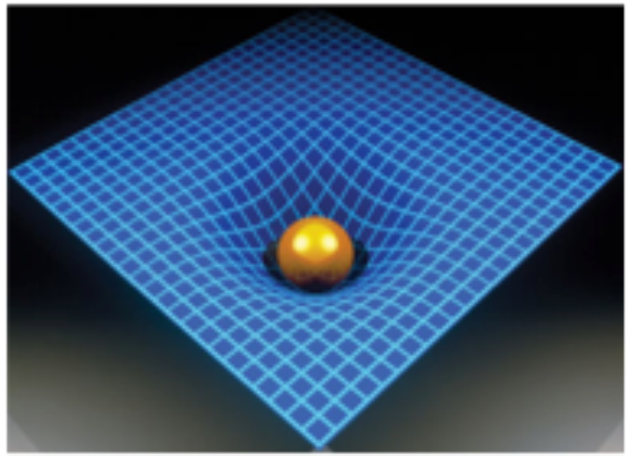
AEgIS, Development of a scintillating fiber detector at cryogenic temperatures for the production of an anti-hydrogen beam

Yves Allkofer

University Zurich

01.03.2011

AEgIS scientific goals



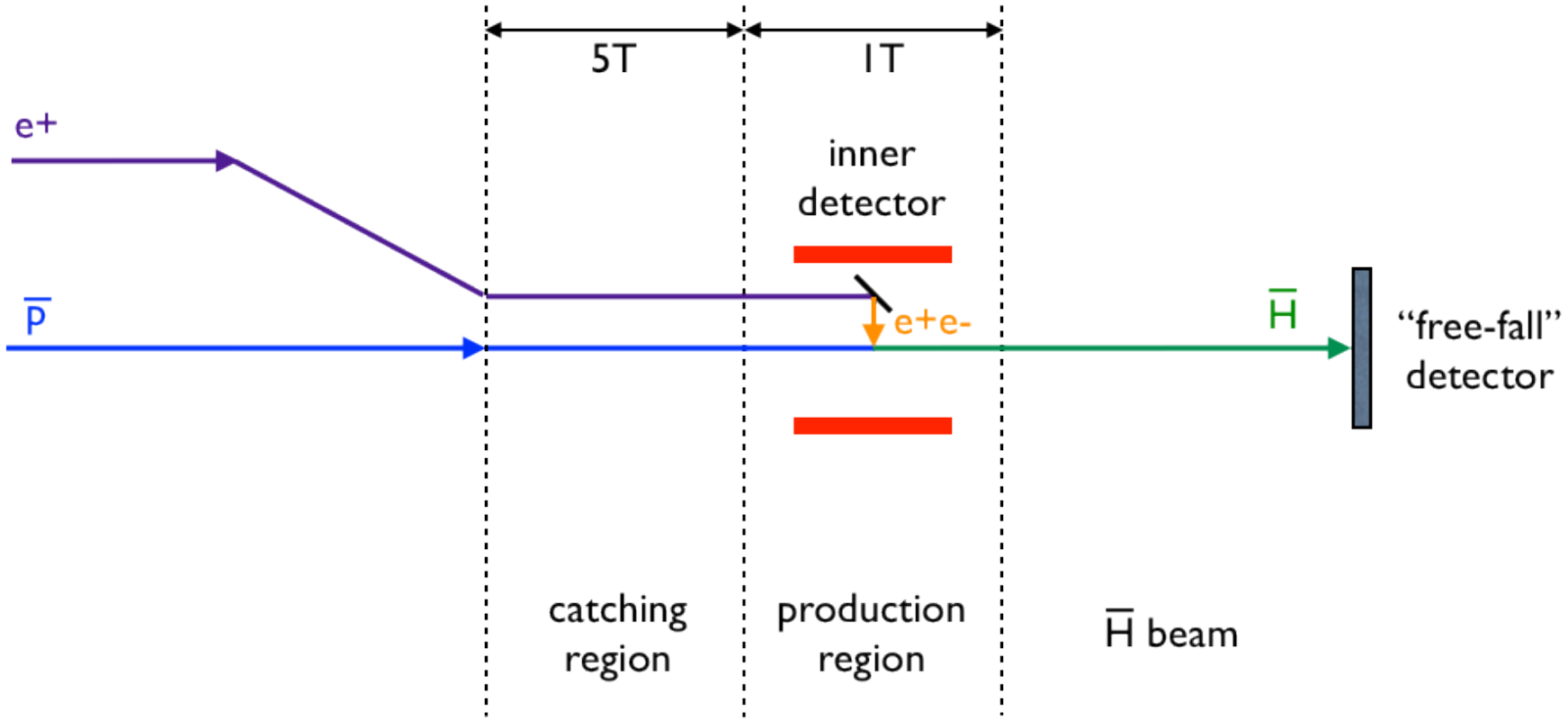
- Measure the Earth's gravitational acceleration on anti-hydrogen atoms by observing the vertical displacement of a Hbar beam as it traverses a Moire deflectometer.
- First direct determination of the effect of gravity on antimatter!

A short review of anti-matter

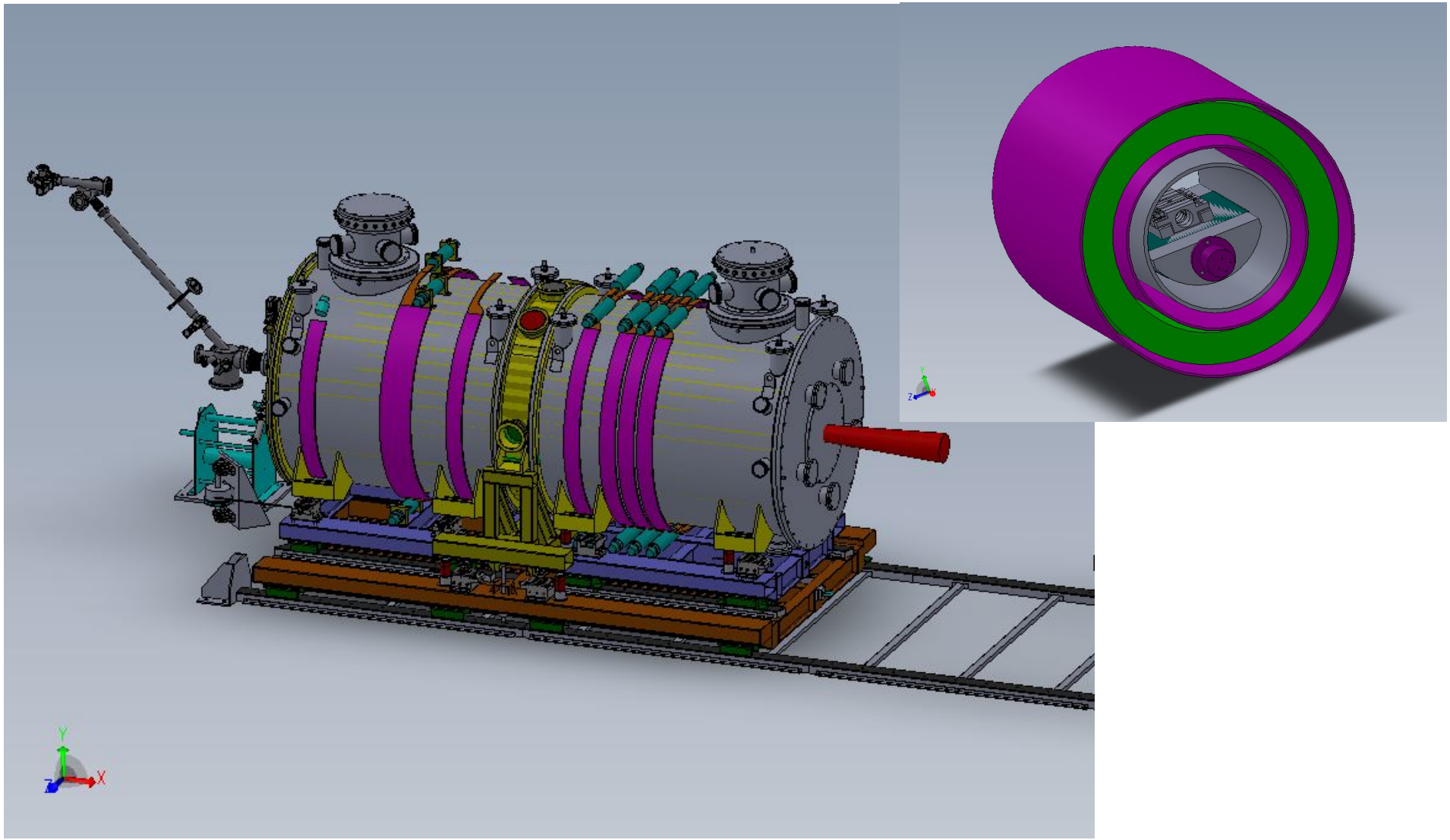
- 1928: P.Dirac - antimatter must exist.
- 1932: e+ discovered in cosmic rays.
- 1954: Antiproton detected at the Bevatron.
- 1960: Anti-neutron detection.
- 1995: 9 anti-hydrogen atoms (relativistic) produced at CERN.
- 1999: Antiproton Decelerator (AD) constructed at CERN to study antihydrogen physics.
- 2002: ATHENA at CERN AD produces millions of cold anti-hydrogen atoms.
- 2010: ALPHA traps 38 anti-hydrogen atoms.

BUT, no measurements about anti-hydrogen properties have yet to be performed!!!

Measurement of the gravitational acceleration of anti-hydrogen

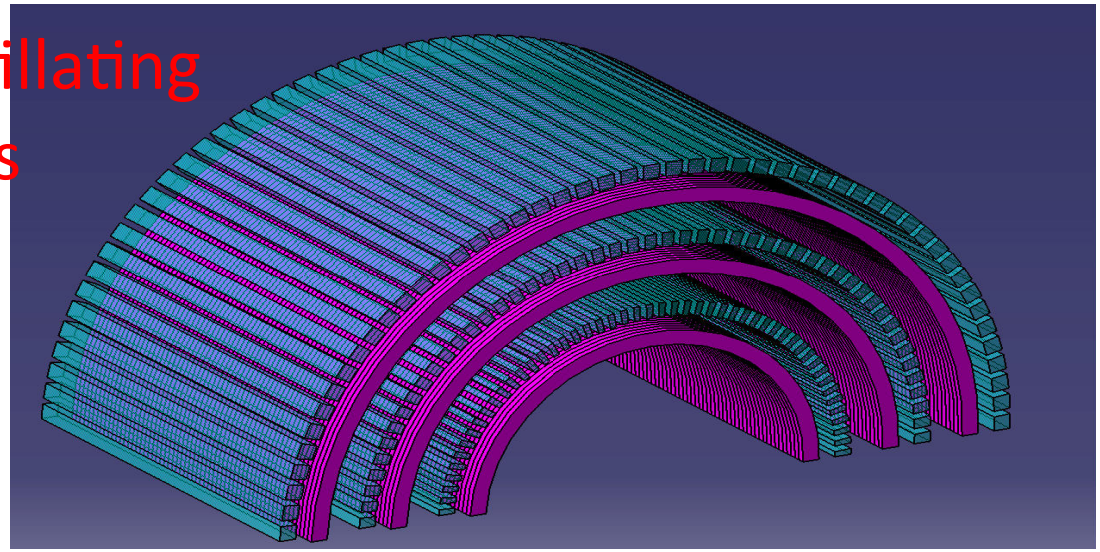


The experiment



Aim of the fiber detector

Scintillating fibers



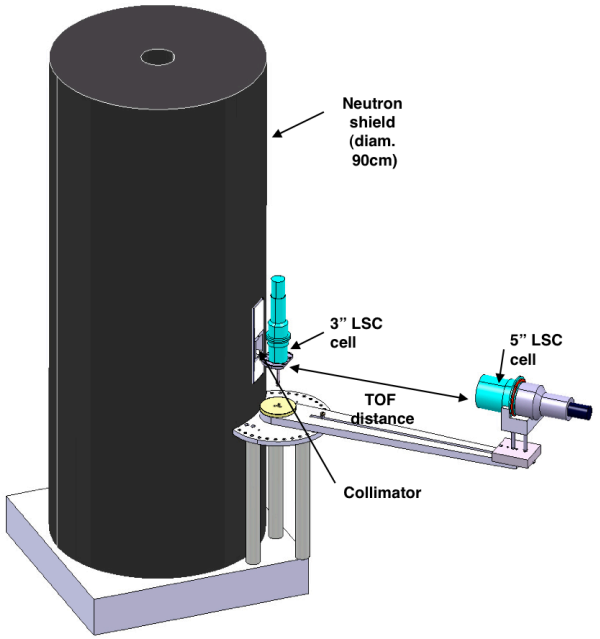
- Demonstrate anti-hydrogen production
- Temperature measurement of produced anti-hydrogen

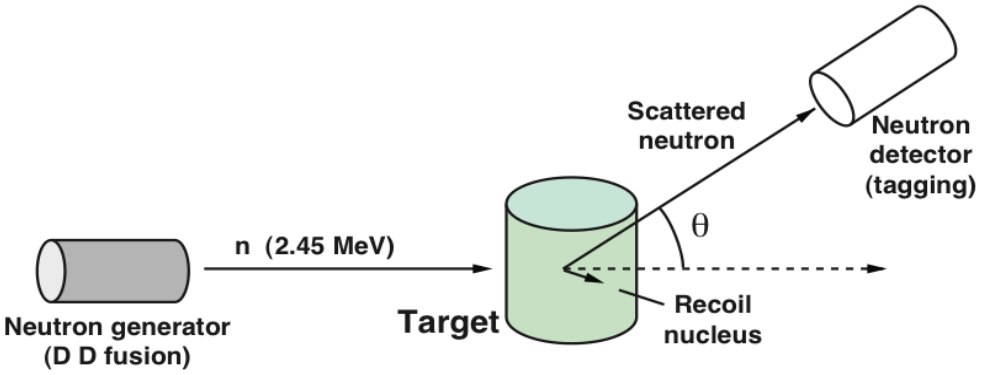
Tasks

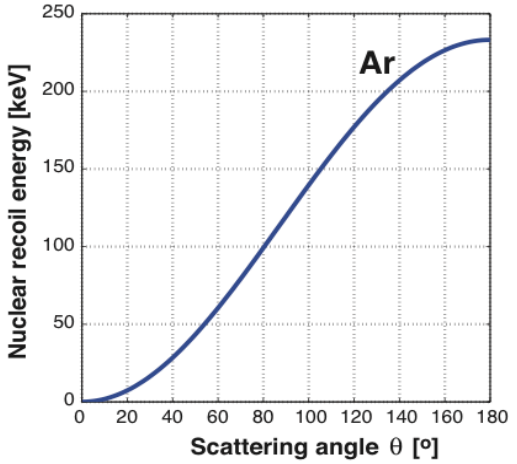
- Measurement of the efficiency and the decay time at liquid nitrogen temperatures.
- Design the read-out architecture of thousands of fibers.

Darwin
(next generation DM detector),
study of dark matter interactions in liquid argon using a mono-chromatic neutron generator at CERN

The existing setup







Tasks

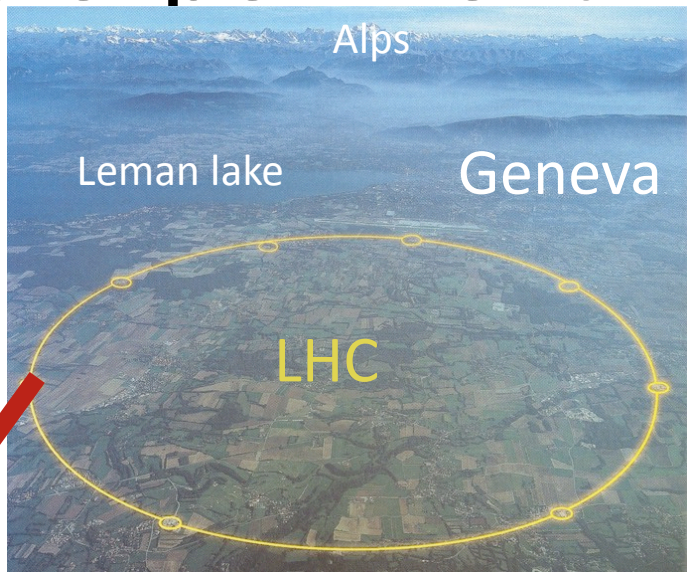
- Improve the coating of the PMTs to shift the light from 128 nm VUV to blue light.
- Calibration of the detector at very low energies (5-10 keV) with Krypton or Iron sources.
- Measurement of the light and charge yields at low energies (extremely relevant for dark matter search).

Master thesis proposals

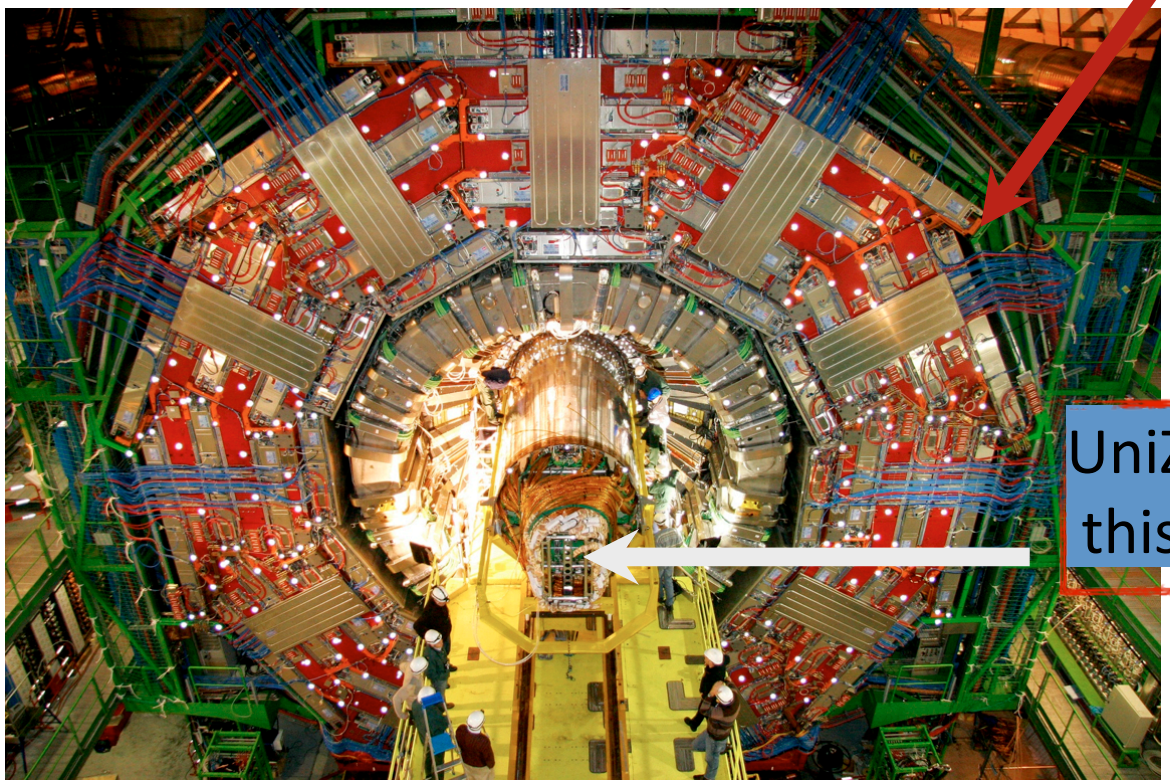
Higgs boson production at the LHC: Exploration of an extended scalar sector

The LHC and the CMS experiment

- No Higgs discovered yet ⇒ Need more colliding energy than in the past
- One of the motivations to build the LHC at CERN!
  - 27 km long accelerator
  - proton-proton collision at 7 TeV (7000 GeV!)
  - 4 big detectors
    - CMS, ATLAS, LHCb, ALICE



CMS

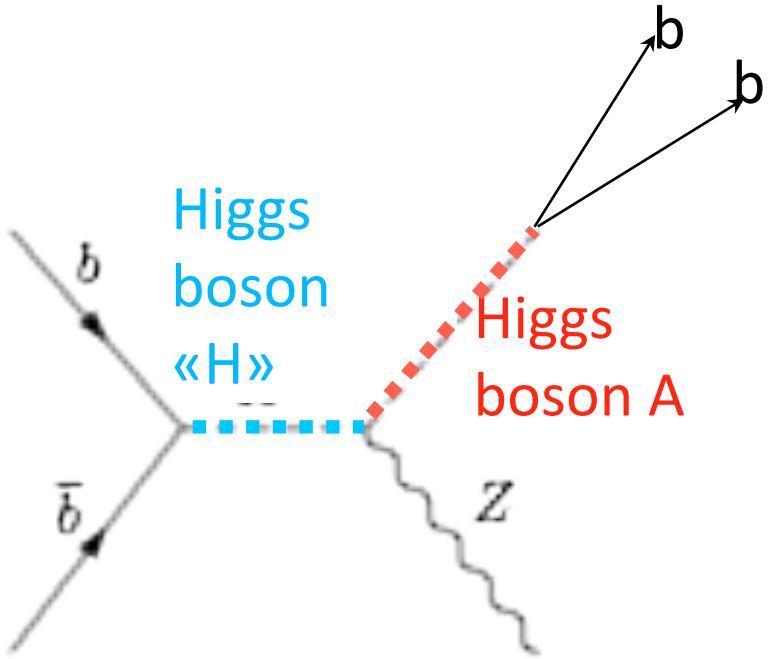


UniZH works a lot on this very central part

First proposal: Z+B mesons in CMS

- Aim: Discovery of the Higgs sector through the study of (Z→leptons)+Higgs boson «A» decaying into a pair of b-quarks
  - b-quark gives B-mesons
  - First, need to do an accurate study of the Standard Model production of leptons pairs + a pair of B mesons candidate in the CMS detector before reaching the sensitivity for Higgs discovery
  - High discovery potential within 2 years in CMS: simultaneous visibility of 2 neutral Higgs bosons + measure of their masses
- Uni ZH is very active: 5(6) people involved
- Take part in the official analysis within CMS, possible collaboration with other institutes

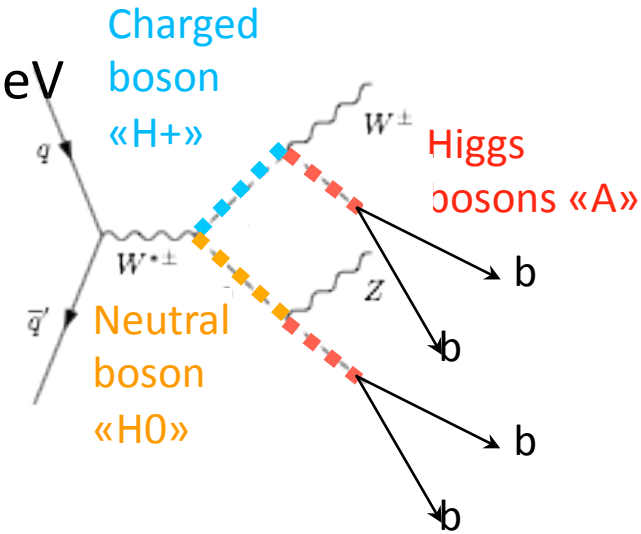
70% Data analysis, 30% simulation



Second proposal: 4 B mesons + W and Z boson in CMS

30% Data analysis, 70% simulation

- Aim: disentangle the low cross-section process involving Higgs bosons from the Standard Model background processes: simultaneous discovery of three Higgs bosons and the measurement of their masses:
  - Region of interest: m(A)~50 GeV, m(H)~150 GeV



- Cross-section with Z/W→leptons ~1.5 femtobarn (10^-15b!)
  - ⇒ Challenging and prospective study, probably nothing expected during 2011/2012 LHC runs
  - Could be made within the CMS software environnement or in an independant detector simulation framework (depending on the wishes)

Contacts

AEgIS

- Dr. Y. Allkofer (Supervisor)
  - yves.allkofer@cern.ch
  - 0041/22/7673367

Darwin

- Dr. C. Regenfus (Supervisor)
  - christian.regenfus@cern.ch
  - 0041/22/7672047

CMS

- Dr. S. de Visscher (Supervisor)
  - sdevissc@cern.ch
  - 0041/22/7672385
- Prof. Dr. Vincenzo Chiochia
  - vincenzo.chiochia@cern.ch
  - 0041/22/7676041

Feel free to contact and ask ☺

Prof. Dr. Claude Amsler
claude.amsler@cern.ch
0041/22/7672914