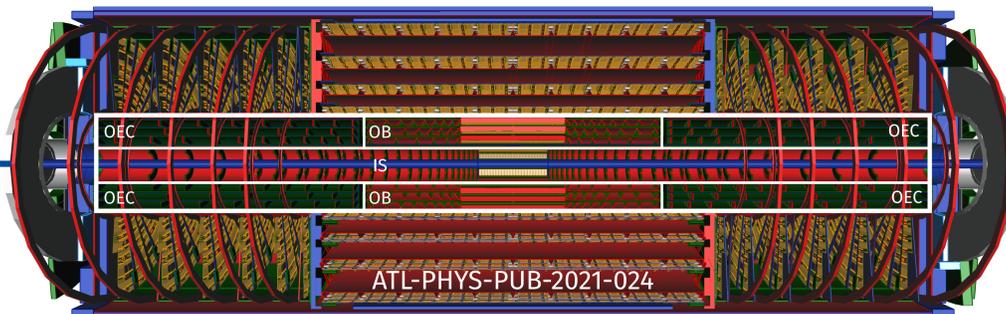




# Development and Evaluation of Prototypes for the ATLAS ITk Pixel Detector

A new Inner Tracker for the ATLAS detector

at the High-Luminosity Large Hadron Collider

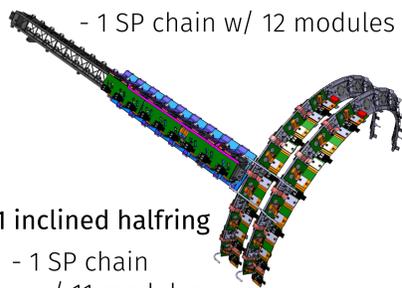


## About the ITk:

- Novel all-silicon tracker to replace the ATLAS inner detector for the HL-LHC (~2027)
- Increased coverage up to  $|\eta| \leq 4$
- Lower material budget e.g. due to serial powering (SP) scheme and CO<sub>2</sub> cooling
- 5 innermost layers will consist of pixel detectors
- Need an intermediate step between individual modules and a full detector  $\Rightarrow$  local support prototypes (staves and rings)

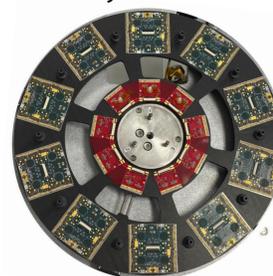
### Outer Barrel (OB)

- 1 longeron:
  - 1 SP chain w/ 6 modules
  - 1 SP chain w/ 12 modules
- 1 inclined halfring:
  - 1 SP chain w/ 11 modules



### Inner System (IS)

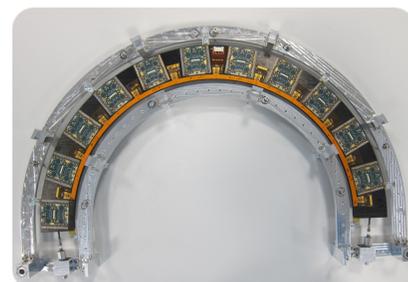
ring prototype w/ fully loaded side



Outer ring: planar pixel modules  
Inner ring: 3D pixel modules

### Outer End-Caps (OEC)

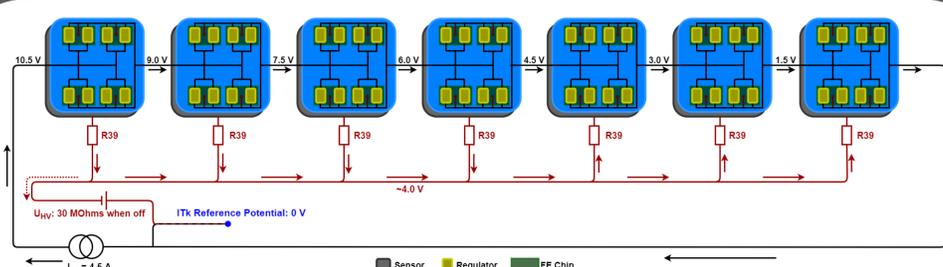
ring prototype



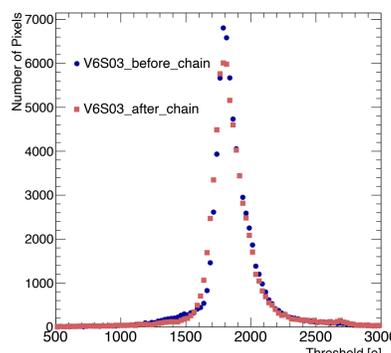
one side fully loaded

## Serial powering

ATL-ITK-PUB-2022-002



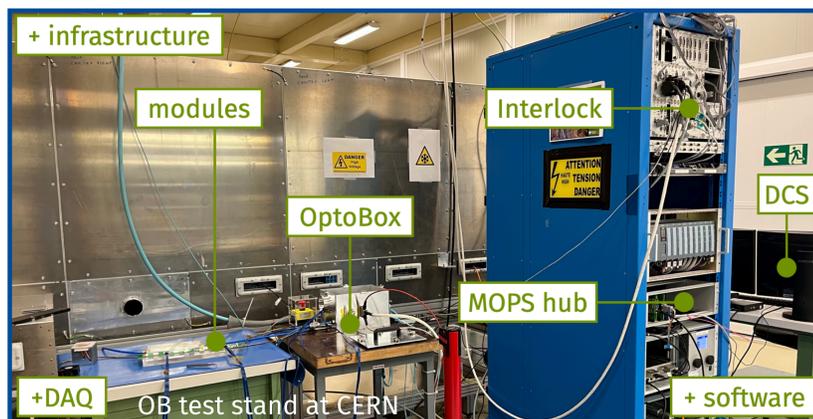
- Readout ASICs (front-ends) are serial powered, but the sensors will be connected in parallel to a common bias voltage line
- Some sensors will receive a small forward bias due to the high-ohmic off mode of the HV power supply, which leads to small currents between the sensor backside and the readout ASIC, esp. when sensors are irradiated
- Studies show this feature does not lead to damages on the front-ends



Add. system test stands exist for general SP chain studies with pixel modules

## Ongoing OB pre-production tests

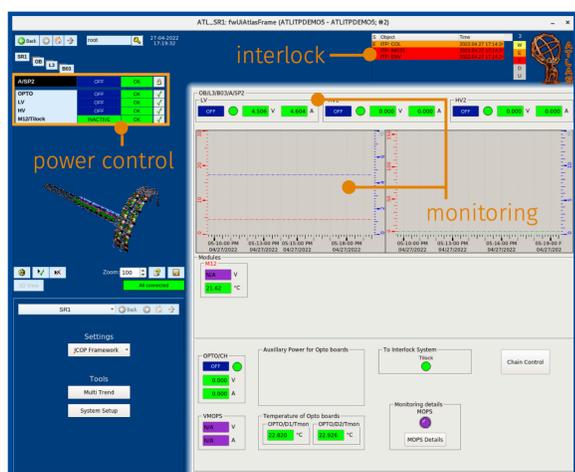
- Development of the necessary infrastructure, e.g. browser-based GUI to control the full DAQ chain, interlock matrix, detector control system, ...
- Built a realistic power and DAQ chain and read out modules successfully



- Support structures currently being loaded with modules

## Detector control system (DCS)

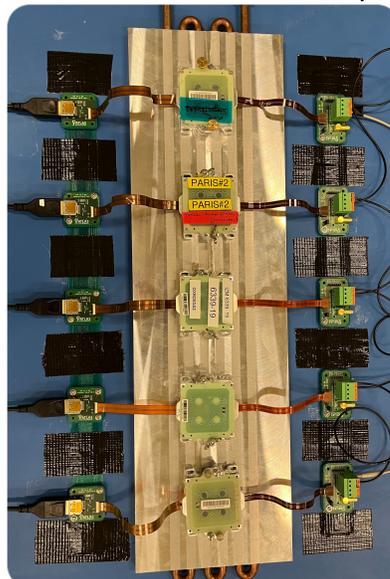
Diagnostics, control, feedback and safety handled by a central (WinCC-based) system



- Input e.g. from on-detector ASICs (MOPS) that monitor voltages and temperatures
- Interlock system to ensure safety of prototypes and operators

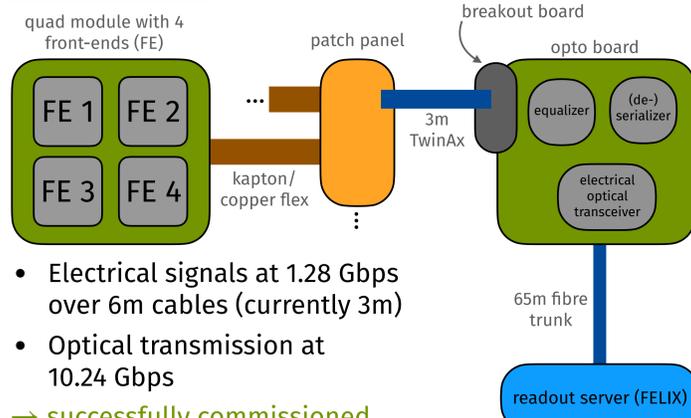
## Data acquisition (DAQ)

### multi-module DAQ setup



[Display Port and SMA instead of TwinAx cables]

### Readout chain:



- Electrical signals at 1.28 Gbps over 6m cables (currently 3m)
- Optical transmission at 10.24 Gbps

$\rightarrow$  successfully commissioned important tool for DAQ development

