Development of Glass Resistive Plate Chambers for INO

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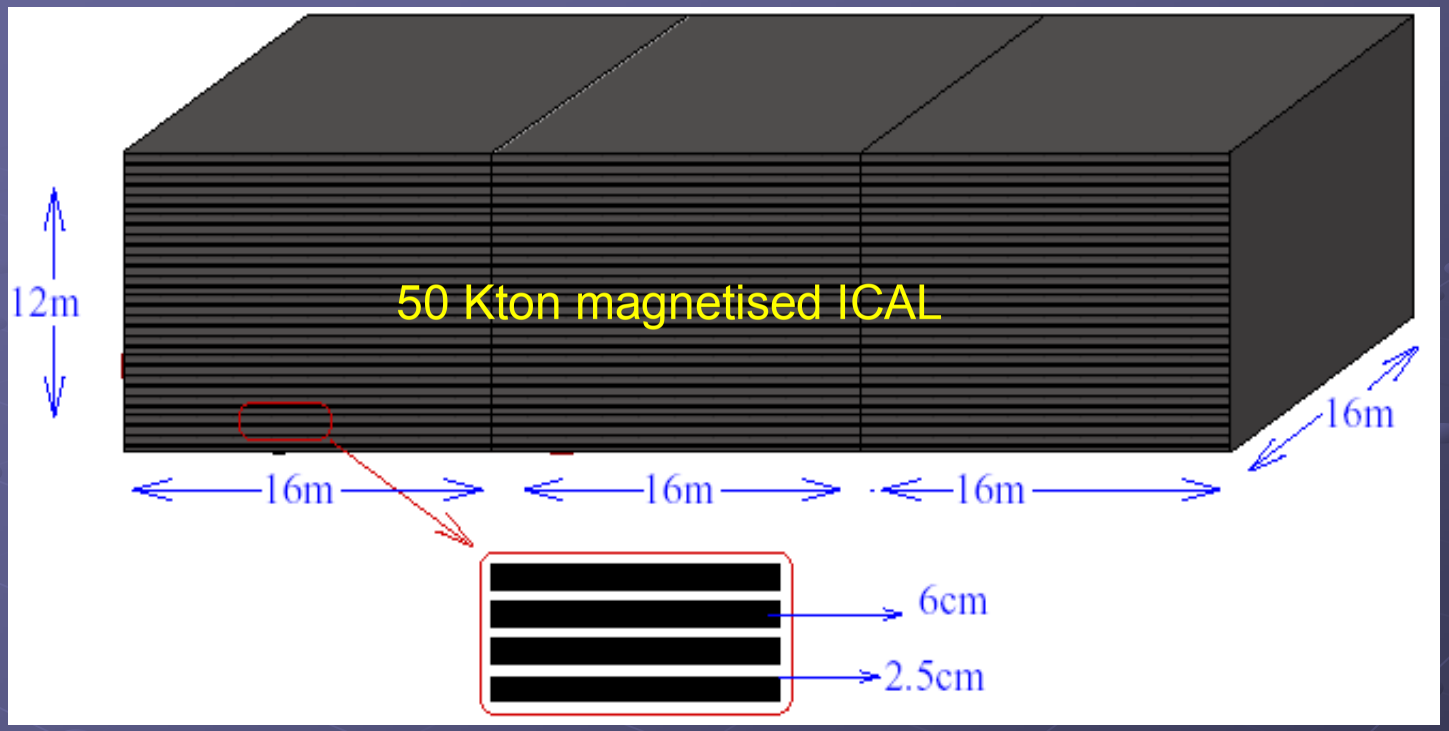
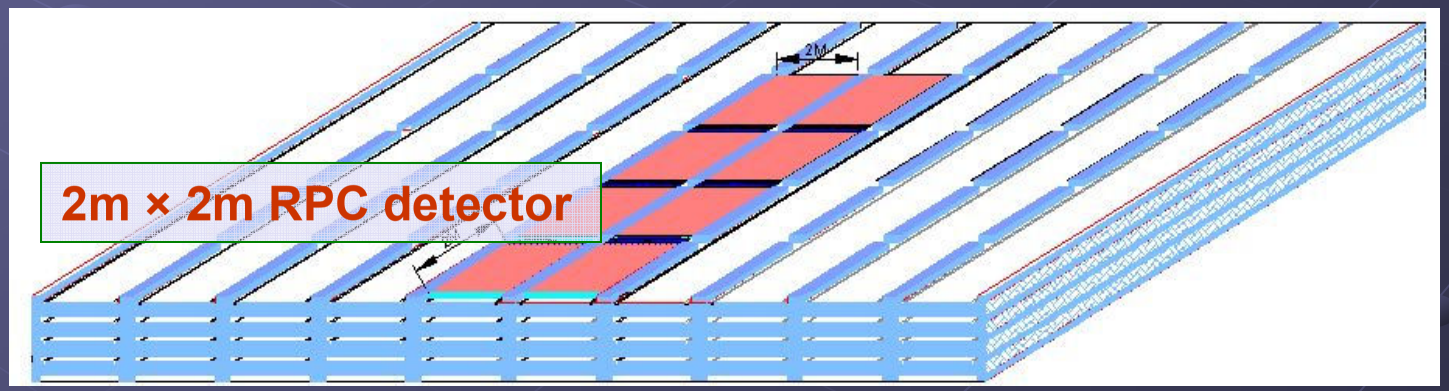
INO Iron Calorimeter detector concept

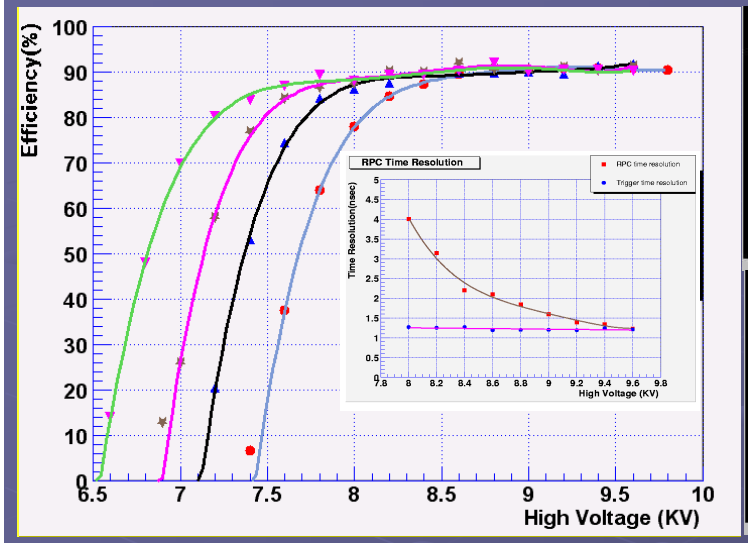


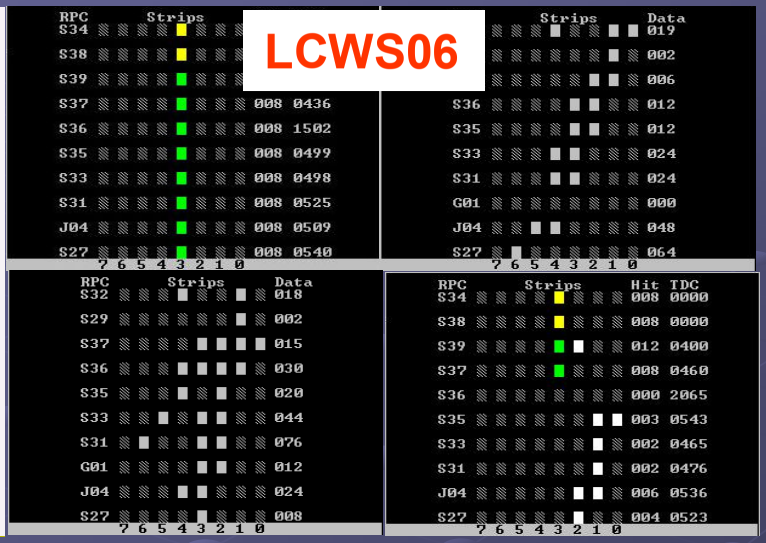


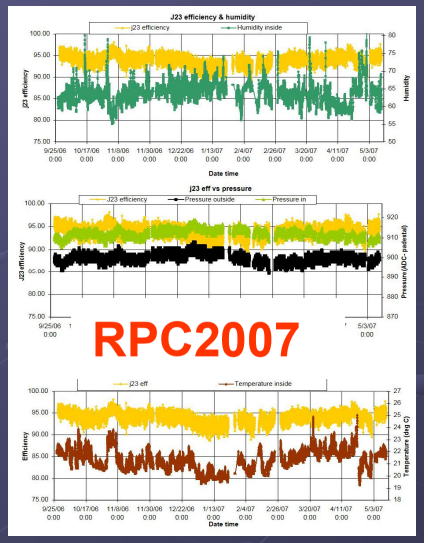
ICAL detector fact sheet

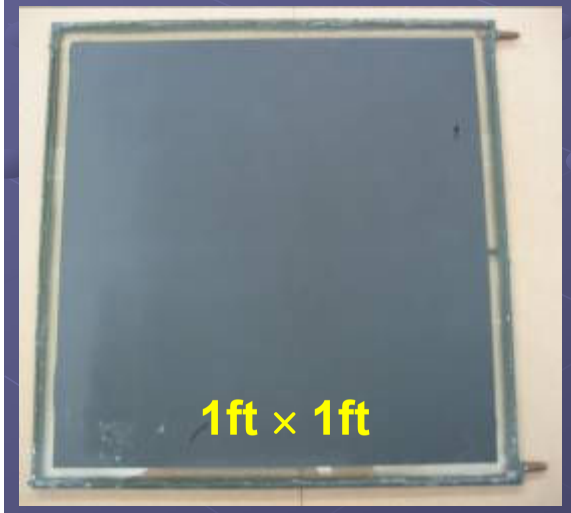
No. of modules	3
Module dimensions	16 m X 16 m X 12 m
Detector dimensions	48 m X 16 m X 12 m
No. of layers	140
Iron plate thickness	6 cm
Gap for RPC trays	2.5 cm
Magnetic field	1.3 Tesla
RPC dimensions	2 m X 2 m
Readout strip width	3 cm
No. of RPCs/Road/Layer	8
No. of Roads/Layer/Module	8
No. of RPC units/Layer	192
No. of RPC units	26880
No. of readout channels	3.6×10^6

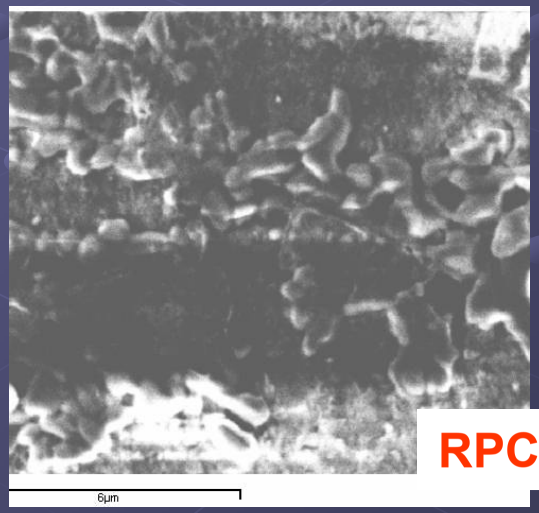
Highlights of earlier work

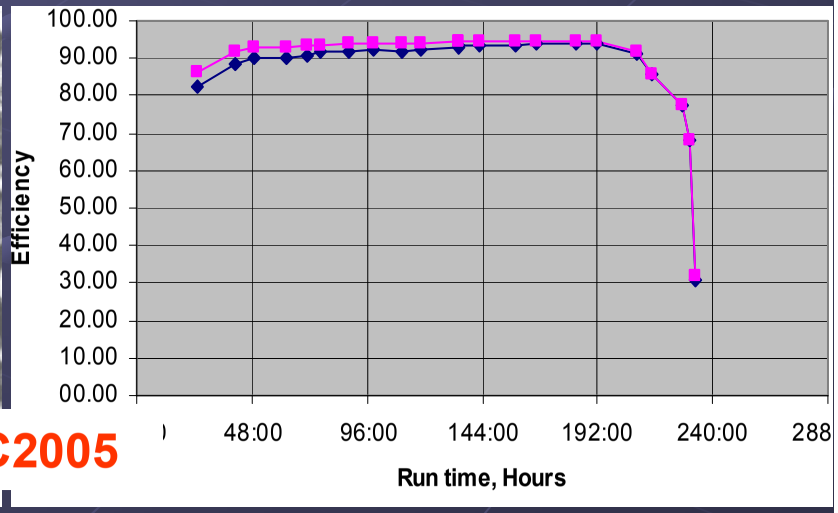








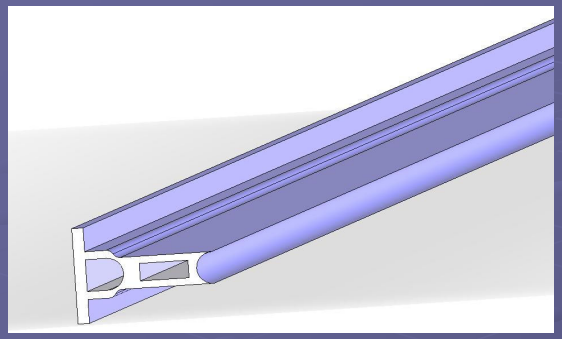


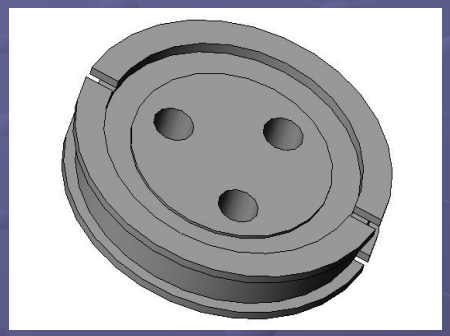


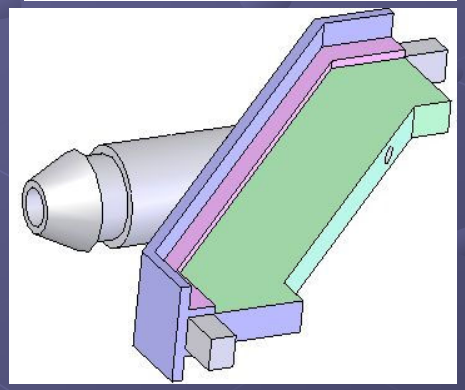
Development of RPC materials and procedures

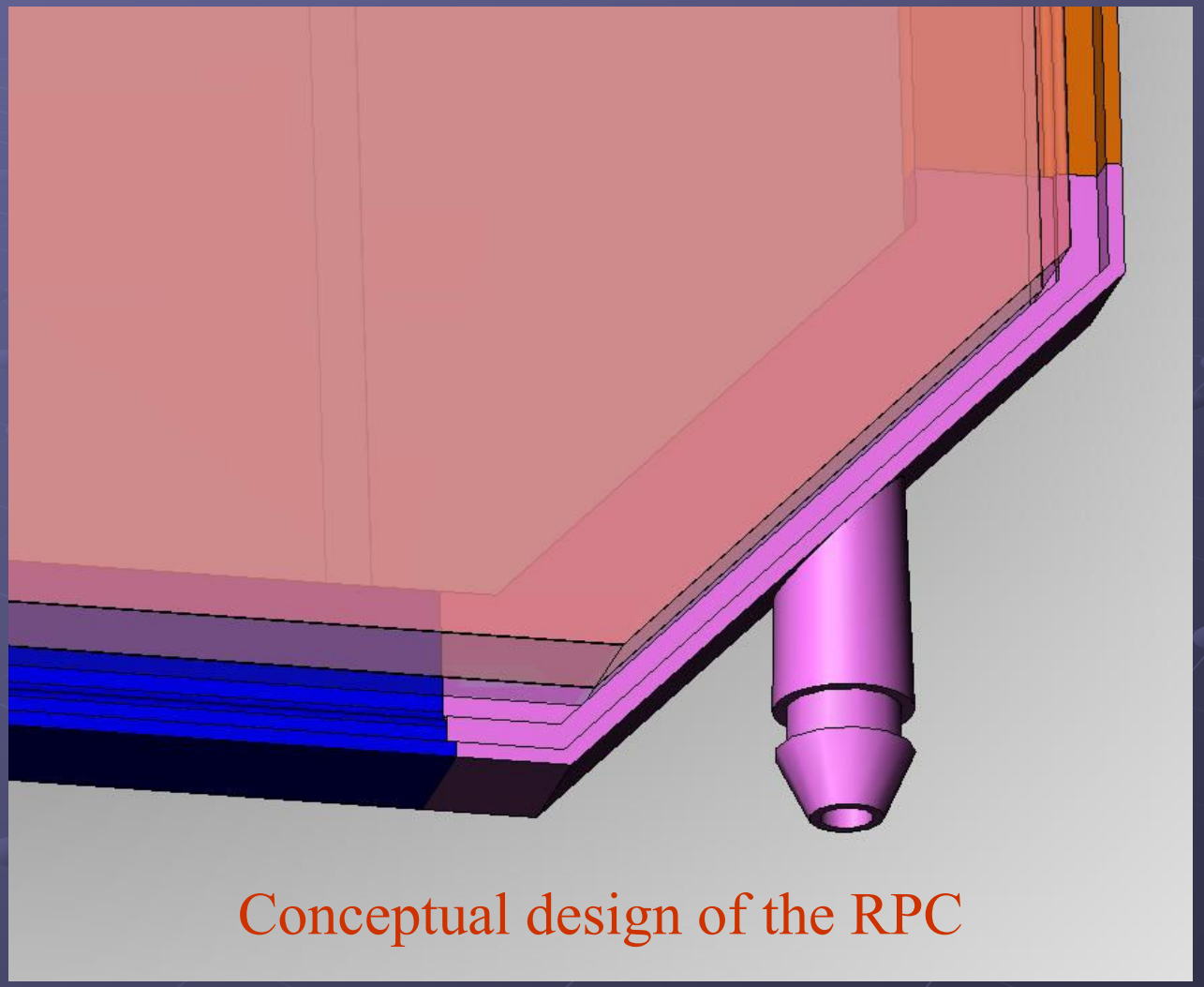
- Electrode glass and its characterisation
- Electrode coating & resistance measurement techniques
- Frames, spacers, buttons, gas nozzles etc.
- Adhesives, cleaning agents etc.
- Pneumatic jig development for chamber assembly
- Gases, gas mixing systems and gas proportions
- Gas leak and assembly testing of RPCs
- High Voltage insulating Mylar sheets
- Spark free high voltage contacts
- High voltage holding tests etc.
- Pickup panel designs and characterisation
- Chamber mounting assemblies
- Chamber characterisation test stands
- Electronics and data acquisition and monitoring systems
- Quality control parameters and procedures

RPC spacers, buttons and nozzles









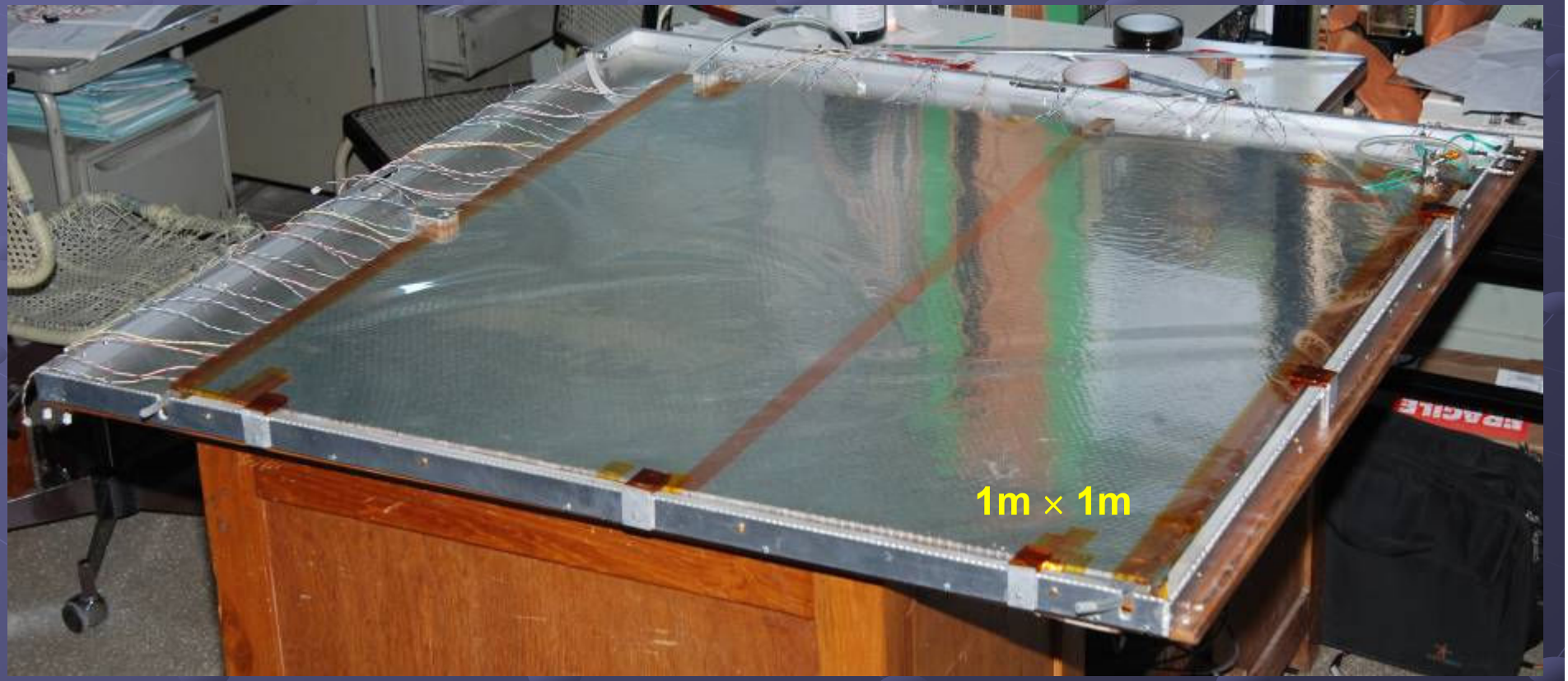
Conceptual design of the RPC

Multi-channel gas mixing system

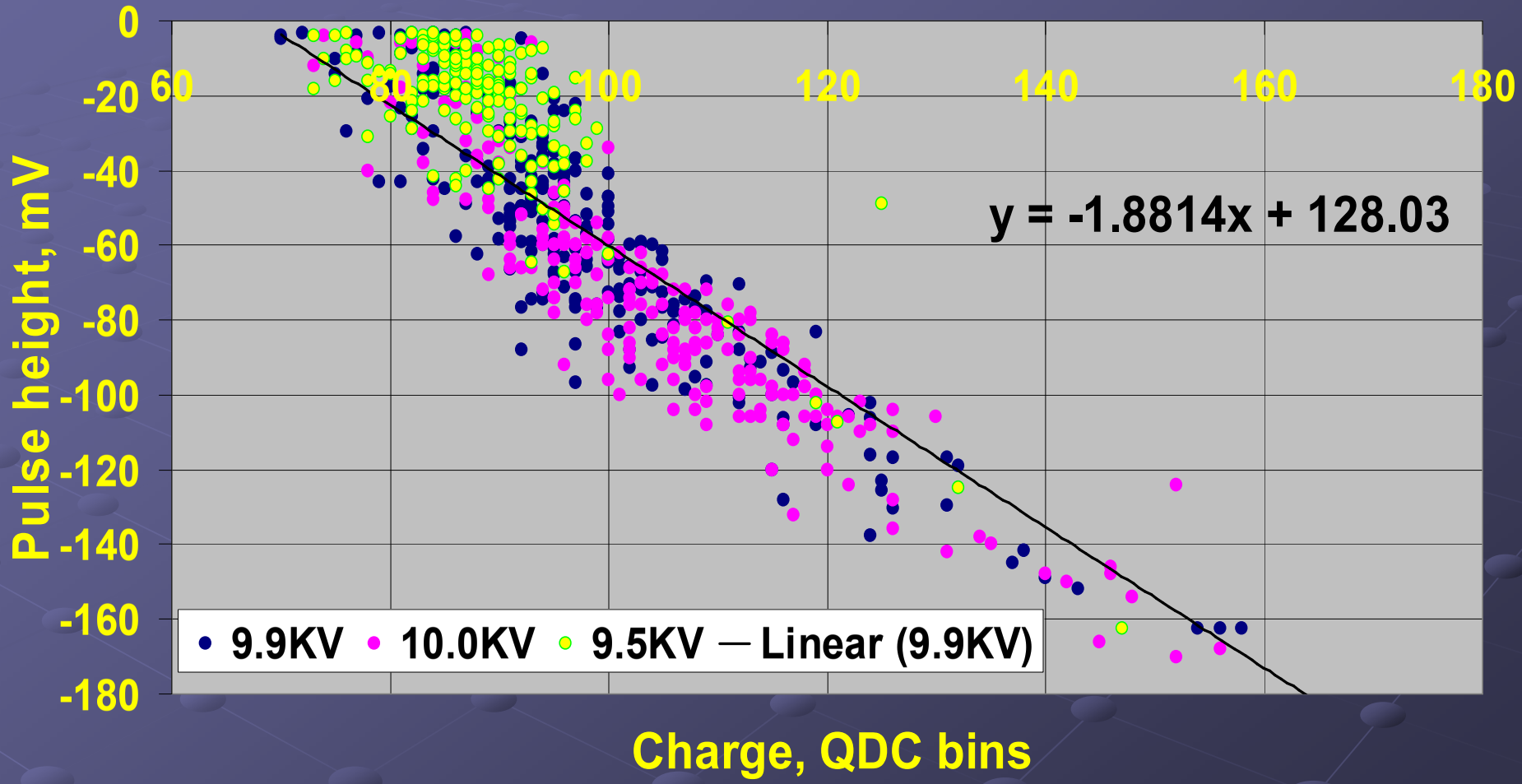
- Four input gases
- 16 pneumatically controlled outputs
- Molecular sieve based input filter columns
- Nippon Tylan made model FC-760 MFCs
- Parker made fine filters on the mixed gas
- On-line moister readout on mixed gas
- Output flow control by SS 0.3mm capillaries
- Bleeder bubblers for RPC protection
- Facility to add controlled moister into the mixture
- Computer interface for control and monitoring

RPCs for prototype detector

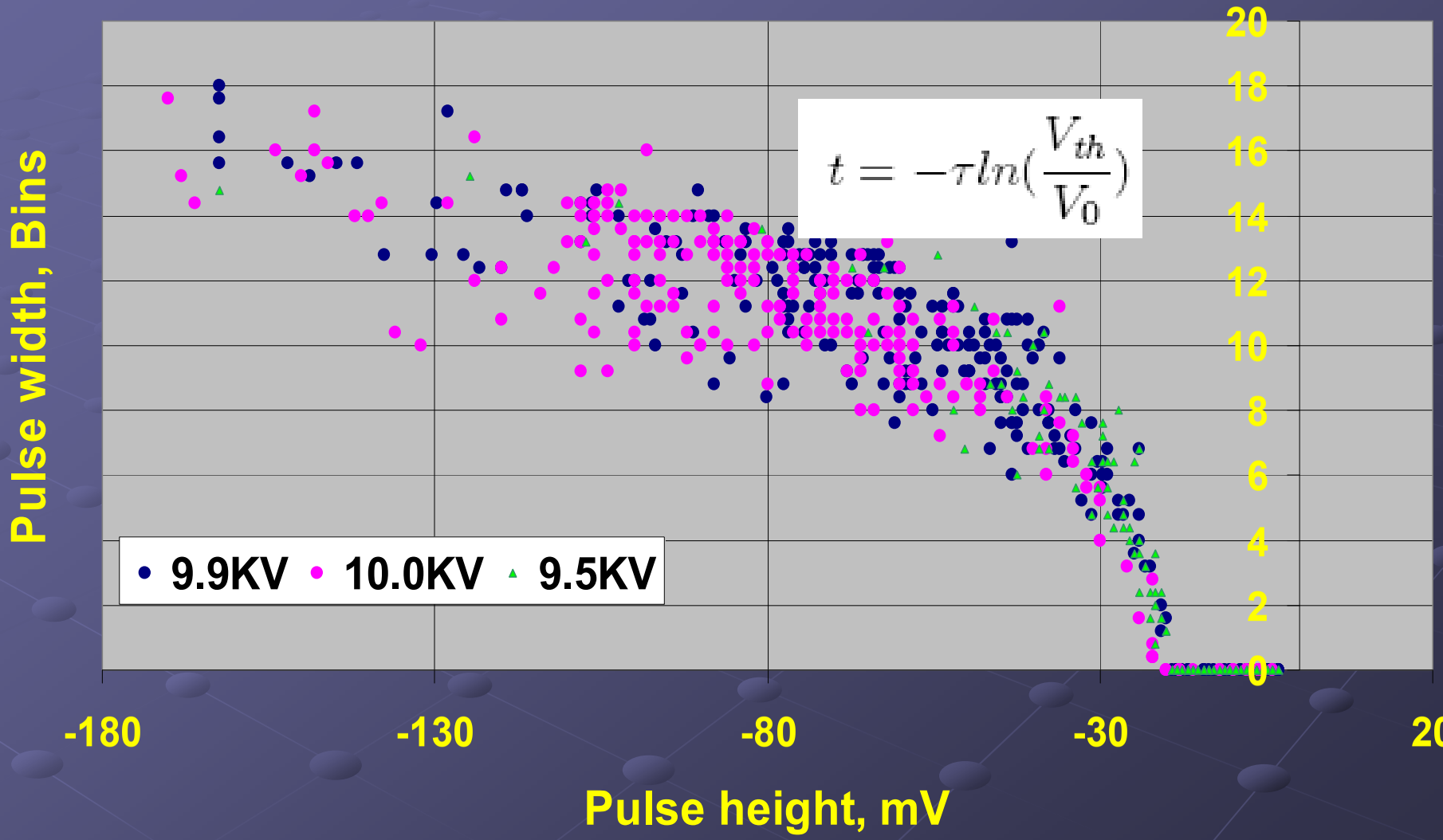
- Using 3mm thick Asahi Float glass procured from local market
- Polycarbonate buttons, spacers and gas nozzles developed and fabricated
- Resistive coat developed in collaboration with a local industry
- Operated in avalanche mode using R134:Iso:SF_6::95.5:5.0:0.5 gas mixture



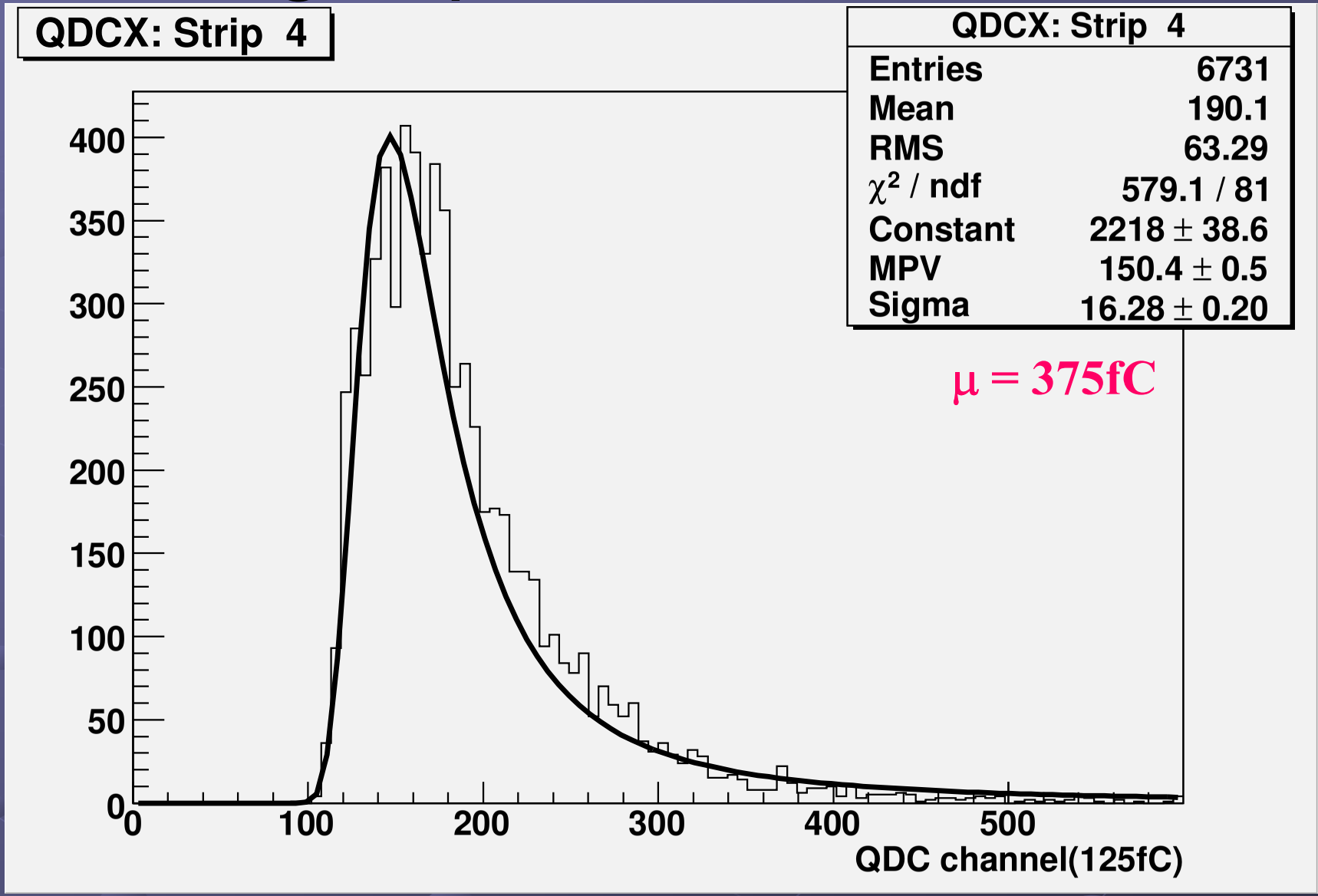
Charge-pulse height plot



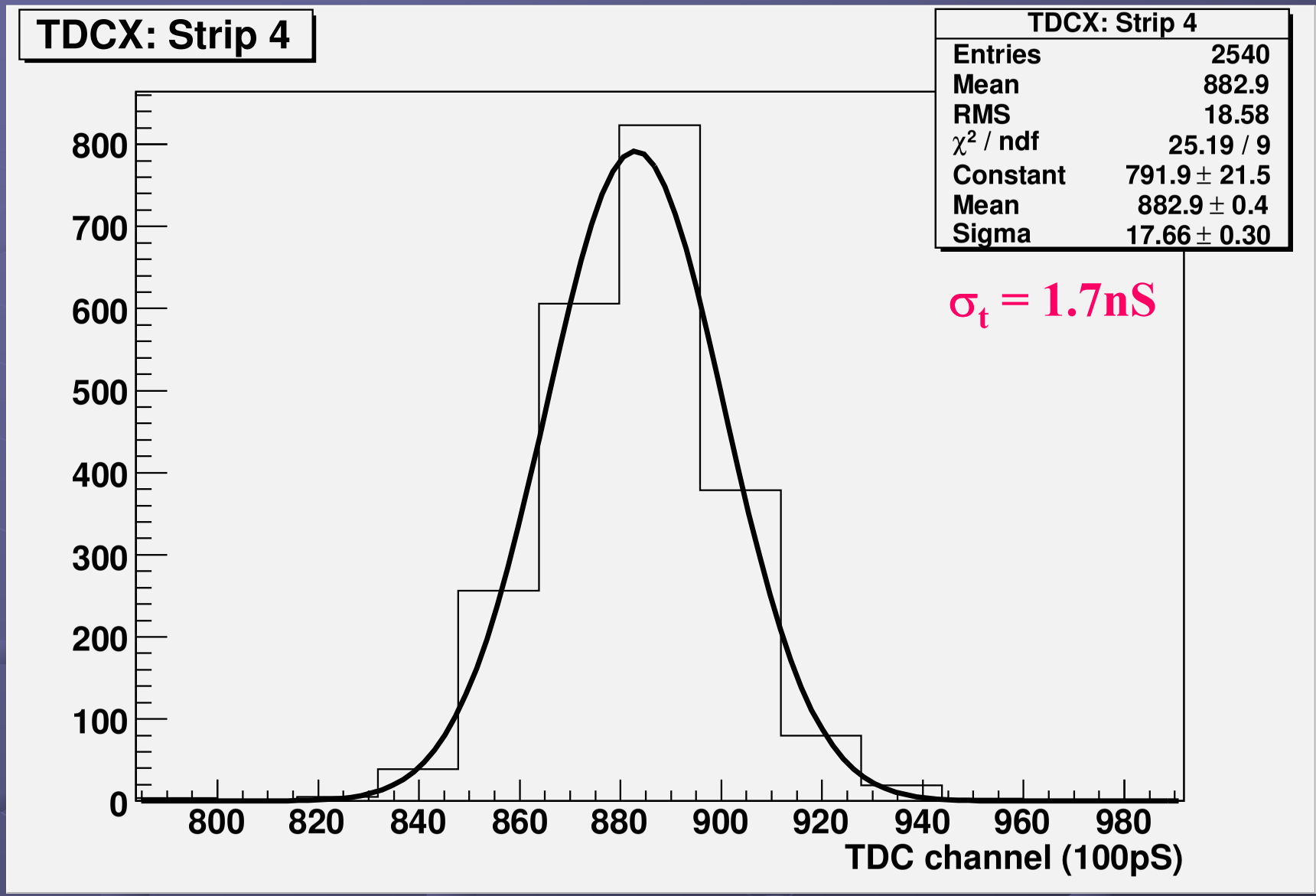
Pulse height-pulse width plot



Charge spectrum of the RPC



Time spectrum of the RPC

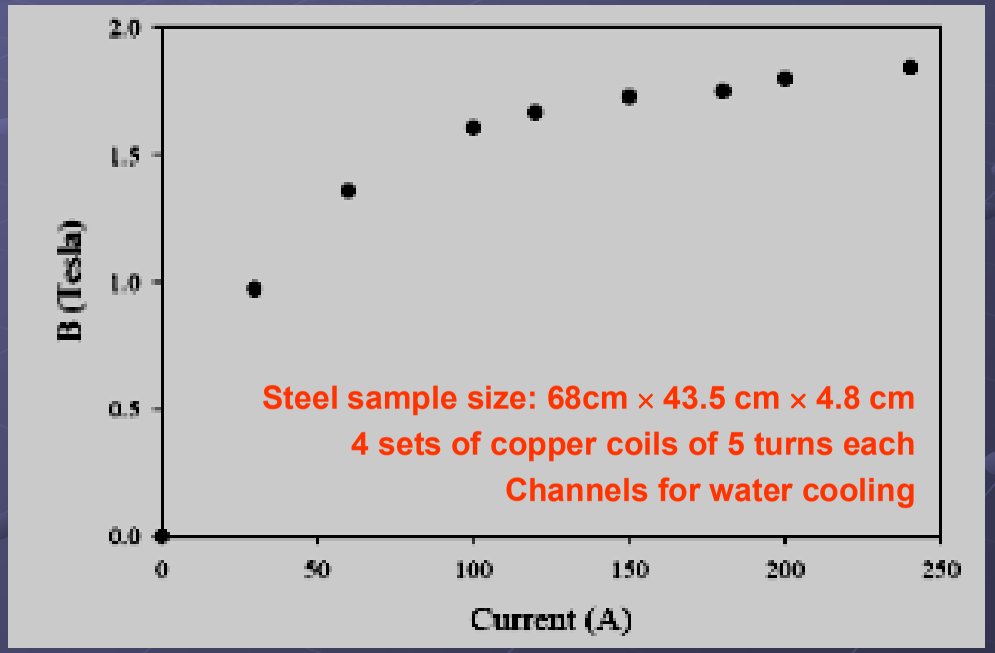


ICAL prototype detector

- 13 layers of 50 mm thick low carbon iron plates
- 35 ton absorber mass, rectangular design
- 1.5 Tesla uniform magnetic field
- 12, 1m^2 RPC layers
- About 768 readout channels
- Trigger on cosmic ray muons
  - In situ, using RPCs
  - Using scintillation paddle layers
- Record strip hit and timing information
- Chamber and ambient parameter monitoring

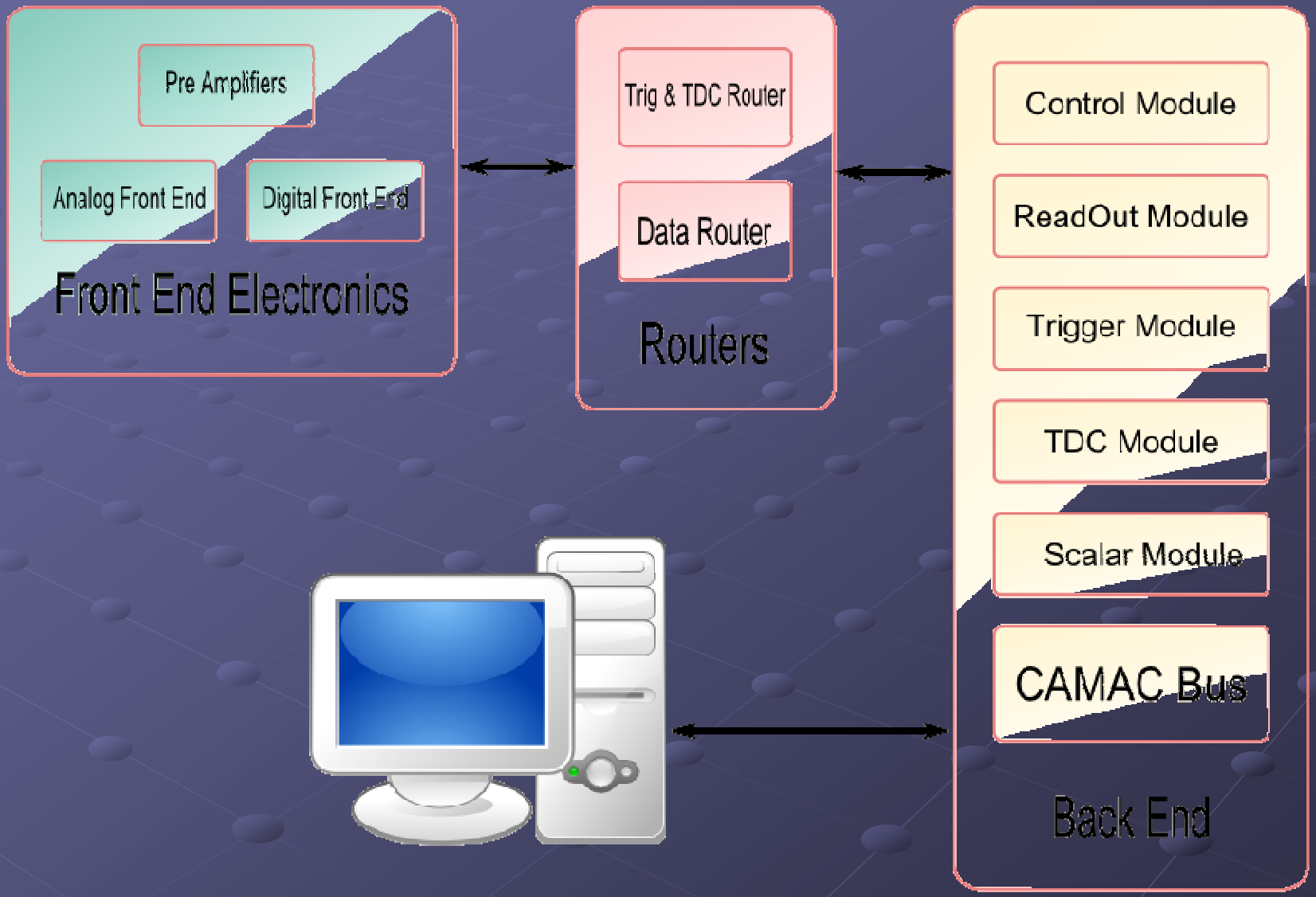
Magnet iron installation

Assembled magnet

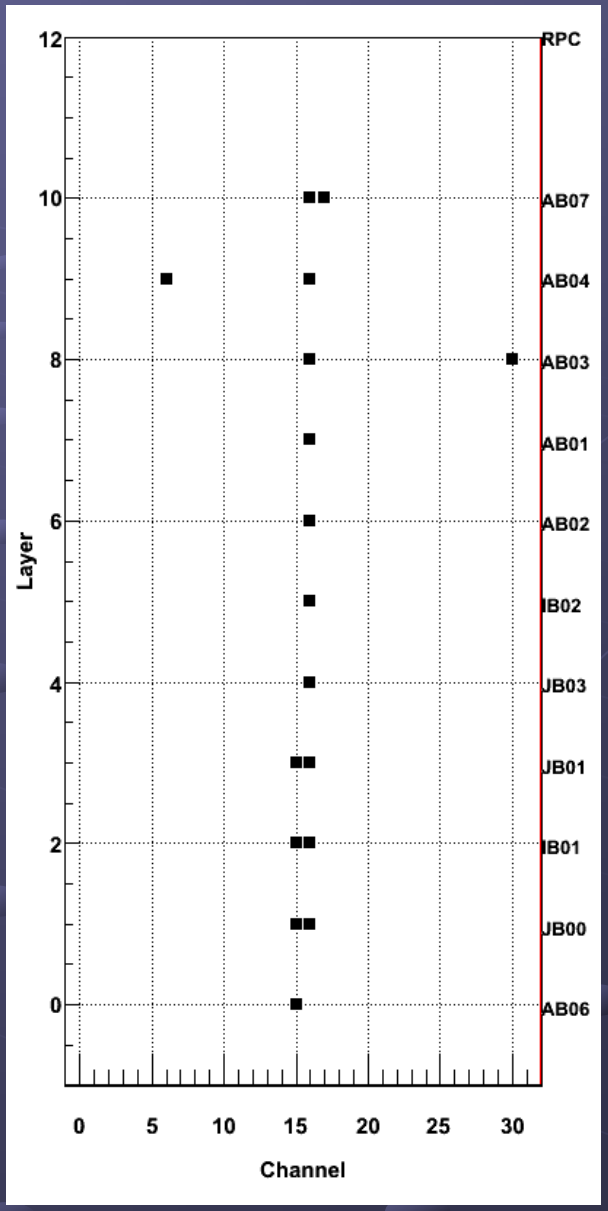


B-H curve of the magnet

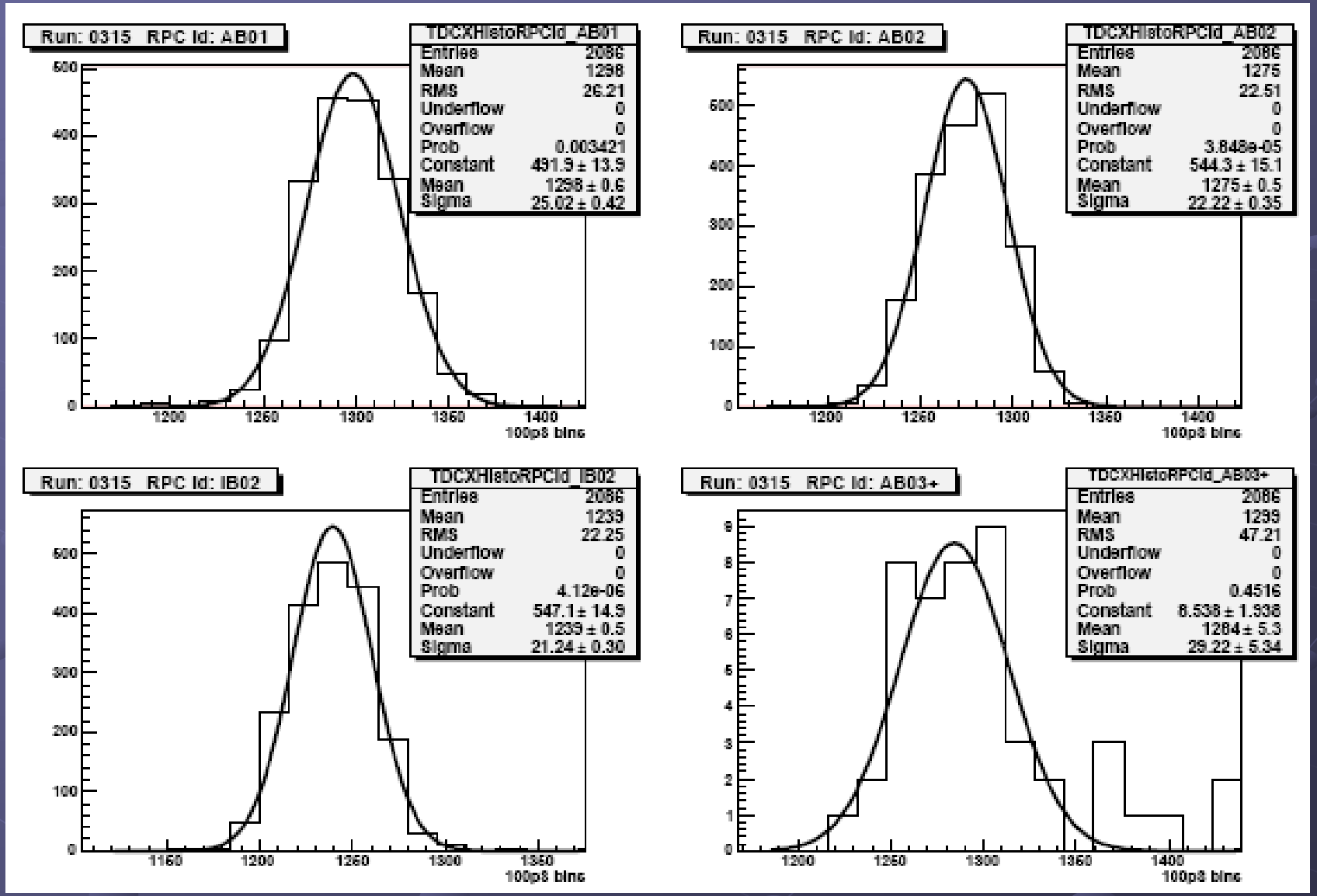
Electronics scheme for prototype detector



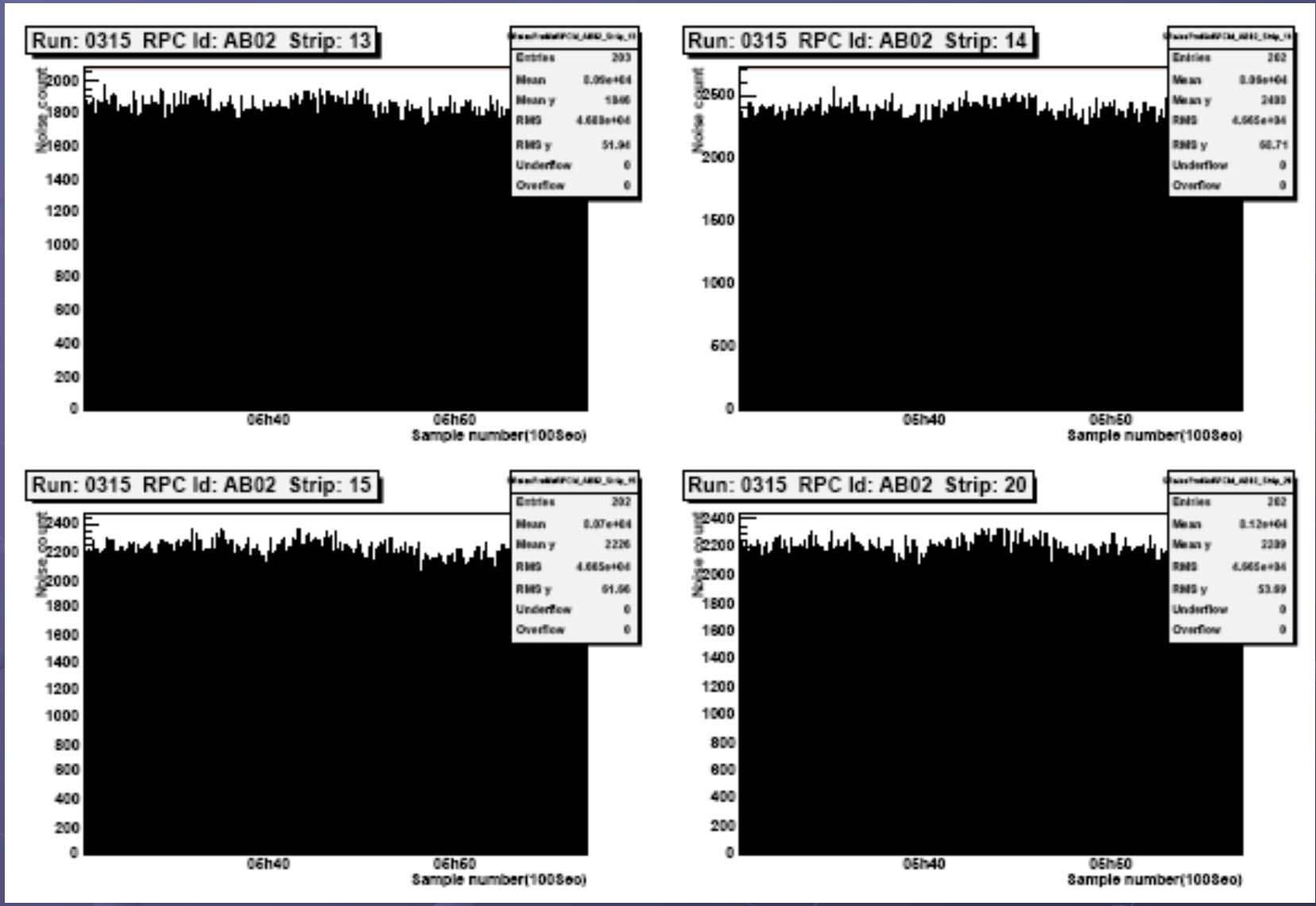
RPC stack for INO prototype detector



RPC timing resolution plots



Strip noise rate history plots



Current status and future work

- Successfully developed, fabricated and characterised 1m^2 RPCs. Preparing to start making 4m^2 RPCs.
- Magnet for prototype detector assembled and tested up to **B** of 0.65 T at 2000 amp turns
- Dozen chambers under long term test in a detector stack, tracking cosmic ray muons
- Design and fabrication of electronics and data acquisition systems completed; commissioning in final stages
- Expecting to start taking data in coming months