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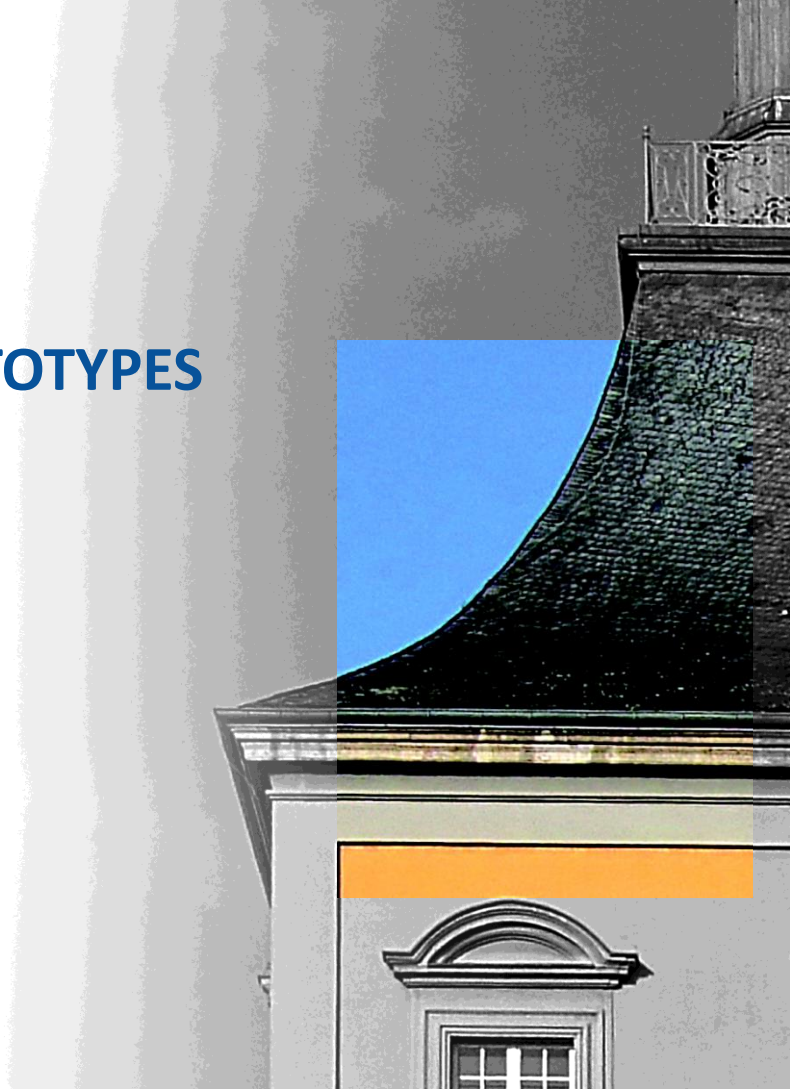
ATLAS EXPERIMENT

DEVELOPMENT AND EVALUATION OF PROTOTYPES FOR THE ATLAS ITK PIXEL DETECTOR

FLORIAN HINTERKEUSER ON BEHALF OF THE ATLAS COLLABORATION



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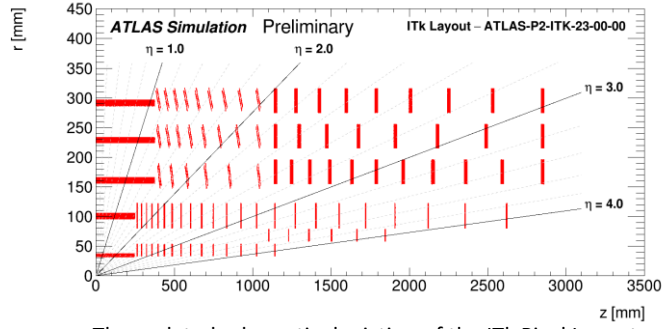
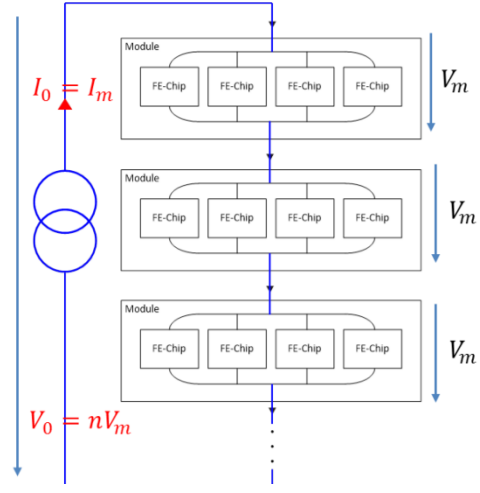
ATLAS PIXEL UPGRADE

- New all-silicon ATLAS inner detector for HL-LHC: ITk
  - Same volume as current tracking detector
  - Pixel and Strips
- Pixel detector consists of multi-chip modules
  - Quad modules (4 chips on 1 large sensor) and pseudo triplets (3 single chip modules on shared flex PCB)
- One design goal: Excellent performance with minimal material budget
- Use a serial powering scheme
  - Modules powered by constant current, voltage generated by on-chip voltage regulator (Shunt-LDO)
  - New powering scheme: requires extensive prototyping



The updated schematic depiction of the ITk Pixel Layout



Simplified schematic of the serial powering scheme used for the ITk pixel detector

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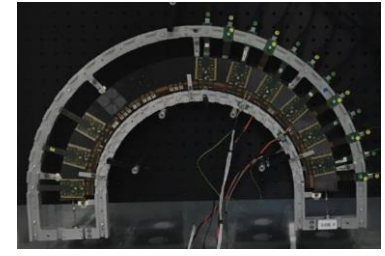
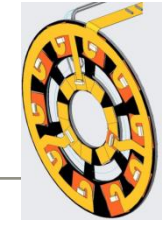
ITK PIXEL PROTOTYPING

- Prototypes for the different subsystems Inner System (IS), Endcaps (EC) and Outer Barrel (OB) to cover mechanics, electronics and integration
- Prototyping with FE-I4b modules yielded valuable input for system design, integration and further developments of the new readout chip generation (RD53A)
  - Chain length of up to 16 modules prototyped
- Large scale prototypes with RD53A modules are in early development stages

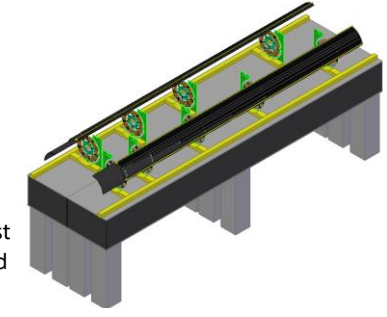
Populated half cooling line during OB demonstrator integration



Ring-0 prototype for the EC, fully loaded quadrant on a half ring



R0/1 coupled ring for the inner endcaps. First prototype to be loaded with RD53A modules



Integration concept for the inner endcaps.

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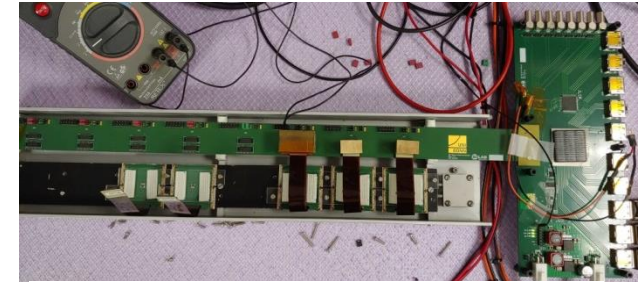
SERIAL POWERING PROTOTYPING

- Requirements to **further develop Shunt-LDO** voltage regulator based of ITk pixel prototyping
  - **New features added**: Input voltage clamps, overload protection and a low power mode for testing during integration without cooling
  - **Design and features verified**, radiation hardness proven in several X-ray campaigns
- Studying of low-level system aspects in **serial powering chains** with current generation readout chips **(RD53A)**
  - One of several existing setups: serial powering chain for **up to 16 quad modules** in Bonn
  - First results very promising, RD53A module **performance as expected**

A Shunt-LDO prototype chip for the ITkPixV1 readout chip used to verify the improved design



A serial powering chain prototype loaded with digital RD53A quad modules (without a sensor)