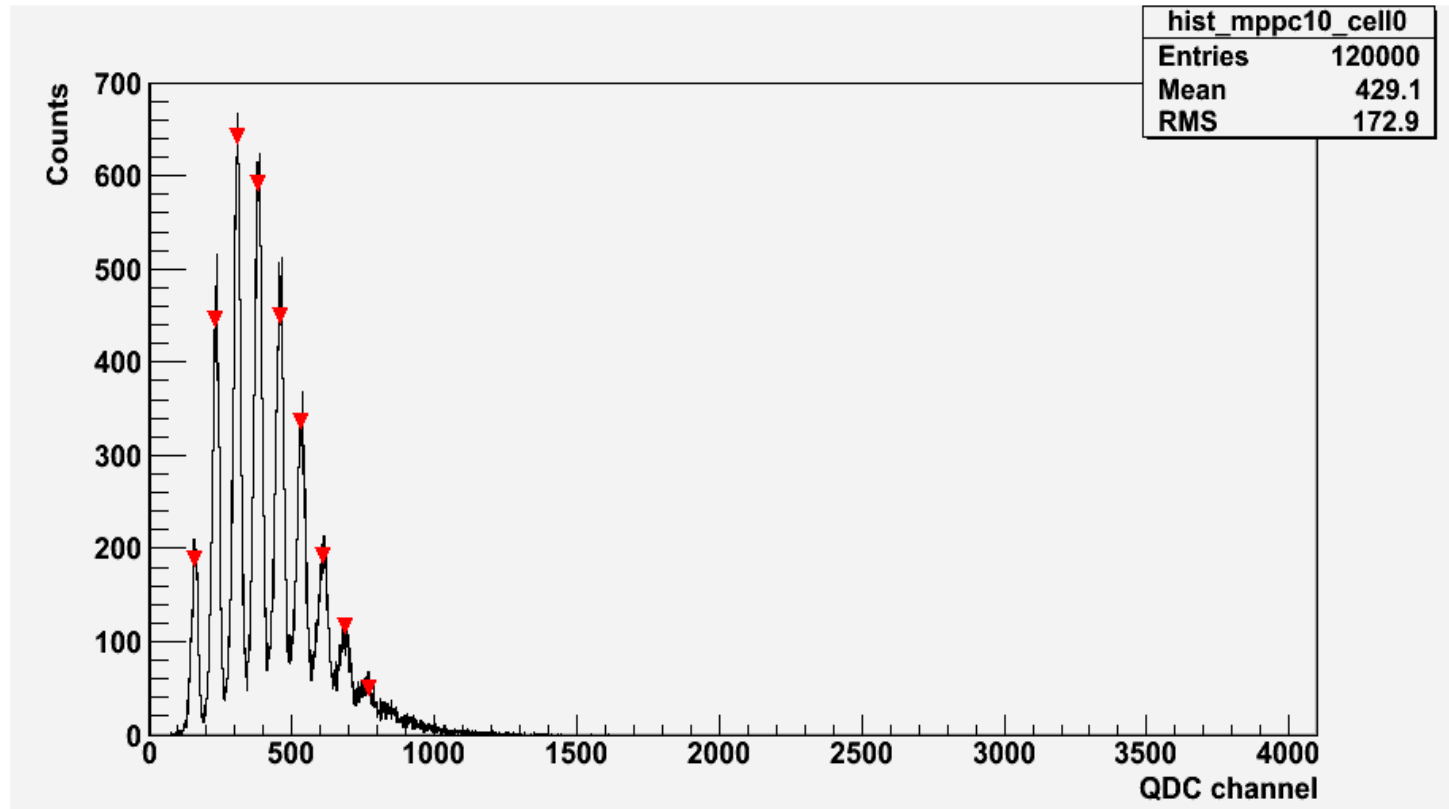


Operational Voltage Selection. Orlando Soto.

Given a temperature T_{USM} , for each cell in one MPPC we have histograms at 13 different bias voltages¹ V_i , starting with corrected Hamamatsu operational voltage², decreasing -0,1 [V] steps.

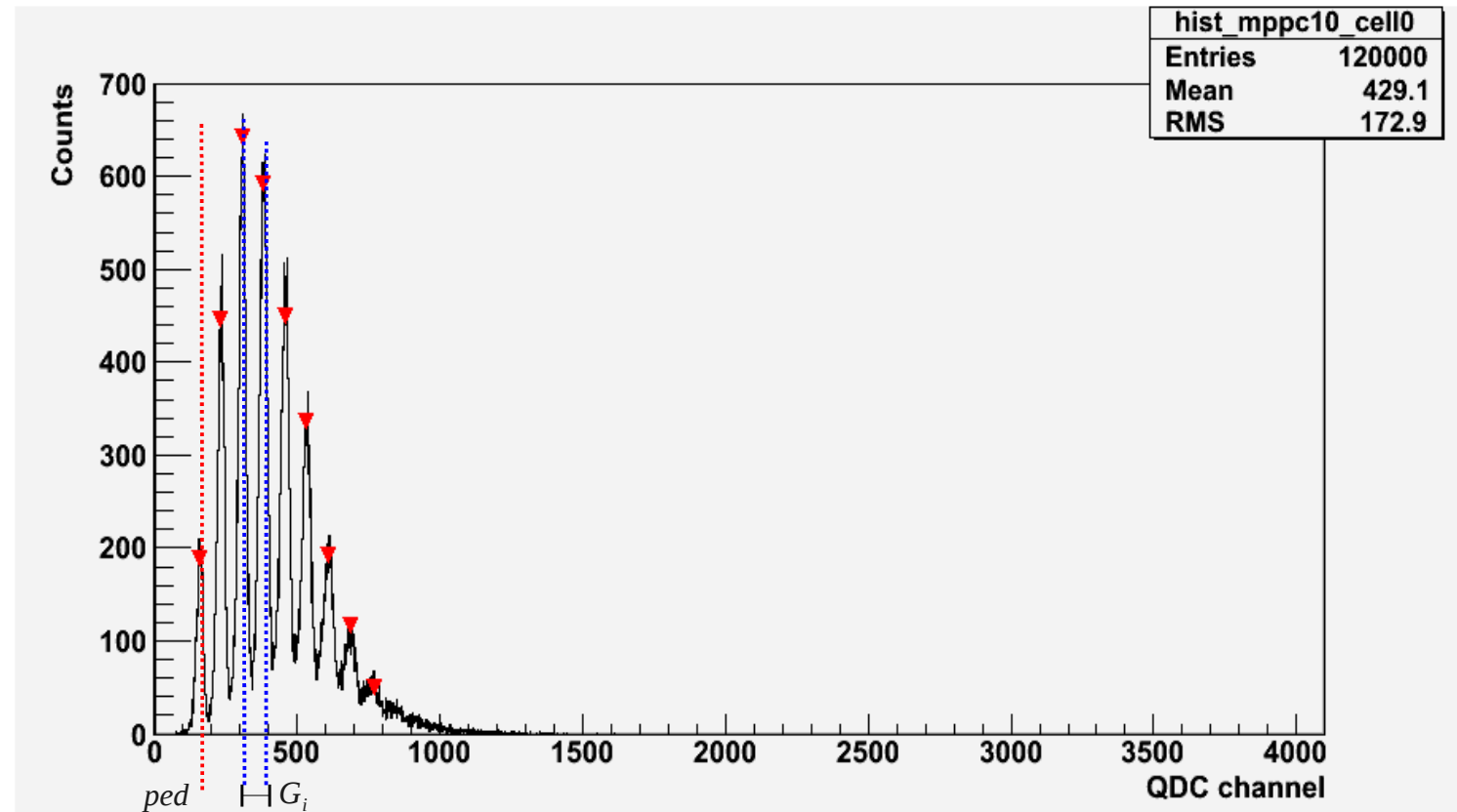


¹ $V_i = V_0 - 0,1 \cdot i$

² temperature correction:

$$\Delta t \cdot 0.056 [V] \Rightarrow V_0 = \bar{V}_{hamamatsu} + (25 - T_{usm}) \cdot 0.056$$

From these histograms we get gain (G_i), average number of photoelectrons (μ_i), cross-talk probability ($\Delta\mu_i$) according to:

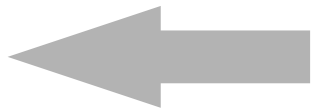


Mean

RMS

ped

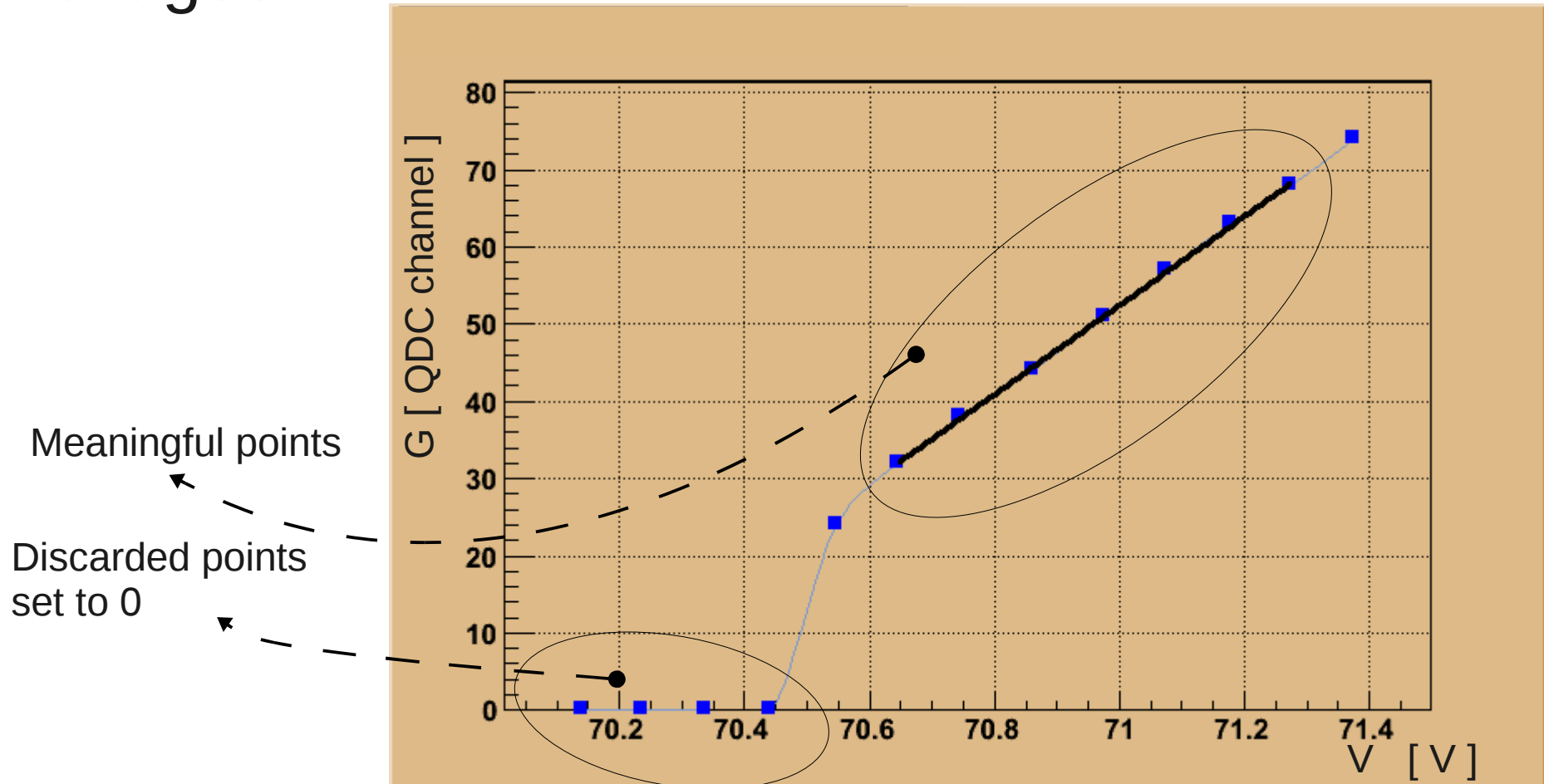
G_i



$$\mu_i = \frac{-(RMS^2/G_i - (Mean - ped)/G_i) + \sqrt{((RMS^2/G_i - (Mean - ped)/G_i)^2 + 4 * ((Mean - ped)/G_i)^2)}}{2}$$

$$\Delta\mu_i = \frac{(Mean - ped)}{\mu_i} - 1$$

For each cell we estimate Break Down Voltage from first order polynomial fit over the meaningful voltages.



$$G(V) = p_0 + p_1 \cdot V$$

$$G(V_{BDV}) = 0 \Rightarrow V_{BDV} = -p_0 / p_1$$

The next slides shows the evolution of the dispersion between cells of the same mppc for the quantities: number of photoelectrons, gain, and the product of both quantities, at a given temperature (5 °C, 7 °C, 20 °C).

$$(1) Mean_{\mu_i} = \frac{1}{16} \cdot \sum_{k=1}^{16} \mu_{ik}; \quad RMS_{\mu_i} = \sqrt{\frac{1}{16} \cdot \sum_{k=1}^{16} (\mu_{ik})^2 - Mean_{\mu_i}^2}$$

$$(2) Mean_{G_i} = \frac{1}{16} \cdot \sum_{k=1}^{16} G_{ik}; \quad RMS_{G_i} = \sqrt{\frac{1}{16} \cdot \sum_{k=1}^{16} (G_{ik})^2 - Mean_{G_i}^2}$$

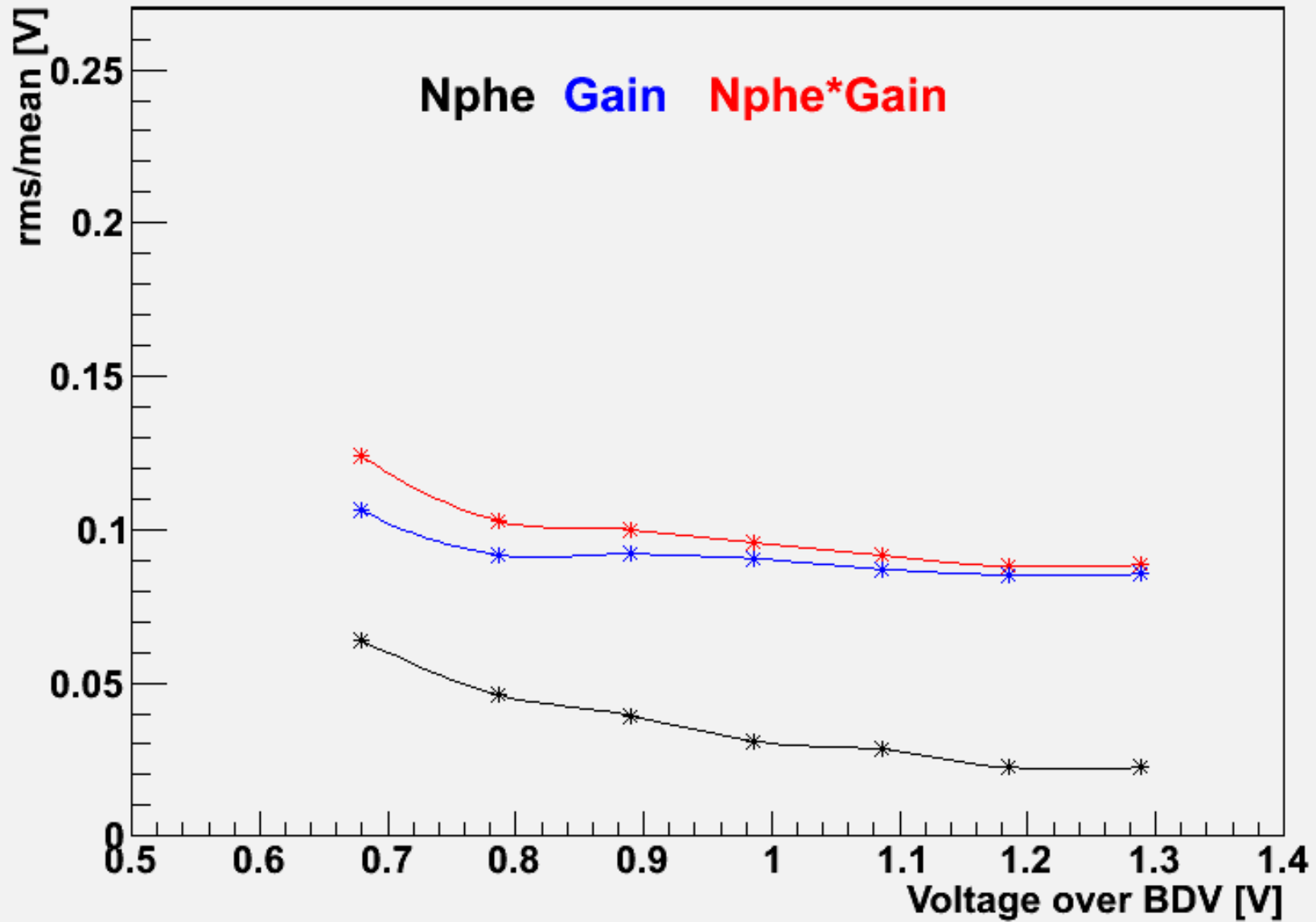
$$(3) Mean_{\mu_i \cdot G_i} = \frac{1}{16^2} \cdot \sum_{k=1}^{16} \sum_{m=1}^{16} \mu_{ik} \cdot G_{im}; \quad RMS_{\mu_i \cdot G_i} = \sqrt{\frac{1}{16^2} \cdot \sum_{k=1}^{16} \sum_{m=1}^{16} (\mu_{ik} \cdot G_{im})^2 - Mean_{\mu_i \cdot G_i}^2}$$

The y-axis of plots shows $RMS_{xxx} / Mean_{xxx}$.

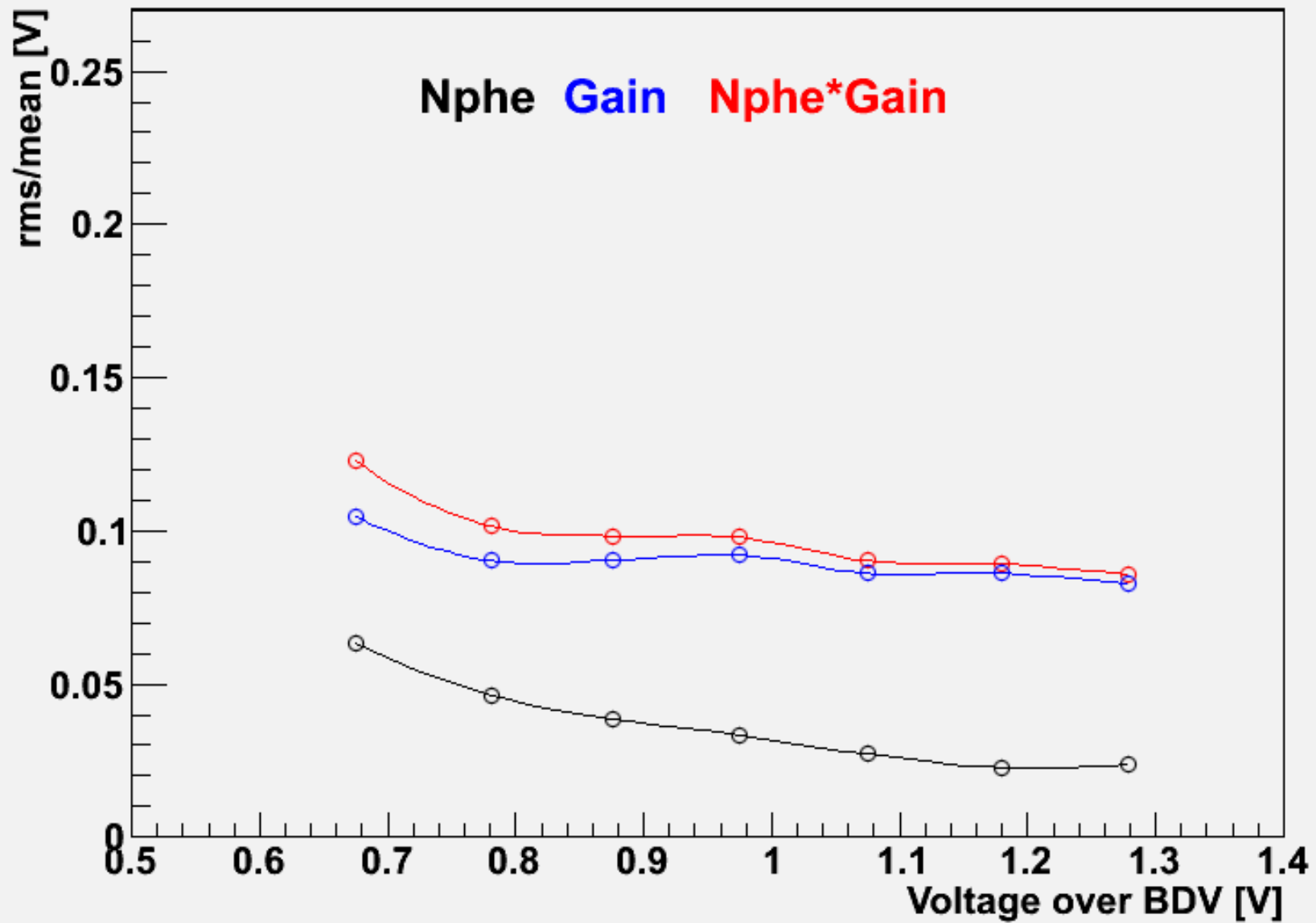
The x-axis of the plots shows the over voltage from the average BDV for the MPPC.

$$avg_{V_{BDV}} = \frac{1}{16} \cdot \sum_{k=1}^{16} V_{BDV_k}$$

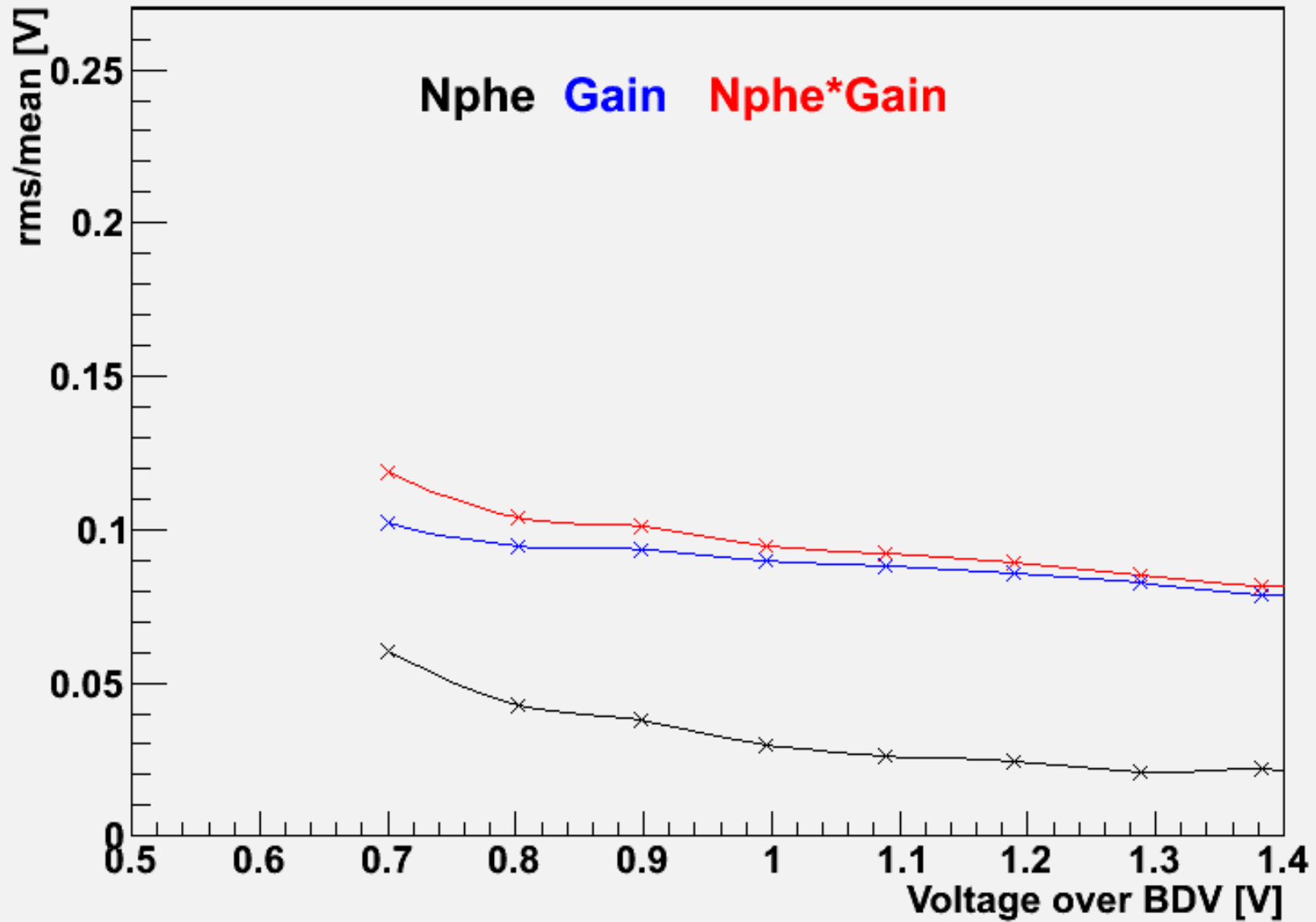
1821_T05



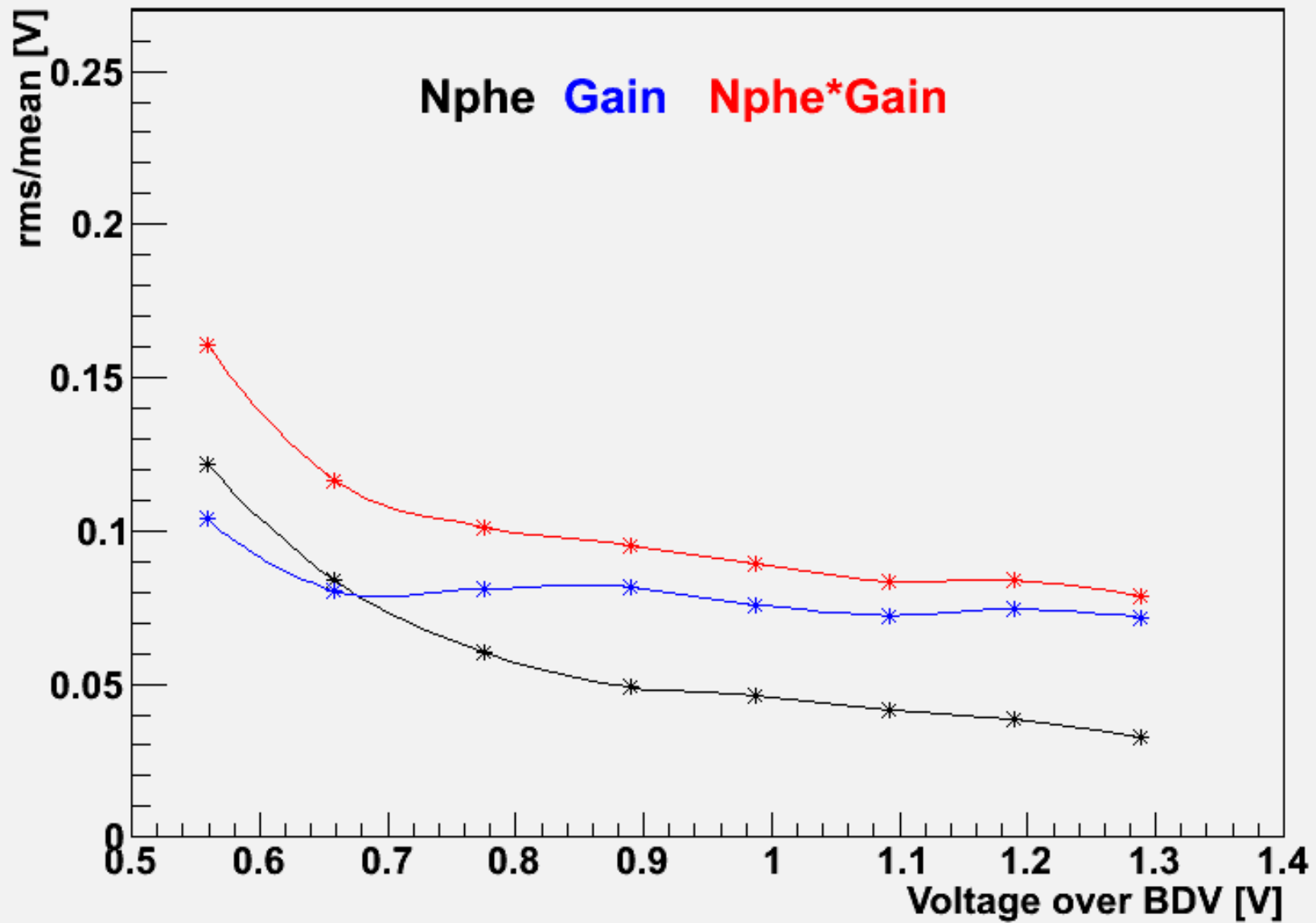
1821_T07



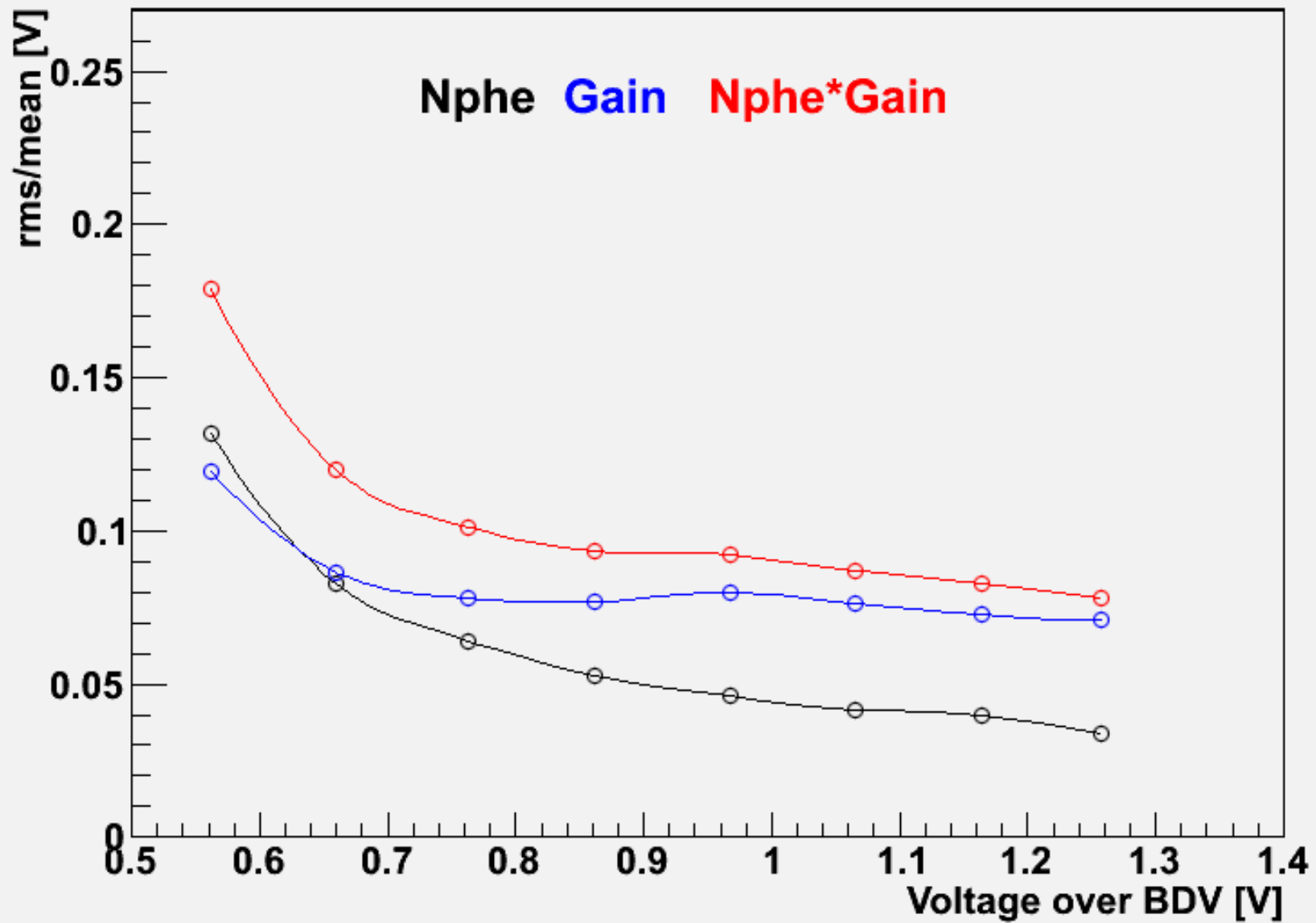
1821_T20



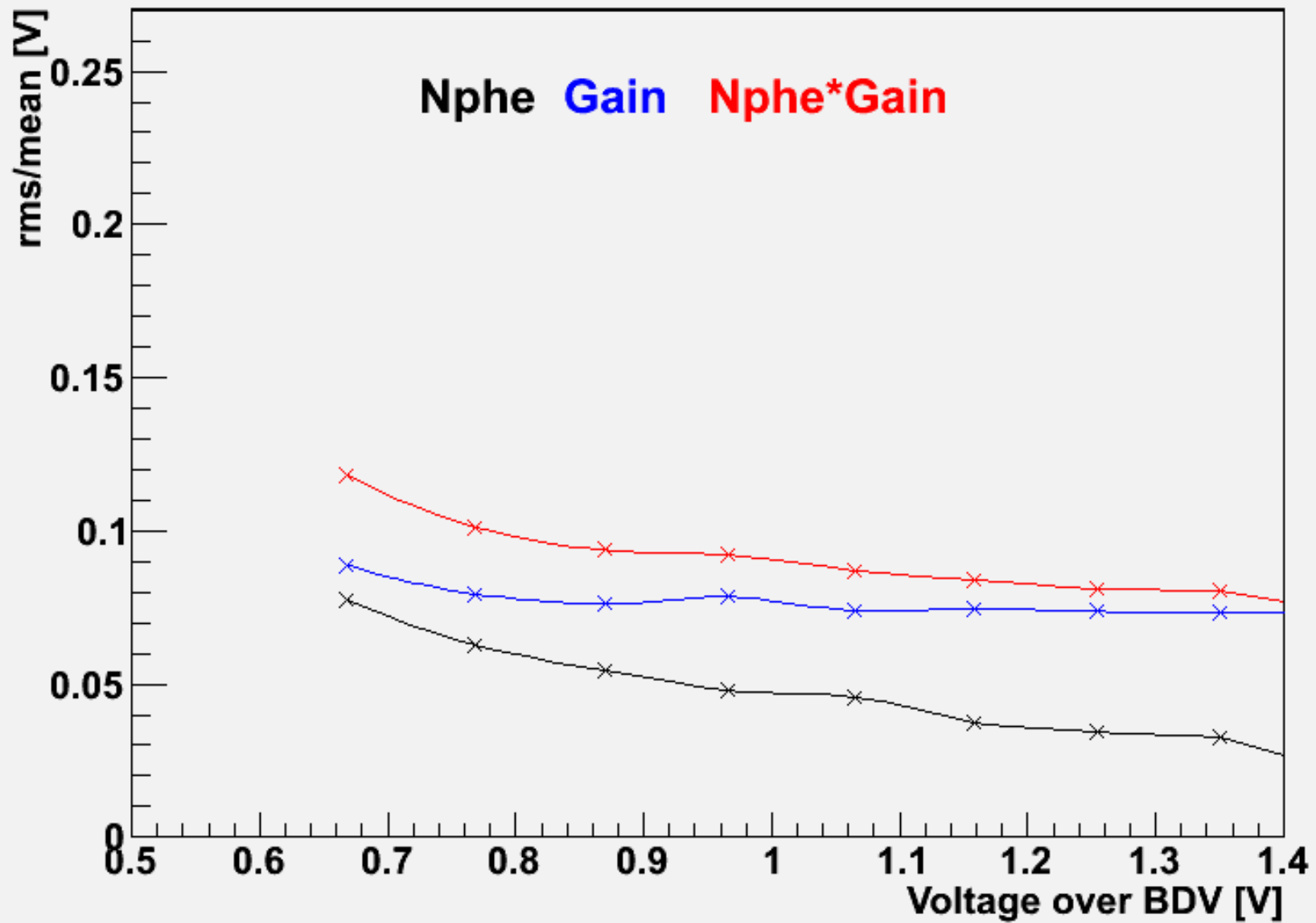
1896_T05



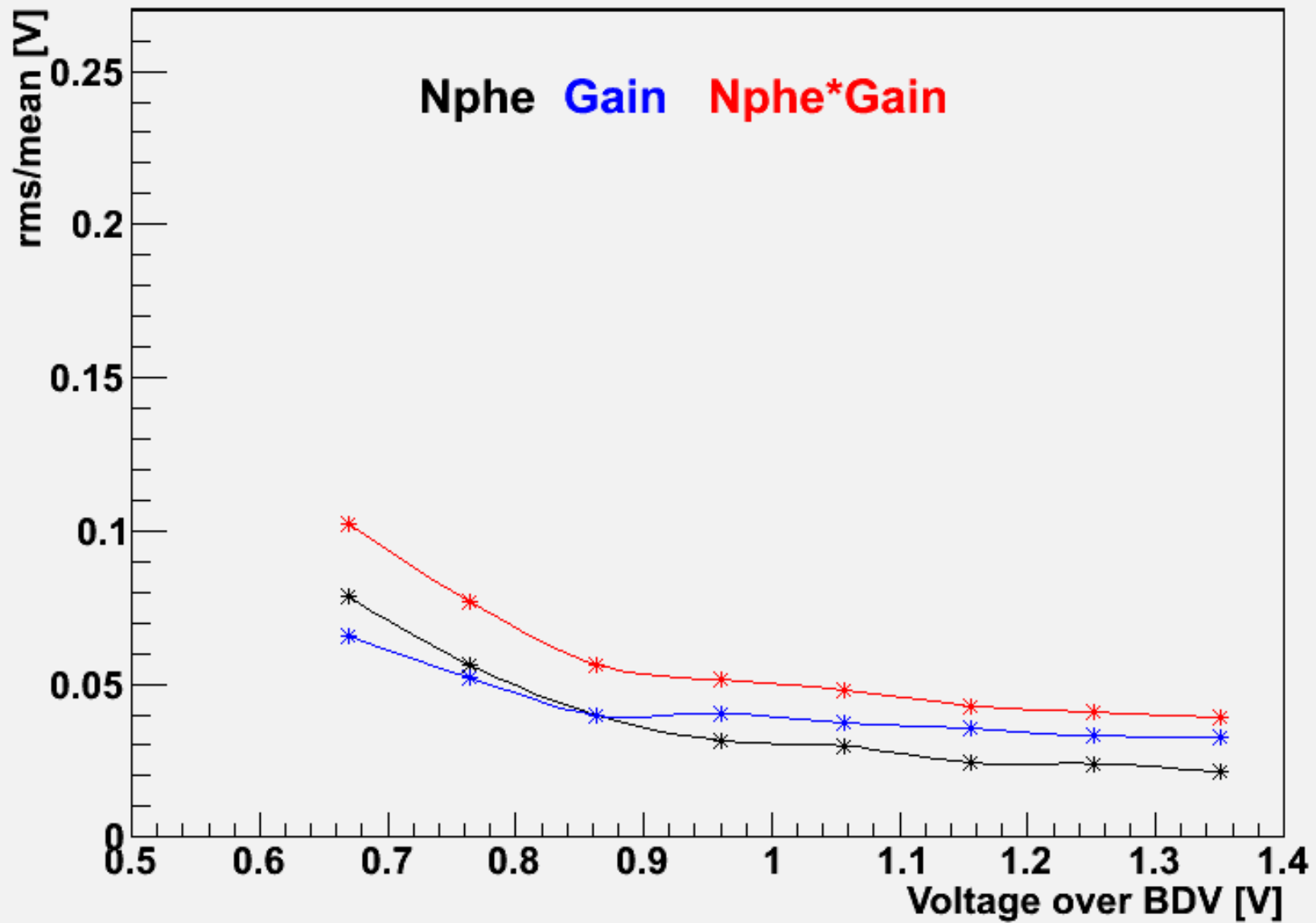
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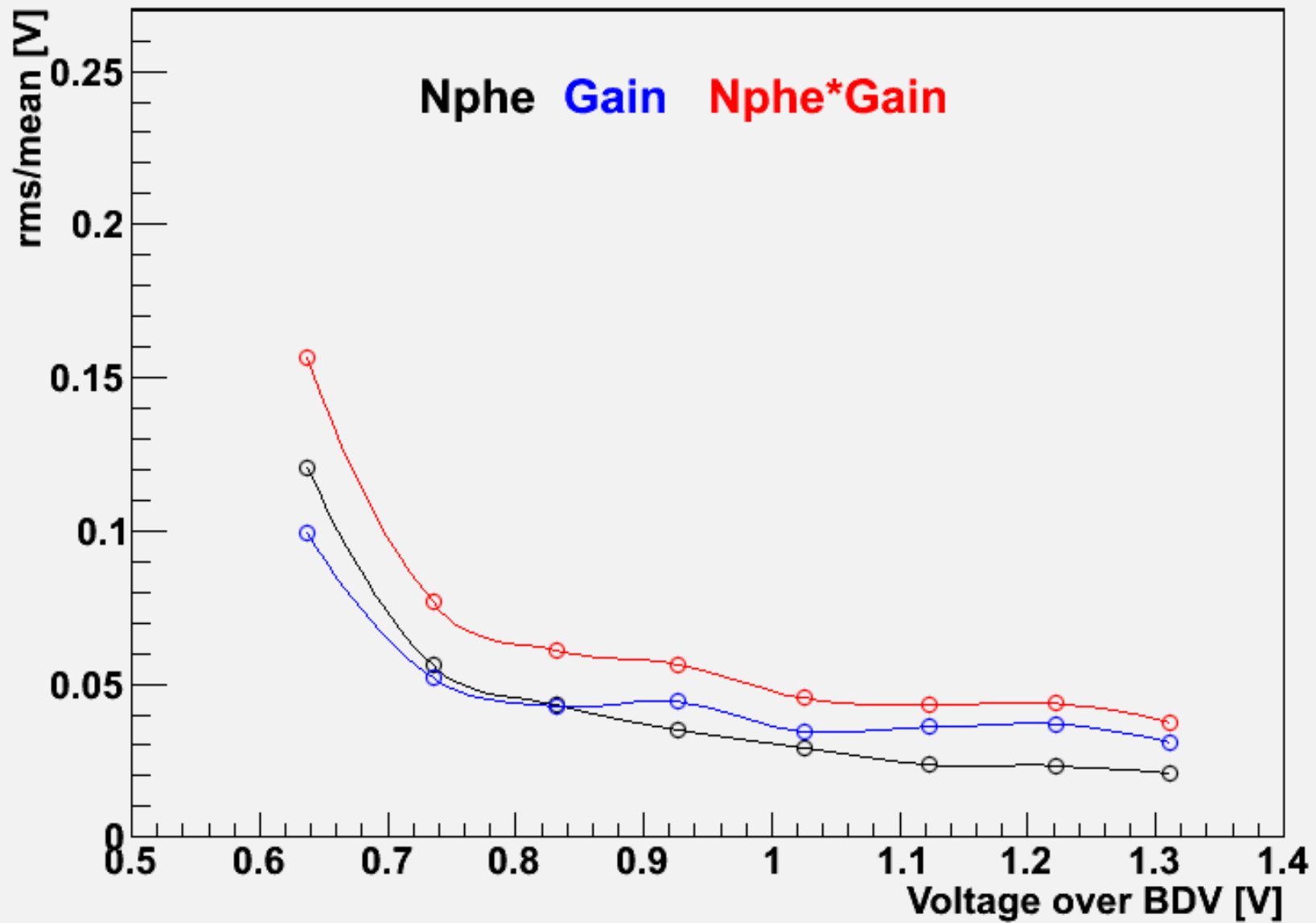
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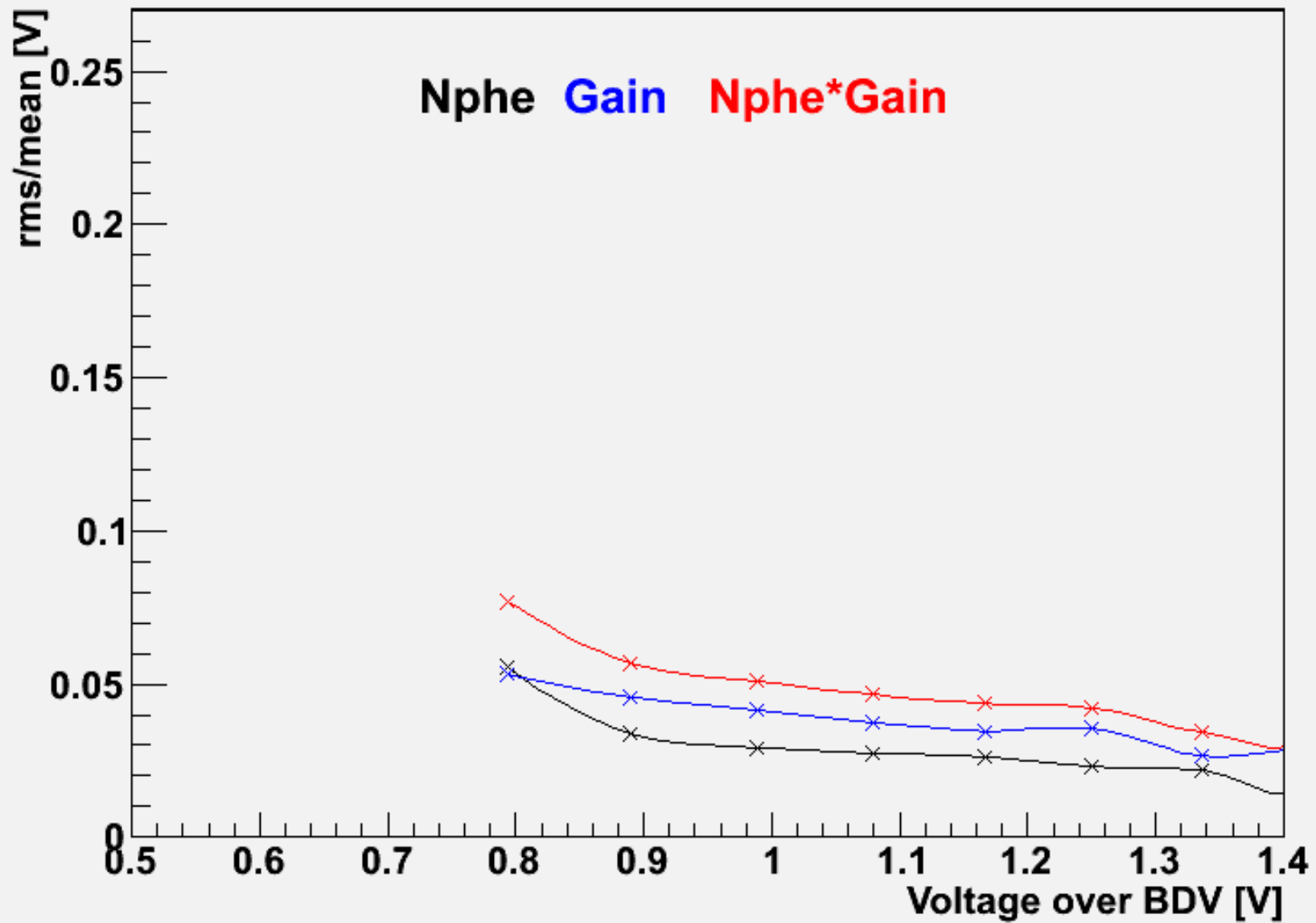
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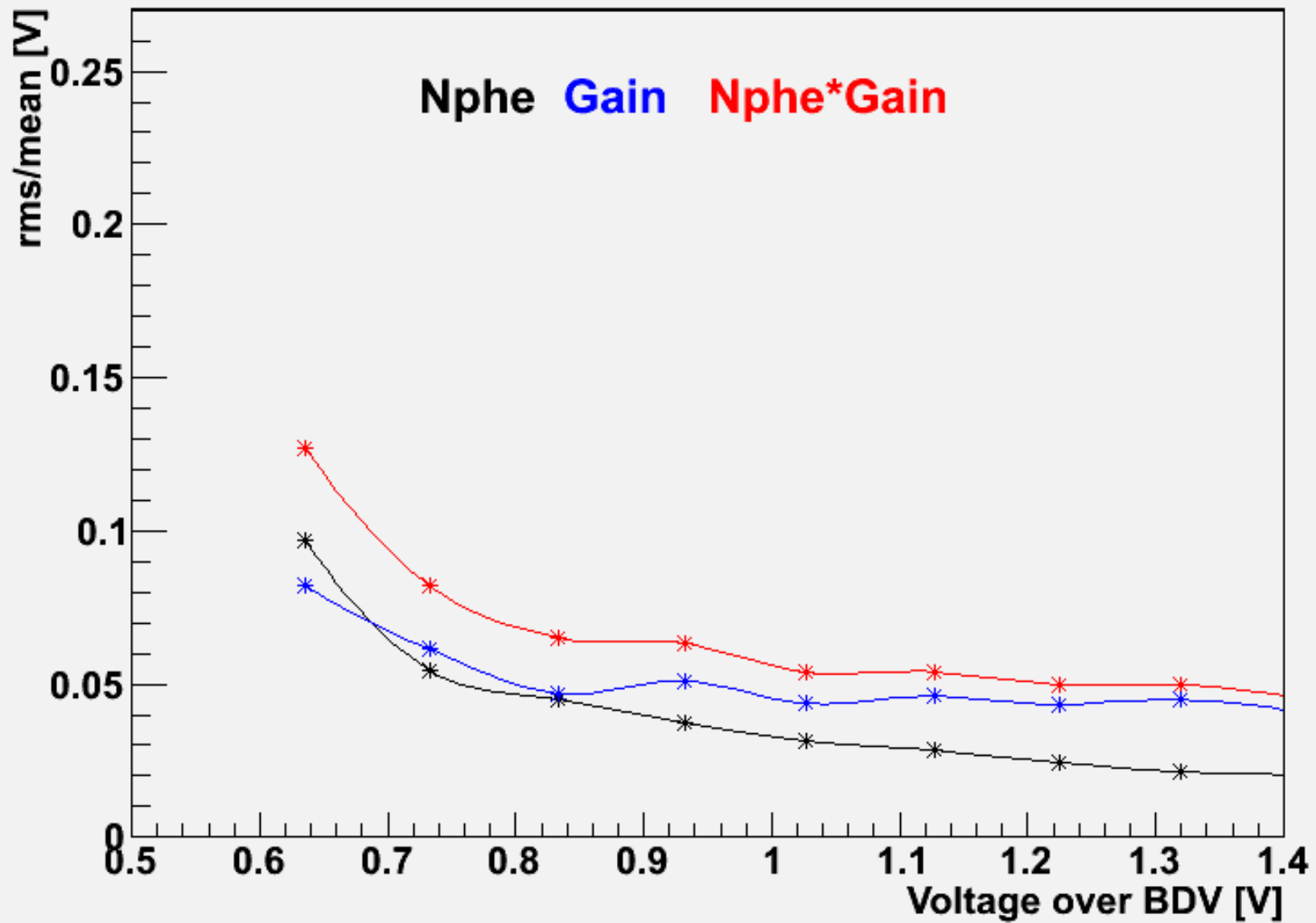
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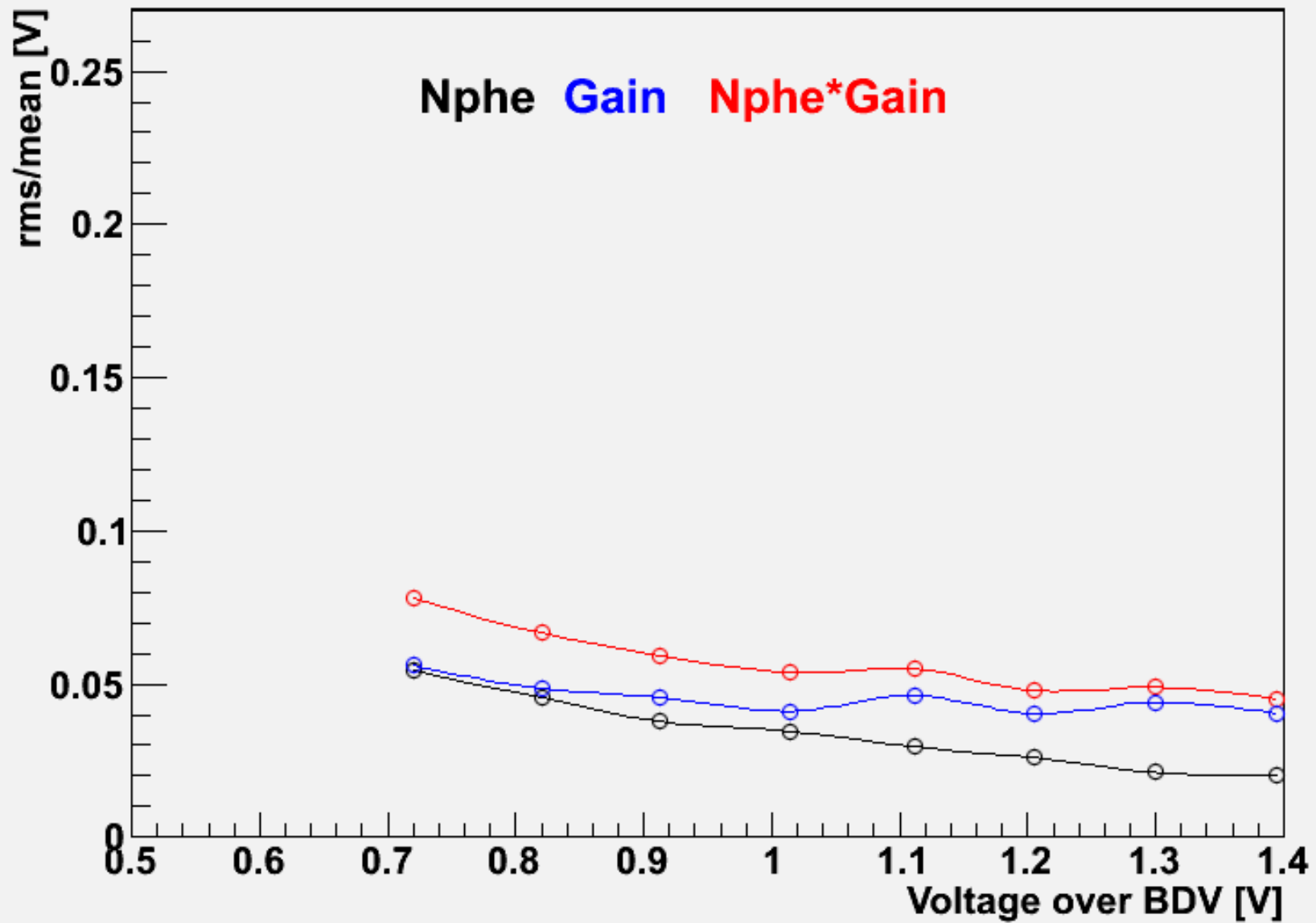
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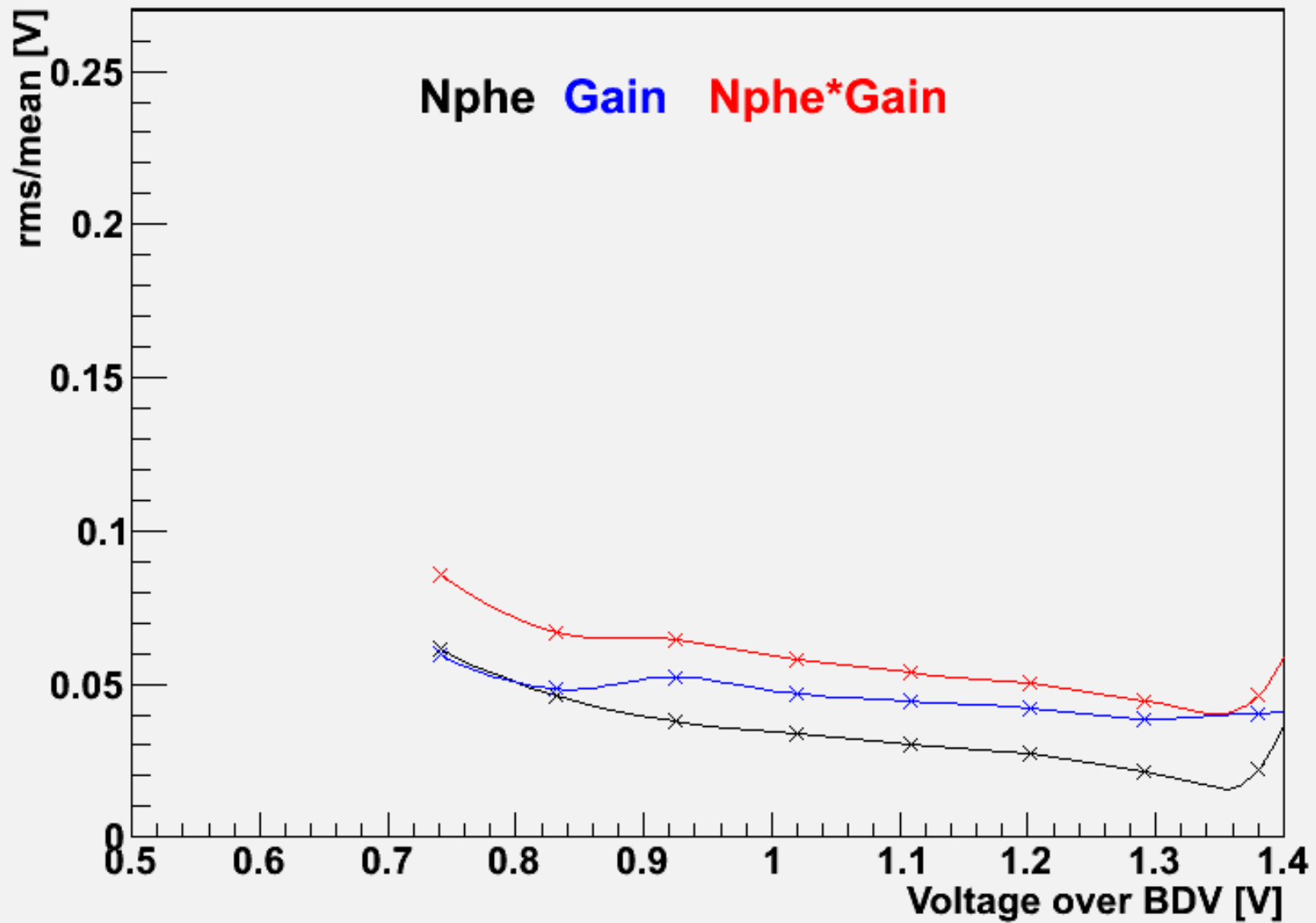
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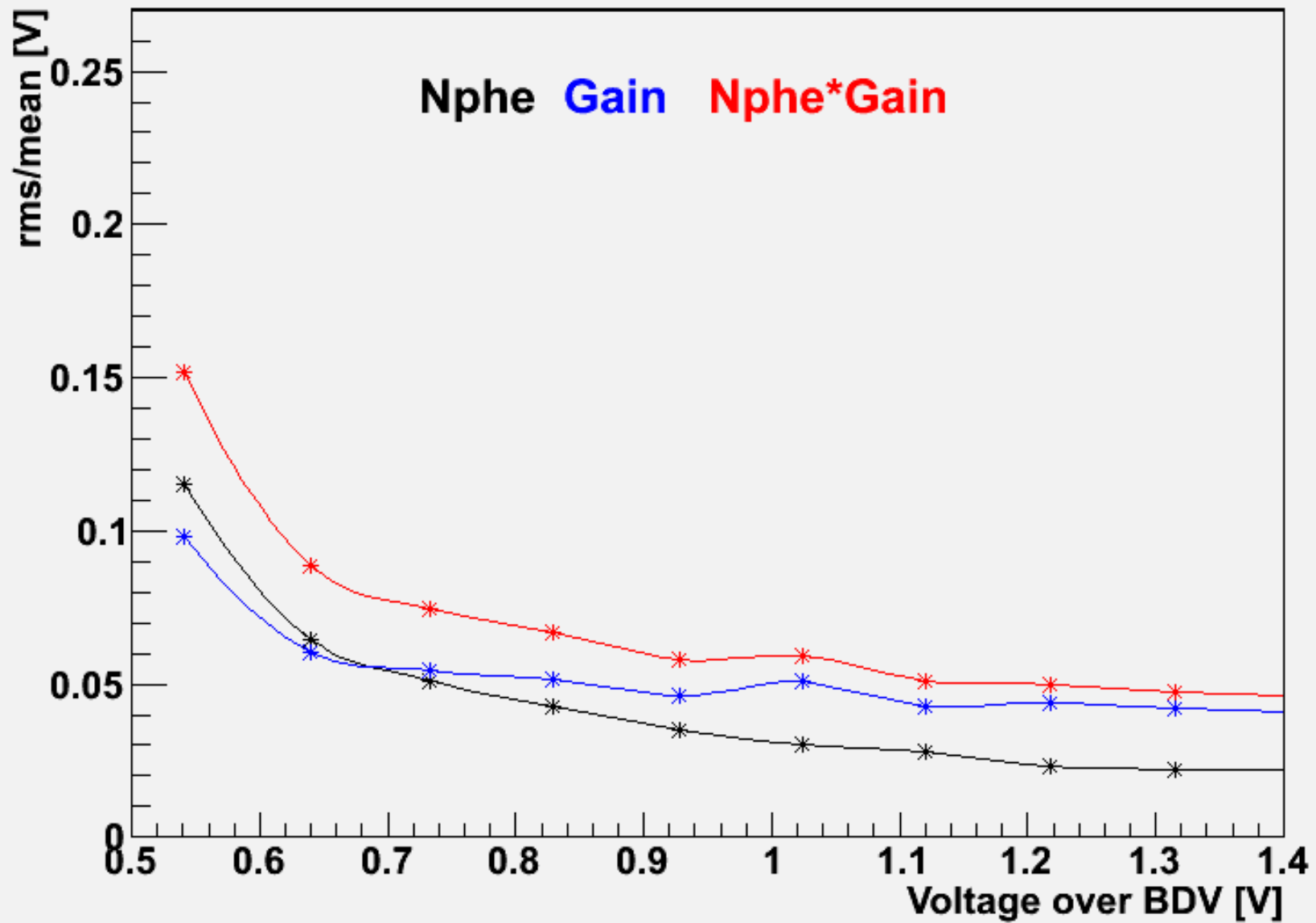
2044_T07



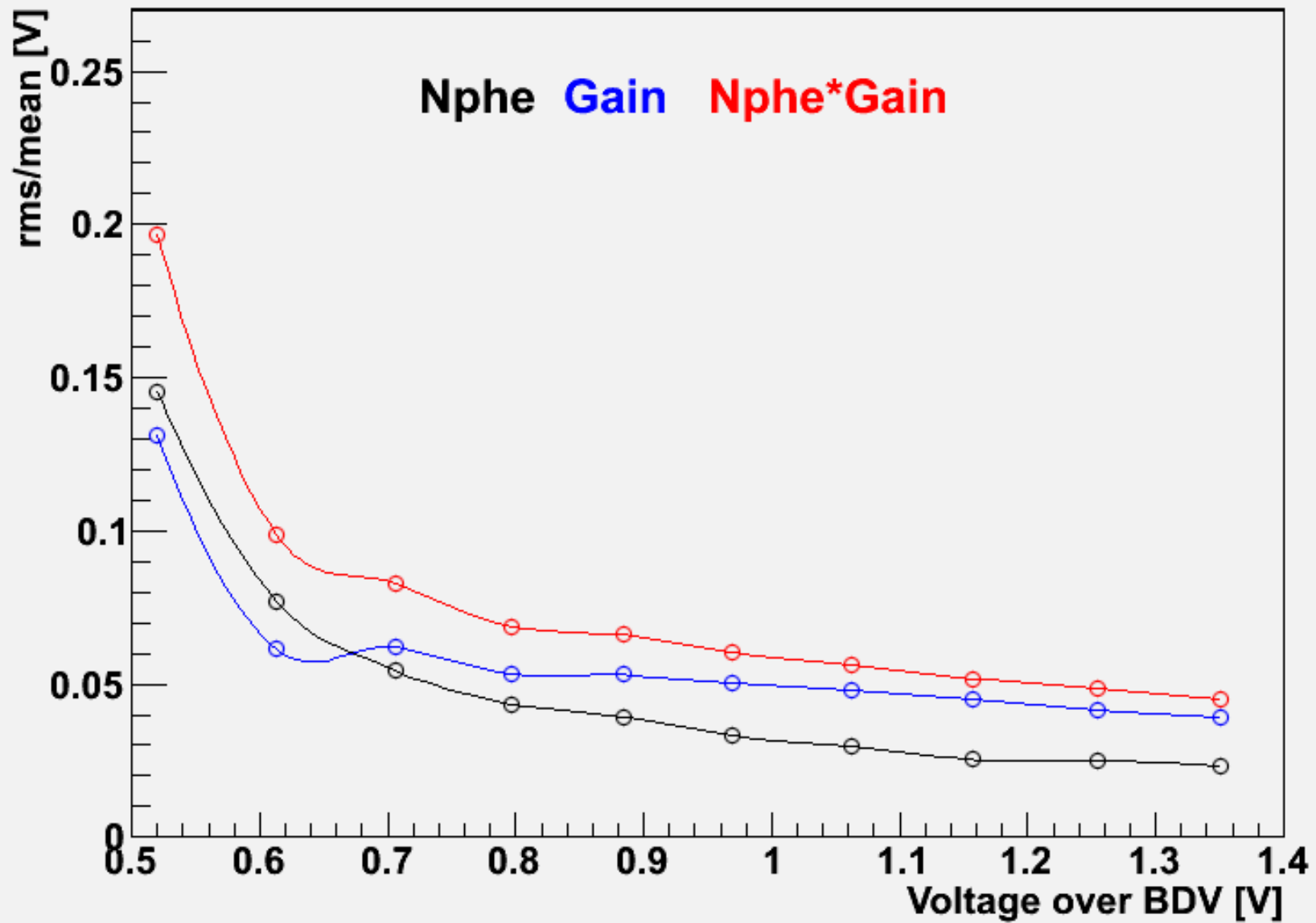
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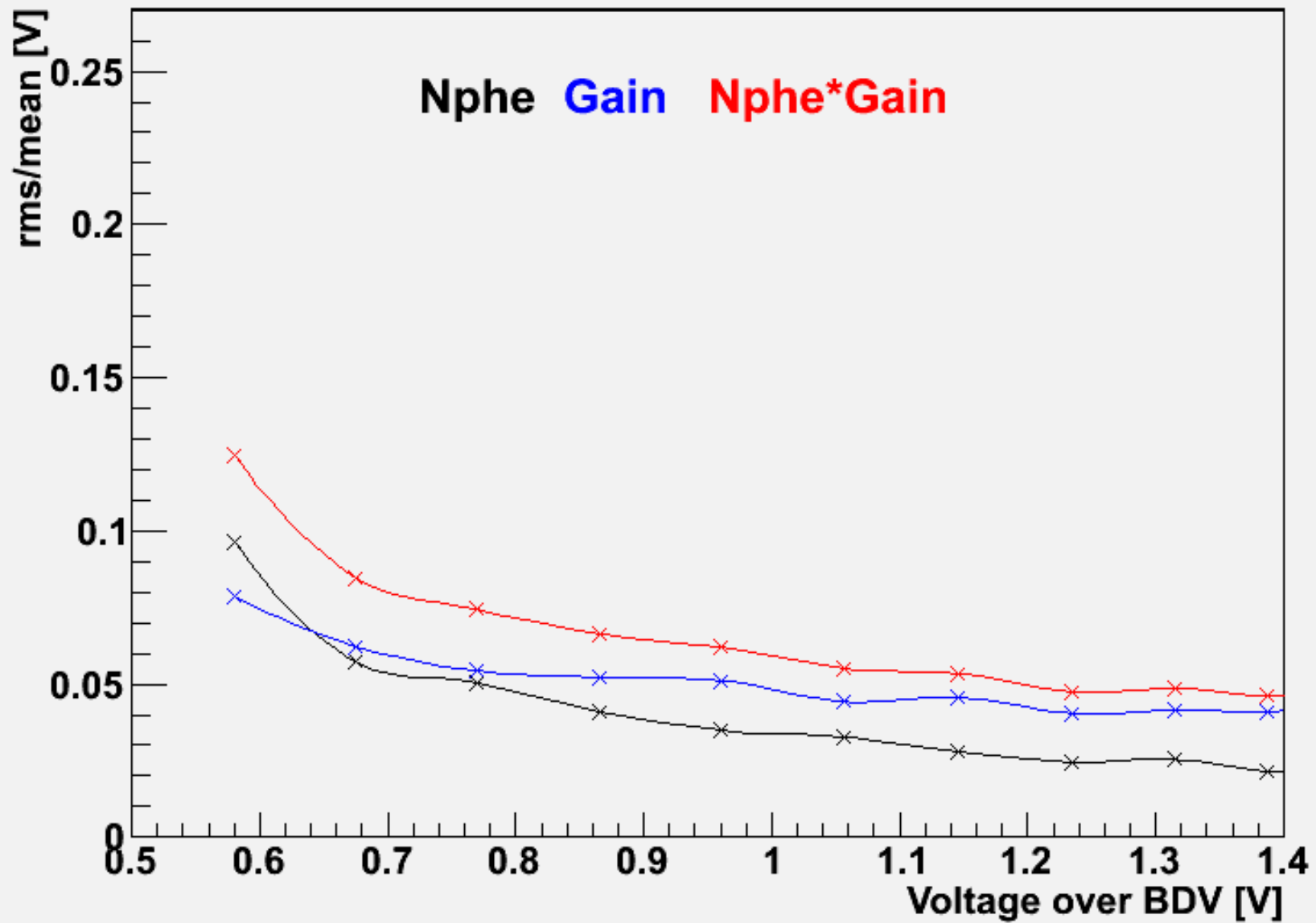
2083_T05



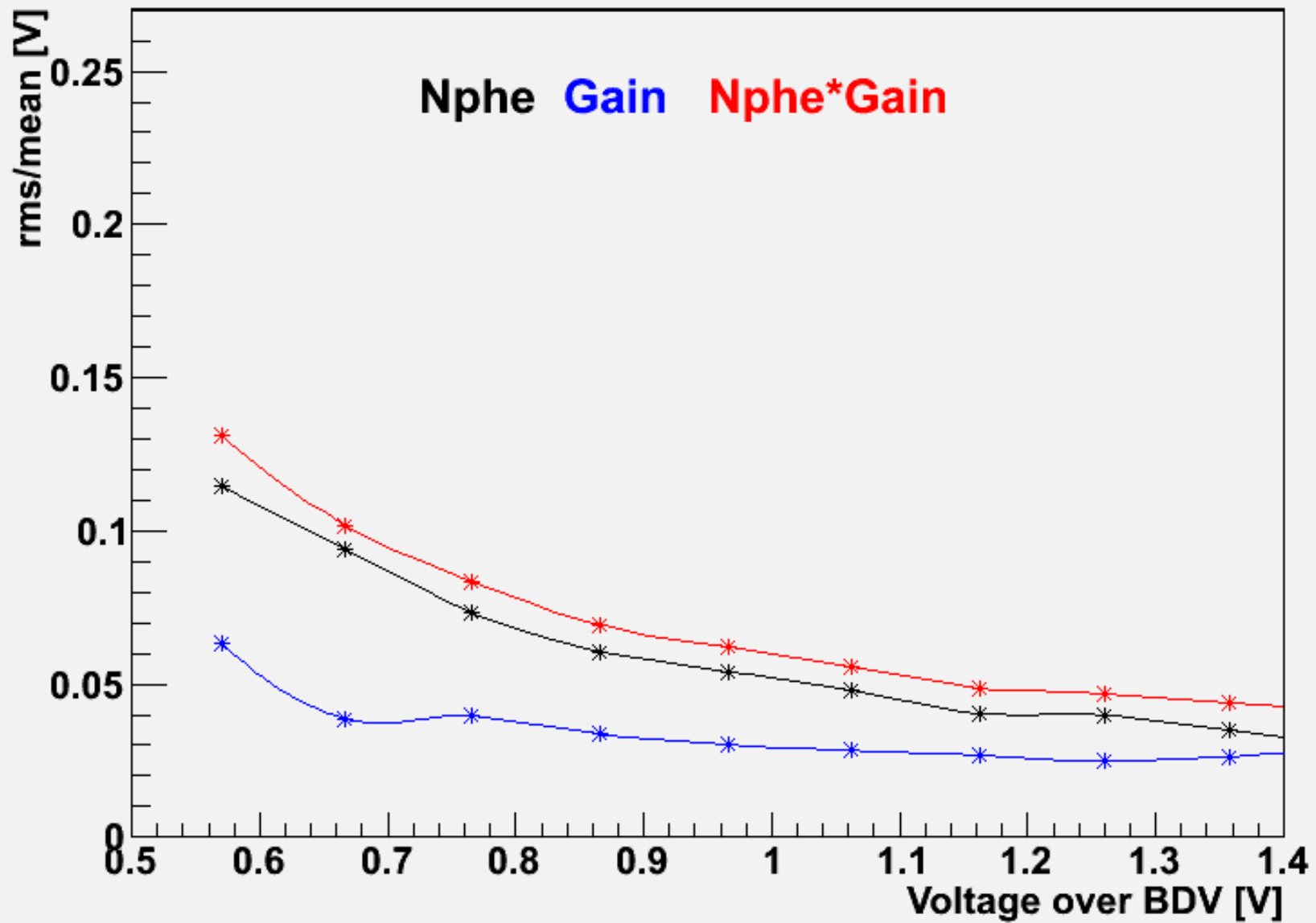
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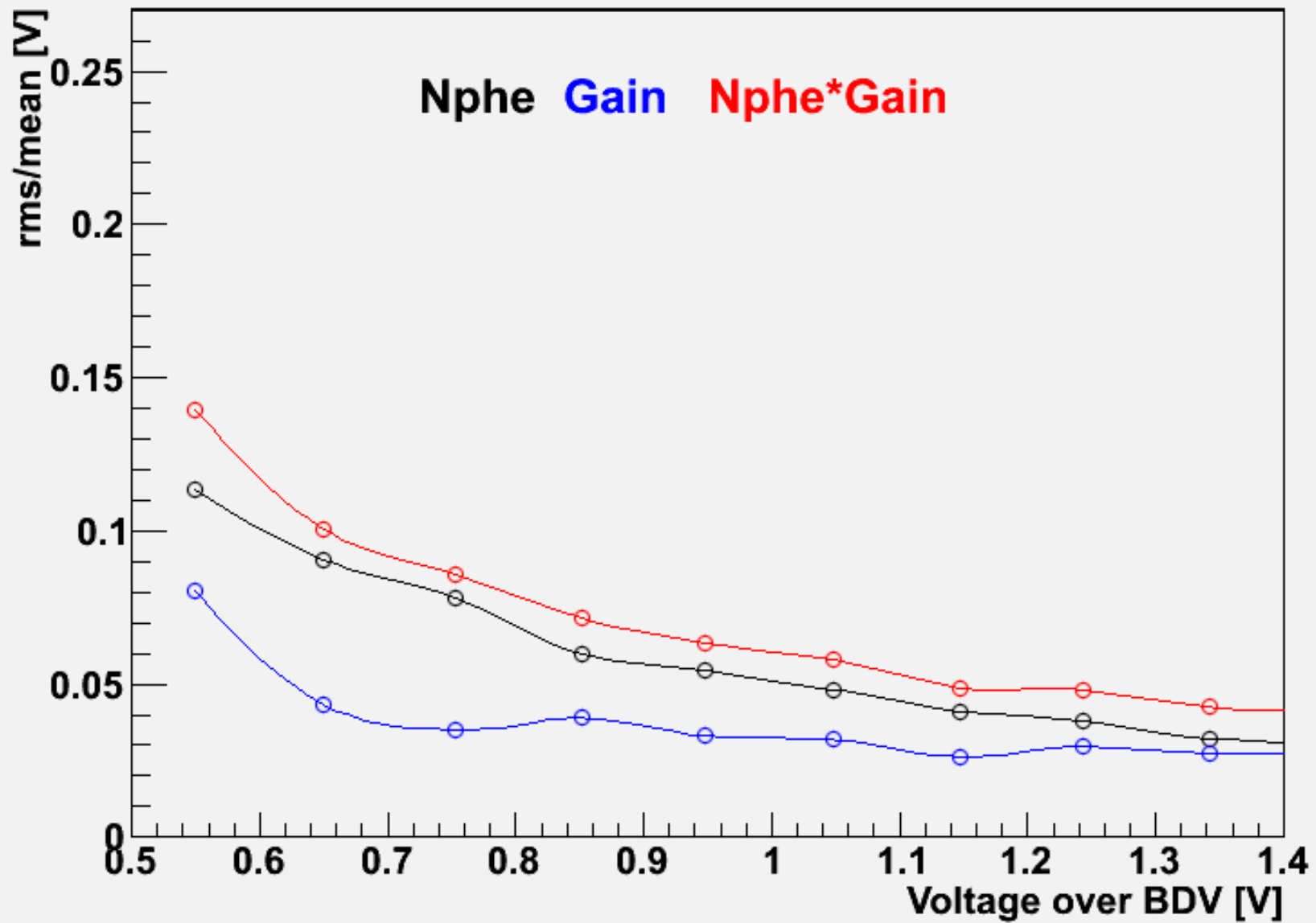
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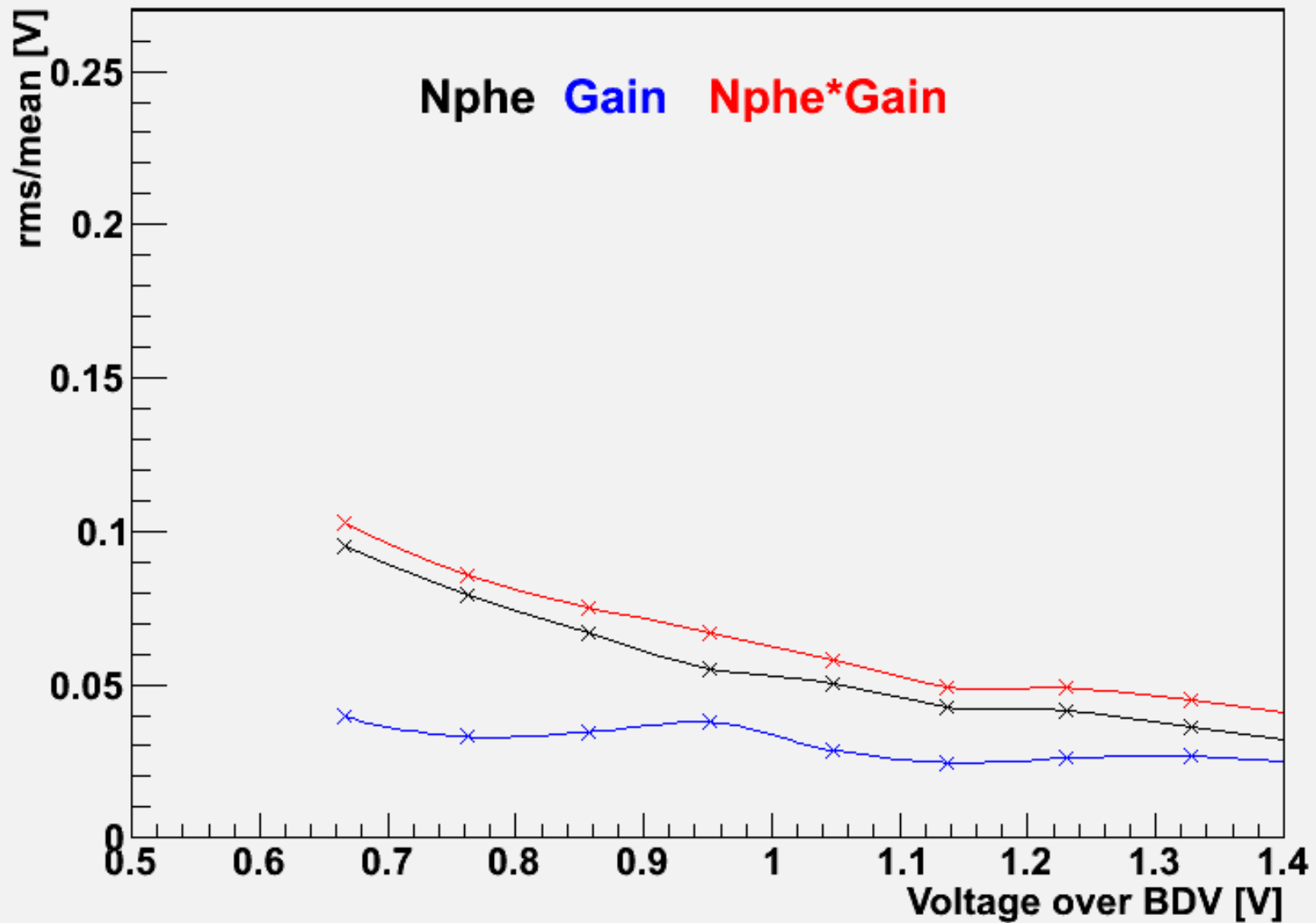
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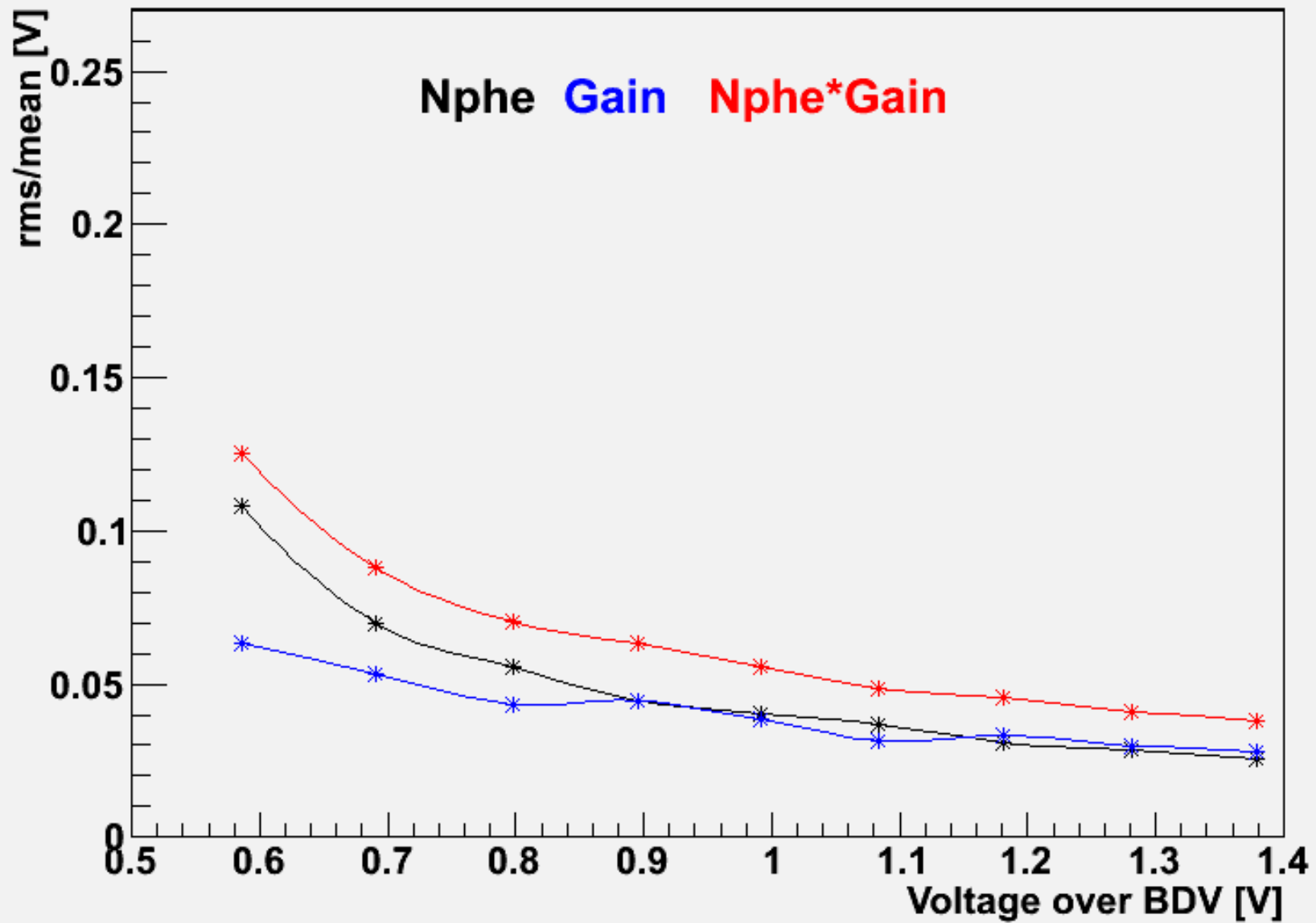
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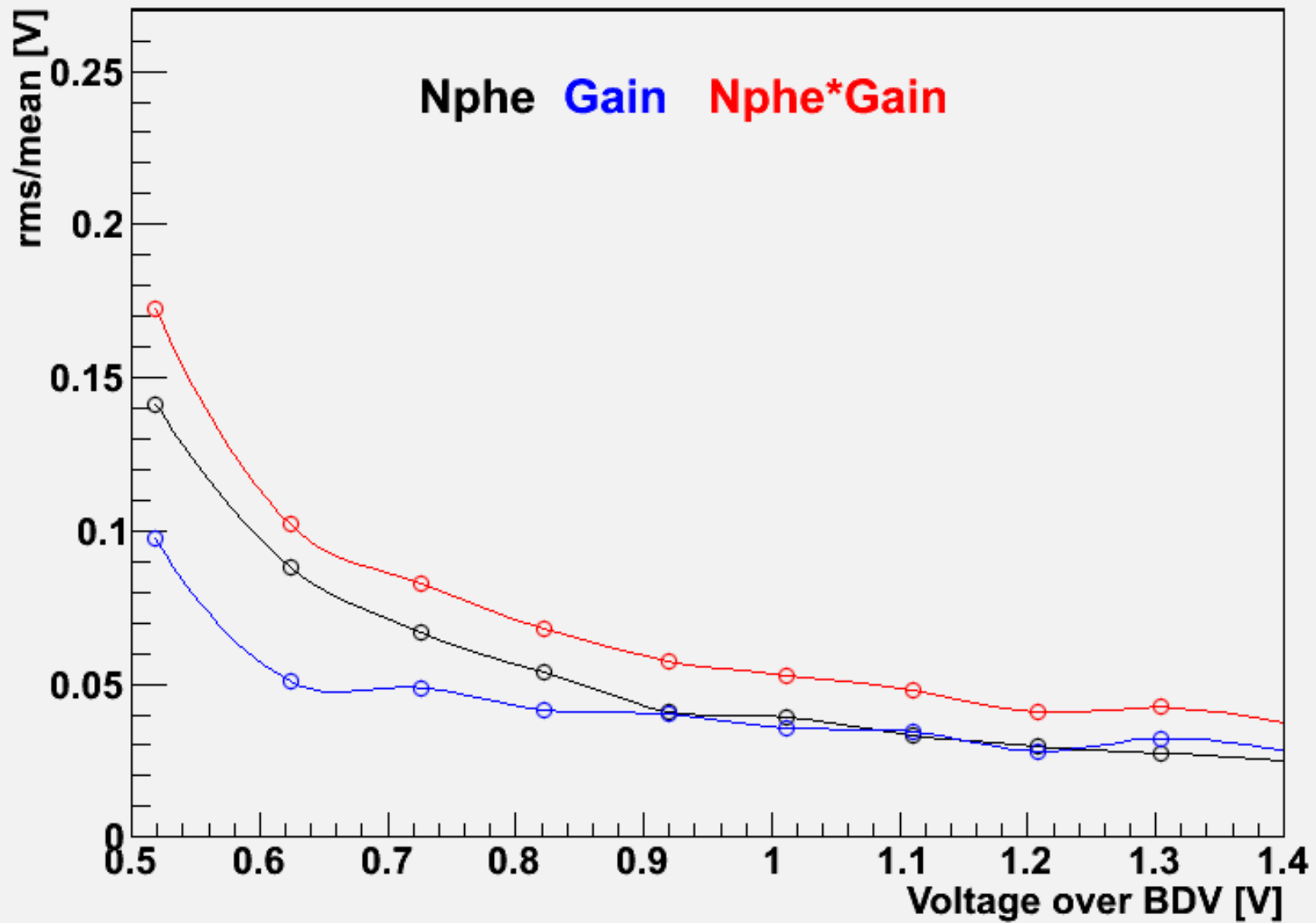
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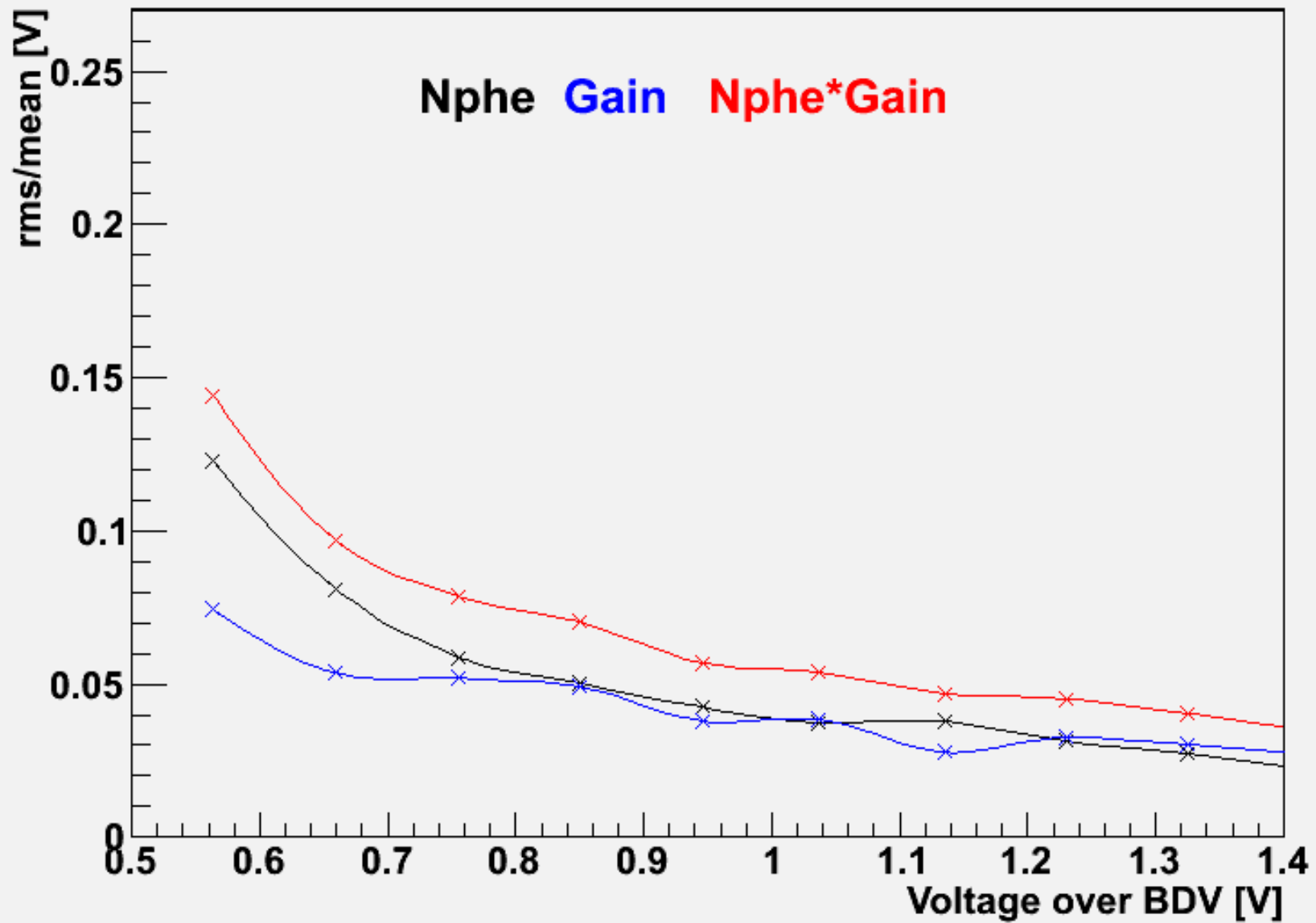
2120_T05



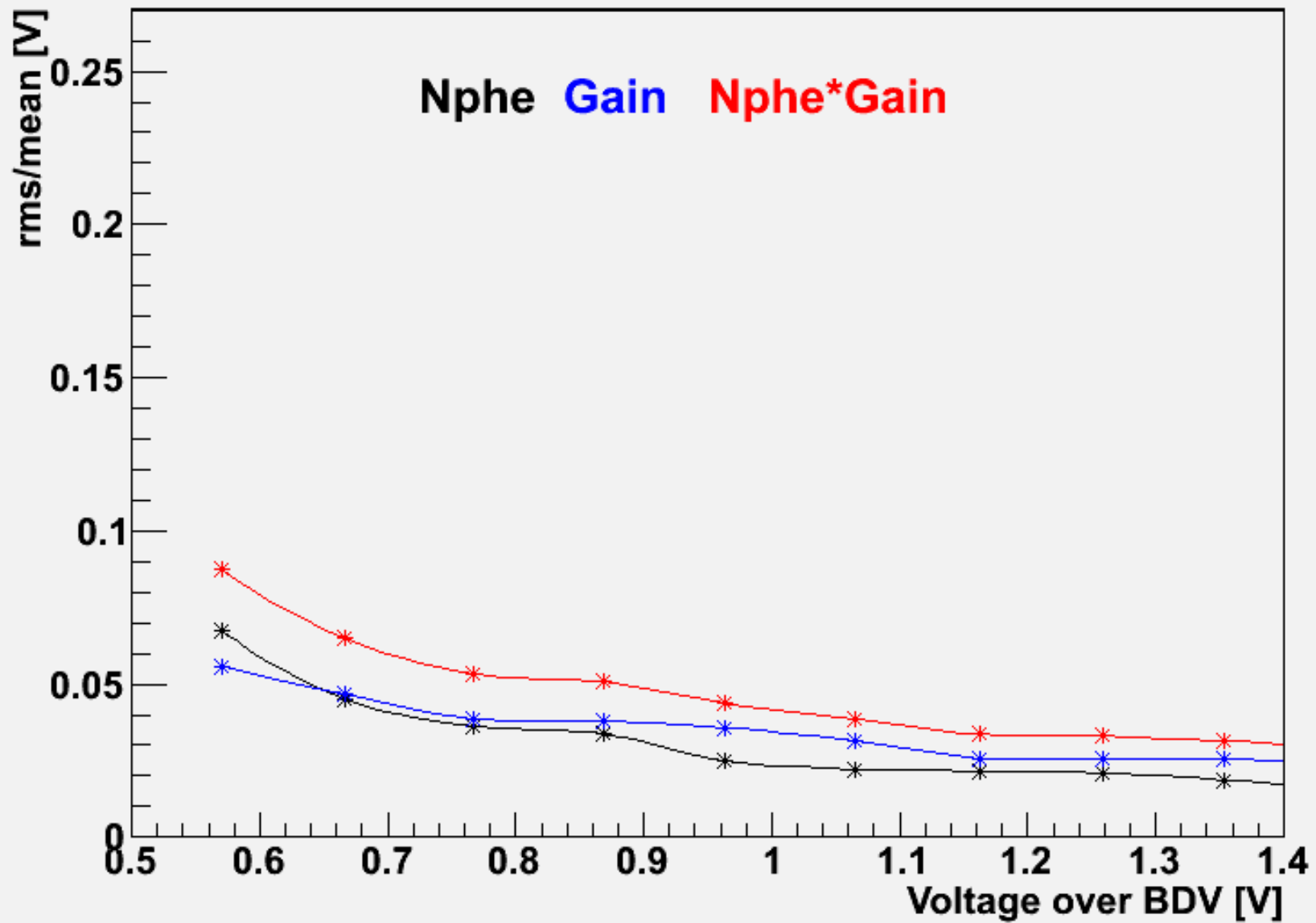
2120_T07



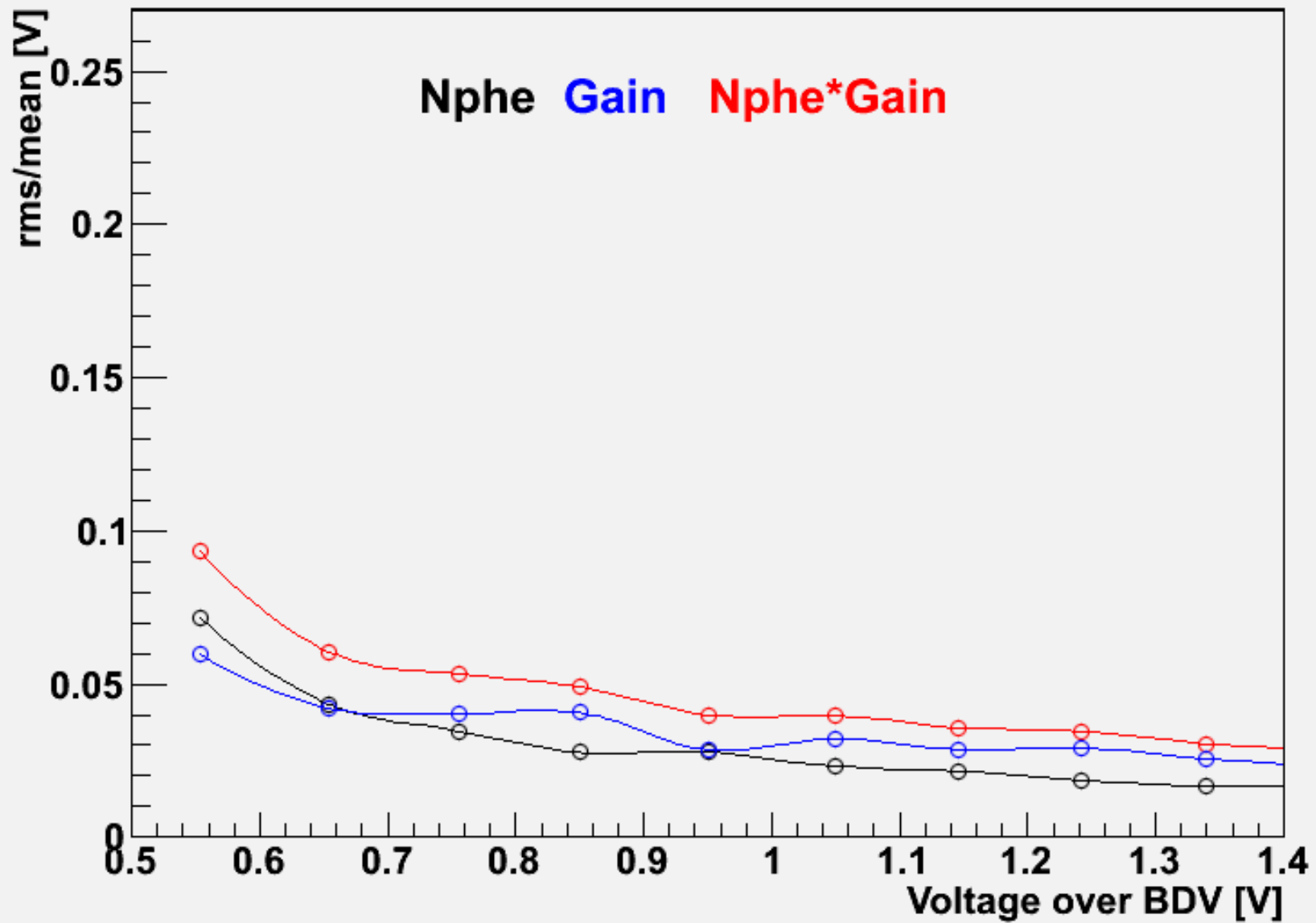
2120_T20



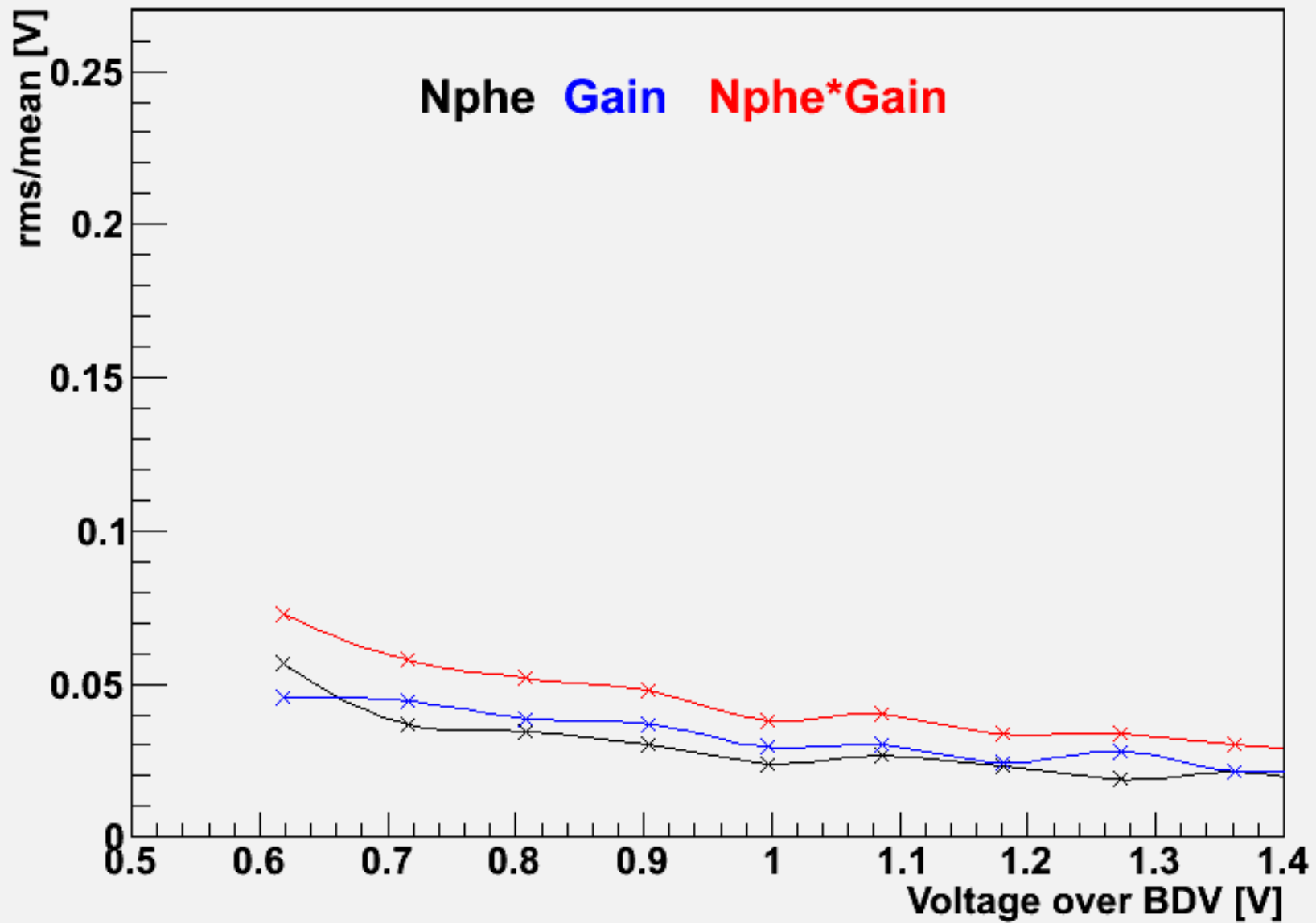
2198_T05



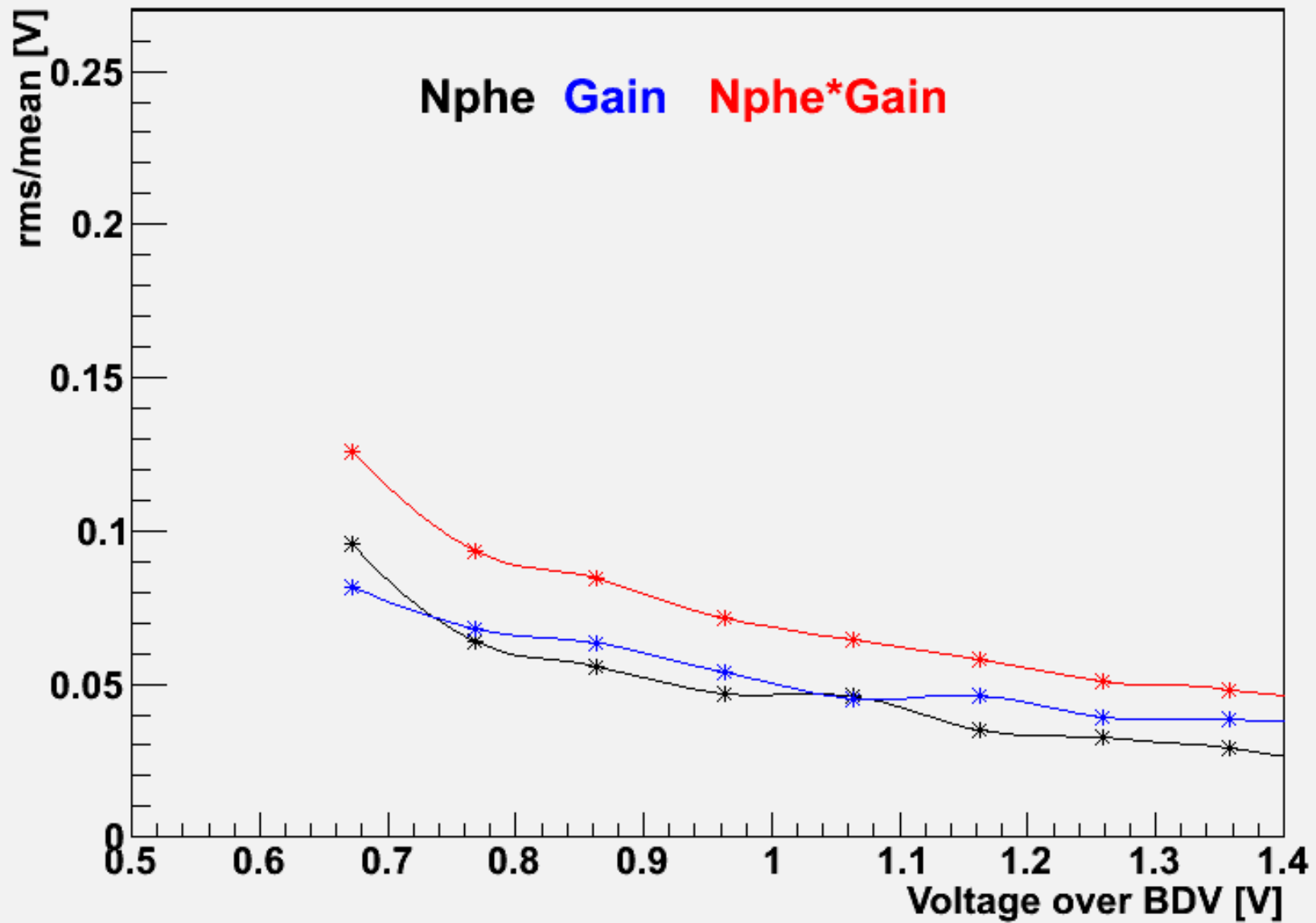
2198_T07



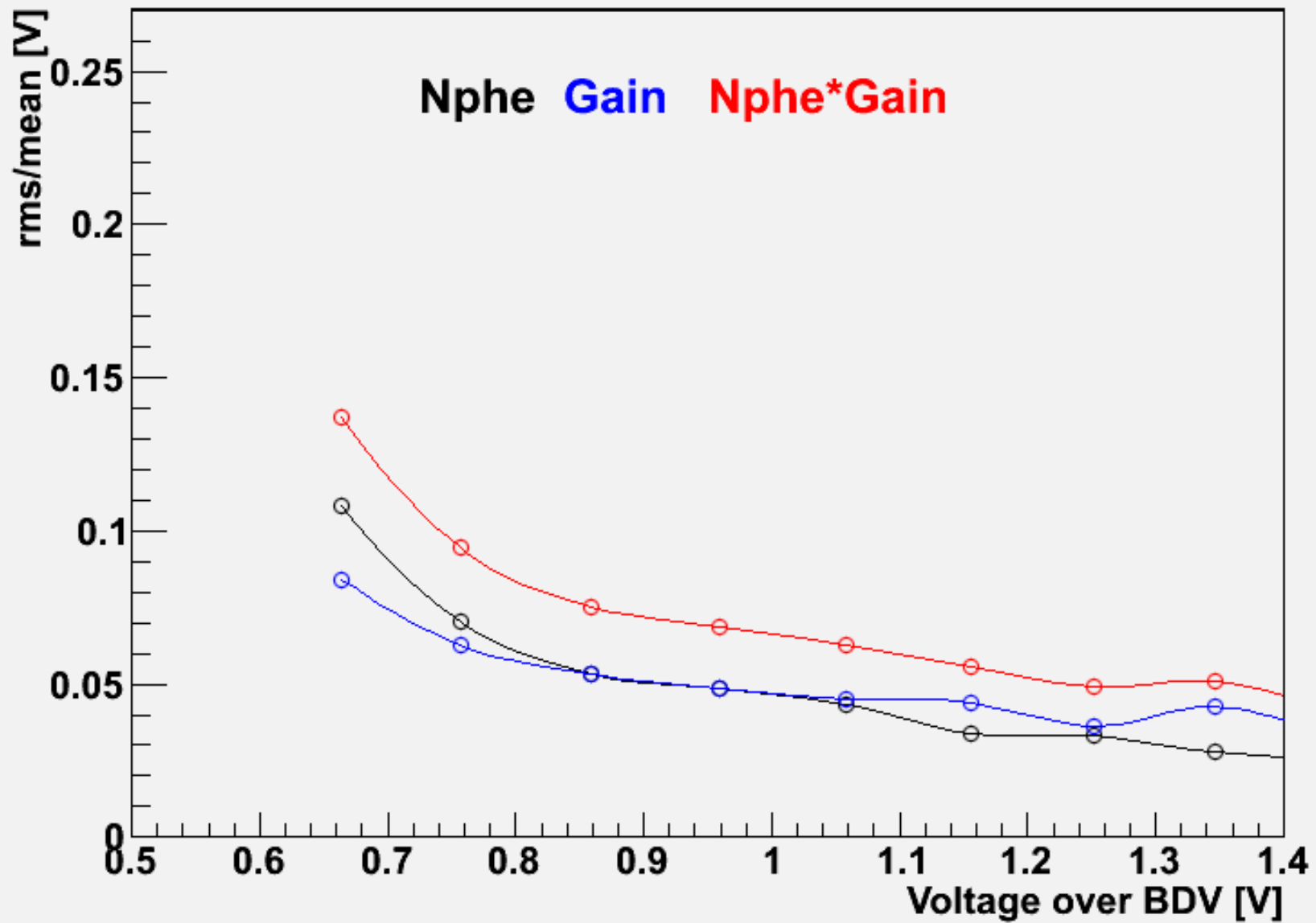
2198_T20



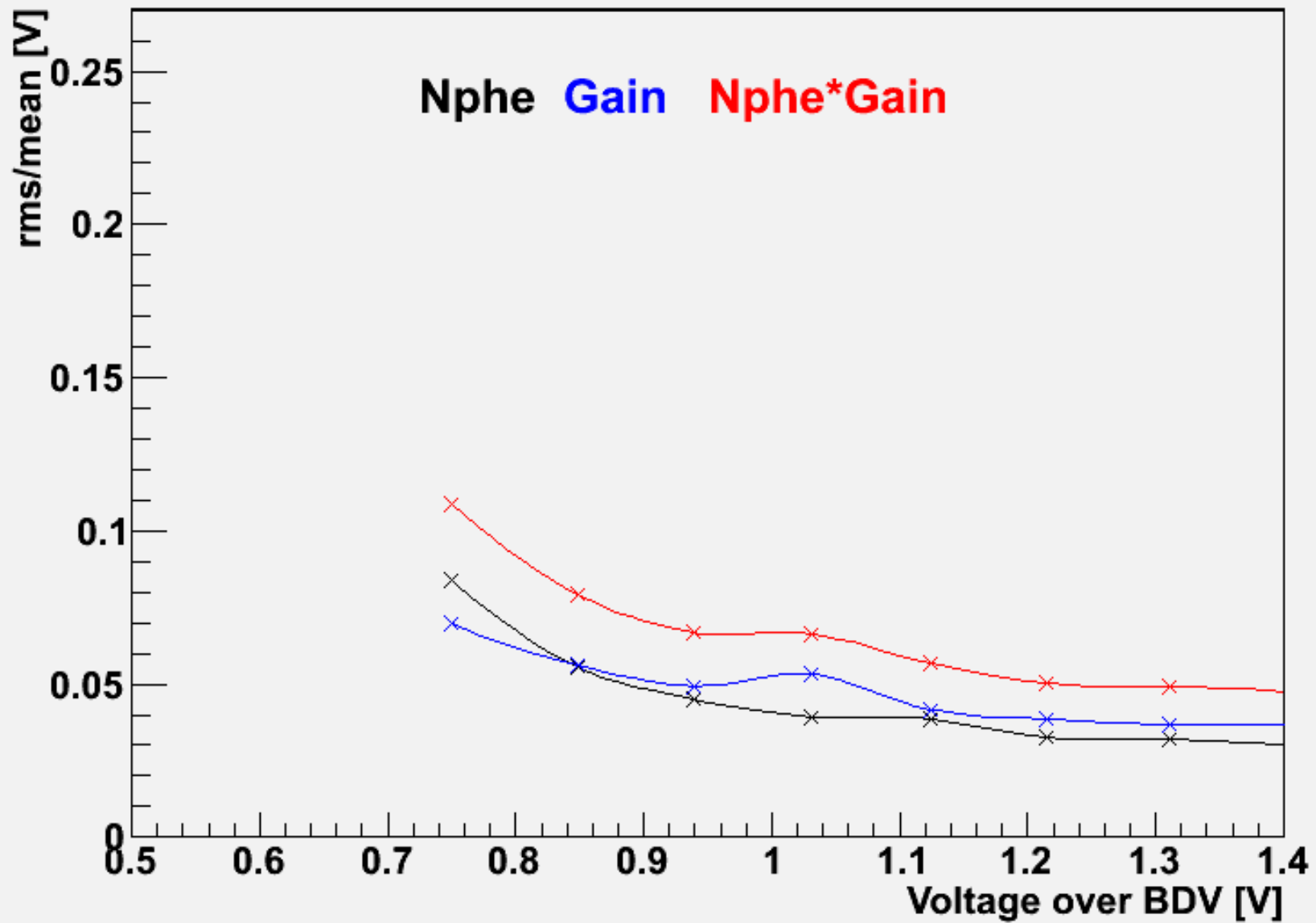
2247_T05



2247_T07



2247_T20

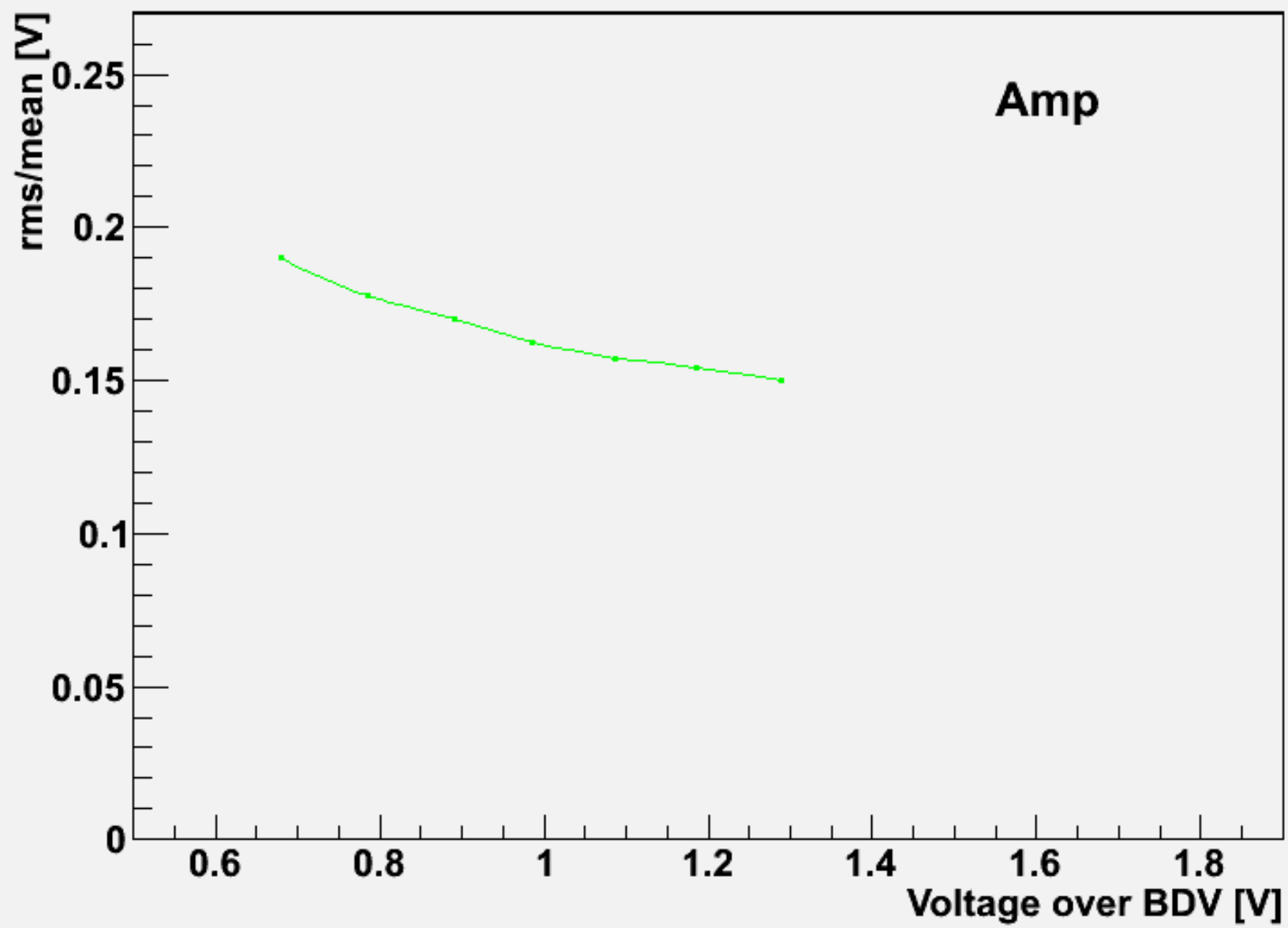


In order to get plots for each mppc amplitude we made the following.

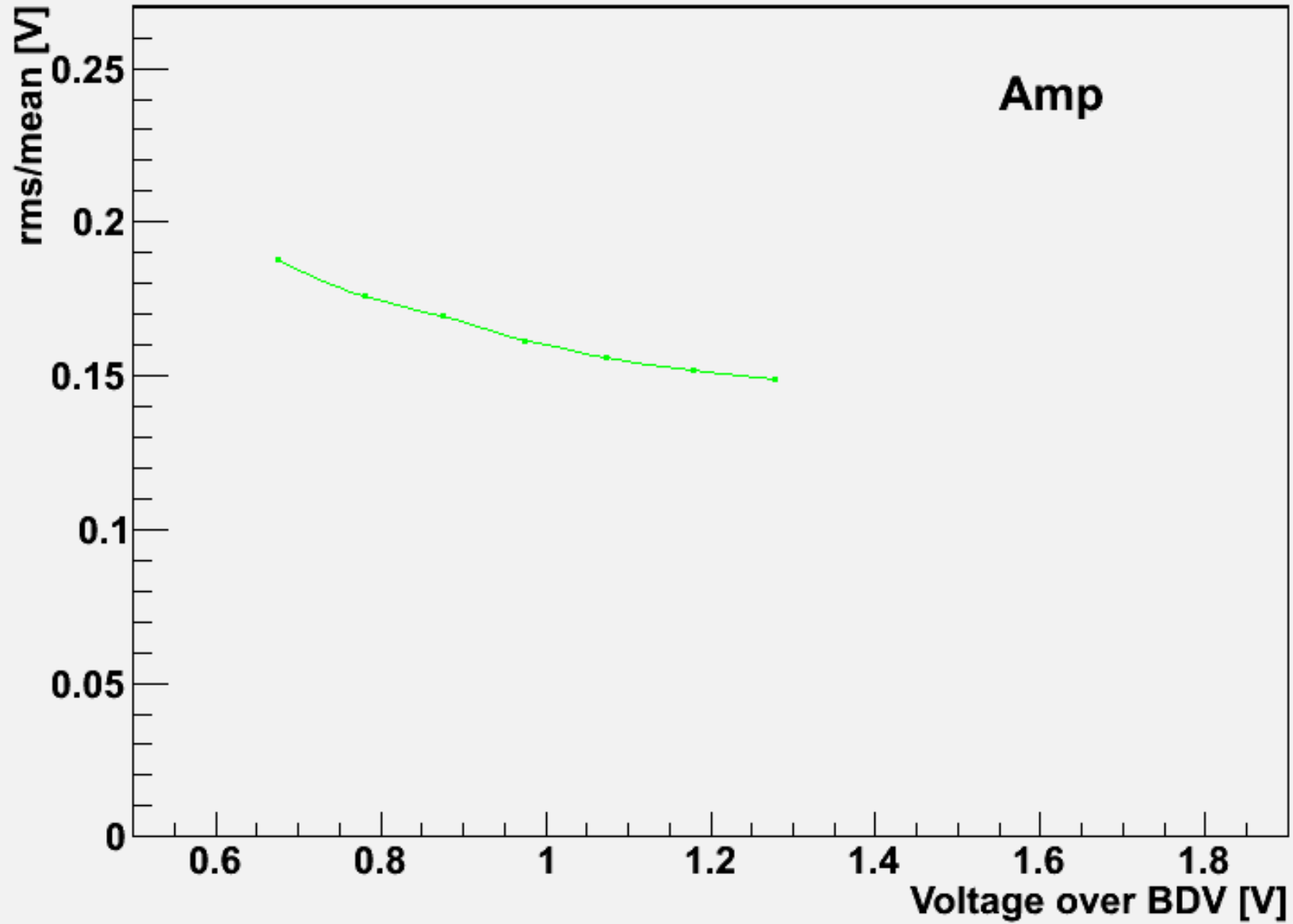
For each temperature, voltage.

1. We take the light histogram with pedestal subtracted from each cell (hcell_ps_i).
2. we made a new histogram with range [-5000 , 4096*16 -5000] (h_sum_amp_v).
3. we filled h_sum_amp_v taking values from random numbers distributed according the histograms hcell_ps_i:
sum_amp = hcell_ps_0->GetRandom() + hcell_ps_1->GetRandom()
+ ... + hcell_ps_15->GetRandom()
h_sum_amp_volt->Fill(sum_amp)
we take 120000 events.
4. Finally we made the plots rms/mean vs volt for h_sum_amp_v in each temperature.

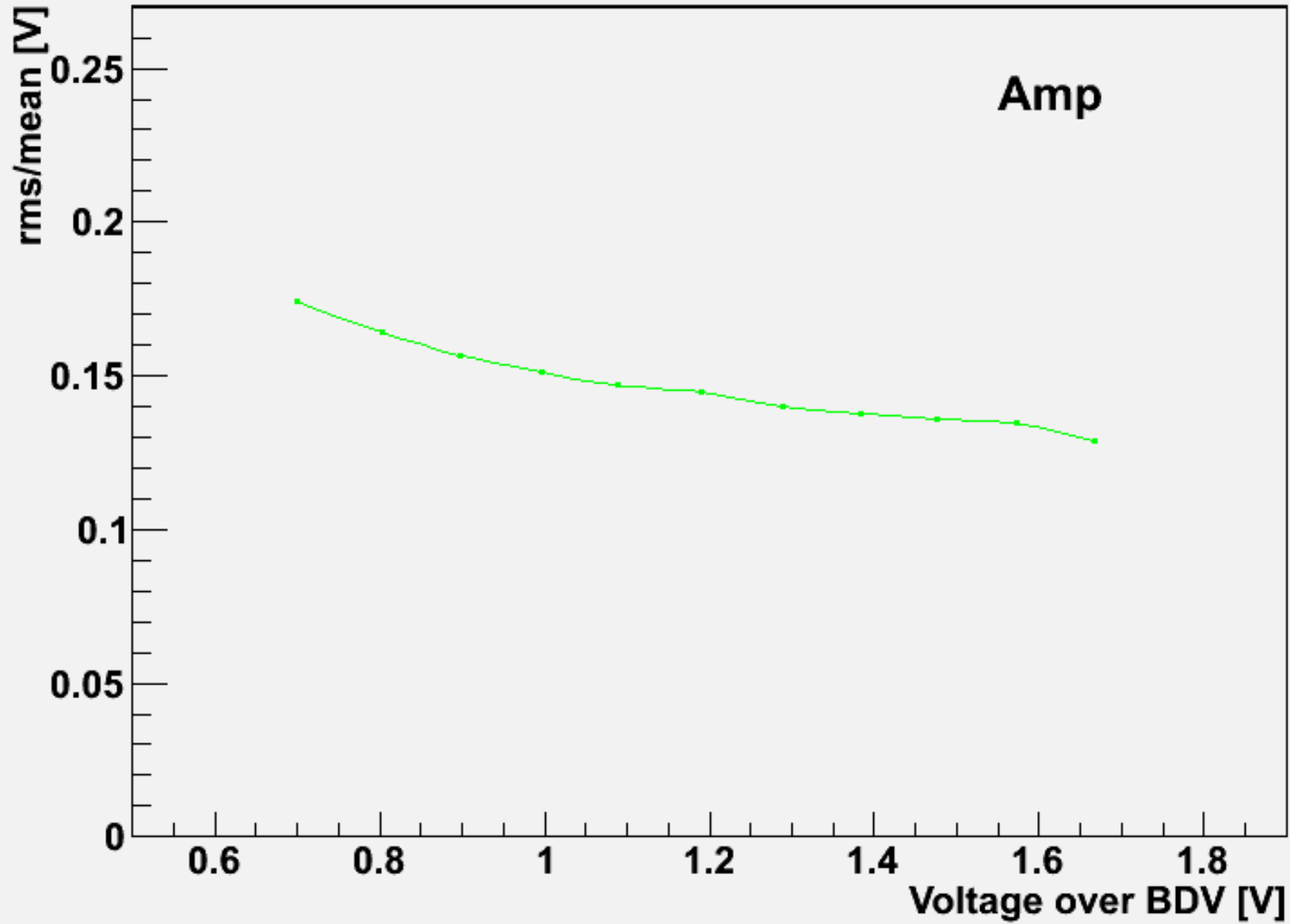
1821_T05



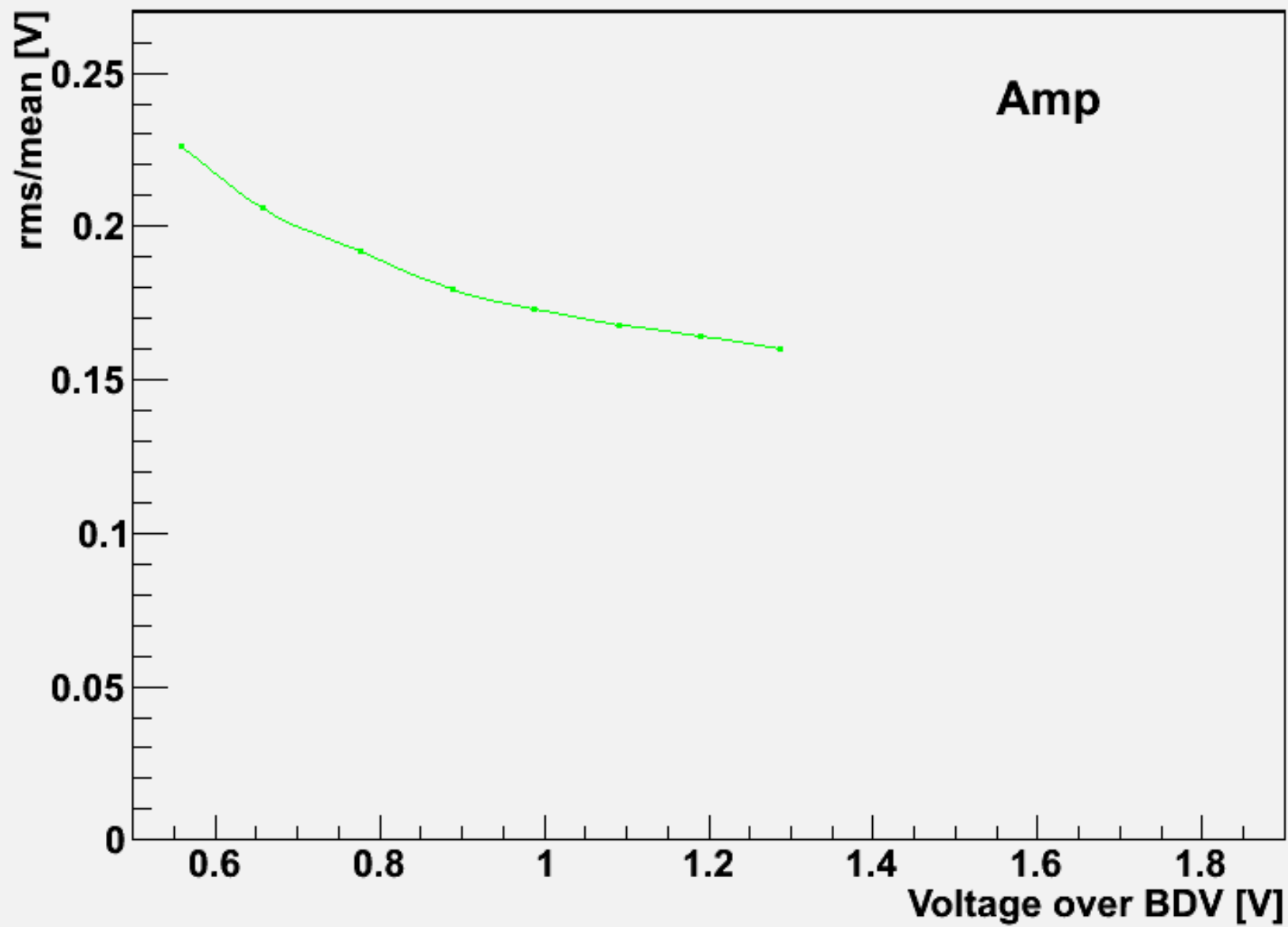
1821_T07



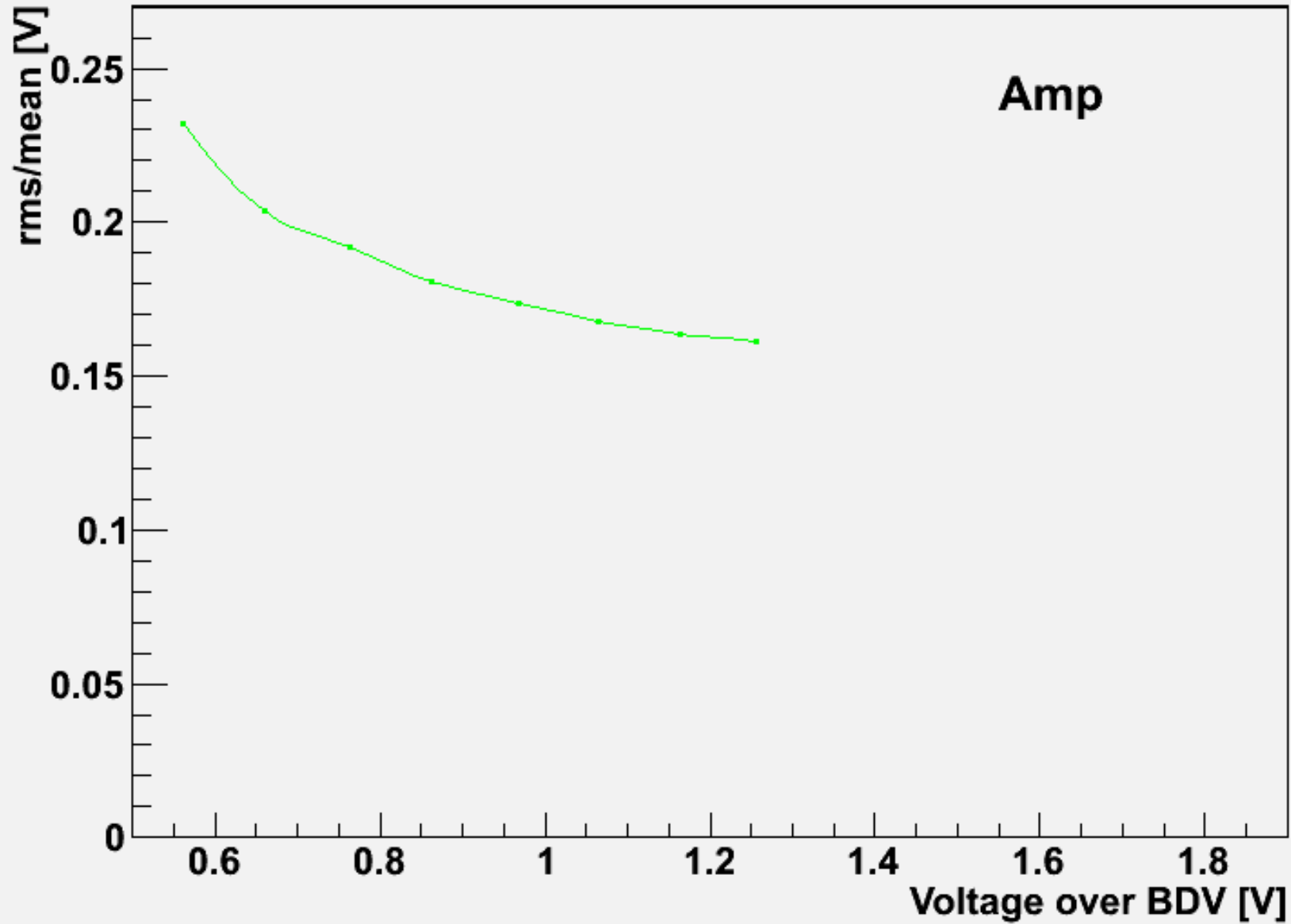
1821_T20



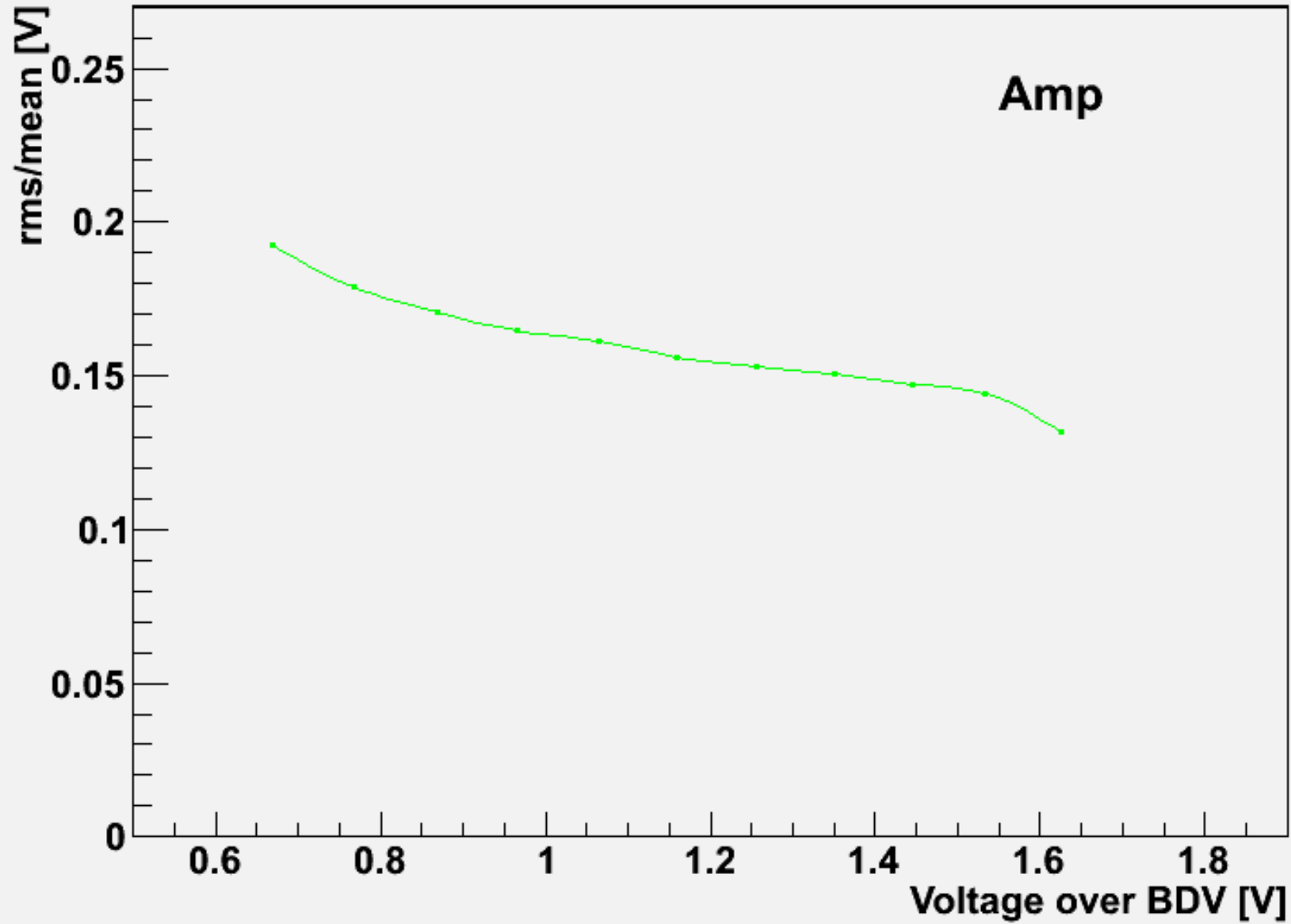
1896_T05



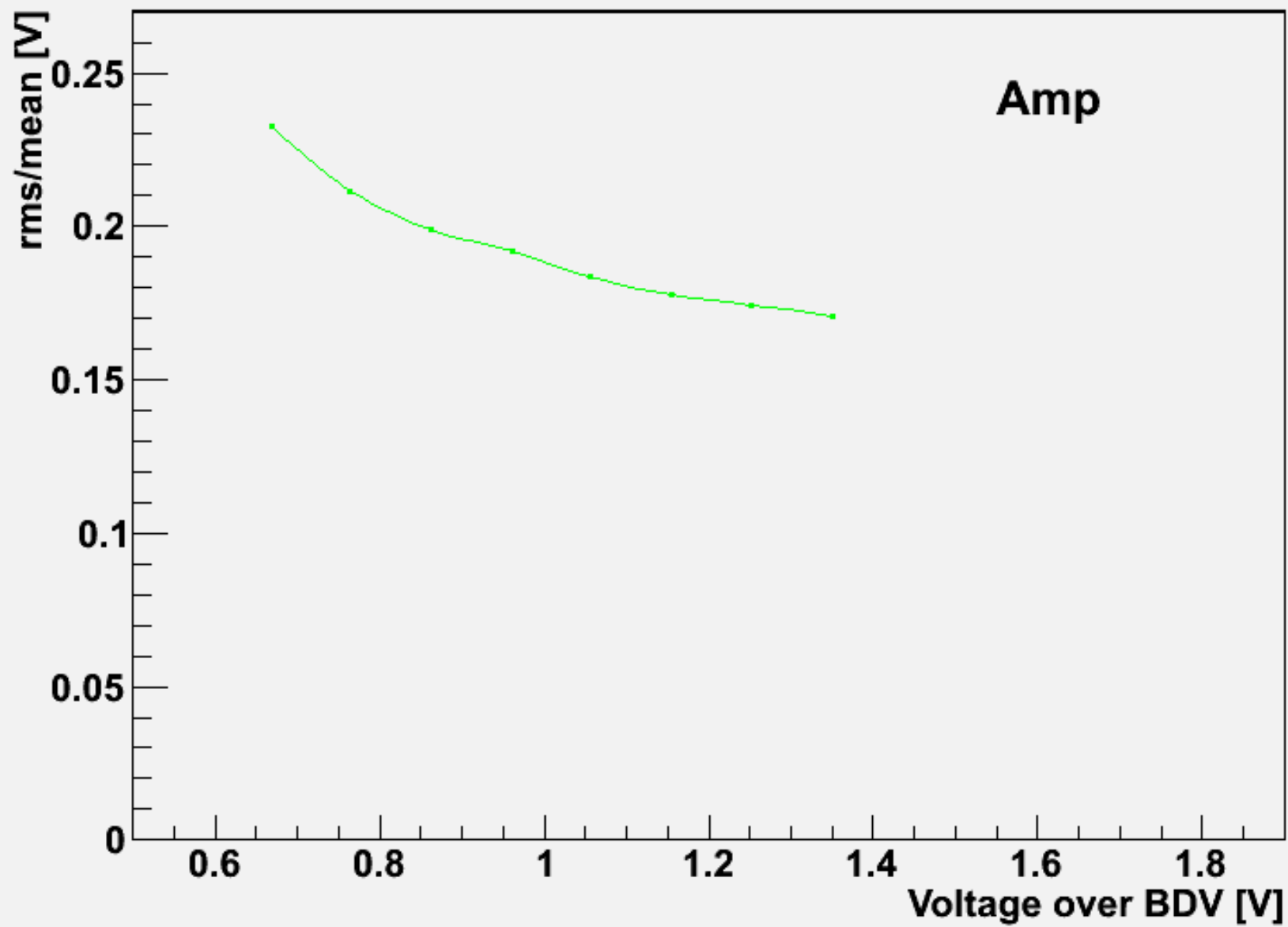
1896_T07



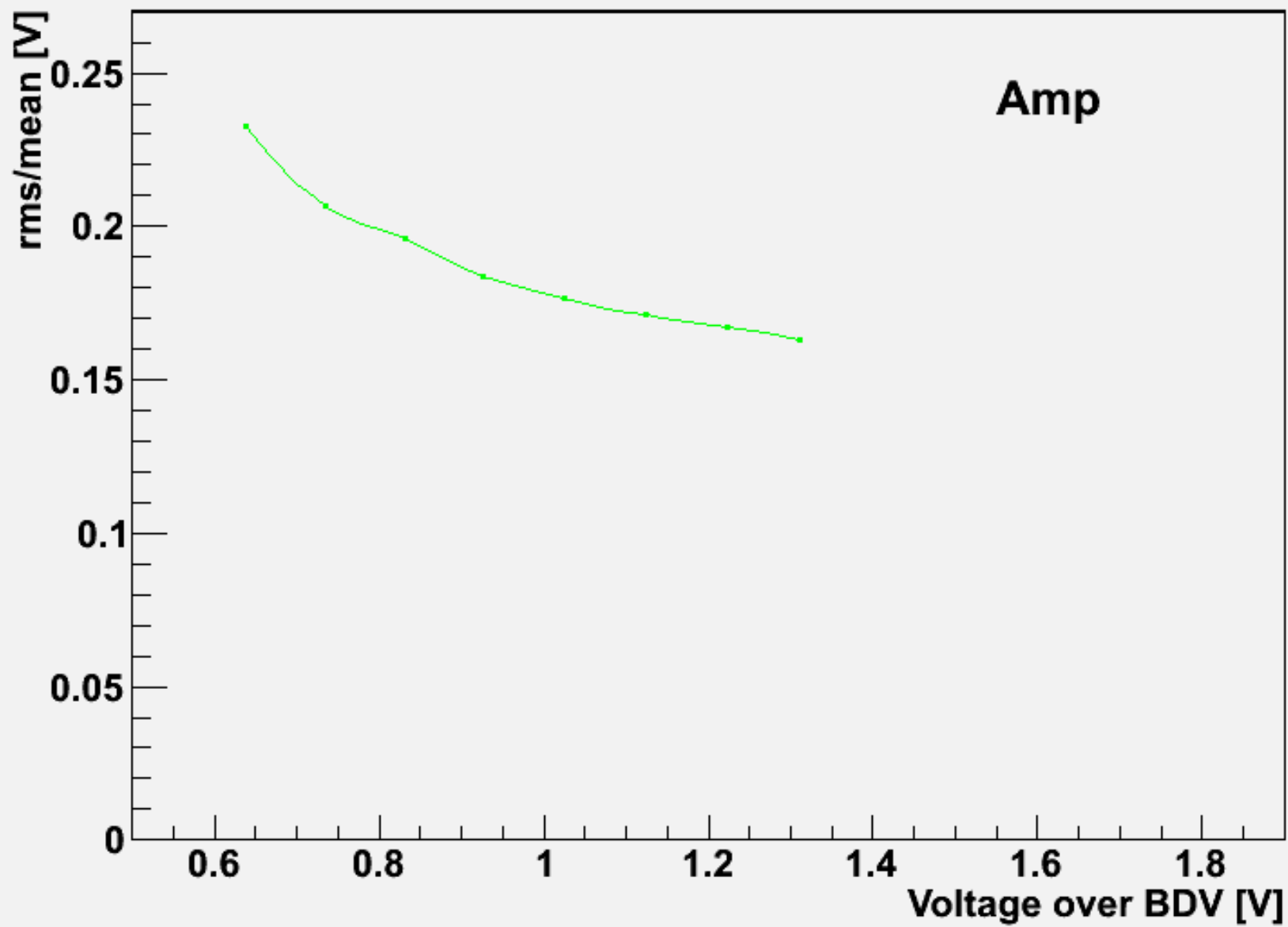
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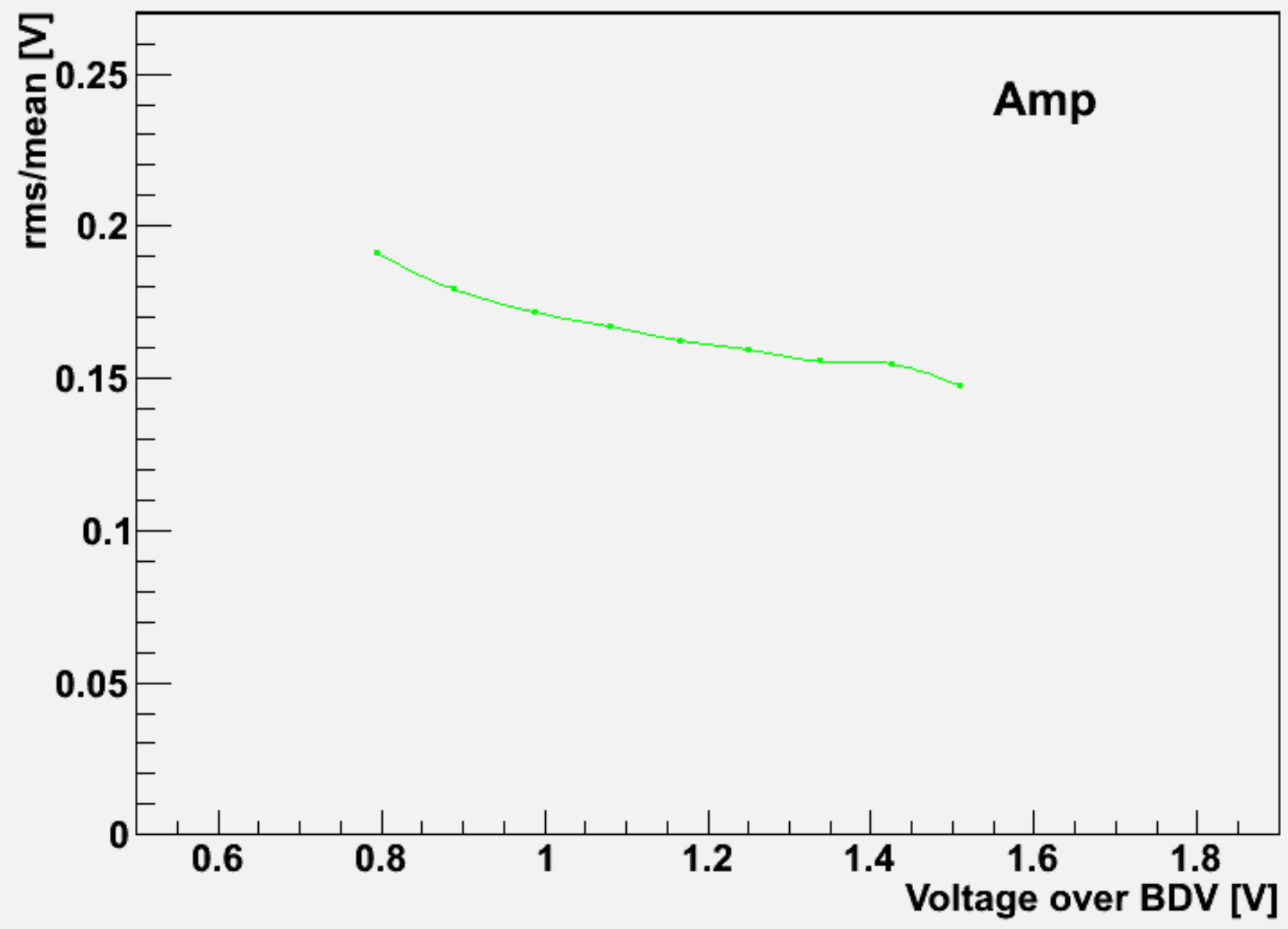
2009_T05



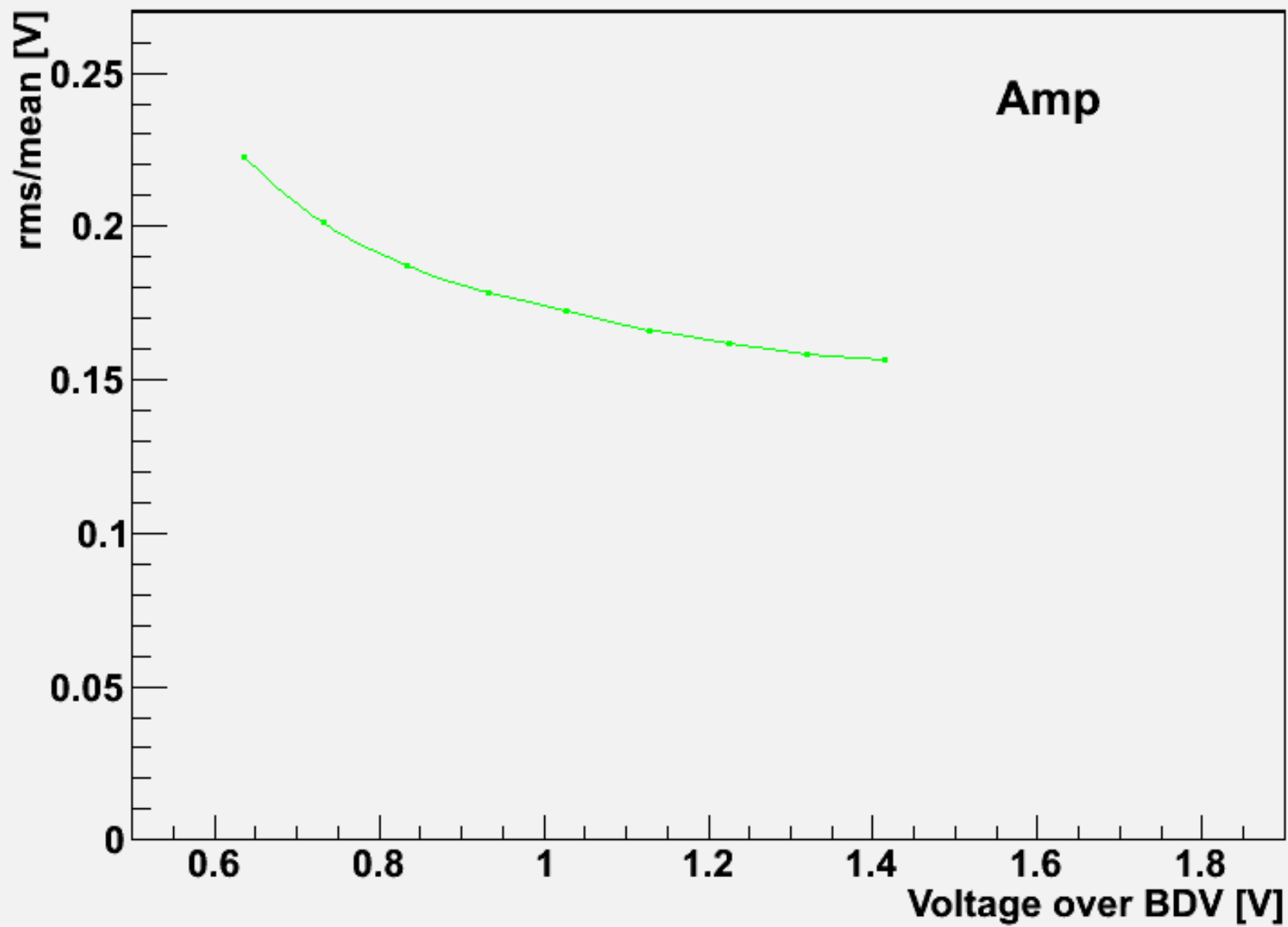
2009_T07



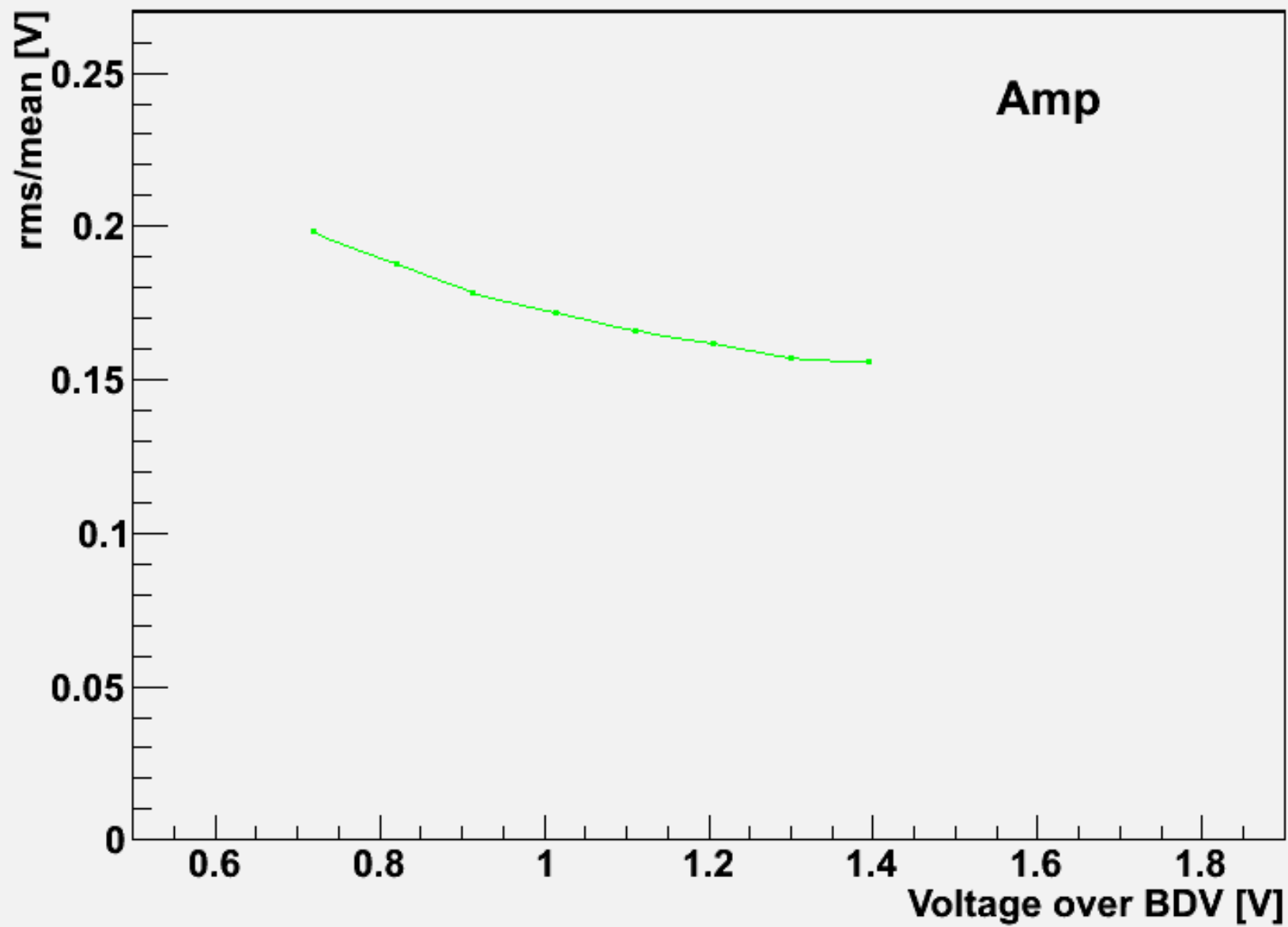
2009_T20



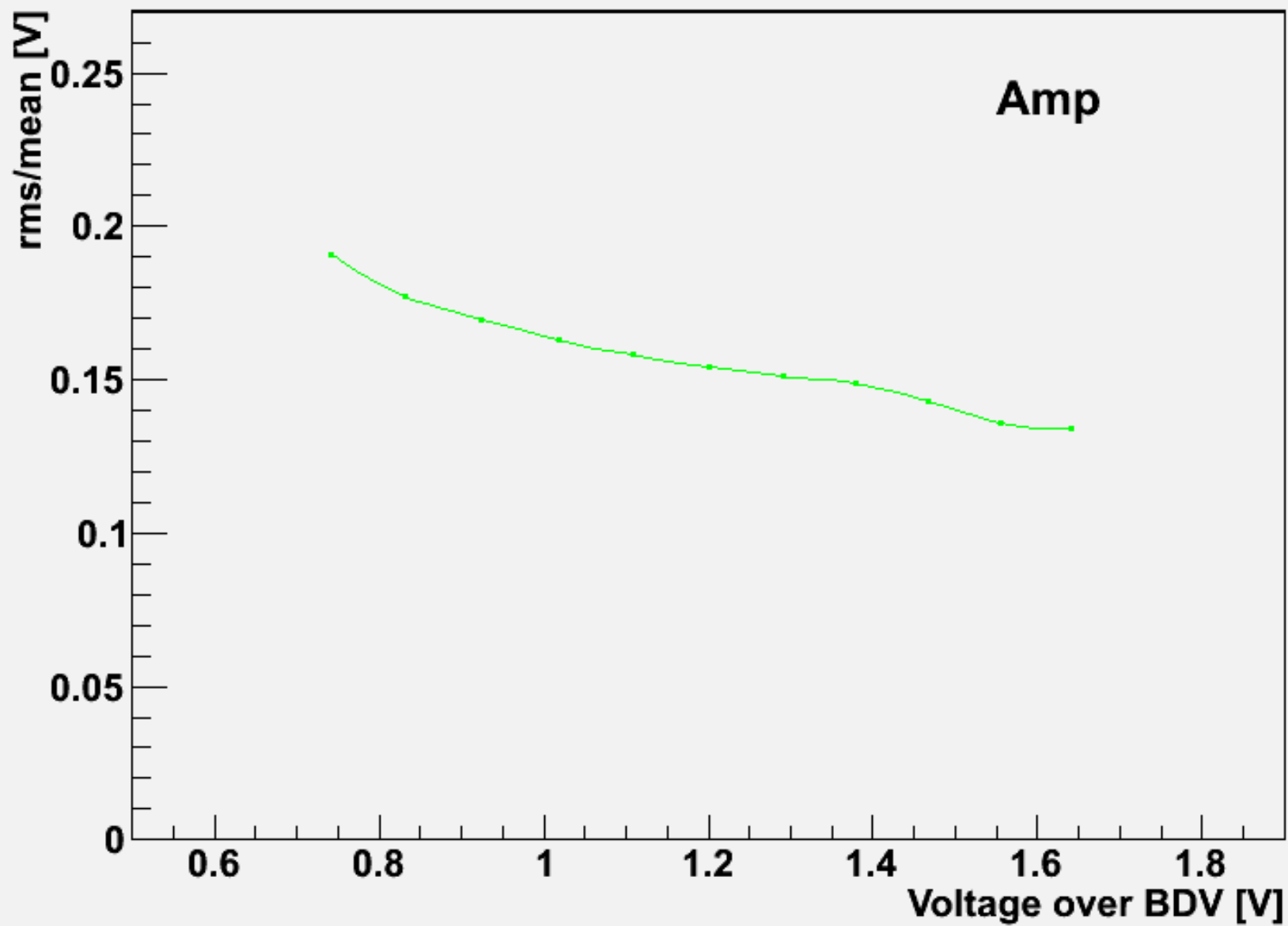
2044_T05



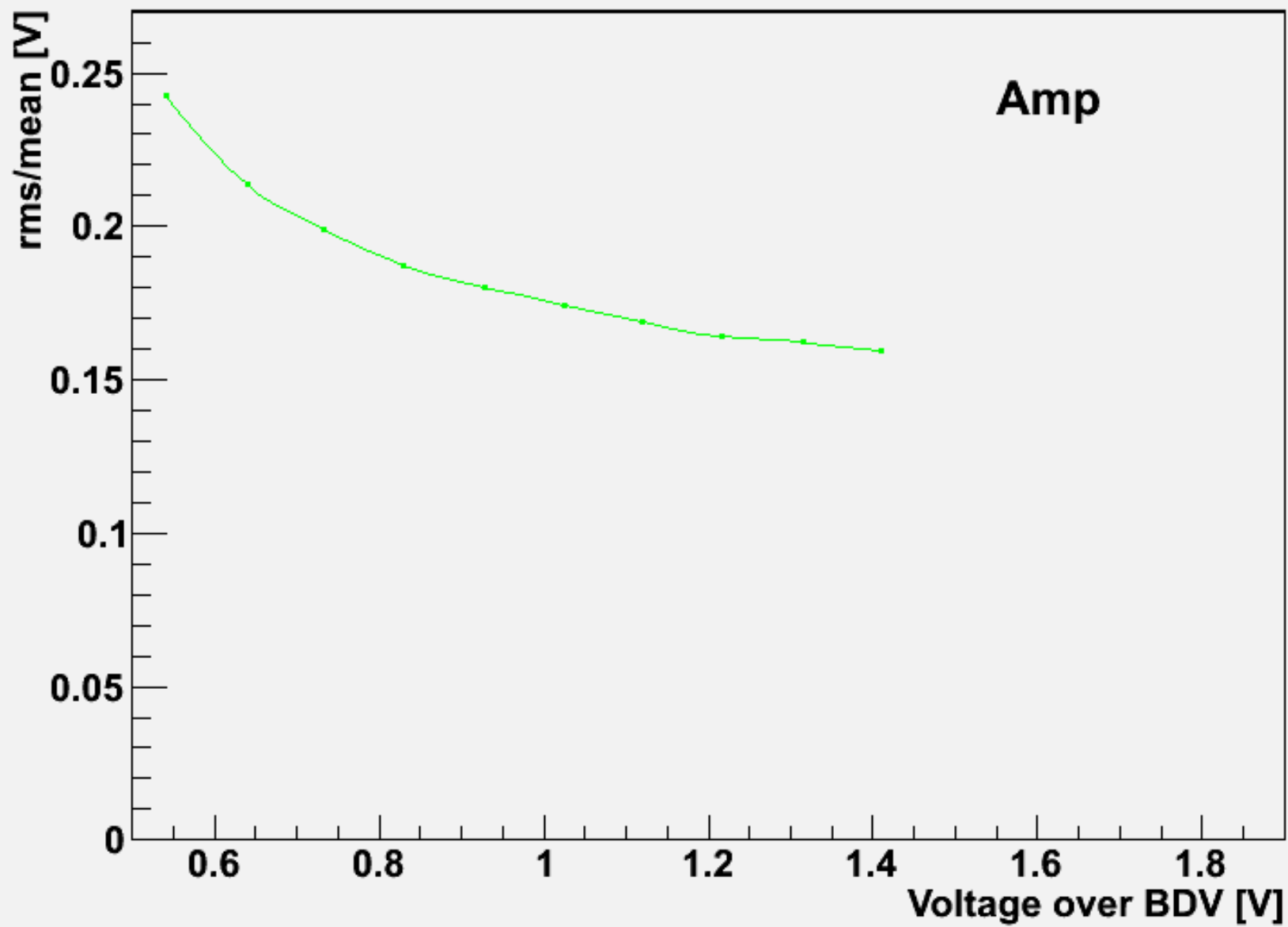
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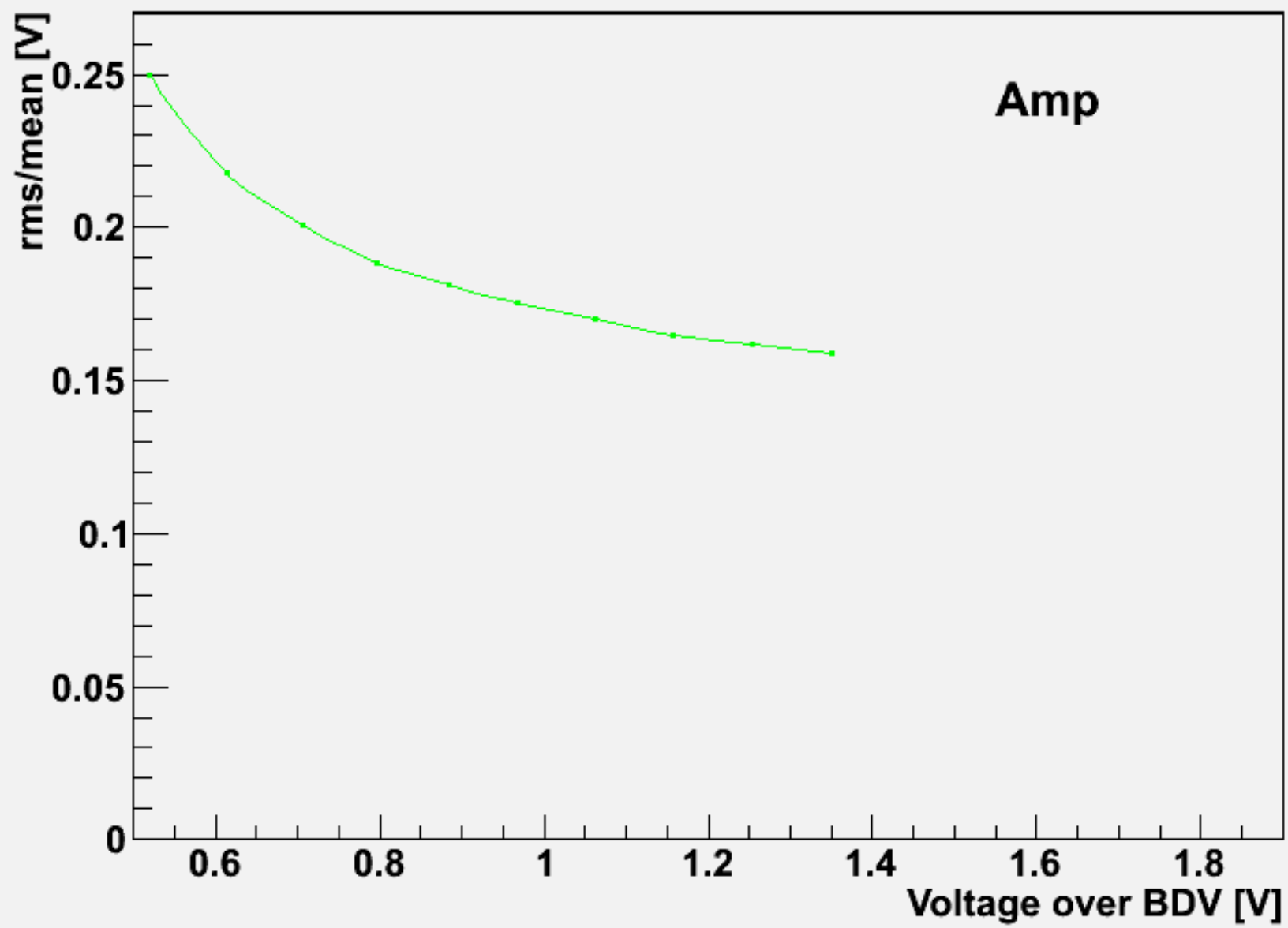
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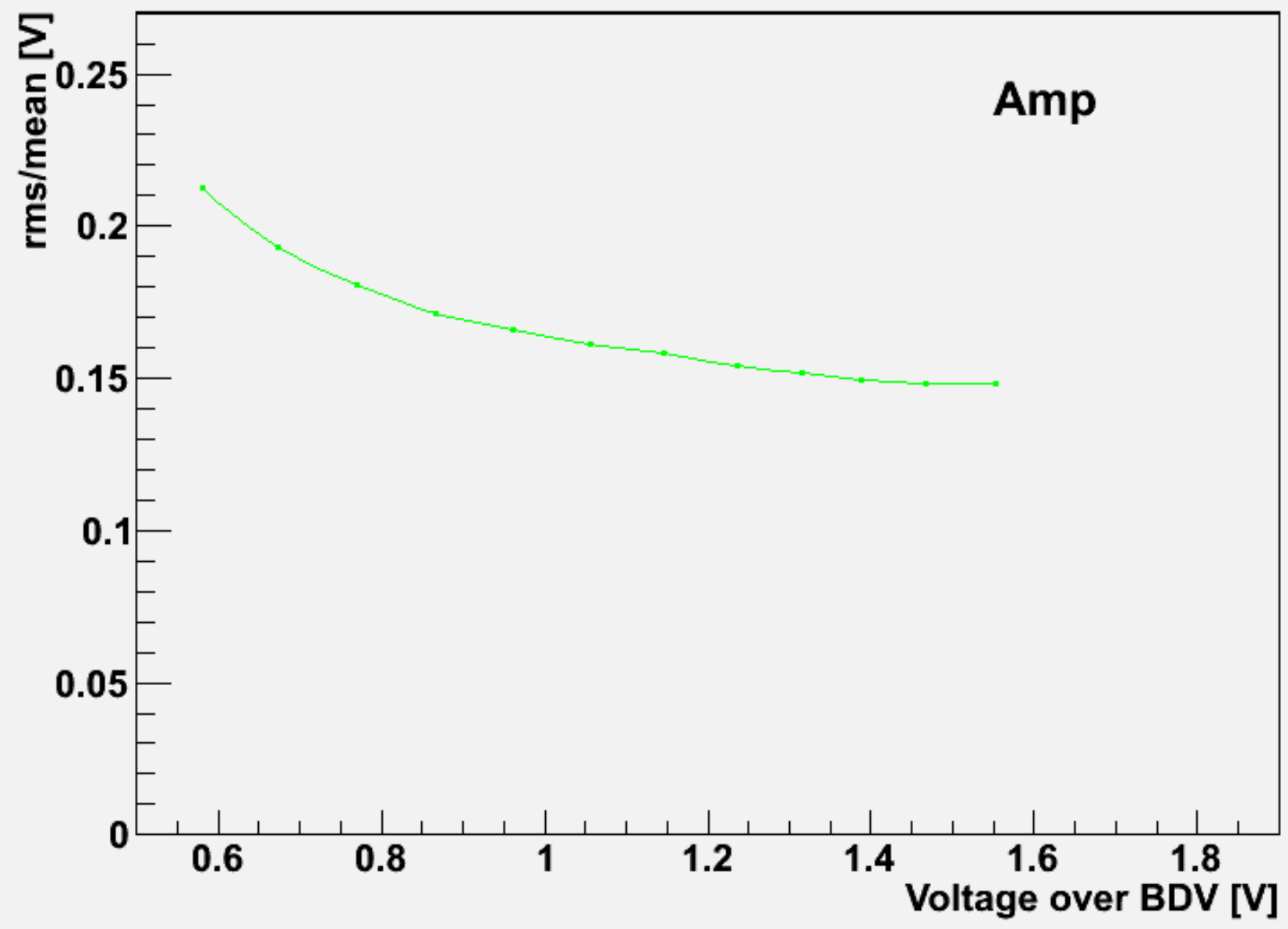
2083_T05



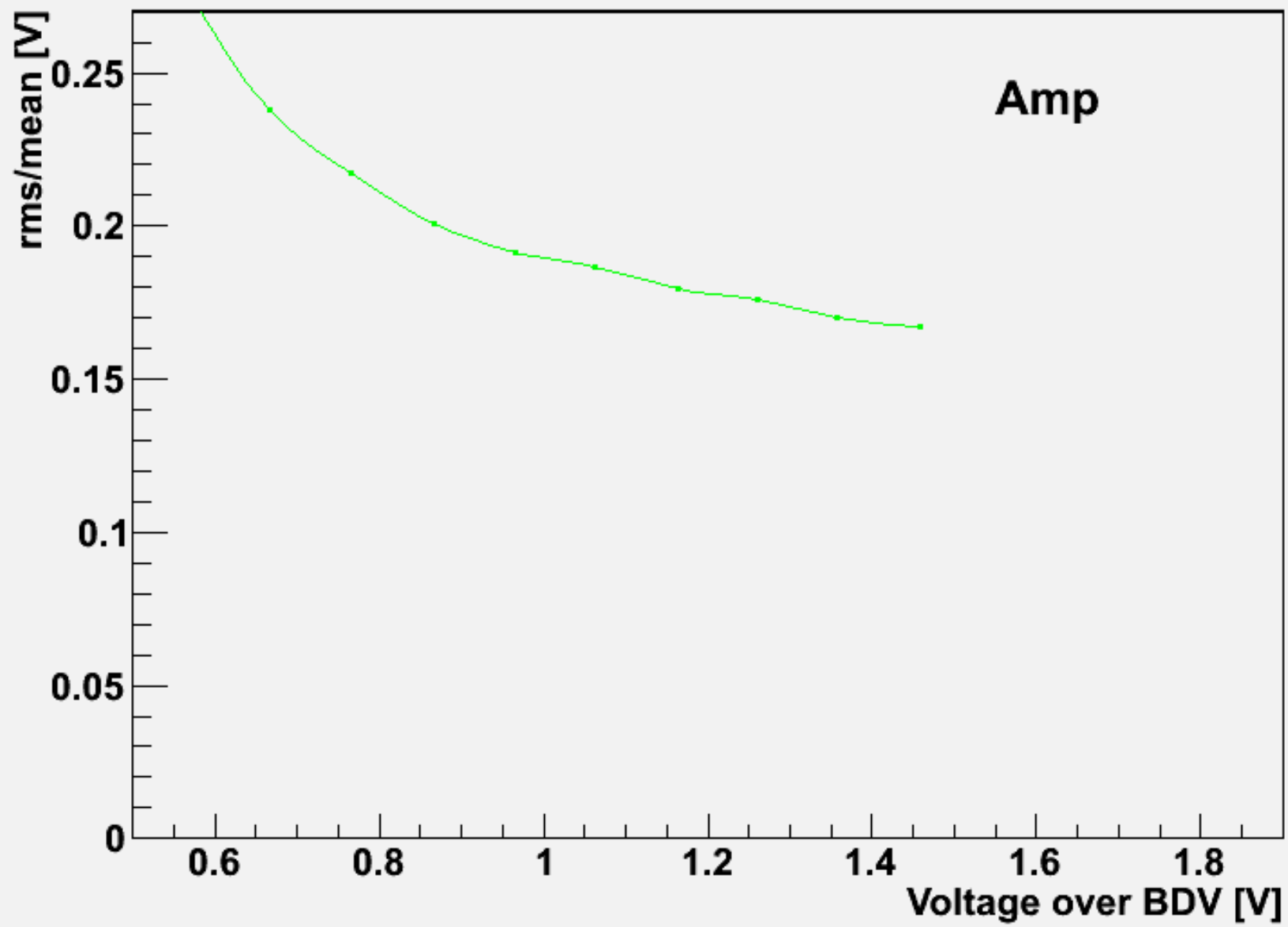
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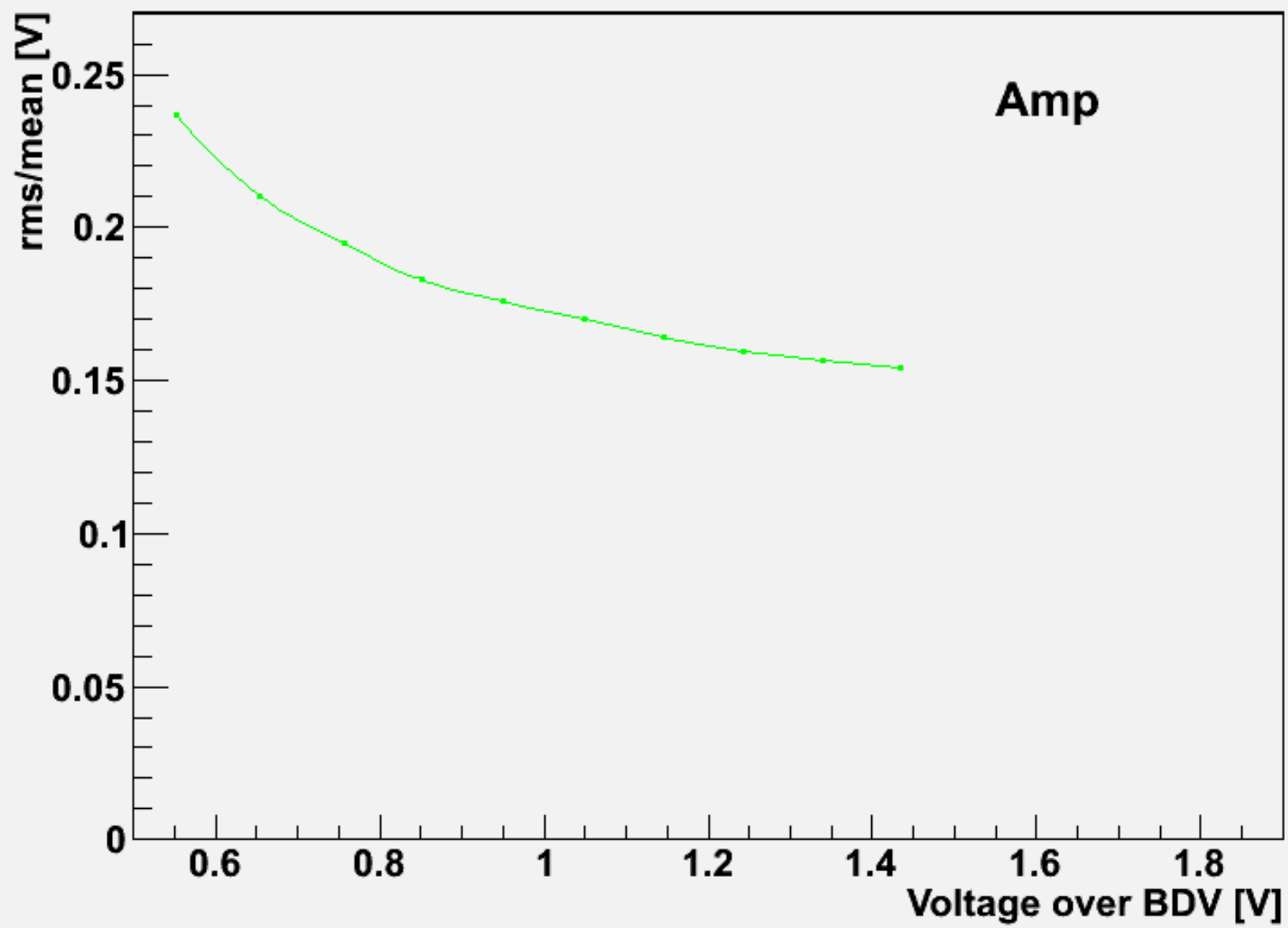
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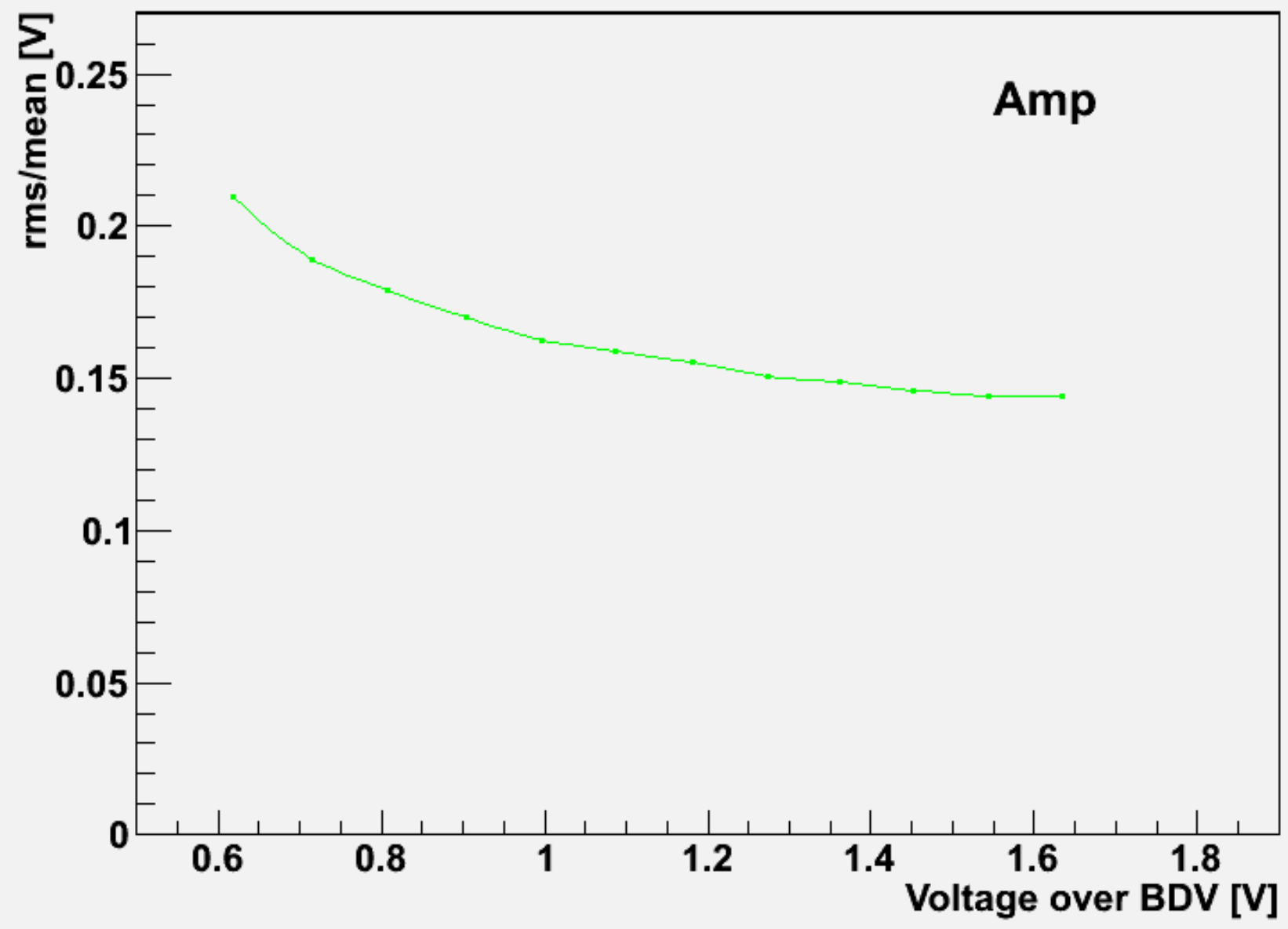
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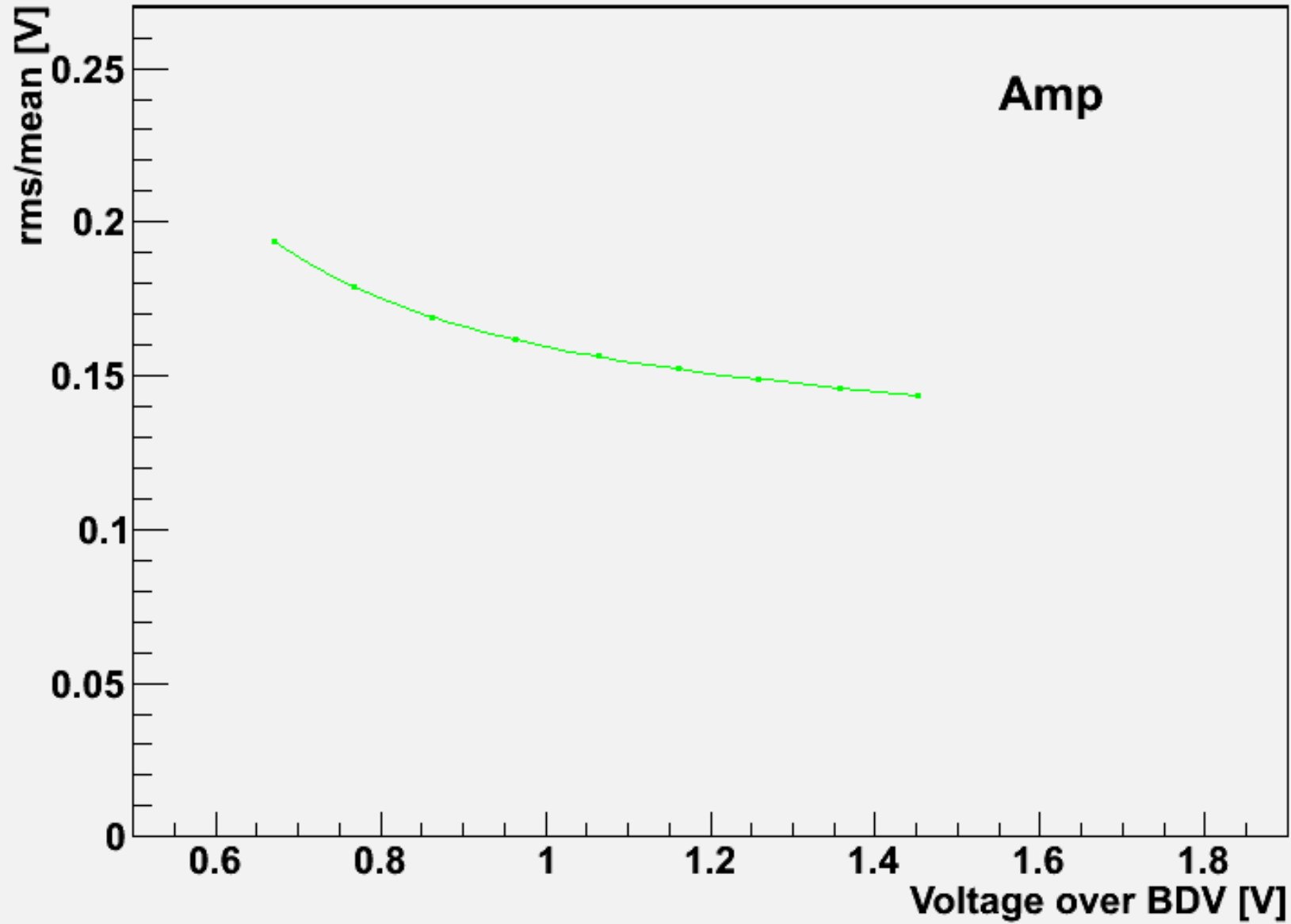
2198_T07



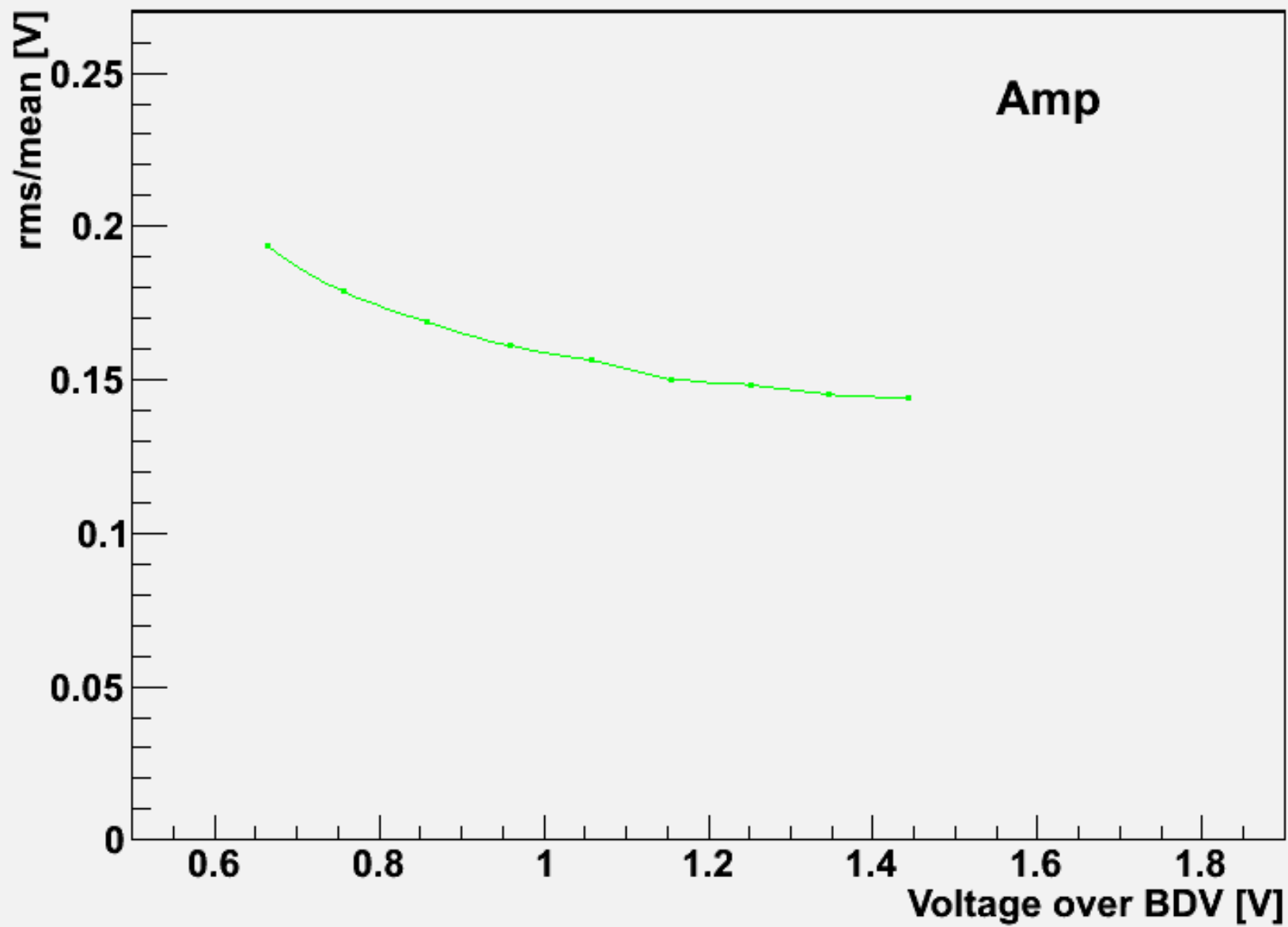
2198_T20



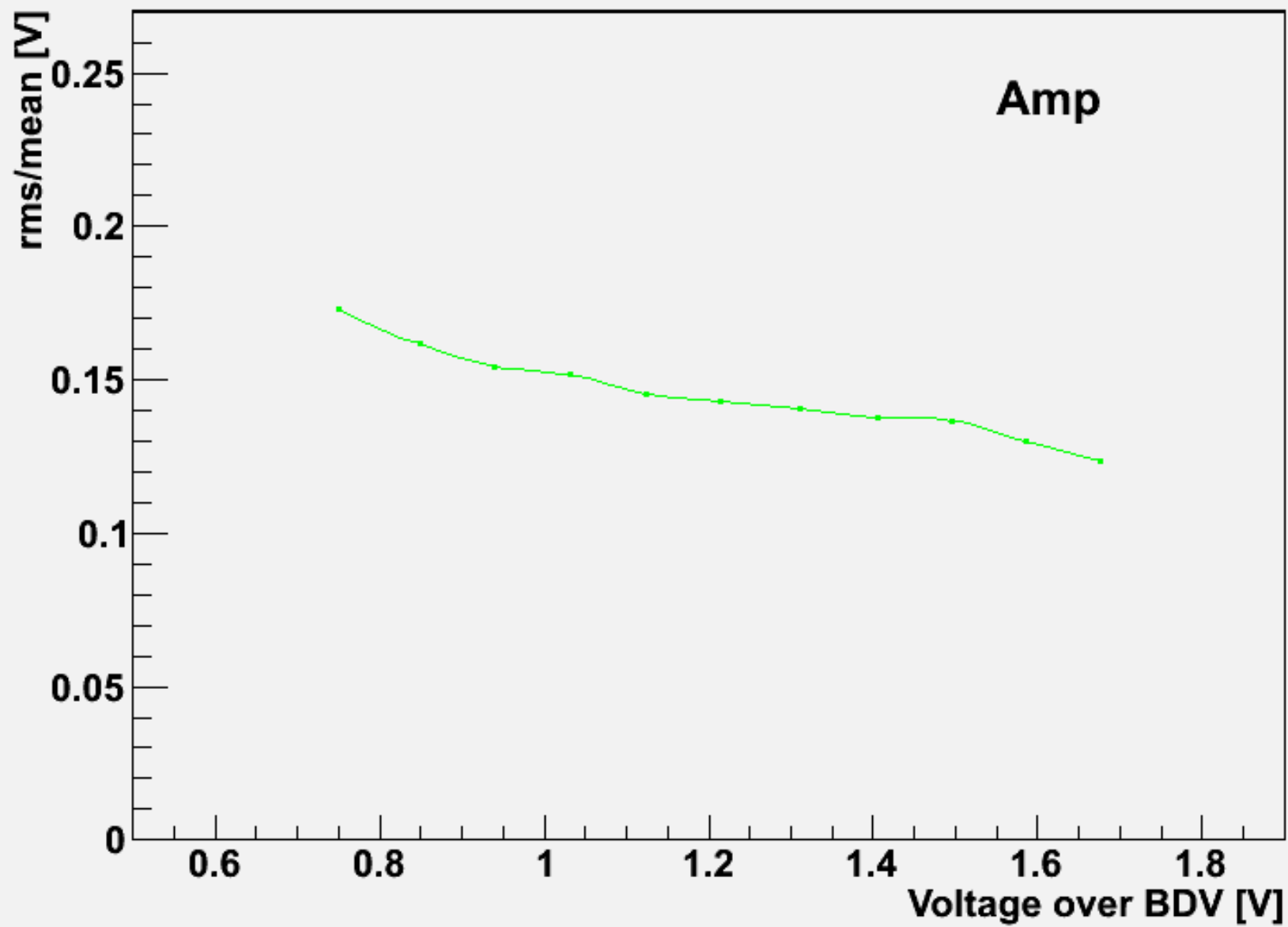
2247_T05



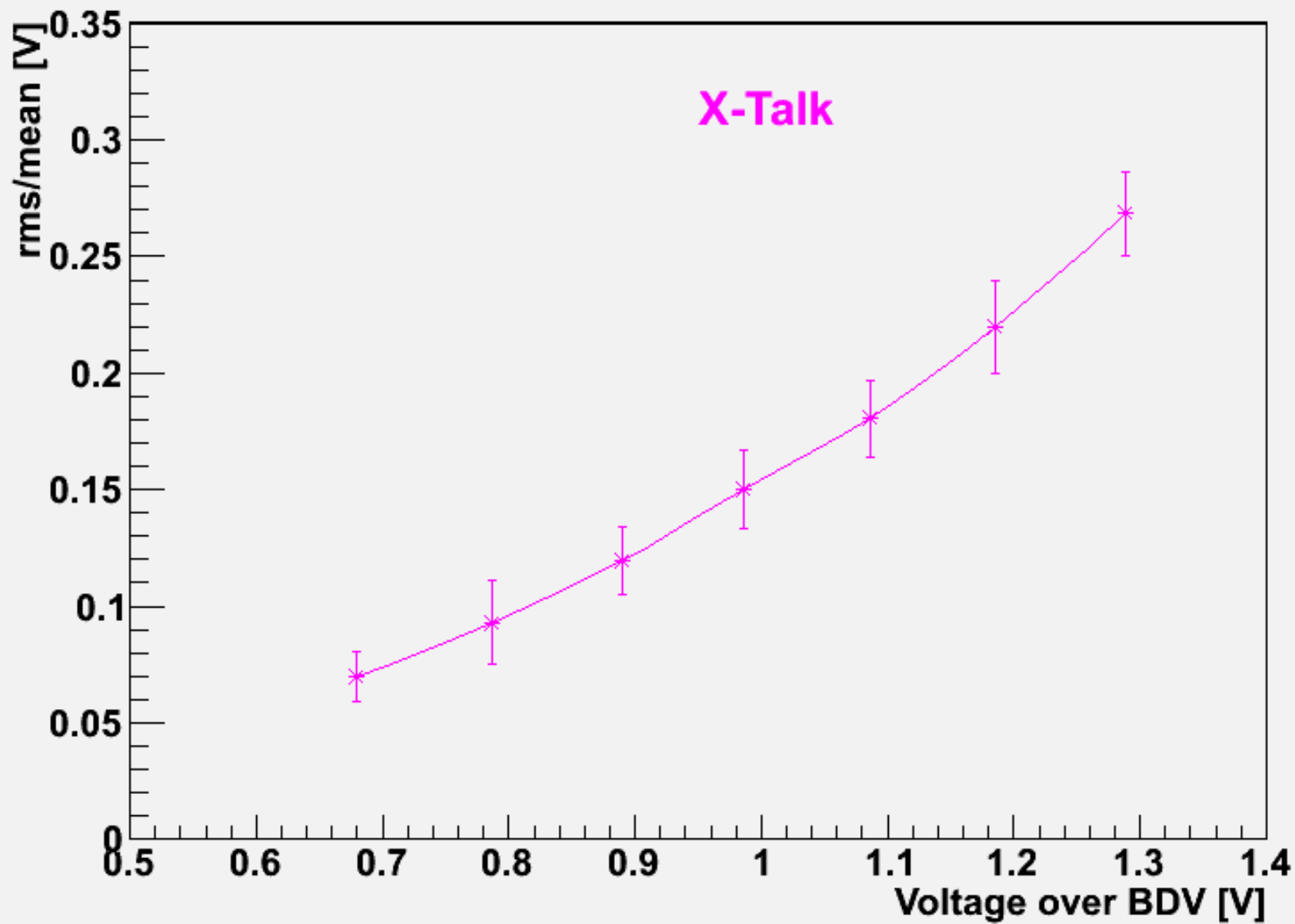
2247_T07



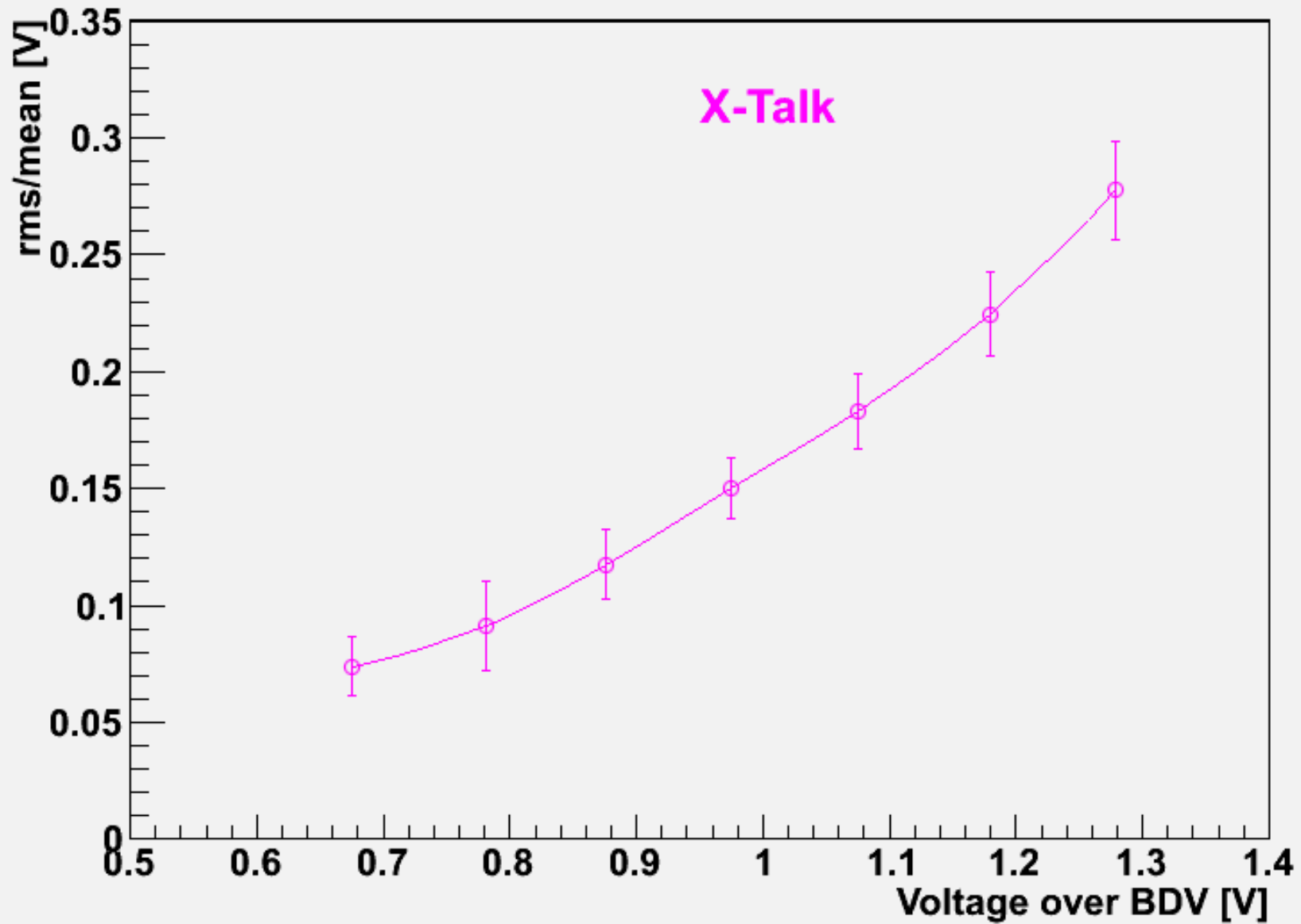
2247_T20



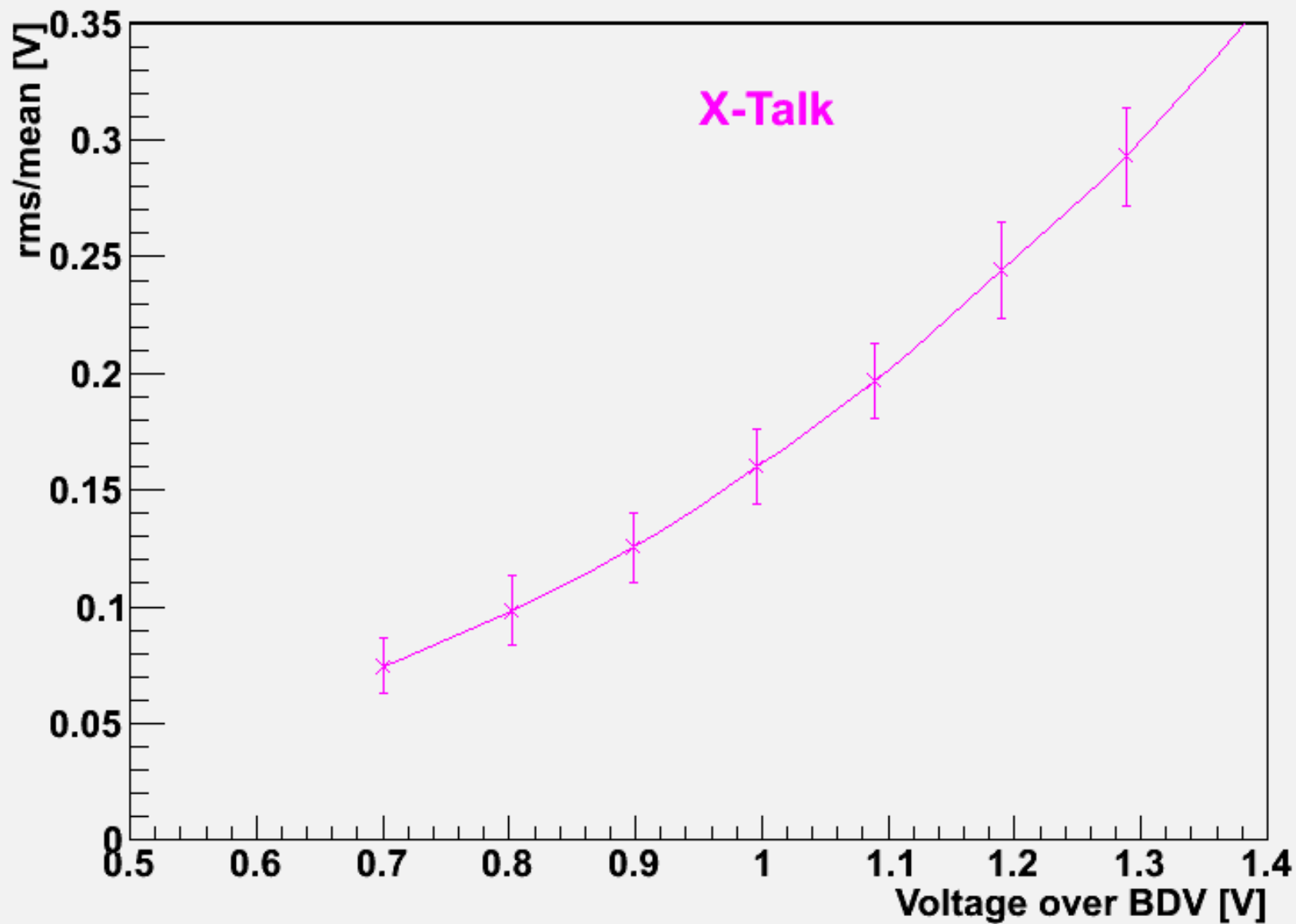
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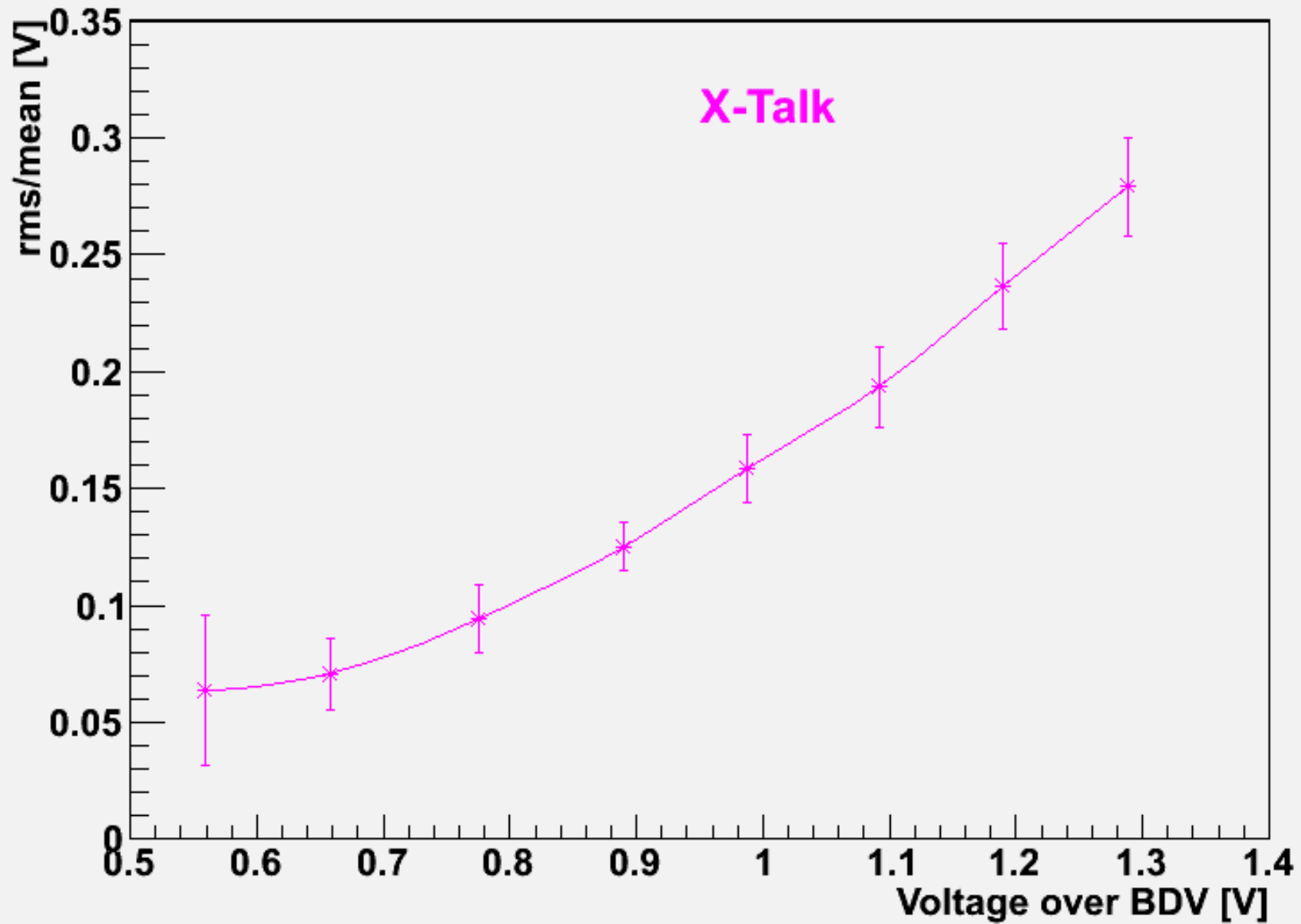
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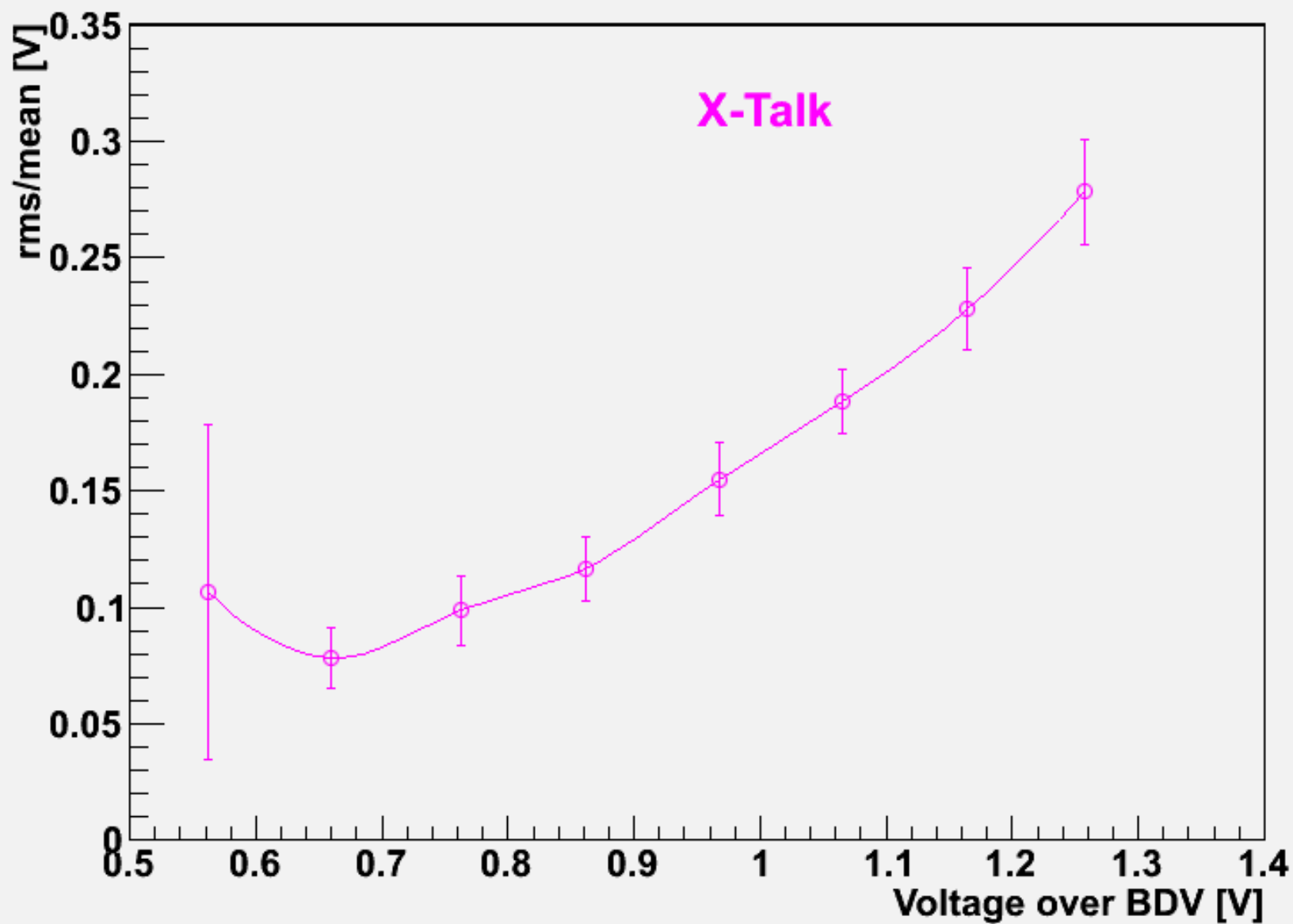
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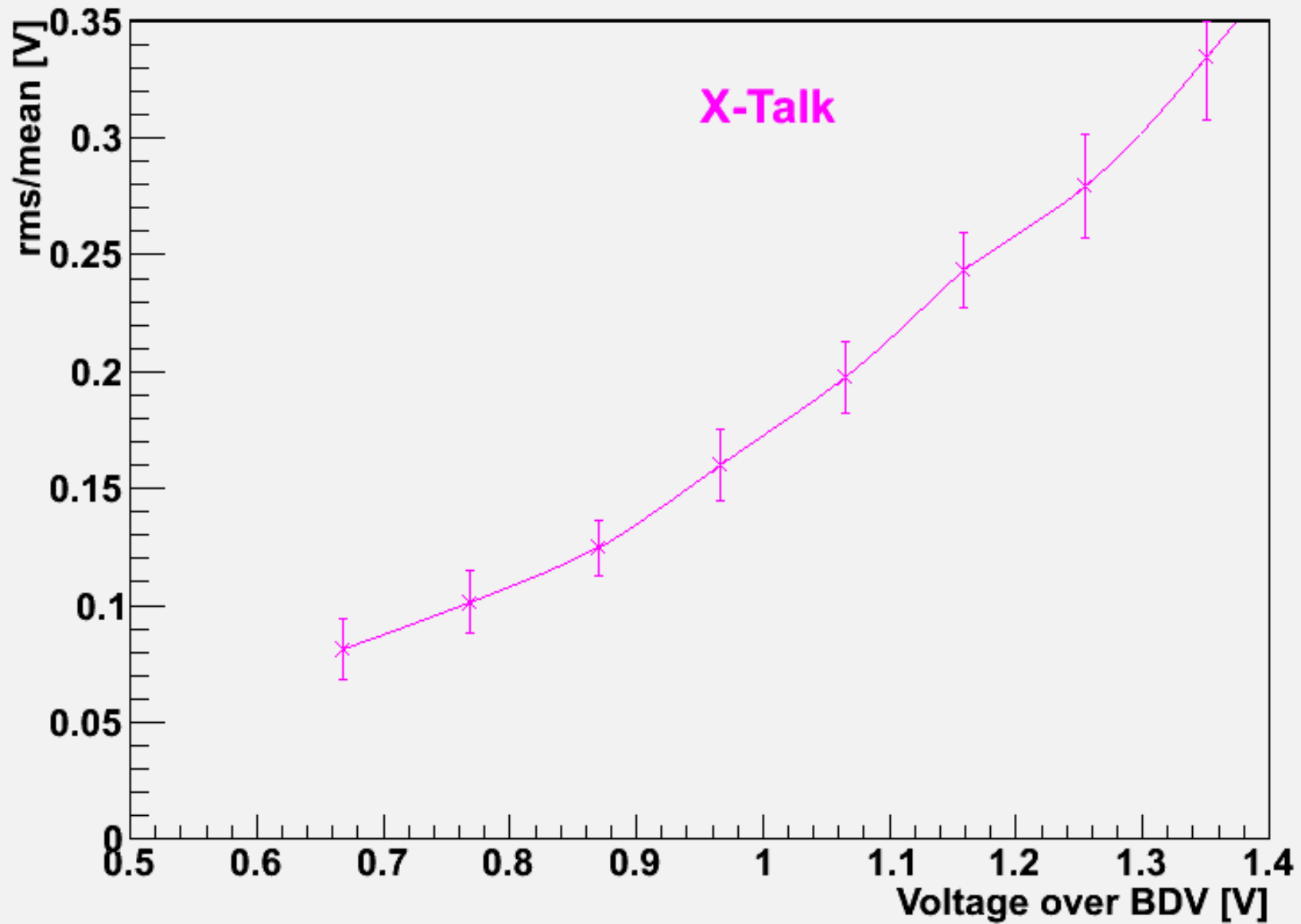
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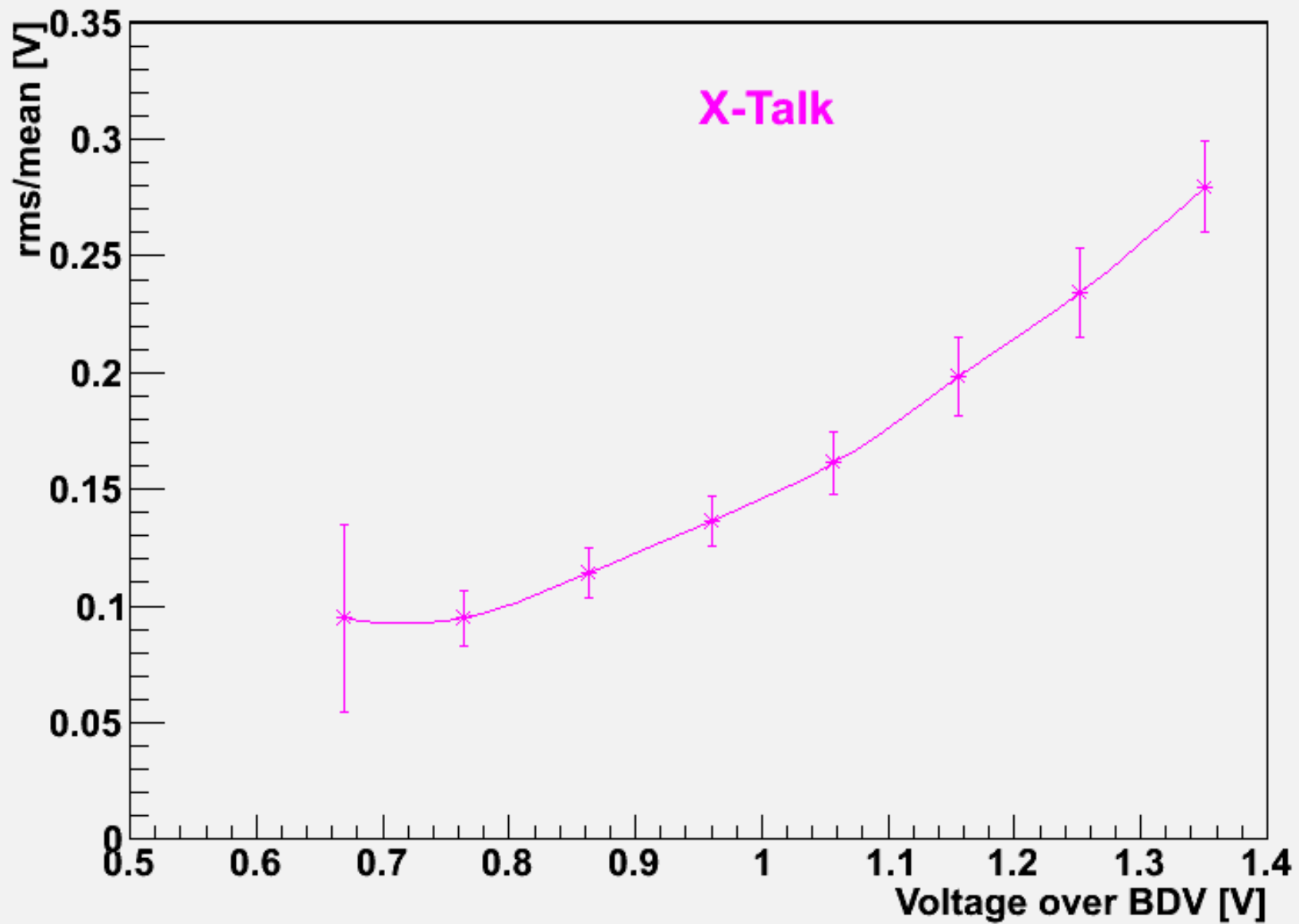
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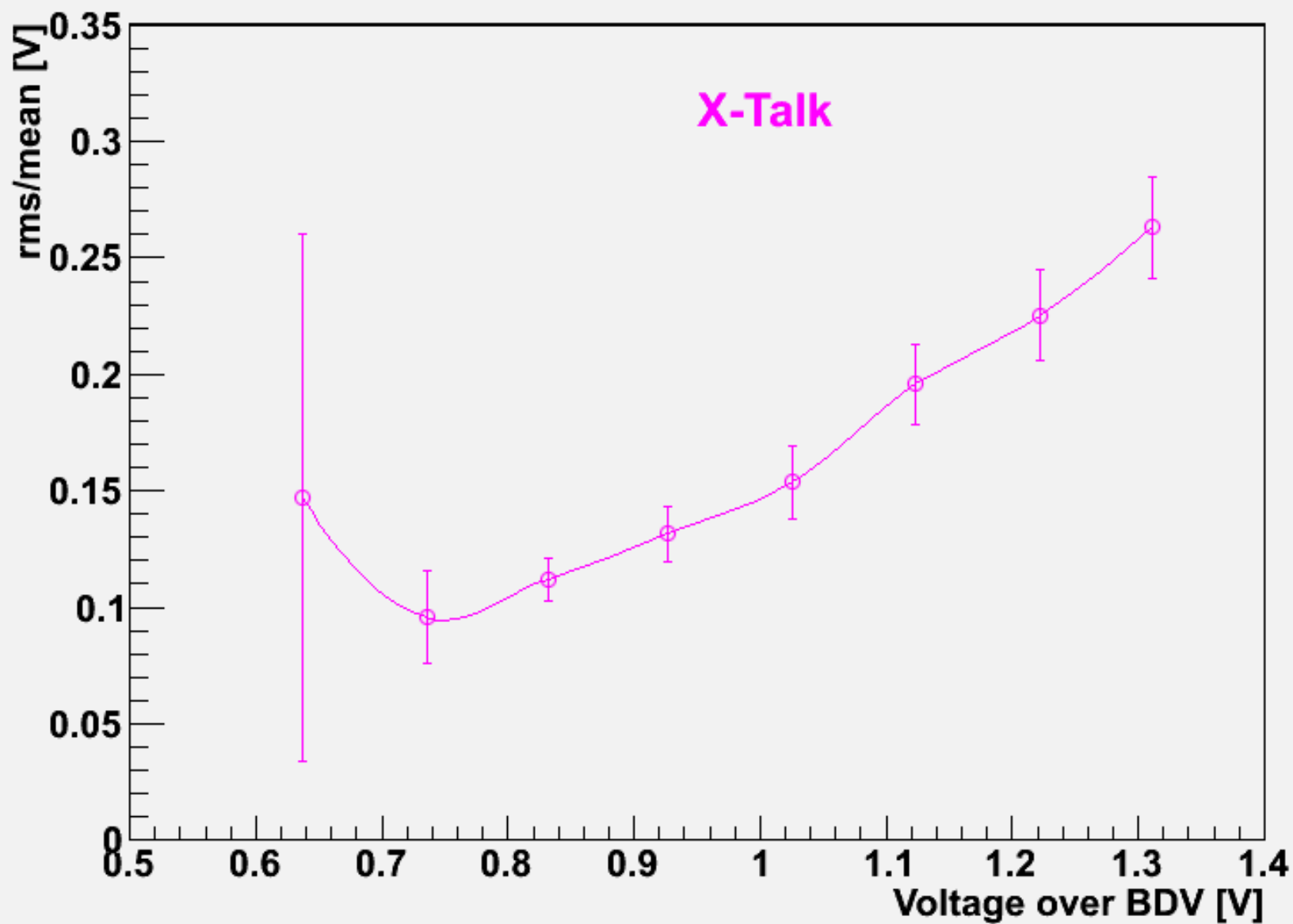
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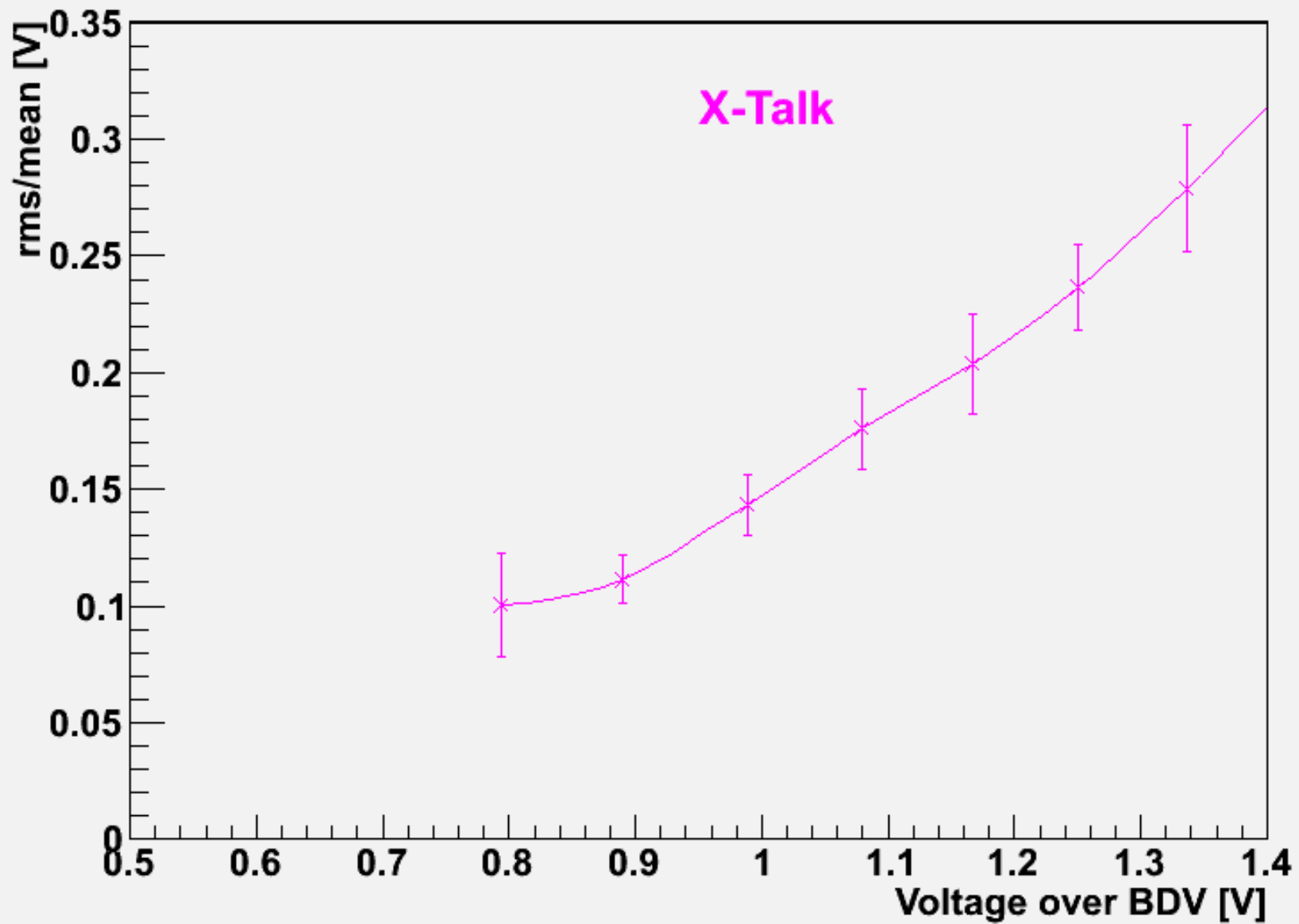
2009_T05



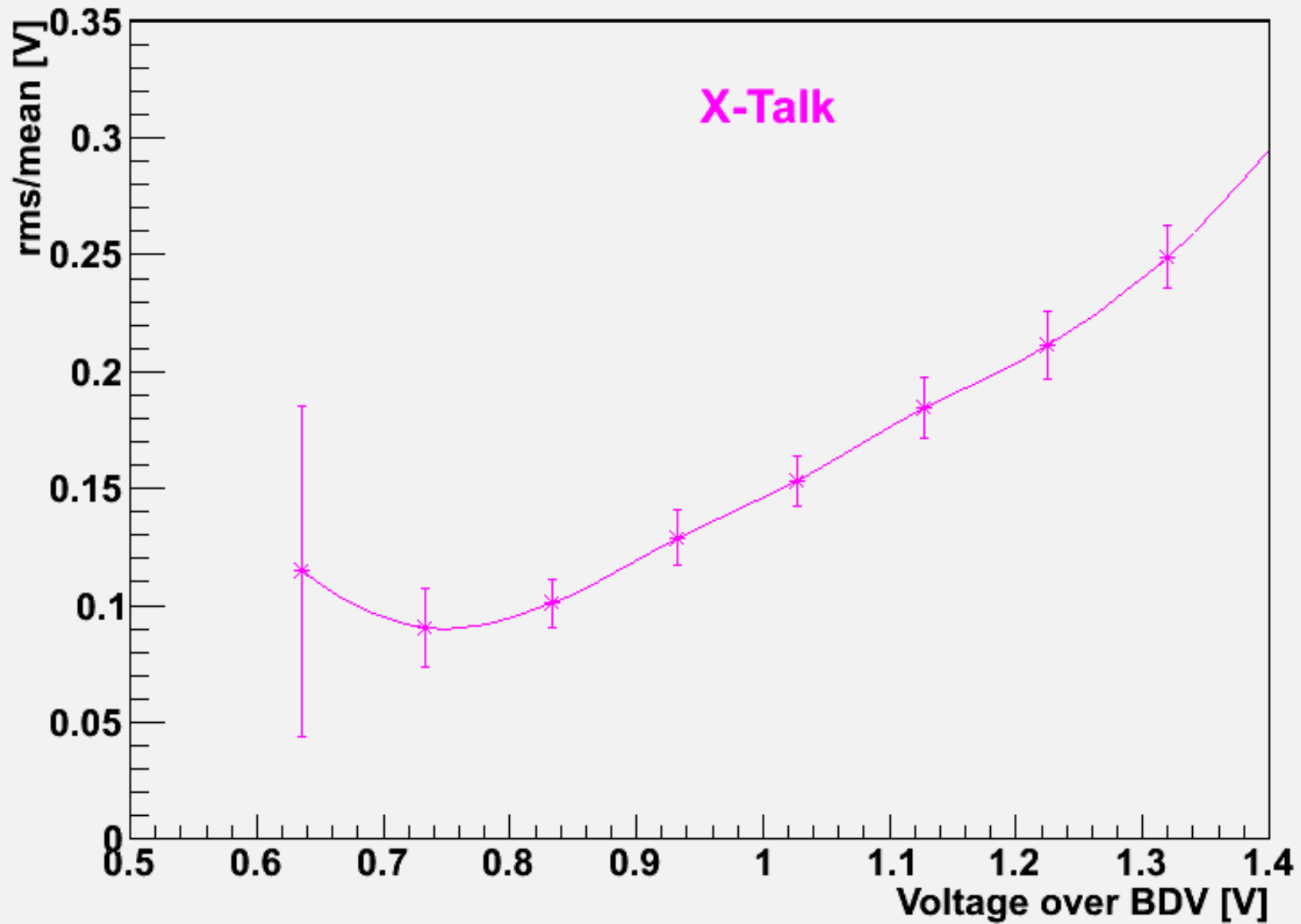
2009_T07



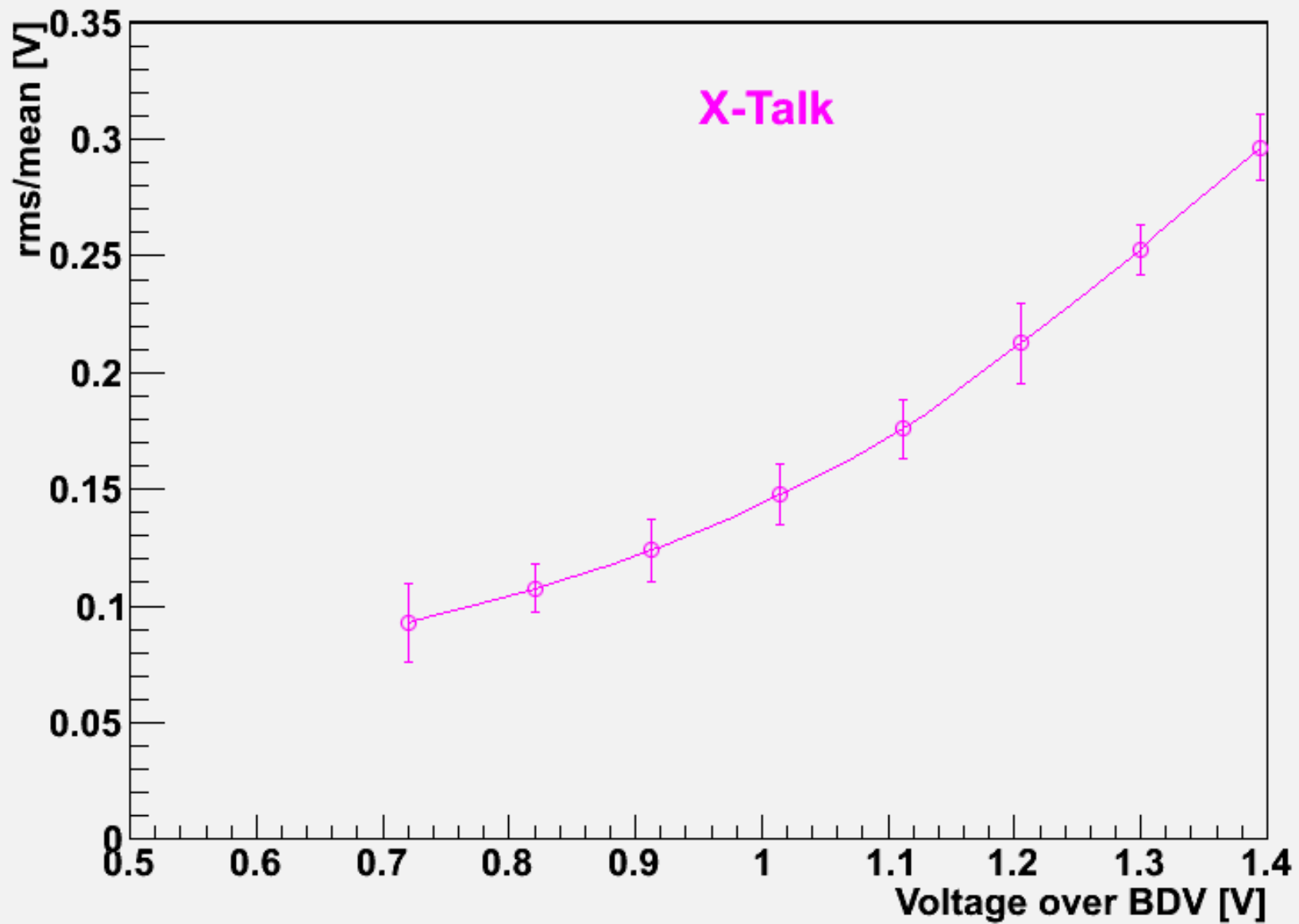
2009_T20



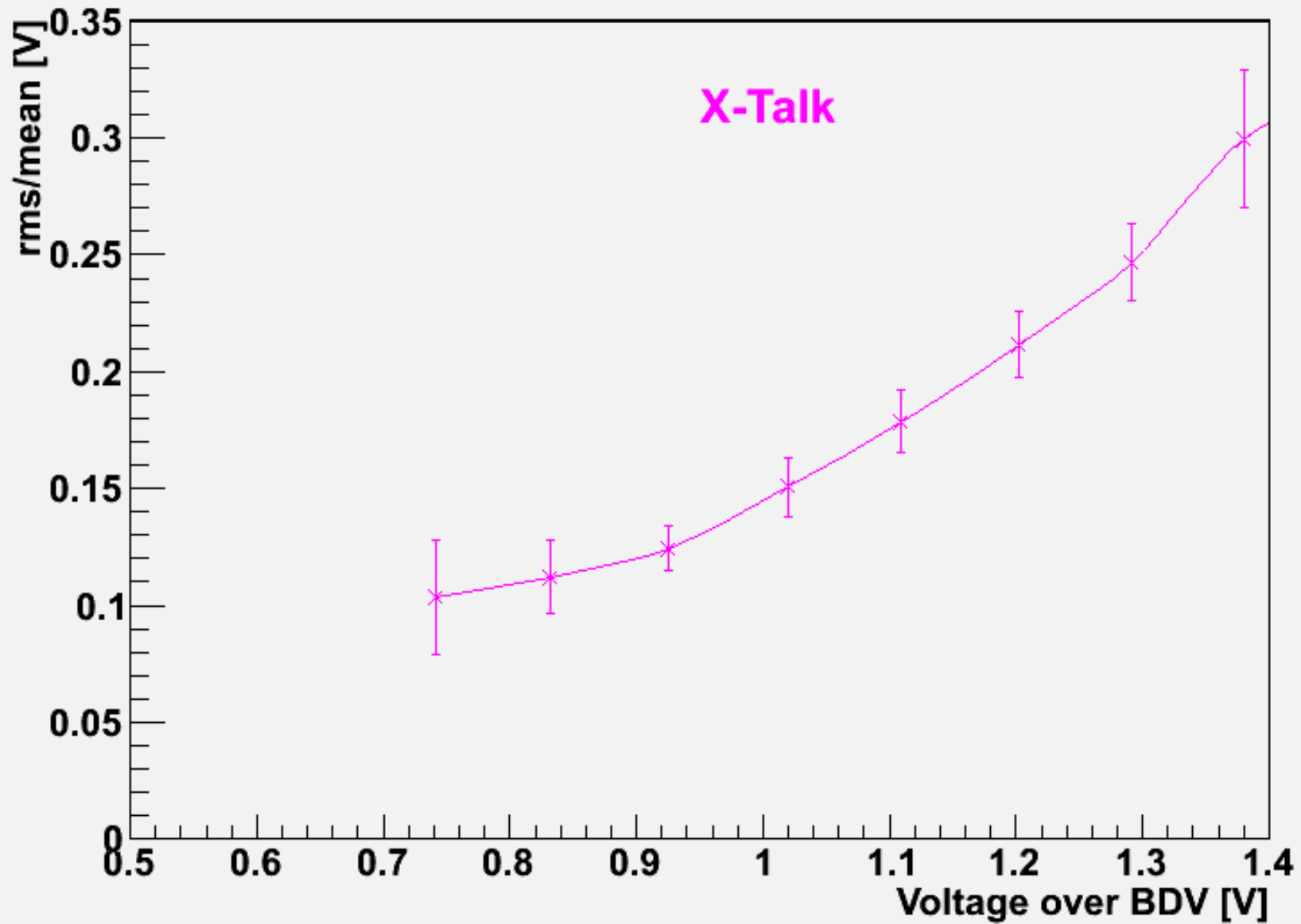
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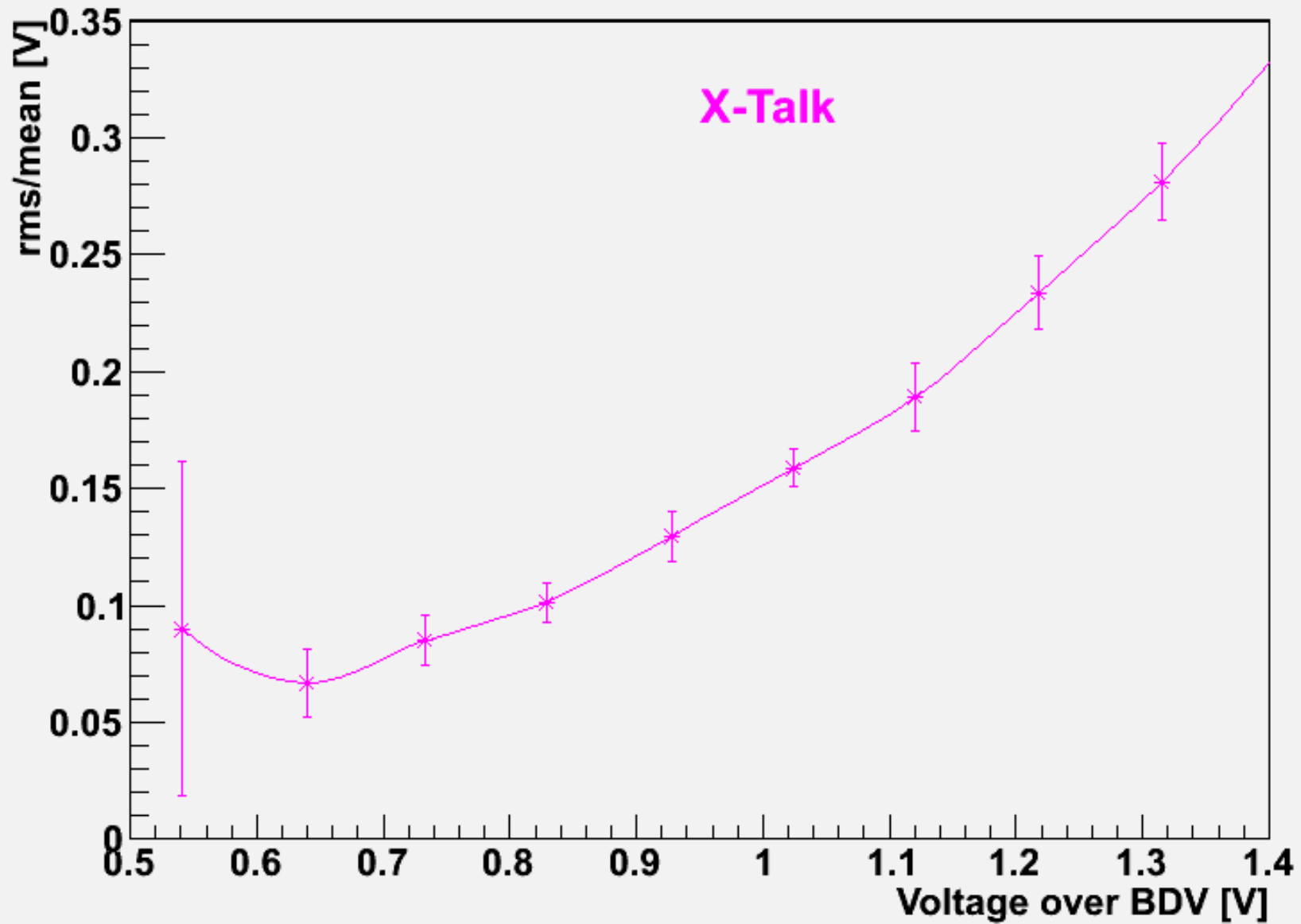
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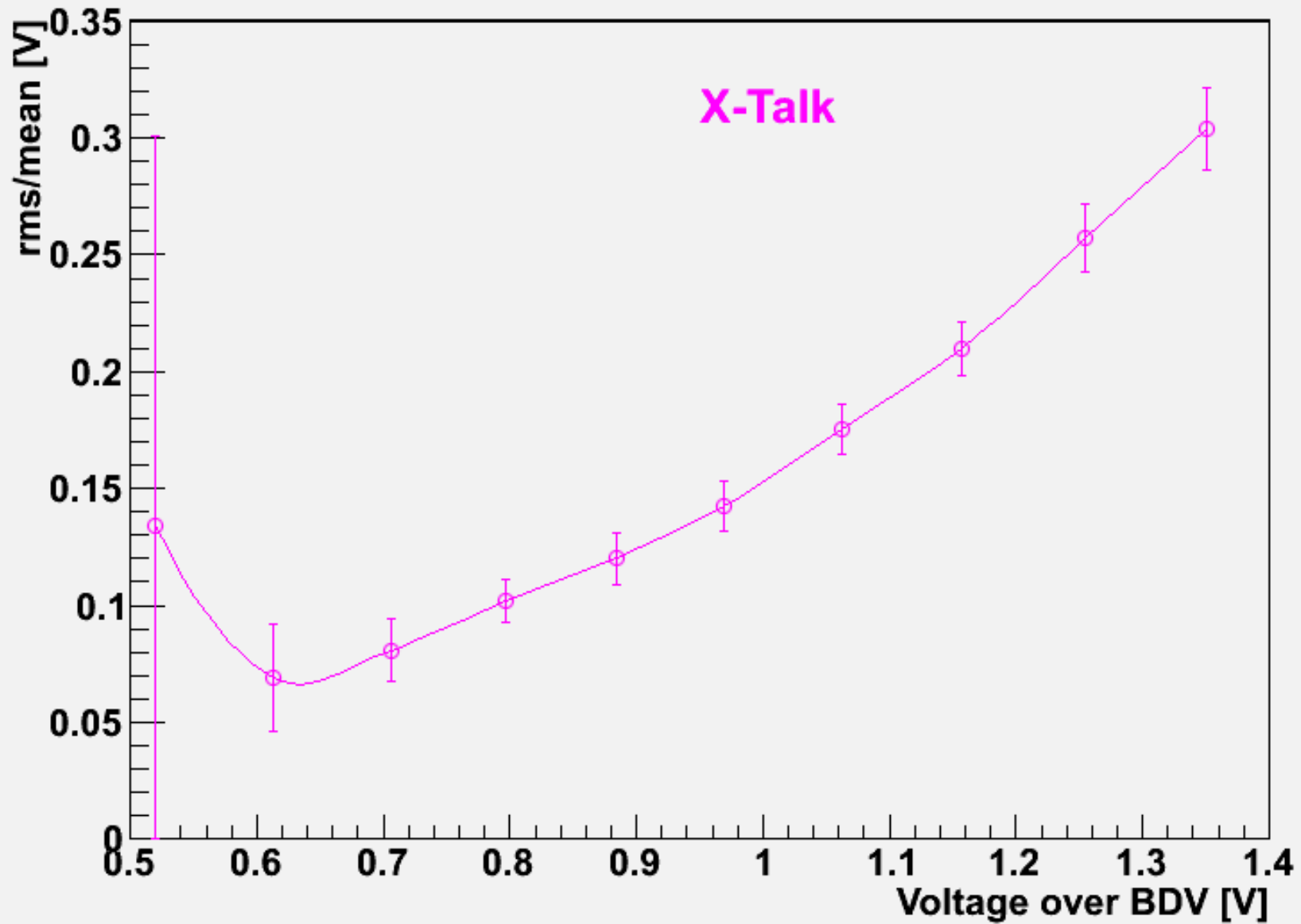
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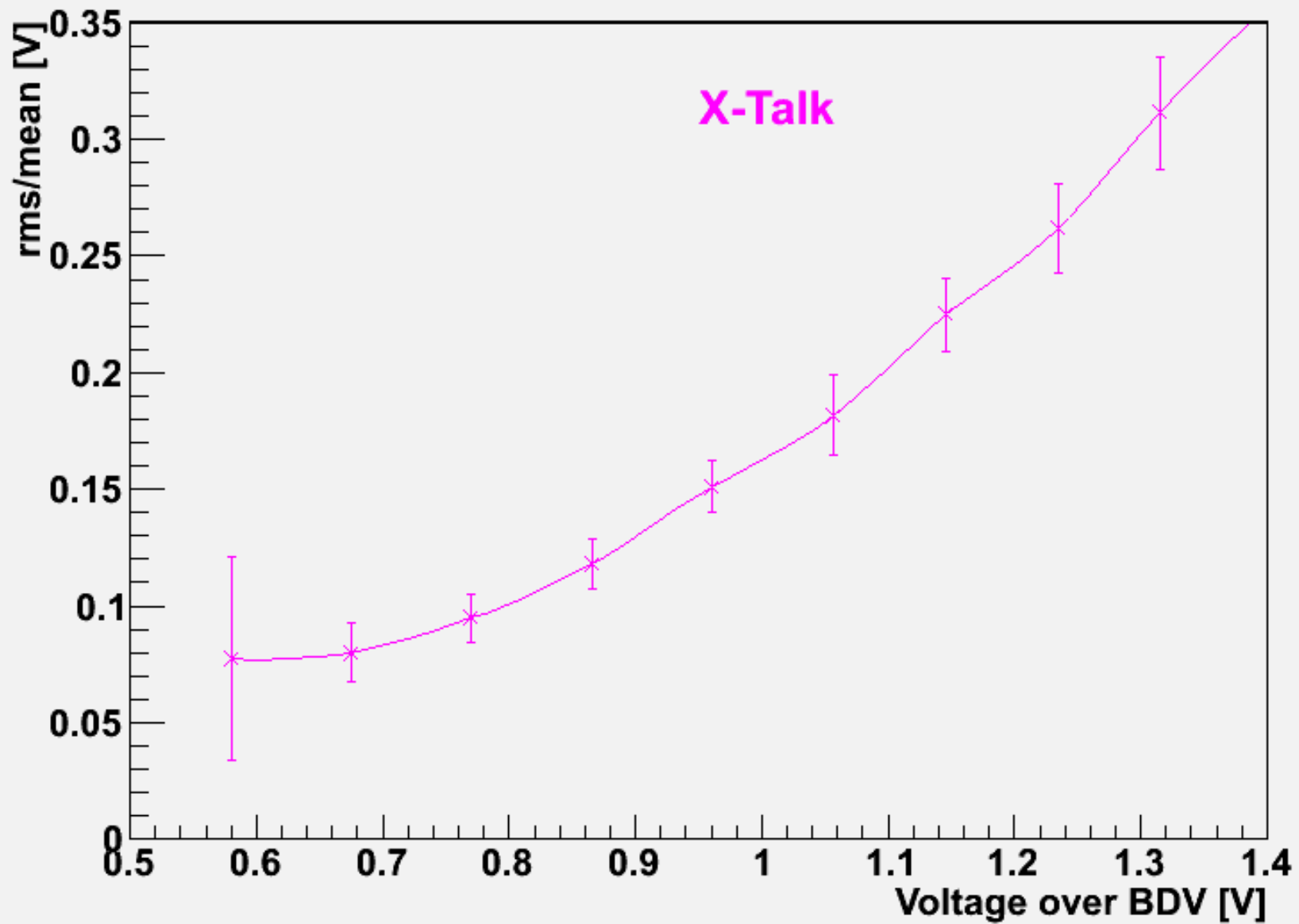
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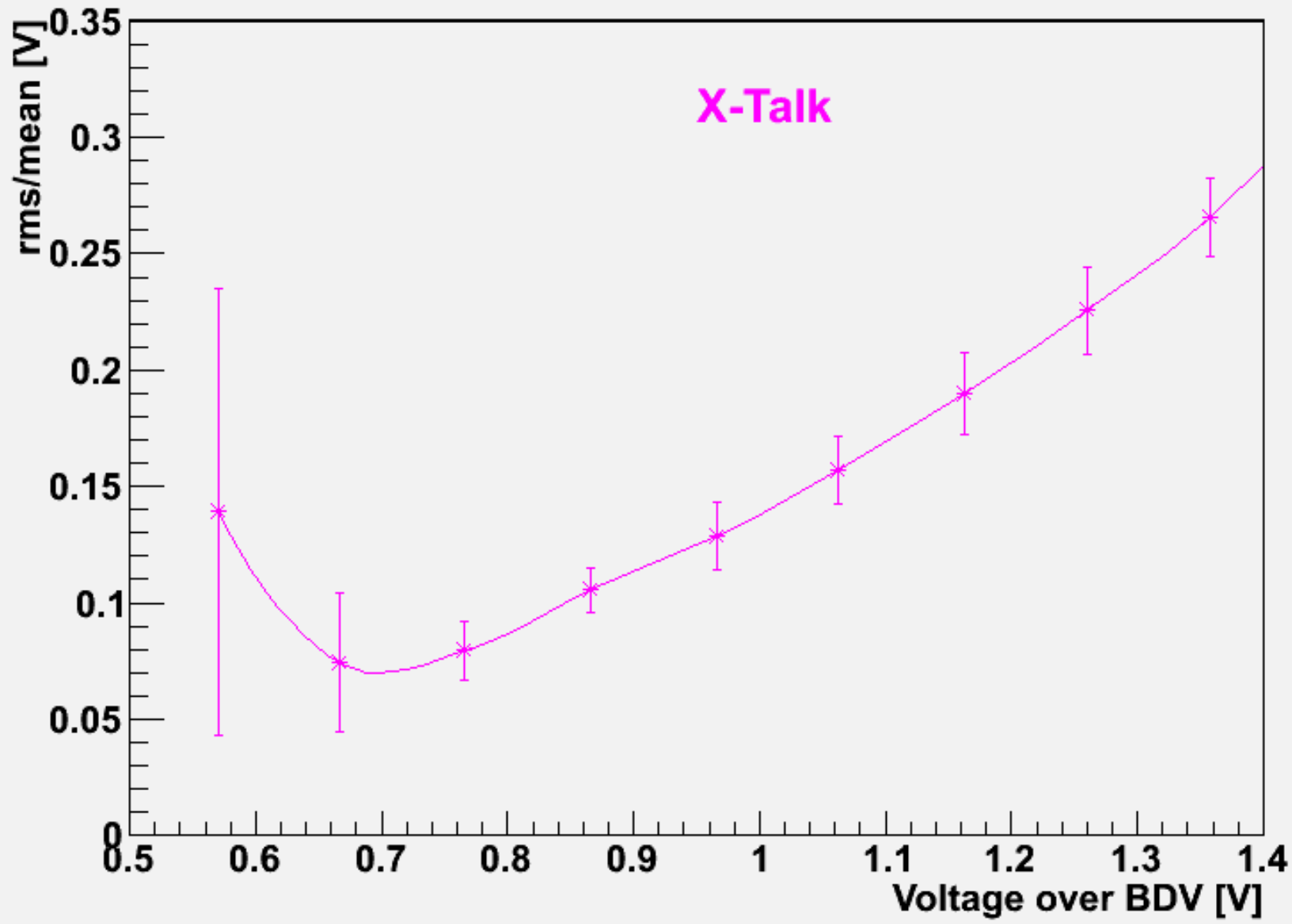
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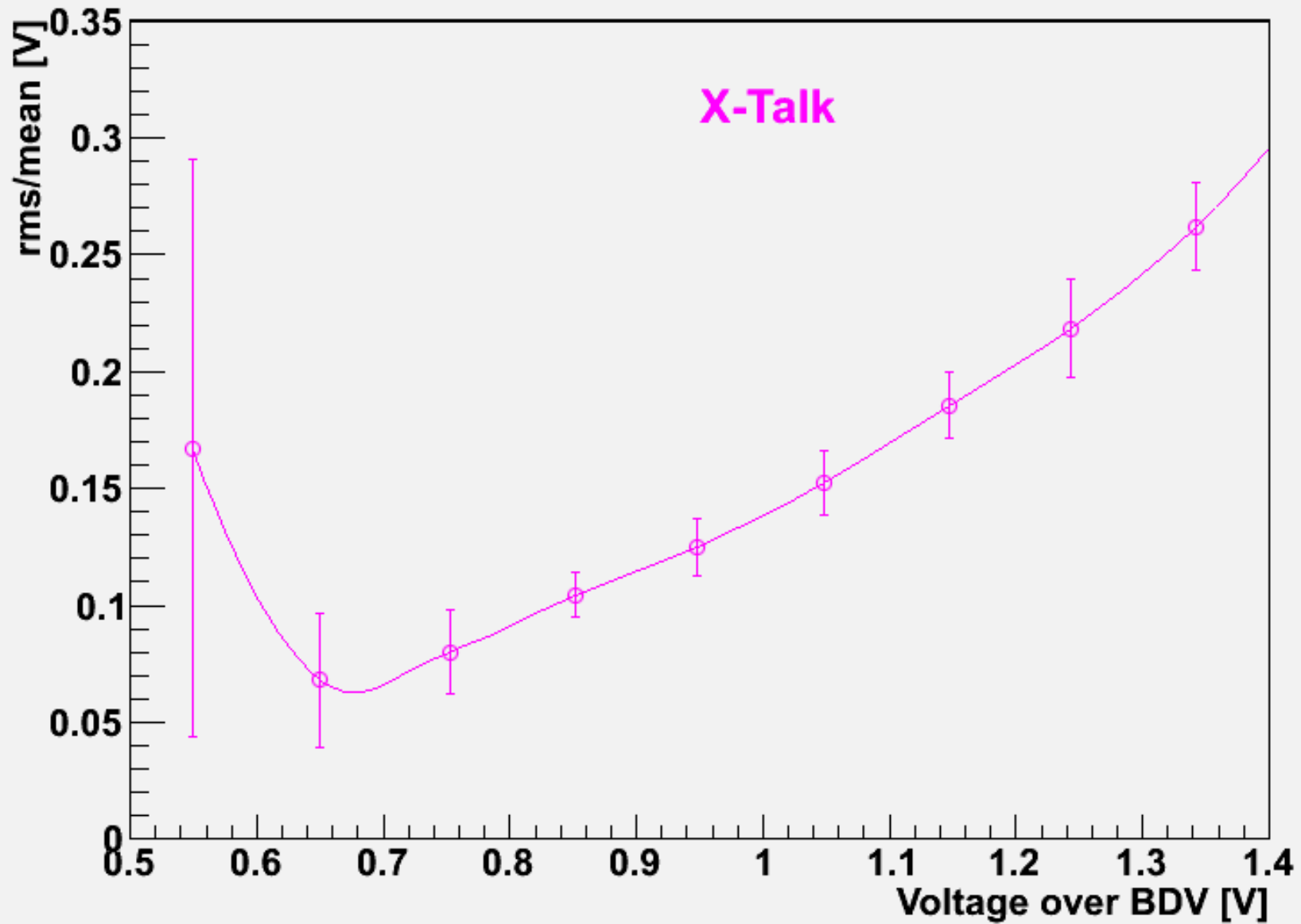
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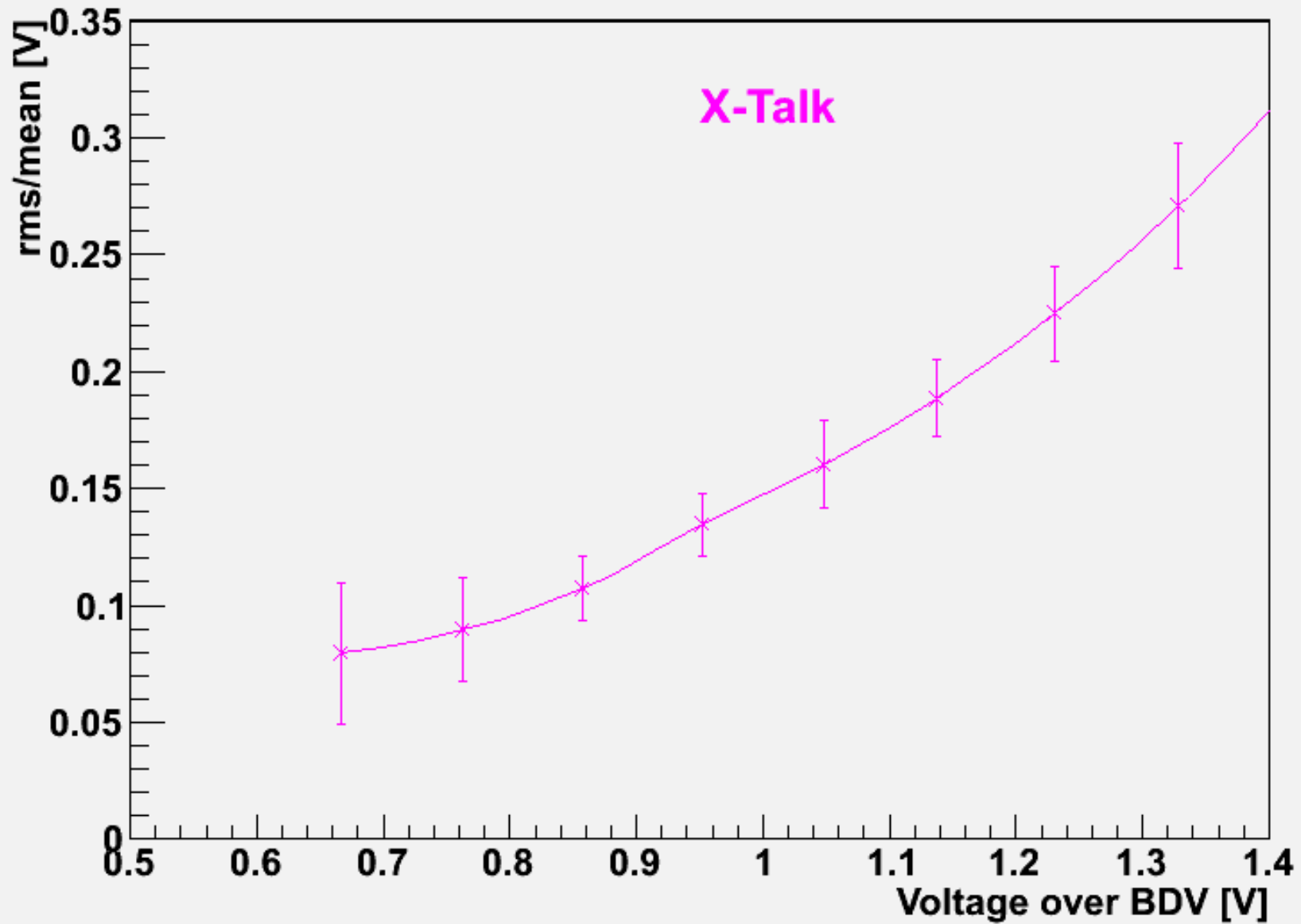
2098_T05



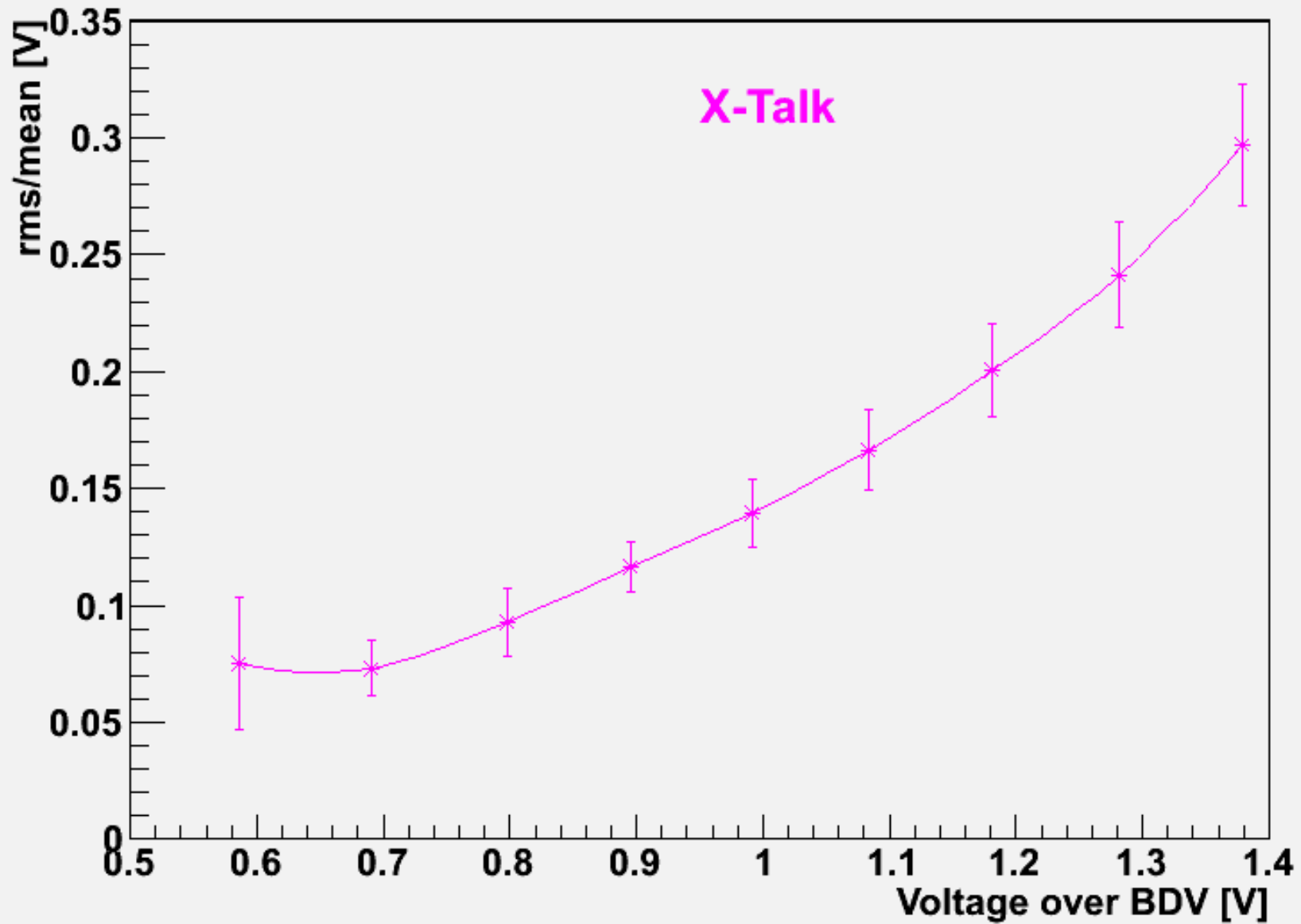
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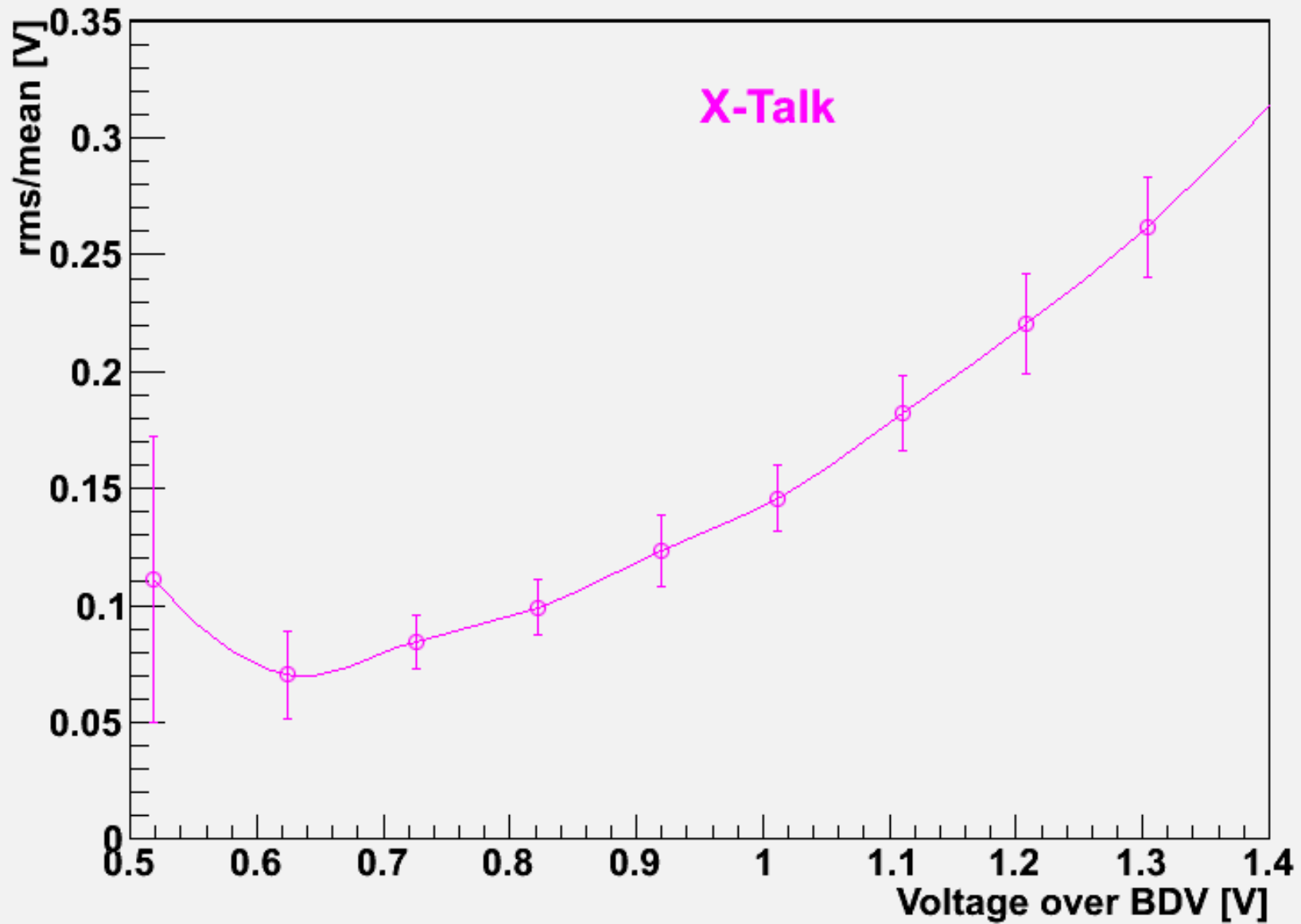
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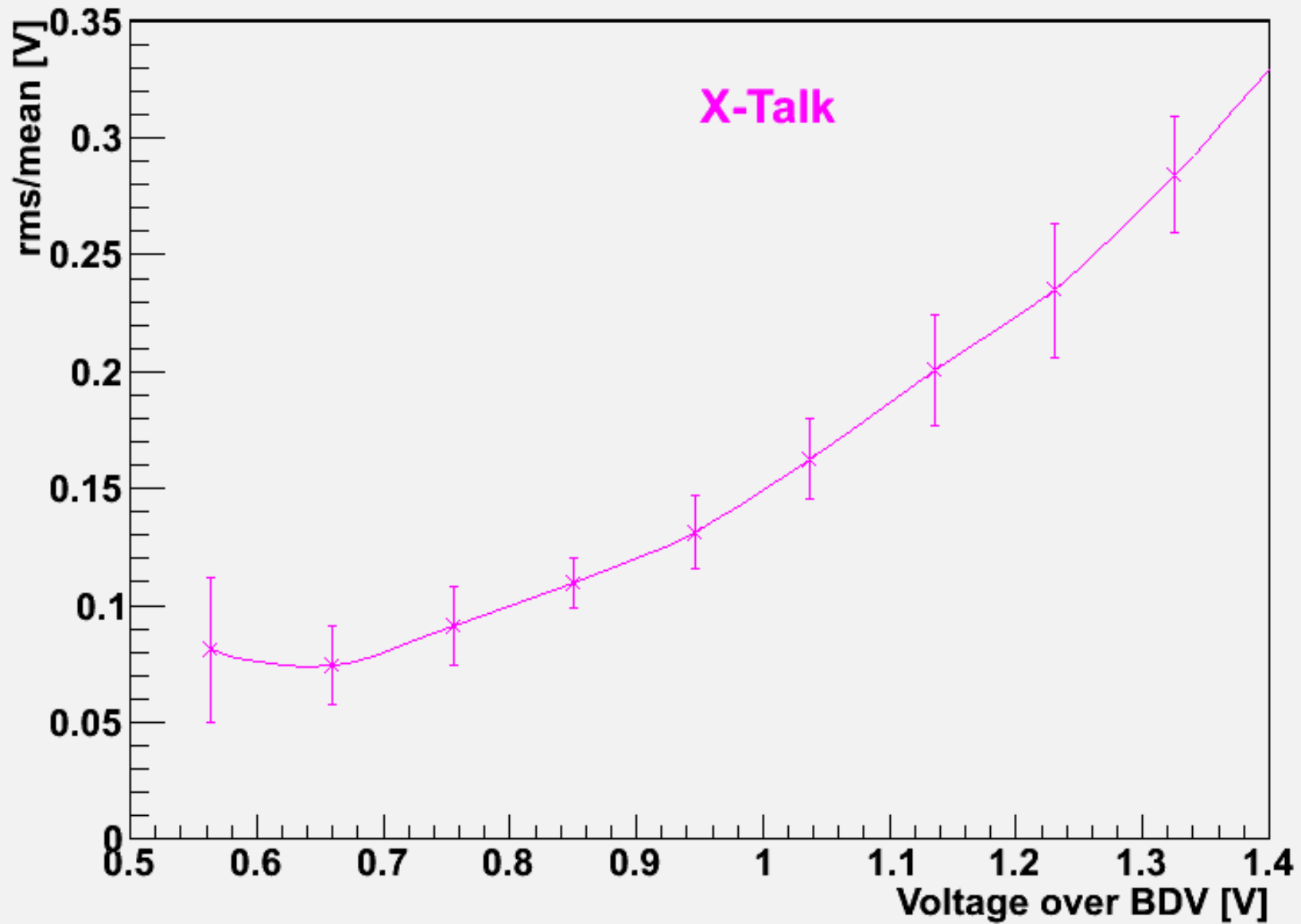
2120_T05



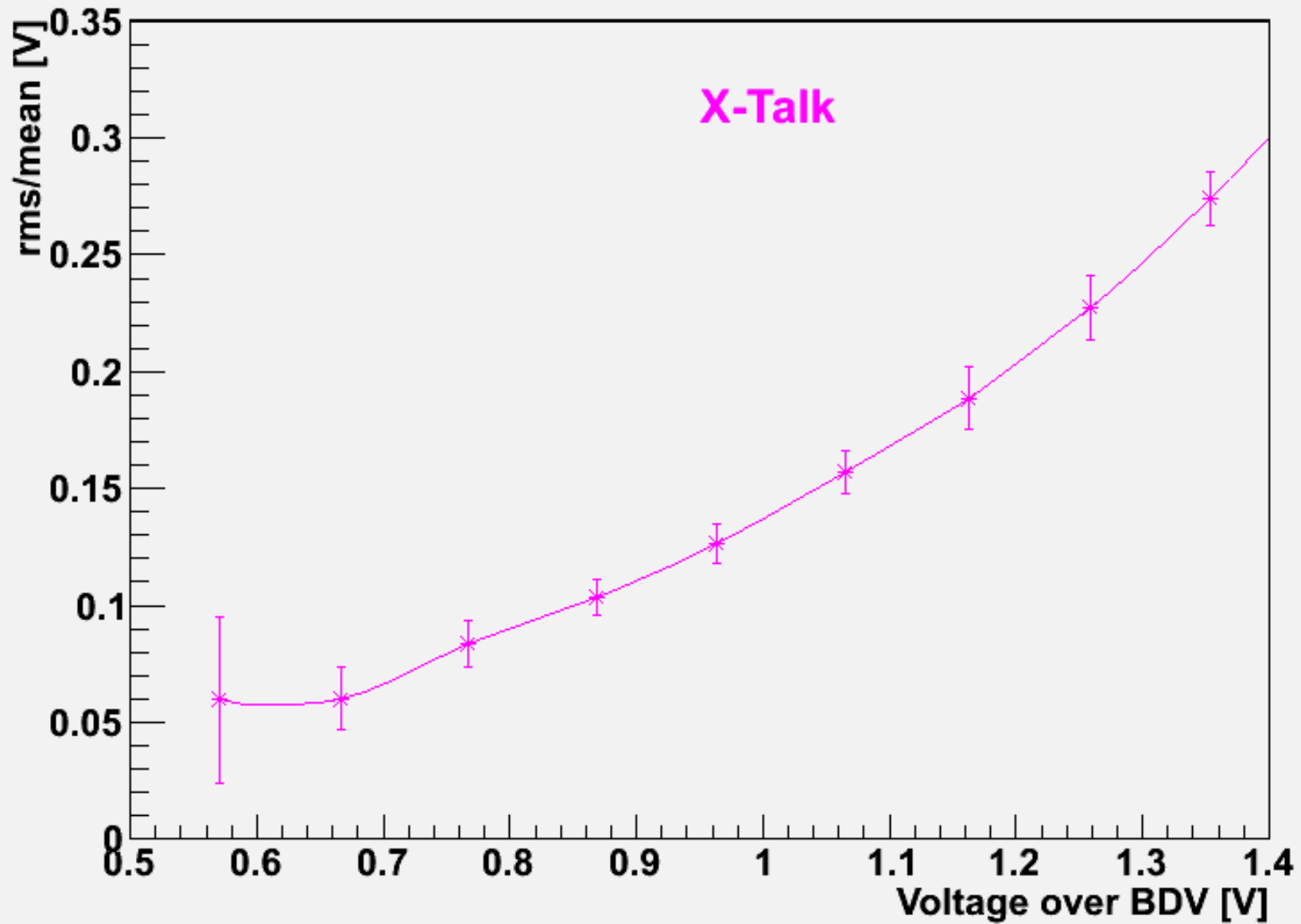
2120_T07



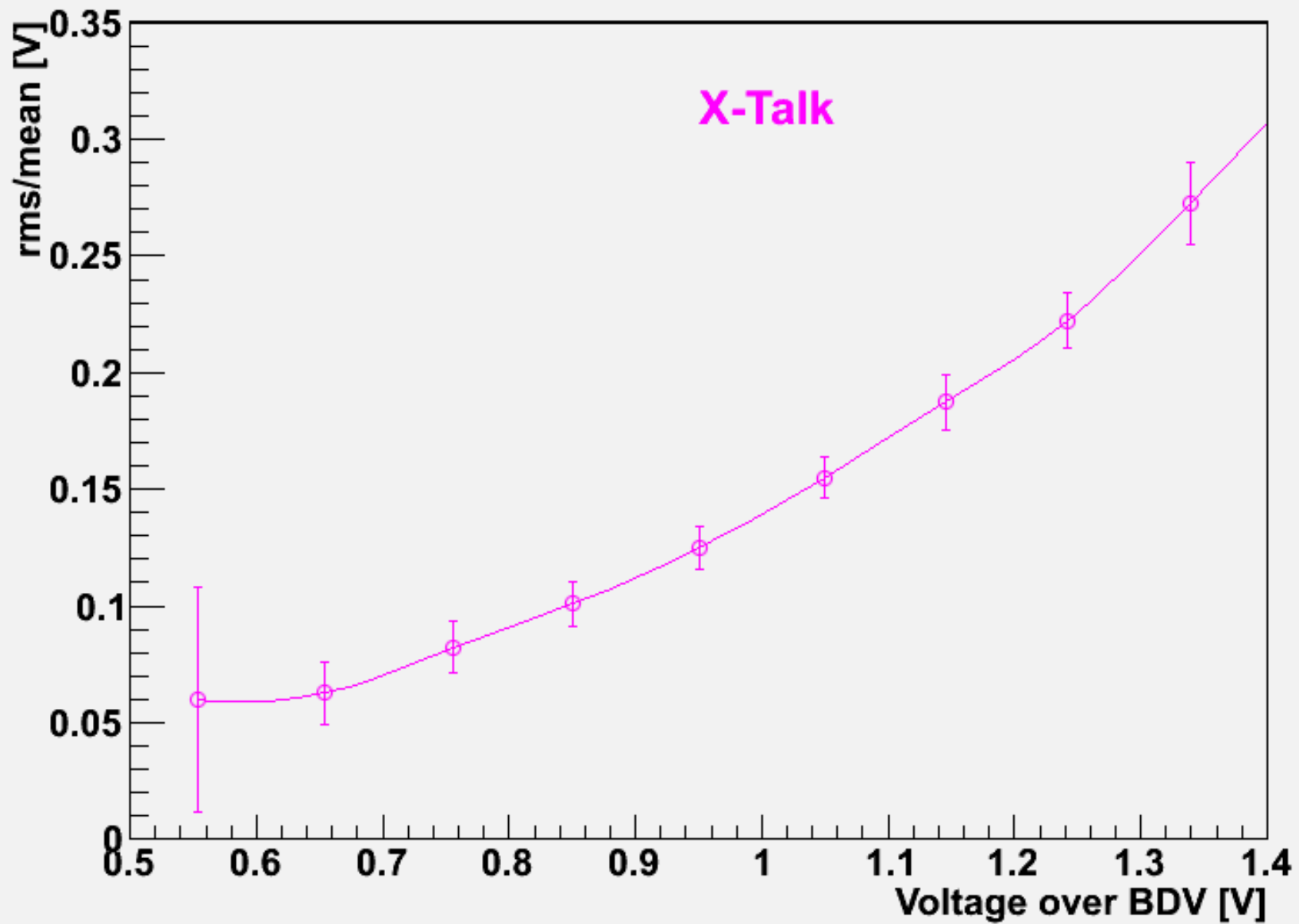
2120_T20



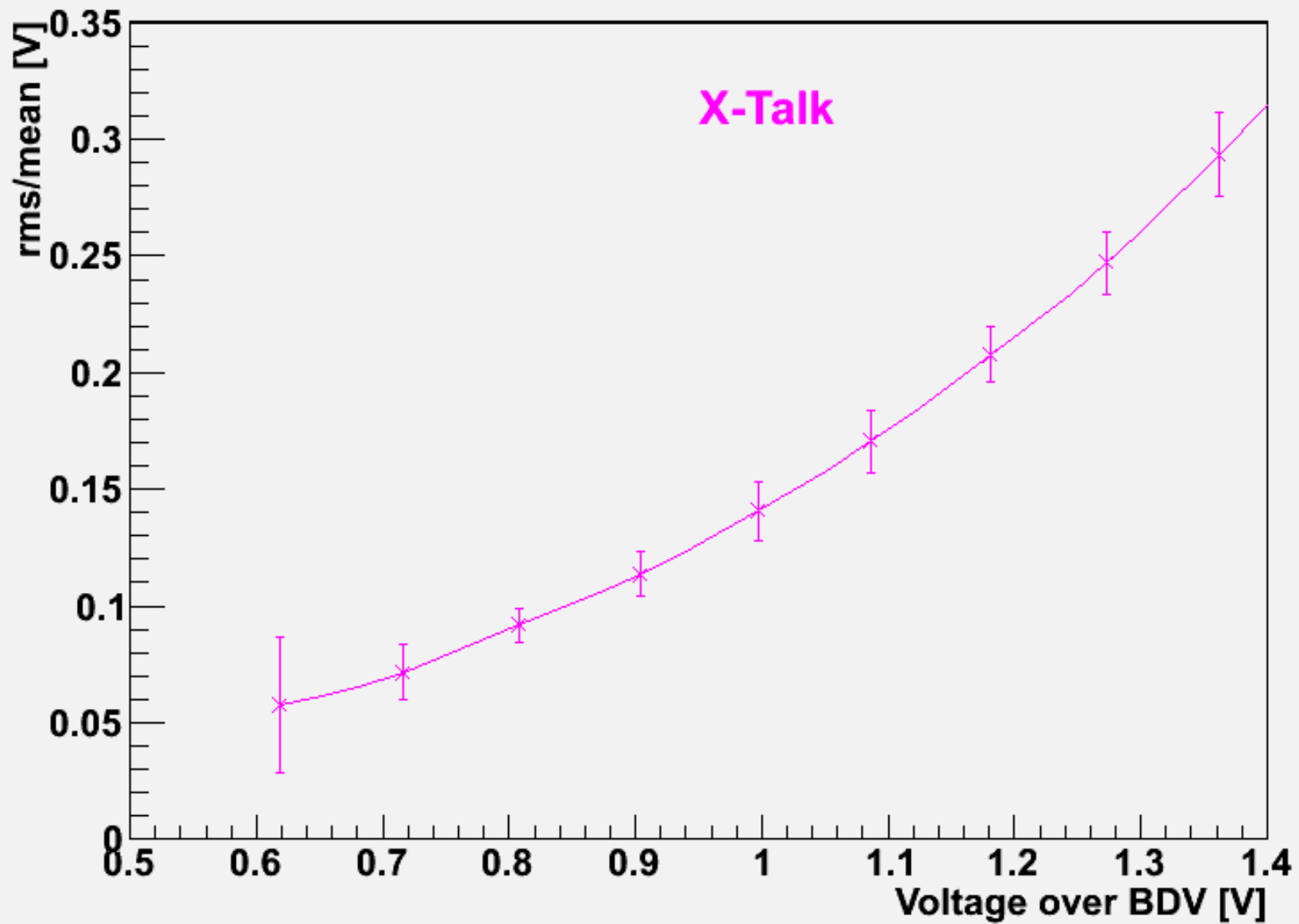
2198_T05



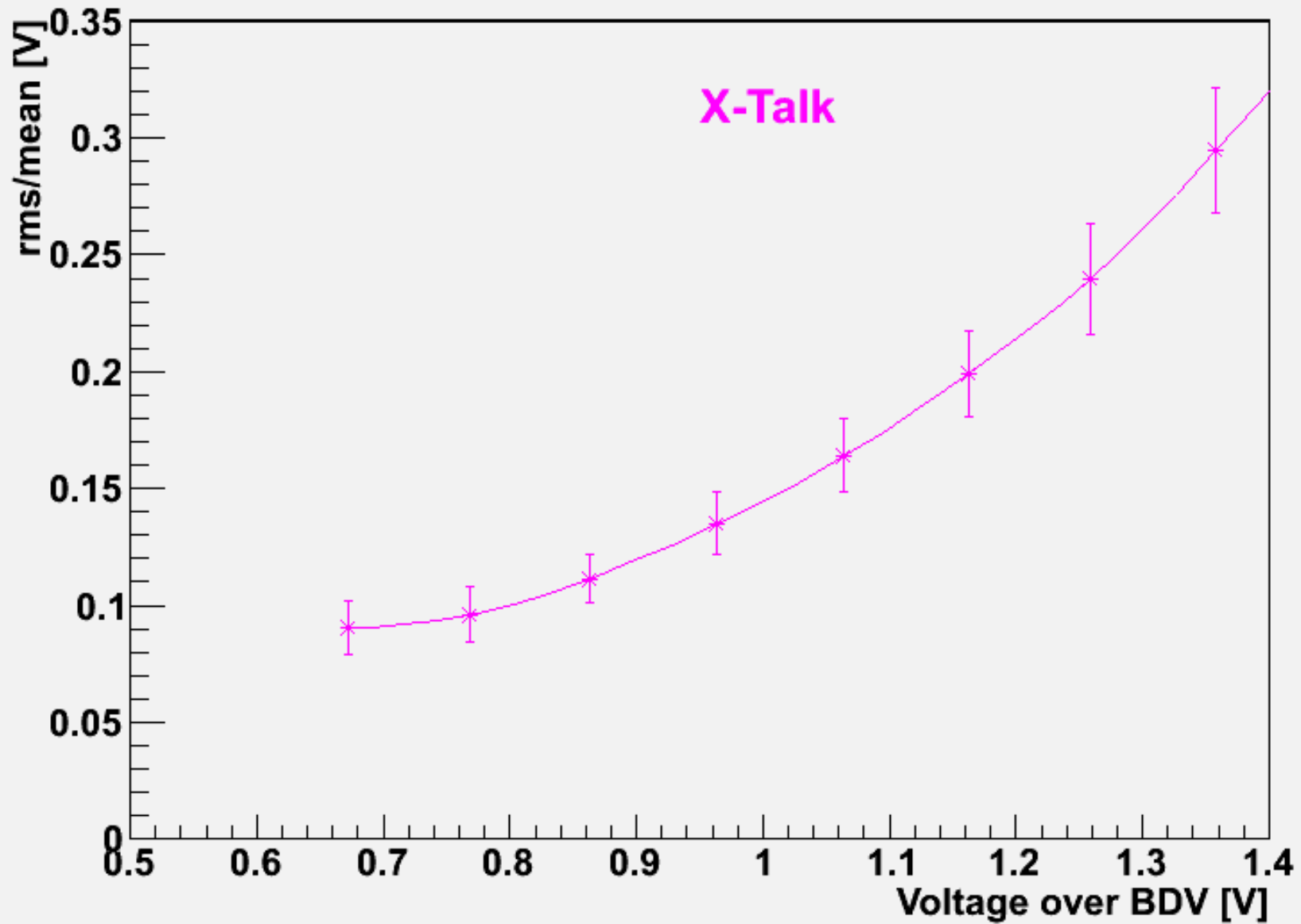
2198_T07



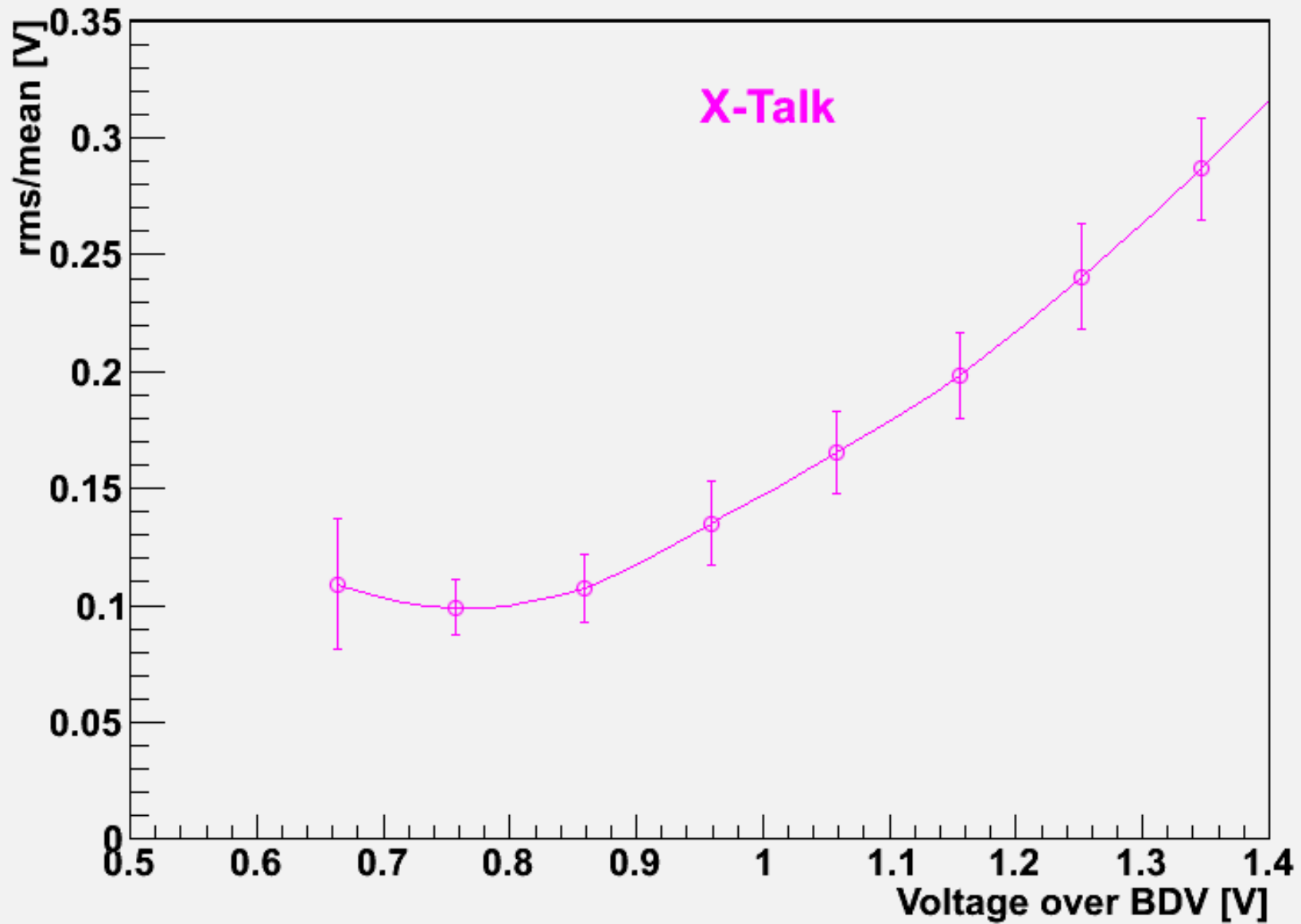
2198_T20



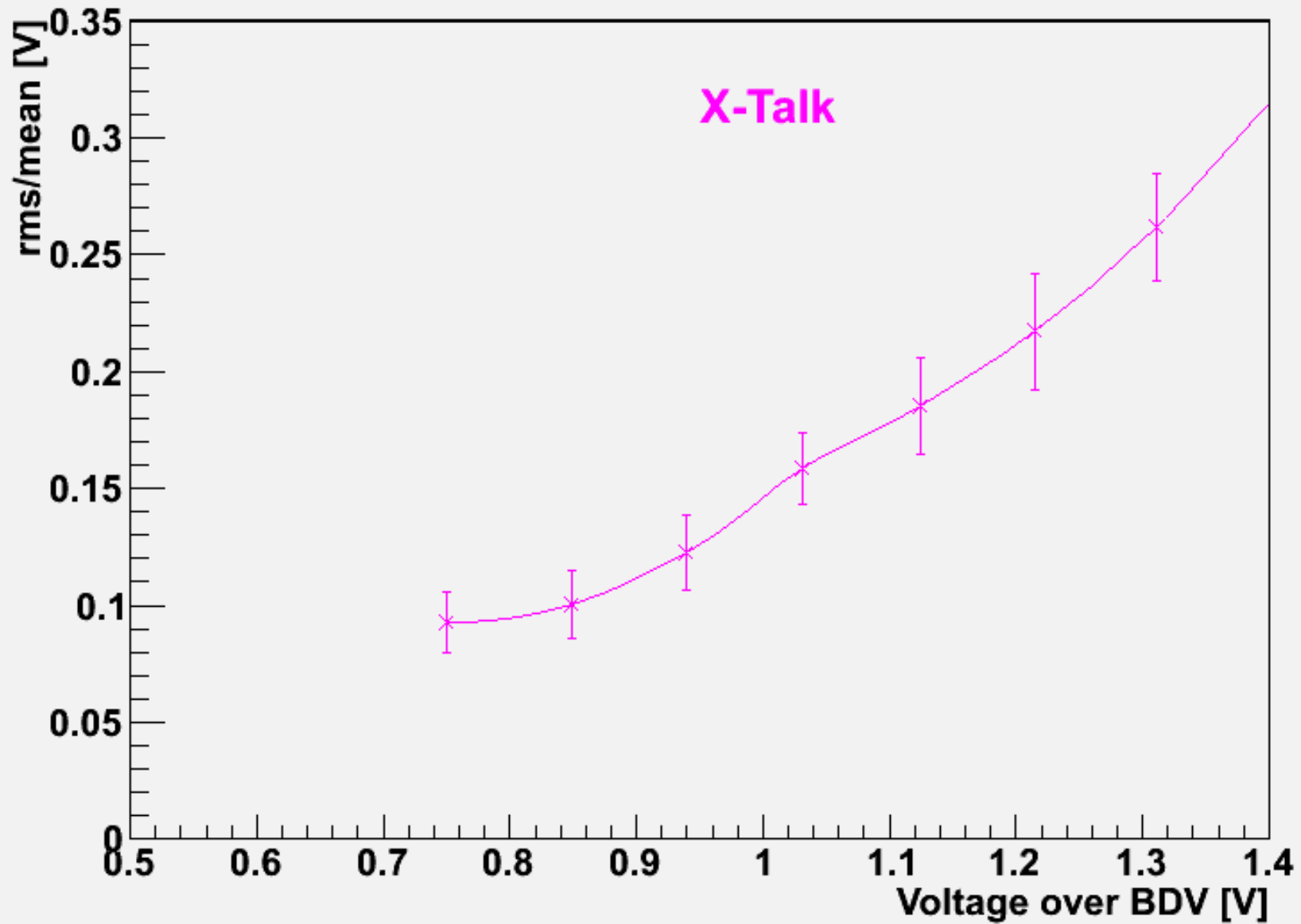
2247_T05



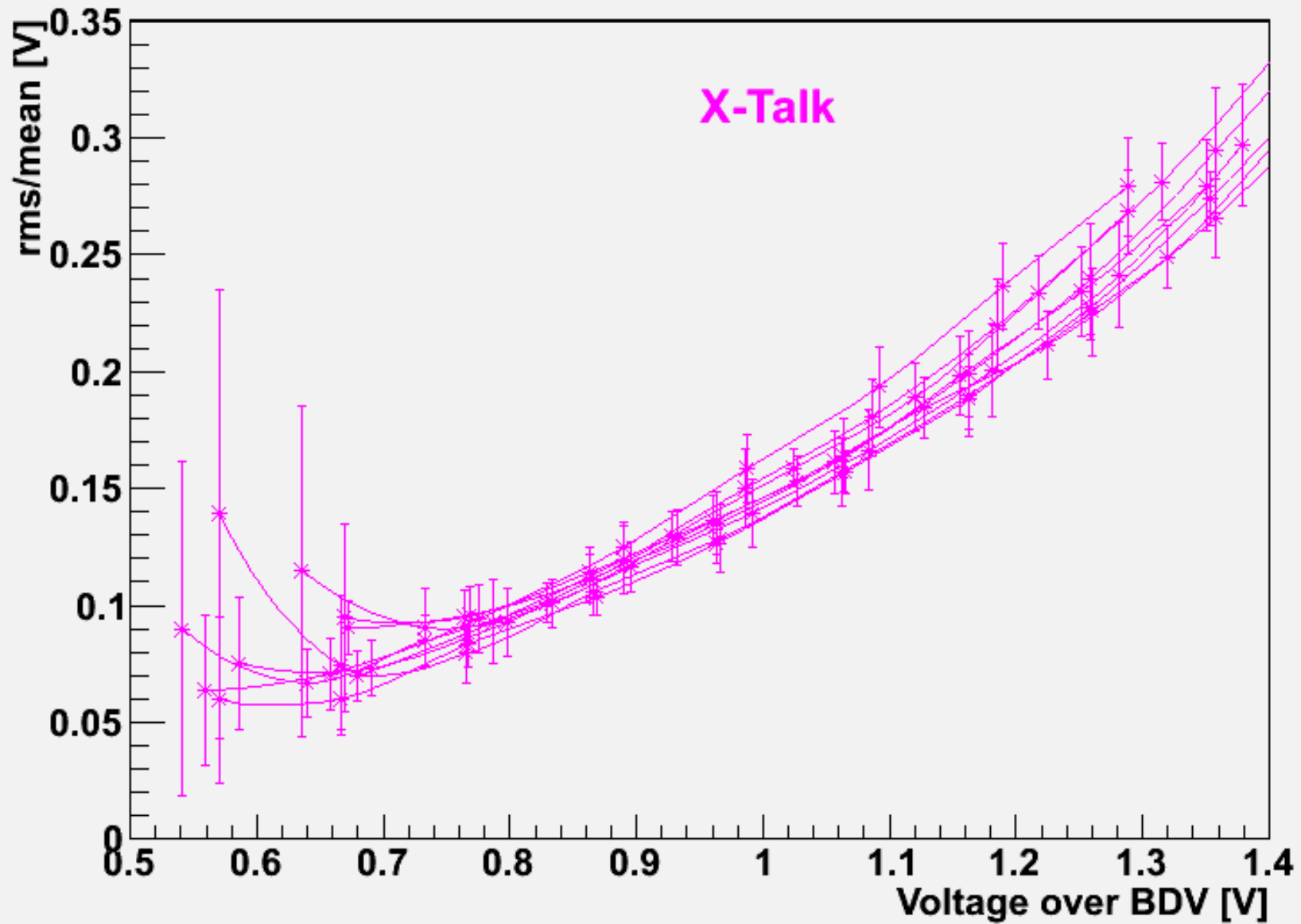
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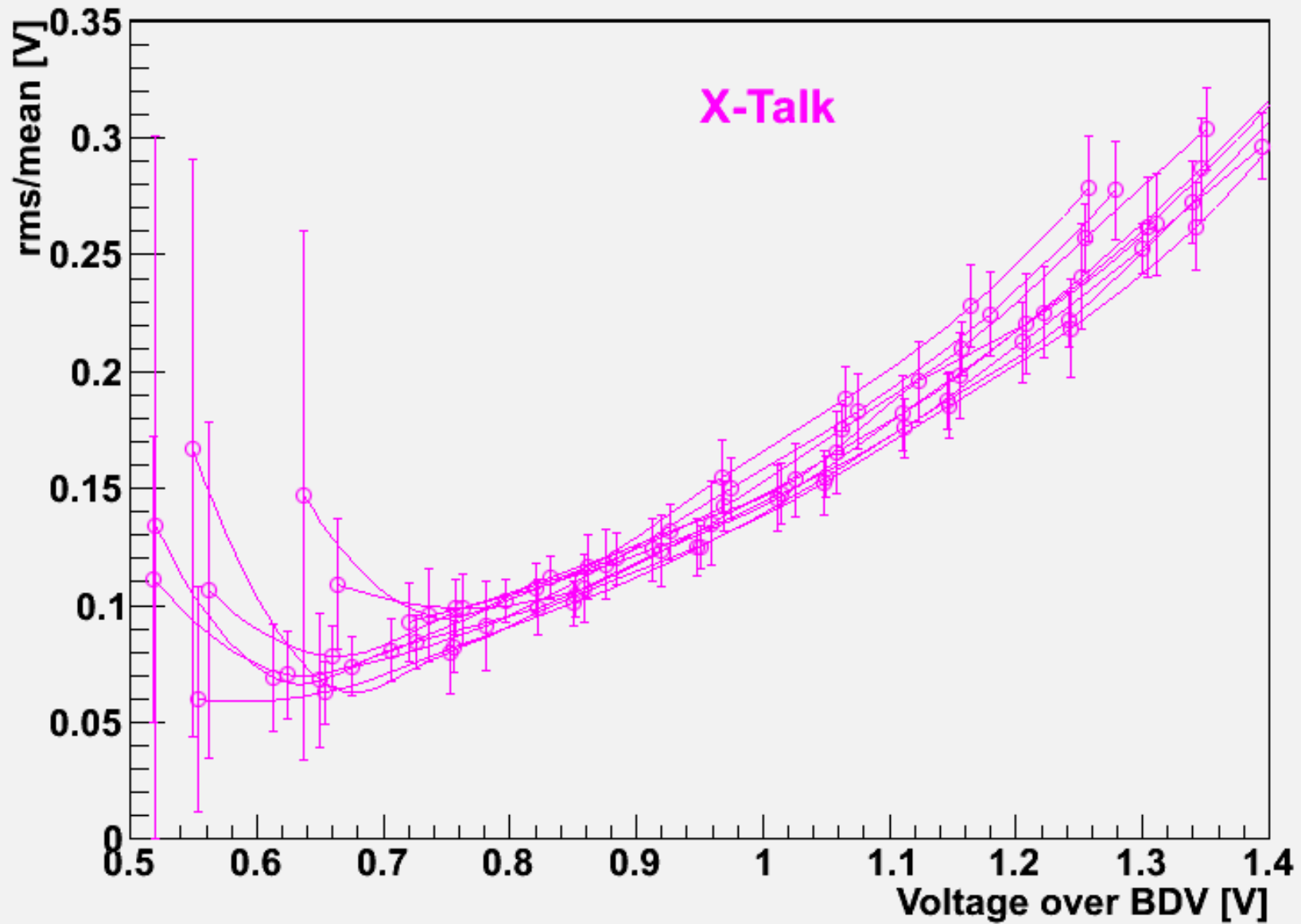
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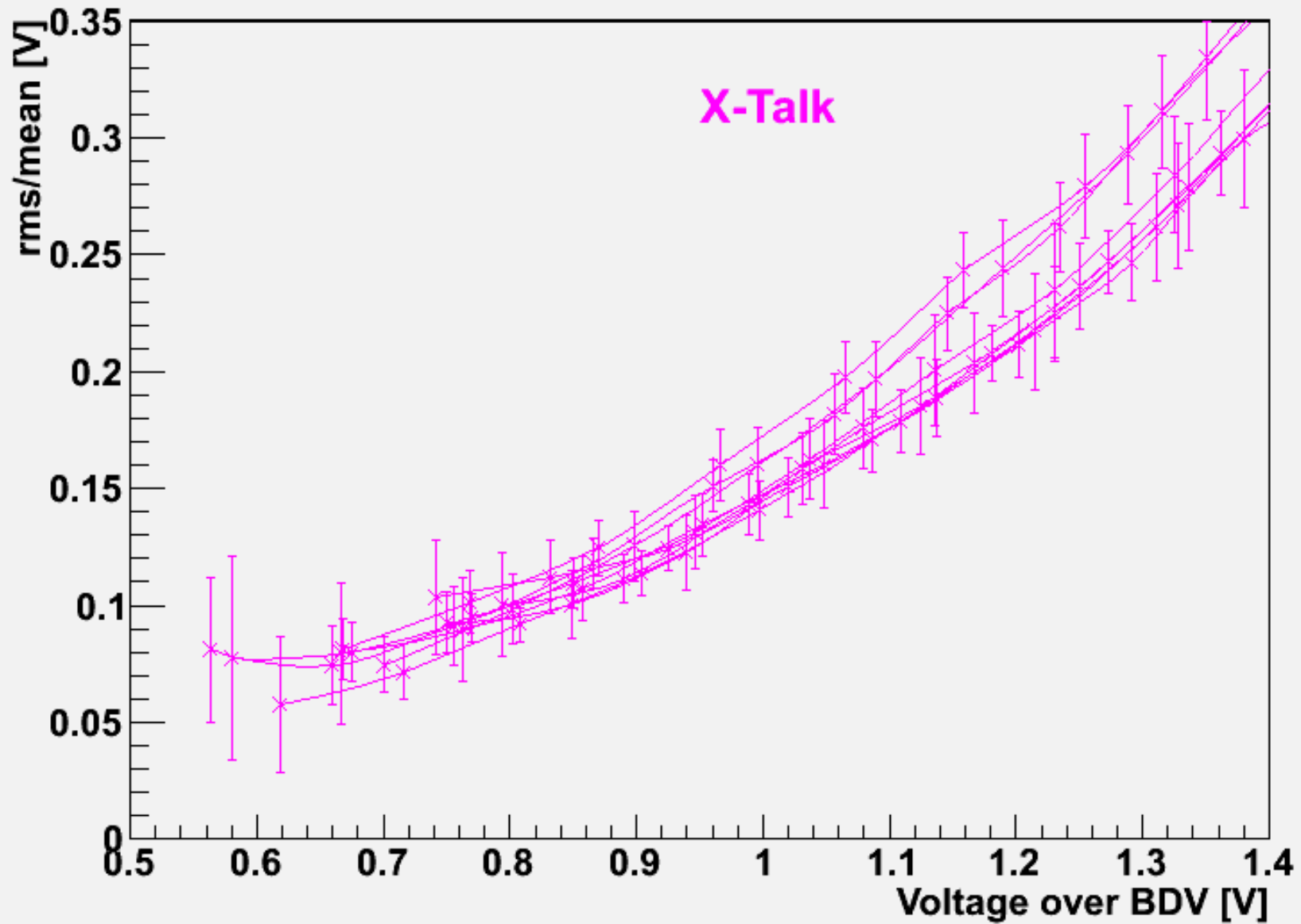
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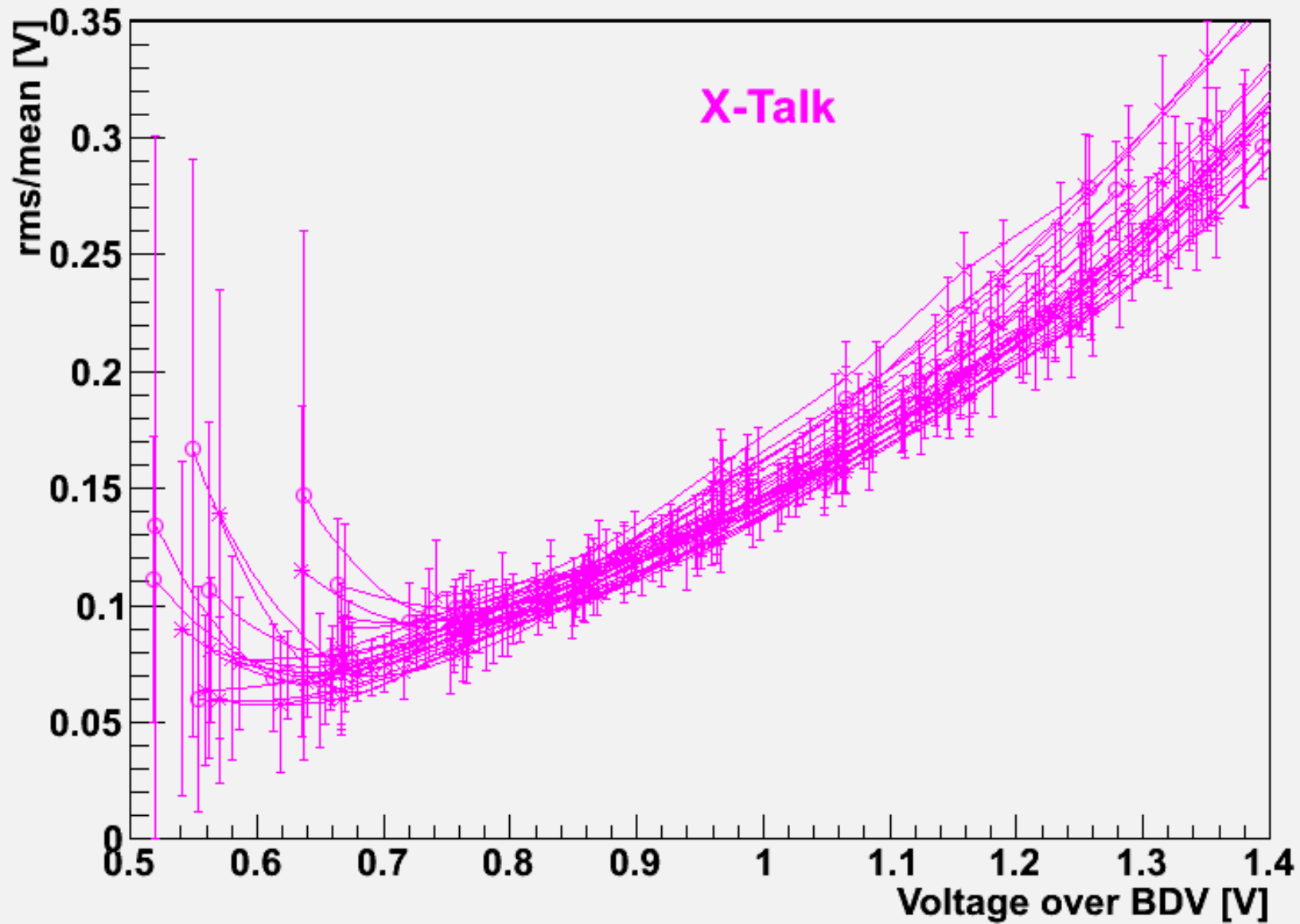
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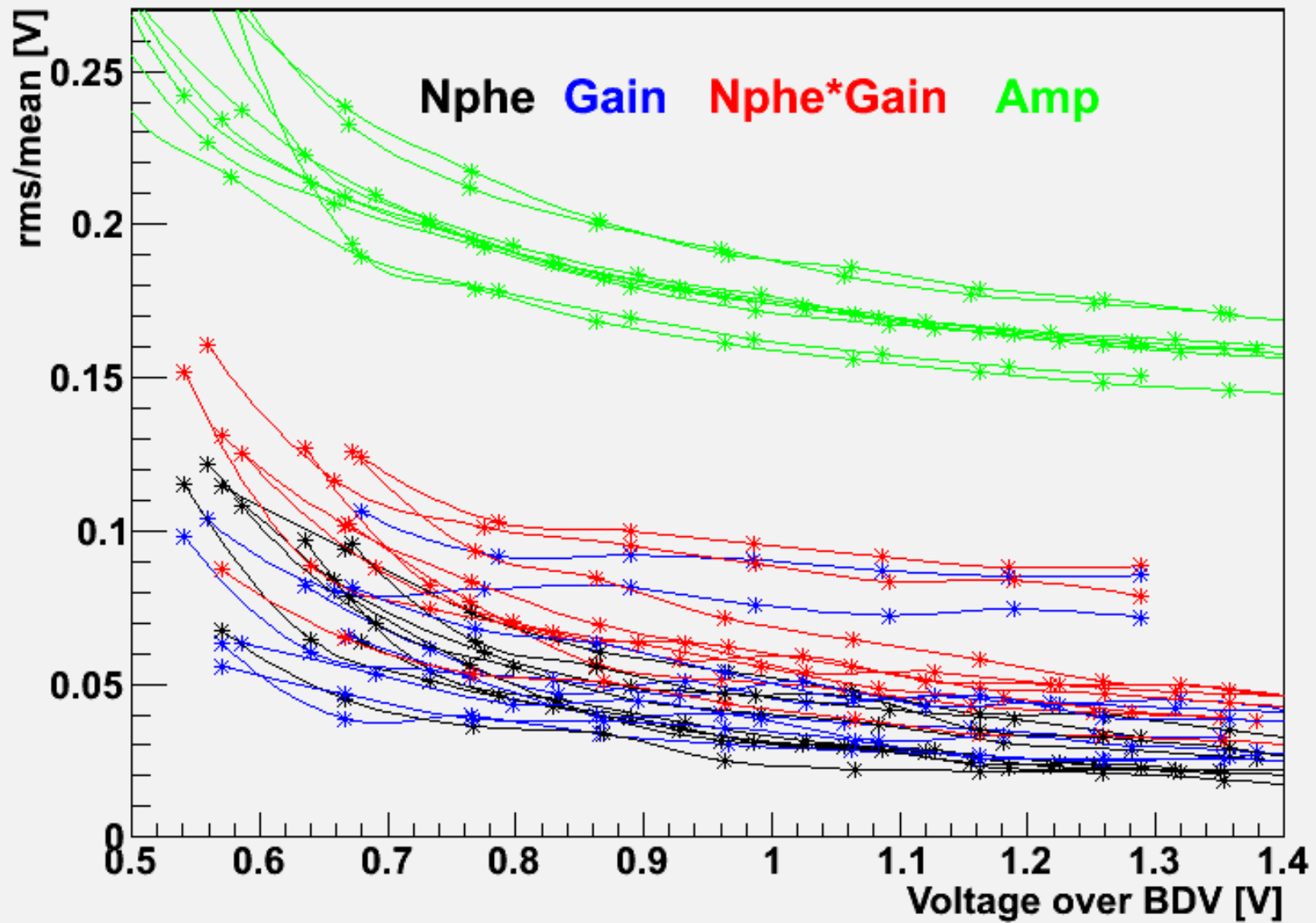
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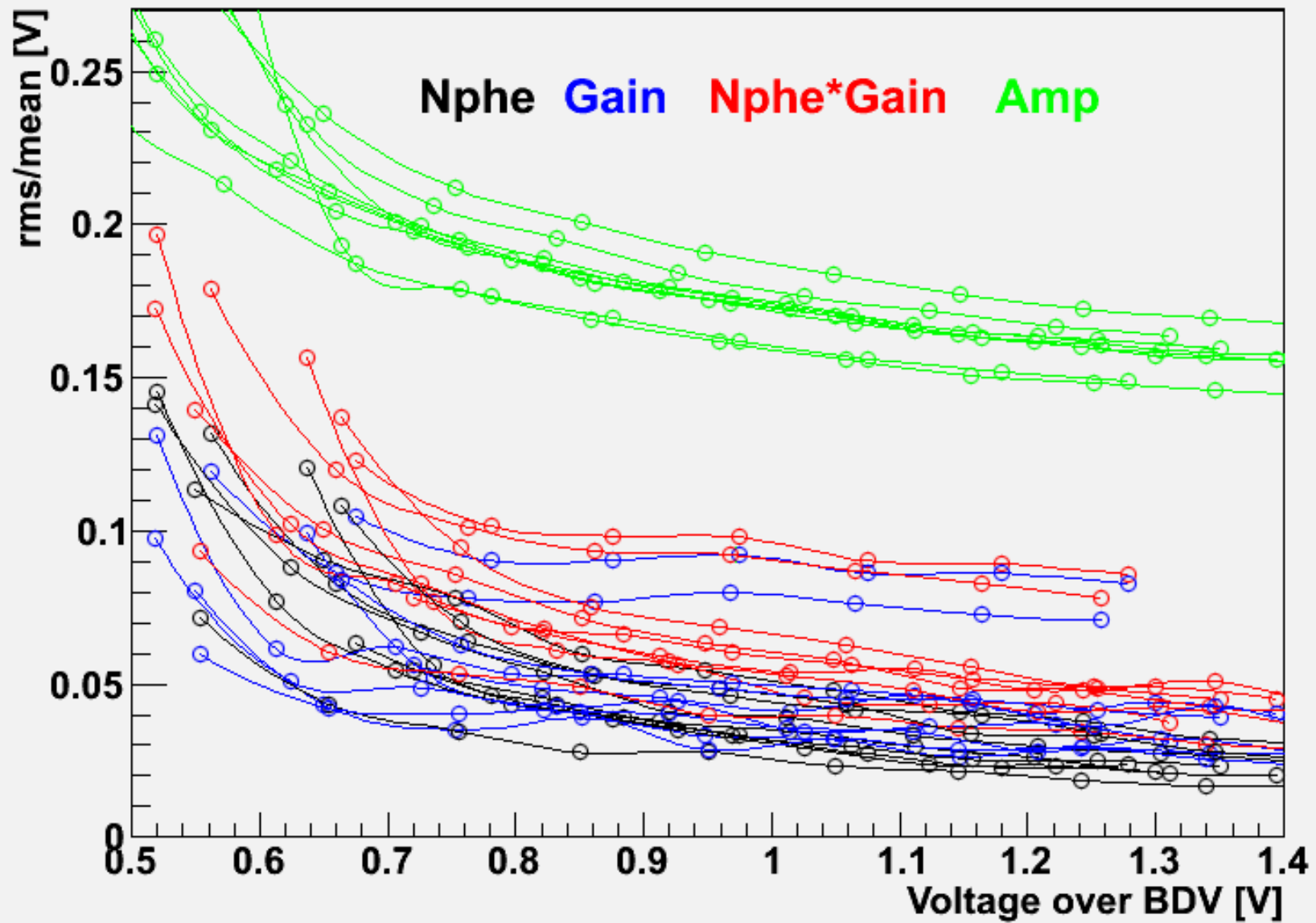
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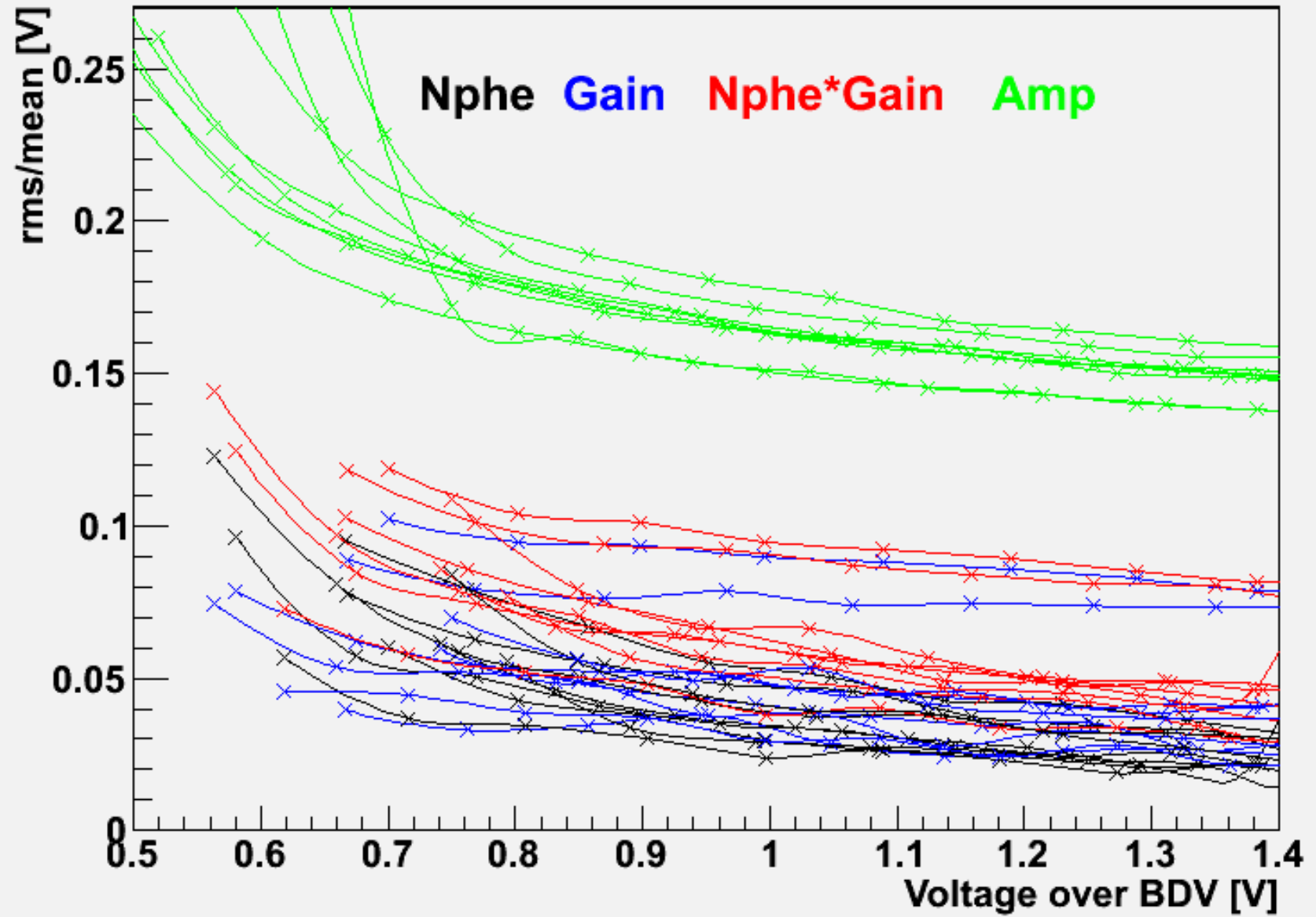
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2044_T07



2044_T20



2044_T05

