FINUDA

Collaboration Meeting

L.N.F. - October 20th 21st, 2004

FINUDA
BARI

A. Pantaleo

on behalf of the FINUDA Bari Group

Sezione di Bari

INFN

ISTITUTO NAZIONALE DI FISICA NUCLEARE

Dipartimento Interateneo di Fisica "Michelangelo Merlin" - Bari

SIGILLUM UNIVERSITATIS BARENSIS MCMXXV

de' remi facemmo ali 1990 POLITECNICO DI BARI

TOF synchronization

by Daniela Di Santo

Timing alignment

TOFONE
TOFINO

TOFONE

- Events used:
  - BHABHA
    - To get e^+ and e^- TOFONE slabs time difference
  - COSMIC
    - To get the mean value of impact points distribution along each TOFONE slab

MINUIT calculation of new t0

TOFONE

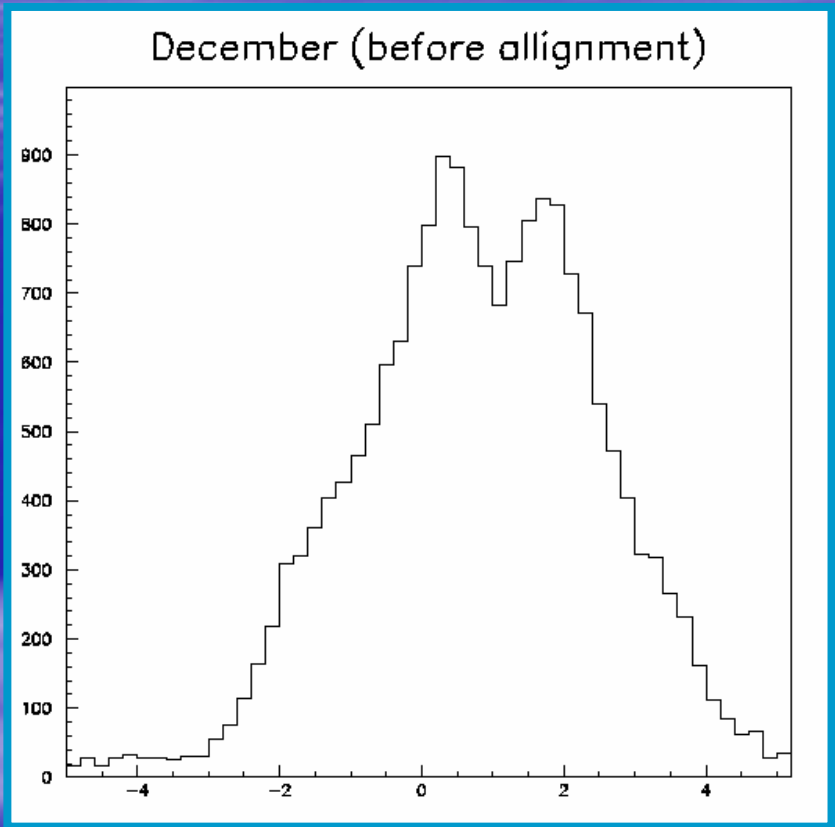
- We had two initial *t0* sets:
  - December
  - since January and on

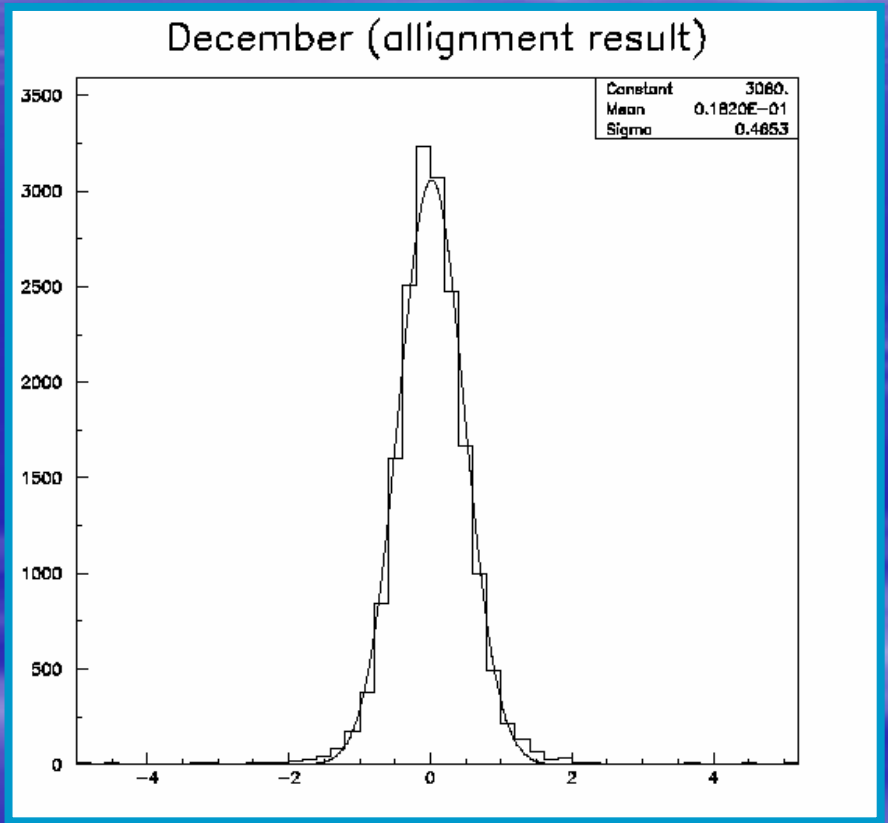
- We get two different alignement calculations

  in order to

  have two new sets of *t0* “*syncronized*”

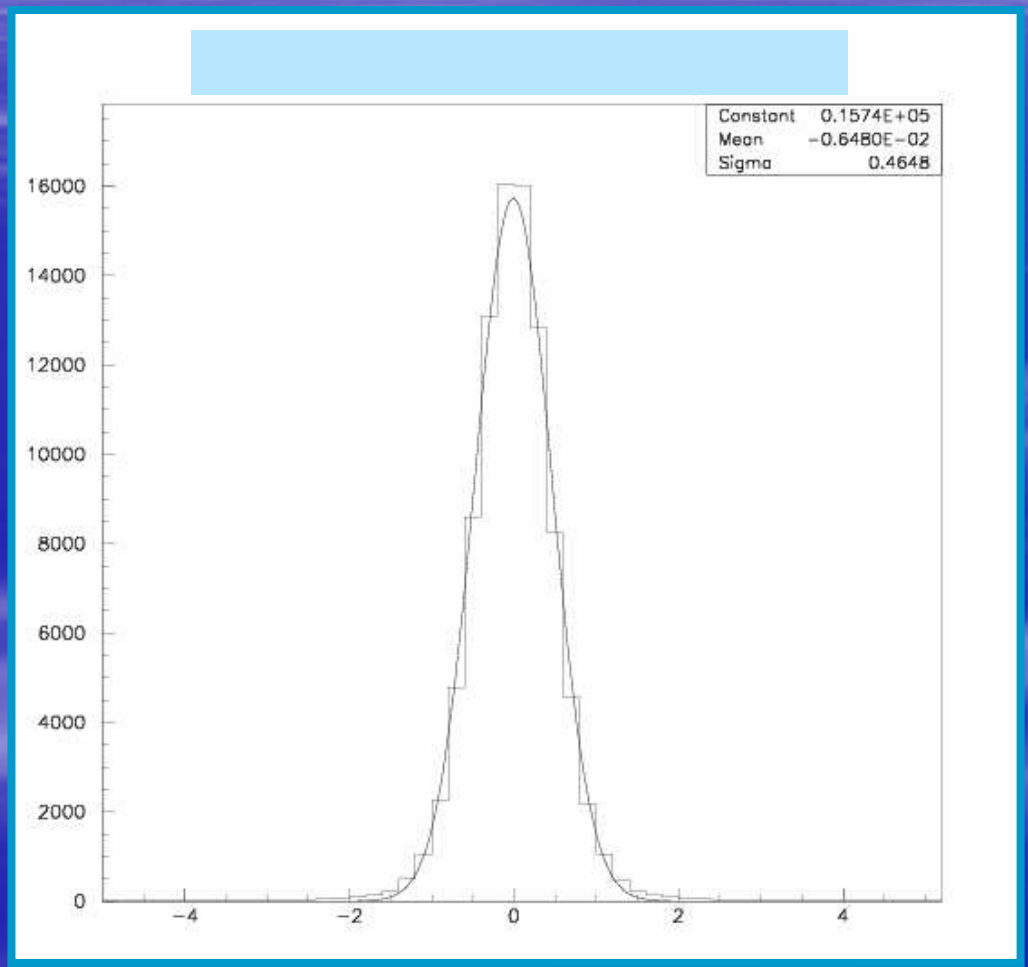
TOFONE – TOFONE (December time resolution)



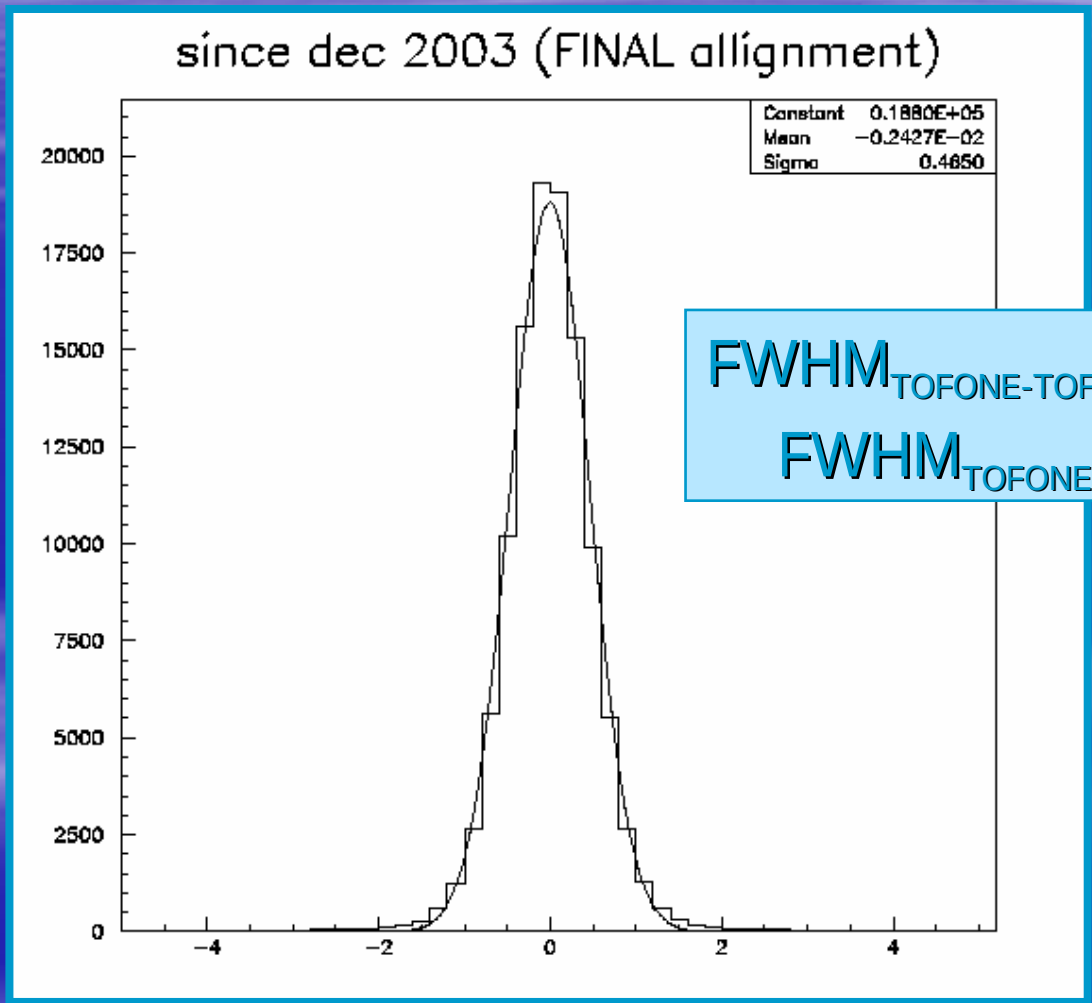


done for the first time

TOFONE – TOFONE (2004 Time resolution)



TOFONE (overall resolution)



$FWHM_{TOFONE\text{-}TOFONE}$=1.088 *ns*

$FWHM_{TOFONE}$=0.772 *ns*

TOFINO

- Events used:
  - HYPE trigger
  - K+ K- on TOFINO
  - Multiplicity on TOFINO = 2
  - CFD good quality

TOFINO timing behaviour *ranges*
(*by* Diego Faso)

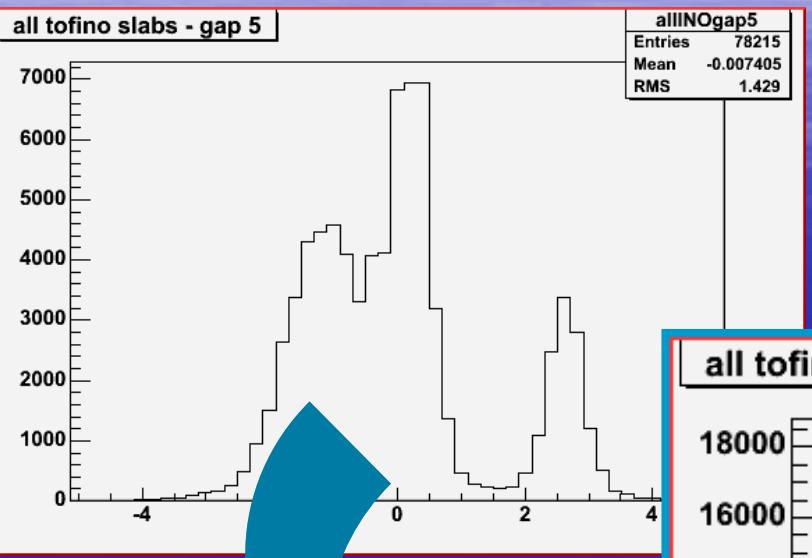
RUN number

- 529 – 588 (2/12/2003 3:23 -> 4/12/2003 4:05)
- 589 – 604 (4/12/2003 4:09 -> 5/12/2003 10:13)
- 605 – 1160 (5/12/2003 10.14 -> 11/01/04 8:03)
- 1161 – 1231 (11/01/04 8:06 -> 20/01/04 7:54)
- 1232 – 2255 (20/01/04 8:01 -> 7/3/04 21:46)
- 2256 – 2385 (7/03/04 21:48 -> 13/03/04 20:21)
- 2386 – 2509 (13/03/04 21:29 -> 19/03/04 12:56)
- 2510 – 2583 (19/03/04 -> 22/03/04 6:52)

We perform
one calculation for each of the
previous ranges

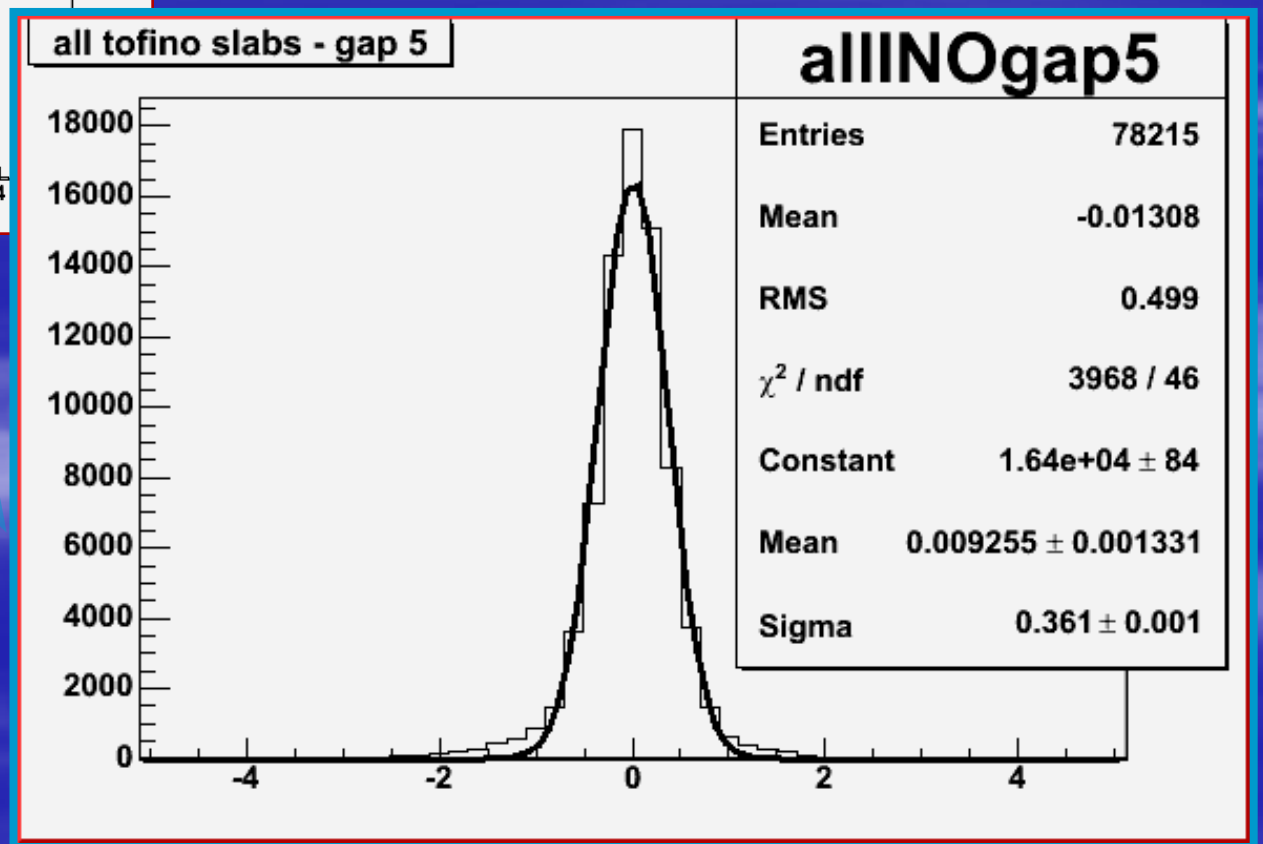
2510 – 2583 RUN-range

all slabs – gap 5



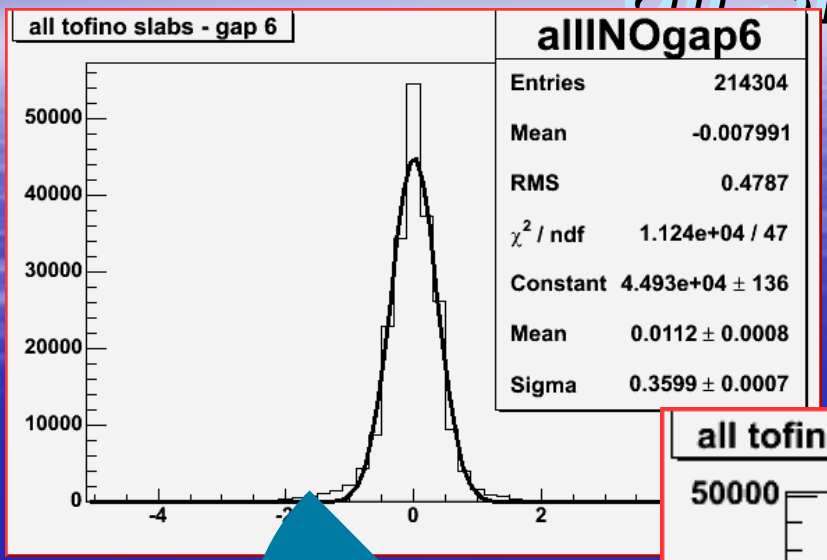
... for example...

What we get



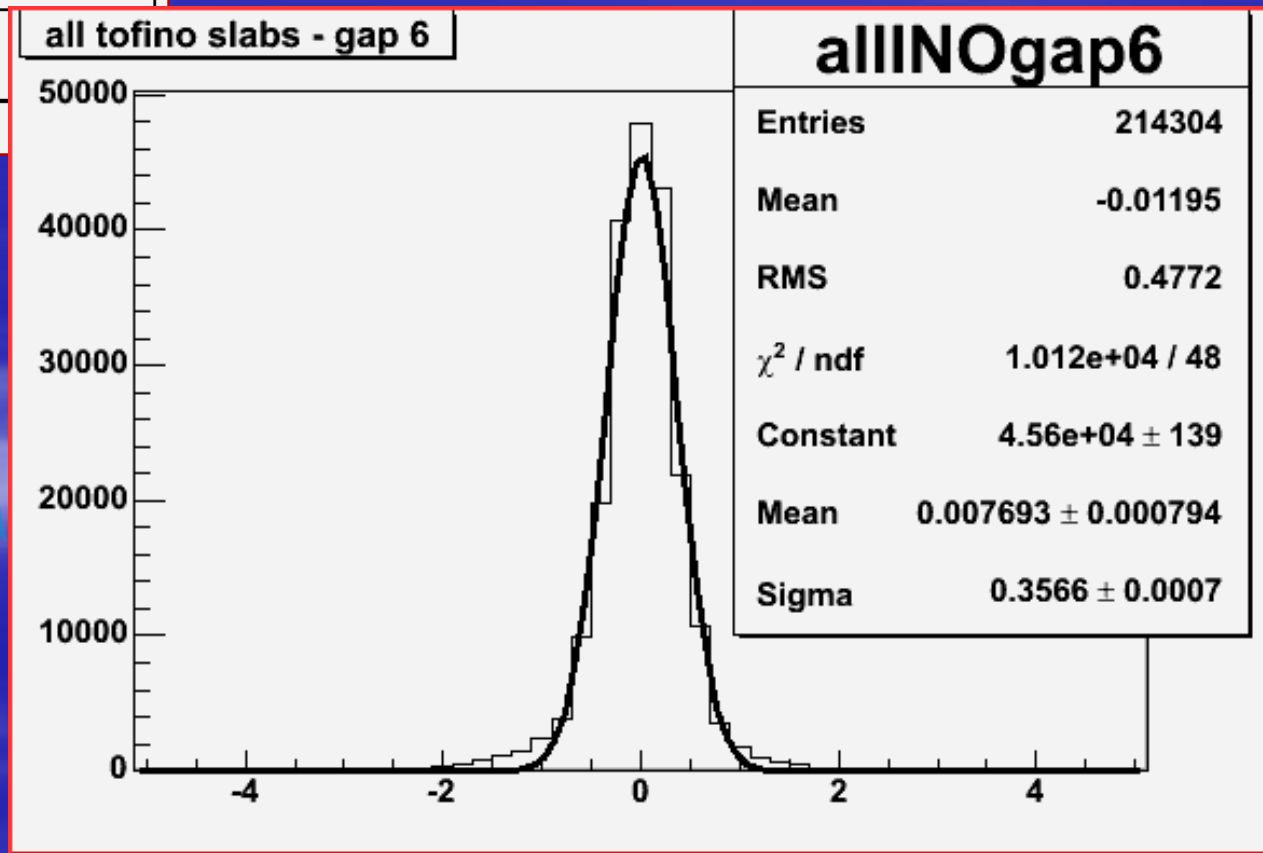
2510 – 2583 RUN-range

all slabs – gap 6



... for example...

What we get



TOFINO calculation: problems

RUN number

- 529 – 588 (2/12/2003 3:23 -> 4/12/2003 4:05)
- 589 – 604 (4/12/2003 4:09 -> 5/12/2003 10:13)
- 605 – 1160 (5/12/2003 10.14 -> 11/01/04 8:03)
- 1161 – 1231 (11/01/04 8:06 -> 20/01/04 7:54)
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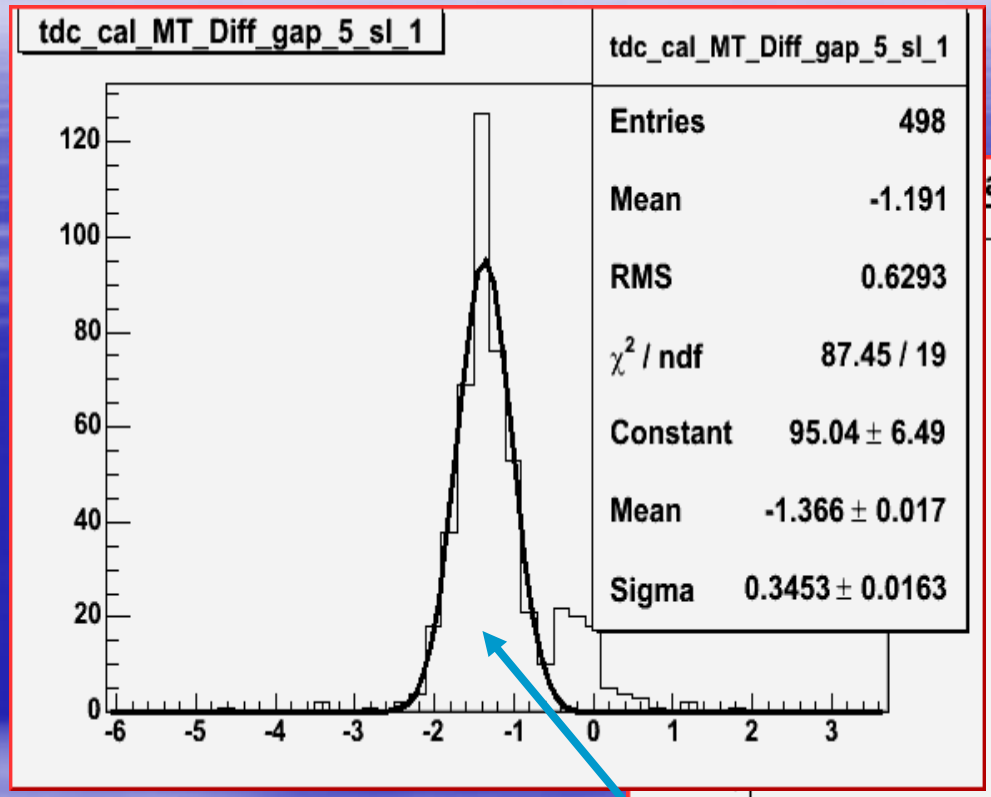
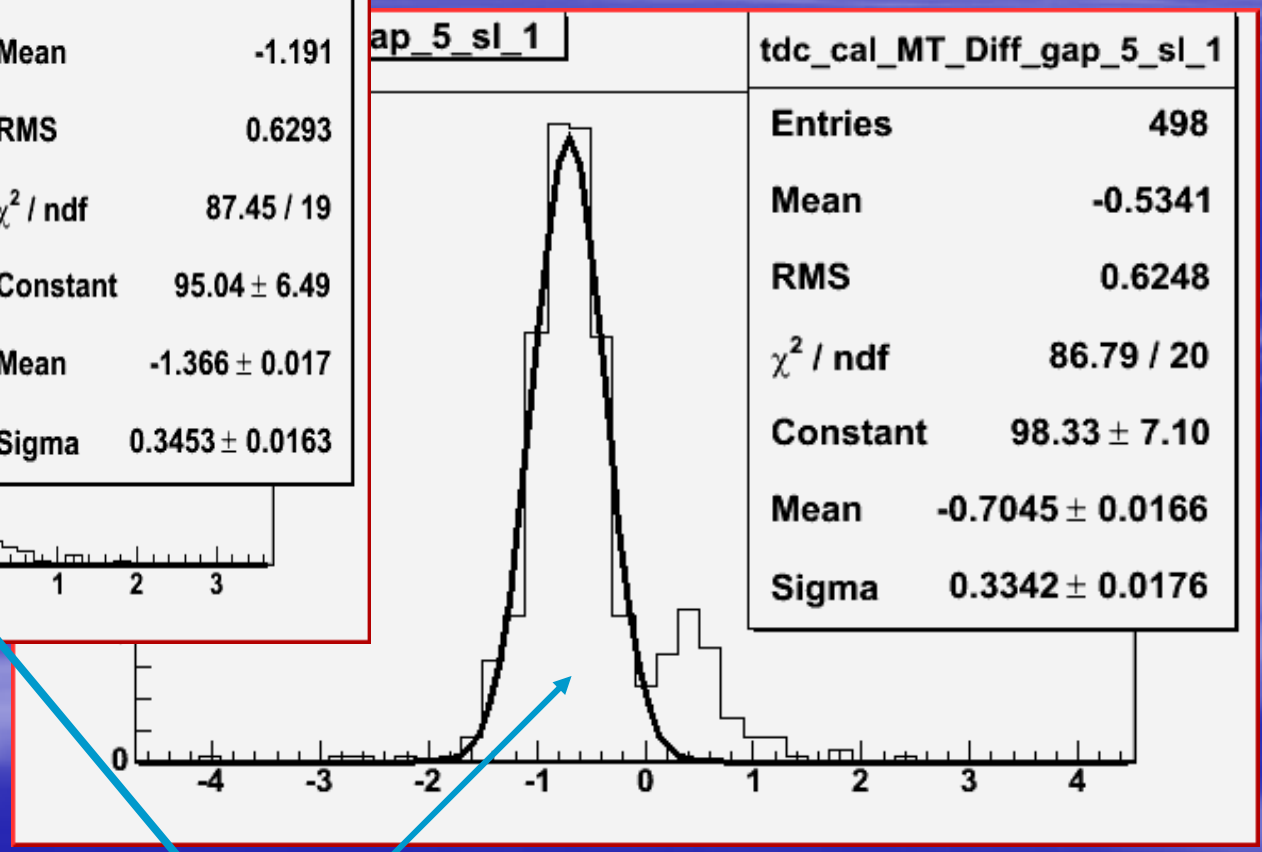
- 2256 – 2385 (7/03/04 21:48 -> 13/03/04 20:21)
- 2386 – 2509 (13/03/04 21:29 -> 19/03/04 12:56)
- 2510 – 2583 (19/03/04 -> 22/03/04 6:52)

We don’t manage to get synchronization for the run range 589 –604

589-604 RUN-range

slab 1 – gap 5



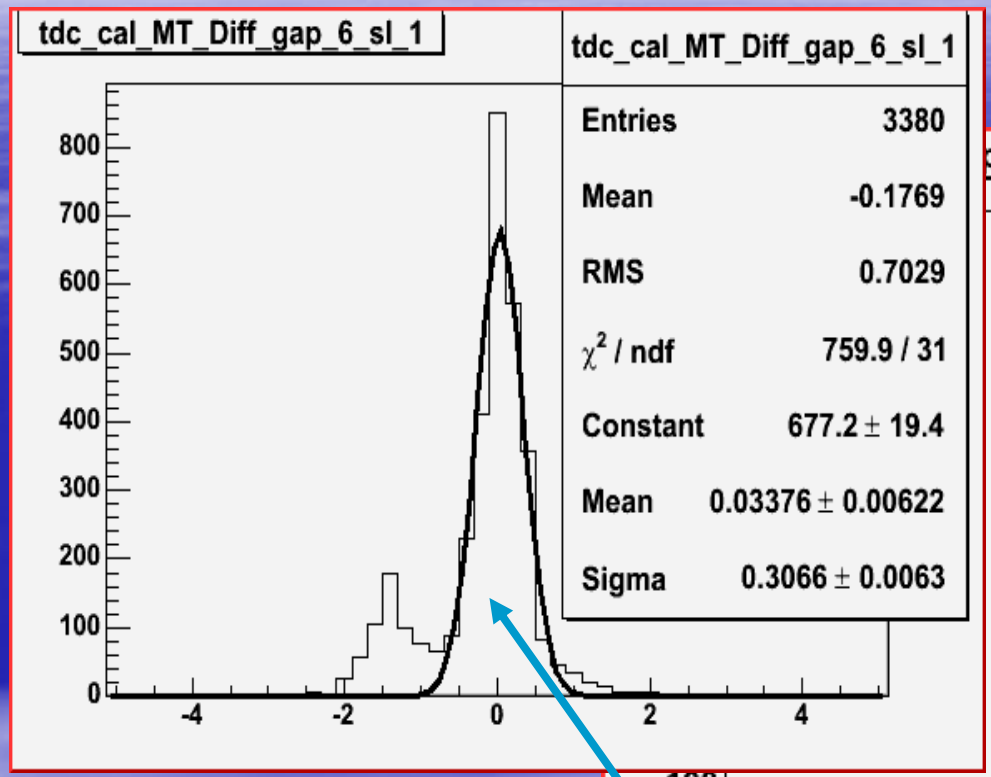


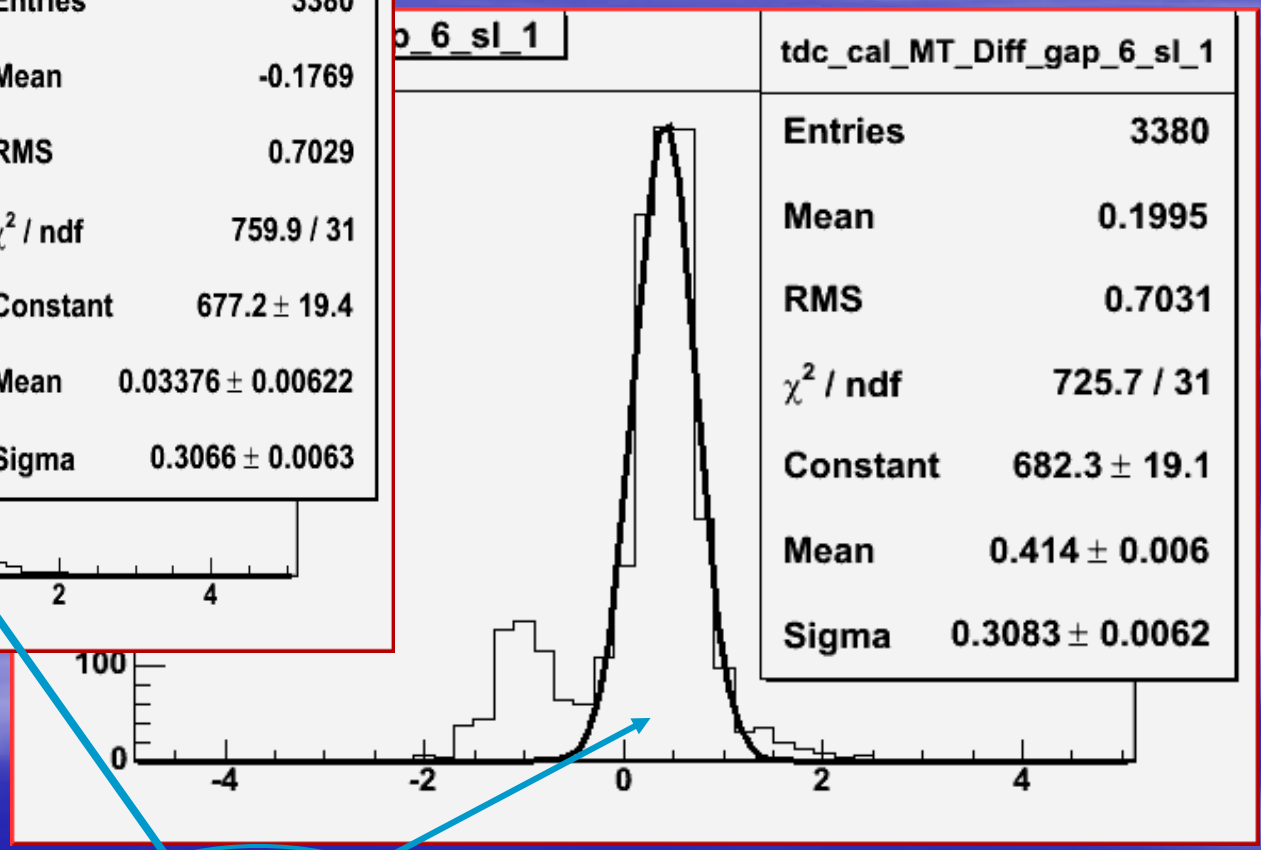
better mean value

on the right

589-604 RUN-range

slab 1 – gap 6





WORSE

Diego Faso TOFINO timing study

Re-evaluate T0 ???

In any case t_0 for TOF detectors
must be evaluated
in these run-ranges:

- < 529
- [529 – 588]
- [589 – 604] (No good for TOF)
- [605 – 1160]
- [1161 – 1231]
- [1232 – 2255]
- [2256 – 2385] (No good for TOF)
- [2386 – 2509]
- [2510 – 2583]

Bad synchronization

Good synchronization

TOFINO timing behaviour
a suggestion

RUN number

- 529 – 588 (2/12/2003 3:23 -> 4/12/2003 4:05)
- 589 – 604 (4/12/2003 4:09 -> 5/12/2003 10:13)
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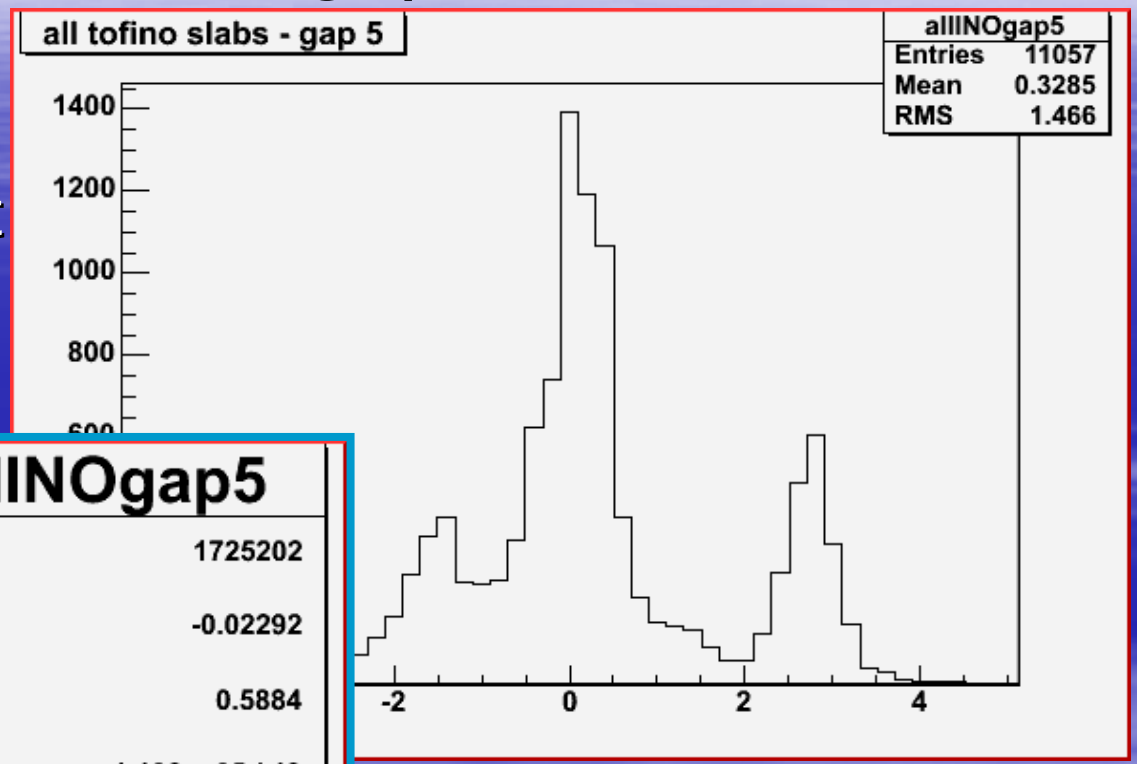
- 2510 – 2583 (19/03/04 -> 22/03/04 6:52)

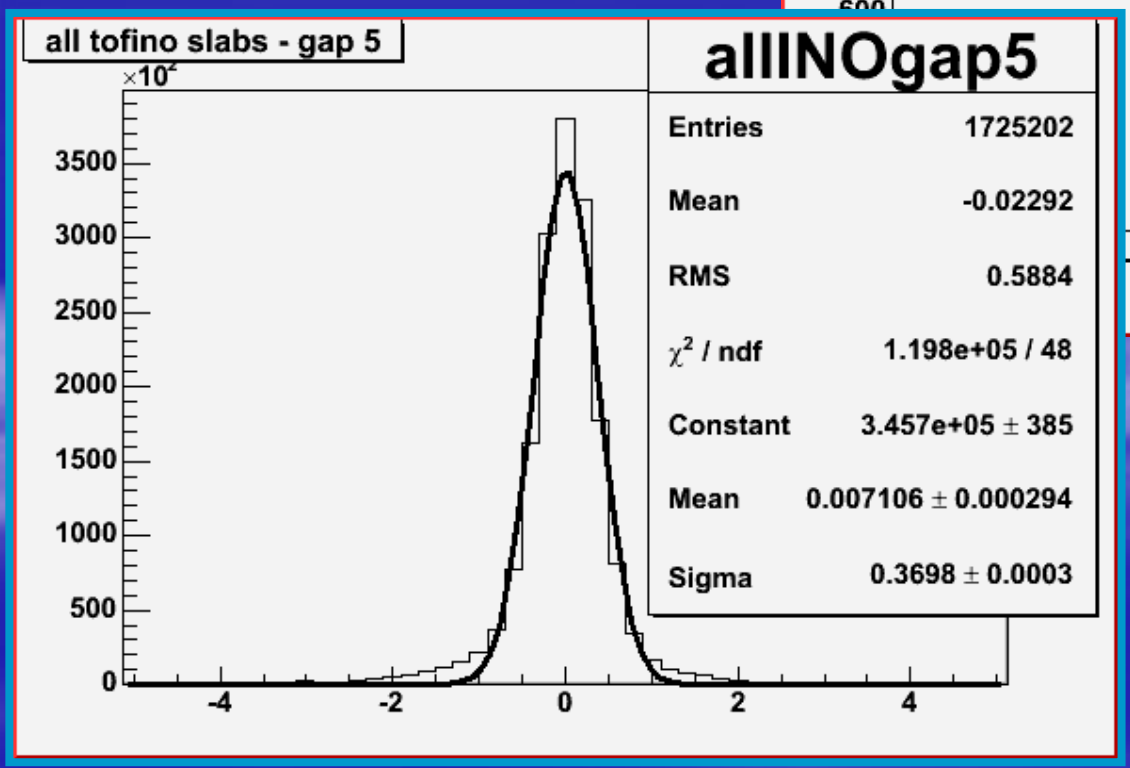
It’s better not to use range 589-604 to perform timing considerations

605 – 2583 RUN-range

all slabs – gap 5

What we get

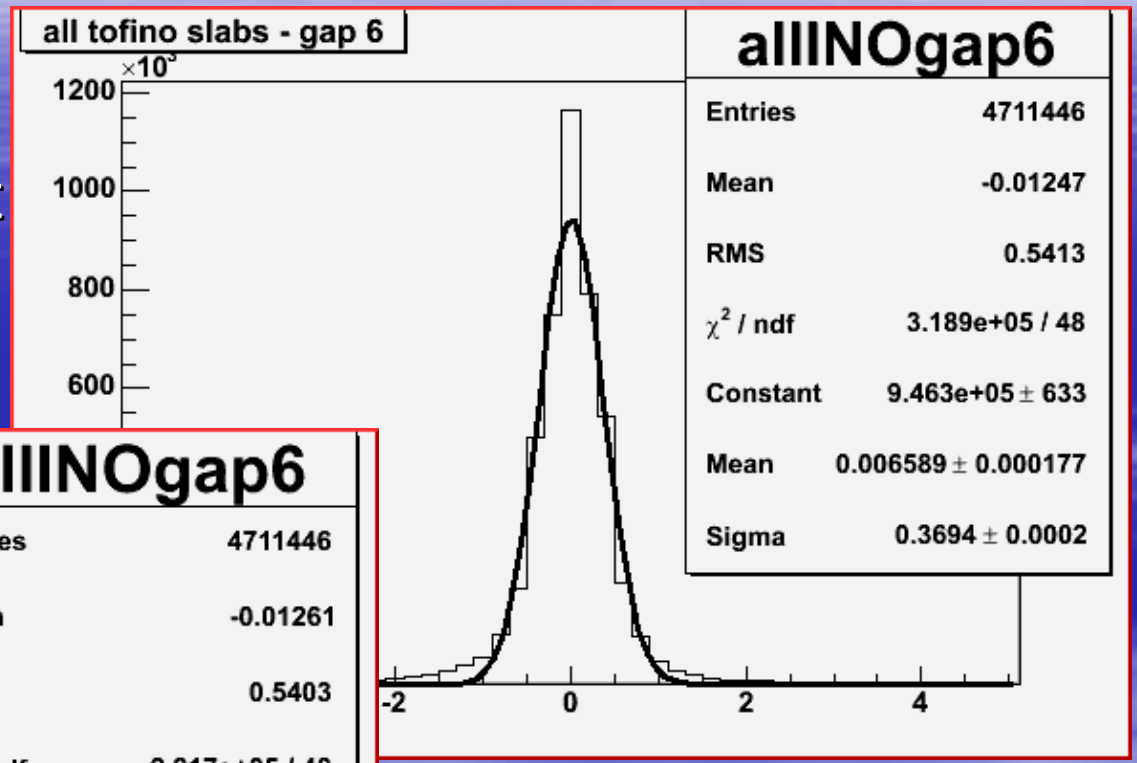


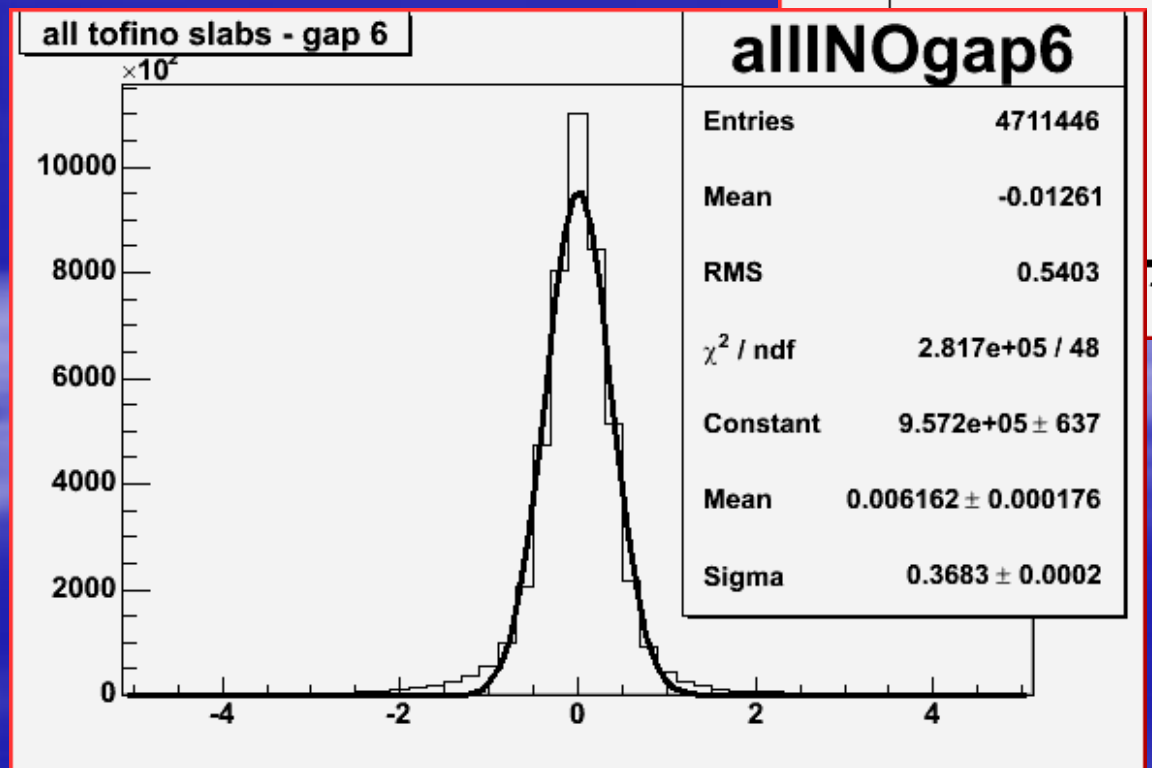


605 – 2583 RUN-range

all slabs – gap 6

What we get





Final Resolutions:

- TOFONE - TOFONE:

  FWHM = 1.088 *ns*

- TOFINO - TOFINO:

  FWHM = 0.862 *ns*

- TOFONE – TOFINO:

  FWHM = 0.981 *ns*

  (only a numerical calc.)

TOF offsets

by Barbara Dalena

FINUDA

BARI

FINUDA TOF

TOFONE and TOFINO

sub-detector analysis

Our starting point:

FINUDA Collaboration Meeting Sept. 2nd-3rd, 2004:

In order to evaluate the trigger acceptance (TA) of K^+ decay time, we consider:

- ✓ long tracks (Longplu=1);
- ✓ K^+ stopped on target 1 (Stopplu=1,Ntarplu=1);
- ✓ fitted successful (Fiteplu=0);
- ✓ forward handed (Normplu< 75);
- ✓ positive tracks coming from K^+ stopped on target, having momentum > 215 MeV/c (Chrgplu = +1, Pmodplu*1000 > 215);
- ✓ back-tracking ok (Extrplu =1);

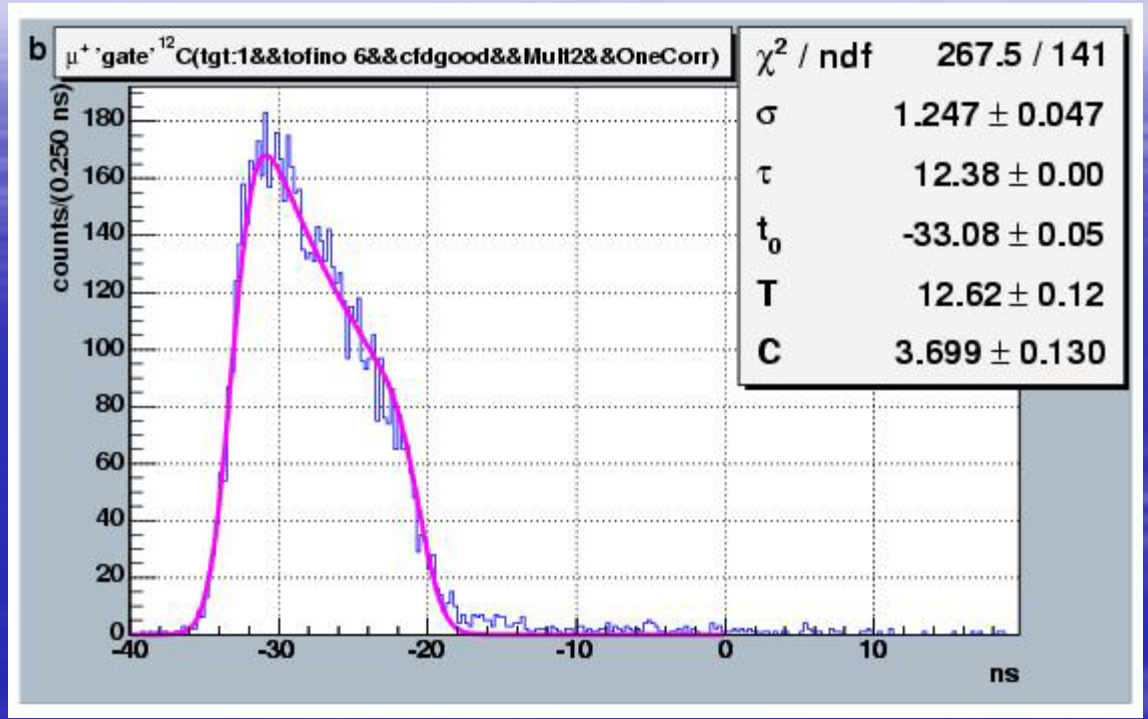
filling the spectra by:

$$\mathbf{TA} = MT_{TOFONE} - t.o.f._{\text{spectrometer}} - MT_{\text{TOFINO}}$$

$$t.o.f._{\text{spectrometer}} = \frac{\text{track length}_{\mu^+}}{c\beta} \quad ; \quad \beta = \frac{p_{\text{spectrometer}}}{\sqrt{p^2_{\text{spectrometer}} + m^2_{\mu}}} \rightarrow \text{(Pmagplu)}$$

We have got

- target 1
  & TOFINO 6
  & CFD failures rejected
  & 2 slab TOFINO



Fitting function:

$$f(t,\sigma,\tau,t_0,T,C) = Ce^{\frac{\sigma^2-2x\tau}{2\tau^2}}\sqrt{\frac{\pi}{2}}\sigma$$

$$\left[Erf\left(\frac{\sigma^2+(t_0+T)\tau-t\tau}{\sqrt{2}\sigma\tau}\right)-Erf\left(\frac{\sigma^2+t_0\tau-t\tau}{\sqrt{2}\sigma\tau}\right)\right]$$

New things done

- New production (thanks to Diego Faso for help).
- Completed TOFONE, TOFINO synchronization (Daniela).
- Filled the same spectra for all targets.
- Improved the fit procedure:
  limited region of the spectra is fitted with a two step *fit*.
  - First step: 5 parameters searched for with physical constrained;
  - Second step: 4 parameters serched for, starting from the first step and fixing K^+ life time.

- Simulated the same spectra.

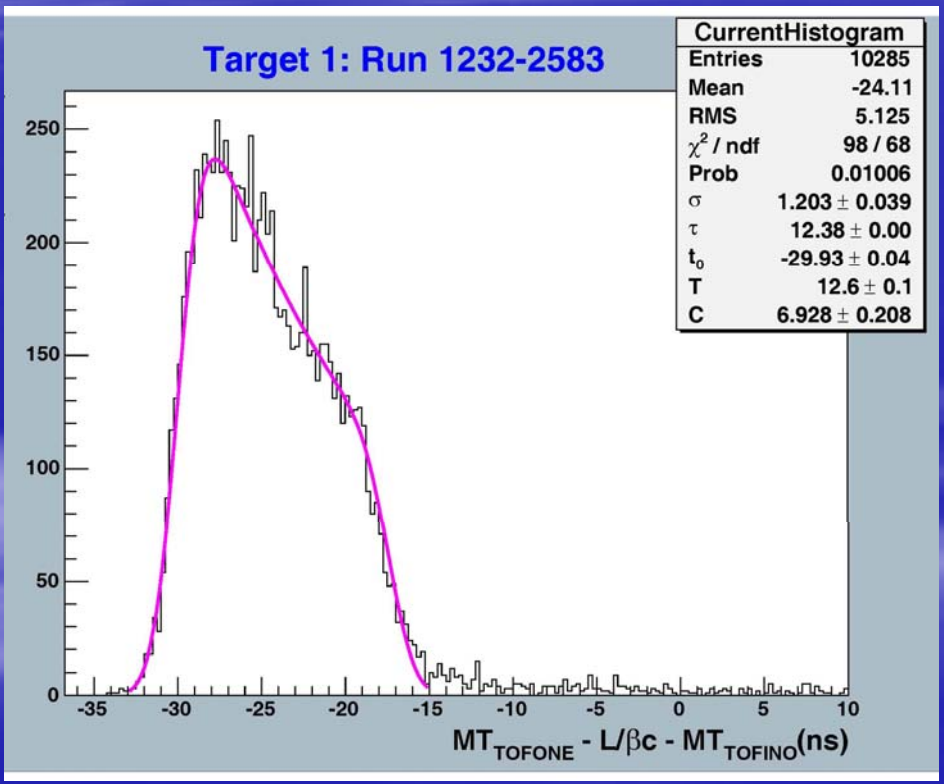
What we get now

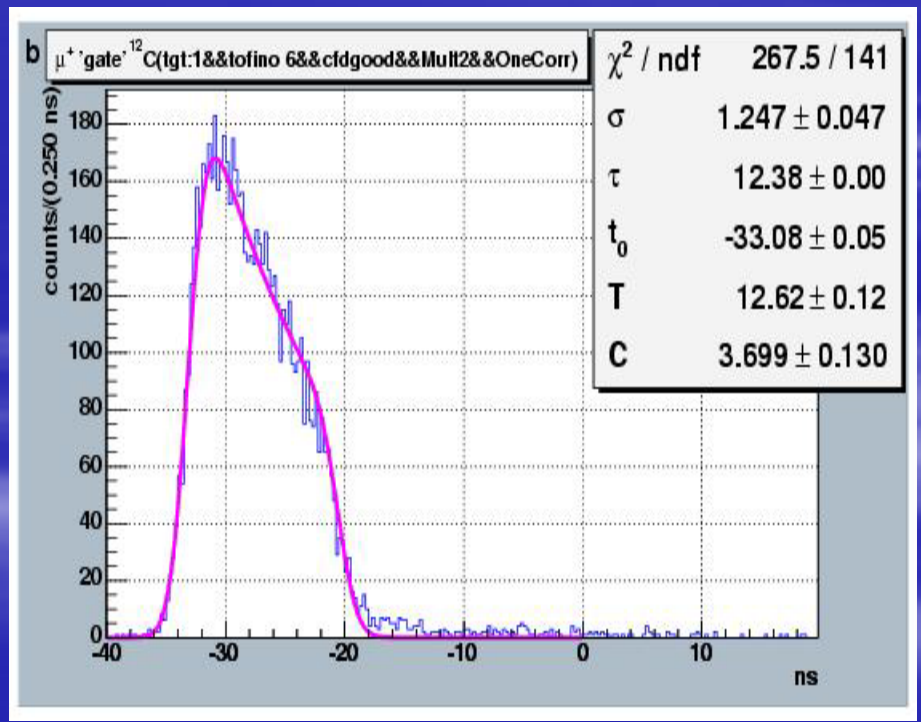
New production:

- ✓ Old pattern recognition of TOFONE slabs.
- ✓ TOFINO and TOFONE synchronization.

Old production:

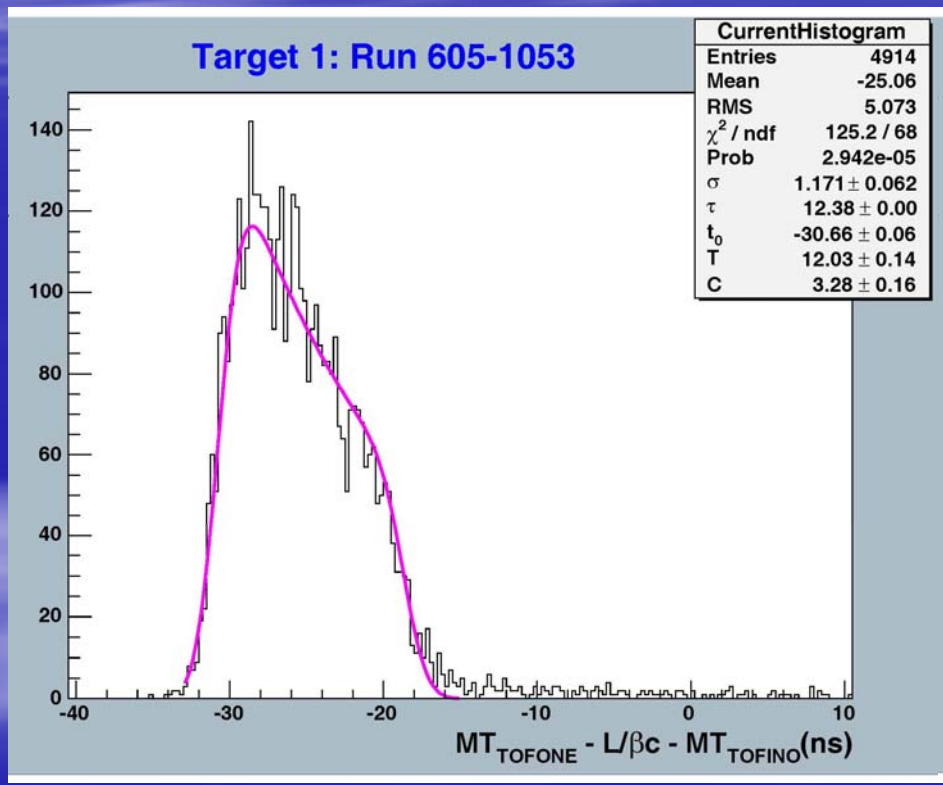
- ✓ New pattern recognition of TOFONE slabs (De Mori).
- ✓ Only TOFONE synchronization (for run 1054-2583).

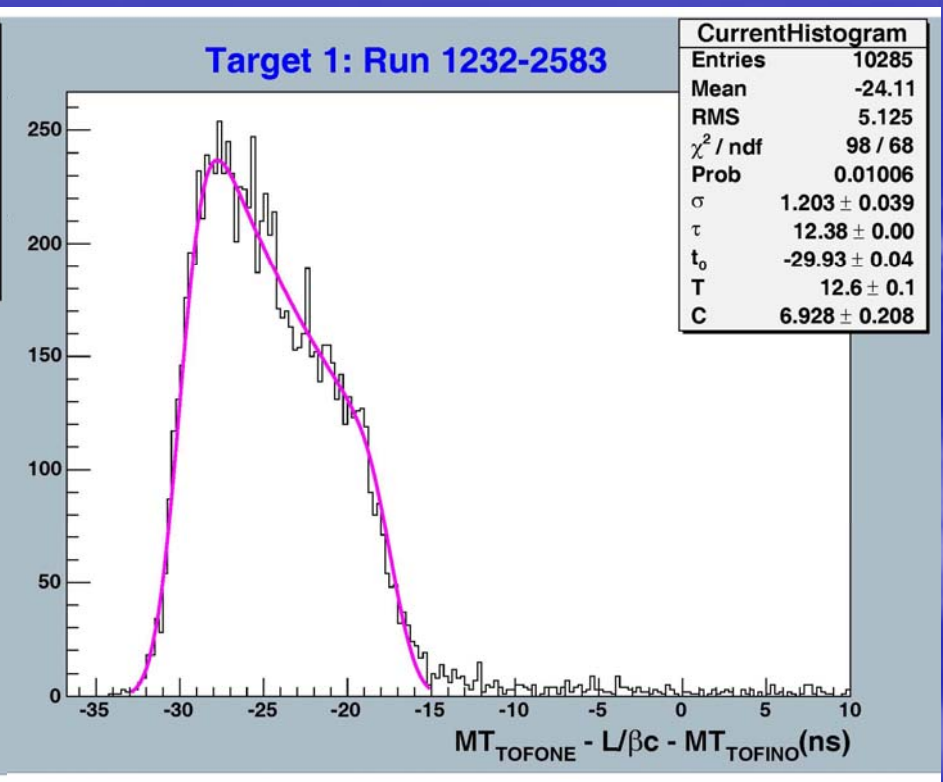




First group of data

Good agreement between new production run ranges: **run 605-1053** and **run 1232-2583.**

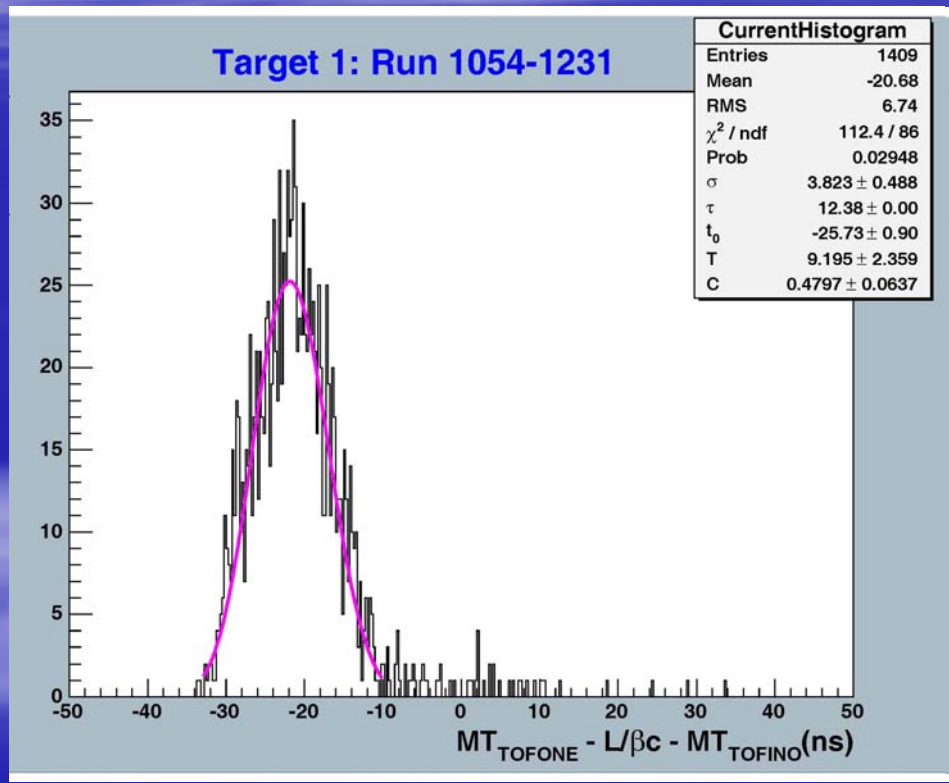


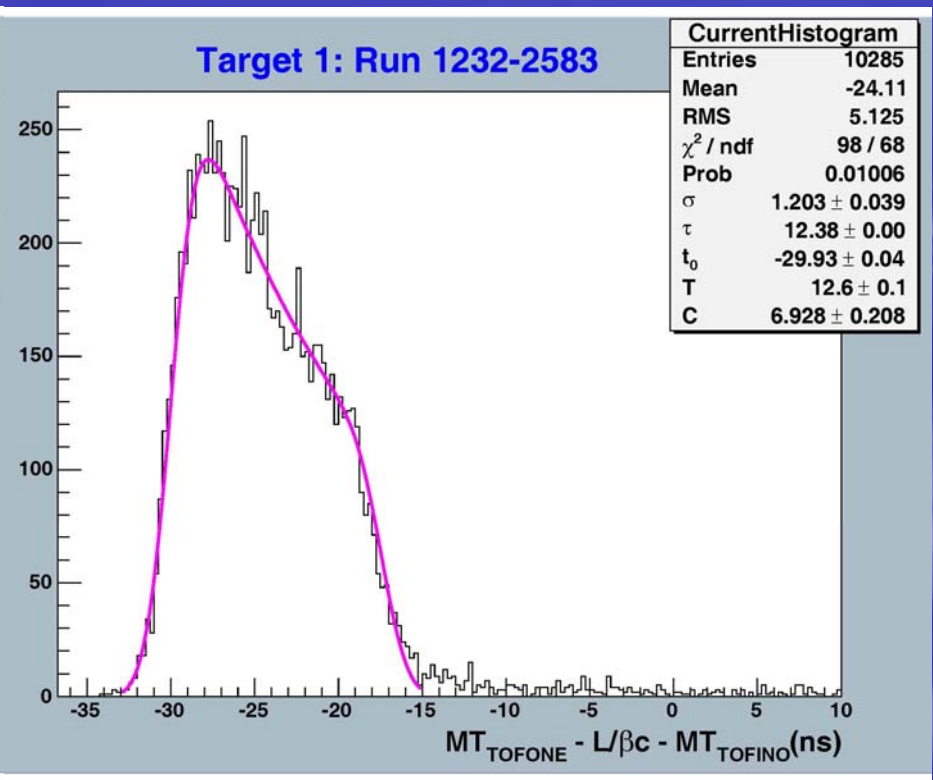


?

Bad data quality
in the intermediate
range of runs: **1054-1231.**

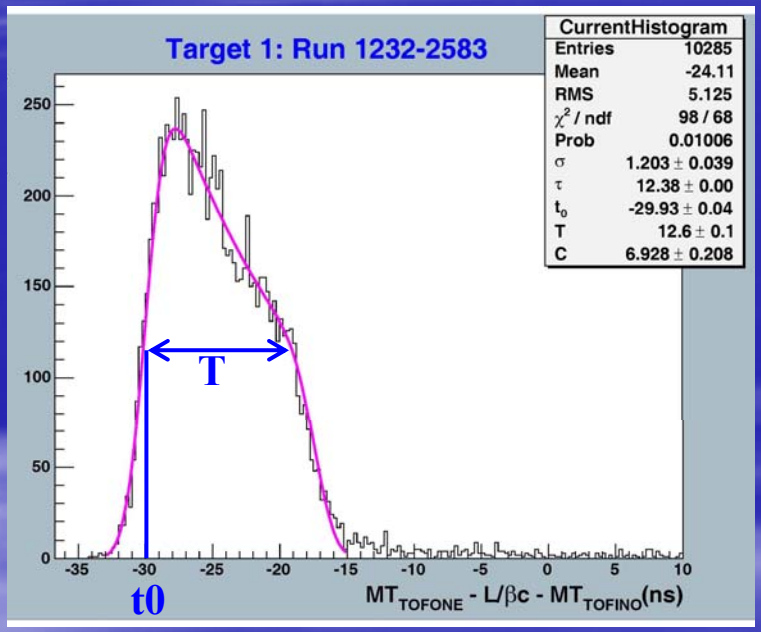
Reference quality

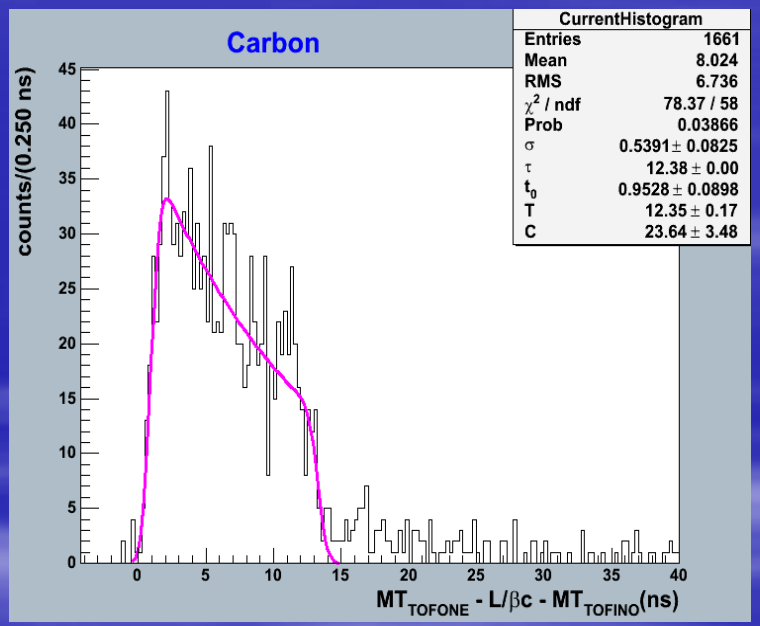




Simulation

We have made a simulation of the same time spectra (No TOF resolution simulated).
We don't have the same statistic compared to data, anyway T value seems almost the same between data and simulation.





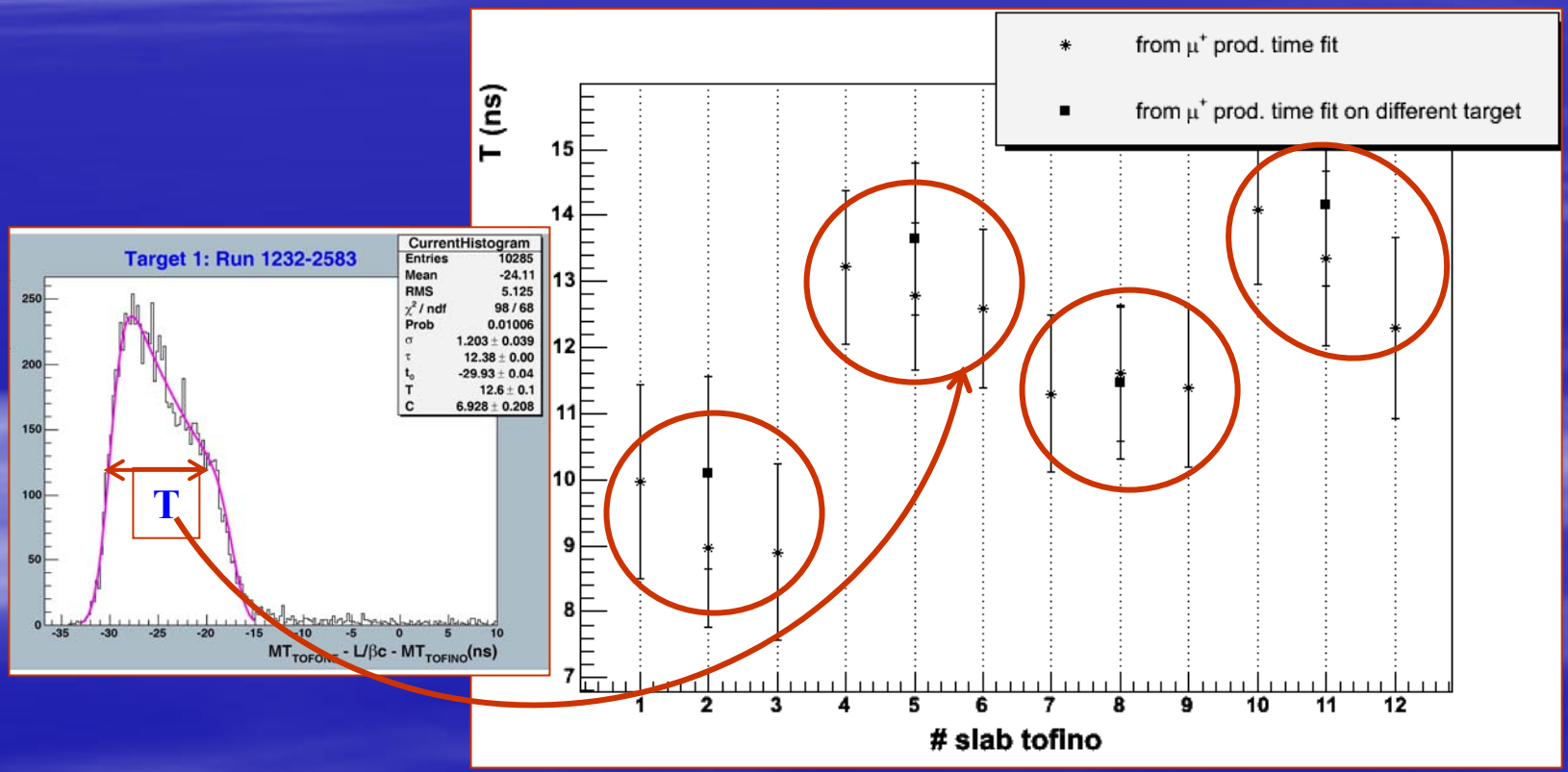
In order to get T value ≈ 12 ns we use TOFTHRESH = 18 ns (routine: TRIGHYP, if TOFTHRESH = 12 ns ⇒ T ≅ 6 ns).

Results for each target of good quality data

target	TOFINO slab	σ	t0	T
1	5	1.12 ±0.06	-30.98 ±0.06	12.78 ±0.14
	6	1.21 ±0.04	-29.93 ±0.04	12.59 ±0.10
2	4	1.17 ±0.04	-30.43 ±0.04	13.22 ±0.09
	5	1.15 ±0.05	-30.85 ±0.06	13.65 ±0.14
3	2	1.20 ±0.04	-28.10 ±0.04	8.97 ±0.09
	3	1.34 ±0.03	-27.83 ±0.03	8.90 ±0.06
4	1	1.48 ±0.04	-28.64 ±0.04	9.97 ±0.09
	2	1.46 ±0.04	-28.81 ±0.04	10.10 ±0.10
5	11	1.33 ±0.03	-31.21 ±0.04	13.35 ±0.09
	12	1.38 ±0.02	-30.10 ±0.02	12.30 ±0.02
6	10	1.13 ±0.02	-31.26 ±0.02	14.09 ±0.05
	11	1.23 ±0.02	-31.42 ±0.03	14.16 ±0.06
7	8	1.02 ±0.03	-28.82 ±0.04	11.60 ±0.10
	9	1.22 ±0.02	-28.31 ±0.02	11.40 ±0.02
8	7	1.19 ±0.04	-28.49 ±0.04	11.30 ±0.10
	8	1.16 ±0.03	-28.67 ±0.04	11.47 ±0.08

Trigger acceptance of $K^+ \mu^+$ decay: results

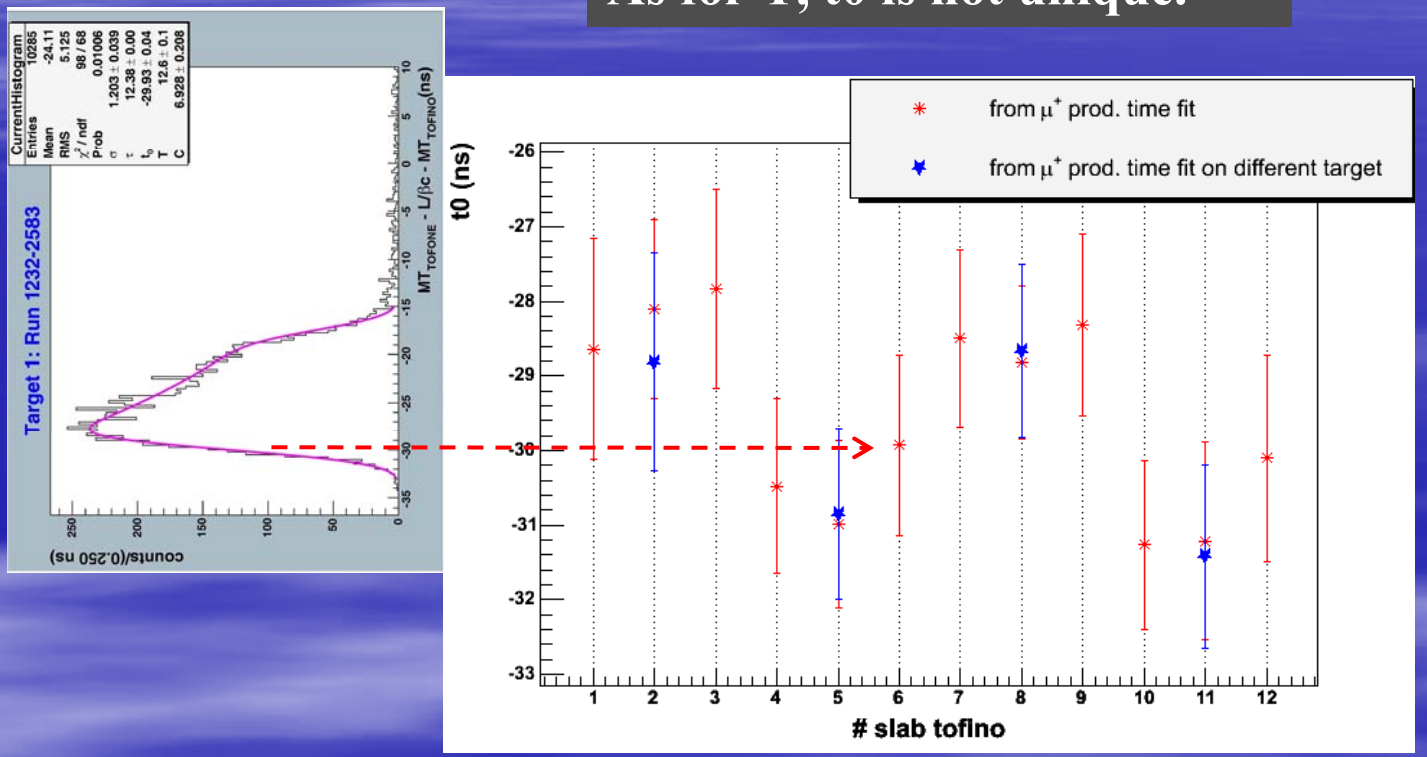
T is not unique.
It seems to be different according to TOFINO slab and, in part, of target.



Which offset ?

A. μ^+ production from K^+

As for T, t0 is not unique.



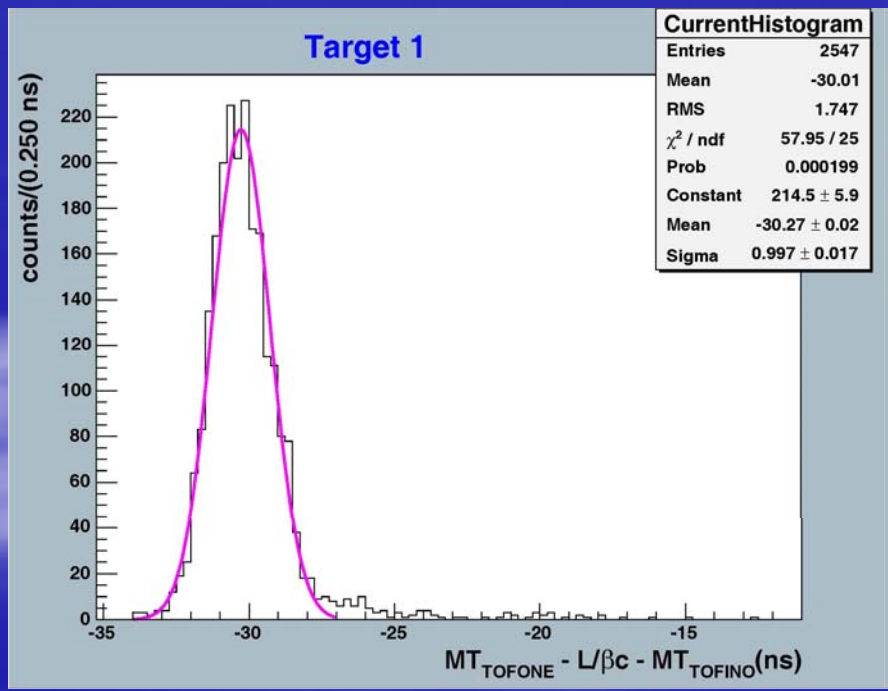
In the case of more values for the same TOFINO slab we evaluate a single value by:

$$\bar{x} = \frac{\sum_{i=1}^{2} \frac{1}{\sigma_i^2} x_i}{\sum_{i=1}^{2} \frac{1}{\sigma_i^2}}$$

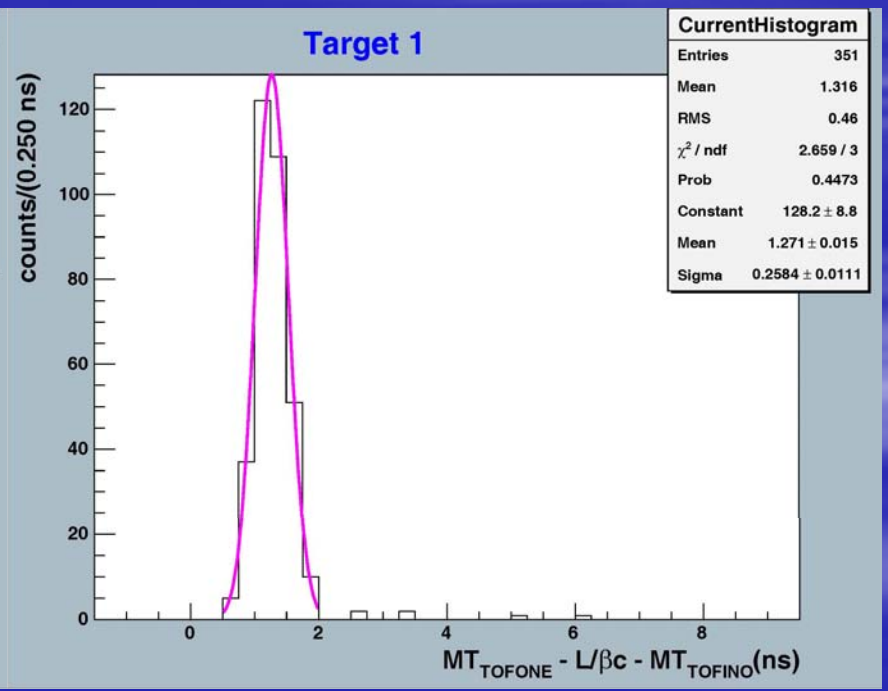
B. π^- production from K^-

$$MT_{TOFONE(\pi^-)} - \frac{L}{\beta c} - MT_{TOFINO(K^-)}$$

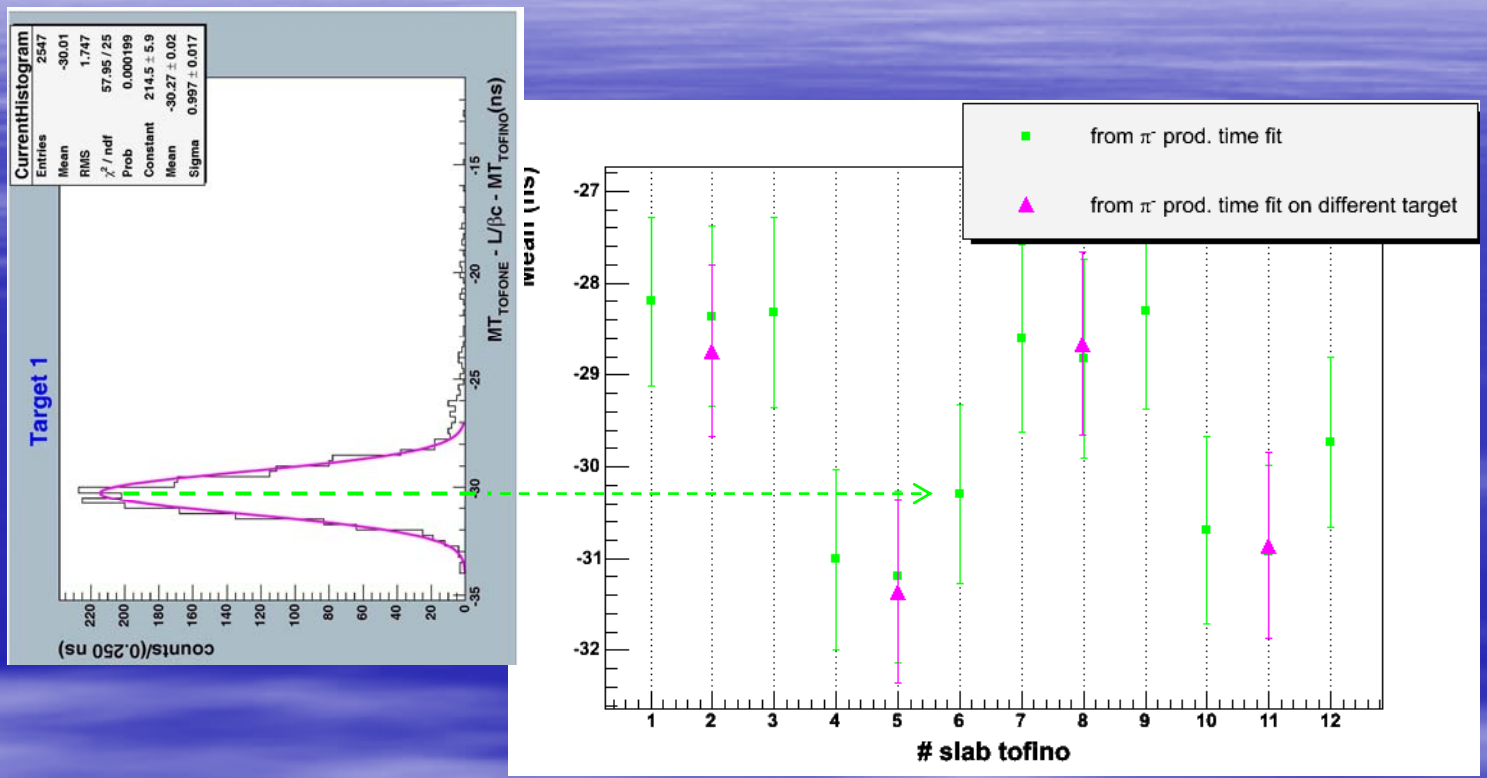
data



simulation



π^- production time for each target

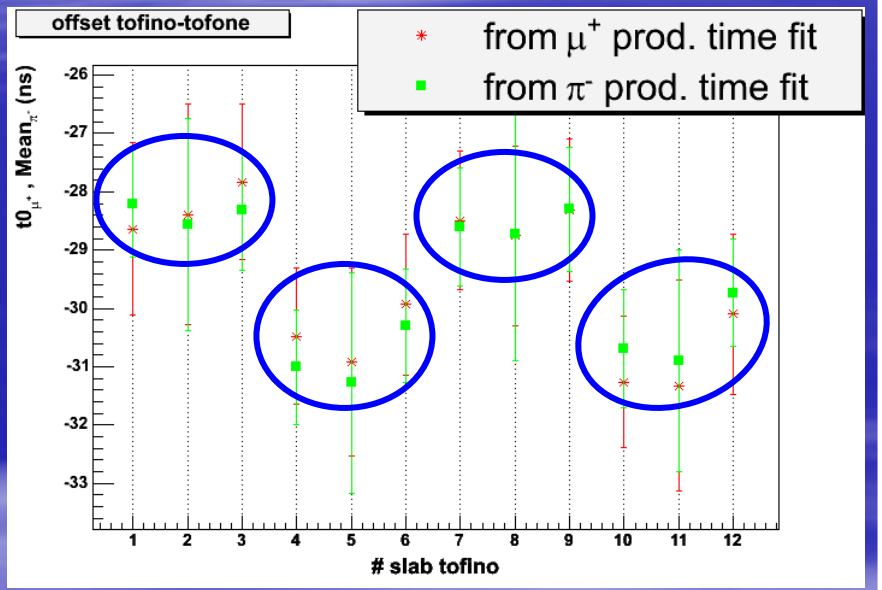


In the case of more values for the same TOFINO slab we evaluate a single value by:

$$\bar{x} = \frac{\sum_{i=1}^{2} \frac{1}{\sigma_i^2} x_i}{\sum_{i=1}^{2} \frac{1}{\sigma_i^2}}$$

Comparison

In any case we have not a unique offset. It seems to be different according to TOFINO slab!



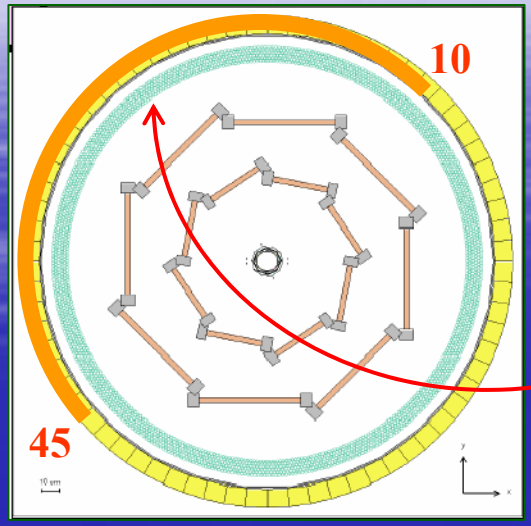
TOFINO slab	t0 ($K^+ \mu^+$) (ns)	Mean ($K^- \pi^-$) (ns)
1	-28.64	-28.20
2	-28.39	-28.57
3	-27.83	-28.32
4	-30.48	-31.01
5	-30.92	-31.28
6	-29.93	-30.30
7	-28.49	-28.60
8	-28.75	-28.73
9	-28.31	-28.30
10	-31.26	-30.69
11	-31.32	-30.89
12	-30.10	-29.73

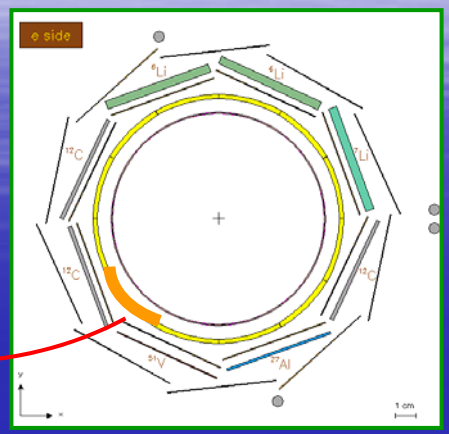
Difference between

t0 ($K^+ \mu^+$) and Mean ($K^- \pi^-$)

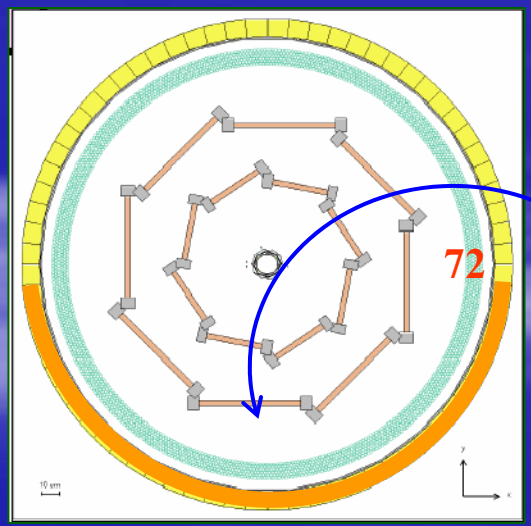
~ 600 ps !!!

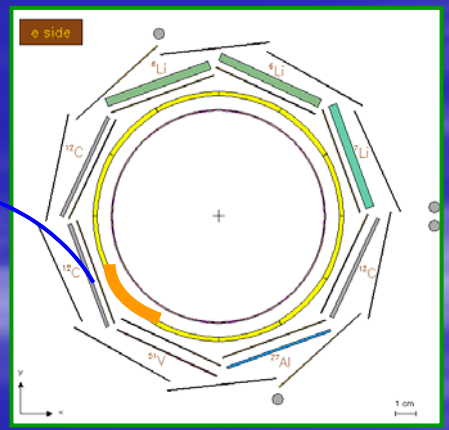
Different TOFINO-TOFONE correlation





→ Example of TOFINO TOFONE slabs correlation in in the case of μ^+ tracks coming from K^+ stopped in target 8. The right TOFONE slab in a multiplet is the one with the grater number.





→ Example of TOFINO TOFONE slabs correlation in in the case of π^- tracks coming from K^- stopped in target 8. The right TOFONE slab in a multiplet is the one with the smaller number.

We have to check results with the improvement to TOFONE pattern recognition (De Mori) !!.

Other ways to obtain the offset between TOFINO and TOFONE Mean Time

C. **Bhabha events: $MT_{TOFONE} - L/\beta c - MT_{TOFINO} = 0$ (we don't have results by now ; which is TOFINO time resolution with Bhabha ?).**

D. **Backward handed tracks: $MT_{TOFONE} - L/\beta c - MT_{TOFINO} = 0$ (we need time to work on TOFINO JSDT bank to these track).**

Neutron's analysis

1) Vincenzo LUCCHERINI *has identified* the candidates on Carbon's targets (coincidence with π^- from ipernucleus g.s. peack and a proton almost back-to-back).
2) We calculate TOF by new corrected t0 and $K^- \pi^-$ offset between TOFINO and TOFONE Mean Time.
3) We calculate reconstructed "Z" on TOFONE by : $Z = (Tp - Te) /2 * 0.061$ (see TOFDEC) [1].
4) We calculate the Base (of flight) as: $((X_{ONE}–X_{INO})^2 + (Y_{ONE}-Y_{INO})^2 + (Z_{ONE}-Z_{INO})^2)^{1/2}$, where $(X,Y,Z)_{INO}$ and $(X,Y)_{ONE}$ are fixed to the slab central values.
5) We calculate neutron momentum as : $P_n = m_{neutrone}\beta\gamma$.
6) We calculate neutron kinetic energy as : $T_n = E_{tot} –M_{neutrone}$.

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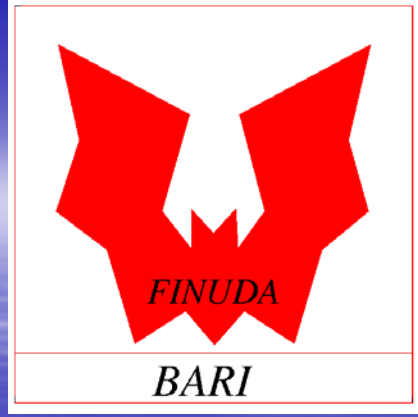
1. If both TDC are > 0.



Search for NEUTRONS in p – $^{12}_{\Lambda}C$ ground state coincidence events

NEUTRONS in p – $^{12}_{\Lambda}$C coincidences

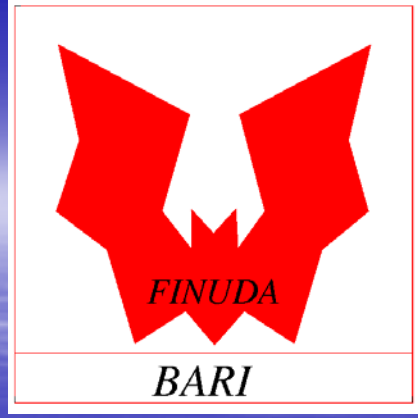
15 candidate events (with possible neutral particle TOFONE hits) selected by LNF people (Lucherini) among 50 (p – $^{12}_{\Lambda}$C) coincidences.

6 candidate events present **"multiple responses"** from adjoining TOFONE slabs ⟶ **CROSS TALK** (total = 30 TOFONE candidates).

13 / 30 slabs are **lacking of one TDC** coordinate, but only **4 / 30** are **lacking also ADC coordinates**. In the case of lacking TDC coordinates almost always also the TDC of the meantimer hardware is lacking : **importance of z - determination also from ADC's**.

PROBLEMS from **K^+ decays into π^0 going into 2 γ**:
HIGH RATES +
DECAY TIME ⟶ Difficulty of classification n-γ up to ~15 ns TOF.

NEUTRONS in p – $^{12}_{\Lambda}C$ coincidences



Only 5 neutral events can be identified as a neutron , of which only the last out of any doubt:

Run #	EV #	TOF(ns)	Base(cm)	En(MeV)
928	6560	11.8	163.5	119.3
1019	1670	13.4	134.0	57.1
1452	16200	9.1	141.5	159.5
1645	14509	11.9	176.1	142.0
2468	6346	19.0	150.3	34.0

Events with a TOF less than 9 ns, when hypothesized as neutrons, give En > 400 MeV and hence discarded as gamma rays.

Only one event (Run=1376, Ev=10784, TOF=65, b-o-f=156, En=3.1) is strange with a too low energy (why not under threshold ?)