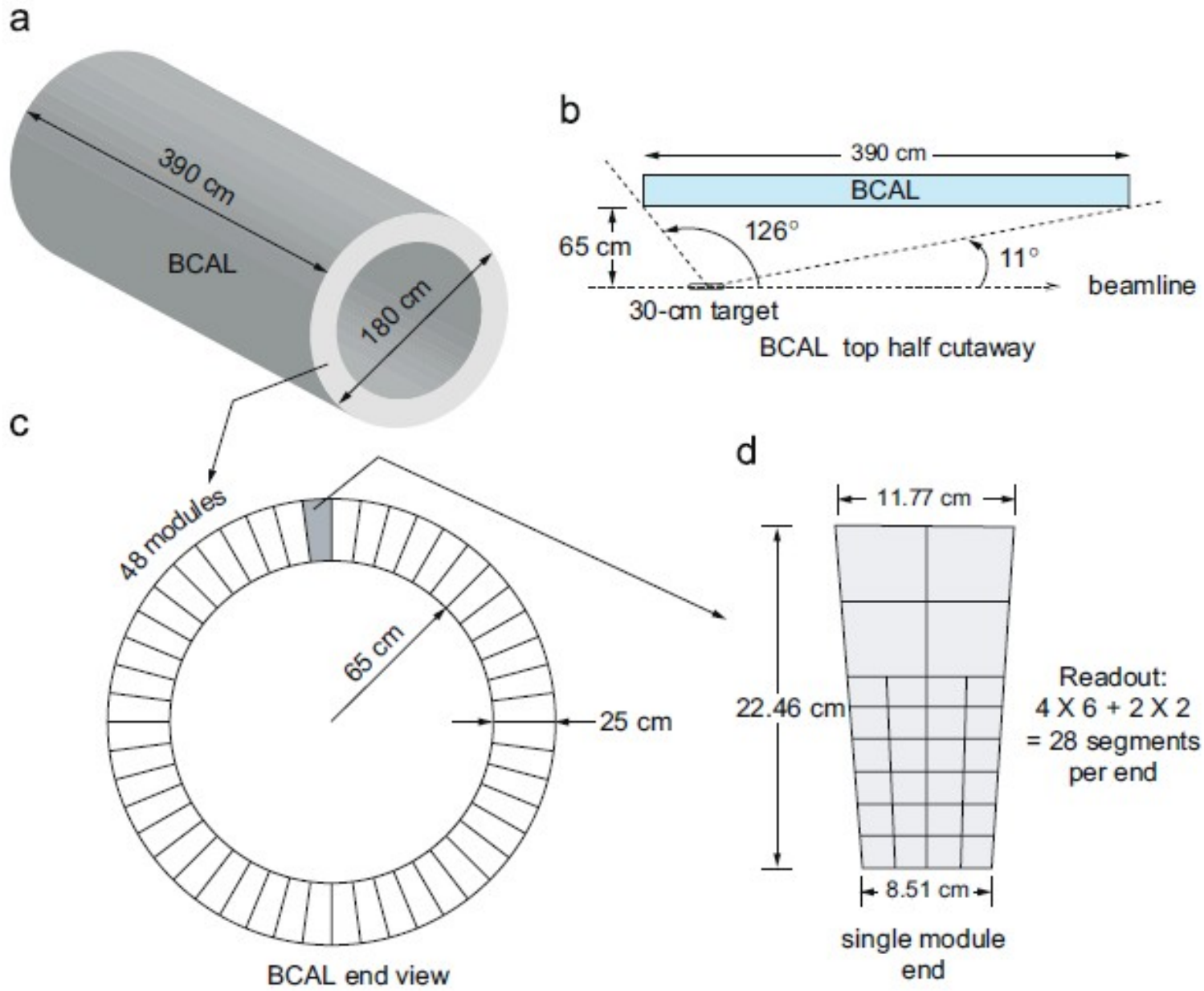
Report on UTFSM/GlueX MPPC test and light guides fabrication projects

Hayk Hakobyan
(Universidad Técnica Federico Santa María)

Hall-D Colaboration meeting

October 4 – 5, 2012

Cylindrical electromagnetic calorimeter (BCAL)



MPPC test project (Staff and Roles)

Director, SiLab Detector Laboratory: Sergey Kuleshov

Production manager: Javiera Quiroz

Head engineer: Alam Toro

Project engineering: Orlando Soto, Rimsky Rojas, René Rios, Pavlo Bazalyeyev, Juan (Iñaki) Vega, Martín Cortés.

Software coordination: Hayk Hakobyan

Software engineering: Ricardo Oyarzún, Orlando Soto, Juan Pavez

Director, CCTVal: Ivan Schmidt

Business and Projects Management, CCTVal: Francisco Soto

Administrative: Cynthia Sánchez

Project Coordination: Will Brooks

HAMAMATSU product MPPC

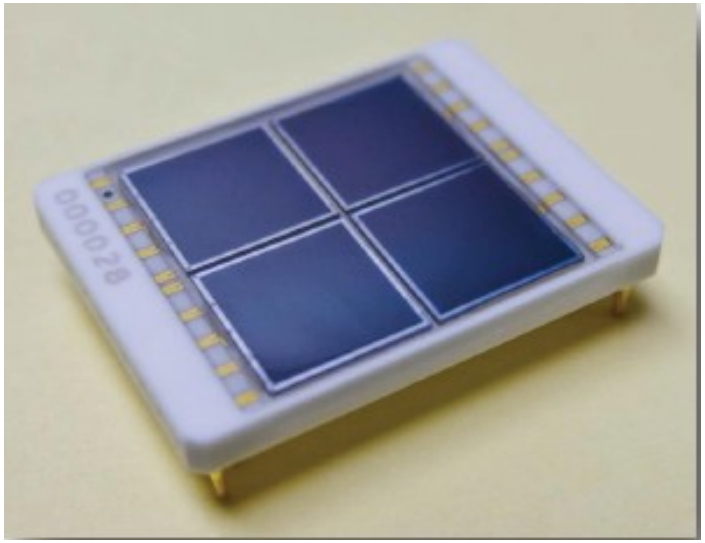
Multi Pixel Photon Counter (MPPC) is a solid state photon counter using Geiger-mode APD and self-quenching resistance.

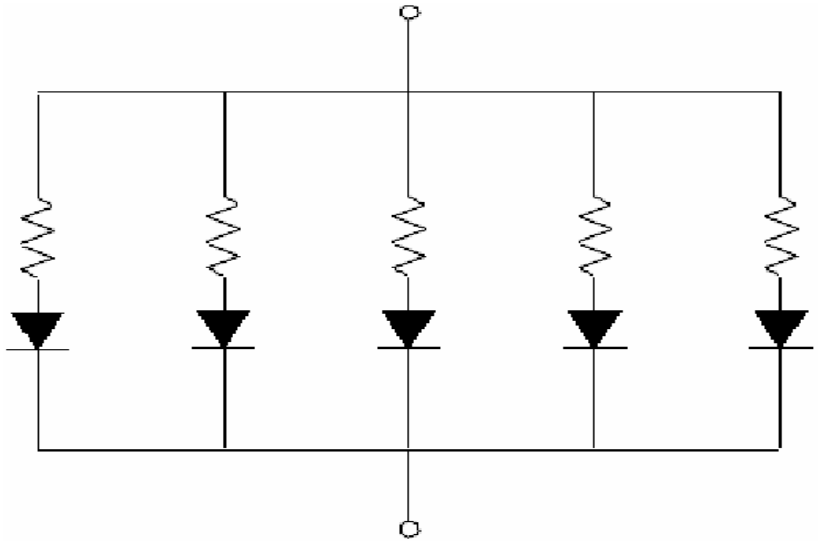
Main features:

- low bias voltage operation
- high gain
- insensitivity to magnetic fields

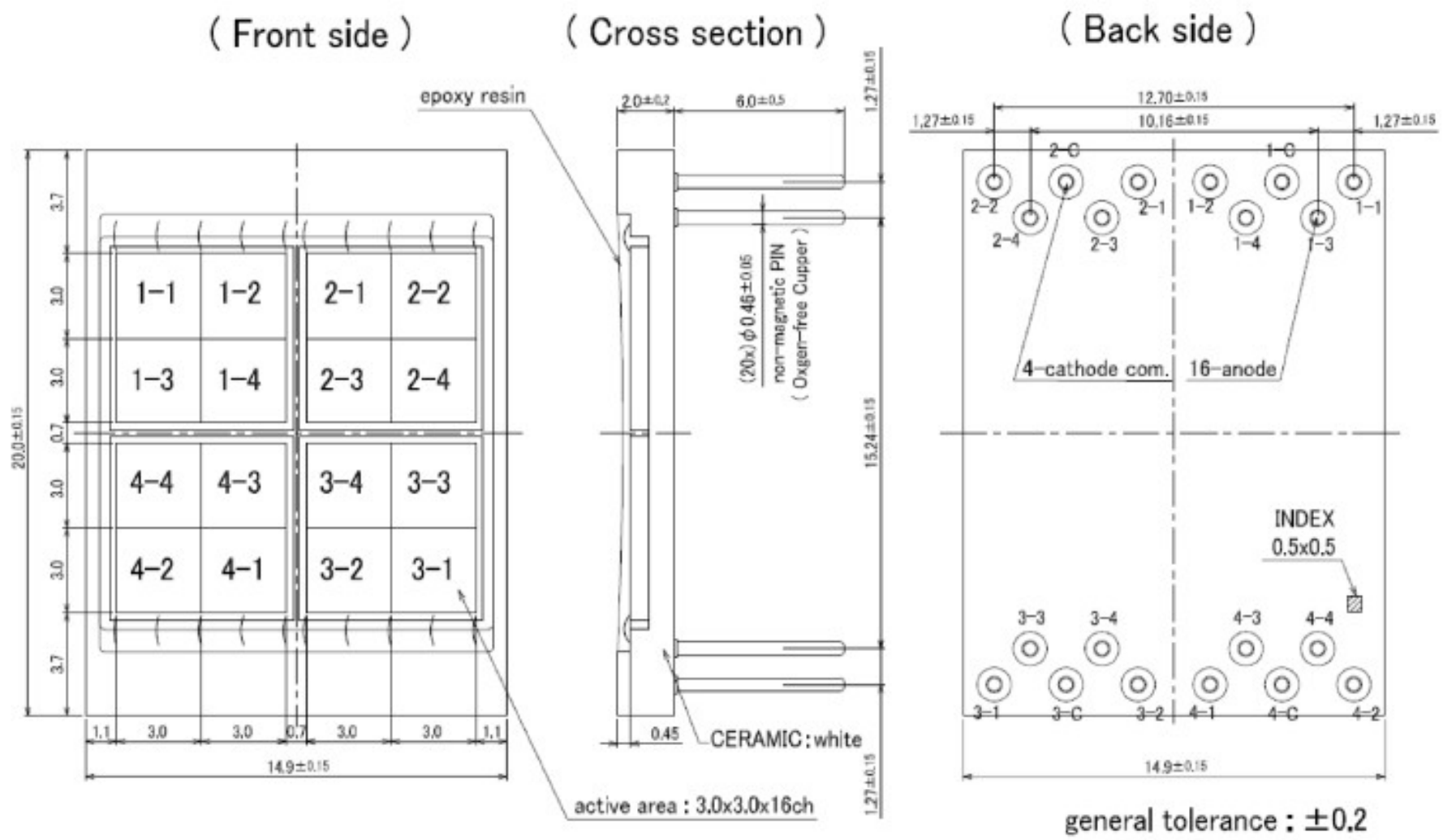
Three kinds of MPPCS with effective area 1mm x 1mm each:

40 pixels x 40 pixels, 25um pitch, f_{geo}=30.8%
20 pixels x 20 pixels, 50um pitch, f_{geo}=61.5%
10 pixels x10 pixels,100um pitch, f_{geo}=78.5%





HAMAMATSU MPPC Array

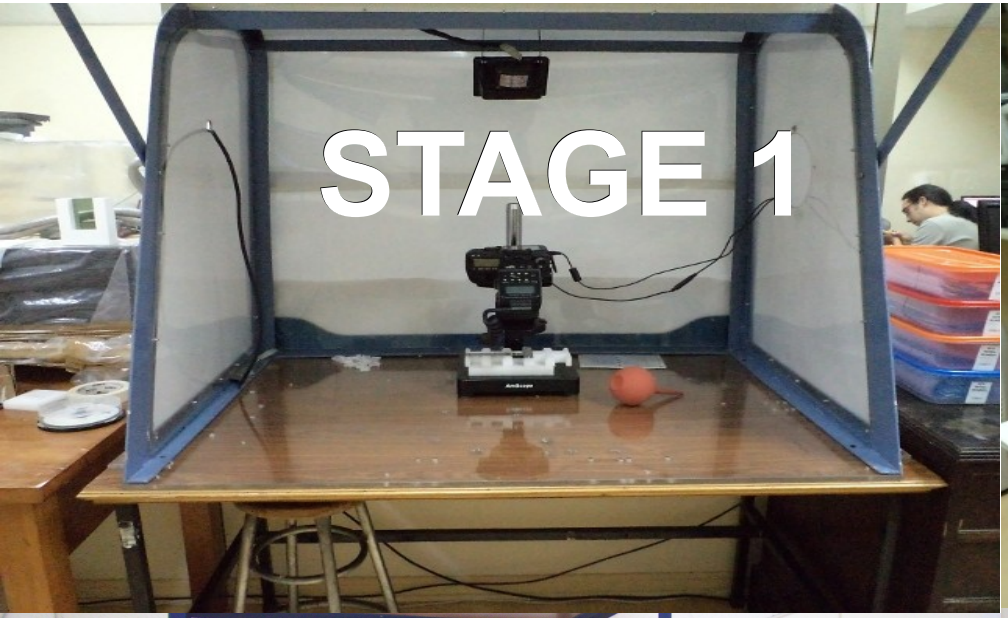


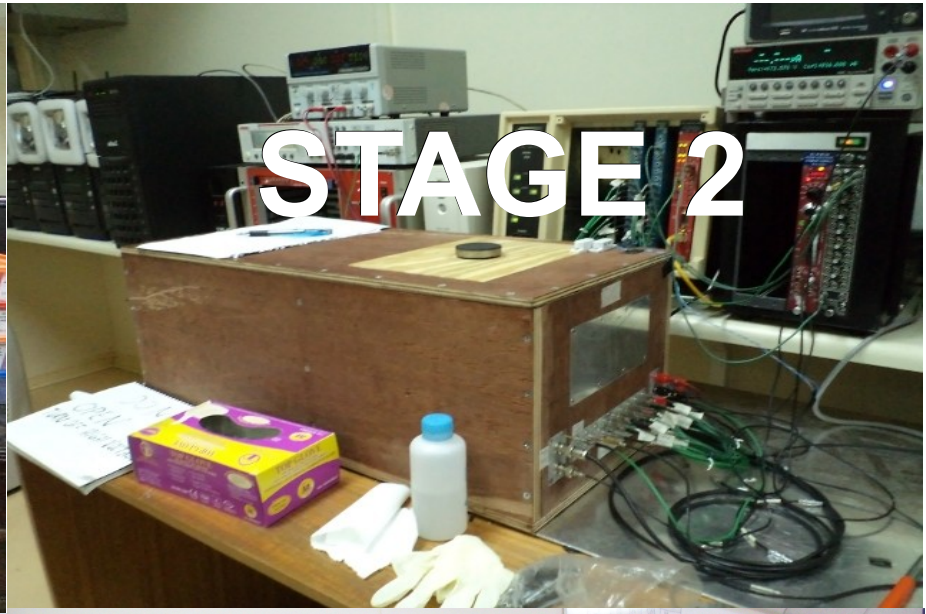
Three-station equipment for three stages of MPPC test

- Station 1: visual inspection station which includes a high resolution photographic camera
- Station 2: PDE and pulse shape characteristics measurement taking data with LED/green-fiber light source.
- Station 3: 32-MPPC station using variable intensity LED, can change temperatures over wide range, can measure I-V curves.

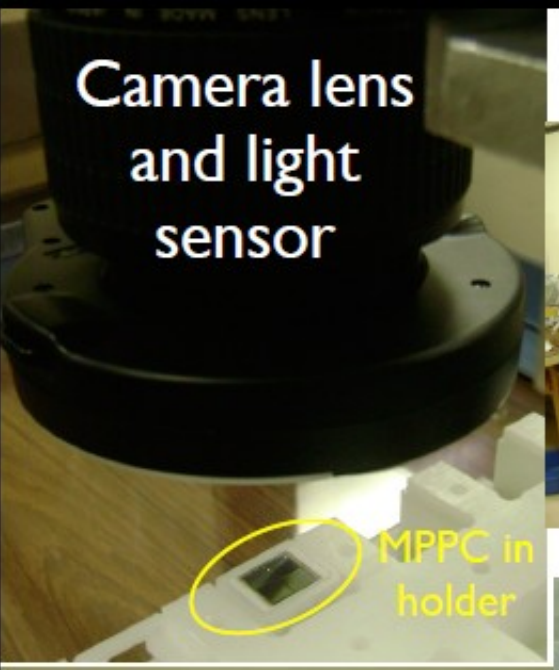
Whole system is provided with a MySQL database with a web access: http://atlasusr.fis.utfsm.cl:8000/

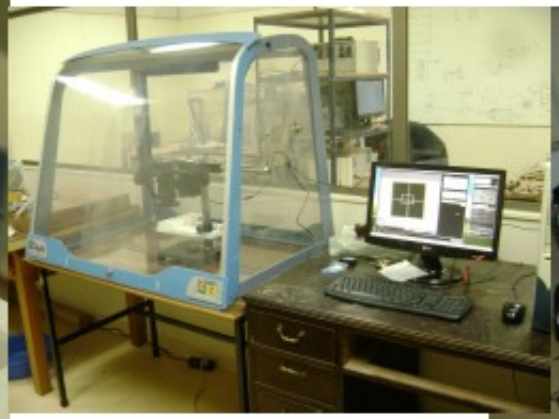
Three stages of testing

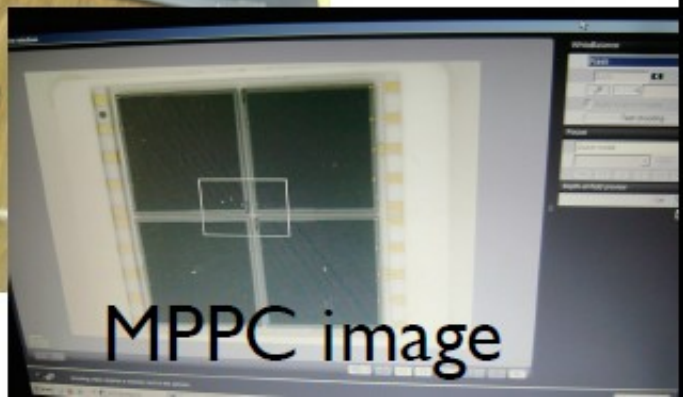




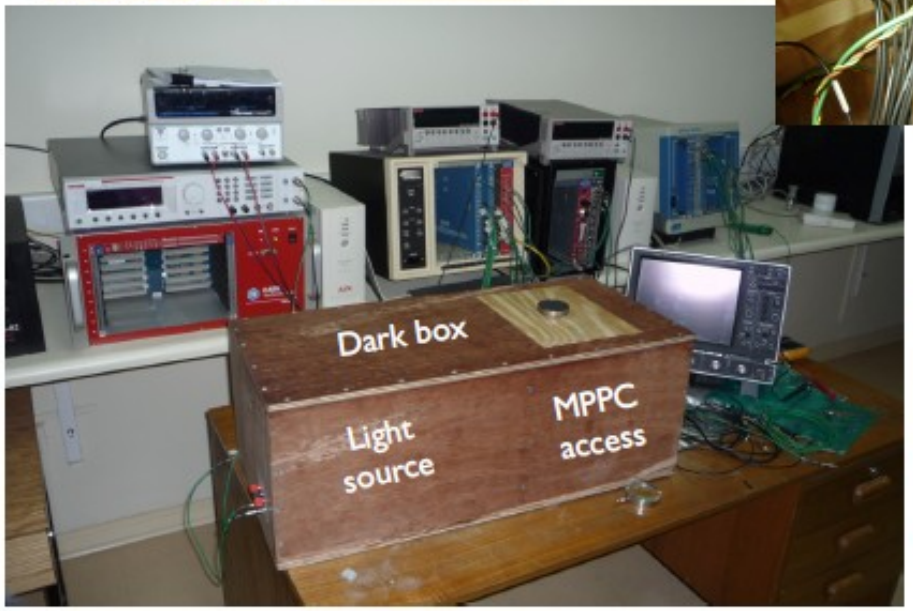
Inspection Station (Stage I)

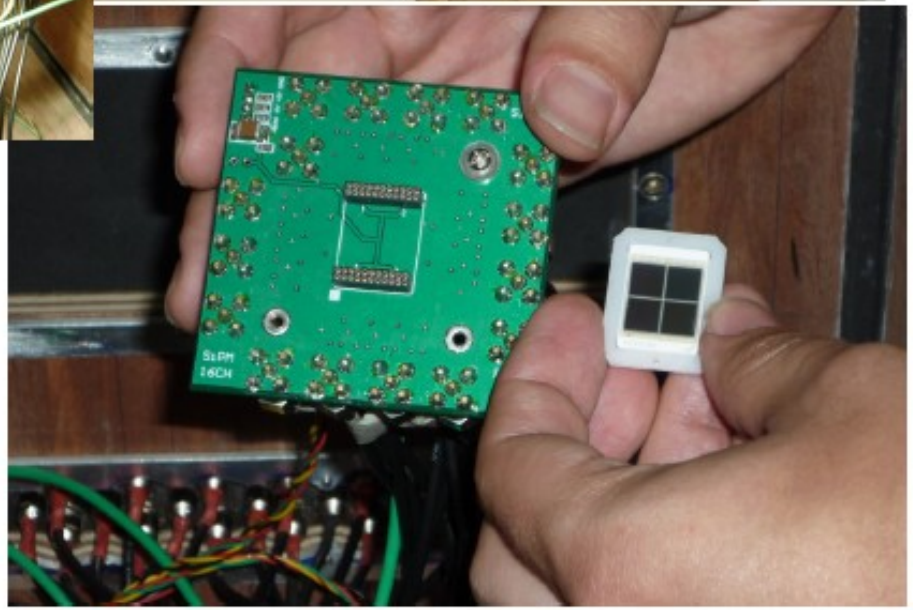




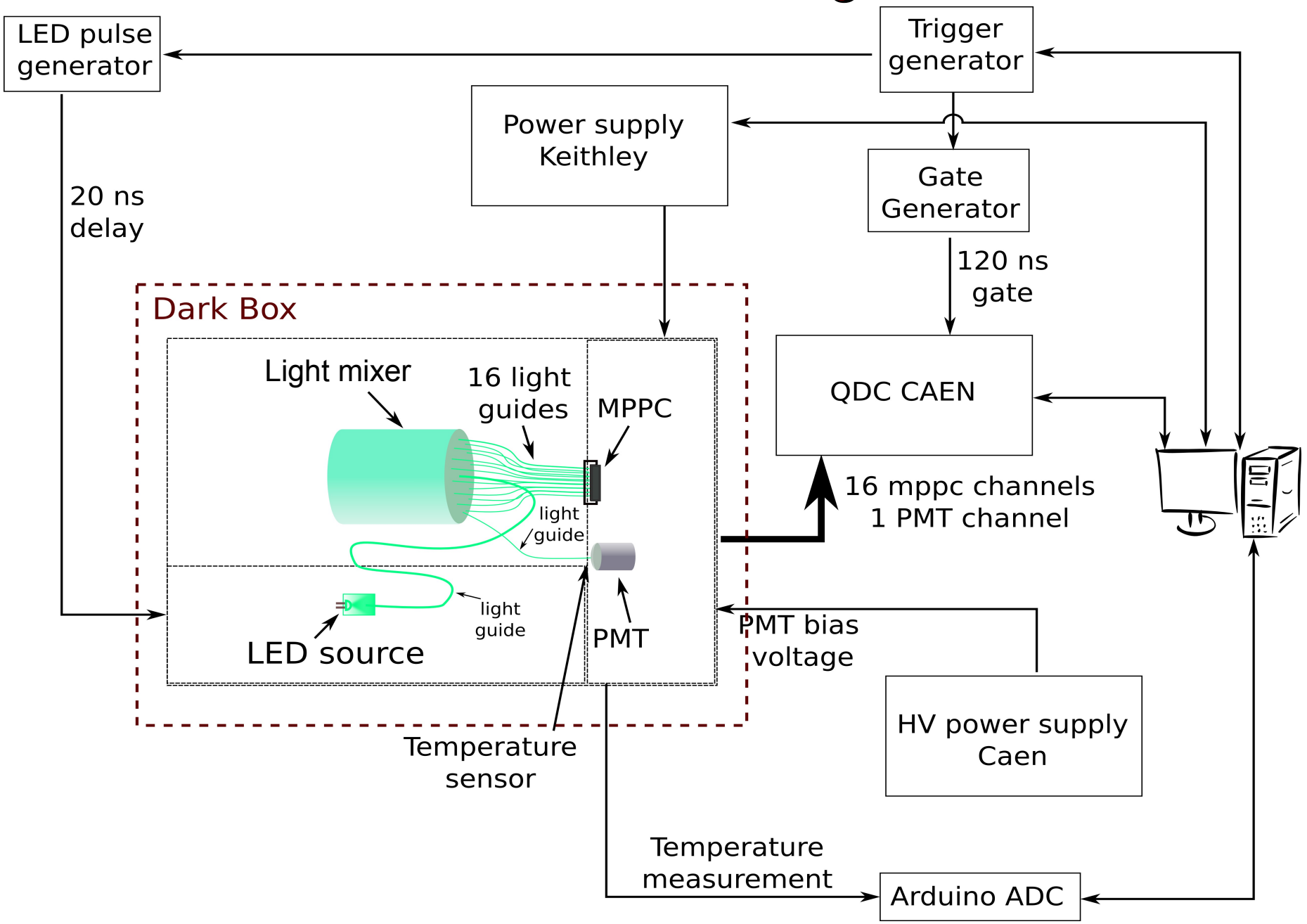


PDE Station (Stage II)

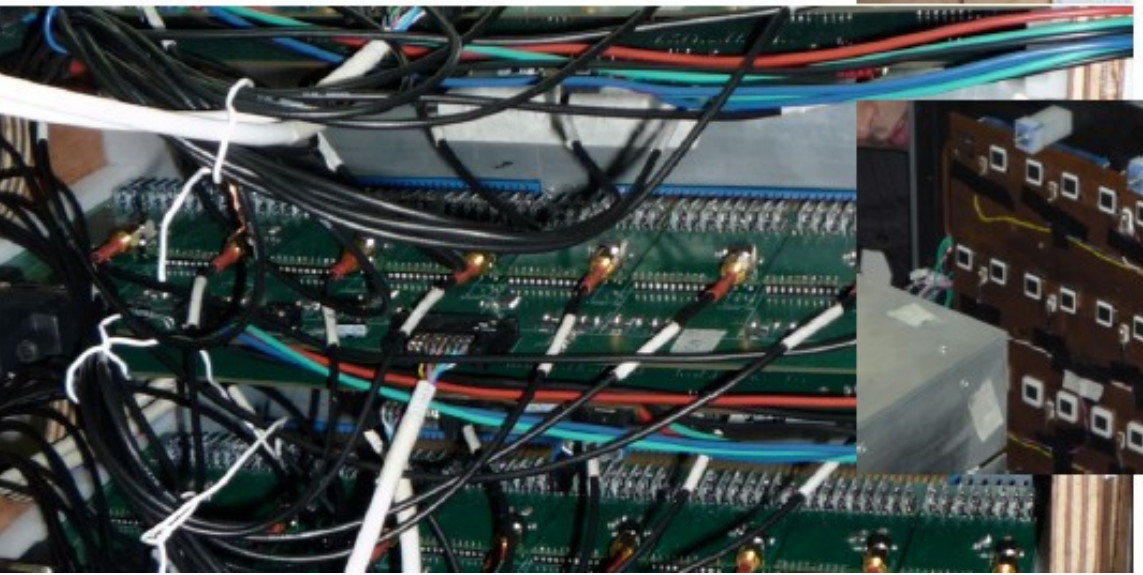


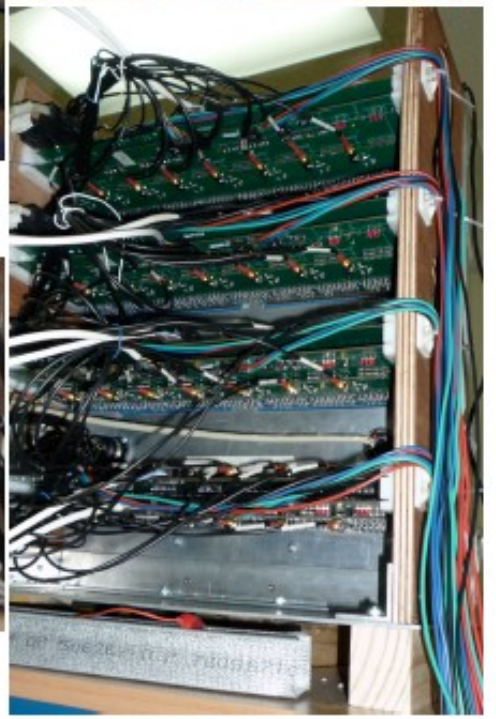


STATION 2 Diagram

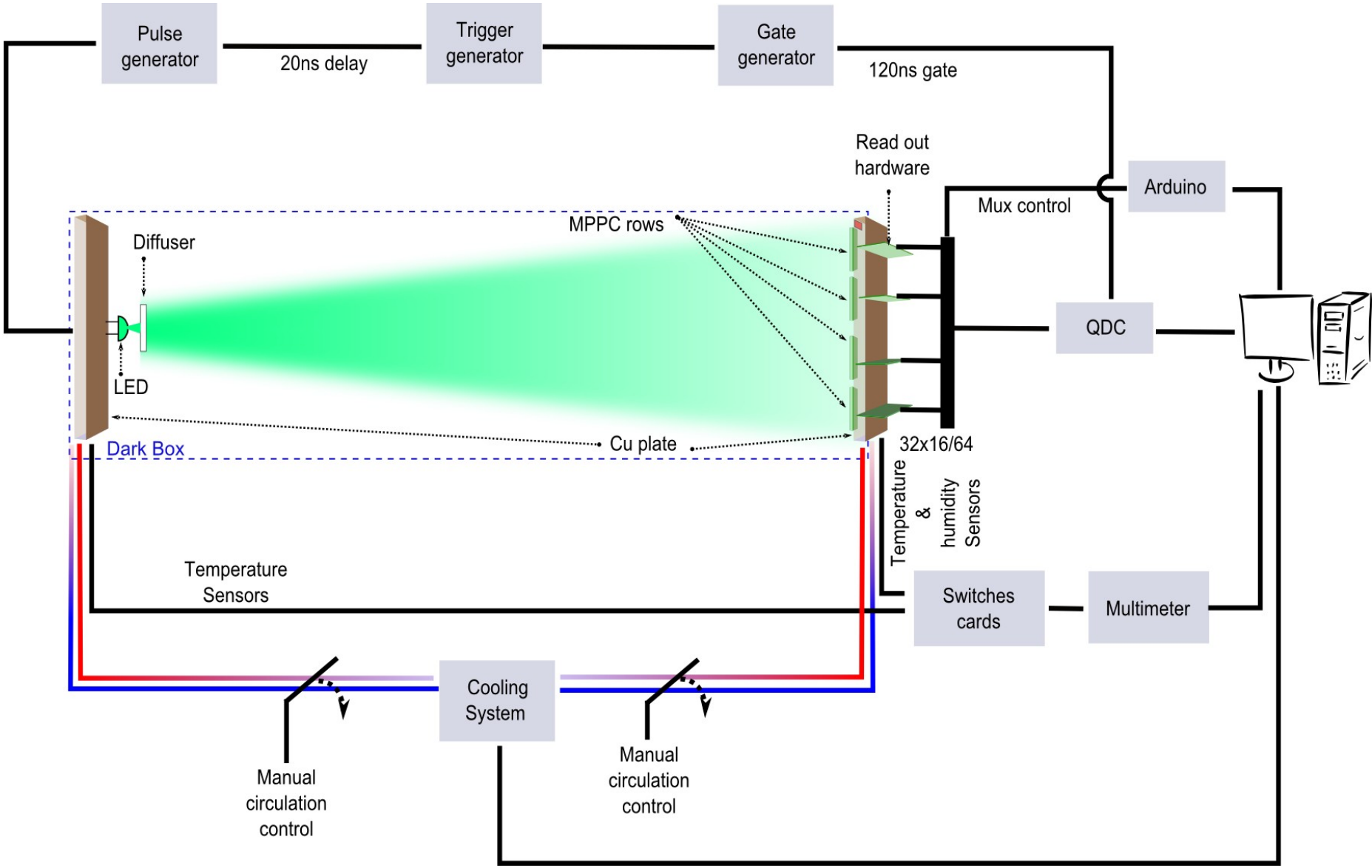


Temperature-Controlled Station (Stage III)



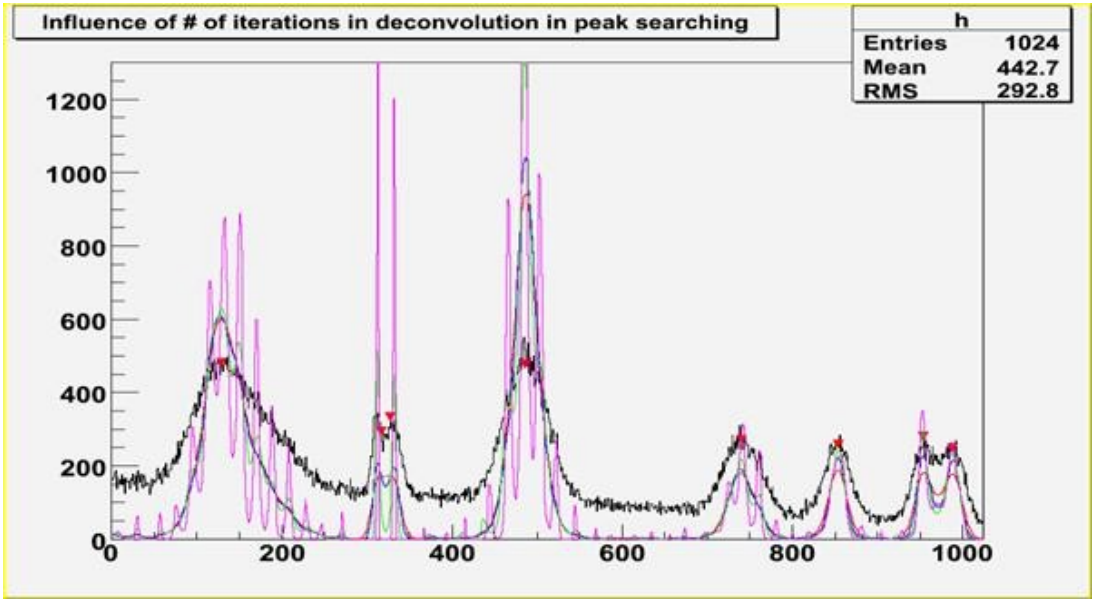


STATION 3 Diagram



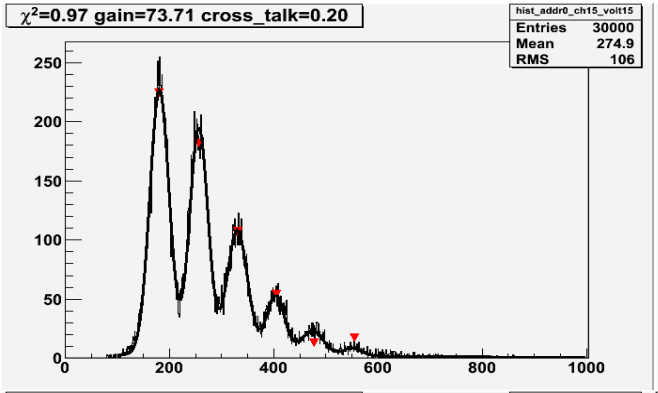
Peak searching and Background elimination using Markov chain method

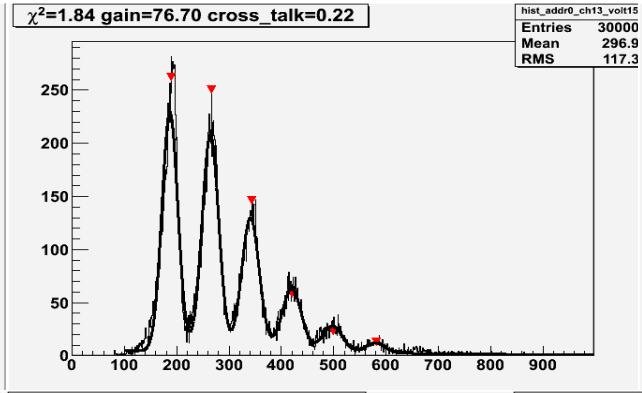
The function searches for peaks in source spectrum with technique based on deconvolution method. First the background is removed (if desired), then Markov smoothed spectrum is calculated (if desired), then the response function is generated according to given sigma and deconvolution is carried out. The goal of this function is to identify automatically the peaks in spectrum with the presence of the continuous background and statistical fluctuations - noise.

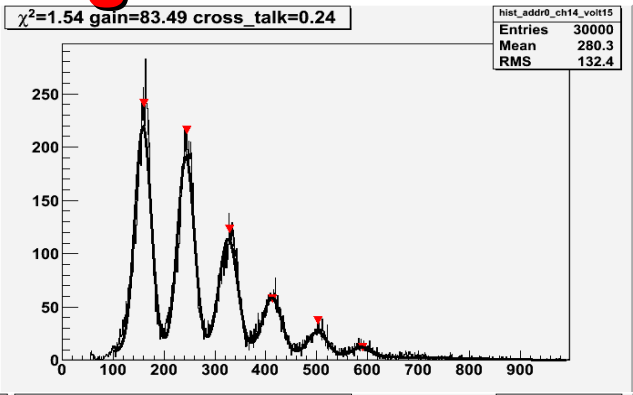


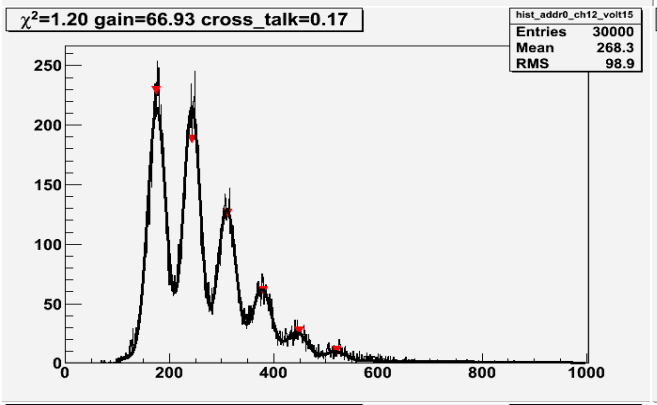
M. Morháč, J. Kliman, V. Matoušek, M. Veselský, I. Turzo .: NIM, A401 (1997) 113-132.
C. G Ryan et al.: NIM, B34 (1988), 396-402.
M. Morháč, J. Kliman, V. Matoušek, M. Veselský, I. Turzo.: NIM, A443 (2000) 108-125.
M.A. Mariscotti: NIM 50 (1967), 309-320.

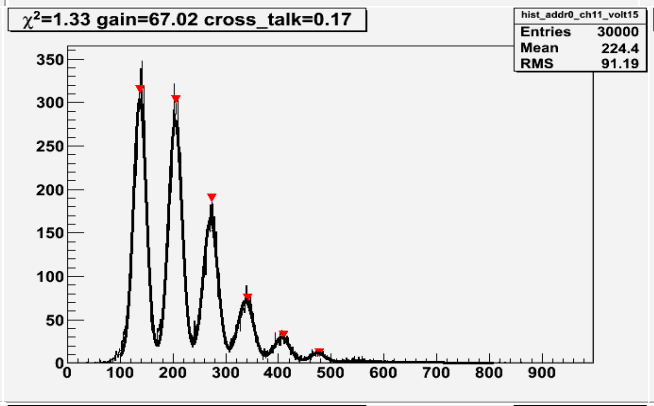
MPPC counts spectrum for the same MPPC cell for different voltages

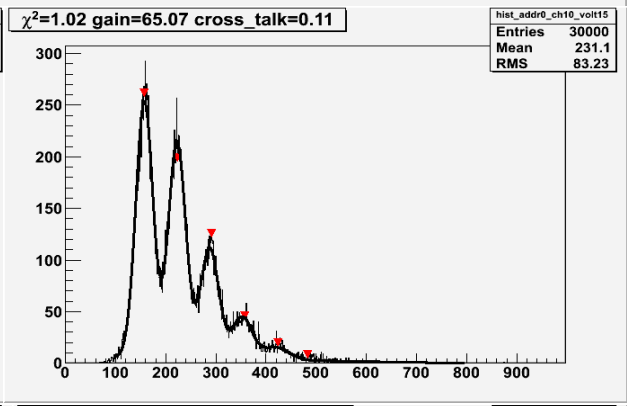


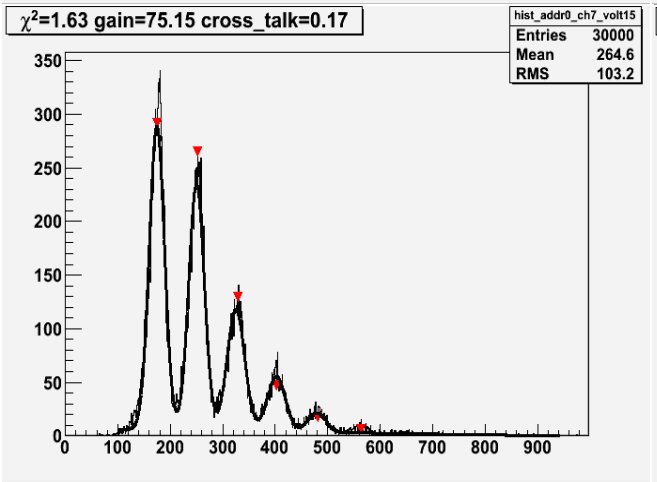


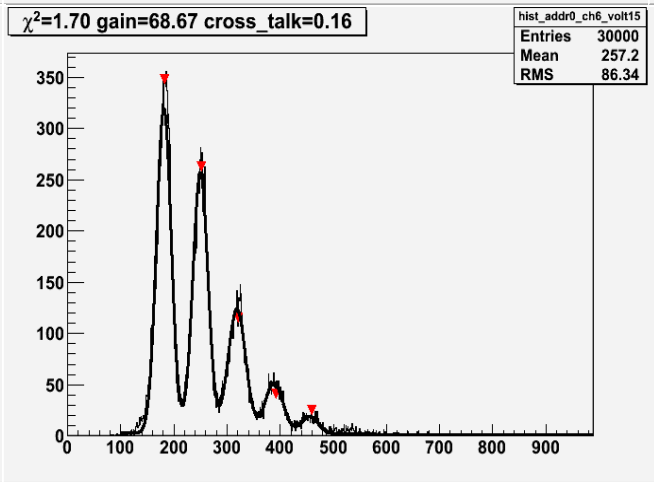


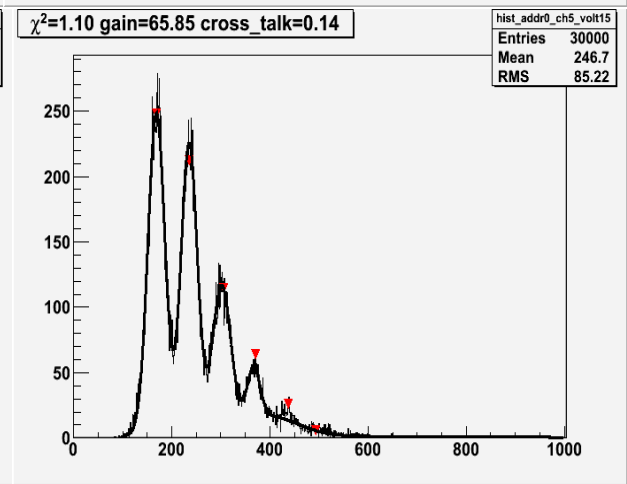




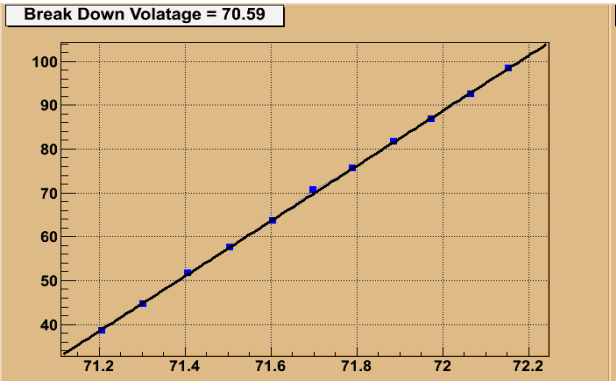


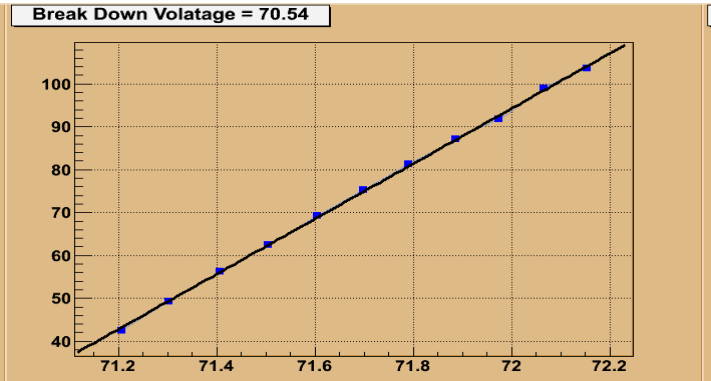


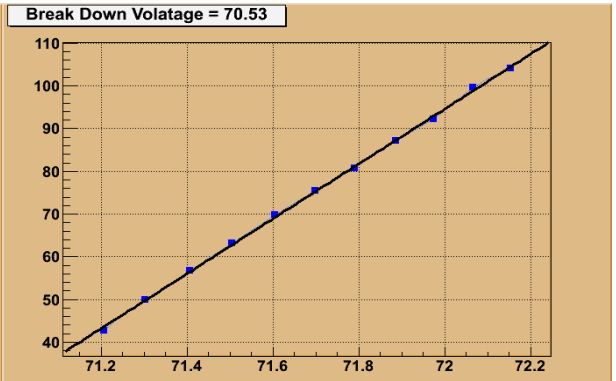


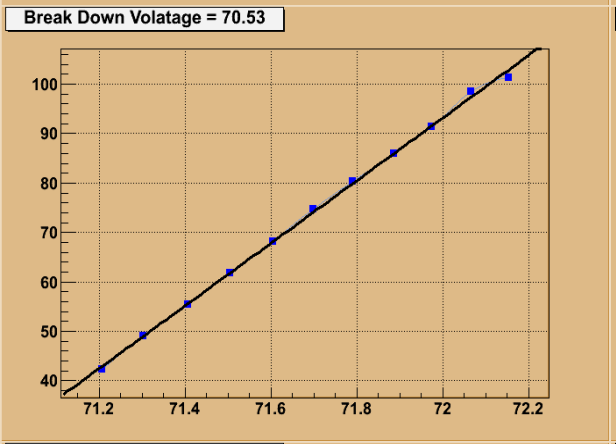


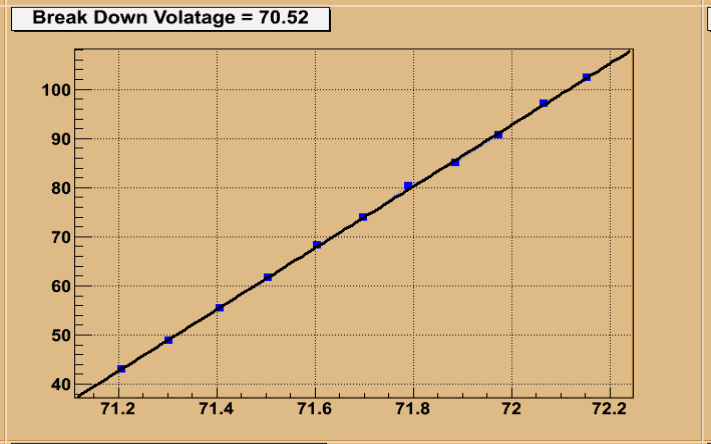
Gain vs. voltage (different channels of the same MPPC)

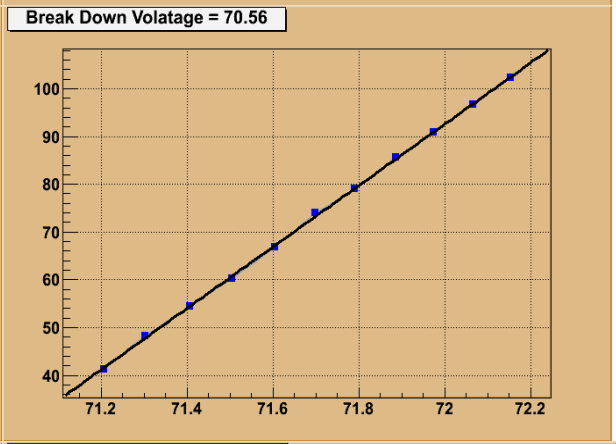


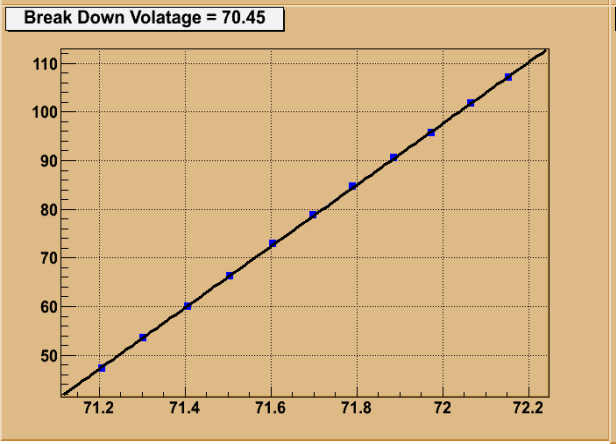


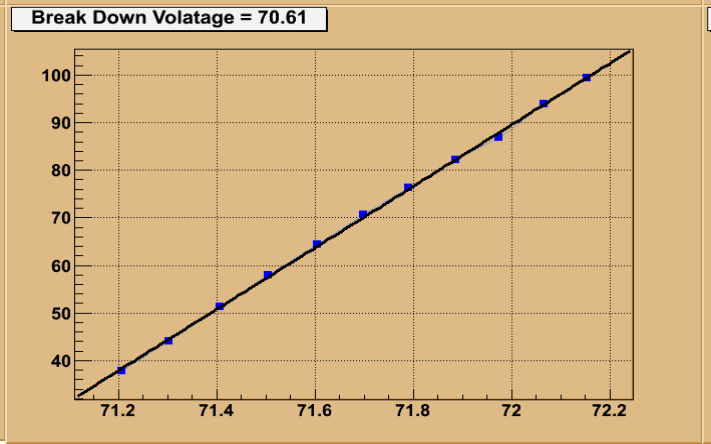


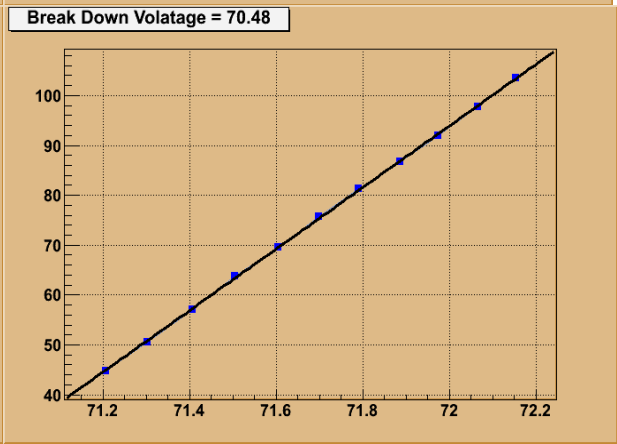




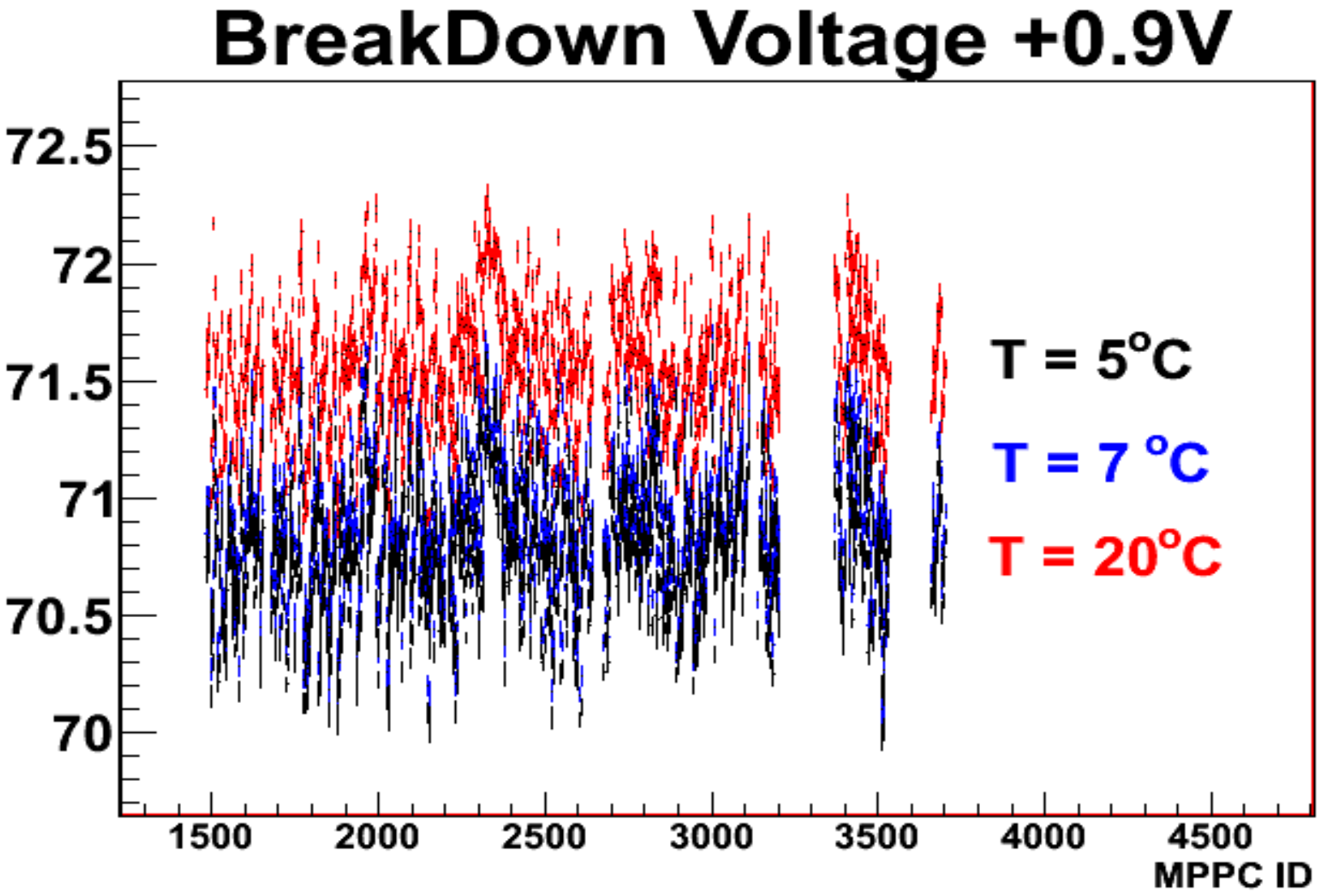








Result on $V_{Operation} = V_{BreakDown} + 0.9\ V$



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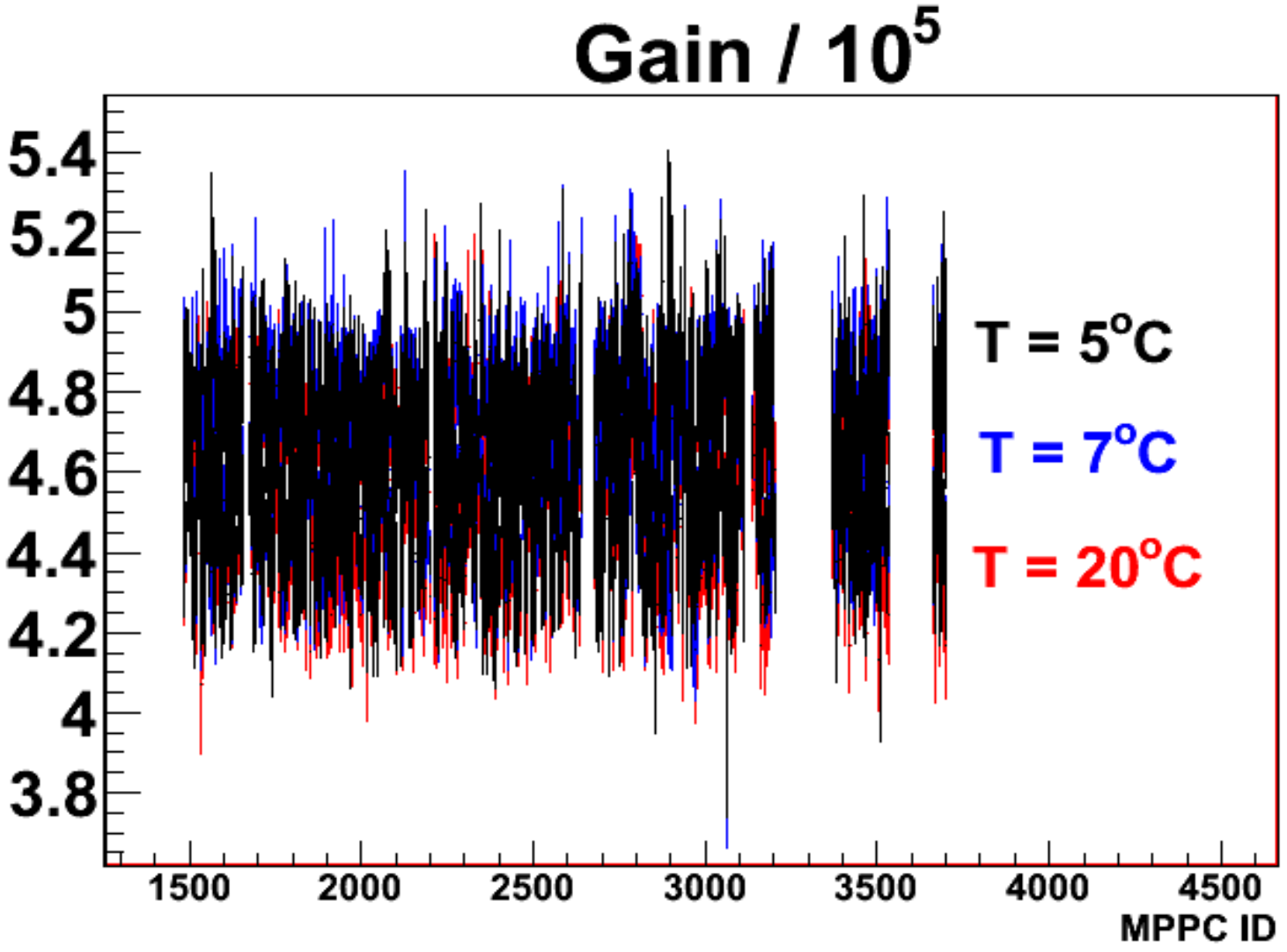

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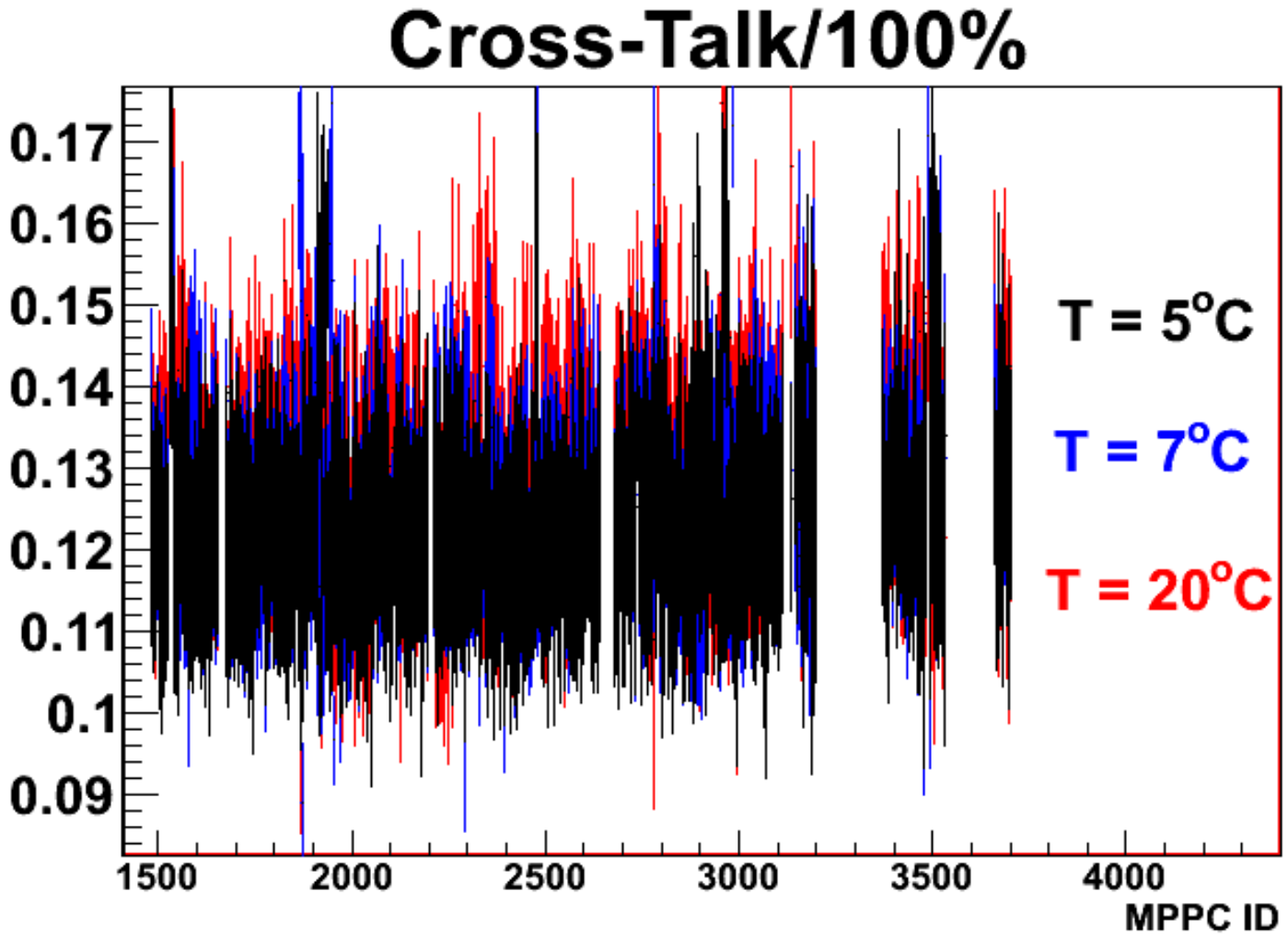
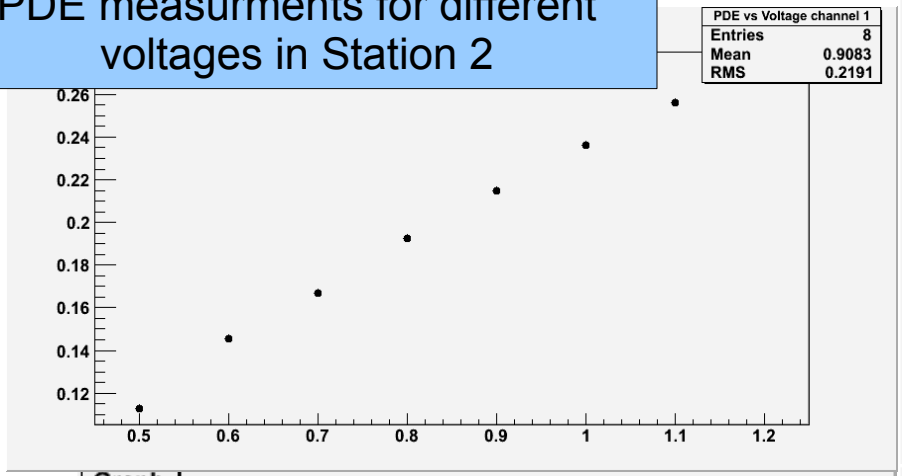
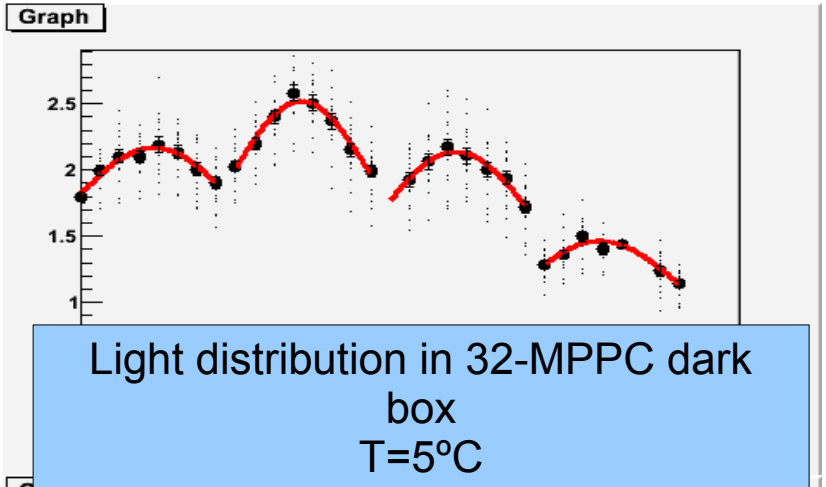


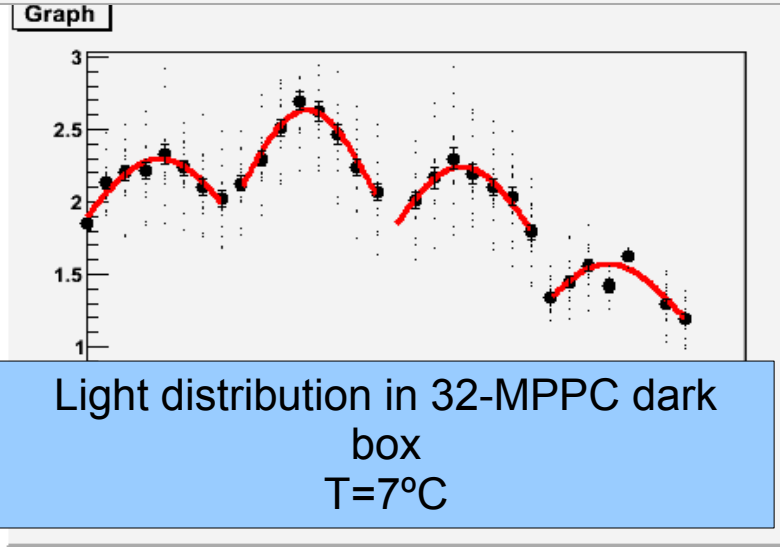
PDE estimation for all MPPCs using information from Station 2

PDE measurments for different voltages in Station 2

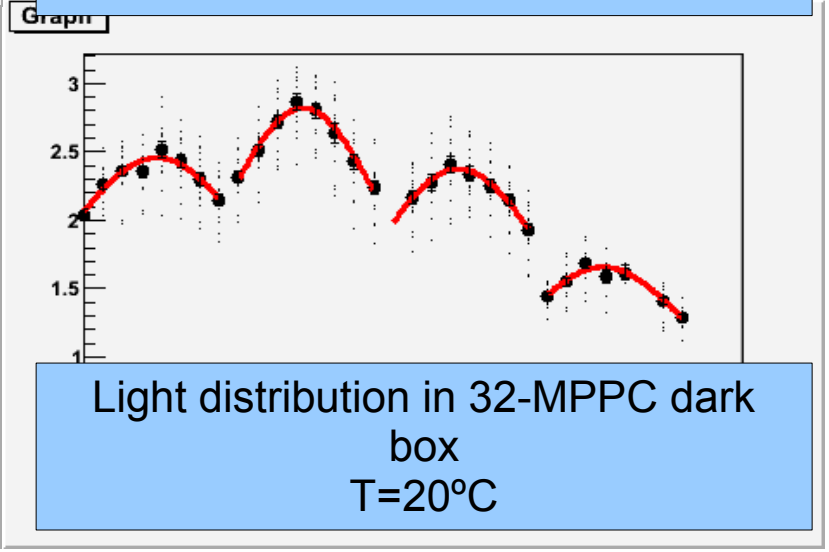




Light distribution in 32-MPPC dark box
T=5ºC

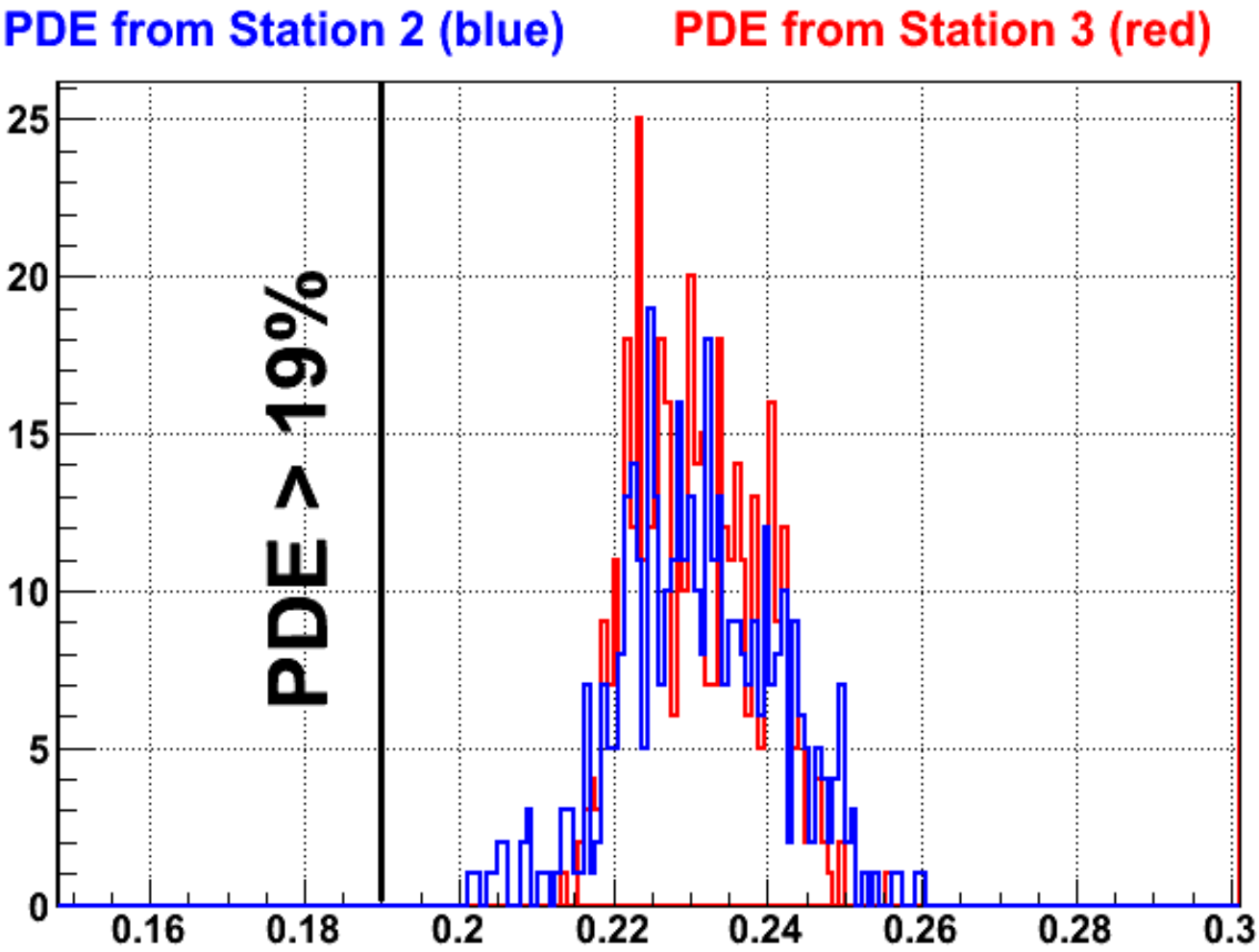


Light distribution in 32-MPPC dark box
T=7ºC



Light distribution in 32-MPPC dark box
T=20ºC

Result on $V_{Operation} = V_{BreakDown} + 0.9\ V$



	Original Plan	Current Plan	Completed
	Total required	Total required	
Receive from Hamamatsu	2800	2800	2440
Accepted by Stage 1	2800	2800	2440
Accepted by Stage 2	280	800	2021
Accepted by Stage 3	2800	2800	2400
Shipped to Jlab	2800	2800	1520

- 4th Bunch with 280 MPPCs scheduled to send on October 9.

Light guides fabrication project (Staff and Roles)

Head engineer: Juan (Iñaki) Vega

Machining technicians: Elias Rojas, Karina Jara, Sebastian Cepeda, Pavlo Bazalyeyev

Dimensional control: Cristian de la Cerda, Carlos Gallardo, Felipe Ponce

Polishing group leader: Ariel Lobos

Polishing group technicians: Sergio Sandoval, Juan Gutierrez, Rodrigo Lopez, Hugo Briceño, Juan Alarcon, Carlos Montero, Maria Jose Nuñez

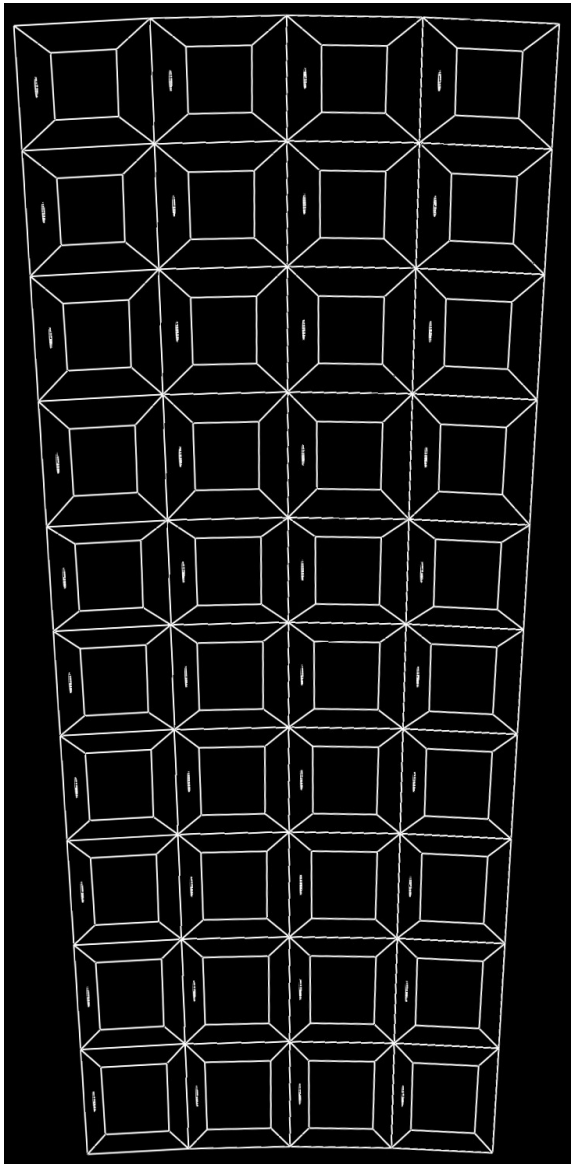
Director, CCTVal: Ivan Schmidt

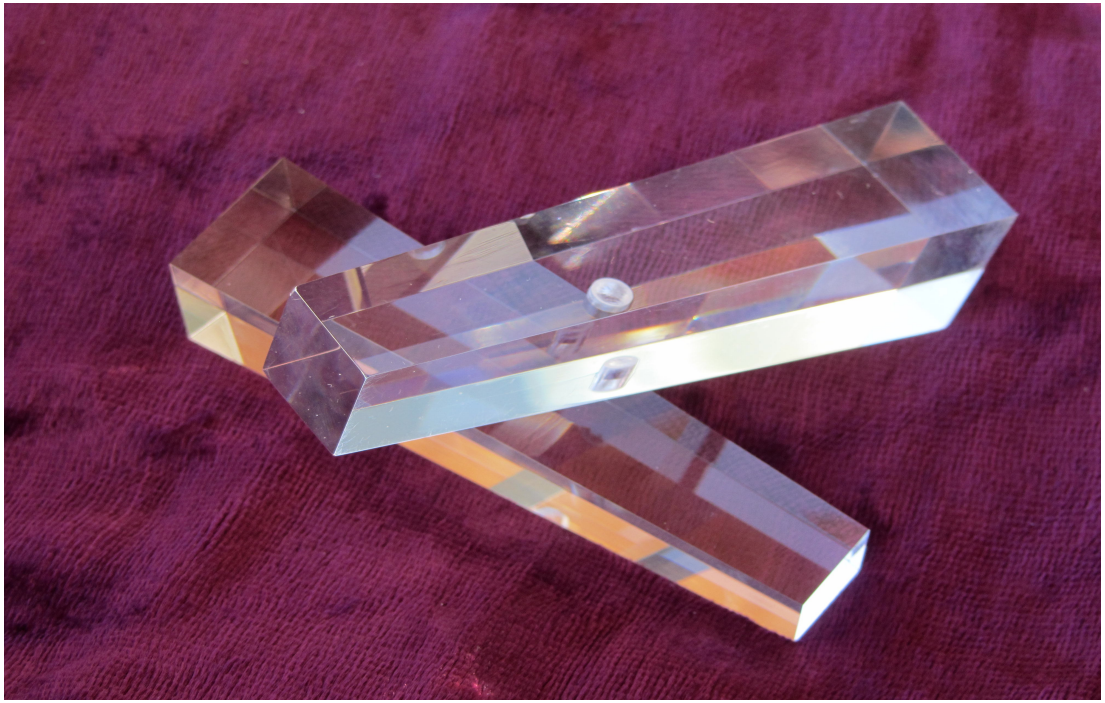
Business and Projects Management, CCTVal: Francisco Soto

Administrative: Cynthia Sánchez

Project Coordination: Will Brooks

Production of 4000 light guides of 10 different geometrical types (shapes) (A, B, C, D, E, F, G, H, J, K) for Hall-D BCAL





3 Stages of Production

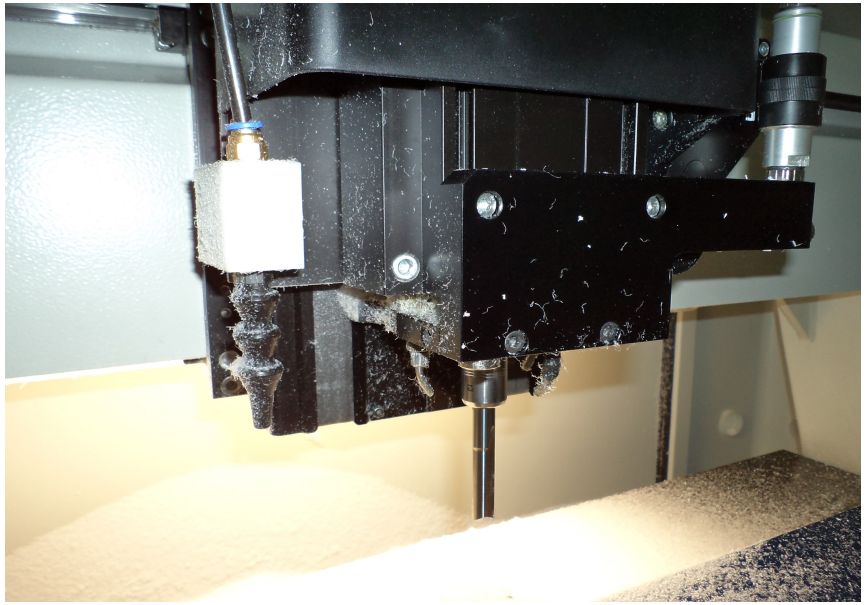
STAGE I
Milling

STAGE II
Polishing

STAGE III
Quality Control
(Measuring)

Stage 1 (milling)

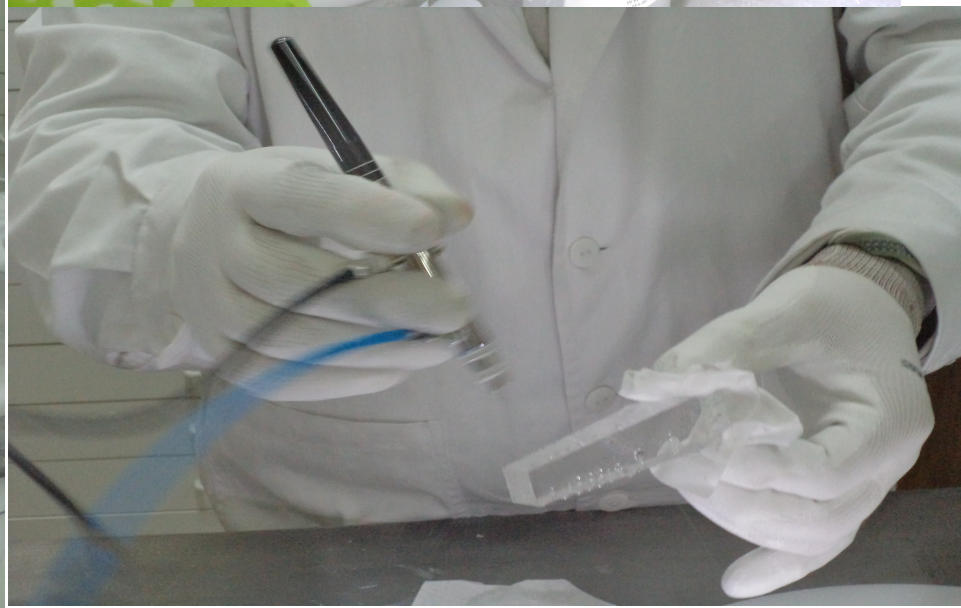
5 axis CNC (computer numerical control) milling machine, Datron M8



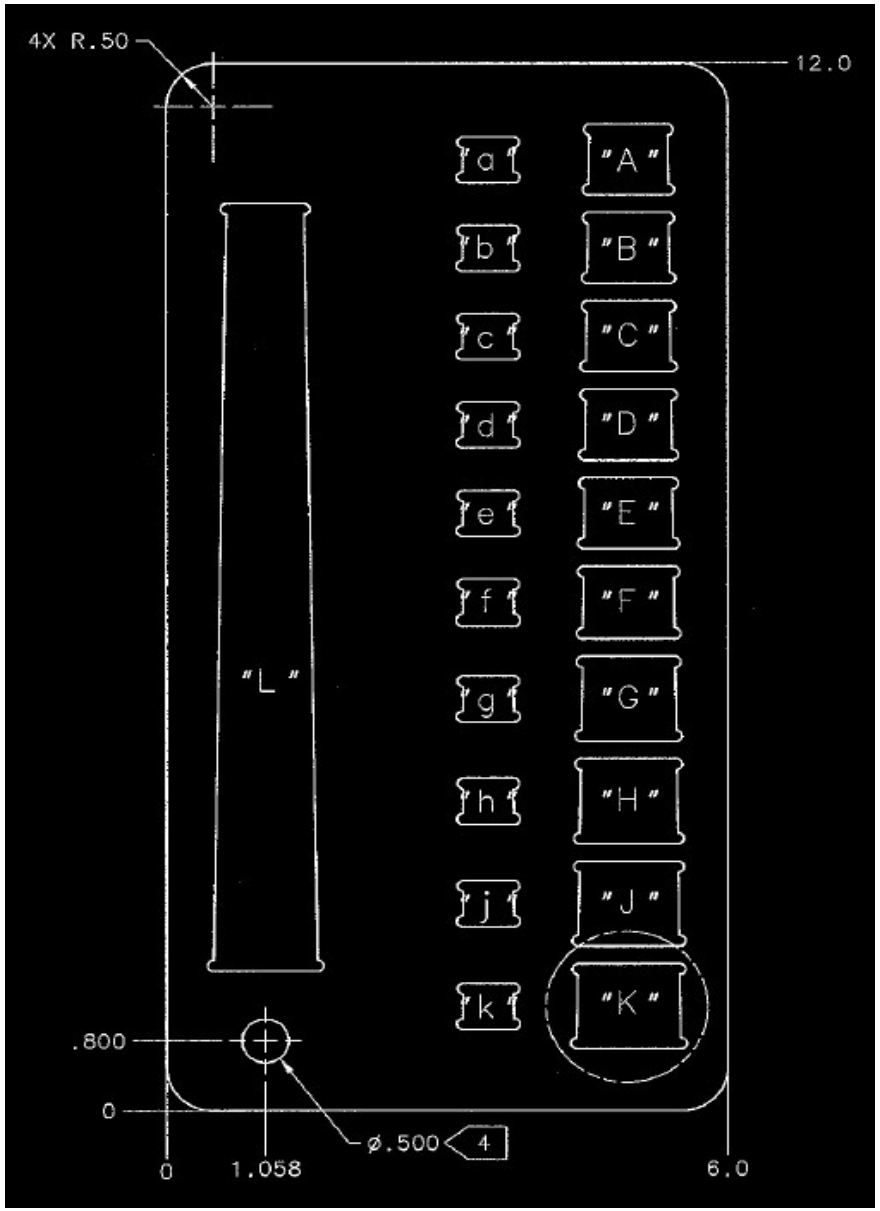
Stage 2 (polishing)

The polishing procedure is developed in UTFSM based on known techniques from metallography + polishing of telescope mirrors.

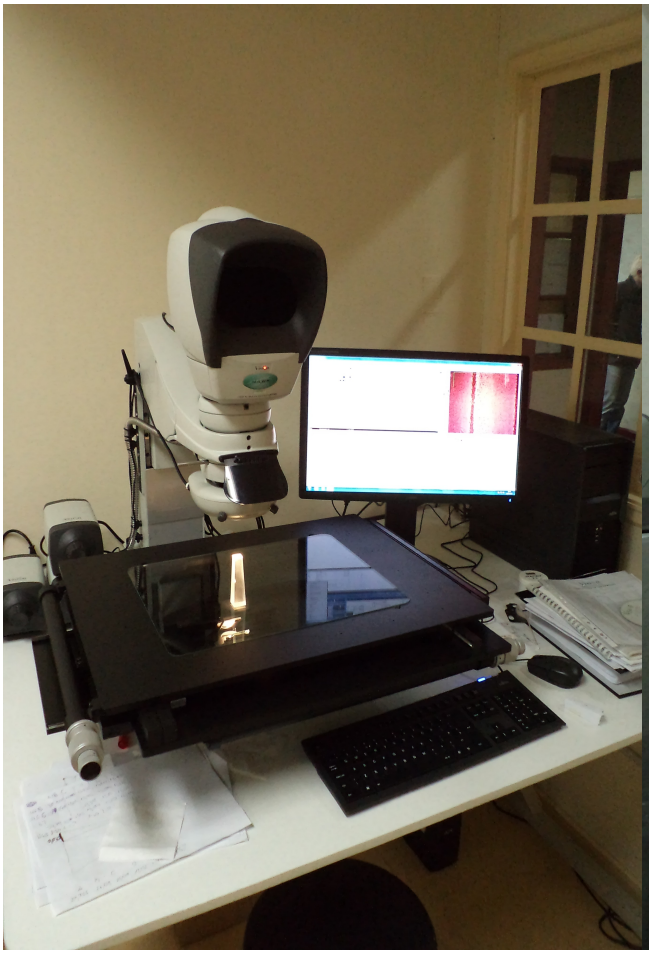
As a abrasive material aluminium oxide (Al_2O_3) is used with two types of granuls (5mk in the beggining and 0.3 mk in the end).

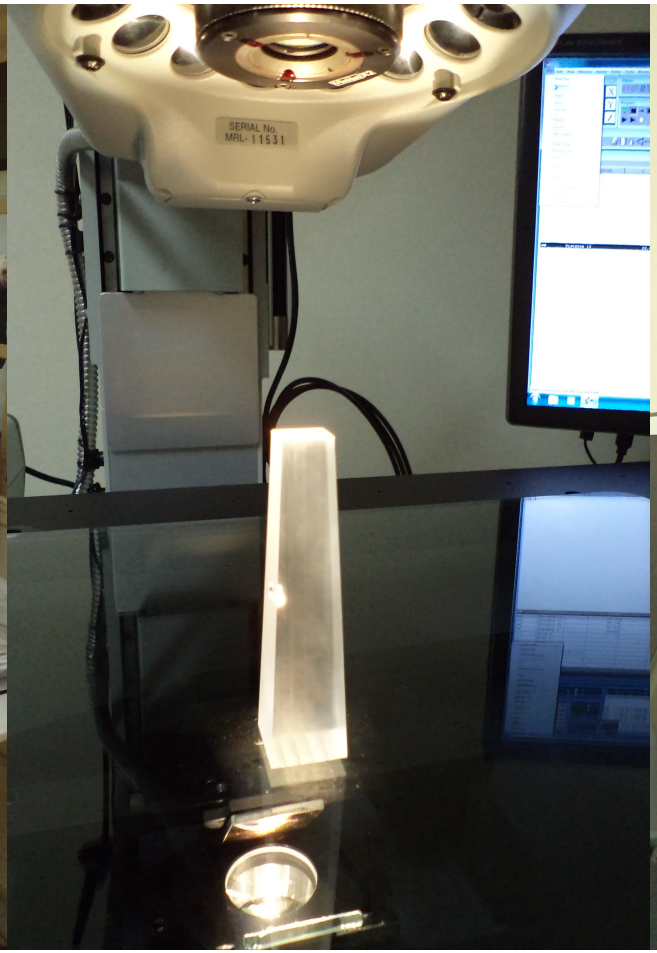


Preliminary light guide´s dimensional controll is performed on a special template fabricated and sent to UTFSM by Jlab/Hall-D team.



Stage 3 (quality control)



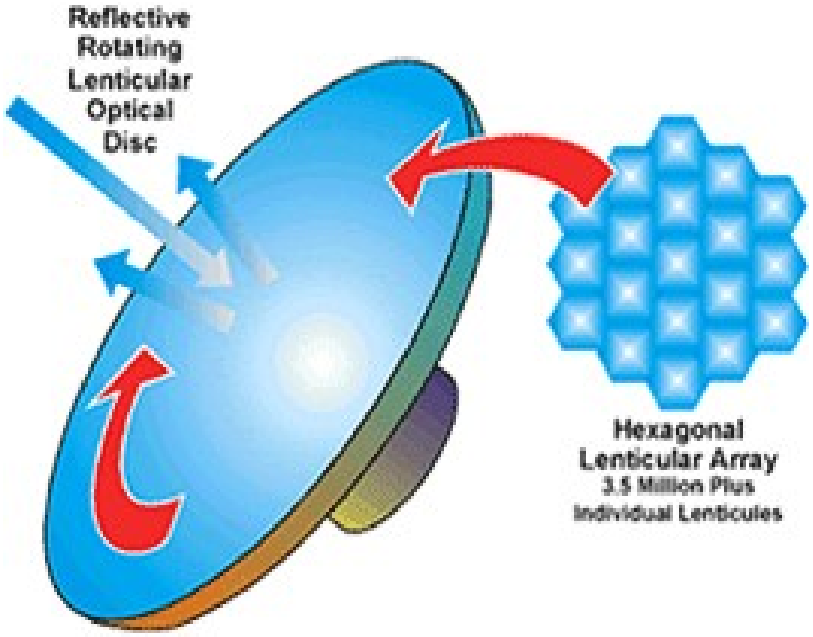


Vision engineering Hawk 5000 monodynascope

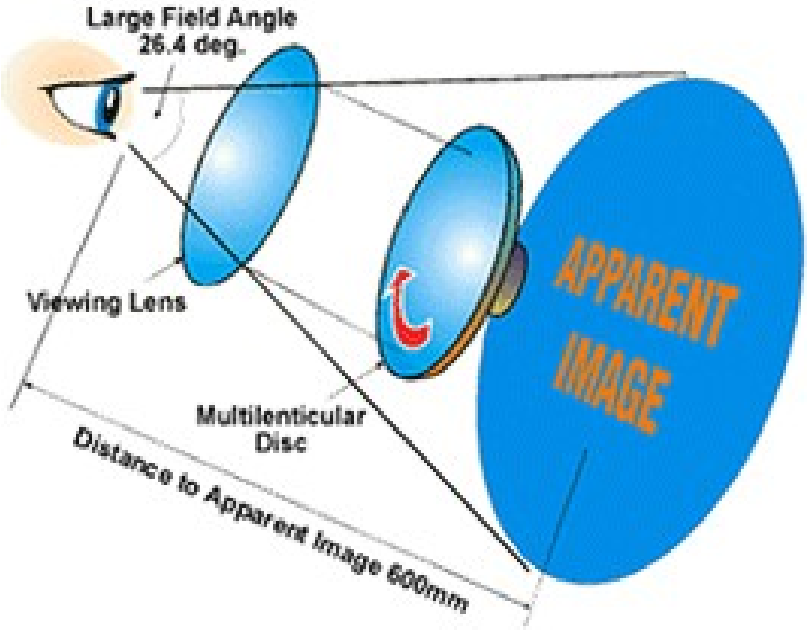
Provides measurments with 3mk accuracy

While lightguides can have ~127mk tolerance

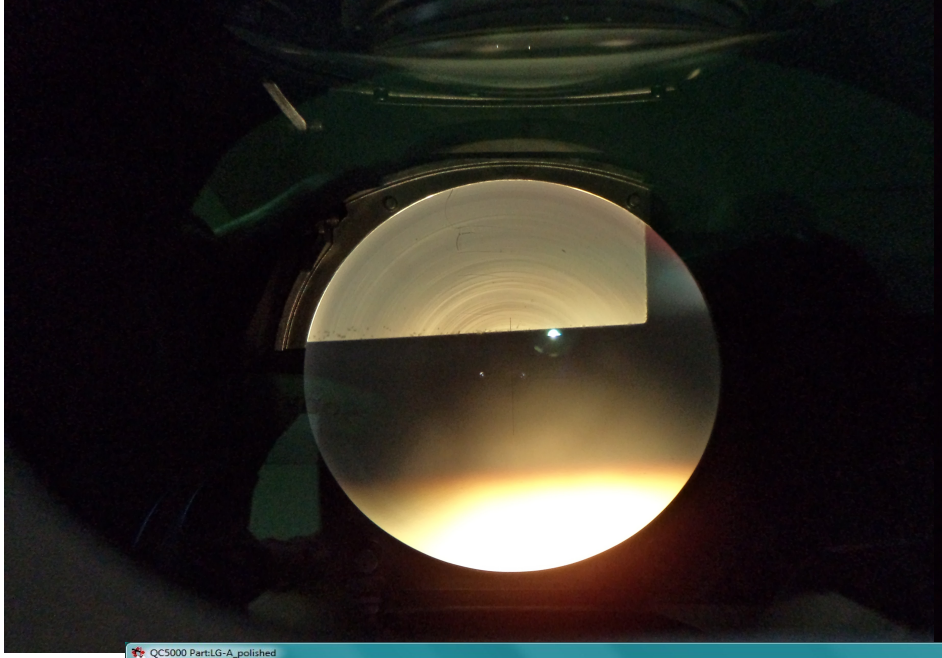
Dynascope uses a 148mm diameter multi-lenticular disc surface comprises of over 3.5 million individual lenticules (lenses), each measuring just 70 microns in size. The Dynascope™ disk spins at 3,400rpm to merge the millions of individual optical paths, delivering a smooth expanded-pupil stereo image with a generous depth of focus and a wide field of view.

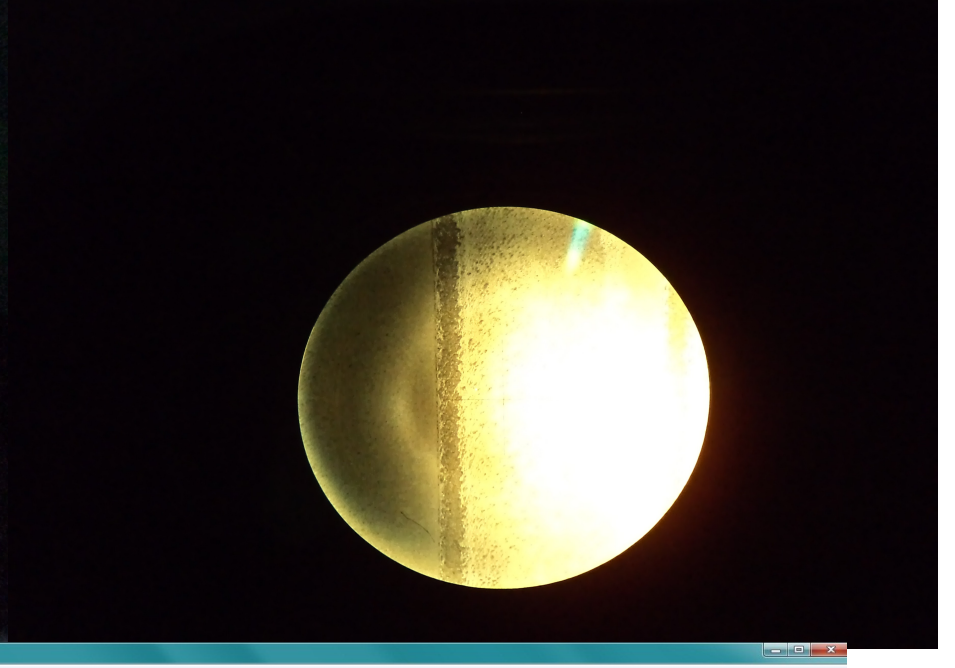


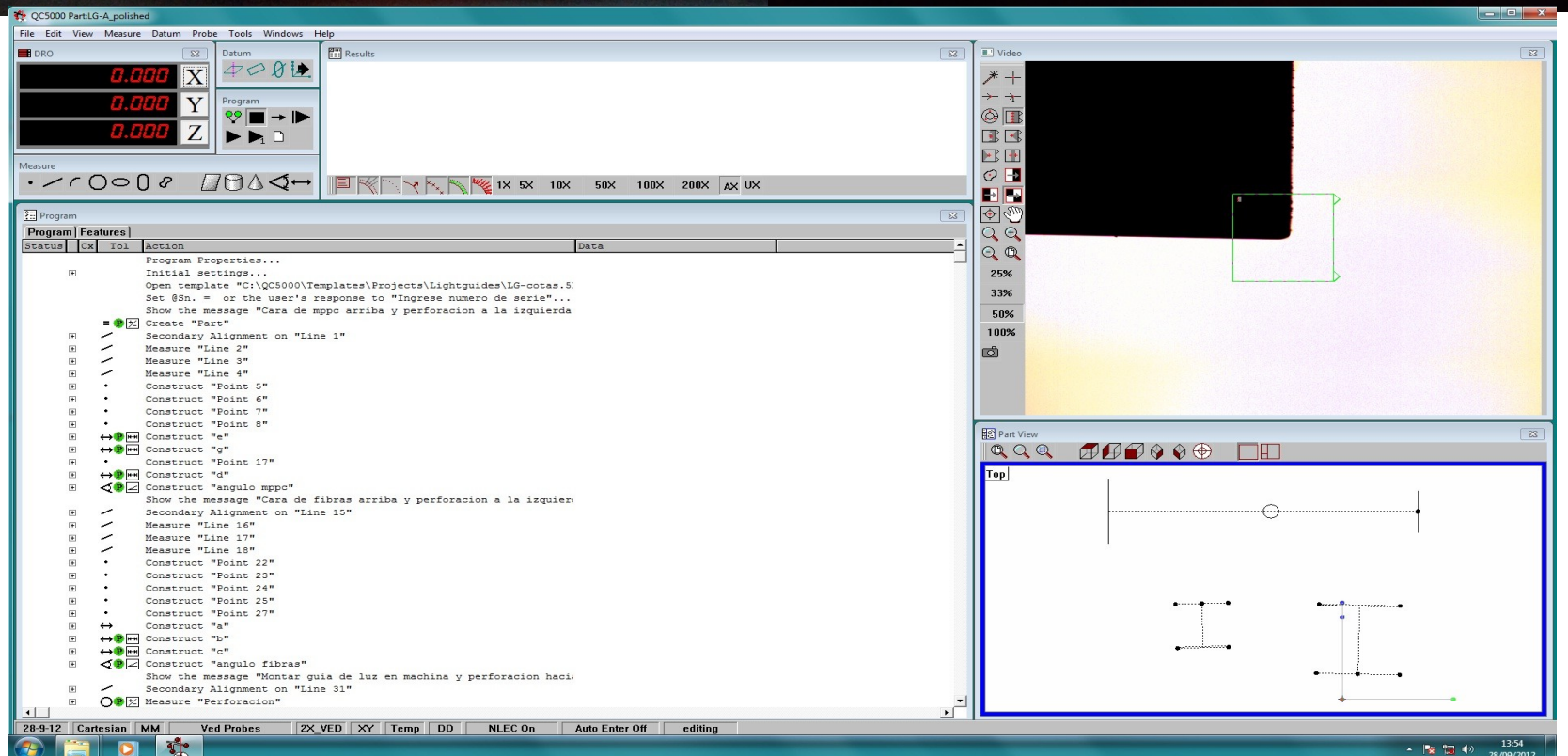
ASPHERIC MULTILENTICULAR DISC DETAIL

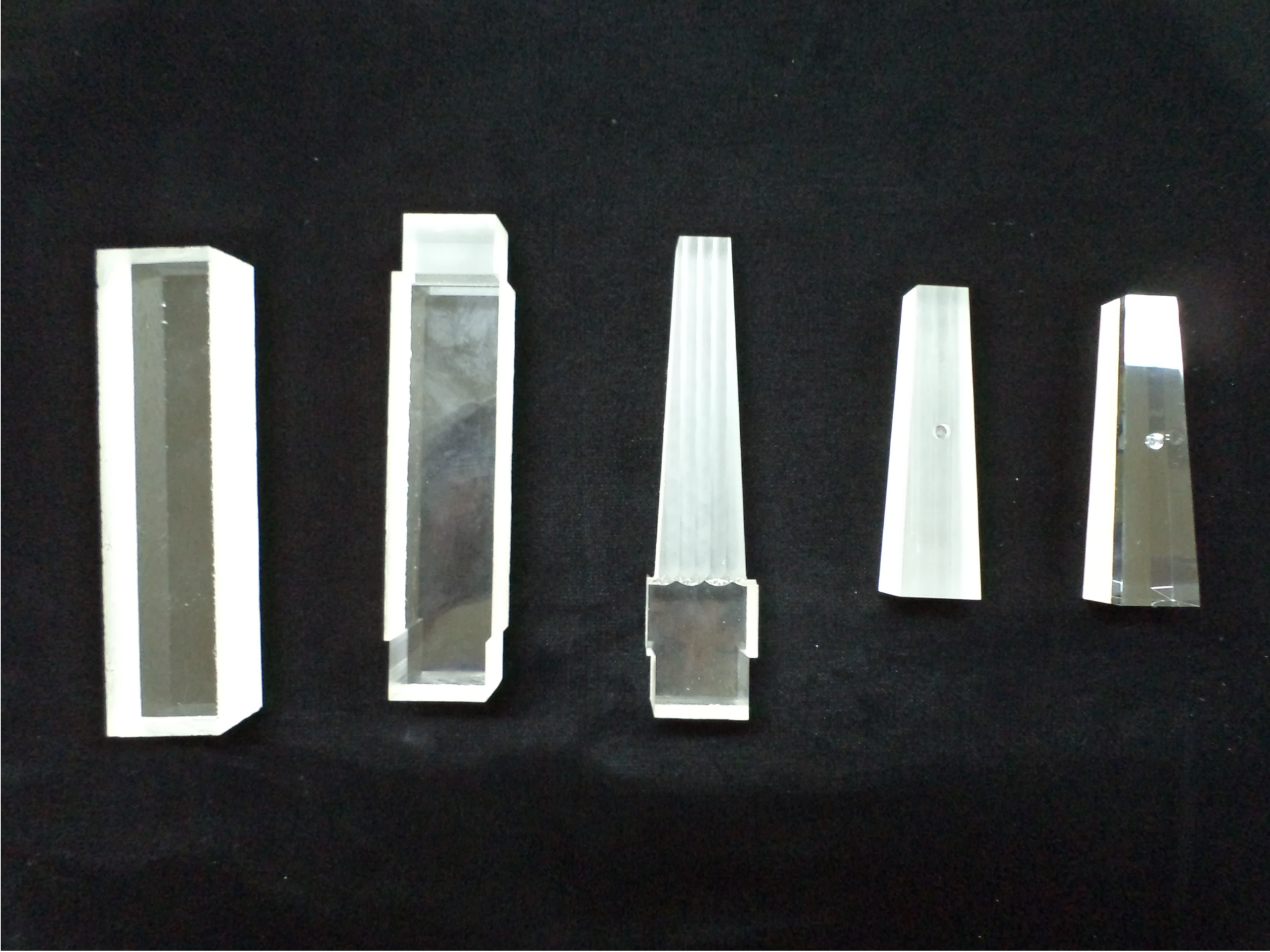


OPTICAL PARAMETERS






QC5000 Part:LG-A_polished
File Edit View Measure Datum Probe Tools Windows Help
DRO
0.000
0.000
0.000
Datum
Program
Measure
Results
1X 5X 10X 50X 100X 200X AX UX
Video
25%
33%
50%
100%
Program
Program Features
Status Cx Tol Action Data
Program Properties...
Initial settings...
Open template "C:\QC5000\Templates\Projects\Lightguides\LG-cotas.5
Set @Sn. = or the user's response to "Ingrese numero de serie"...
Show the message "Cara de mppc arriba y perforacion a la izquierda
Create "Part"
Secondary Alignment on "Line 1"
Measure "Line 2"
Measure "Line 3"
Measure "Line 4"
Construct "Point 5"
Construct "Point 6"
Construct "Point 7"
Construct "Point 8"
Construct "e"
Construct "g"
Construct "Point 17"
Construct "d"
Construct "angulo mppc"
Show the message "Cara de fibras arriba y perforacion a la izquier
Secondary Alignment on "Line 15"
Measure "Line 16"
Measure "Line 17"
Measure "Line 18"
Construct "Point 22"
Construct "Point 23"
Construct "Point 24"
Construct "Point 25"
Construct "Point 27"
Construct "a"
Construct "b"
Construct "c"
Construct "angulo fibras"
Show the message "Montar guia de luz en machina y perforacion haci
Secondary Alignment on "Line 31"
Measure "Perforacion"
Part View
Top
28-9-12 Cartesian MM Ved Probes 2X_VED XY Temp DD NLEC On Auto Enter Off editing
13:54



For one lightguide fabrication:
STAGE 1 ~ 20 min
STAGE 2 ~ 20 min
STAGE 3 ~ 7 min

Number of lightguides produced per day:
STAGE 1 – 60
STAGE 2 – 60
STAGE 3 – 30

One day per week is dedicated to milling machine maintenance.

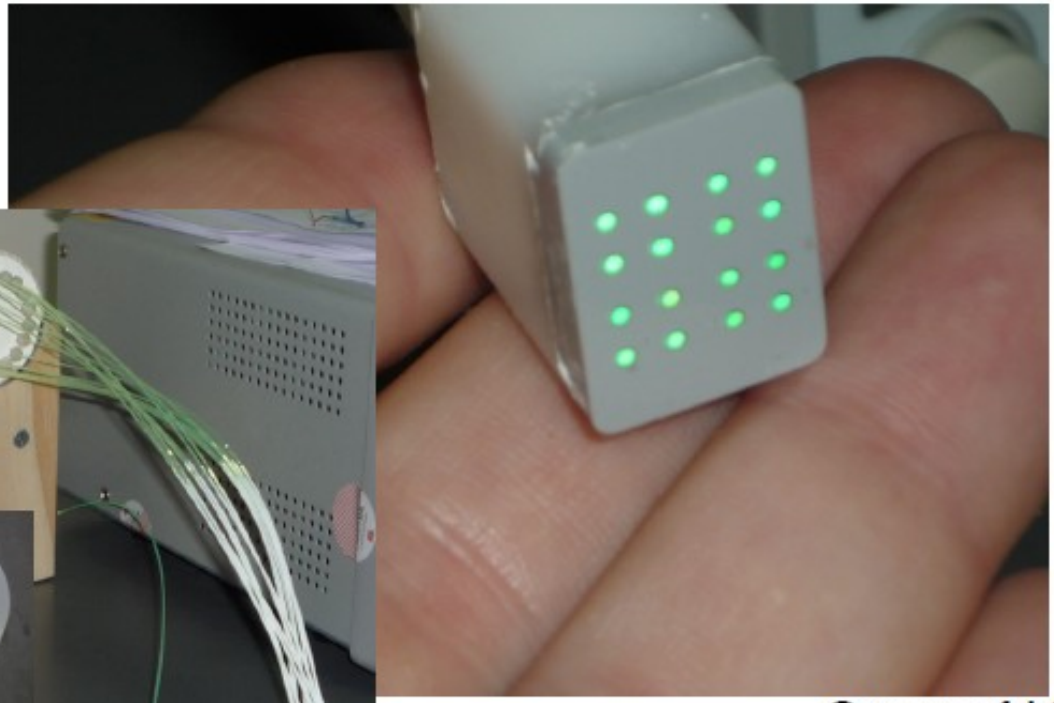
UP-TO-DATE fabricated:

A – 31	**G – 25**
B – 97	**H – 1**
C – 15	**J – 15**
D – 43	**K – 18**
E – 47	**----------**
F – 41	**TOTAL – 333**

BACKUP SLIDES

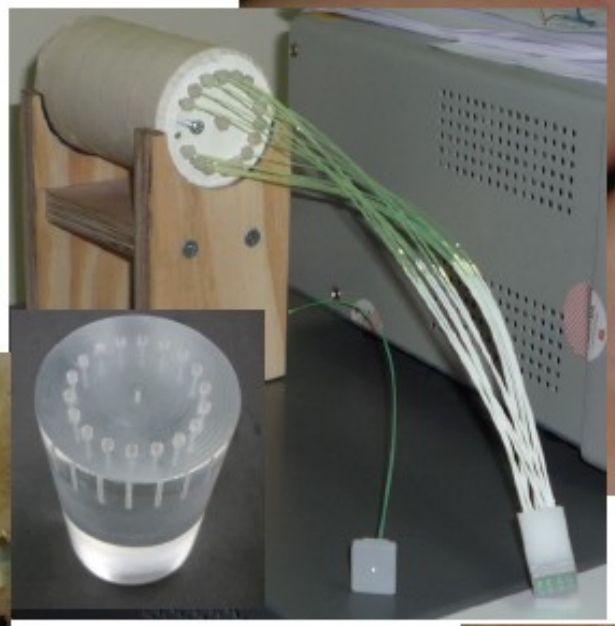
PDE Station Light Source

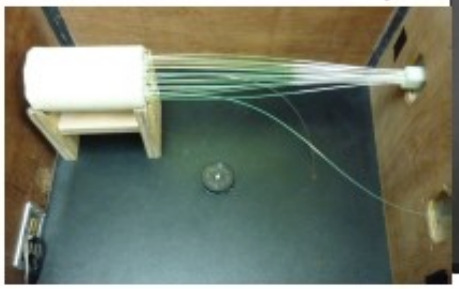
Recessed positioner; fibers on this side, MPPC on other side



Output of 16 green fibers following mixer

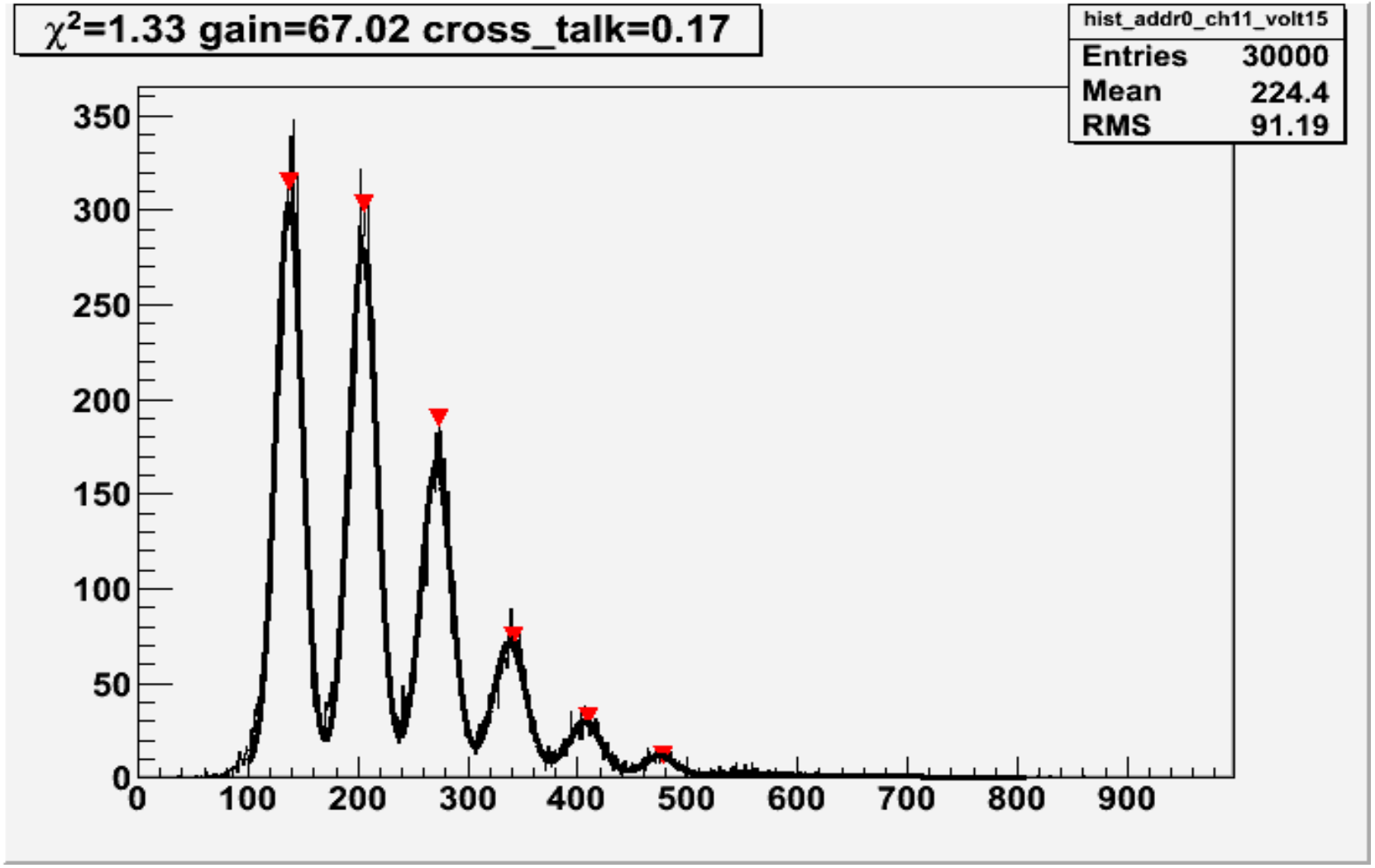
Light mixer (clear fiber goes into center)





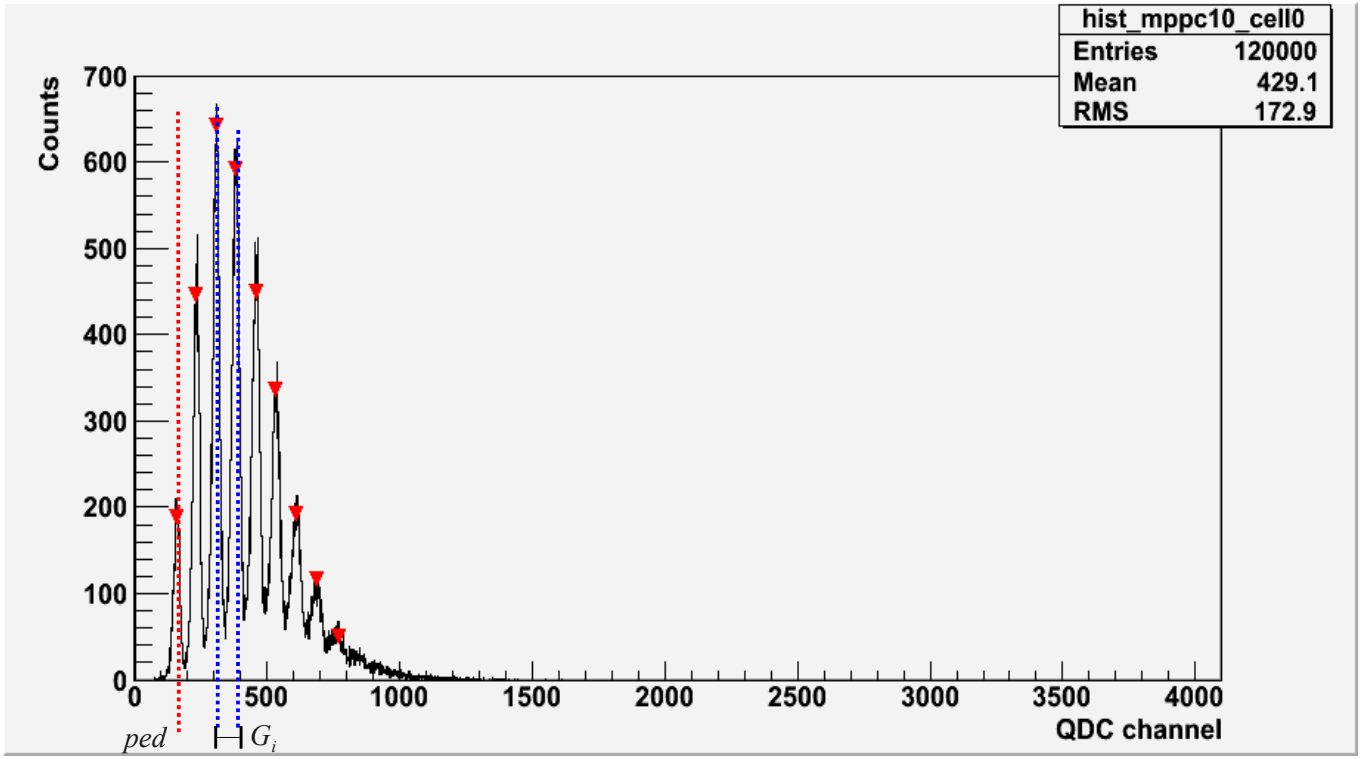
1-fiber input, 17-fiber output (16 to MPPC, 17th to monitor PMT

Blue LED feeding clear fiber



Completely automatic fit based on Markov method from spectroscopy
Fit was performed for
3(temperature)x2(dark/LED)x13(voltage)x16(channels)=1248
cases for each MPPC.
For all fits 1<Chi²<2.2

From these histograms we get gain (G_i), average number of photoelectrons (μ_i), cross-talk probability ($\Delta\mu_i$) according to:



$Mean$

RMS

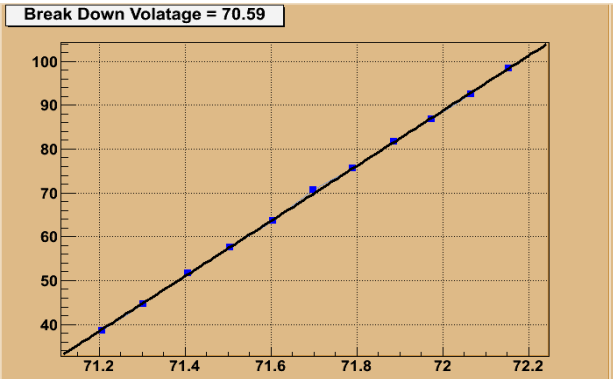
ped

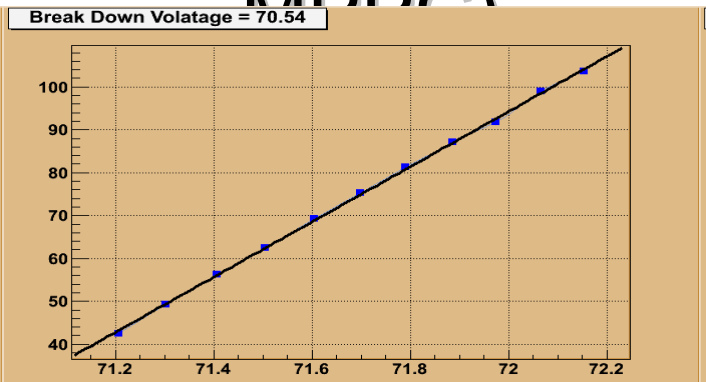
G_i

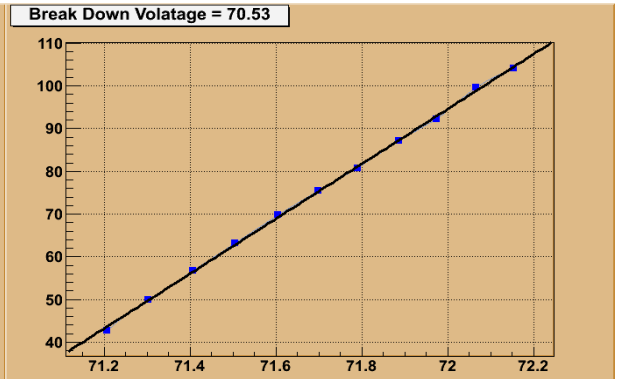
$$\mu_i = \frac{-(RMS^2/G_i - (Mean - ped)/G_i) + \sqrt{((RMS^2/G_i - (Mean - ped)/G_i)^2 + 4*((Mean - ped)/G_i)^2)}}{2}$$

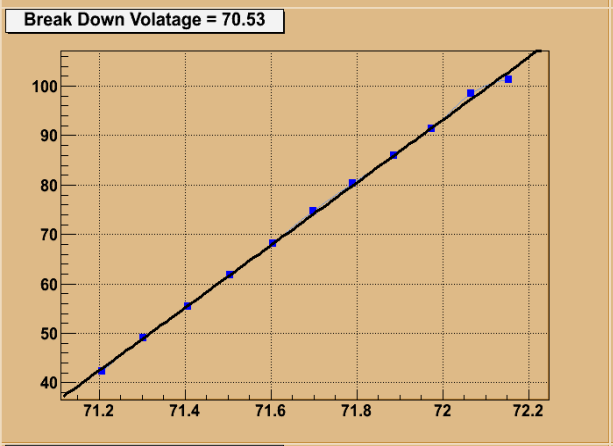
$$\Delta\mu_i = \frac{(Mean - ped)}{\mu_i} - 1$$

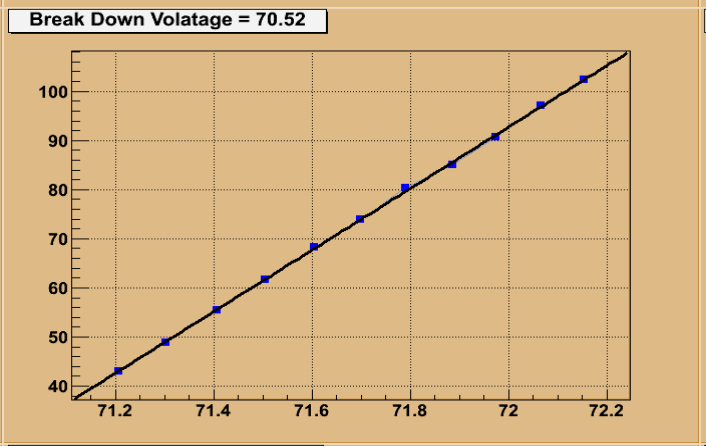
Gain vs. voltage (different channels of the same MRPC)

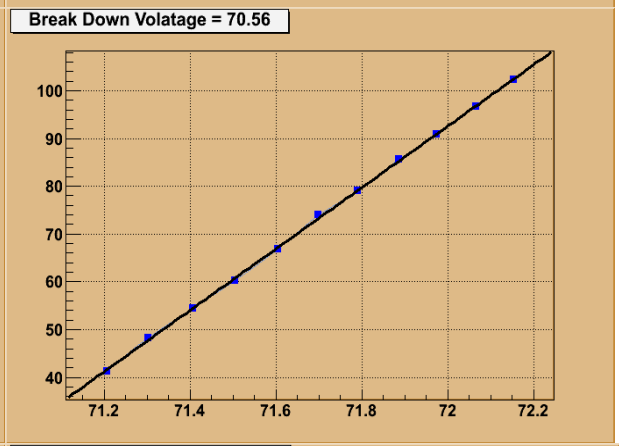


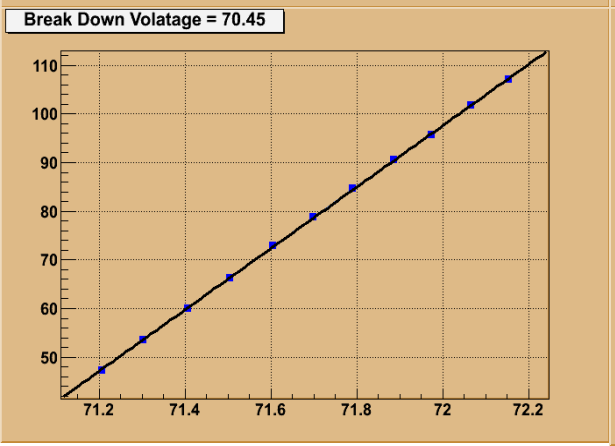


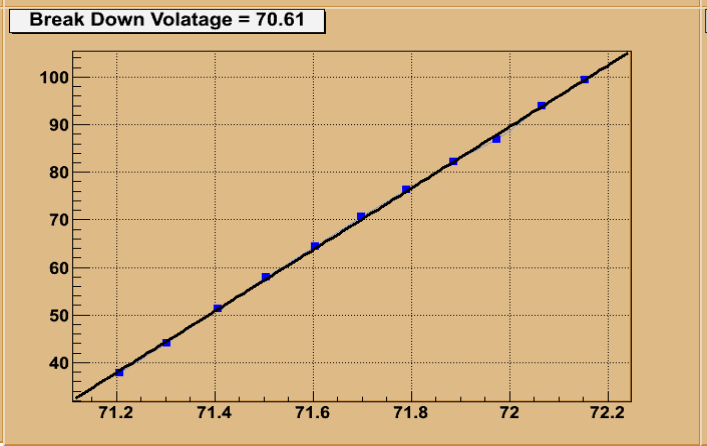


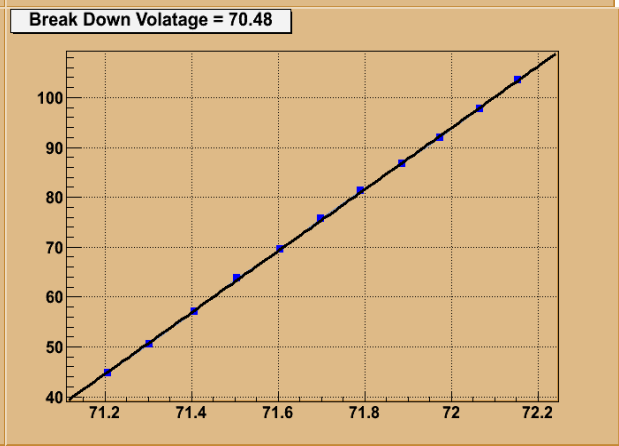






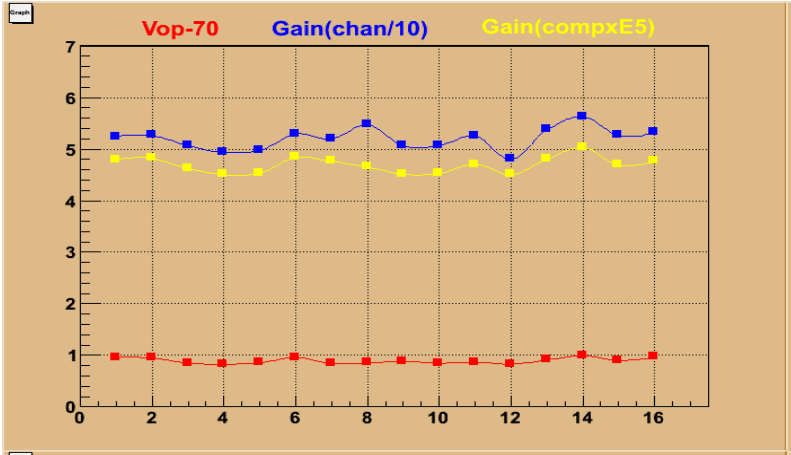


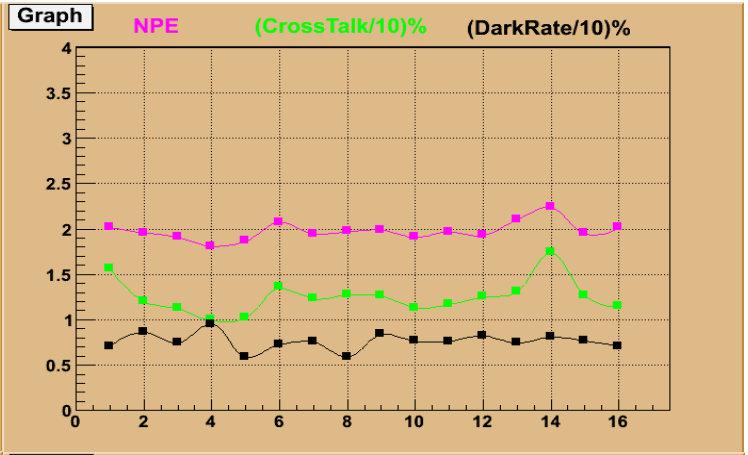




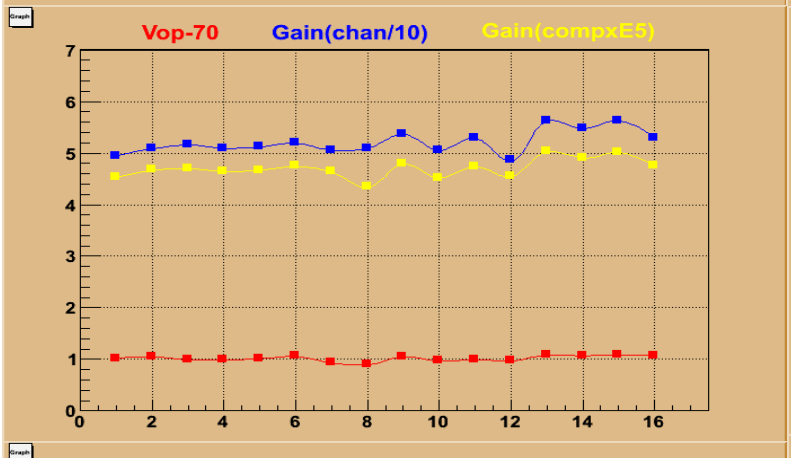
MPPC characteristics measurements results from stage 3

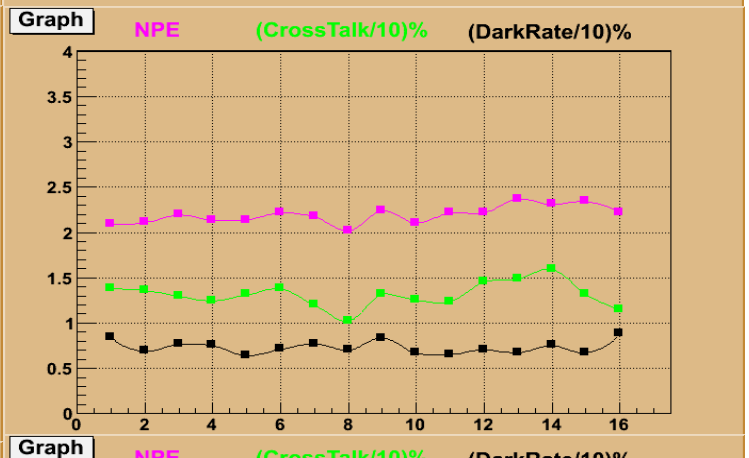
T=5º





T=7º





T=20º