

2023 TB data analysis tutorial

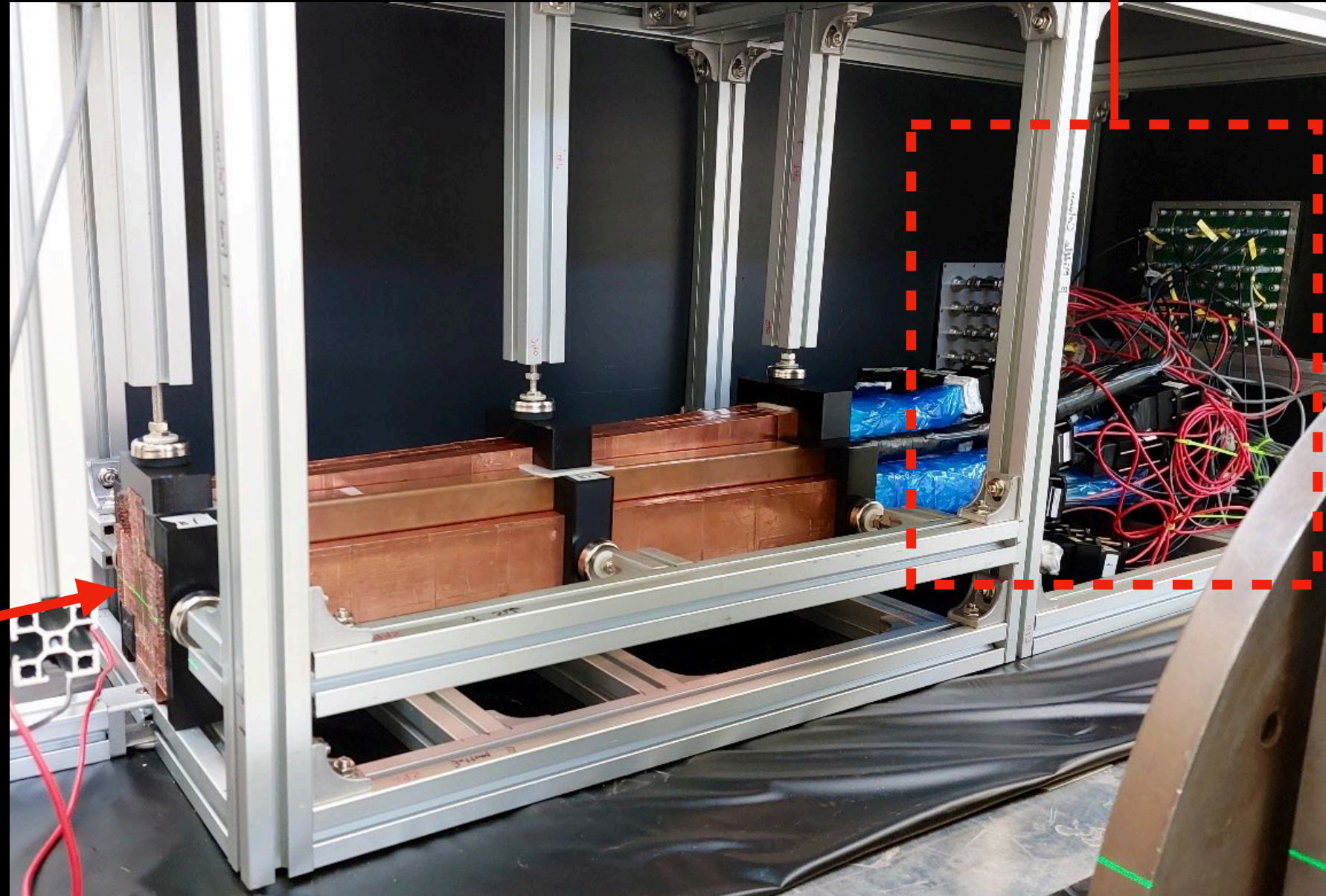
2024 GWNNU DRC workshop

2024.02.17 Sungwon Kim

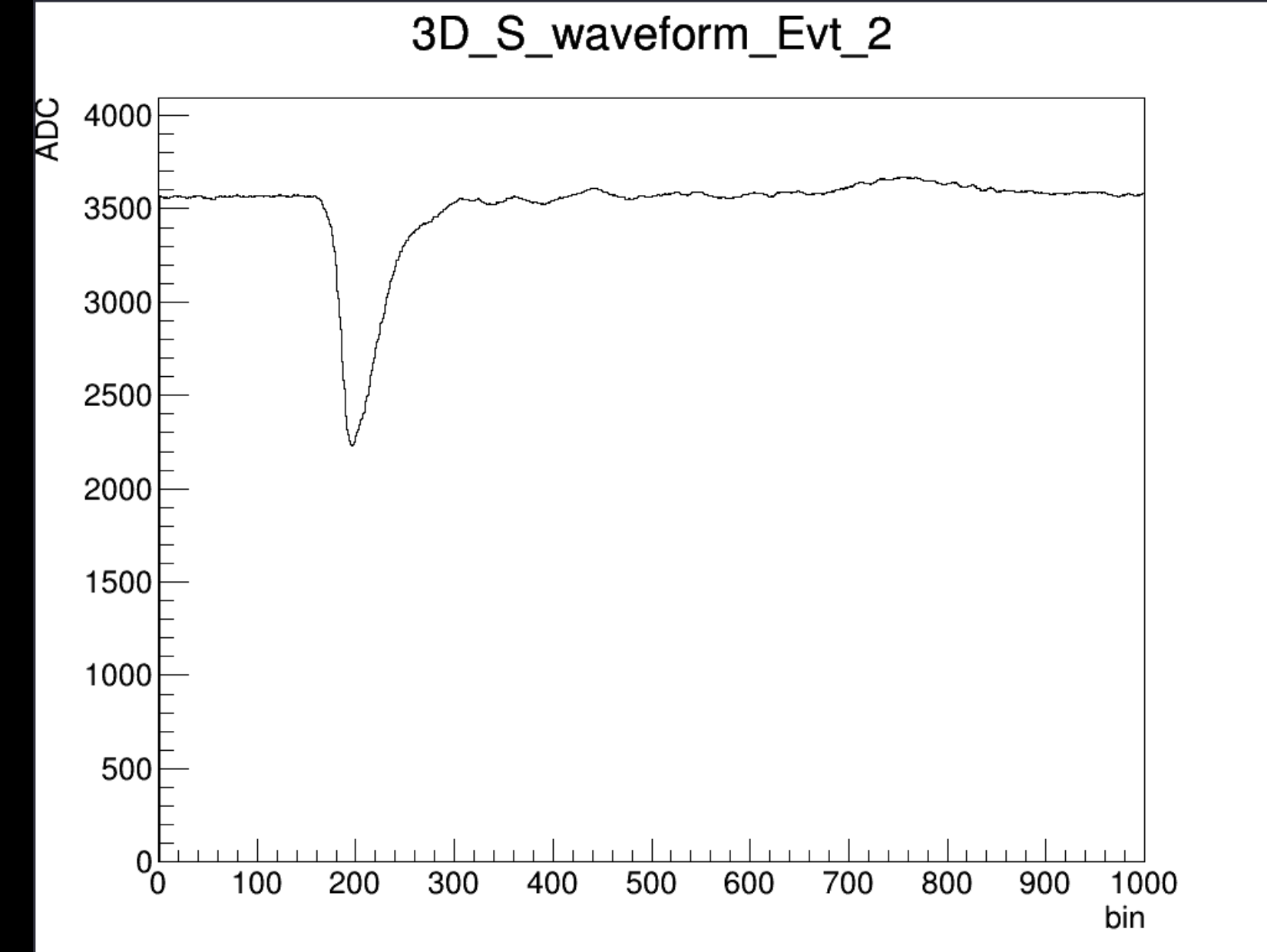
Tutorial goals

1. Learn how to execute analysis scripts on iDREAM server
2. Understand waveform, pedestal, IntADC, PeakADC, PID
3. Hands-on calibration & measuring energy

2023 TB ntuple



```
[swkim@idream 2023_DRC_TB_ntuple]$ ls  
Run_3977 Run_4011 Run_4045 Run_4074 Run_4105 Run_4135  
Run_3978 Run_4012 Run_4046 Run_4075 Run_4106 Run_4136  
Run_3980 Run_4013 Run_4047 Run_4076 Run_4107 Run_4137  
Run_3981 Run_4014 Run_4049 Run_4077 Run_4108 Run_4138  
Run_3983 Run_4015 Run_4050 Run_4079 Run_4109 Run_4139  
Run_3984 Run_4016 Run_4051 Run_4080 Run_4111 Run_4140  
Run_3985 Run_4018 Run_4052 Run_4081 Run_4112 Run_4141  
Run_3986 Run_4019 Run_4053 Run_4082 Run_4113 Run_4142  
Run_3987 Run_4020 Run_4054 Run_4083 Run_4114 Run_4144  
Run_3988 Run_4023 Run_4055 Run_4084 Run_4115 Run_4145  
Run_3989 Run_4025 Run_4056 Run_4085 Run_4116 Run_4146  
Run_3990 Run_4026 Run_4057 Run_4086 Run_4117 Run_4147  
Run_3991 Run_4027 Run_4058 Run_4087 Run_4118 Run_4148  
Run_3992 Run_4028 Run_4059 Run_4088 Run_4120 Run_4149  
Run_3993 Run_4030 Run_4060 Run_4089 Run_4121 Run_4150  
Run_3994 Run_4031 Run_4061 Run_4090 Run_4122 Run_4152  
Run_3995 Run_4032 Run_4062 Run_4091 Run_4123 Run_4153  
Run_3996 Run_4033 Run_4063 Run_4093 Run_4124 Run_4154  
Run_3997 Run_4034 Run_4064 Run_4095 Run_4125 Run_4155
```



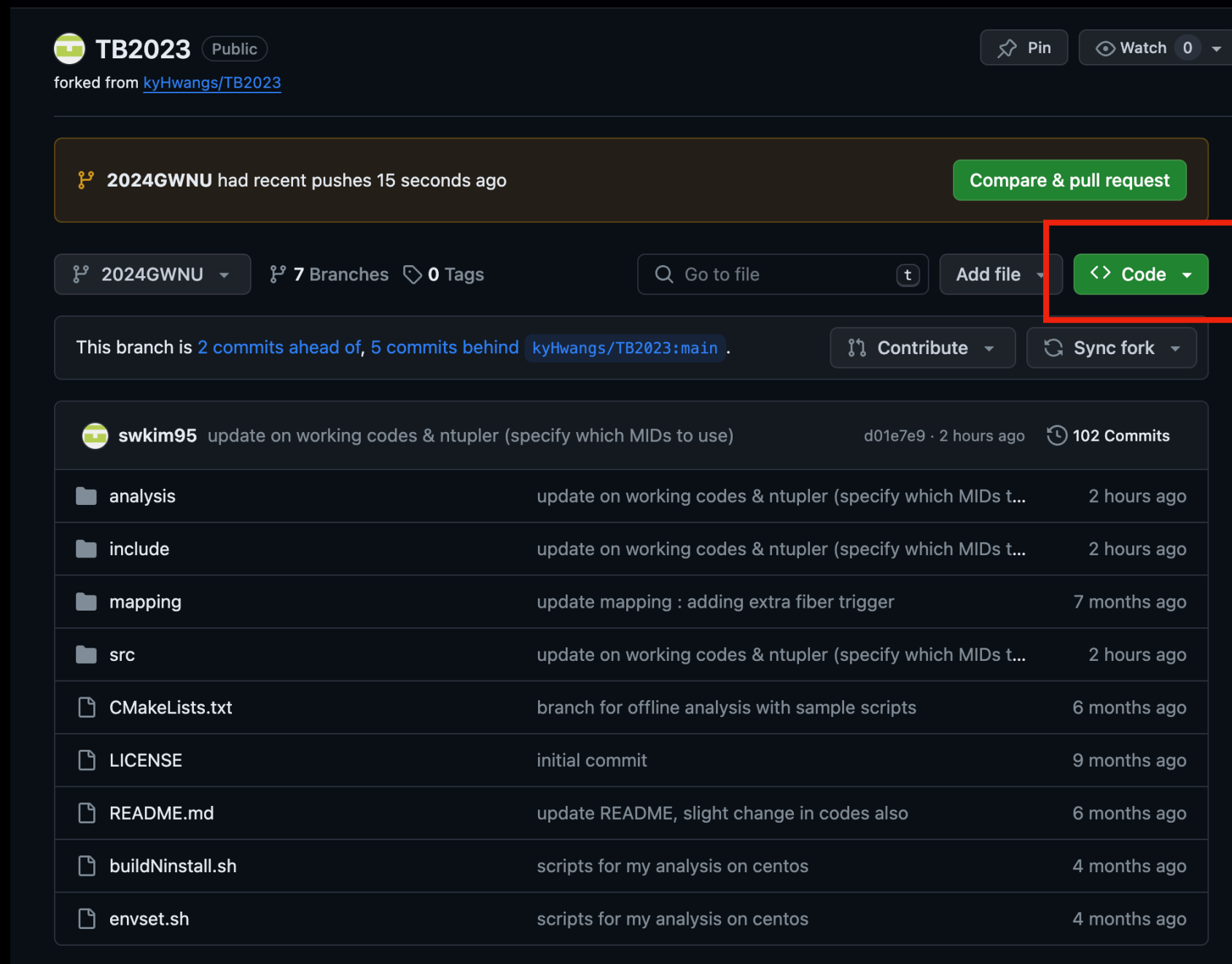
- Data recorded with DRC at CERN PS
- 2023 TB ntuple : Signal recorded from readouts (DRC, Aux) in waveform format
- Not only DRC, but also trigger & auxiliary detector data is accessible

Analysis basics - server access

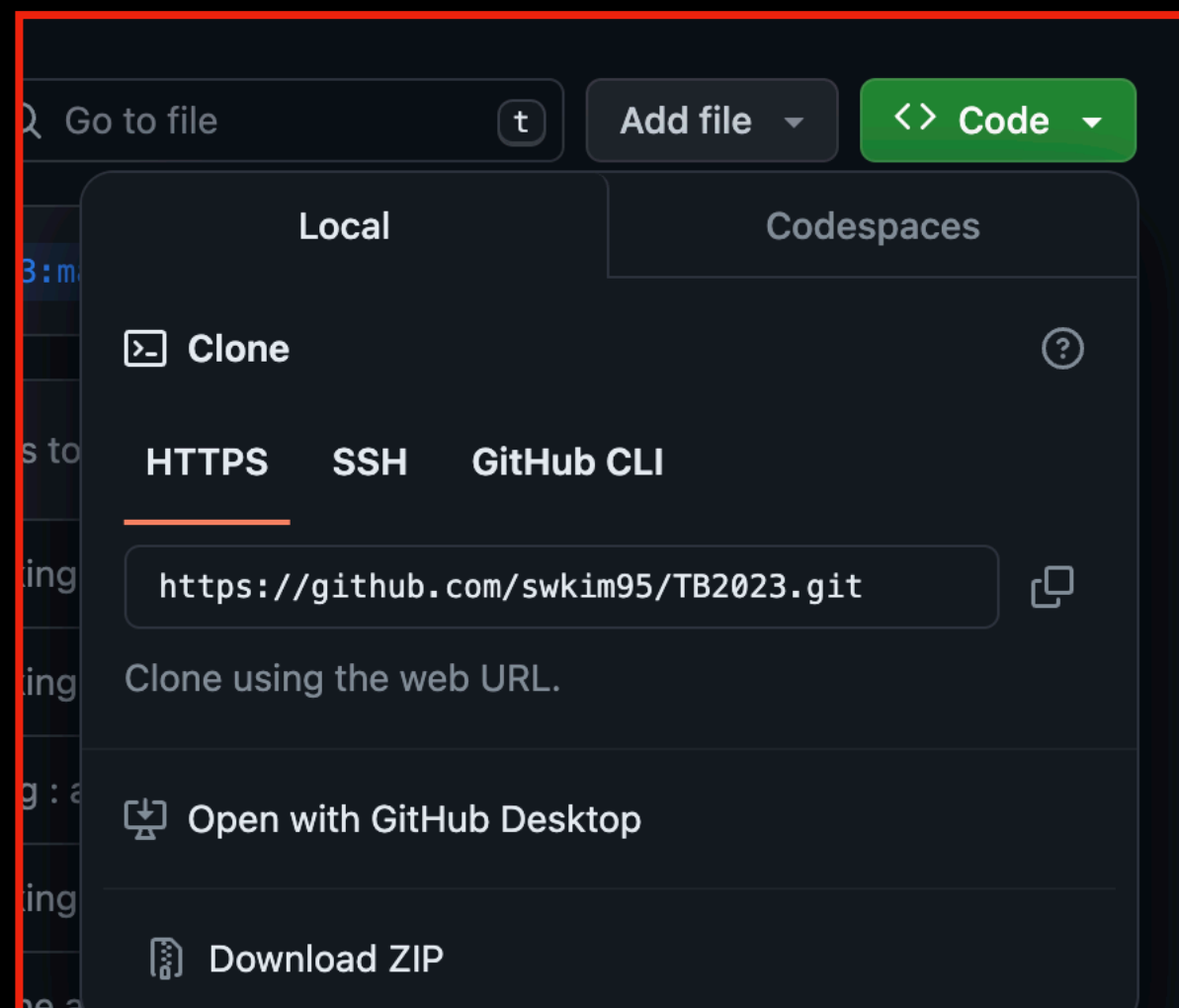
```
Last login: Sat Feb 17 05:40:15 on ttys002
🍏 ~ ssh swkim@idream.knu.ac.kr
swkim@idream.knu.ac.kr's password:
Last login: Sat Feb 17 03:05:32 2024 from 165.132.30.120
[swkim@idream ~]$ _
```

- Access to iDream server using "ssh"
- Please use wifi "gwnu_kfcw" (passwd : 20240217)
- `ssh <account>@idream.knu.ac.kr`
 - Ex) `ssh dream21@idream.knu.ac.kr`
- Please change your initial password!
- **Please do not mistake your password!!**

Analysis basics - Github clone



```
[swkim@idream tmp]$ git clone -b 2024GWNU https://github.com/swkim95/TB2023.git
Cloning into 'TB2023'...
remote: Enumerating objects: 748, done.
remote: Counting objects: 100% (206/206), done.
remote: Compressing objects: 100% (139/139), done.
remote: Total 748 (delta 110), reused 119 (delta 67), pack-reused 542
Receiving objects: 100% (748/748), 538.30 KiB | 1.38 MiB/s, done.
Resolving deltas: 100% (496/496), done.
[swkim@idream tmp]$ ls
TB2023
[swkim@idream tmp]$
```



- Github link : <https://github.com/swkim95/TB2023/tree/2024GWNU>
- Clone this repository by
 - `git clone -b 2024GWNU https://github.com/swkim95/TB2023.git`

Analysis basics - analysis scripts

```
[swkim@idream TB2023]$ source buildNinstall.sh
-- The C compiler identification is GNU 11.2.0
-- The CXX compiler identification is GNU 11.2.0
-- Detecting C compiler ABI info
-- Detecting C compiler ABI info - done
-- Check for working C compiler: /cvmfs/sft.cern.ch/lcg/releases/gcc/11.2.0-8a51a/x86_64-centos7/bin/gcc - skipped
-- Detecting C compile features
-- Detecting C compile features - done
-- Detecting CXX compiler ABI info
-- Detecting CXX compiler ABI info - done
-- Check for working CXX compiler: /cvmfs/sft.cern.ch/lcg/releases/gcc/11.2.0-8a51a/x86_64-centos7/bin/g++ - skipped
-- Detecting CXX compile features
-- Detecting CXX compile features - done
-- Found nlohmann_json: /cvmfs/sft.cern.ch/lcg/views/LCG_102/x86_64-centos7-gcc11-opt/lib64/cmake/nlohmann_json/nlohmann_jsonConfig.cmake (found suitable version "3.10.5", minimum required is "3.10.5")
-- Configuring done
-- Generating done
-- Build files have been written to: /u/user/swkim/tmp/TB2023/build
[ 7%] Generating G__drcTB.cxx, libdrcTB_rdict.pcm, libdrcTB.rootmap
Scanning dependencies of target drcTB
[ 28%] Building CXX object CMakeFiles/drcTB.dir/src/TBconfig.cc.o
[ 28%] Building CXX object CMakeFiles/drcTB.dir/src/TBdetector.cc.o
[ 28%] Building CXX object CMakeFiles/drcTB.dir/src/TBevt.cc.o
[ 35%] Building CXX object CMakeFiles/drcTB.dir/src/TBfastengine.cc.o
```

```
dream
swkim@idream.knu.ac.kr's password:
Last login: Sat Feb 17 14:41:31 2024 from 203.243.41.220
[swkim@idream ~]$ cd 2024_GWNU_workshop/TB2023/
[swkim@idream TB2023]$ ls
analysis build buildNinstall.sh CMakeLists.txt envset.sh include install LICENSE mapping README.md src
[swkim@idream TB2023]$ source envset.sh
[swkim@idream TB2023]$
```

- First compile the workspace by : `source buildNinstall.sh`
- Run `source envset.sh` whenever you re-access the server

Analysis basics - analysis scripts

```
[swkim@idream TB2023]$ ls
analysis build buildNinstall.sh CMakeLists.txt envset.sh include install LICENSE mapping README.md src
[swkim@idream TB2023]$ cd analysis/
[swkim@idream analysis]$ ls
avgTime.cc calib.cc calib_EvtPed.cc compile.sh draw_waveform.cc energy.cc energy_EvtPed.cc functions.cc intADC.cc intADC_EvtPed.cc
[swkim@idream analysis]$ _
```

```
[swkim@idream analysis]$ ./compile.sh draw_waveform.cc
Compiling draw_waveform.cc to draw_waveform
Done!
[swkim@idream analysis]$ ls
avgTime.cc calib.cc calib_EvtPed.cc compile.sh draw_waveform draw_waveform.cc energy.cc energy_EvtPed.cc functions.cc intADC.cc intADC_EvtPed.cc
[swkim@idream analysis]$ ./draw_waveform 4183 10
0 Ntuple file added to TChain : /gatbawi/dream/TB2023/2023_DRC_TB_ntuple/Run_4183/Run_4183_Wave/ntuple_Run_4183_Wave_0.root
1 Ntuple file added to TChain : /gatbawi/dream/TB2023/2023_DRC_TB_ntuple/Run_4183/Run_4183_Wave/ntuple_Run_4183_Wave_1.root
2 Ntuple file added to TChain : /gatbawi/dream/TB2023/2023_DRC_TB_ntuple/Run_4183/Run_4183_Wave/ntuple_Run_4183_Wave_2.root
3 Ntuple file added to TChain : /gatbawi/dream/TB2023/2023_DRC_TB_ntuple/Run_4183/Run_4183_Wave/ntuple_Run_4183_Wave_3.root
Total entries : 30577
Will process maximum 10 events
Info in <TCanvas::Print>: png file ./Waveform/3D_S_waveform_Evt_0.png has been created
Info in <TCanvas::Print>: png file ./Waveform/3D_S_waveform_Evt_1.png has been created
Info in <TCanvas::Print>: png file ./Waveform/3D_S_waveform_Evt_2.png has been created
```

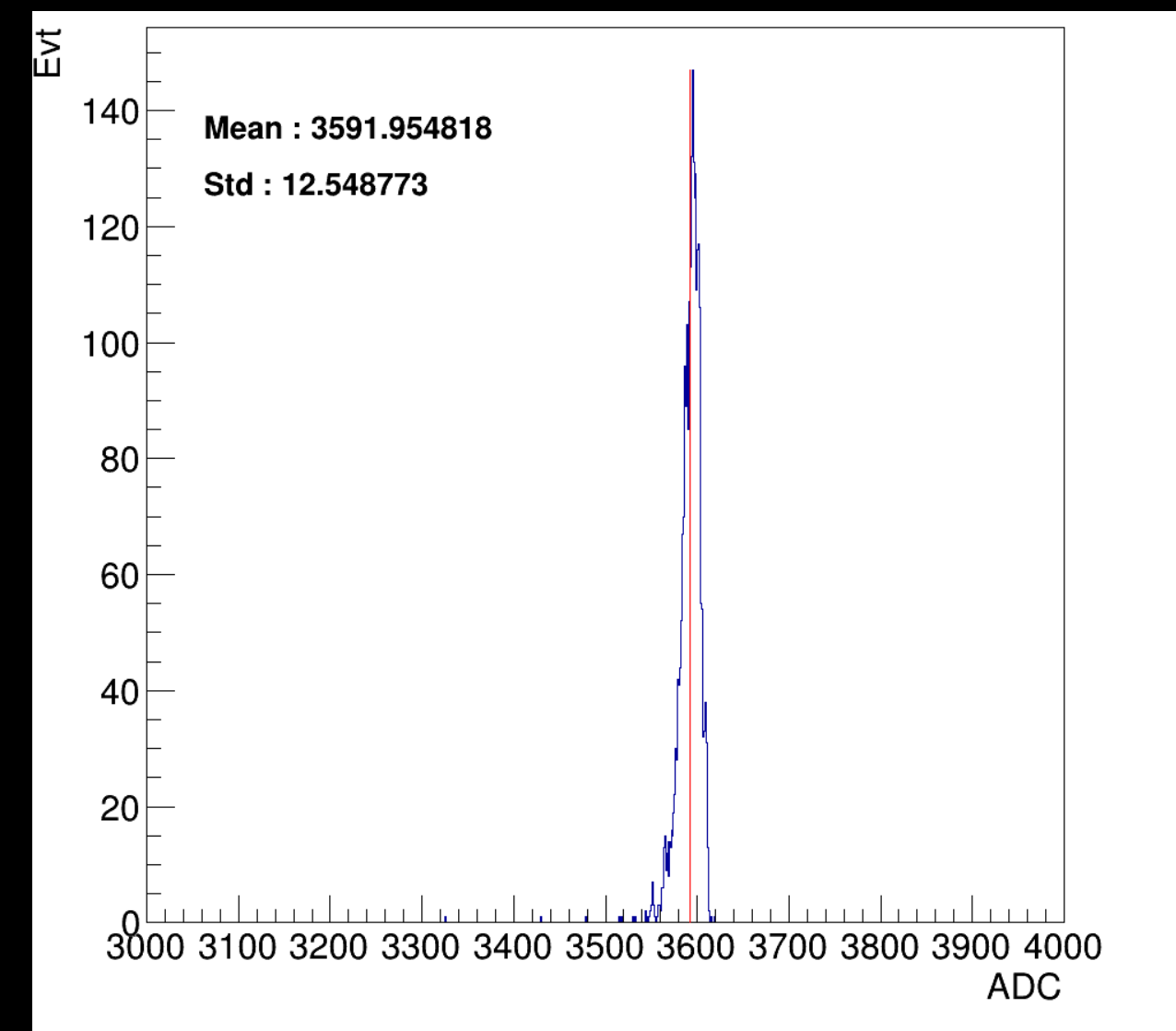
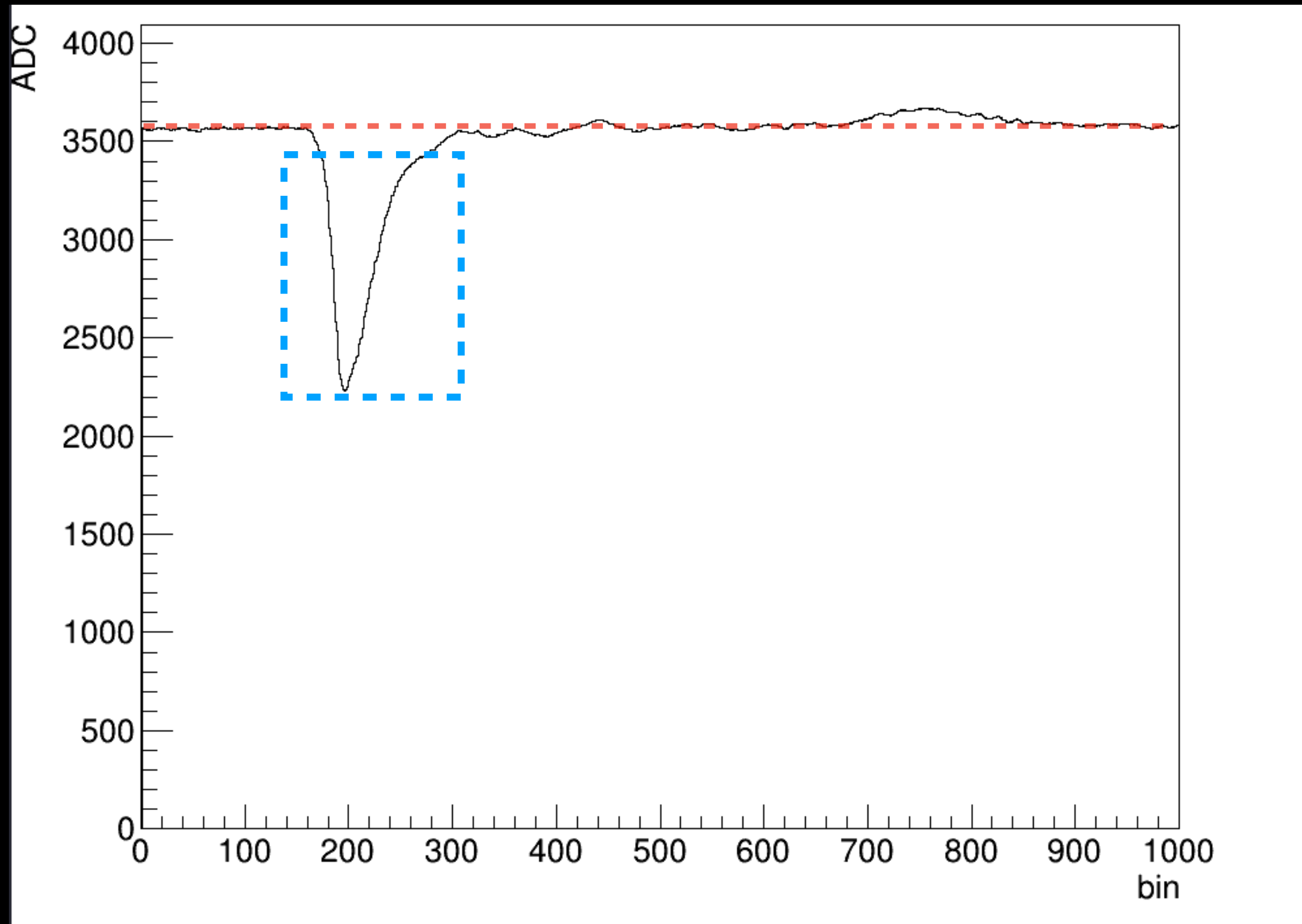
- All the working scripts are in `analysis` directory
- Descriptions of each scripts are written in each code
- Basic usage
 - First compile the script : `./compile.sh <script name>.cc`
 - Ex) `./compile.sh draw_waveform.cc`
 - Run the script : `./<script name> <run number> <entries>`
 - Ex) `./draw_waveform 4183 50`

Analysis basics - analysis scripts

```
avgTime.cc  
calib.cc  
calib_EvtPed.cc  
compile.sh  
draw_waveform.cc  
energy.cc  
energy_EvtPed.cc  
functions.cc  
intADC.cc  
intADC_EvtPed.cc
```

- **draw_waveform** : Draw waveform per event (produce lots of png files, be careful!)
- **avgTime** : Draw average time structure
- **intADC** : Draw integrated ADC count histograms
- **calib** : Draw calibrated (not scaled) energy histograms
- **energy** : Draw scaled energy histograms
- Same scripts with "_EvtPed" : Basically same, but uses event-pedestal
- **compile.sh** : Compile the analysis scripts
- **functions.cc** : Useful utility functions (loading ntuple etc...) defined

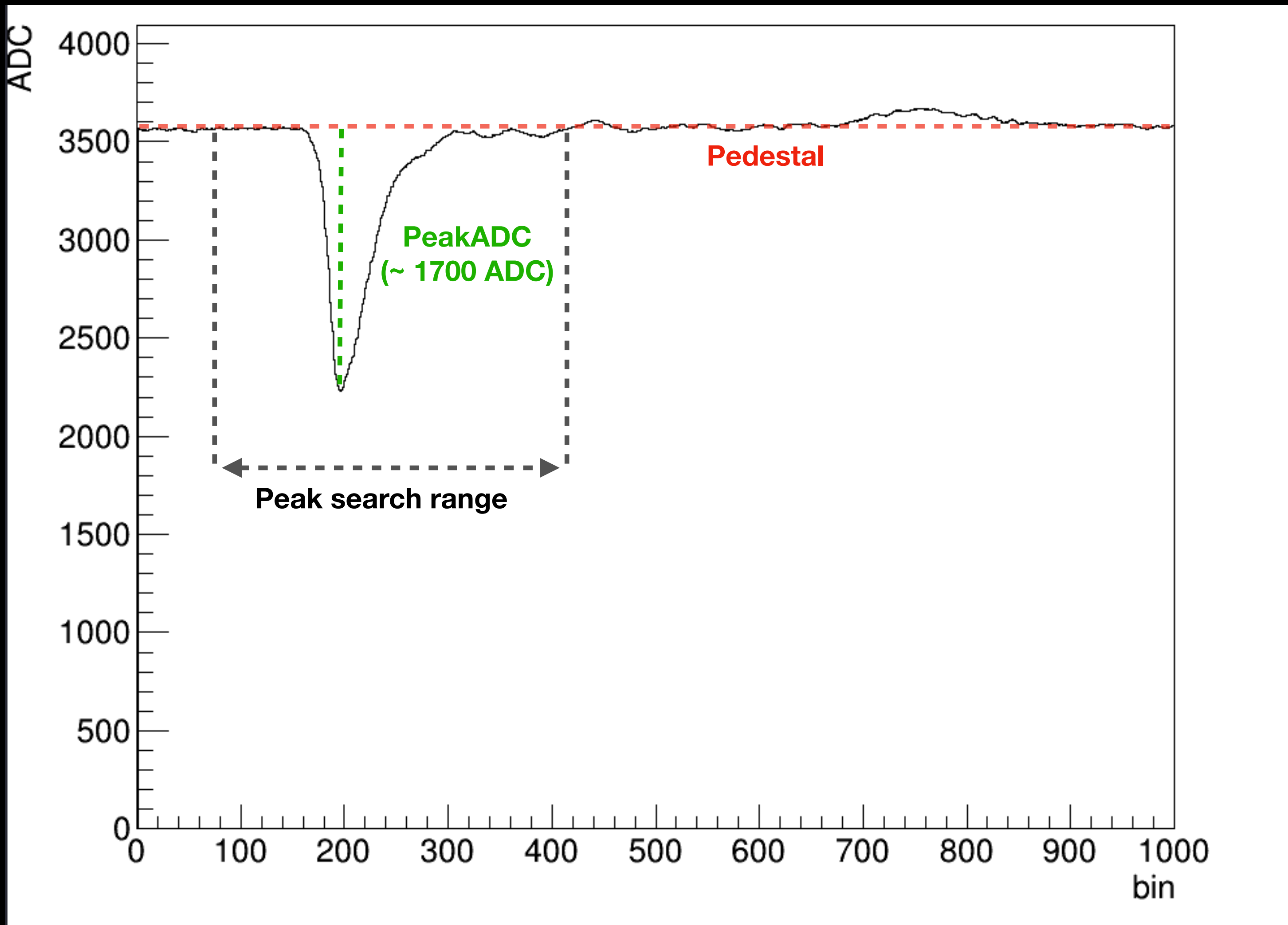
Analysis basics - Waveform



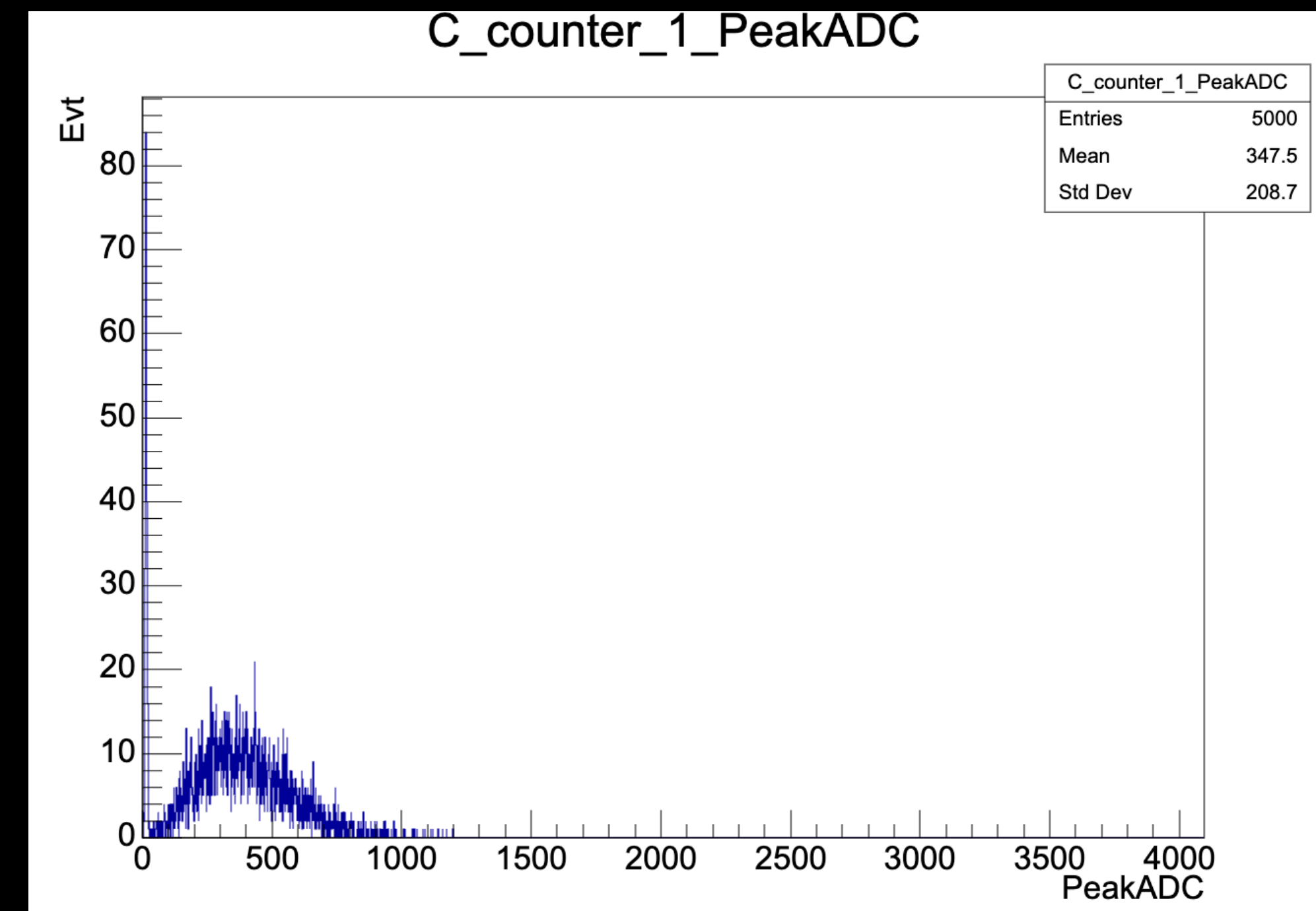
- Digitized readout signal recorded with DAQ system
- x-axis : time (0.2 ns per bin)
- y-axis : ADC count (0 ~ 4095)

- Pedestal : base level of waveform
- Can be measured event-by-event or run-by-run
- EvtPed : Measured per event, average ADC count of first 100 bins (bin 1 ~ 100)
- RunPed : Measured per run, mean value of EvtPed distribution

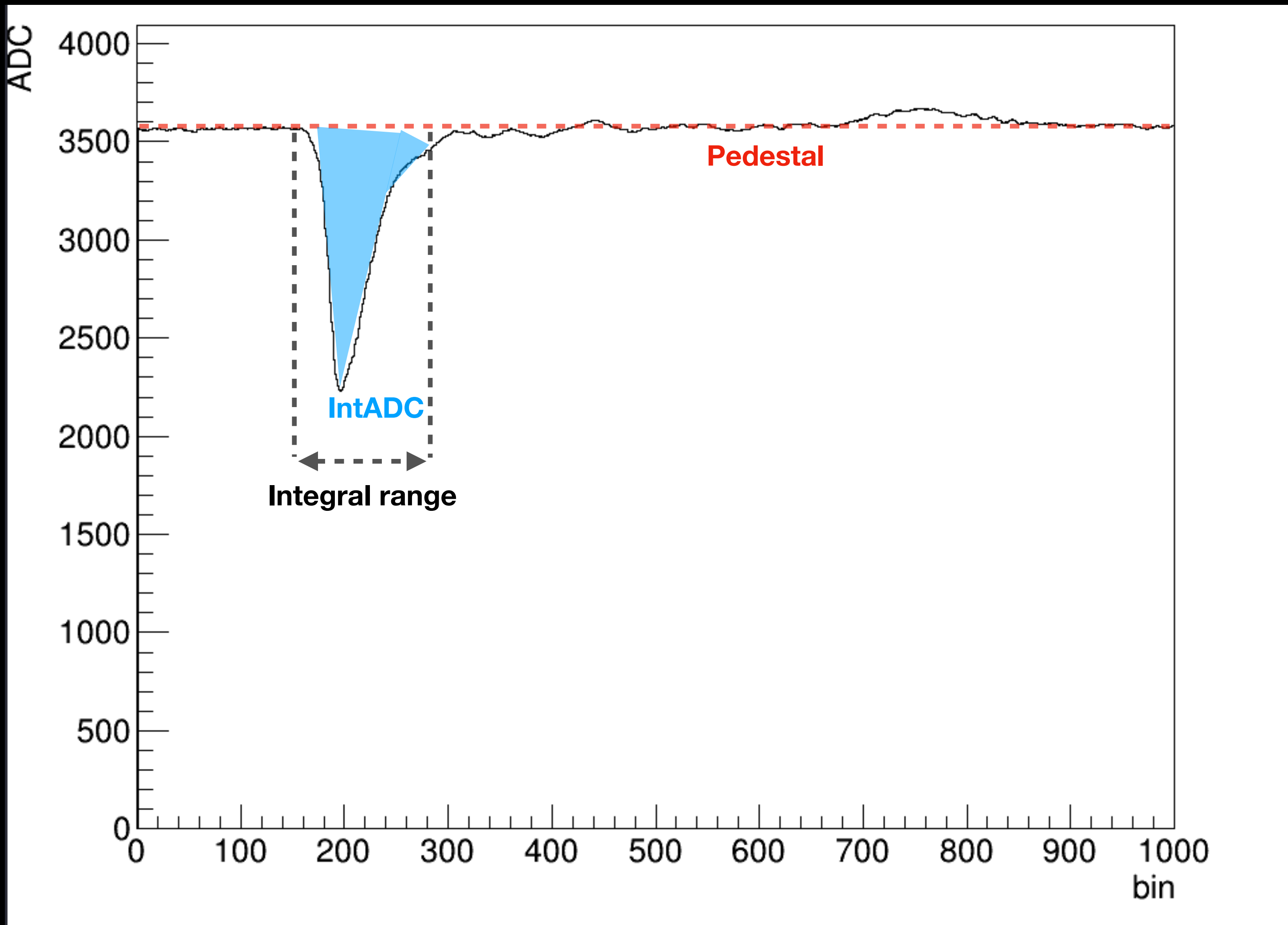
Analysis basics - IntADC, PeakADC



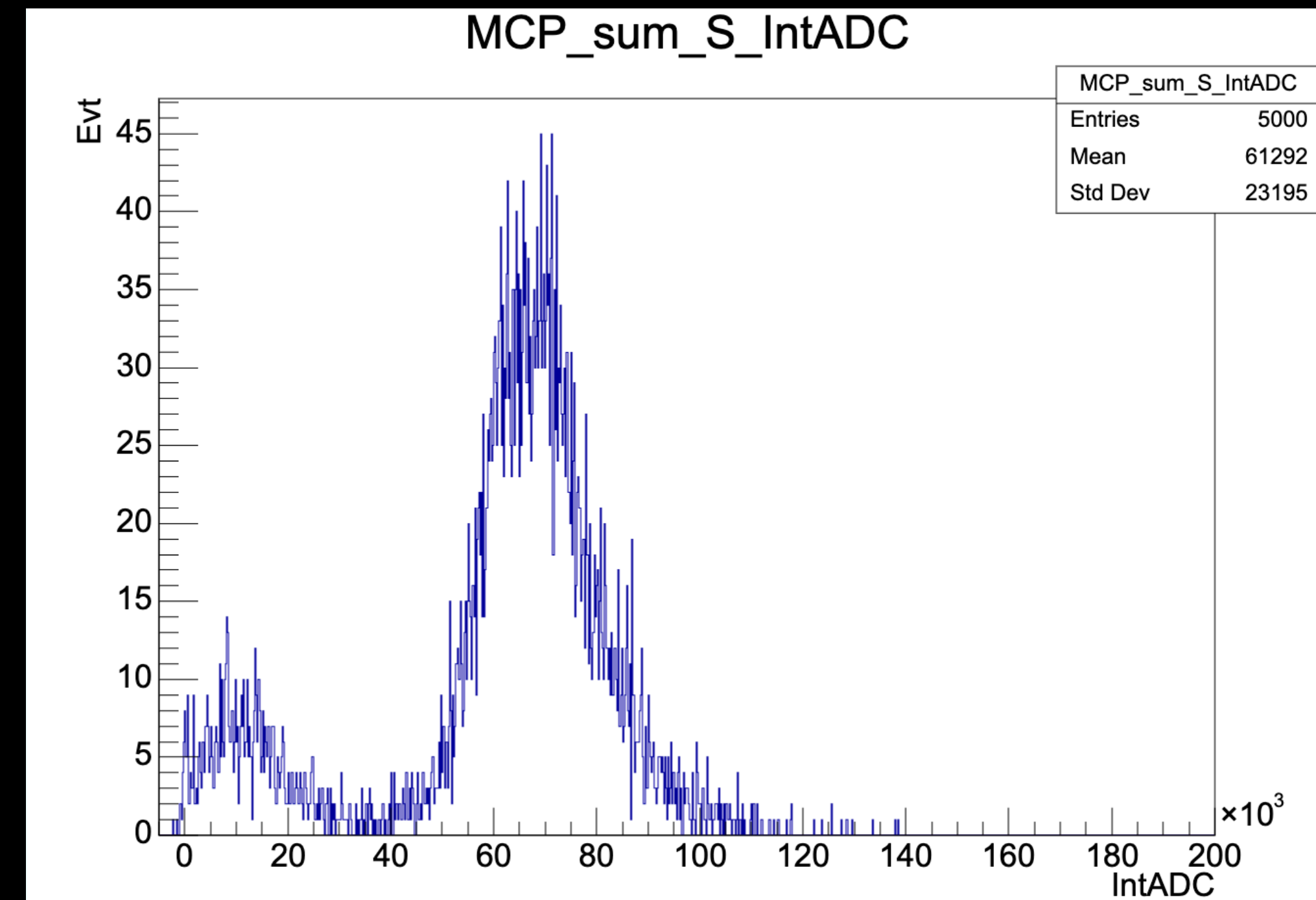
- PeakADC : Maximum value of (Ped - Waveform) ADC count within peak search range
- Used for Cherenkov counter PID



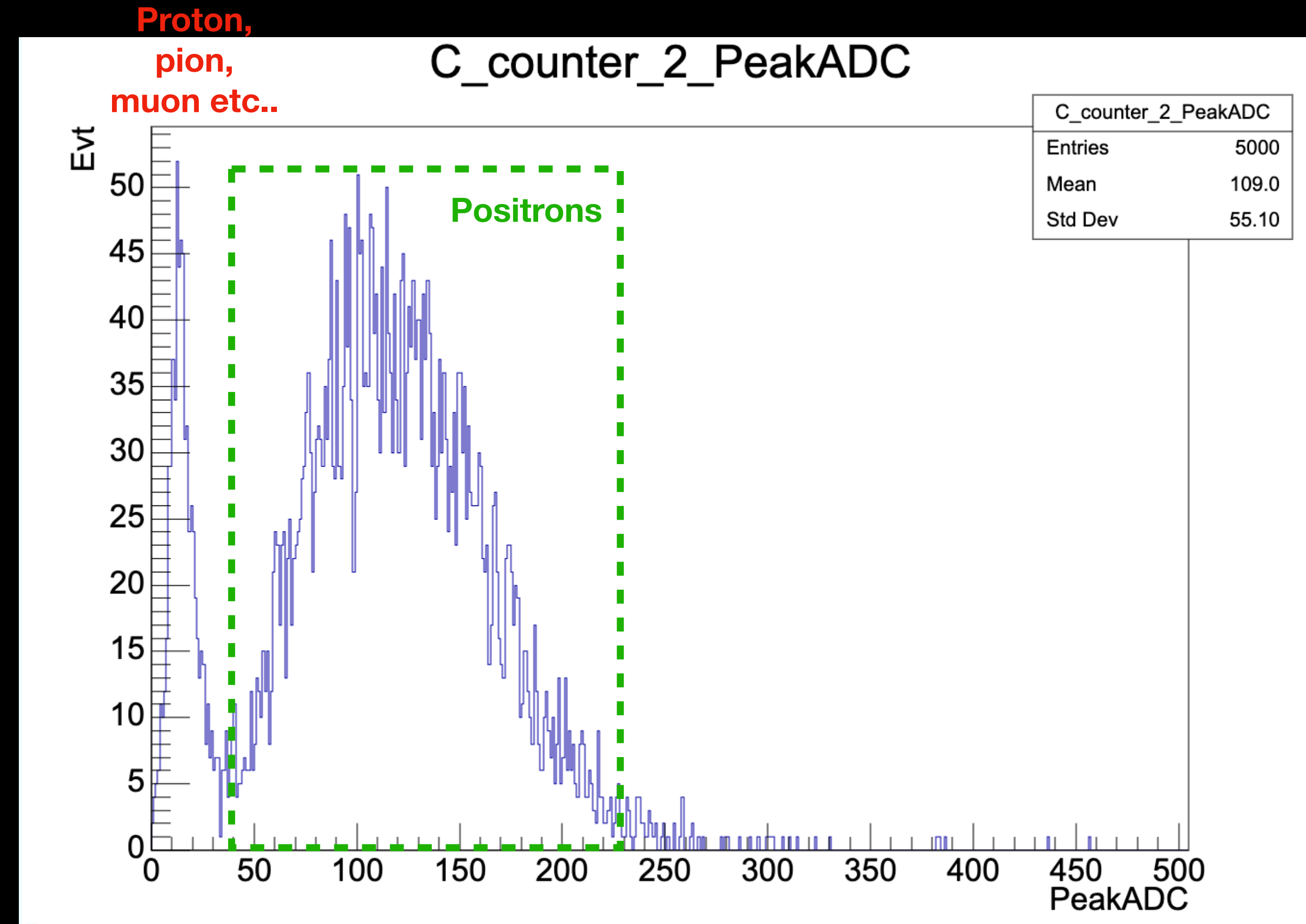
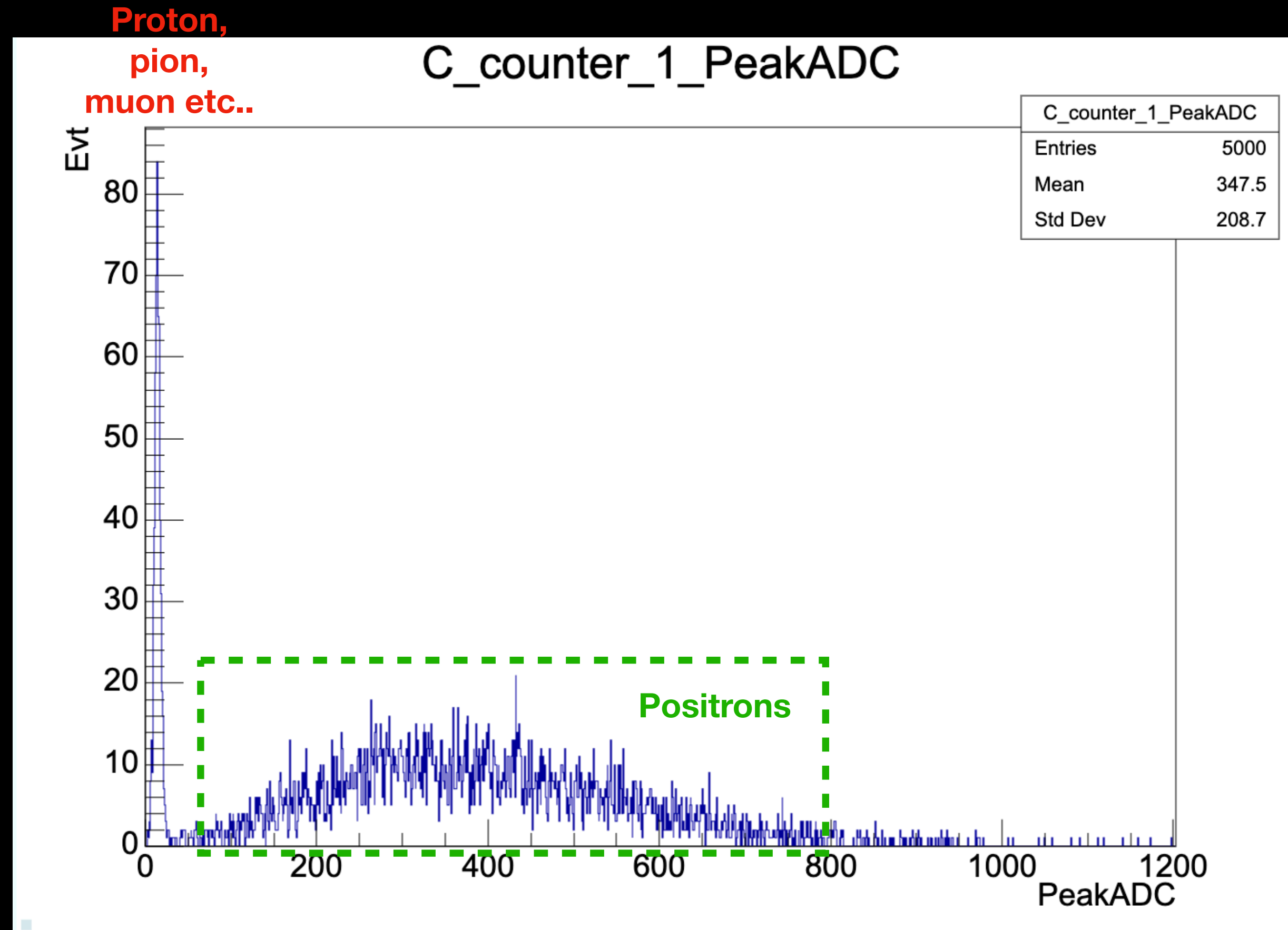
Analysis basics - IntADC, PeakADC



- IntADC : Integral value of area surrounded with pedestal & signal within integral range
- Used for all the other detectors



Analysis basics - PID



- Use positron beam for the calibration
- Remove non-positron events by PID (Particle IDentification)
- PID can be done by using 2 Cherenkov counters

Useful links

- 2023 TB Run log : [Run log](#)
- 2023 TB mapping info : [Mapping info](#)
- 2023 TB Indico page : [Indico](#)
- Analysis package Github : [Git](#)
- Physics run list : [Run list](#)
- Calibration helper sheet : [Calib](#)

Hands-on

Backup