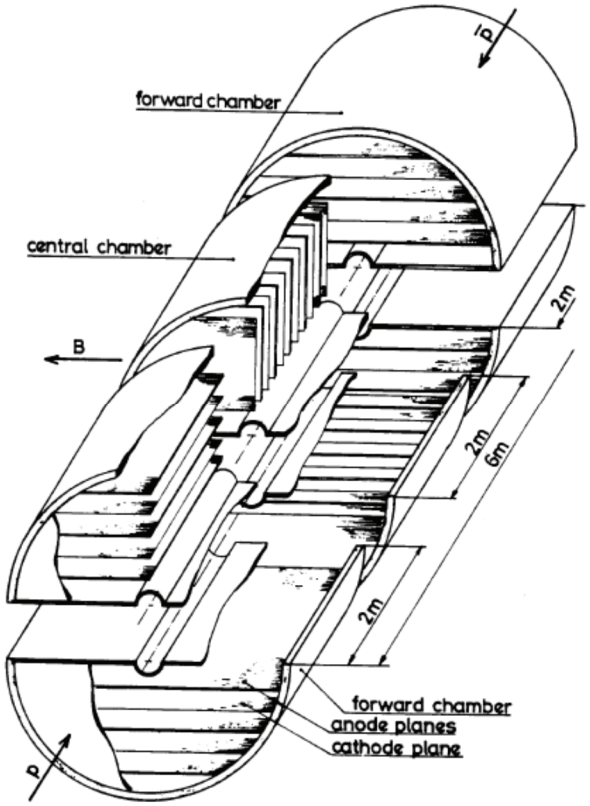
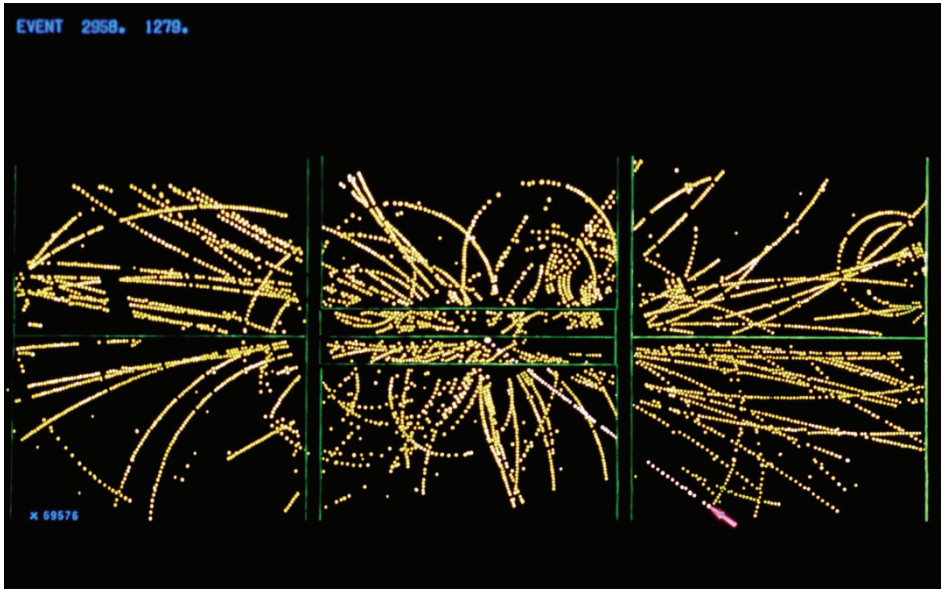

ATLAS Tracker:
Version '2026'
(The expert & newcomers view)
ATLAS
Utrecht, 18 December 2018

1984… ‘State-of-the-Art’

(1e large LHC workshop – Lausanne)



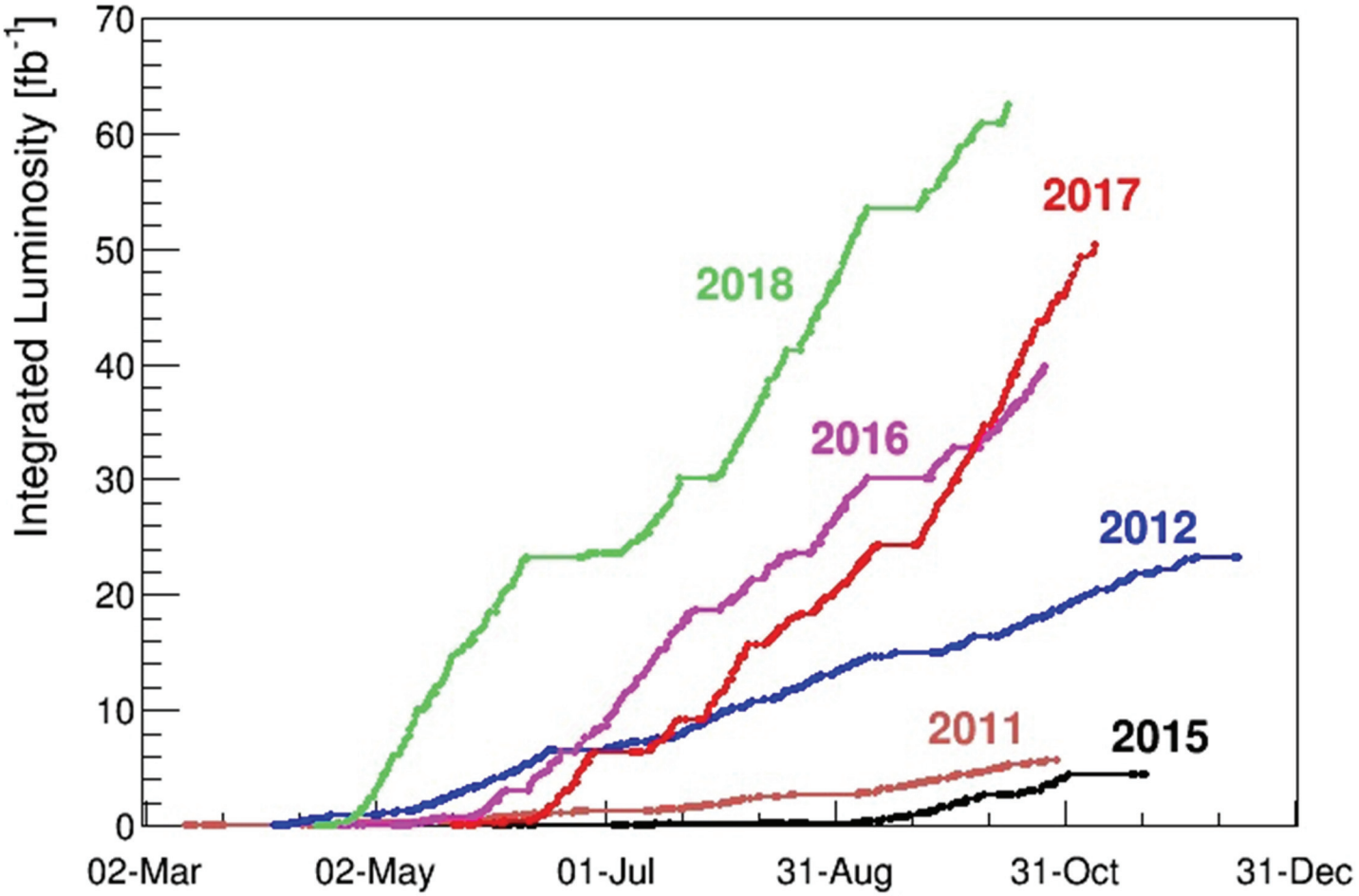
- Wire chamber technology
- Small amount of material
- $\mathcal{L} \sim 10^{29}\ cm^{-2}\ \mathrm{s}^{-1}$
- # of (hard) proton-antiproton collisions/bunch-crossing < 1
- Low occupancy



- UA1 & UA2: discovery W and Z^0 in $p - \overline{p}$ @ 540 (630) GeV

LHC: 2011 - 2018… proton – proton luminosity

(integrated per year)

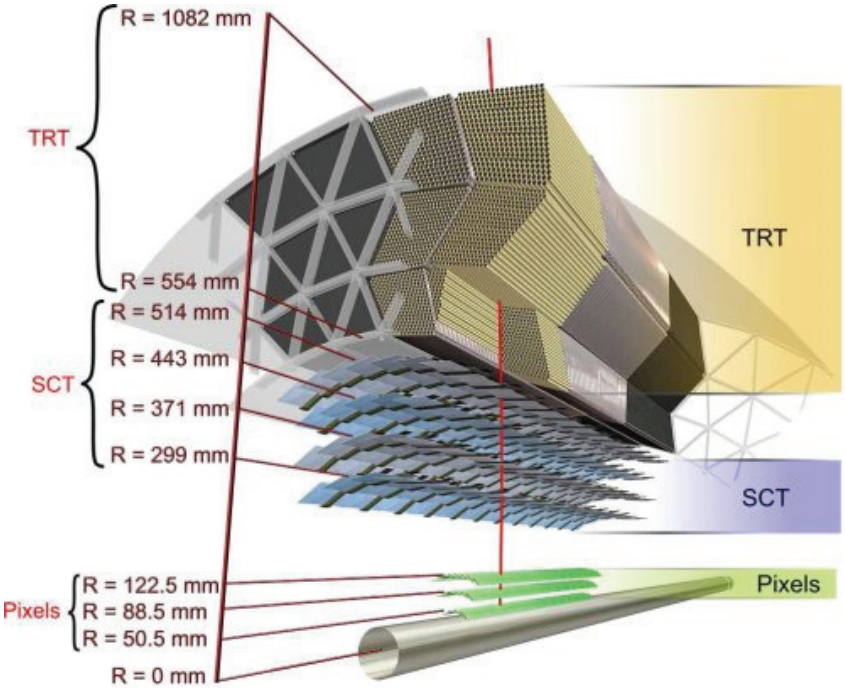


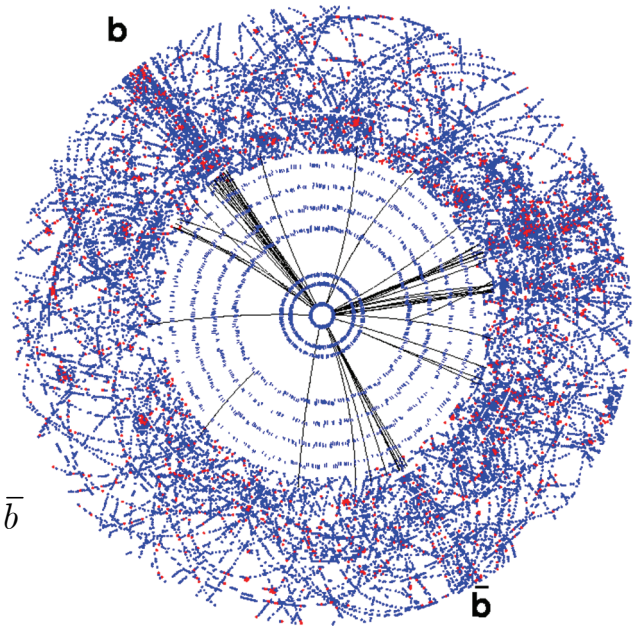
- Nom. luminosity: $\mathcal{L} = \frac{N^2}{\Delta t \times S_{eff}} \sim \frac{\left(1.15 \times 10^{11}\right)^2}{25 \times 10^{-9} \times 4\pi \times \left(16 \times 10^{-4}\right)^2} \sim 10^{34}\ cm^{-2}\ \mathrm{s}^{-1}$

2011 - 2023… ‘State-of-the-Art’

(in ATLAS Inner Detector)

- Silicon + wire ‘chamber’ technology
- Decent amount of material
- # of (hard) proton-proton collisions/bunch-crossing ~ 25
- Low (SiO)/high (TRT) occupancy

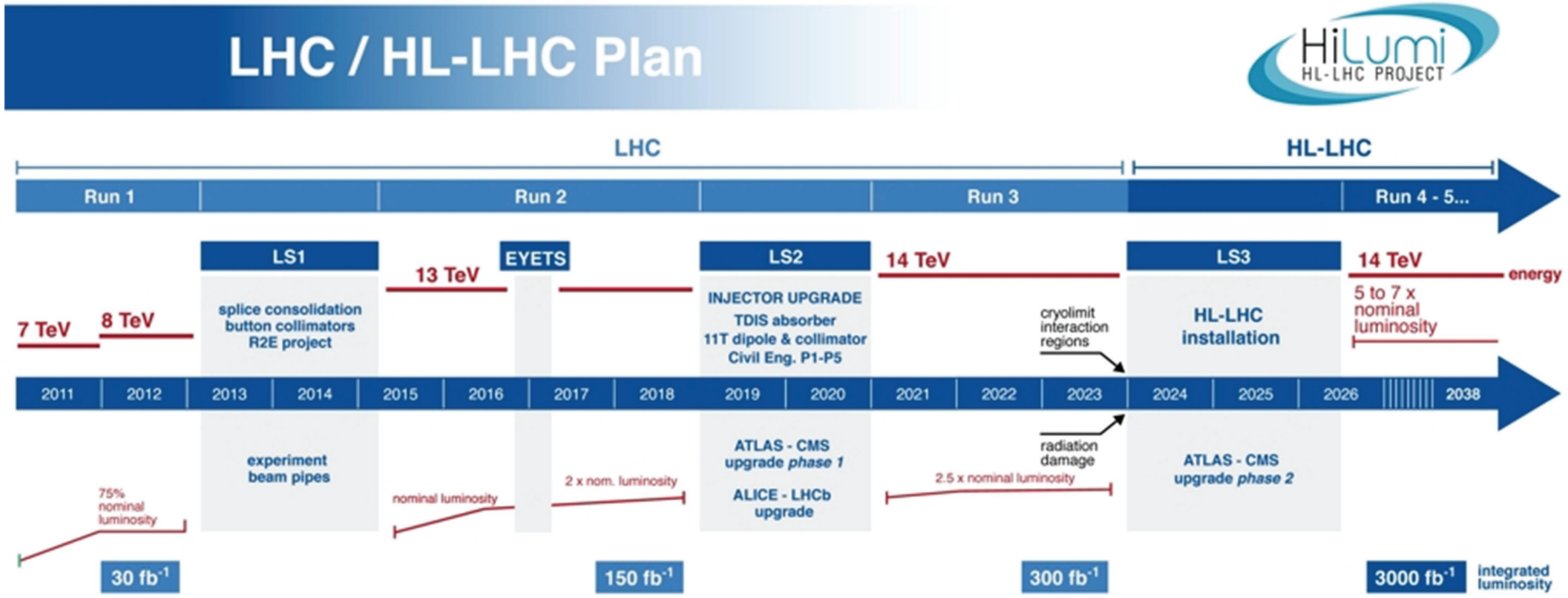




$H^0 \rightarrow b\,\bar{b}$

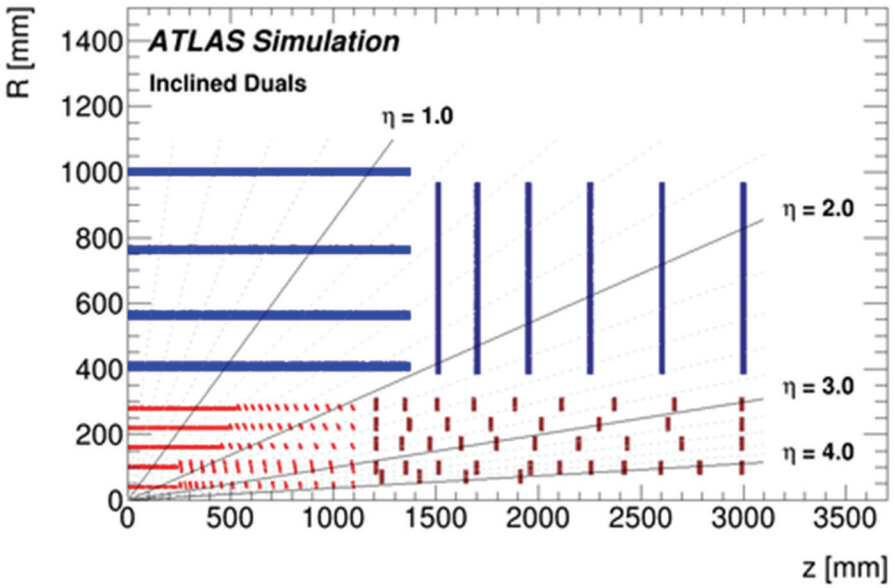
2021 and beyond…

(2026: ATLAS Inner Detector → ATLAS Inner Tracker - ITk)

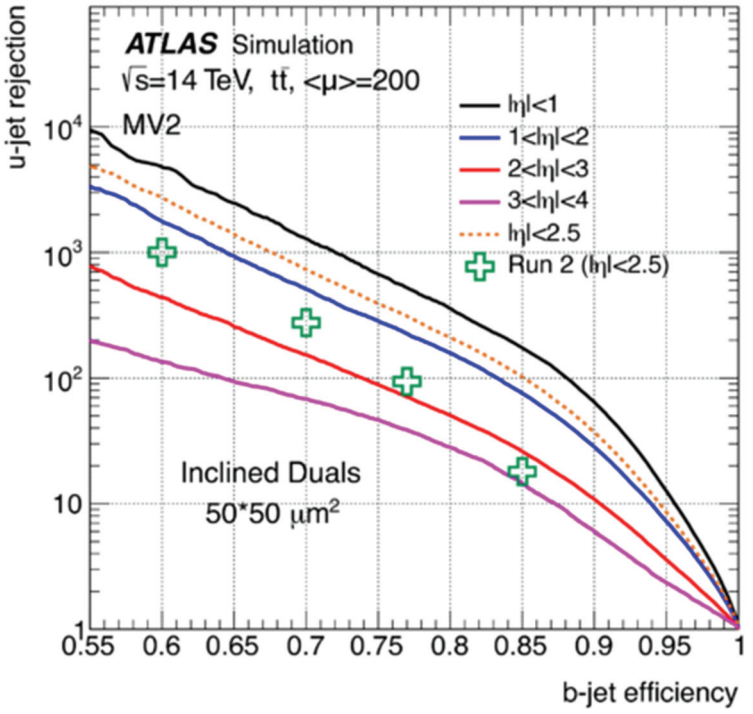


- 2017 – 2018: 2 x nom. lum. @ 13 TeV
- 2021 – 2023: 2.5 x nom. lum. @ 14 TeV
- 2026 – 5 – 7 x nom. lum. @ 14 TeV

…towards 2026: build completely new Inner Tracker

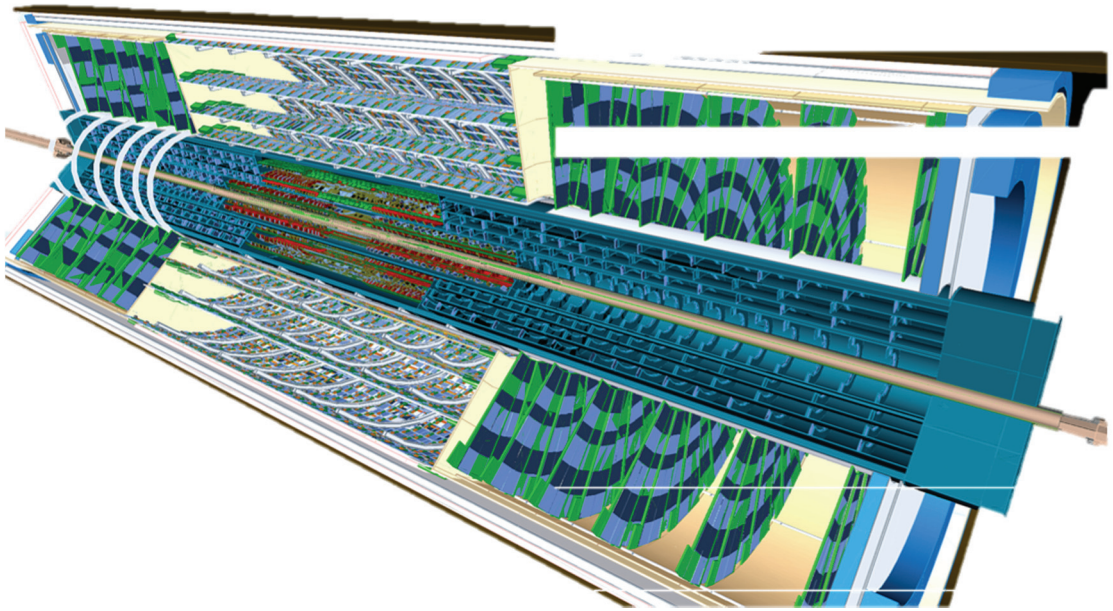


- All silicon tracker
- Tolerable amount of material
- # of (hard) proton-proton collisions/bunch-crossing ~ 200

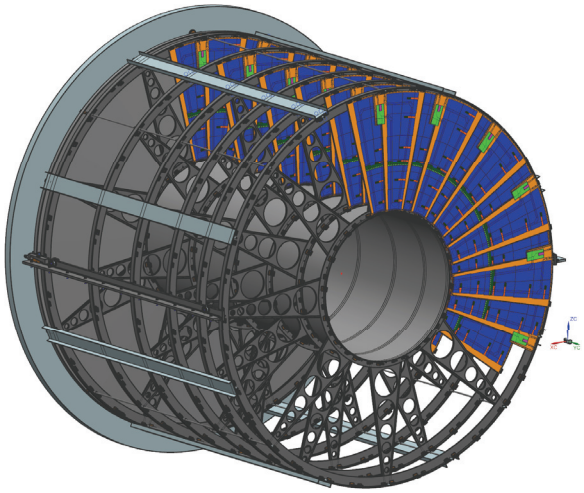


- Trigger rate 100 kHz → 1 MHz
- New electronics (130 nm)
- Strip detector $\left(8\times10^{7}\ strips, |\eta| < 2.7\right)$
- Pixel detector $\left(5\times10^{9}\ pixels, |\eta| < 4\right)$
- Silicon: ~200 m^2

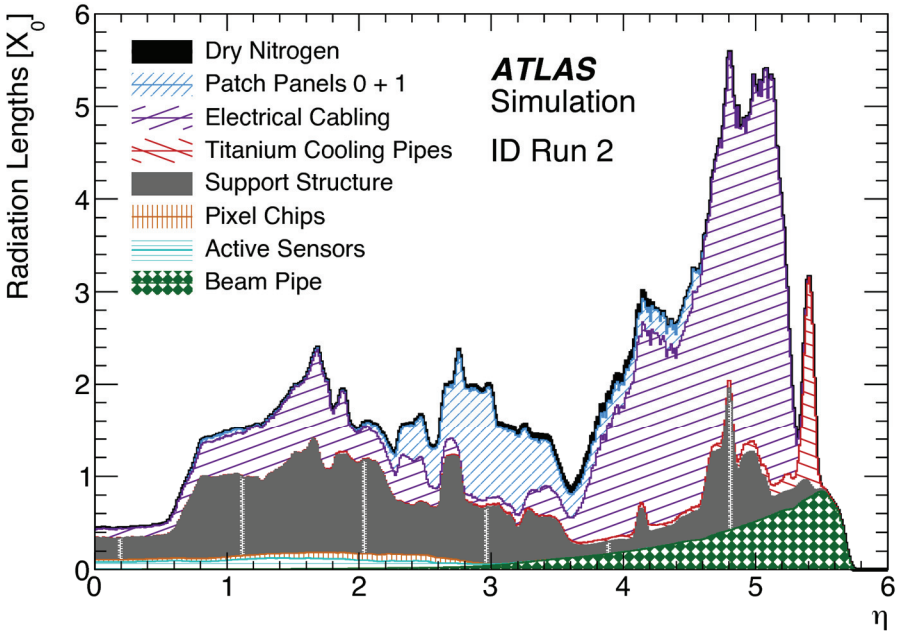
…towards 2026: build completely new Inner Tracker

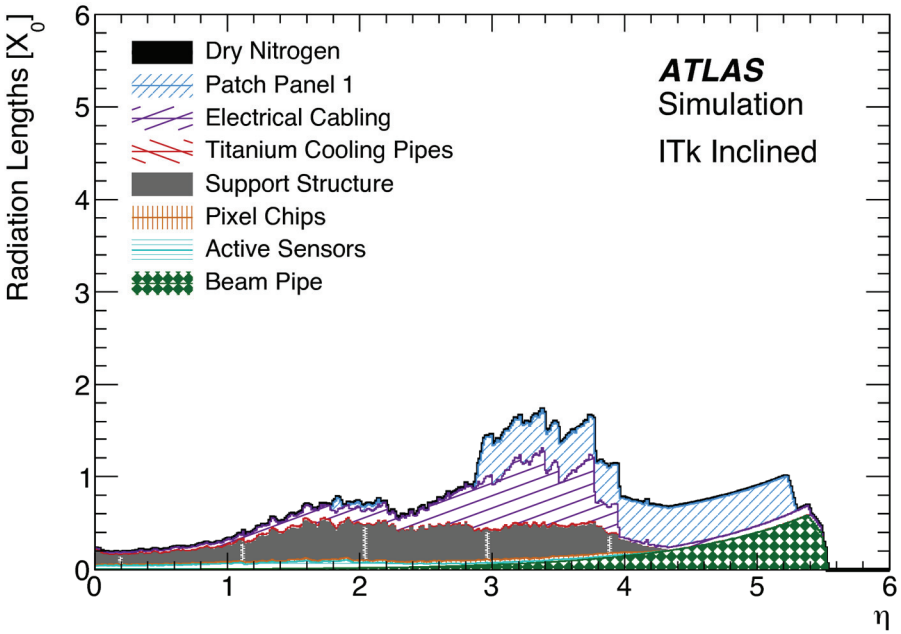


- End-cap: 6 disks with 32 petals
- 40,000 readout chips → cooling
- Open carbon support structure vs disks



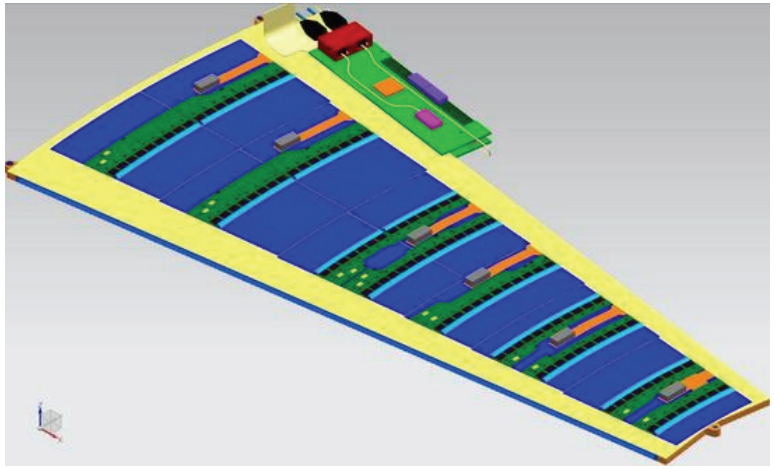
…towards 2026: material budget



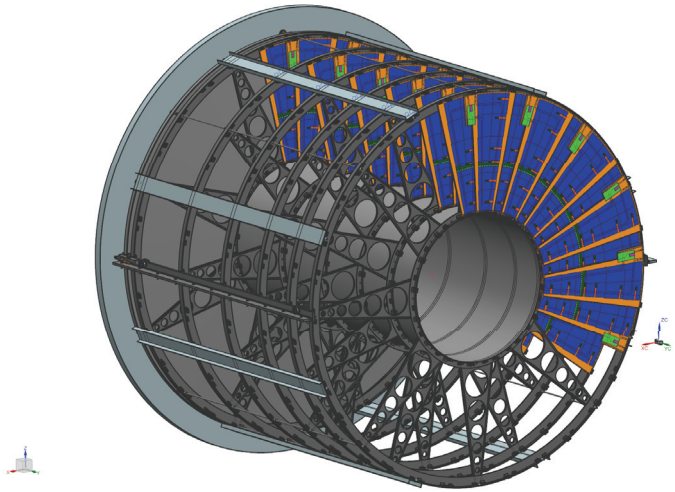


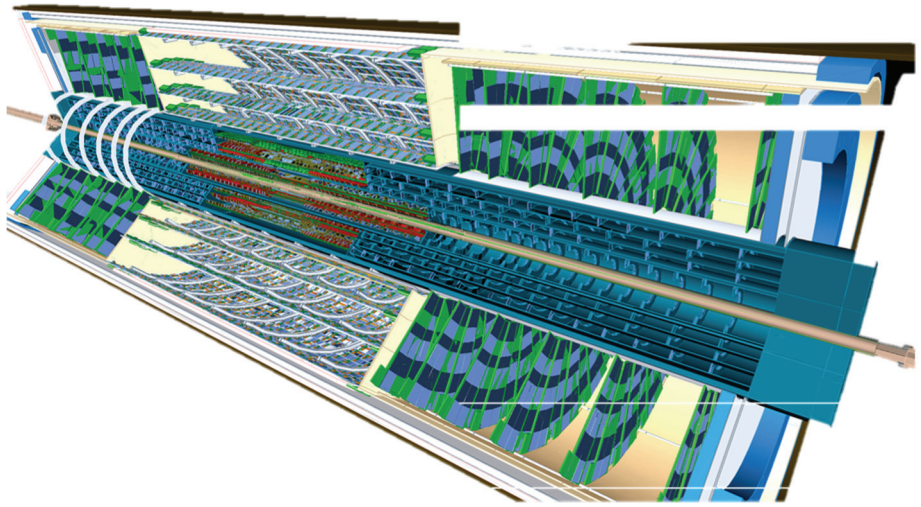
- Inner Detector (old):
  - Pixels
  - SCT (strips)
  - TRT (straws + foil)
- Inner Tracker (new):
  - Pixels
  - Strips

…towards 2026: build completely new Inner Tracker

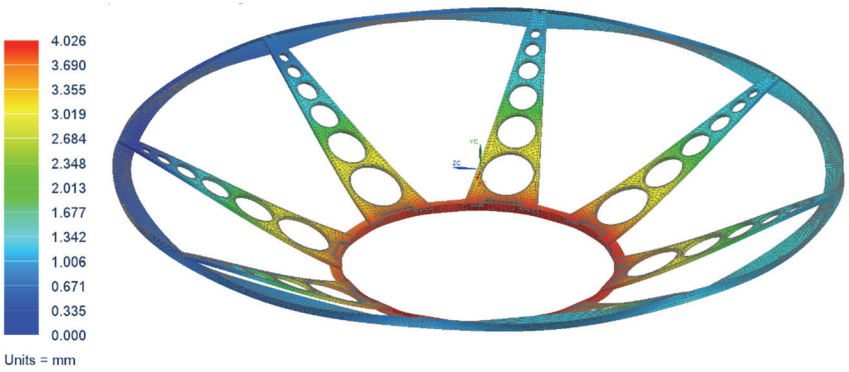


- n in p, 75 μm pitch, 1280 strips/unit
- 310 μm thick wavers
- End-cap: 6 disks with 32 petals
- 40,000 readout chips → cooling
- Open carbon support structure vs disks



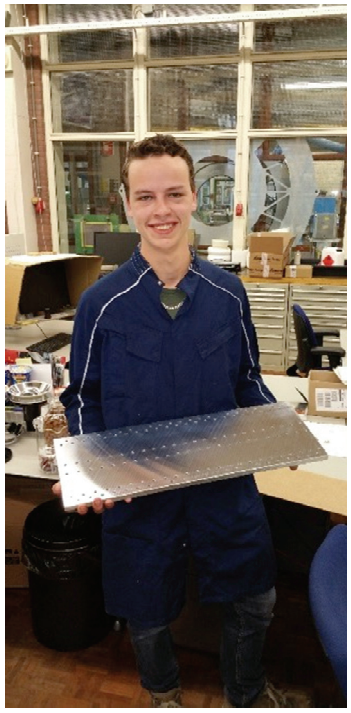


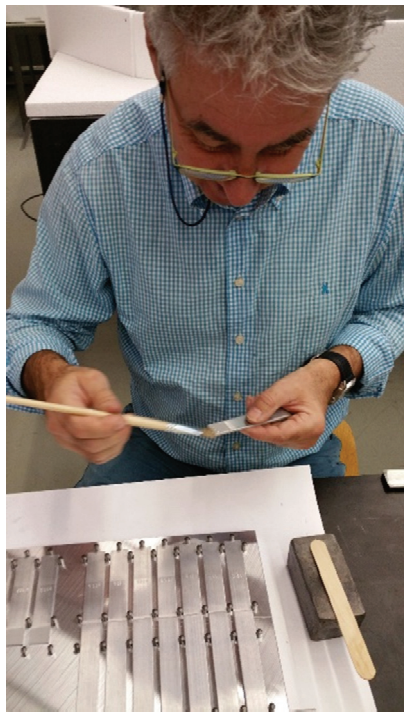
Open carbon petal support structure vs carbon disks



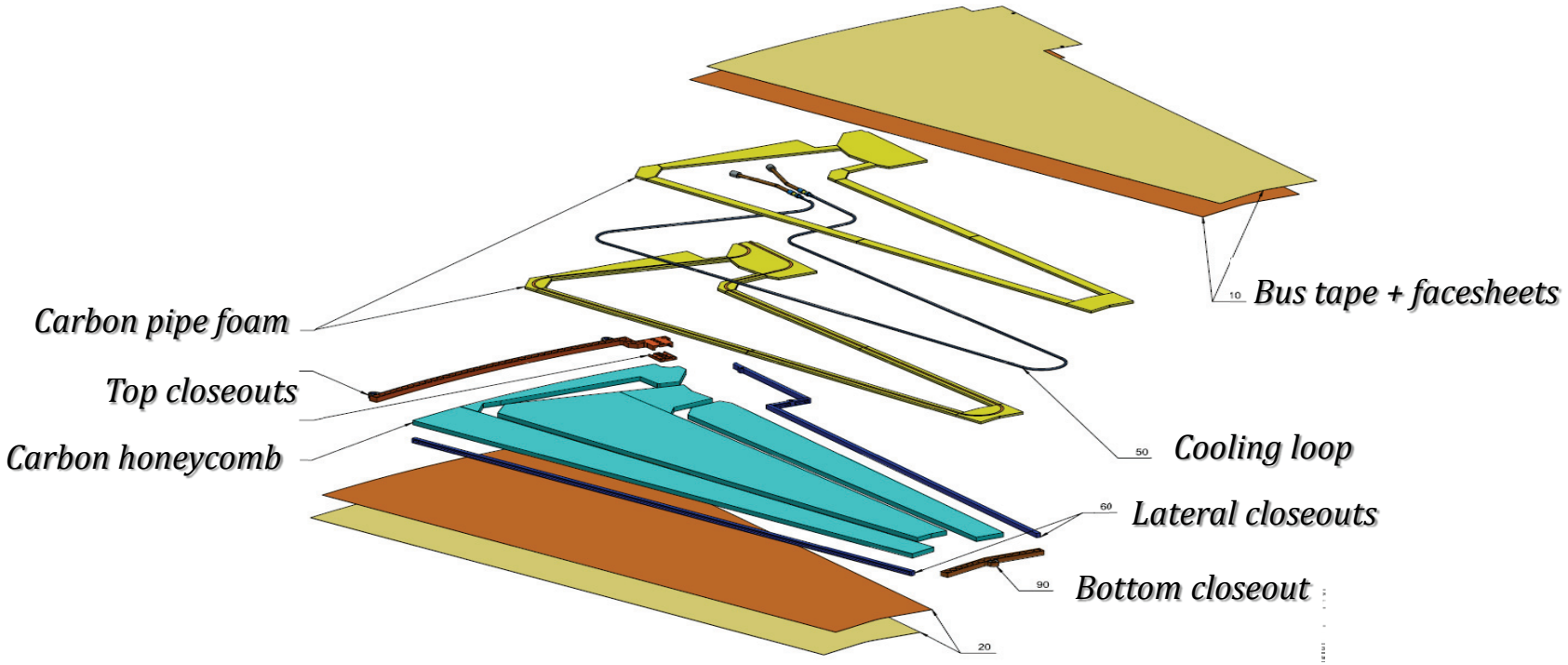
- Design petal support structure & validation

- Epoxy irradiation tests



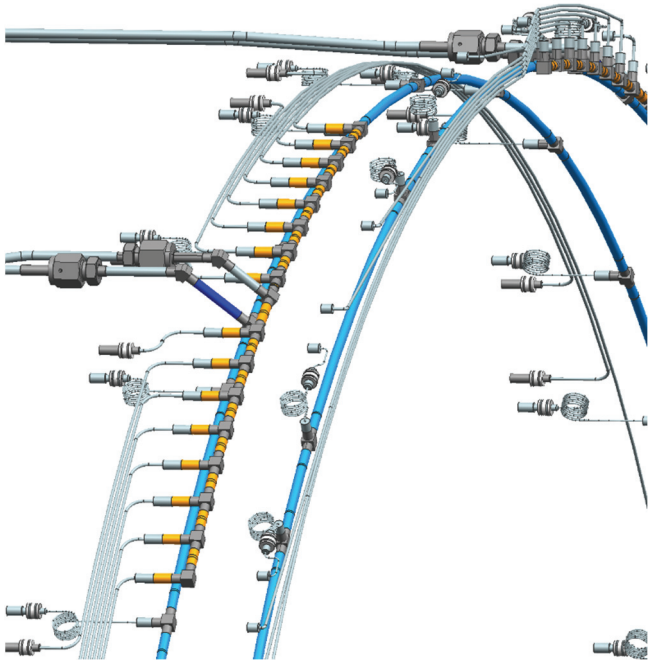


Petal sandwich structure with integrated cooling pipe

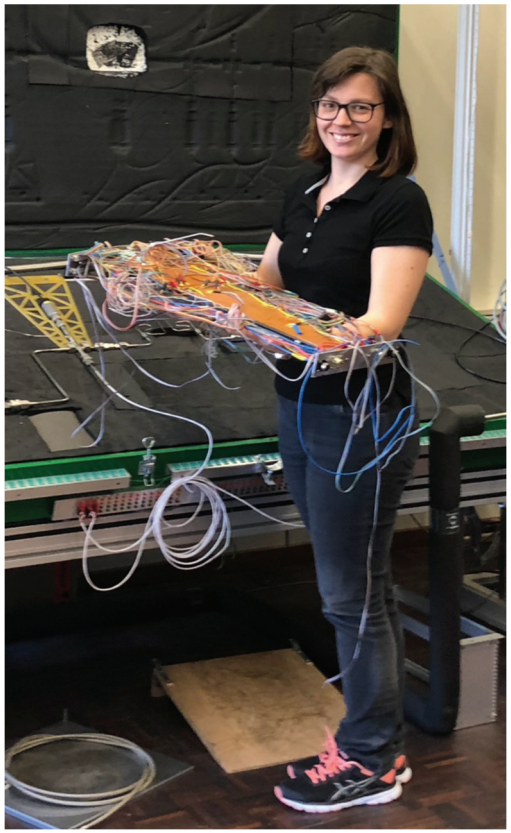


- Titanium cooling pipe connects to outer rim pipes (support structure)

Connecting cooling pipes from petals to manifolds

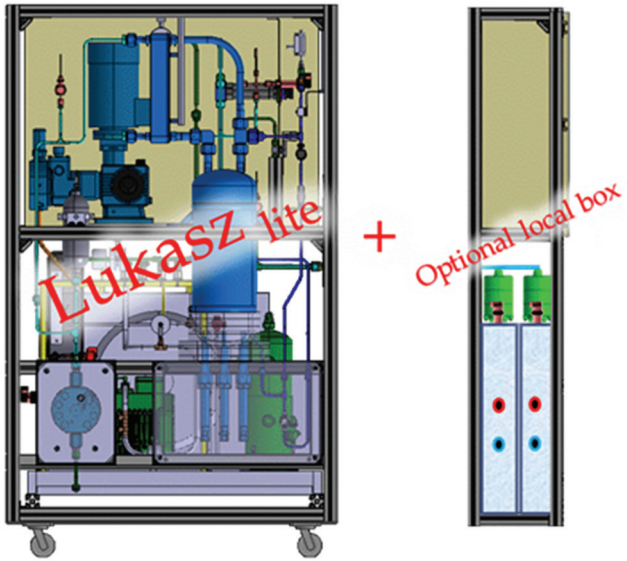


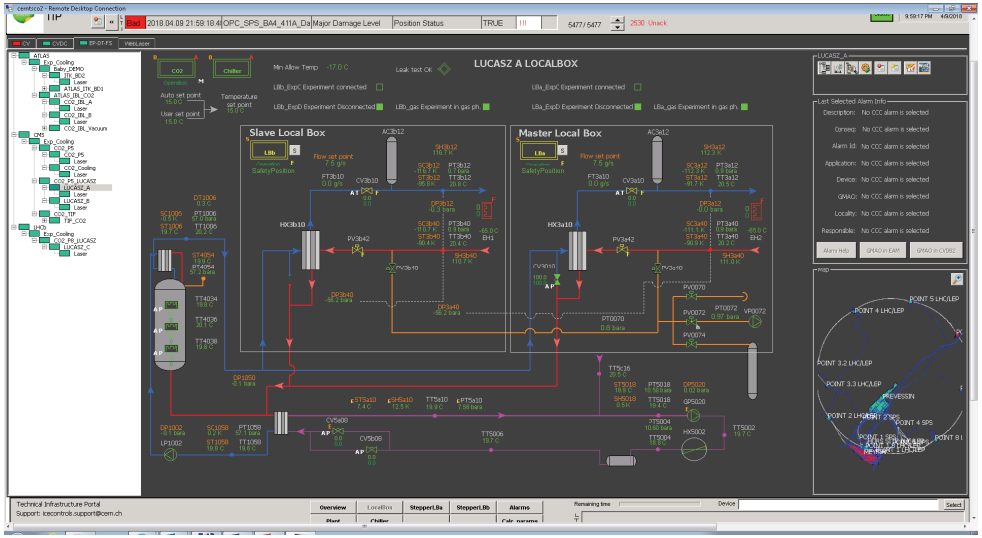
- Extensive cooling tests



- Cooling pipes from petals are connected to inlet and outlet manifolds at the outer rim

CO_2 cooling plant





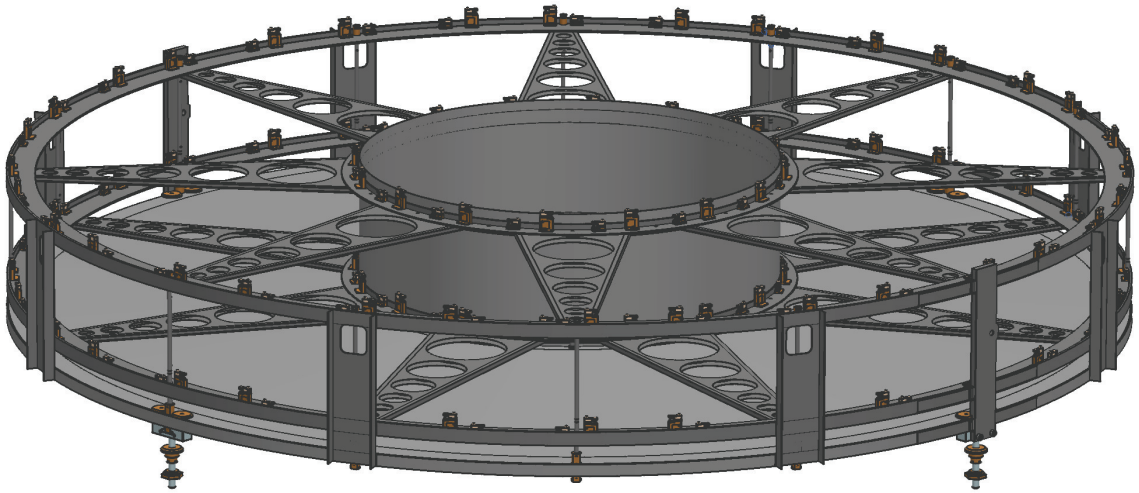
Can operate alone but requires expert user.
All regulations are manual.

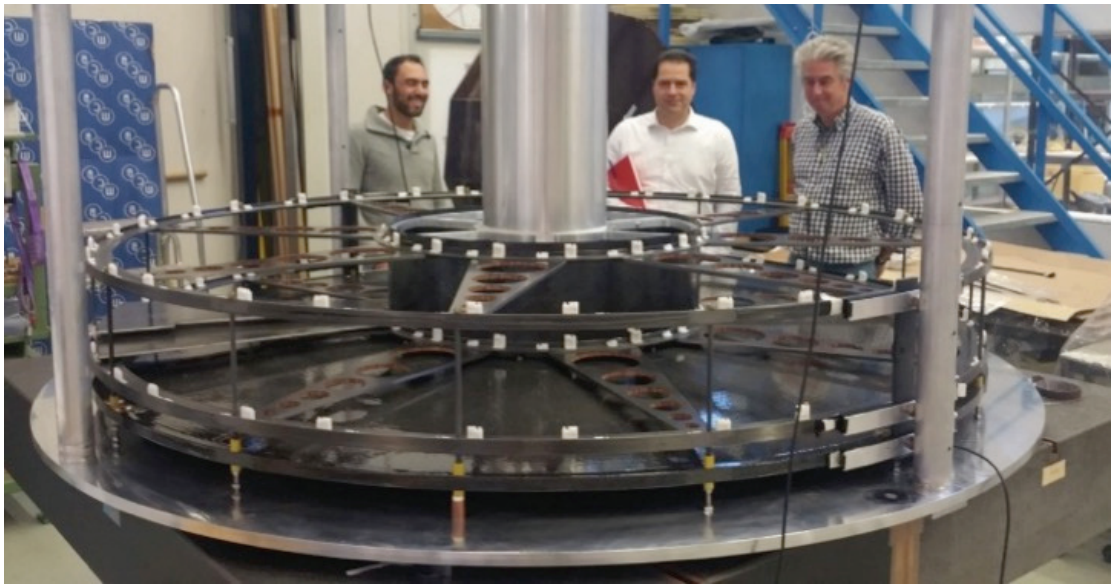
The local boxes contain all the control and automation part, making the units user friendly for non experts

09/04/2018 B. Verlaat 5

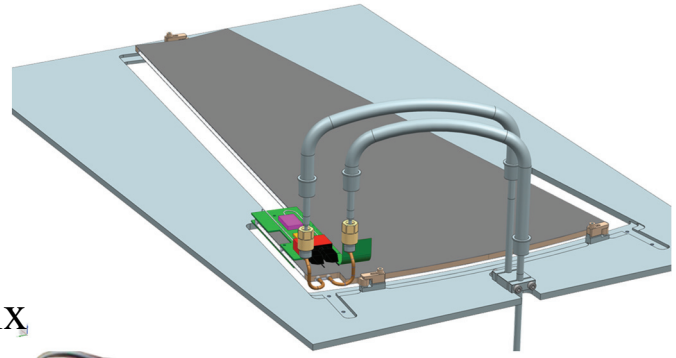
- 2 kWatt CO_2 cooling plant with remote control

Nikhef global support prototype

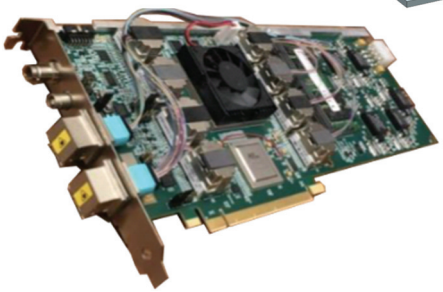




Petal reception test and end-cap assembly

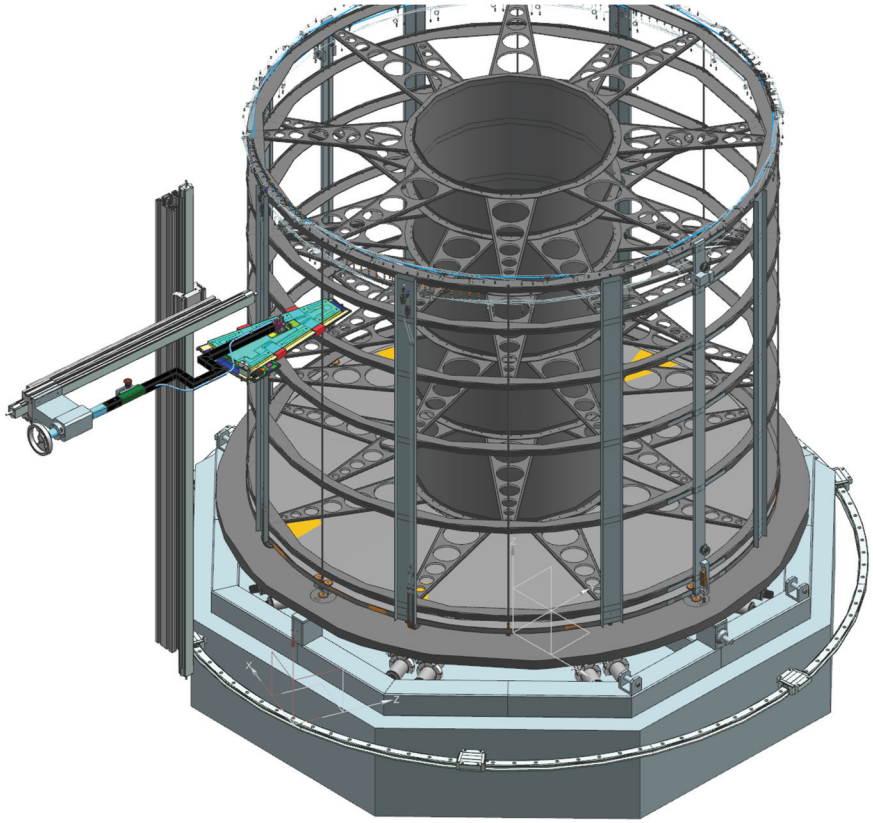


Felix

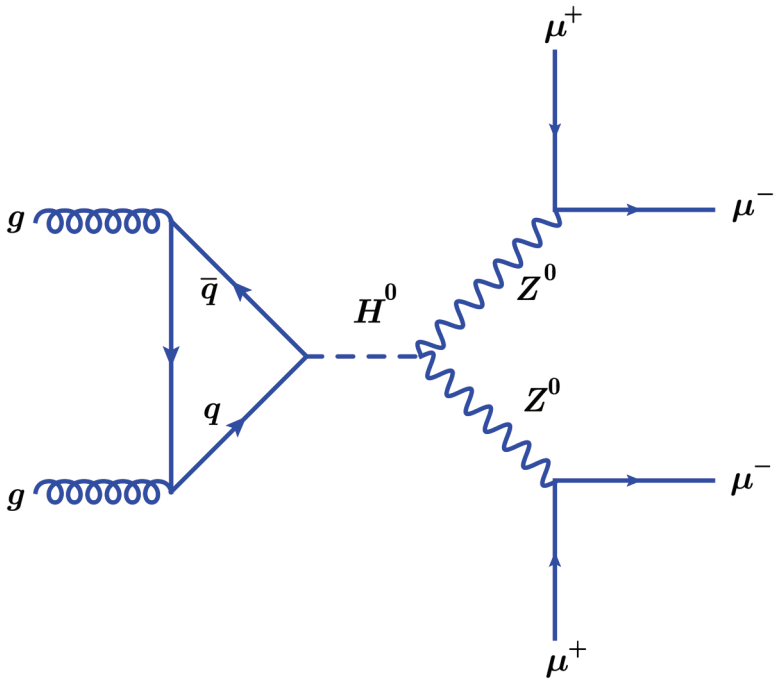


- Petal reception test:
  - DAQ
  - DCS
  - Cooling

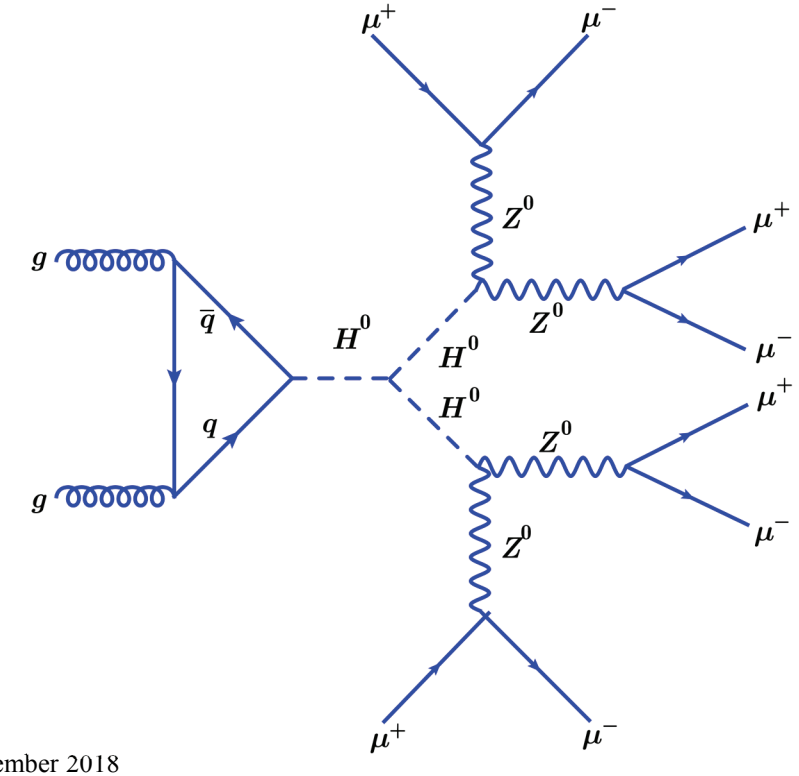
- Vertical assembly
- Robot petal insertion



From science fiction (1984) to science reality (2038?)



- ‘Golden’ event @ LHC



- Platinum event @ HL-LHC?