Neutron Detector Array NAND Lesson 4

Ambar Chatterjee

- Realistic example of building neutron spectra
- Adapting the programs for your data
- Its common to just see blank spectra till you get it right!
- Try to write the programs yourself, just use my programs for guidance
- Time-shifted TDCs to be discussed next time

All the files used here are available at
http://www.ambar-chatterjee.com
Questions?
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Getting the files you need

Website: http://www.ambar-chatterjee.com

The programs from Lesson 3 are slightly modified for this example data. The modified files are in the archive nand04.tgz

Ambar Chatterjee

Work:

- Bhabha Atomic Research Centre, Mumbai (Retd.)
- MS Univ of Baroda
- Inter University Accelerator Centre, New Delhi

Websites:

- LAMPS Data Acquisition
- AIWCF Chess Server

Download lamps_offline	Click	
Chess Diagrams	App	Online
ROOT Videos YouTube	Click	
Neutron Array YouTube	Click	

Videos

NAND Lesson 1	MWPC Slicing, Angle Calculations	Click
NAND Lesson 2	Structured ROOT programs	Click
NAND Lesson 3	Building Neutron Spectra	Click

Support Files

NAND Lesson 1	nand01.tgz	
NAND Lesson 2	IUAC_NAND_data.001	nand02.tgz
NAND Lesson 3	nand03.tgz	
NAND Lesson 4	nand04.tgz	

Details of the example data for today's lesson

File: MySampleData.root   442.6 MB (not provided in website)

Data was taken in LAMPS system not RoseNIAS.
Tree name is LampsTree.

Parameters are **int**, not **double**.

There were 50 neutron detectors defined of which 1 was not in use.

Individual TDC calibrations for all the neutron detectors were done
Calibration slope values (ns/channel) will have to be placed in a file.
Calibration intercept is not important.

Dimesion of the MWPC is 11cm (horizontal) x 16cm (vertical)
(Height is more than width)

Calibration of the MWPC is generally done in the detector lab before the experiment

Adapting Prog001.cpp (run as a compiled program)

Only change is in the name of the root data file and the name of the Tree.
After running the program ParaList.txt is produced.

Edit ParaList.txt by hand

Remove unwanted parameters and reorder . Remove all unused parameters.

Detector 8135 is missing. Remove TOF8135, PSD8135
NDet becomes 49 instead of 50

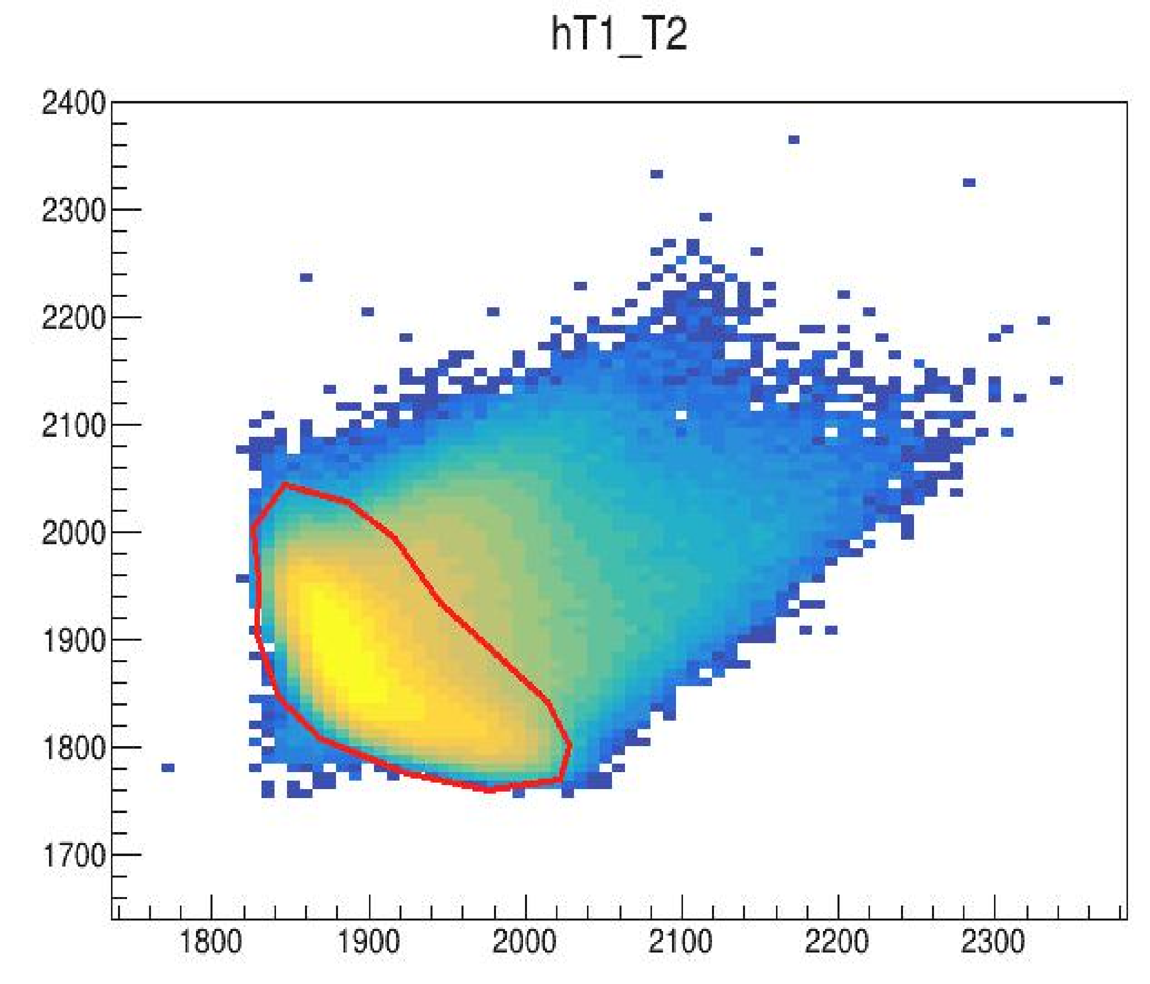
No need to adjust the indexes of P[ ] in all the programs except that MWPC1 (not MWPC2) is at forward angle.

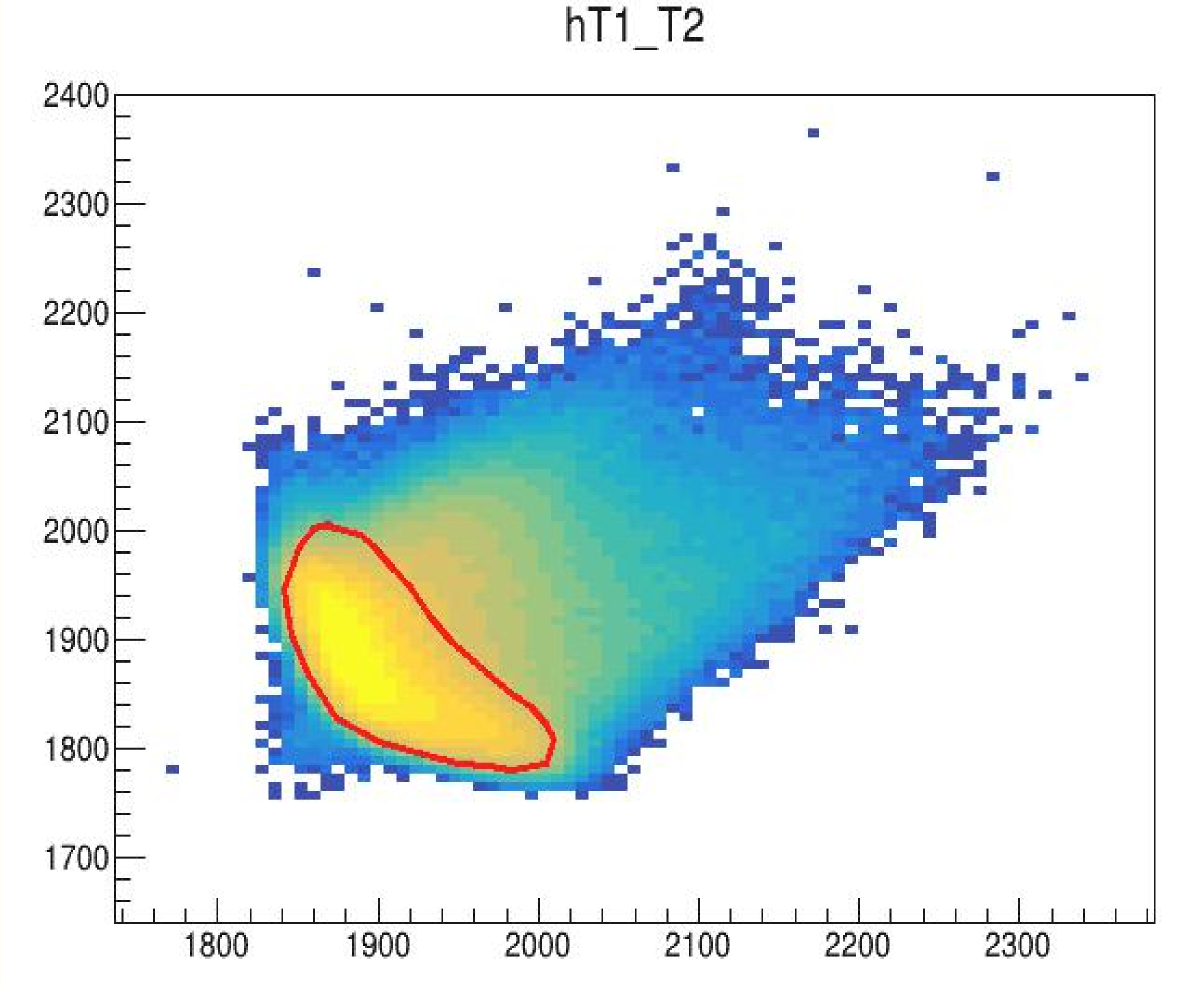
Adapting Prog002.cpp (run as a Macro)

Create FileList.txt with MySampleData.root
Examine the data. Leaves are type **int** instead **of double**
Replace **double** `P[MAX_PAR]` with **int** `P[MAX_PAR]`
Change the tree name: TChain MyChain("LampsTree");
Insert status print in Entries loop
Use <chrono> timer
Run as Macro ($ root Prog002.cpp) then:
Draw the CUTG for fission

```
CUTG -> SetName("CutT1_T2");
Tf = new TFile("Work.root","recreate");
CutT1_T2 -> Write();
Tf -> Close();
.q
```

Drawing CutT1_T2





CORRECT

Looses statistics, but no other problem

Prog002a.cpp (run as compiled program)

A new program to ensure we are on the right track

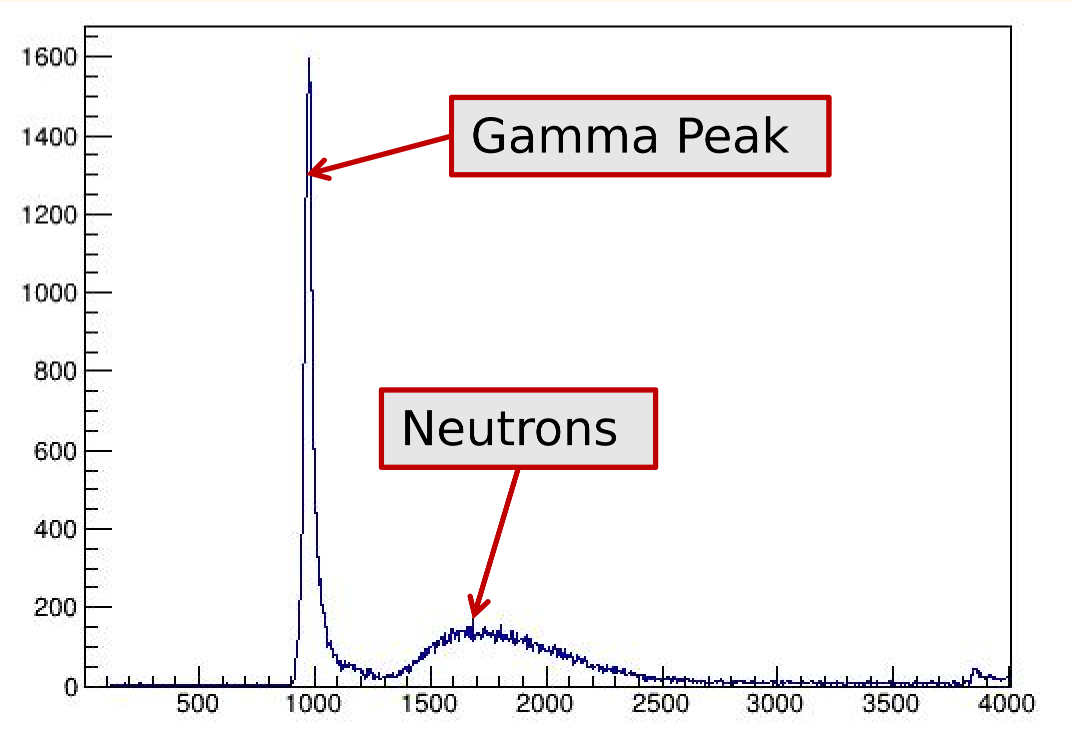
Displays all the 49 TOF spectra

NDet=49 h[j]->Fill(P[2*j+11])

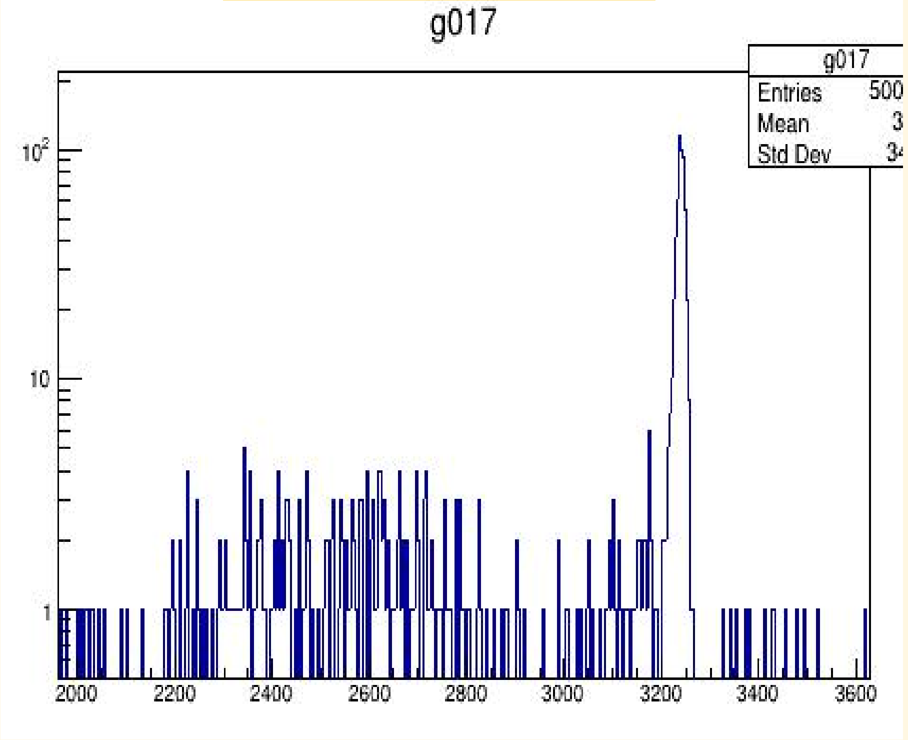
Only 1 thing I want to explain:

Line 86: `h[i]->SetAxisRange(10.,4000.,"X"); h[i]->Draw();`

With the present data



In Lesson 2 / 3



Execution Speed

Event Loop execution

As a compiled program: 87.8 s , 118 KEvts/s

Run as a macro: 172.2 s , 60 KEvts/s

Compiled programs run about twice as fast as macros

Adapting Prog003.cpp (run as a compiled program)

Prog003.cpp bulids all the TOF spectra, determines the gamma peak position and saves the results in gPos.txt

Change: `NDet=49`   Tree name: `LampsTree`
Change double P[MAX_PAR] to int P[MAX_PAR]
Line 87: Change `SetRangeUser(2000,4000)` to `SetRangeUser(300,3000)`

Add: Progress printf line
Add: <chrono>

Adapting Prog004.cpp (run as compiled program)

Build all PSD vs TOF and save in Work.root so that later we can draw the neutron selection graphical cuts.

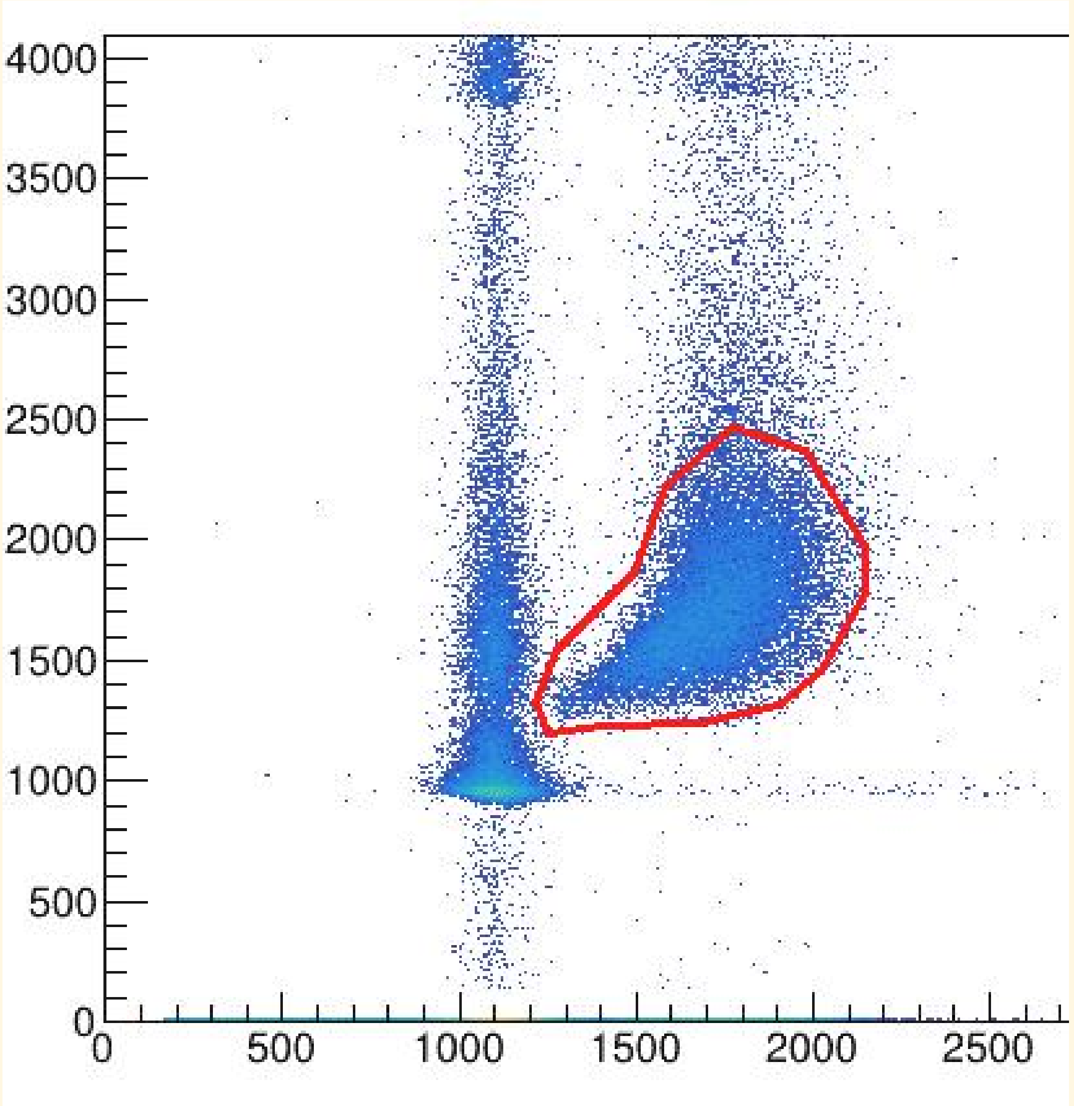
Change: `NDet=49`   Tree name: `LampsTree`
Change double P[MAX_PAR] to int P[MAX_PAR]

Add: Progress printf line
Add: <chrono>

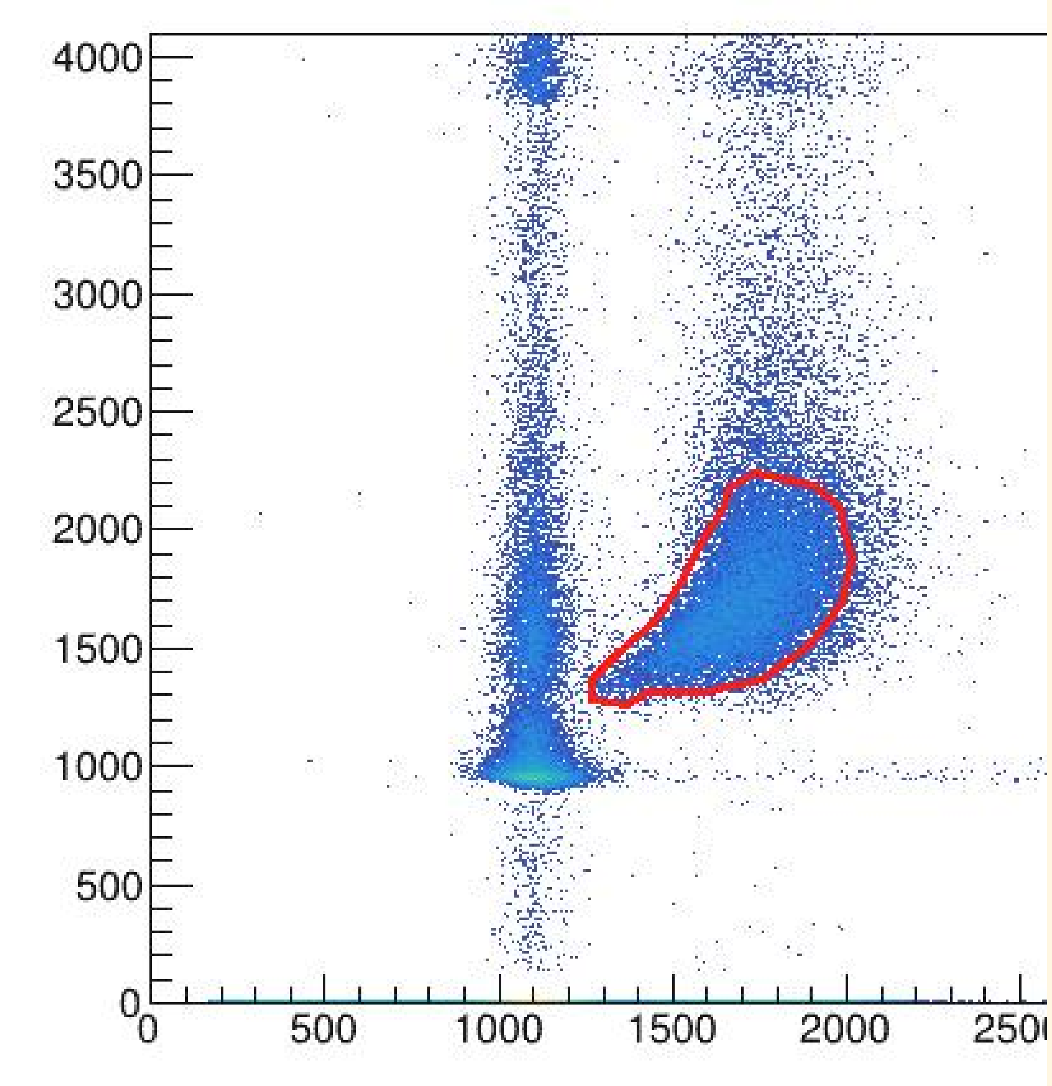
From ROOT command line
Save all the neutron selection cuts

```
TFile *Tf = new TFile("Work.root","update");
TH2S *h=(TH2S *)Tf->Get("h001");
h->Draw("COLZ"); gPad->SetLogz(1);

//Now draw the TCut on the canvas
CUTG->SetName("CutN001"); CutN001->Write();
//Then repeat for all the detectors
. . . .

Tf->Close();  //At the end
.q
```

Drawing the Neutron Selection Cuts



CORRECT

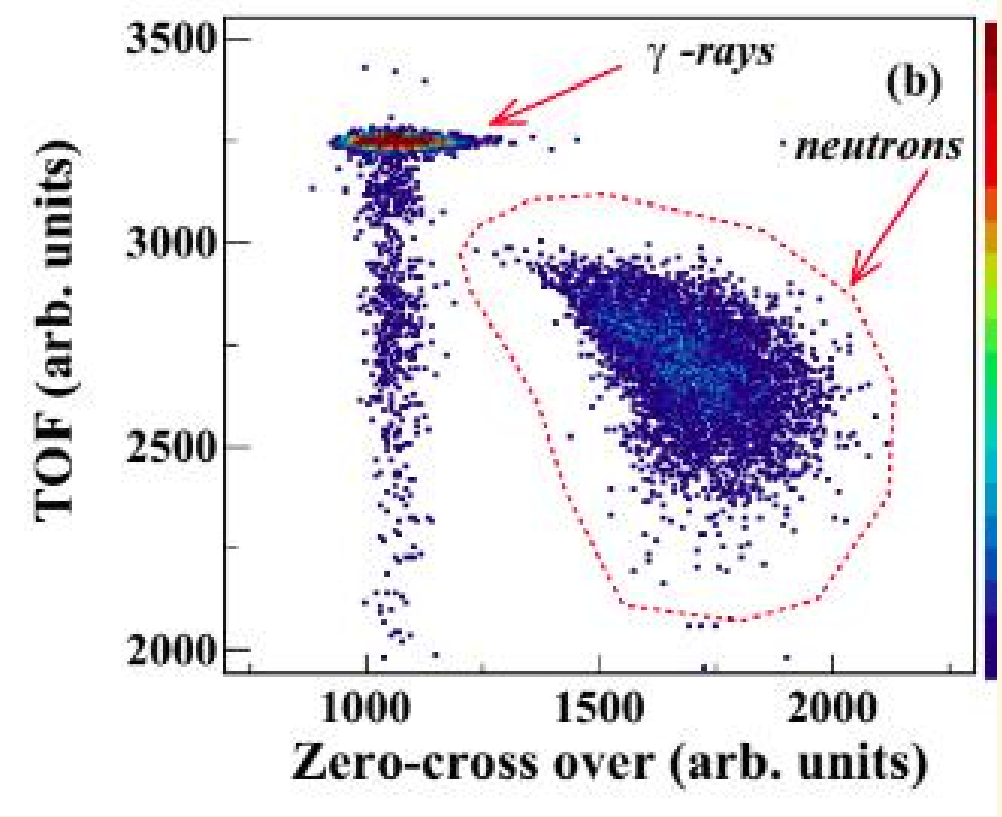


WRONG

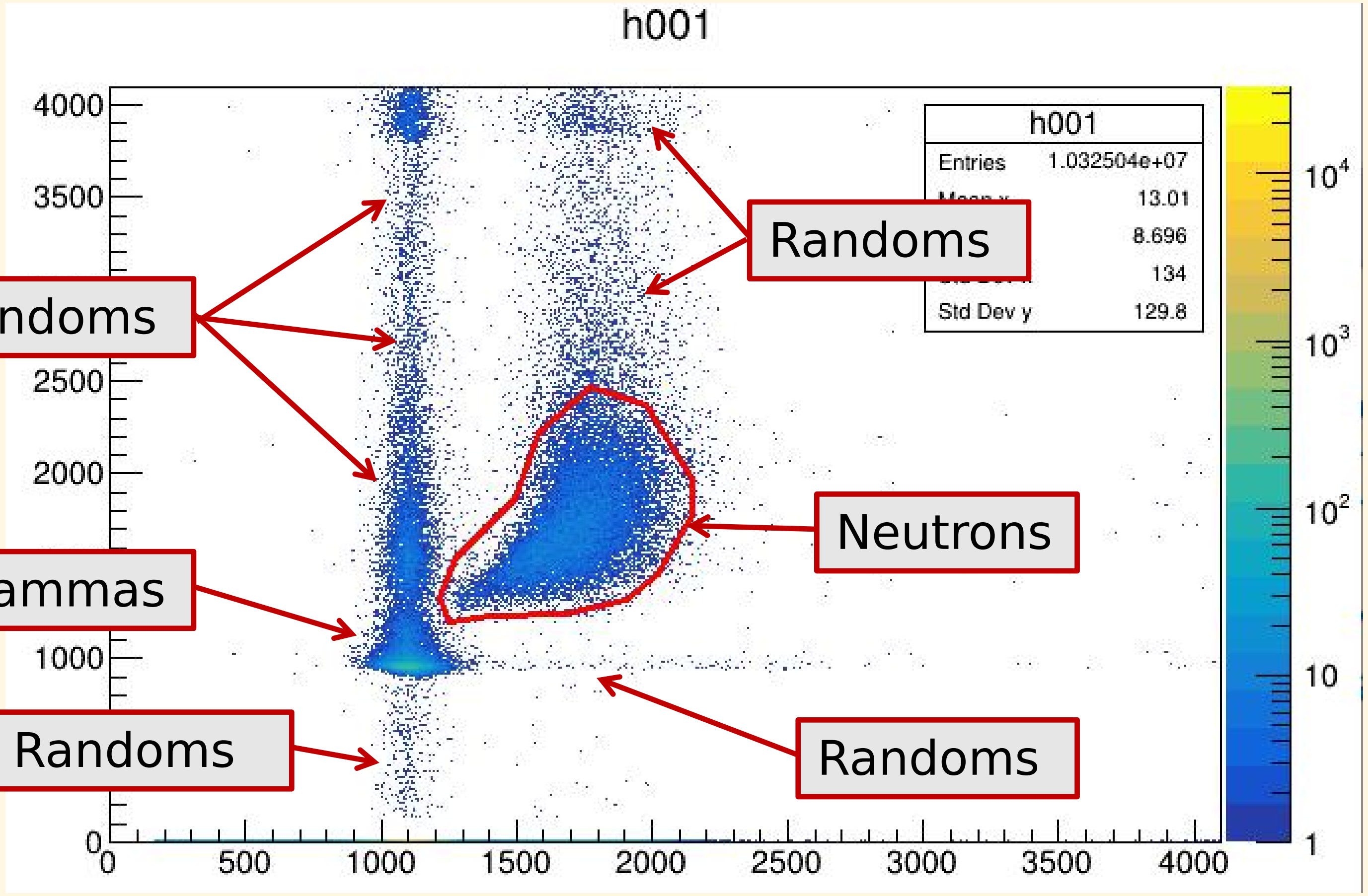
Will result in incorrect low neutron multiplicity!

Changed from earlier

In Lesson 2 / 3



With the present data



Adapting Prog005.cpp (run as compiled program)

Display the 2d position spectrum of MWPC1 (here MWPC1 was at forward angle)
Tree name: `LampsTree`
Change double P[MAX_PAR] to int P[MAX_PAR]
Change values of Mx, Cx, My, Cy calibration of MWPC

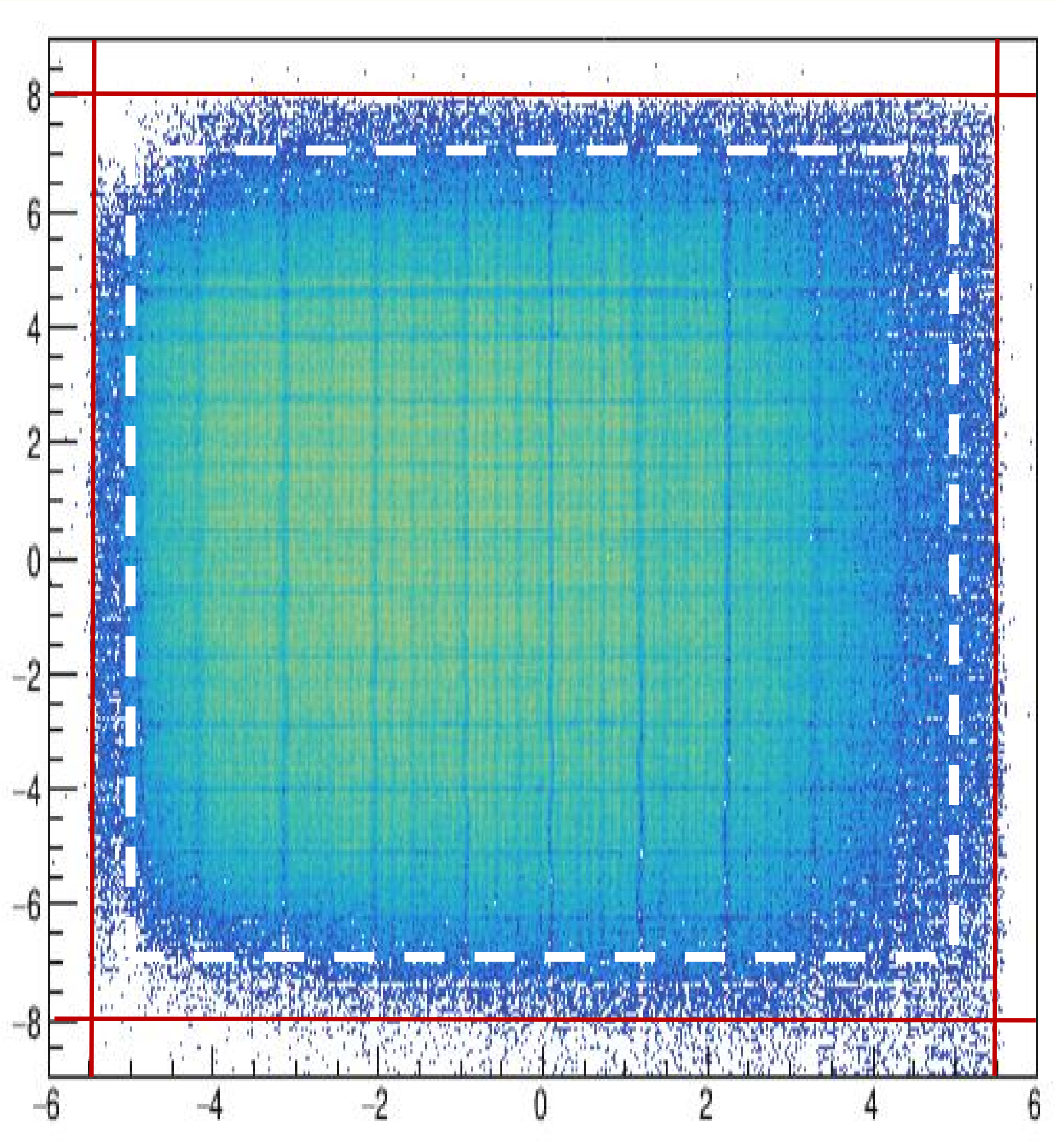
lines 69-71: Constructors of histograms:
Change the x and y ranges according to detector dimensions (11cm x 16cm)

Lines 82-83: Change P[ ] indices for MWPC1 instead of MWPC2
Left-Right reversal: MWPC1XR - MWPC1XL according to as decided

```
x_MWPC=Mx*(P[3]-P[2])+Cx;          //MWPC1XR - MWPC1XL
y_MWPC=My*(P[4]-P[5])+Cy;          //MWPC1YU - MWPCYD
```

Add: Progress printf line
Add: <chrono>

Calibrated 2d Histogram of Fission Events in MWPC1 11cm (X) x 16cm (Y)

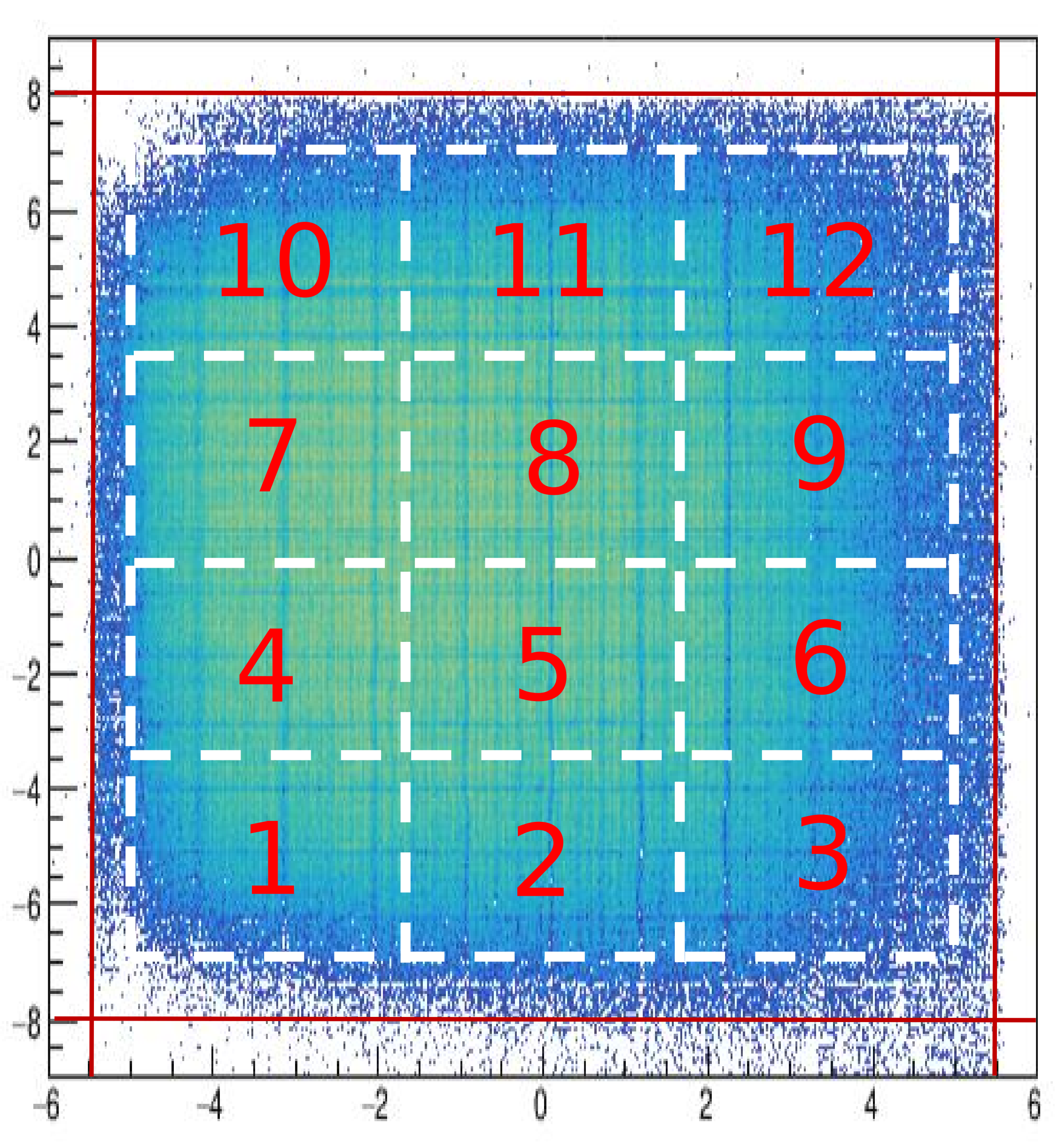


Avoid edges where signals may not be proper.

Instead of X from -5.5 to 5.5 cm and Y from -8 to 8 cm, take as full acceptance:

-5cm < X < 5cm
-7cm < Y < 7cm

Divide in 12 slices but 3 x 4 instead of 4 x 3



Slice 1: -5.00<x<-1.67, -7.0<y<-3.5
Slice 2: -1.67<x< 1.67, -7.0<y<-3.5
Slice 3: 1.67<x< 5.00, -7.0<y<-3.5

Slice 4: -5.00<x<-1.67, -3.5<y<0.0
Slice 5: -1.67<x< 1.67, -3.5<y<0.0
Slice 6:   1.67<x< 5.00, -3.5<y<0.0

Slice 7: -5.00<x<-1.67, 0.0<y<3.5
Slice 8: -1.67<x< 1.67, 0.0<y<3.5
Slice 9:   1.67<x< 5.00, 0.0<y<3.5

Slice 10: -5.00<x<-1.67, 3.5<y<7.0
Slice 11: -1.67<x< 1.67, 3.5<y<7.0
Slice 12:   1.67<x< 5.00, 3.5<y<7.0

Adapting Prog006.cpp (run as compiled program)

Display 12 slices
Tree name: `LampsTree`
Change double P[MAX_PAR] to int P[MAX_PAR]
Change values of Mx, Cx, My, Cy calibration of MWPC
Prepare/Modify SliceData.txt 3 x 4

line 100: Constructors of histograms:
Change the x and y ranges according to detector dimensions (11cm x 16cm)

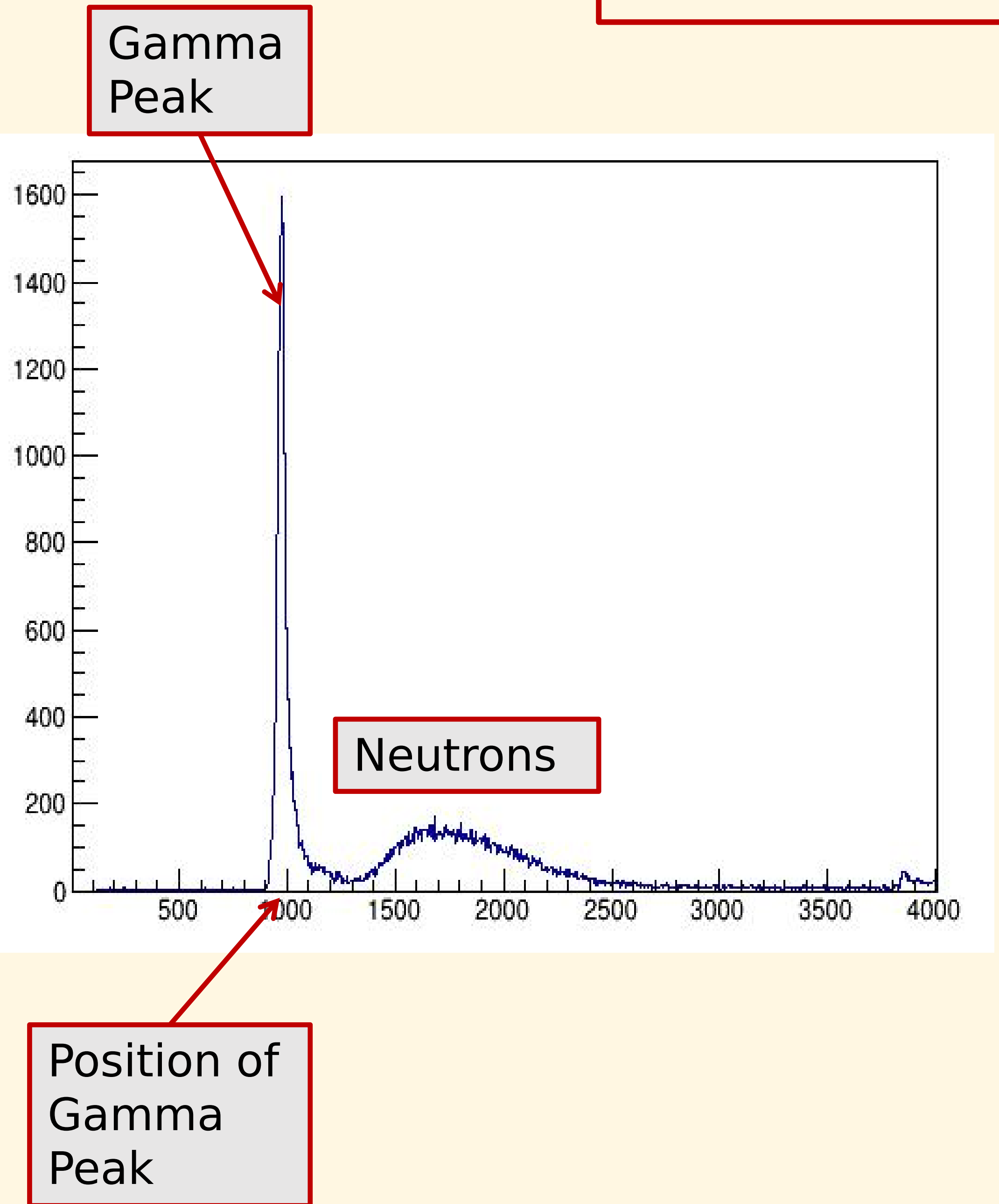
Lines 111-112: Change P[ ] indices for MWPC1 instead of MWPC2
Left-Right reversal: MWPC1XR - MWPC1XL according to as decided

```
x_MWPC=Mx*(P[3]-P[2])+Cx;        //MWPC1XR - MWPC1XL
y_MWPC=My*(P[4]-P[5])+Cy;        //MWPC1YU - MWPCYD
```

No other changes even though slicing is different

Added: Progress printf line
Added: <chrono>

Calculating neutron energy



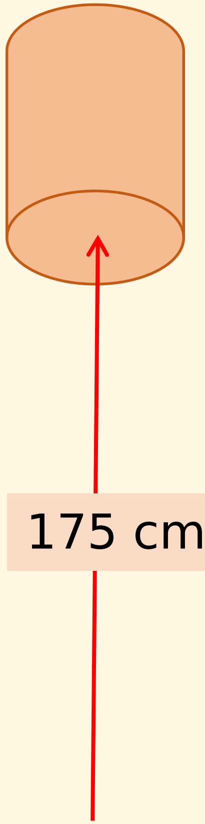
Velocity of light, c=29.979 cm/ns

$$T(ns) = TSlope \times (P - G) + \frac{175}{29.979}$$

$$T(ns) = TSlope \times (P - G) + 5.837$$

$$E_n = \frac{1}{2} m_n v^2 = 0.5 \frac{939.56}{29.979^2} (\frac{175}{2})^2$$

$$E_n = \frac{1.601e4}{[TSlope \times (P - G) + 5.837]^2} MeV$$



Adapting Prog007.cpp (run as compiled program)

Tree name: `LampsTree`
Change double P[MAX_PAR] to int P[MAX_PAR]
NDet=49
Change values of Mx, Cx, My, Cy calibration of MWPC

Add GetTCalib() to read TDC calibrations for individual neutron detectors
We need only the slopes (ns/ch) in tCal.txt not the offsets

Line 150,151: Change indices of P[ ]
Line 154: No change as P[ ] indexes do not need correcttion
Line 156: changed for two reasons (see previous slide)

En=1.601e4/pow(TSlope[DetNo]*(P[2*DetNo+11]-GPos[DetNo])+5.837,2.)

Added: Progress printf line
Added: <chrono>