GUI "picos(am)" program with ASICs in ISTC-A2390

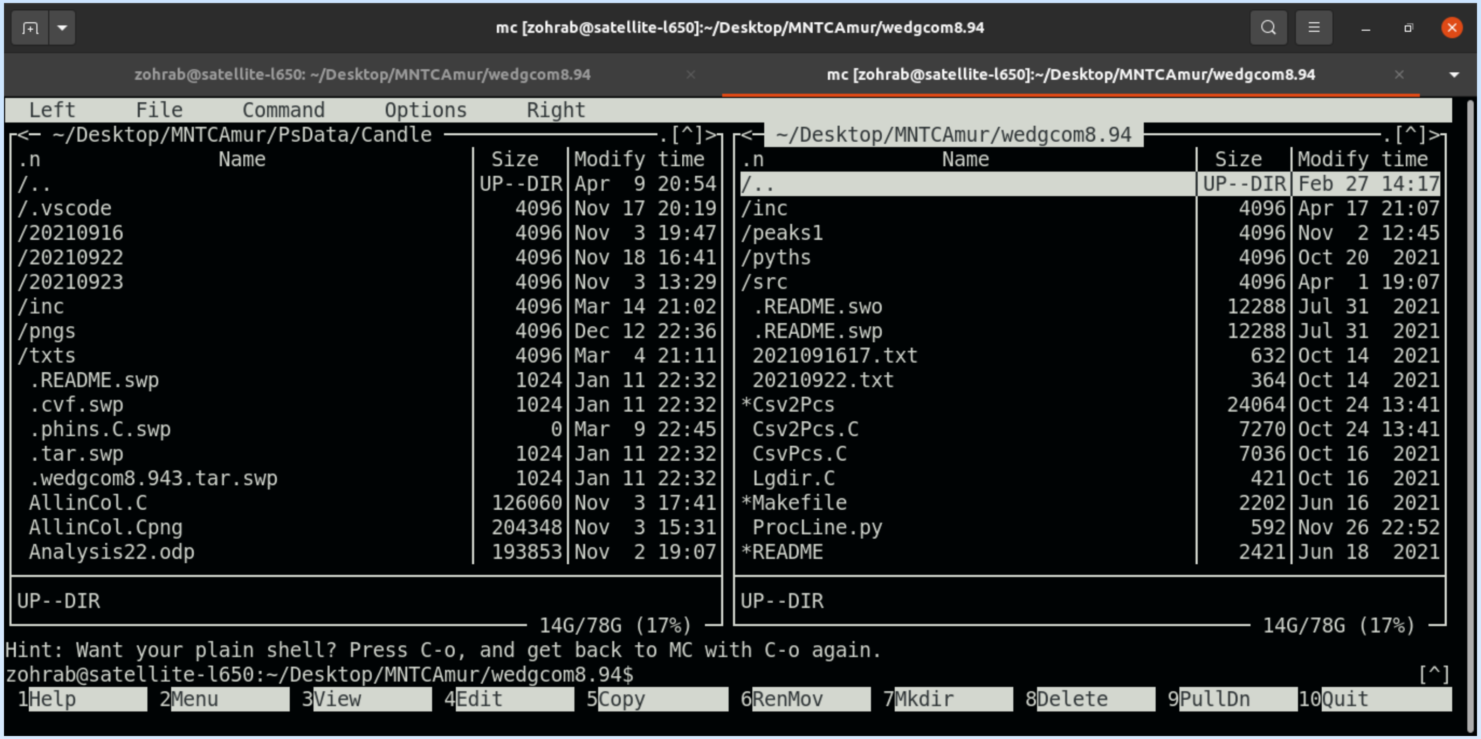
Hamlet Zohrabyan

The Talk Layout

- GUI usage prehistory
- This Usage
- Conclusion

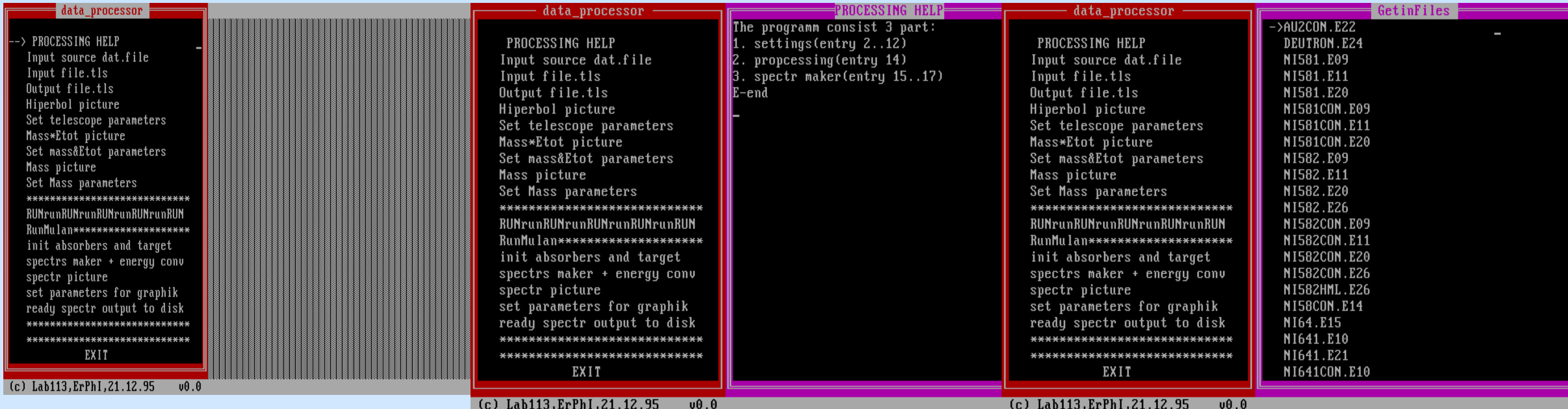
GUI usage prehistory

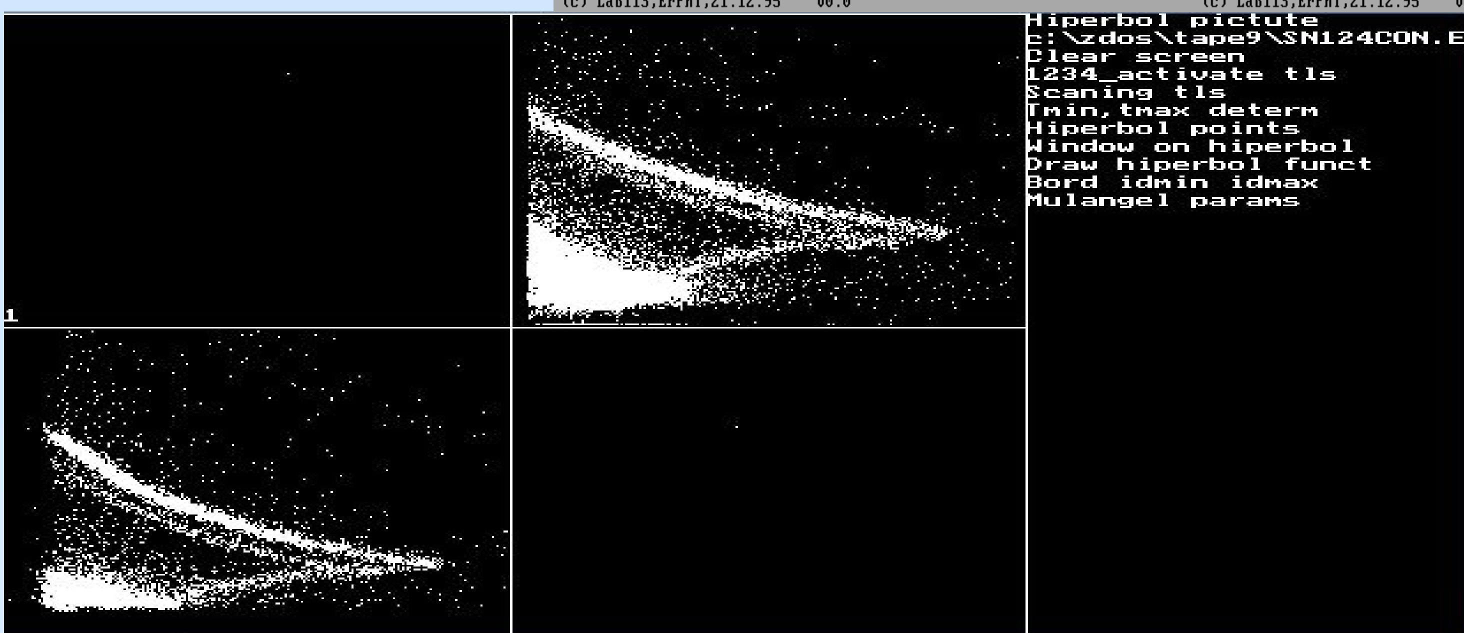
Before GUI was a UI, just for human-computer(any device!!) interaction.
For early computers there were key-options extend functionality,
Example: ls [OPTION]... [FILE]… or dir [OPTION]... [FILE]…
To make life easier there where developed TUI. ((n)curses lib)
Classic example: Midnight Commander (mc)



GUI usage prehistory

My early program “obr” for “e-A” experiment a TUI with turbo pascal.

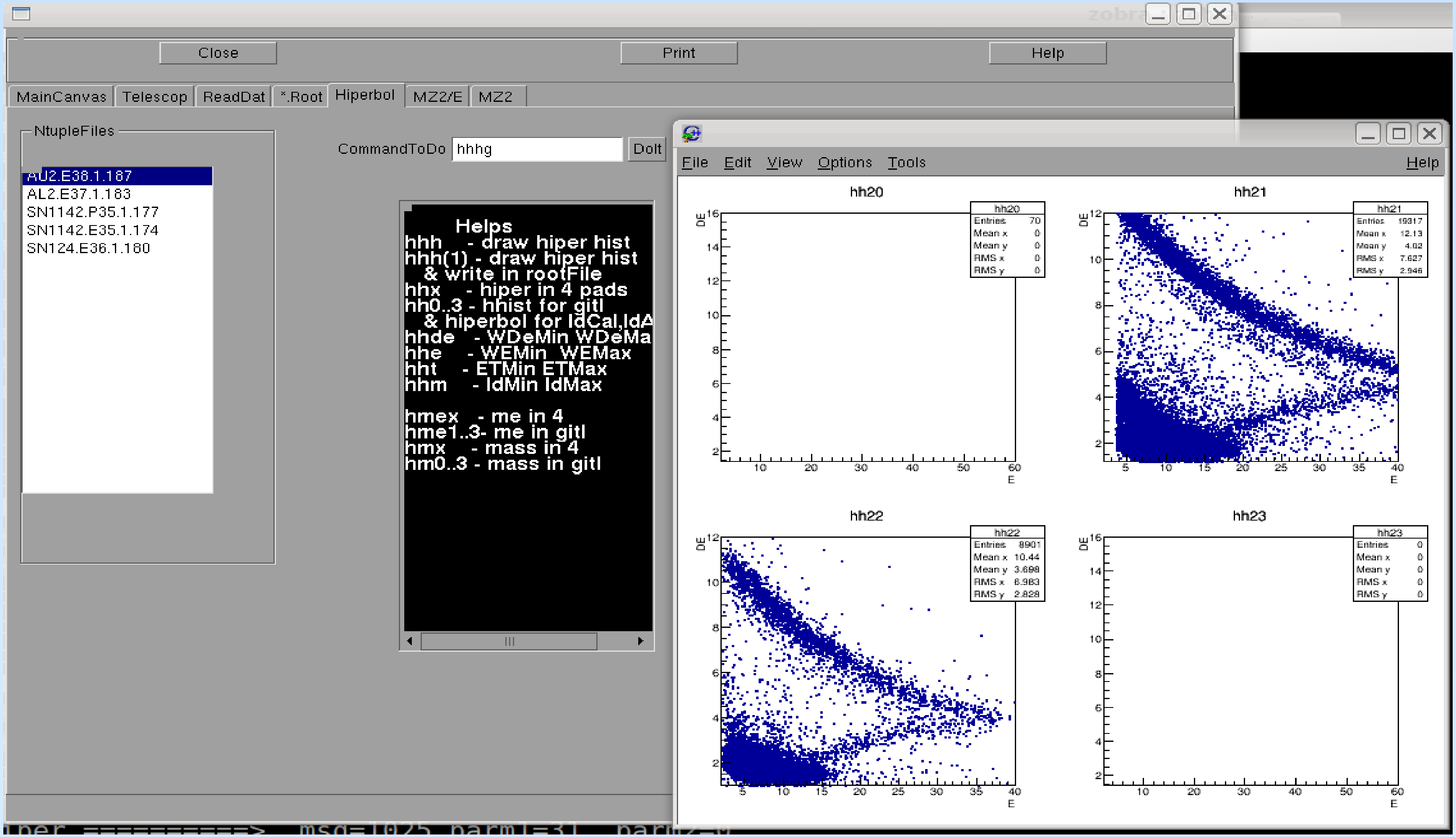




No mouse used
Only keyboard
with arrow keys

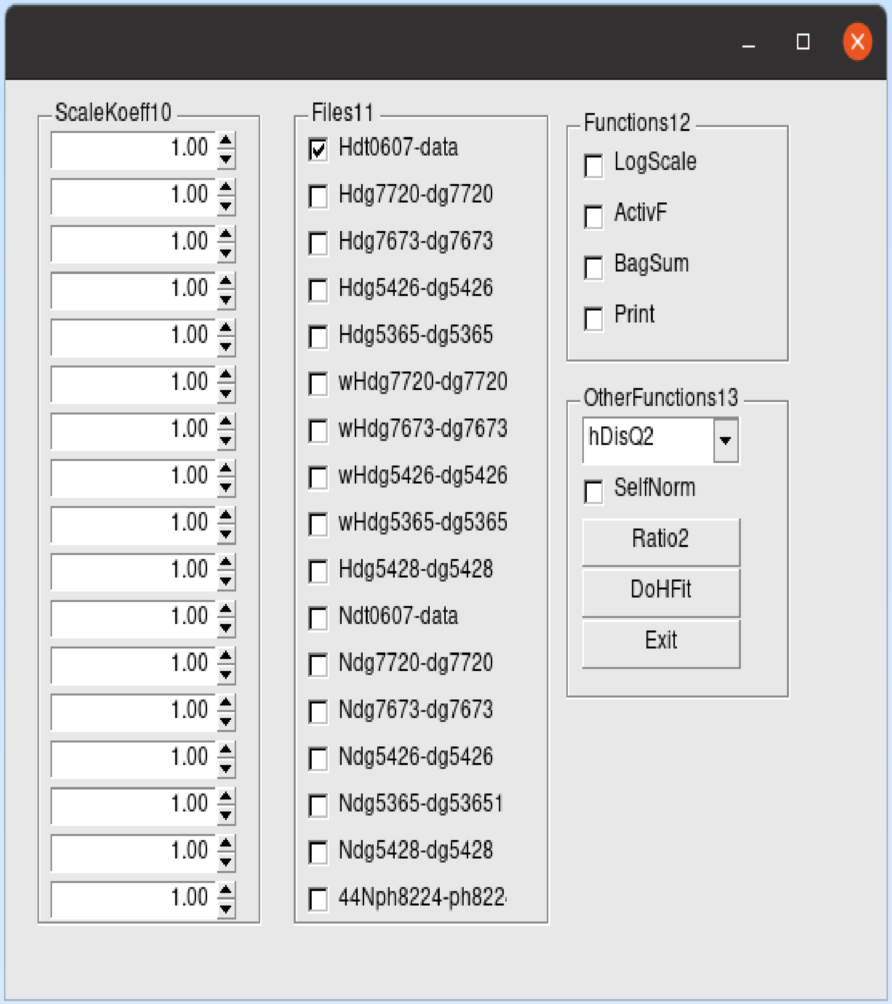
ROOT GUI usage

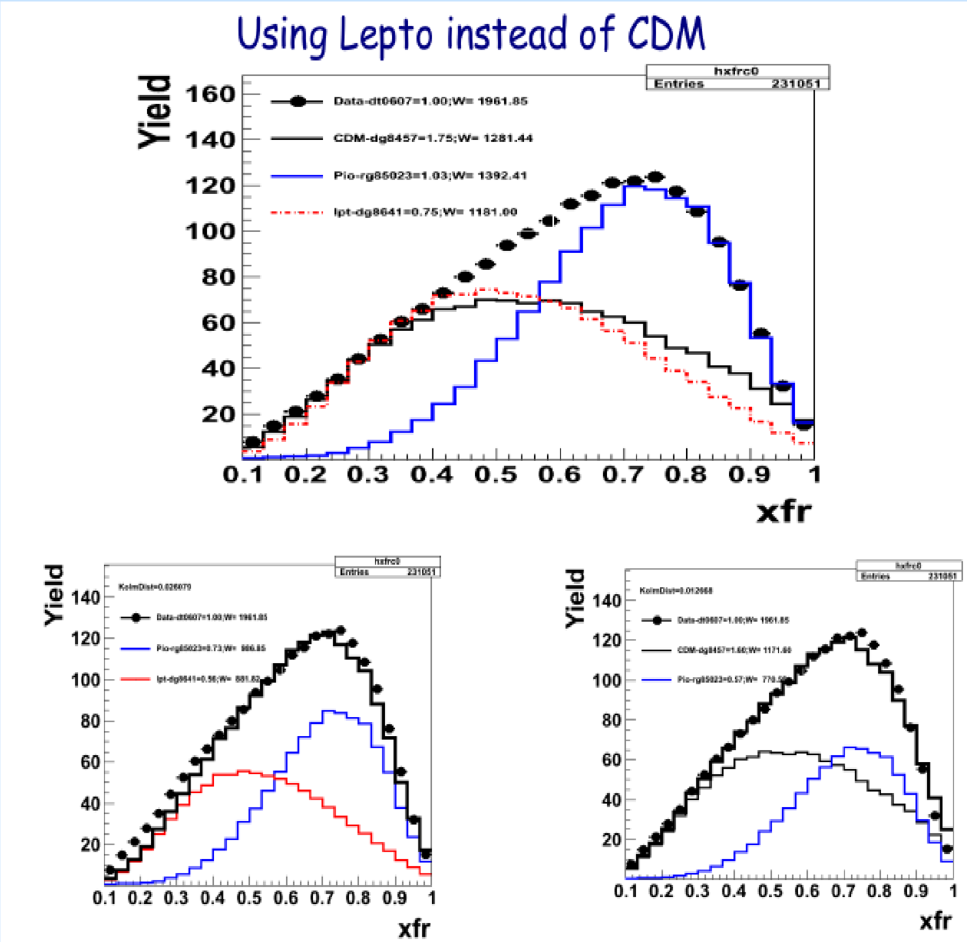
ROOT for “e-A” experiment ΔE-E Silicon Semiconductor Telescopes.
TGClasses used for GUI. Was rerun old data to find any H4, H5….



ROOT GUI in physics

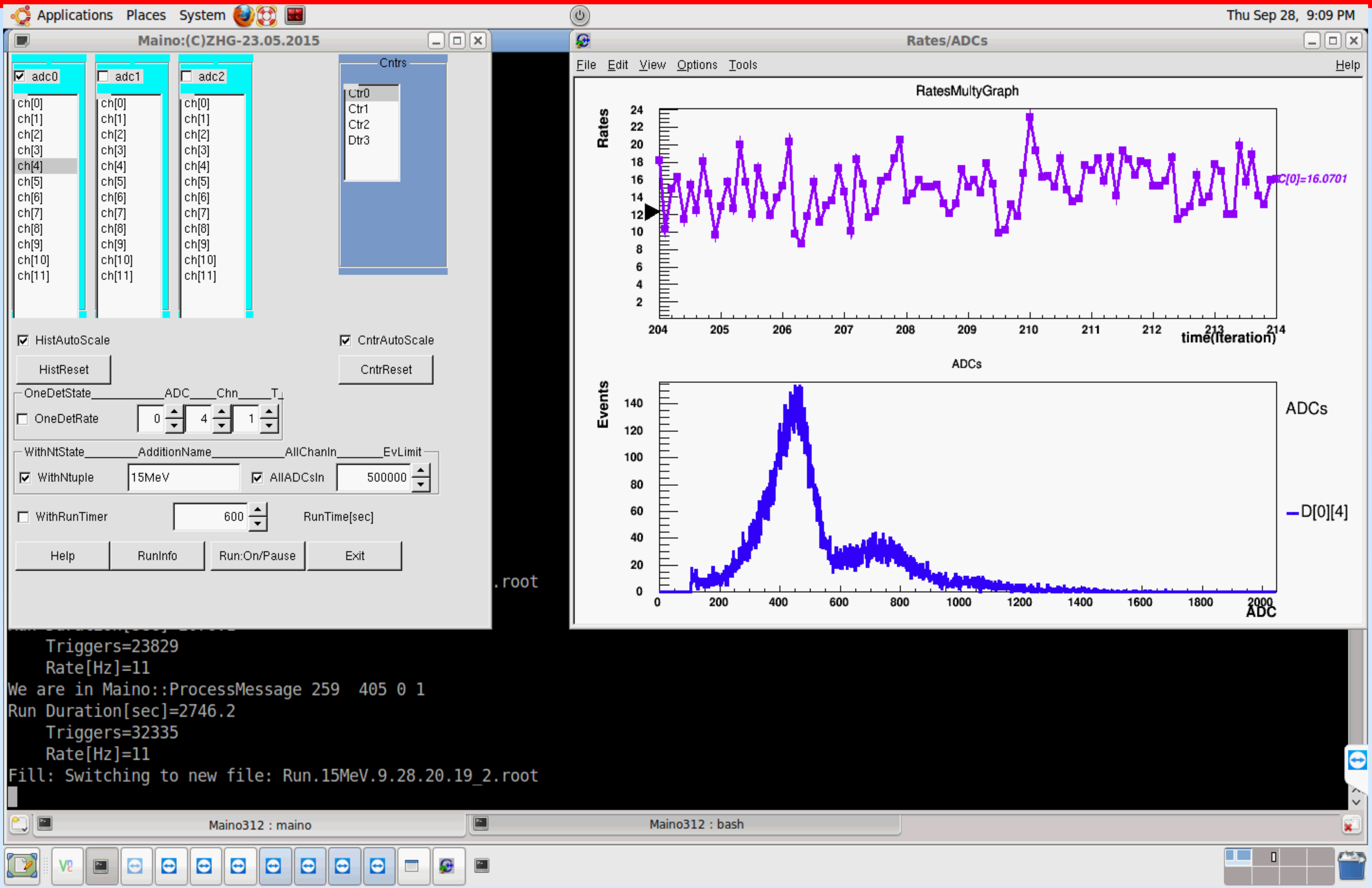
In H1 collaboration started to use ROOT-GUI to manipulate with files/histograms to achieve meaningful/best/visual fit models to data.



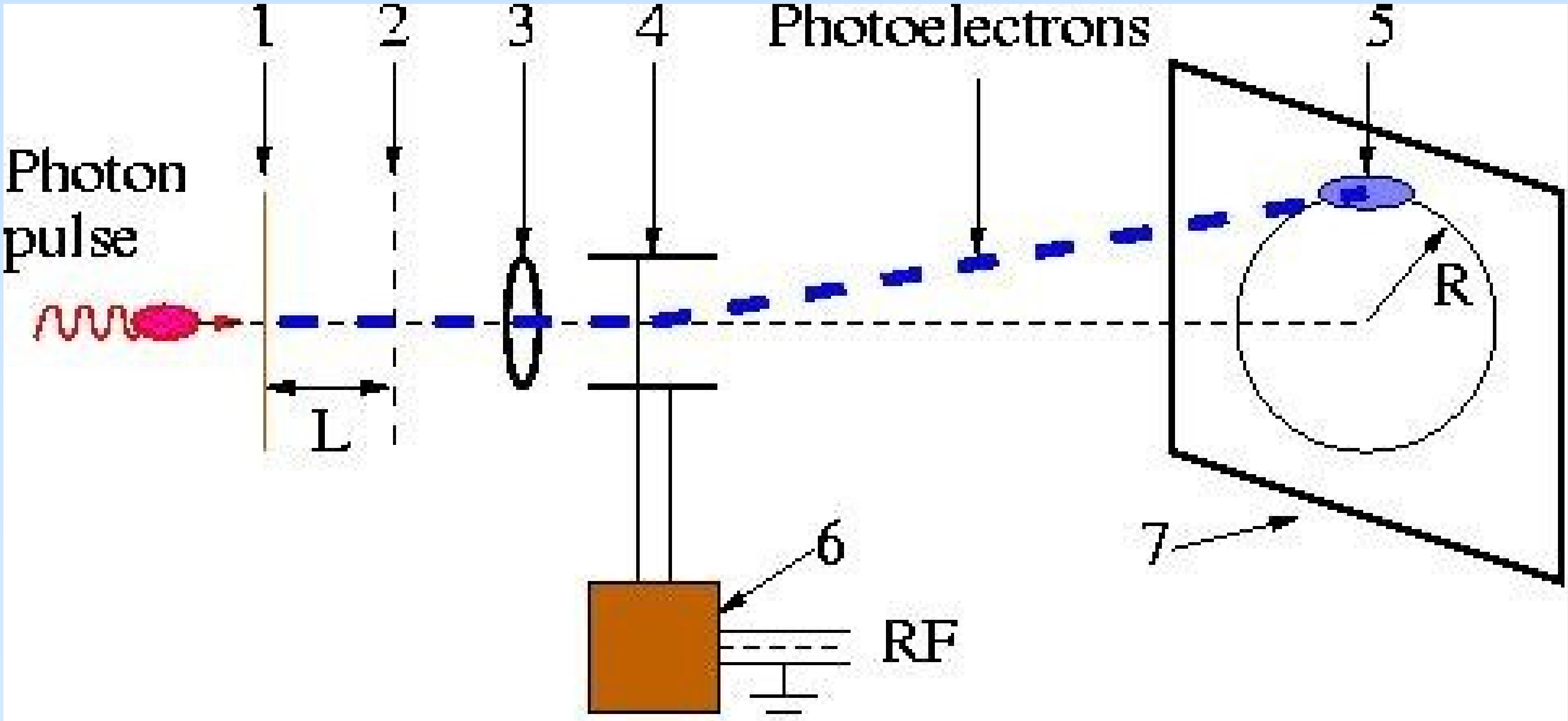


With Lepto description is worse. Use to estimate model uncertainty.

An other usage was “maino”



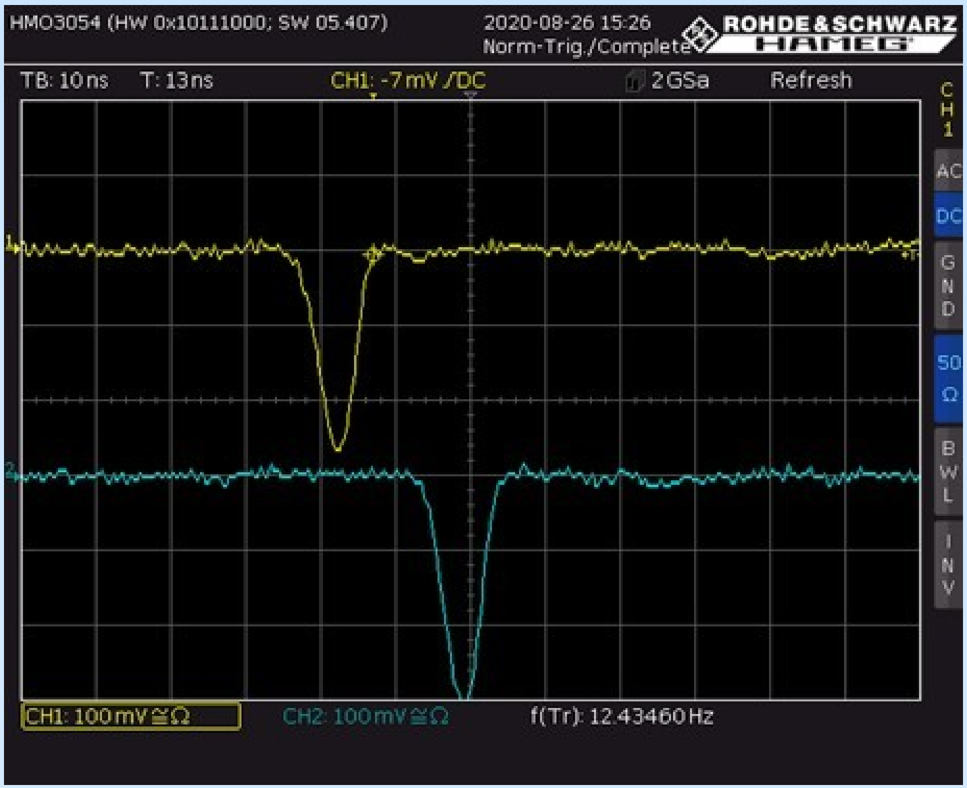
This usage for ~PicoSec resolution



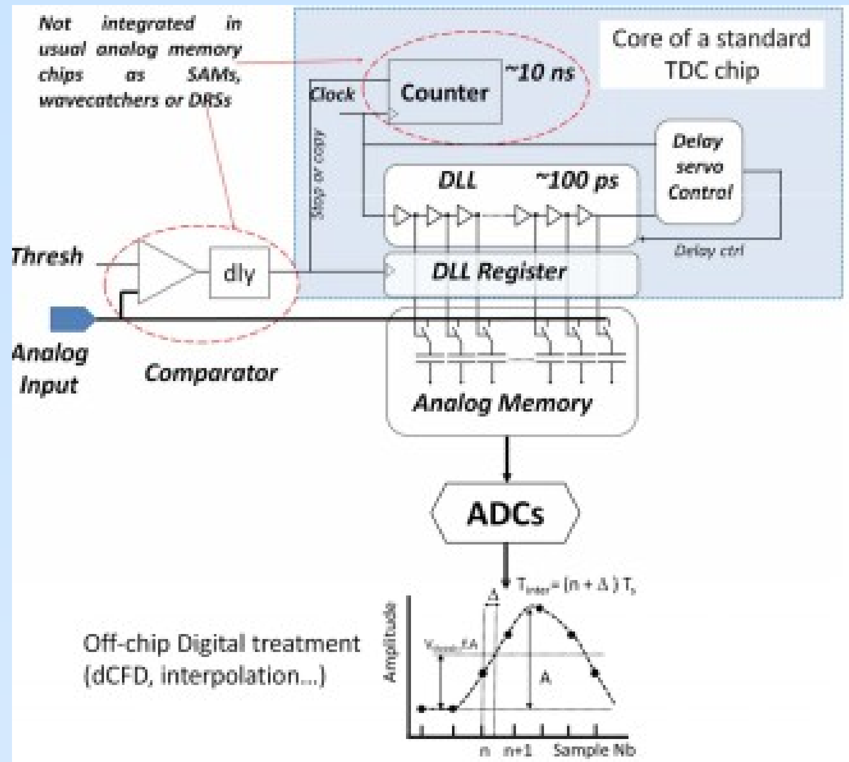
Idea comes from 1970-ies

Fighting for ~picosec resolution

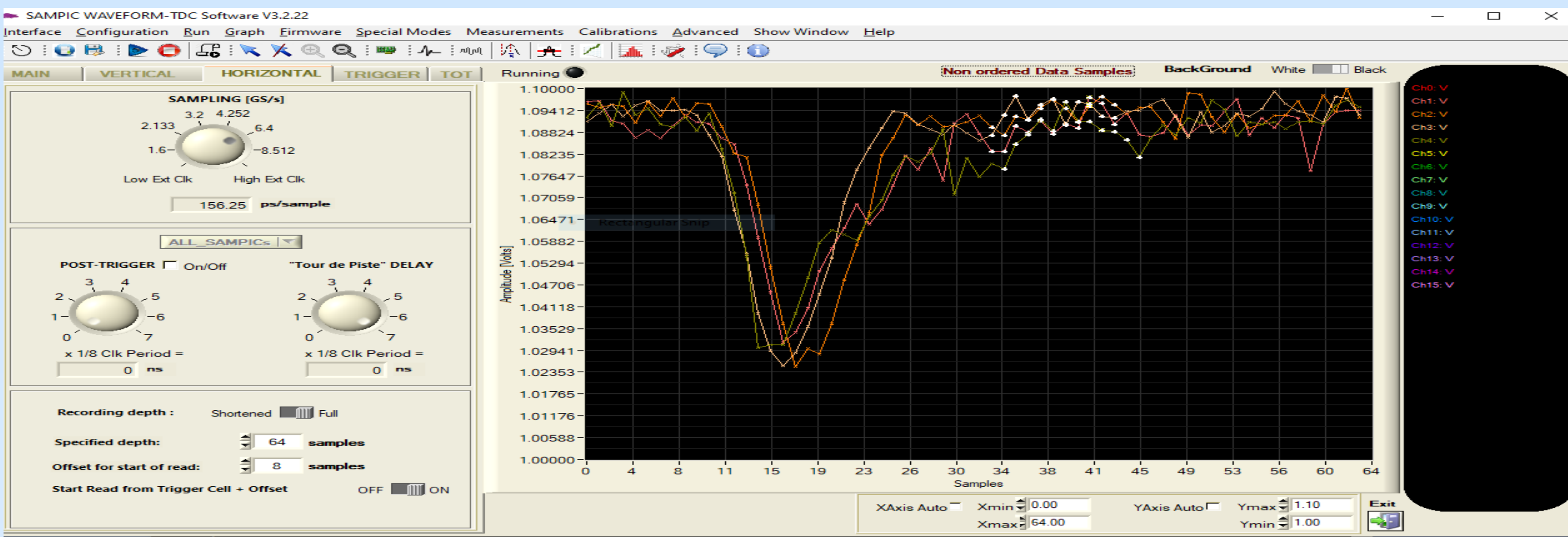
Signal picture Osciloscope



Typical DLL scheme



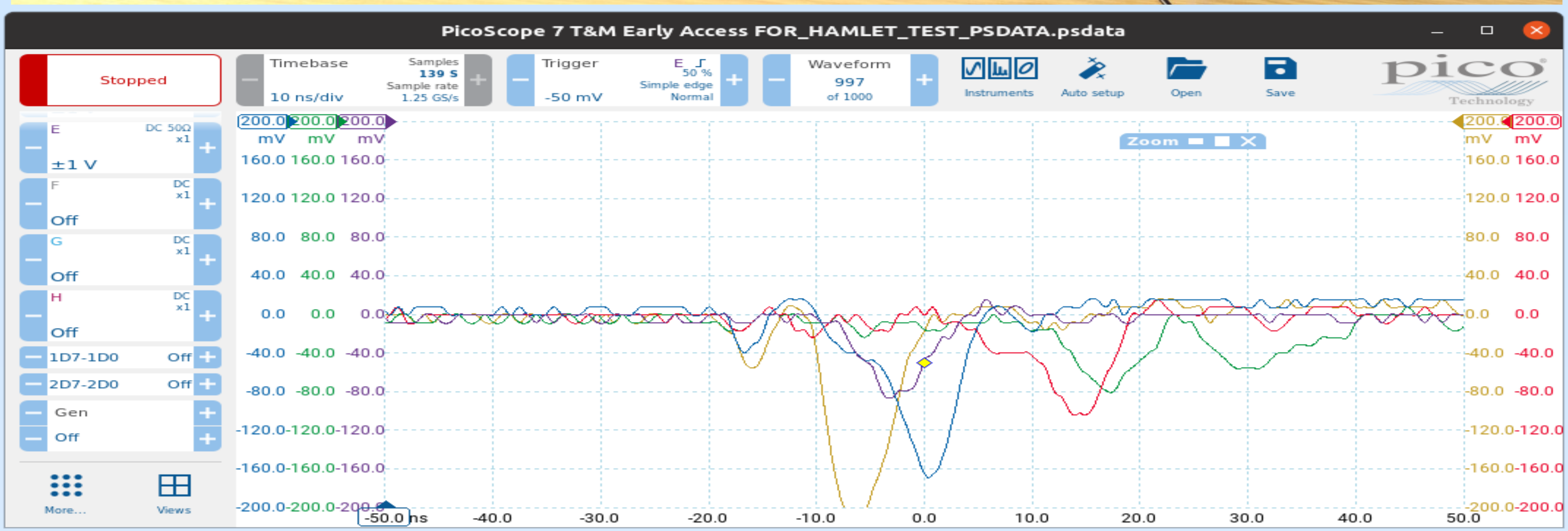
Application-specific integrated circuit SAMPIC



SAMPIC: PERFORMANCE SUMMARY

		Unit
Technology	AMS CMOS 0.18µm	
Number of channels	16	
Power consumption (max)	180 (1.8V supply)	mW
Discriminator noise	2	mV rms
SCA depth	64	Cells
Sampling speed	0.8 to 8.5 (10.2 for 8 channels only)	GSPS
Bandwidth	> 1	GHz
Range (unipolar)	~ 1	V
ADC resolution	7 to 11 (trade-off time/resolution)	bits
SCA noise	< 1	mV rms
Dynamic range	> 10	bits rms
Conversion time	0.1 (7 bits) to 1.6 (11 bits)	µs
Readout time / ch @ 2 Gbit/s (full waveform)	< 450	ns
Single Pulse Time precision before correction (4.2 to 8.5 GS/s)	< 15	ps rms
Single Pulse Time precision after time INL correction (4.2 to 8.5 GS/s)	< 3.5	ps rms

Application-specific integrated circuit **PicoScope**

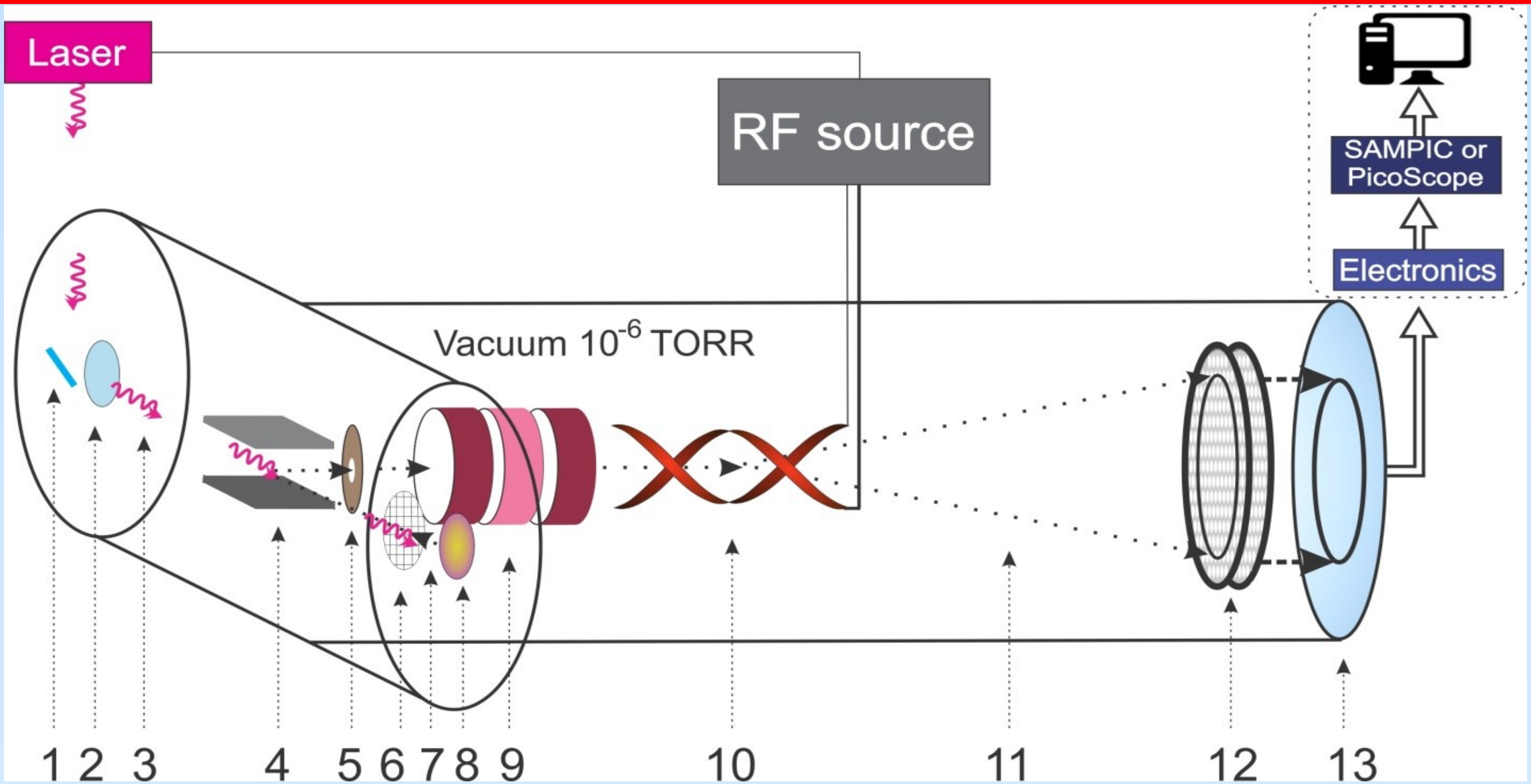


PicoScope 6407 Digitizer Specifications

VERTICAL	
Number of Channels	4
Input connectors	SMA
Bandwidth (-3 dB)	1 GHz
Rise time (calculated)	350 ps
Resolution	8 bits (12 bits with software enhancement)
Input impedance	50 Ω ±2%
VSWR	< 1.5:1 DC to 1 GHz typical over full bandwidth of scope
Input coupling	DC
Input sensitivity	20 mV/div (10 vertical divisions)
Input ranges	±100 mV
DC accuracy	±3% of full scale
Overvoltage protection	±2 V (DC + Peak AC)
HORIZONTAL	
Sampling rate (real time 1 Channel)	5 GS/s
Sampling rate (real time 2 Channels)	2.5 GS/s (using A+C, A+D, B+C, B+D)
Sampling rate (real time 4 Channels)	1.25 GS/s
Sampling rate (cont. USB streaming)	1 MS/s in PicoScope software. >10 MS/s using supplied SDK (PC-dependent)
Buffer memory	1 GS
Waveform buffer (no. of segments)	1 to 10,000
Timebase accuracy	±5 ppm
DYNAMIC PERFORMANCE (typical)	
Crosstalk	100:1 DC to 100 MHz 30:1 100 MHz to 1 GHz
Step response	±3% after 3 ns, typical
Noise	<0.5 mV RMS
TRIGGER	
Basic trigger modes	Rising, falling

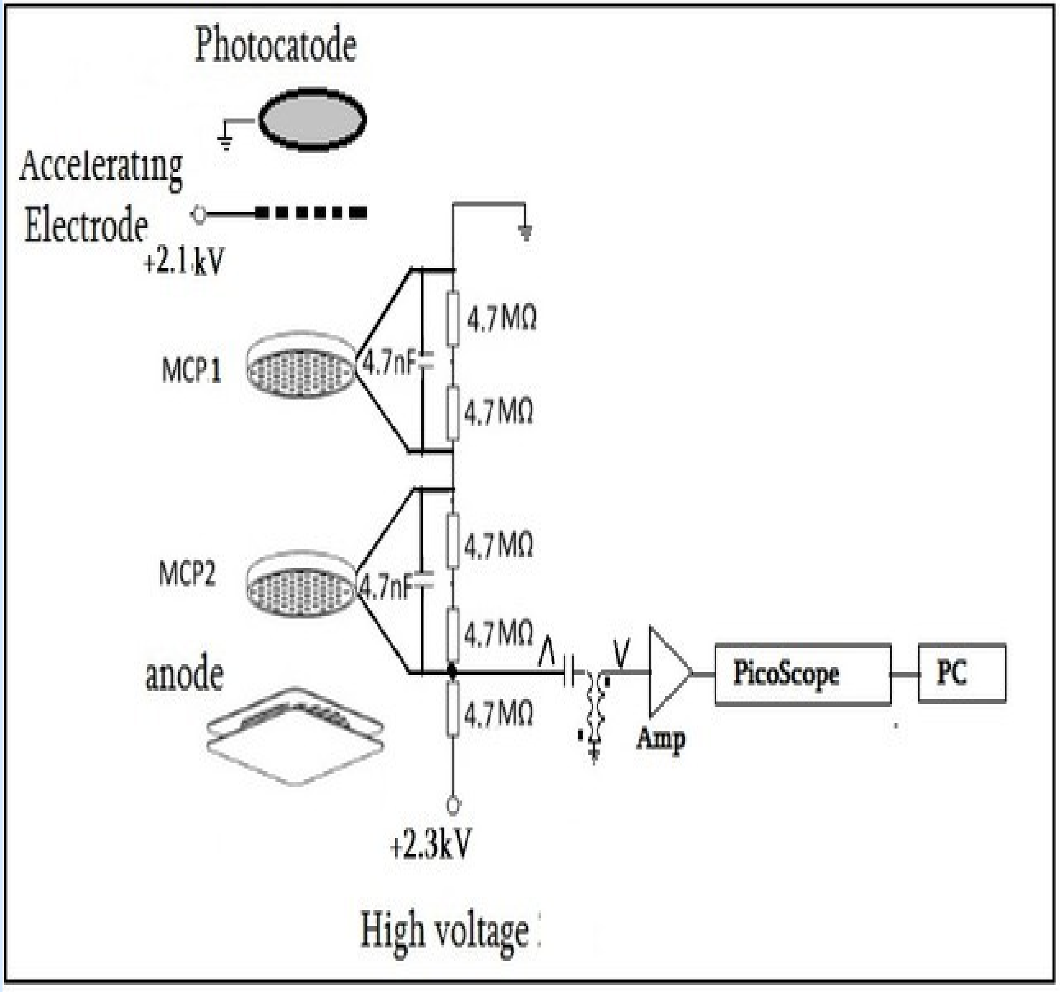
continued

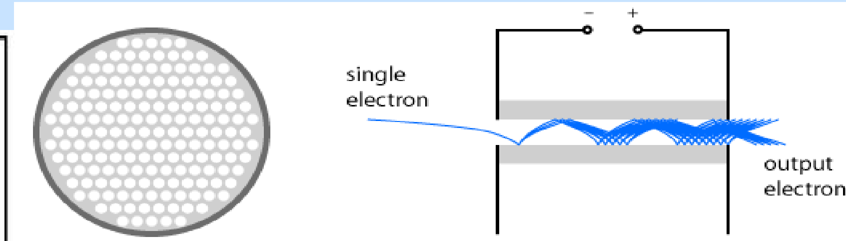
The measurements setup

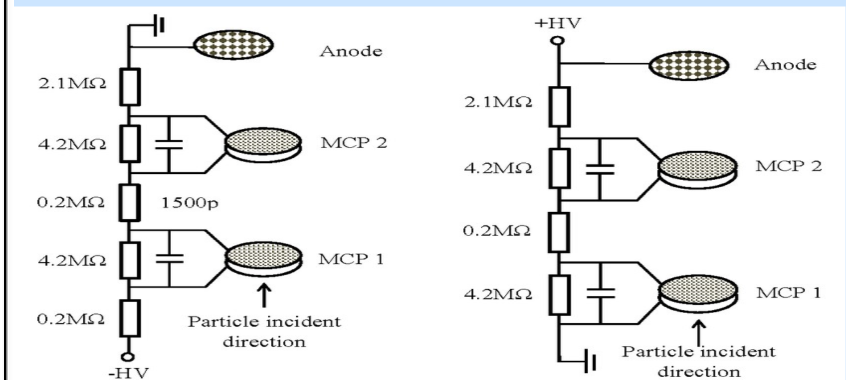


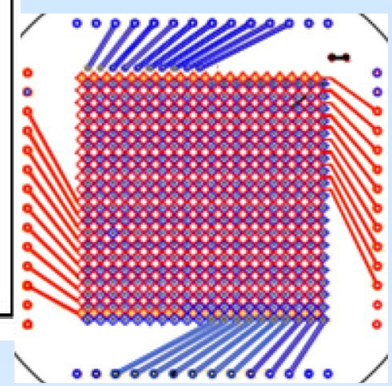
1.mirror; 2.quartz glass window; 3.laser photons; 4. permanent magnet; 5.collimator; 6.accelerating electrode; 7. photoelectrons; 8 tantalum disc cathode;9. electrostatic lens; 10.RF deflector;11.RF scanned electrones; 12.MCP detector; 13.position sensitive anod.

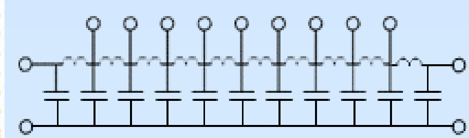
Some details of setup



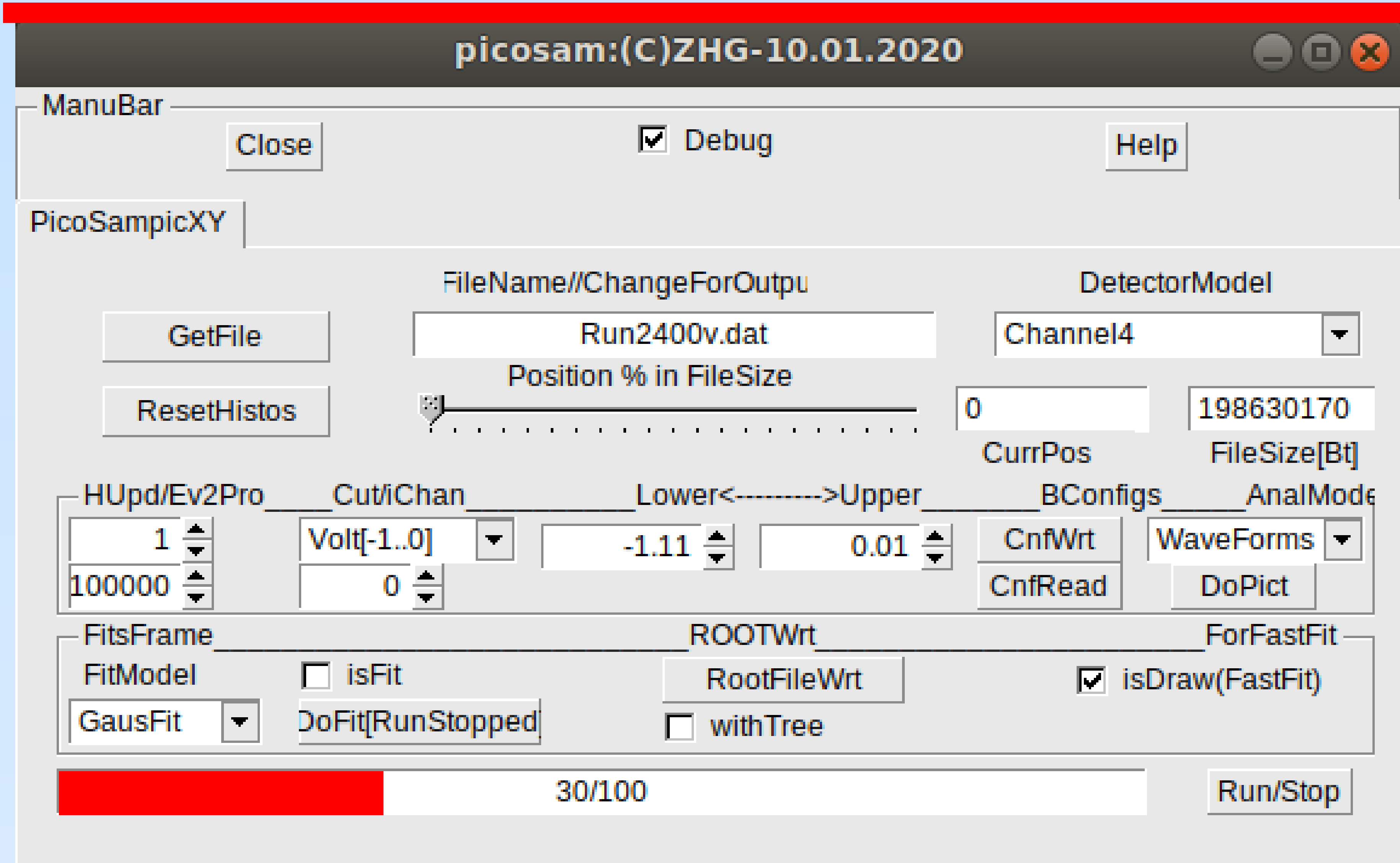




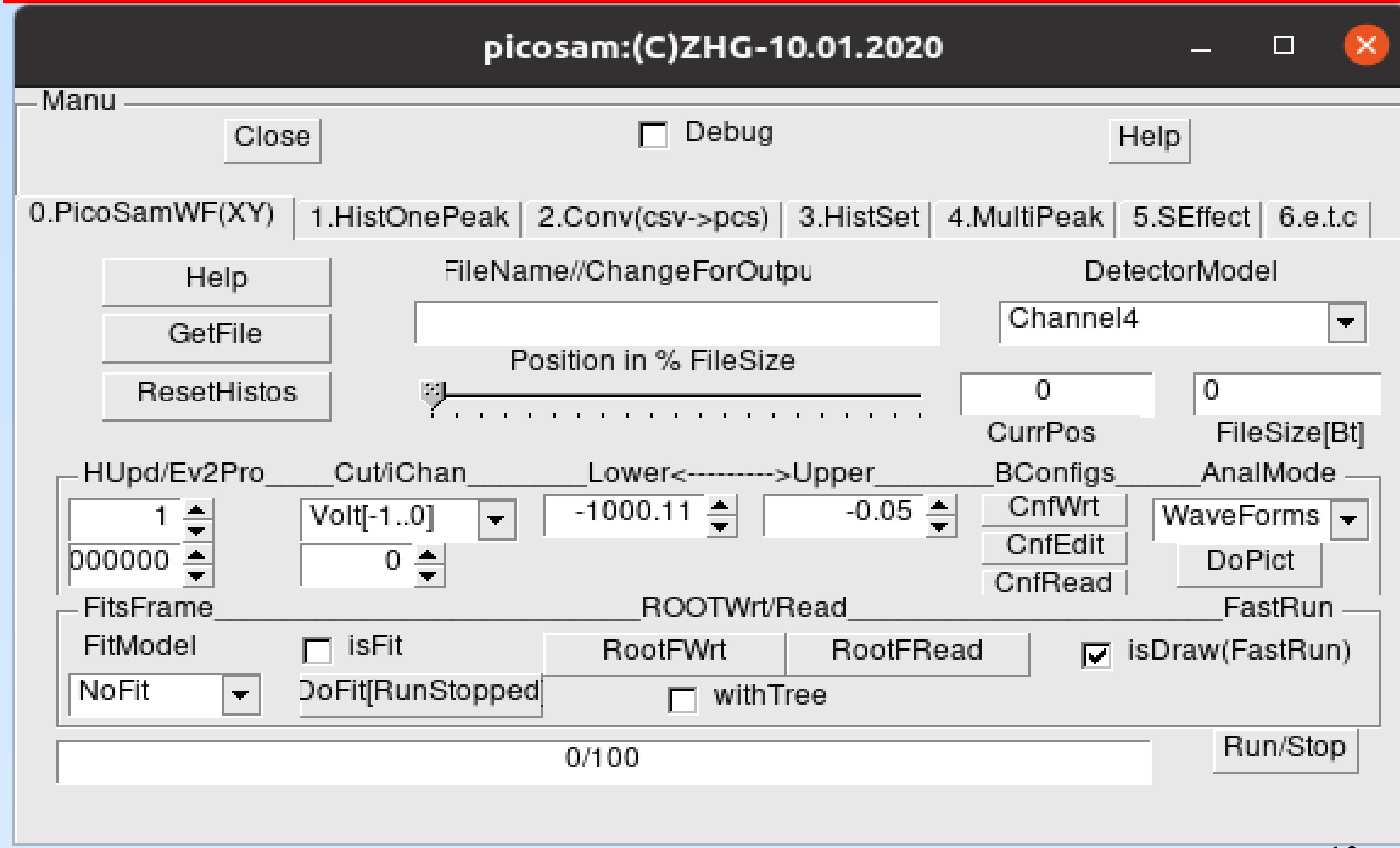




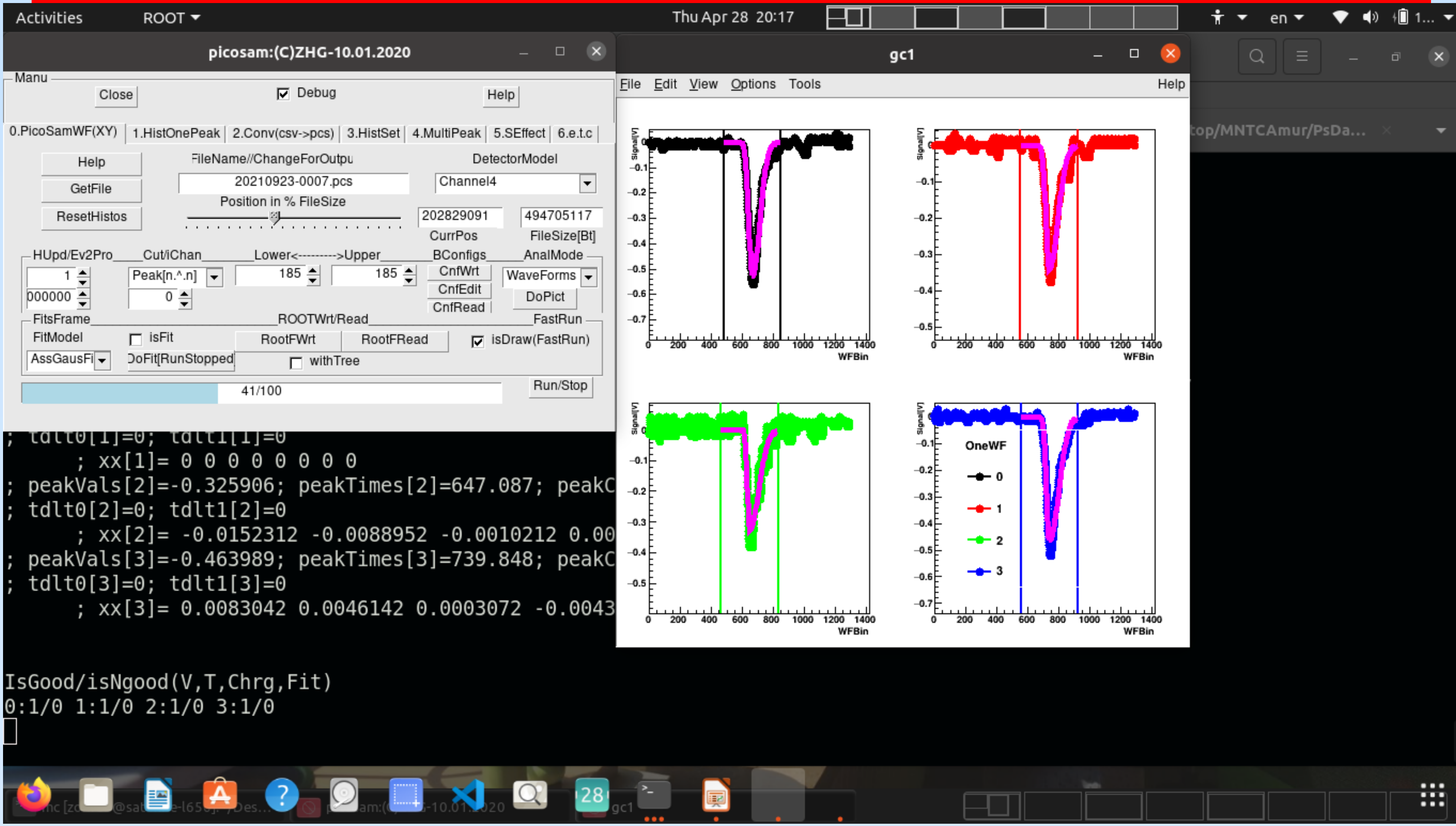
First version of “picos(am)”



First version of “picos(am)”

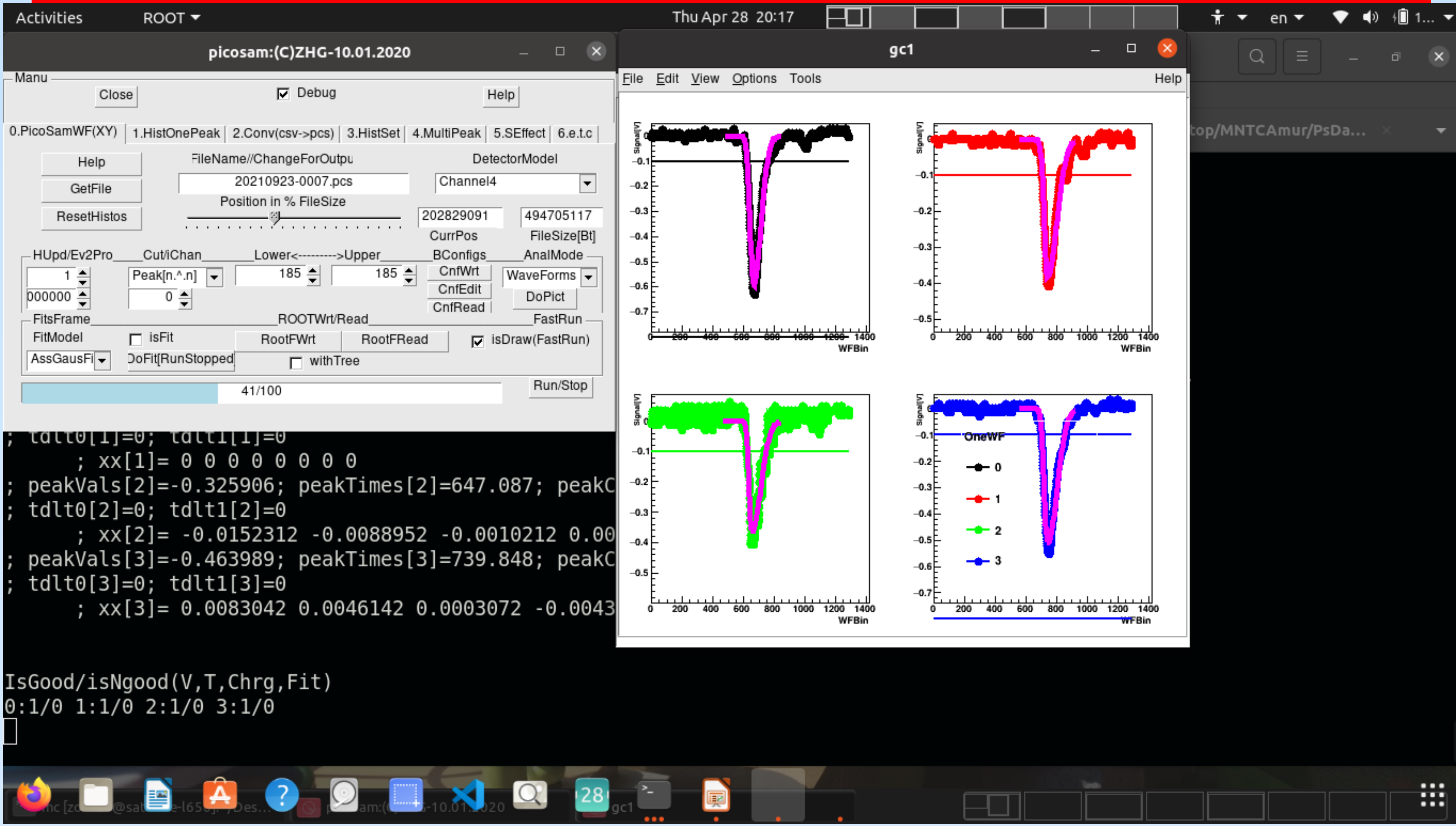


WF pictures



Activities
ROOT
Thu Apr 28 20:17
picosam:(C)ZHG-10.01.2020
Manu
Close
Debug
Help
0.PicoSamWF(XY)
1.HistOnePeak
2.Conv(csv->pcs)
3.HistSet
4.MultiPeak
5.SEffect
6.e.t.c
Help
GetFile
ResetHistos
FileName//ChangeForOutpu
20210923-0007.pcs
Position in % FileSize
DetectorModel
Channel4
202829091
494705117
CurrPos
FileSize[Bt]
HUpd/Ev2Pro
Cut/iChan
Lower<--------->Upper
BConfigs
AnalMode
Peak[n.^.n]
185
185
CnfWrt
CnfEdit
CnfRead
WaveForms
DoPict
FitsFrame
ROOTWrt/Read
FastRun
FitModel
isFit
RootFWrt
RootFRead
isDraw(FastRun)
AssGausFi
DoFit[RunStopped]
withTree
41/100
Run/Stop
; tdlt0[1]=0; tdlt1[1]=0
; xx[1]= 0 0 0 0 0 0 0 0
; peakVals[2]=-0.325906; peakTimes[2]=647.087; peakC
; tdlt0[2]=0; tdlt1[2]=0
; xx[2]= -0.0152312 -0.0088952 -0.0010212 0.00
; peakVals[3]=-0.463989; peakTimes[3]=739.848; peakC
; tdlt0[3]=0; tdlt1[3]=0
; xx[3]= 0.0083042 0.0046142 0.0003072 -0.0043
IsGood/isNgood(V,T,Chrg,Fit)
0:1/0 1:1/0 2:1/0 3:1/0
gc1
File
Edit
View
Options
Tools
Help
Signal[V]
WFBin
OneWF
0
1
2
3

WF pictures


picosam:(C)ZHG-10.01.2020
gc1
Manu
Close
Debug
Help
0.PicoSamWF(XY)
1.HistOnePeak
2.Conv(csv->pcs)
3.HistSet
4.MultiPeak
5.SEffect
6.e.t.c
FileName//ChangeForOutpu
DetectorModel
GetFile
20210923-0007.pcs
Channel4
Position in % FileSize
ResetHistos
202829091
494705117
CurrPos
FileSize[Bt]
HUpd/Ev2Pro
Cut/iChan
Lower<--------->Upper
BConfigs
AnalMode
Peak[n.^.n]
185
CnfWrt
WaveForms
CnfEdit
DoPict
CnfRead
FitsFrame
ROOTWrt/Read
FastRun
FitModel
isFit
RootFWrt
RootFRead
isDraw(FastRun)
AssGausFi
DoFit[RunStopped
withTree
41/100
Run/Stop
; peakVals[2]=-0.325906; peakTimes[2]=647.087; peakC
; tdlt0[2]=0; tdlt1[2]=0
; xx[2]= -0.0152312 -0.0088952 -0.0010212 0.00
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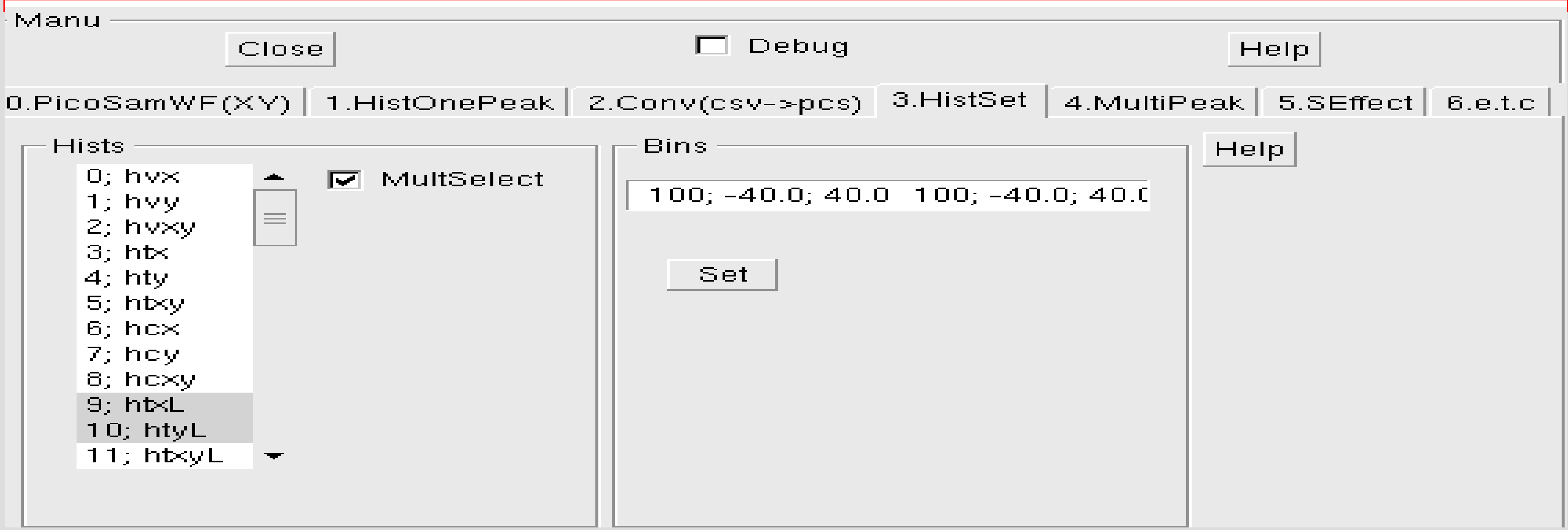
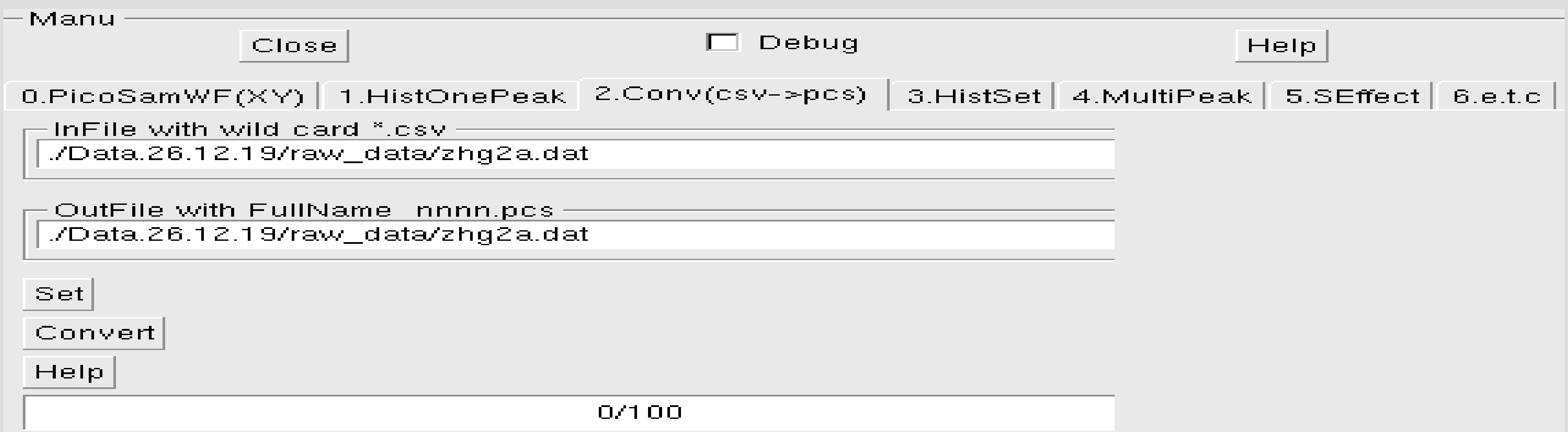
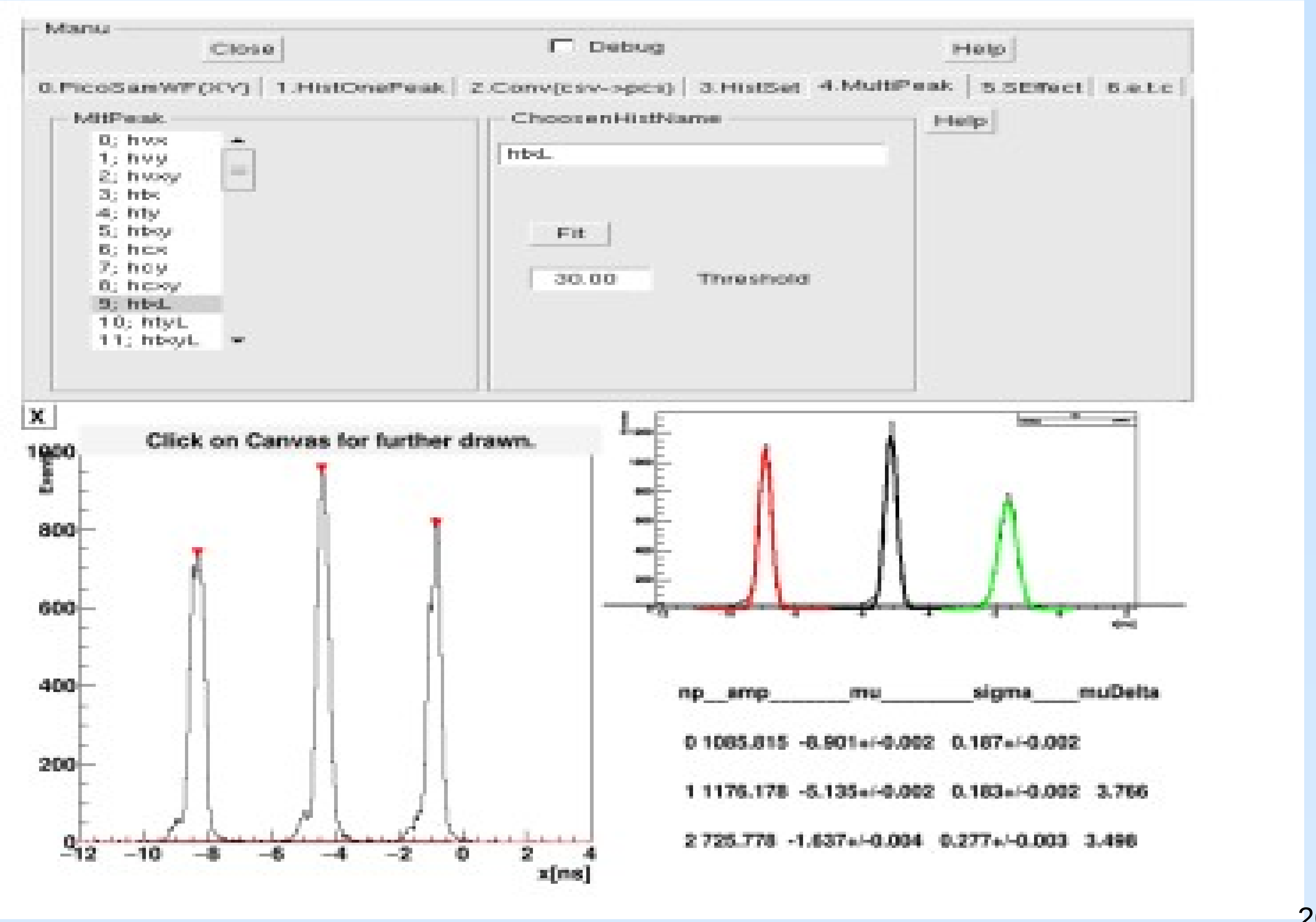
; tdlt0[3]=0; tdlt1[3]=0
; xx[3]= 0.0083042 0.0046142 0.0003072 -0.0043
IsGood/isNgood(V,T,Chrg,Fit)
0:1/0 1:1/0 2:1/0 3:1/0
File
Edit
View
Options
Tools
WFBin
OneWF

Histograms and csv → pcs conversion





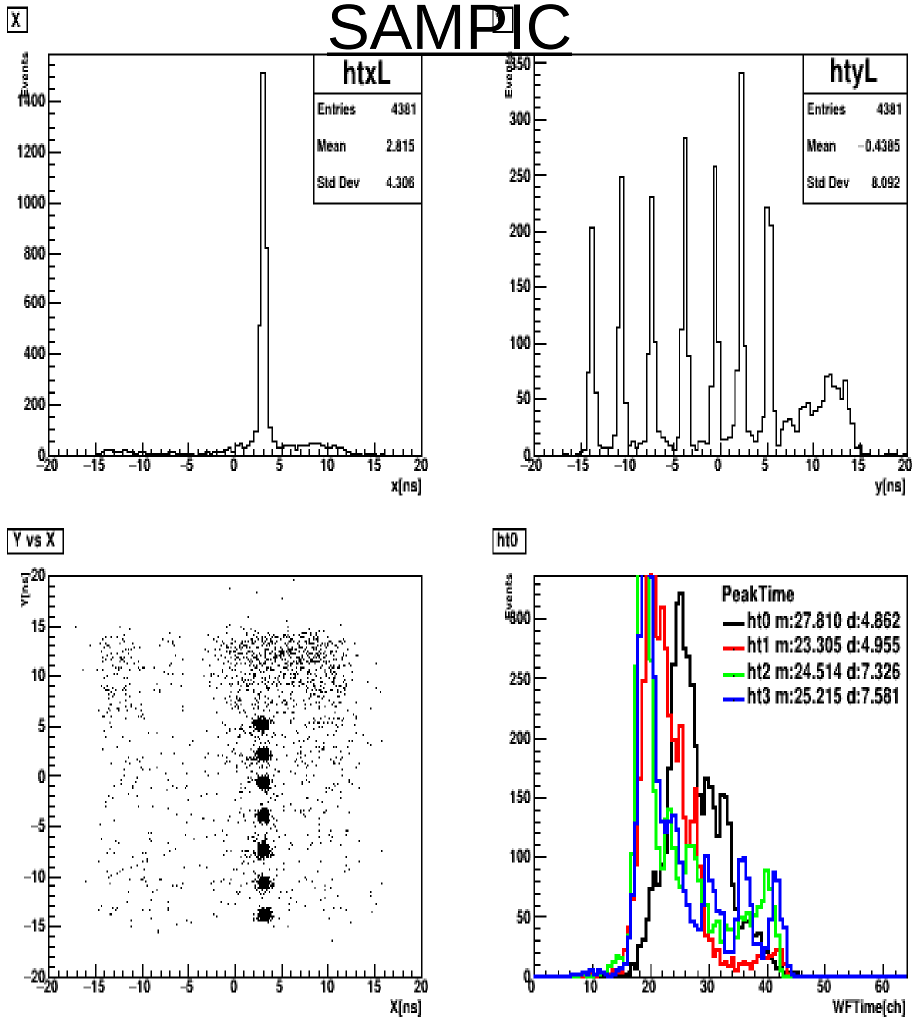
Multi-peaks



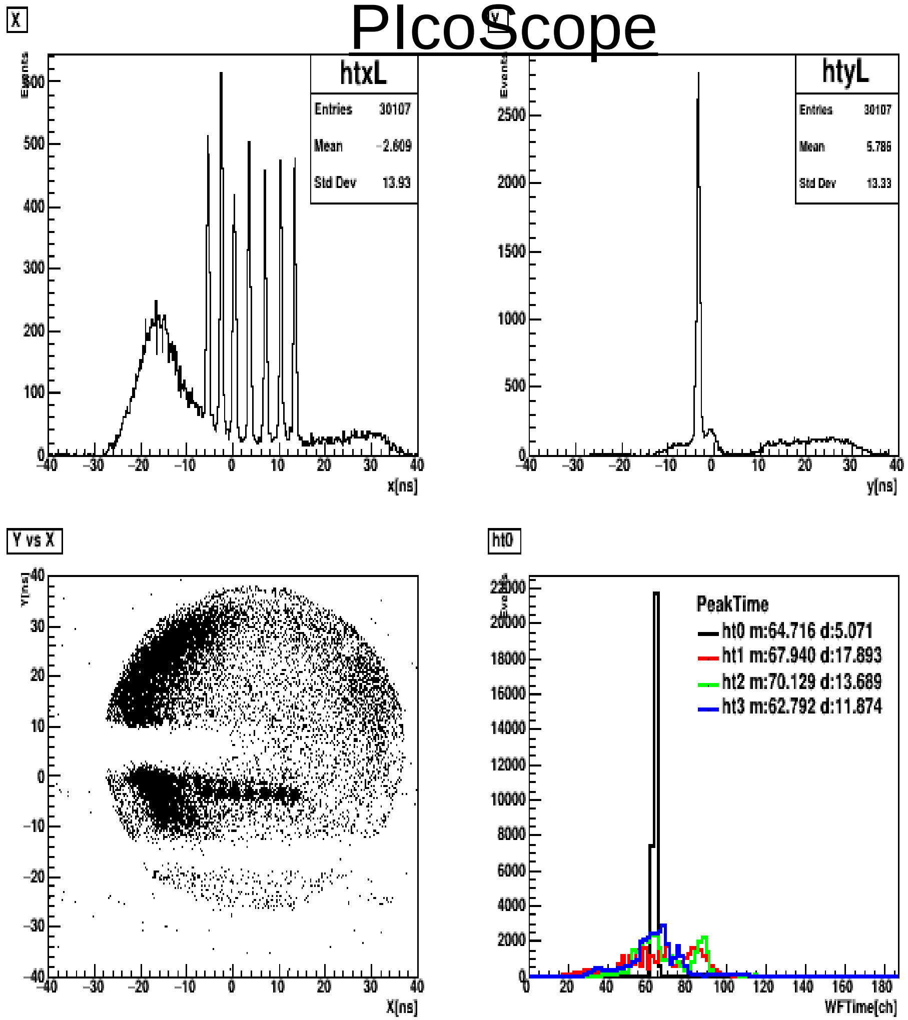
Manu
Close
Debug
Help
0.PicoSamWF(XY)
1.HistOnePeak
2.Conv(csv->pcs)
3.HistSet
4.MultiPeak
5.SEffect
6.e.t.c
MltPeak
ChoosenHistName
Help
0; hvx
1; hvy
2; hvxy
3; htx
4; hty
5; htxy
6; hcx
7; hcy
8; hcxy
9; htxL
10; htyL
11; htxyL
htxL
Fit
30.00
Threshold
Click on Canvas for further drawn.
1000
800
600
400
200
0
−12
−10
−8
−6
−4
−2
0
2
4
x[ns]
np__amp______mu________sigma____muDelta
0 1085.815 -8.901+/-0.002 0.167+/-0.002
1 1176.178 -5.135+/-0.002 0.163+/-0.002 3.766
2 725.778 -1.637+/-0.004 0.277+/-0.003 3.498

7 hole collimator

SAMPIC

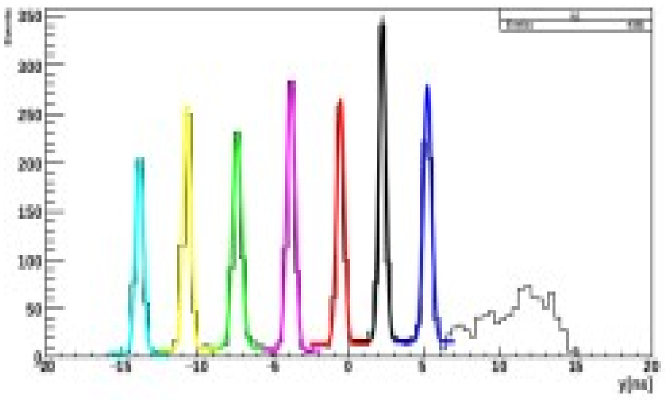


PIcoScope



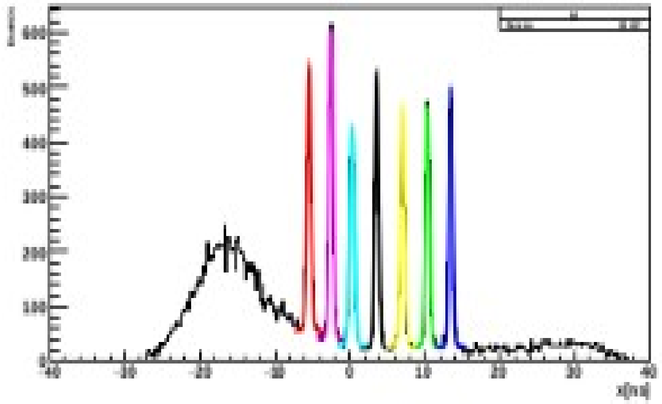
7 hole collimator

Sampic



np	amp	mu	sigma	muDelta
0	200.180	-13.823	0.259	
1	249.751	-10.680	0.250	3.144
2	218.515	-7.380	0.296	3.300
3	276.556	-3.826	0.272	3.554
4	249.794	-0.555	0.243	3.271
5	324.133	2.219	0.228	2.775
6	261.998	5.196	0.265	2.976

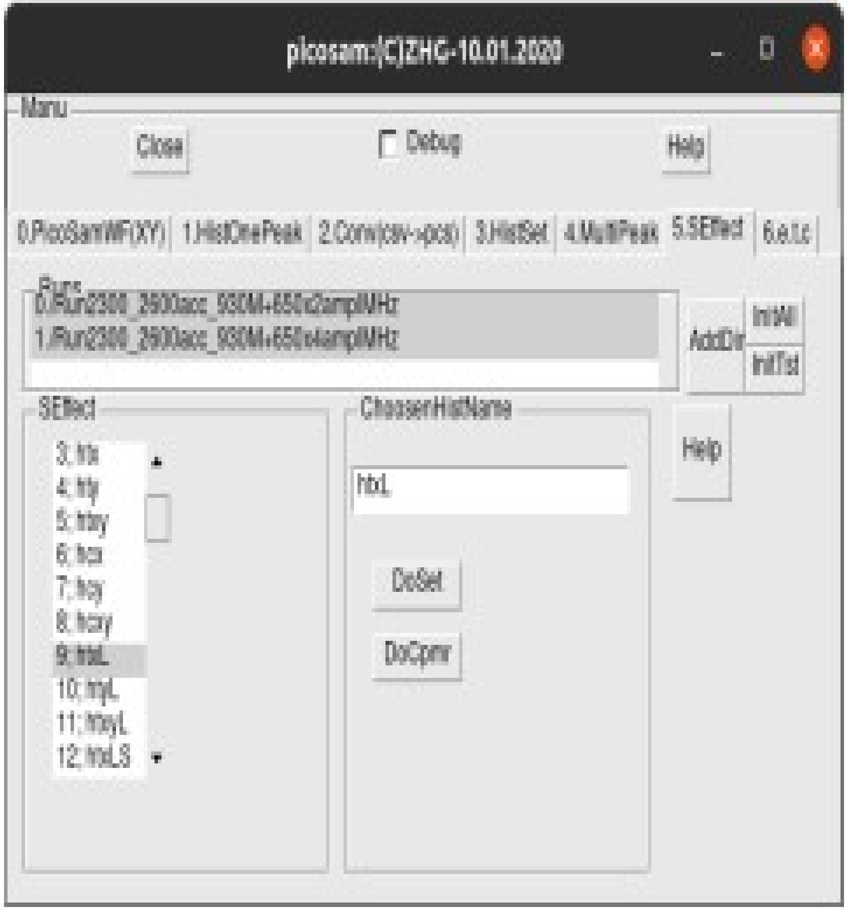
PicoScope

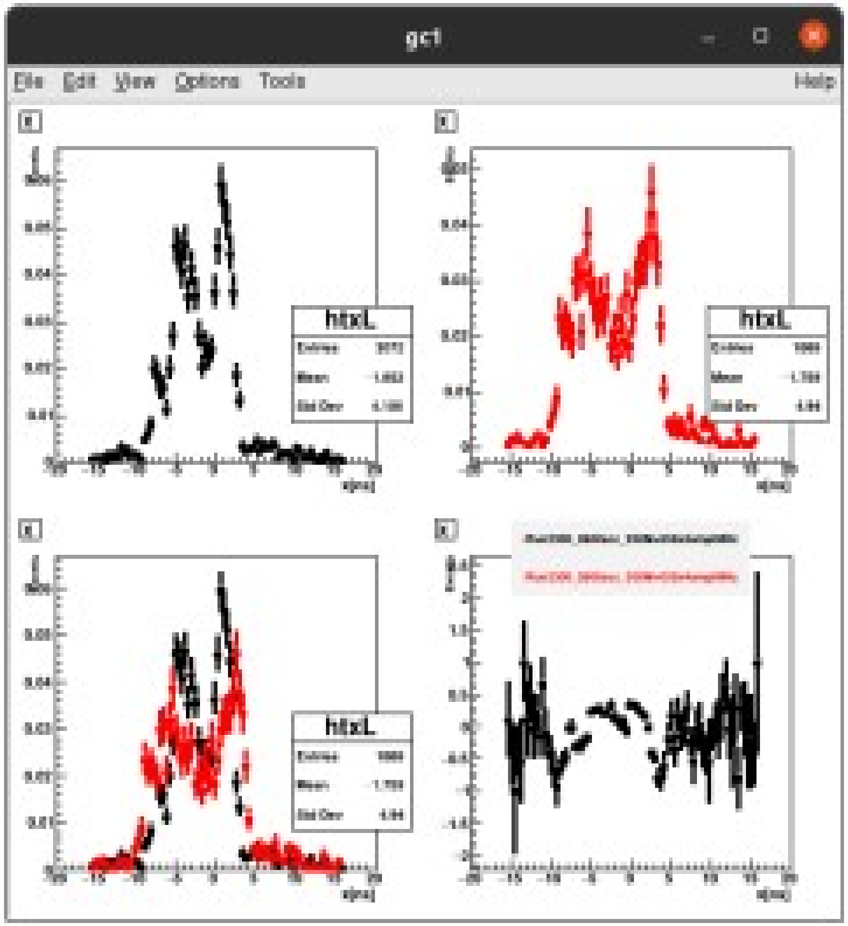


np	amp	mu	sigma	muDelta
0	478.727	-5.430	0.279	
1	560.895	-2.503	0.262	2.927
2	399.136	0.305	0.316	2.808
3	501.052	3.586	0.274	3.281
4	437.840	7.007	0.300	3.421
5	434.195	10.346	0.271	3.339
6	475.226	13.463	0.247	3.117

Histos comparison

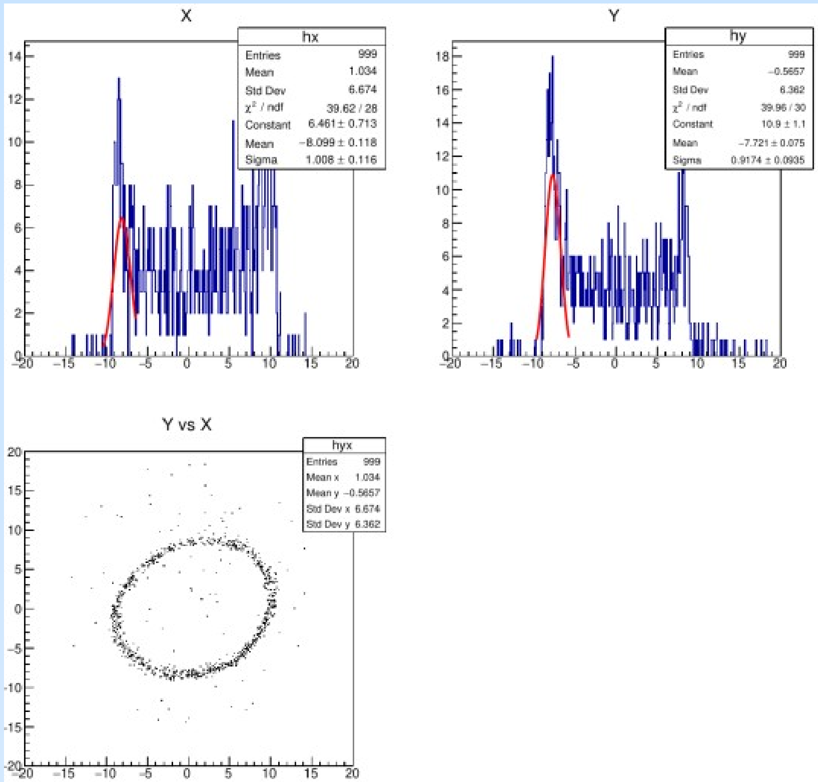
Search for effects/defects from different files



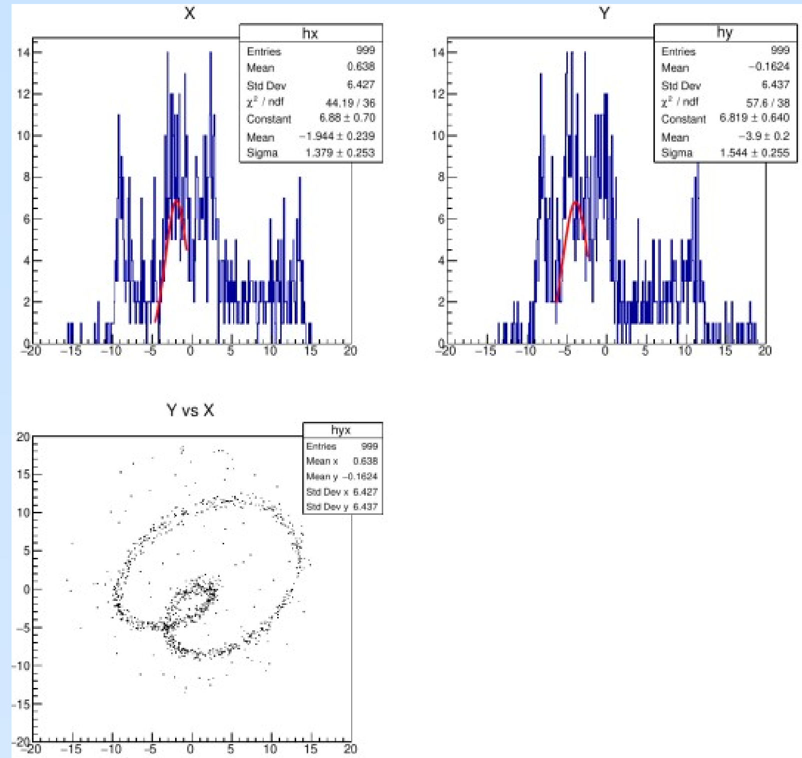


Playing with RF

500Mhz

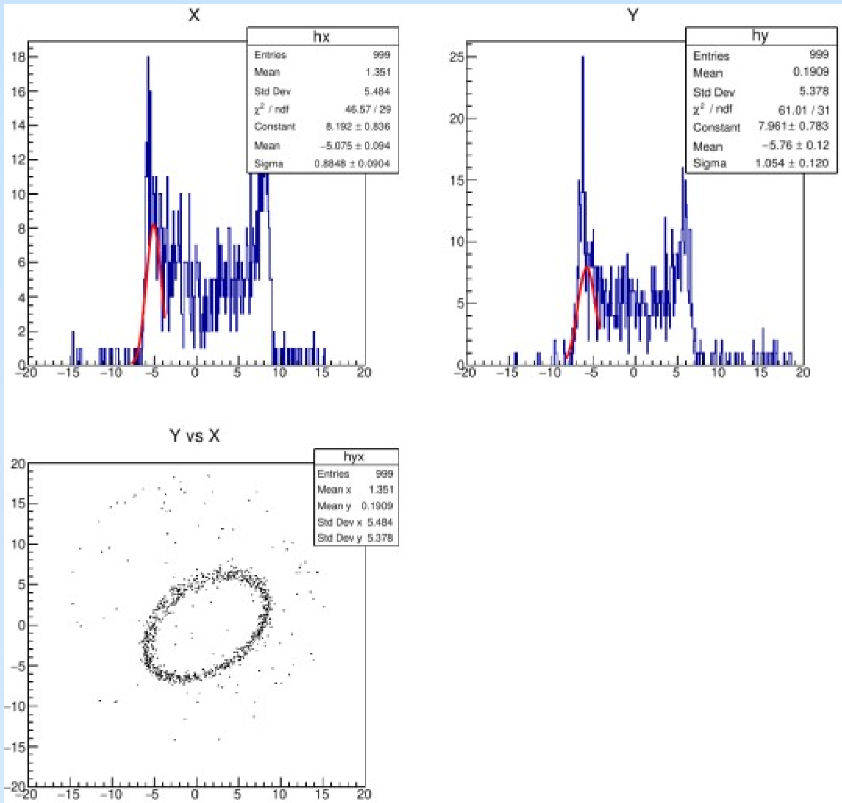


1000-500Mhz

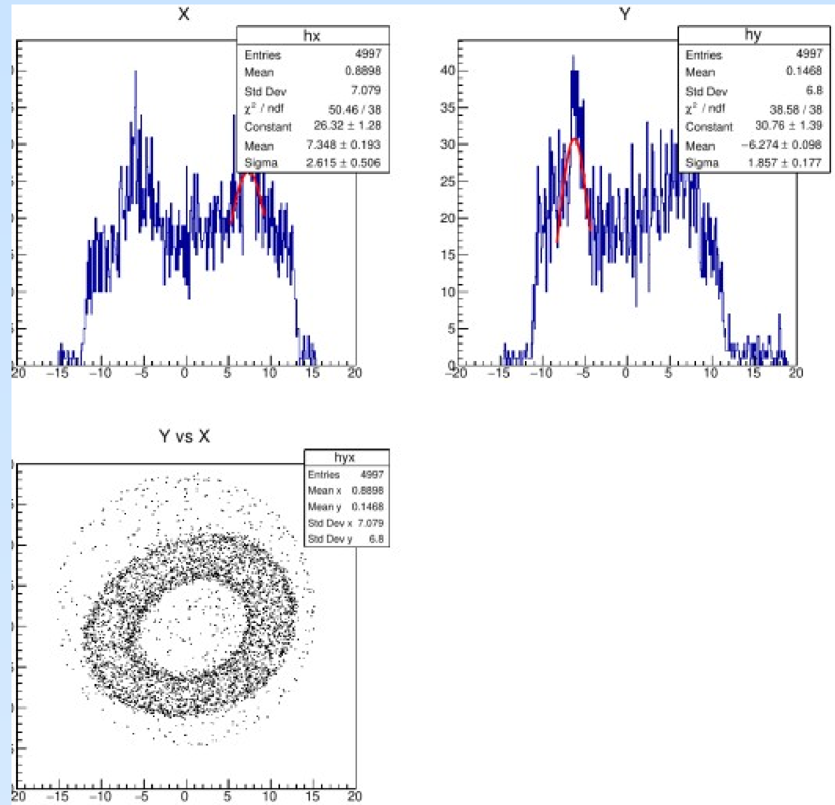


Playing with RF

<u>1000Mhz-10db</u>

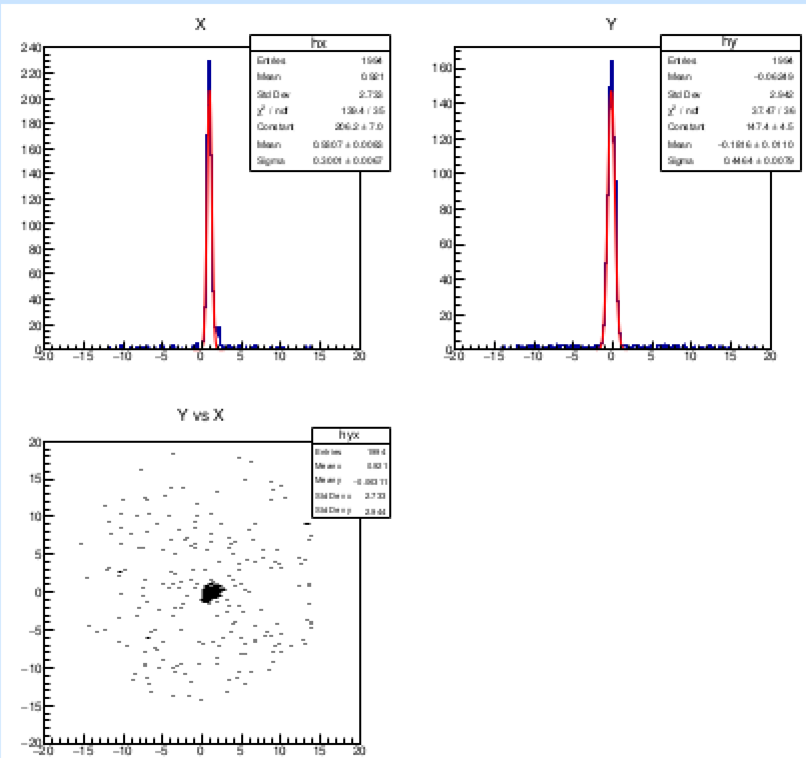


<u>490Mhz/30db+500Mhz/20db</u>

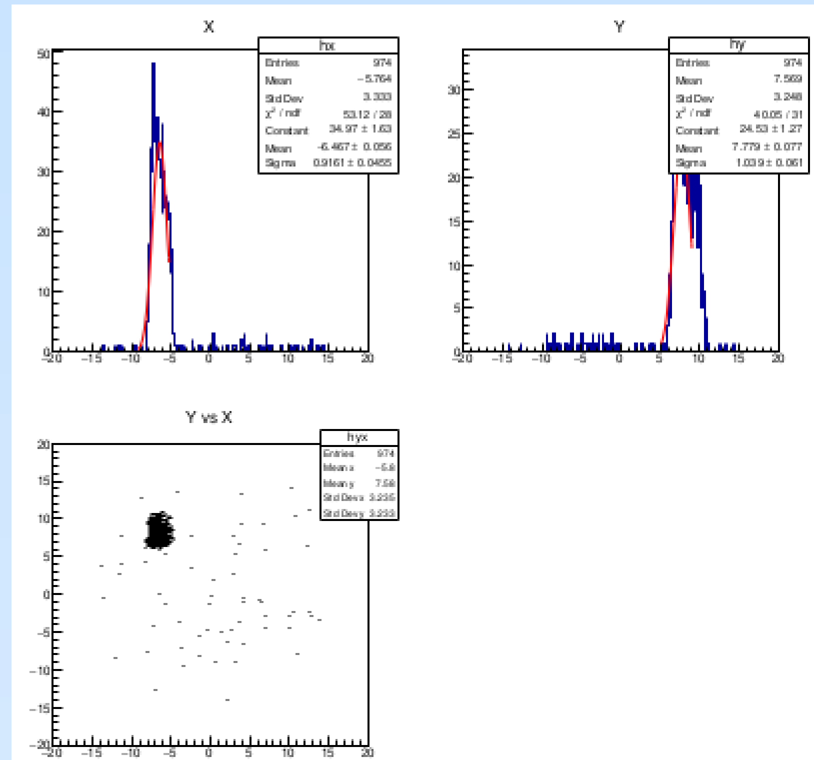


2.85 keV electrons Focusing

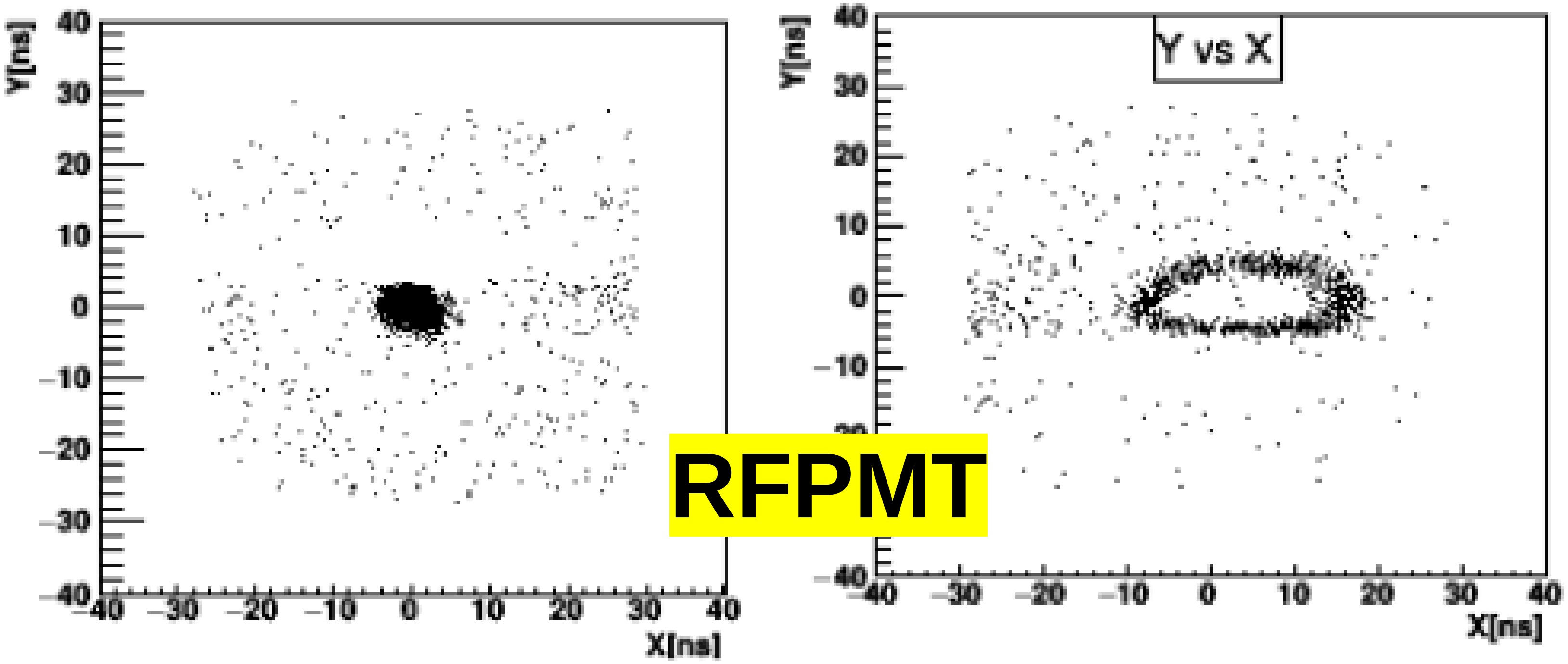
On



Off



First "Circle" on 28.03.2021!!!

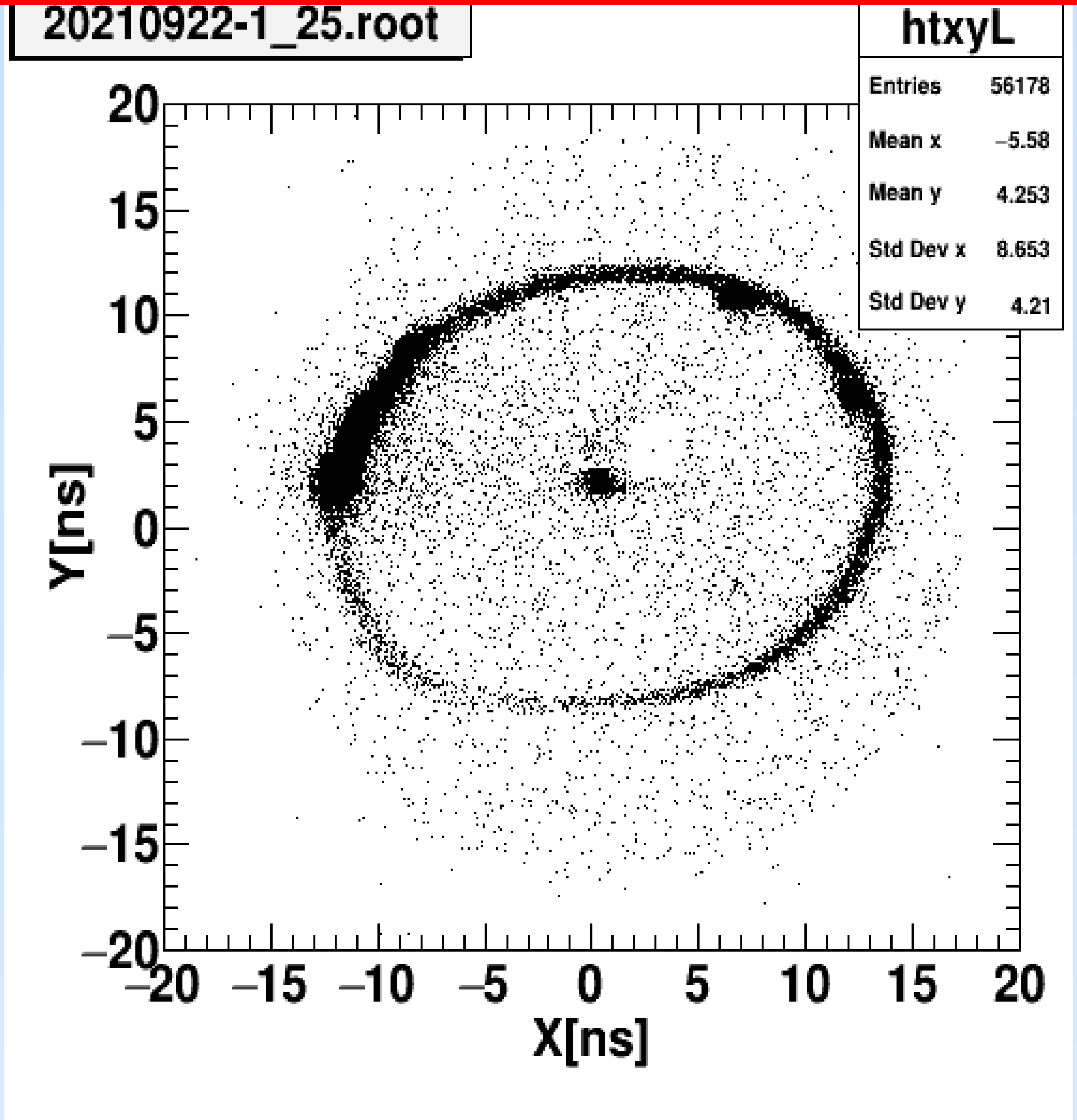


(a) (b)

Figure 29: 2D image of the 2.5 keV electrons: (a) RF deflector off, (b) RF deflector on.

The 2D image of the electron beam is presented in Figure 29: (a) RF deflector off; (b) RF deflector with 805 MHz frequency and pick to pick 10 V amplitude on. This result was obtained on March 28, 2021. Therefore, this day can be coined as the birthday of a new timing technique, which combines two timing principles – the principle of regular timing with nanosecond scale signals and the streak camera principle.

The CANDLE measurements(17-23.09.21)



The CANDLE measurements

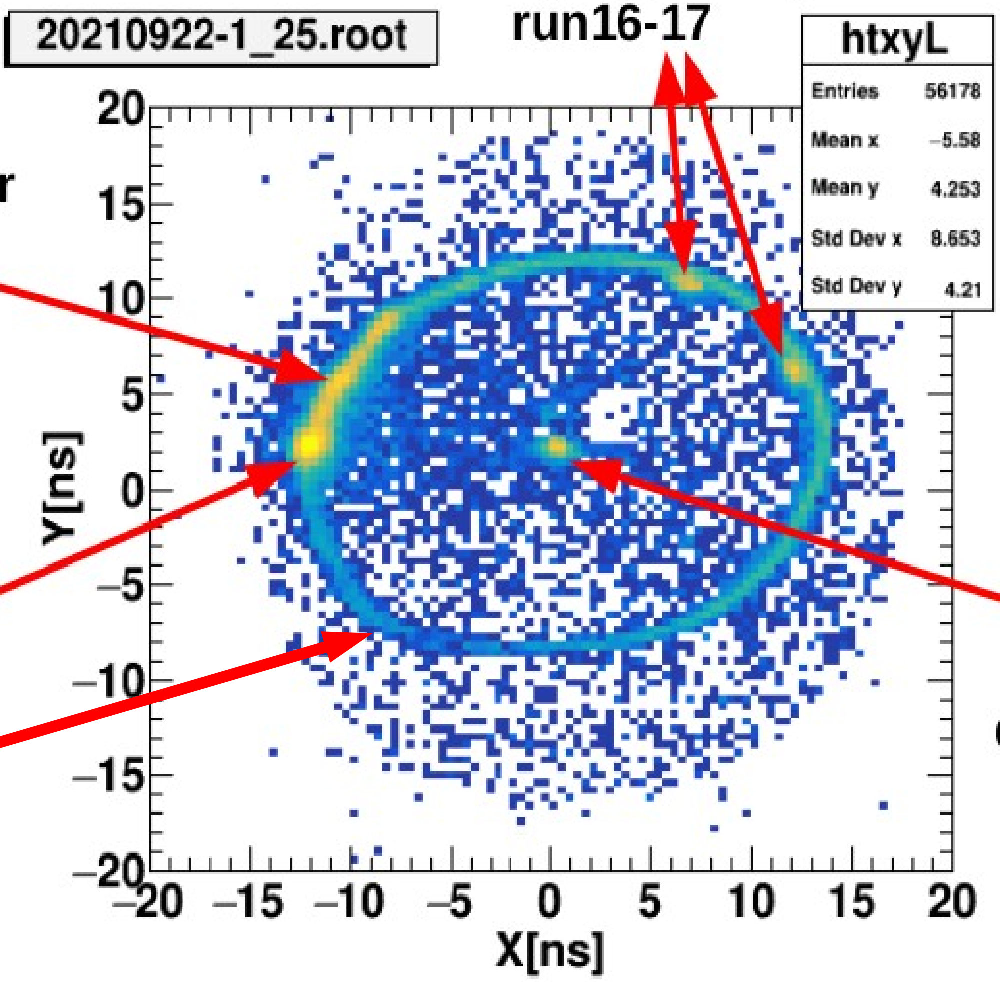
RF SyncShifts2Laser
run 5-14

Shifted by 25 psec

Stability run 18-25

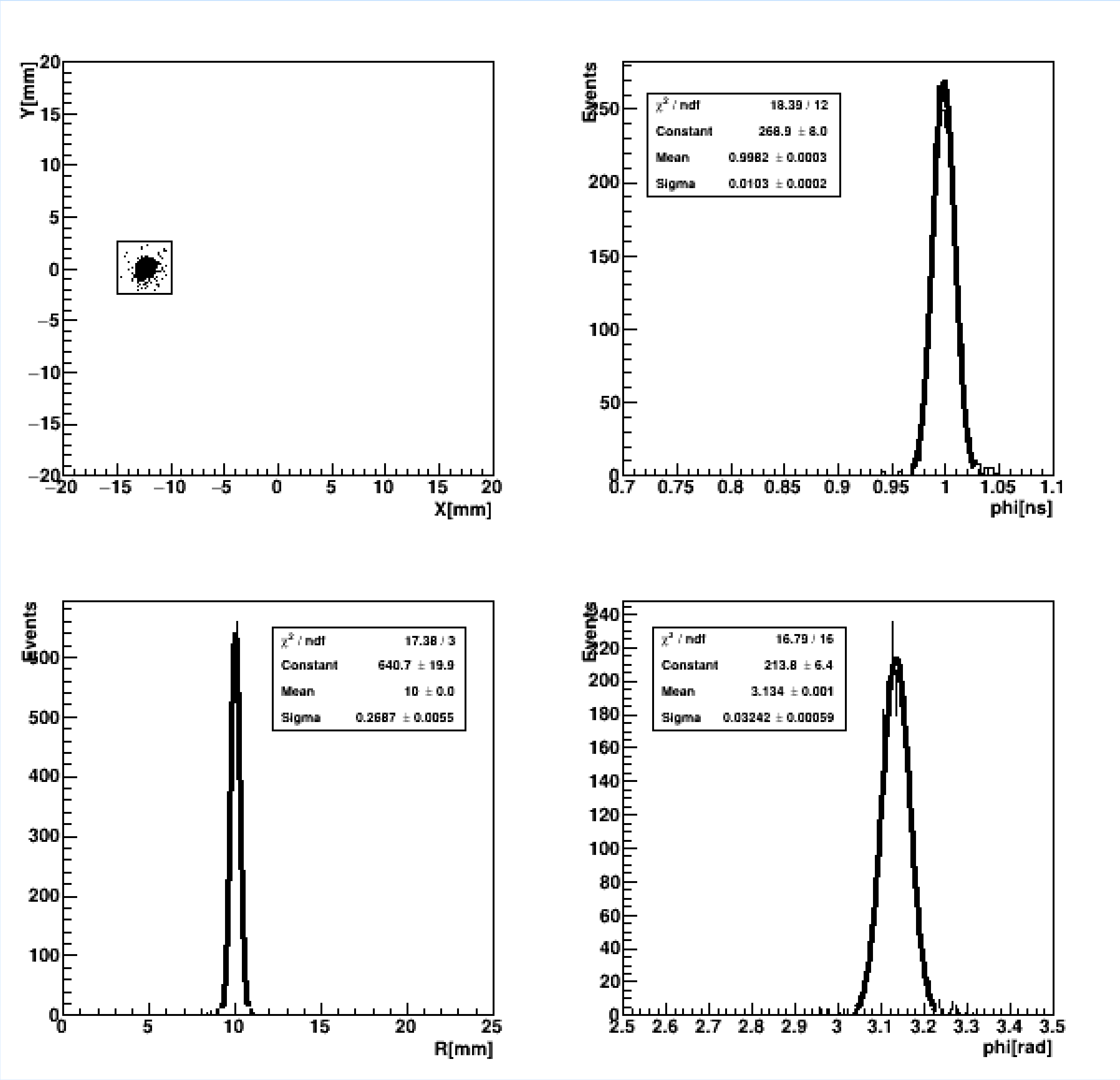
RF on,No Sync
Circle

RF Sync_Shifts_toLaser
run16-17

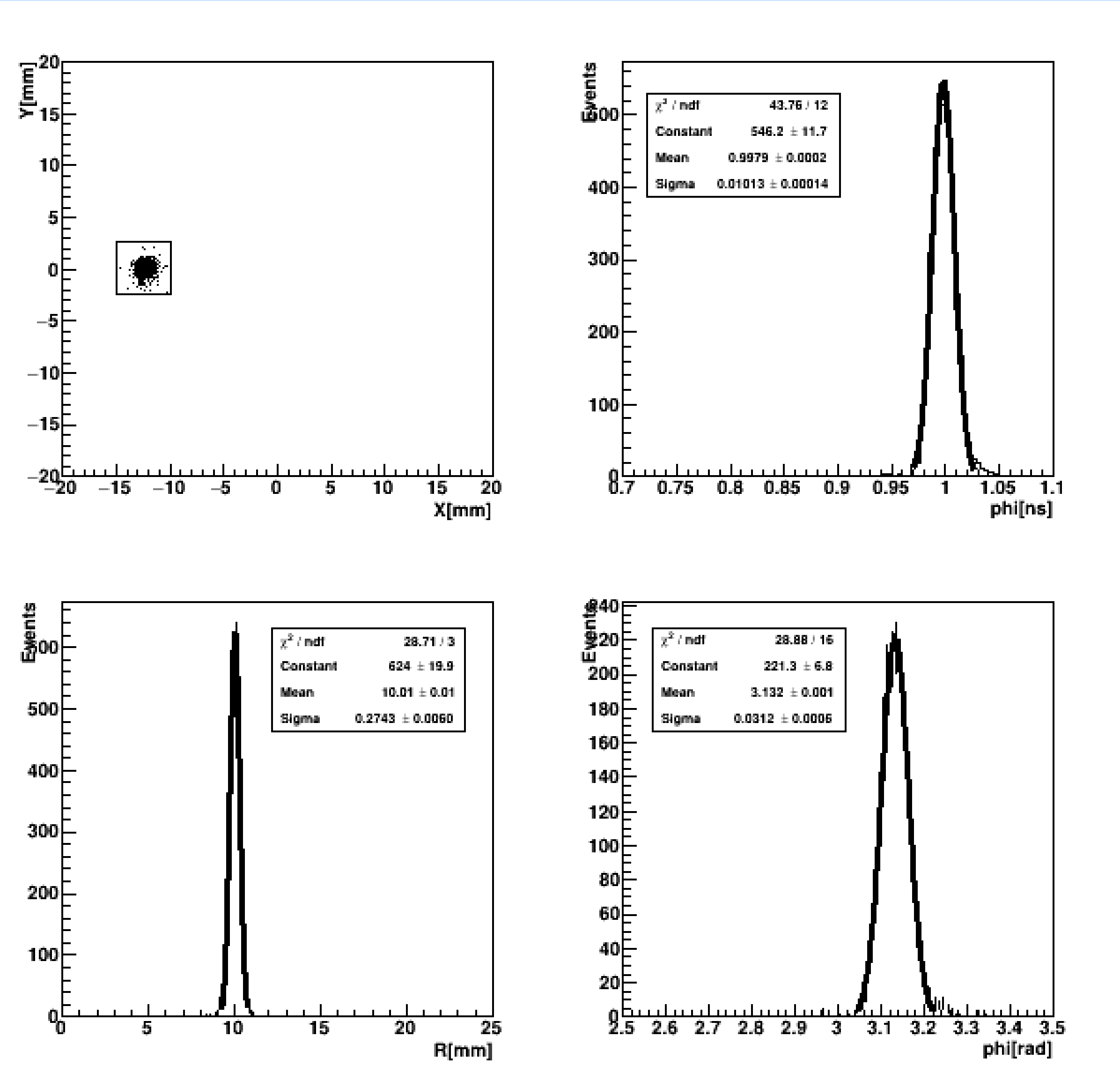


Center from run4
RF off,No Sync

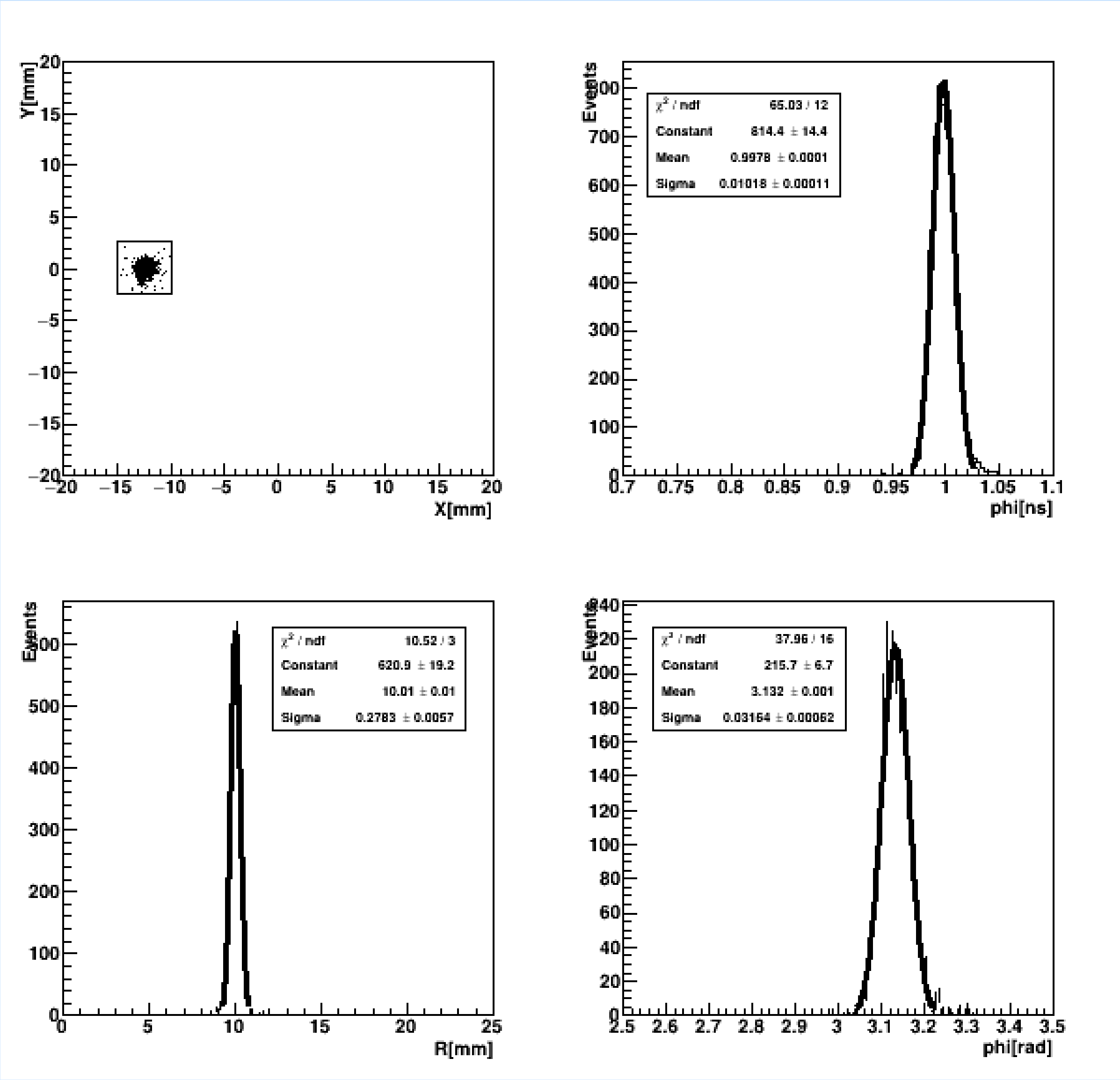
The Stability(run18)



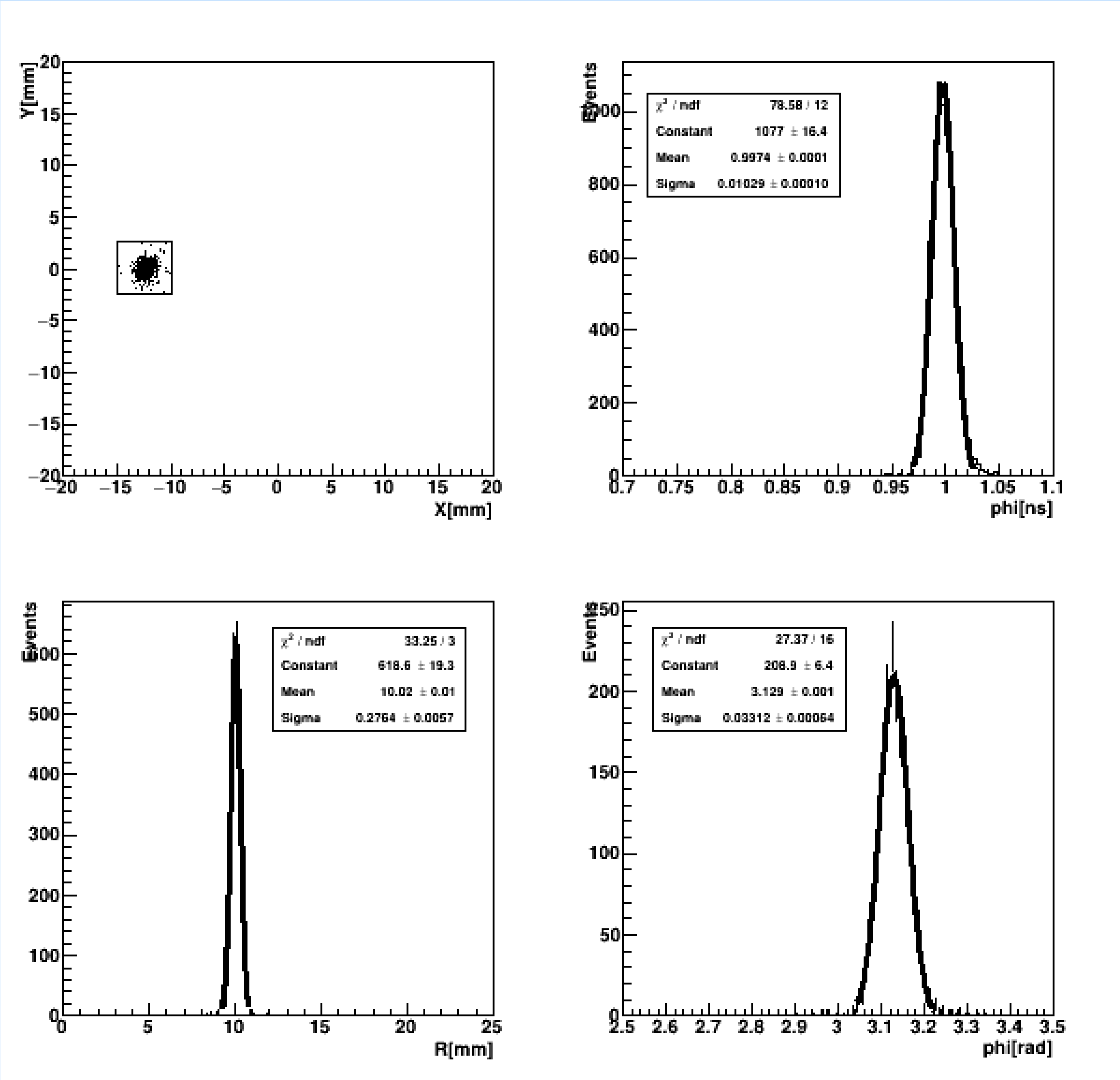
The Stability(run19)



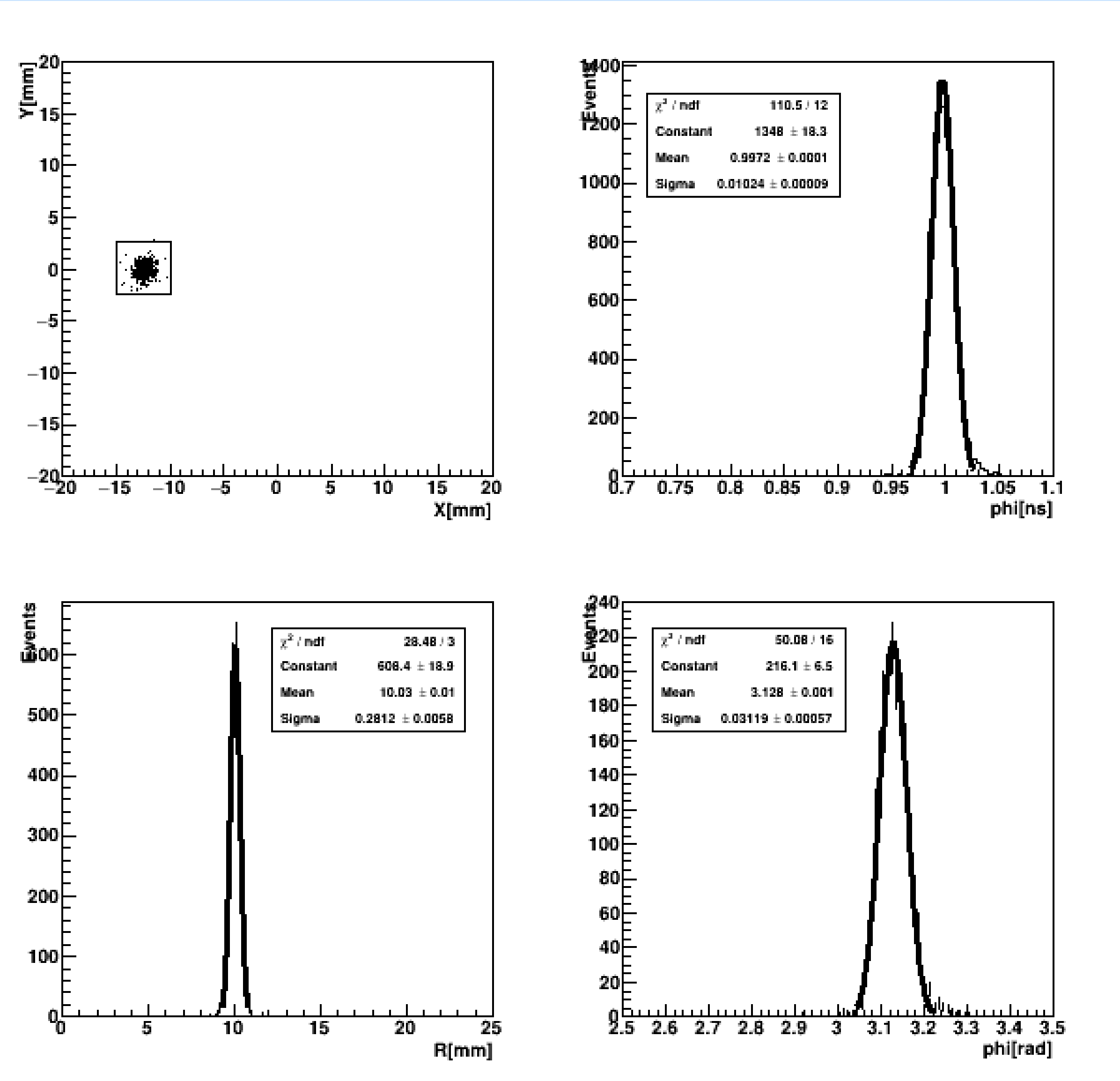
The Stability(run20)



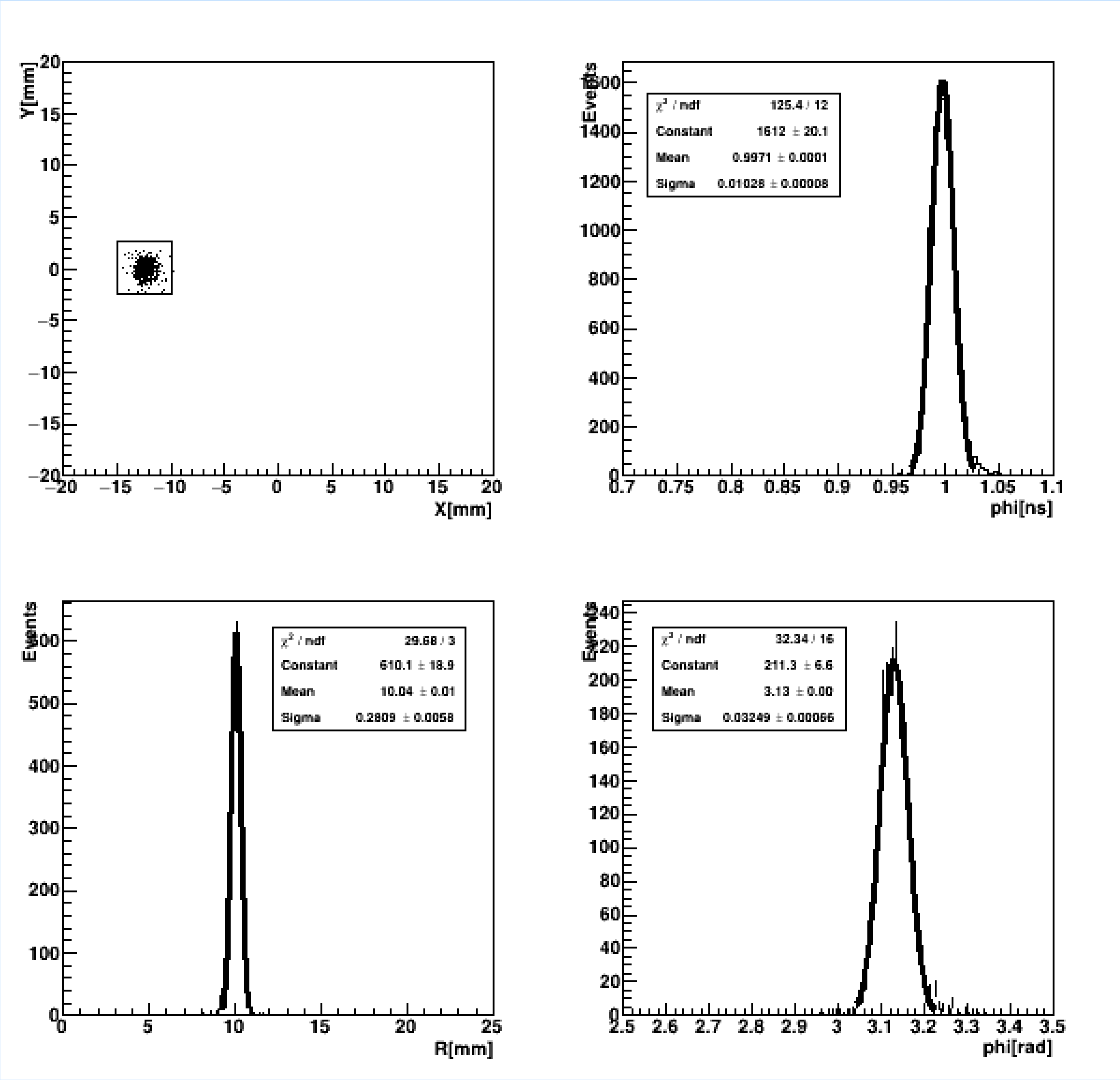
The Stability(run21)



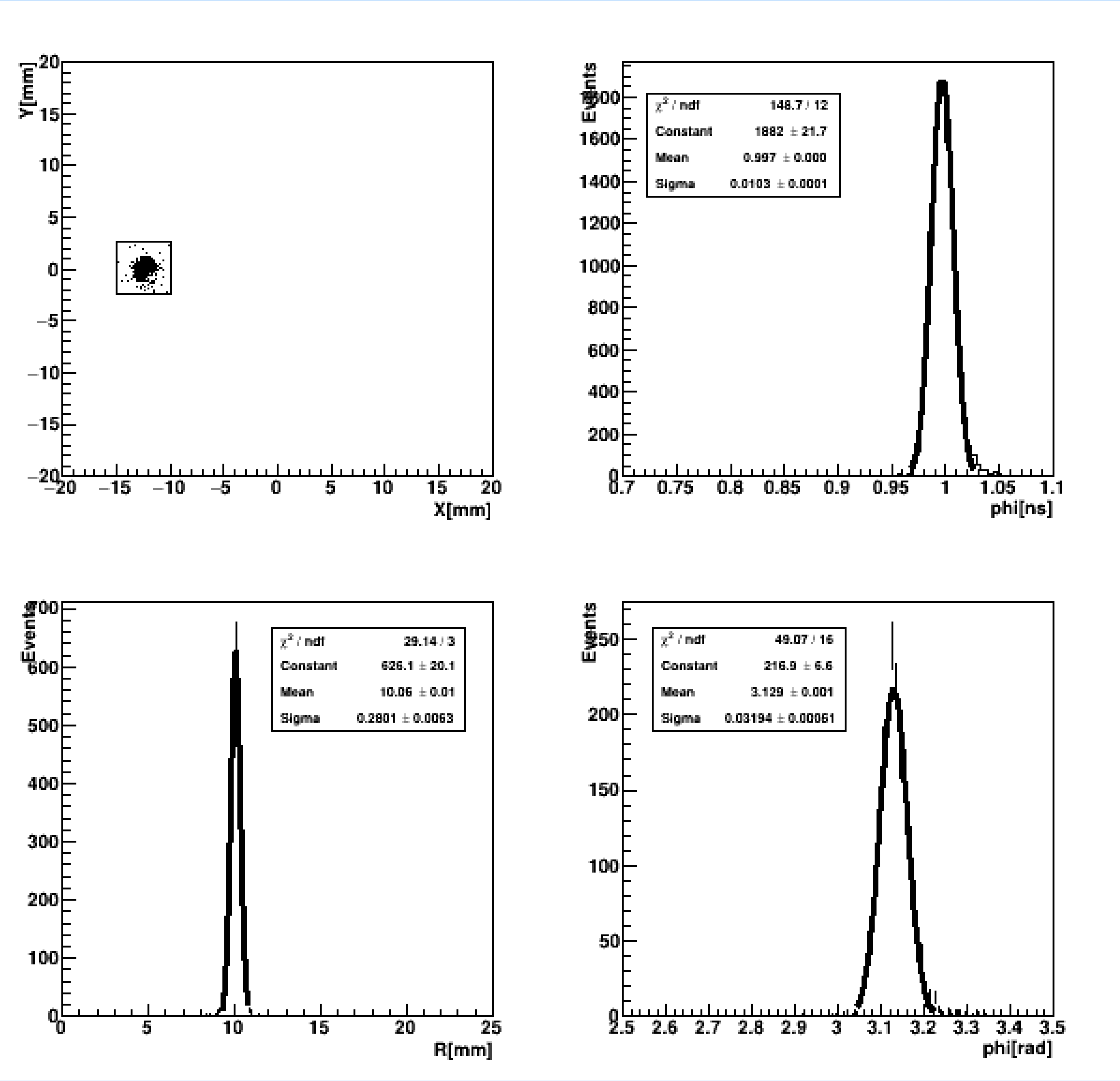
The Stability(run22)



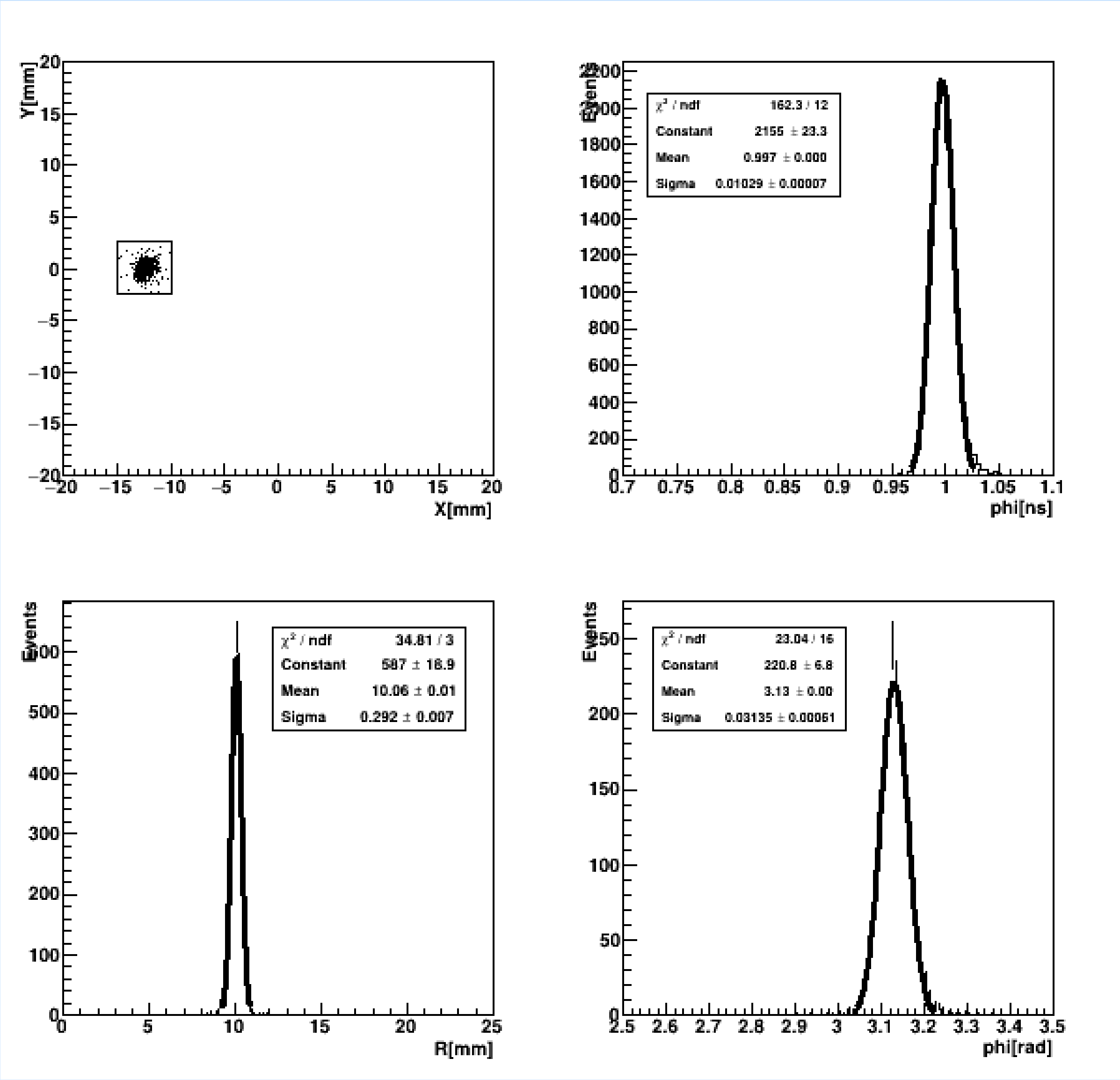
The Stability(run23)



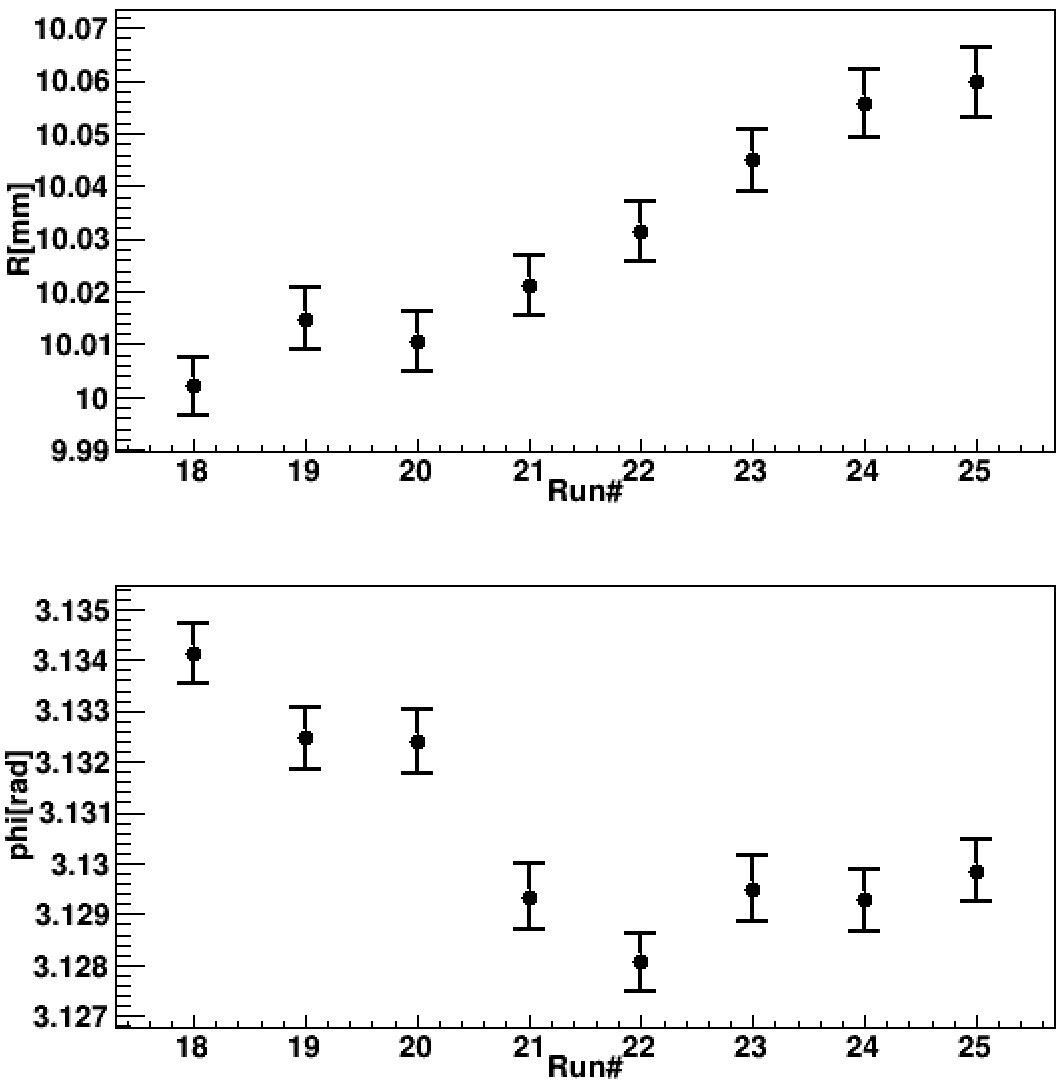
The Stability(run24)



The Stability(run25)



The Stability

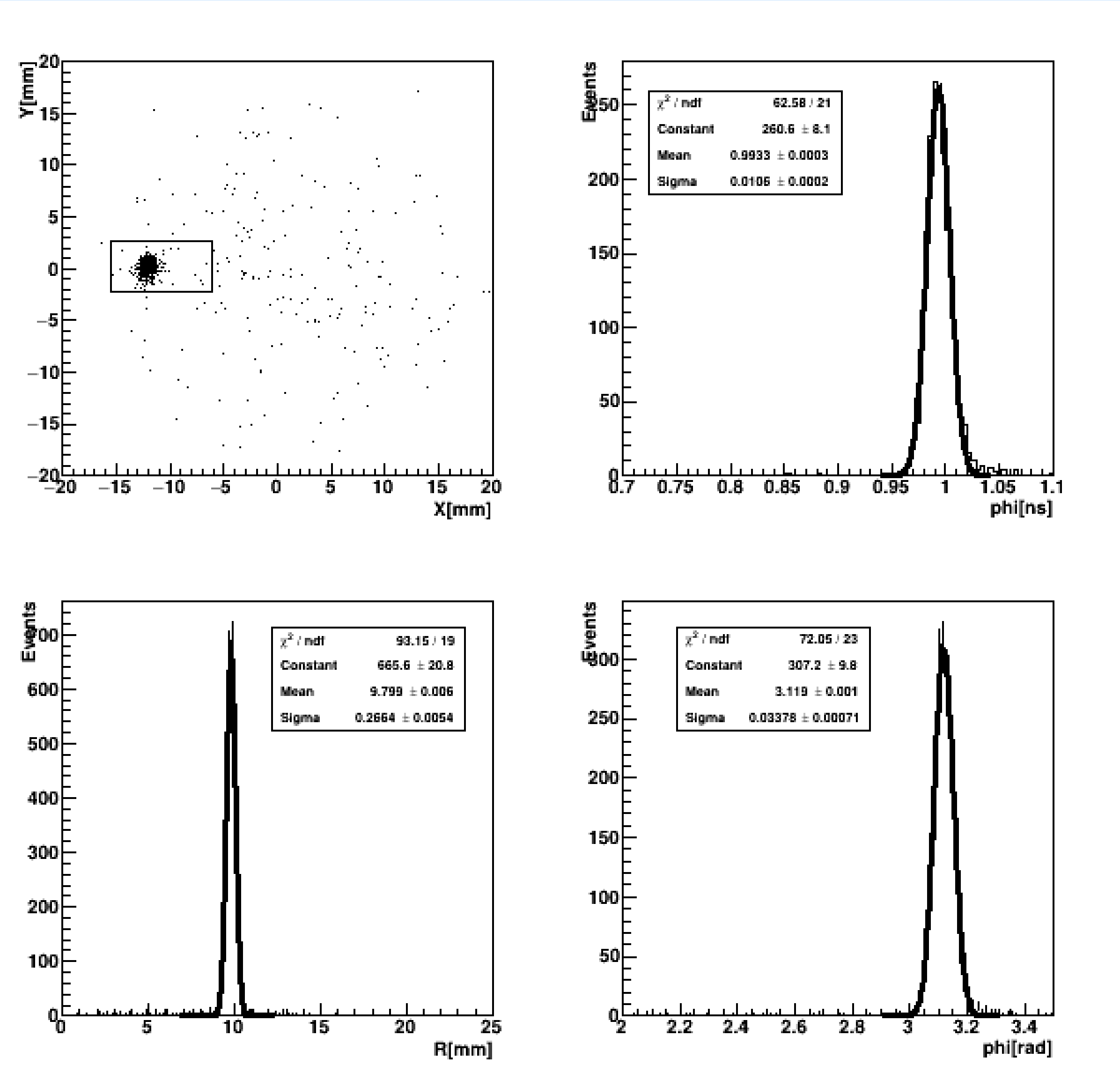


~60mkm shift observed

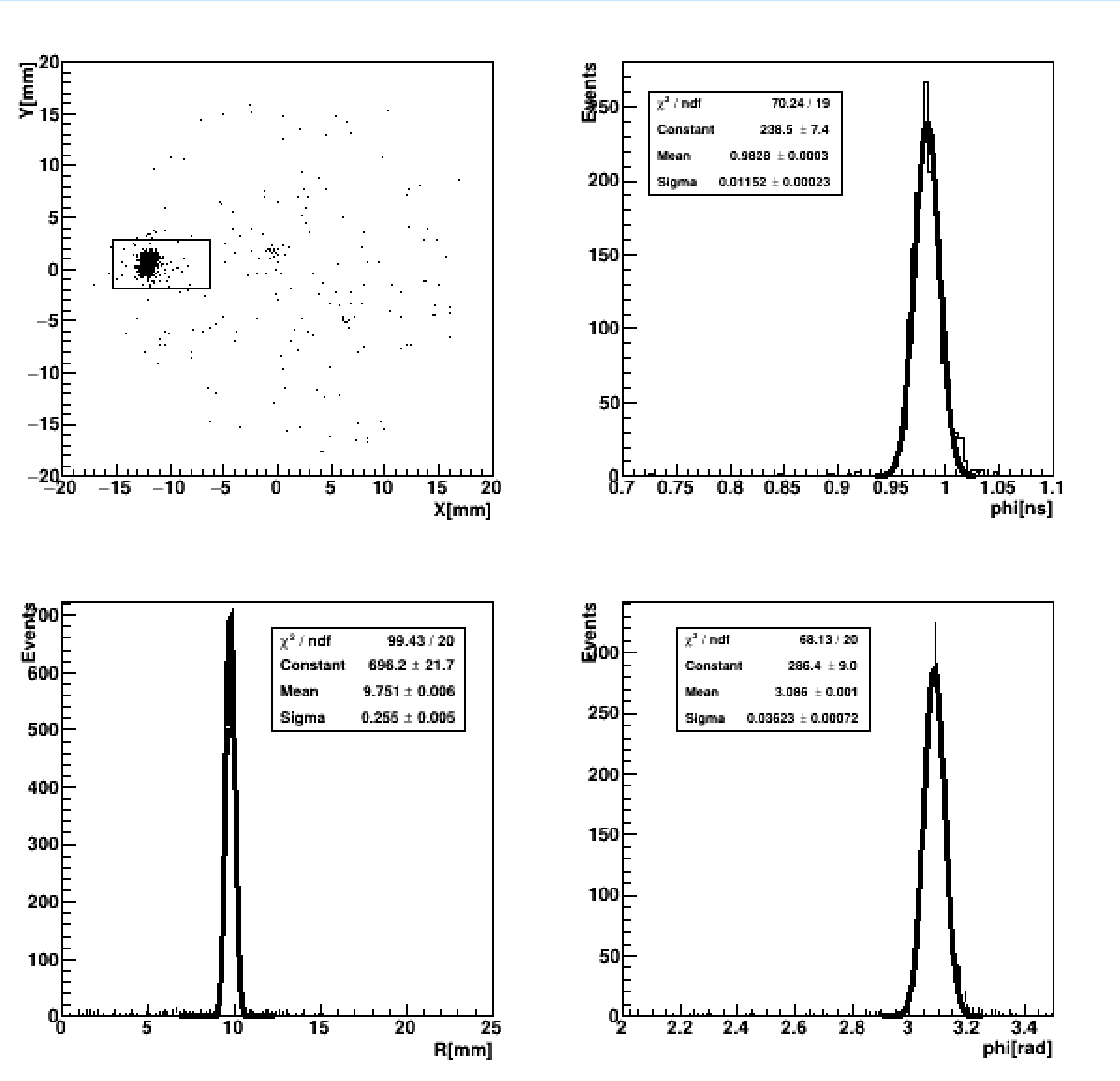
Last 4 points are good.

To be tested again!!!

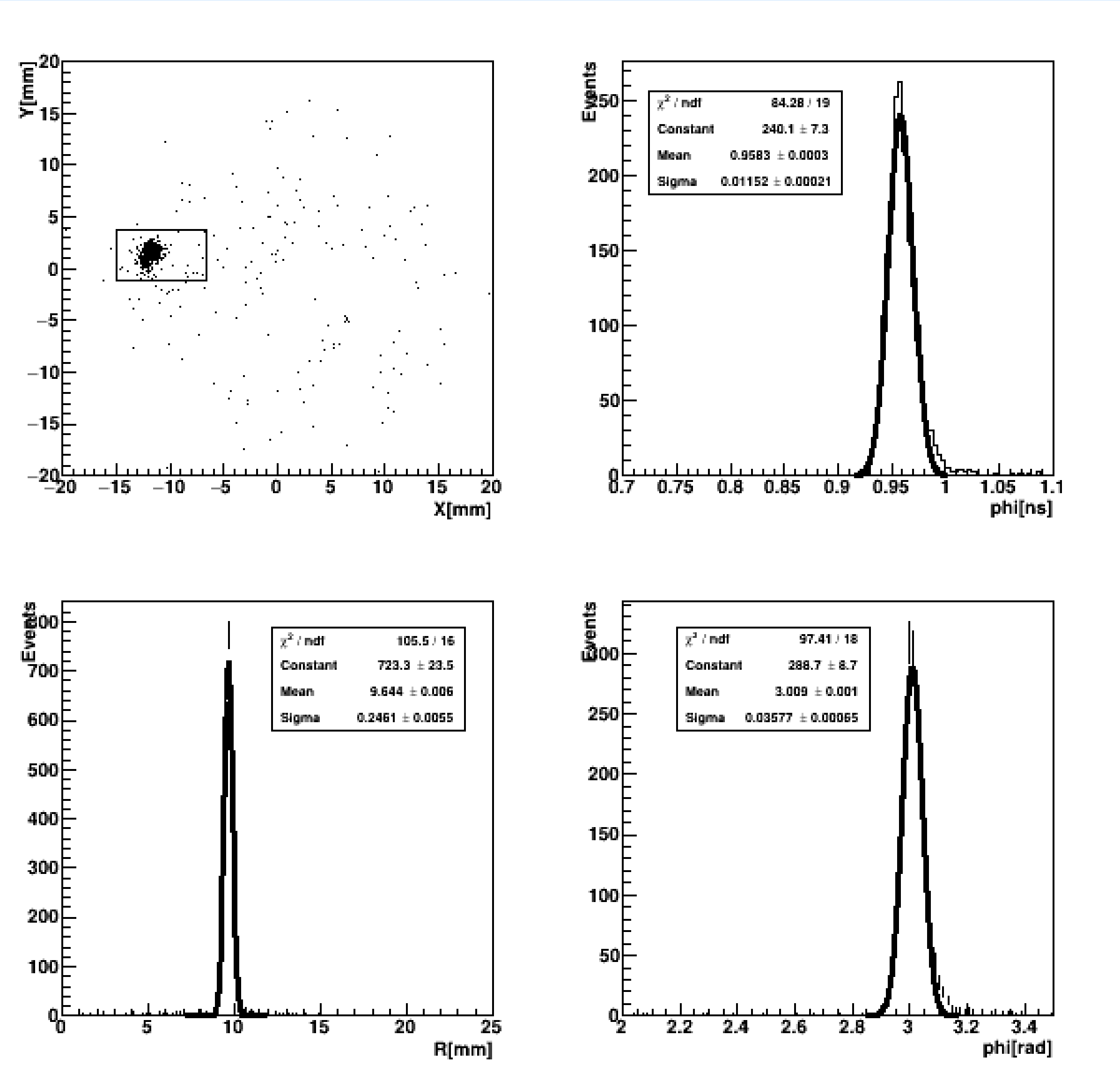
The Calibration(run5)



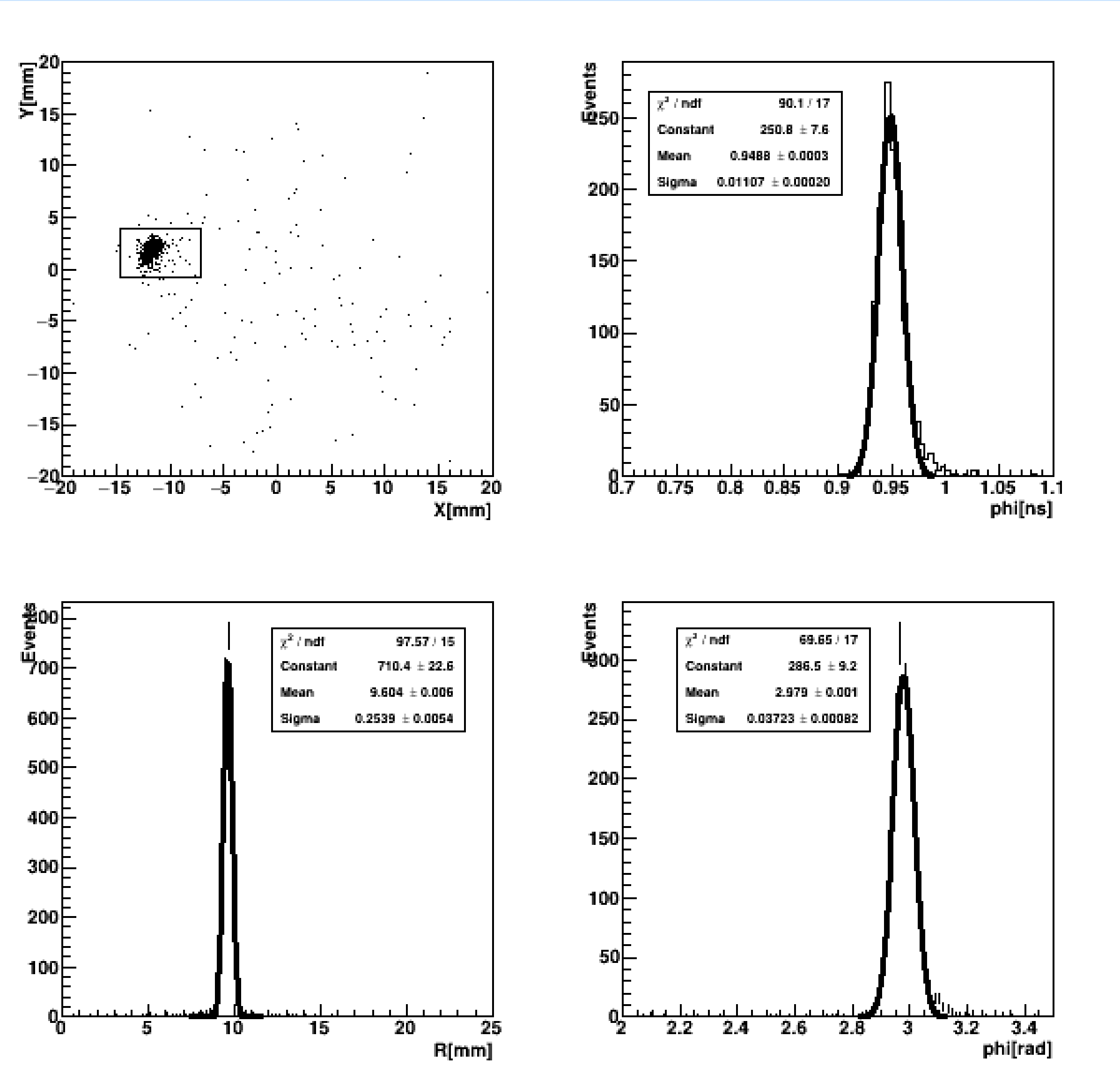
The Calibration(run6)



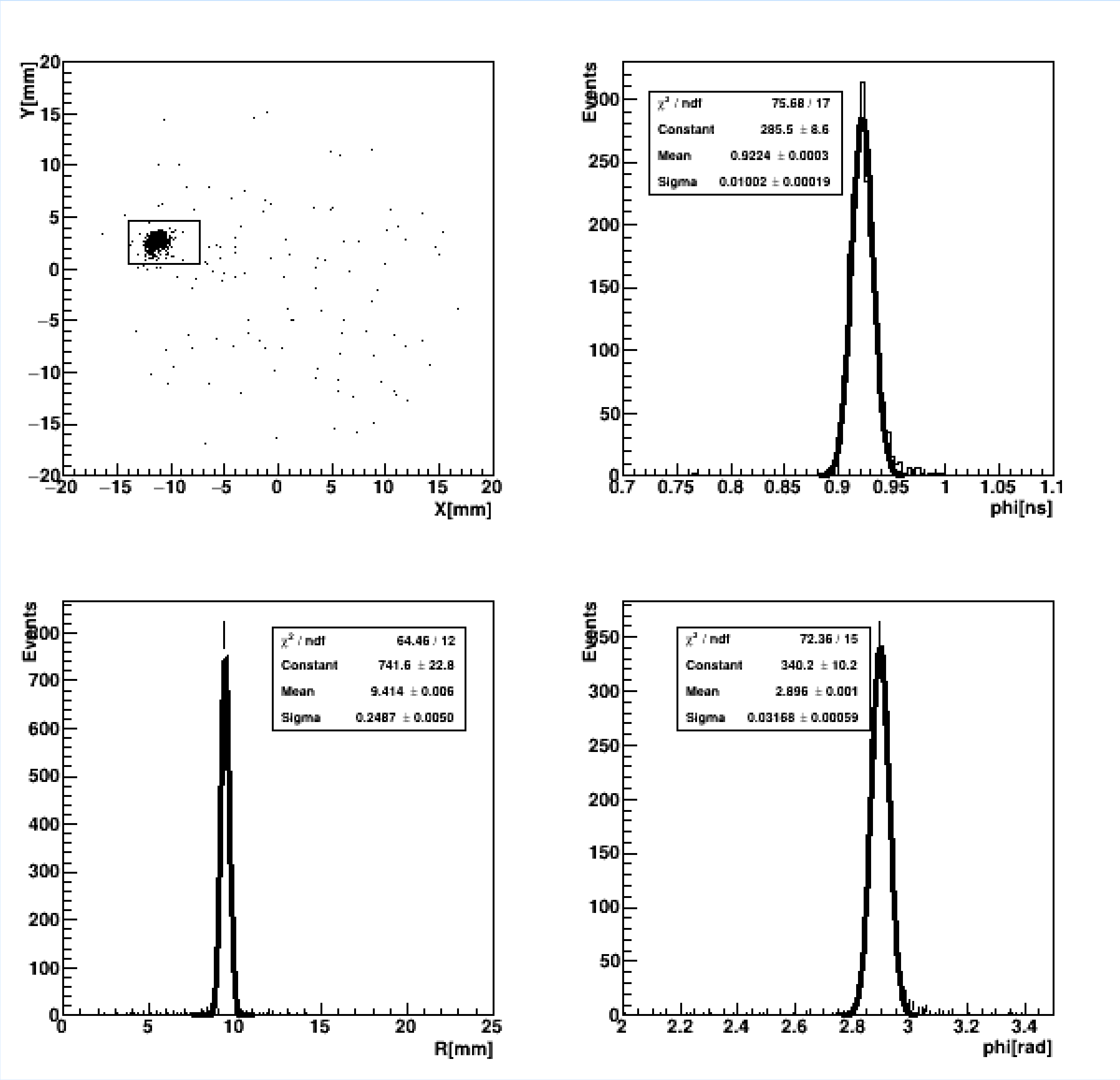
The Calibration(run7)



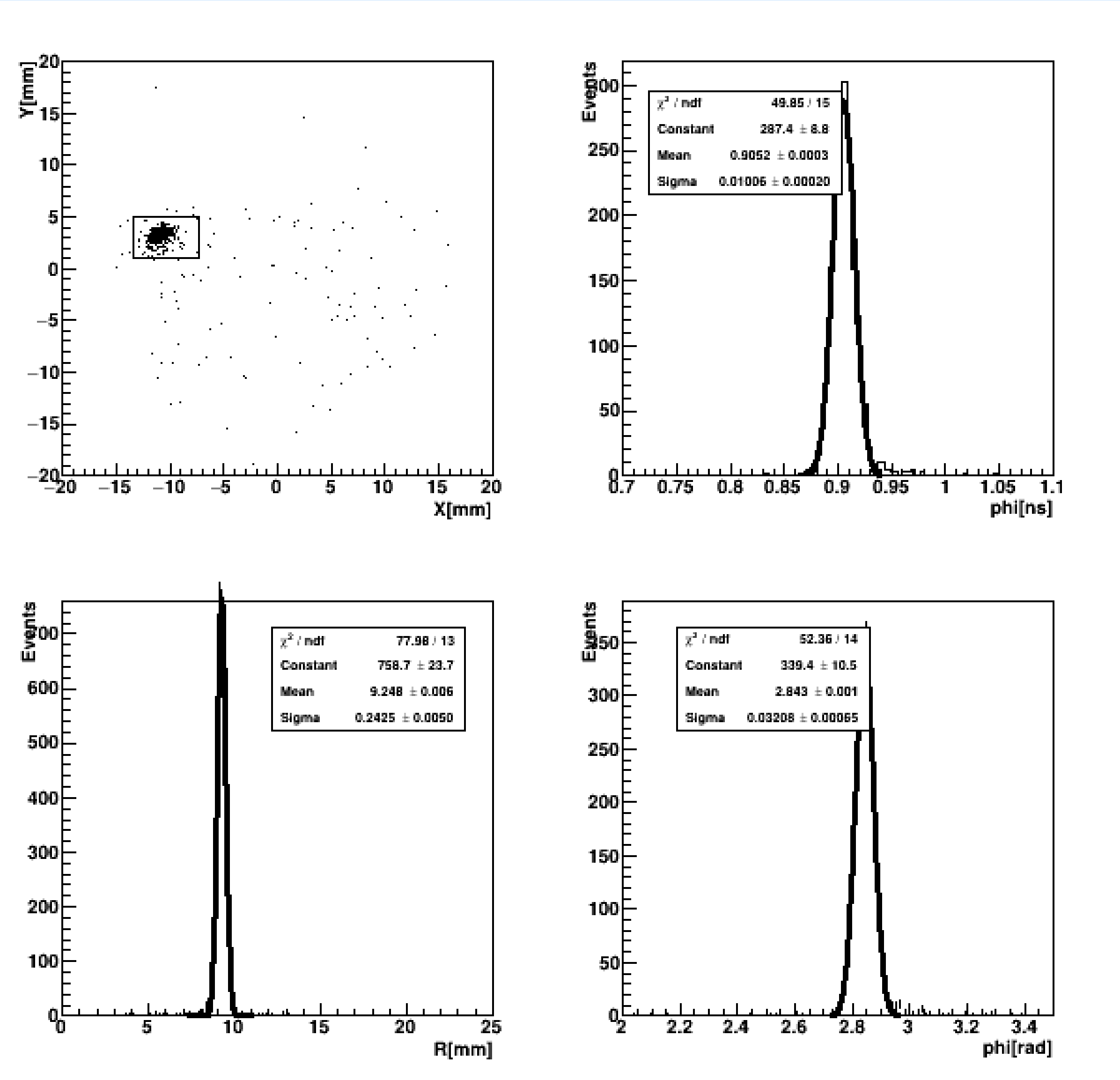
The Calibration(run8)



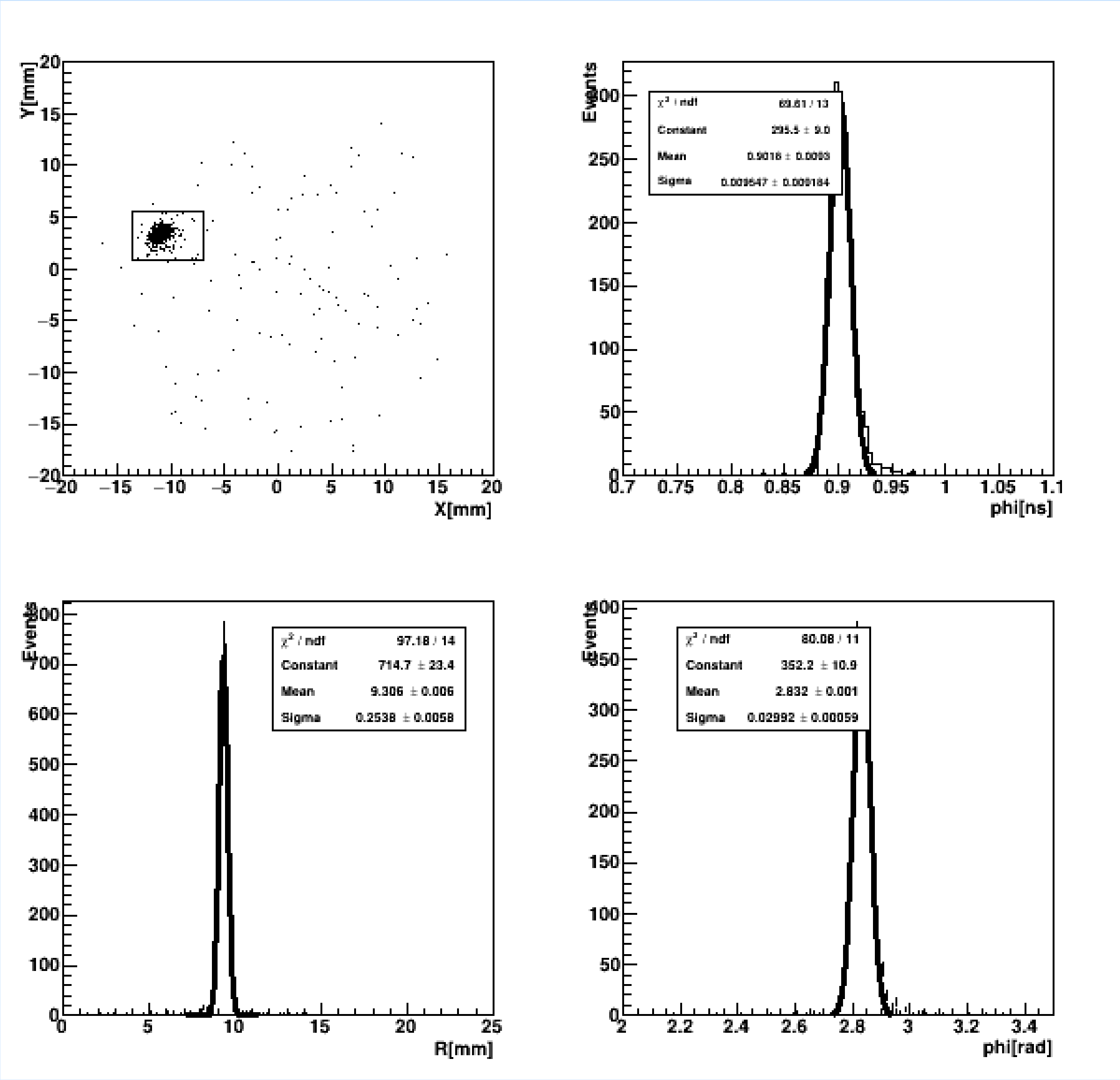
The Calibration(run9)



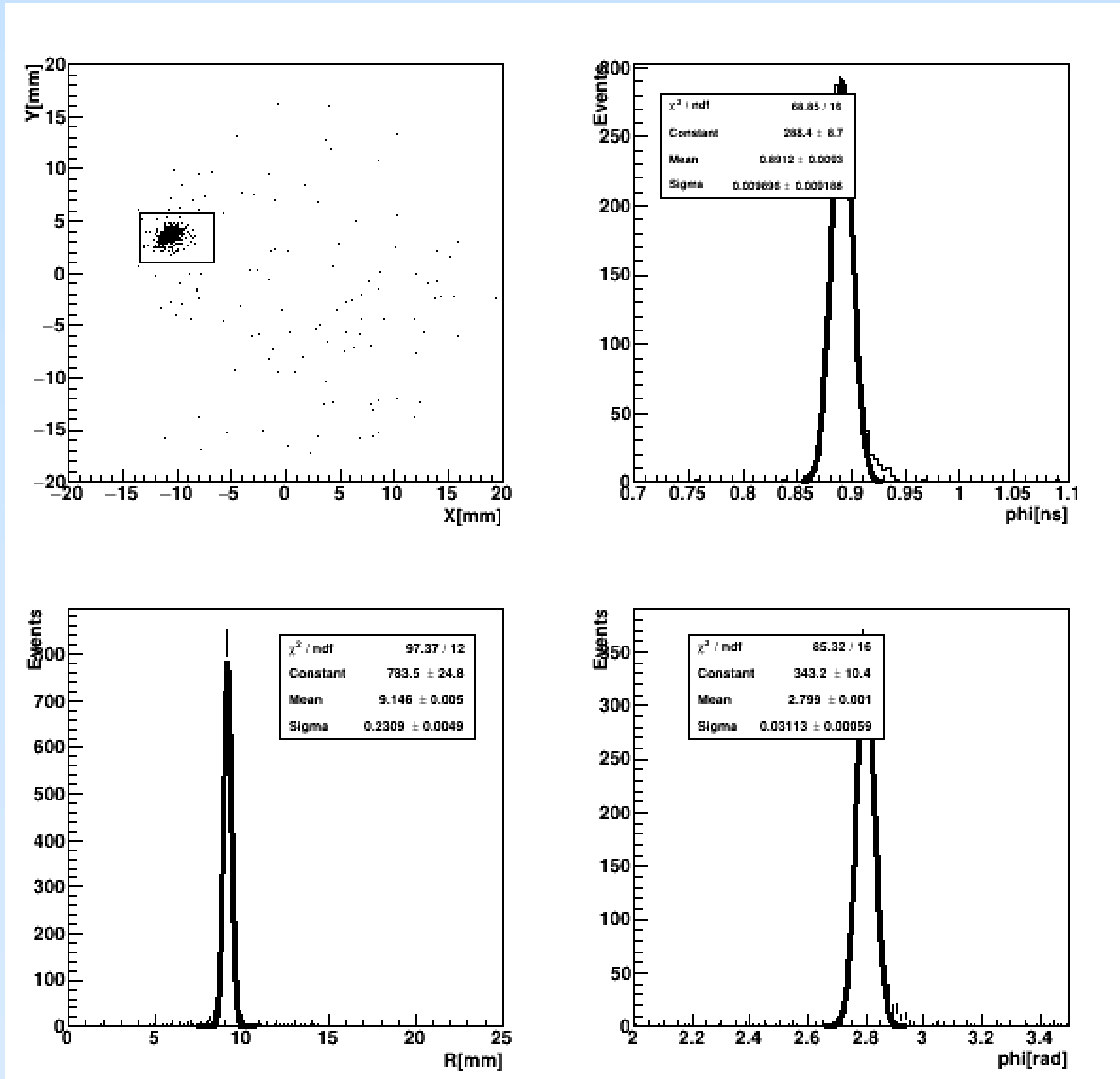
The Calibration(run10)



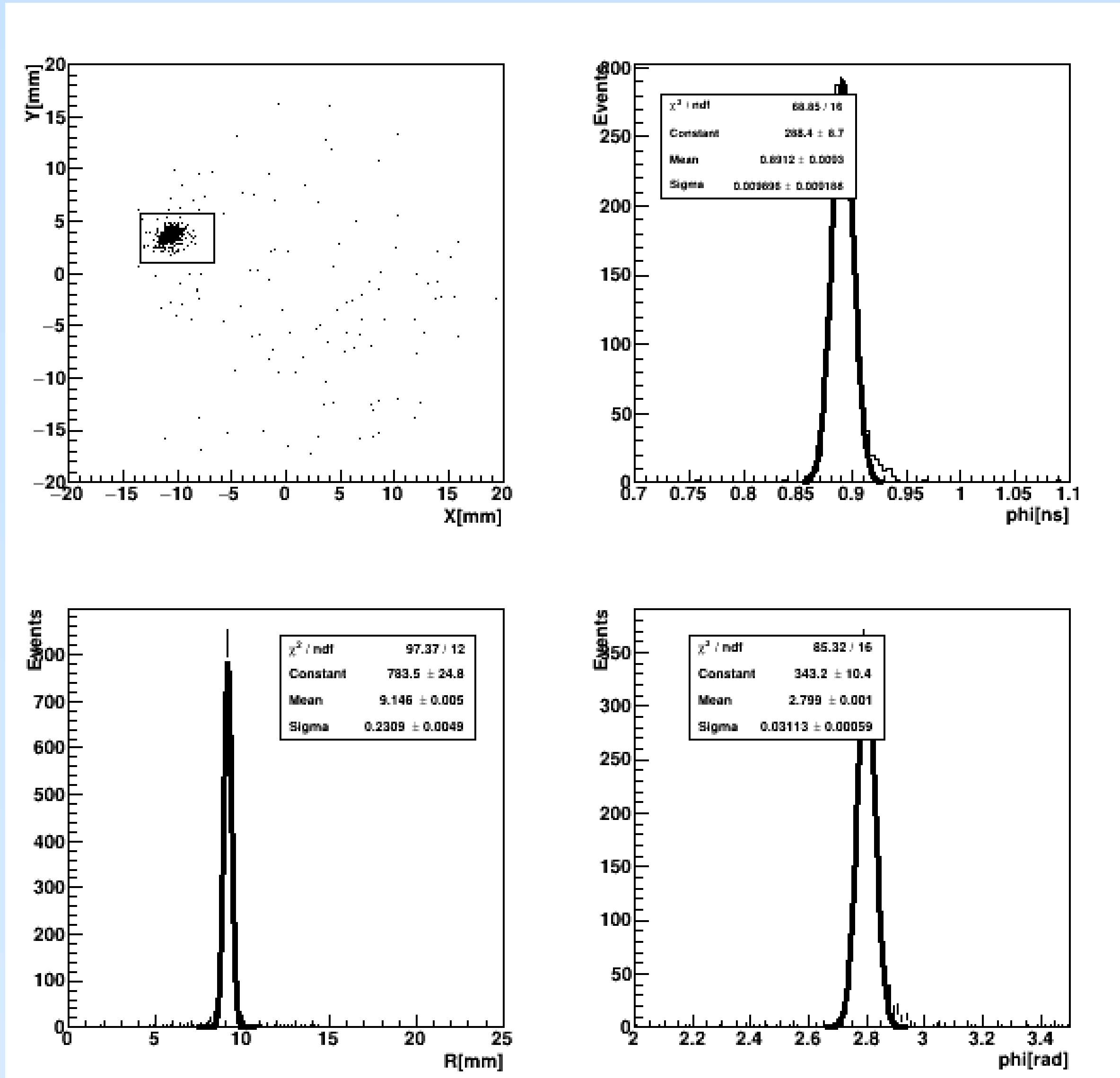
The Calibration(run11)



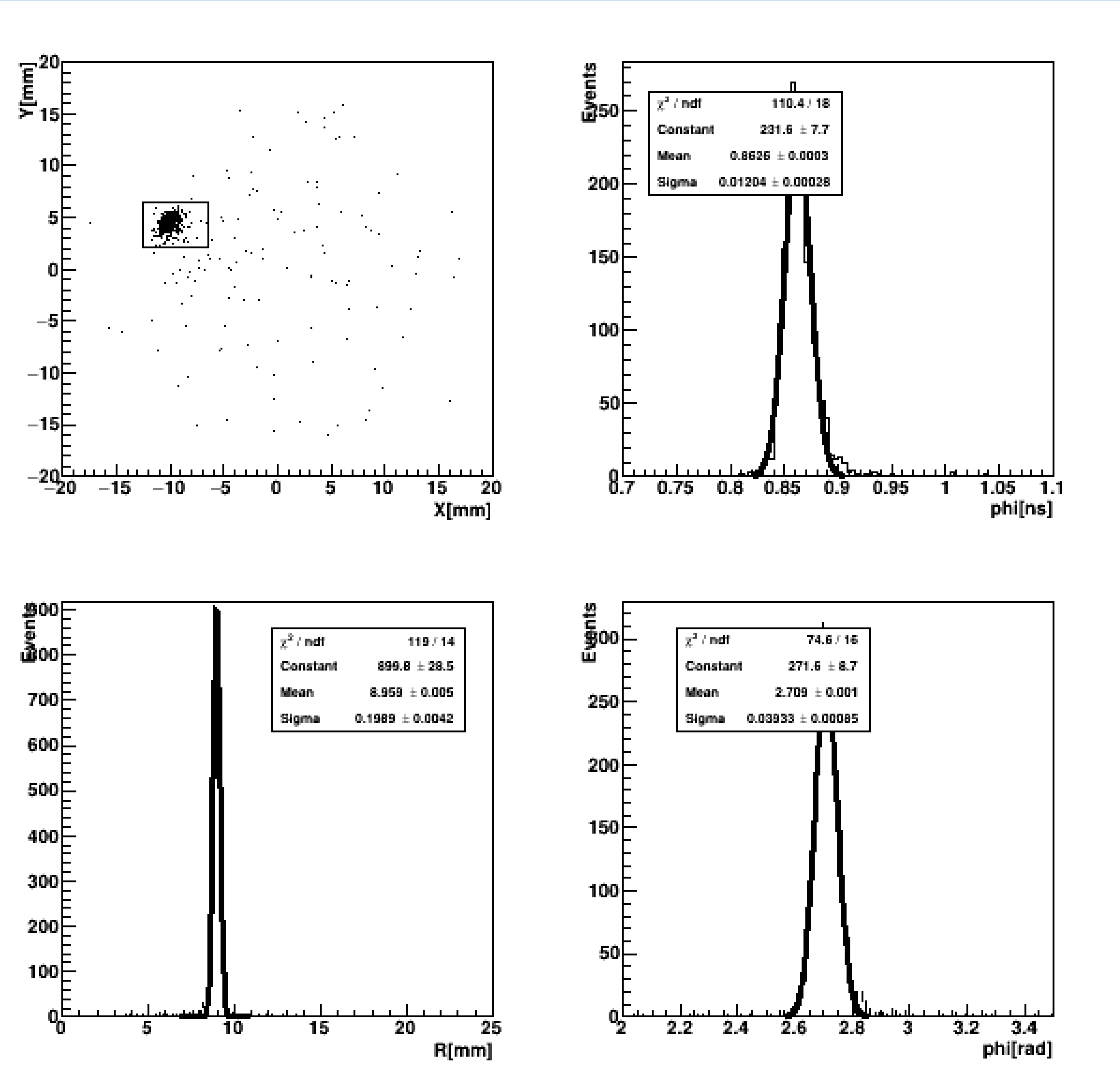
The Calibration(run12)



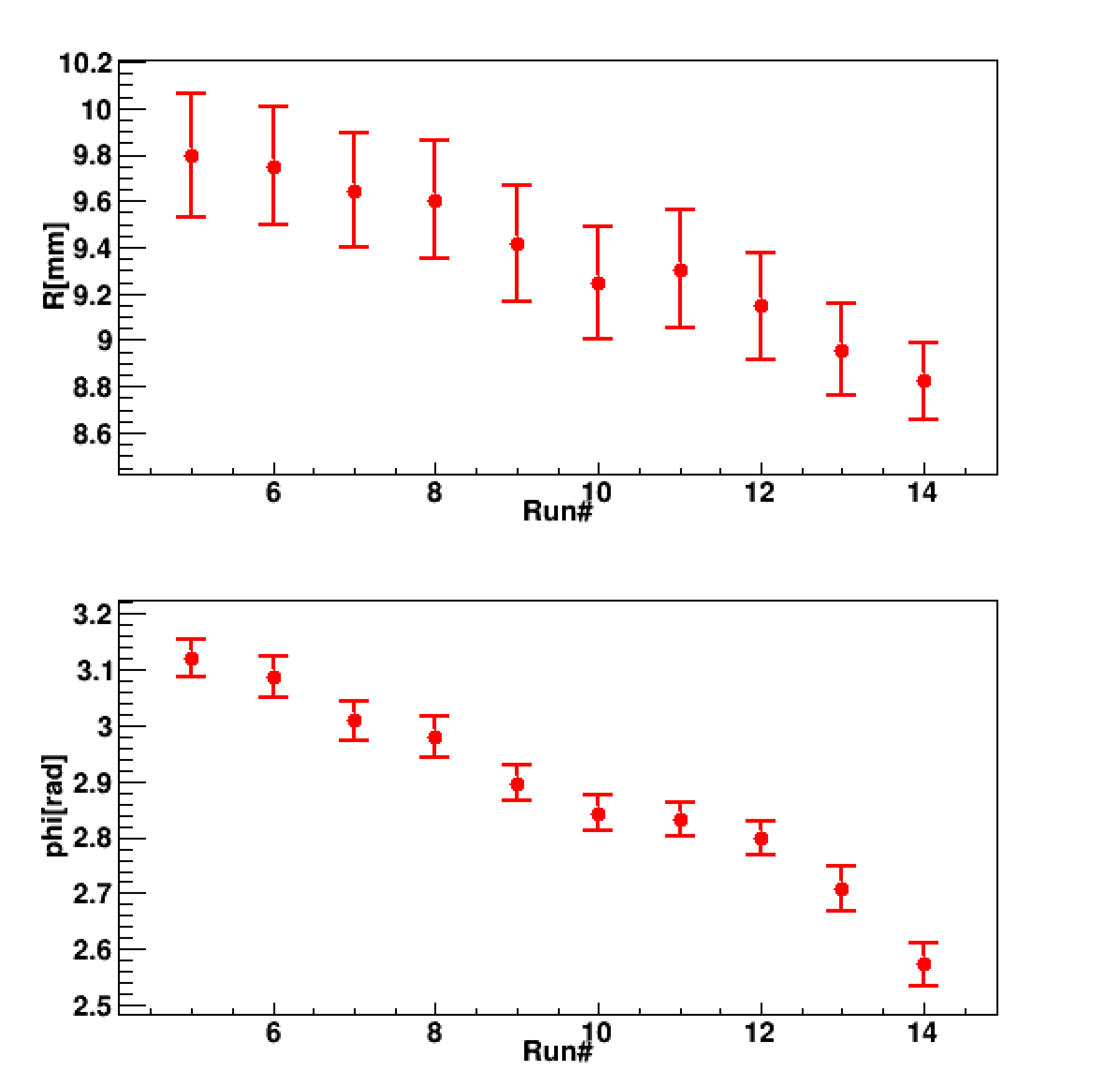
The Calibration(run12)



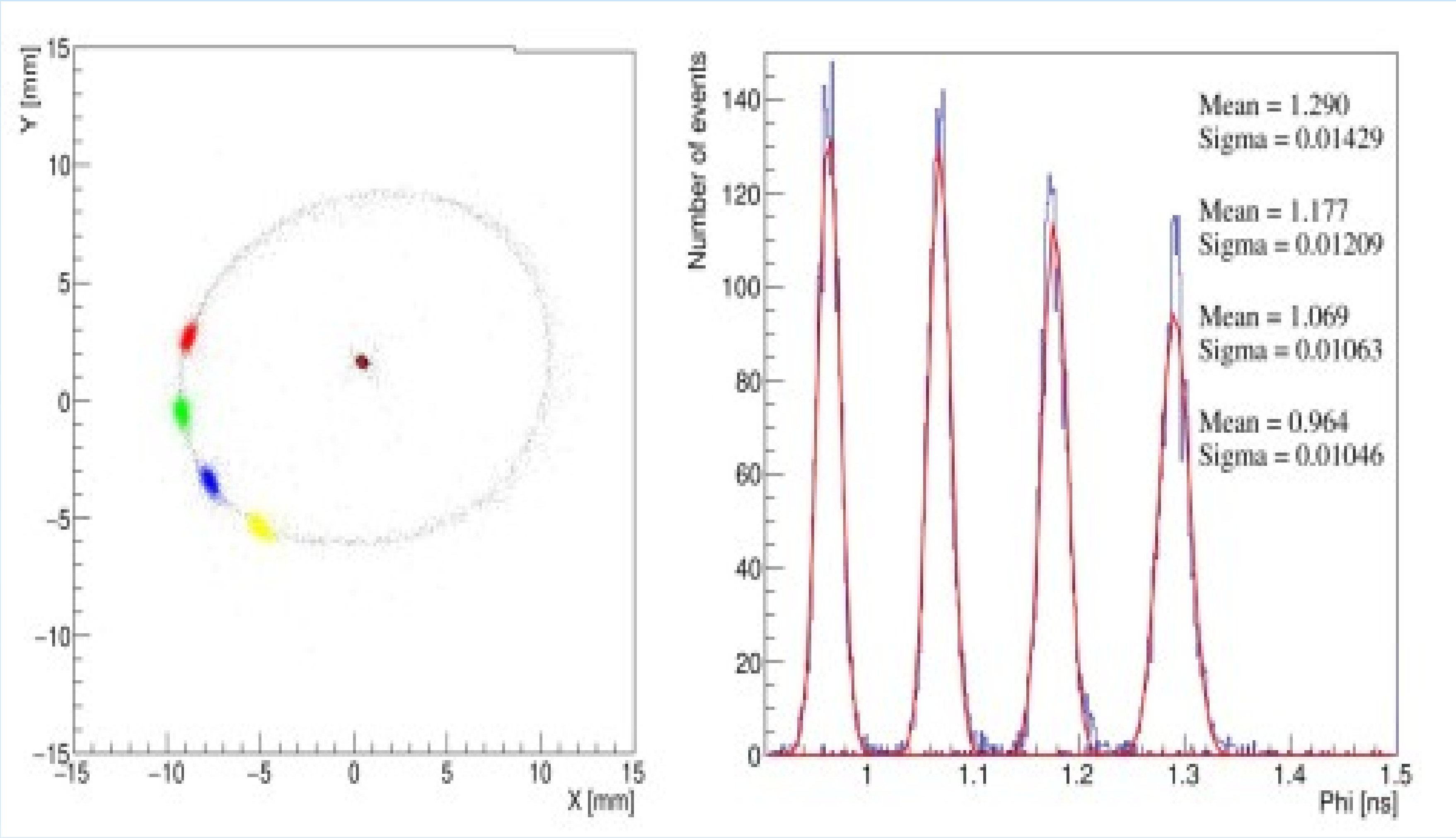
The Calibration(run13)



The Calibration



Final result from Candle



Conclusion & TODOes

PicoSec resolution experimentally with RFPMT achieved!!!

TODOes

Go to FemtoSec resolution.

Optimize the Setup configuration.

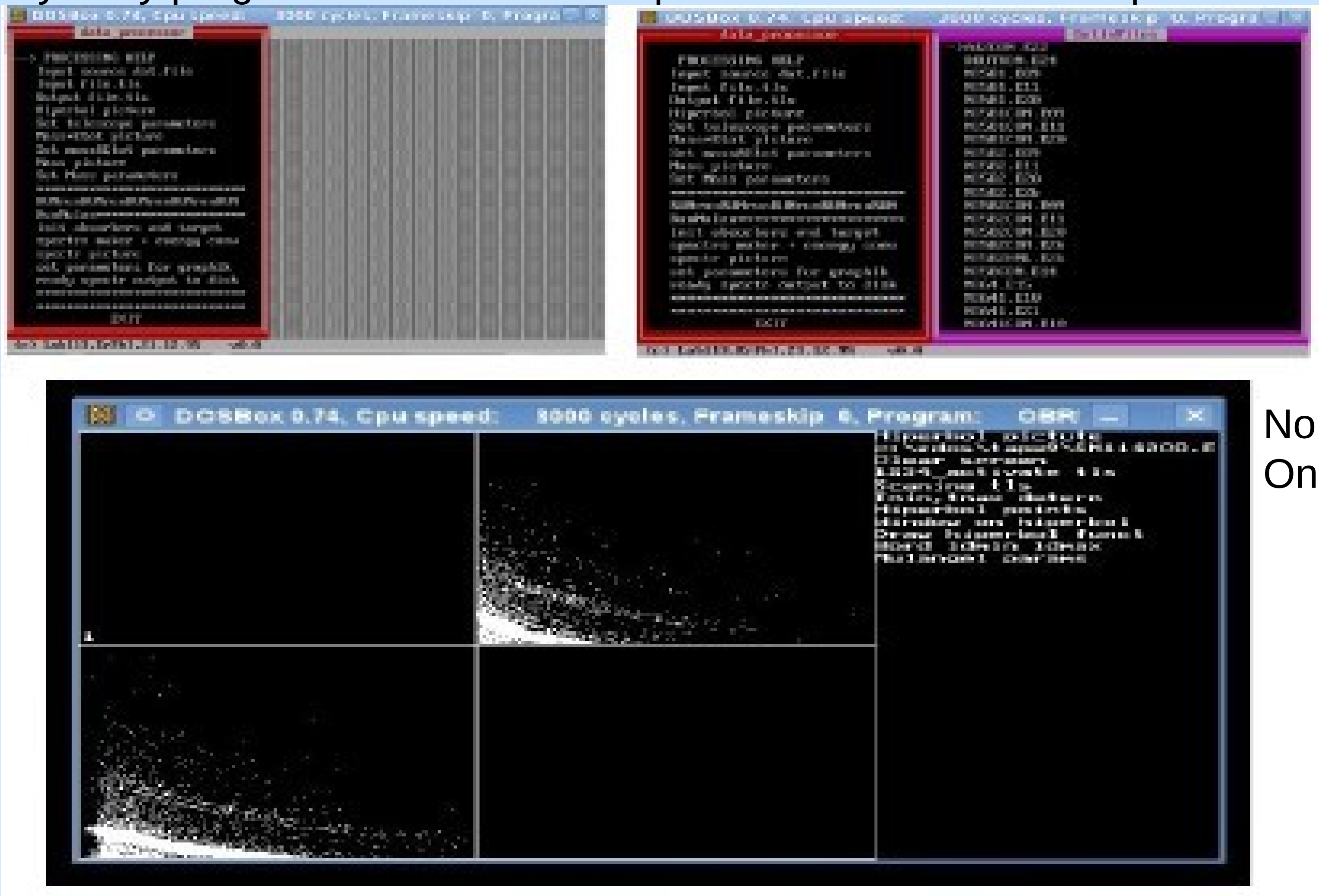
Use in possible experiments.

Many thanks to colleagues for support.

BACKUP

GUI usage prehistory

My early program “obr” for “e-A” experiment a TUI with turbo pascal.



No mouse used
Only keyboard

ROOT GUI in physics

In H1 collaboration I started to use ROOT-GUI to manipulate with files/histograms to achieve meaningful/best/visual fits models to data.

Root-Application to manipulate with histograms