# SiPM Production Testing

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Production Manager

# Summary

- 3 setups, one for each stage
- Production started on January $9^{th}$.
- For the first 2 months we had 5 shifters
- Since the middle of March the number of shifters increased to 10.
- 1520 MPPCs measured in stages I and III to date.

# Shipping and Receiving

- 1520 MPPCs have been received to USM

Shipping box received from Hamamatsu

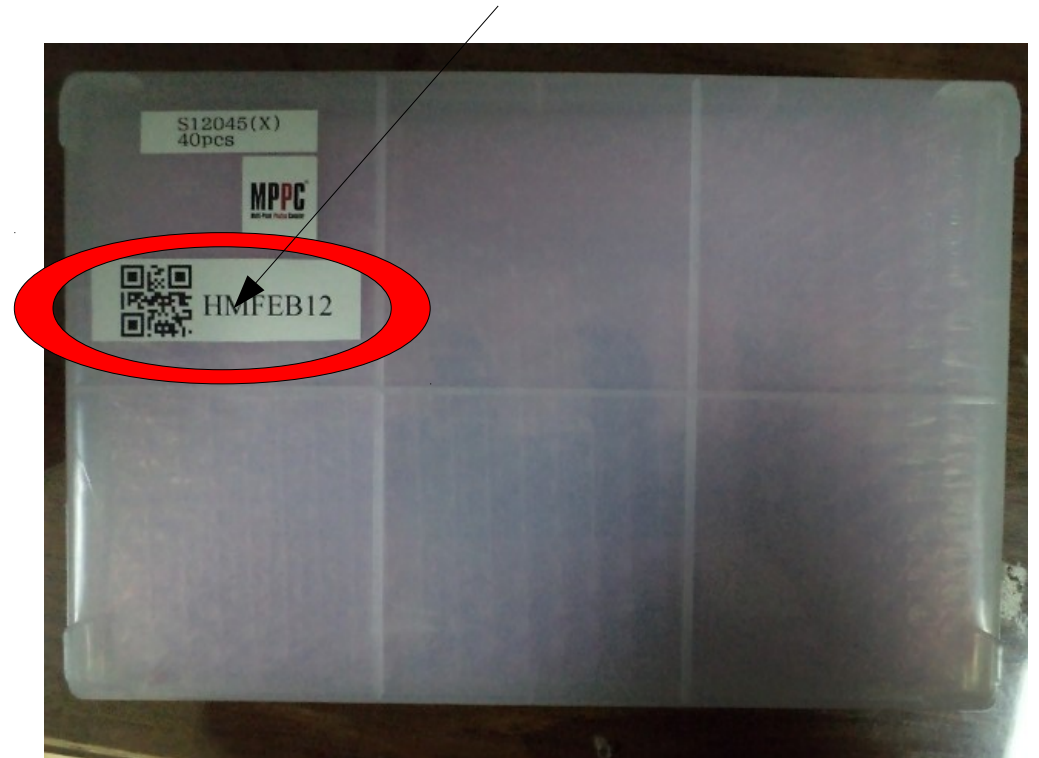Shipping bag used by Hamamatsu

# Shipping and Receiving

Hamamatsu Plastic box

Hamamatsu Plastic box after labeling



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# Shipping and Receiving

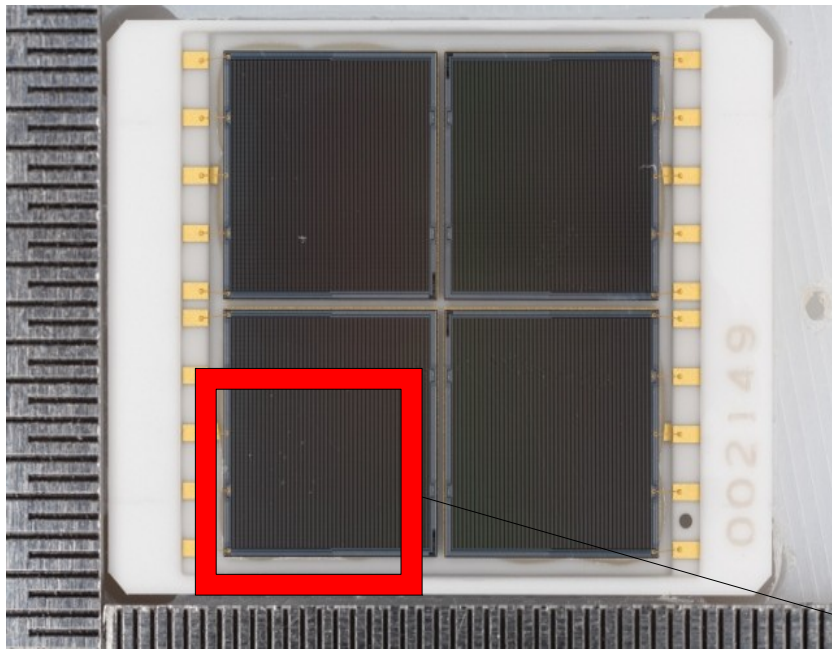Labeled Hamamatsu Plastic box after sealing to send to Jefferson Lab

# Stage I

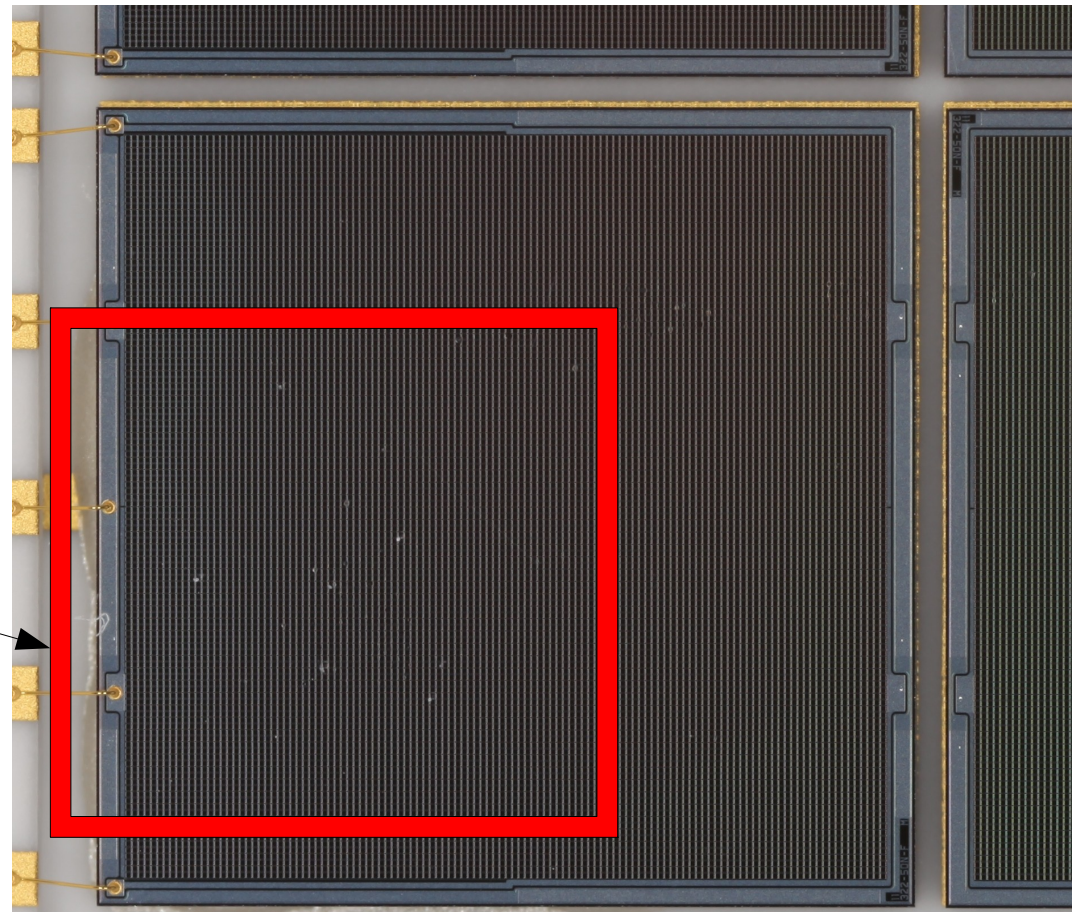- Consists of a Camera and a macro lens. The camera is interfaced to a computer.



Credits: René Ríos, Iñaki Vega, Francisco Valenzuela, Esteban Zambrano.

# Stage I

- Pictures of all MPPCs (front and rear side) have been taken (1520).
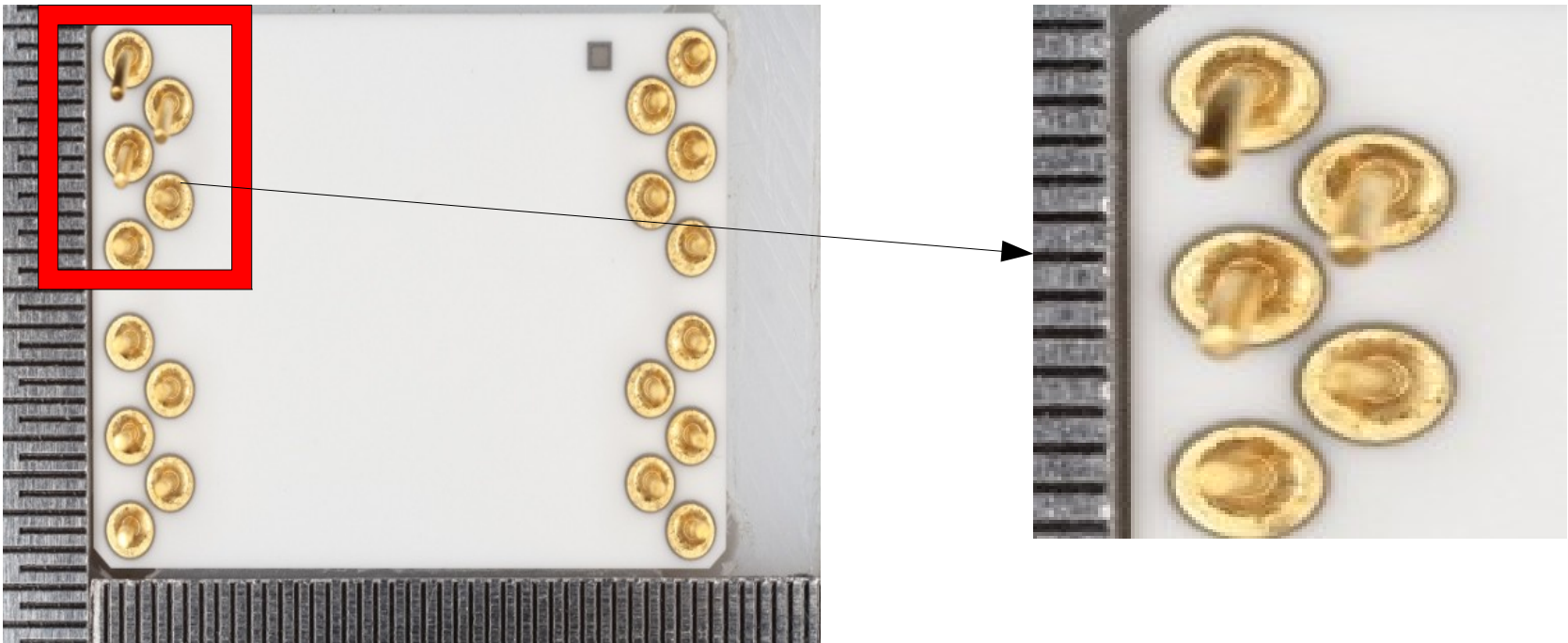  - MPPCs with blobs and bent pins detected



Two shifters working in this stage

# Stage I

- Pictures of all MPPCs (front and rear side) have been taken (1520).
  - MPPCs with blobs and bent pins detected

# Stage I Progress

- First few weeks
  - 1 shifter working 8 hours/day
  - Calibration of the camera parameters
  - Photograph acquisition rate
    - 90 MPPCs/day in one shift
- Now (Classes ongoing)
  - 2 shifters working 16 hours/day
  - Software to detect dimensions of every MPPC from the photograph: active area, total area, pin's distance, etc.

# Stage II

- Consists of 2 dark boxes without Temperature Control.

PDE station

Pulse Shape station



Credits: Sergey Koulechov, René Ríos, Rimsky Rojas, Gerardo Vásquez.

# Stage II

- 2 kind of measurements: PDE and Pulse shape

-  A PMT is used like a reference to calculate the PDE from the MPPC

- Cross check with analysis in Stage III

# Stage II Progress

- First 10 weeks (Summer vacations)
  - 3 shifters working 24 hours/day
  - CAMAC CAMAC CAEN C111C Ethernet controller with Lecroy 2249A QDC
  - Data acquisition rate
    - 3 MPPCs/day (first 2 weeks)
    - 8 MPPCs/day
- Now (Classes ongoing)
  - 4 shifters working 16 hours/day
  - VME CAEN V1718 controller with CAEN VME V792 QDC
    - Data acquisition rate increased
      - Total capacity of 40 MPPCs/day
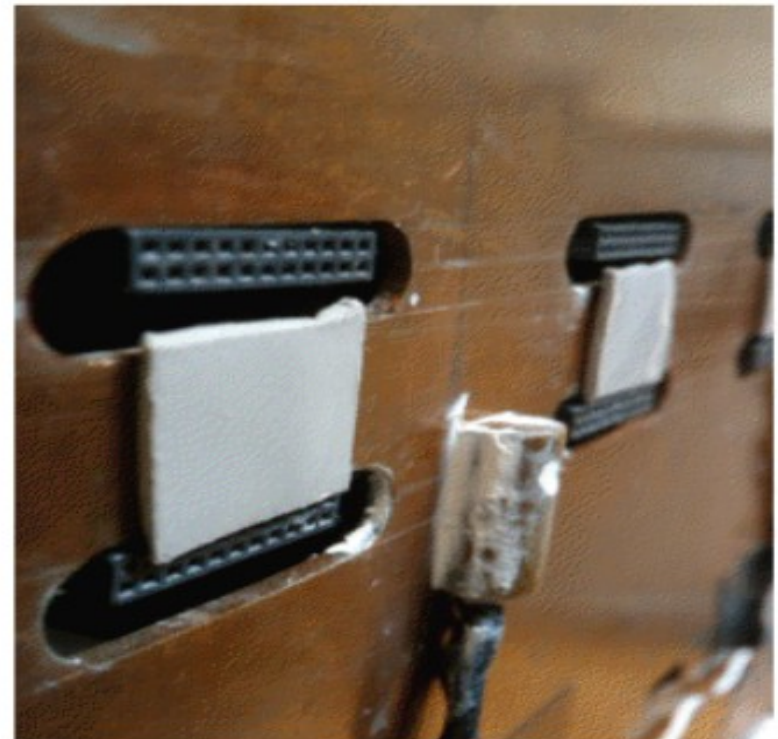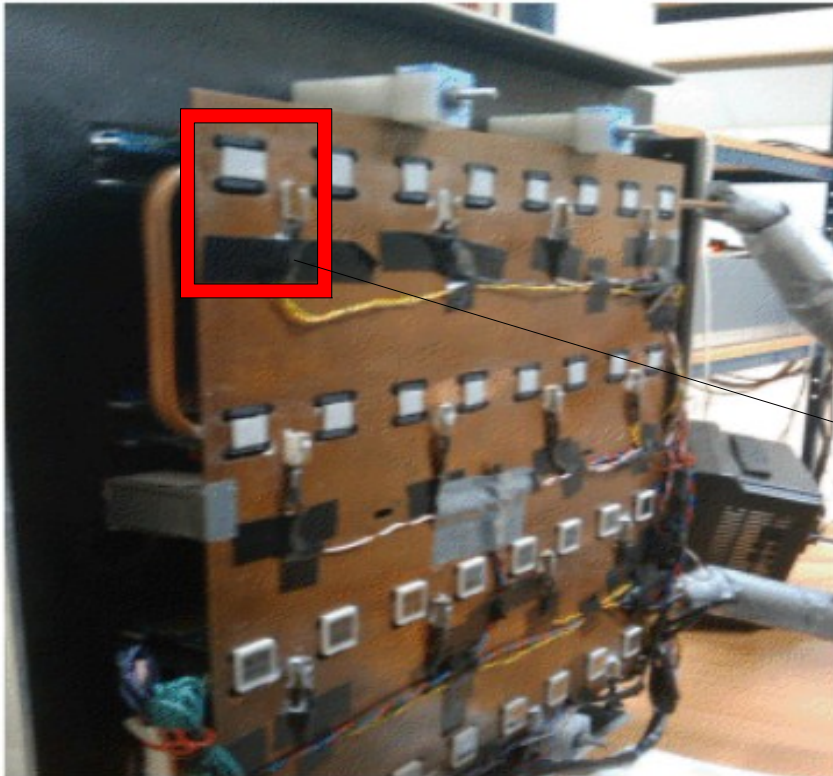      - MPPCs measured/day: 30

# Stage III

- One big dark box with temperature control.



Chiller and Chiller controler

# Stage III

- Measurement of 32 MPPCs at the same time
- 3 runs at 3 different temperatures for each set of MPPCs (5, 7 and 20 C°).



14 Credits: Sergey Koulechov, Pablo Bunout, Esteban Zambrano, Pedro Toledo, Iñaki Vega, Orlando Soto, Alam Toro.

# Stage III Progress

- First 10 weeks (Summer vacations)

  - Calibration of the setup

  - 1 shifter working 8 hours/day

  - CAEN VME V792 QDC

  - Data acquisition rate:

    - 30 MPPCs/day (first 2 weeks)

- Now (Classes ongoing)

  - shifters working 24 hours/day 5 days per week

  - One 8 hours shift on Saturdays and Sundays

    - Data acquisition rate:

      - 54 MPPCs/day

# Data analysis

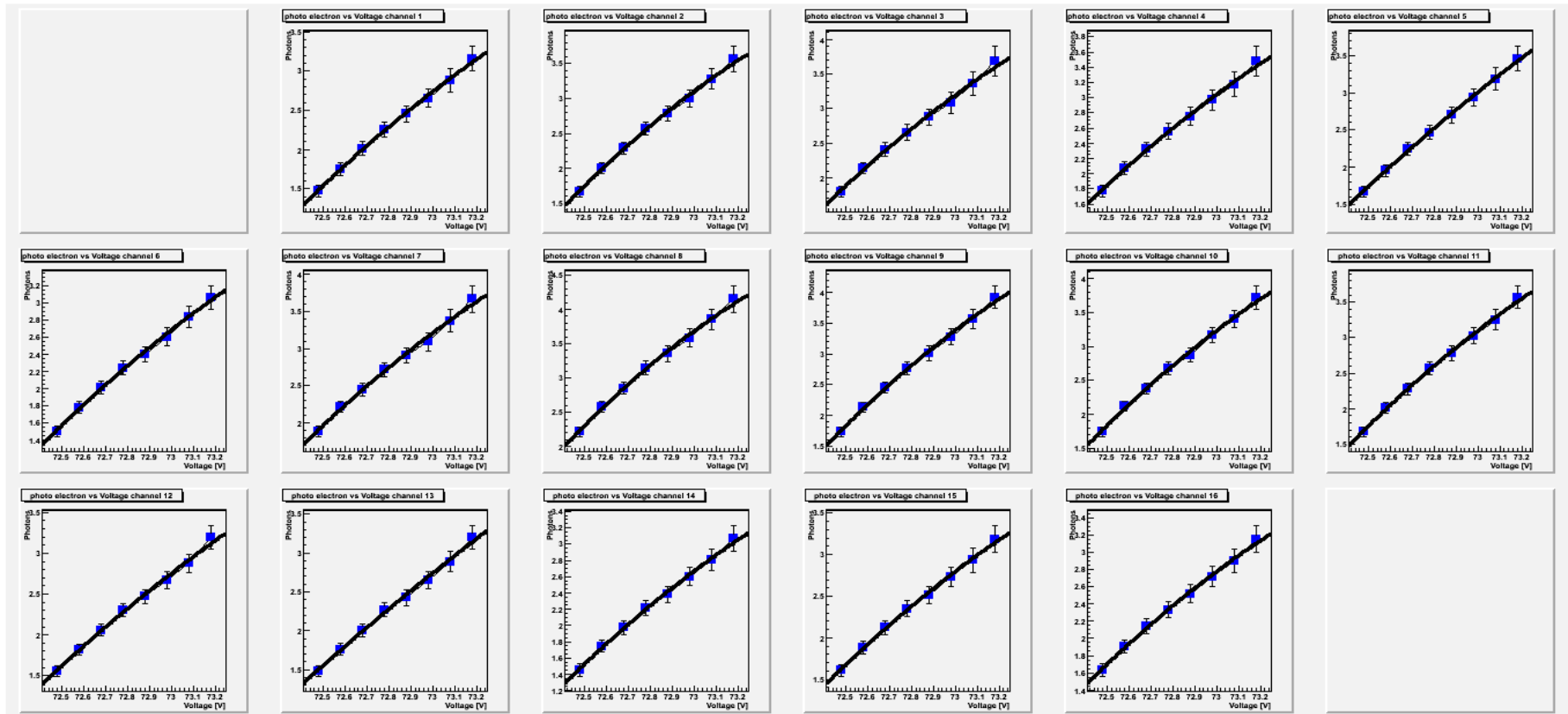## Stage II analysis:
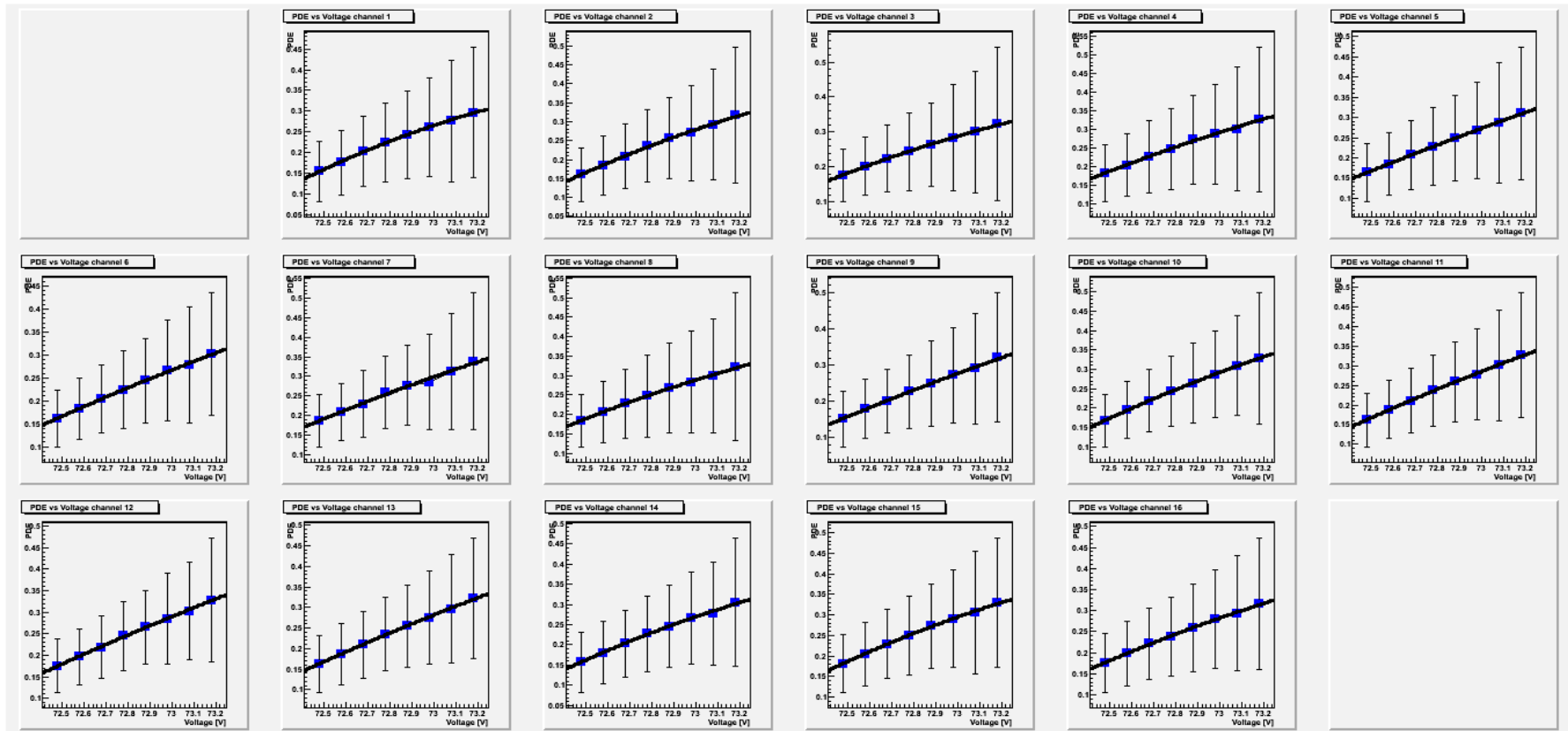
– Gain v/s voltage for 16 channels

Plots made by Rimsky Rojas
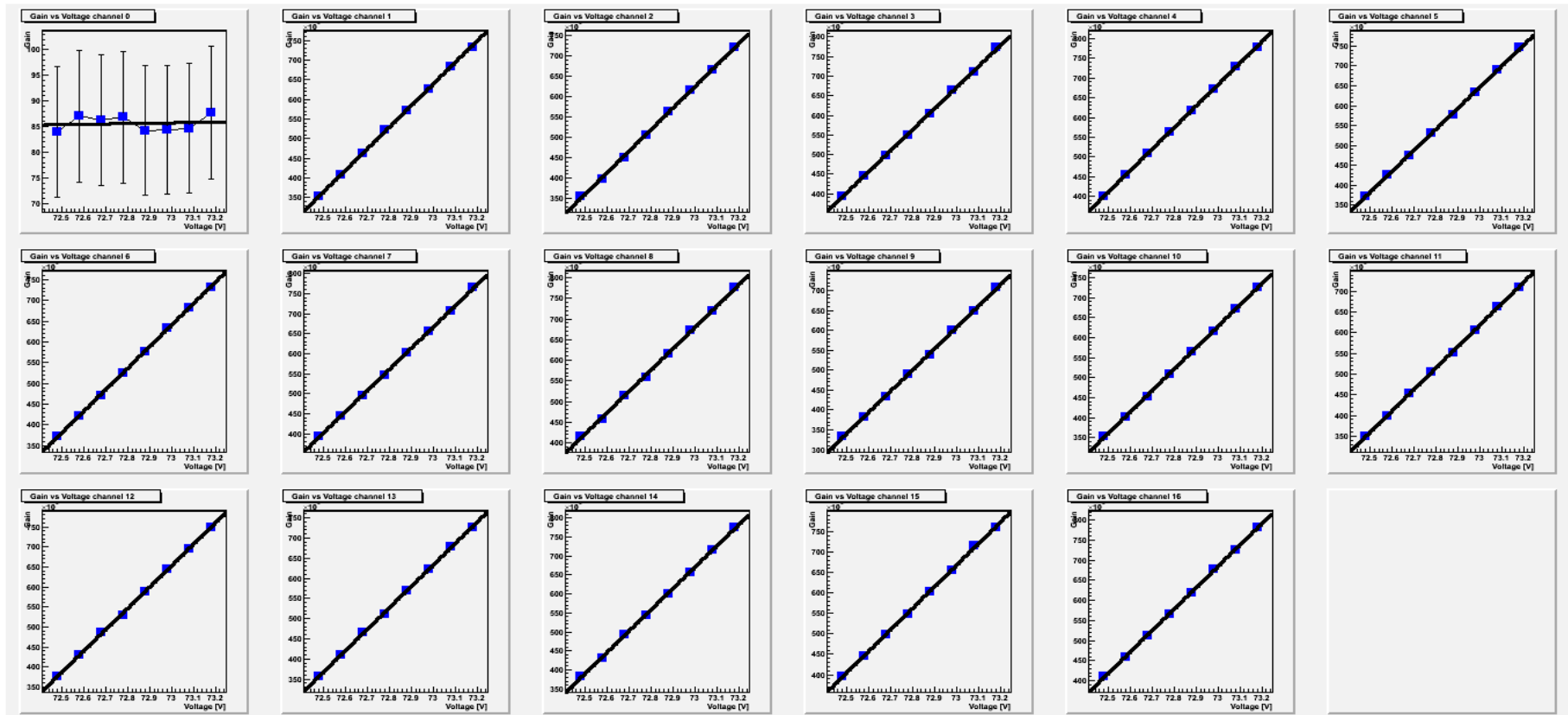
# Data analysis

## Stage II analysis

– Photon electron v/s Volgage

Plots made by Rimsky Rojas

# Data analysis

## Stage II analysis

– PDE v/s Volgage

Plots made by Rimsky Rojas

# Data analysis

## Stage III analysis

- Number of photoelectron received v/s position

Plots made by Orlando Soto
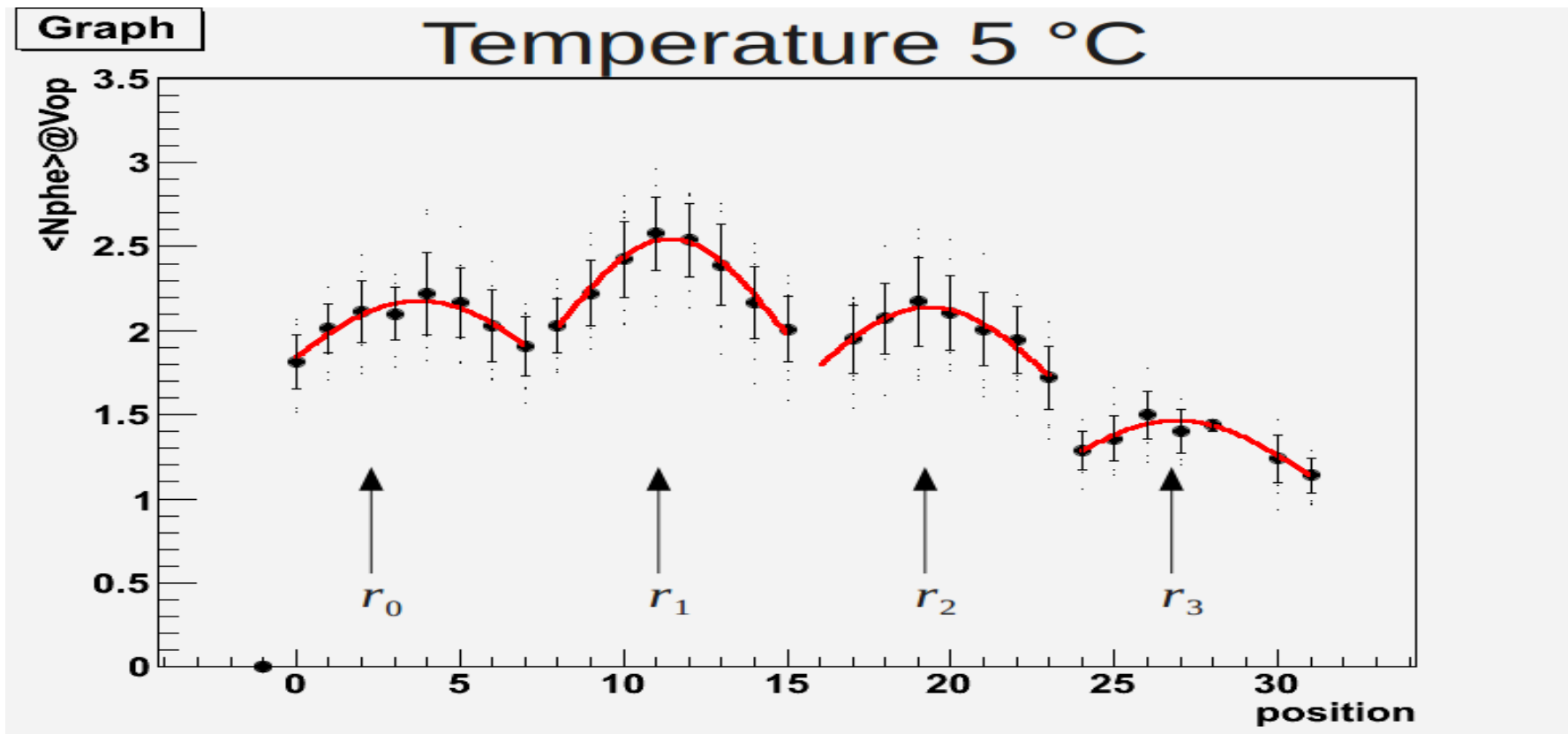
# Data analysis

## Stage III analysis

– Cross talk v/s MPPC
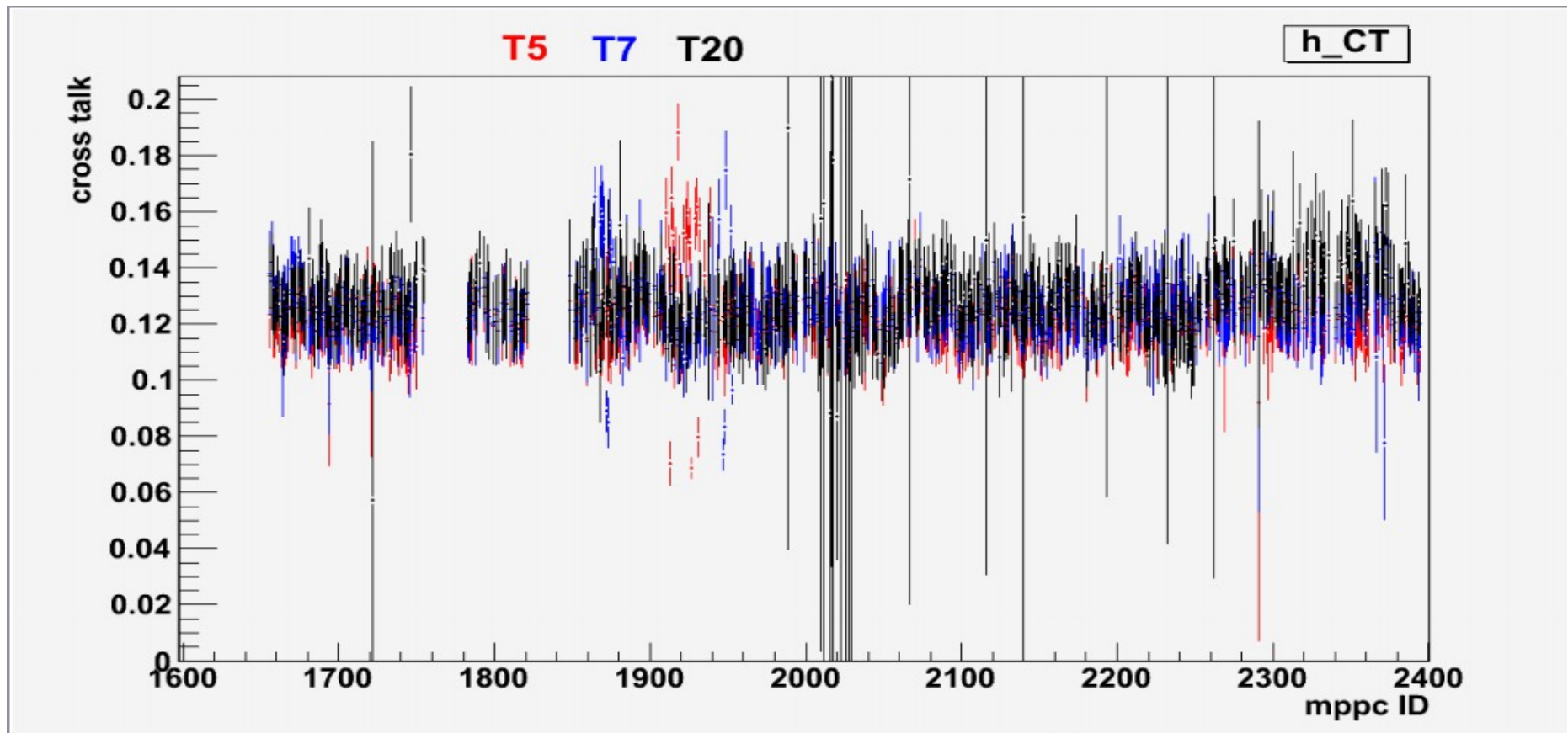
Plots made by Hayk Hakobyan

# Data analysis

## Stage III analysis

- Dark rate v/s MPPC

Plots made by Hayk Hakobyan

# Data analysis

## Stage III analysis

– Dark rate v/s MPPC

Plots made by Hamamatsu
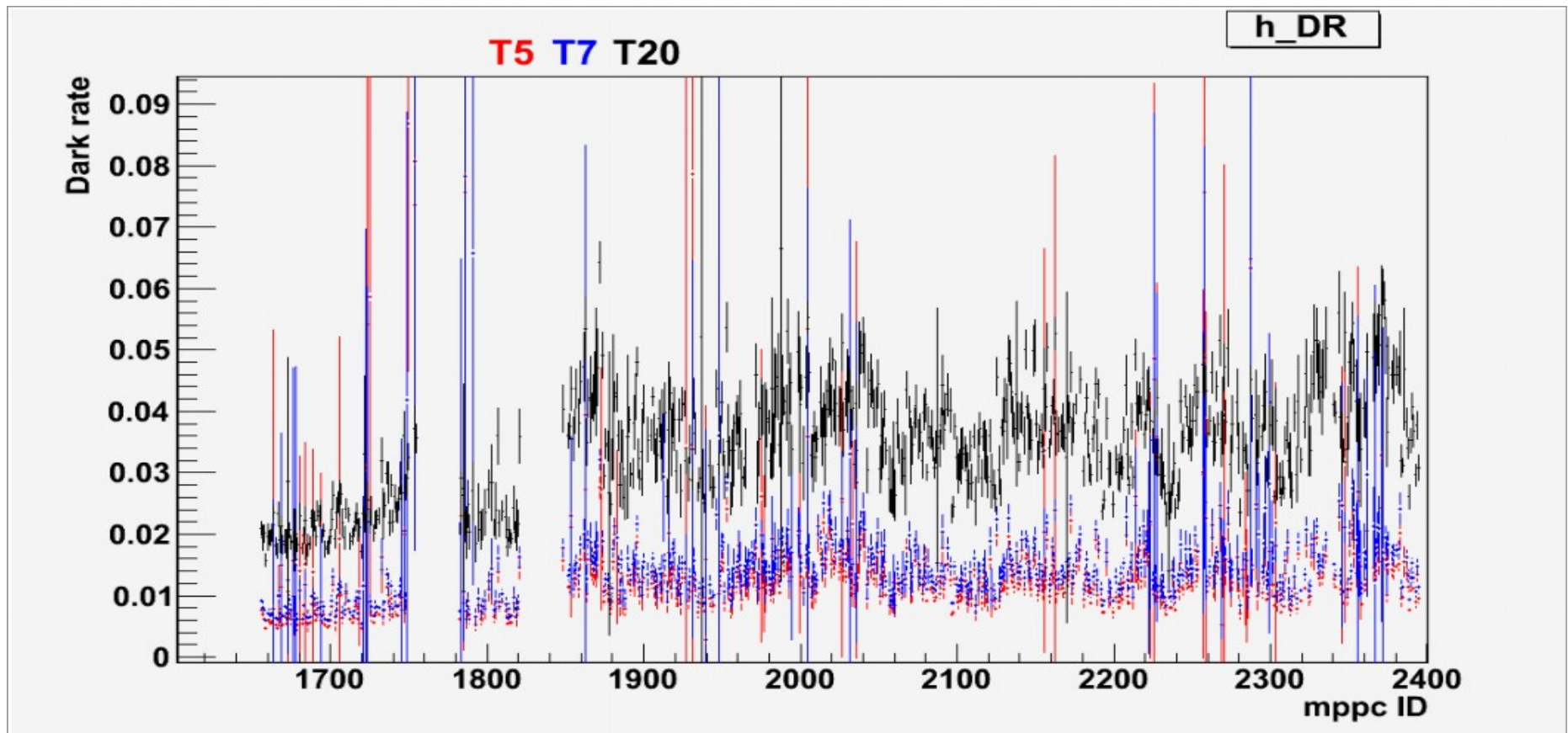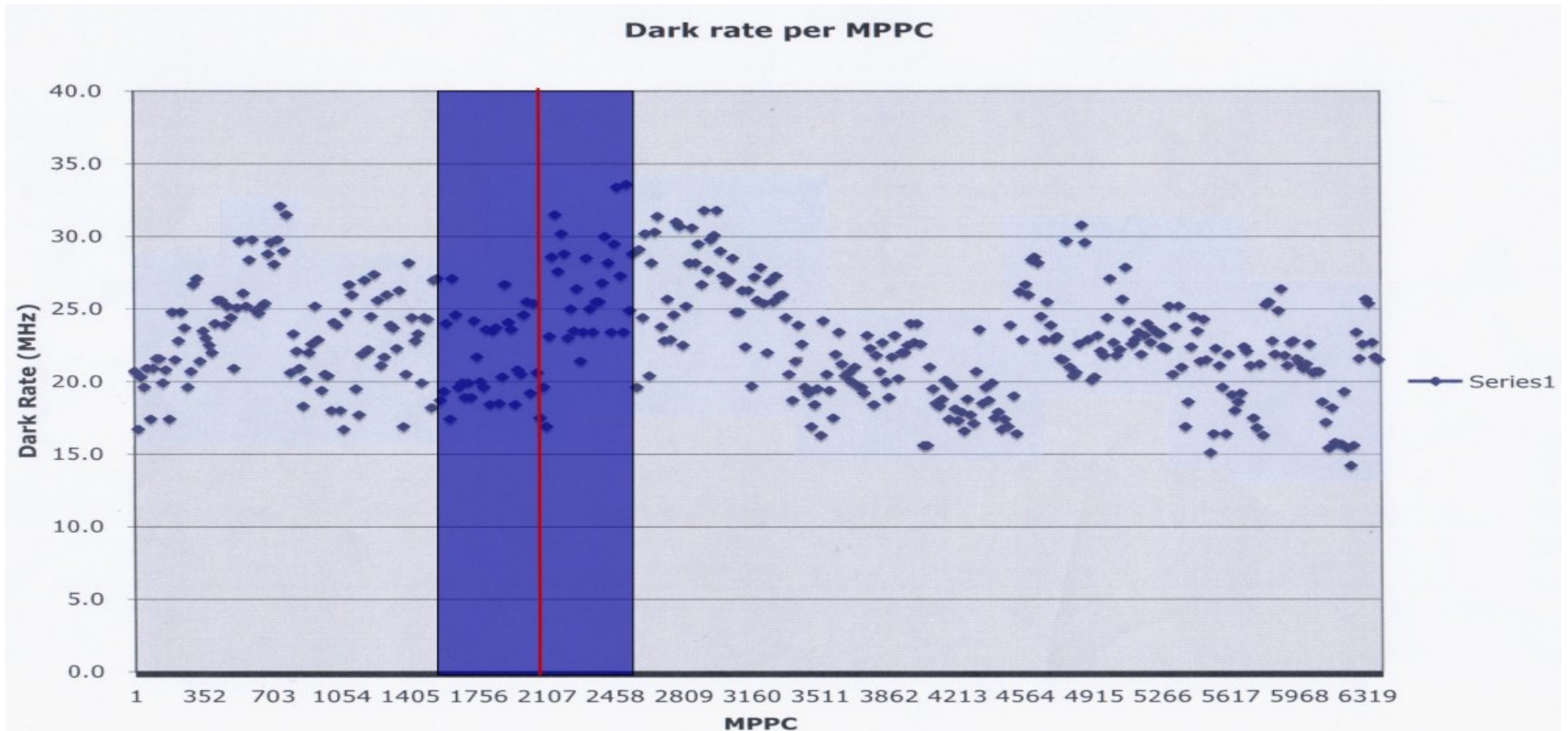
# Update on SiPM Production Test at Jefferson Lab

Bobby Bunton and Yi Qiang

Jefferson Lab

Dark Box

DAQ

Computer

Storage Cabinet
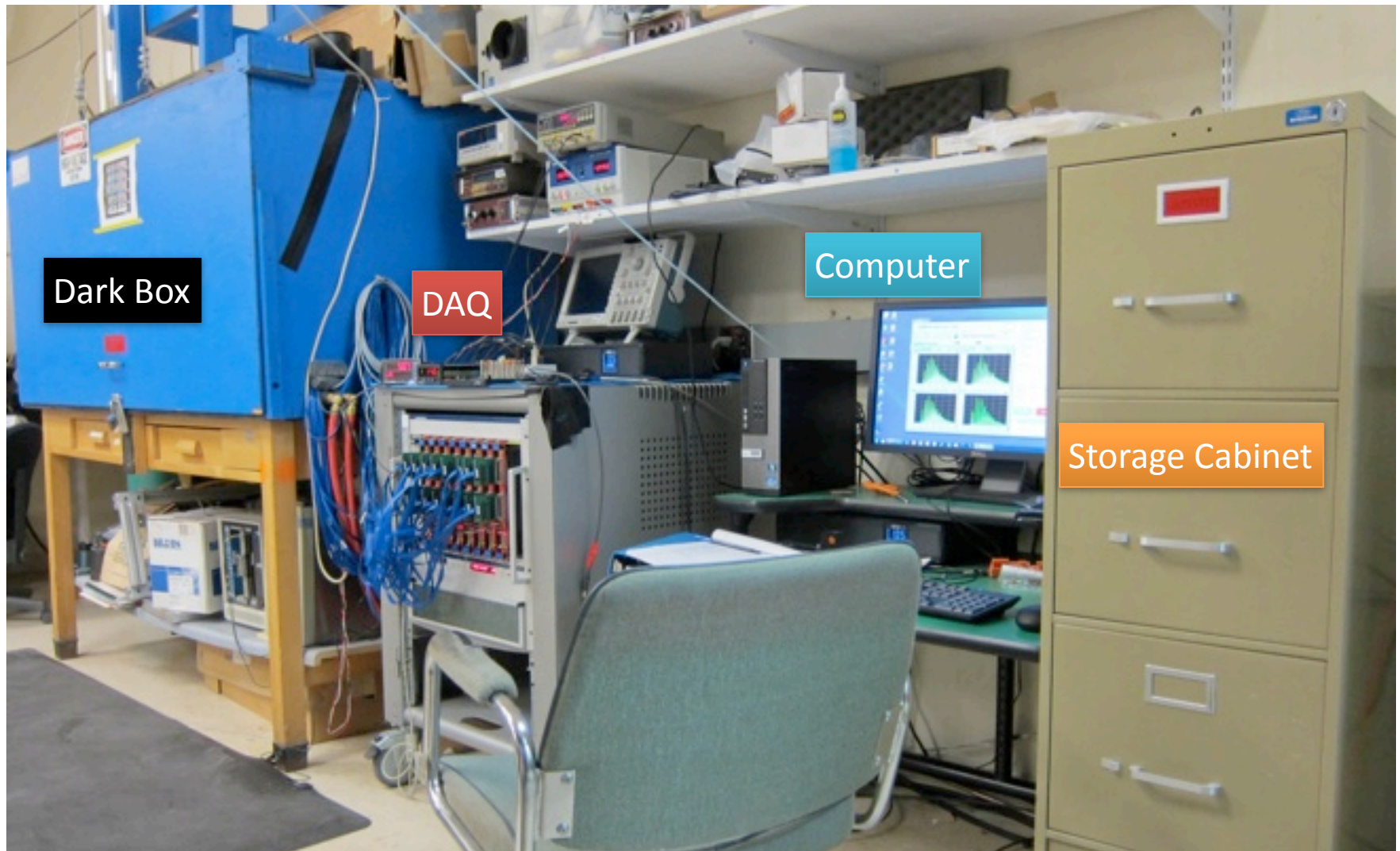
# Temperature Gradient

- ➢ Discovered during uniformity test
    - ❑ 15$^o$C and 0.2V above Hamamatsu bias voltages ($V_{ob}$=1.1V)
    - ❑ Gain: 20% variation!
    - ❑ PDE, X-Talk: strong correlation to the gain
    - ❑ **Voltage offset !**
- ➢ Determined to be temperature gradient
    - ❑ HV power supply very uniform
    - ❑ Huge amount of heat generated by pre-amplifiers: 35 $^o$C without cooling
    - ❑ Lose thermal contact:
        - ○ SiPM ↔ **2 mm Thermal Pad** ↔ Cooling plate
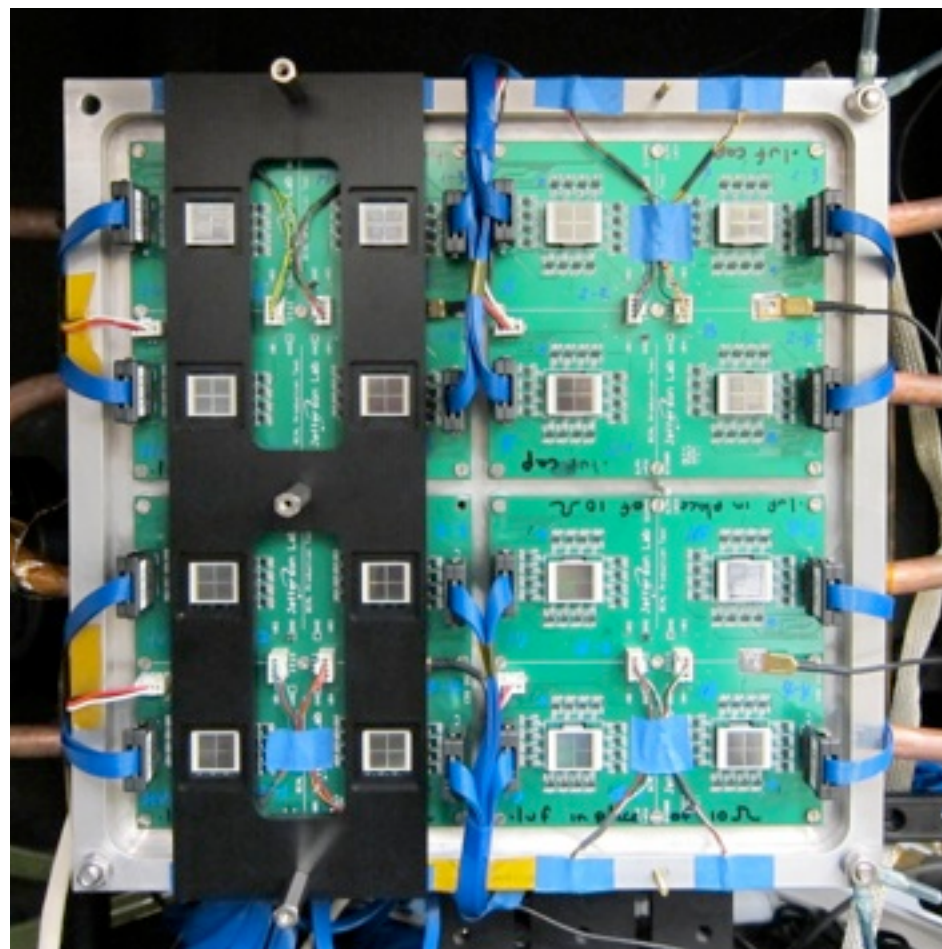    - ❑ 20% → 3 degrees variation

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# Solution

➤ Reduce Thermal Gap

- ❑ Modified stand-offs behind preamplifier boards
- ❑ 2 mm → 0.5 mm

➤ Apply Pressure on SiPMs

- ❑ Added face plates
- ❑ Better thermal contact
- ❑ Better electrical contact

➤ Result

- ❑ < 6% gain variation
- ❑ ~ 1 degree temperature gradient

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# Procedure for Production Test

➤ Technician: Bobby Bunton

➤ 3 Filter Settings: 0, 2%, 5%

❑ Measure PDE, Dark Rate, Gain and Cross talk

➤ 2 Voltage Settings: $V_{ob}$ = 0.6, 1.2 V

❑ Measure break down voltage

❑ Voltage dependence

➤ One temperature: 15°C

❑ Well above dew point

➤ Logging

❑ Pansophy Traveler: http://pansophy.jlab.org/pansophy

❑ Hall-D Elog: https://halldweb1.jlab.org/elog-halld/SiPM/

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# Progress

➢ A slow start

  ❑ Flaky channels: re-soldered several grounding taps of SAMTEC connectors

  ❑ Noisy board, ringing: solved by reducing the positive voltage for preamplifiers

  ❑ 10 units a day, 120 units measured and analyzed so far

➢ Now

  ❑ Running in full capacity: 16 SiPMs at a time

  ❑ ~ 50 units a day, one to two months to finish all units

➢ Next

  ❑ Measure SiPMs at $5^oC$: add active gas flushing system to control humidity

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Thank you