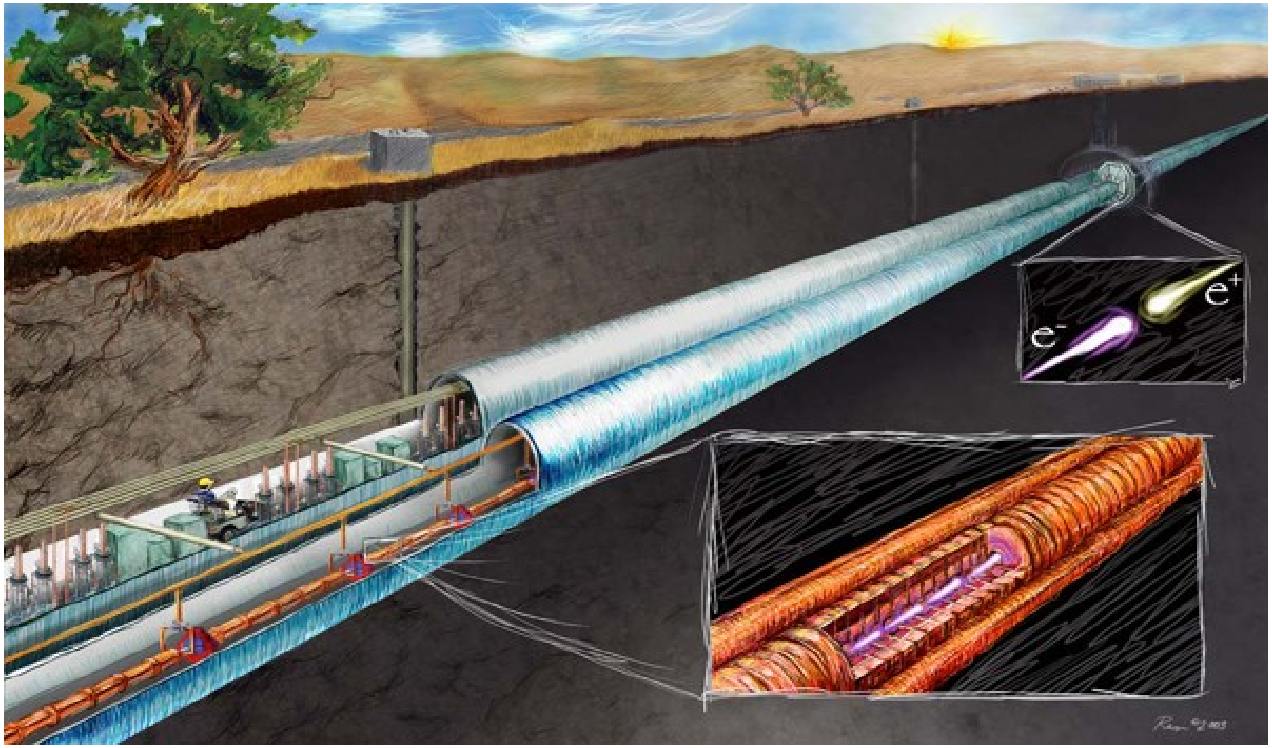
ILC-CALICE @ LLR

~ 5 chercheurs
~ 2 PhD students
~ 8 engineers (mechanical, electronics, computing)

Daniel JEANS

International Linear Collider (ILC)

Proposed electron-positron collider: 0.5 -> 1 TeV, ~30km long



Measure high energy particle physics with high precision

Well controlled energy and spin of initial state

c.f. Hadron colldiers

--> cleaner better understood environment --> precision

ILC could start construction 2015~2020 (depends on funding...)

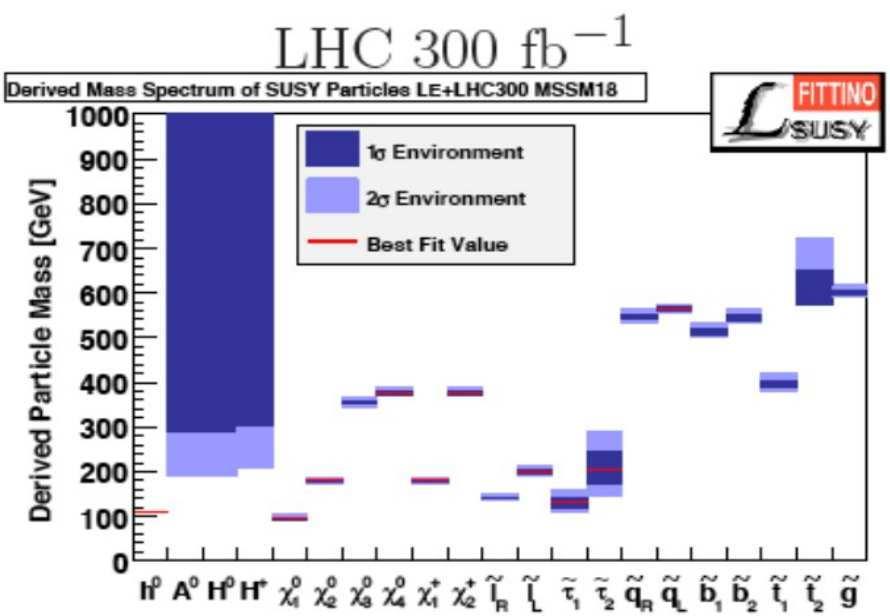
ILC will be able to study:

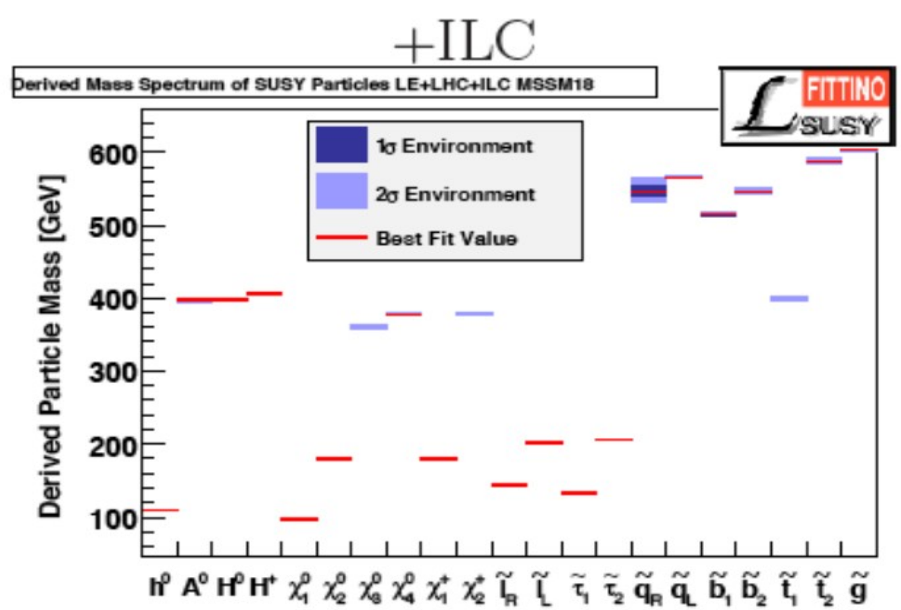
- Higgs physics

  Mass, branching ratios, couplings, CP violation (studied @ LLR) ...

- New physics (probably already discovered @ LHC)

  e.g. possible Supersymmetry models:





Detector for ILC

“general purpose” detector:

identify and measure momentum of all particles in all directions

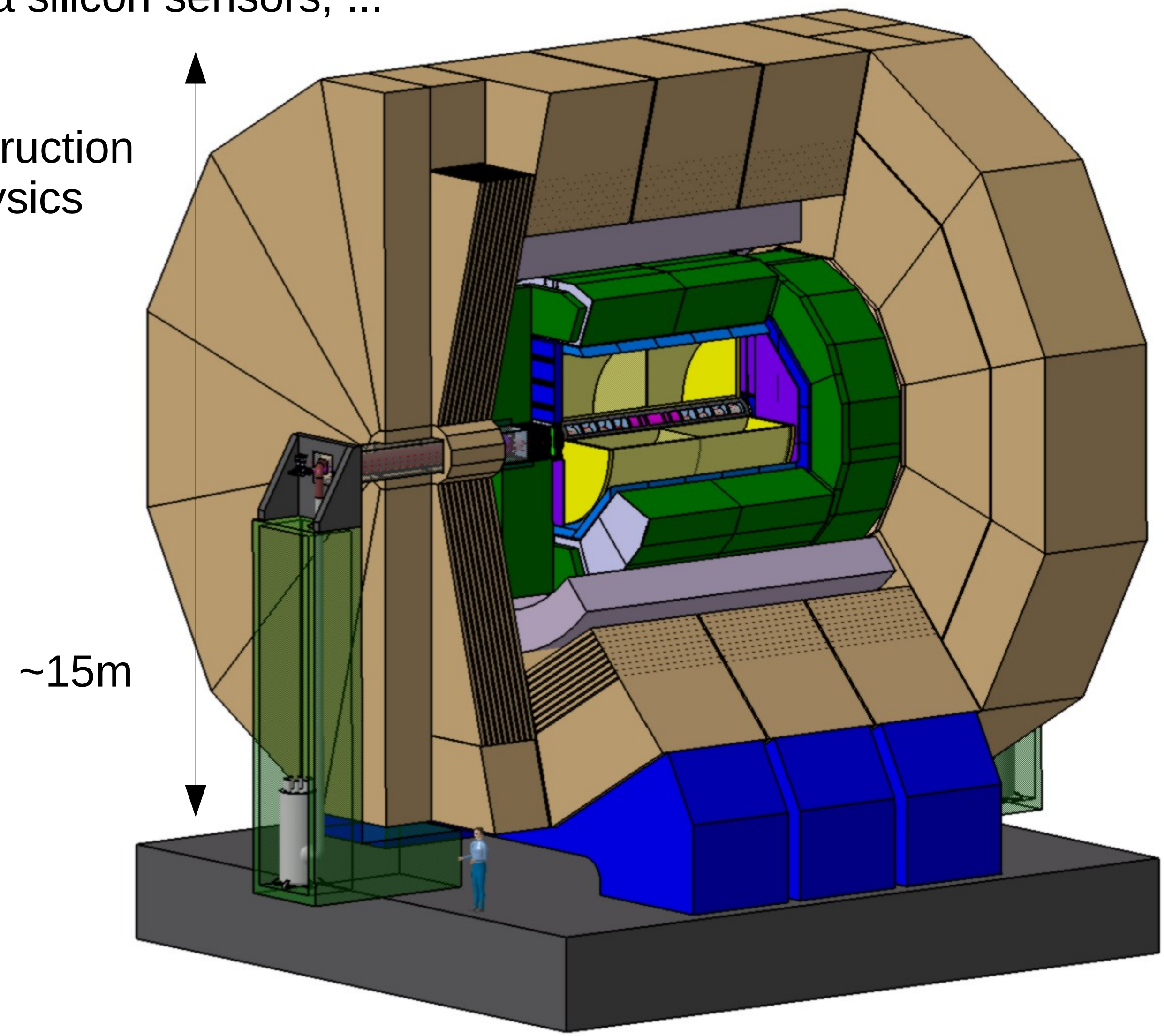
recent technology developments:

miniature electronics, large area silicon sensors, ...

-> new detector designs possible

-> more accurate event reconstruction

-> improve precision of physics measurements



Calorimeters for ILC

the LLR-CALICE group develops calorimeters for ILC detector

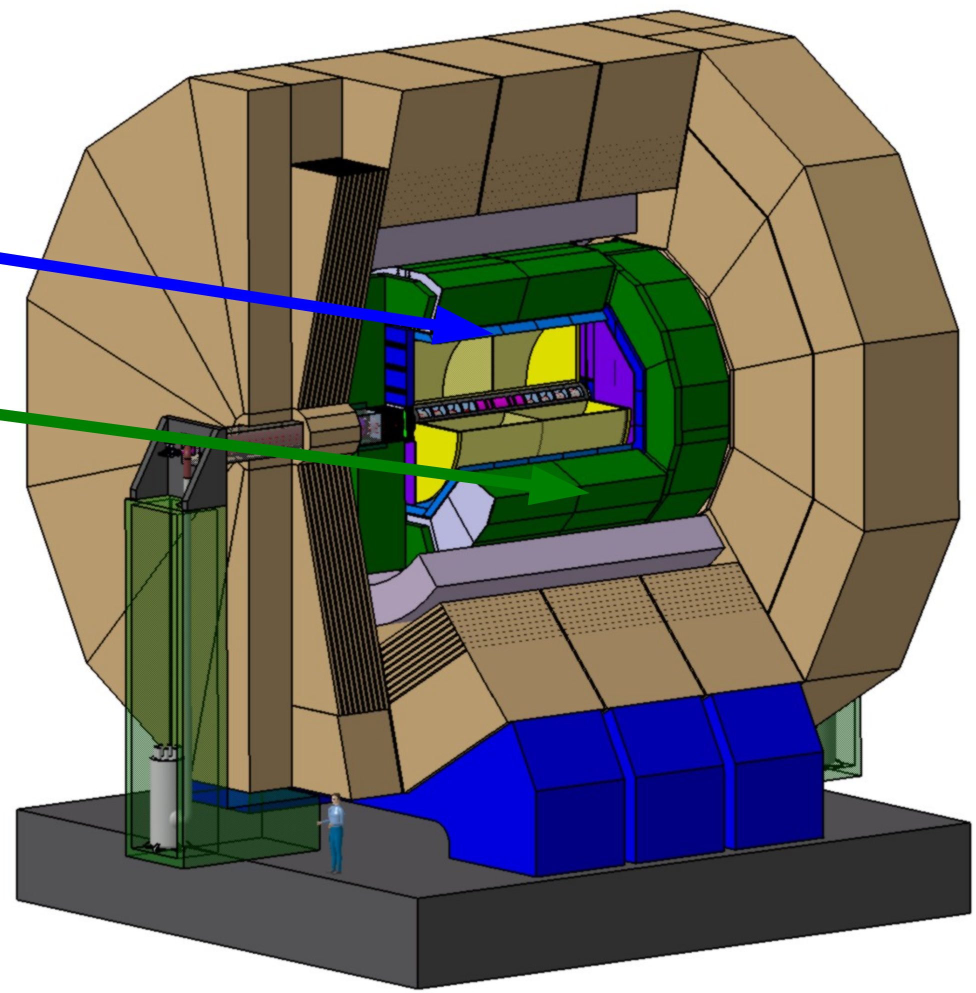
Measure particles' energy by energy deposit in dense material

Electromagnetic calorimeter

photons, electrons

Hadronic caloriemter

Hadrons (pions, protons...)



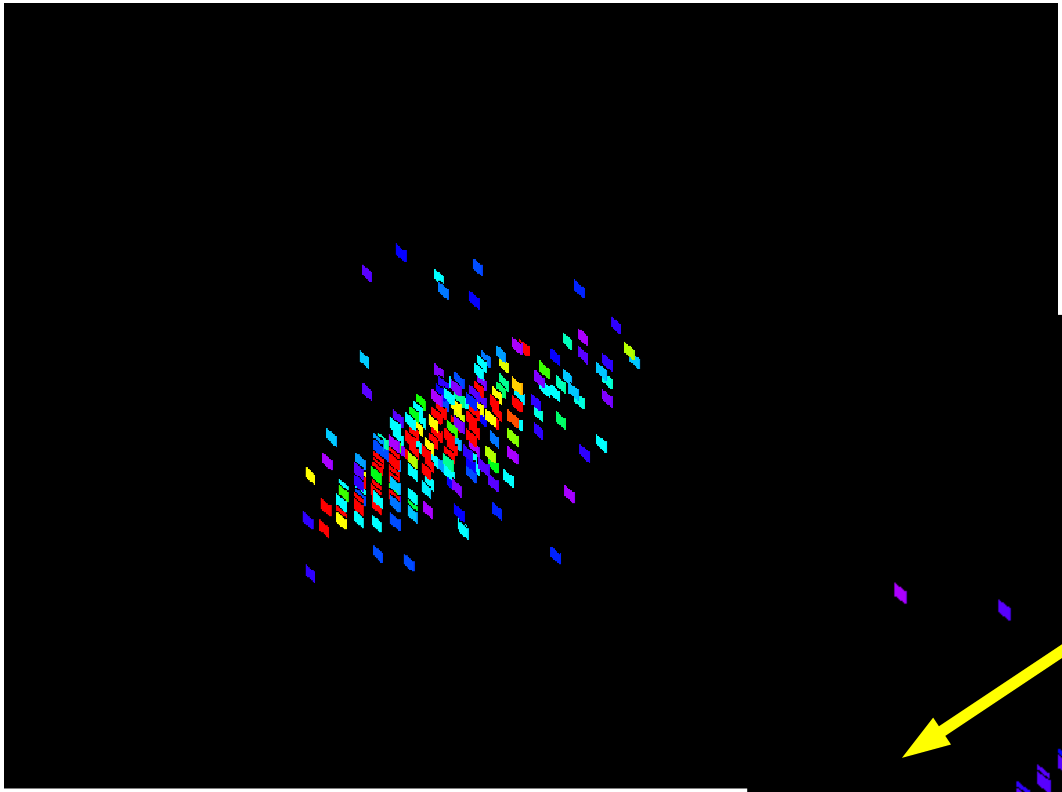
Compared to today's calorimeters,

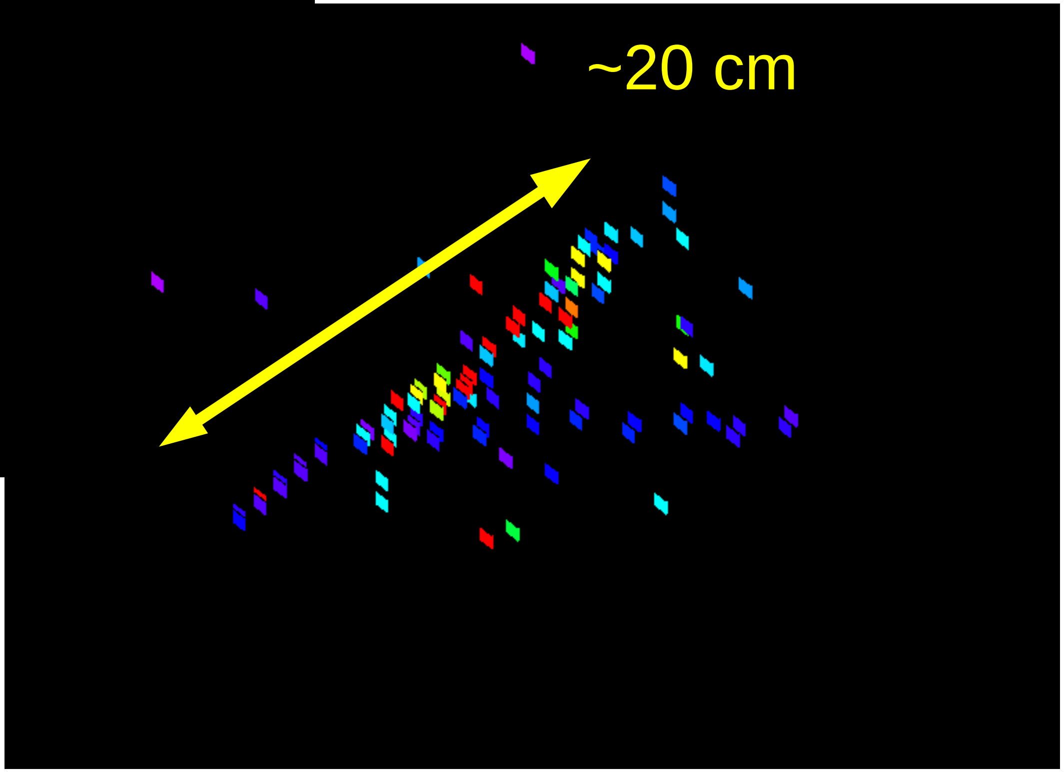
the ones we develop are ultra-granular

Measure deposited energy in very many small regions (~5mm -> 1cm)

-> allows detailed reconstruction of particle interaction in material

Todays calorimeters measure in regions ~10s cm





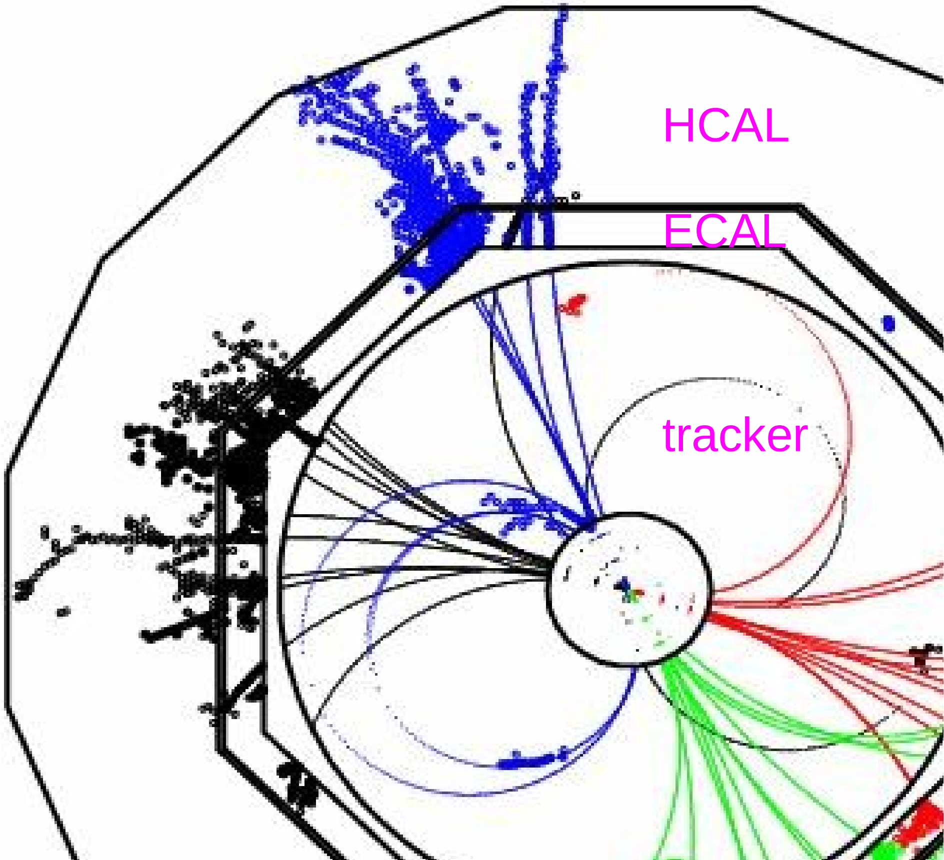
Ultra-granularity allow Particle Flow approach to event reconstruction

Measure energy of hadronic jets (often produced in decays of “interesting” particles)
with unprecedented precision

Measure energy of each particle using best detector
Charged particles – tracker (~10^-5 precision on momentum)
Photons – electromagnetic calorimeter (~10% precision)
Neutral hadrons – hadronic calorimeter (~50% precision)

Need to cleanly distinguish particle showers in

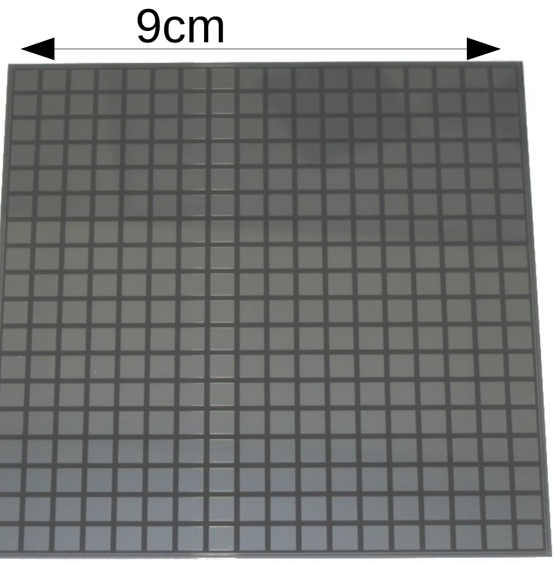
Measure jet energy >2 times better than
in today's experiments (e.g. @ LHC)

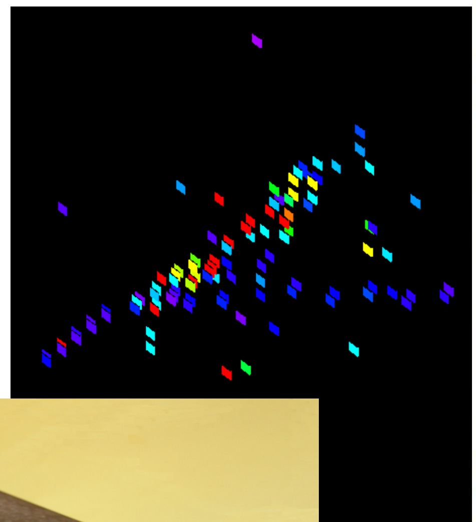


ECAL (electromagnetic calorimeter)

"sandwich calorimeter" (30 layers):

- Thin (~1mm) tungsten sheets -> high Z -> electron/photon interactions
- Silicon detection layers -> thin, split into 5x5 mm^2 regions (>2000m^2 in total)
- Readout electronics inside detector





@ LLR:

- development of silicon sensors
- carbon fibre mechanical structure
- test beams and data analysis
- photon reconstruction software

HCAL (hadronic calorimeter)

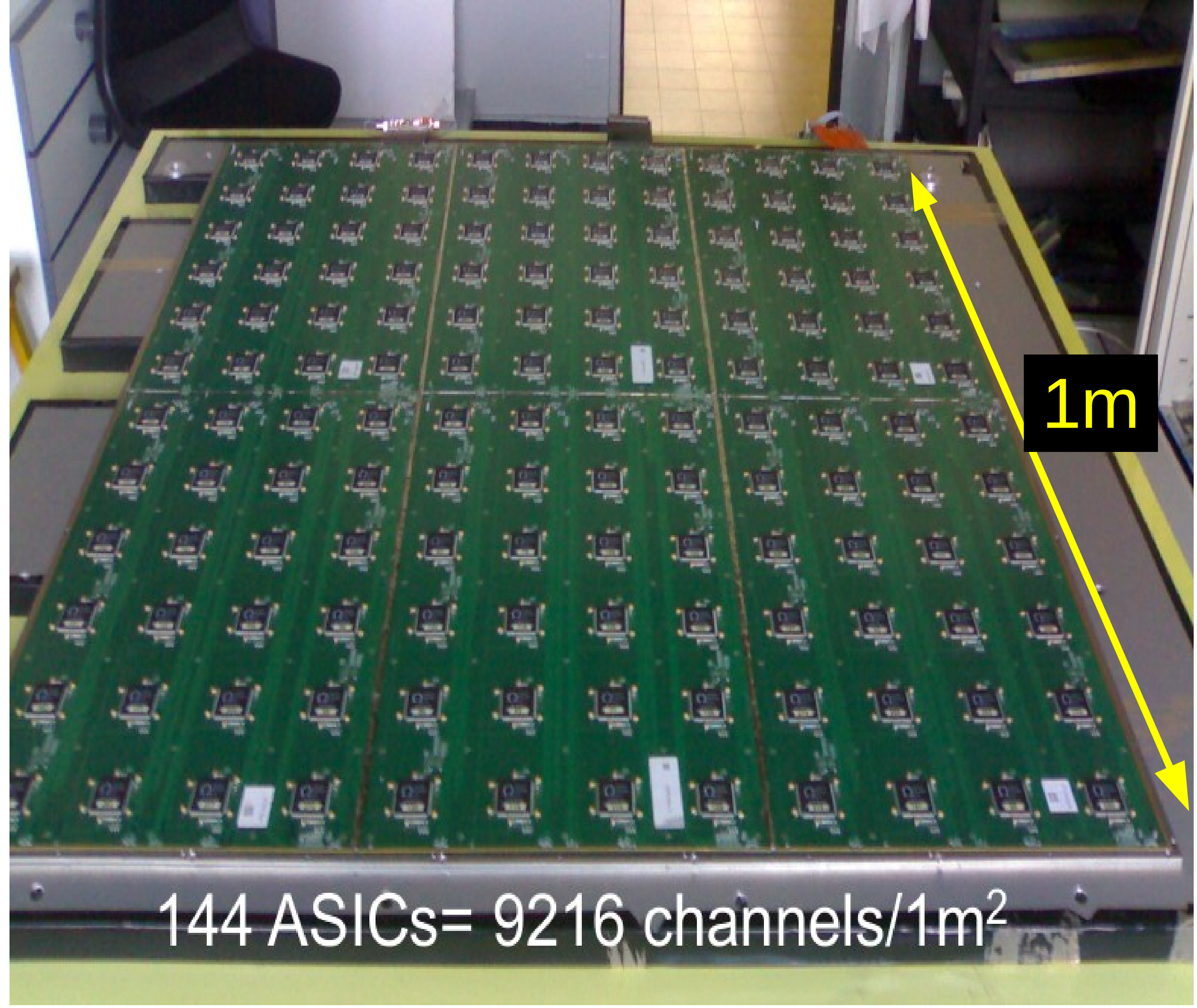
Also “sandwich” calorimeter
- Steel plates
- “Resistive Plate Chambers”

Read energy in each 1x1cm^2 region
- -> ultra-granular

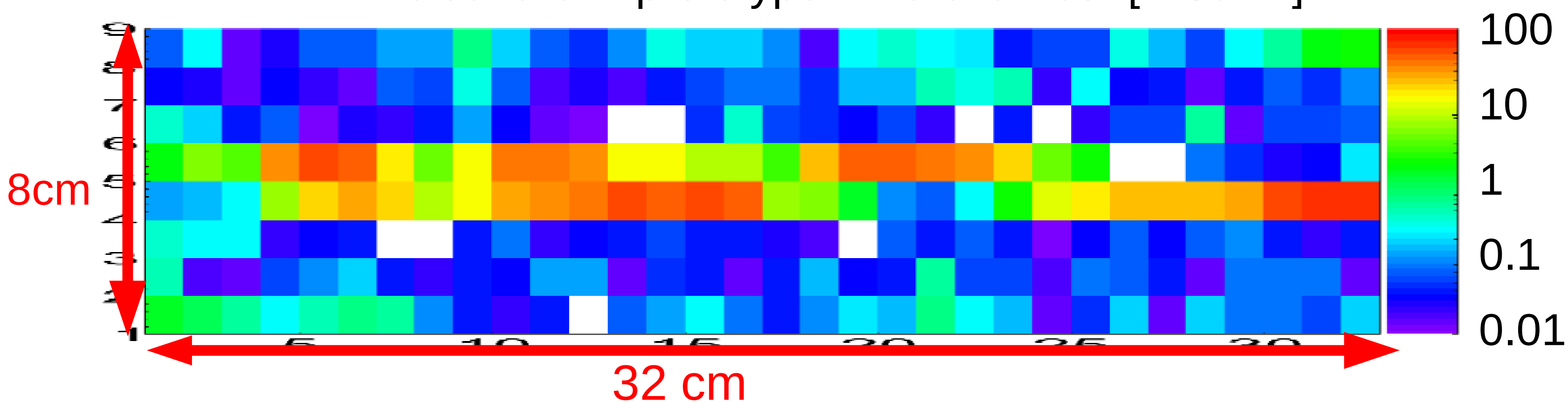
Testing large-area RPC detectors
- -> particle beams

-> efficiency, noise, reliability...

Data acquisition system (also ECAL):
- 3k collisions/ms...
- how to read ~10^8 detector channels ?



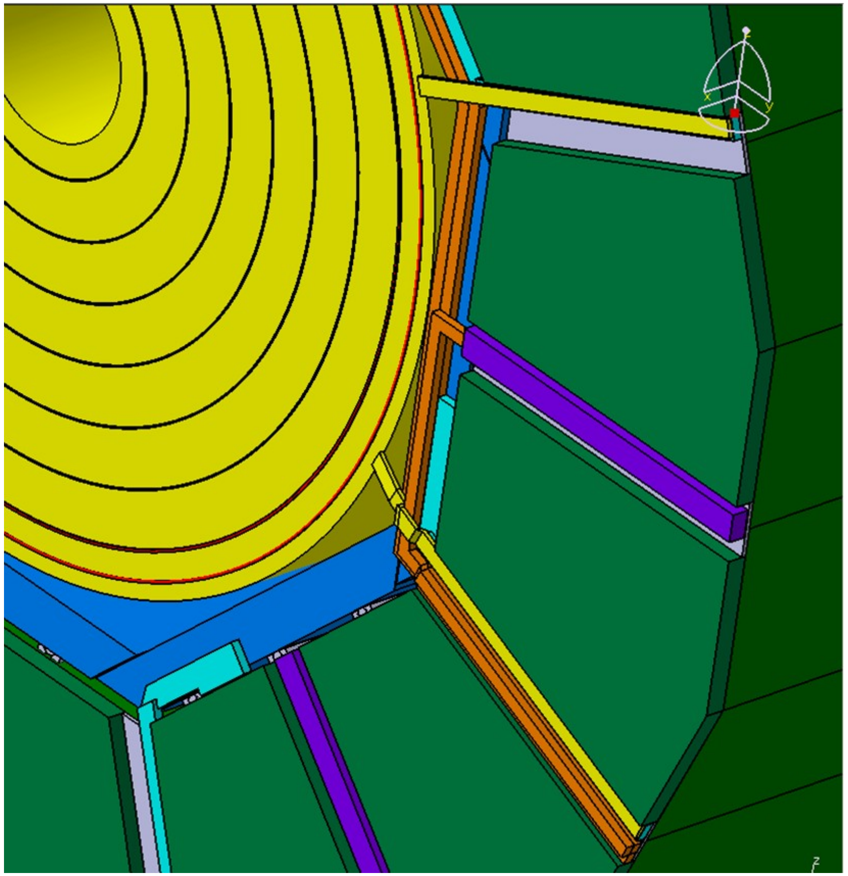
Noise rate in prototype RPC chamber [Hz/cm2]

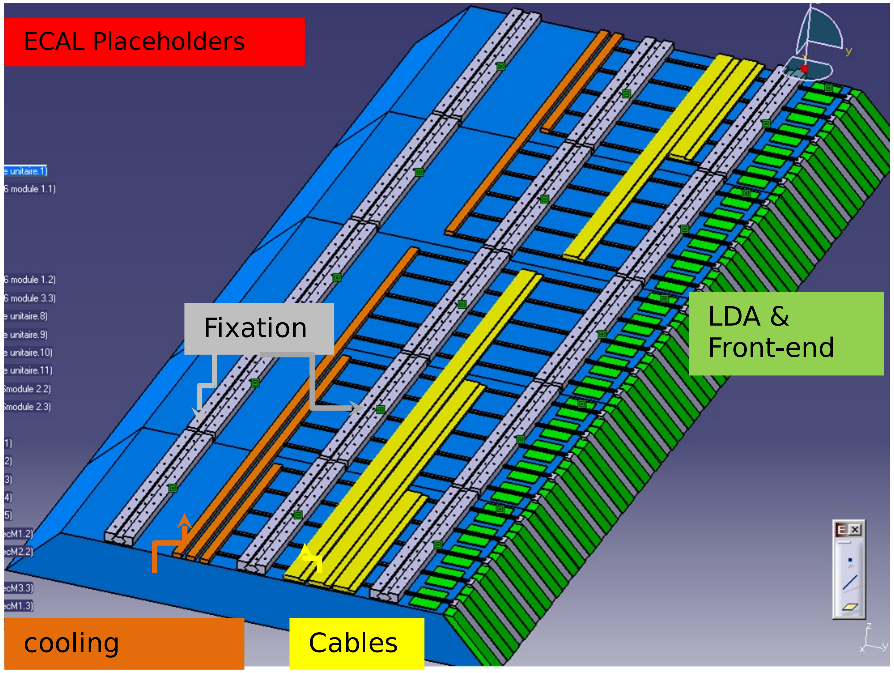


Global detector integration

How to support calorimeters? ~ 10 tonnes
Mechanical deformations: tight tolerances

How to pass cables, cooling to outside world
-> minimise “dead” space





At LLR-CALICE:

Calorimeter development:
- Electromagnetic calorimeter
  - Large area silicon sensors
  - Minimised electronics
  - Mechanical structure:
    - Carbon fibre composite, tungsten
  - Particle beam tests
- Hadronic calorimeter
  - Characterisation of detector prototypes
  - Particle beam tests
  - Development of data acquisition system
- Integration of calorimeters into complete detector

Event reconstruction:
- Photon reconstruction
- Development of Particle Flow technique

Physics measurements:
- CP violation in Higgs boson decay