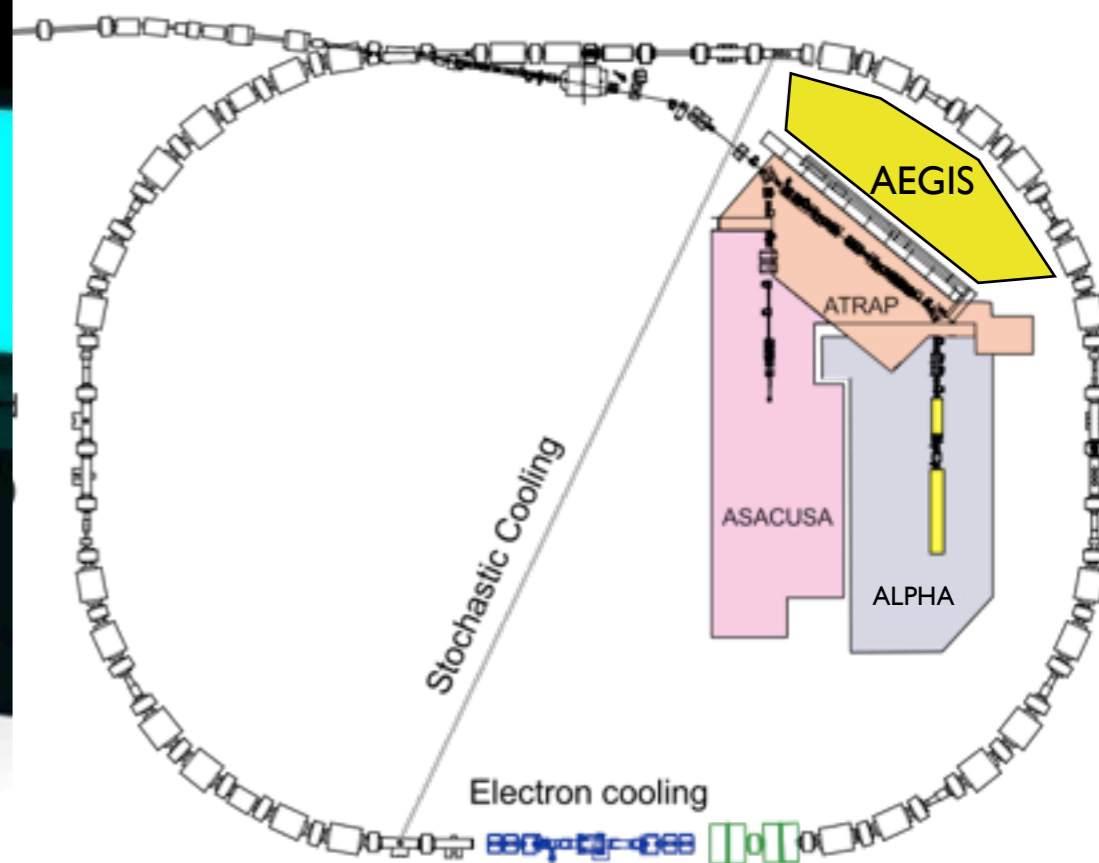
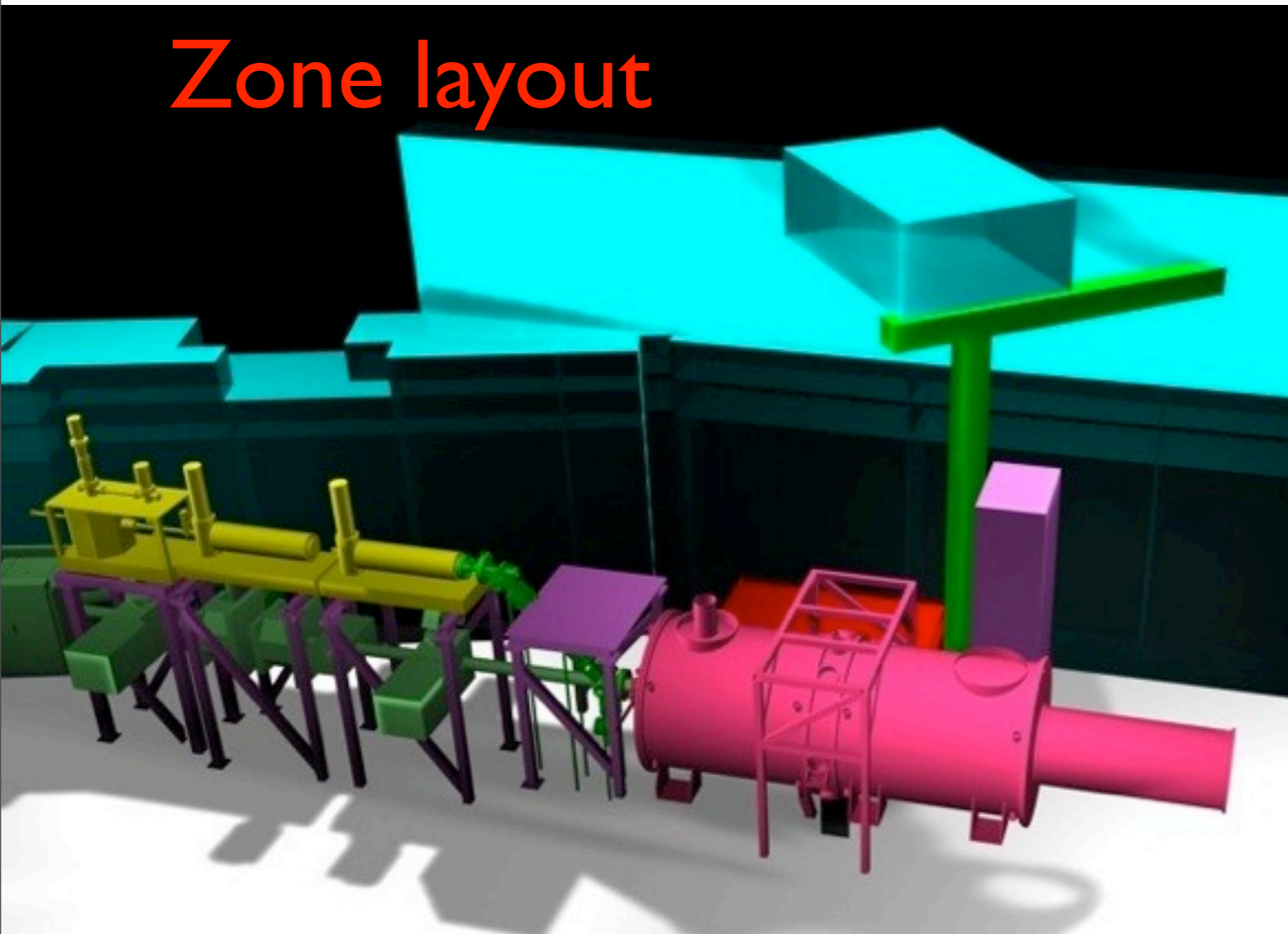


horizontal trajectories

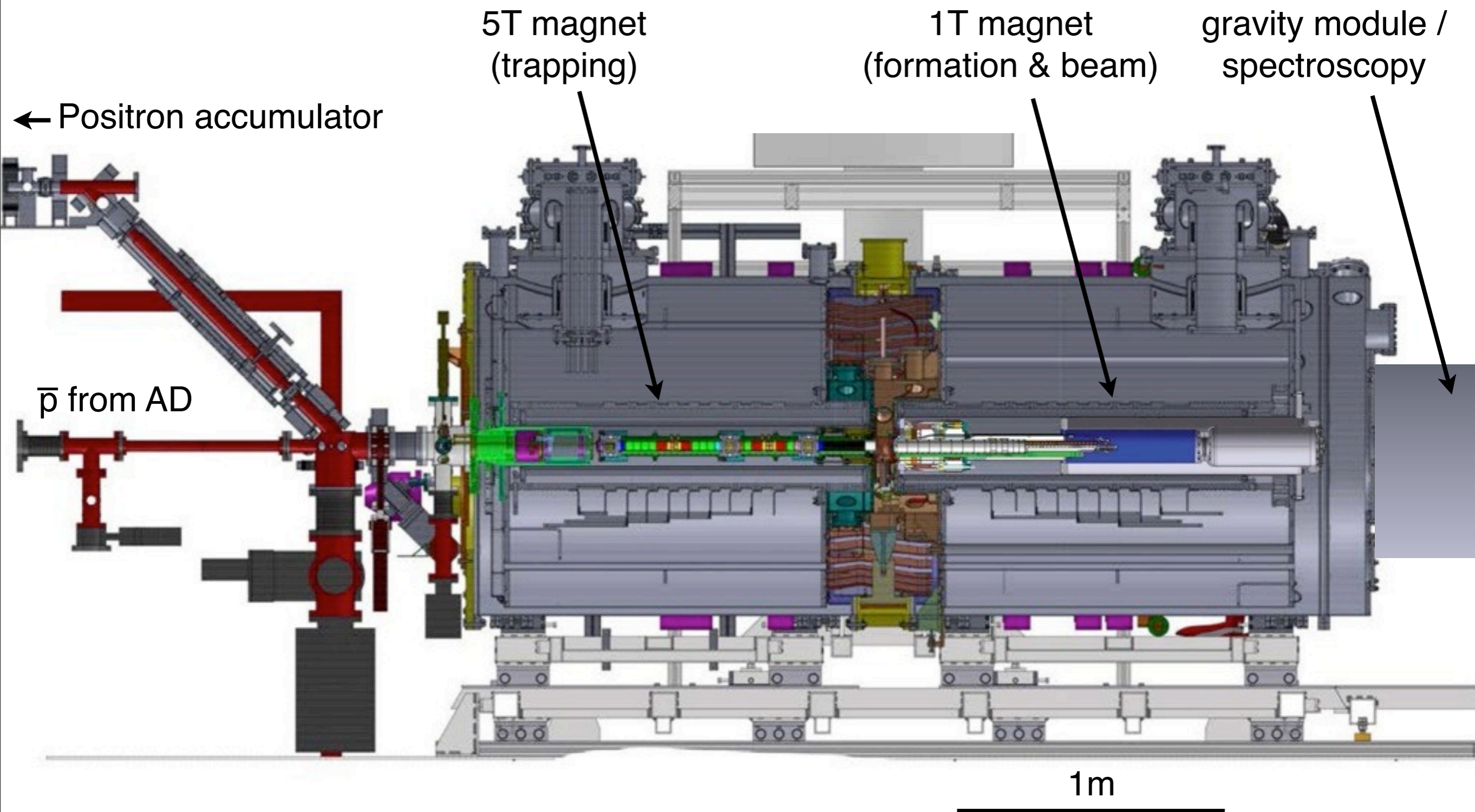
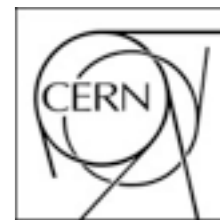
↕ 20  $\mu\text{m}$

parabolic trajectories

# Zone layout



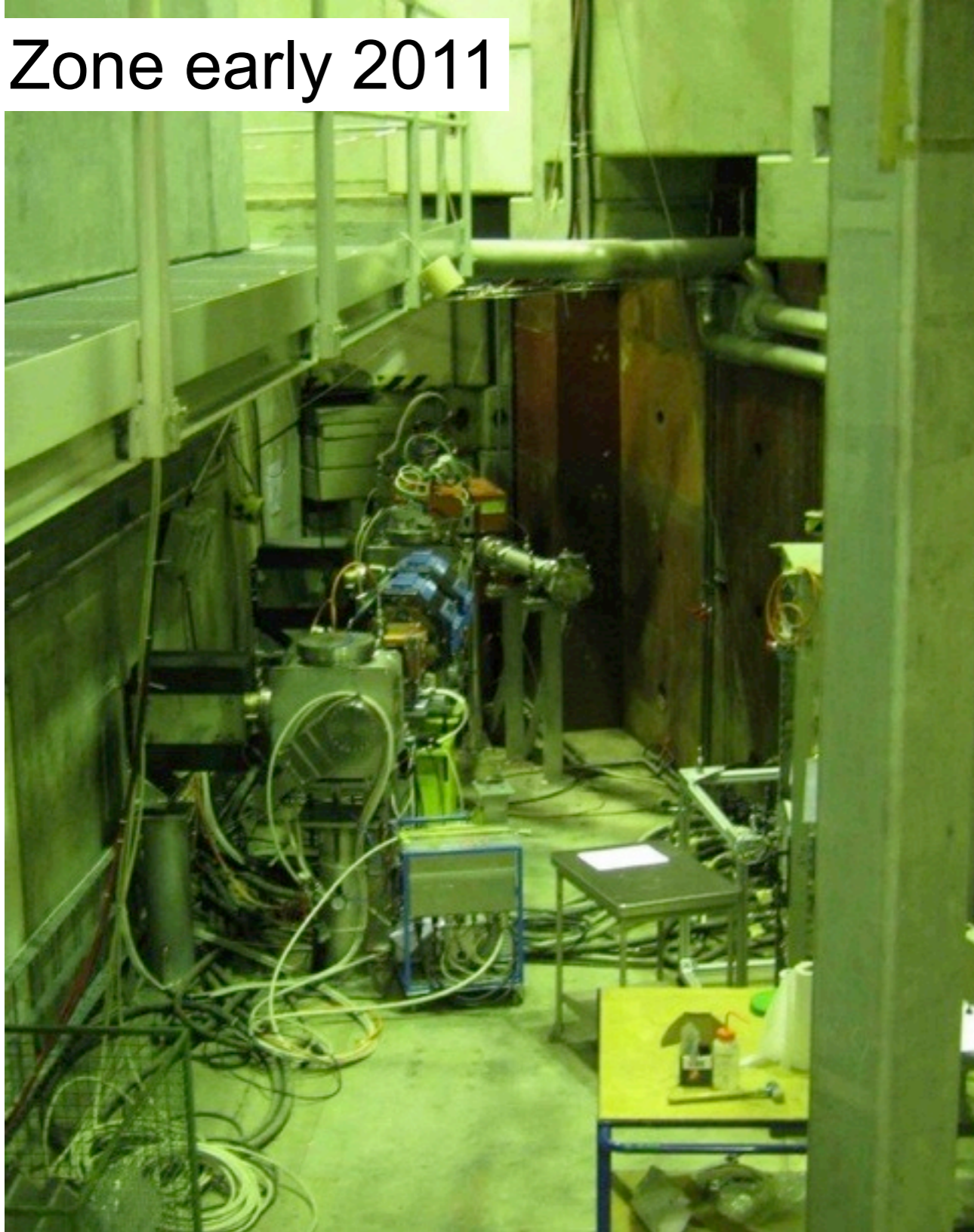
# Experimental Apparatus @ CERN



# Experimental Installation



Zone early 2011

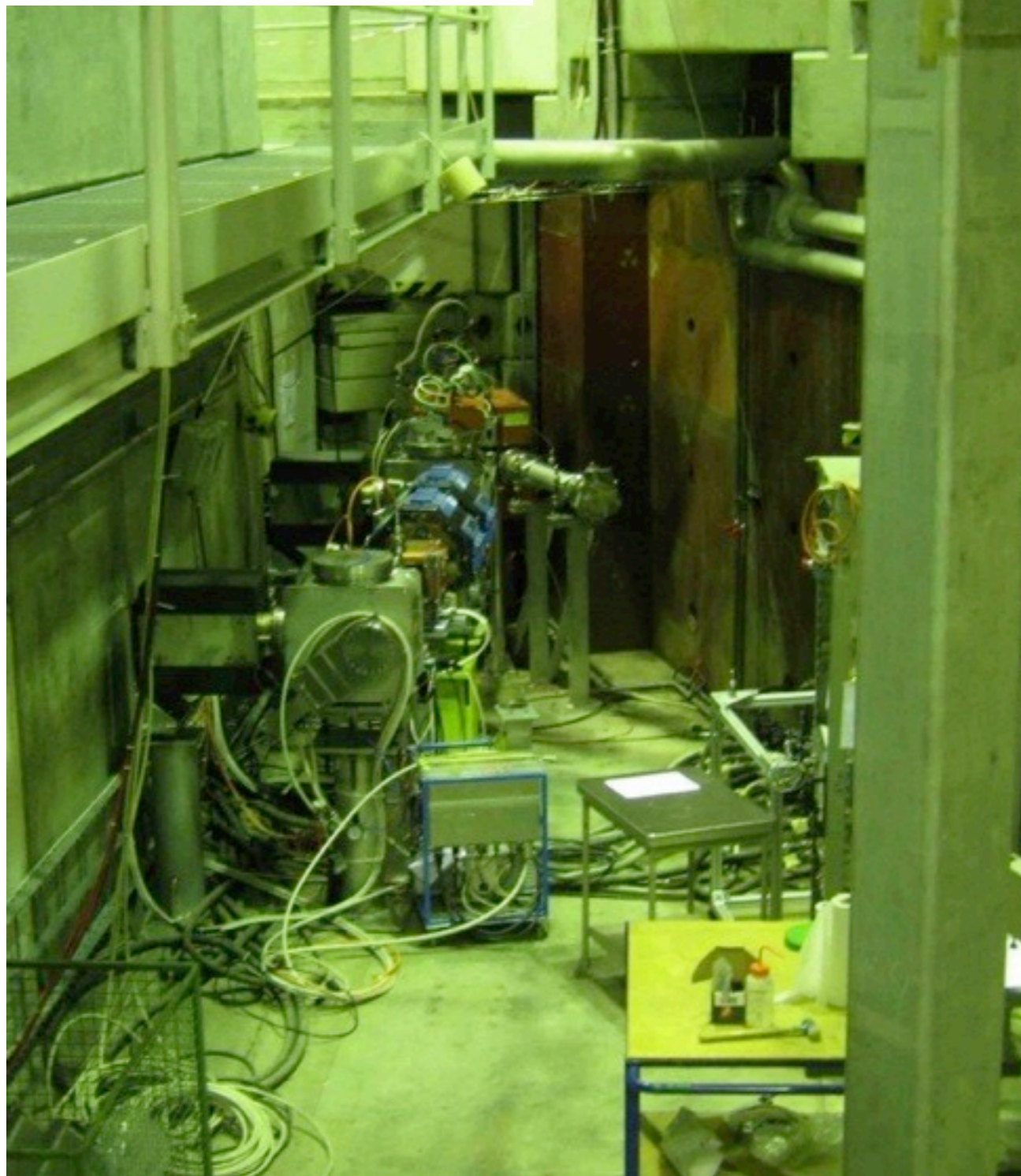




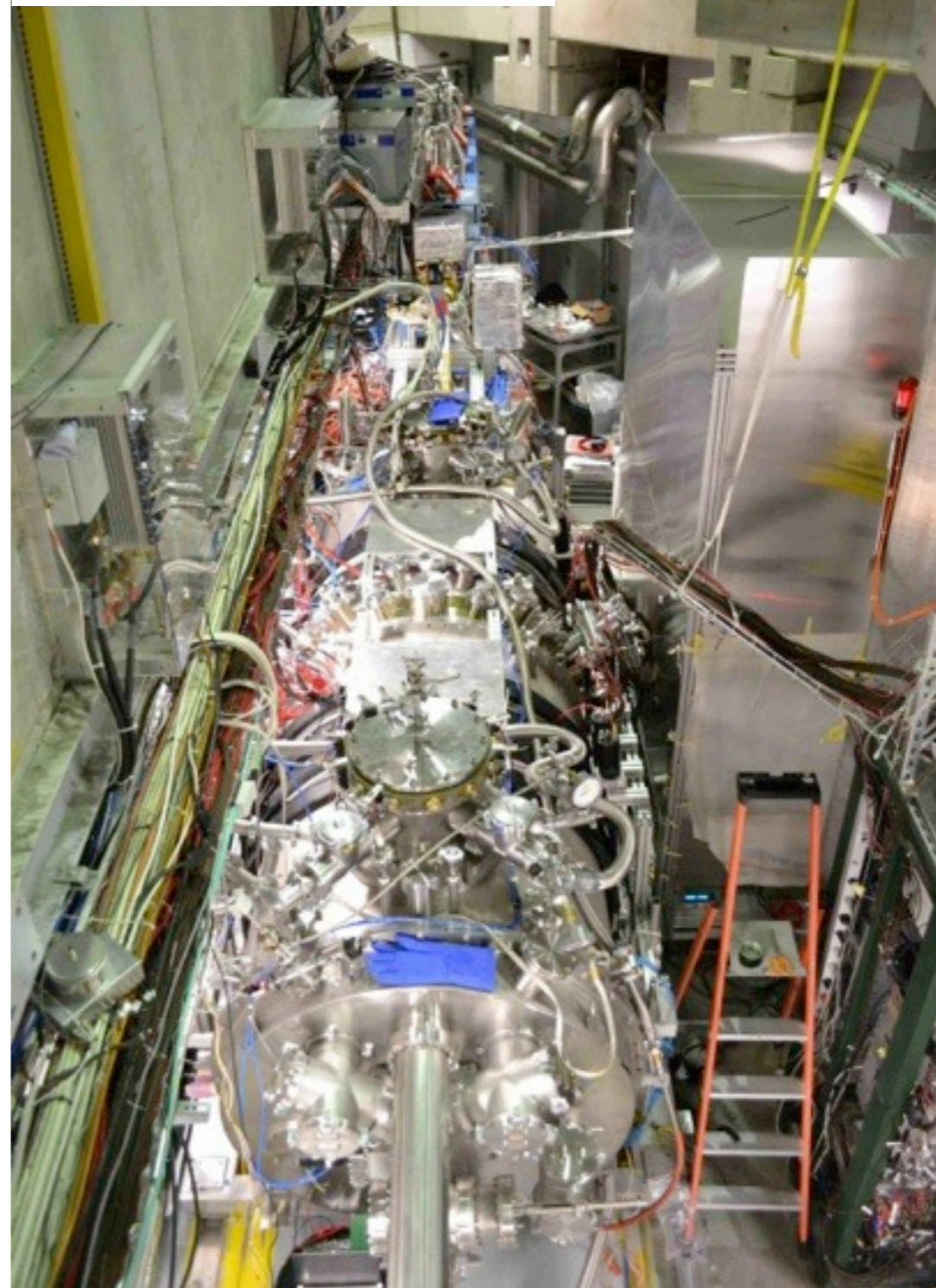
# Experimental Installation



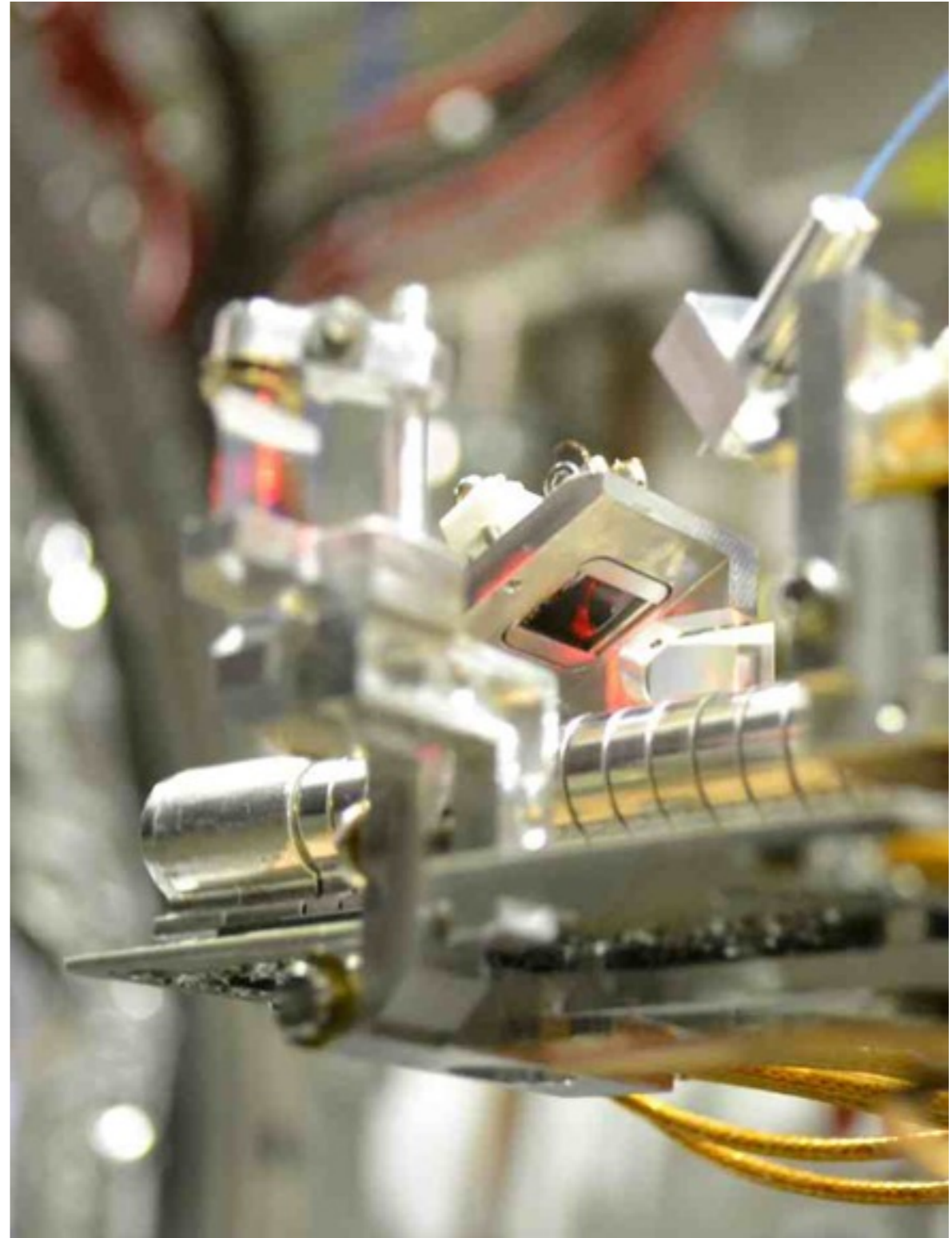
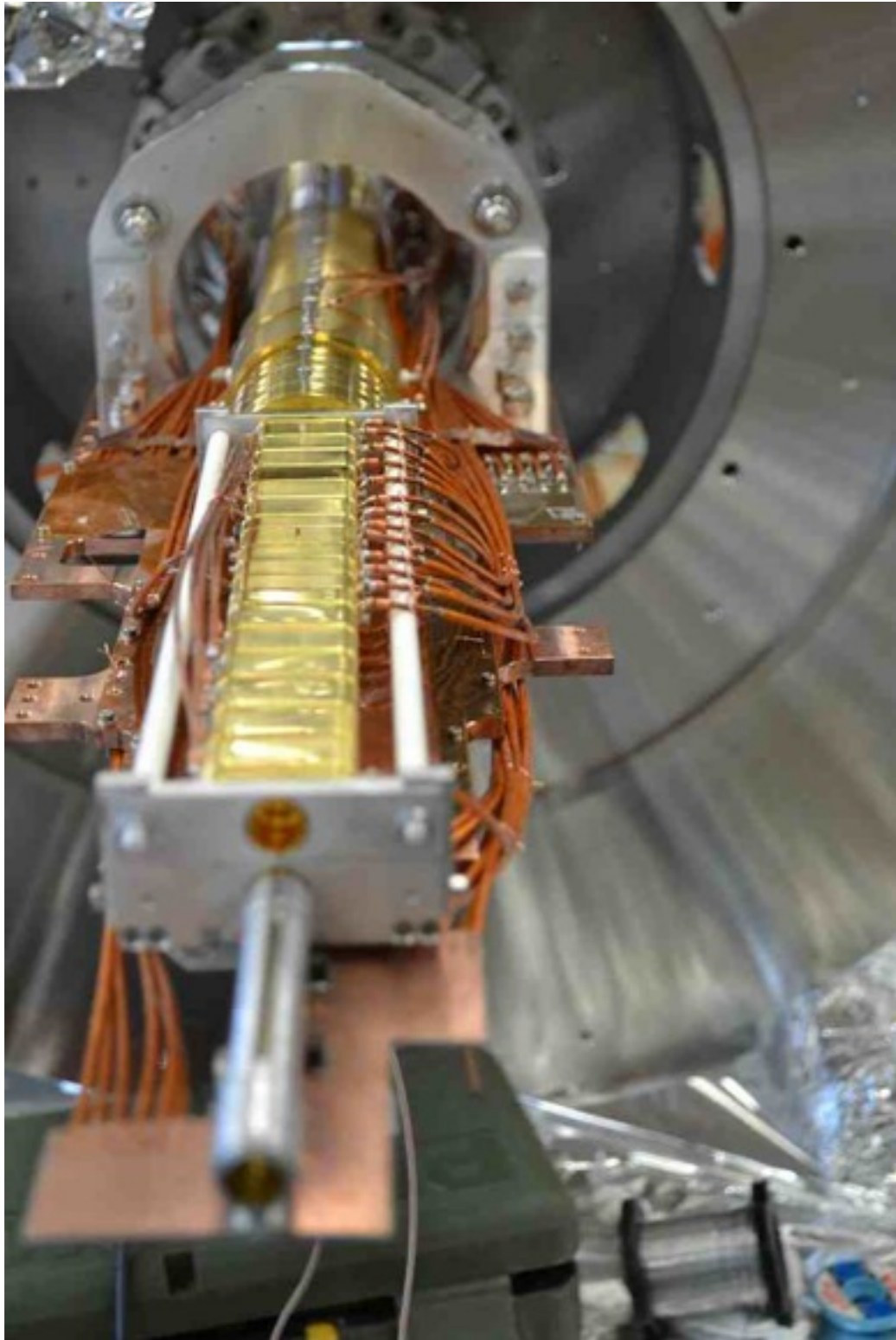
Zone early 2011



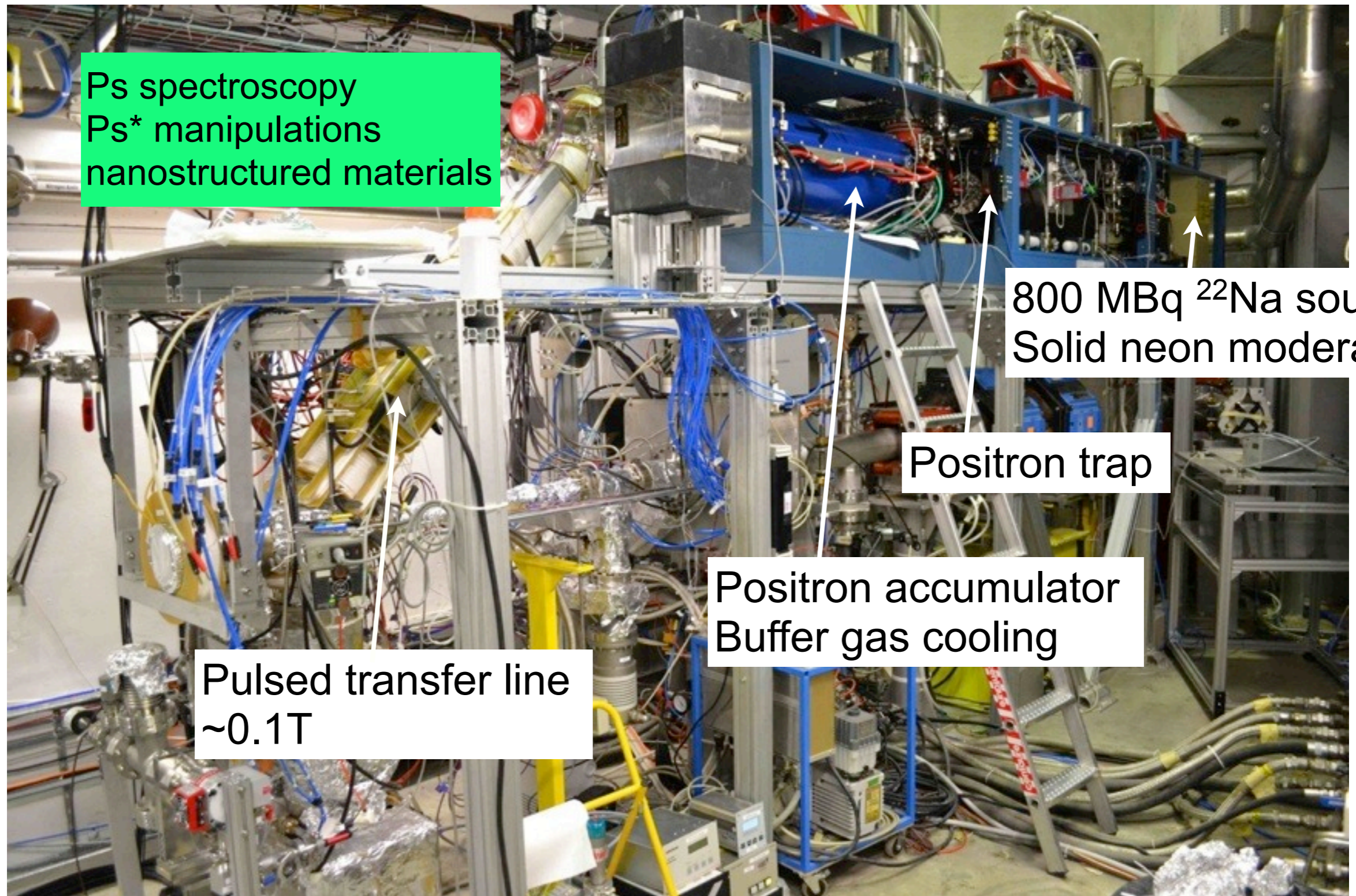
Zone late 2012



# IT Formation Traps



# Positron System



Ps spectroscopy  
Ps\* manipulations  
nanostructured materials

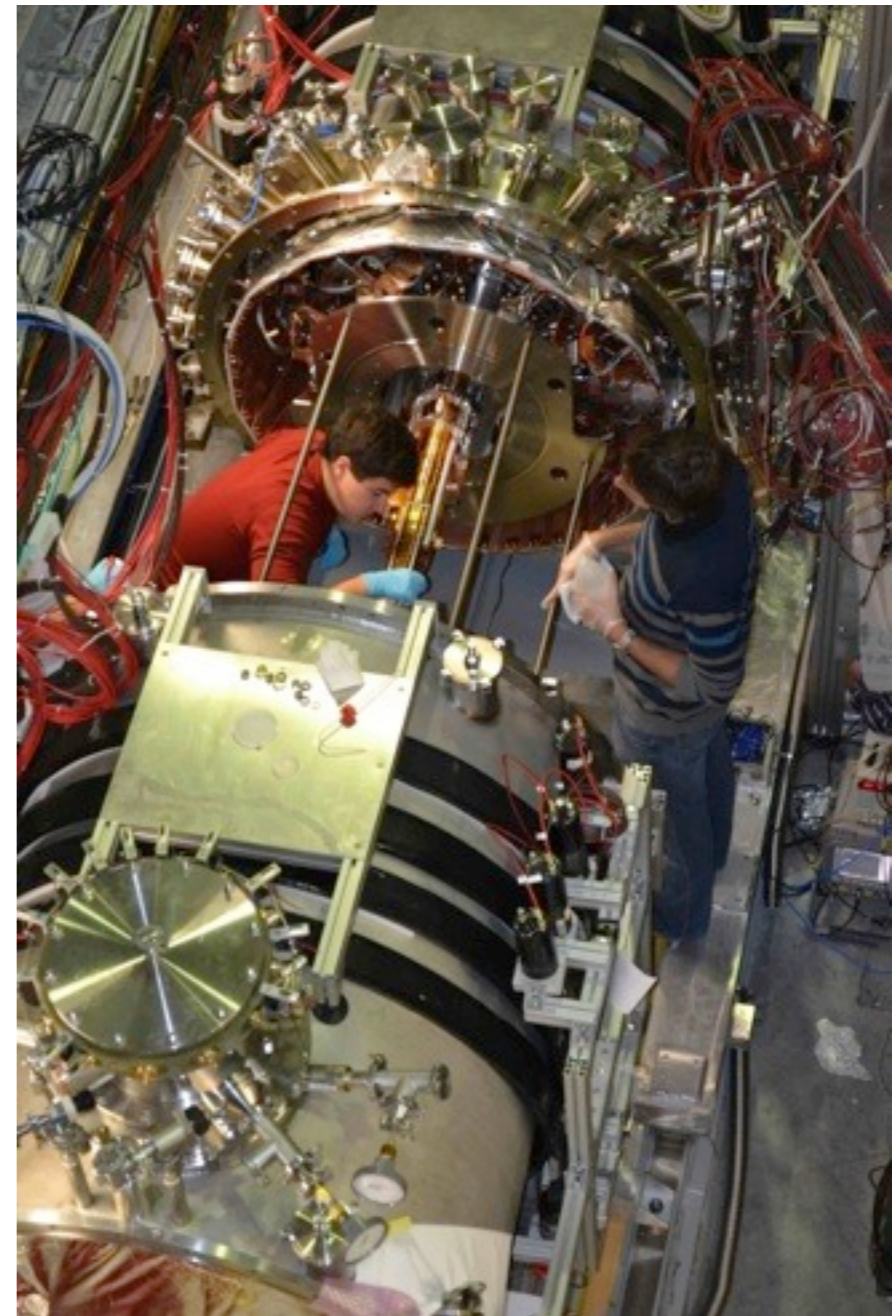
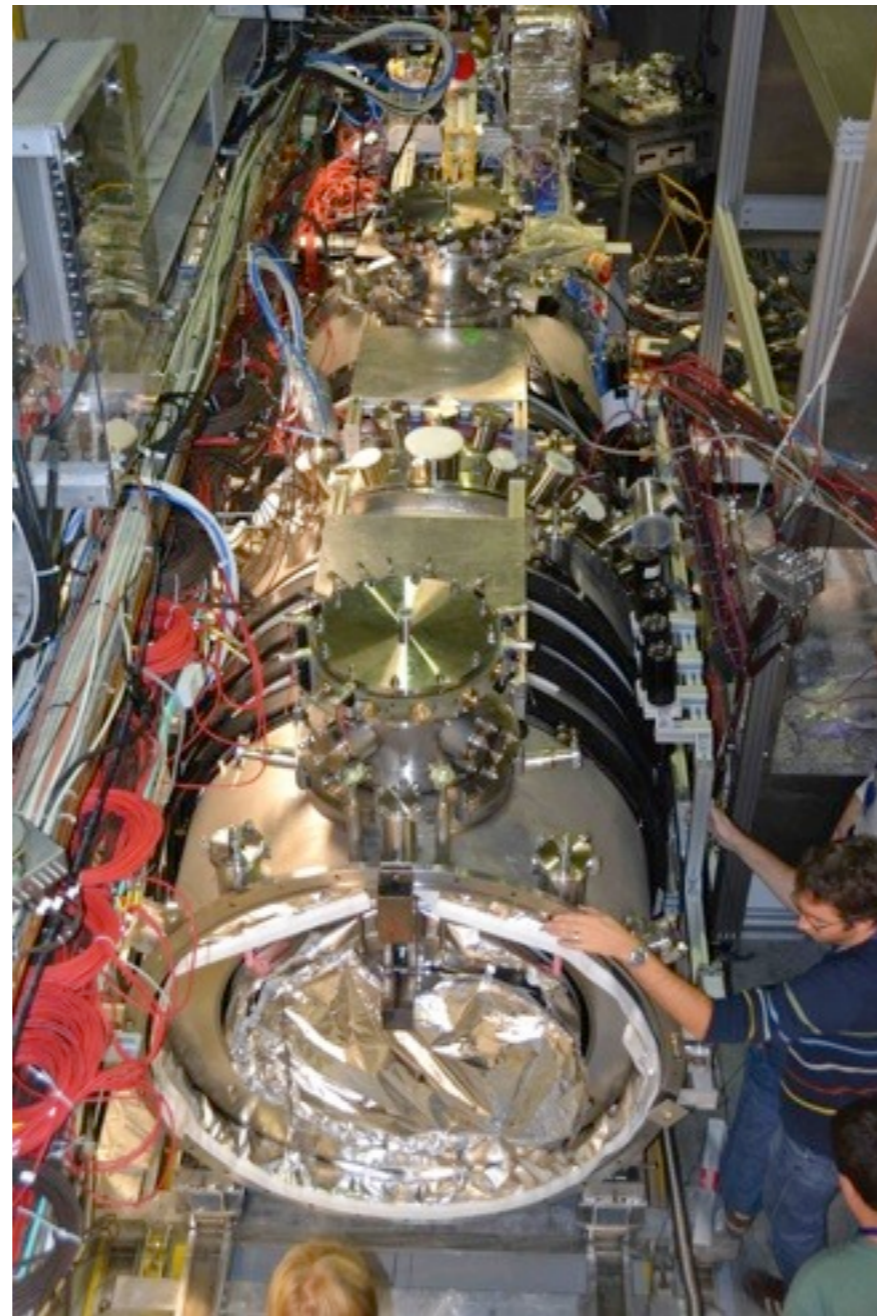
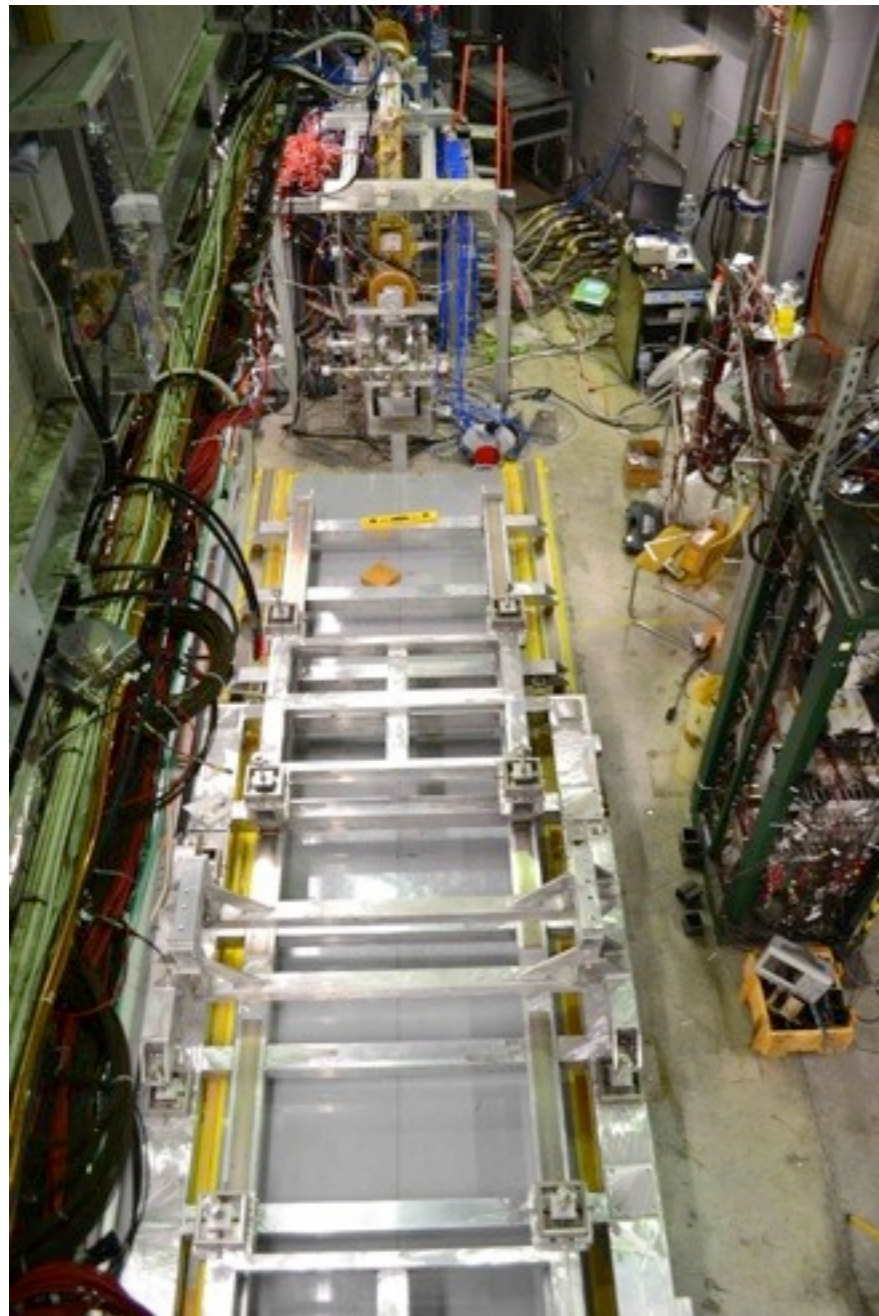
800 MBq  $^{22}\text{Na}$  source  
Solid neon moderator

Positron trap

Positron accumulator  
Buffer gas cooling

Pulsed transfer line  
 $\sim 0.1\text{T}$

# Assembly in 2012



Assembly completed end of November 2012; immediate pump-down and cool-down (10 days) during which commissioning with antiprotons and positrons could take place

# Possible projects



- ⊙ Installation of base apparatus largely completed and commissioned
- ⊙ Parasitic measurements essential in converging to an optimal deflectometer/detector layout → nice to have a test beam line @ ELENA
- ⊙ Ongoing work in coming months:
  - ⊙ install proton source, **hydrogen detector**
  - ⊙ commission **Rydberg positronium formation** (targets, lasers, atomic physics)
  - ⊙ **validate fiber detector** for antihydrogen, positrons, positronium
  - ⊙ help doctoral students (**mathematics-heavy** topics)
- ⊙ goal: be ready for antihydrogen formation in autumn 2014