PAUL SCHERRER INSTITUT

PSI

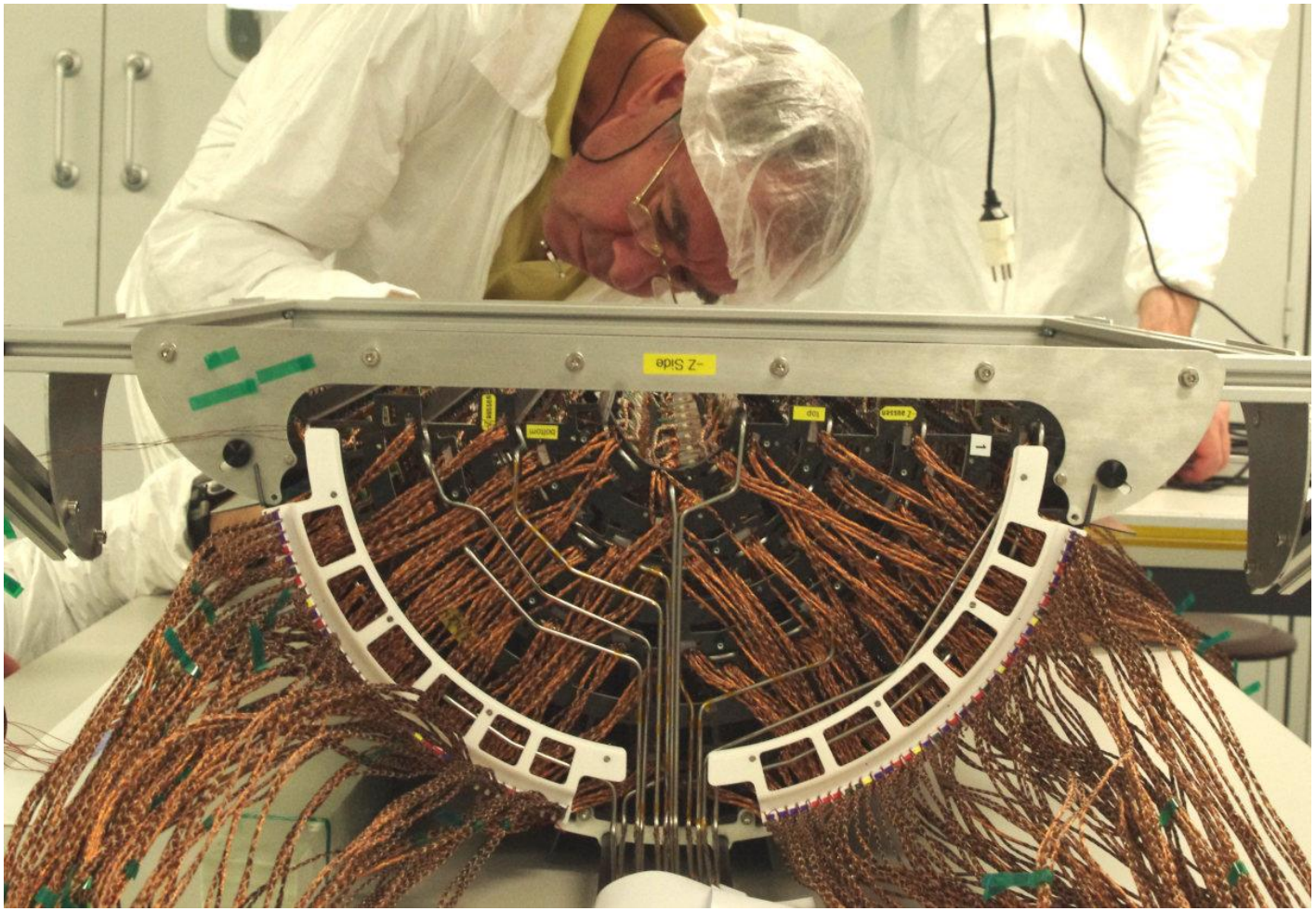
Beat Meier :: Chip Design Team :: Paul Scherrer Institut

Readout Cables Inside Detector Mu3e Integration Meeting

19/20. May 2018

CMS Barrel Pixel Detector BPIX

Can we use the same type of cable for the Mu3e pixel detector?



CMS BPIX assembly with cables and cooling tubes (¼ detector)

BPIX vs. Mu3e Pixel Cabling

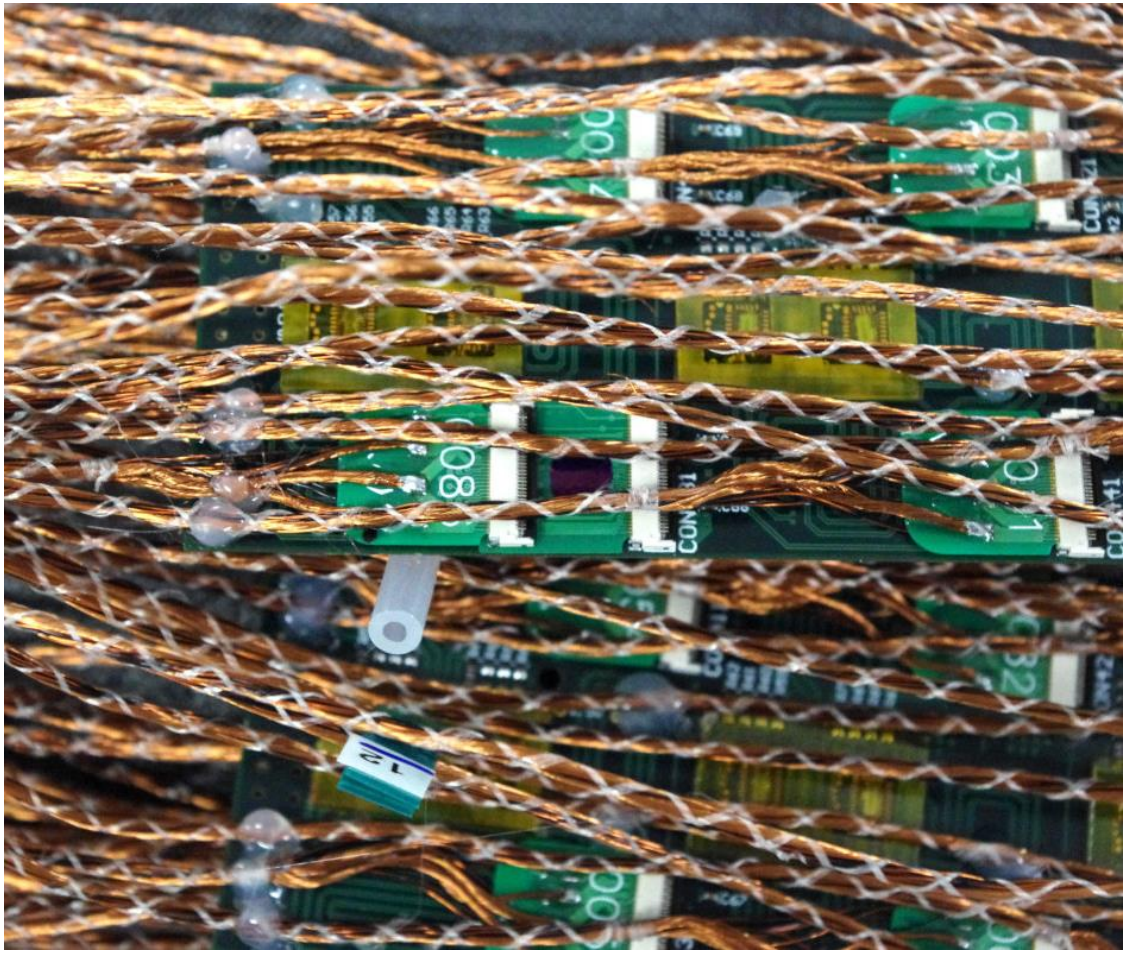
Similar requirements

- low mass
- limited space
- cable length 1m
- high speed data transfer

BPIX: **400 Mbit/s**
without pre-emphasis

Mu3e: **1.25 Gbit/s**
with pre-emphasis

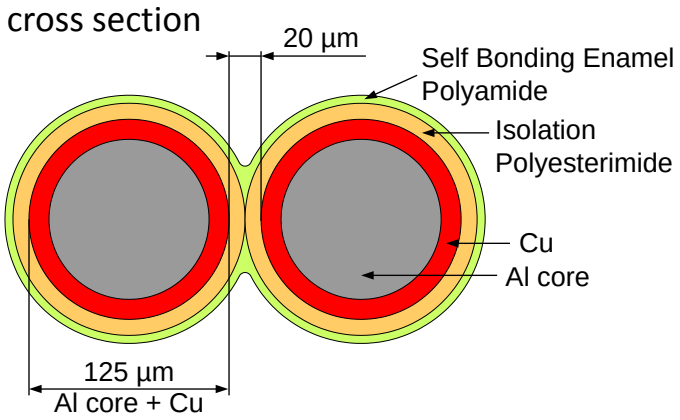
Speed is the critical point



Module cabling on the BPIX connector board

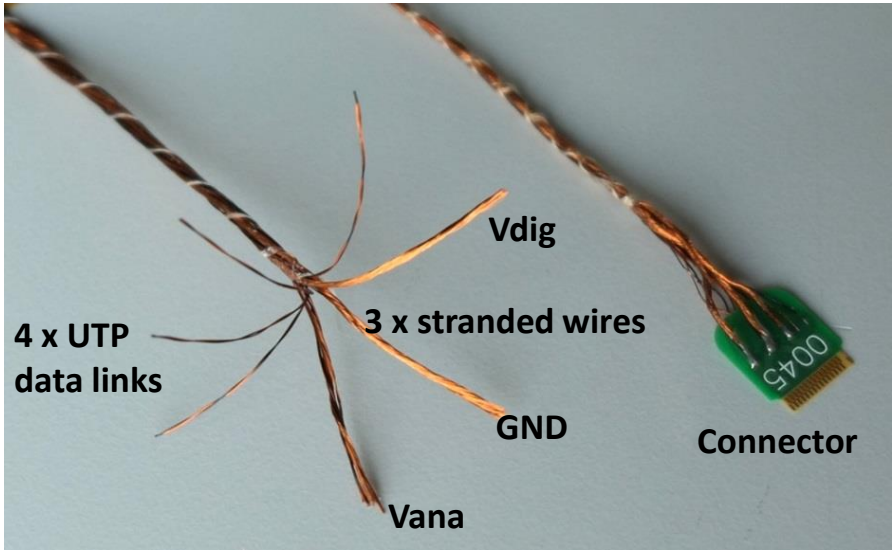
Micro Twisted Pair Cable for BPIX

Unshielded Twisted Pair UTP



- Self bonding wire (Elektrisola)
- 125 µm wire diameter Cu
  tests with Cu layer on Al core
  → difficult to handle
- twisted: 10 mm per turn
- unshielded
- diff. impedance: 60 Ohms

Module Cable



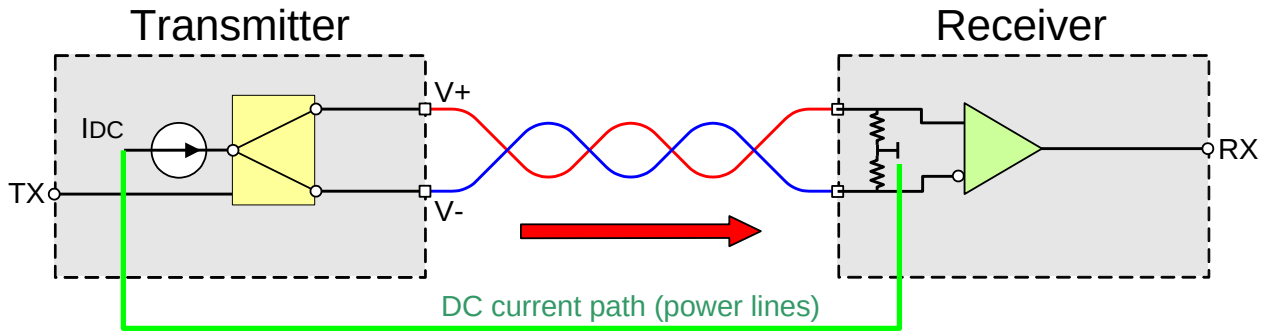
pros

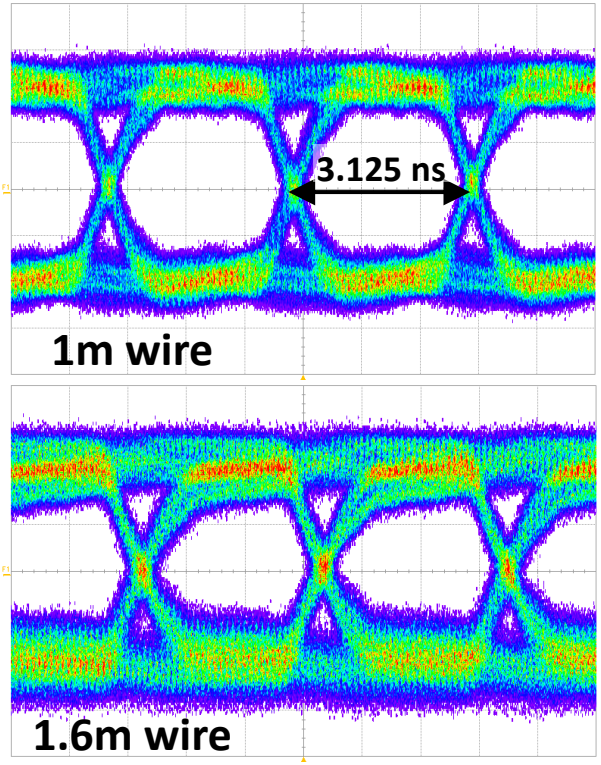
- very flexible in all directions
- minimal material / diameter

cons

- high loss; R_{DC} = 2.3 Ohm/m
  Skin depth = 8.5 µm @ 100 MHz
- difficult assembly (connectors)

Electrical Driver and Receiver

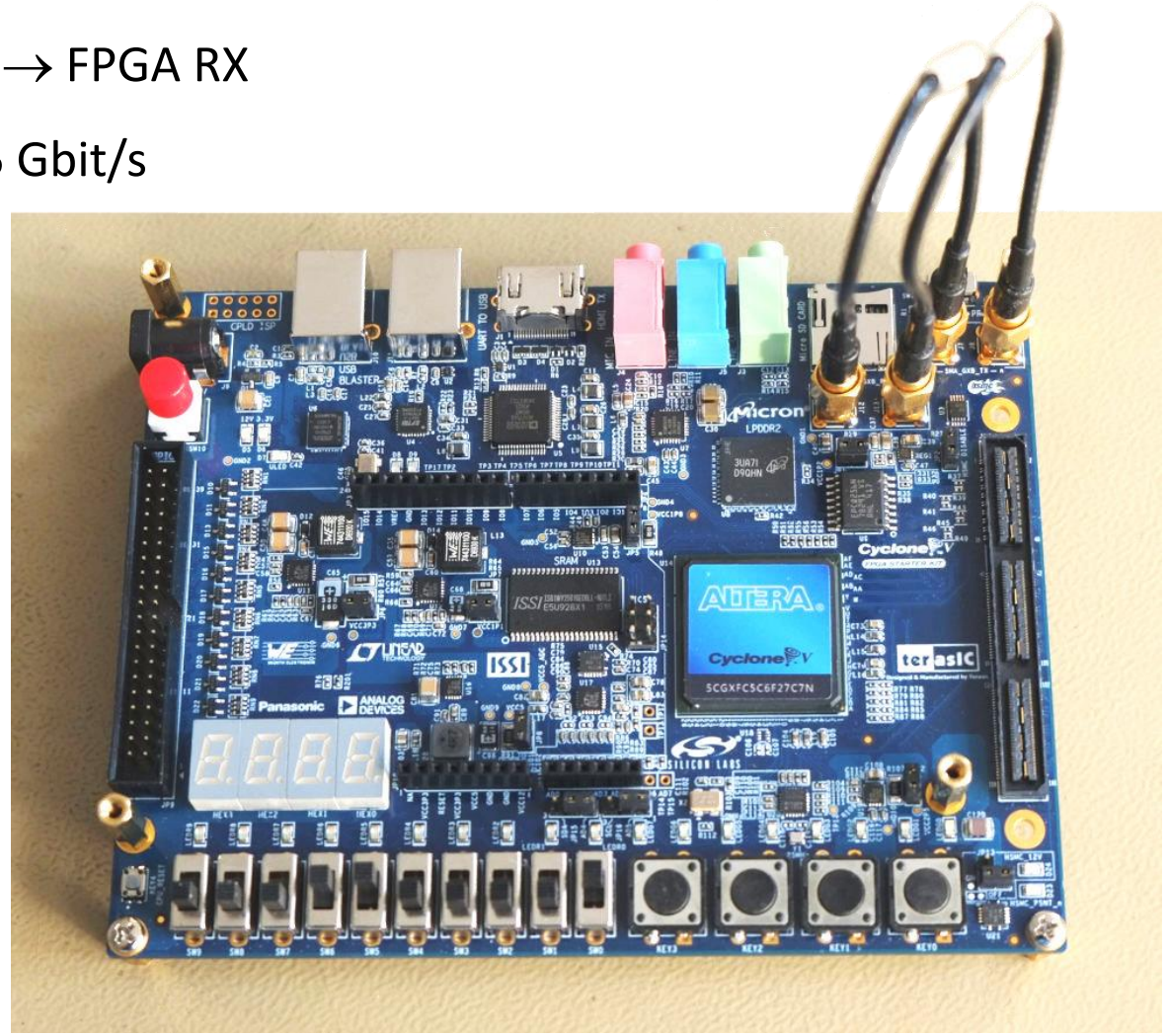




- Custom driver and receiver LCDS (500 Mrad)
- 320 Mbit/s
- Minimal amplitude: 20 mVpp
- +/- 500 mV DC offset between driver and receiver
- Bit error rate < 10e-12 (different condition)
- Crosstalk: -27 dB
- Power consumption / link: 4mW (12 pJ/bit)

First Test Setup for 1.25 Gbit/s

- Cyclone V GX starter kit
- FPGA TX → UTP → FPGA RX
- speed up to 1.25 Gbit/s



MuPix8 Readout System

- MuPix8 Chip, boards and cables from Heidelberg
- Arria V FPGA development Kit (PCIe Card)
- MuPix8 → UTP → FPGA RX