

ITk Strips Endcap module loading process: from modules to petals.

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The High Luminosity Large Hadron Collider (HL-LHC).

In 2026 the LHC will start the upgrade into the HL-LHC. After the shutdown the luminosity of the LHC will increase up to 10 times. Higher luminosity will produce more collisions, leading to potentially generate more rare process. However, more collisions will also create more pile-up leading to harsher radiation conditions and higher occupancy conditions on the current detectors. Therefore, the detectors will undergo an upgrade programme being the innermost parts of the detectors the central part of the upgrade.



Approximate pile-up of 40.

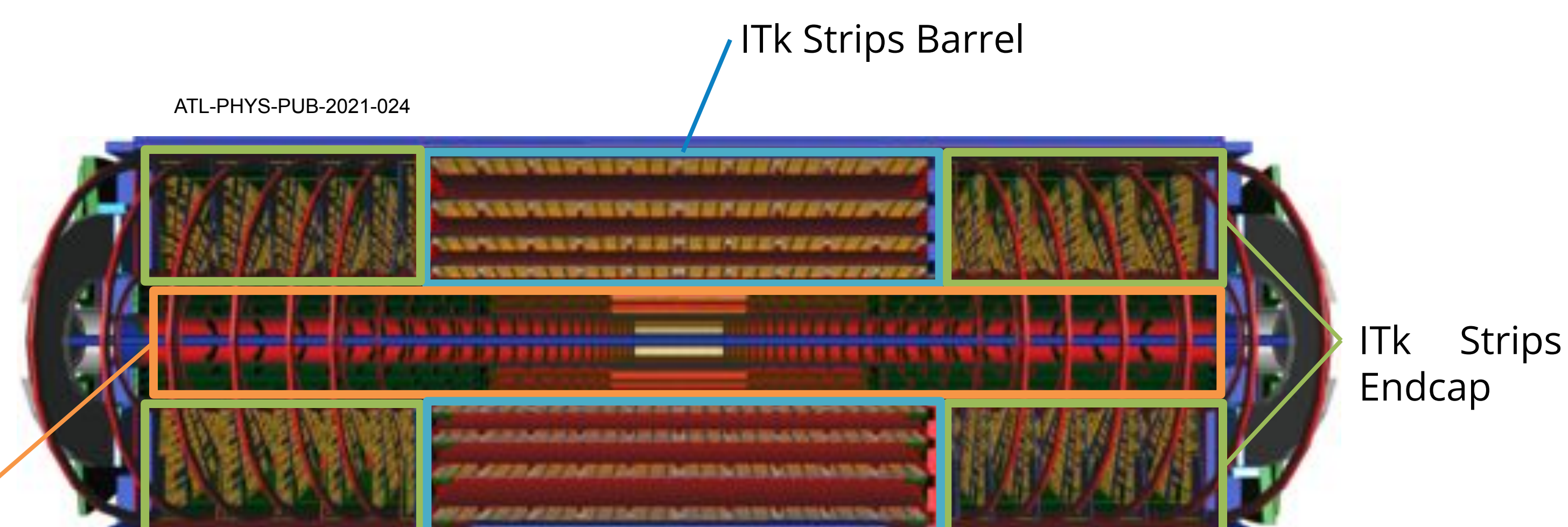


Approximate pile-up of 200.

Talk in XLIX International Meeting on Fundamental Physics by Arantxa Ruiz.

The upgrade plan for ATLAS: The ITk.

The trackers are the more sensitive detectors to the new conditions created as they are the closest ones to the interactions points. In the ATLAS case, the current tracker composed of different technologies (IBL, Pixels, TRT and SCT) will be replaced by the new inner tracker (ITk) fully based on silicon.

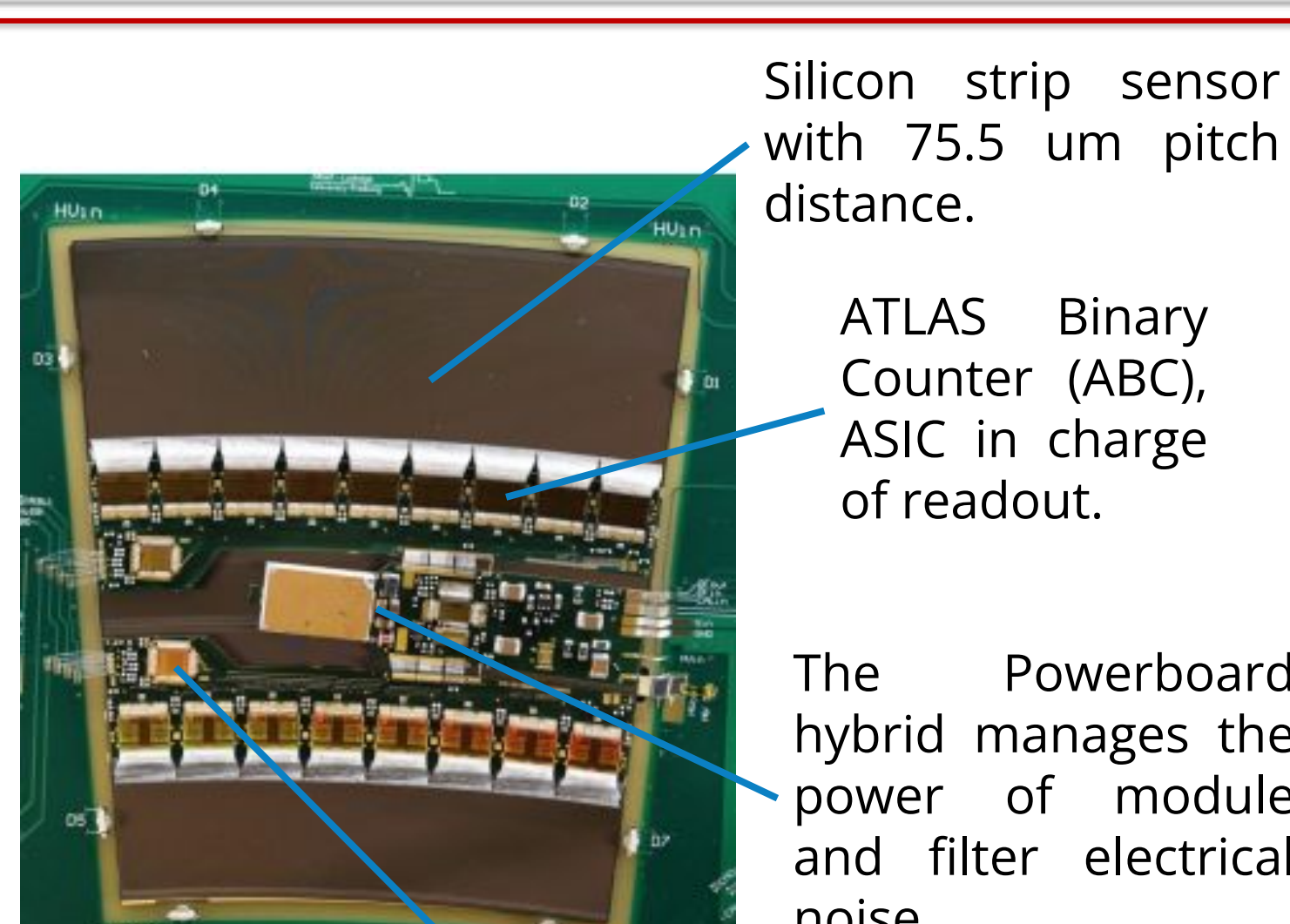


ITk Pixels covers the innermost regions as it can deal with the highest occupancy conditions and harsher radiation

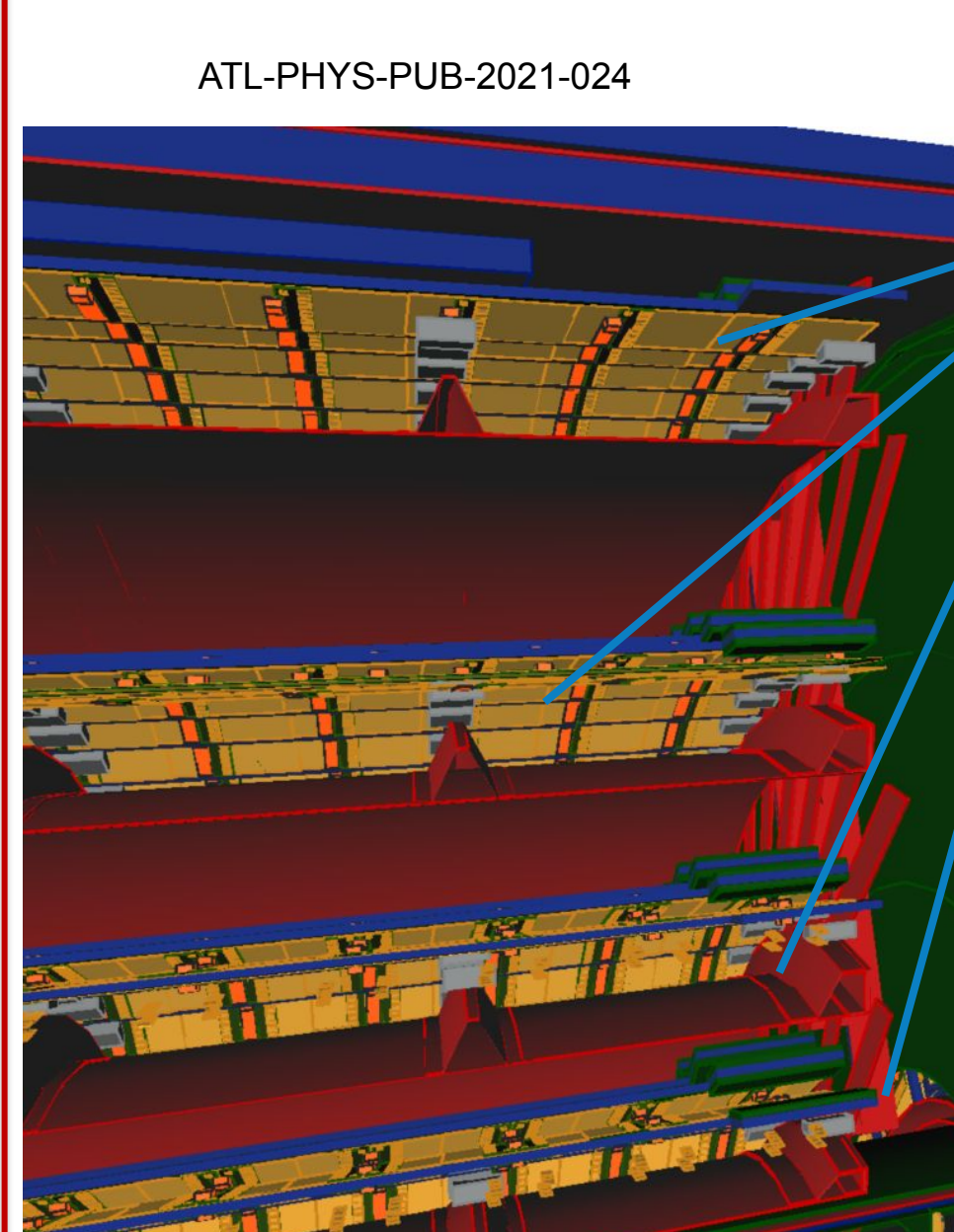
ITk Strips.

The ITk Strips subdetector is divided in two regions: the Barrel and the Endcaps. The barrel covers the sides of the solenoid while the endcaps are the face of it.

For both regions the fundamental units of detection are the modules. A 320 μm silicon detector with the frontend electronics, known as hybrids, glued on top. The modules are glued into a local support structure that provides power and cooling.



Strips Barrel.



4 layers of staves, for a total of 392 staves.

End of sub-structure (EoS) is in charge of controlling the powering and the data transfer.

Each stave holds 28 modules, 14 per side. For a total of 10976 modules.

Stave core made of carbon fiber and kapton bustape co-cured.

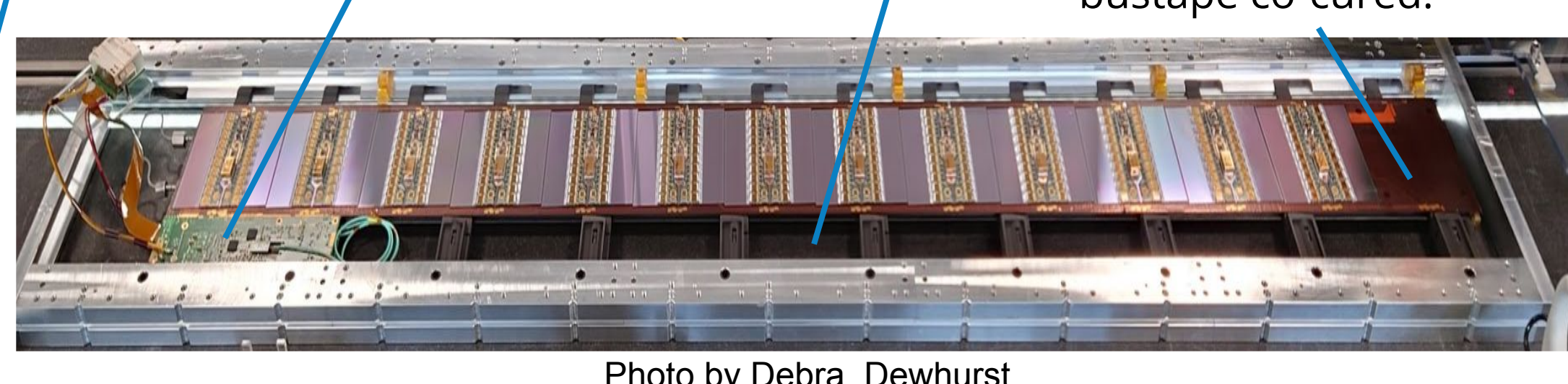


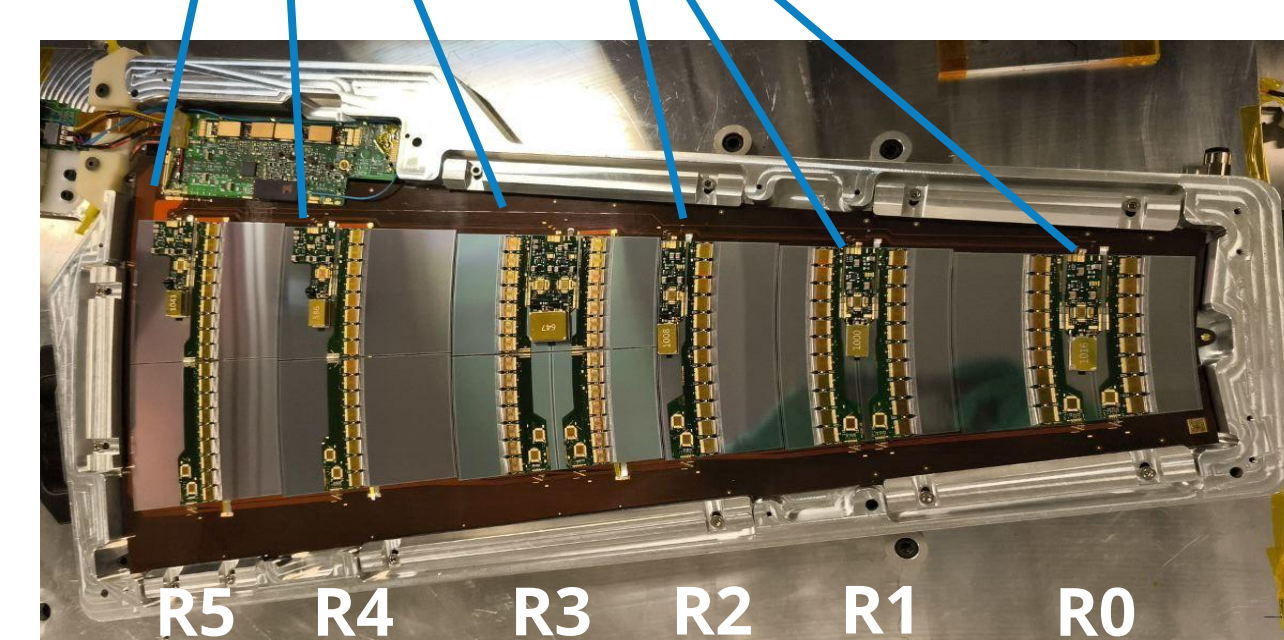
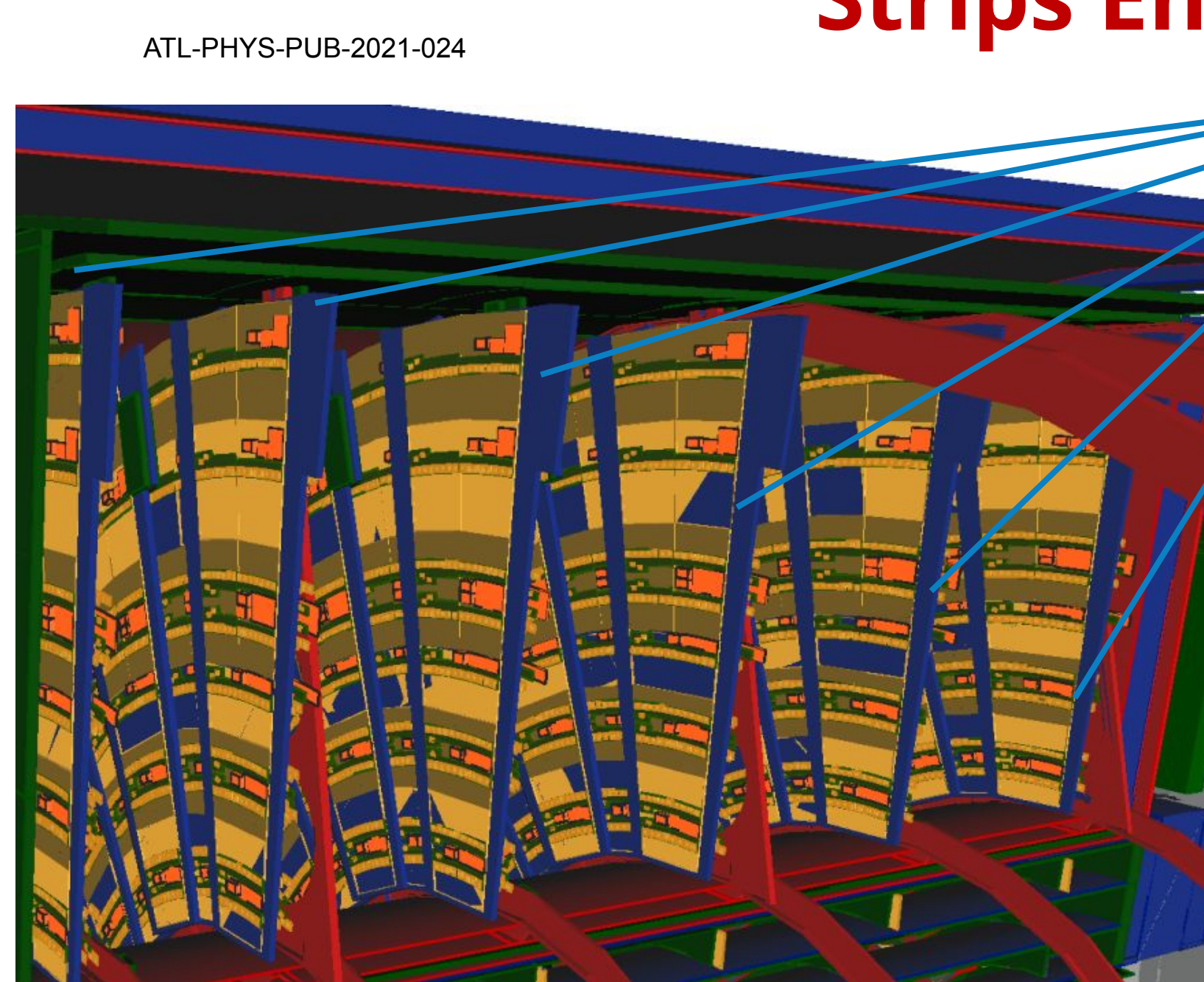
Photo by Debra Dewhurst

Strips Endcap.

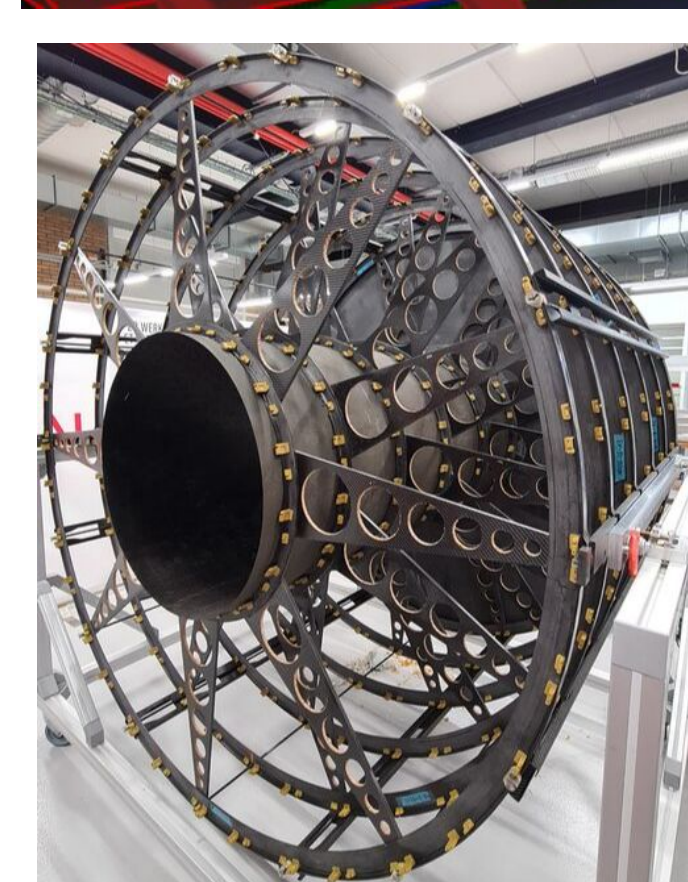
6 Disks per Endcap, 32 petals per disk. 384 petals and 4608 modules (6912 sensors).

Outer rings, double sensor modules.

Inner rings, one sensor modules.



Petal loaded at IFIC.

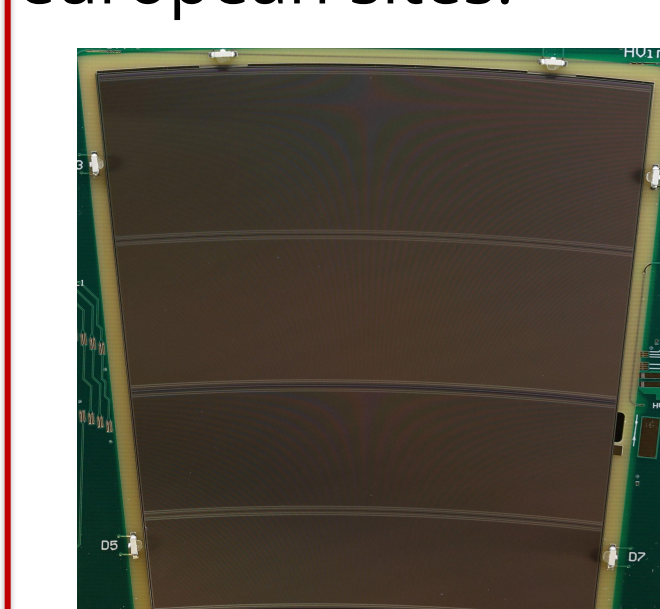


Endcap structure at Nikhef. The petals will start arriving in 2026 for the integration on the structure. Photo by Andrea García Alonso.

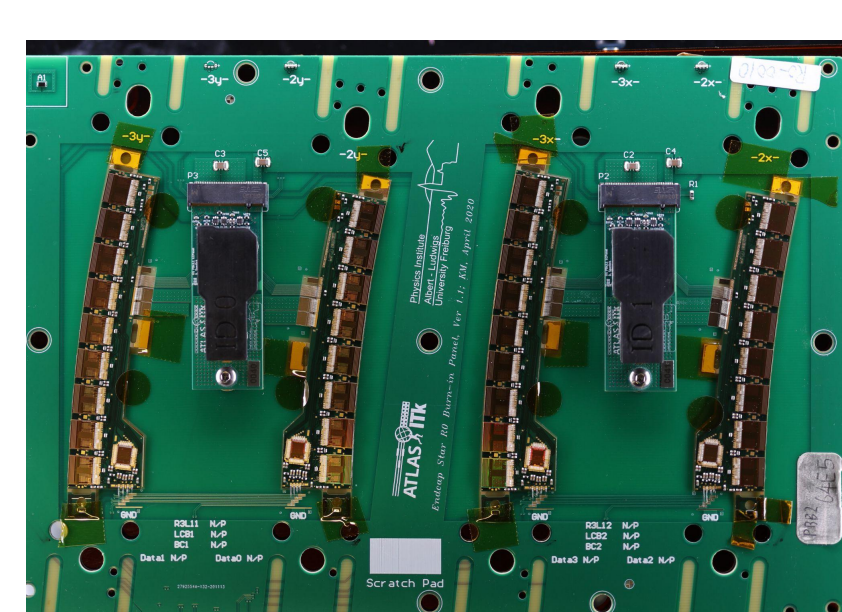
During the years the IFIC ITk team has contributed to designs and prototypes of different parts of the detector. The three main areas the IFIC has contributed to are modules, petals and services, including key designs like sensors, petal core and patch panels. Currently, IFIC is involved in the production of ITk as one of the main european sites.

Module production.

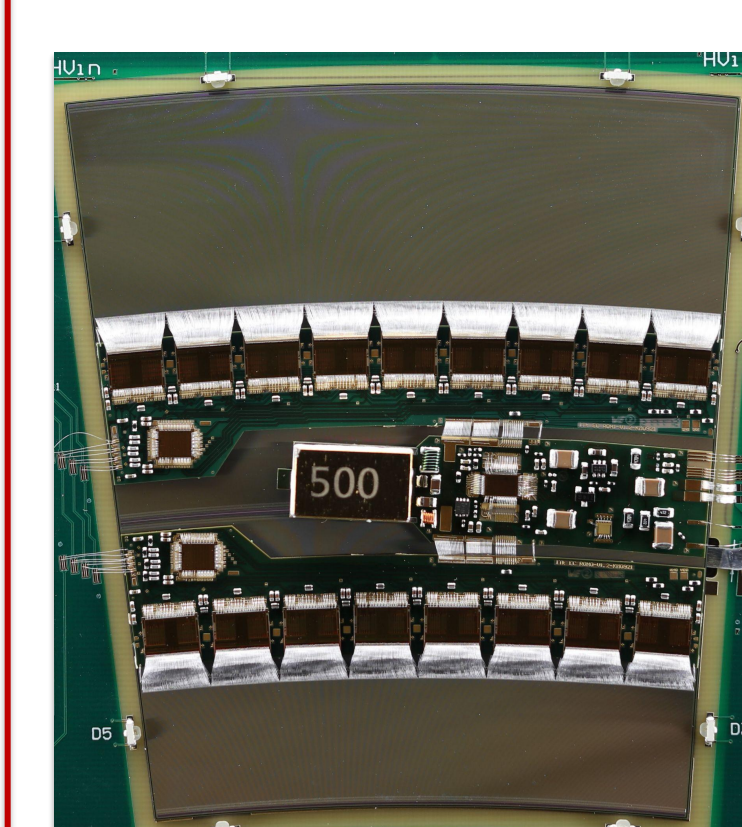
At IFIC, R0 and R5 modules are produced while the other modules types are received from other european sites.



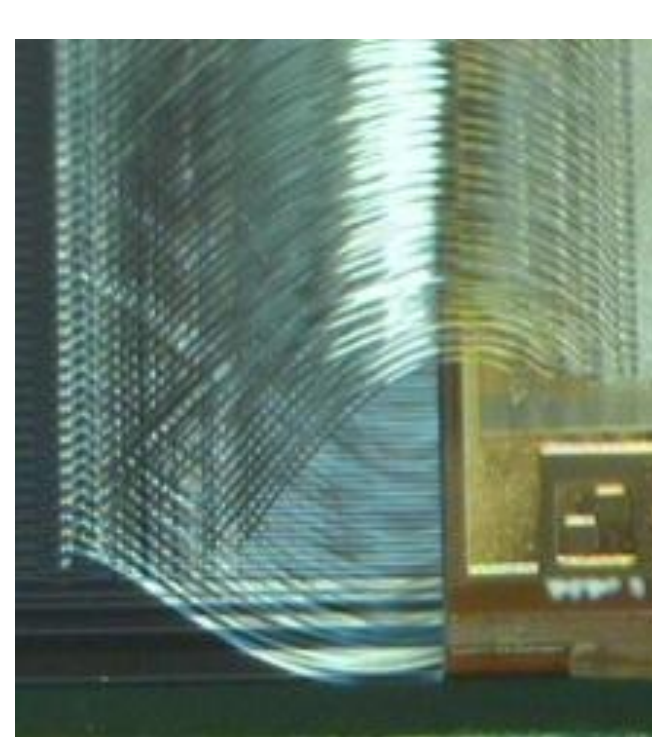
Bare sensor.



The hybrids are glued on the sensor using a radiation hard glue.

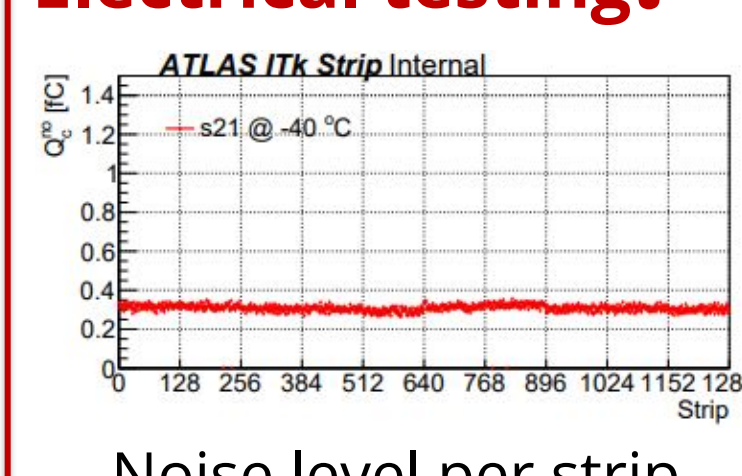


Finished module.



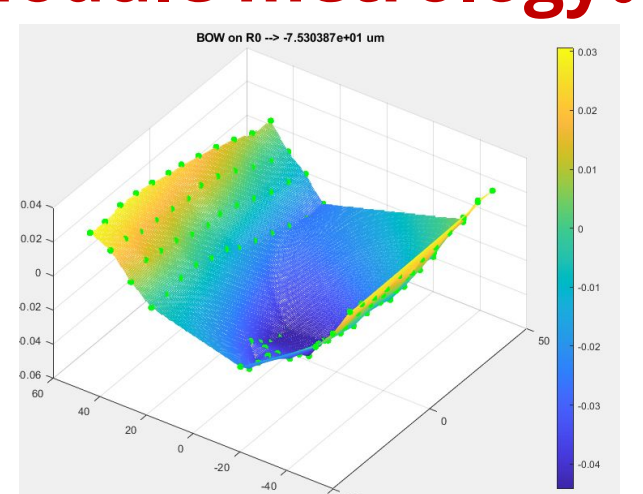
ABC wirebonds.

Electrical testing.



Noise level per strip.

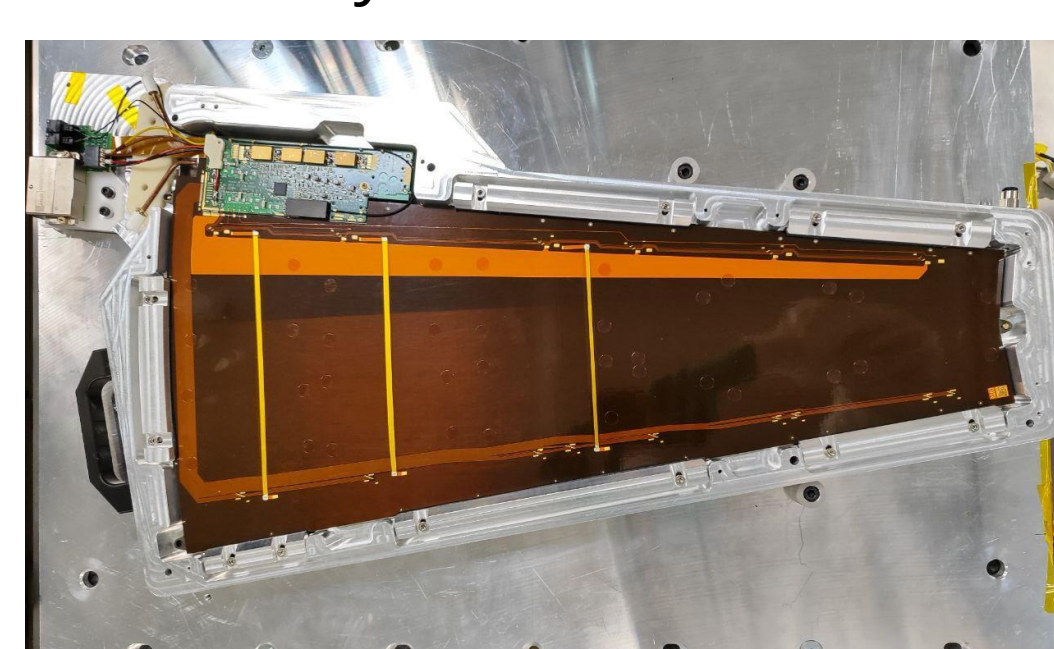
Module metrology.



Module metrology.

Petal production.

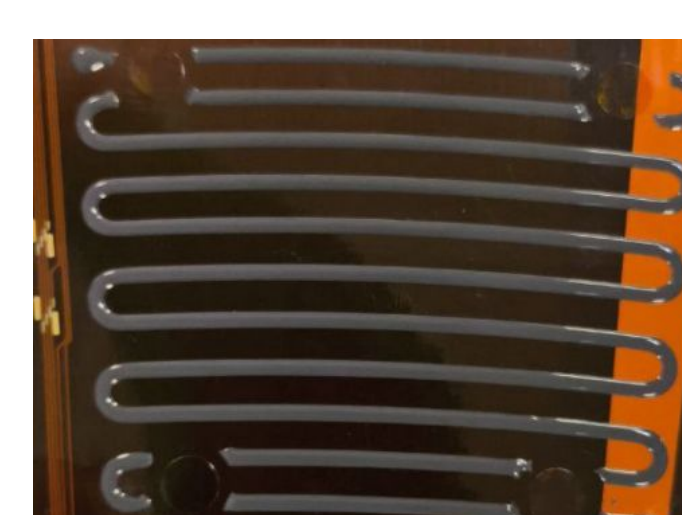
IFIC is a petal loading site, where modules are glued on petals, the petal loading requires a 4-axis computer controlled machine by Alio that holds and controls different tools.



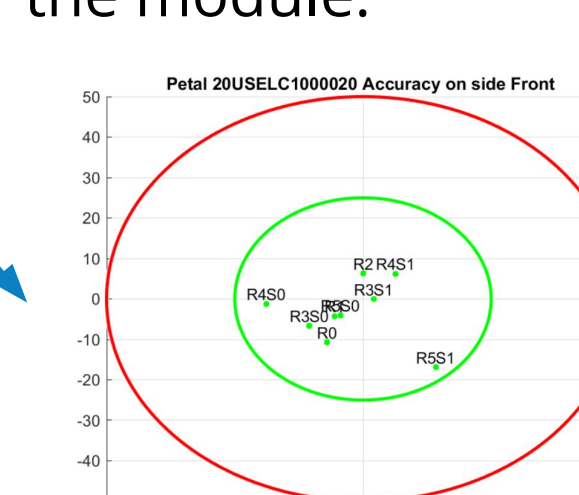
Petal core ready for module loading after the core has passed the testing process, the EoS, the DC-DC and the optic fibers has been installed as well as the core metrology has been carried out.



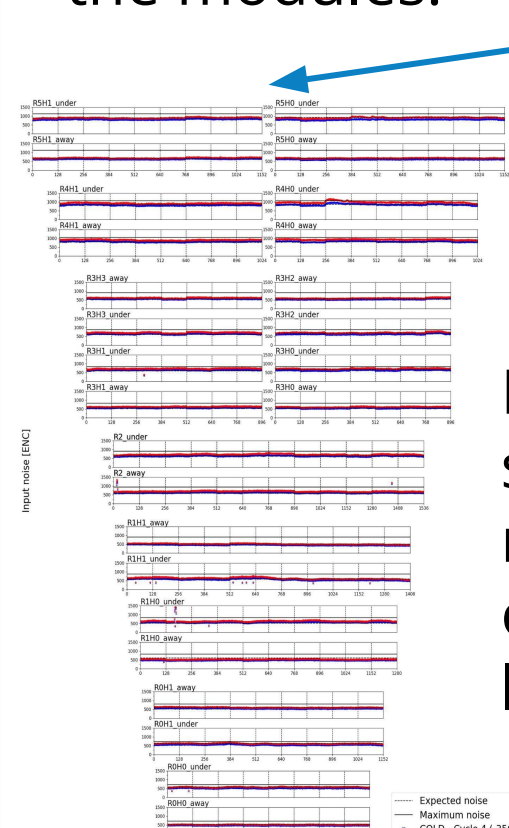
Fully loaded petal during glue curing. The pick and place tools used for module loading can be seen on top of the modules.



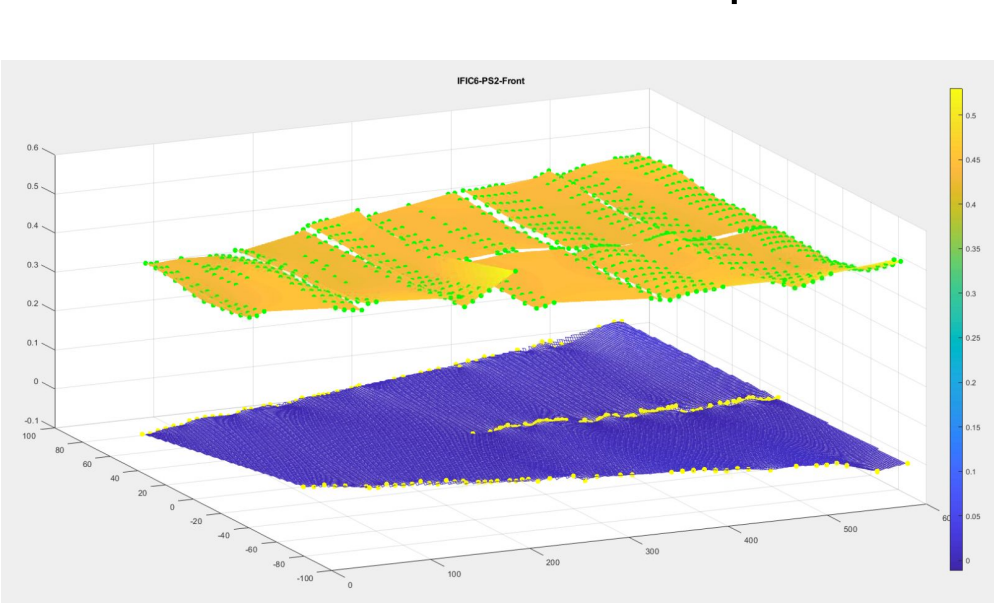
Glue pattern optimised for maximum support for the module.



Module placement accuracy within the 50 μm requirement.



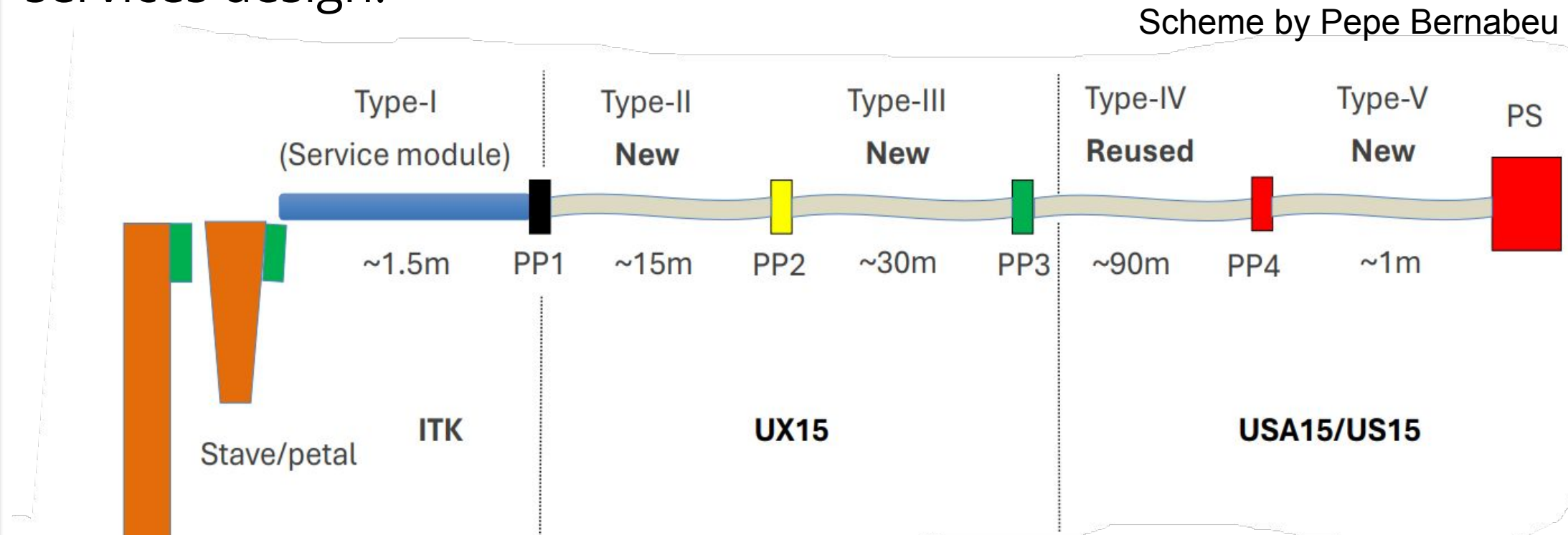
Racket plot showing the noise per strip of a fully loaded petal



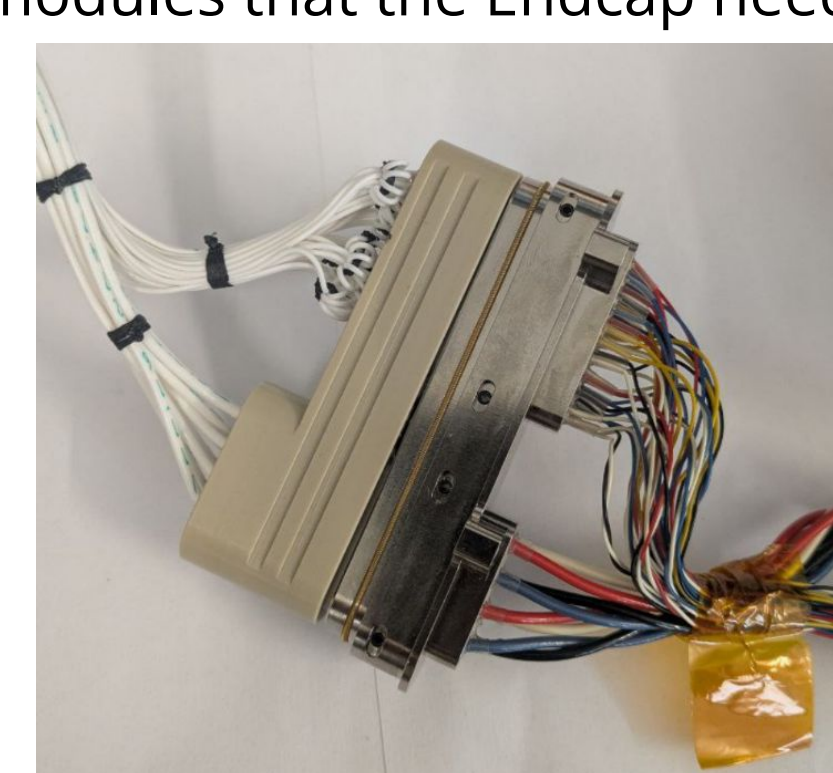
Petal metrology after loading.

Services.

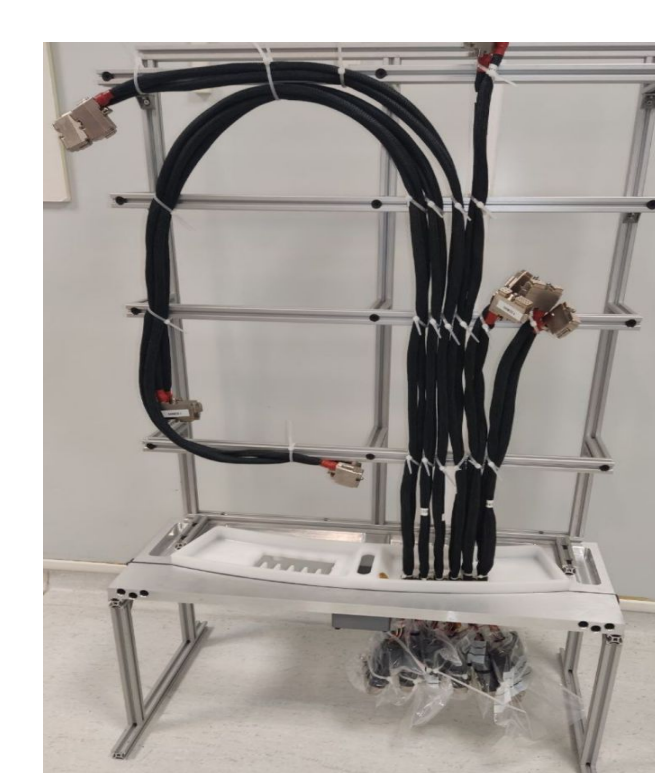
IFIC has also contributed to the on-detector and off-detector services design.



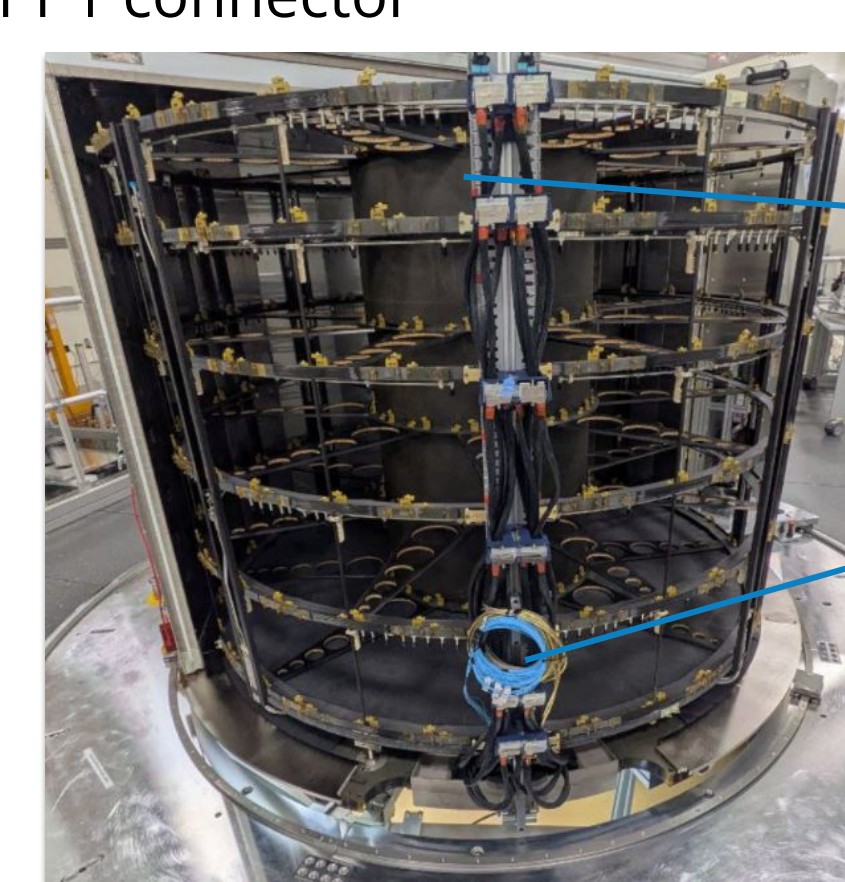
The ITk powering scheme starts in the cabins outside of ATLAS, from there the specific designed cables and patch panels take the high voltage and low voltage to the petals and staves. IFIC has produced the 16 services modules that the Endcap needs.



PP1 connector



PP1 built at IFIC



Cable connector to a petal.

Optical fiber for data transfer.

Endcap structure at DESY with the PP1 built at IFIC installed.

Photo by Pepe Bernabeu

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