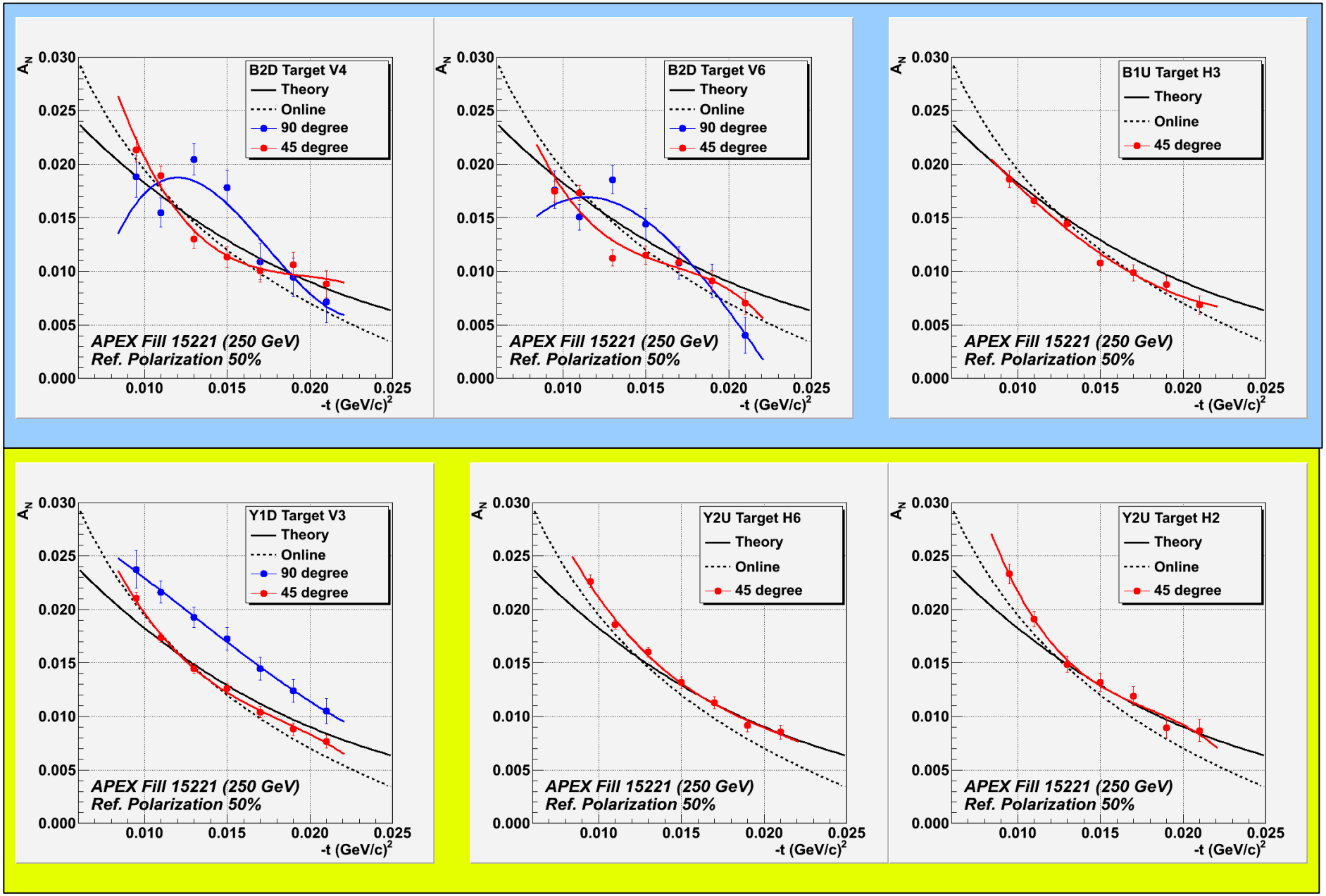
A. Poblaguev

Comments about t_0/x_{DL} calibration

Analyzing Power. RHIC. APEX (February 23, 2011) Sweep target



- ***All BNL detectors have consistent ONLINE calibration***
- ***Calibration for Hamamatsu detectors is different***

Mathematics of Dead-Layer

$$\frac{dE}{dx} = f(E) \;\Rightarrow\; L(E) = \int_0^E \frac{d\varepsilon}{f(\varepsilon)} \;\Rightarrow\; \frac{dE}{dx} = 1/(dL/dE)$$

Dead-Layer condition: $L_0(E) - L_0(\alpha A) = d$

$$L(p,E) - L(p,\alpha A) = 1$$

$$(L(p,E) = pL_0(E), \quad p = 1/d)$$

Stopping range parametrization:

1. $L(E) = pL_0(E)$ — "standard parametrization", *p=1/d*
2. $L(E) = pE$ — constant energy loss, *p=E*$_{loss}$
3. $L(E) = p_1E + p_2E^2 + p_3E^3 + \ldots$ — polinomial
4. $L(E) = ?$

Carbon Energy from measured amplitude:

$$E(\alpha A) = L^{-1}[1 + L(\alpha A)]$$

Inverse task:

If ***E(αA)*** is known then we can determine ***L(E)*** and ***dE/dx***

If t_0 is know then we can measure Carbon energy as a function of the amplitude ***αA***

$$E_{\mathrm{Carbon}} = \frac{Ml^2}{2(t-t_0)^2} \iff \alpha A$$

A model independent calibration of the amplitude

and thus we can measure ***dE/dx*** (*in deadlayer length units*)

WARNING: In such a way we measure ***effective dE/dx*** which may be different from ionization losses ***dE/dx***.

If t_0 is unknown we can make a fit, that is to try all possible t_0 and select one which provides best data consistency. It might provide us with value of t_0 and calibration of the measured amplitude $E_{Carbon} = E(\alpha A)$.

WARNING: the fit may work incorrectly if parameterization of stopping range ***L(p, αA)*** can not approach well true *effective* ***dE/dx.***

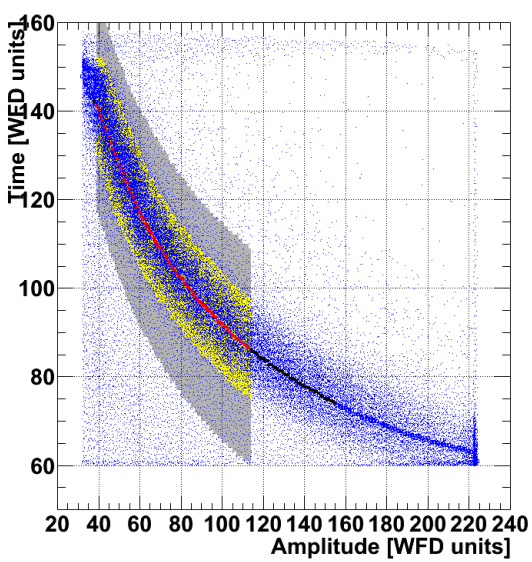
Banana is inconvenient to check the calibration

WFD

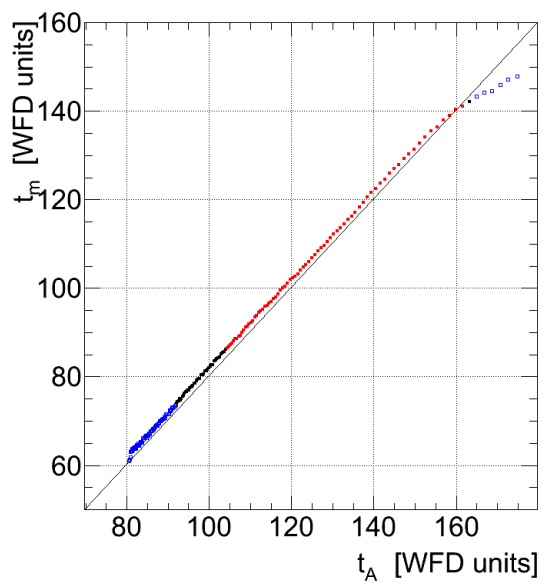
$$A \;\Rightarrow\; E_{\rm det} = \alpha A \;\Rightarrow\; E_A(E_{\rm det}, x_{\rm DL}) \;\Rightarrow\; t_A = \sqrt{\frac{M}{2}}\frac{L}{\sqrt{E_A}}$$

$$t \;\Rightarrow\; t_{\rm TOF} = t - t_0 \;\Rightarrow\; E_t = \frac{M}{2}\left(\frac{L}{t - t0}\right)^2$$

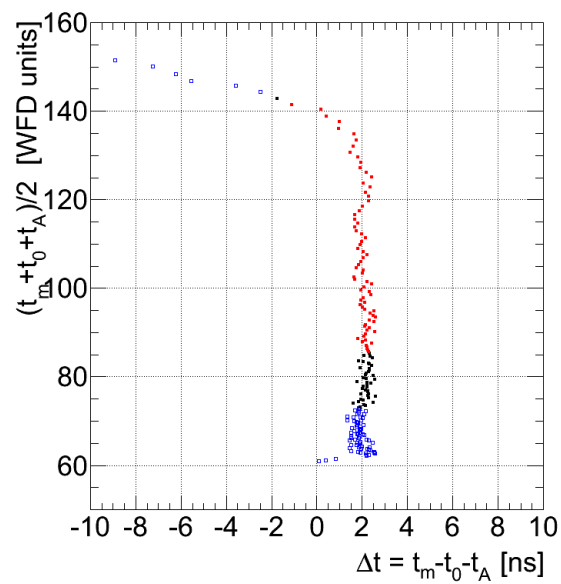
Banana: t vs E_A



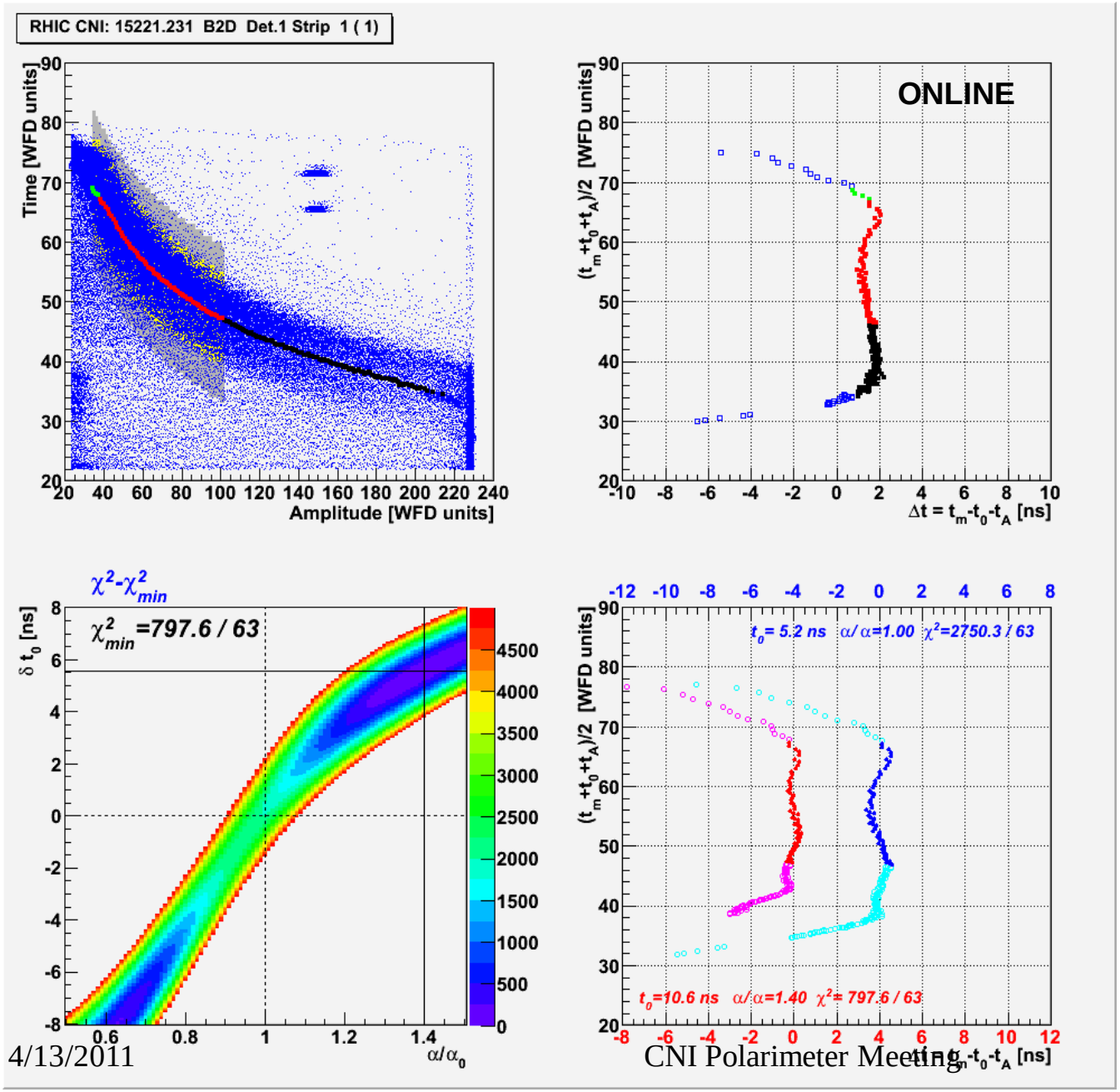
$$t = t_0 + t_A$$



$$t - t_0 - t_A = 0$$



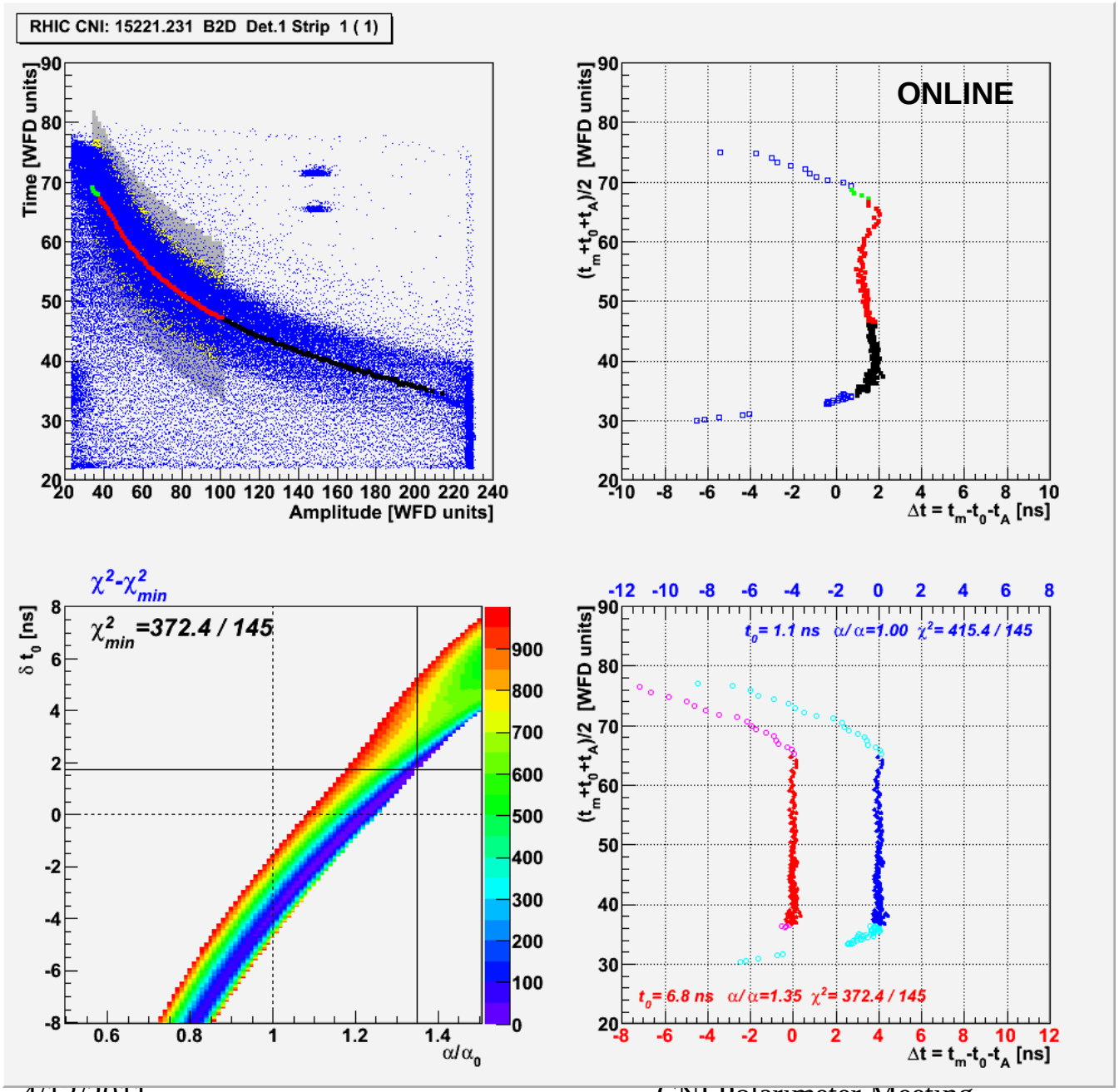
B2D: 15221.231 (APEX) BNL strip 0 (1)



Standard Calibration:

$$L(E) = pL_0(E)$$

B2D: 15221.231 (APEX) BNL strip 0 (1)

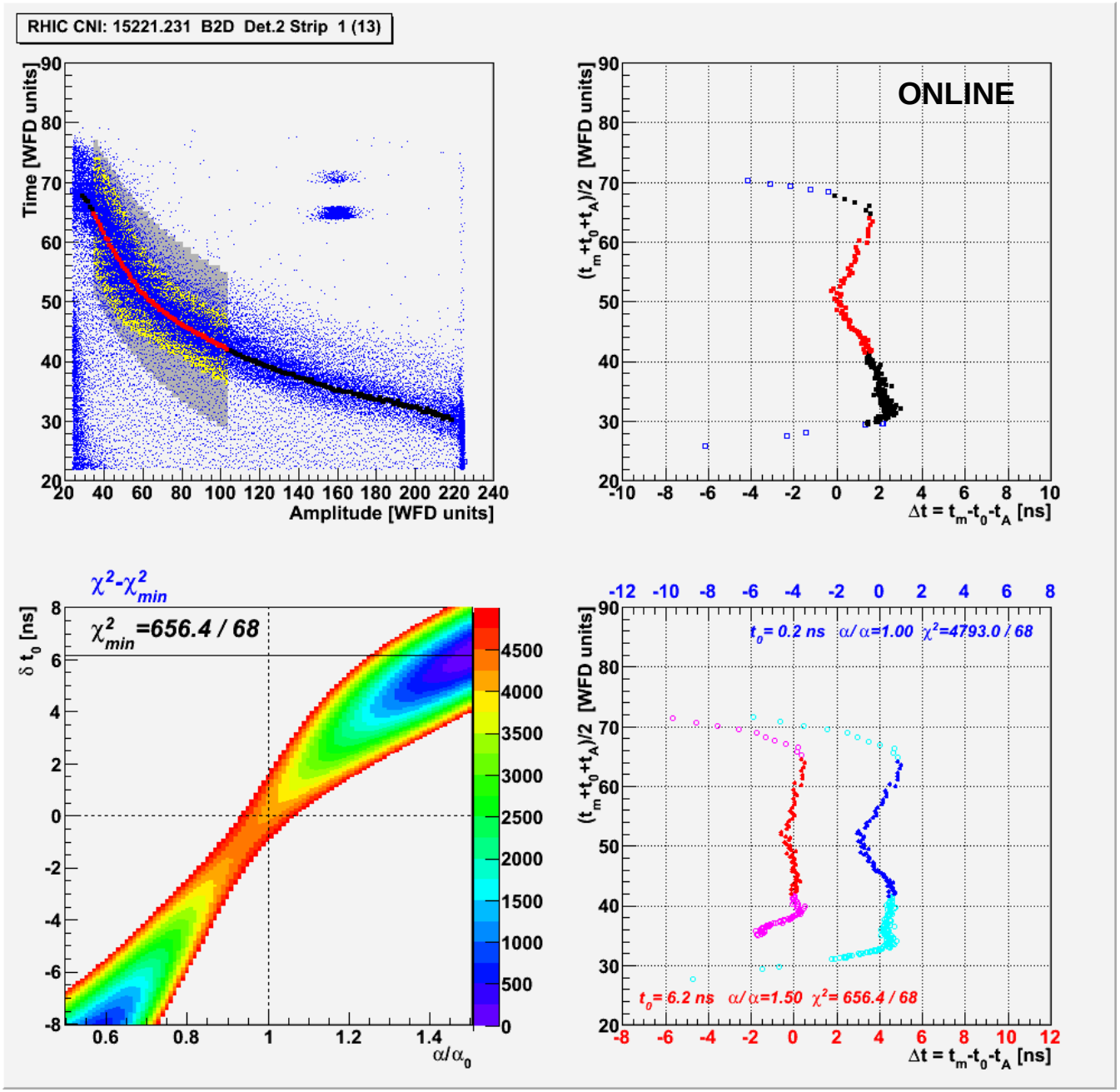


Polinomial Calibration:

$$L(E) = p_0 E + p_1 E^2 + p_2 E^2$$

$$\Delta t_0 = -4.1 \text{ ns}$$

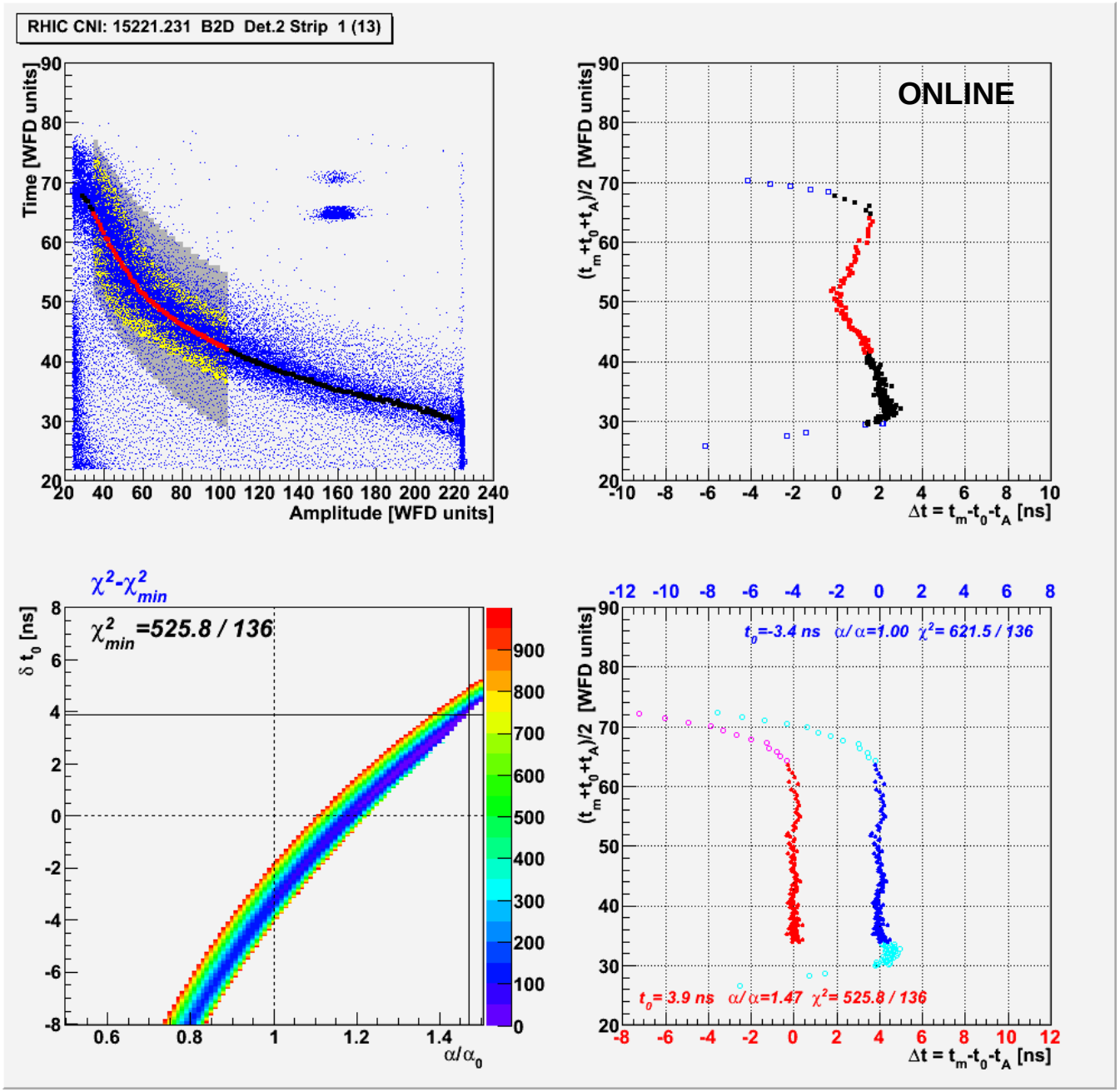
B2D: 15221.231 (APEX) Hamamatsu strip 12 (13)



Standard Calibration:

$$L(E) = pL_0(E)$$

B2D: 15221.231 (APEX) Hamamatsu strip 12 (13)

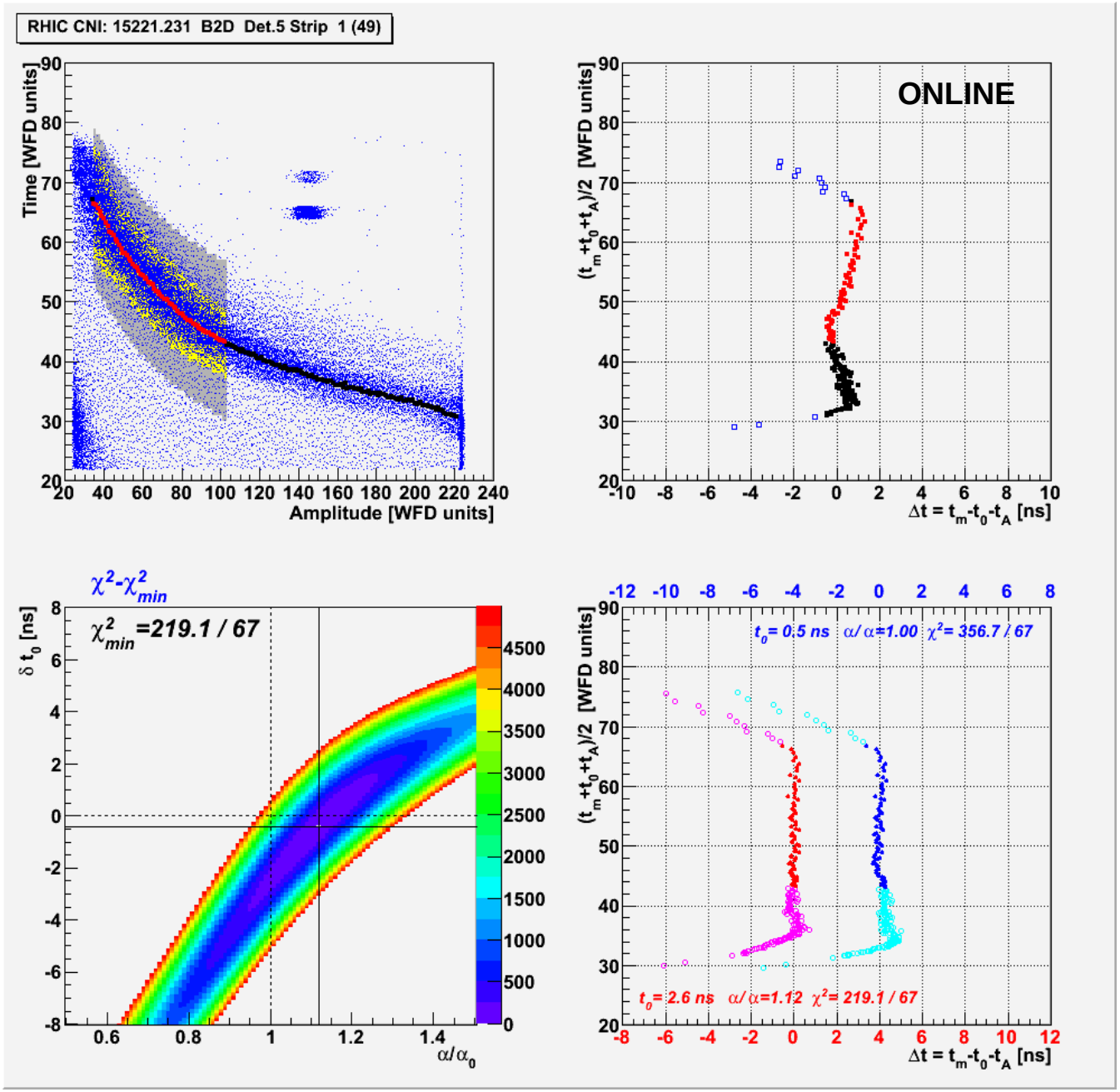


Polinomial Calibration:

$$L(E) = p_0 E + p_1 E^2 + p_2 E^2$$

$$\Delta t_0 = -3.6 \text{ ns}$$

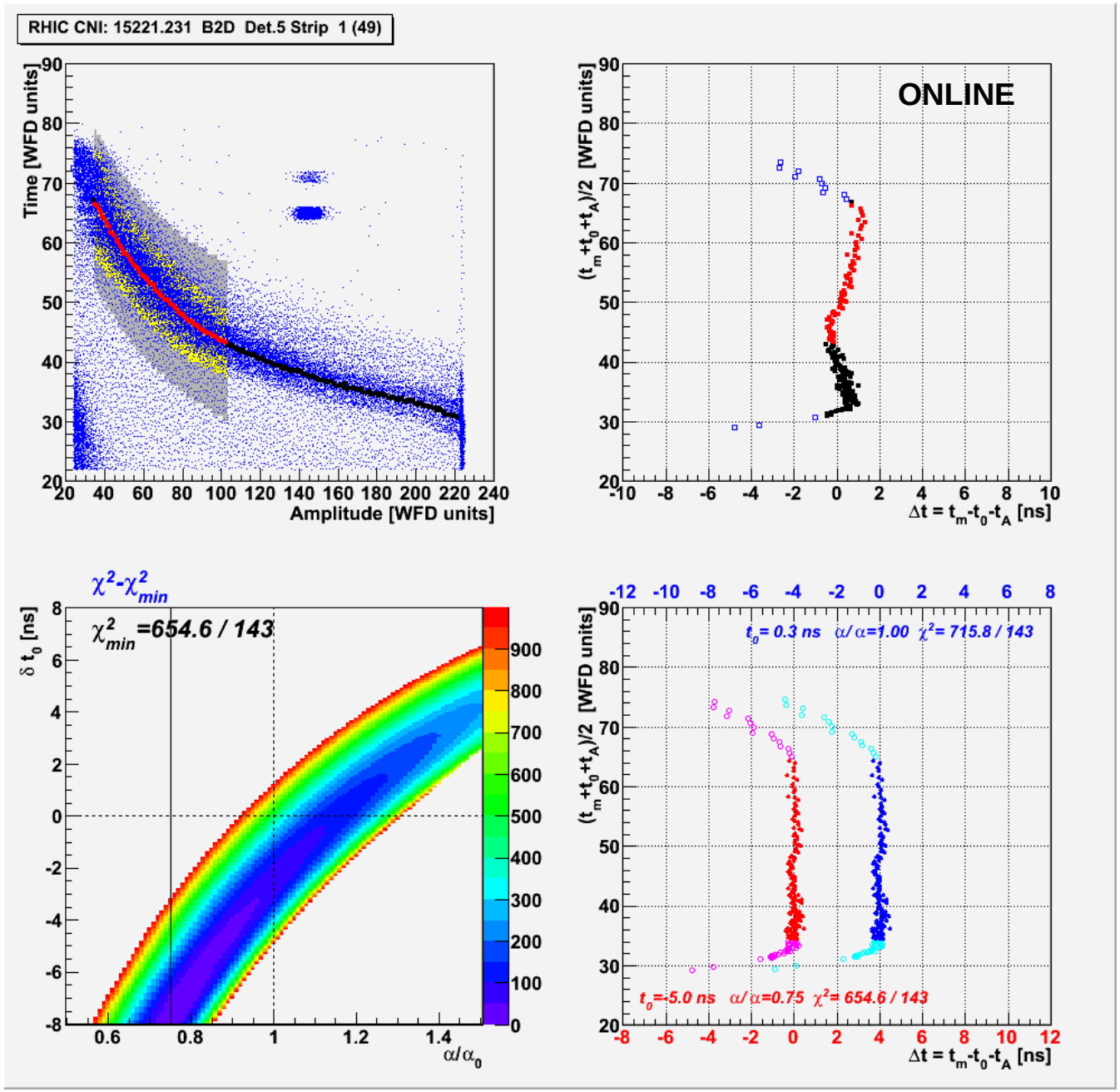
B2D: 15221.231 (APEX) Hamamatsu strip 48 (49)



Standard Calibration:

$$L(E) = pL_0(E)$$

B2D: 15221.213 (APEX) Hamamatsu strip 48 (49)

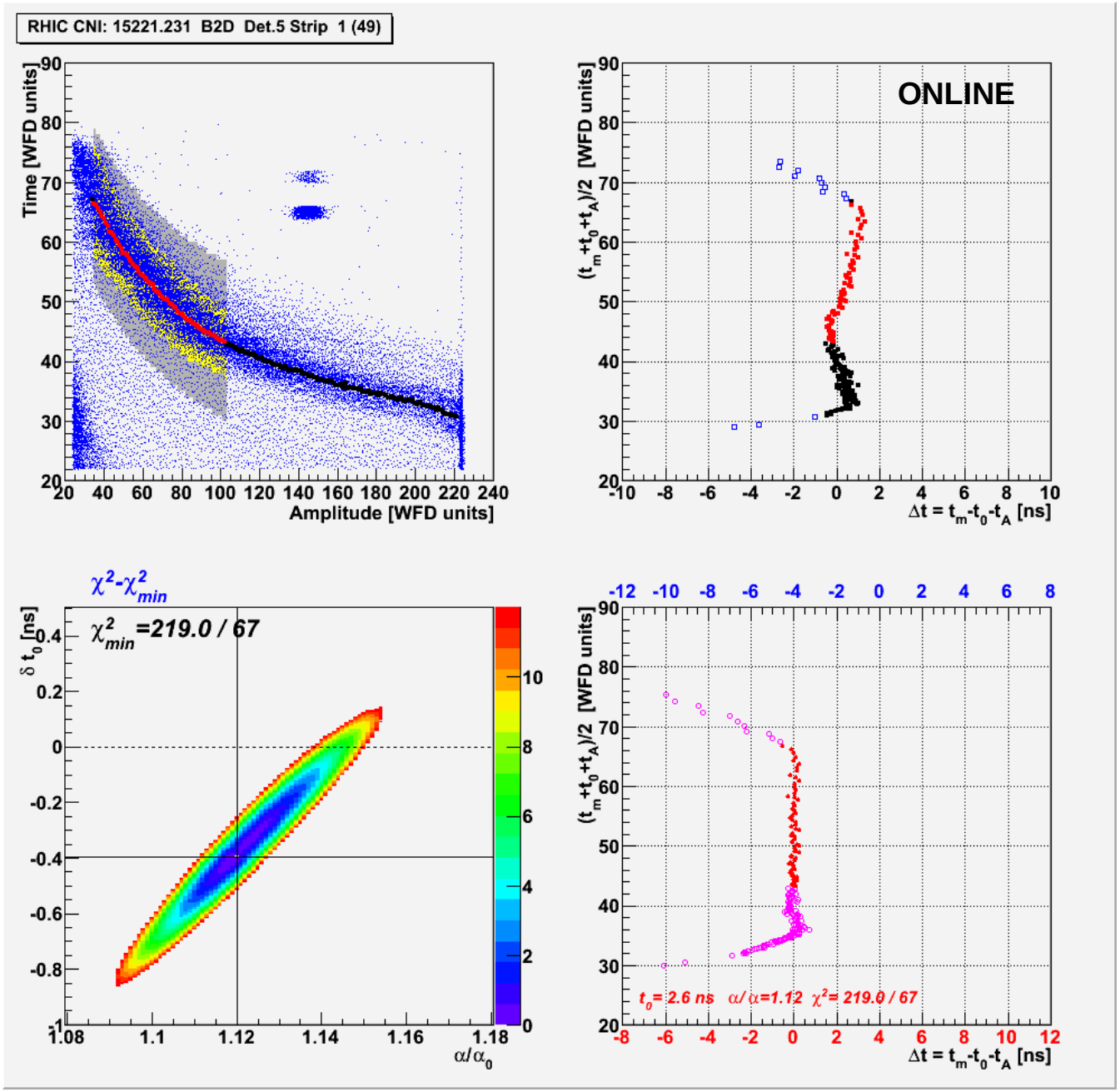


Polinomial Calibration:

$$L(E) = p_0 E + p_1 E^2 + p_2 E^2$$

$$\Delta t_0 = -0.2 \text{ ns}$$

B2D: 15221.231 (APEX) Hamamatsu strip 48 (49)



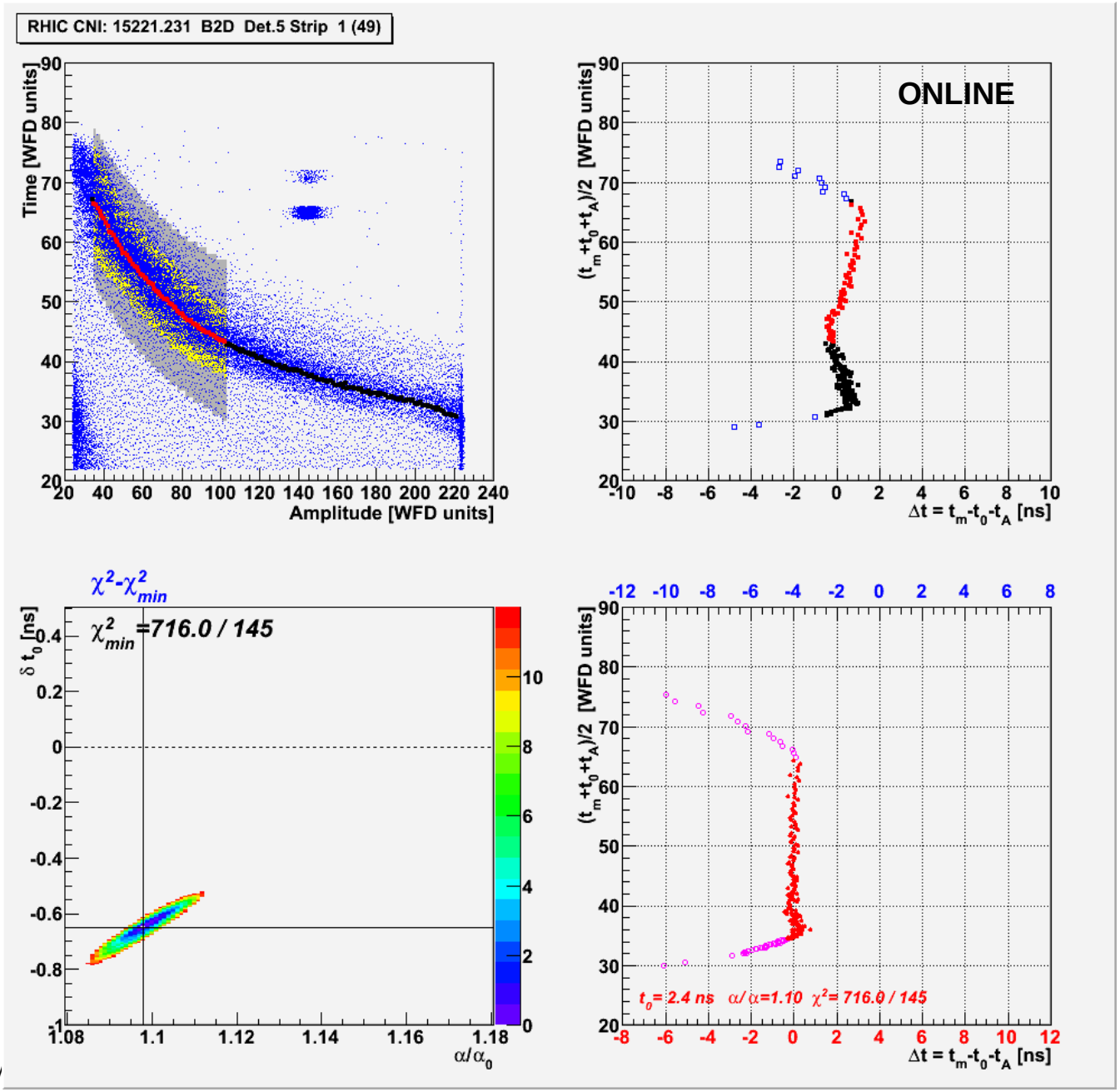
Standard Calibration:

$$L(E) = pL_0(E)$$

$$\sigma_t \sim 0.2 - 0.3 \text{ ns}$$

$$\sigma_{\alpha/\alpha_0} \sim 0.01 - 0.02$$

B2D: 15221.231 (APEX) Hamamatsu strip 48 (49)



Standard Calibration:

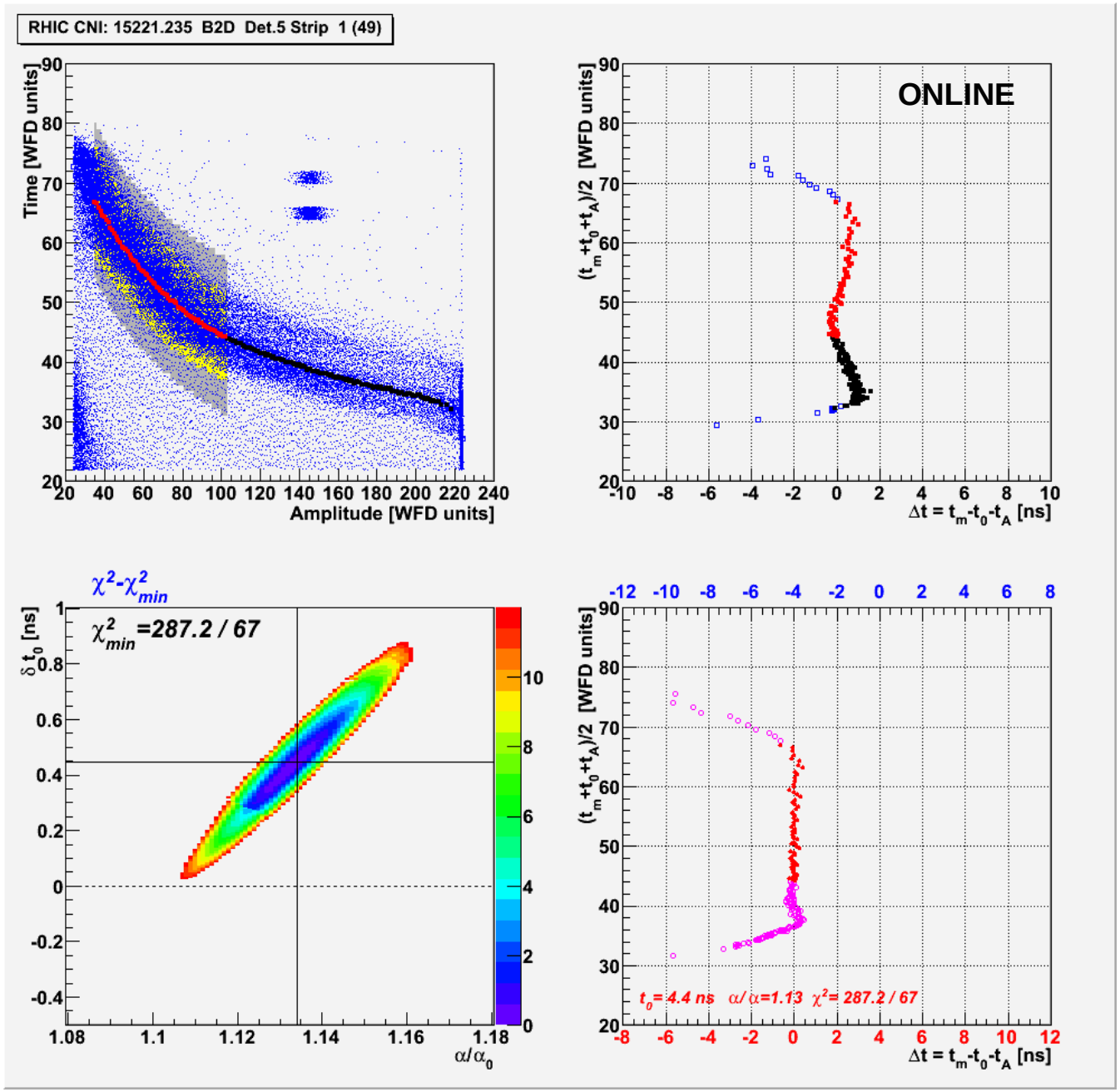
$$L(E) = pL_0(E)$$

Extended Energy Range:

$$\Delta t_0 = -0.2 \text{ ns}$$

$$\Delta(\alpha/\alpha_0) = -0.02$$

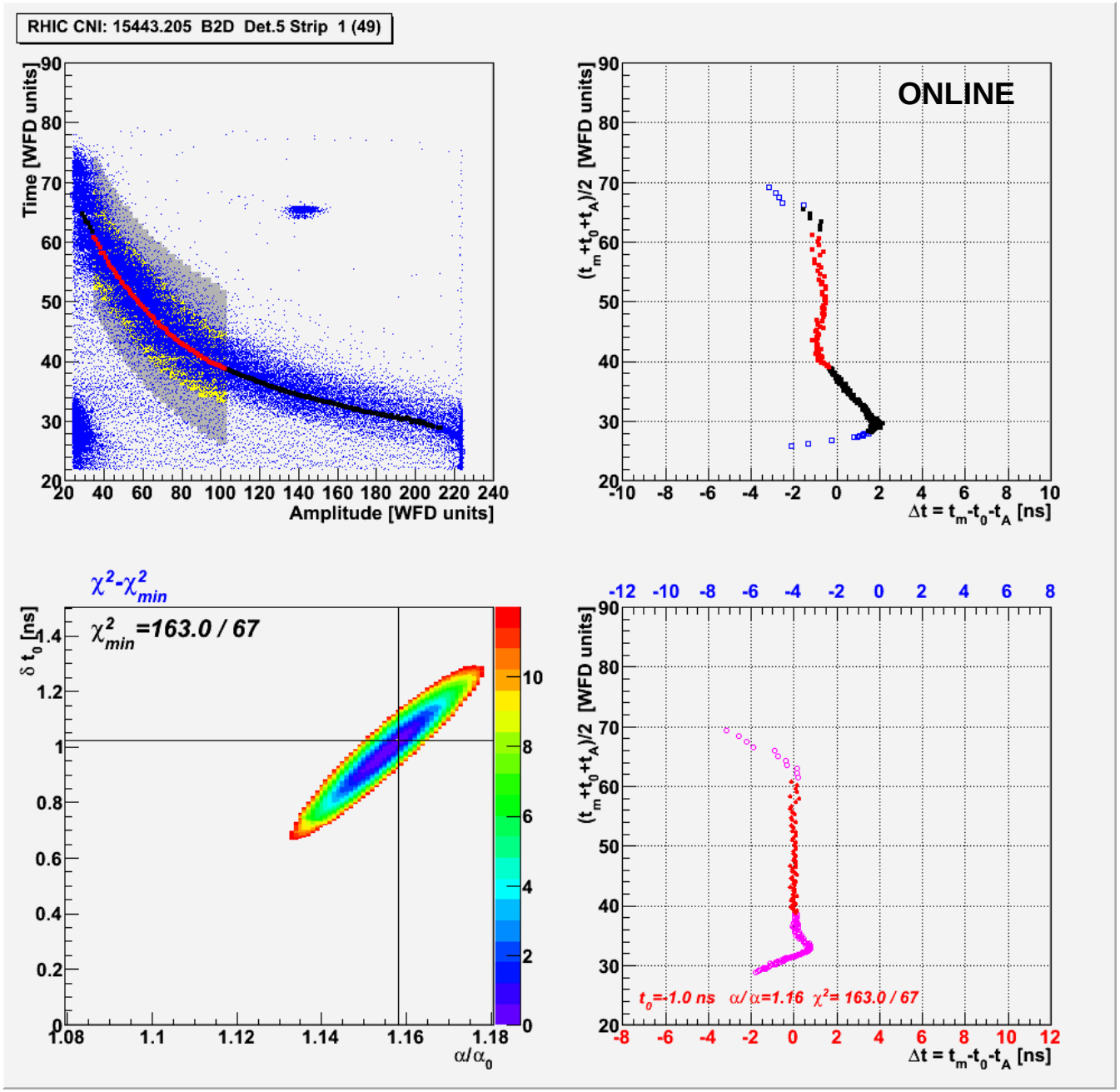
B2D: 15221.235 (APEX) Hamamatsu strip 48 (49)



Standard Calibration:

$$L(E) = pL_0(E)$$

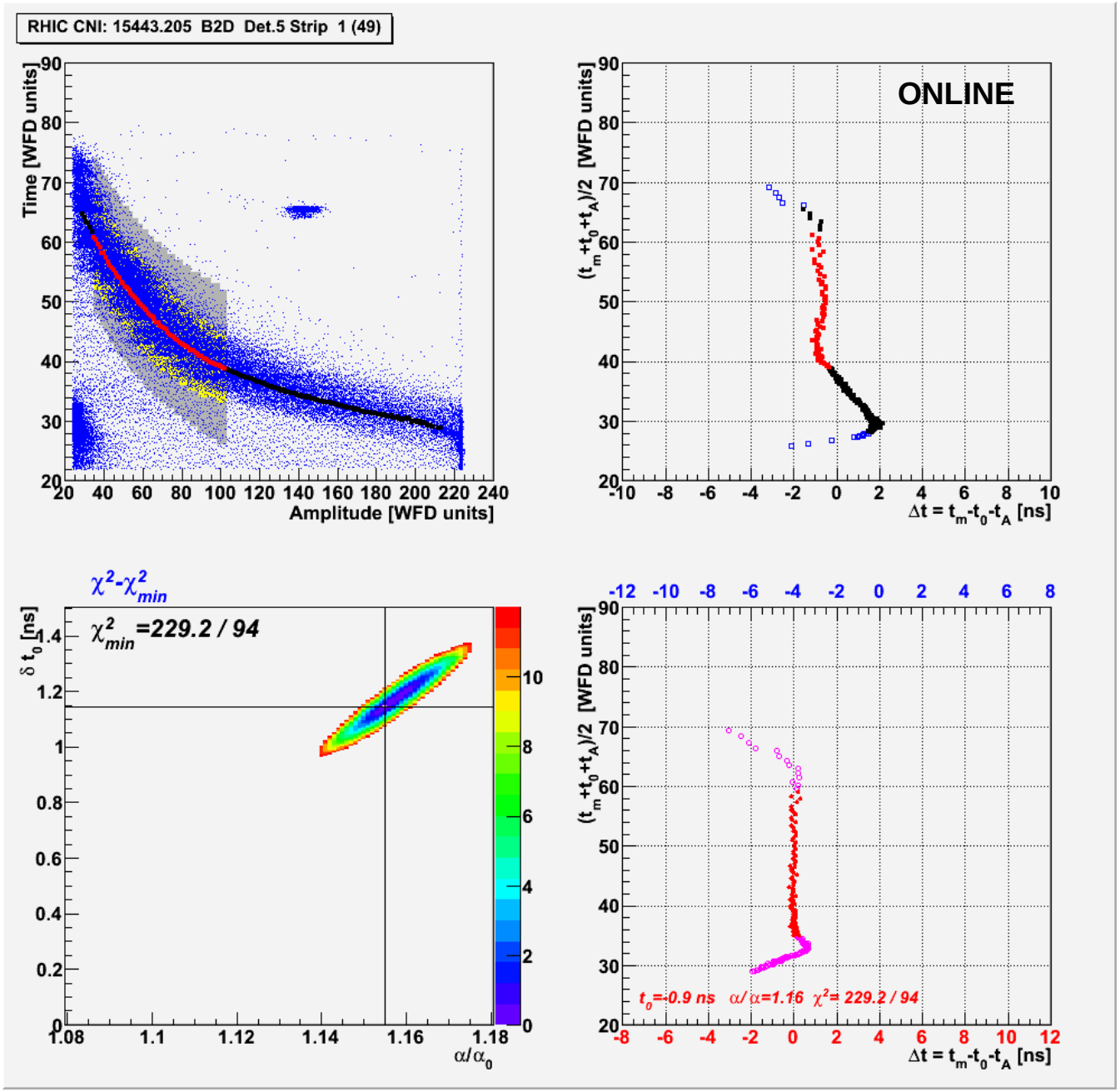
B2D: 15443.205 (APEX) Hamamatsu strip 48 (49)



Standard Calibration:

$$L(E) = pL_0(E)$$

B2D: 15443.205 (APEX) Hamamatsu strip 48 (49)



Standard Calibration:

$$L(E) = pL_0(E)$$

Extended Energy Range:

$$\Delta t_0 = 0.1 \text{ ns}$$
$$\Delta(\alpha/\alpha_0) = 0.0$$

Comparison of the calibrations for the B2D strip 48(49)

Run	Energy Range	t_0 (ns)	α/α_0	x_{DL} ($\mu g/cm^2$)	Comment
15221.231	regular	2.60	1.12	46.4	V6, APEX
	extended	2.35	1.10	47.9	
15231.235	regular	4.45	1.13	50.4	V4, APEX
15443.205	regular	-0.98	1.16	57.0	V6
	extended	-0.85	1.16	58.1	

All numbers to be verified !

Summary

- Standard calibration (dead layer model + MSTAR approximation for the dE/dx) works well for one Hamamatsu detector (B2D, detector #5, strips 49-60)
- Gain may be found in the fit.
- Polinomial calibration is consistent with standard one, but gain has to be fixed.

- For other detectors, BNL and Hamamatsu, standard calibration does not give trustable results.
- There is disagreement about 4 ns for the values of t_0 obtained in standard and polinomial calibrations for those detectors.

- Calibration is "corrupted " in ceramics and/or in preamplifiers. Induced pulse?

<u>Possible explanations of wrong calibration:</u>

$$t = t_0 + \frac{\tau}{\sqrt{E + \delta E(A)}}$$

Polinomial calibration may fix the problem

$$t = t_0 + \delta t(A) + \frac{\tau}{\sqrt{E}}$$

<u>I do not know</u> how to fix the problem without explicit knowledge of the δt(A)