

**GUI “picos(am)” program
with ASICs in ISTC-A2390**

Hamlet Zohrabyan

The Talk Layout

- **GUI usage prehistory**
- **This Usage**
- **Conclusion**

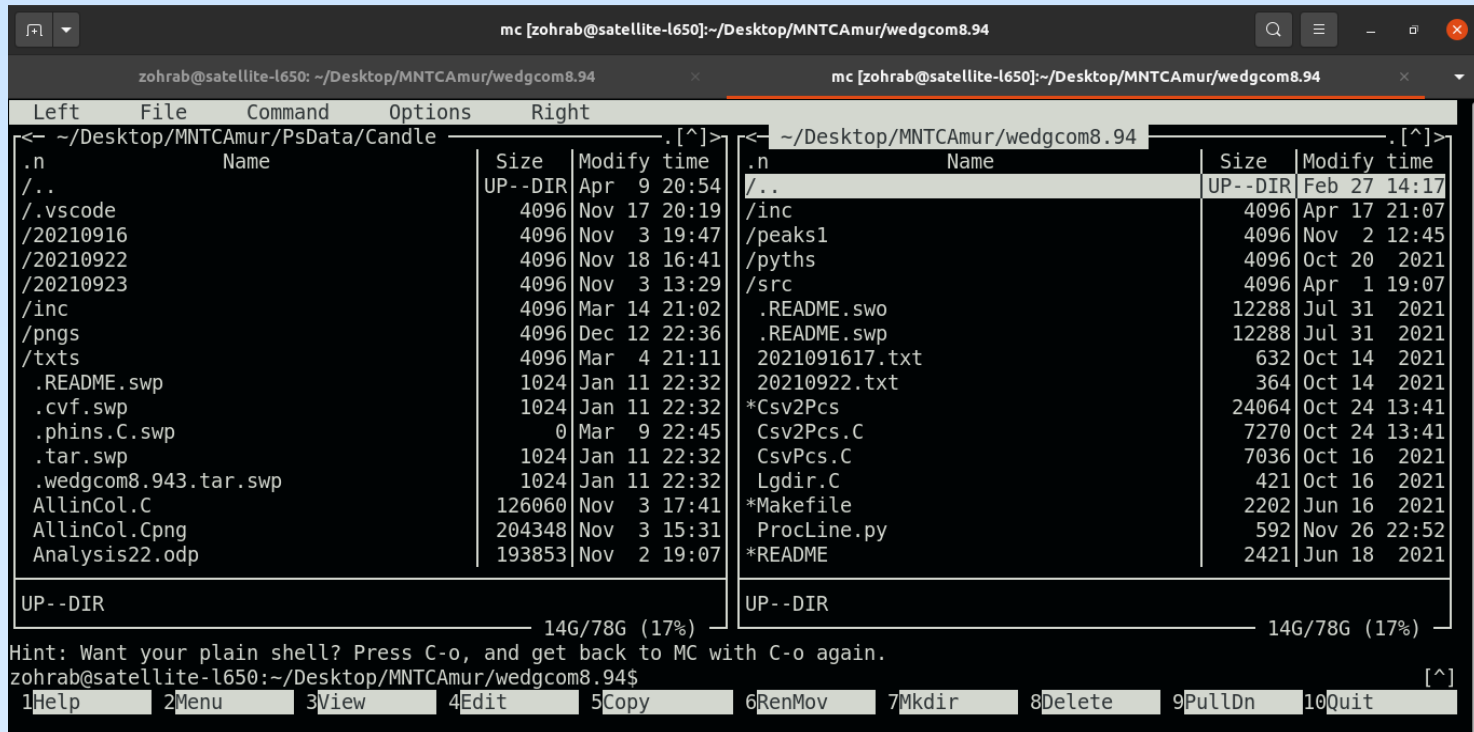
GUI usage prehistory

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)

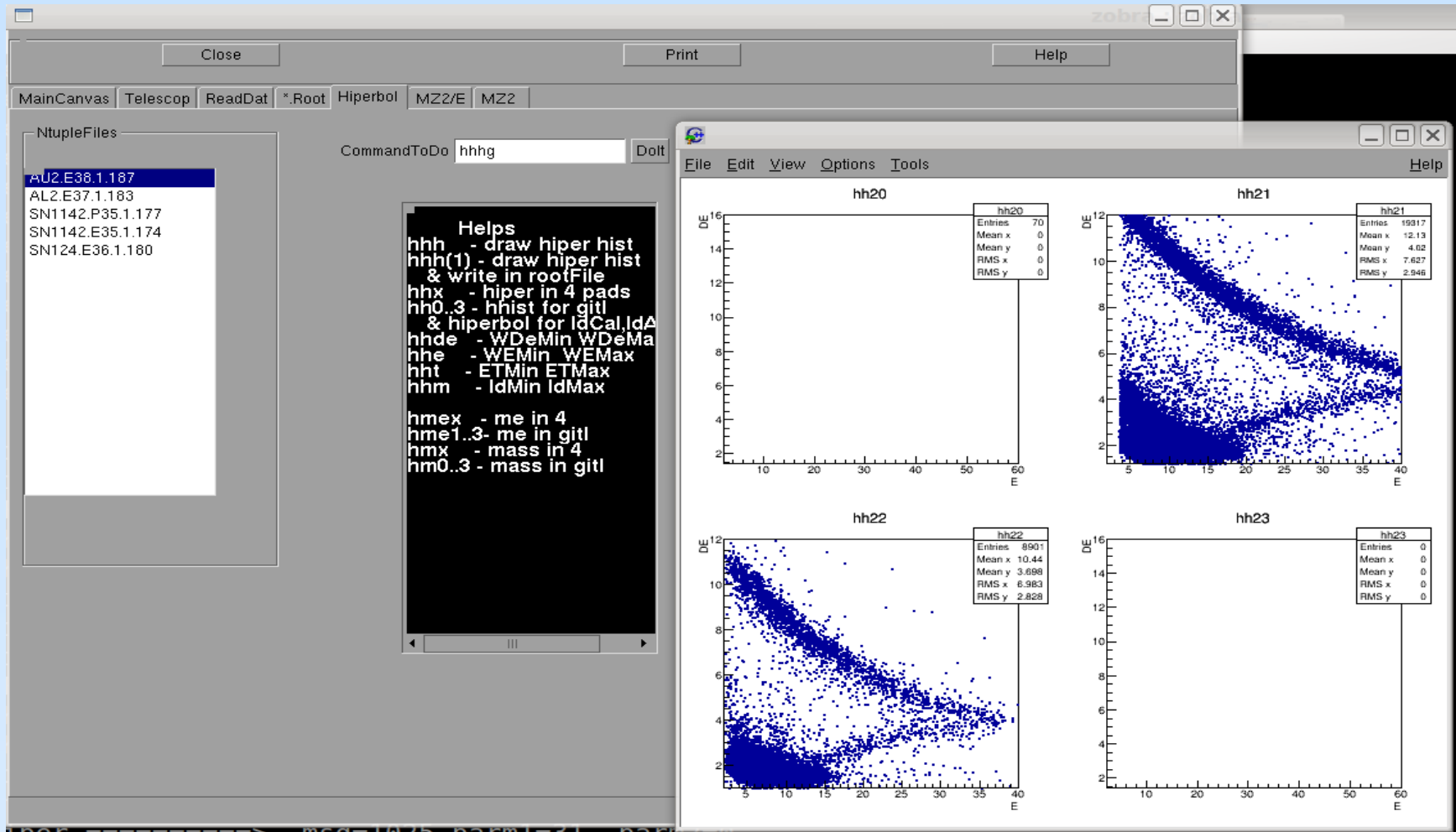


The screenshot shows the Midnight Commander (mc) interface. The top window title is "mc [zohrab@satellite-l650]:~/Desktop/MNTCAmur/wedgcom8.94". The interface is split into two panels, "Left" and "Right", each displaying a file listing table. The "Left" panel shows the directory structure of "/Desktop/MNTCAmur/PsData/Candle", and the "Right" panel shows the directory structure of "/Desktop/MNTCAmur/wedgcom8.94". Both panels show columns for "Name", "Size", and "Modify time". The "Left" panel also shows a "Command" column with "UP - -DIR". The "Right" panel shows a "Command" column with "UP - -DIR". At the bottom, there is a hint: "Hint: Want your plain shell? Press C-o, and get back to MC with C-o again." and a status bar with keyboard shortcuts: "1Help 2Menu 3View 4Edit 5Copy 6RenMov 7Mkdir 8Delete 9PullDn 10Quit".

Left	File	Command	Options	Right	
<-	~/Desktop/MNTCAmur/PsData/Candle			<-	~/Desktop/MNTCAmur/wedgcom8.94
.n	Name			.n	Name
UP - -DIR				UP - -DIR	
Size	Modify time			Size	Modify time
4096	Nov 17 20:19			4096	Apr 17 21:07
4096	Nov 3 19:47			4096	Nov 2 12:45
4096	Nov 18 16:41			4096	Oct 20 2021
4096	Nov 3 13:29			4096	Apr 1 19:07
4096	Mar 14 21:02			12288	Jul 31 2021
4096	Dec 12 22:36			12288	Jul 31 2021
4096	Mar 4 21:11			632	Oct 14 2021
1024	Jan 11 22:32			364	Oct 14 2021
1024	Jan 11 22:32			24064	Oct 24 13:41
0	Mar 9 22:45			7270	Oct 24 13:41
1024	Jan 11 22:32			7036	Oct 16 2021
1024	Jan 11 22:32			421	Oct 16 2021
126060	Nov 3 17:41			2202	Jun 16 2021
204348	Nov 3 15:31			592	Nov 26 22:52
193853	Nov 2 19:07			2421	Jun 18 2021

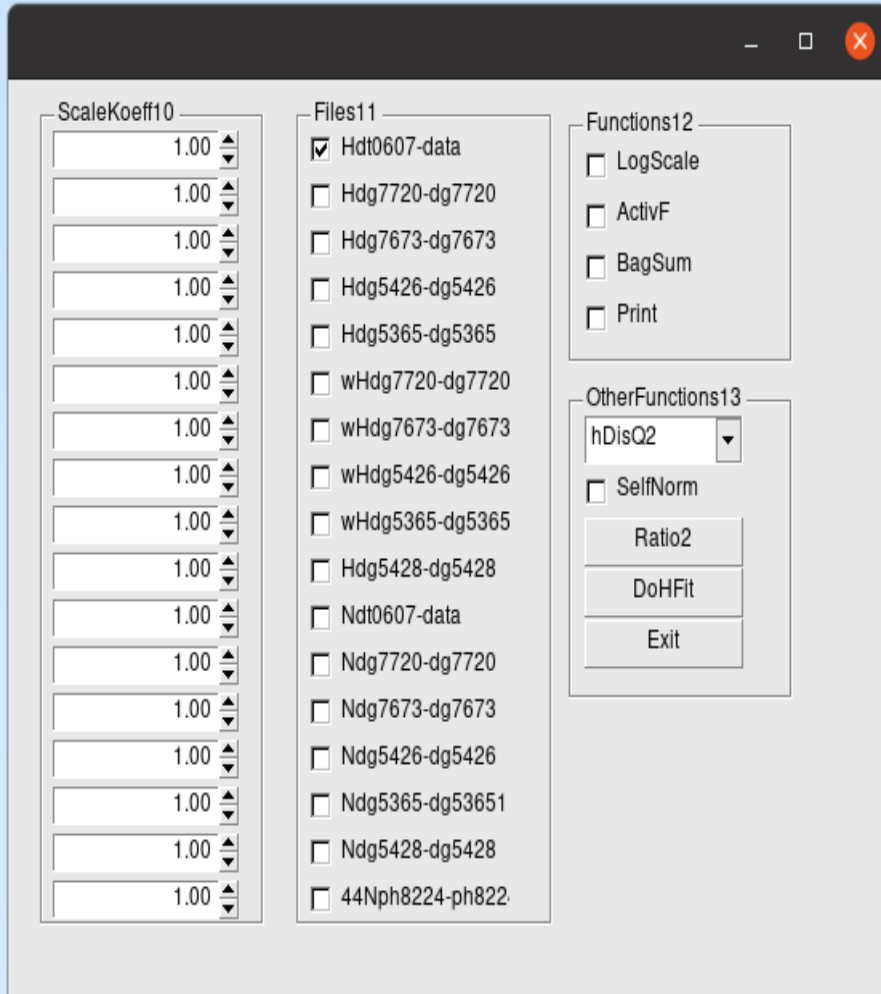
ROOT GUI usage

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

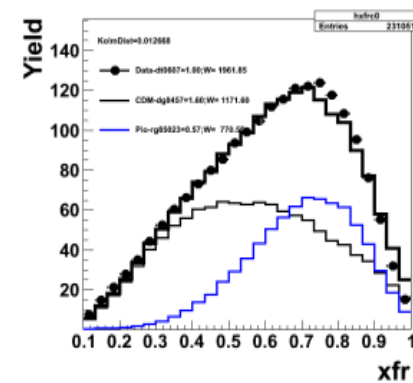
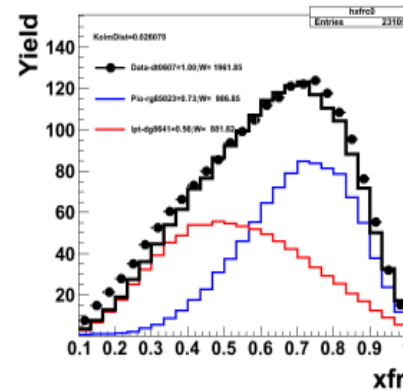
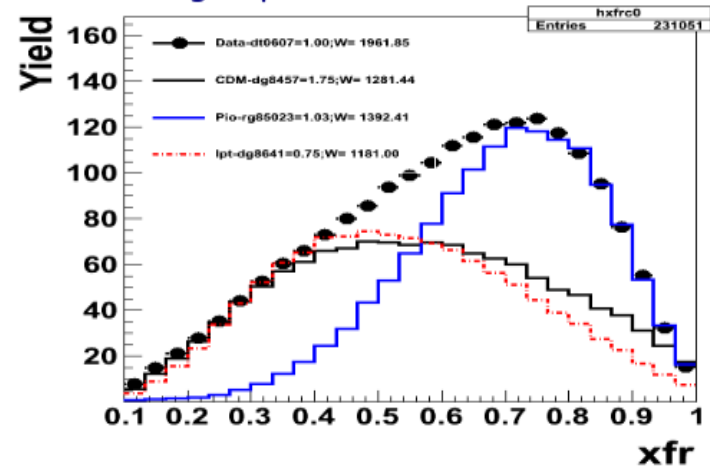


ROOT GUI in physics

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



Using Lepto instead of CDM



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

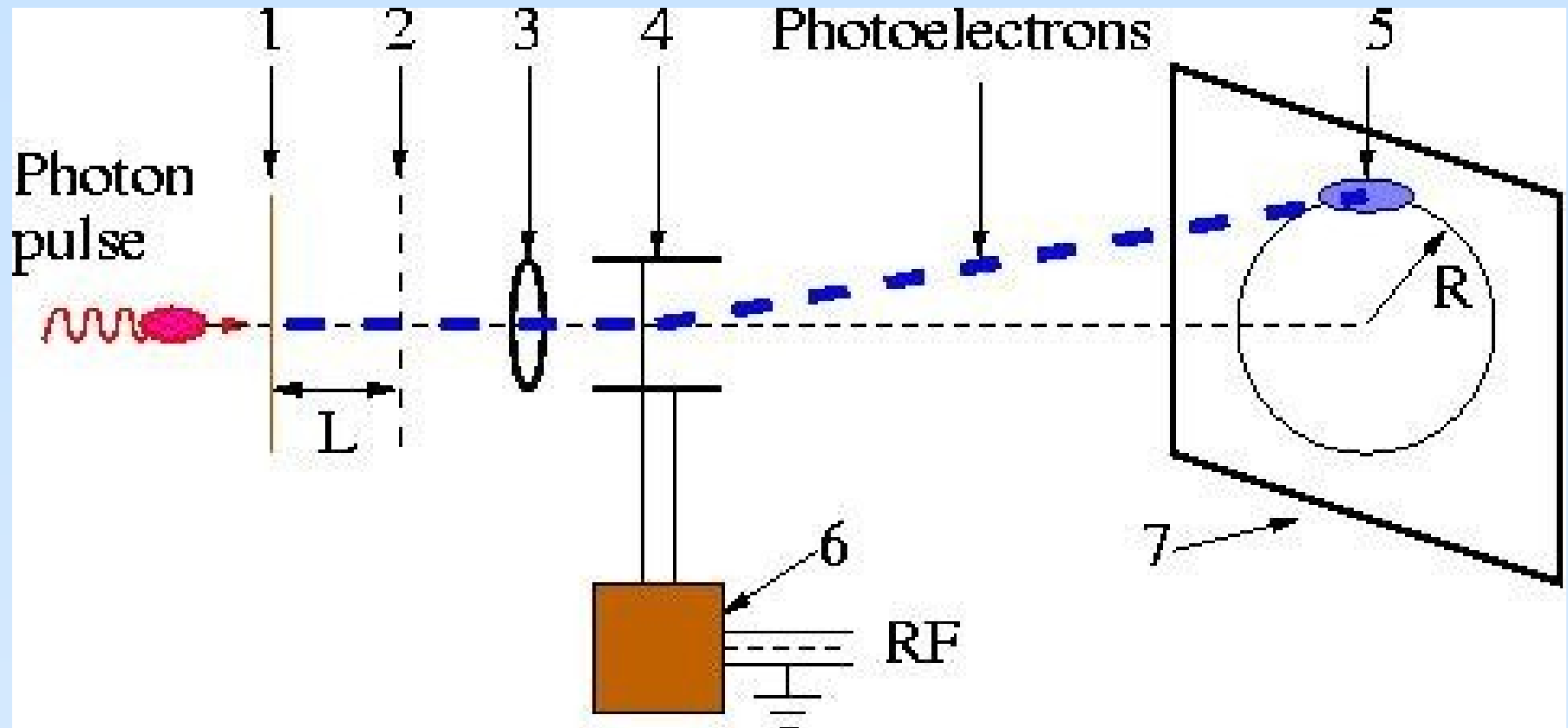
An other usage was "maino"

The screenshot displays a desktop environment with two main windows. The left window, titled 'Maino:(C)ZHG-23.05.2015', is a control interface for a detector system. It features three columns of channel lists (adc0, adc1, adc2) and a 'Cnts' section. Below these are various configuration options, including 'HistAutoScale', 'CntrAutoScale', and 'WithNTuple' (set to 15MeV). A terminal window at the bottom shows the following output:

```
Triggers=23829
Rate[Hz]=11
We are in Maino::ProcessMessage 259 405 0 1
Run Duration[sec]=2746.2
Triggers=32335
Rate[Hz]=11
Fill: Switching to new file: Run.15MeV.9.28.20.19_2.root
```

The right window, titled 'Rates/ADCs', contains two plots. The top plot, 'RatesMultyGraph', shows 'Rates' on the y-axis (0 to 24) versus 'time(iteration)' on the x-axis (204 to 214). A purple line graph fluctuates around a mean value of 16.0701. The bottom plot, 'ADCs', shows 'Events' on the y-axis (0 to 140) versus 'ADC' on the x-axis (0 to 2000). A blue histogram shows a peak at approximately 500 ADC units, labeled 'D[0][4]'.

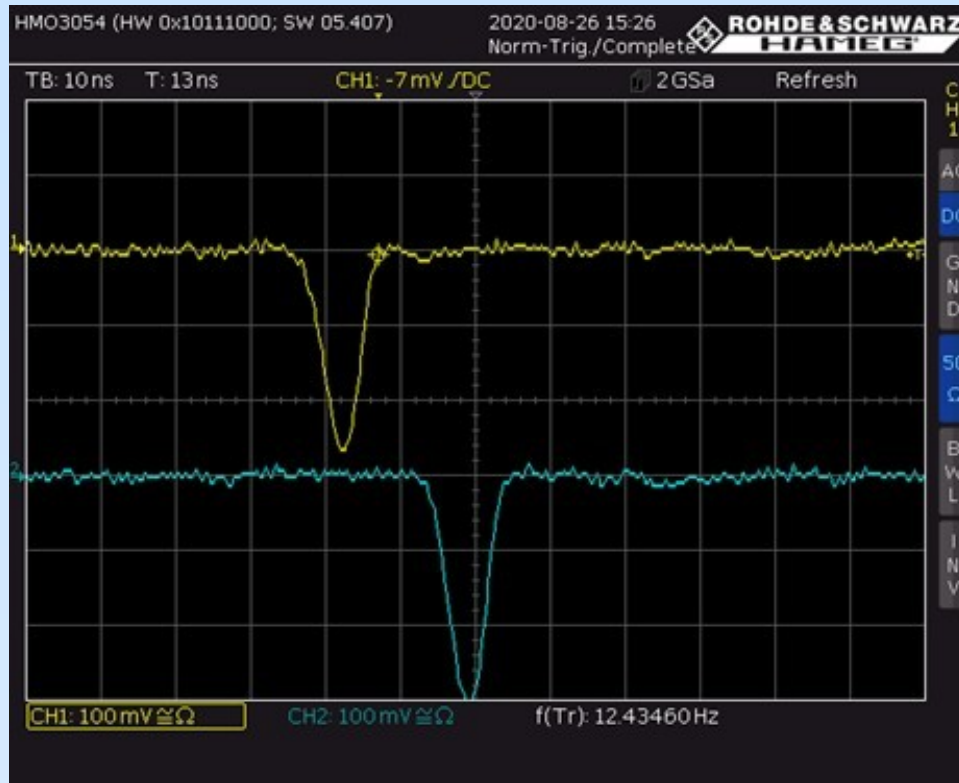
This usage for ~PicoSec resolution



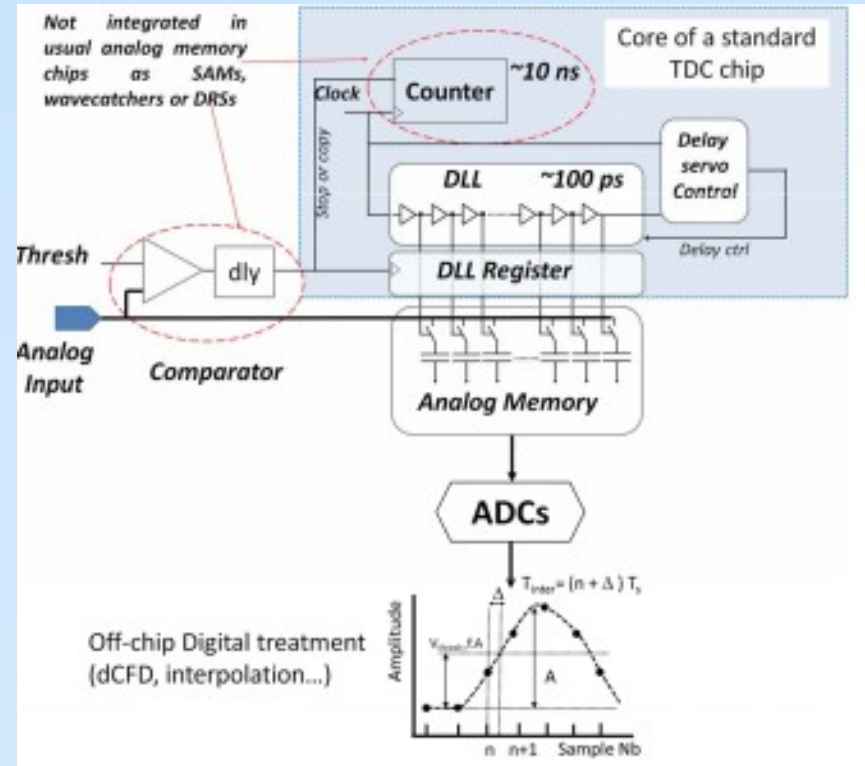
Idea comes from 1970-ies

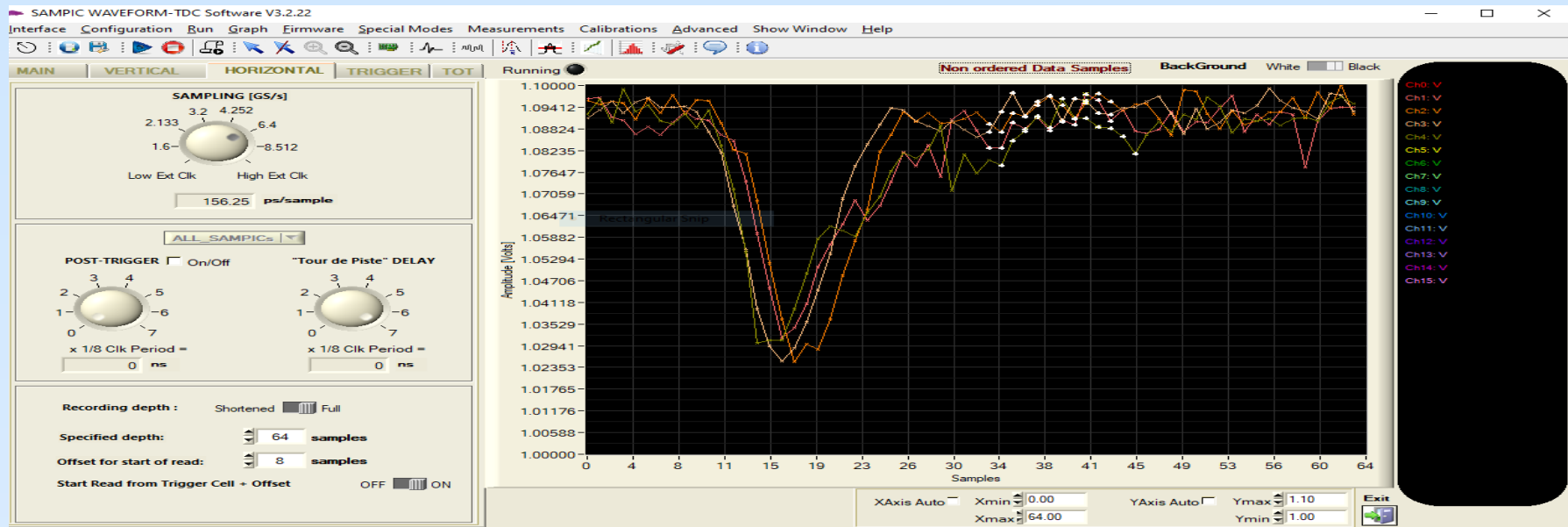
Fighting for ~picosec resolution

Signal picture Oscilloscope



Typical DLL scheme



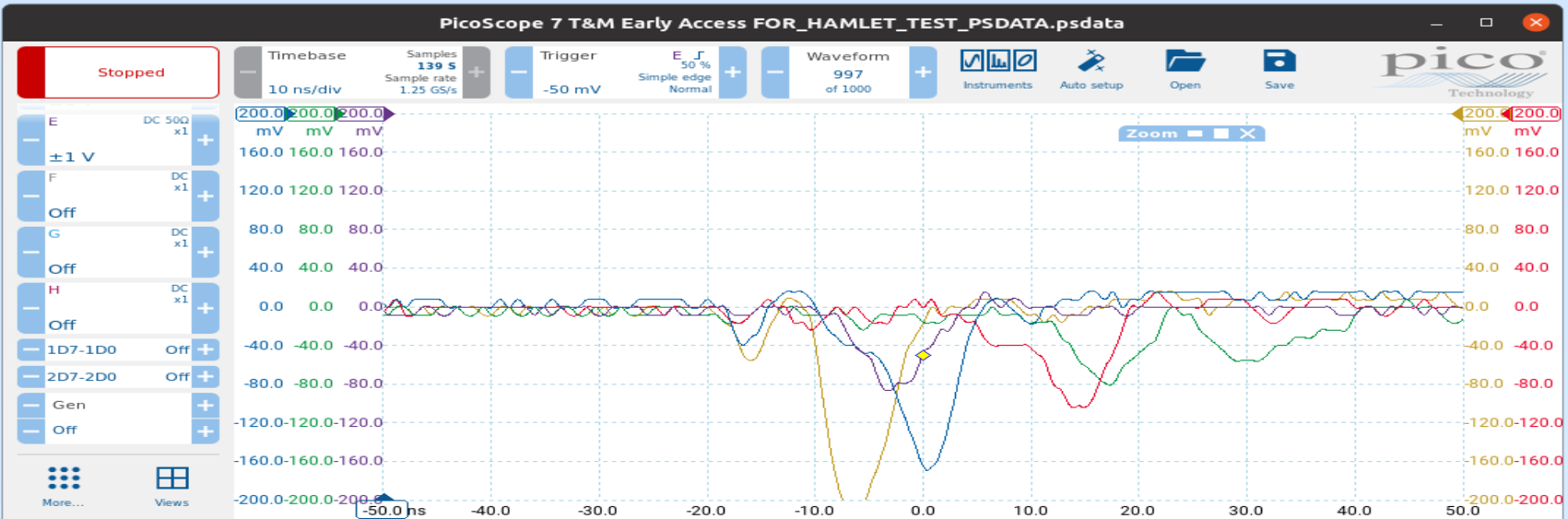


SAMPIC: PERFORMANCE SUMMARY

		Unit
Technology	AMS CMOS 0.18 μ m	
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)	μ s
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

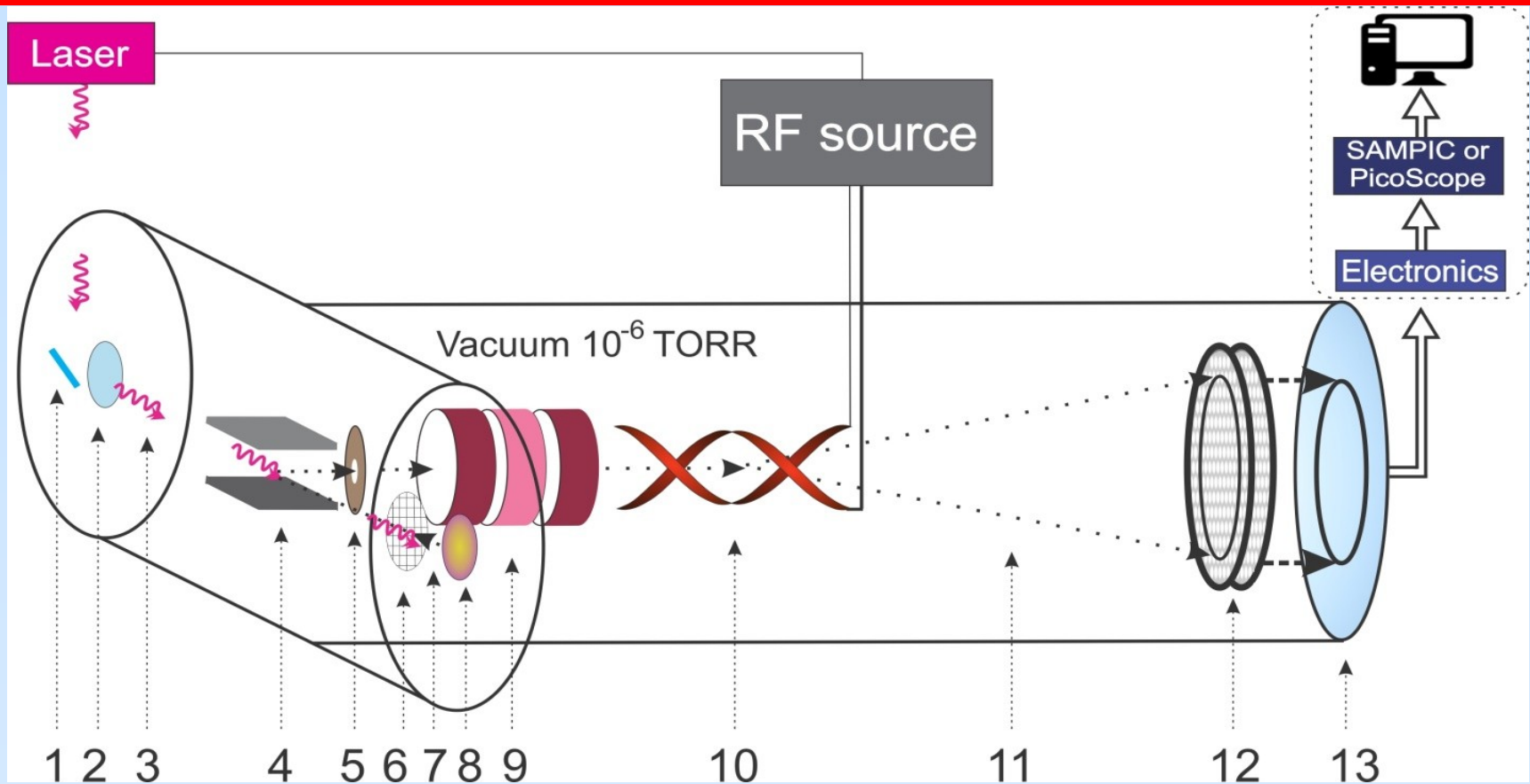


PicoScope 6407 Digitizer Specifications

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 \pm 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	\pm 100 mV
DC accuracy	\pm 3% of full scale
Overvoltage protection	\pm 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	\pm 5 ppm
DYNAMIC PERFORMANCE (typical)	
Crosstalk	100:1 DC to 100 MHz 30:1 100 MHz to 1 GHz
Step response	\pm 3% after 3 ns, typical
Noise	<0.5 mV RMS
TRIGGER	
Basic trigger modes	Rising, falling

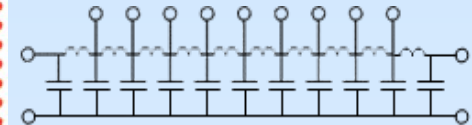
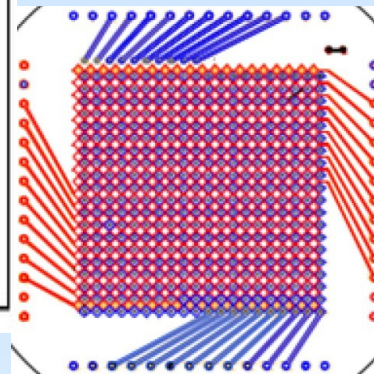
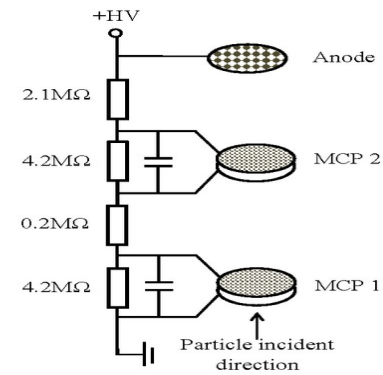
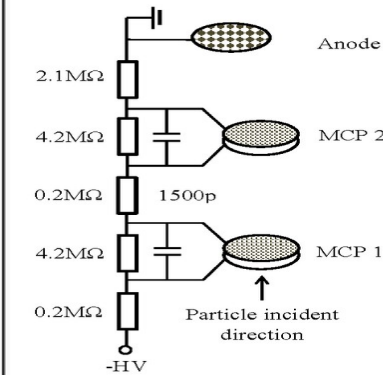
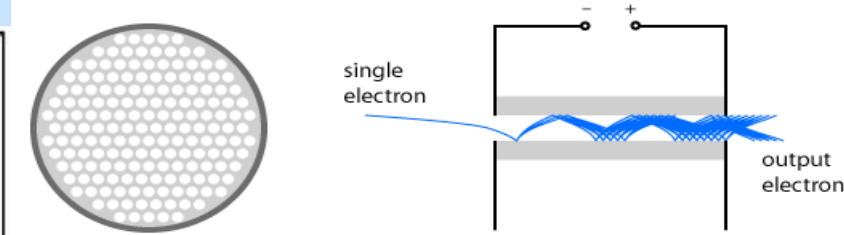
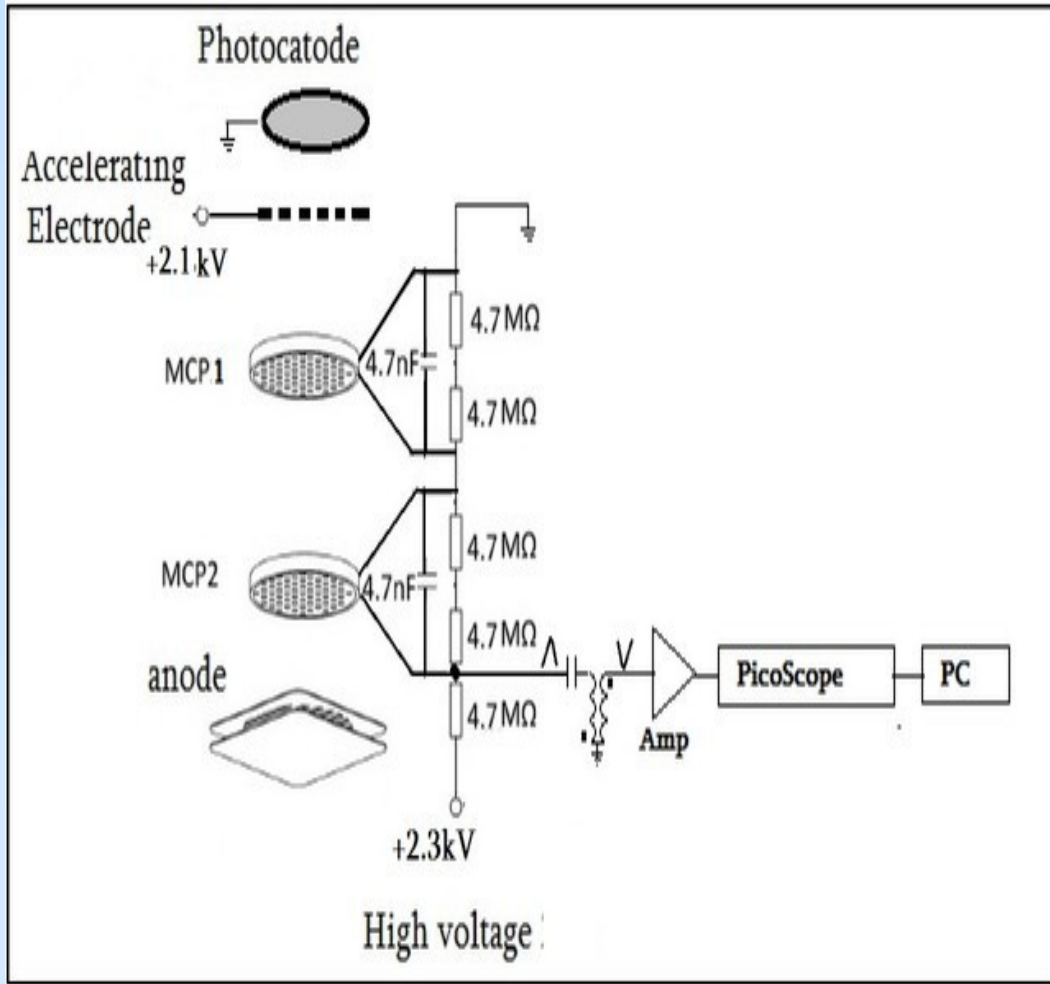
continued

The measurements setup

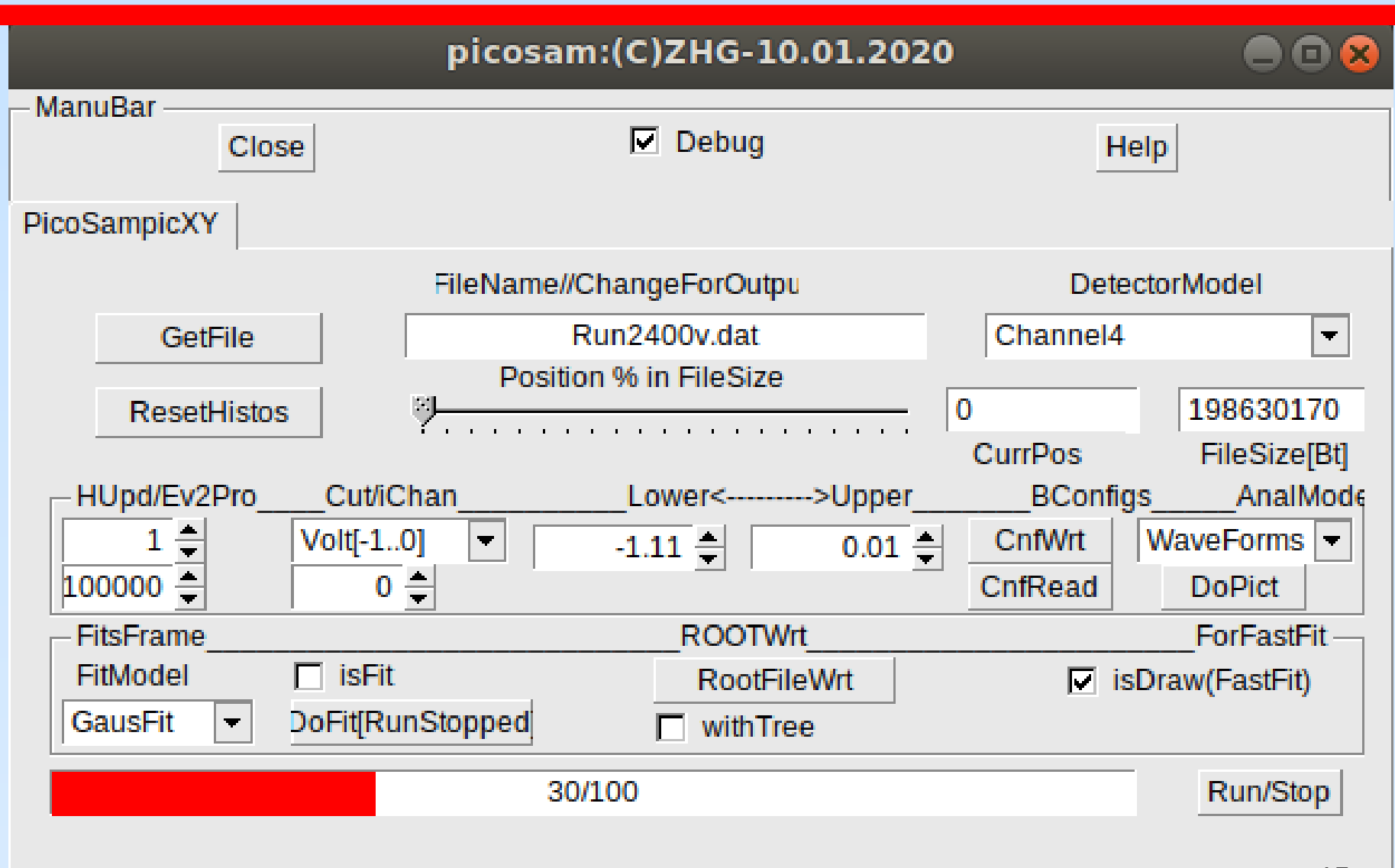


1.mirror; 2.quartz glass window; 3.laser photons; 4. permanent magnet; 5.collimator; 6.accelerating electrode; 7. photoelectrons; 8 tantalum disc cathode;9. electrostatic lens; 10.RF deflector;11.RF scanned electrones; 12.MCP detector; 13.position sensitive anod.

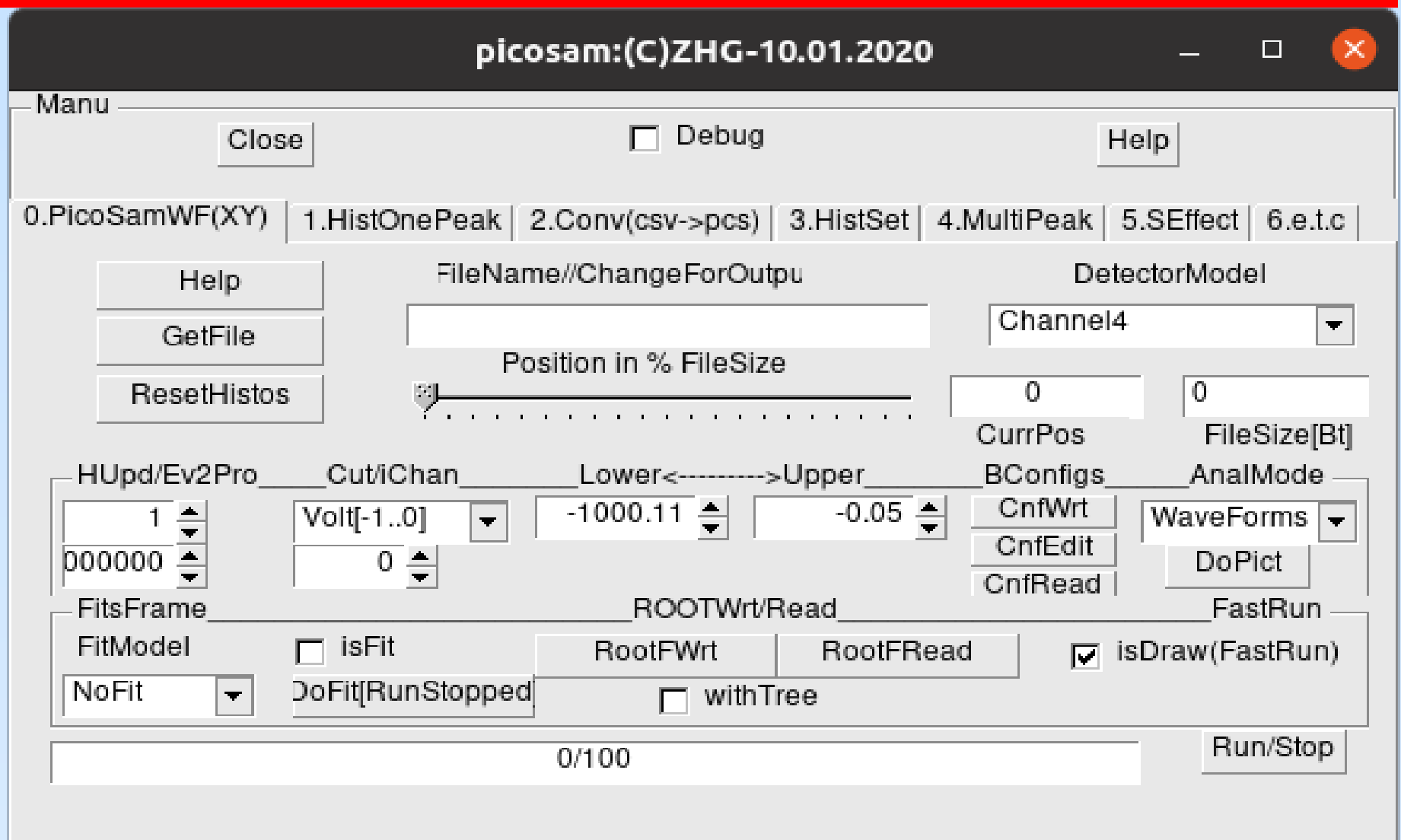
Some details of setup



First version of “picos(am)”



First version of “picos(am)”



WF pictures

The screenshot displays a Linux desktop environment with the PicoSam software running. The main window, titled "picoSam:(C)ZHG-10.01.2020", contains a control panel with various settings and a terminal window. The control panel includes a menu bar (Close, Debug, Help), a file selection section (FileName//ChangeForOutput: 20210923-0007.pcs, DetectorModel: Channel4), and a waveform configuration section (HUpd/Ev2Pro, Cut/Chan, Lower/Upper, Peak[n.^n], WaveForms). The terminal window shows the following code:

```
tdlt0[1]=0; tdlt1[1]=0  
; xx[1]= 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
```

Below the terminal, the status "IsGood/isNgood(V,T,Chrg,Fit)" is shown with values "0:1/0 1:1/0 2:1/0 3:1/0". To the right, a window titled "gc1" displays four plots of Signal/V versus WFBin (0 to 1400). The plots show waveforms for different channels: 0 (black), 1 (red), 2 (green), and 3 (blue). Each plot has vertical lines indicating peak positions. A legend in the bottom-right plot identifies the channels: 0 (black), 1 (red), 2 (green), and 3 (blue).

WF pictures

Activities ROOT Thu Apr 28 20:17

picosam:(C)ZHG-10.01.2020 gc1

0.PicoSamWF(XY) 1.HistOnePeak 2.Conv(csv->pcs) 3.HistSet 4.MultiPeak 5.S.Effect 6.e.t.c

Help Close Debug Help

FileName//ChangeForOutput 20210923-0007.pcs DetectorModel Channel4

Position in % FileSize 202829091 494705117

CurrPos FileSize[Bt]

HUpd/Ev2Pro Cut/Chan Lower Upper BConfigs AnalMode

1 Peak[n.^n] 185 185 CnfWrt WaveForms

000000 0 CnfEdit DoPict

CnfRead

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

Signal/WFBin

Signal/WFBin

Signal/WFBin

Signal/WFBin

OneWF

- 0
- 1
- 2
- 3

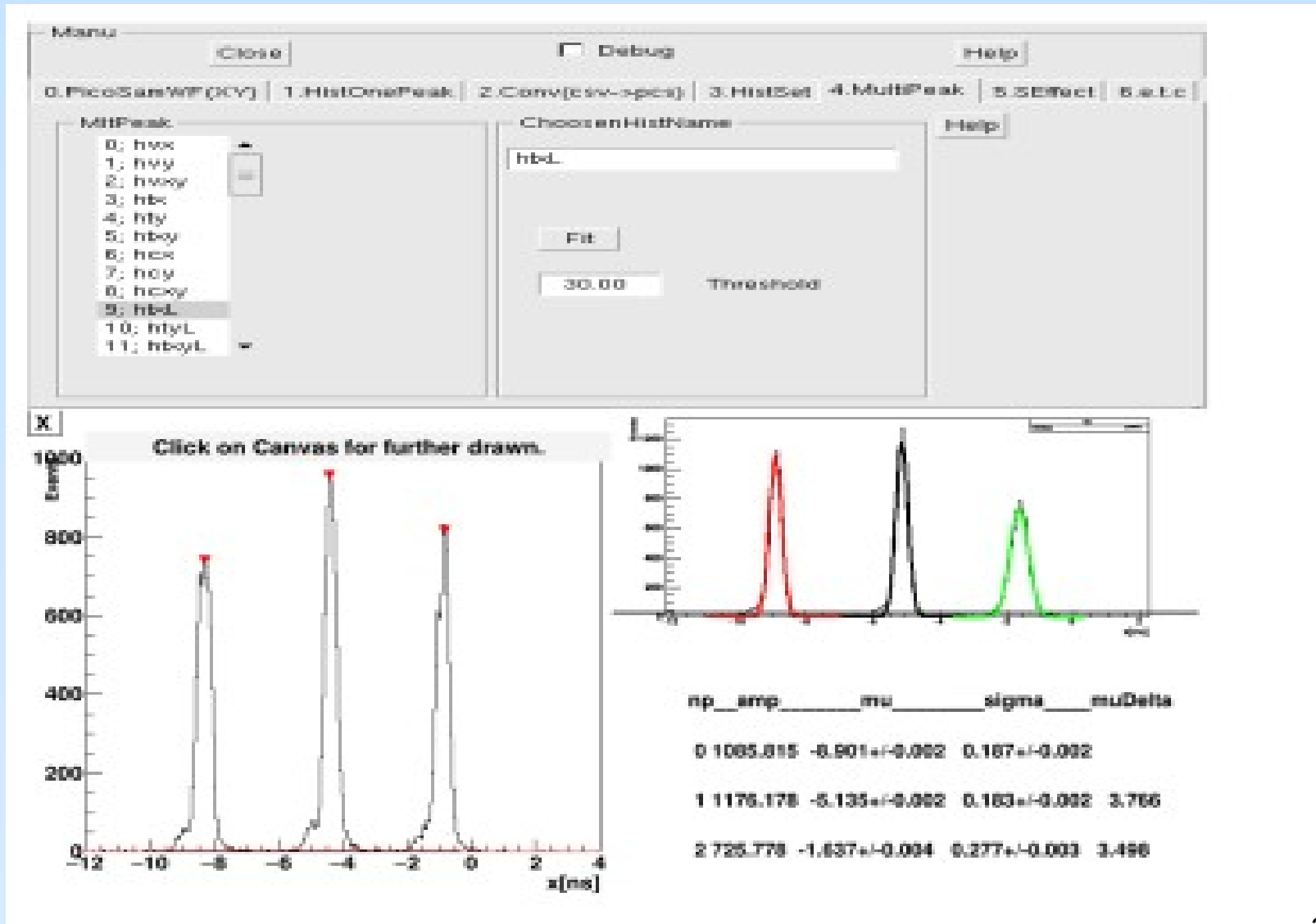
gnome desktop icons: Firefox, Files, LibreOffice, etc.

Histograms and csv → pcs conversion

The screenshot shows a software window with a menu bar containing 'Manu', 'Close', 'Debug' (with an unchecked checkbox), and 'Help'. Below the menu bar is a tabbed interface with tabs labeled '0.PicoSamWF(XY)', '1.HistOnePeak', '2.Conv(csv->pcs)', '3.HistSet', '4.MultiPeak', '5.SEffect', and '6.e.t.c'. The '2.Conv(csv->pcs)' tab is active. The main area is divided into two panels: 'Hists' and 'Bins'. The 'Hists' panel contains a list of histogram names from '0; hvx' to '11; hbxyL', with '9; hbL' selected. A 'MultSelect' checkbox is checked. The 'Bins' panel contains a text input field with the value '100; -40.0; 40.0 100; -40.0; 40.0' and a 'Set' button.

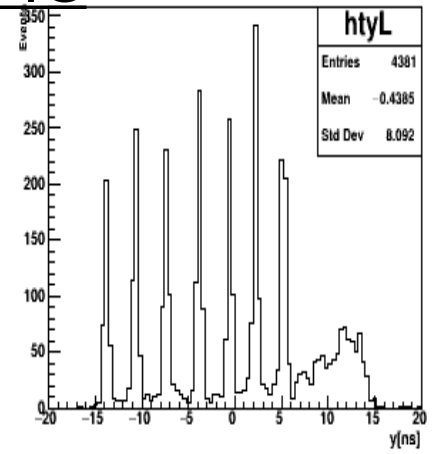
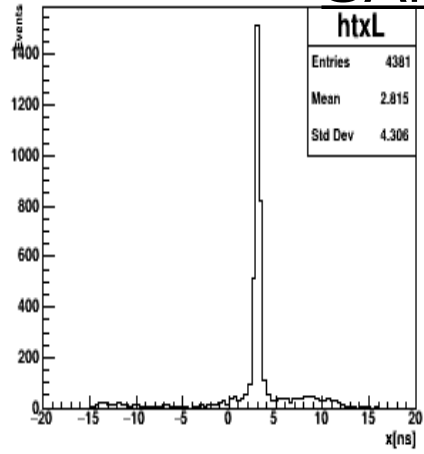
The screenshot shows a software window with a menu bar containing 'Manu', 'Close', 'Debug' (with an unchecked checkbox), and 'Help'. Below the menu bar is a tabbed interface with tabs labeled '0.PicoSamWF(XY)', '1.HistOnePeak', '2.Conv(csv->pcs)', '3.HistSet', '4.MultiPeak', '5.SEffect', and '6.e.t.c'. The '2.Conv(csv->pcs)' tab is active. The main area contains two text input fields: 'InFile with wild card *.csv' with the value './Data.26.12.19/raw_data/zhg2a.dat' and 'OutFile with FullName nnnn.pcs' with the value './Data.26.12.19/raw_data/zhg2a.dat'. Below these fields are buttons for 'Set', 'Convert', and 'Help'. At the bottom, a status bar displays '0/100'.

Multi-peaks

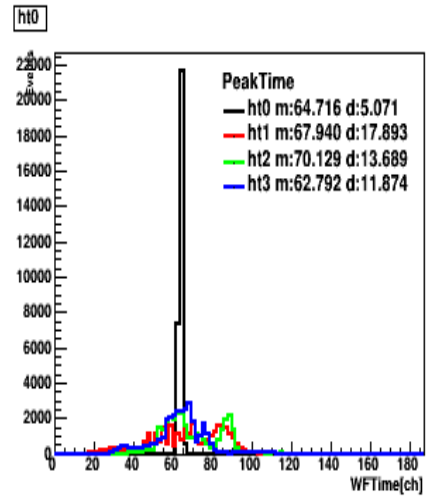
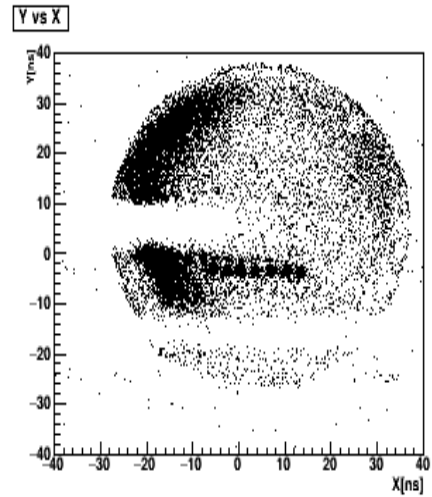
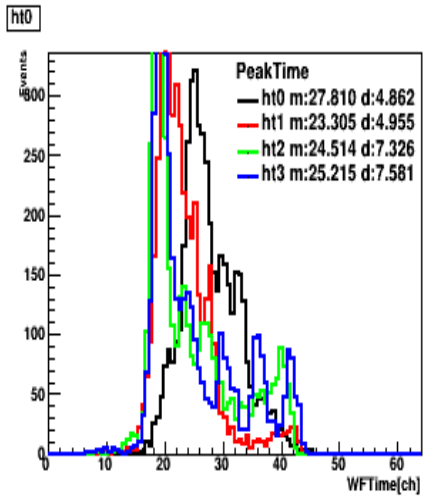
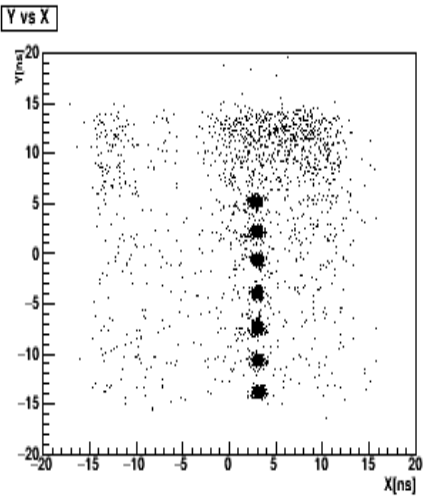
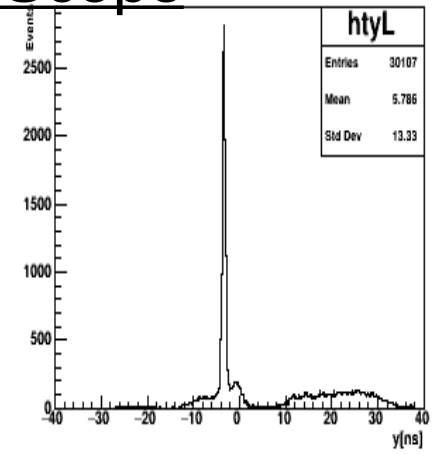
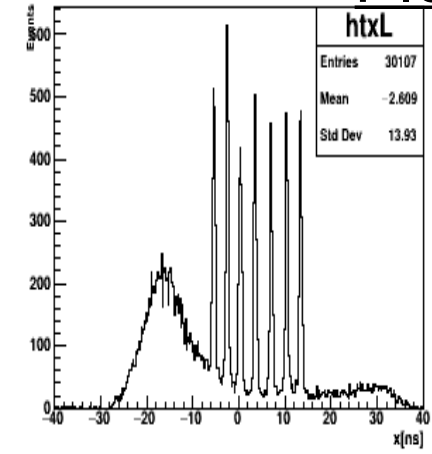


7 hole collimator

SAMPIC

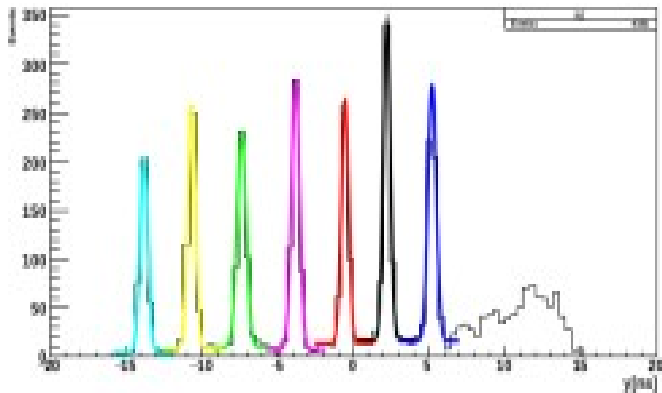


PicoScope



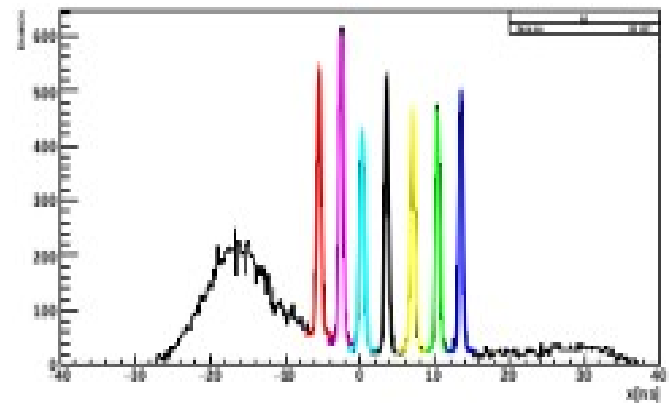
7 hole collimator

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

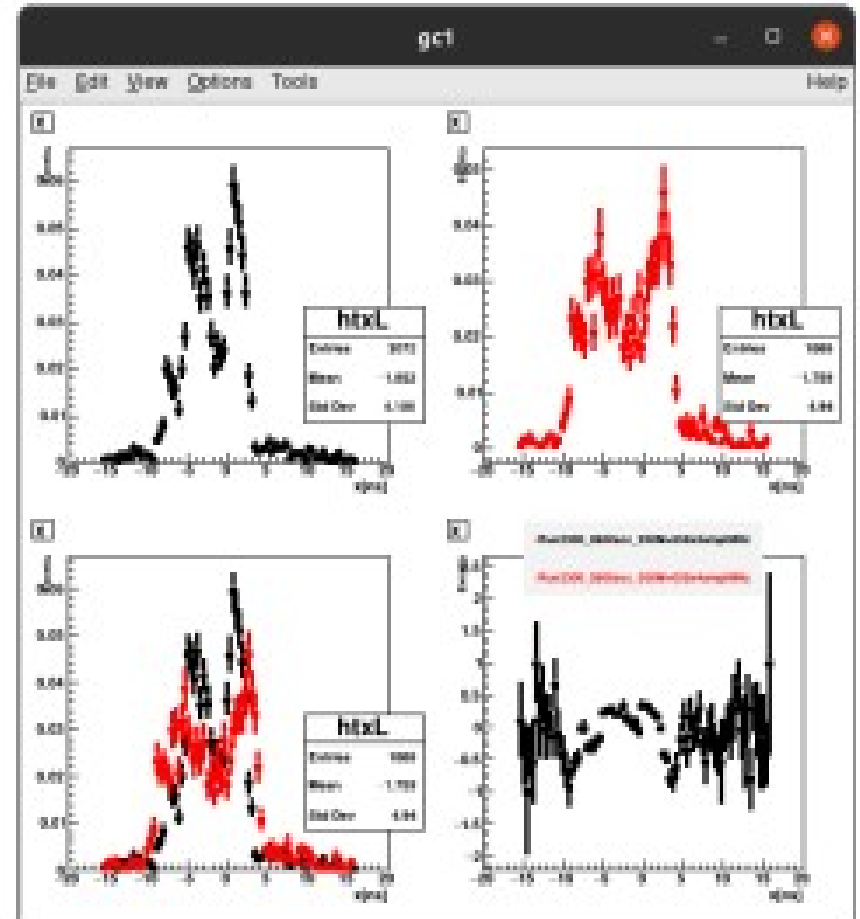
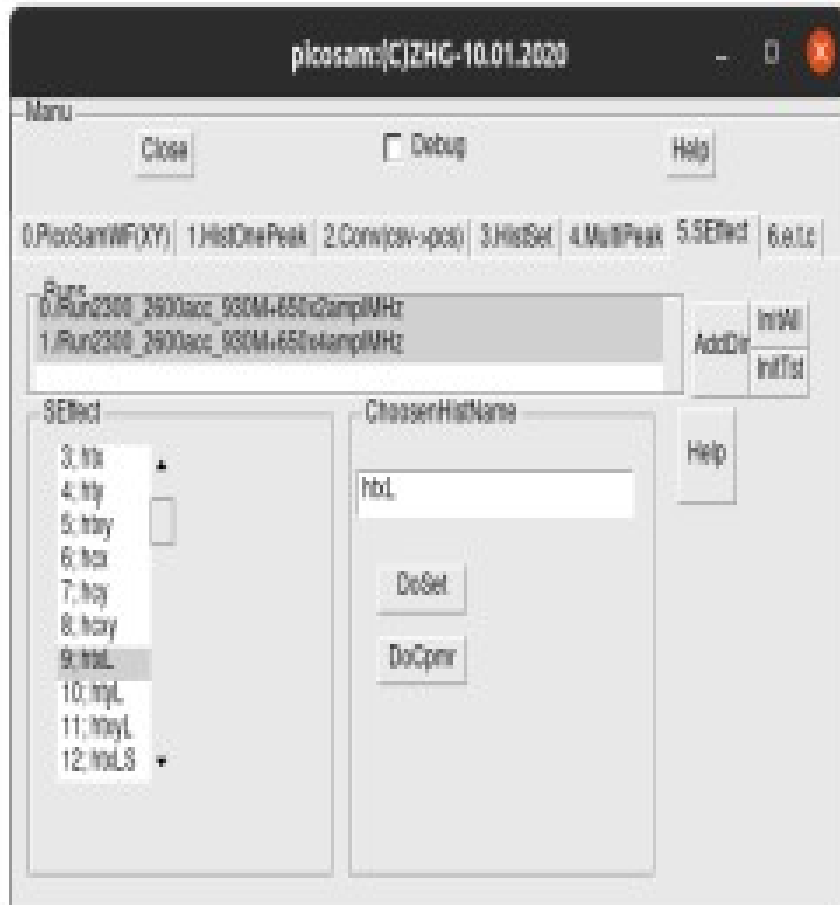
PicoScope



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

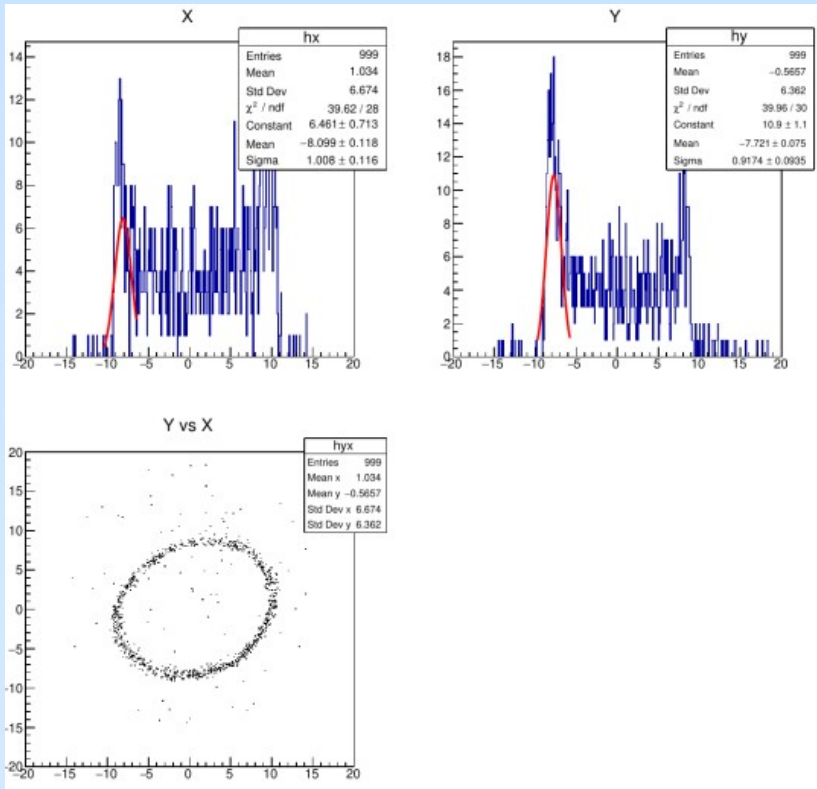
Histos comparison

Search for effects/defects from different files

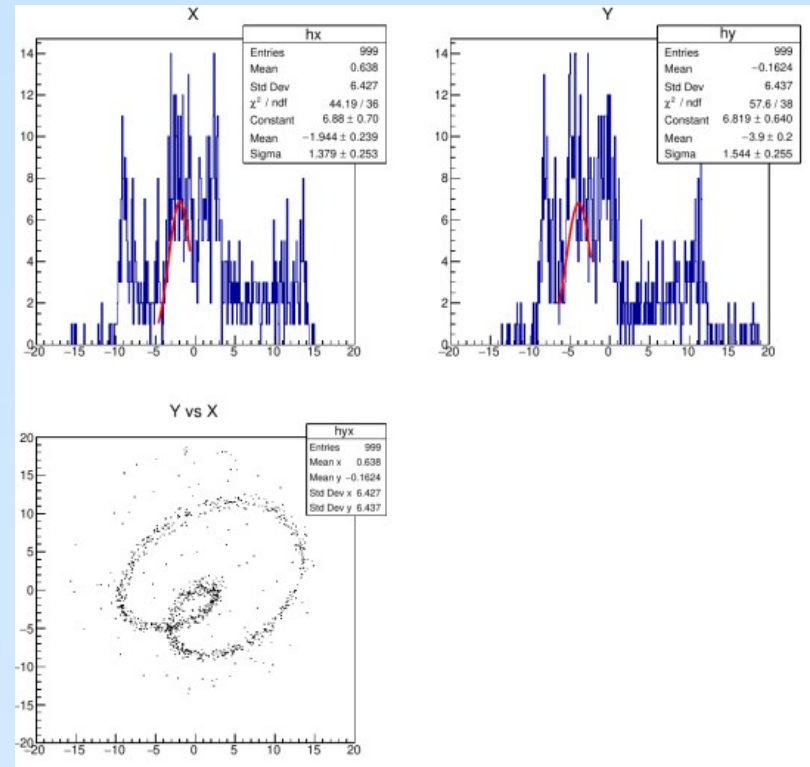


Playing with RF

500Mhz



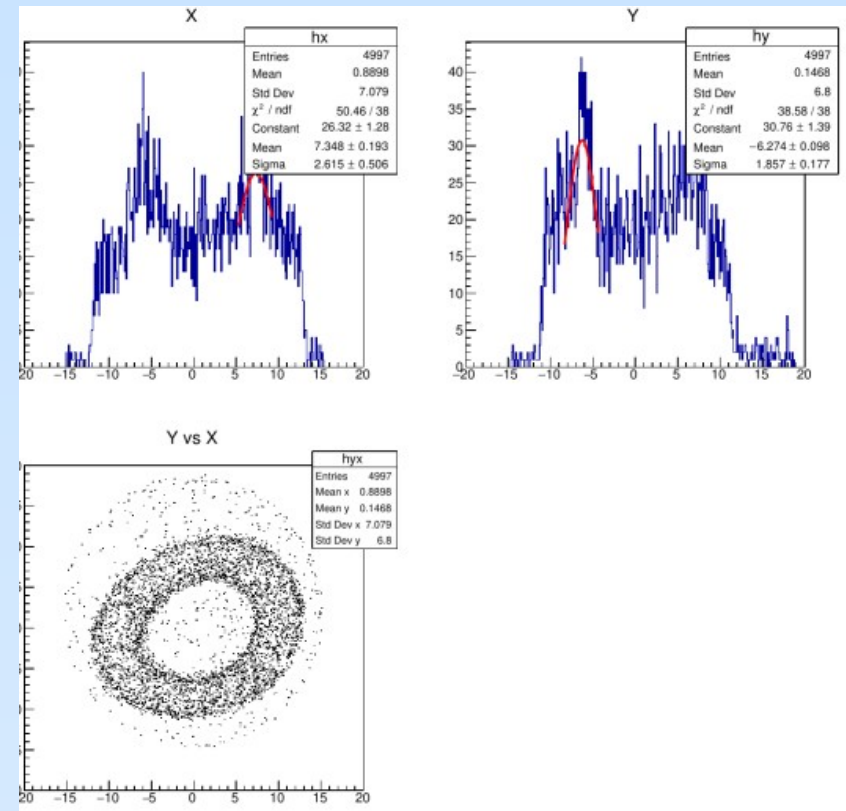
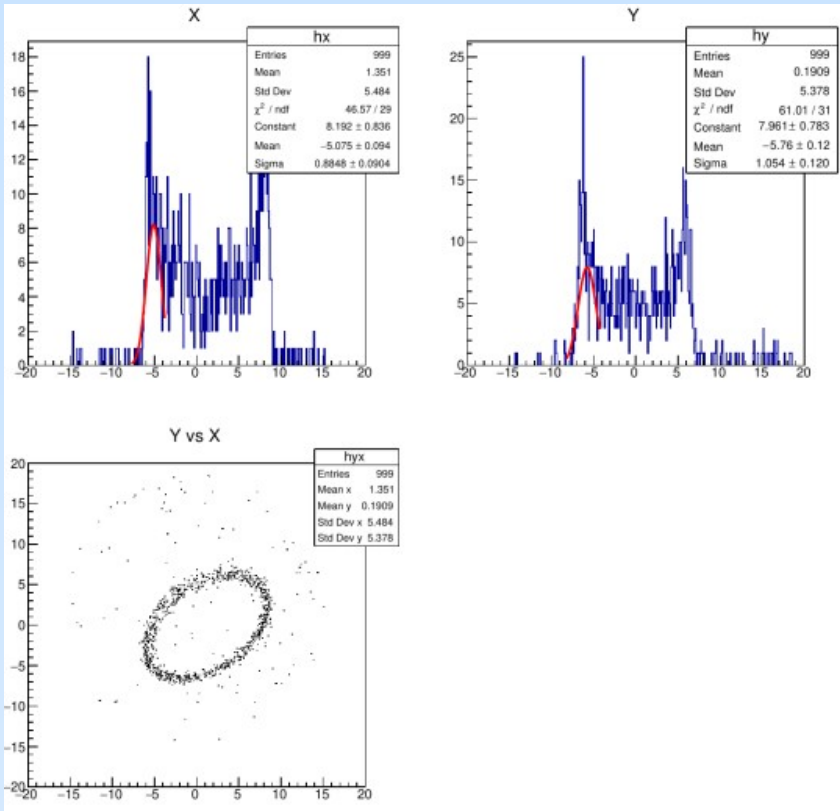
1000-500Mhz



Playing with RF

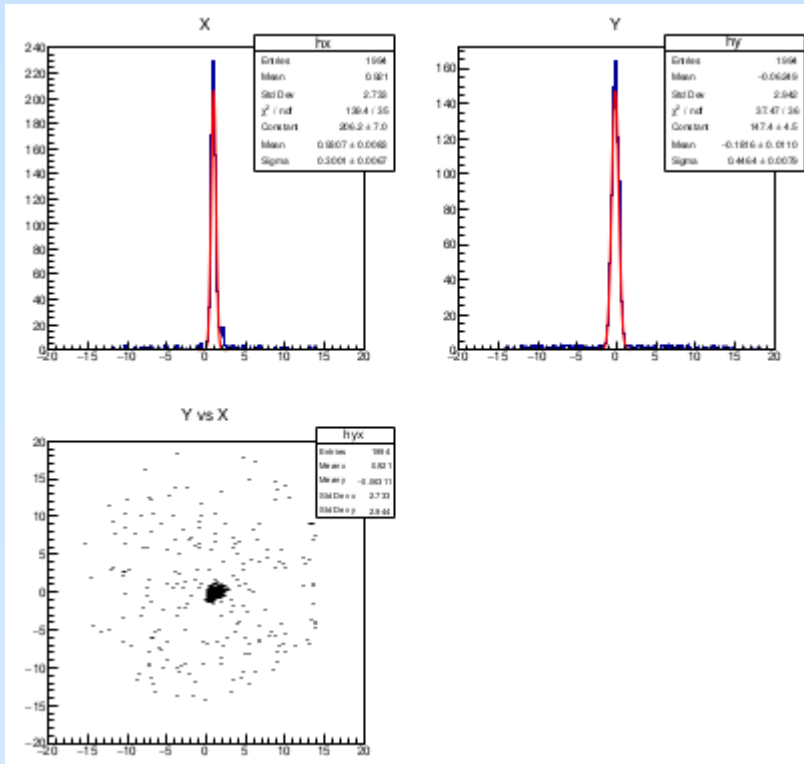
1000Mhz-10db

490Mhz/30db+500Mhz/20db

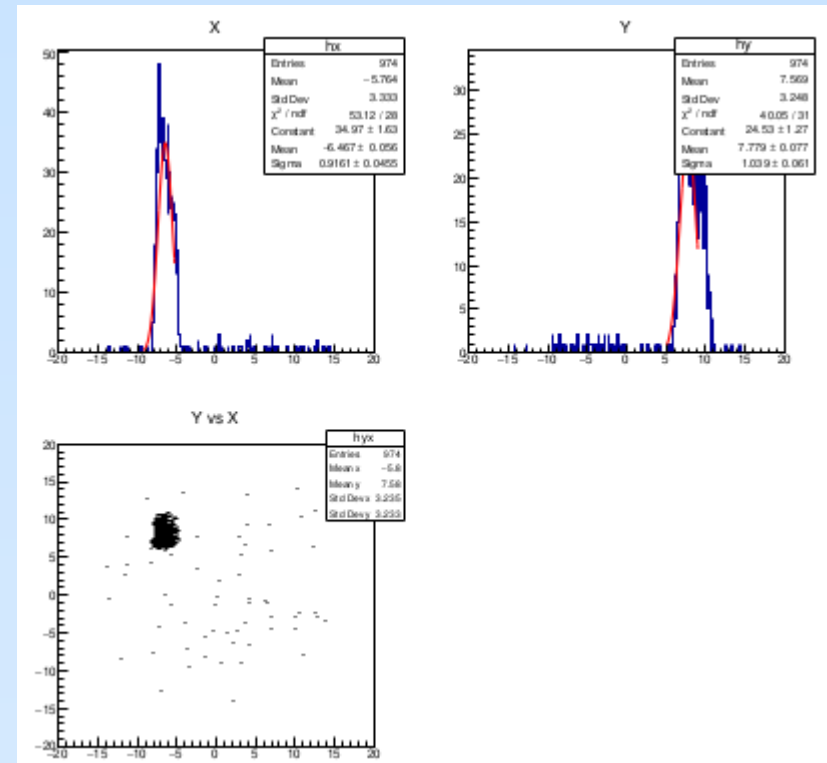


2.85 keV electrons Focusing

On



Off



First “Circle” on 28.03.2021!!!

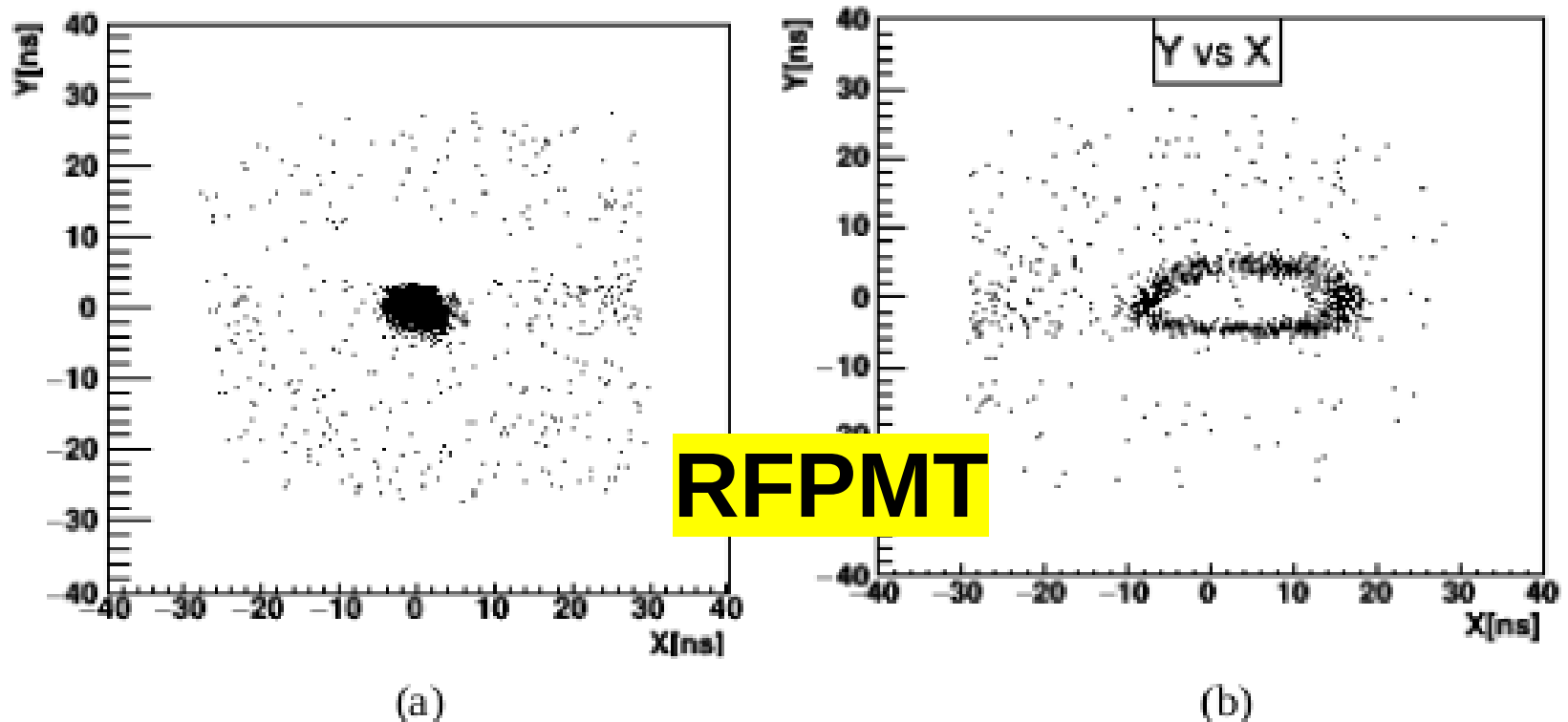
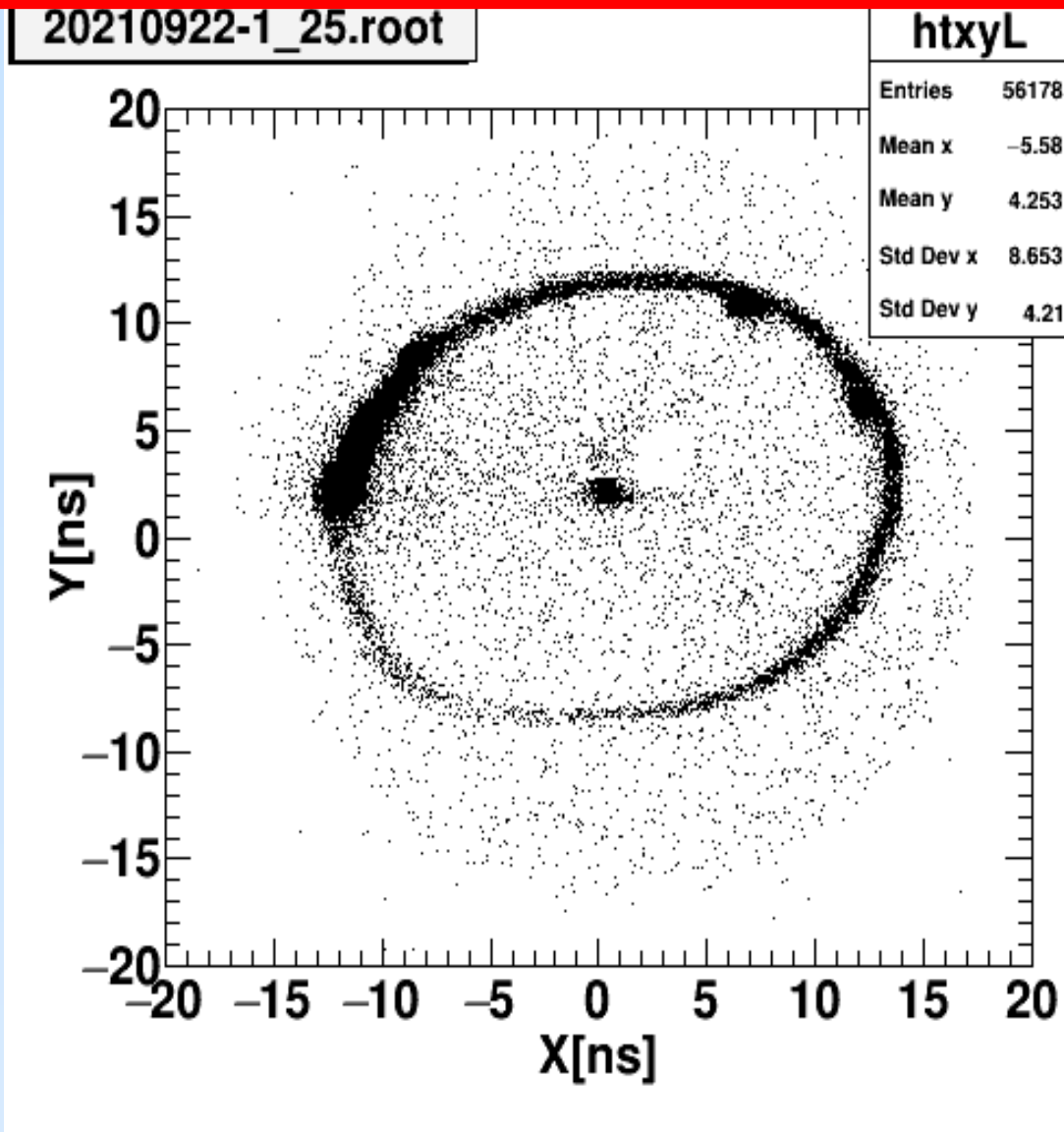


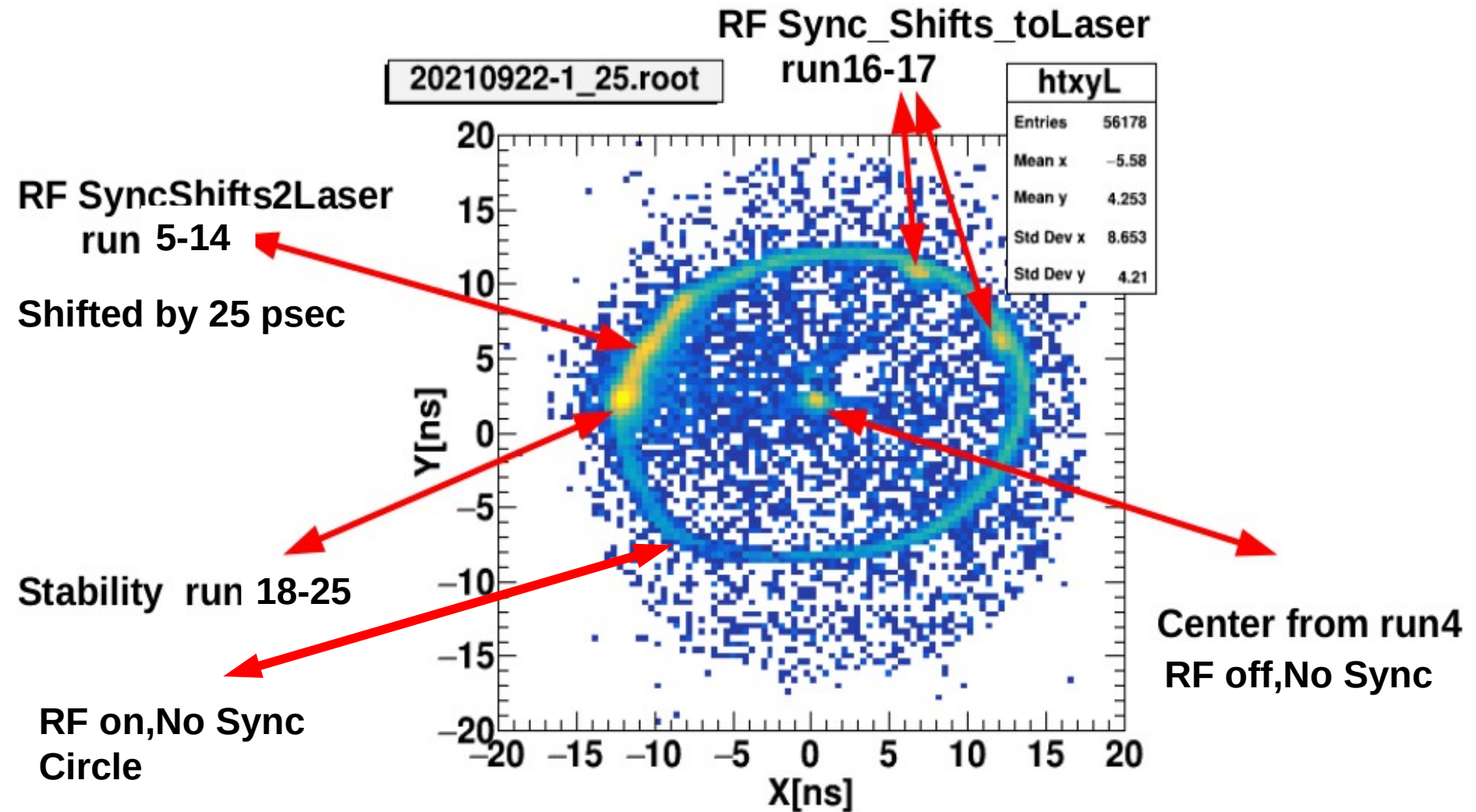
Figure 29: 2D image of the 2.5 keV electrons: (a) RF deflector off, (b) RF deflector on.

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.

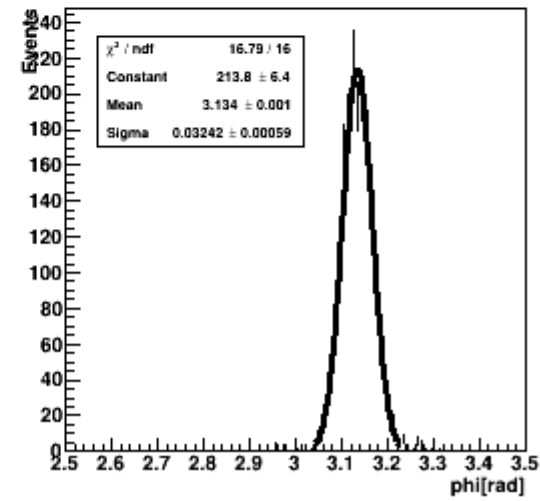
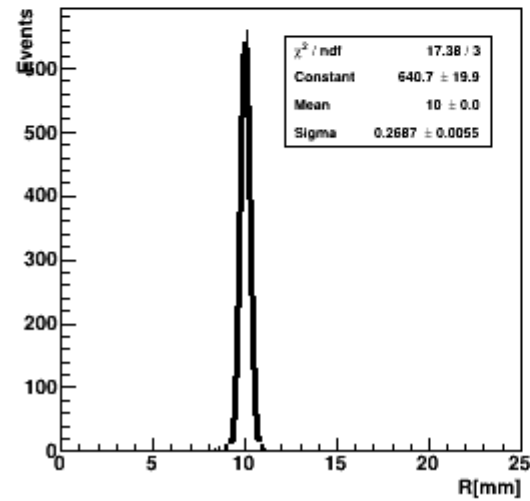
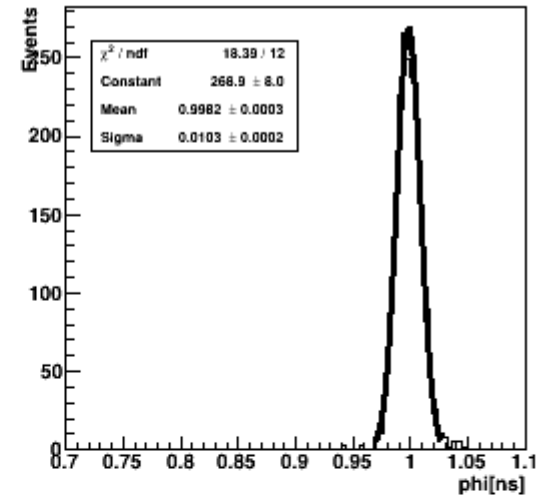
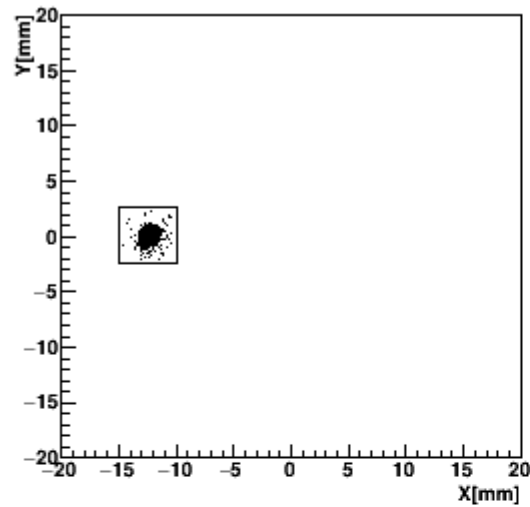
The CANDLE measurements(17-23.09.21)



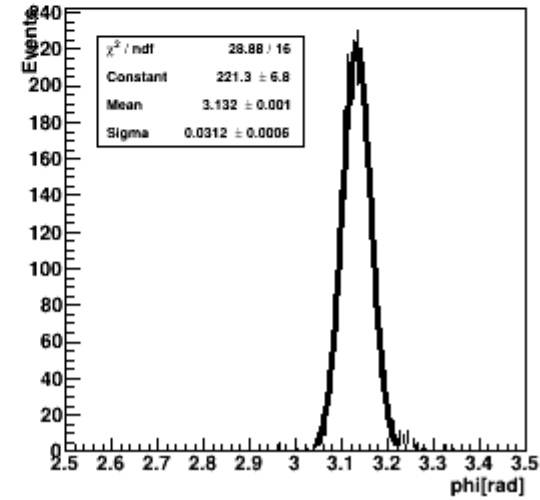
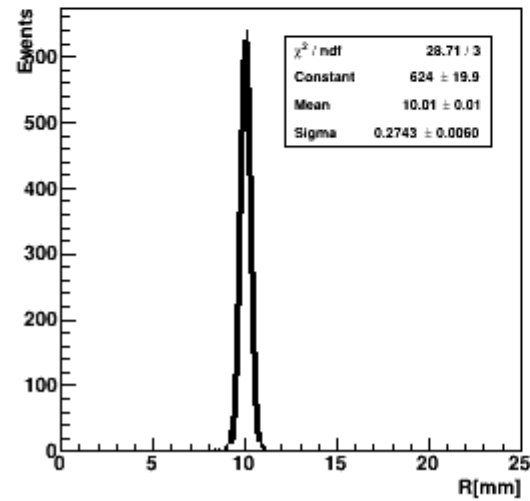
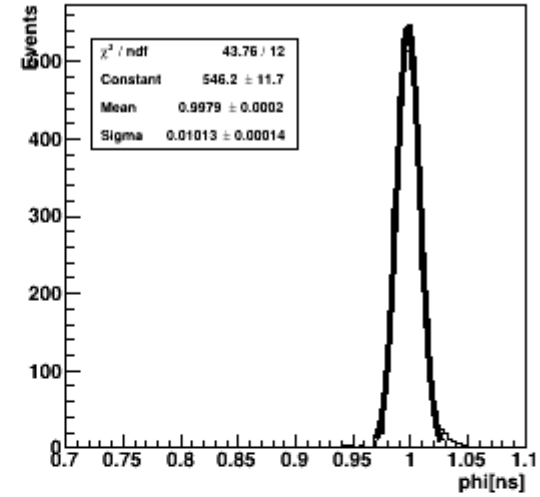
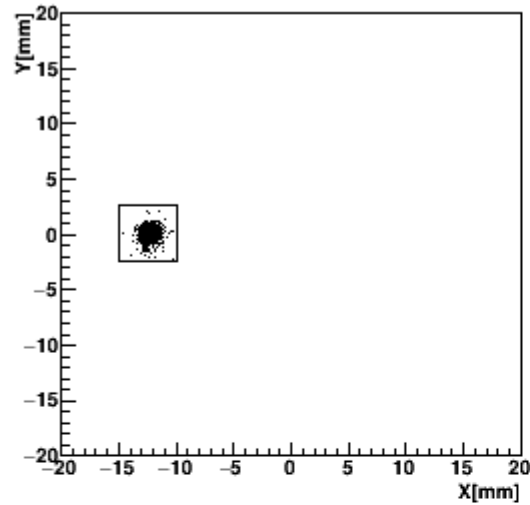
The CANDLE measurements



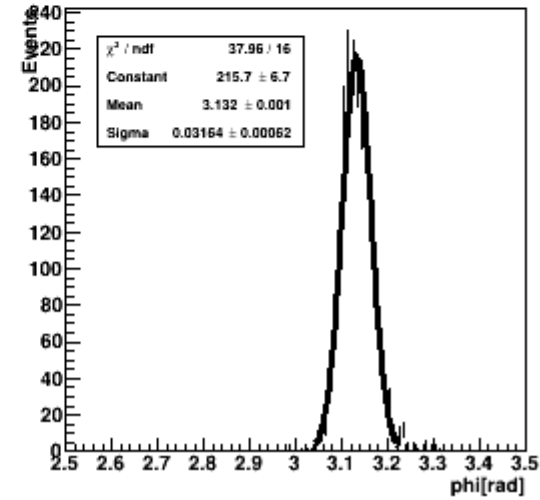
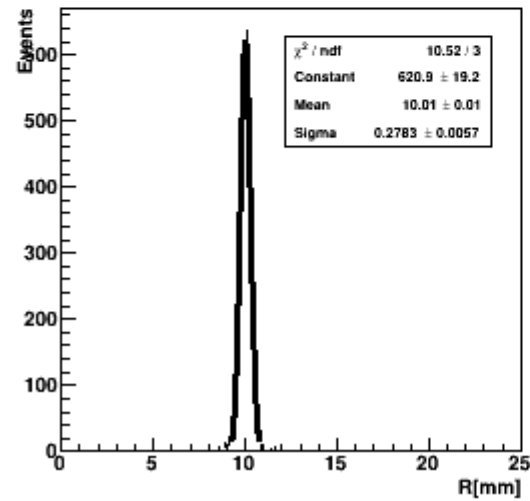
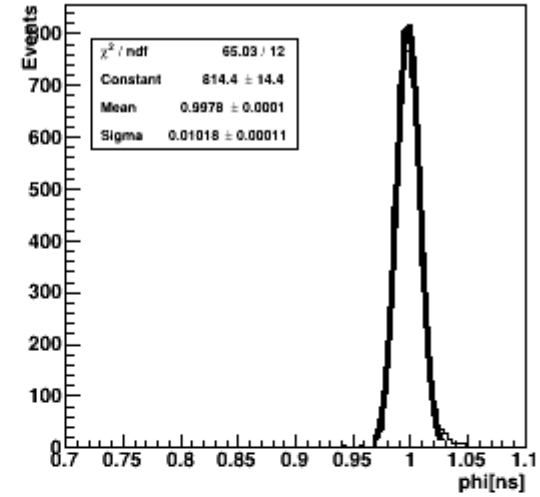
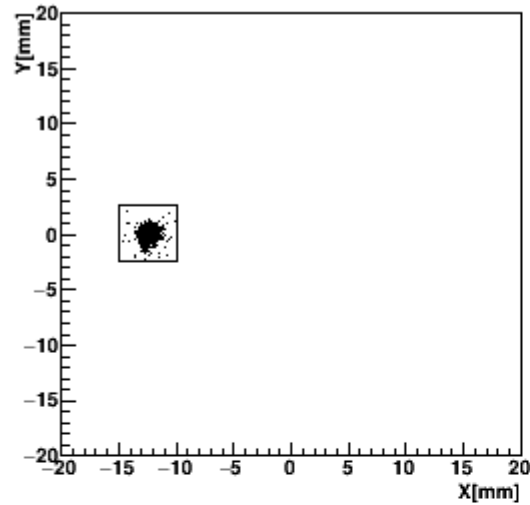
The Stability(run18)



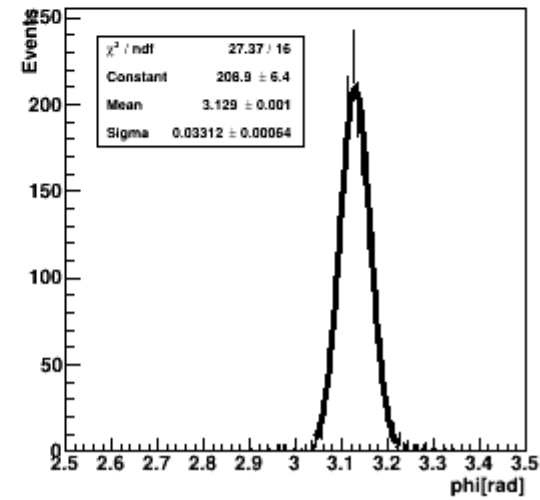
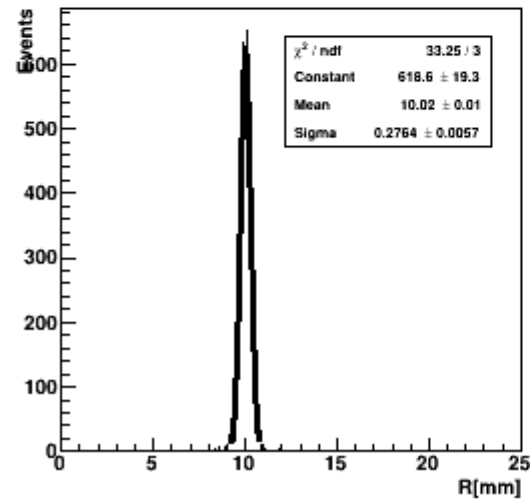
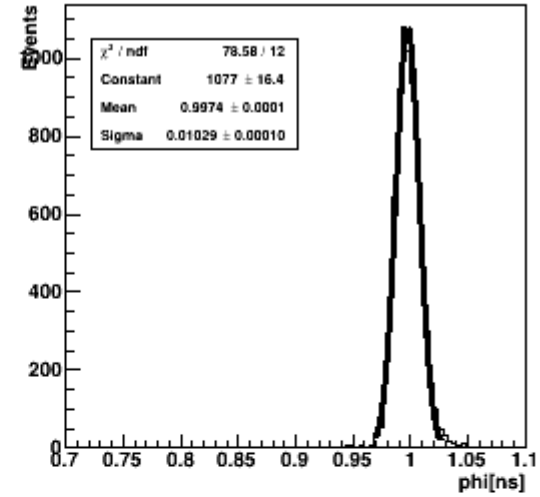
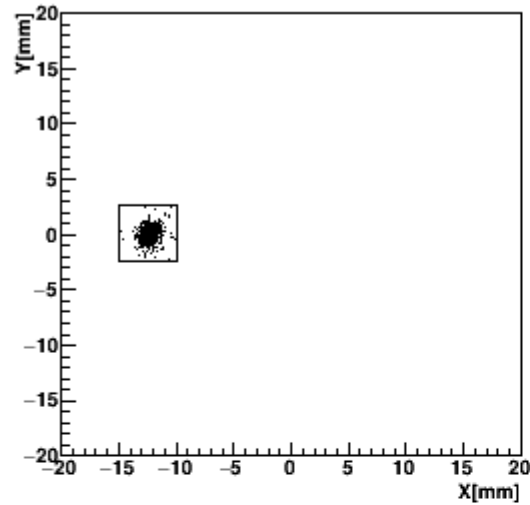
The Stability(run19)



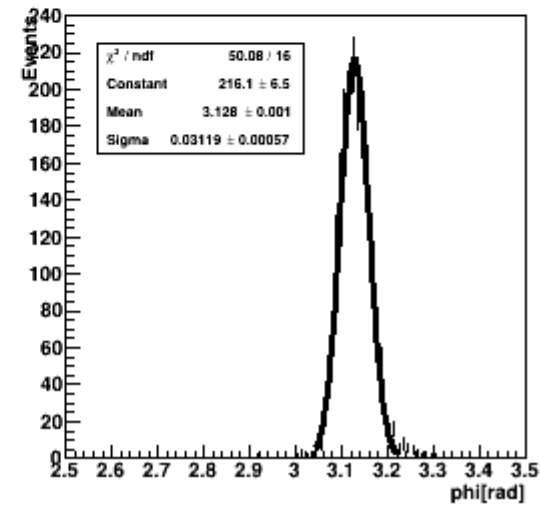
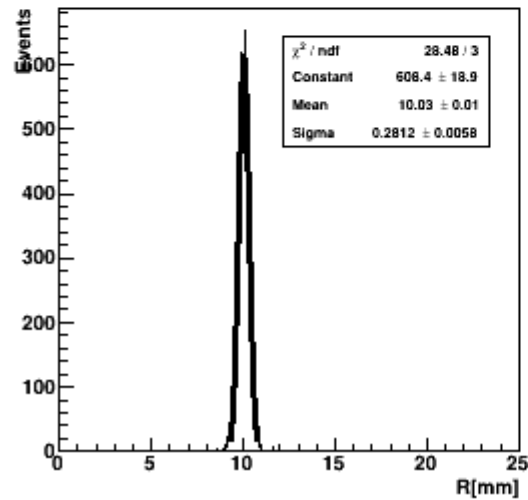
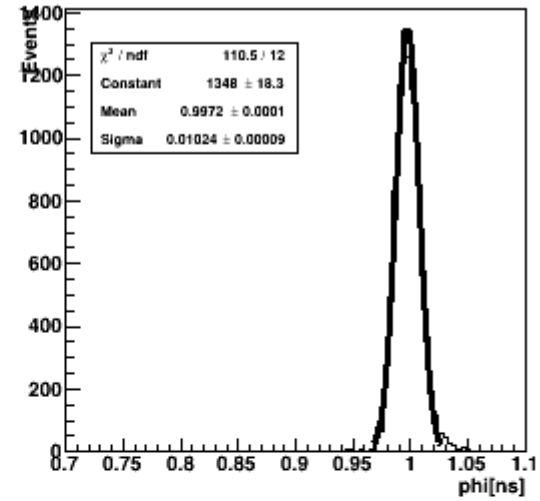
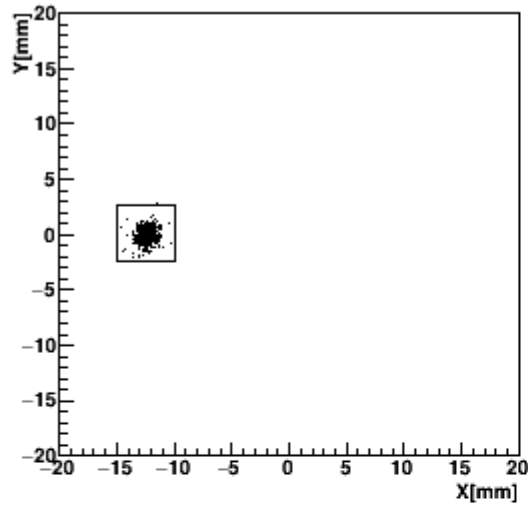
The Stability(run20)



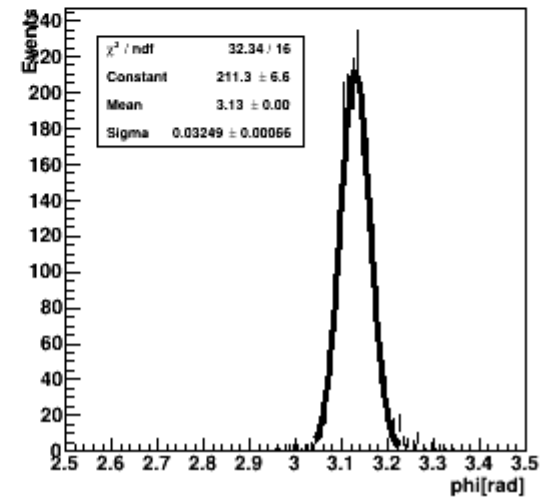
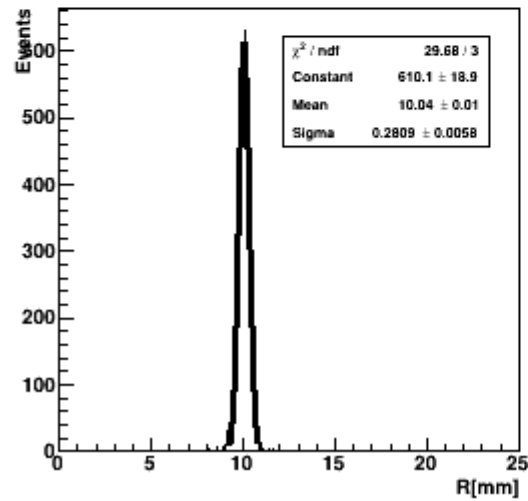
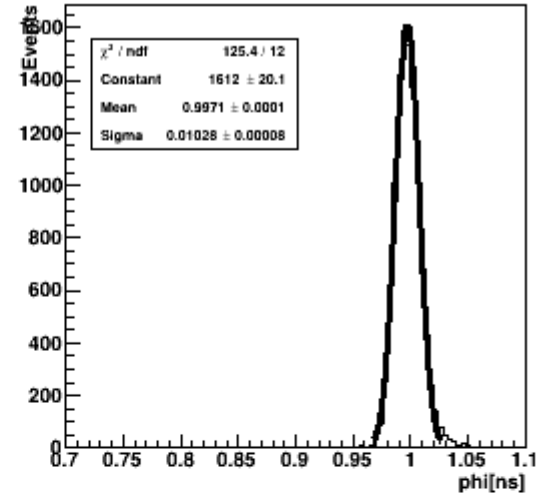
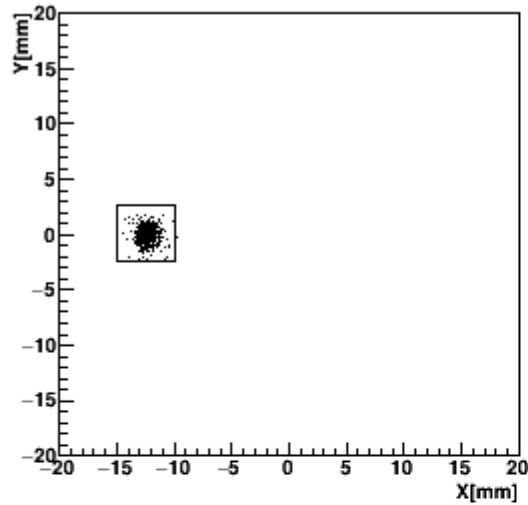
The Stability(run21)



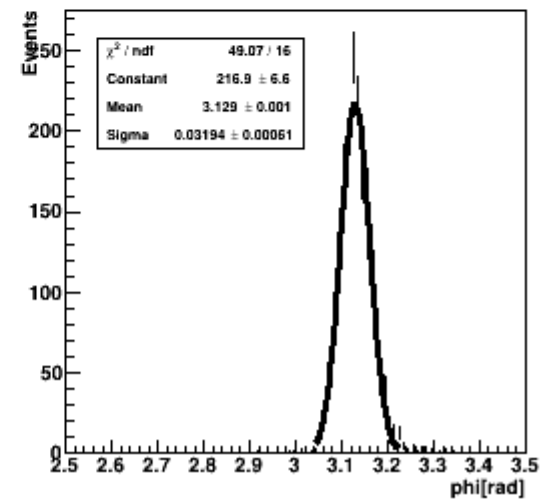
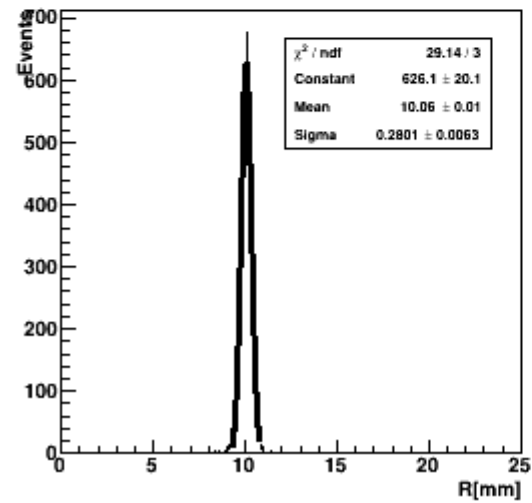
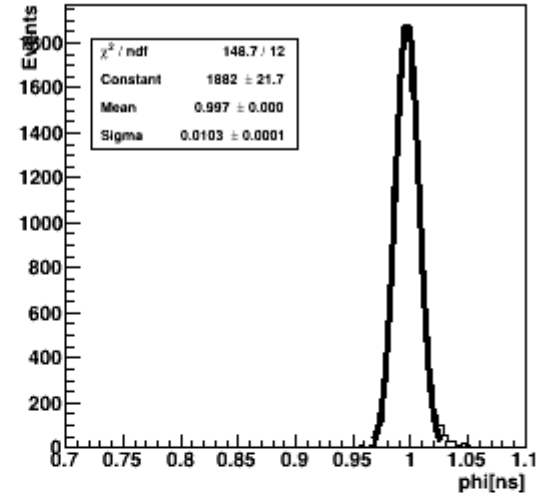
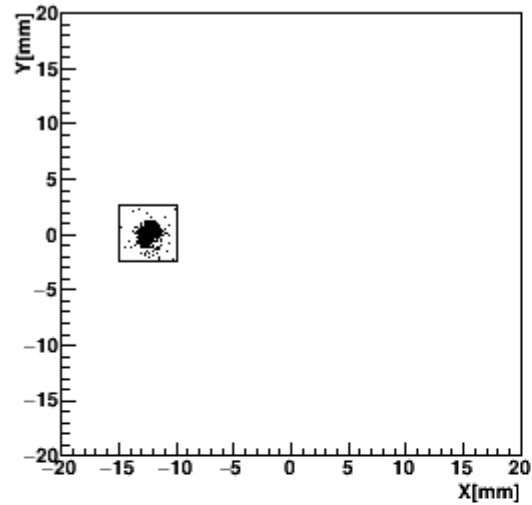
The Stability(run22)



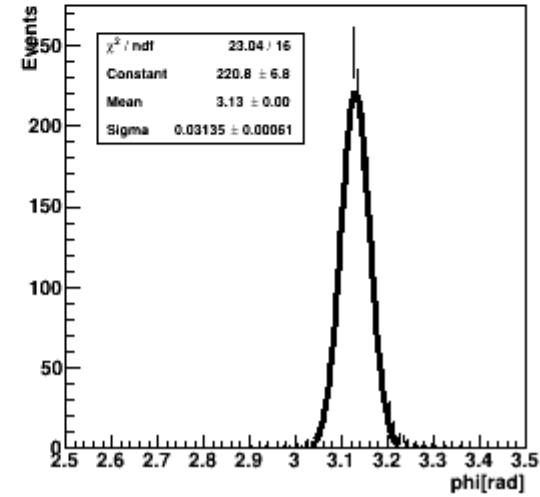
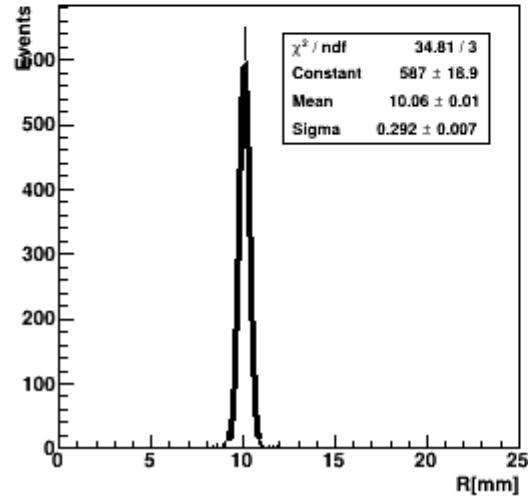
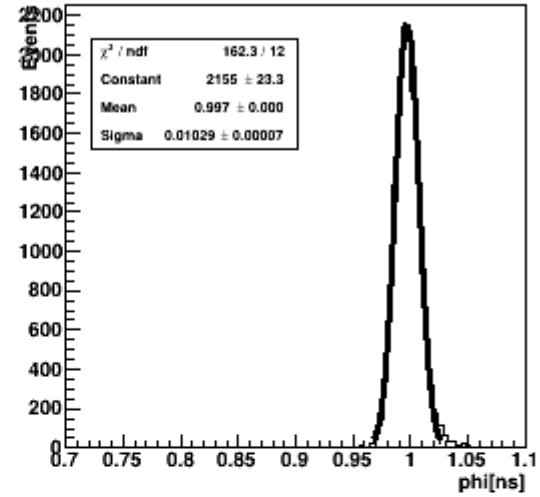
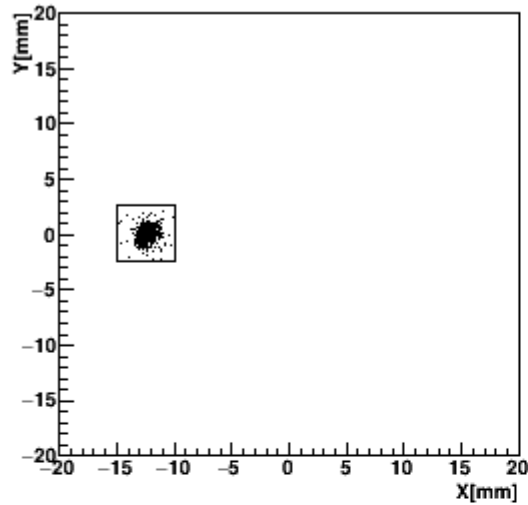
The Stability(run23)



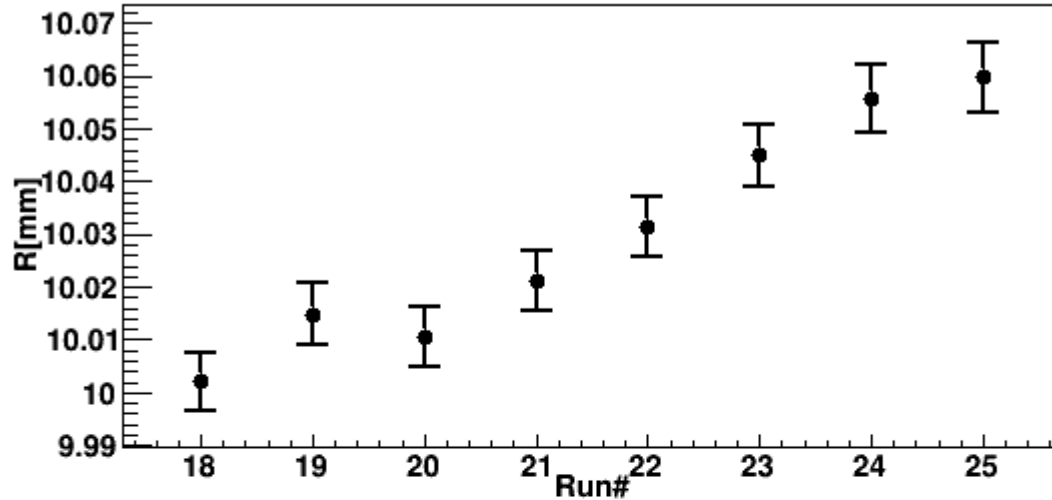
The Stability(run24)



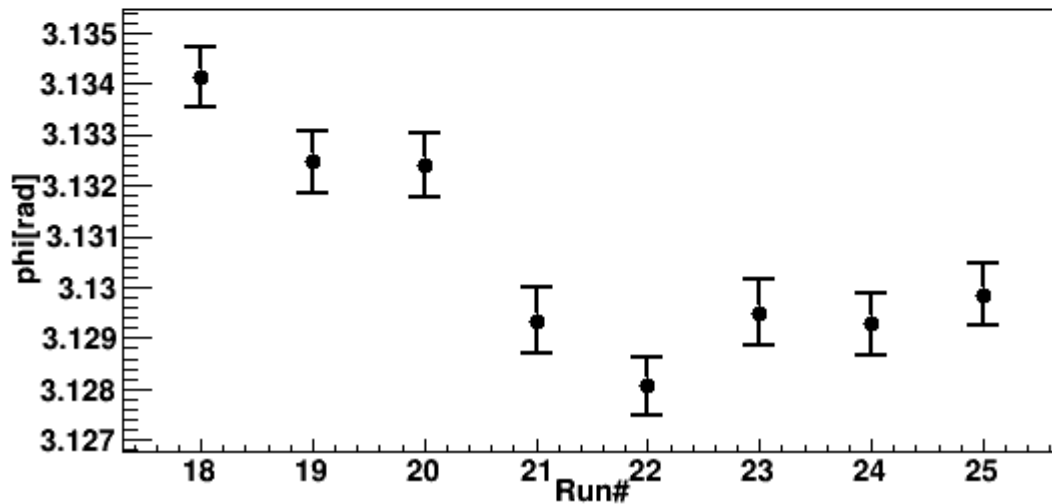
The Stability(run25)



The Stability

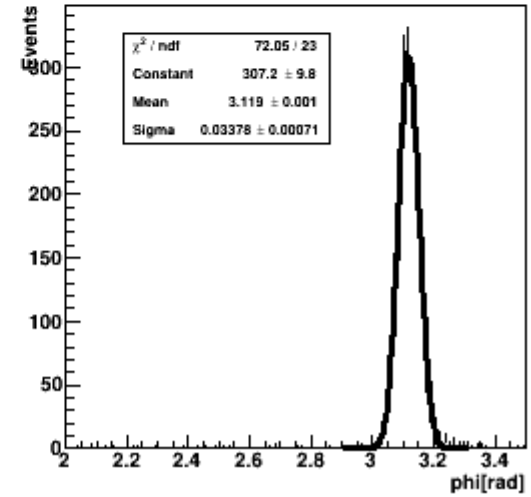
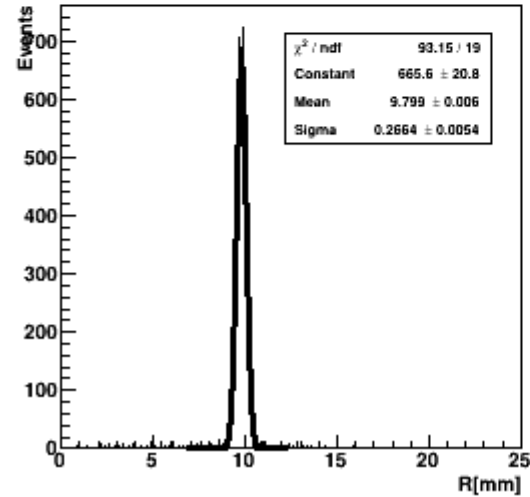
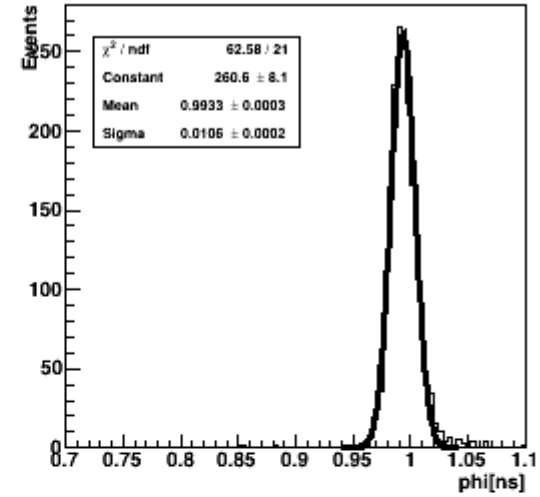
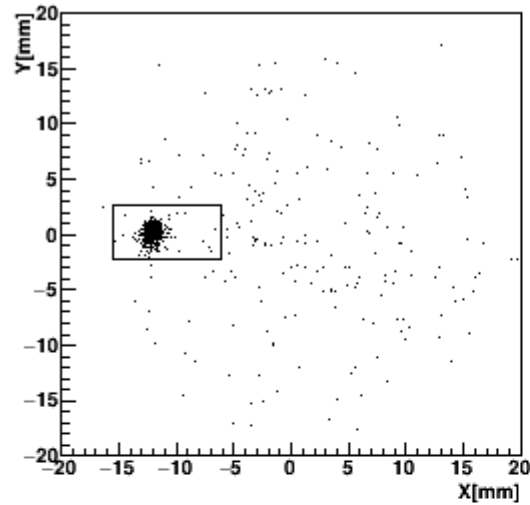


~60mm shift observed

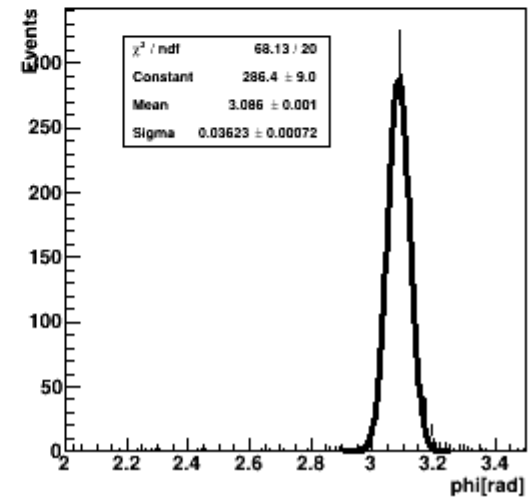
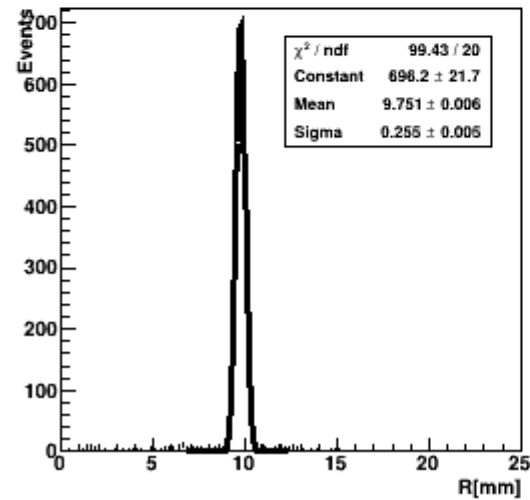
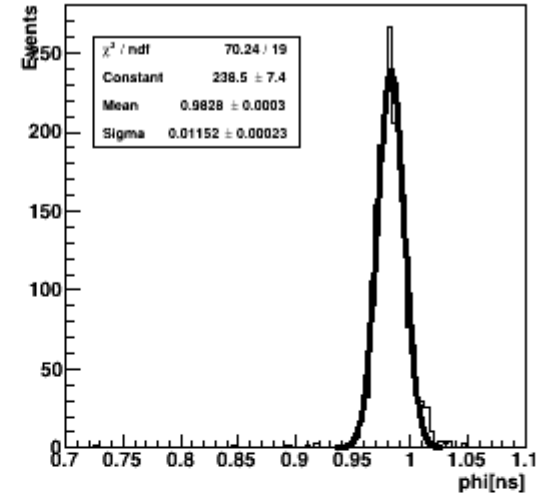
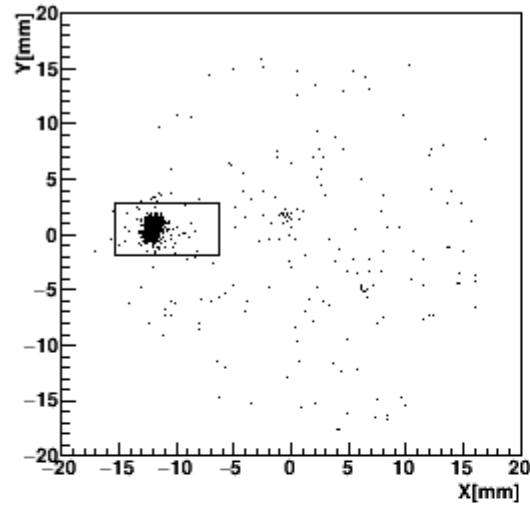


Last 4 points are good.
To be tested again!!!

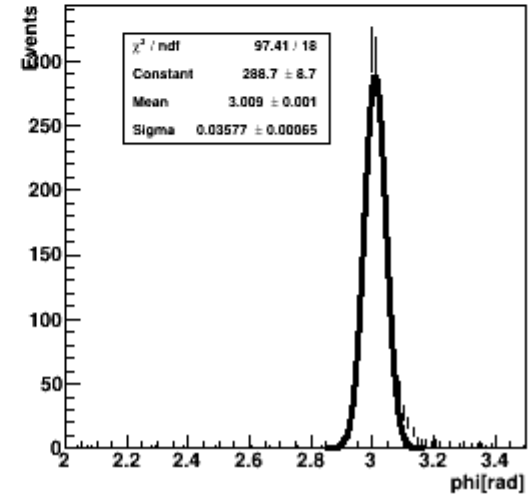
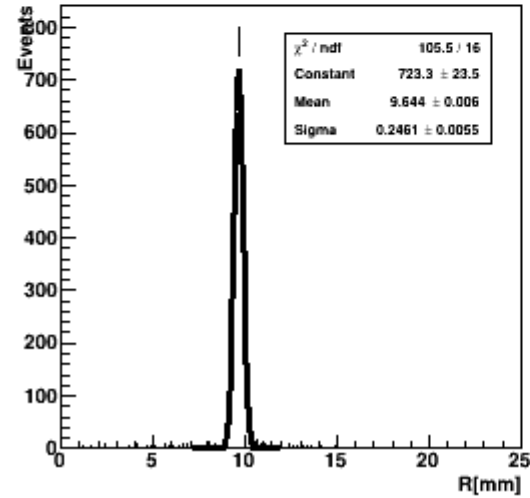
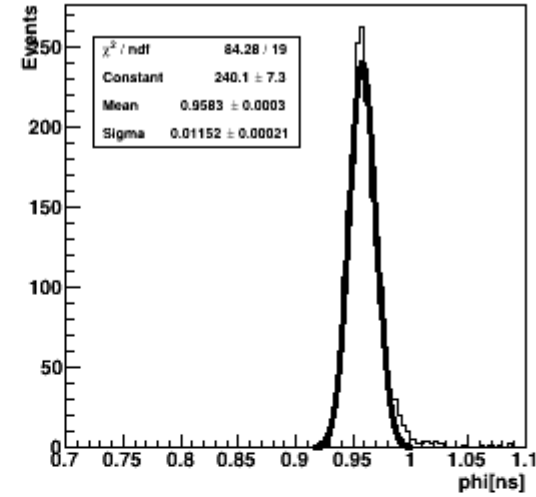
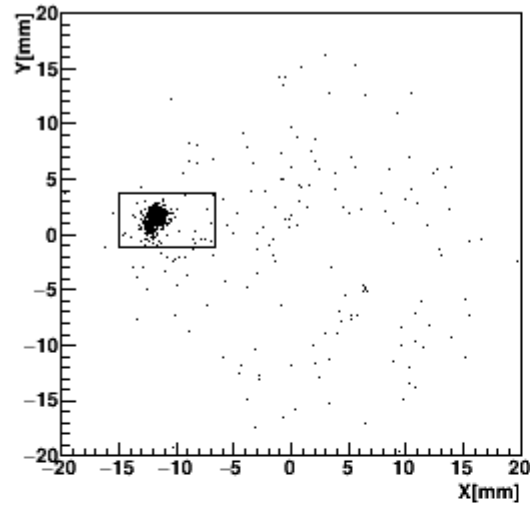
The Calibration(run5)



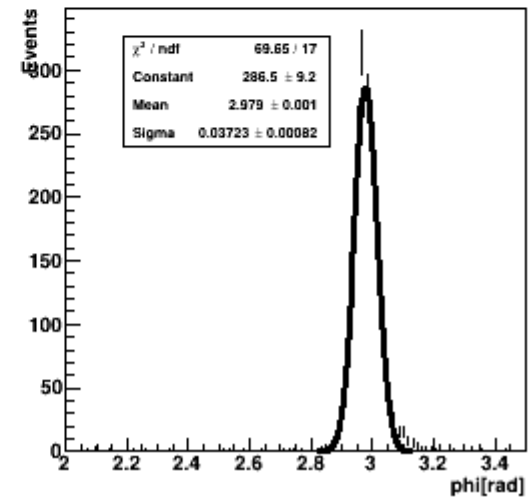
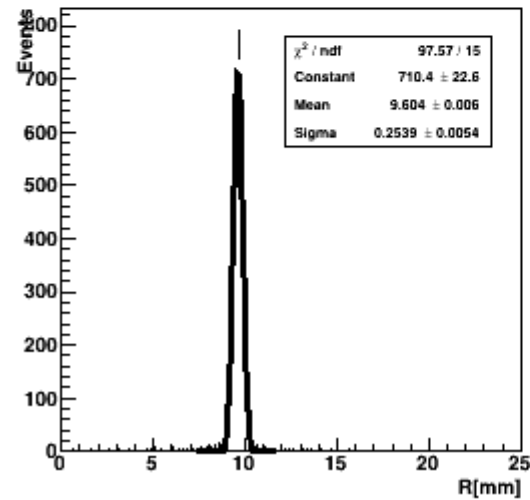
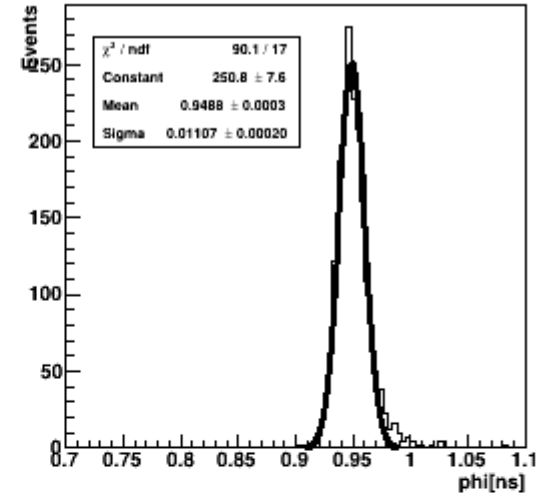
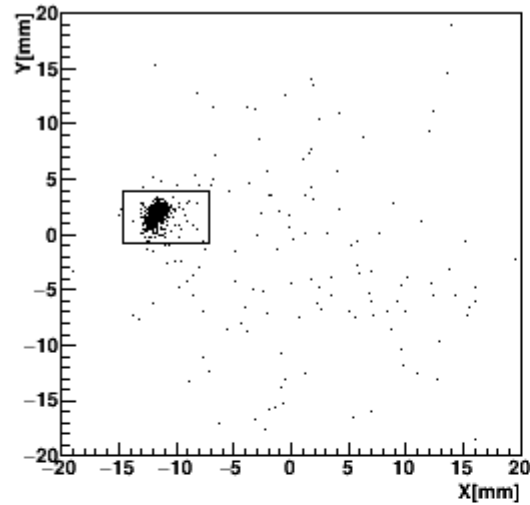
The Calibration(run6)



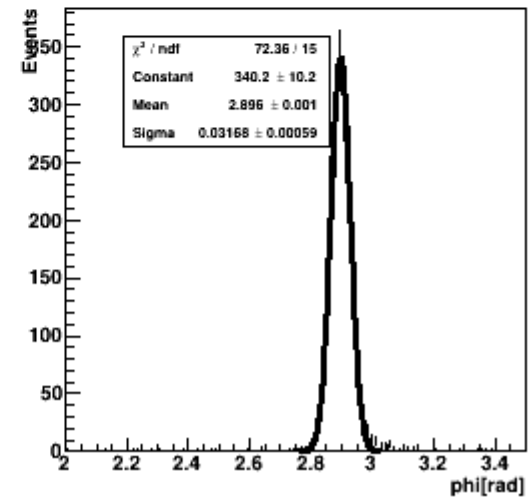
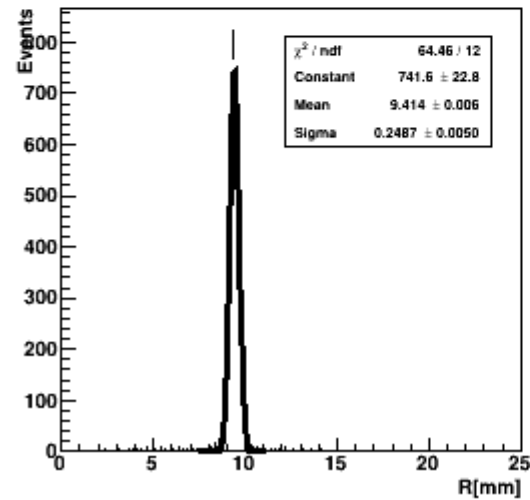
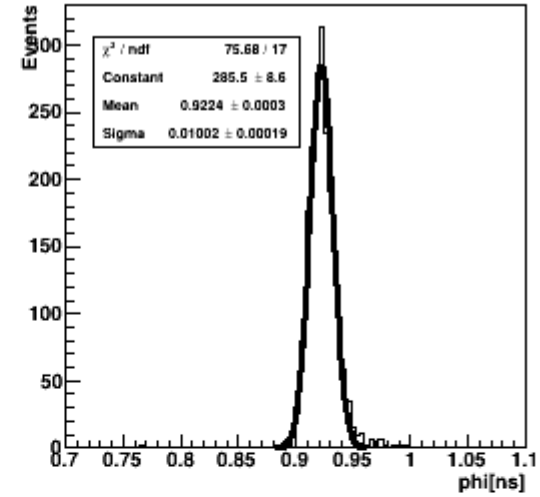
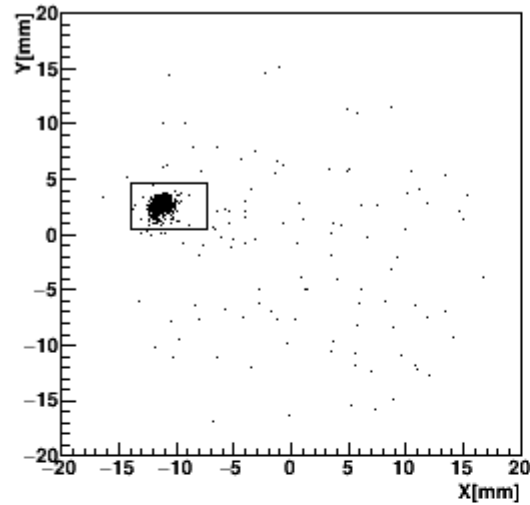
The Calibration(run7)



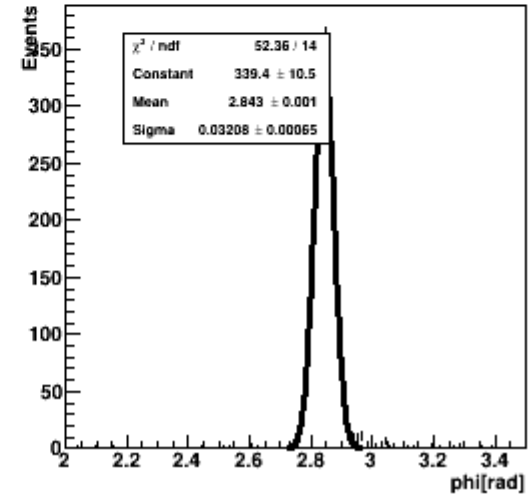
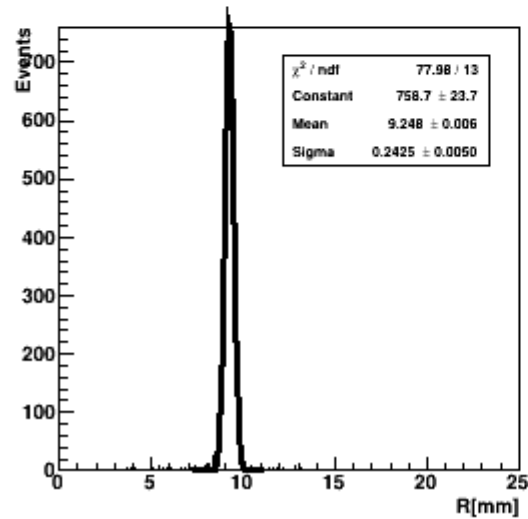
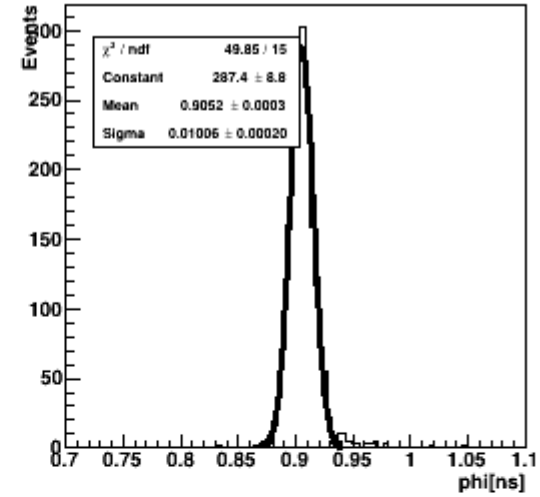
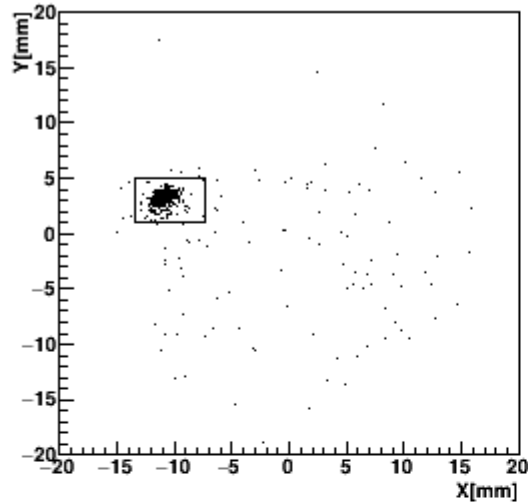
The Calibration(run8)



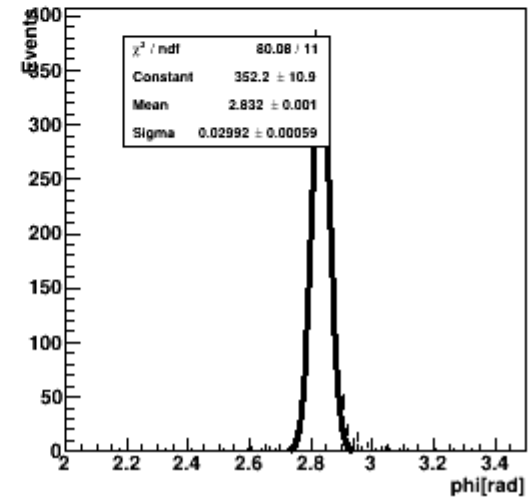
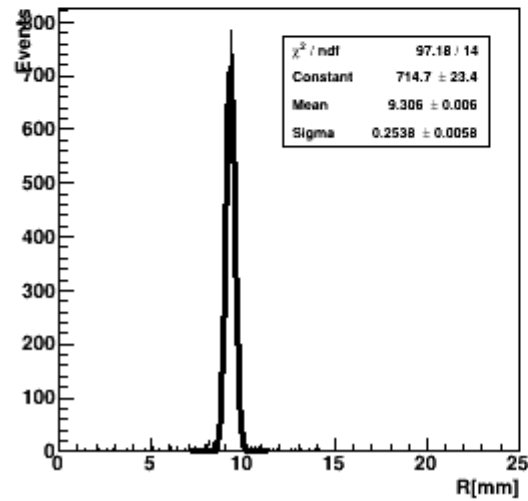
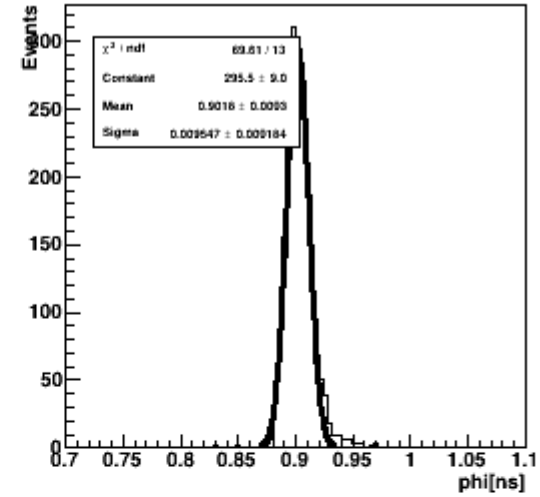
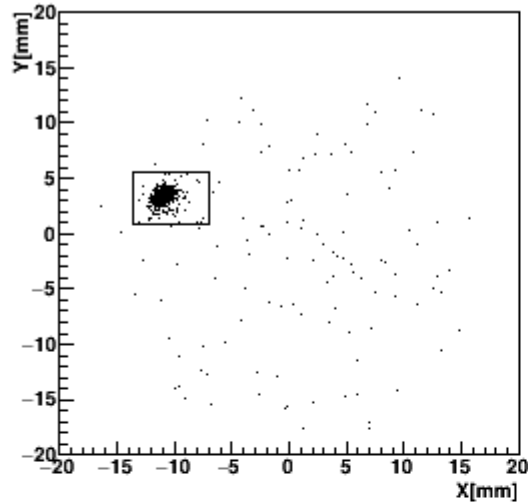
The Calibration(run9)



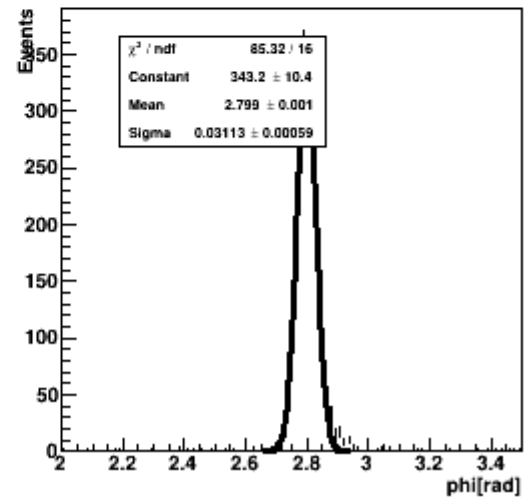
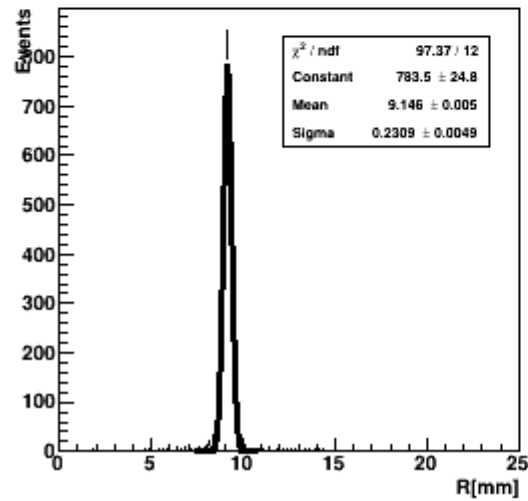
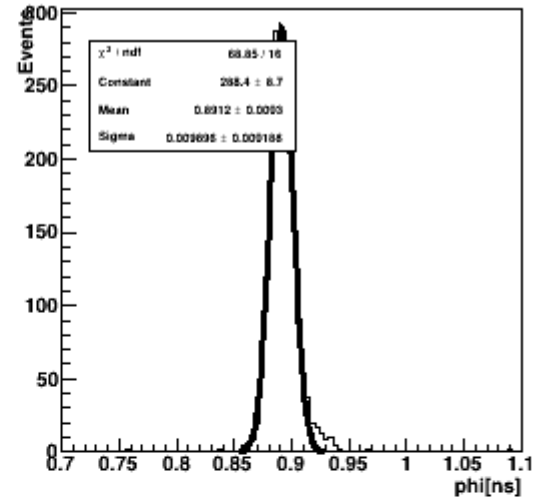
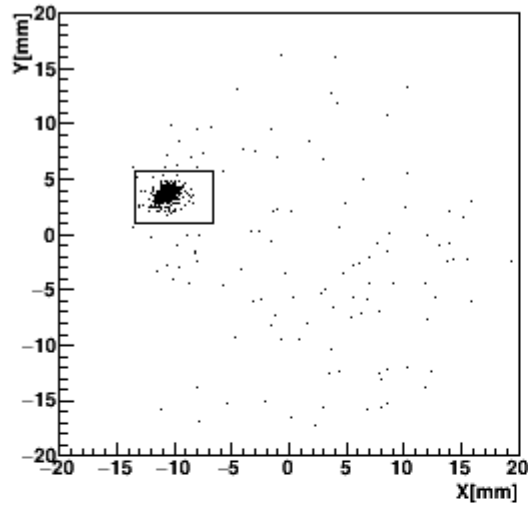
The Calibration(run10)



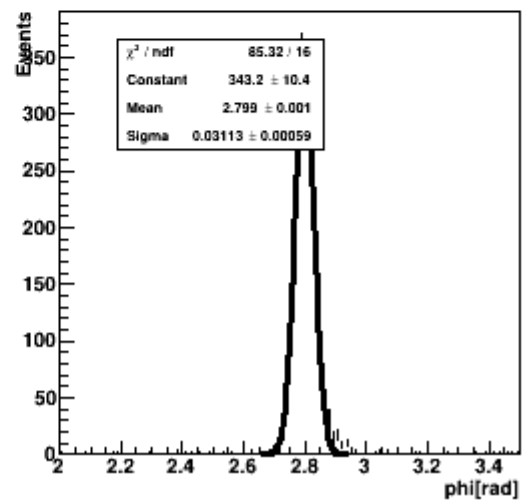
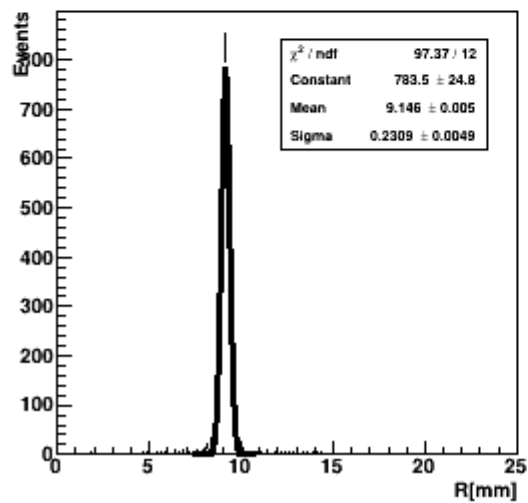
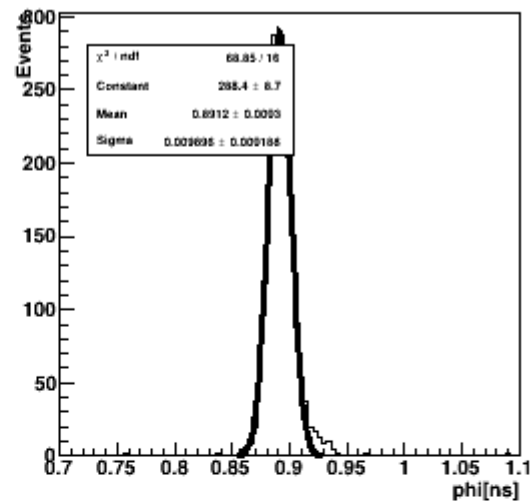
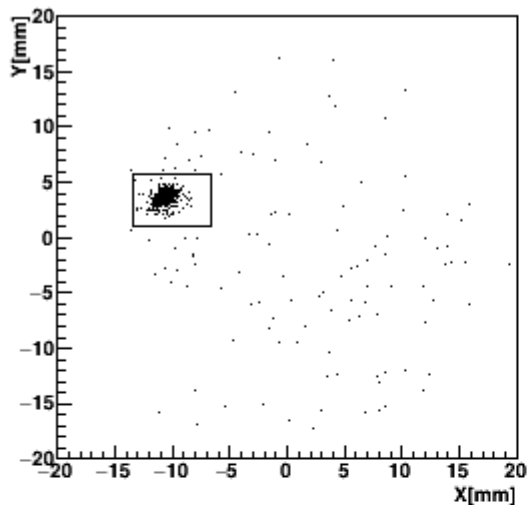
The Calibration(run11)



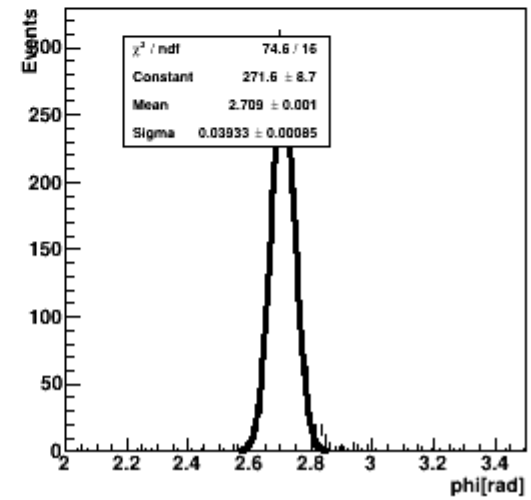
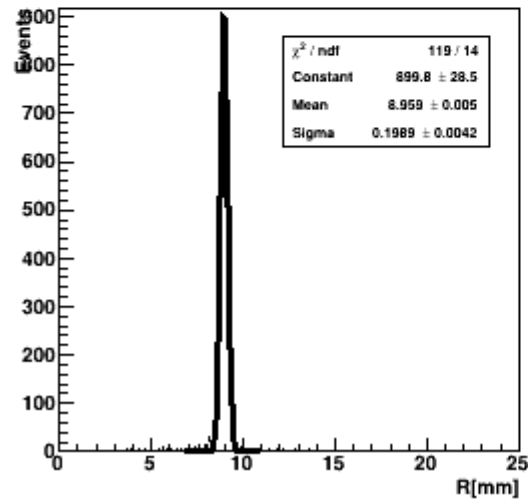
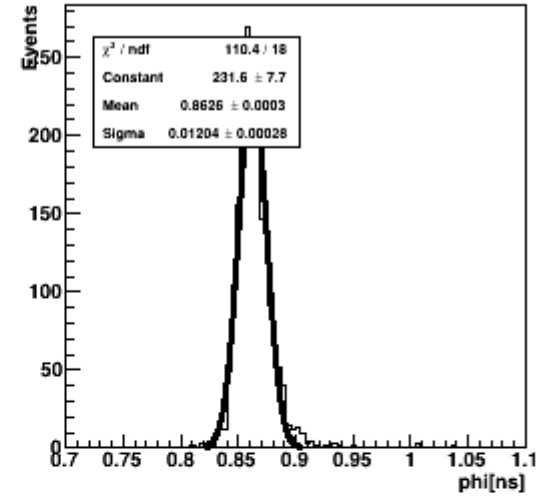
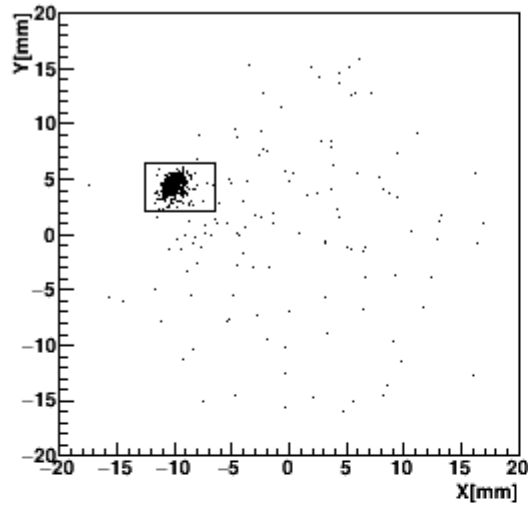
The Calibration(run12)



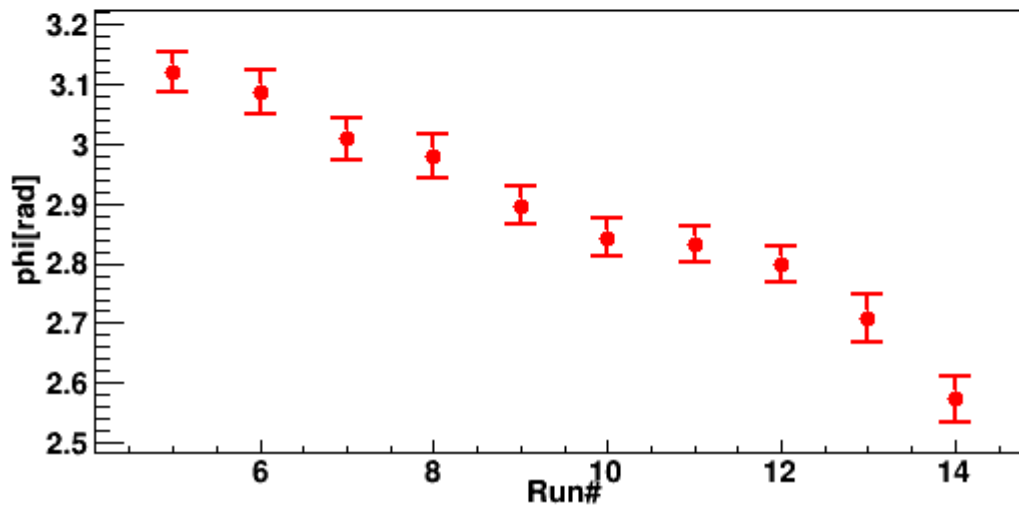
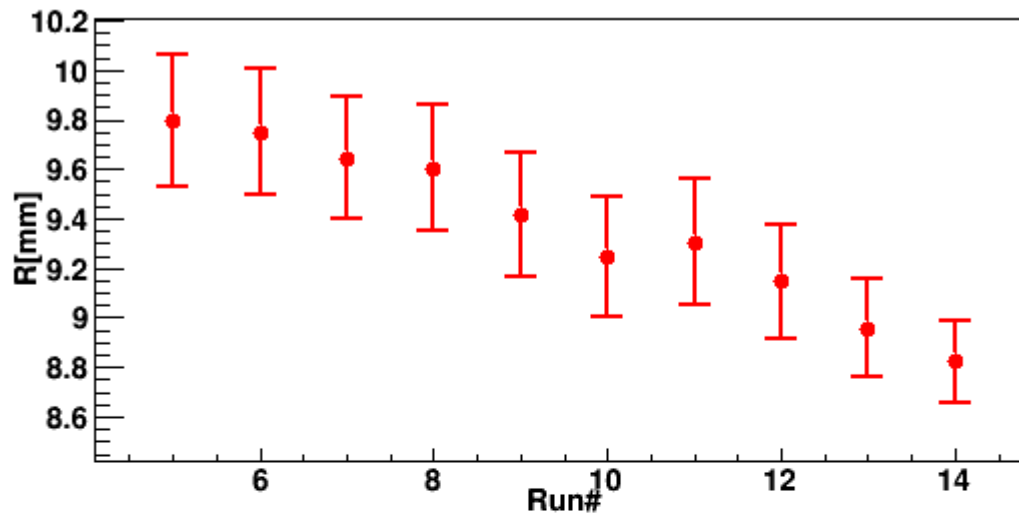
The Calibration(run12)



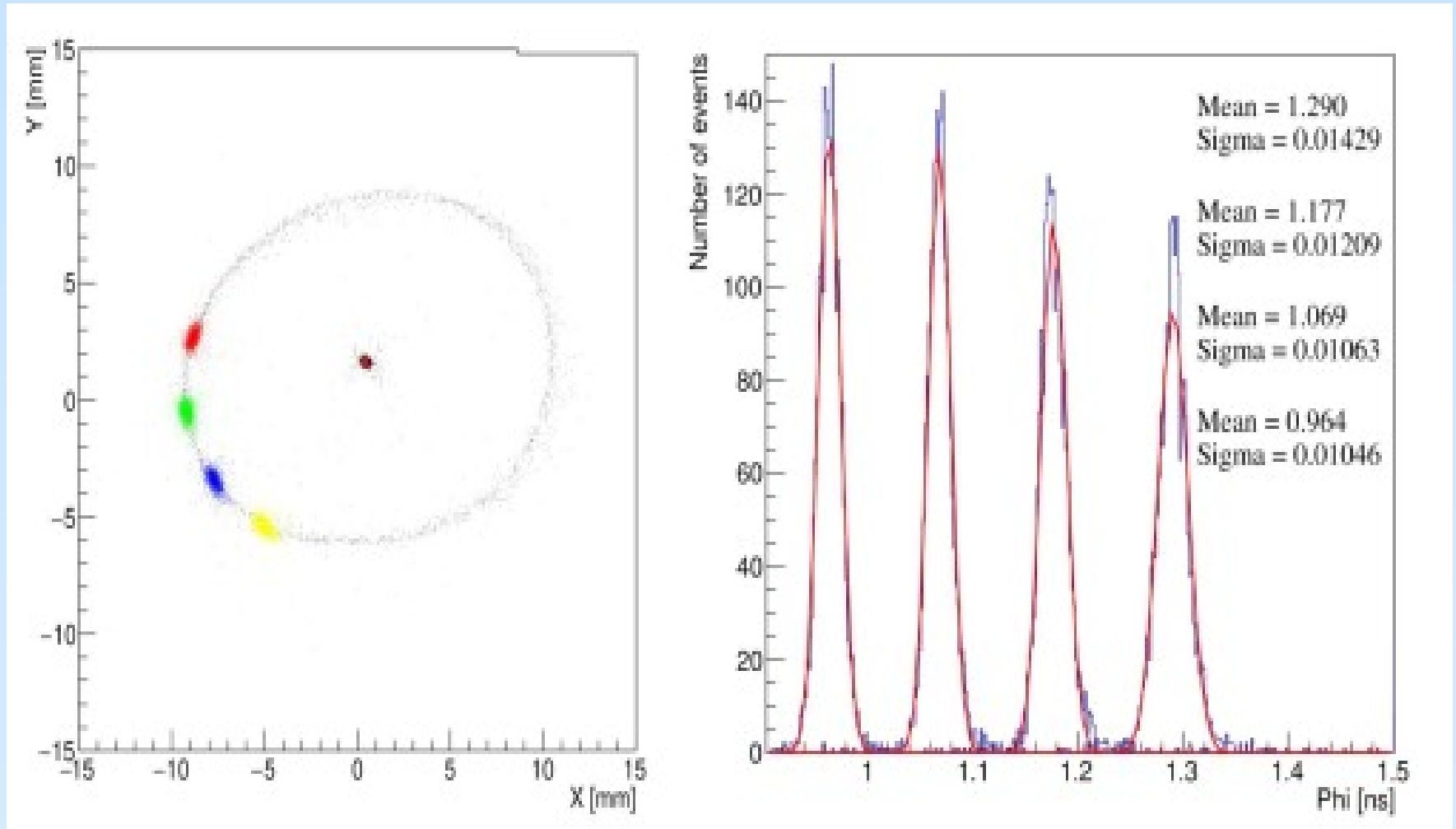
The Calibration(run13)



The Calibration



Final result from Candle



Conclusion & TODOes

**PicoSec resolution experimentally with
RFPMT achieved!!!**

TODOes

Go to FemtoSec resolution.

Optimize the Setup configuration.

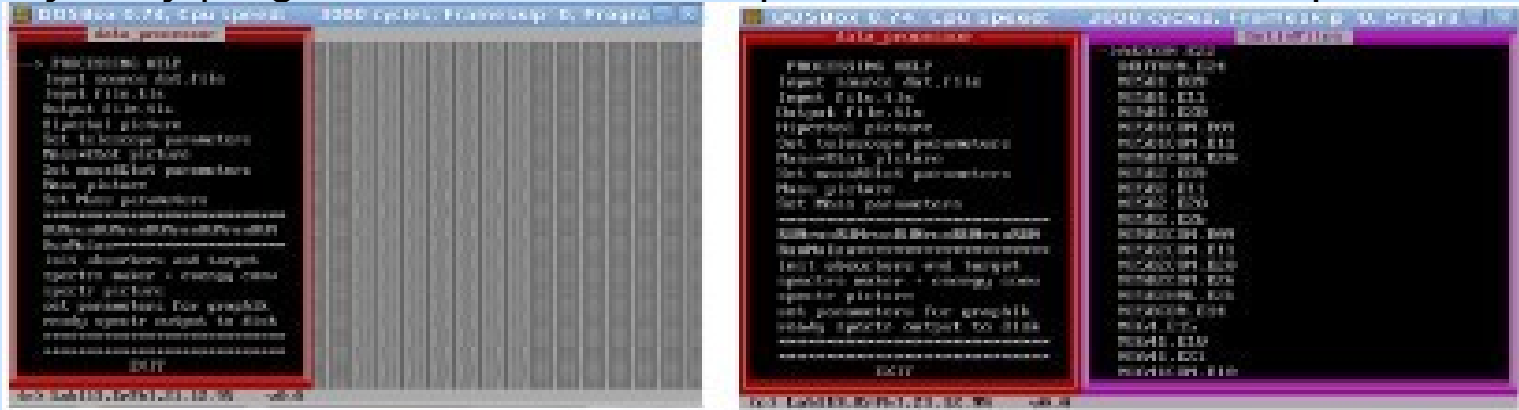
Use in possible experiments.

Many thanks to colleagues for support.

BACKUP

GUI usage prehistory

My early program "obr" for "e-A" experiment a **TUI** with turbo pascal.

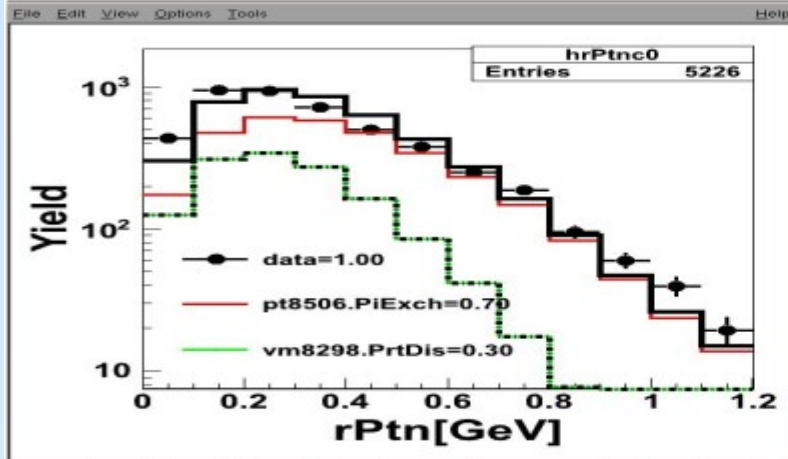
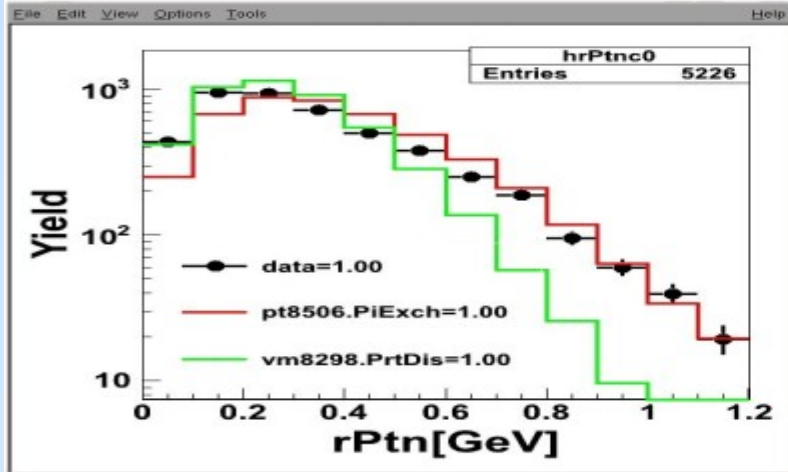


No mouse used
Only keyboard

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



ScaleKoeff10

ActiveFiles11

Functions12

OtherFunctions13

Detailed description: This is a ROOT GUI control panel. It contains several sections: 'ScaleKoeff10' with four spinners, each set to 1.00; 'ActiveFiles11' with a list of files and checkboxes: 'data' (checked), 'pt8506.PIExch' (checked), 'vm8298.PrtDis' (checked), and 'pt7640.PIExch' (unchecked); 'Functions12' with checkboxes for 'LogScale' (checked), 'ActivF' (checked), 'BagSum' (unchecked), and 'Print' (unchecked); and 'OtherFunctions13' with a dropdown menu showing 'hrPtn' and three buttons: 'Fit', 'DoffDraw', and 'Exit'.