

TOF Calibrations in Au+Au and d+Au

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OUTLINE:

update on **Au+Au calibrations** and pid performance...

NIM paper is 99.44% finished and queue'd on spokesman's desk for GPC decision...

primary focus of recent work is on d+Au calibrations....

start corrections 95%, stop corrections 5%

- **entire data set**
- **all TOF chs**

start-side corrections in d+Au

event classes and subclasses...

PH scale w.r.t. threshold...

calibration techniques...

$\langle 2 \rangle$ - $\langle 4 \rangle$, $1-\langle 2 \rangle$ (e or w), 1.and.1 OS, 1.and.1 SS so far....

fit functions...

iteration...

backgrounds...

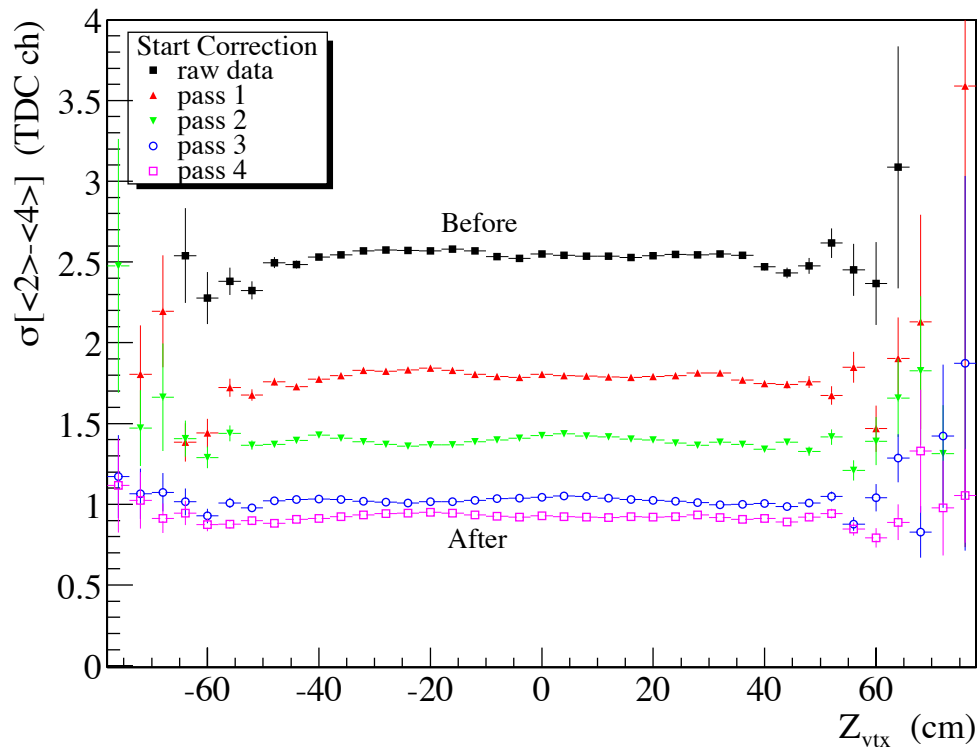
“Epochs” during the run....

results from $1-\langle 2 \rangle$, adc dependence of resn and efficiency...

results from other techniques...

first **invbeta/PID from TOFp+pVPD in d+Au...**

summary/near-term plans...



Au+Au start-side slewing....

all six PMTs live in every event

→ 3 start time measurements in each event
based on two pmts

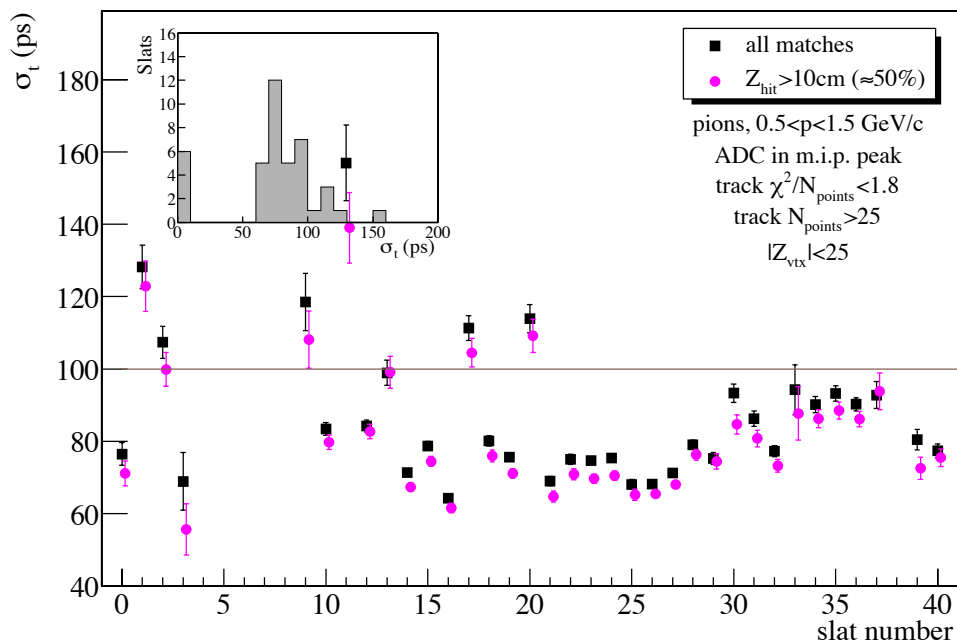
→ 2 start time measurements,
one w/ 2 PMTs and the other w/ 4 PMTs

minimize dependence of
the difference of these 2 start times
on the ADC values in the 2-PMT sum.

iterate, attacking different pairs of ADC dependences..

$$\sigma_{\langle 2 \rangle - \langle 4 \rangle} \sim 0.9 \text{ch} * 50 \text{ps} \quad \sim \mathbf{45 \text{ ps}}$$

$$\sigma_{\langle 6 \rangle} = 0.47 * \sigma_{\langle 2 \rangle - \langle 4 \rangle} \quad \sim \mathbf{24 \text{ ps}}$$



Au+Au stop-side slewing and hit prop time...

work in invbeta space from first step...

minimize $\text{invbeta}(\text{meas}) - \text{invbeta}(\text{expected}, \text{pion})$
vs (ADC, Z_{hit})

w/ event & track quality cuts:

avgd over all slats...

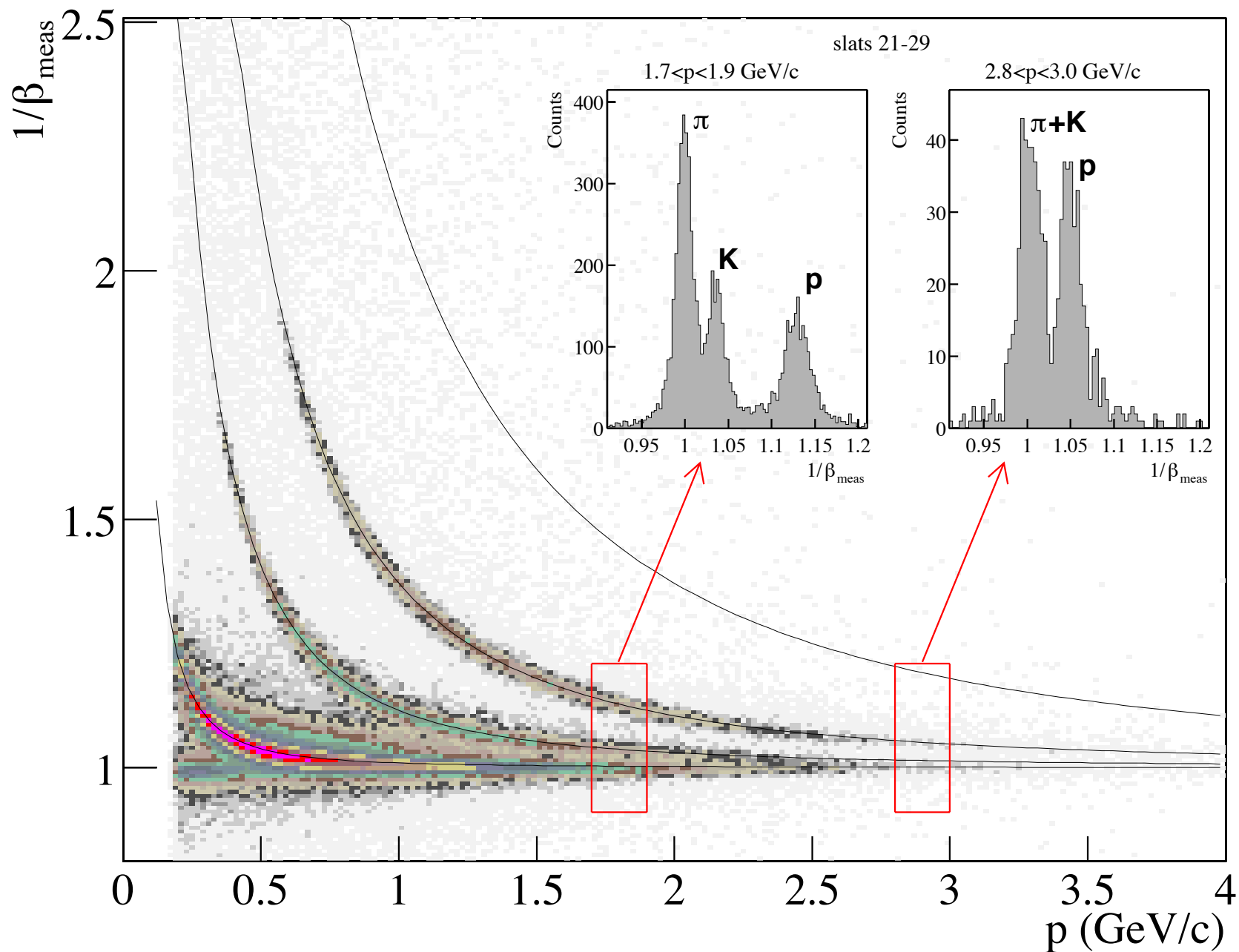
$$\sigma_{\text{total}} \quad \sim \mathbf{87 \text{ ps}}$$

$$\sigma_{\text{stop}} \quad \sim \mathbf{83 \text{ ps}}$$

avgd over best 25 slats...

$$\sigma_{\text{total}} \quad \sim \mathbf{79 \text{ ps}}$$

$$\sigma_{\text{stop}} \quad \sim \mathbf{75 \text{ ps}}$$



invbeta resolution is consistent w/ quoted time resolutions... (from insets)

AuAu calibrations “complete”... (modulo coordination w/ embedding)

major focus now is getting efficiency numbers to take care of **losses, polarity dependence**, etc...

pVPD in Au+Au (~2.5M evts)

in every event, all six PMTs struck by tens of prompt particles (mostly γ)...

→ big signals at moderate gain...

→ there is only *one* (1) “start class” (only one way to select 6 PMTs out of 6 total).

→ slewing correction algorithms naturally treat *both*
the 6 ADC dependences (standard candle is an ind. meas. start time in the same evt)...
and all relative offsets from start-side...

easy!

pVPD in d+Au (~9M evts)

finite rate for any combination of Ne from 1 to 3 and Nw 1 to 3.... (local trigger was “1.and.1”)

relative rate per start class:

	Nw=1	Nw=2	Nw=3
Ne = 1	13%	4%	0.6%
Ne = 2	18%	5%	0.7%
Ne = 3	45%	11%	1.5%

total = 100%

number of subclasses per start class:

	Nw=1	Nw=2	Nw=3
Ne = 1	9	9	3
Ne = 2	9	9	3
Ne = 3	3	3	1

total = 49

unless Ne!=3 and Nw!=3 (i.e. >99% of the dAu data)

slewing corrections treat ADC dependences (by definition)

but *do not* necessarily take care of all relative offsets coming from the local trigger...

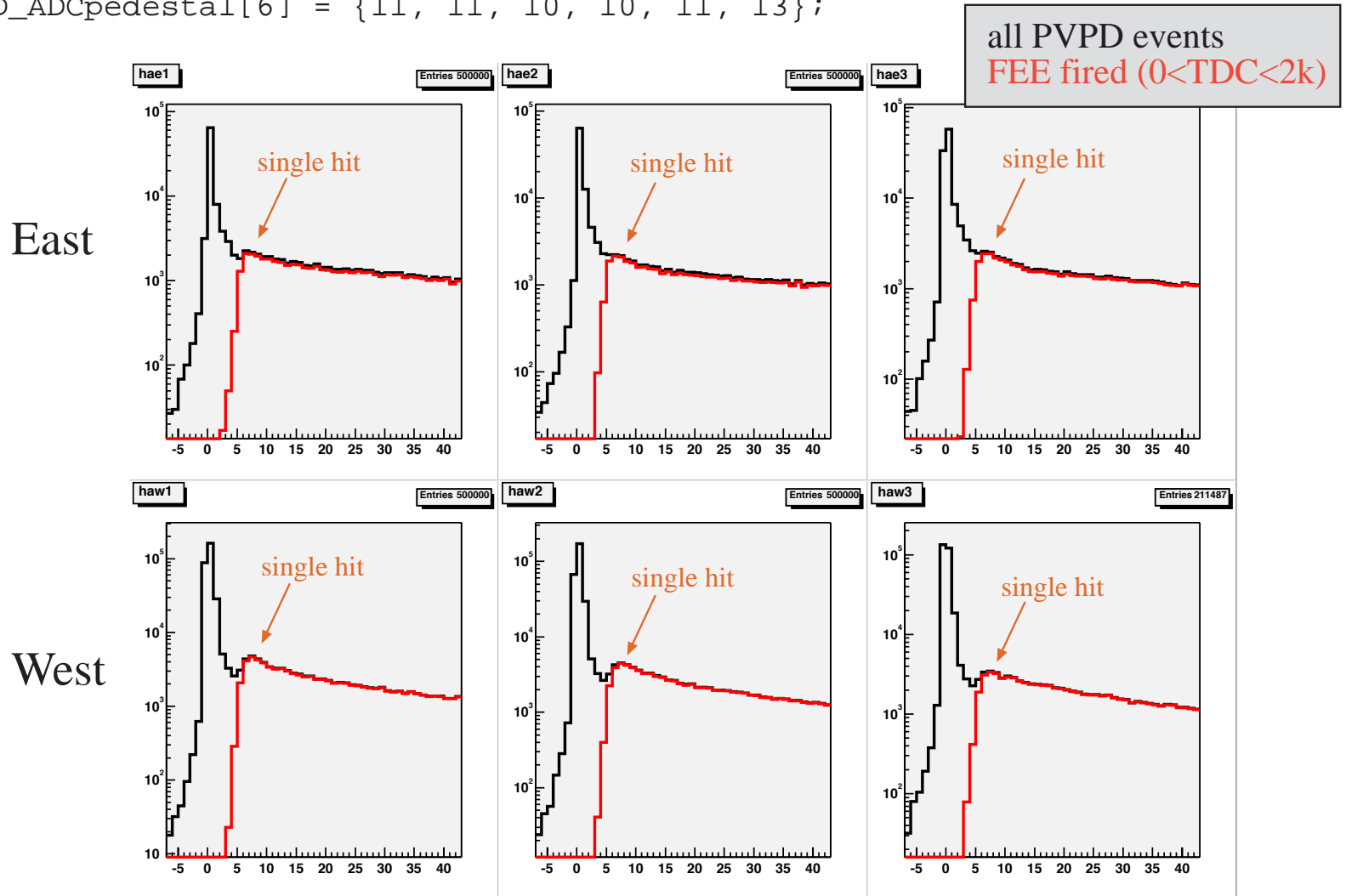
signals smallish even though gains are cranked to maximum possible...

not so easy....

pVPD d+Au pedestal subtracted ADC values...

using only HR ADC...

```
Float_t pVPD_ADCpedestal[6] = {11, 11, 10, 10, 11, 13};
```



Most common ADC values are also those w/ the largest slewing...

→ screams for **variable width ADC binning** during all dAu slewing corrections...

Single hit: ADC ~ 7-8 chs

Threshold: ADC ~ 4 chs

→ local trigger based on events w/ PH/Thres > ~2... (gain limited)
typically want PH/Thres >> 2.... *ouch...*

total of 9 different start classes w/ various rates
total of 49 different subclasses, w/ subtly correlated relative offsets....

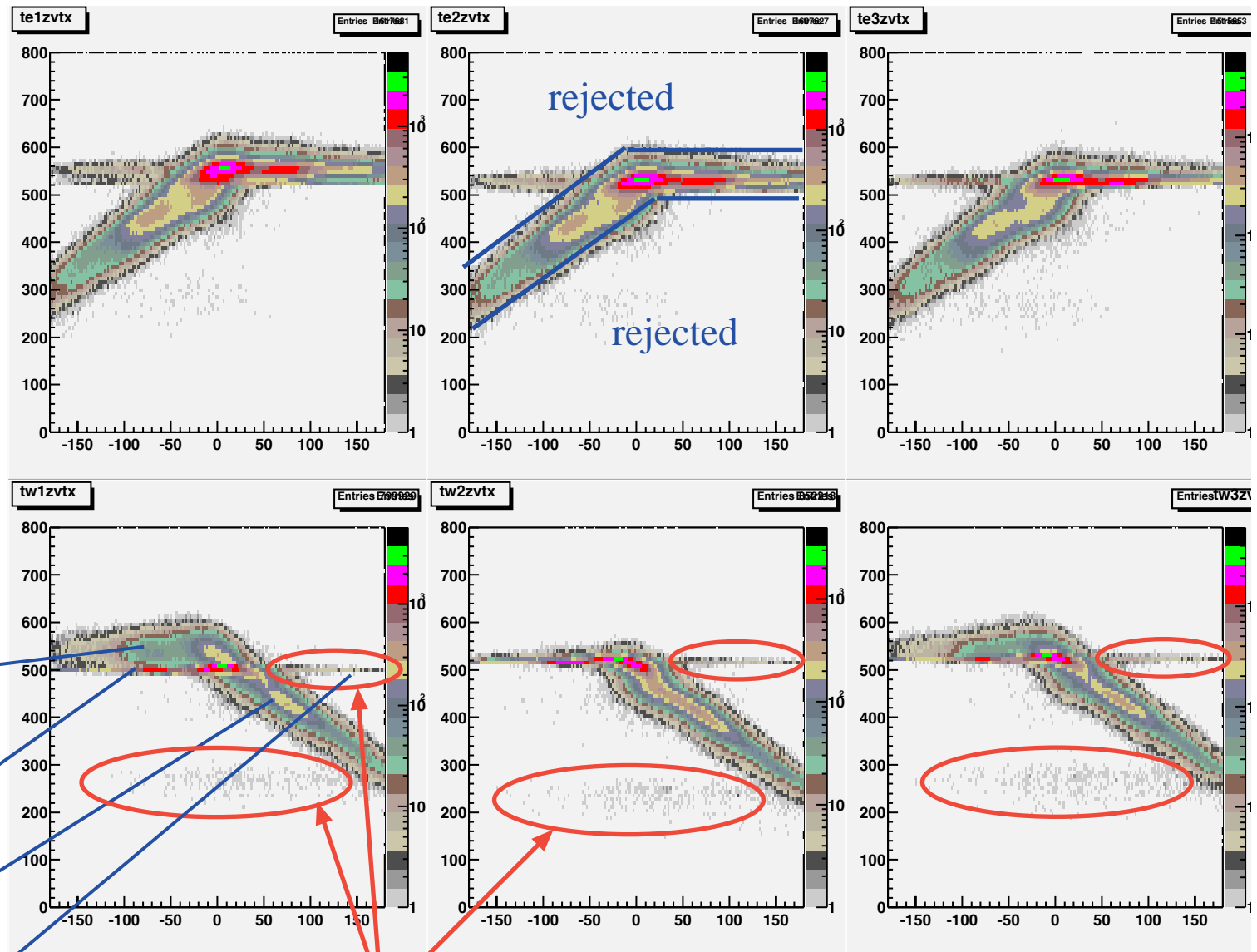
recent goal has been to calibrate the most populous of these classes
w/ “relative timing” (a.k.a. “standard candle”) techniques...

Studied so far....

start classes:	technique:	Nsubclasses:	
“3 and 3”	“⟨2⟩-⟨4⟩”	1	major player in AuAu “zero” rate in dAu
“3 same side” a_pvpde3.C a_pvpdw3.C	“⟨1⟩-⟨2⟩”	1 (east or west)	major player for East in dAu
“1 and 1 same side” a_pvpd11ss.C	“1-1”	9	towards N=2 events on east or west
“1 and 1 opp. side” a_pvpd11.C	“1-1” - poll(Zvtx)	9	major player for p+p
“east 3 and west 1” a_pvpde3w1.C	calibrate east “⟨1⟩-⟨2⟩” teast - west(i) - poll(Zvtx)	3	40% of the dAu events...

Backgrounds.....

raw TDC values
versus Zvtx...
(all event classes)



W1 on same side
as start ch

W1 is the start ch

Start ch on East

W1 is start ch but
Zvtx on wrong side!

Backgrounds: possible start chs that cannot be “in-time”....
pVPD E-W totally inconsistent w/ Zvtx...
screws up entire timing scale (i.e. stop side)...

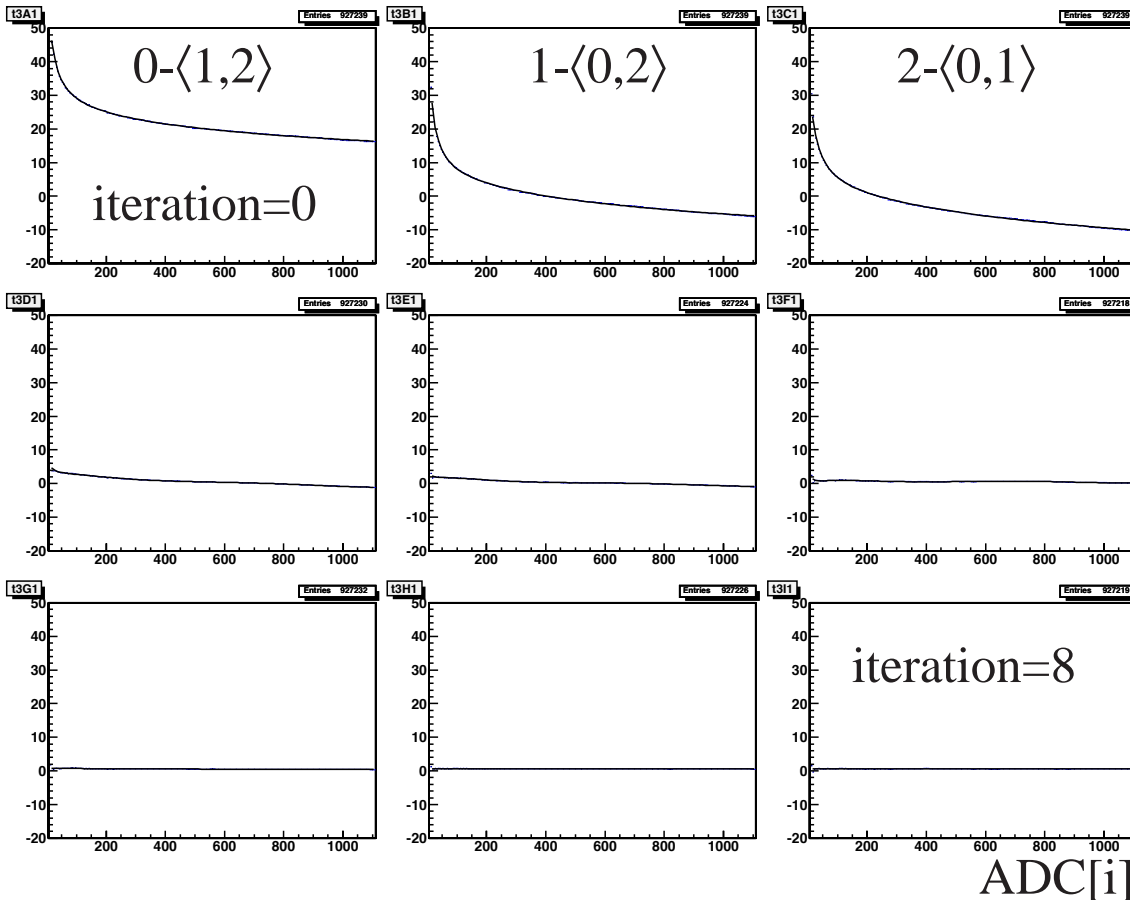
for all event classes and subclasses, **fit functions** are 7 parameter polynomials....

can handle (sometimes v. steep) trends
but doesn't "over-fit", quick, general

"first" pass for given subclass:
polynomial in $1/\text{Sqrt}(\text{ADC})$
all subsequent passes:
polynomial in $\text{Sqrt}(\text{ADC})$

```
const Float_t adcLL = 10.;
Double_t zv,adca,radc,zhit,result;
//
const Int_t npar_t3=7;
Double_t fun_t3(Double_t *x, Double_t *par) {
    result = 0;
    if (x[0]>0){
        radc = TMath::Sqrt(x[0]);
        result = par[0] + par[1]/radc
                + par[2]/radc/radc
                + par[3]/radc/radc/radc
                + par[4]/radc/radc/radc/radc
                + par[5]/radc/radc/radc/radc/radc
                + par[6]/radc/radc/radc/radc/radc/radc;
    } return result; }
//
const Int_t npar_t3B=7;
Double_t fun_t3B(Double_t *x, Double_t *par) {
    result = 0;
    if (x[0]>0){
        radc = TMath::Sqrt(x[0]);
        result = par[0] + par[1]*radc
                + par[2]*radc*radc
                + par[3]*radc*radc*radc
                + par[4]*radc*radc*radc*radc
                + par[5]*radc*radc*radc*radc*radc
                + par[6]*radc*radc*radc*radc*radc*radc;
    } return result; }
```

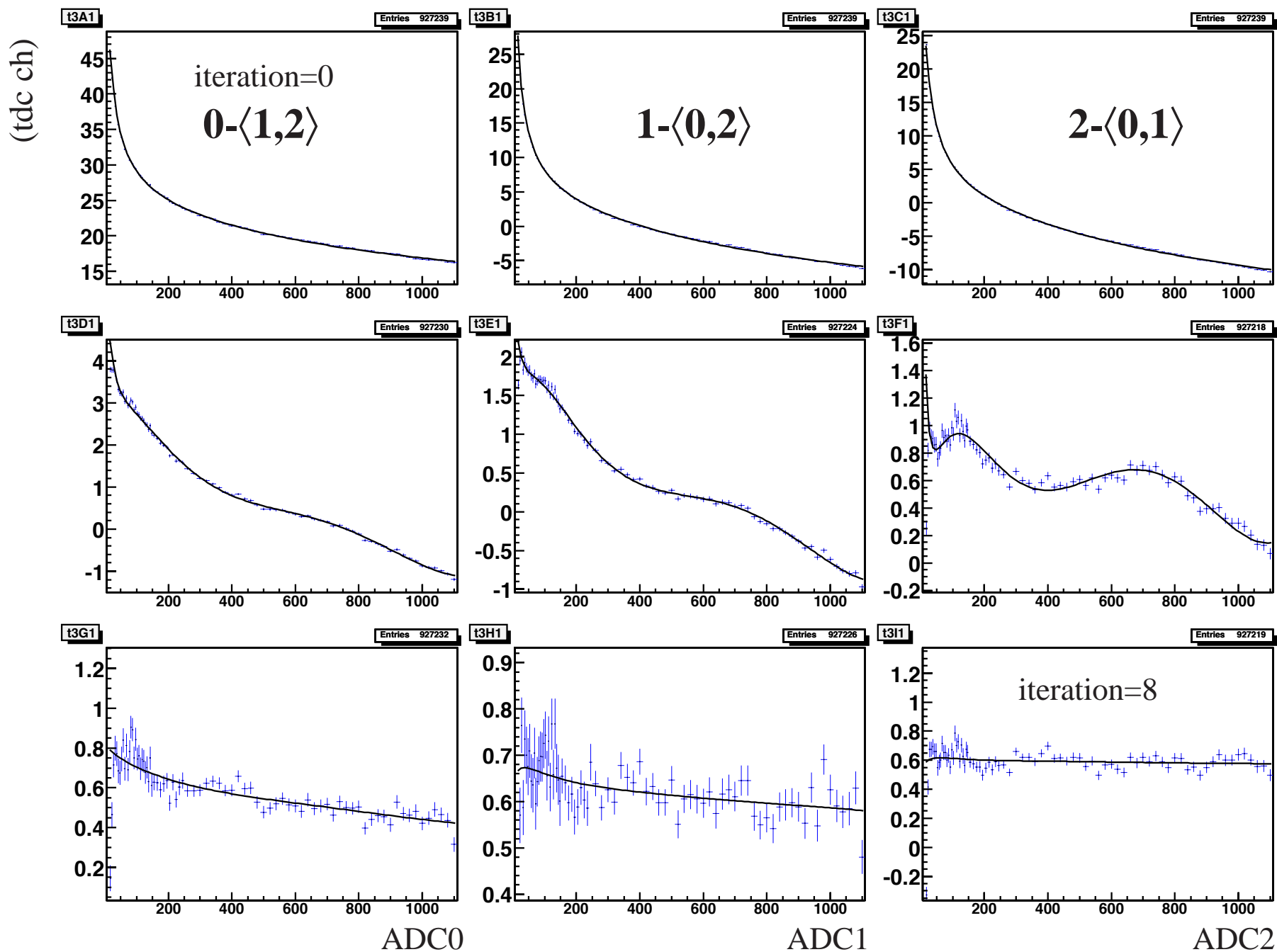
East N=3, $1-\langle 2 \rangle$ minimization



...might think only 5-6 passes
are needed...

same results as on previous page, but expanded to show details....

(Ne==3, East)

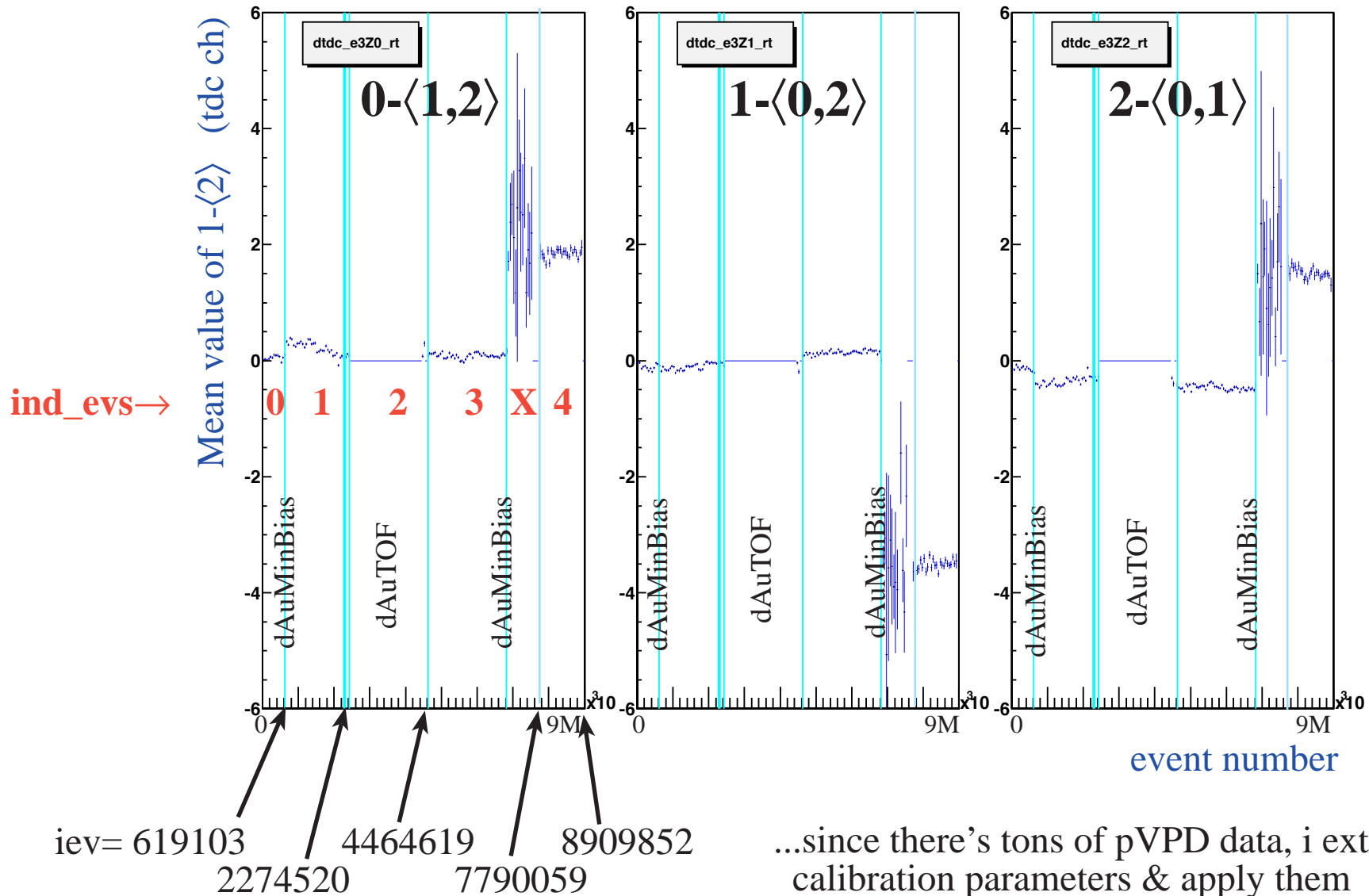


“Epochs” during dAu...

events in match ntuple (from frank) are ordered monotonically non-decreasing in day number...

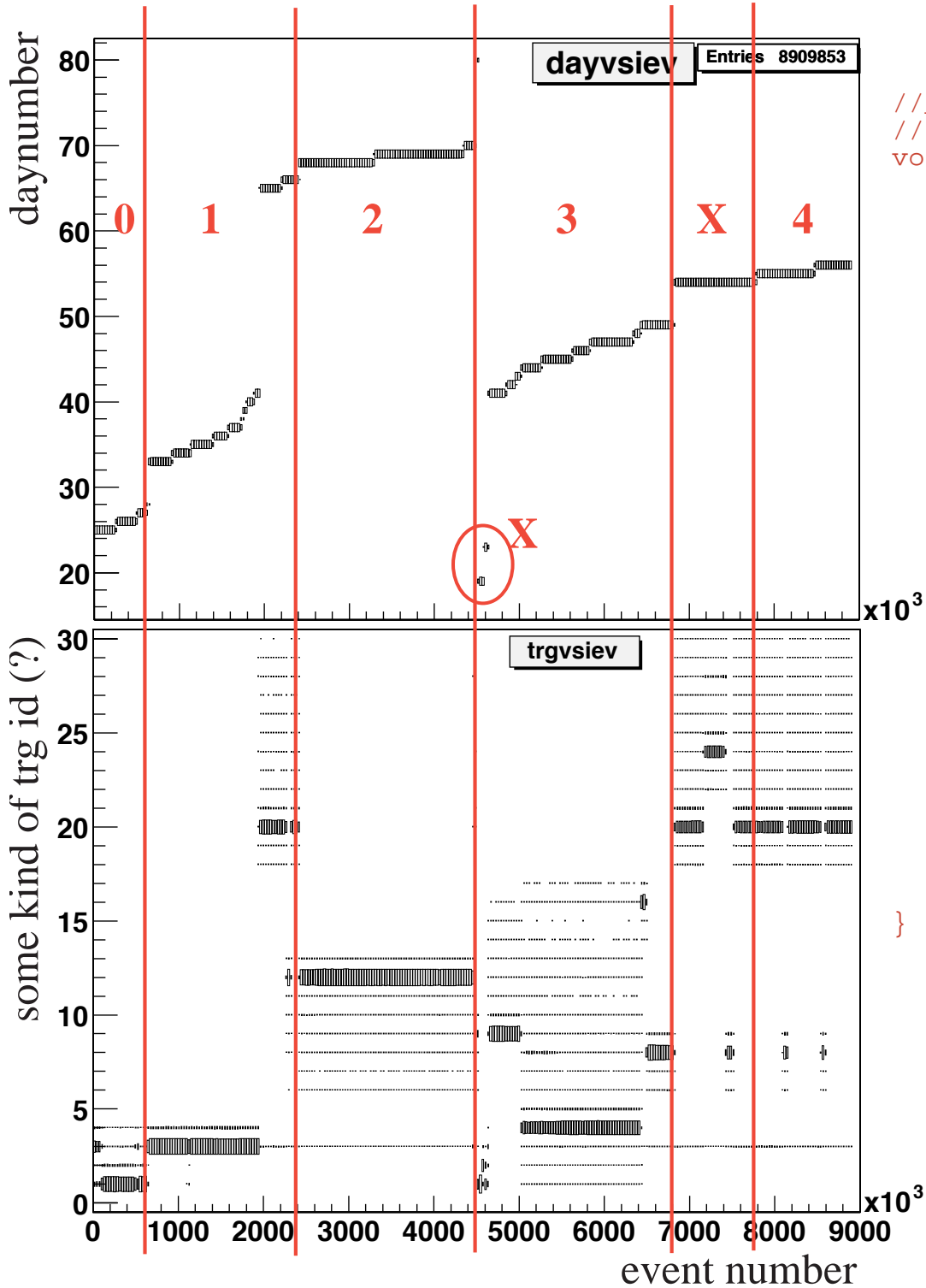
(all polA first, then all polB)...

noticed some **definite jumps in the mean values of 1-⟨2⟩** at specific times throughout dAu run...



...since there's tons of pVPD data, i extract calibration parameters & apply them independently in these 5 separate periods ...

```
par[7][iter][ind_ews][subclass][class]
```



```

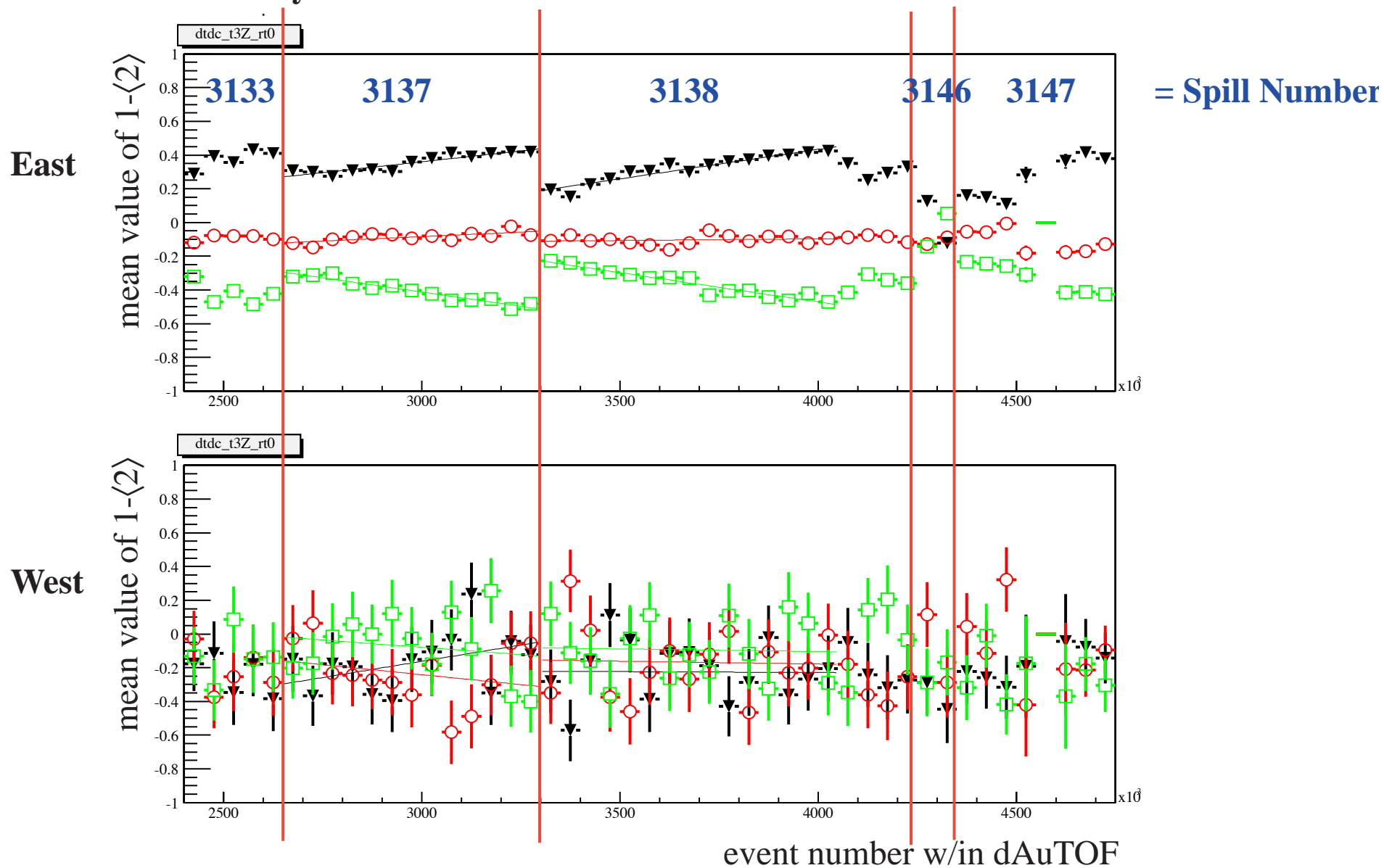
// _____
//
void GetIndEvS(const Int_t   iev,
               const Float_t run,
               const Int_t   ipol,
               const Int_t   daynumber) {
    //
    Bool_t dAuTOF;
    //
    dAuTOF = false;
    //
    if ( run      == 4066046 ) { dAuTOF=true; }
    if ( run      >= 4068010
        && run    <= 4070011 ) { dAuTOF=true; }
    if ( ipol==1) { // polarity A...
        if (daynumber<=27) {ind_evs=0;}
        else if (!dAuTOF)  {ind_evs=1;}
        else if ( dAuTOF)  {ind_evs=2;}
    } else if ( ipol==-1) { // polarity B...
        if (daynumber<=49) {ind_evs=3;}
        else                {ind_evs=4;}
    } if (ind_evs != ind_evs_prev) {
        cout<<"eventset change "
             <<ind_evs_prev<<"->"
             <<ind_evs<< ", at event "
             <<iev<< ", in run "
             <<TMath::Nint(run)<<endl;
        SetFunctions(ind_evs);
    }
    ind_evs_prev = ind_evs;
}

```

and reject all events w/
 daynumber<=23 (pVPD@2kV)
 daynumber==54 (L2 issues)

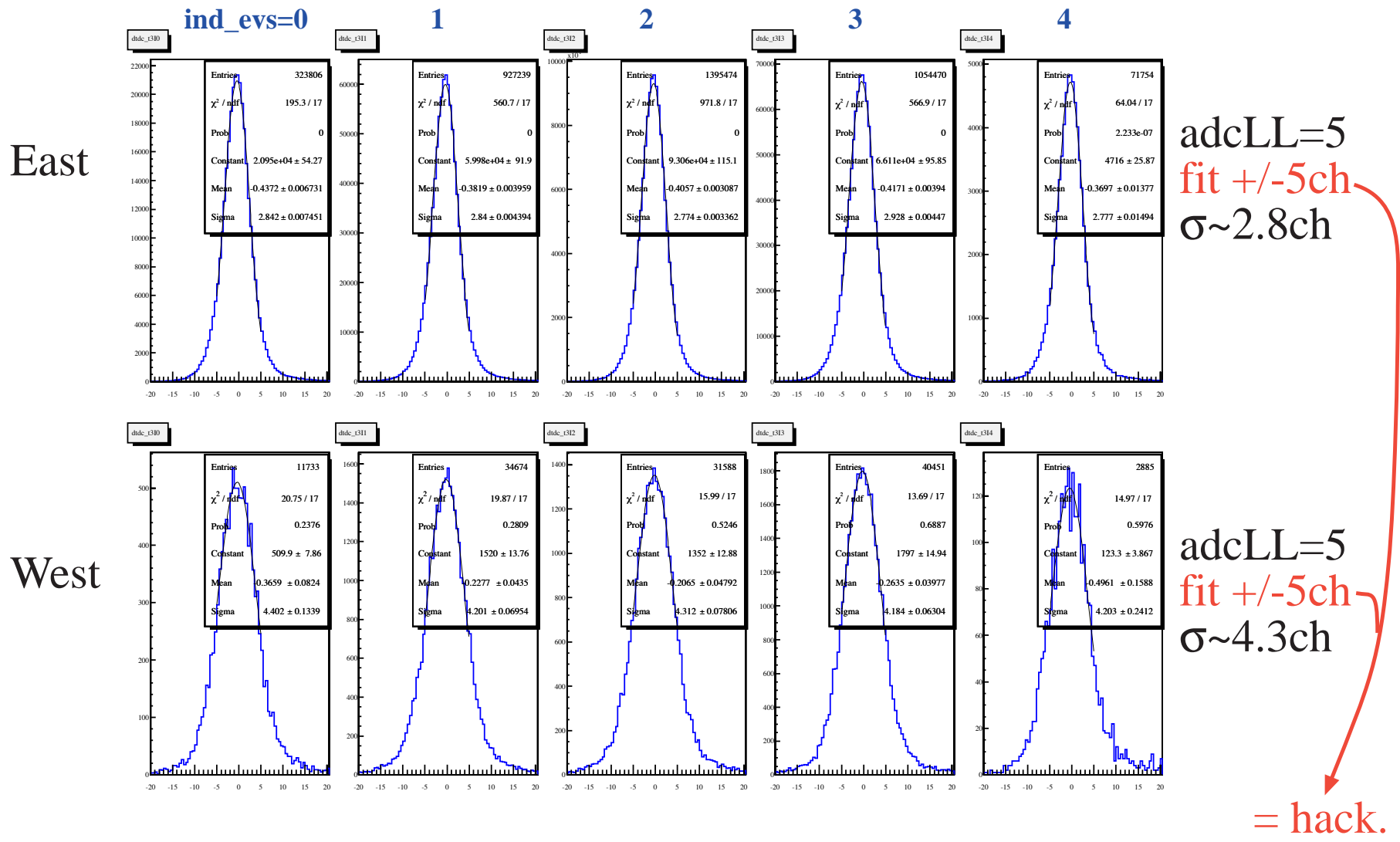
...now **no more jumps** in the mean values of the tdc differences (in any technique...)
...however there *are* jumps in the avgs (the start times).... these are real.

dAuTOF events only...



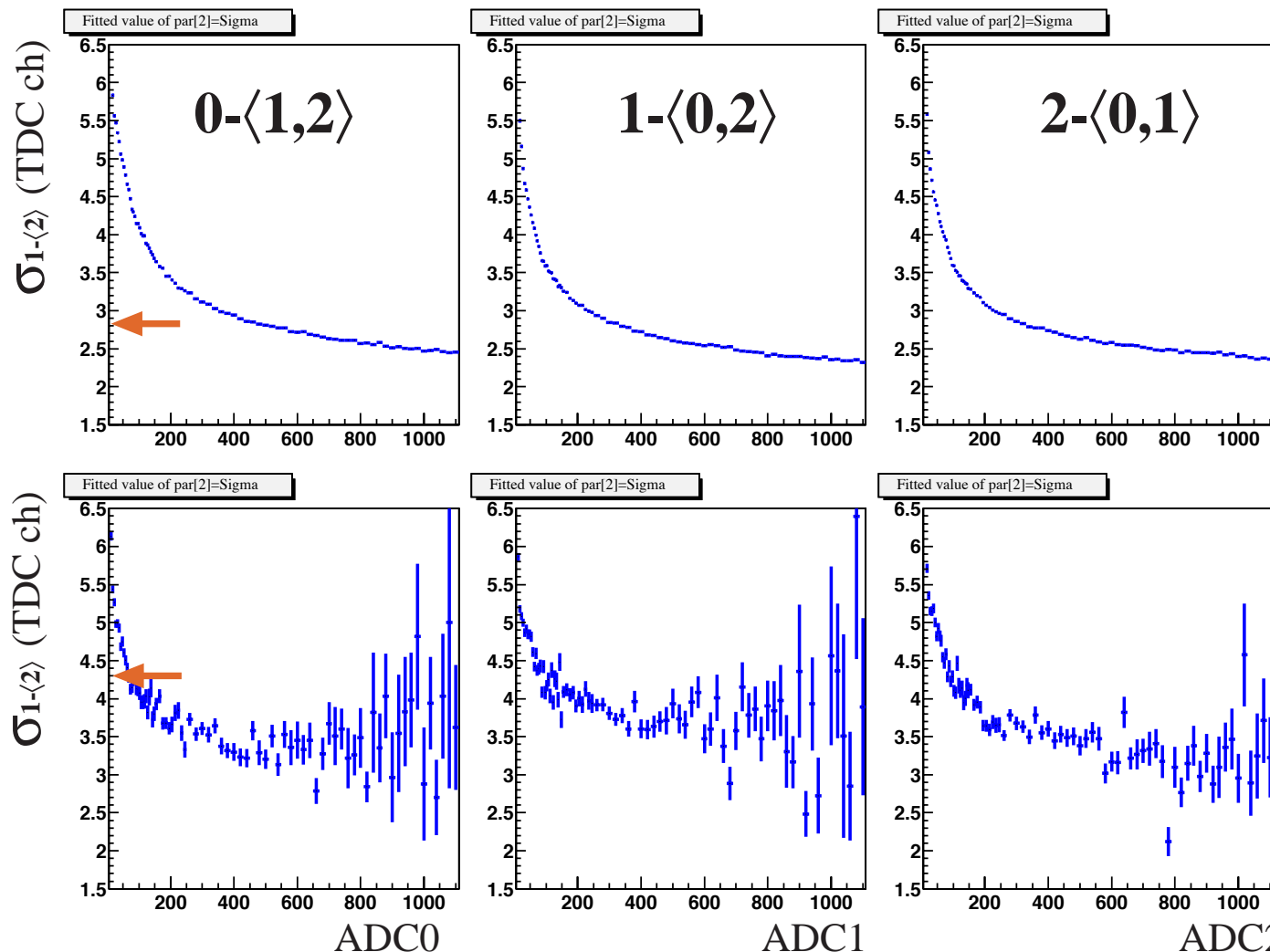
first results on d+Au resn came out w/in first few weeks of run...
 2 independent analysis w/ fairly consistent results... (lijuan, me)...

N=3 classes... "1-⟨2⟩" after 9 iterations



$\sigma(\text{east pmts}) / \sigma(\text{west pmts}) \sim 1.5$ very roughly...
 best resn in sets 1 and 3 (<10% effect)...

= **hack** ...this gaussian-fitting within limits is effectively a fuzzy adc lower-limit cut...



East

$\langle \text{ADC}_{\text{East}} \rangle \gg \langle \text{ADC}_{\text{West}} \rangle$

West

very soon now we'll be comparing TOFp and TOFr results from d+Au and p+p....

to get "good" start timing, pVPD ADC lower limits are unavoidable

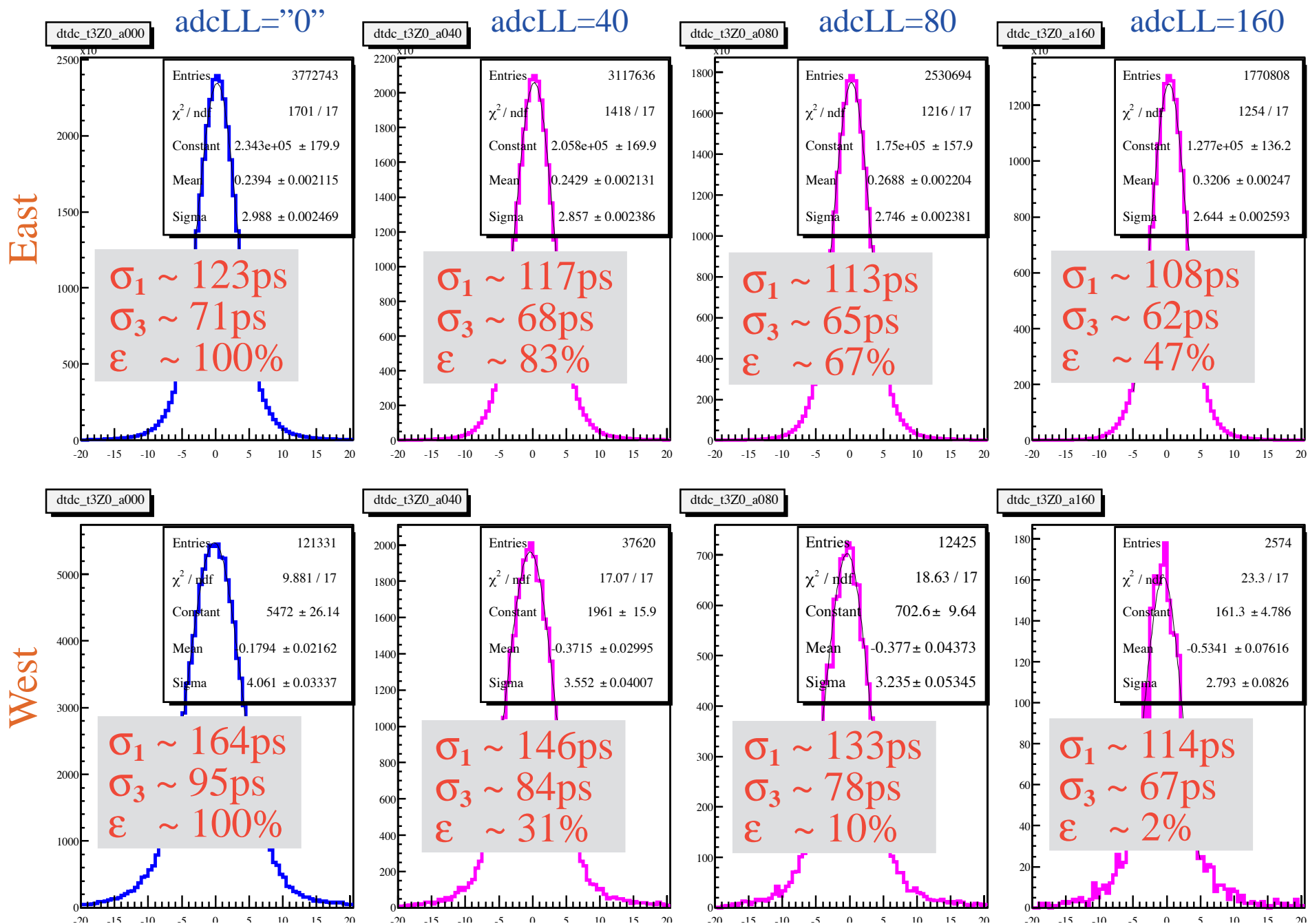
resolution and efficiency of the start correction depends strongly on the chosen ADC limits...

→ we need to agree on some **consistent set of pVPD ADC ranges & algorithms**
so we can directly compare stop-side results (TOFp vs TOFr)...

N=3 classes: dependence of resolution and efficiency from $1-\langle 2 \rangle$ on adcLL....

all 3 ADCs must exceed adcLL

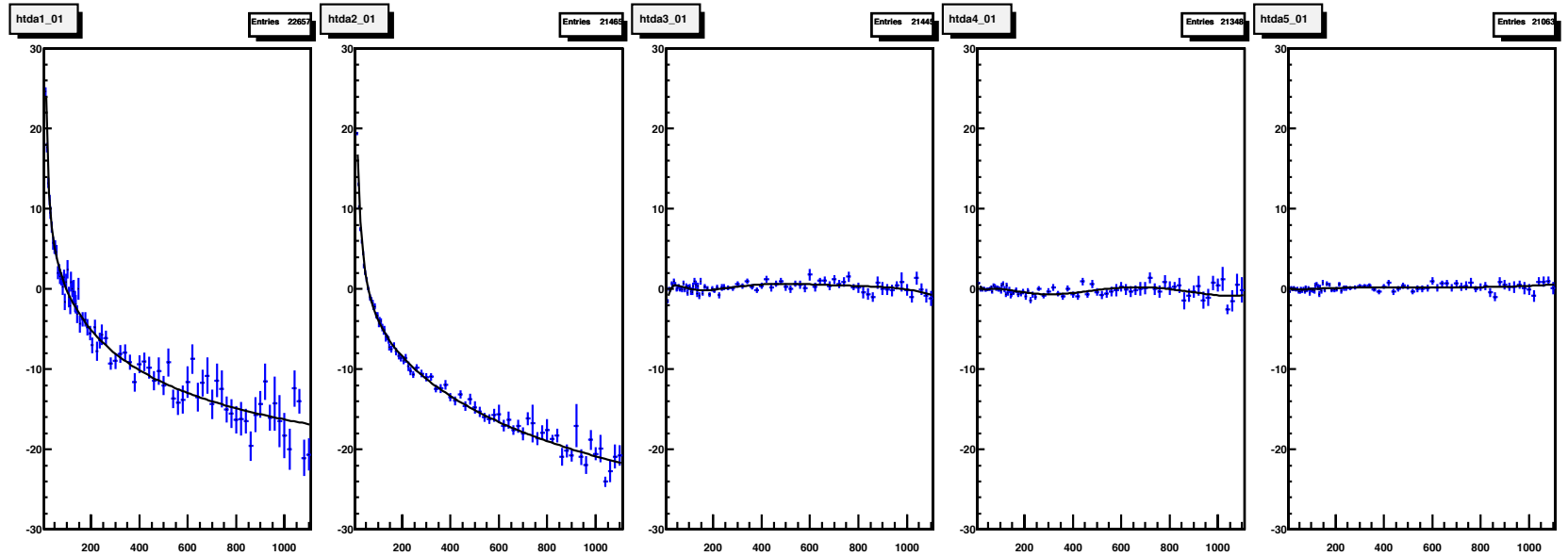
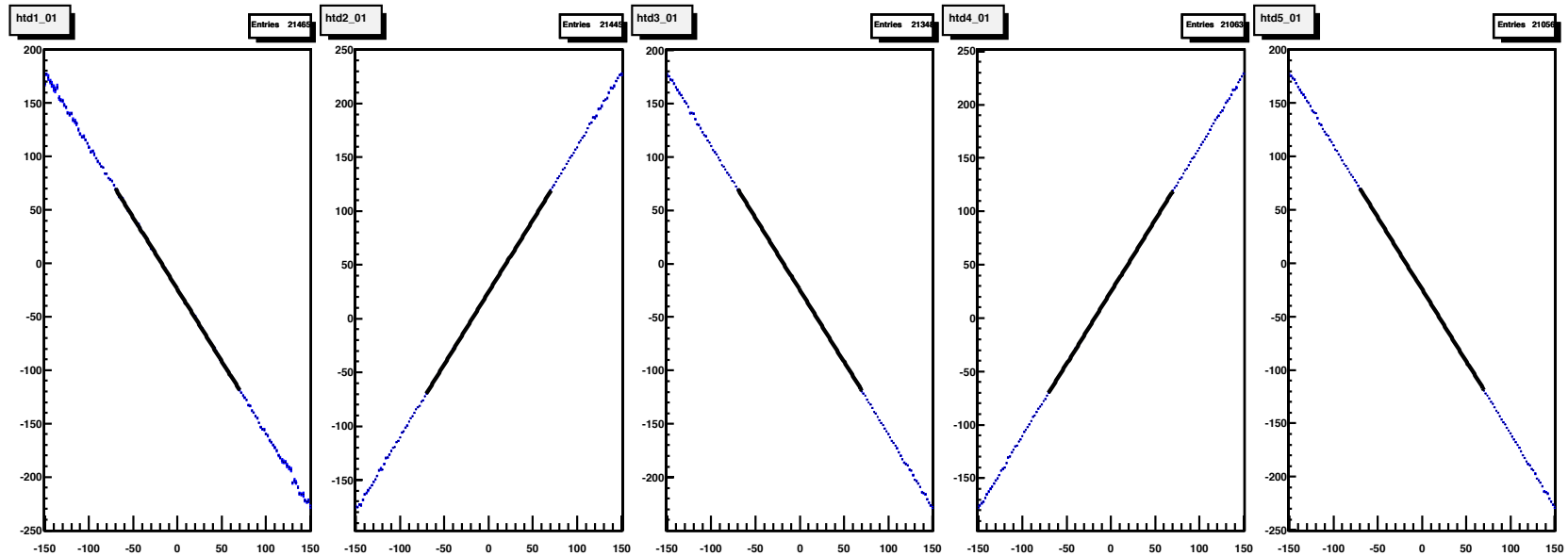
results w/ same hack (fit centroid of the distributions +/- 5ch)



1.and.1 Opposite Side....

standard candle is pVPD time difference minus Z_{vtx} ...

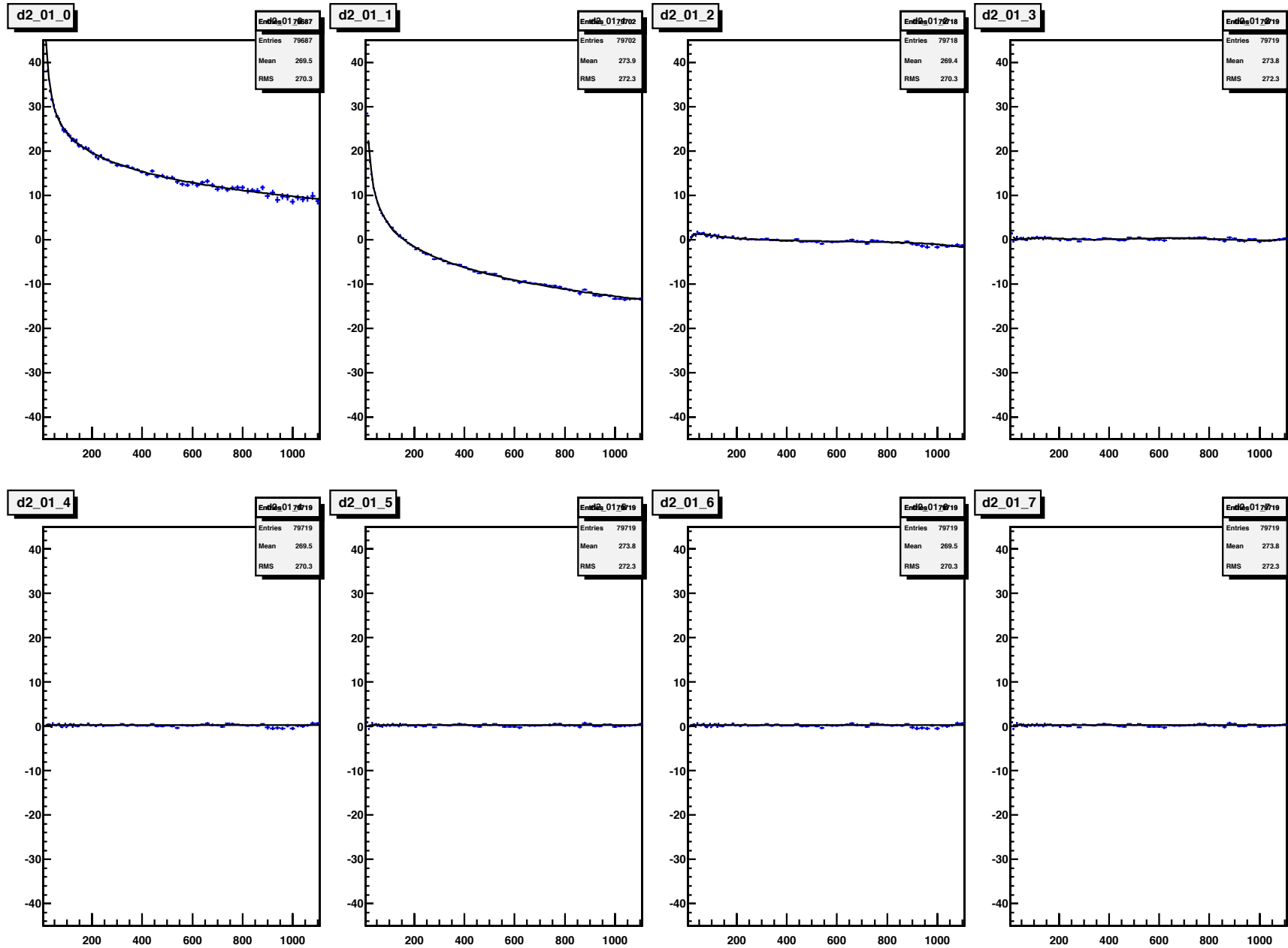
remove ADC dependence of Z_{vtx} residual....



1.and.1 Same Side....

standard candle is a tdc on the same side in the same event...

remove ADC dependence of tdc difference....



so many classes, so many techniques

`par[7][iter][ind_evs][subclass][class]`
7 6-12 5 9, 3, or 1 9 → ~thousands of start-side parameters for d+Au

main goal is to rationalize all this into a simpler approach inasmuch as possible...

- primary **consistency check** across techniques and subclasses...

The “single-detector equivalent resolution,” σ_1 , should be a sensible consistent constant.

	N	Classes	σ/σ_1	σ_1/σ_N
$\langle 2 \rangle - \langle 4 \rangle$	6	Ne or Nw = 3	$\sqrt{(3/4)}$	$\sqrt{6}$
1- $\langle 2 \rangle$	3 (same side)	Ne or Nw = 3	$\sqrt{(3/2)}$	$\sqrt{3}$
1-1 ss	2	Ne or Nw = 2	$\sqrt{2}$	$\sqrt{2}$
1-1 os	2	Nw and Nw = 1	$\sqrt{2}$	$\sqrt{2}$

- comparison of relative offsets in specific pVPD chs in the different techniques

main near-term goal is to directly compare σ_1 from the various techniques...

more ‘qualified’ start classes → larger fraction of the total stop-side matches that can be calibrated.

Not Yet Preliminary Resolution from TOFp in dAu

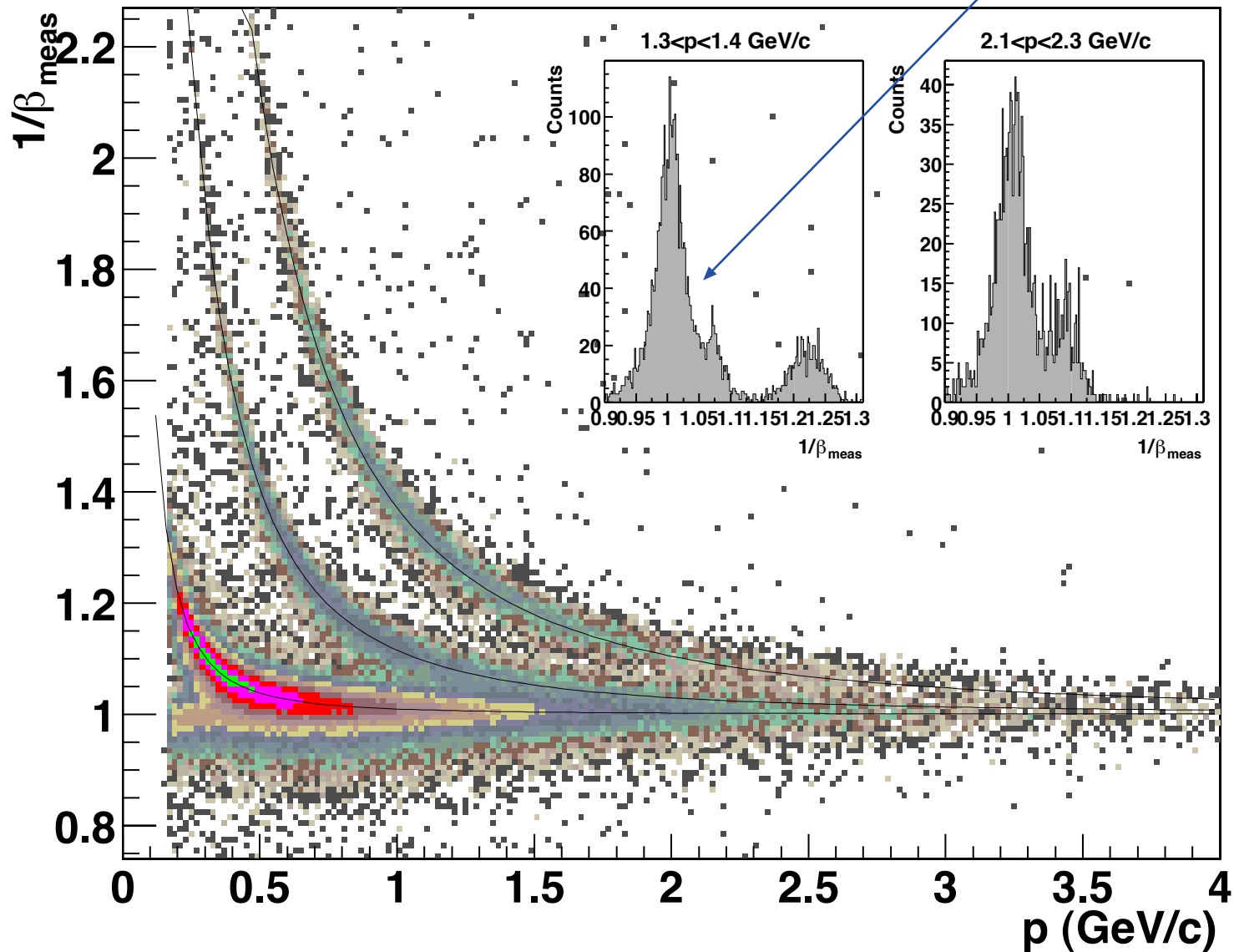
start timing from East3+West1 class,

all three subclasses added together (~40% of stops data)

! not handling event classification (wrt outliers) as well as possible

! TDC calibrations not checked at all.

$\pi/K(\text{AuAu}) \gg \pi/K(\text{dAu}) !!$



v. encouraging...

TOFp PID in d+Au
is definitely there...

Near-term plans.....

- work w/ Frank towards efficiencies etc from embedding for run-2 Au+Au → ratios, spectra
- rationalize dAu pVPD calibrations across techniques, classes, subclasses
simpler algorithms?
fewer parameters?
- show consistent σ_1 across different classes and techniques...
- improve stop-side calibrations for TOFp
functions are good but constants could be better
tdc calibrations!!
→ direct comparison of TOFr and TOFp physics results....
- expecting “match ntuple” for TOFr v.soon
apply these start corrections, and TOFp-style stop calibrations
→ direct comparison of TOFr performance from different calibration approaches...
- TOFp and TOFr in the same events... (direct ID both daughters of $\phi?$, $K^*?$, $\Lambda?$,...)