Data taking & ONLINE analysis at MCR

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- Memos.
- How to start data taking.
- Preparation for Physics data taking.
- What I did during RUN8 period.

Memos:

- Login to **pc2pc.rhic.bnl.gov** machine as user **e950:**

>ssh pc2pc.rhic.bnl.gov –l e950 –X (pass:)

- RUN8 raw data:

>cd /usr/local/polarim/bin/jet

name of data: xDDMM.5AB.data

DD is day, MM is month and AB is from 01~

Ex. The first data on Feb. 26th is “x2602.501.dat”.

- RUN-log for RUN8: (Ron and Yousef know how to look)

>cd /usr/local/polarim/bin

>oocalc JETRUNLOG08.sxc &

How to start data taking:

- To start GUI on Yousef's document page2:

>cd /usr/local/polarim/bin

>./jetrun.pl &

- To start data taking: follow the instruction of Yousef's document page 1-2.
- This GUI is a set of "data-taking+online analysis"
- To find output ROOT files (ntuple):

>cd /usr/local/polarim/bin/root

name of output root file: xDDMM.5AB.root

DD is day, MM is month and AB is from 01~

Ex. Online analysis for "x2602.501.dat" is "x2602.501.root".

- To re-do online analysis only:

>./jetana.pl &

Ntuple structure:

```
typedef struct {
    int rev;                // revolution number
    int bunch;               // bunch number
    int bpol;               // bunch polarization (-1, 0, +1)
    int jpol;               // jet polarization (-1, 0, +1)
    float time;              // reconstructed time
    float ampl;              // reconstructed amplitude
    float quality;           // event quality
    float ekin;              // recoil kinetic energy, keV
    float tof;              // time of flight, ns
    float rmass;             // recoil mass, GeV
    float angle;             // pi/2 - <scattering angle>, radians
    float mmass2;              // missing mass squared, GeV
//    int wave[192];
 } EventStruct;
```

Preparation for Physics data taking

1. Energy calibration.
2. Banana hunting.
3. Acceptance check (by moving ***vertical position*** of the **RHIC**-beam).
4. time0 check.
5. ROUGH HJET profile measurement by **fixing the RHIC beam** position, by **moving HJET base** position (→ To find a good HJET base position).
6. Spin and bunch pattern check.
7. Channel selection for every energy-bin
8. Repeat items 2~ 6 for the another RHIC beam!

1. Energy calibration

Calibration α: 5.486MeV (Am), 3.183 MeV (Gd)

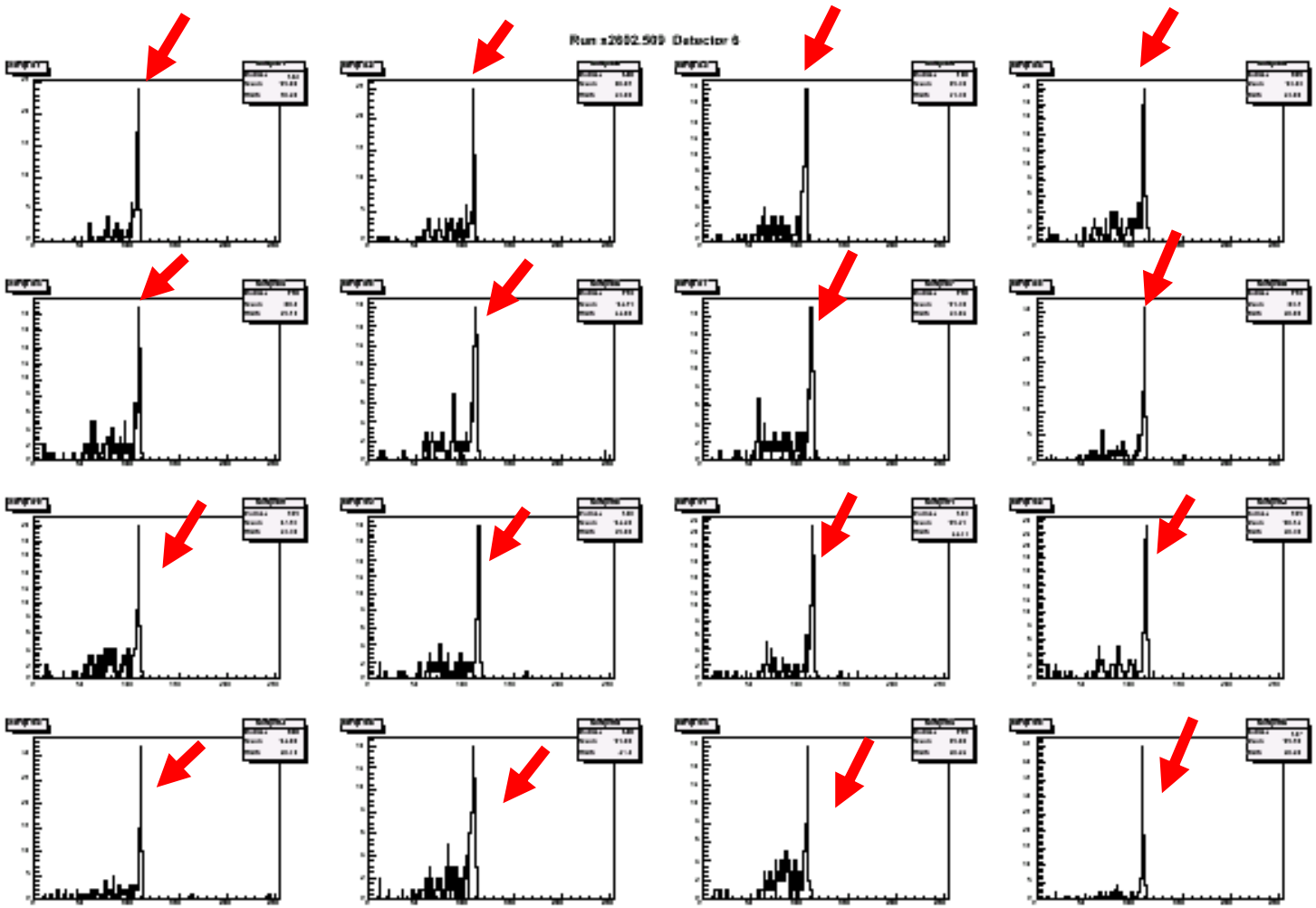
Use Am source data for ONLINE.

- How to take α calibration data?
  - Retract calibration shutter. → ask Yousef, Anatoli or Ron.
  - Just run GUI on slide 4. You do ***not*** need the RHIC beam nor the HJET!
- How to analyze calibration data? →See page 8.
- How to update energy/ADC coefficients? → See page 12.
- How often you need to repeat this?
  - RUN8 case, every 3 days or more.
  - (If you have the RHIC beam, HJET, or both, you can take calibration data!)

How to analyze calibration data?

1. You can copy a tool from "/home/okadah/JET2008/Online_tools/AmPeak.C" to your directory (here directory name is "tmp".
2. And then create "Calib" directory below your "tmp" directory.
3. How to use:
   - Start root session >root –l
   - Run a tool >.x AmPeak.C(DDMM,5AB)
   - Output file "Calib/calib_xDDMM.5AB.txt"
   - Contents : 1st column is channel#, 2nd column is energy coefficient [KeV/ADC]

AmPeak.C picks peak position of ADC spectra for every channel



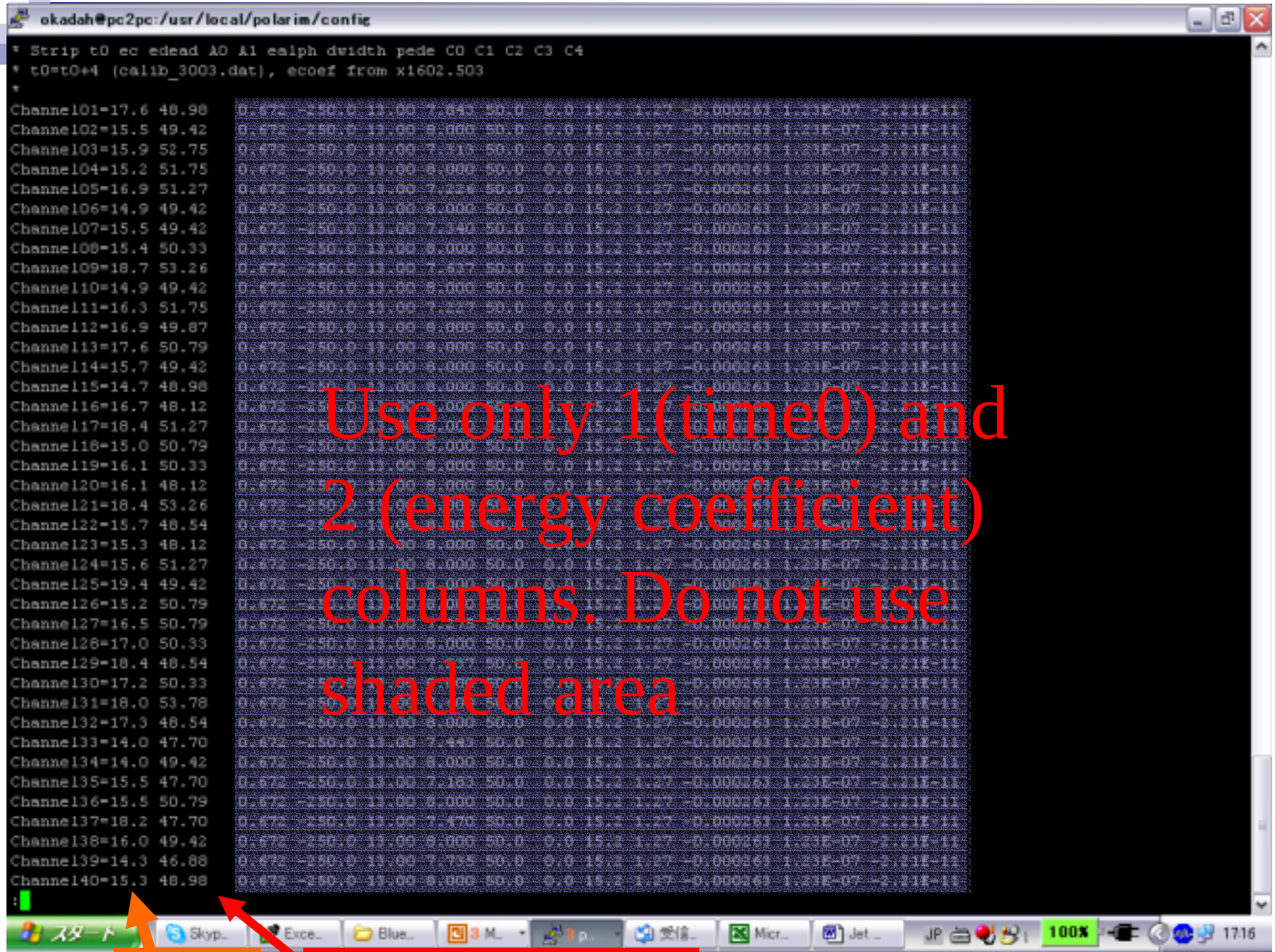
Example of output file:
/home/okadah/HJET2008/Online_tools/Calib/x2602.509.txt

1st column: channel#,

2nd column: energy coefficient [KeV/ADC]

Coeffcient = 5486[keV]/peak[ADC]

```
1,48.98
2,49.42
3,52.75
4,51.75
5,51.27
6,49.87
7,49.42
8,50.80
9,53.26
10,96.25
11,51.75
12,50.33
……
88,48.98
89,50.33
90,48.12
91,48.12
92,48.12
93,48.98
94,50.33
95,50.33
96,49.87
```


okadah@pc2pc:/usr/local/polarim/config
* Strip t0 ec edead A0 A1 ealph dwidth pede C0 C1 C2 C3 C4
* t0=t0+4 (calib_3003.dat), ecoef from x1602.503
*
Channel01=17.6 48.98
Channel02=15.5 49.42
Channel03=15.9 52.75
Channel04=15.2 51.75
Channel05=16.9 51.27
Channel06=14.9 49.42
Channel07=15.5 49.42
Channel08=15.4 50.33
Channel09=18.7 53.26
Channel10=14.9 49.42
Channel11=16.3 51.75
Channel12=16.9 49.87
Channel13=17.6 50.79
Channel14=15.7 49.42
Channel15=14.7 48.98
Channel16=16.7 48.12
Channel17=18.4 51.27
Channel18=15.0 50.79
Channel19=16.1 50.33
Channel20=16.1 48.12
Channel21=18.4 53.26
Channel22=15.7 48.54
Channel23=15.3 48.12
Channel24=15.6 51.27
Channel25=19.4 49.42
Channel26=15.2 50.79
Channel27=16.5 50.79
Channel28=17.0 50.33
Channel29=18.4 48.54
Channel30=17.2 50.33
Channel31=18.0 53.78
Channel32=17.3 48.54
Channel33=14.0 47.70
Channel34=14.0 49.42
Channel35=15.5 47.70
Channel36=15.5 50.79
Channel37=18.2 47.70
Channel38=16.0 49.42
Channel39=14.3 46.88
Channel40=15.3 48.98
Use only 1(time0) and 2 (energy coefficient) columns. Do not use shaded area
time0
Energy coefficient

How to update energy/ADC coefficients txt?

- Copy old config file to new config file at: /usr/local/polarim/config

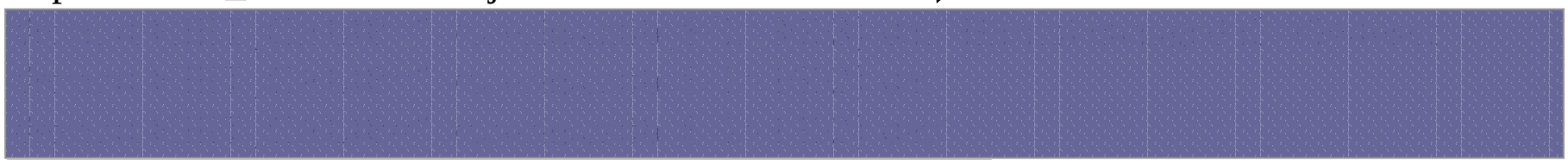
>cp calib_1602.dat calib_XXXX.dat

- XXXX is arbitrary 4 digit (DDMM is recommended).
- Then you have to modify “jetanal.sh”.
  - Open /usr/local/polarim/bin/jetanal.sh
  - Comment out old line starts from “export..”
  - Add new line

    export HJET_CALIB="../config/calib_${2:-XXXX}.dat“
- See next page!

/usr/local/polarim/bin/jetanal.sh

```
#!/bin/bash
# Analize(reanalize) jet run

RUN=$1

export HJET_ROOTFILE="root/"$RUN".root"
export HJET_DATAFILE="jet/"$RUN".data"
```

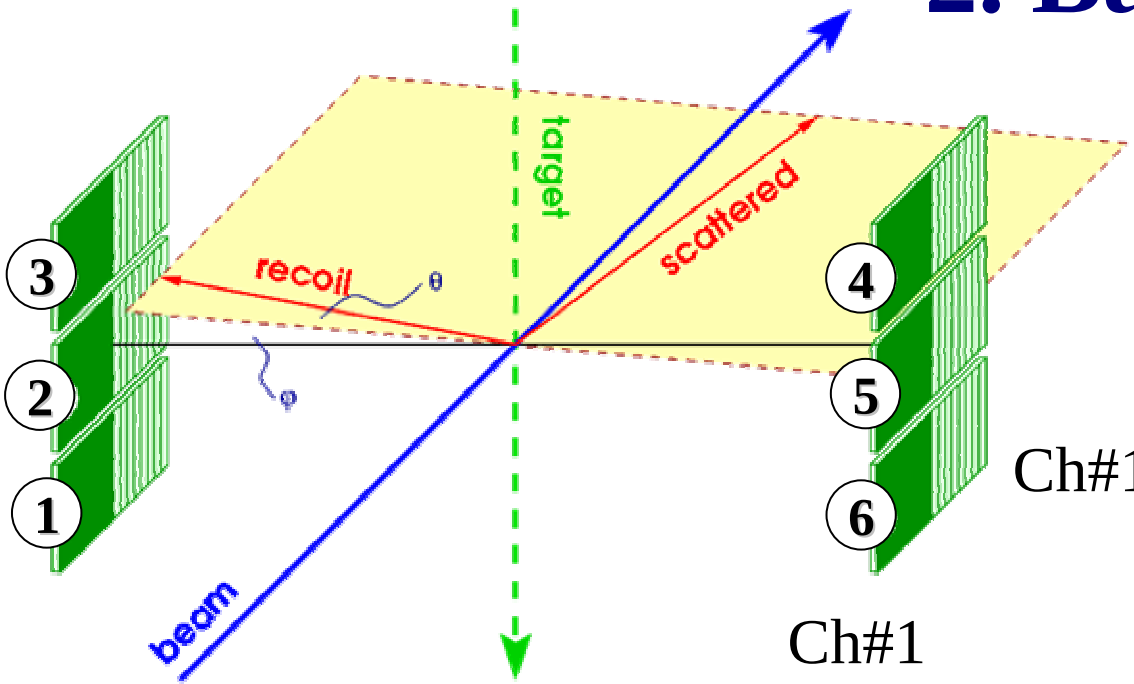


```
export HJET_CALIB="../config/calib_${2:-XXXX}.dat"
export HJET_DAQ=""

if [ "x"$1 == "x" ] ; then
    echo "Usage: ./jetanal.sh <RUN> [<CALIB>]"
else
    root -b jetrun.C
fi
```

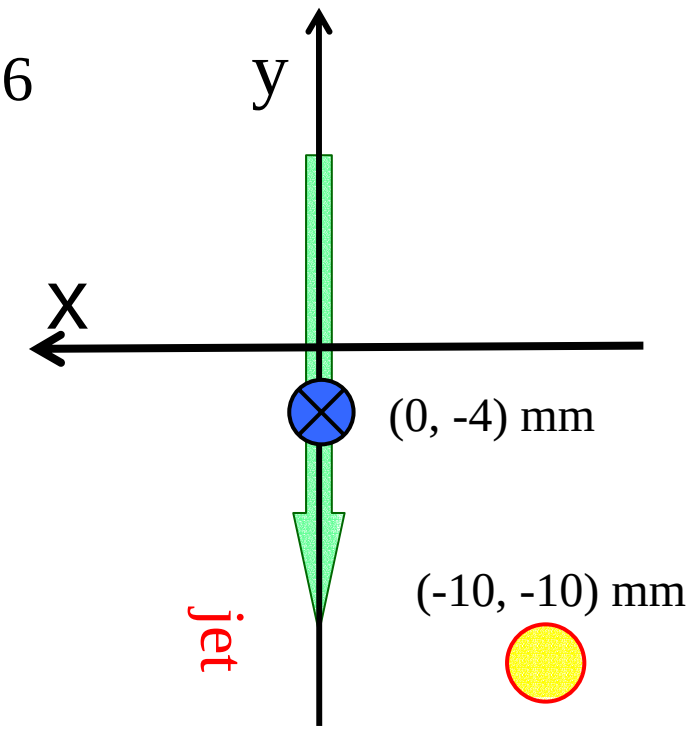
“#” means “comment out”.

New file “calib_XXXX.dat” (XXXX is arbitrary)

2. Banana hunting



Experimental setup



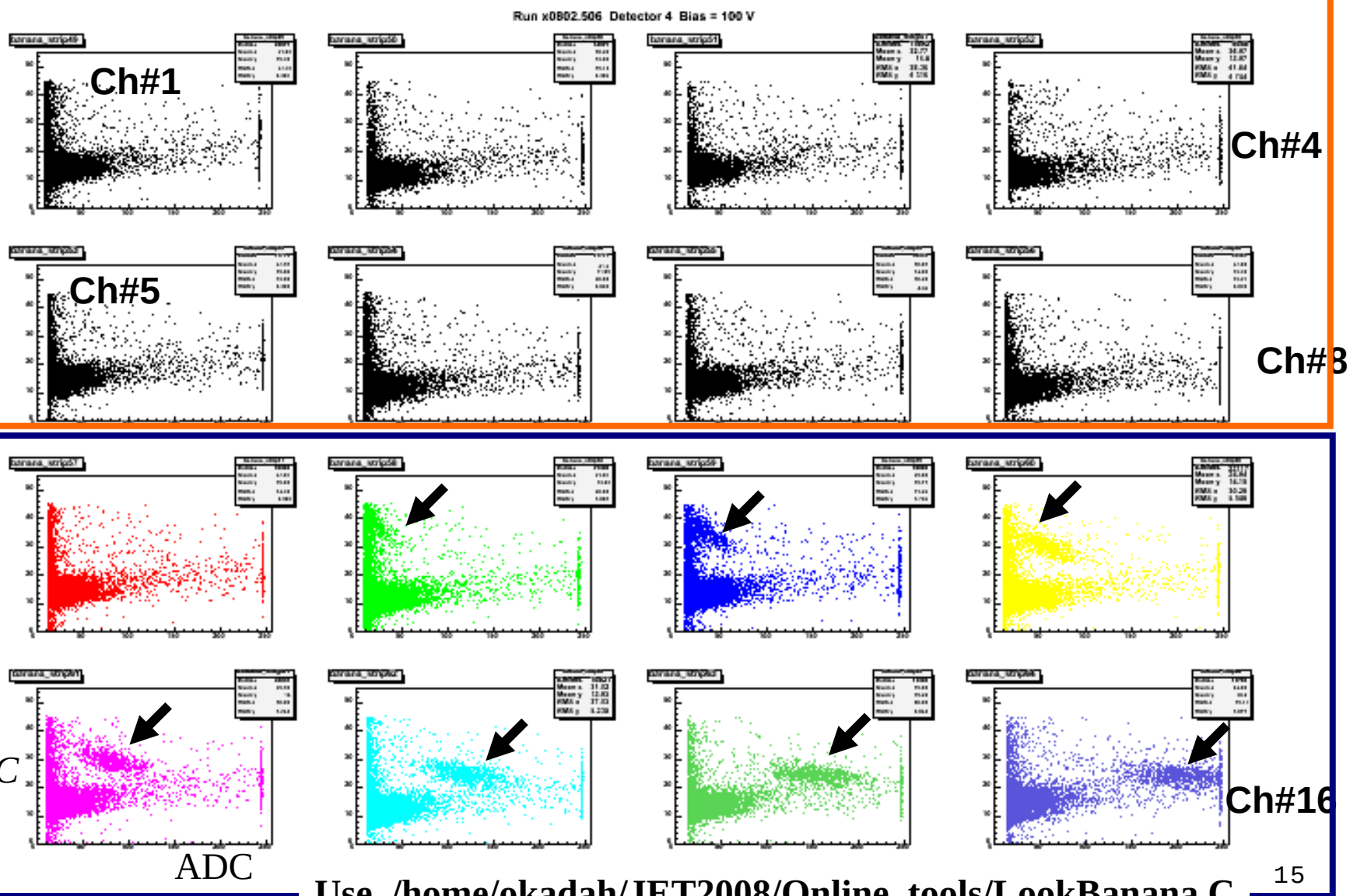
Collision point – detector: 80cm

Cover kinetic energy: $0.5 < T_R < 5$ MeV

(But we use $1.0 < T_R < 4$ MeV.)

Each detector has 16 readout channels.

ADC and TDC correlations from one of the detector



Use /home/okadah/JET2008/Online_tools/LookBanana.C

Useful tools for BANANA hunting:

- To make a plot in slide 15 and 17:
  - ADC vs. TDC 2-D plot for every channel.
  - /home/okadah/JET2008/Online_tools/LookBanana.C

  >root –l

  >.x LookBanana.C

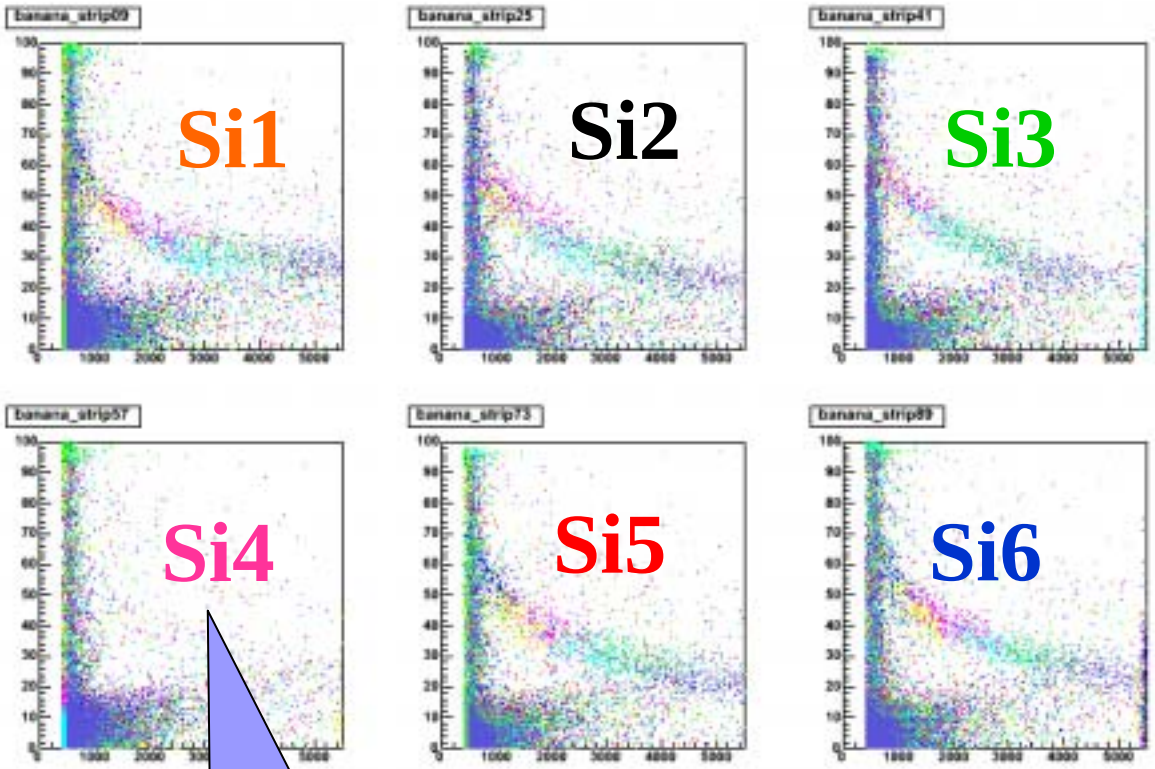
  >Enter run name: xDDMM.5AB

  >Enter mode: –1

Blue mode -1, yellow mode 1

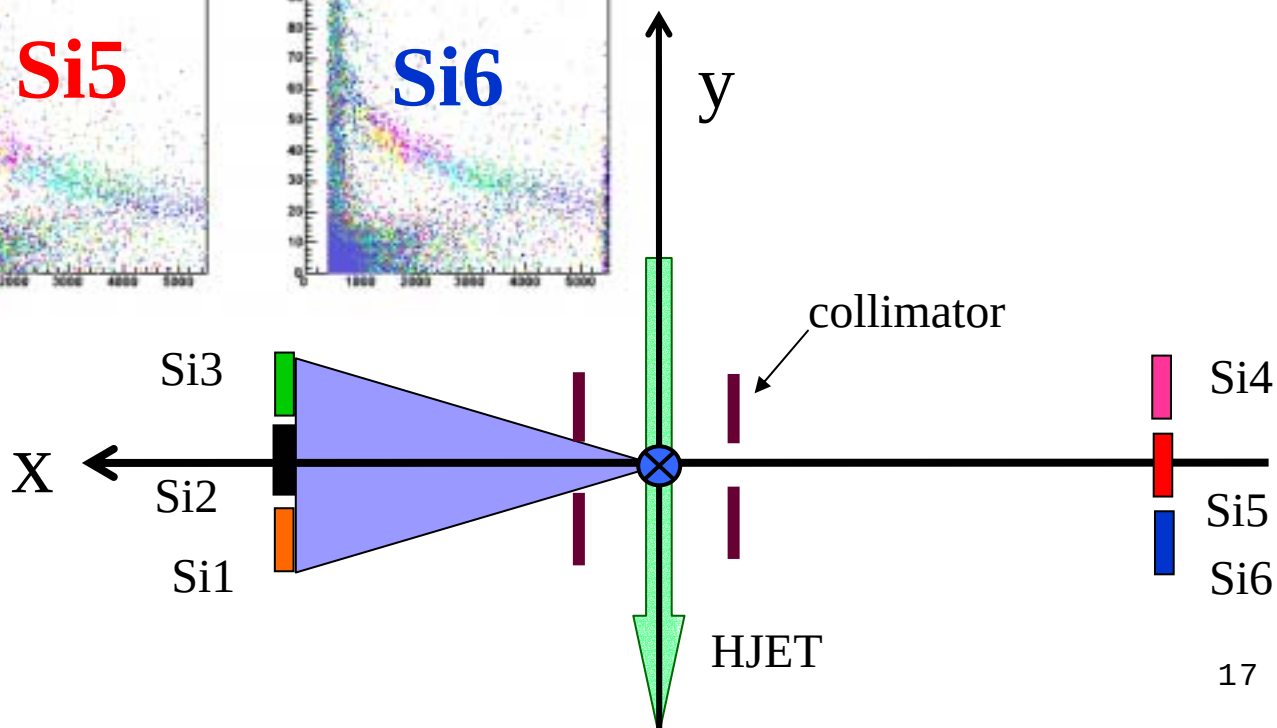
- You can modify easily change TDC ↔ ToF, ADC ↔ Energy in these source codes (After you get correct energy coefficients and time0).

3. Acceptance check



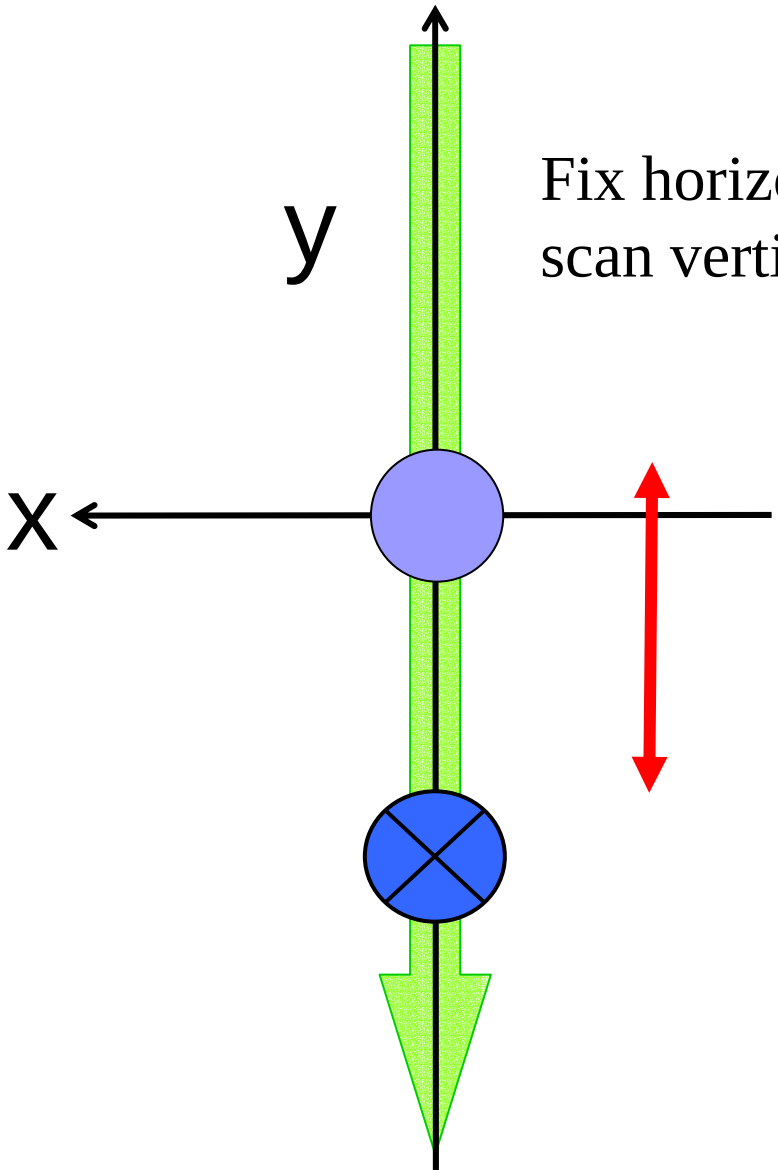
In case the RHIC beam is too high (low) , Si#3 and Si#4 (Si#1 and Si#6) may be shadowed by collimator.

Collimator shadowed !



Use /home/okadah/JET 2008/Online_tools/ LookBanana.C

Please try the RHIC beam vertical scan!!



Fix horizontal (x-position) and scan vertical (along y-axis)

(x,y)=(0, 0)

=(0,-1)

=(0,-2)

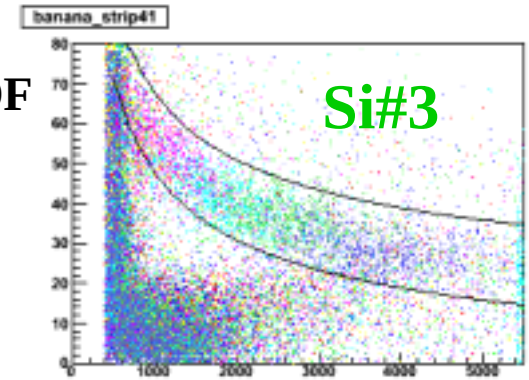
=(0,-4)

Try wider range!

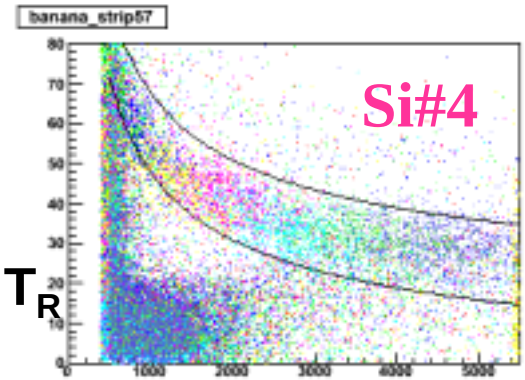
4. time0 check:

- What is time0?
  - We measure signal arrival time start from the RHIC clock.
  - Arrival time = “ToF” + “signal process & travel time”
  - Time0 = “signal process & travel time”
- How to estimate time0?
- Look at BANANA plot and estimate time0 by eyes. → for example, see next page.
  /home/okadah/JET2008/Online_tools/LookBanana3.C
- (You might set a same values for all 96 channels for ONLINE: see page 11 the first column.)

How to look at BANANA plot to estimate time0 by eyes?

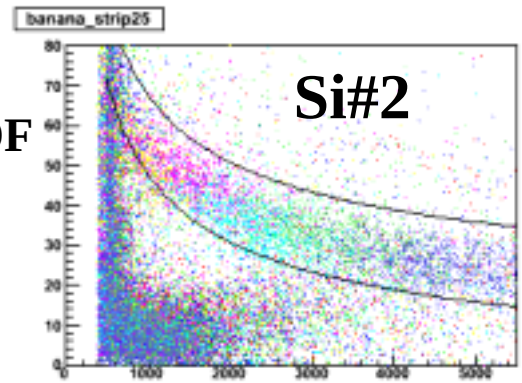


TOF

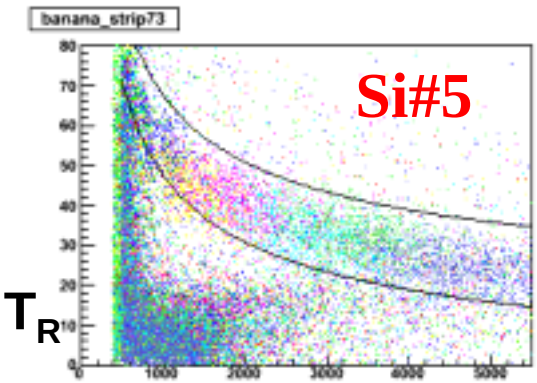


T_R

Confirm BANANA locus is between two solid lines.



TOF

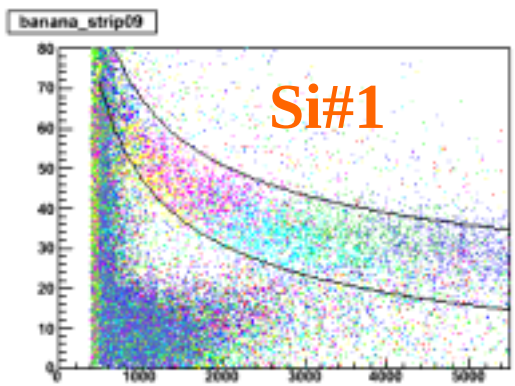


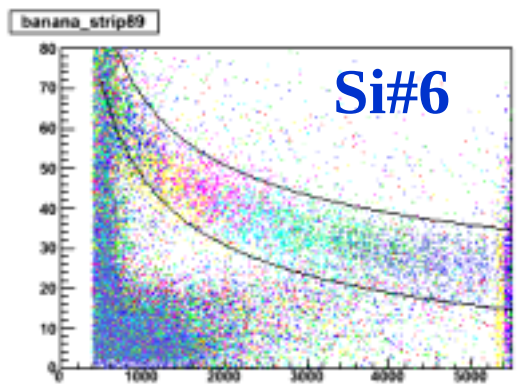
T_R

Recoil particle identification

ToFcal+10 [nsec]

ToFcal–10 [nsec]





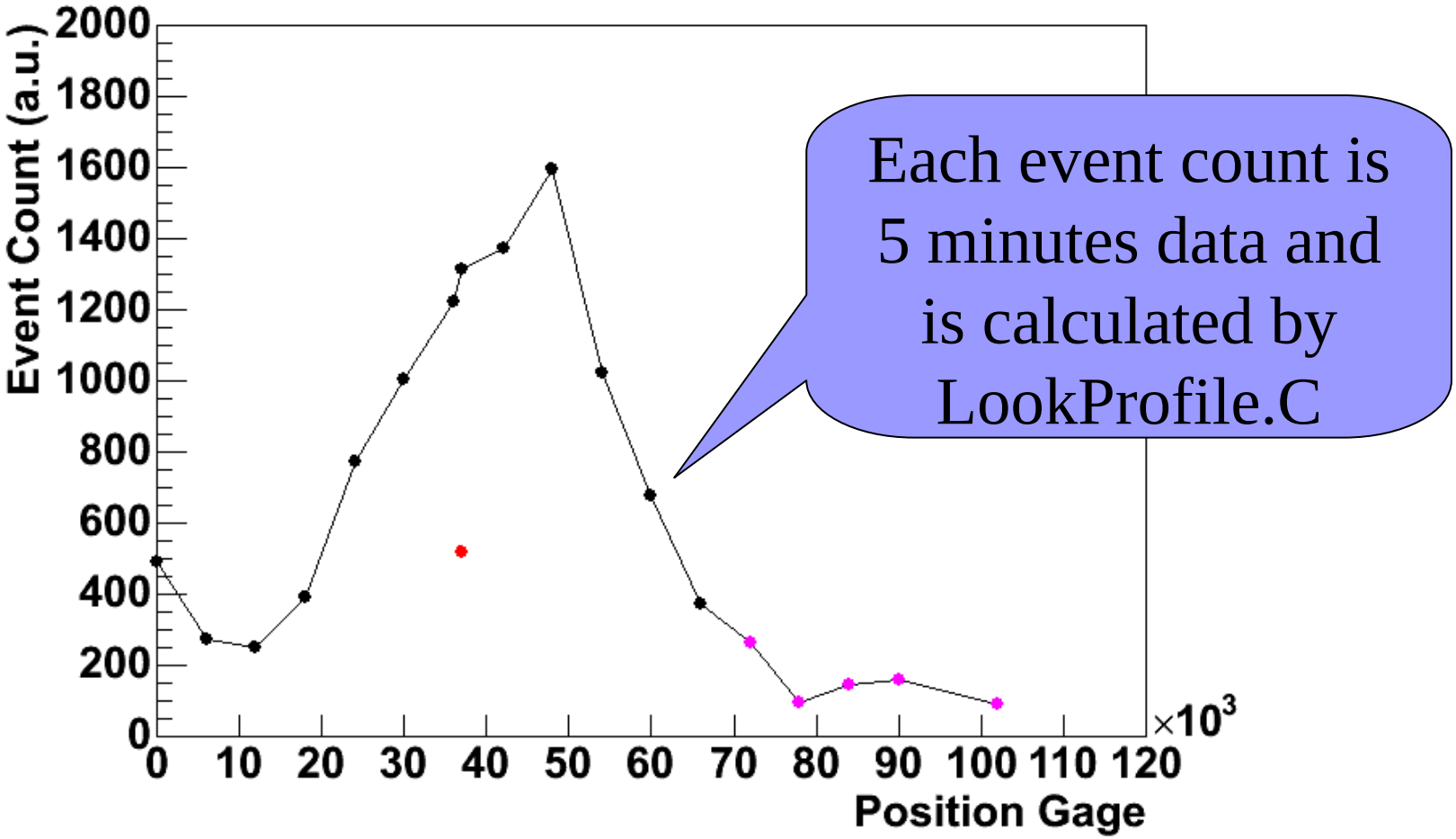
Use /home/okadah/JET 2008/Online_tools/ LookBanana3.C

20 nsec

5. ROUGH HJET profile measurement

- Fix the RHIC beam position (one is at the center, the other is at far away).
- Move HJET base for every 1.5mm step (gage=6000).
- Take short time data (5 minutes is enough, but make sure always same minutes).
- Calculate event counts for every gage point. Use /home/okadah/JET2008/Online_toosl/LookProfile.C
  - BOX shape event cut ($1.2<T_R<2.5$ MeV, $25<ToF<55$ nsec). Look at source code for details.
- Make a plot (gage position vs. event counts).

Sample HJET profile



You can find a good HJET base position!

6. Spin and bunch pattern check.

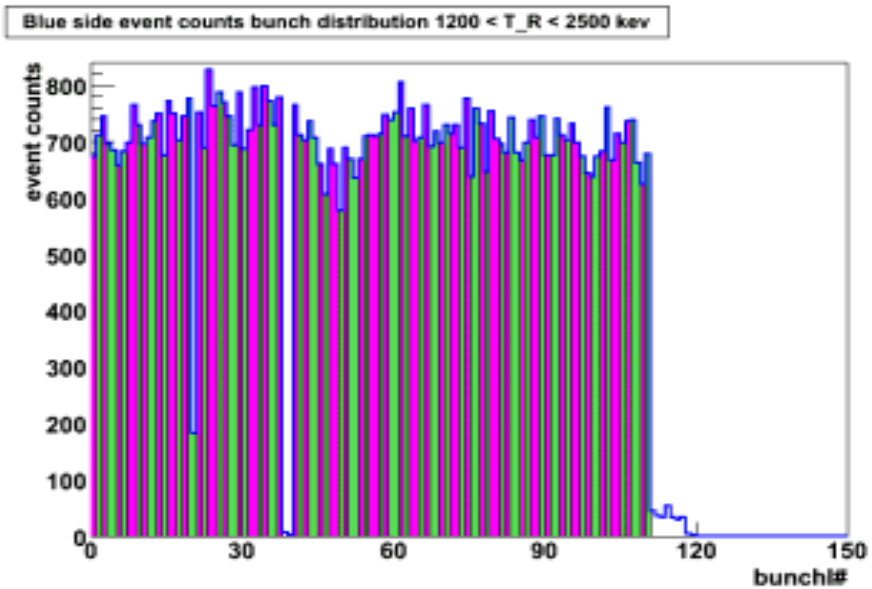
- You need to check bunch pattern and spin pattern for every fill.
- Use /home/okadah/JET2008/Online_tools/LookBunch.C

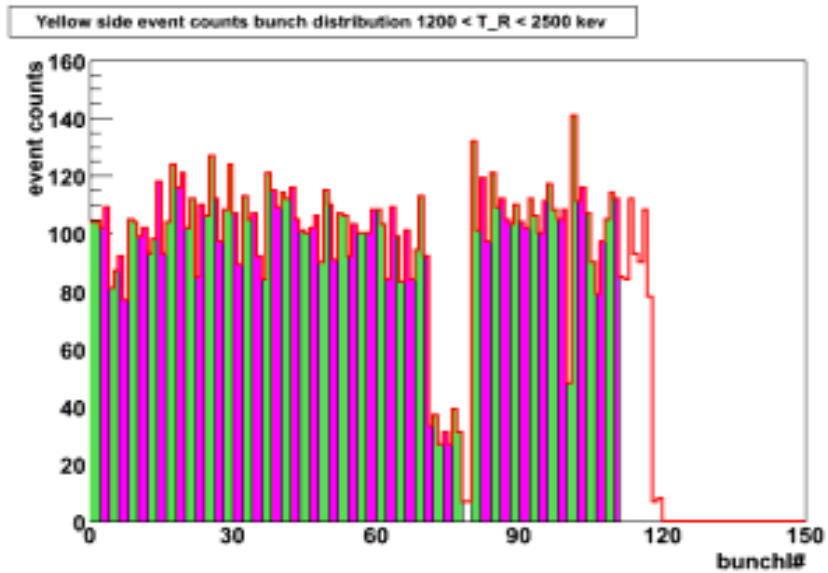
  >root –l

  >.x LookBunch.C

  >Enter run name: xDDMM.5AB
- If you run with blue (yellow) mode, you need to check blue (yellow) side spin and bunch pattern.
- If aboard gap is wrong position, you need to modify ONLINE analysis program source (/usr/local/polarim/bin/HJET.h).
  - Open HJET.h source file and find “#define BUNCHCORR 40”.
  - In RUN8, we used yellow-clock only. And I guess the same for RUN9~. You might need to shift bunch0 for BLUE.
  - (I set BUNCHCORR = 40 for RUN8, →ask Igor if you do not know.)

Output sample plots of LookBunch.C





- Sample data x2602.501 (BLUE mode).
- Filled color corresponds spin sign: pink ↑, green ↓ .
- This sample is BLUE mode, then you need to look at “blue side” data (left.)
- You need to confirm aboard gap sit proper position.

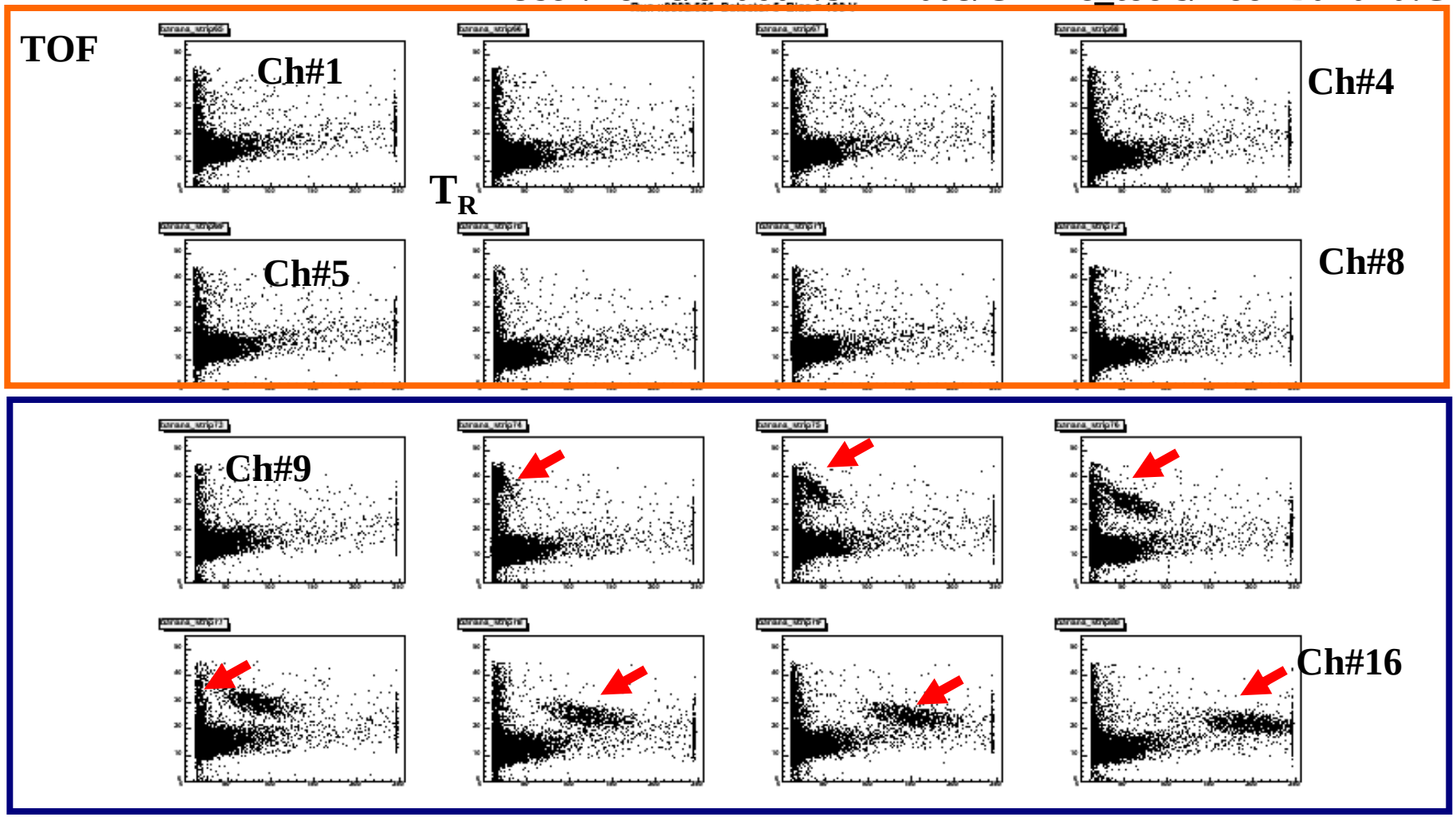
/usr/local/polarim/bin/HJET.h (part)

```
/*
   Class definition for online Hjet data analysis
   I. Alekseev & D. Svirida, 2006.
*/

#ifndef HJET_H
#define HJET_H

#include <stdio.h>
#include <TNamed.h>
#include <TThread.h>
#include <TCanvas.h>
#include <TTree.h>
#include <TH1F.h>
#include <TH1D.h>
#include <TH2F.h>
#include <TFile.h>
#include <TTimer.h>
#include "rhicpol.h"
#include "rpoldata.h"
#include "HCut.h"

#define MAXWAVEFORMS    100
#define MAXSICHAN       100
#define MAXQUEUE        100
#define LINEPOINTS      6
#define DETECTORS       6
#define BUNCHCORR       40 //RUN6 80, RUN8 40 Hiromi Feb. 25, 2008
#define LARGE_VALUE     (1.0E50)

typedef struct {
   int chan;                // Channel number
   int rev;                 // revolution number
   int bunch;               // bunch number
   int bpol;                // bunch polarization (-1, 0, +1)
   int jpol;                // jet polarization (-1, 0, +1)
```

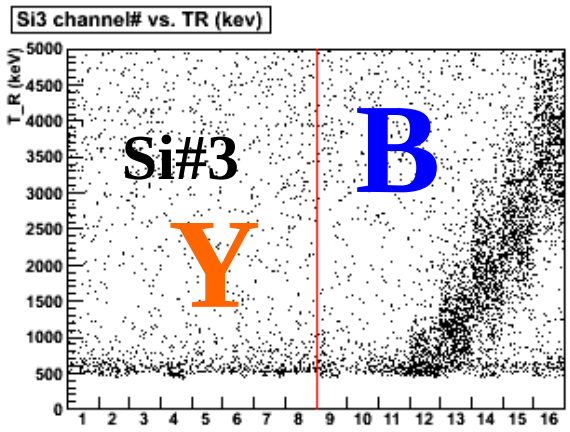
Change "BUNCHCORR" value as needed.

7. Channel selection for every energy-bin

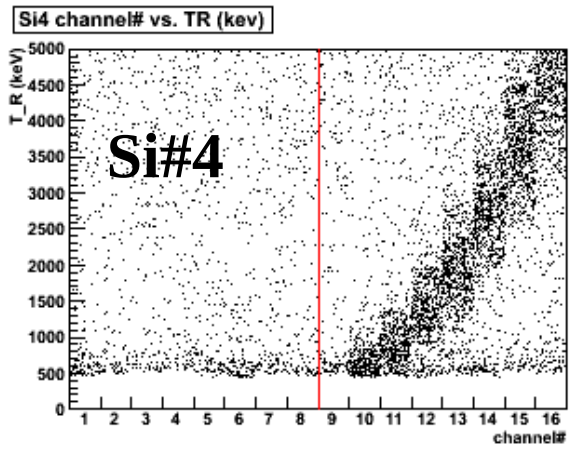
Use /home/okadah/JET2008/Online_tools/LookBanana.C

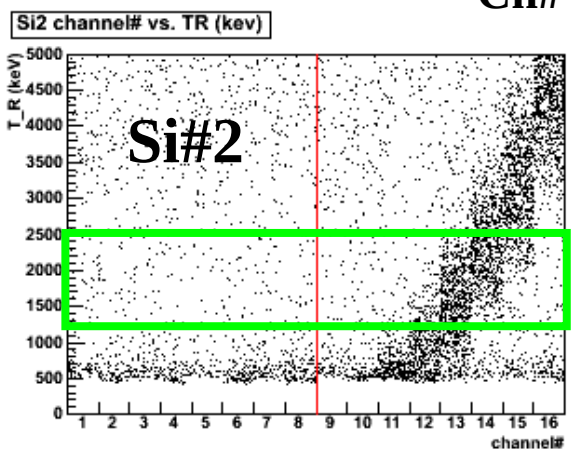


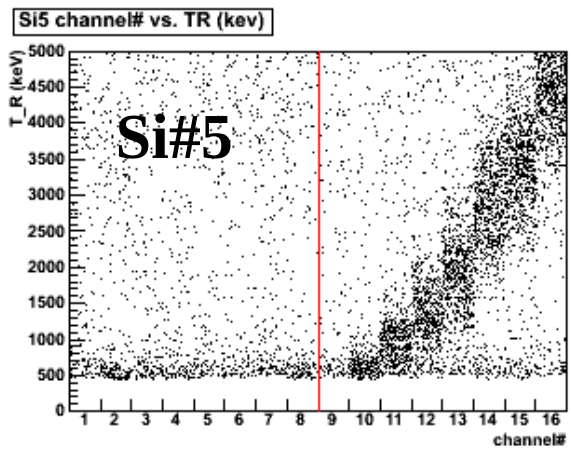
- *pp* elastic scattering events have 2 correlations: "Energy-ToF" and "Energy-recoil angle (channel#)".

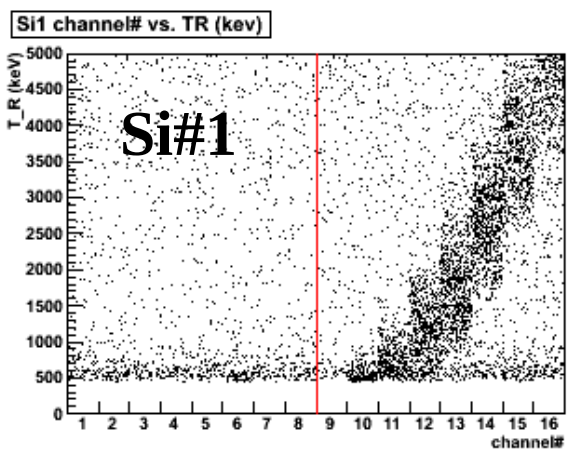


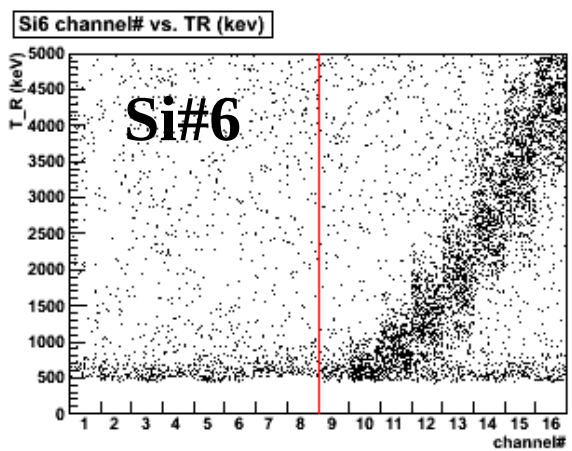
T_R











T_R and ch# correlation

(TOF cut is applied already.)

$$Ch\# \propto \theta_R$$

Forward scattered particle identification

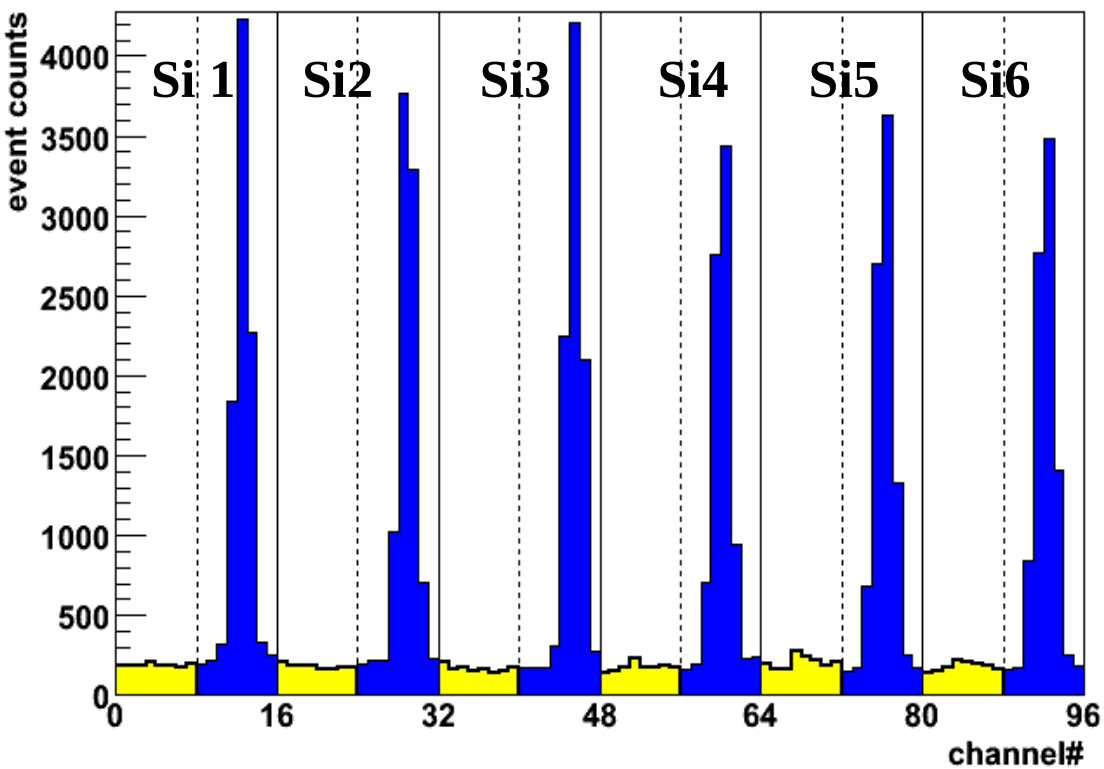
Use /home/okadah/JET2008/Online_tools/LookEx.C

How to select proper channels?

→ Look at event distribution for energy-bin.

Elastic scattering: recoil angle and kinetic energy of recoil proton are highly correlated.

→ Within a certain energy bin, hit channels are always same!



BLUE mode

Use /home/okadah/JET2008/Online_tools/LookEvent.C

You can pink proper channel numbers from this plot by your eyes.

Useful tools for Channel selection for every energy-bin :

- To make a plot in page 24:
  - Energy vs. *ToF* 2-D plot for every Si detector.
  - /home/okadah/JET2008/Online_tools/LookEx.C

  >root –l

  >.x LookEx.C

  >Enter run name: xDDMM.5AB
- To make an event count distribution plot in page 25:
  - /home/okadah/JET2008/Online_tools/LookEvent.C

  >root –l

  >.x LookEvent.C

  >Enter run name: xDDMM.5AB

  >Enter energy bin (1-6): 1

Check every energy-bin!
And pick channel
numbers from plots

How to use selected channel information?

- This information is needed for a tool:
  - /home/okadah/online_tools/LookAsymEvent.C
    - To calculate 8 types of event counts (sorted by energy-bin, spin-info., left-right).
    - Please modify source code followed by comments in the source code.

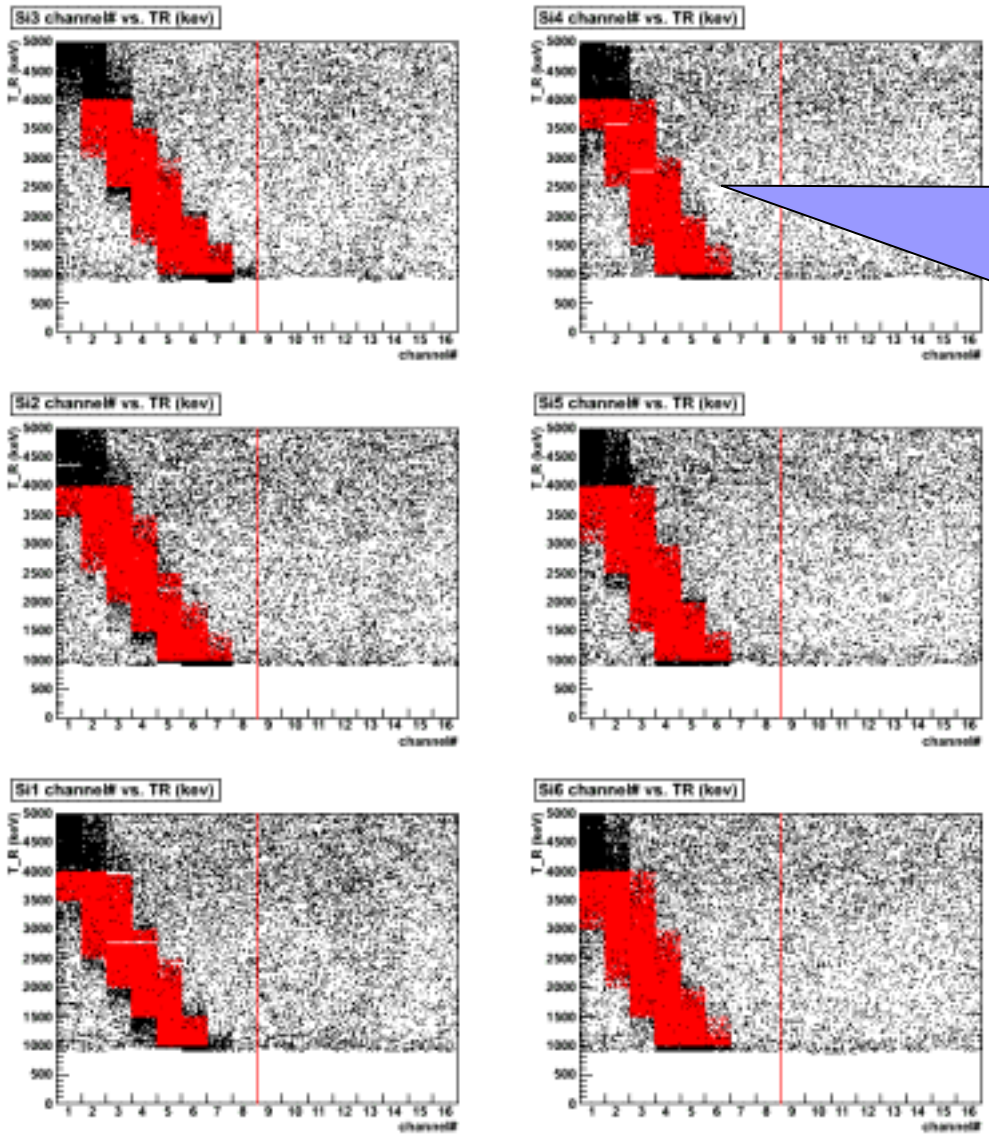
    >root –l

    >.x LookAsymEvent.C

    >Enter run name: xDDMM.5AB

    >Enter mode (blue mode -1, yellow moew 1): 1
    - Output txt format file into directort AsymTxt/xDDMM.5AB.txt
    - Plot channel# vs. Energy plot. Selected events are in red color. See next page.

Example plot channel# vs. Energy plot.



Selected events are in red color.
You should confirm your channel selection (page 28) is reasonable.

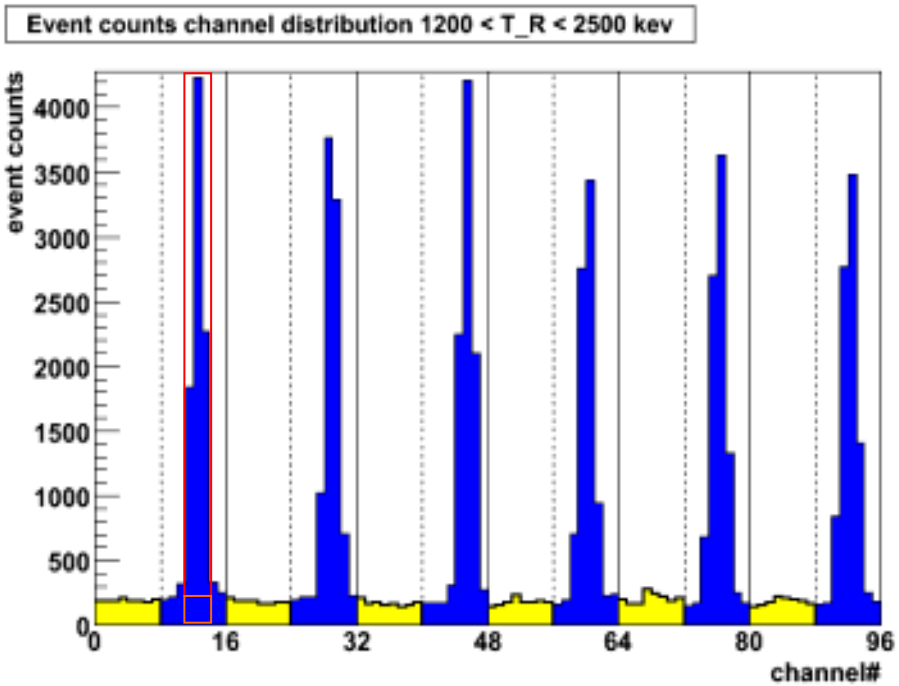
Use /home/okadah/online_tools/LookAsymEvent.C

8. Repeat items 2~ 6 for the another RHIC beam!

What I did during RUN8 physics data taking period.

- Signal/Background ratio stability check by eyes at least every fill.
  - Use /home/okadah/JET2008/Online_tools/LookEvent.C
  - See next page to find how to check data.
- ε_{target}, ε_{beam} and ratio= $\varepsilon_{beam}/\varepsilon_{target}$ calculation for every beam swap (every beam mode change).
  - Use /home/okadah/JET2008/Online_tools/CtoANB.C for blue mode data, and CtoANY.C for yellow mode data.
  - You need to prepare input file: runB.txt (runY.txt) to run CtoANB.C (CtoANY.C).
- Please look at the source code for more details.

Signal/Background stability check



BLUE mode

Elastic scattering: recoil angle and kinetic energy of recoil proton are highly correlated.

→ Within a certain energy bin, hit channels are always same!

→ I picked 3 channels.

Check background level and signal/background ratio.

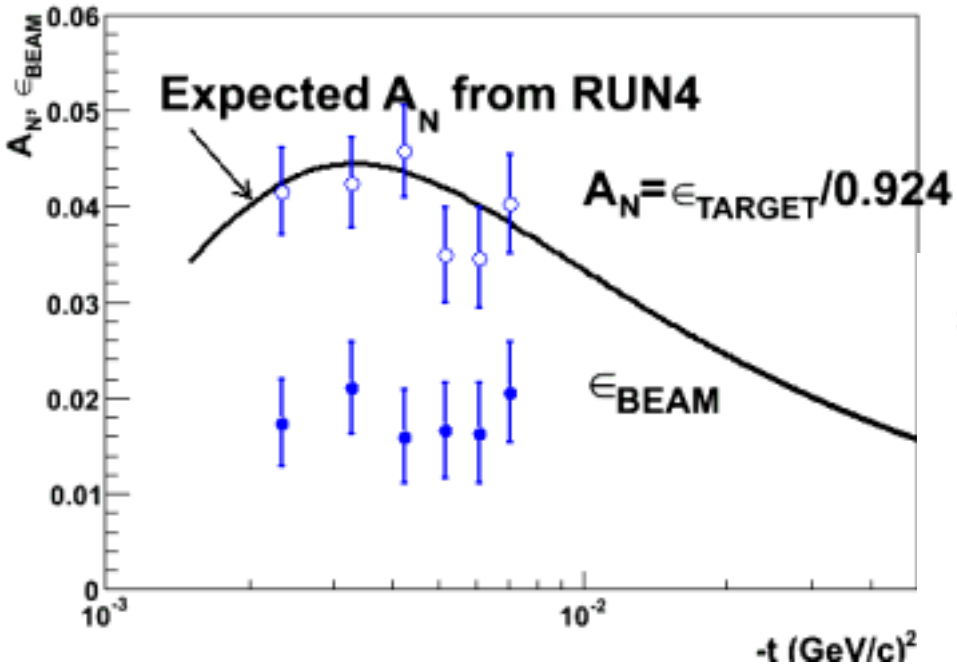
Signal

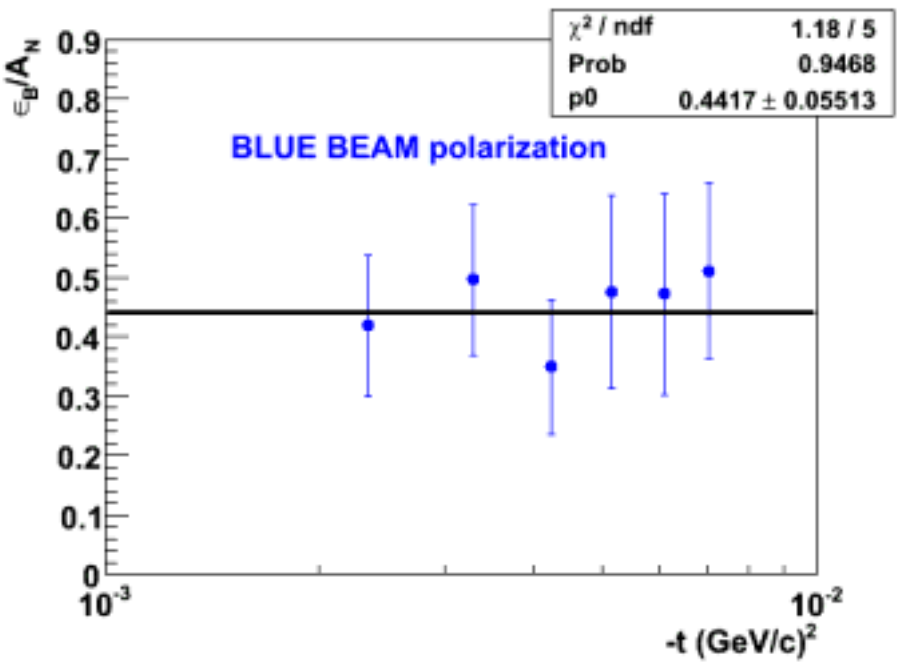
Background (inside cuts accidentally)

Use /home/okadah/JET2008/Online_tools/ LookEvent.C

ONLINE beam polarization

Use /home/okadah/JET2008/Online_tools/CtoANB.C for blue mode data, and CtoANY.C for yellow mode data.





Repeat same thing for every beam-period.