Prospect on detector

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Early Career Researcher session
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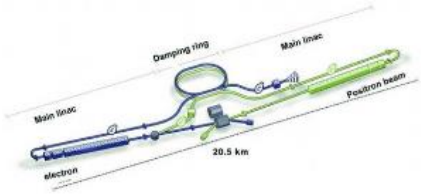
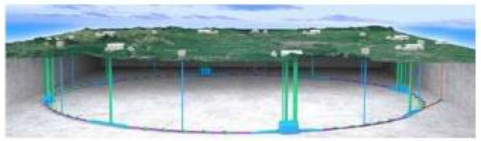
Thank you for session conveners!

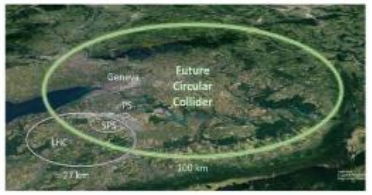
- It’s quire rate to arrow to express my own feeling in front of large audience. I appreciate organizer and session conveners
- Contents of my talk are purely my thought.
- Nevertheless, I respect all works and consideration done in the past decades for Collider projects.
- I do not know many aspect, so please talk to me if I would say any stupid or wrong information.
- I will be more than happy to discuss.

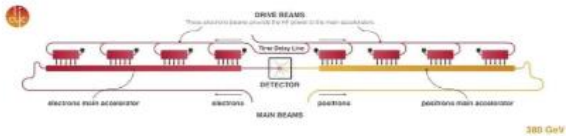
Detector concepts for Higgs factories

Slide inspired from B. Dudar

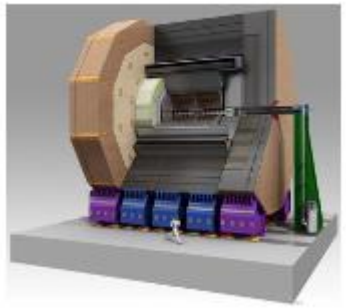




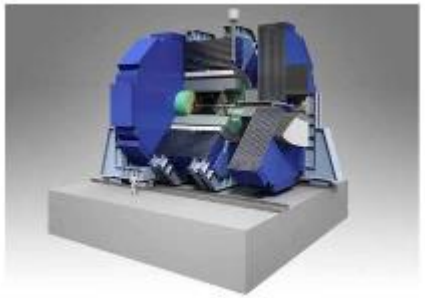




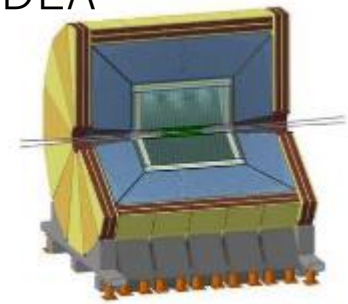
ILD



SiD

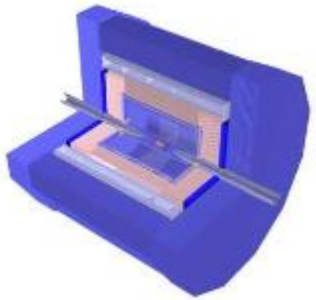


IDEA

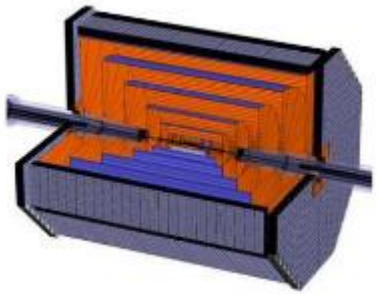


CLICdp

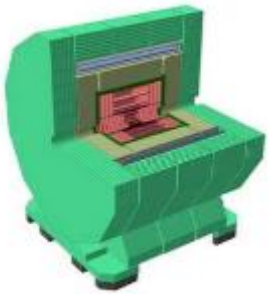
CEPC baseline



FST



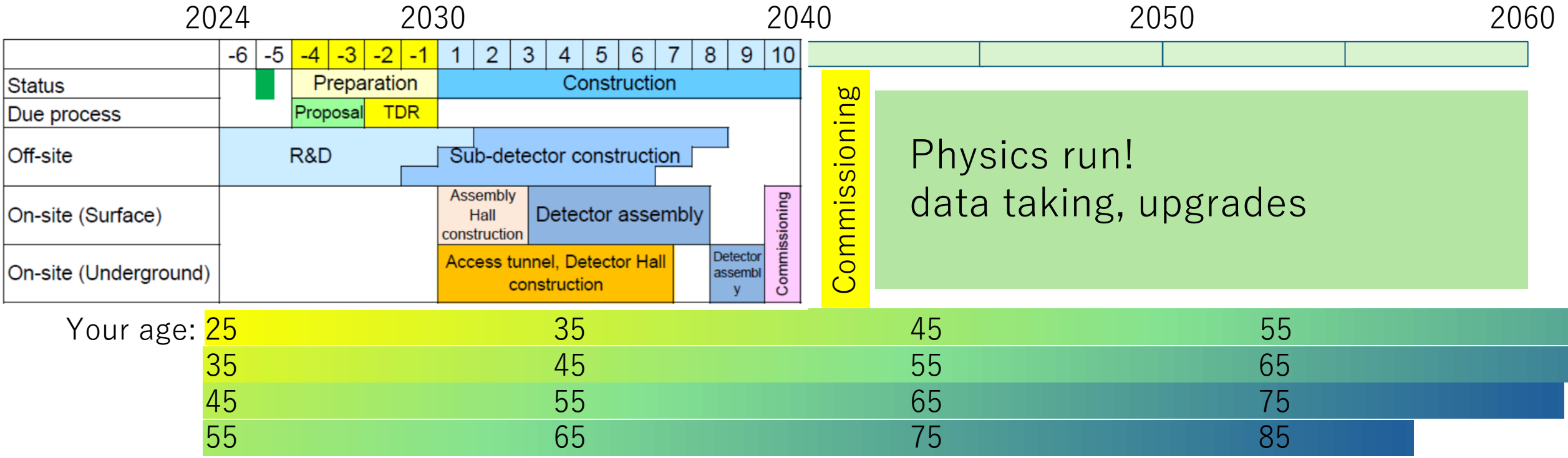
CLD



We are going to build at least one of accelerator with multiple detectors!

Time scale and our life time.

Installation time line
from LCWS2023

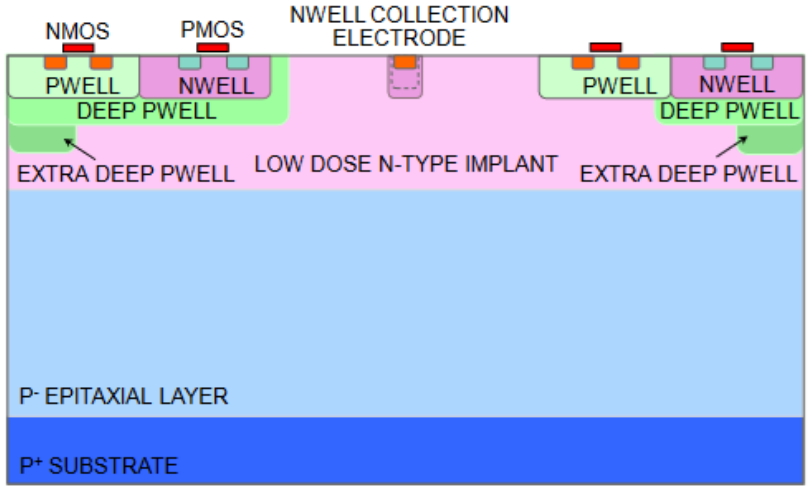


- If we would get green light, the physics run will come in ~ 20 years.
  - Need to accumulate > 10 years to reveal new physics.
- We should build what we want.
  - At least we should not build given detector. Convince ourselves it is the best!
  - There must be opportunity for upgrades, we should proceed R&D as well!

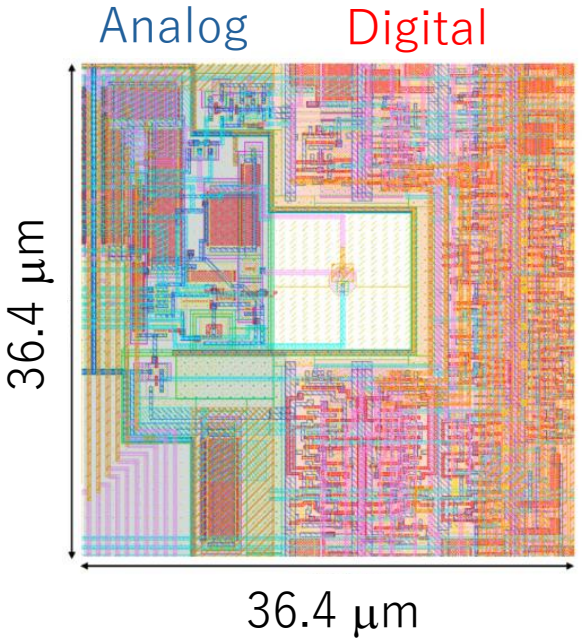
Favorite sensor: Monolithic pixel sensor

Analog and digital circuit on a thin sensor by CMOS process

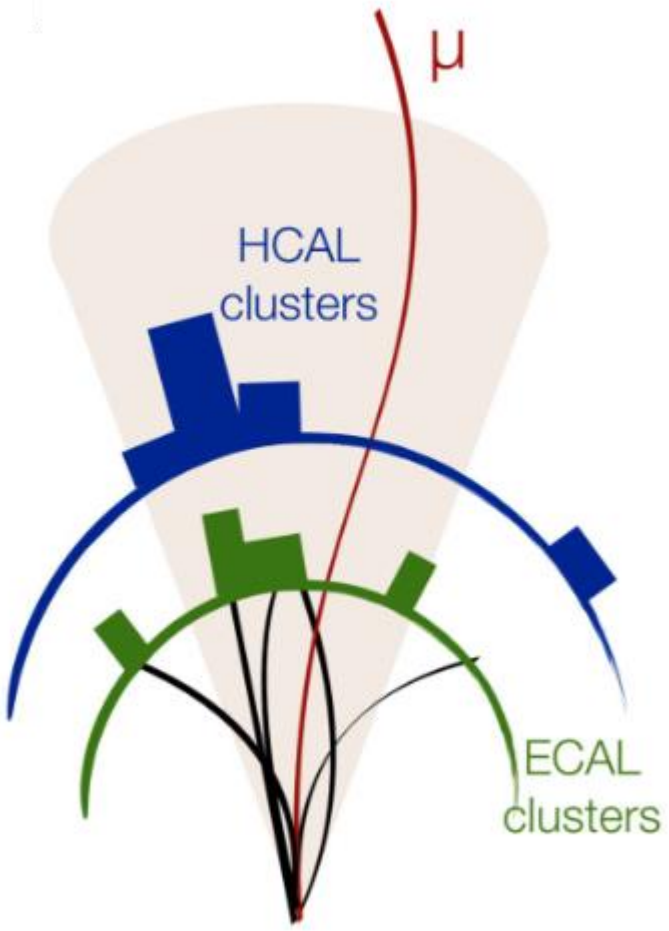
- Mono-structure
  - No bump-bond
  - Fine pitch
  - Low material
  - Easy mass production
  - Digital data processing
    - Data compression
    - Track reconstruction
- Development
  - Thinner(~ 50 μm), finer pixel (a few μm) and precision timing (a few ps)
    - Currently 180 nm to 65 nm for MAPS.
    - 20 years later, we should be able to use the latest technology now, i.e. 2 nm process.
    - Radiation tolerance for future hadron collider
  - Reduce cost for production!



MALTA2, TJ180 nm, 512x512 pixels

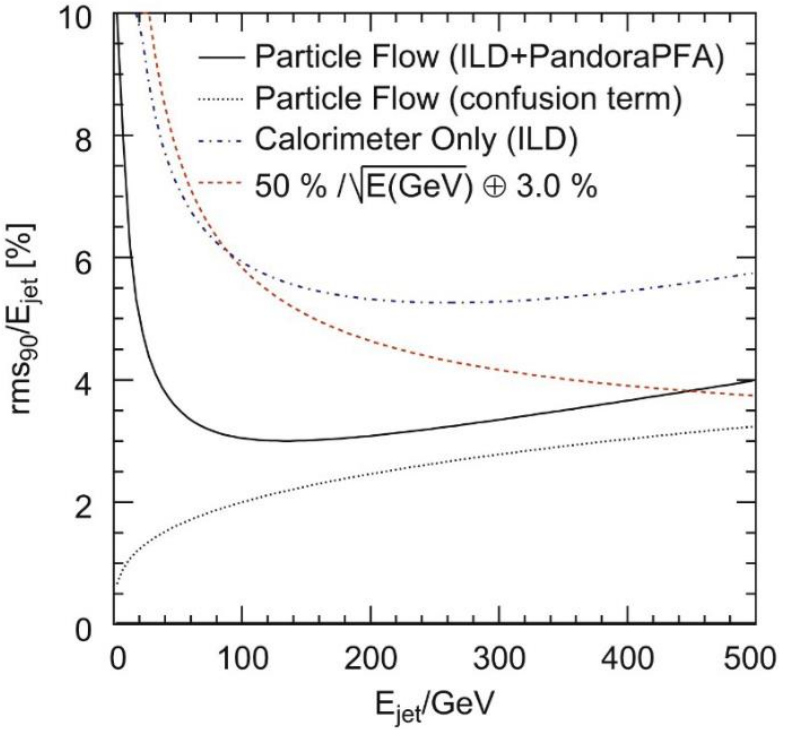


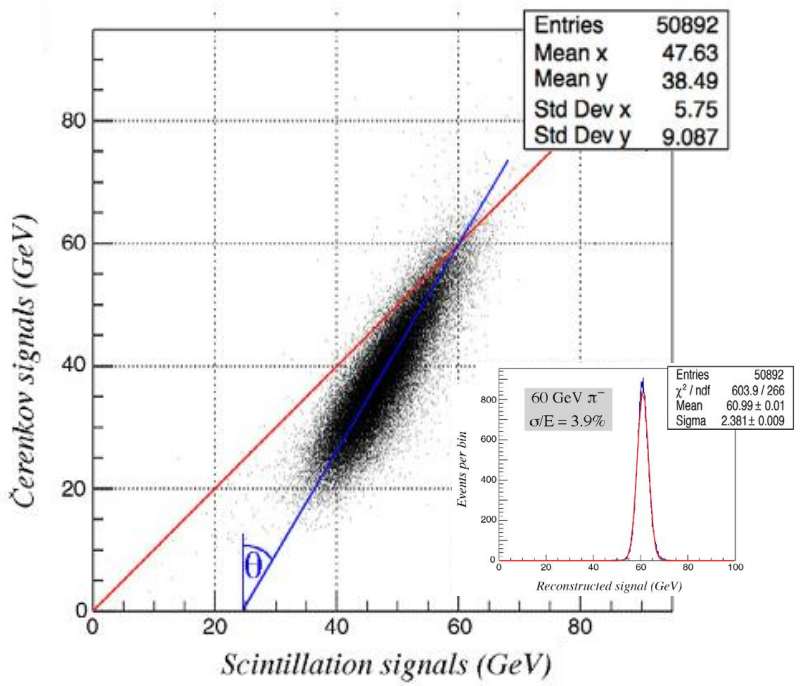
Calorimeter: PF with Dual readout+ps-Timing



Nice figure from S. E. Park(MIT)

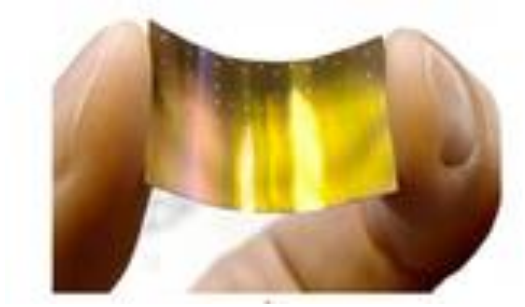
- Particle flow
  - Current best resolution
  - Dual readout based particle flow should be best!
  - By insert pico-sec timing layer with MAPS.





Ultimate sensor use everywhere…

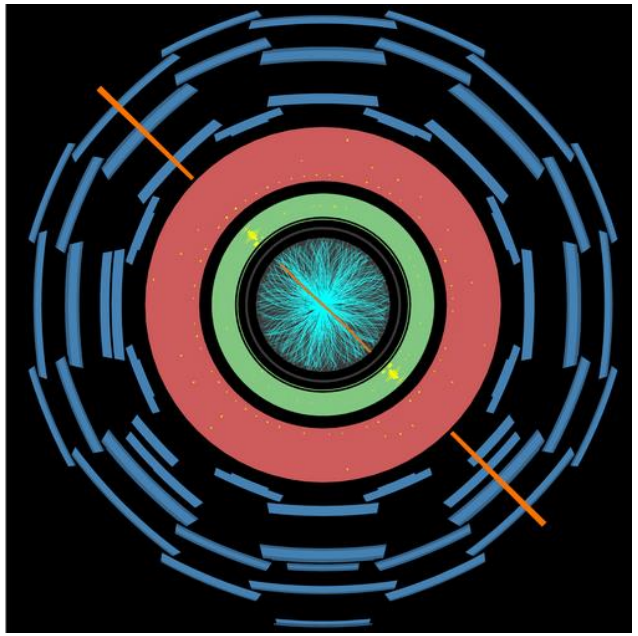
- MAPS which has
  - 1 μm pixel
  - 1 ps timing resolution
  - Low power consumption (~ mW/cm^2)
  - High radiation tolerance
    - 10^16 n_{eq}/cm^2 : can be used at inner part of hadron collider
  - Configurable readout segment by digital processing
    - Readout as 1 cm x 1cm pad easily
  - Reasonable cost for mass production

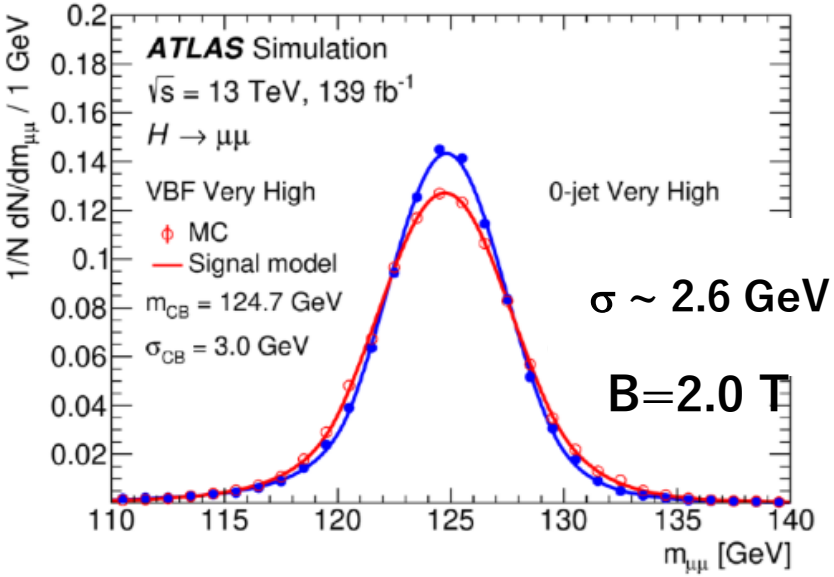


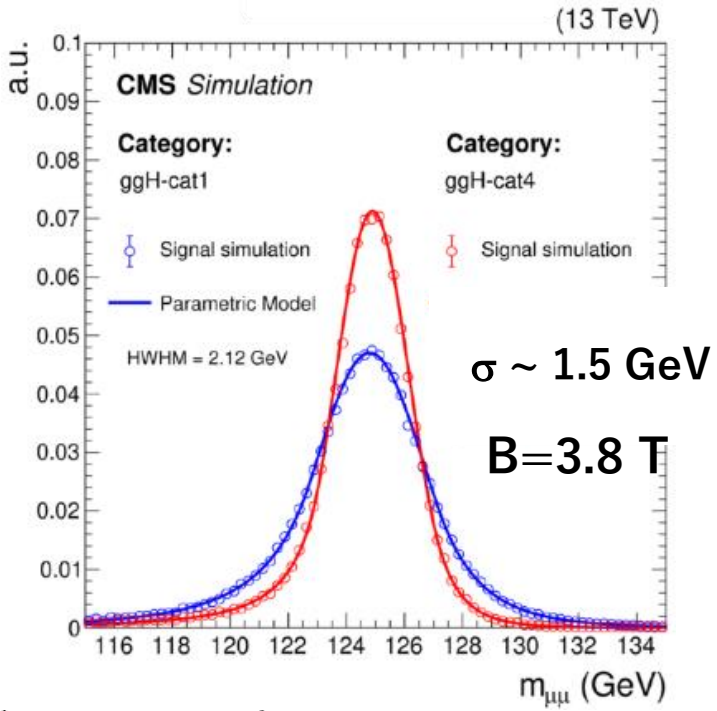
ALICE-ITS3

Use it from inner vertex detector, calo readout to muon detector.

Solenoid magnet: Lesson learned on H→μμ







- Performance of objects reconstruction are almost same between ATLAS and CMS, except muon.
- Due to magnetic field.

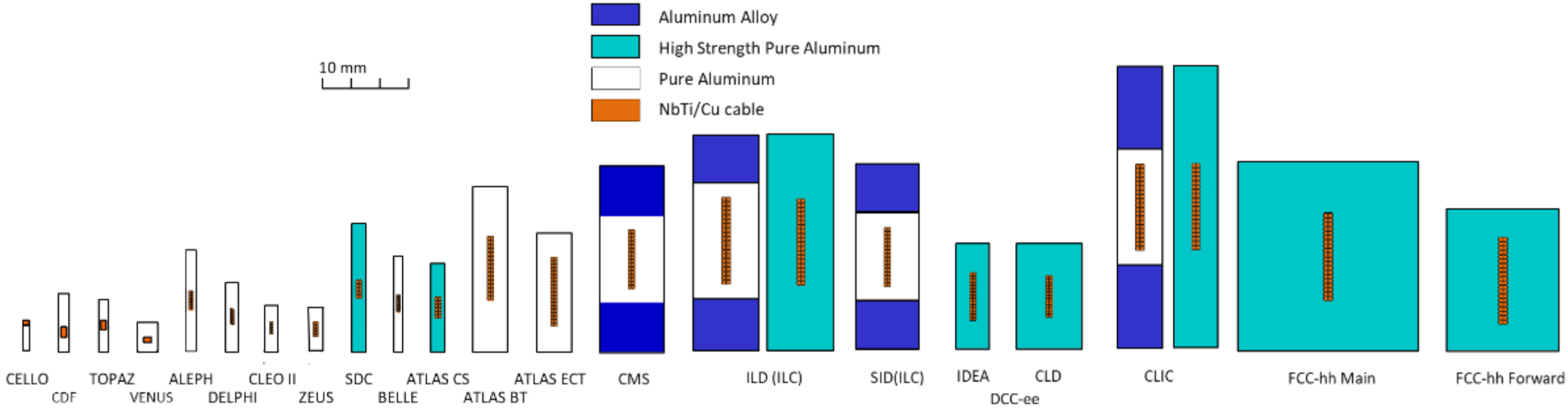
$$\left(\frac{\sigma(p_T)}{p_T}\right)^{meas} = \frac{\sigma(s)}{s} = \frac{\sqrt{\frac{3}{2}\sigma(x)}}{s} = \frac{\sqrt{\frac{3}{2}\sigma(x)\cdot 8p_T}}{0.3BL^2}$$

L ~ 1 m for both ATLAS and CMS

No presentation on muon system at LCWS. Should work on it!

More important on detector magnet

- We can not make solenoid magnet now.
- Technology on Al stabilized super conducting wire is almost lost.
  - Technology revival effort has started (CERN, KEK with company)
  - A company in China also started
- New wire material for solenoid
  - HTS for solenoid would be applicable
  - Low material wire, MgB_2(2.2 g/cm^3) in stead of NbTi(6.6 g/cm^3)



Summary

- Project will be very long
  - Build what we want to build, not given one.
    - Need to convince ourselves it is the best one to build.
  - R&D, design, construction and operation. Also, consider upgrade!
    - Modular detector segment would be nice to replace / upgraded easily.
- MAPS can be ultimate sensor
  - Use everywhere!
- Detector magnet is important
  - Influence big impact on physics result.
  - Let’s work and consider seriously including muon detector

Thank you for your attention!