Crosstalk and noise measurements of a charge-sensitive amplifier input path

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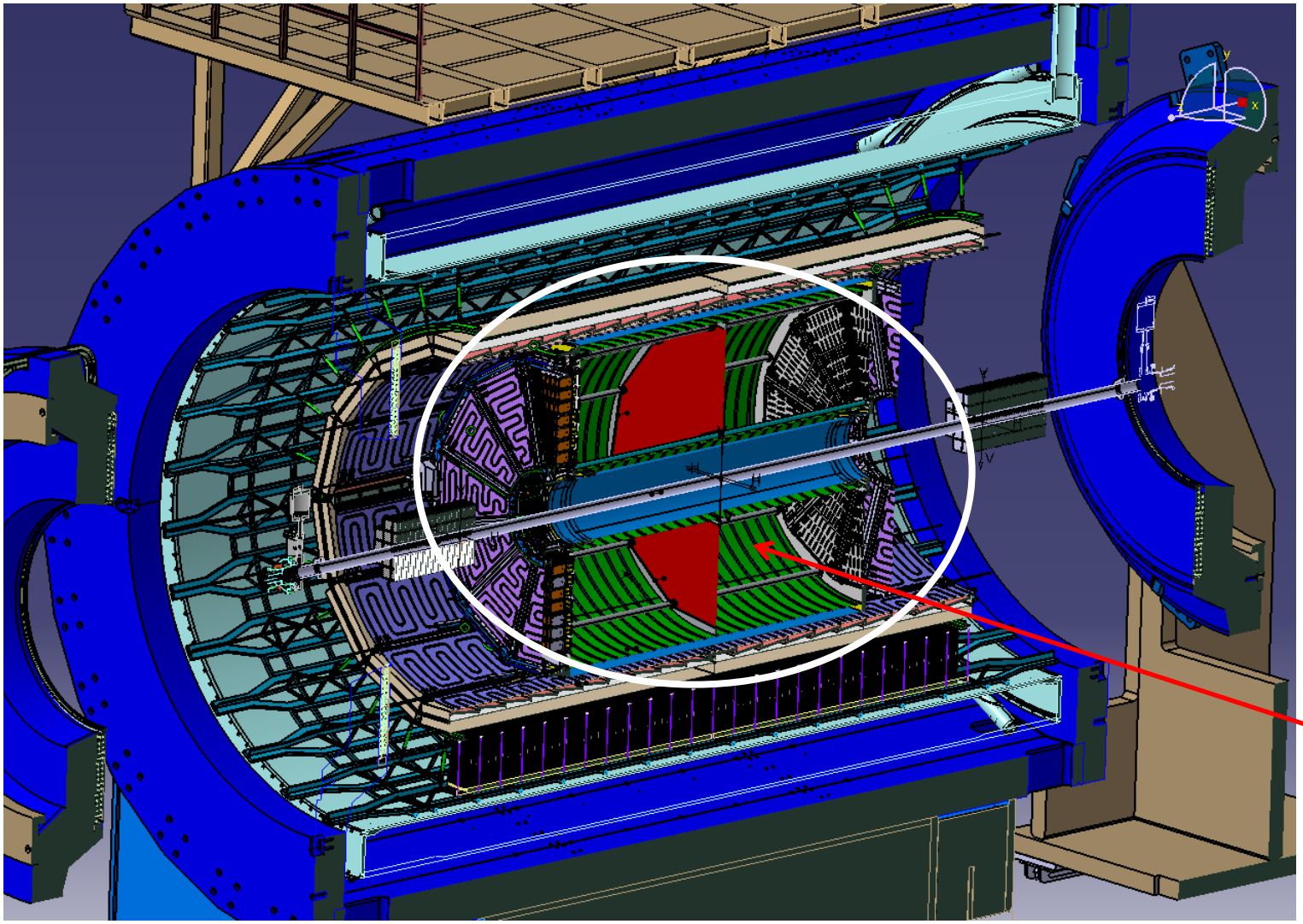
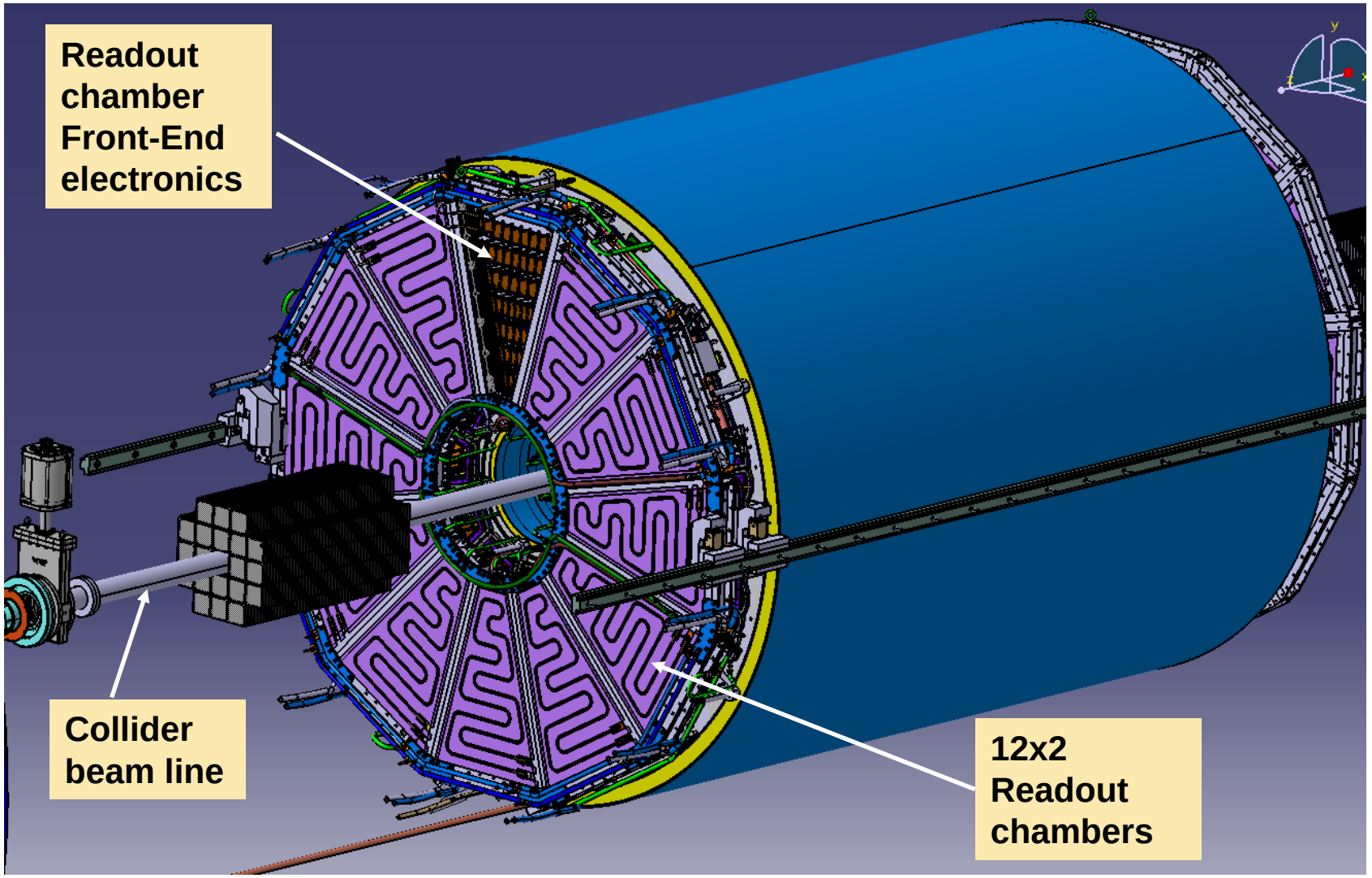
CONTENS

- Introduction (MPD setup, TPC design overview and general characteristics)
- Charge-sensitive amplifier input path parts (PadPlane, Cable, Front-End card)
- Measurement results:
  - input capacitance measurements
  - noise measurements
  - crosstalk measurements
- Conclusion

General view of the MultiPurpose Detector (MPD) of NICA project



TPC design overview

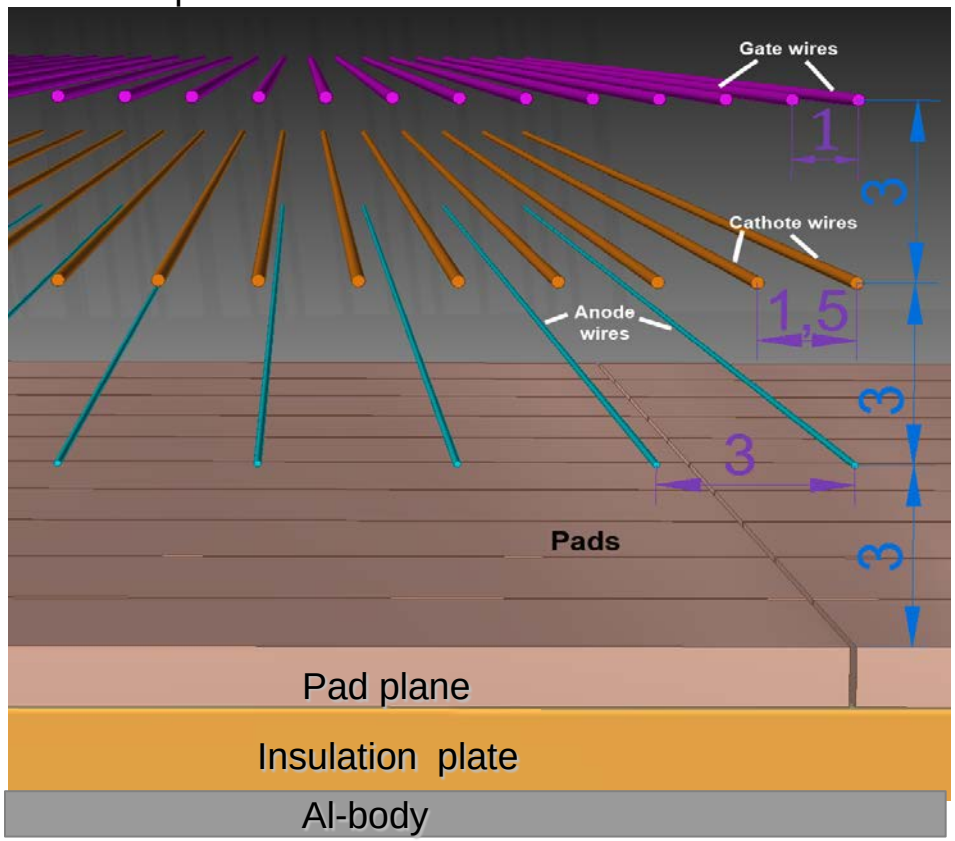


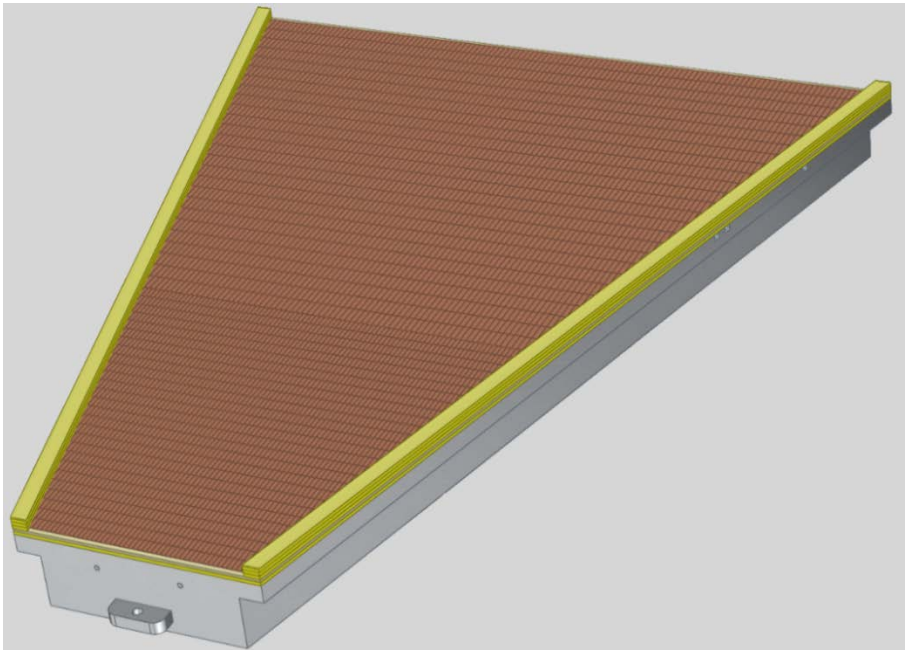
Main parameters of the TPC

Length of the TPC	340 cm
Outer radius of cylinder	140 cm
Inner radius of cylinder	27 cm
Length of the drift volume	170cm (of each half)
Magnetic field strength	0.5 Tesla
Drift gas	90% Ar+10% CH_4
Temperature stability	0.5°C
Gas amplification factor	~ 10^4
Number of readout chambers	24 (12 per end plate)
Pad size	5x12mm^2 and 5x18mm^2
Pad raw numbers	53
Number of pads	95 232
Maximal trigger rate	~7 kHz (at luminosity up to 10^{27} cm^{-2} s^{-1} for Au^{79+} ions over the energy range $4 < \sqrt{S_{NN}} < 11$ GeV)
dE/dx	better than 8%
Δp/p	~ 3% in $0.1 < p_t < 1$ GeV/c

Readout chamber

Structure of readout chamber:
- three wire planes
- pad plane
- insulation plate
- trapezoidal aluminum frame





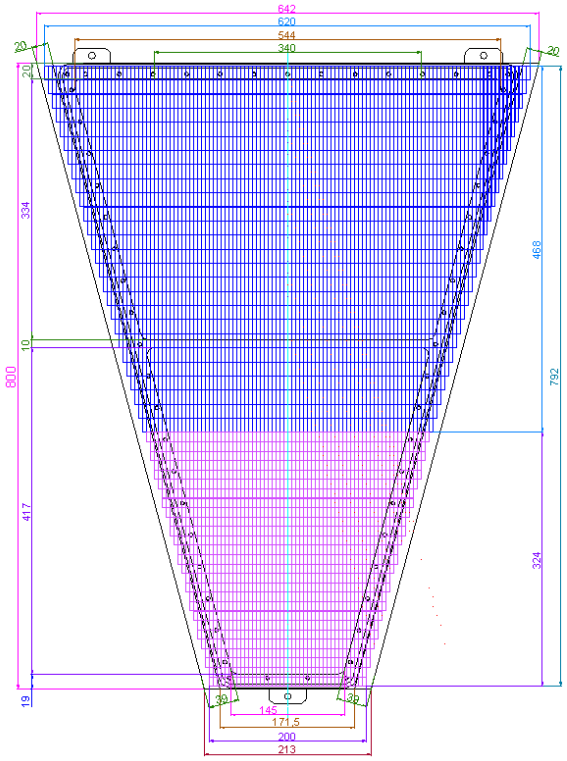
Wires structure
- anode wire pitch 3 mm
- cathode wire pitch 1,5 mm
- gate wire pitch 1 mm
- wires gap 3 mm

Design goal

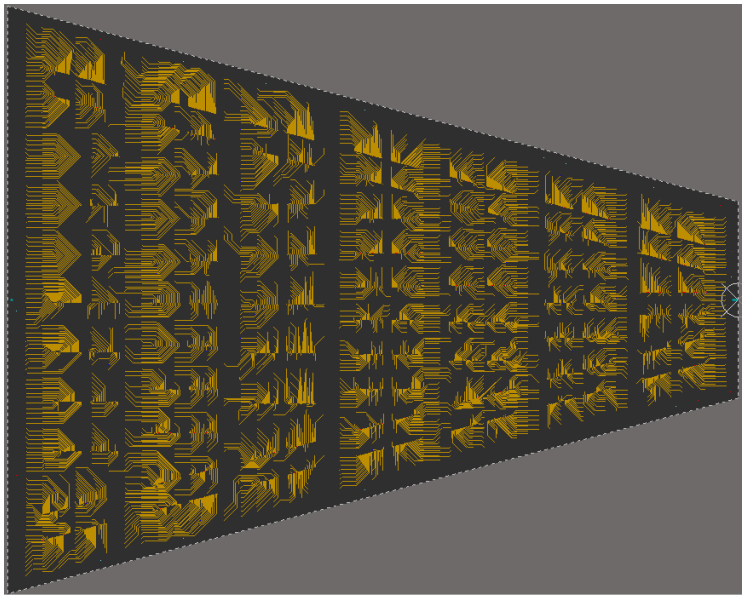
By development of the CSA input paths which include PadPlane, connectors, cables and traces it is necessary to perform special efforts to minimize noise and crosstalk which affect on chamber space resolution.

It is also necessary to conform capacities of a pad and an input of amplifier. Big detector capacitance increase total noise of registration channel.

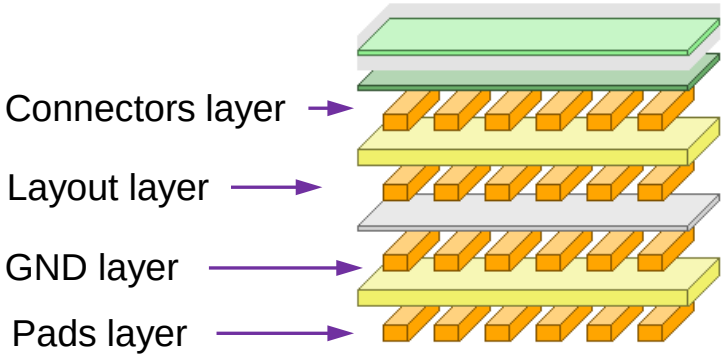
PadPlane



Pads dimensions and quantity are determined by experiment requirements on space and momentum resolutions.

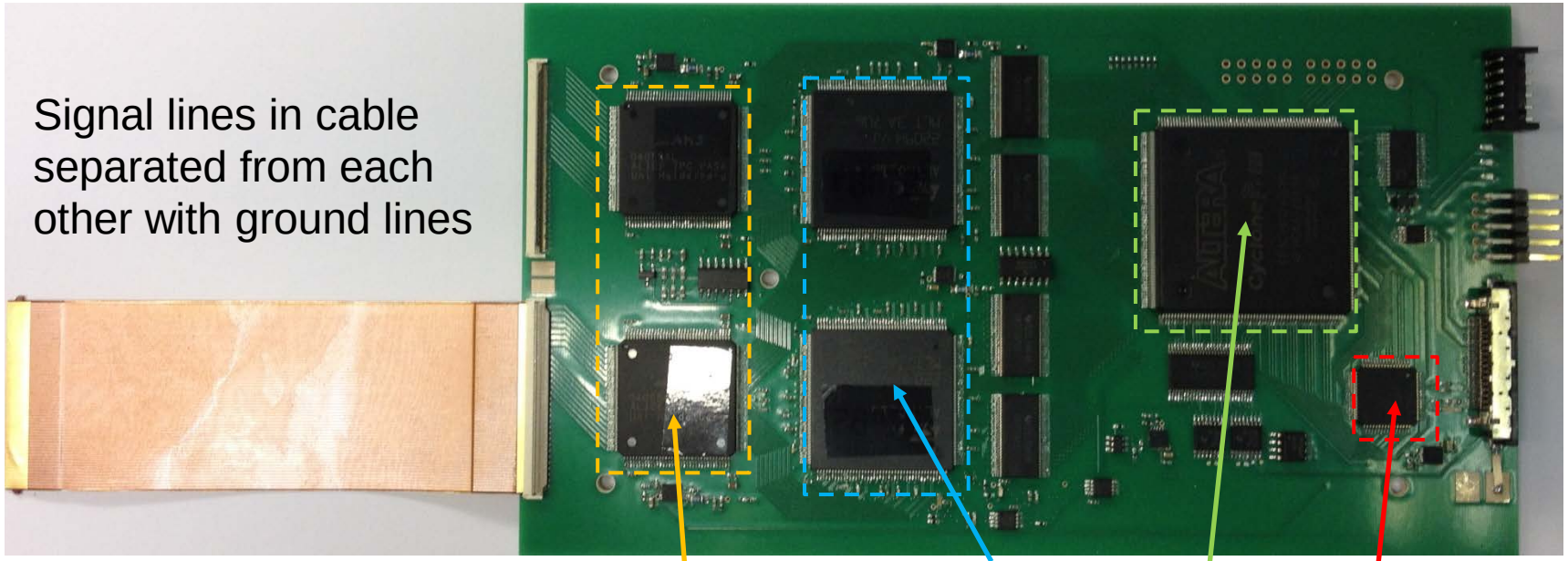


Pad structure
pad raw number 53
rectangle shape
- small pads 5×12 mm^2
- large pads 5×18 mm^2



Layer Name	Type	Material	Thickness (mm)
Top Overlay	Overlay		
Top Solder	Solder Mask/Co...	Surface Material	0.01016
Top Layer	Signal	Copper	0.018
Dielectric1	Dielectric	Core	1
Signal Layer 1	Signal	Copper	0.035
Dielectric2	Dielectric	Prepreg	1
Signal Layer 2	Signal	Copper	0.035
Dielectric3	Dielectric	Core	1
Bottom Layer	Signal	Copper	0.018

64-ch. Front-End Card (top side) with cable



- Signal to noise ratio, S/N - 30
- $\sigma_{NOISE} < 1000e^-$ (C=10-20 pF)
- Dynamic Range – 1000
- Zero suppression
- Buffer (4 / 8 events)

PASA chip
16 channels ASIC
(low noise amplification of the signal)

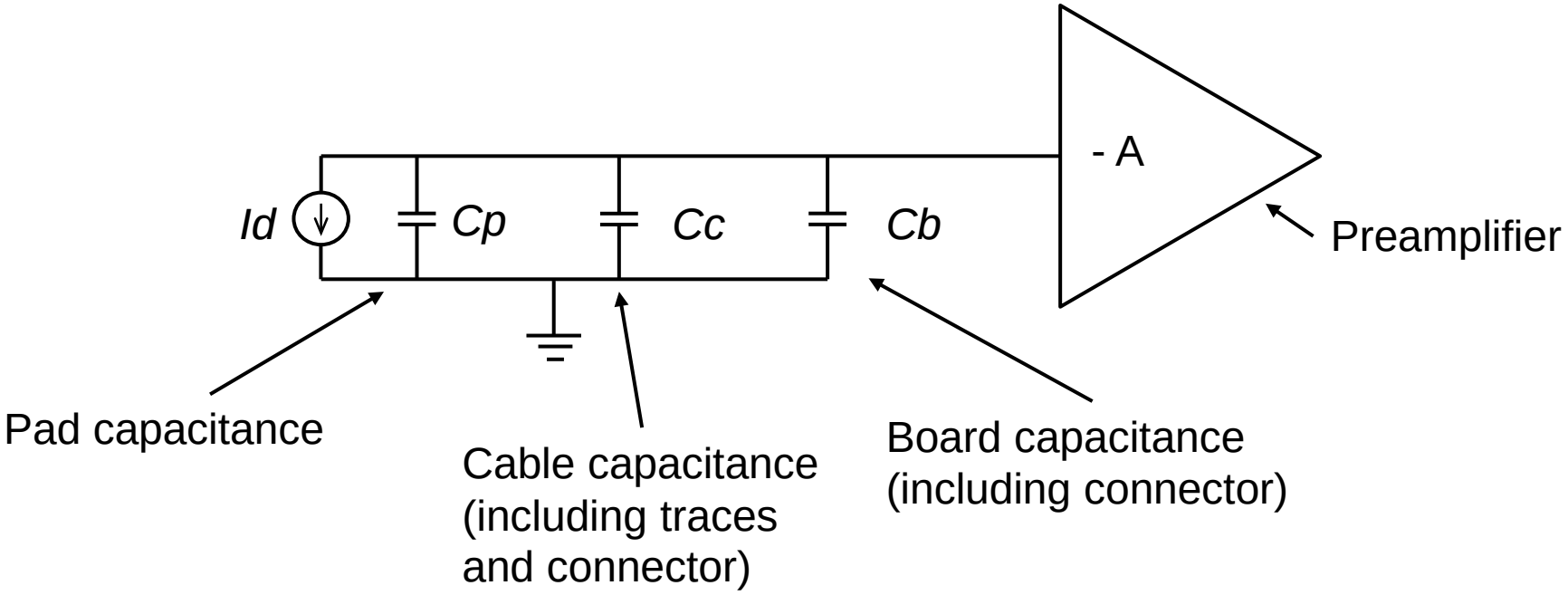
ALTRO chip
16 channels ASIC
(digitization and signal processing)

ALTERA FPGA -
board control

TLK2711
Serial interface
Data throughput up to 2.5 Gb/s

Charge-sensitive amplifier input path

Total input signal path of our design up to amplifier includes pad with trace, two connectors, flat kapton cable with corresponding capacitances.



Test bench for crosstalk and noise measurements on the readout chamber

Front view

Back view

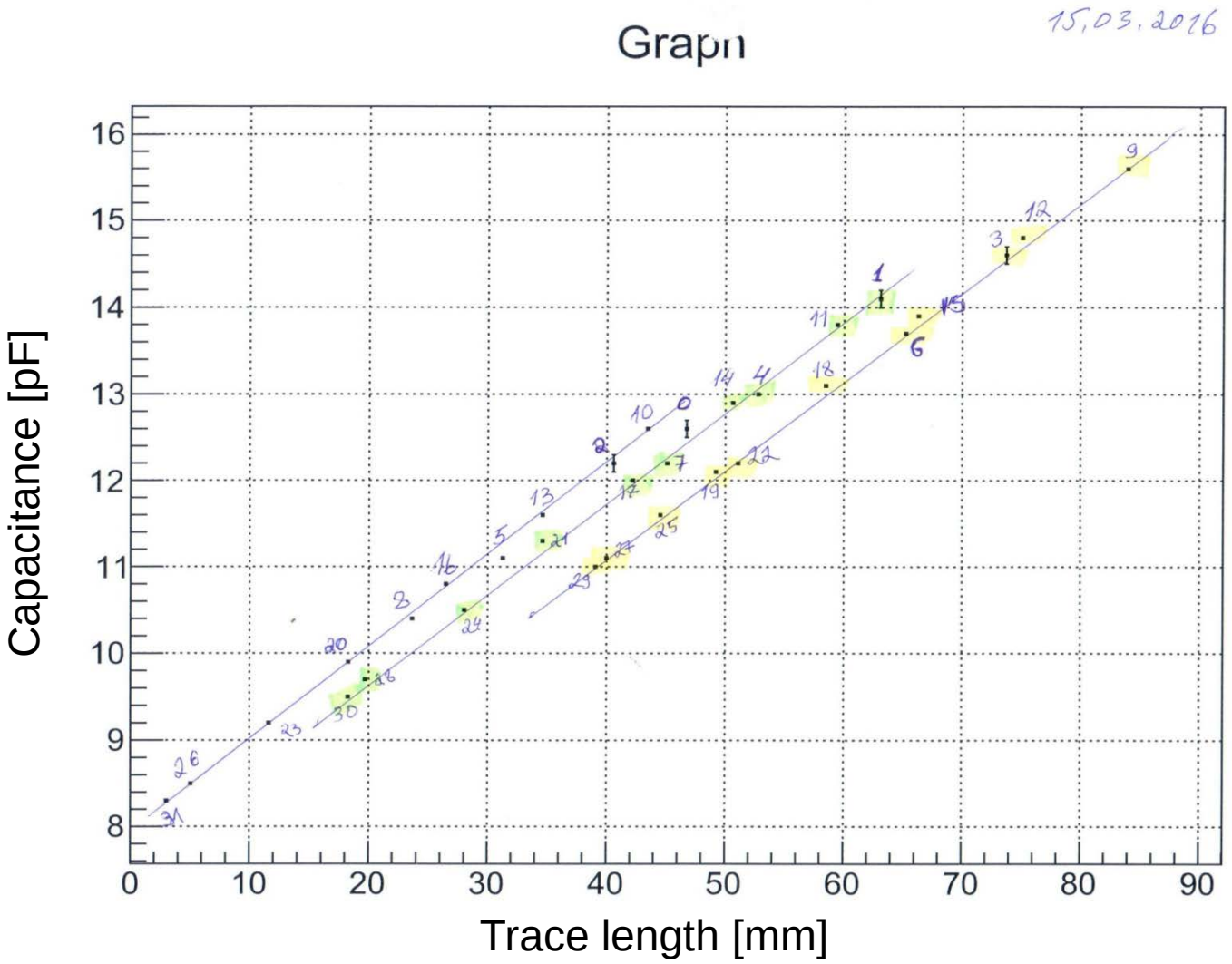
Serial chamber

FEE cards

Shielding

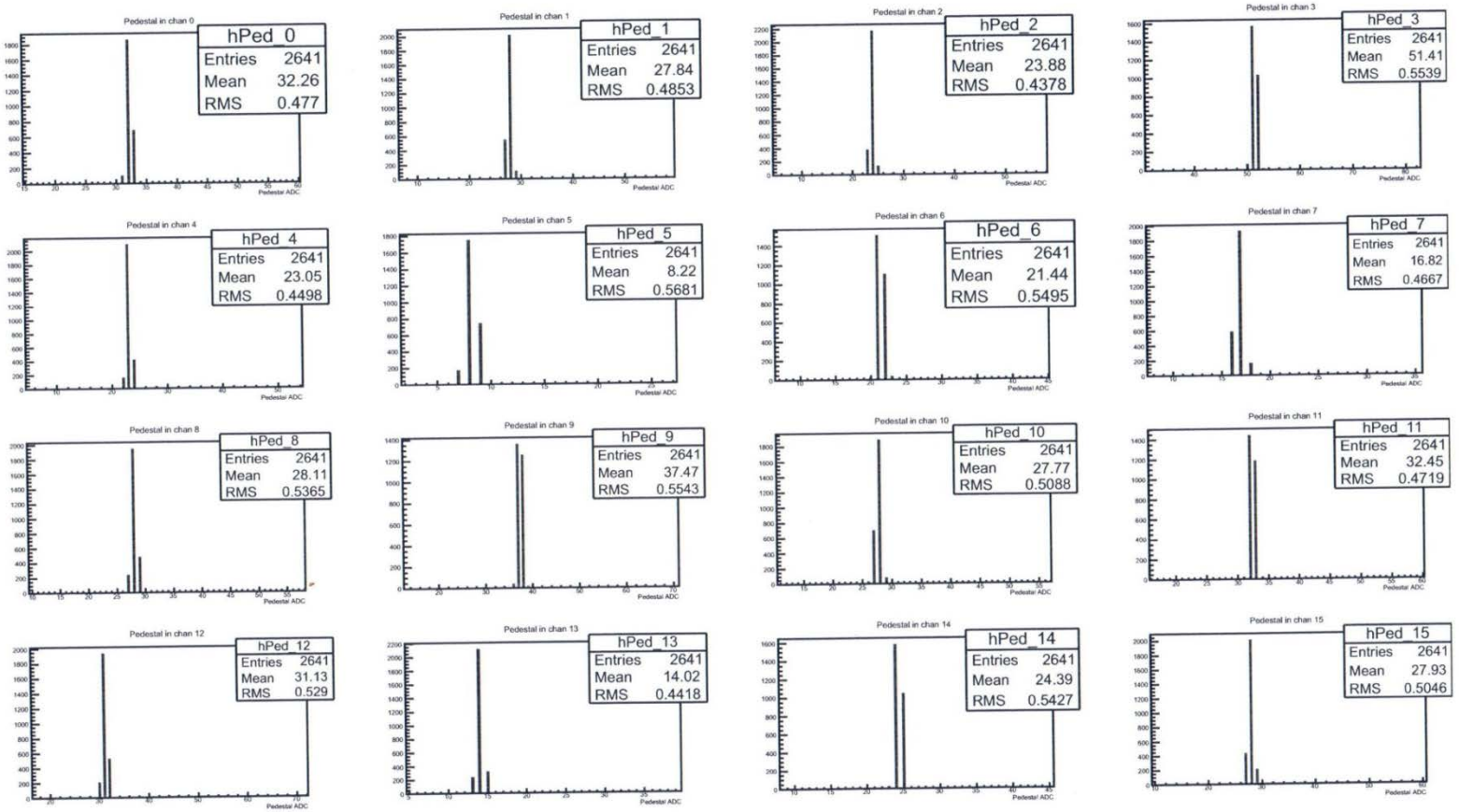
Power supply

Measurement of input capacitance vs. trace length



Noise measurements of the FEE

карта #1 фаза 31 29/03/2016

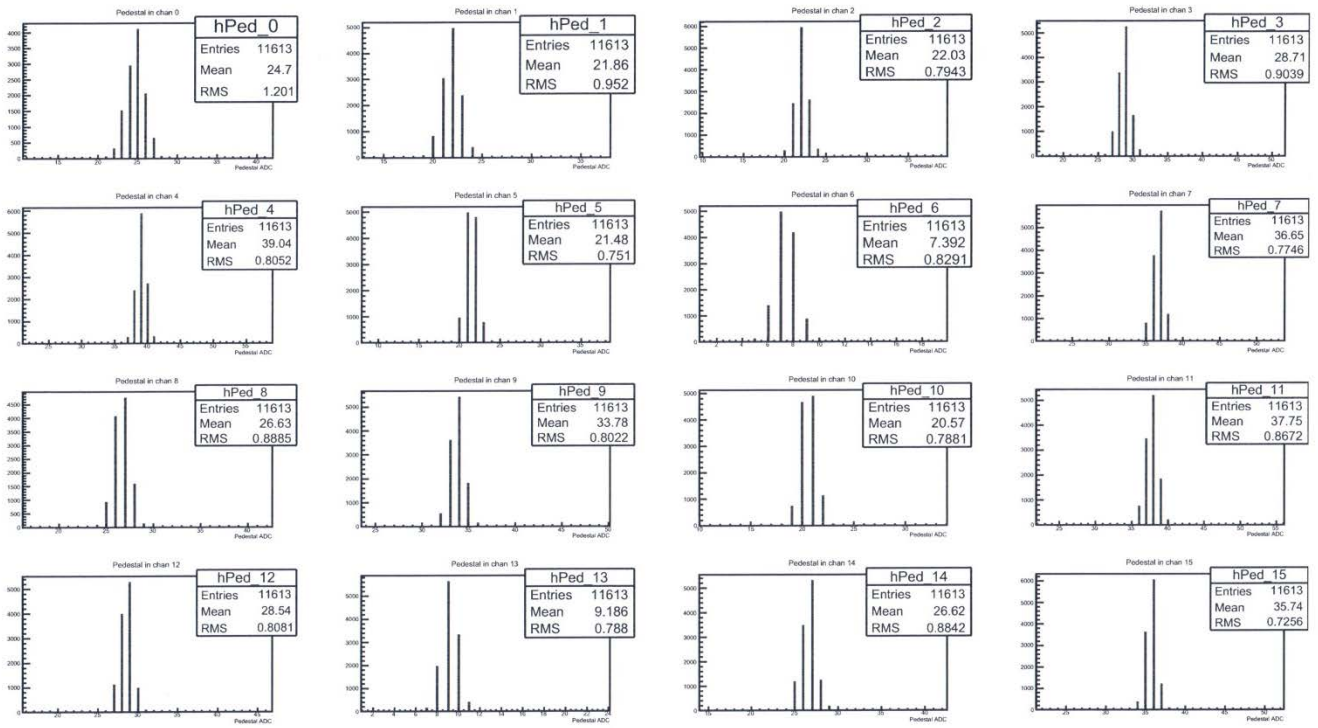


Histograms for ADC amplitudes

Noise measurements of the FEE with connected readout camber

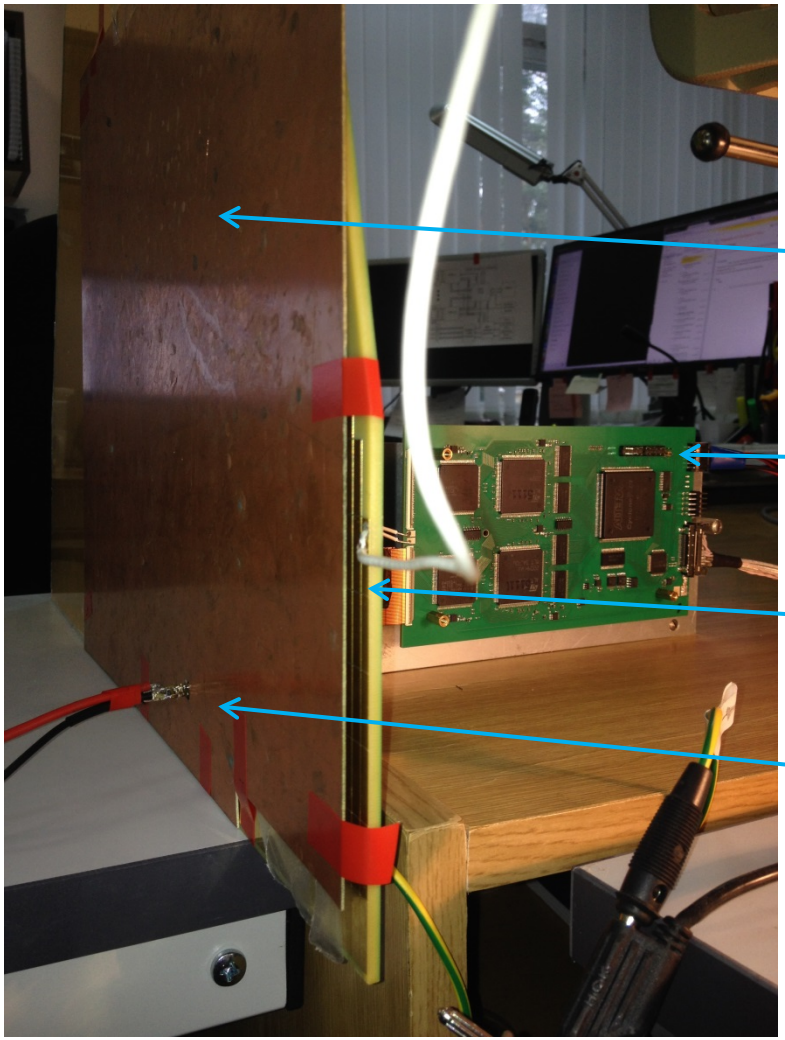
Measurement for first version of the PadPlane

card # 2, pos. 8, file 4. 8/04/2016

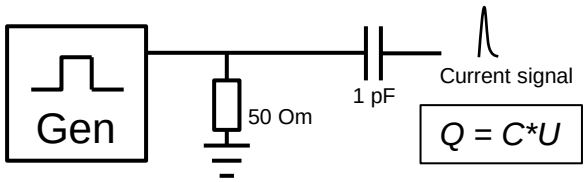


The total noise value for most channels do not exceed 1000e^-

Crosstalk measurements of the CSA input path



Special measurements of crosstalk for full trace from selected pad to amplifier input was performed. The estimated value of the crosstalk on the adjacent pad is 0.5%



Conclusion

- Test bench for measuring crosstalk and noise has been created and trialed.
- Crosstalk and noise measurements was performed.
- Measurements showed values of noise don’t exceed 1000e^- and crosstalk between two neighboring pads has order 0.5 %. That conforms TPC design requirements.

Thank you for your attention!