A study of the integrated luminosity dependence of the F_L and F_2 measurement in e+Au collisions at eRHIC

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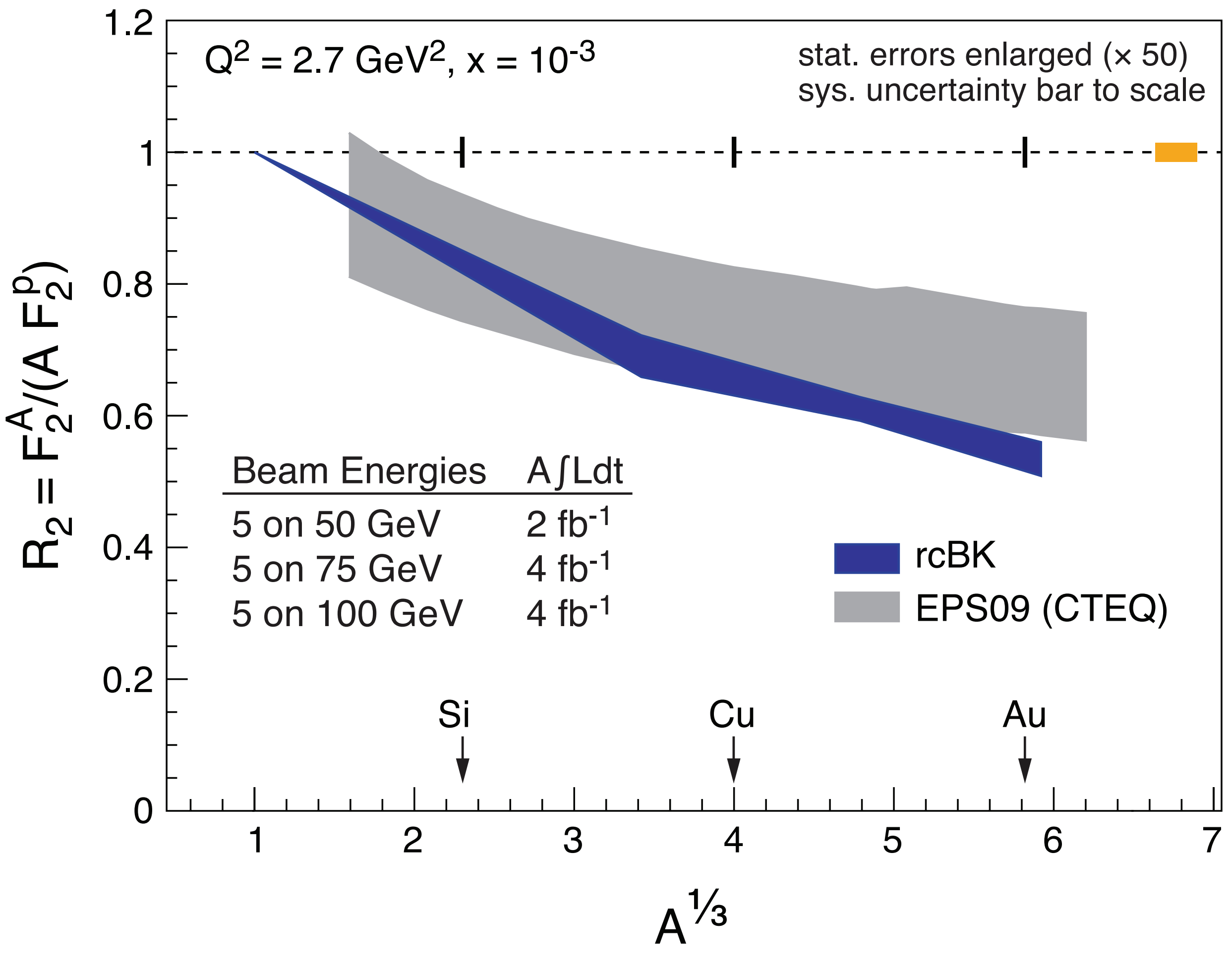
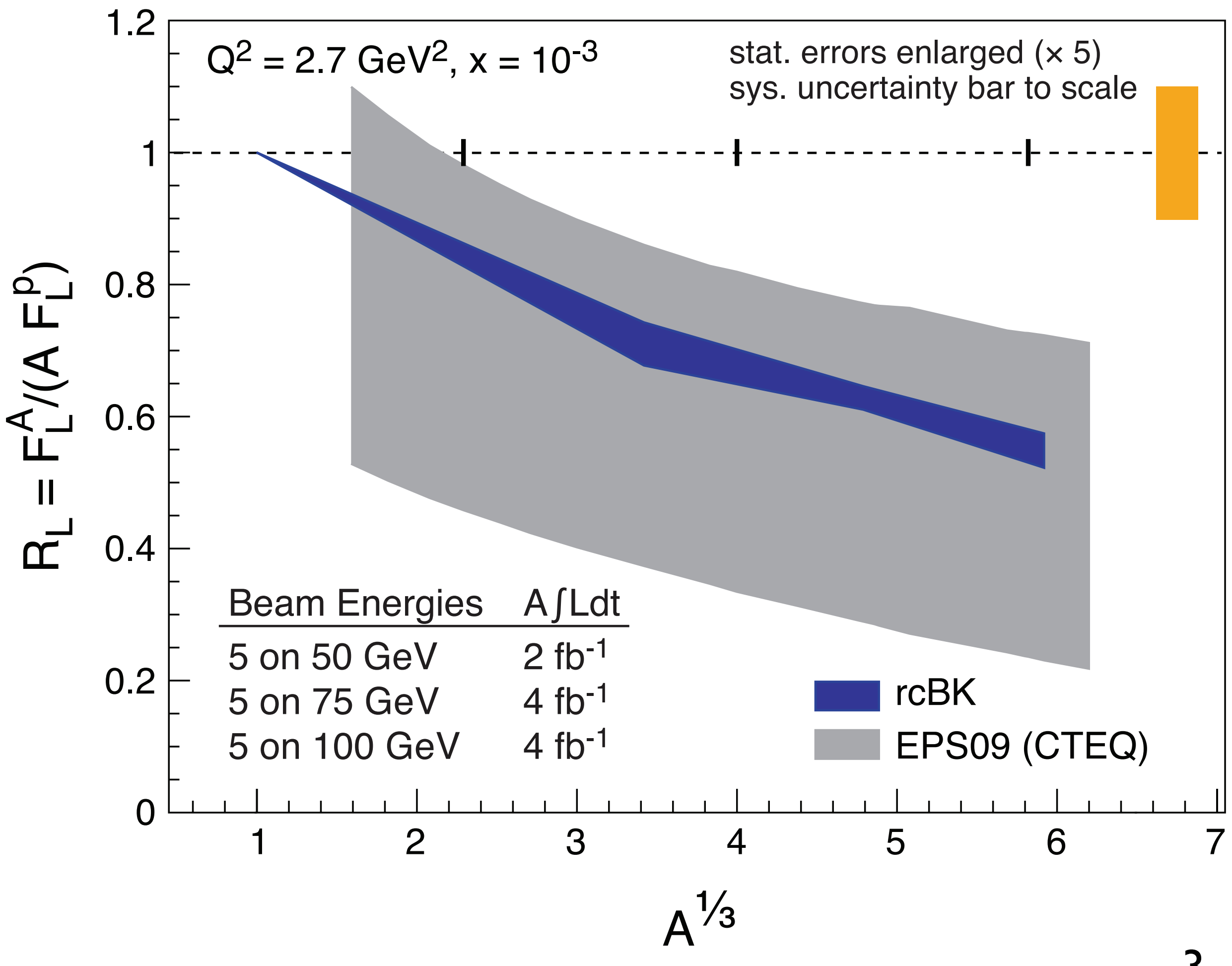
Background to the presentation

- Three different energies run for each stage
    - ➡ 5(20)x50
    - ➡ 5(20)x75
    - ➡ 5(20)x100
- The total integrated luminosity is divided 20/40/40 amongst the energies due to running time.
    - ➡ i.e. 10 fb^{-1}
        - 5(20)x50: 2 fb^{-1}
        - 5(20)x75: 4 fb^{-1}
        - 5(20)x100: fb^{-1}
- This of course could be changed but I don’t think it would have a large effect on the conclusions
- Where systematic errors are included, a 3% uncertainty is added in quadrature with the statistical uncertainty

White paper plot:

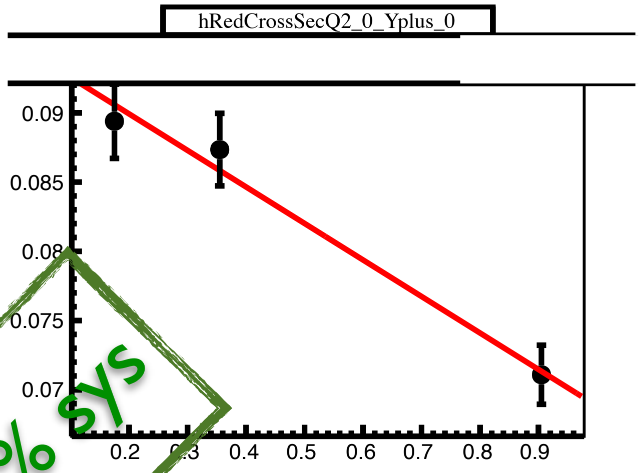
- Ratio of $F_2(F_L)$ in A to $F_2(F_L)$ in p.
- No actual values of $F_2(F_L)$ shown here, just error bars.
- Stat errors are tiny (scaled to be made visible), systematic uncertainties are to scale

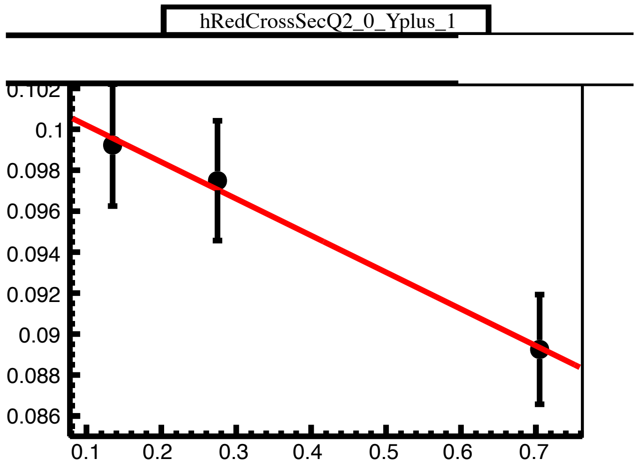


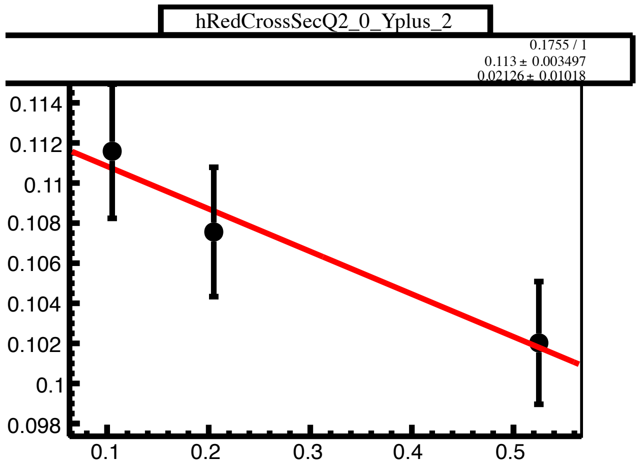


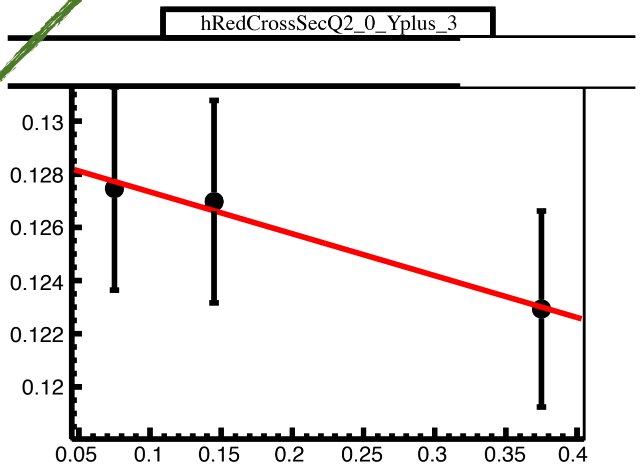
Reduced Cross-sections: $A\int L\,dt = 10\ \text{fb}^{-1}$

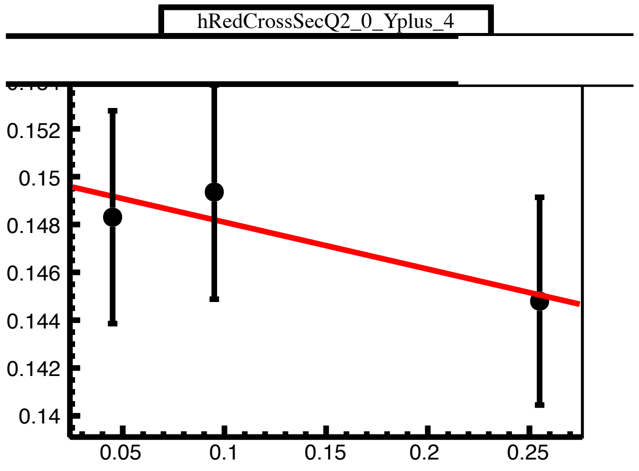
stat + 3% sys

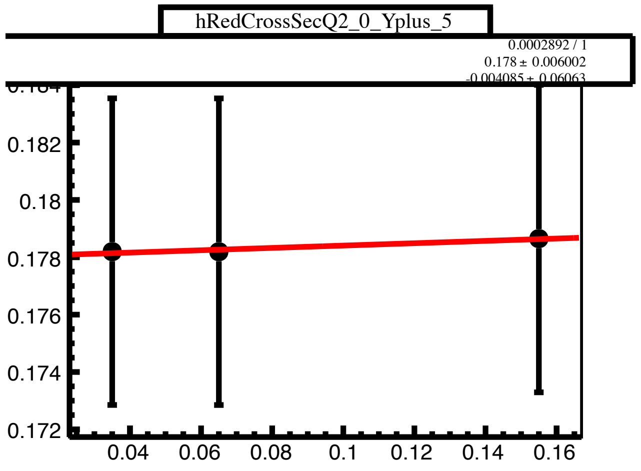


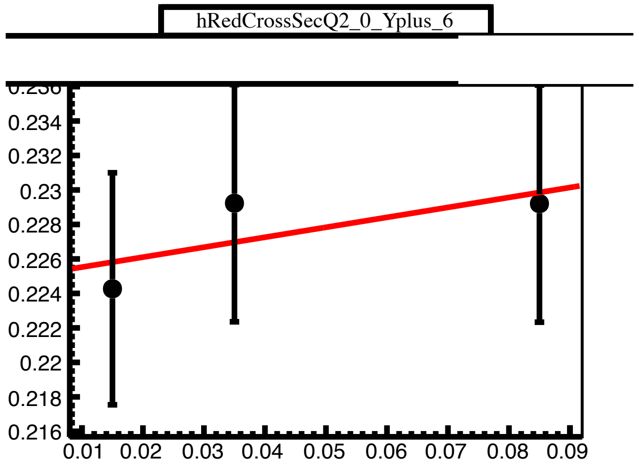


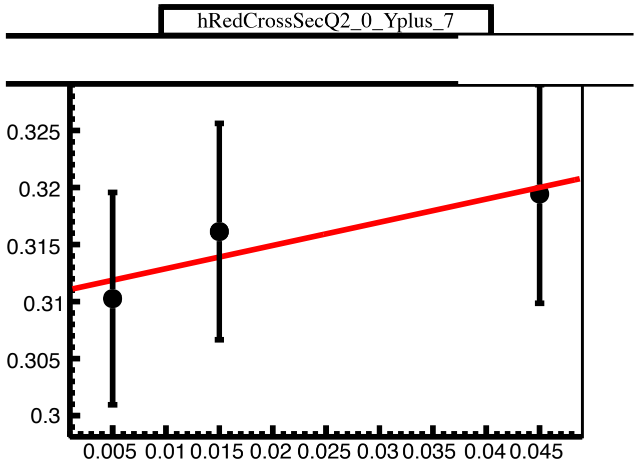


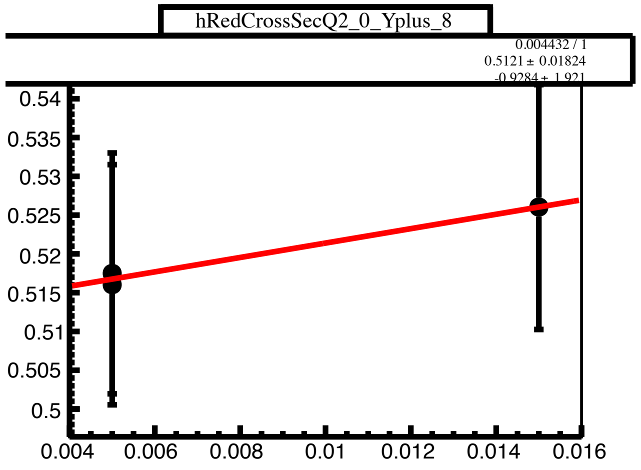












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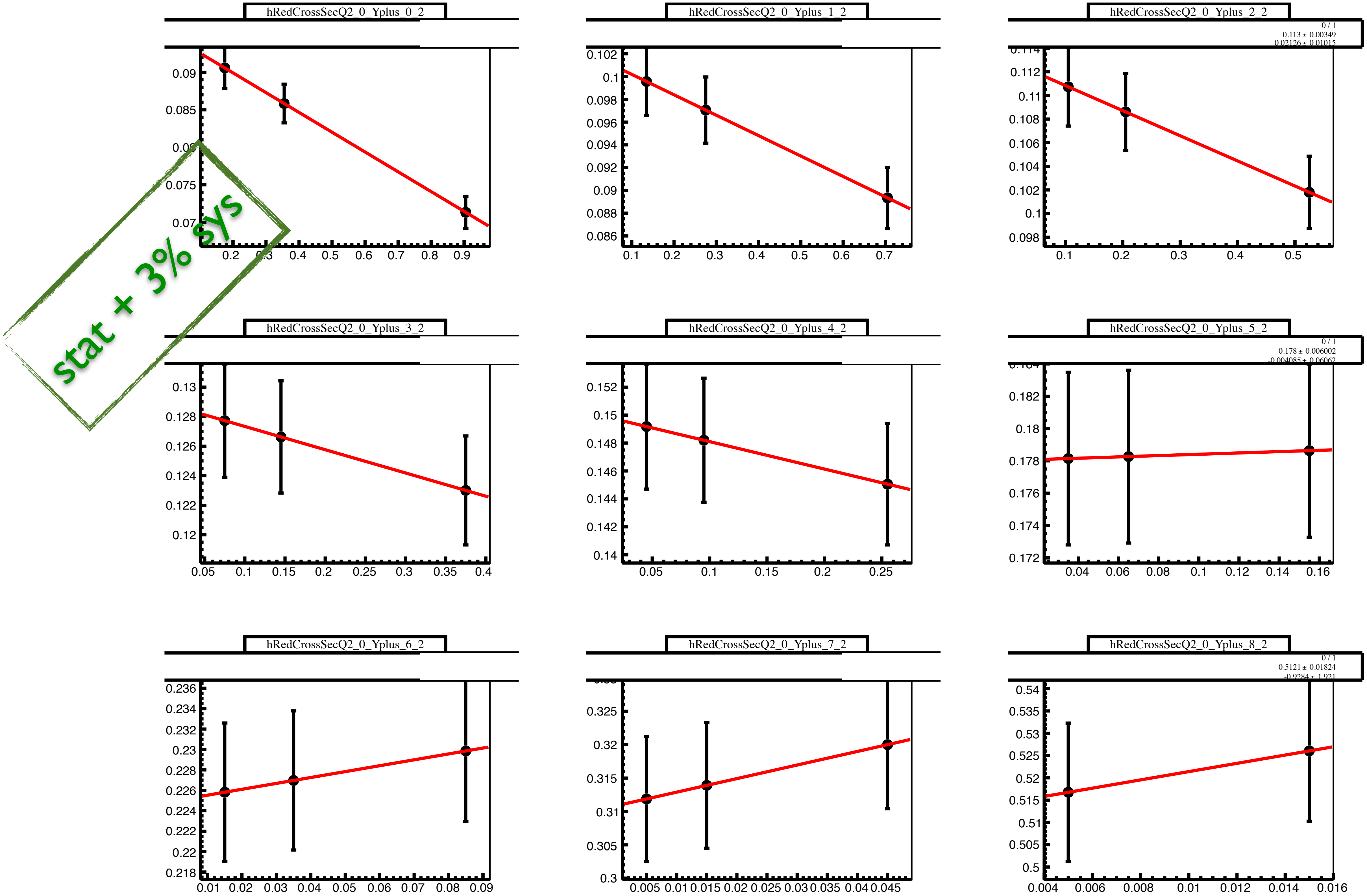
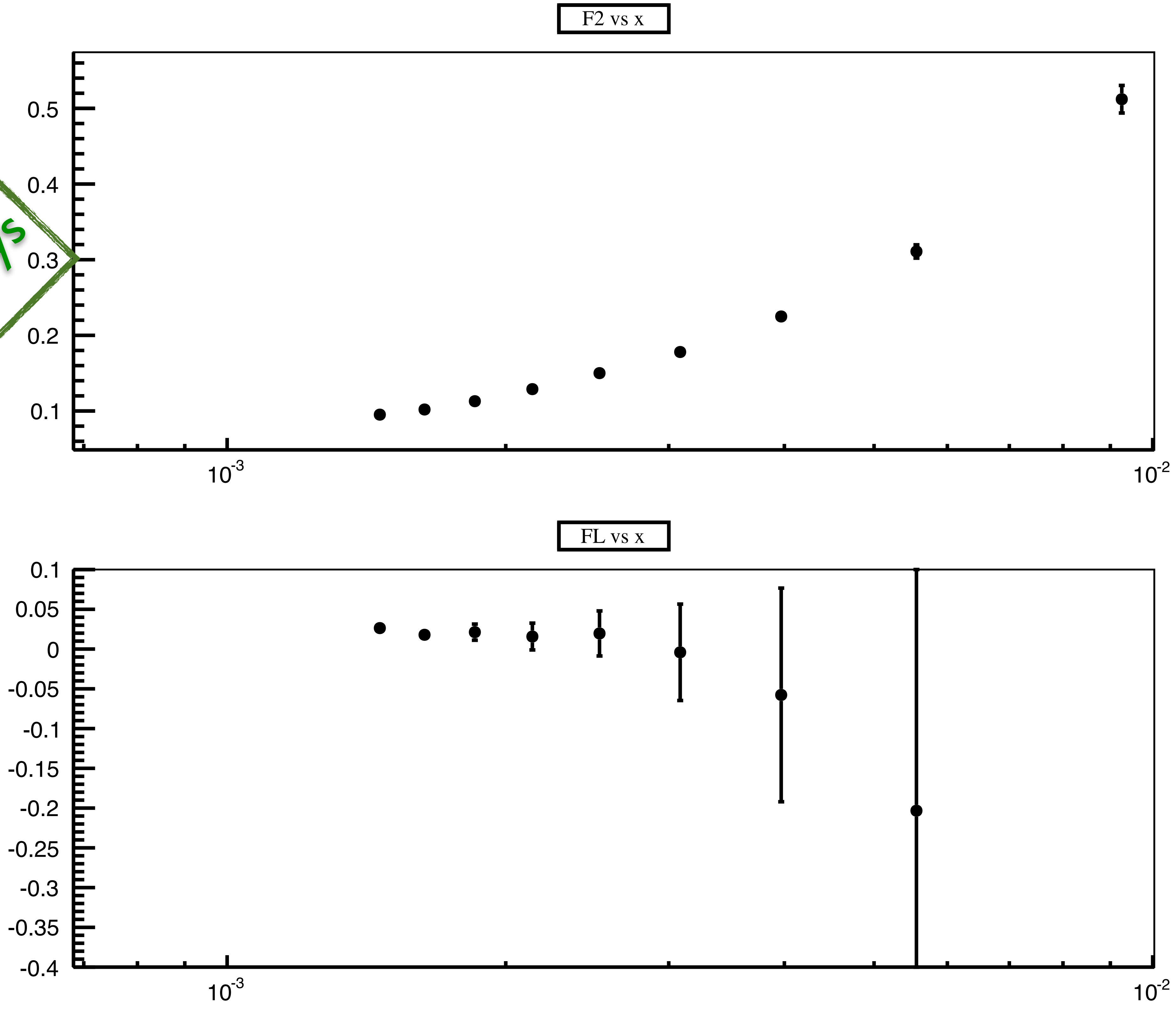


stat + 3% sys

Extracted F_2 and F_L: $A\int L\,dt = 10\ \mathrm{fb}^{-1}$



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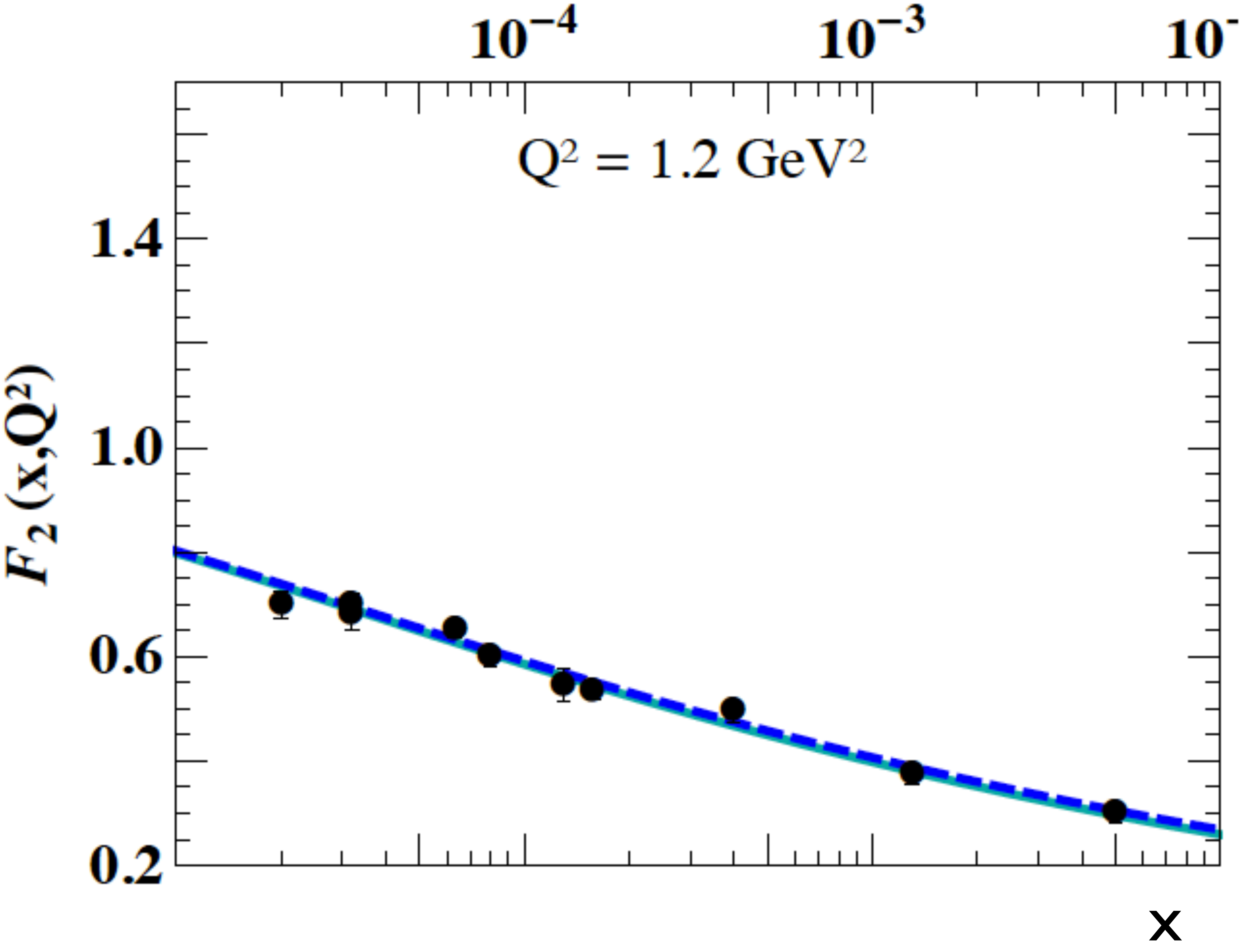
HERA data on F_2:



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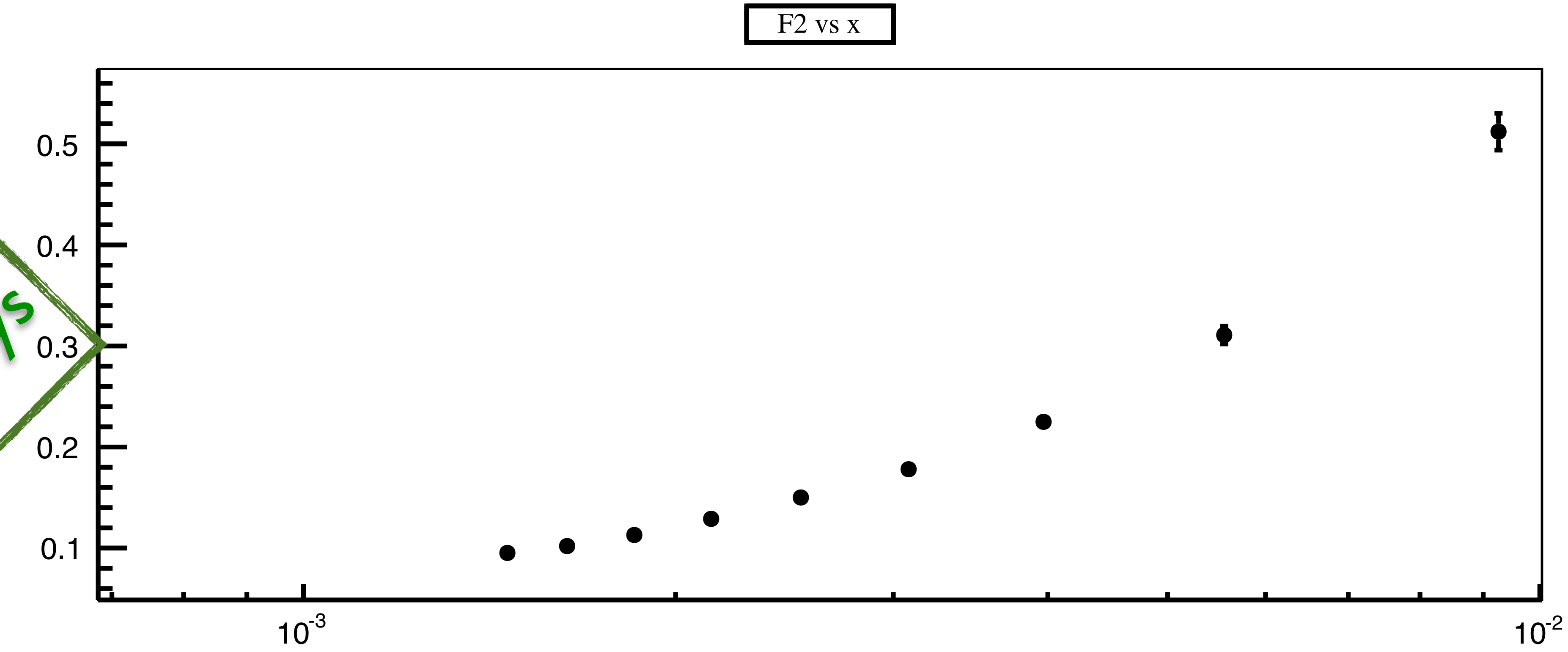

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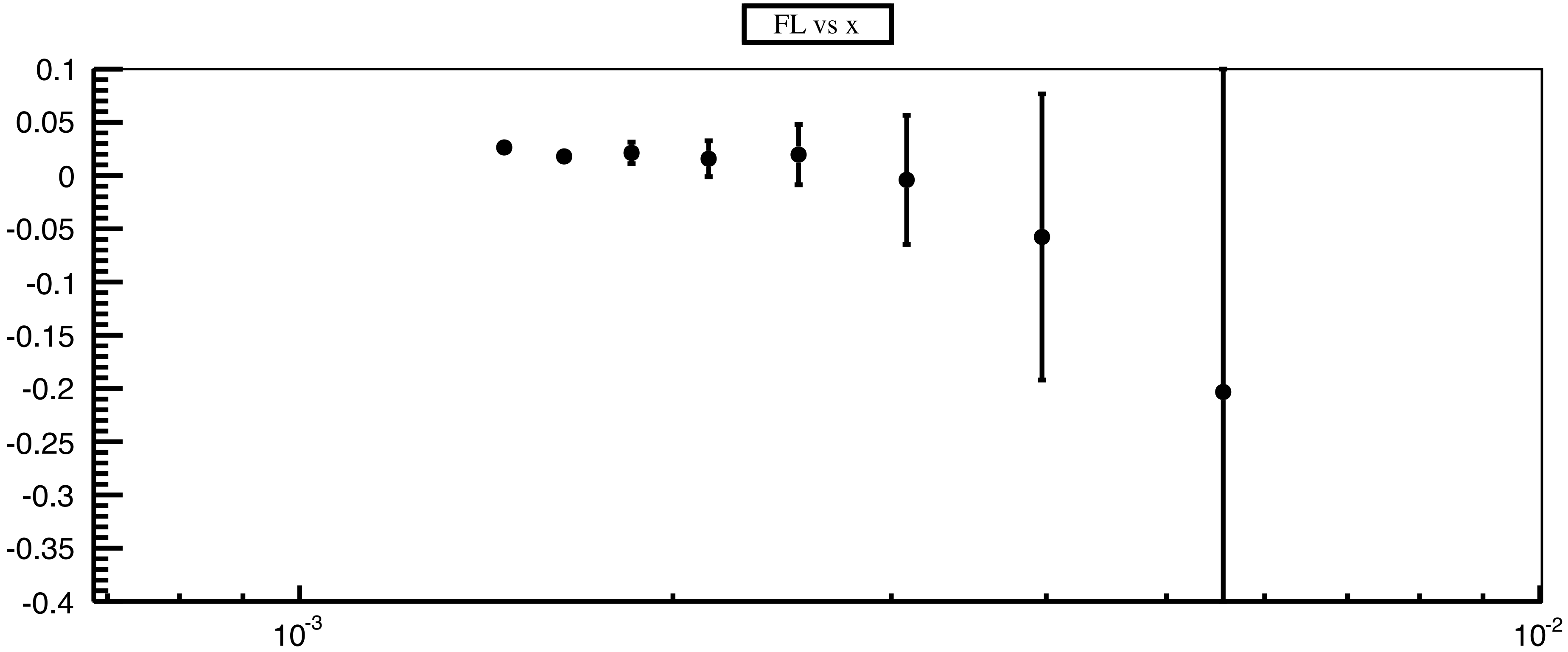

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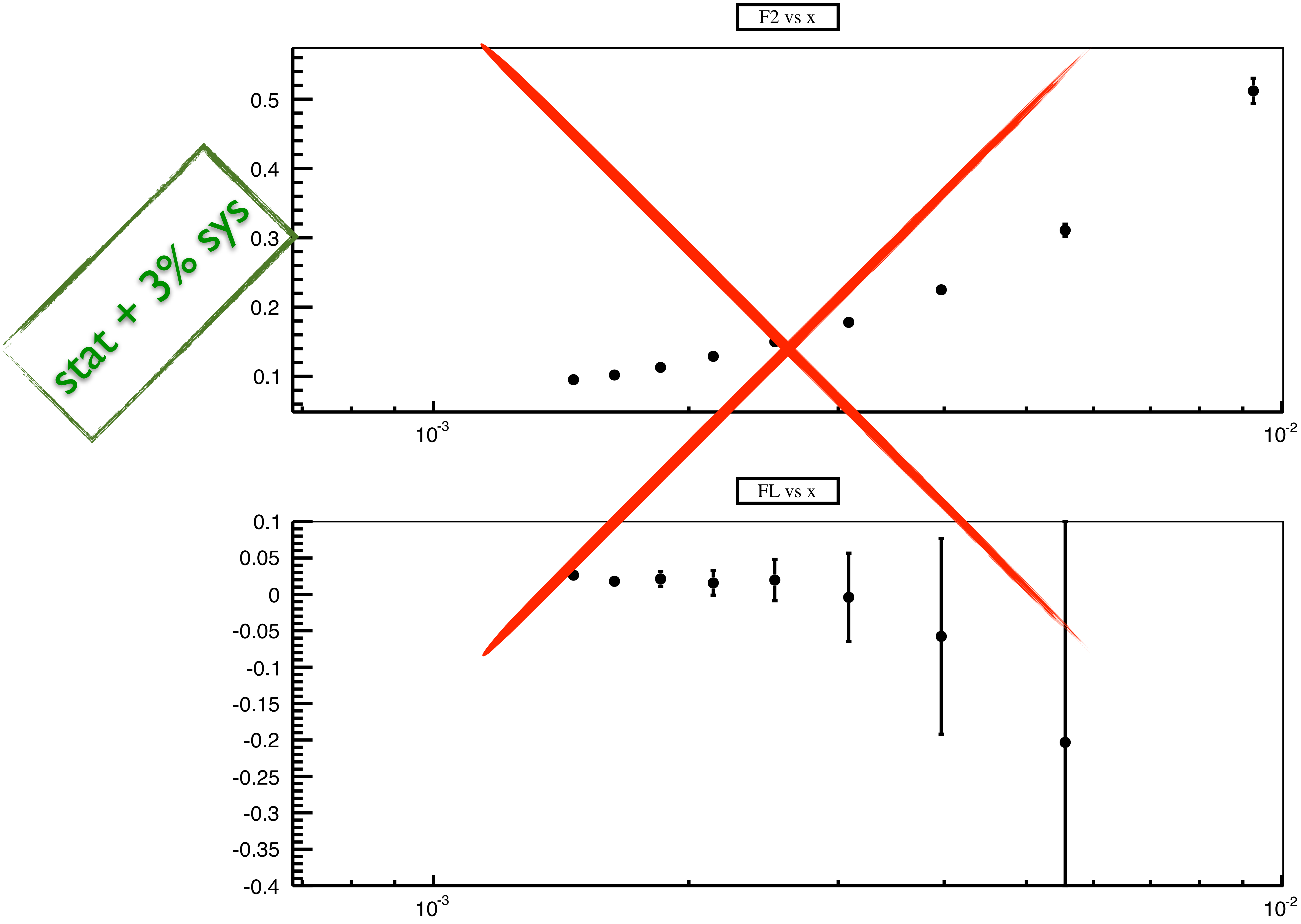

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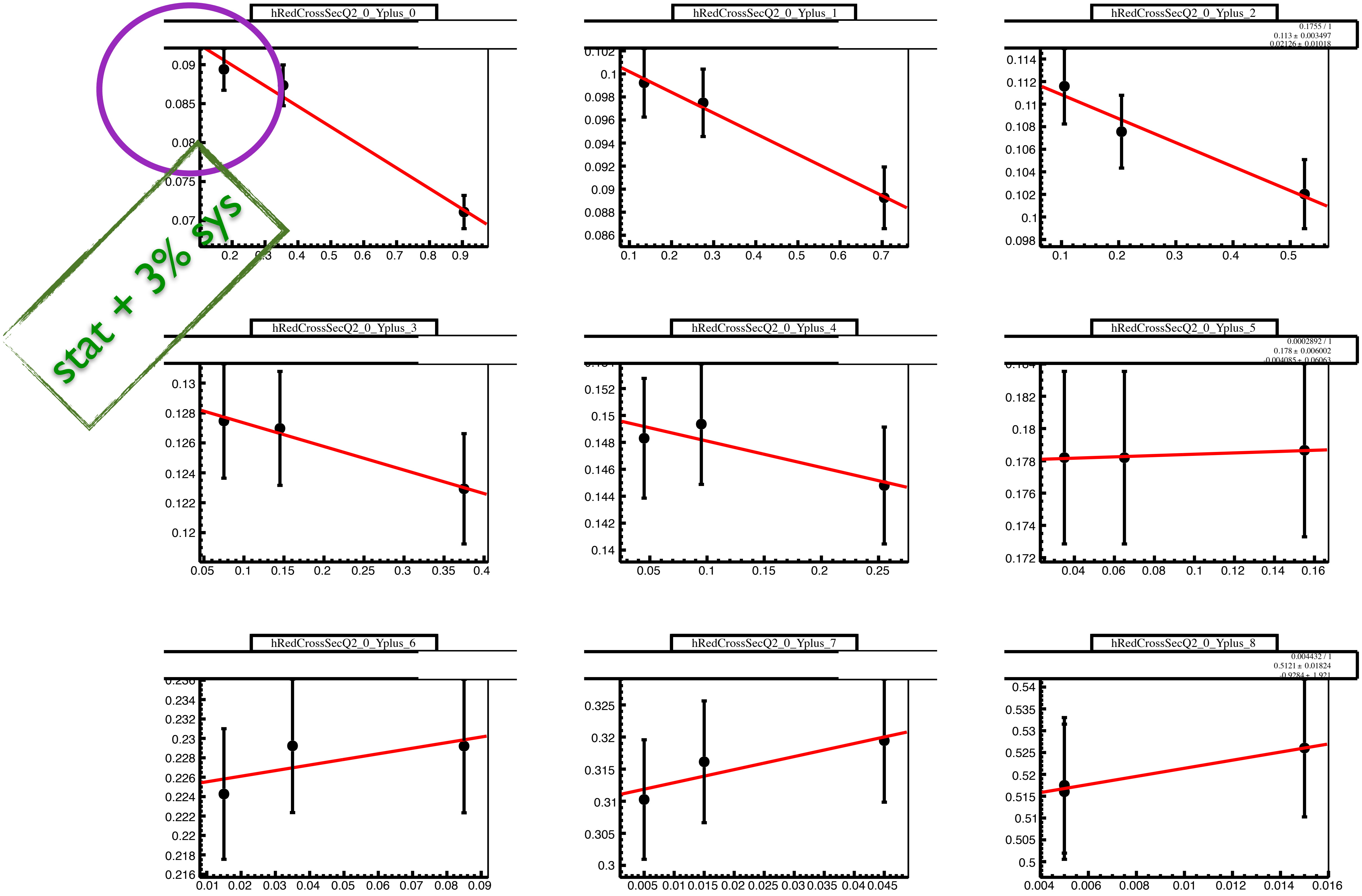

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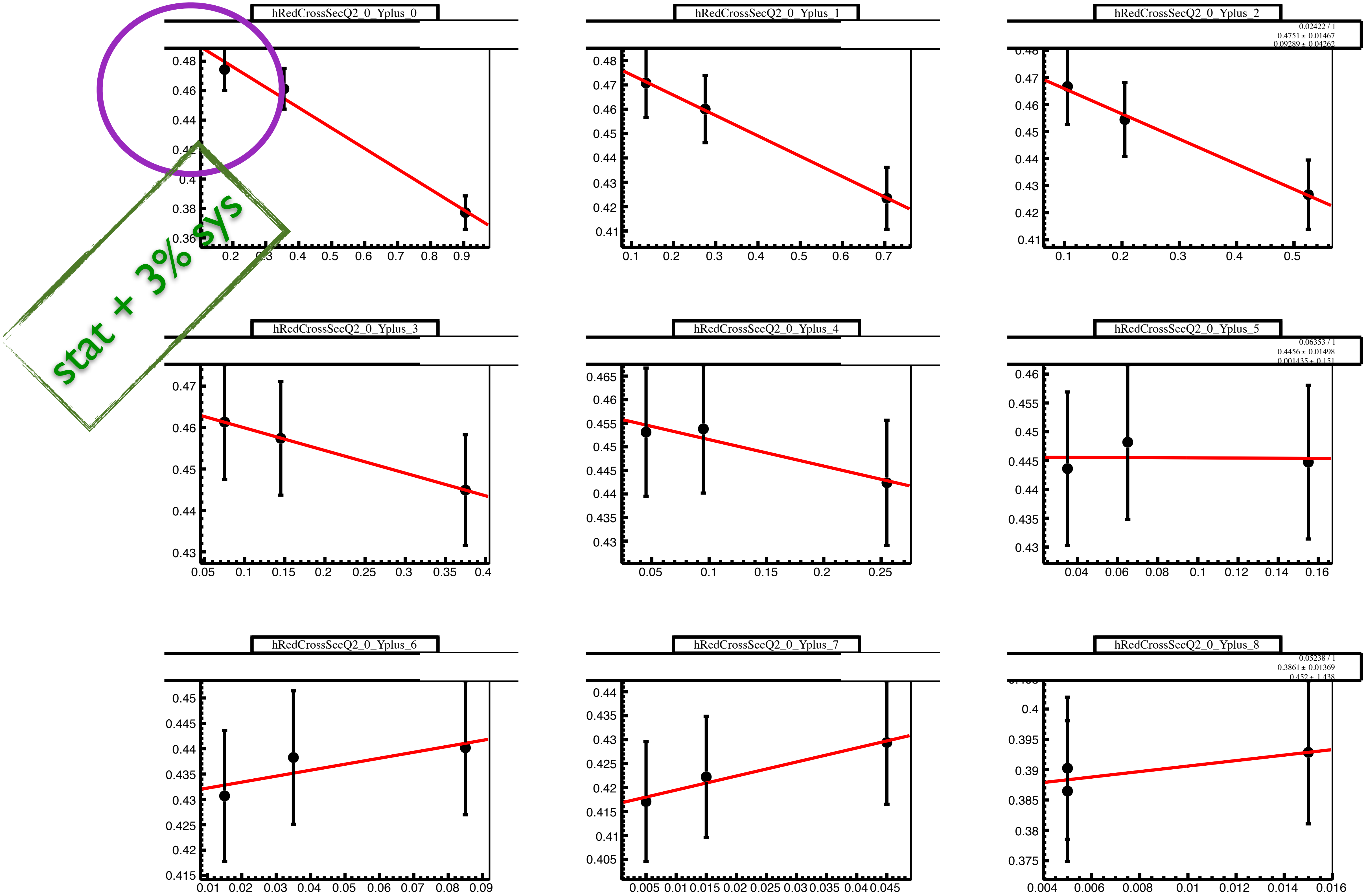

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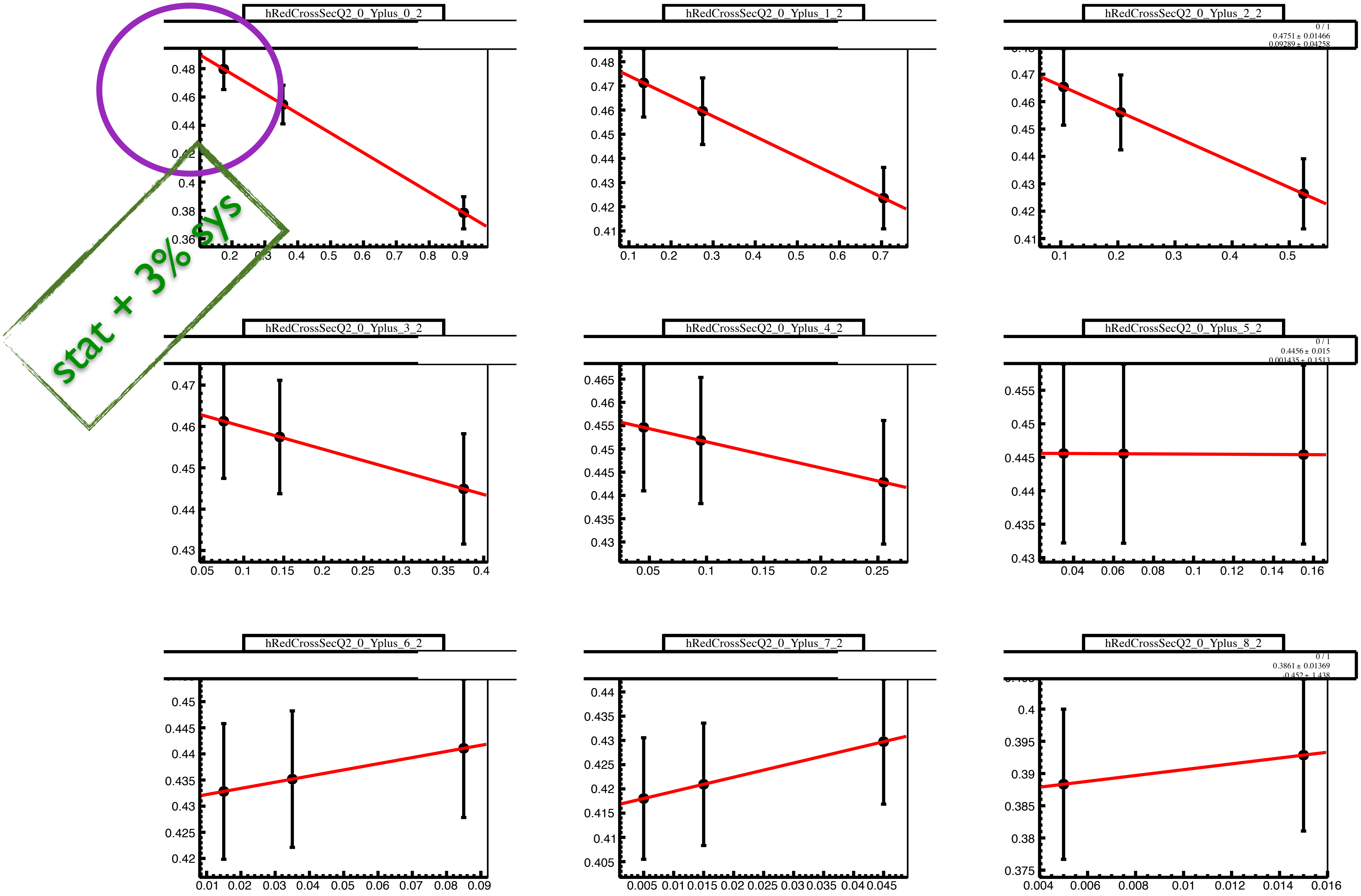

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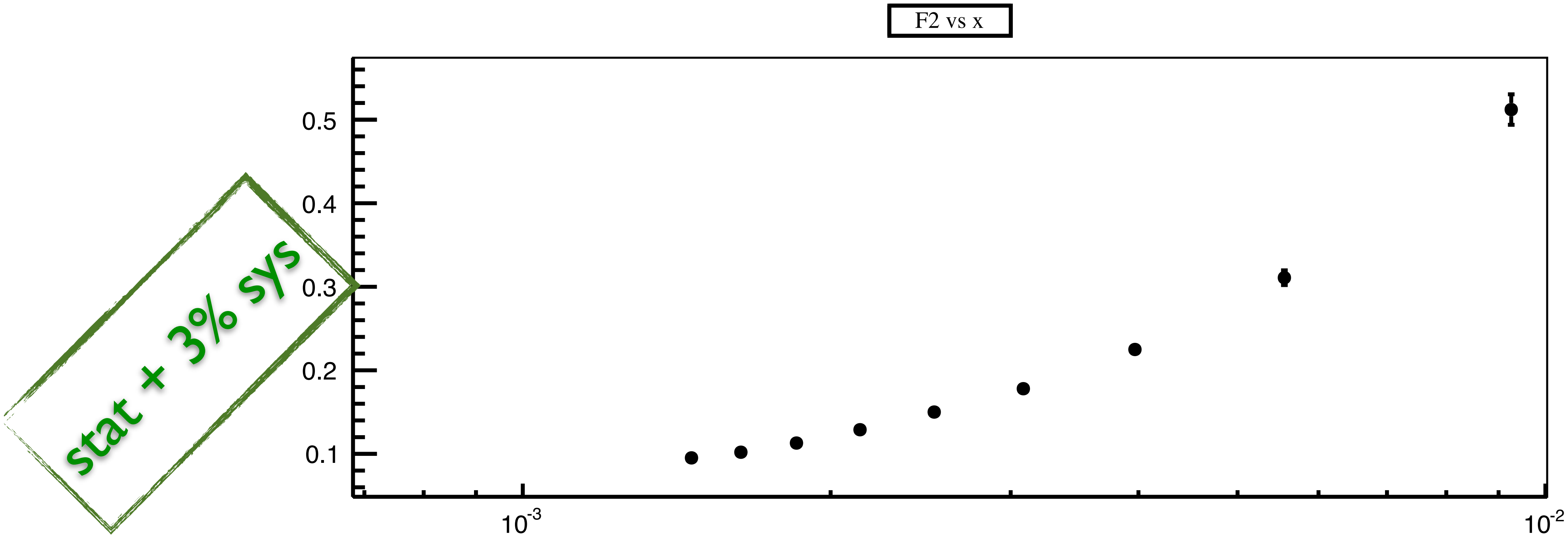
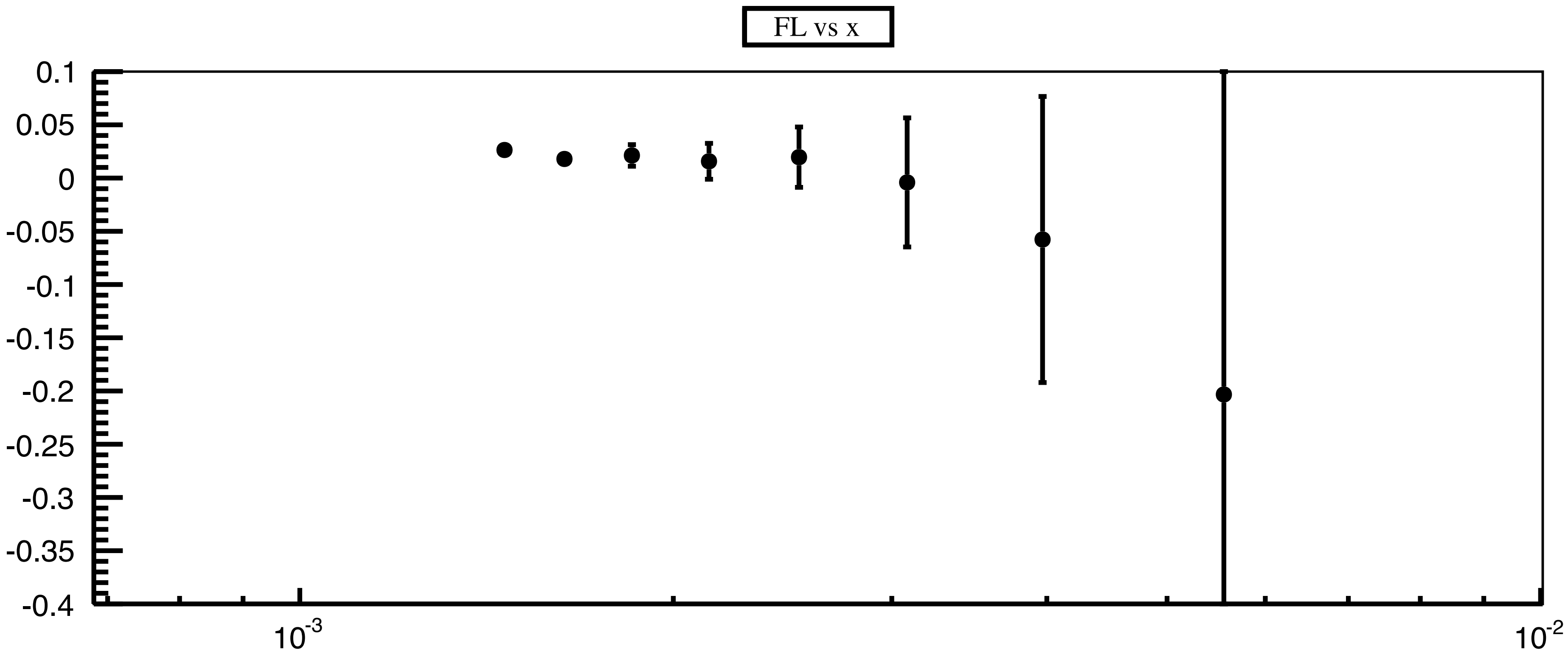

F2 vs x

stat + 3% sys


FL vs x

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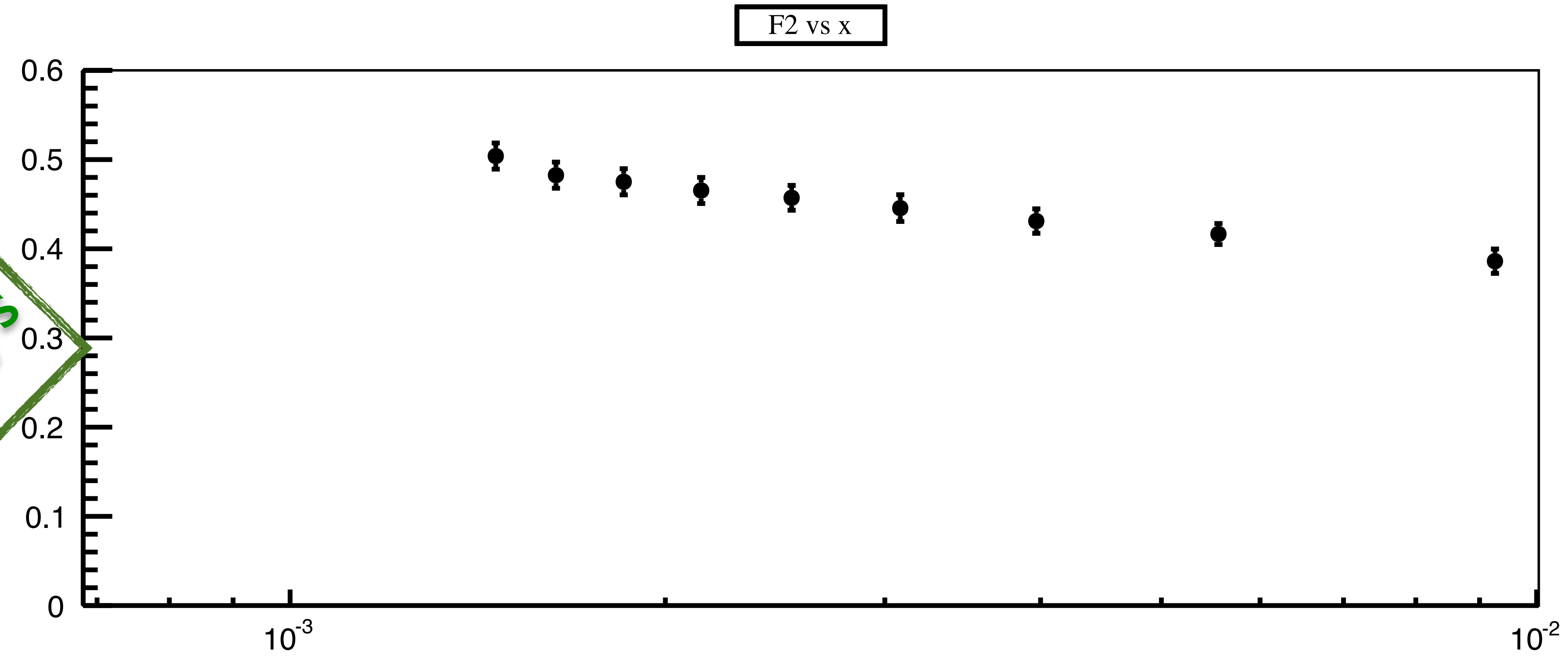

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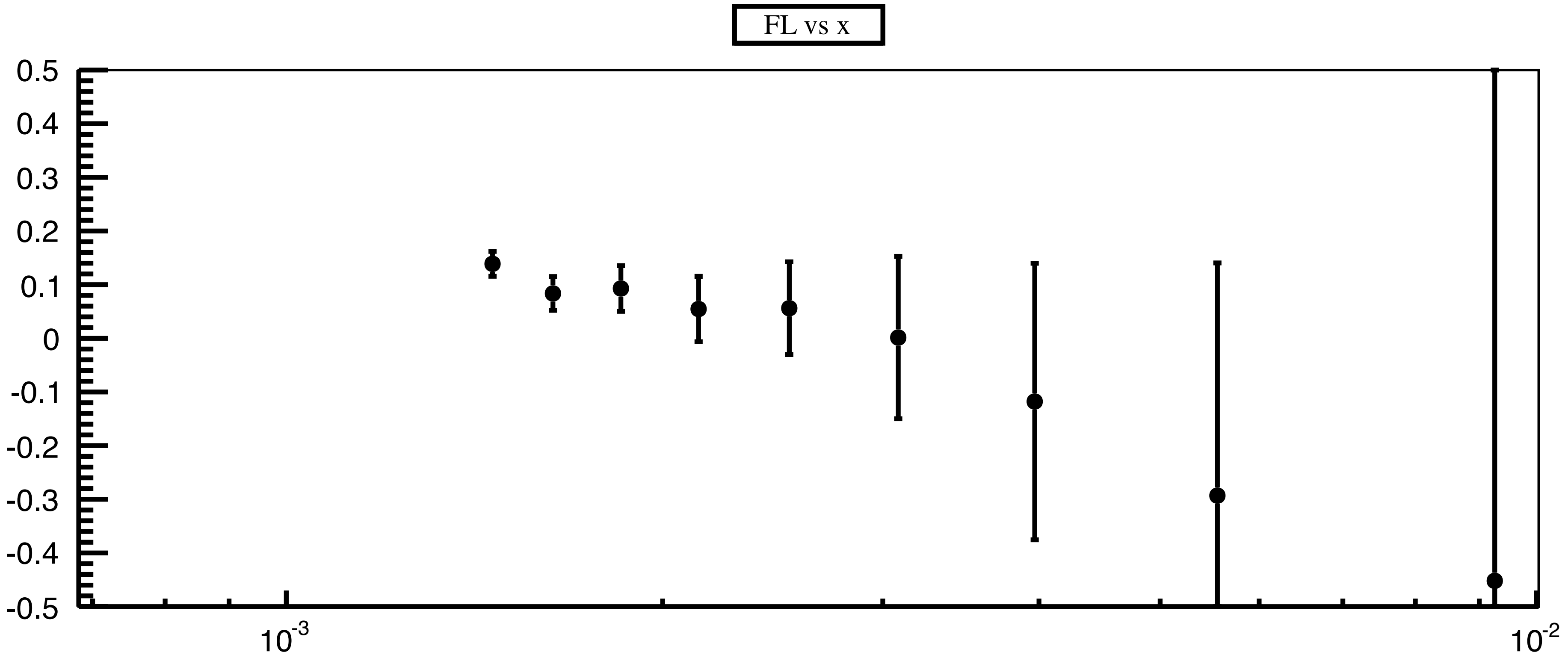


What was wrong?

- Cross-section requires knowledge of “dx”
- I was binning in y and my transform to x had a mistake.
- This mistake was also in the cross-sections that Hannu was fitting but as he was fitting a ratio, these cancel….

- Q) Do we need luminosities of 10^{34}?

- Q) Can we perform F_2 and F_L measurements with integrated luminosities of $< 10\ \mathrm{fb}^{-1}$?
  - ➡ How many bins in F_L can we measure?
  - ➡ How do we do in comparison to HERA's F_L measurement?

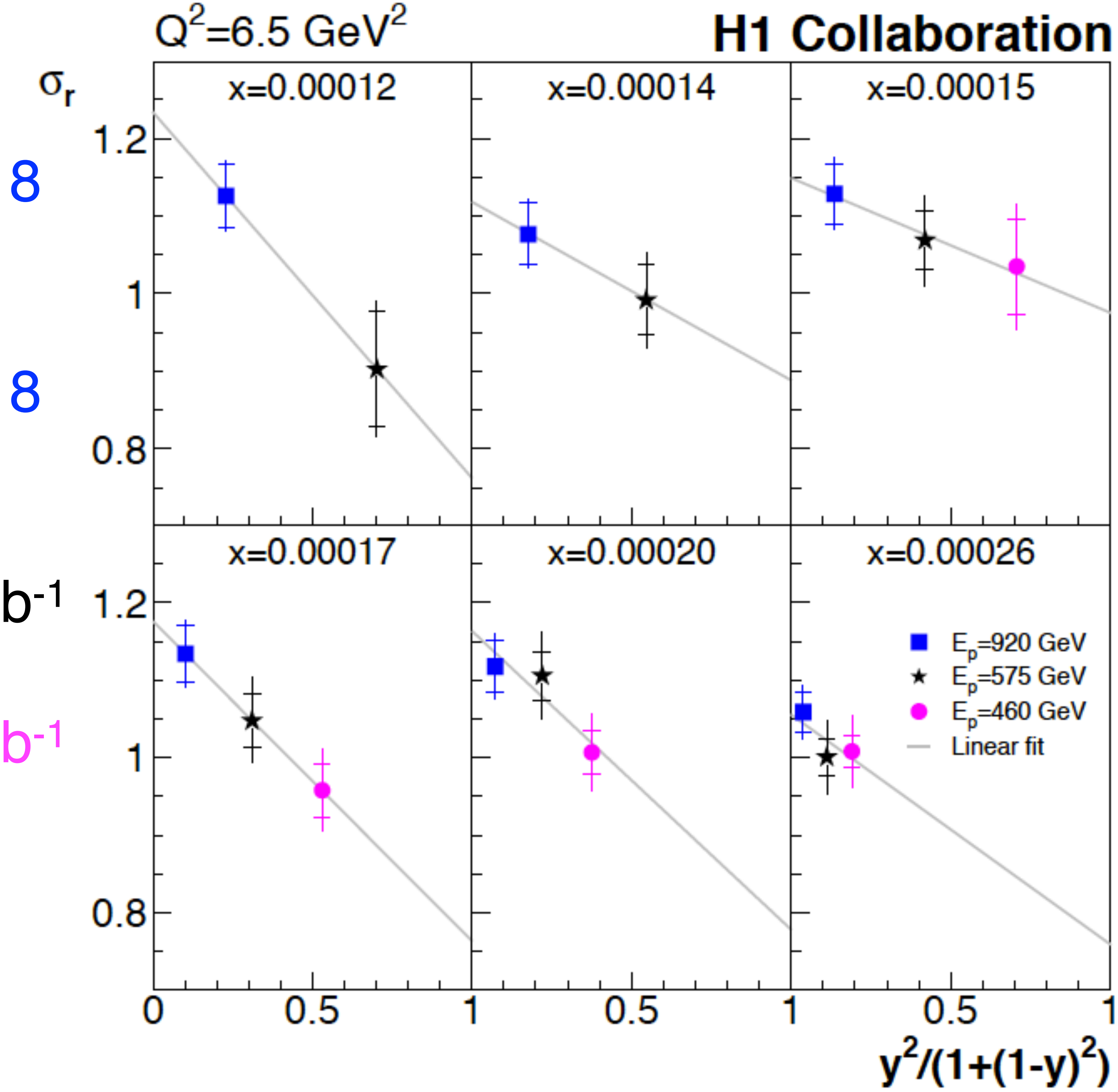
F_L in HERA

E_p = 920 GeV ($Q^2 > 8$ GeV^2): 97 pb^{-1}

E_p = 920 GeV ($Q^2 < 8$ GeV^2): 5.9 pb^{-1}

E_p = 575 GeV: 4.9 pb^{-1}

E_p = 46 GeV: 12.2 pb^{-1}



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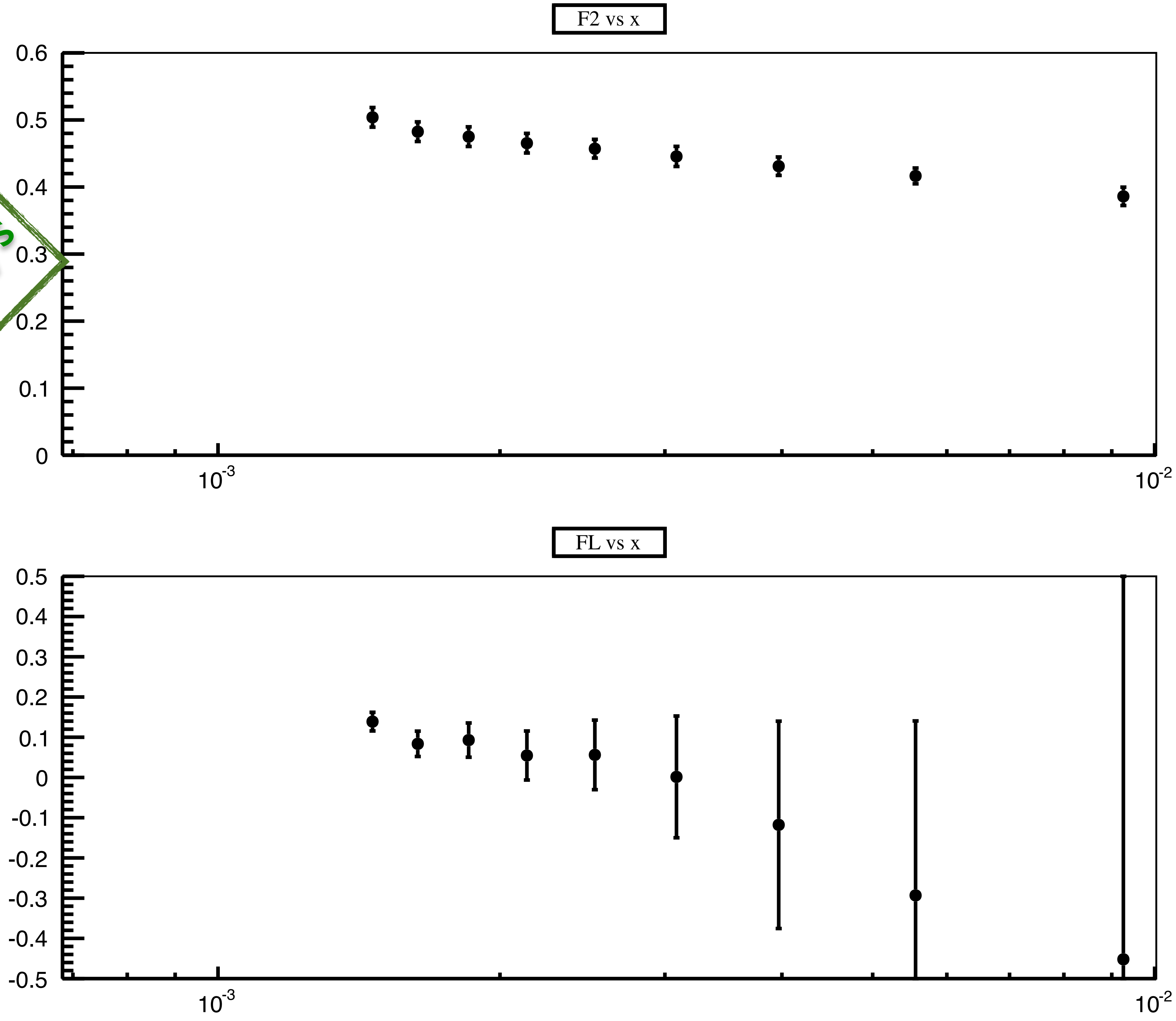
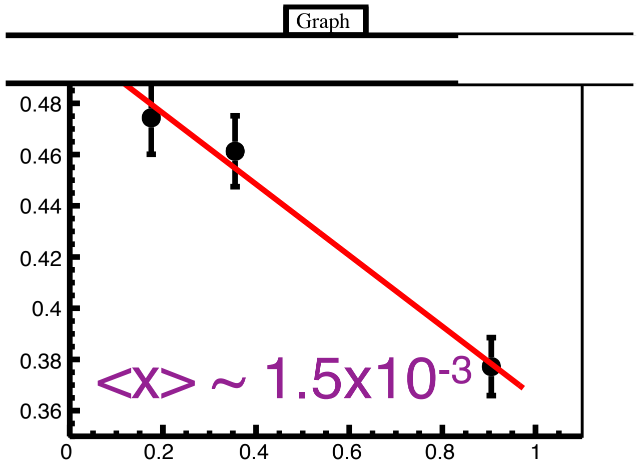
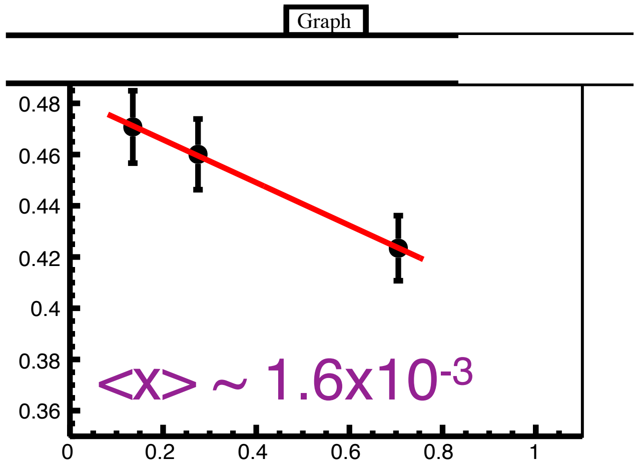


stat + 3% sys

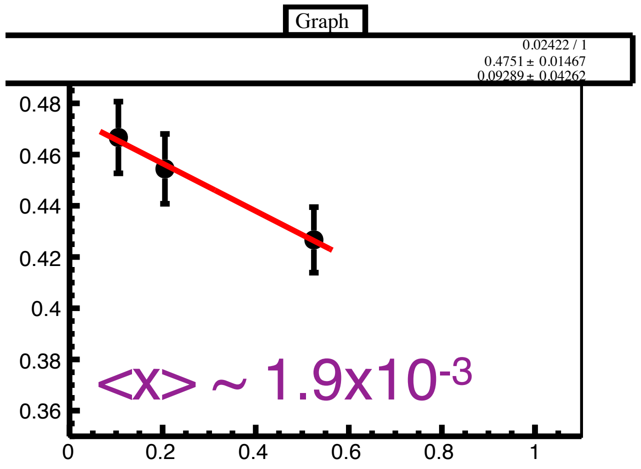
1 < Q^2 < 1.778: Reduced Cross-sections: A∫Ldt = 10 fb^{-1}



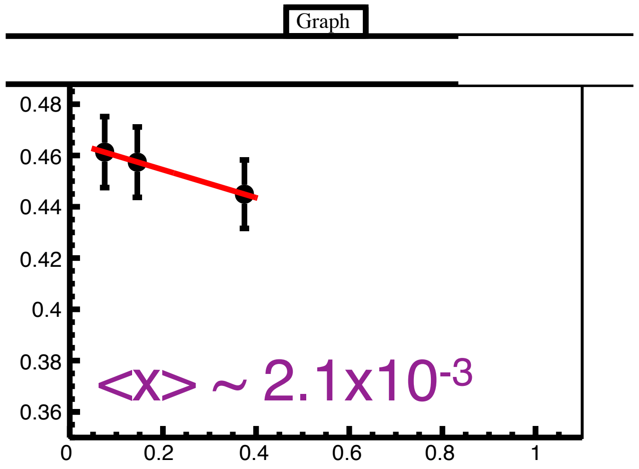
<x> ~ 1.5x10^{-3}



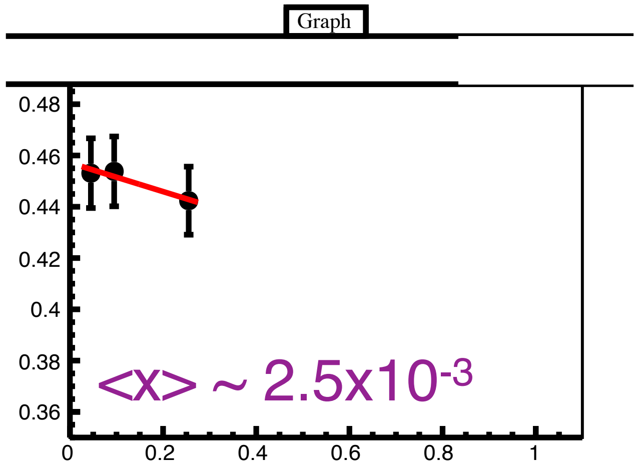
<x> ~ 1.6x10^{-3}



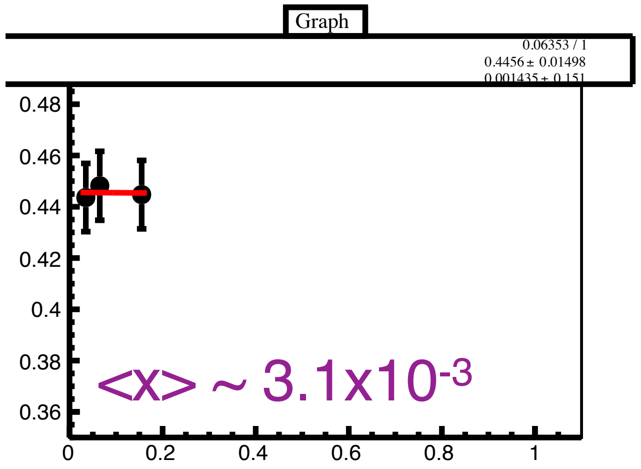
<x> ~ 1.9x10^{-3}



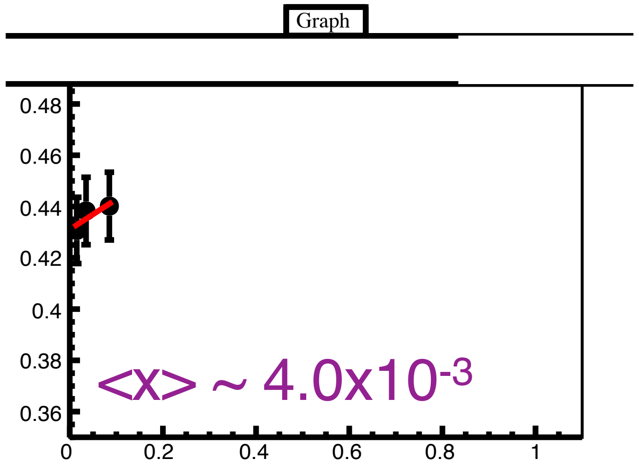
<x> ~ 2.1x10^{-3}



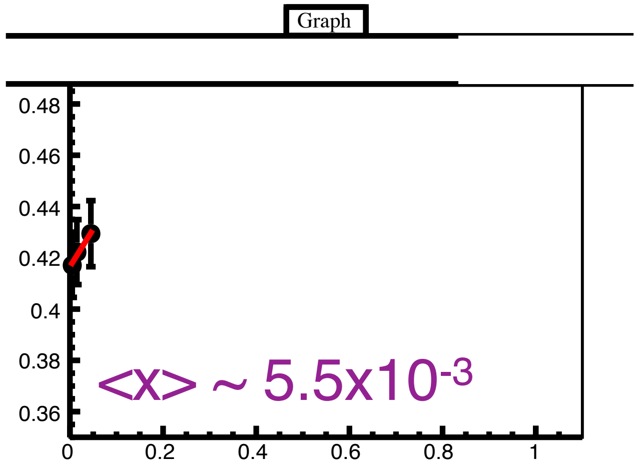
<x> ~ 2.5x10^{-3}



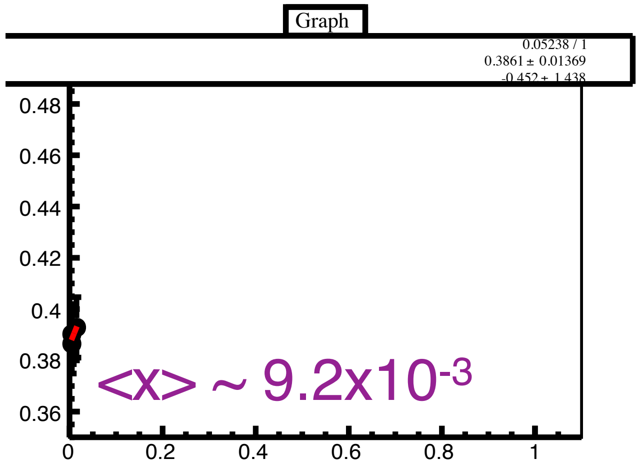
<x> ~ 3.1x10^{-3}



<x> ~ 4.0x10^{-3}



<x> ~ 5.5x10^{-3}



<x> ~ 9.2x10^{-3}

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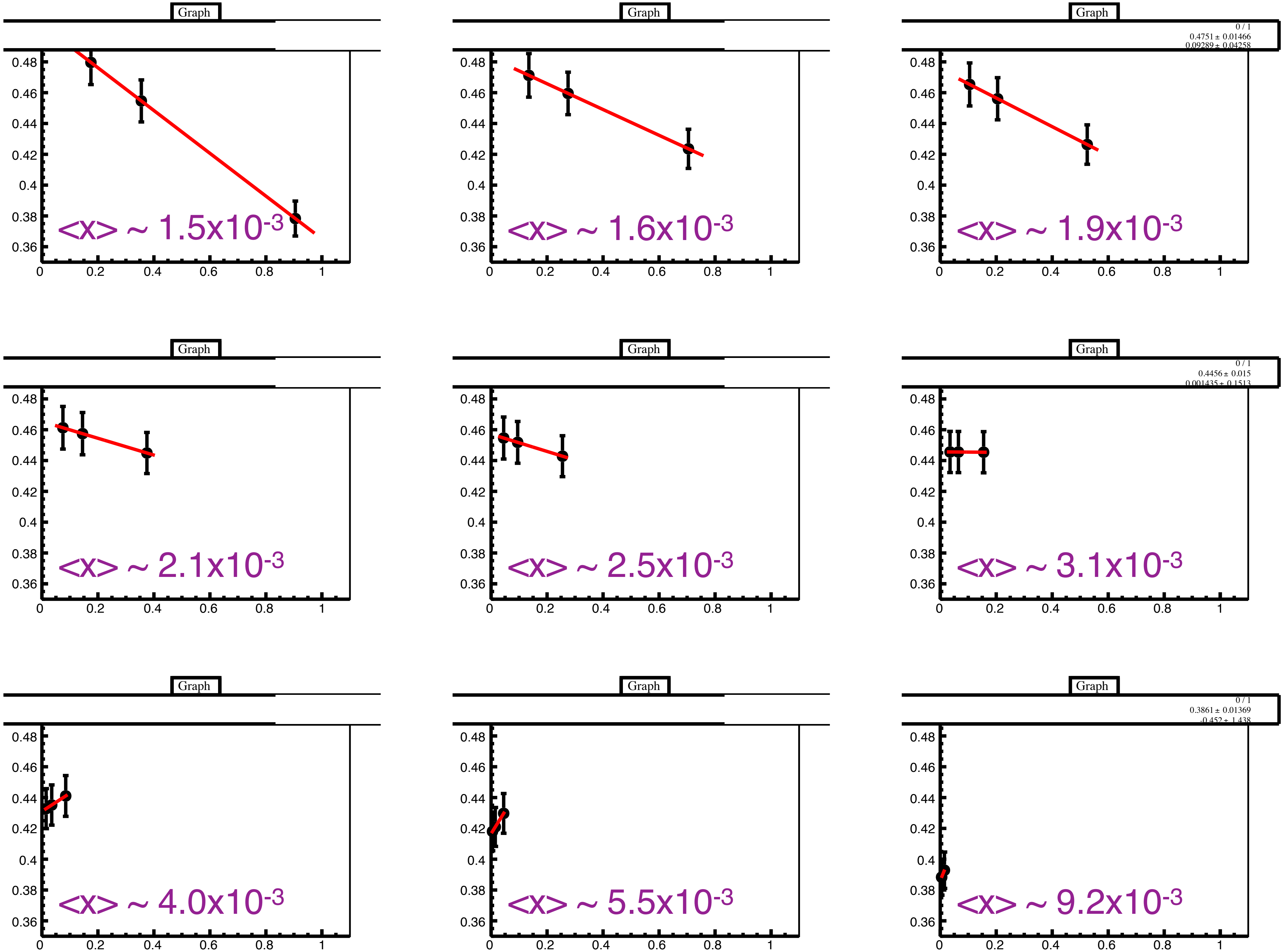

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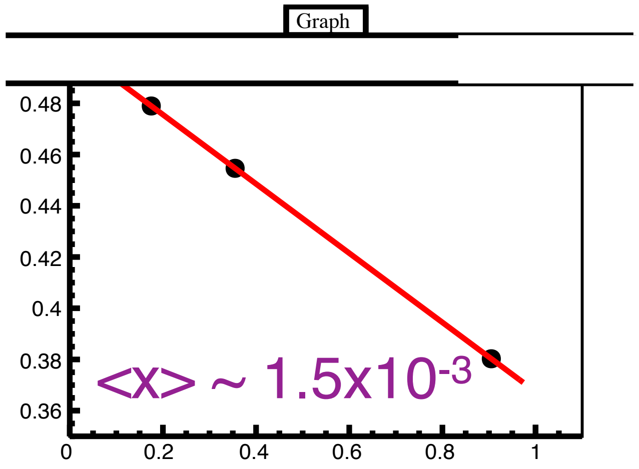
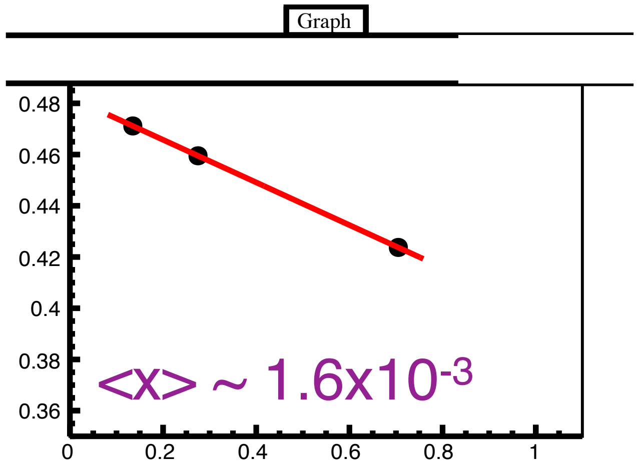
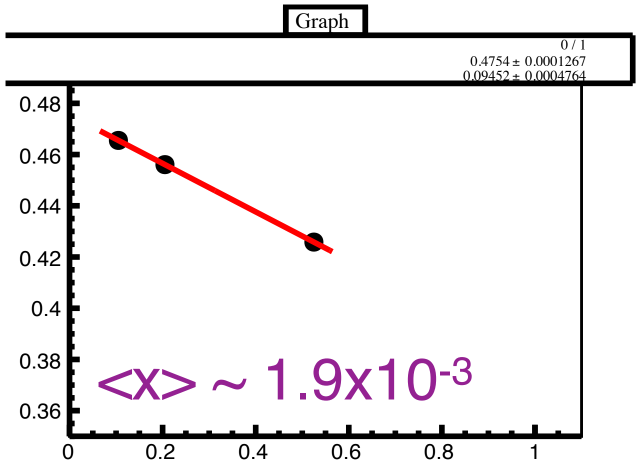
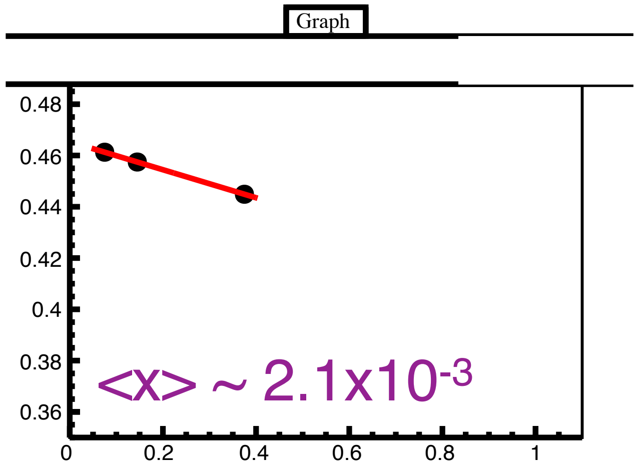
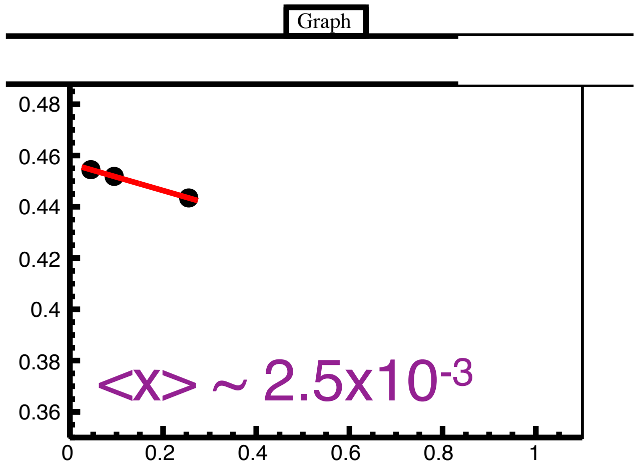
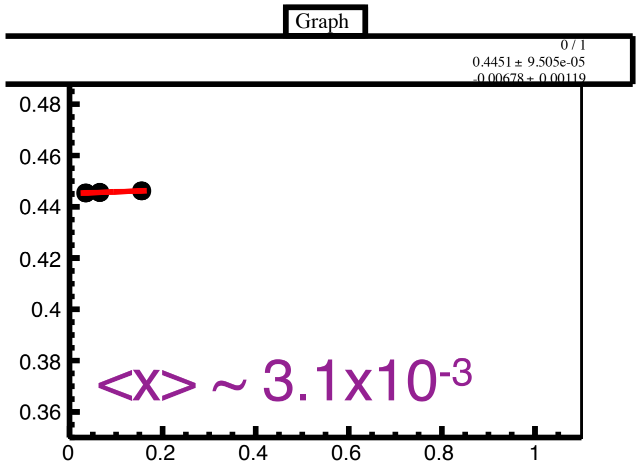


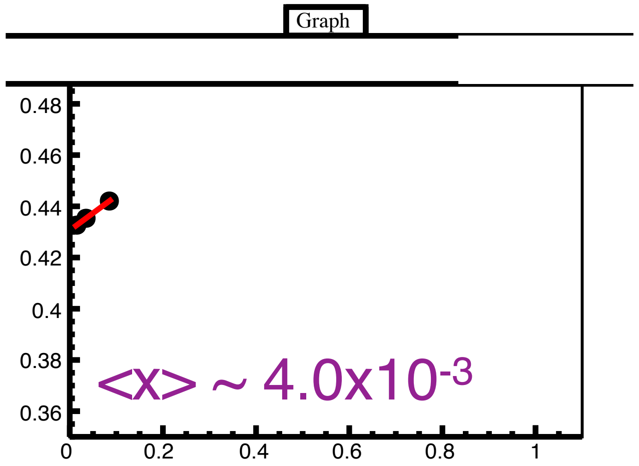


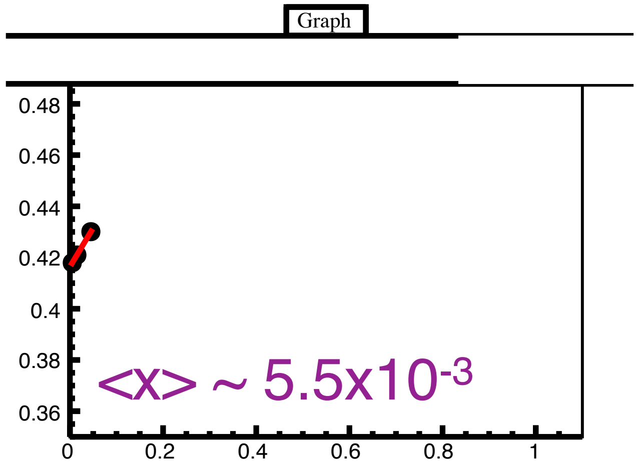


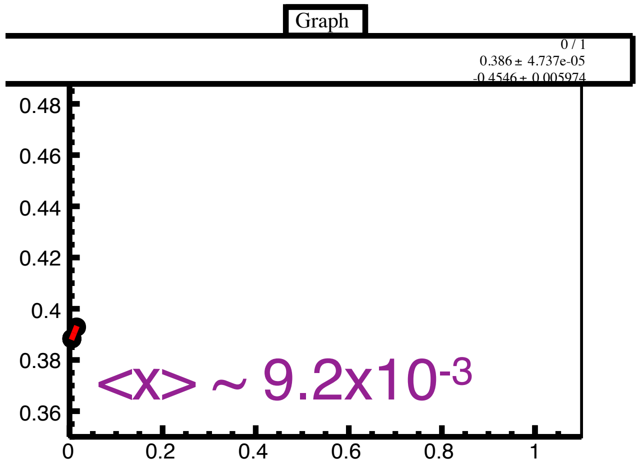




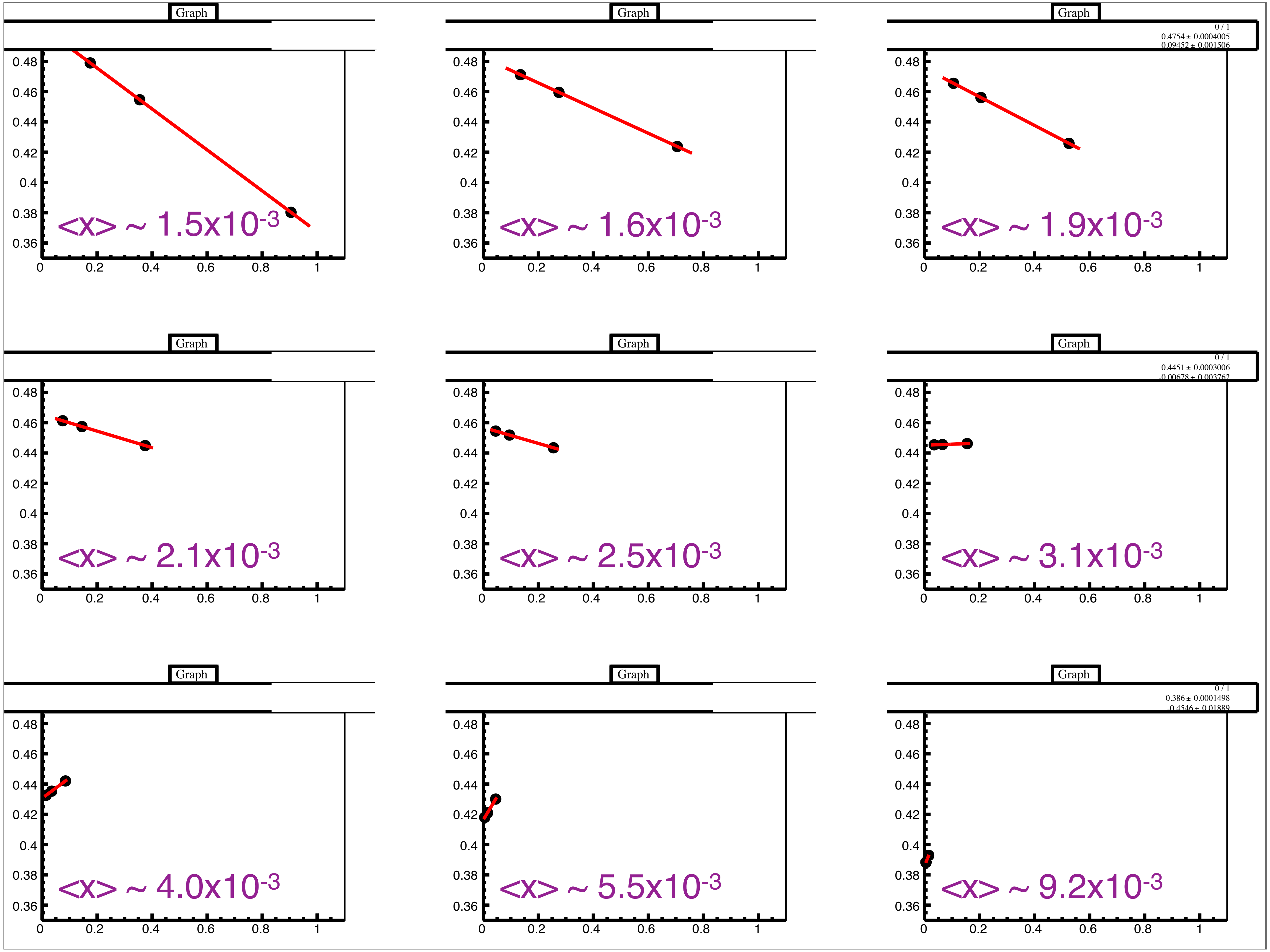




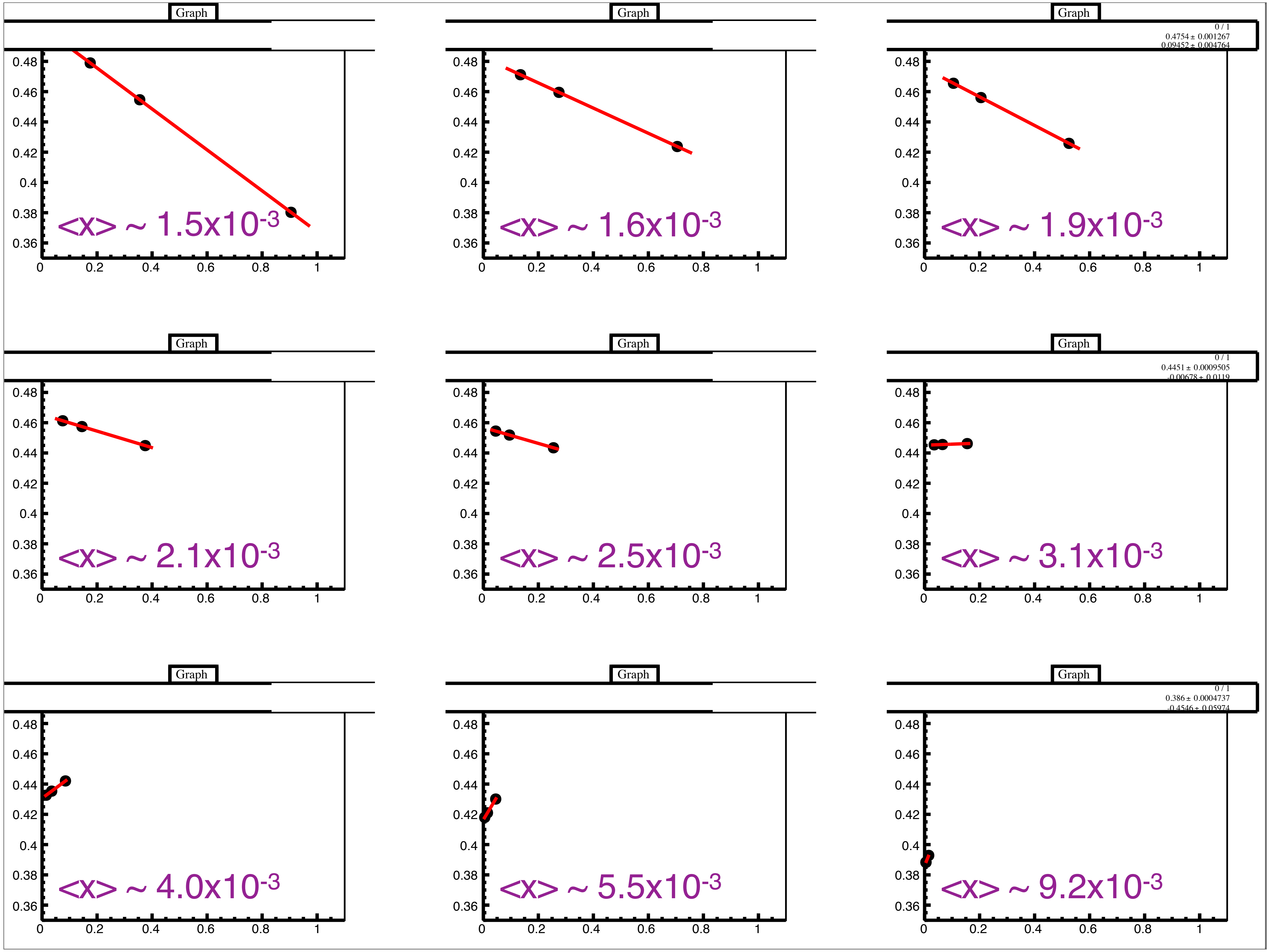




$1 < Q^2 < 1.778$: Reduced Cross-sections: $A \int L dt = 1\ \mathrm{fb}^{-1}$



1 < Q^2 < 1.778: Reduced Cross-sections: A∫Ldt = 100 pb^{-1}



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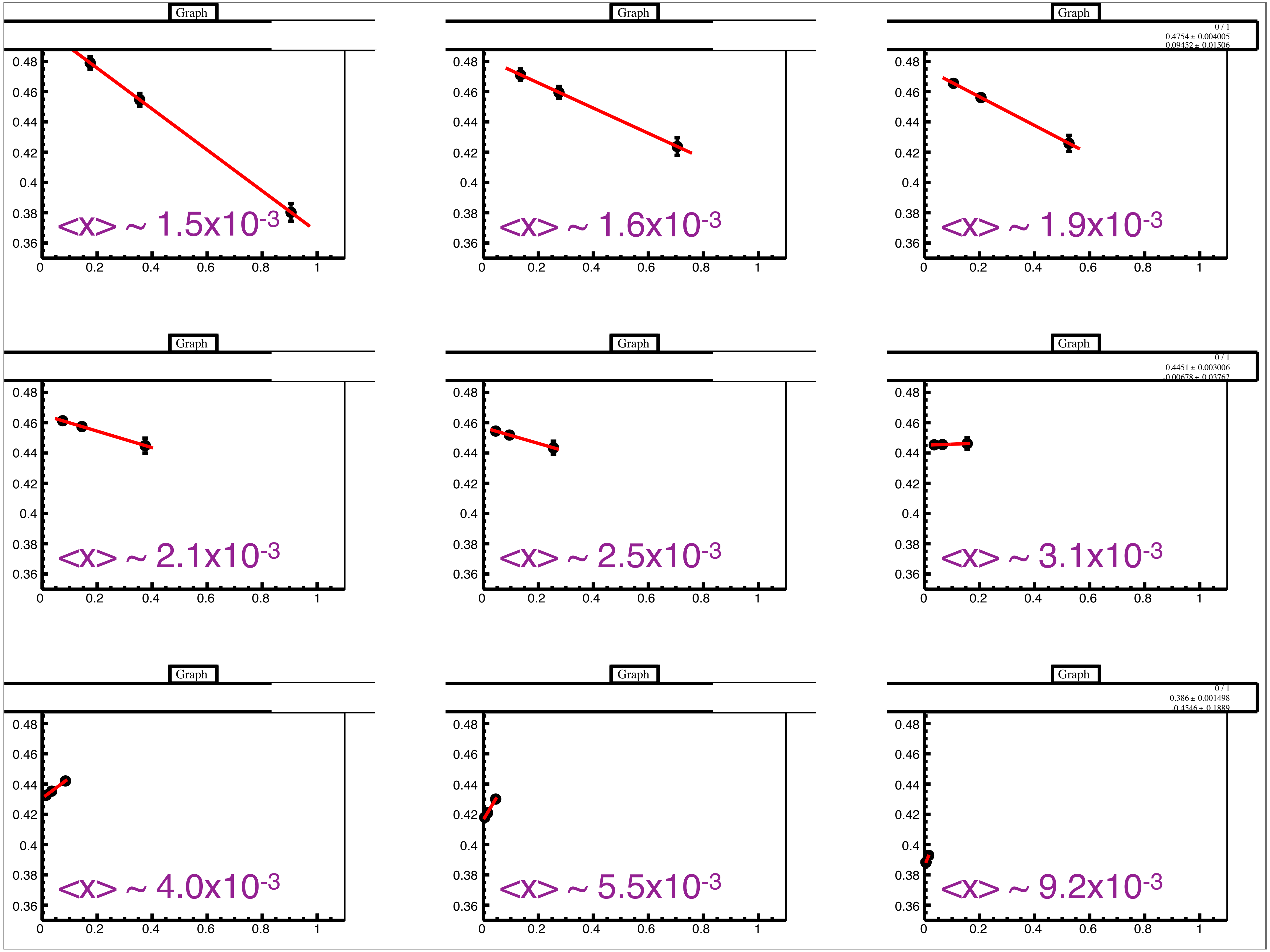

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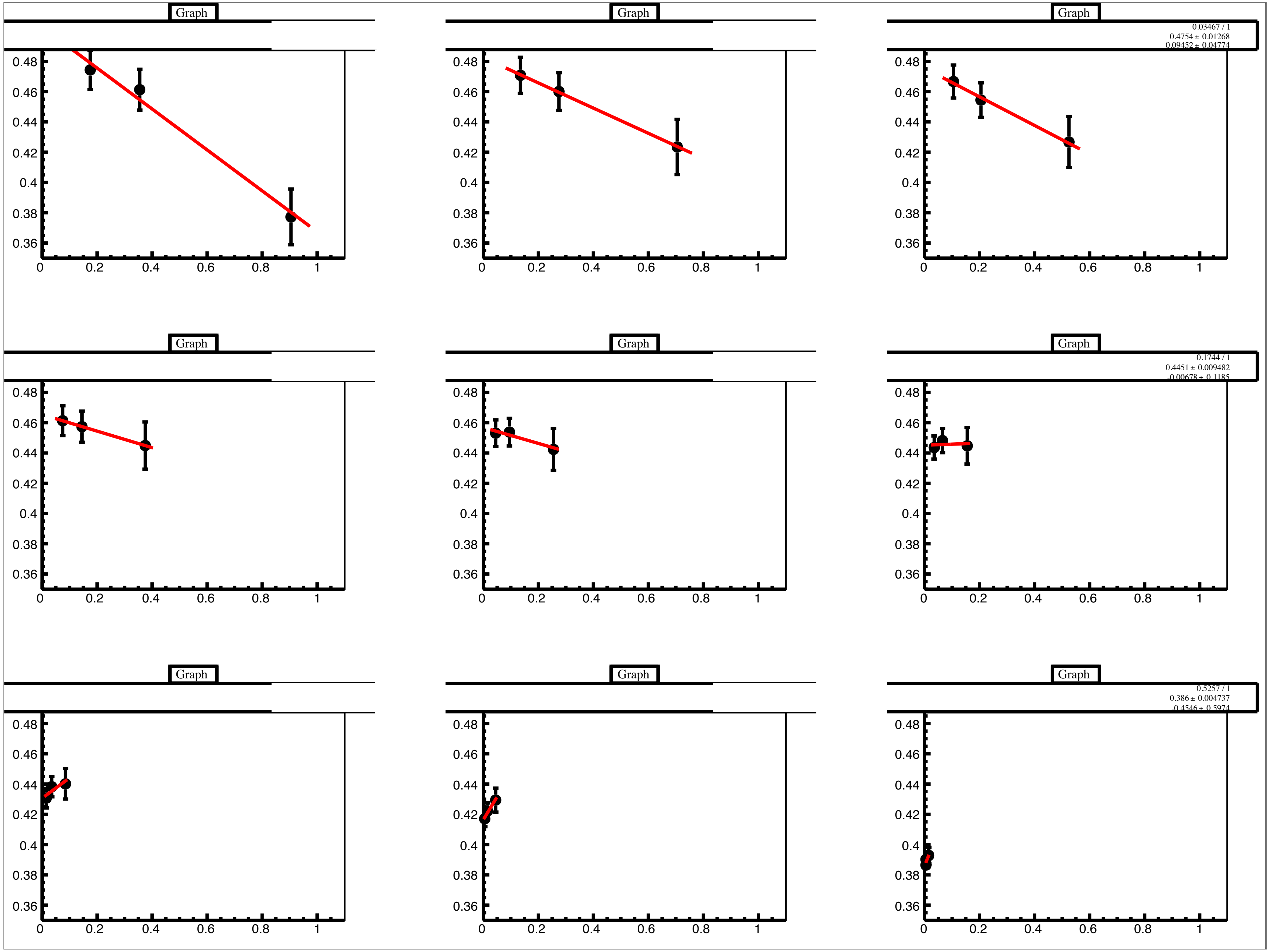

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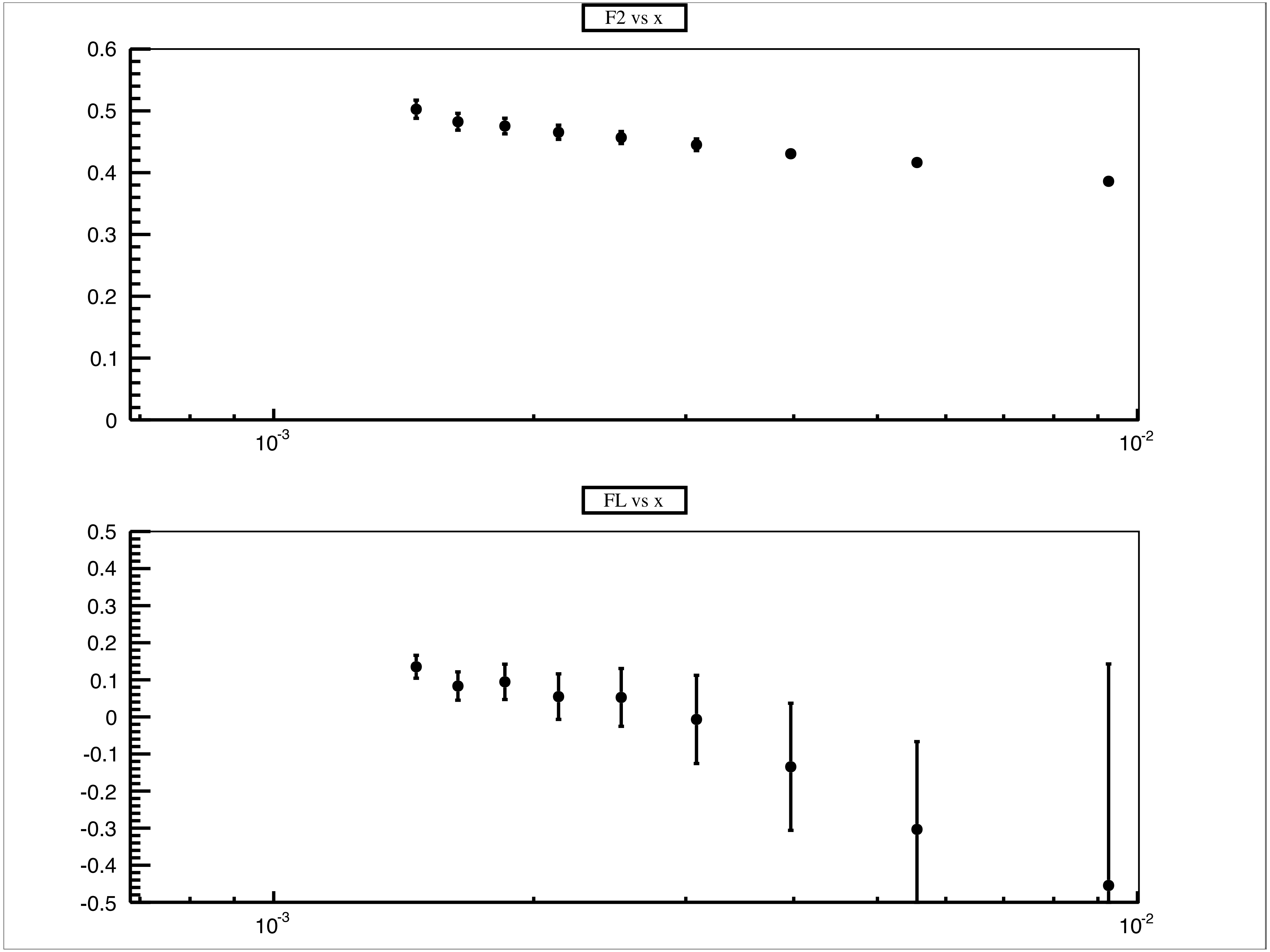

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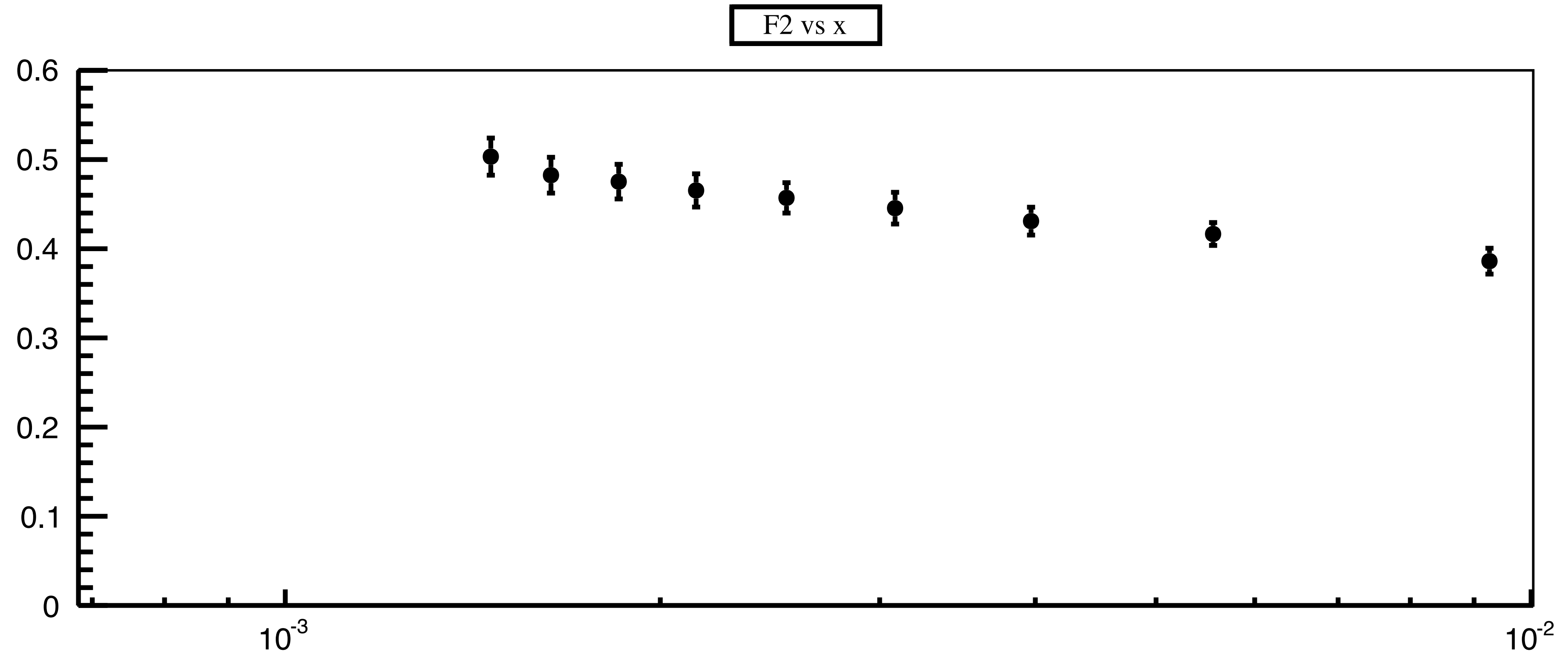

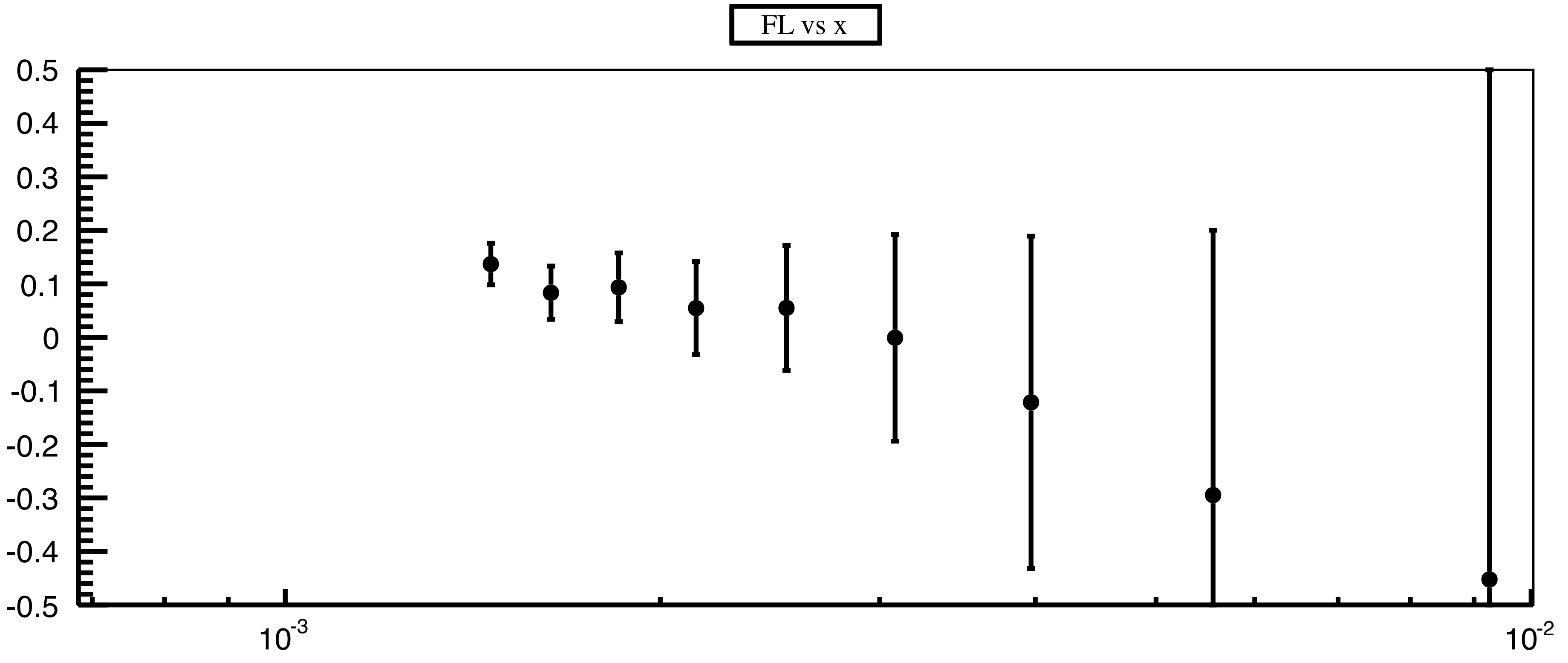

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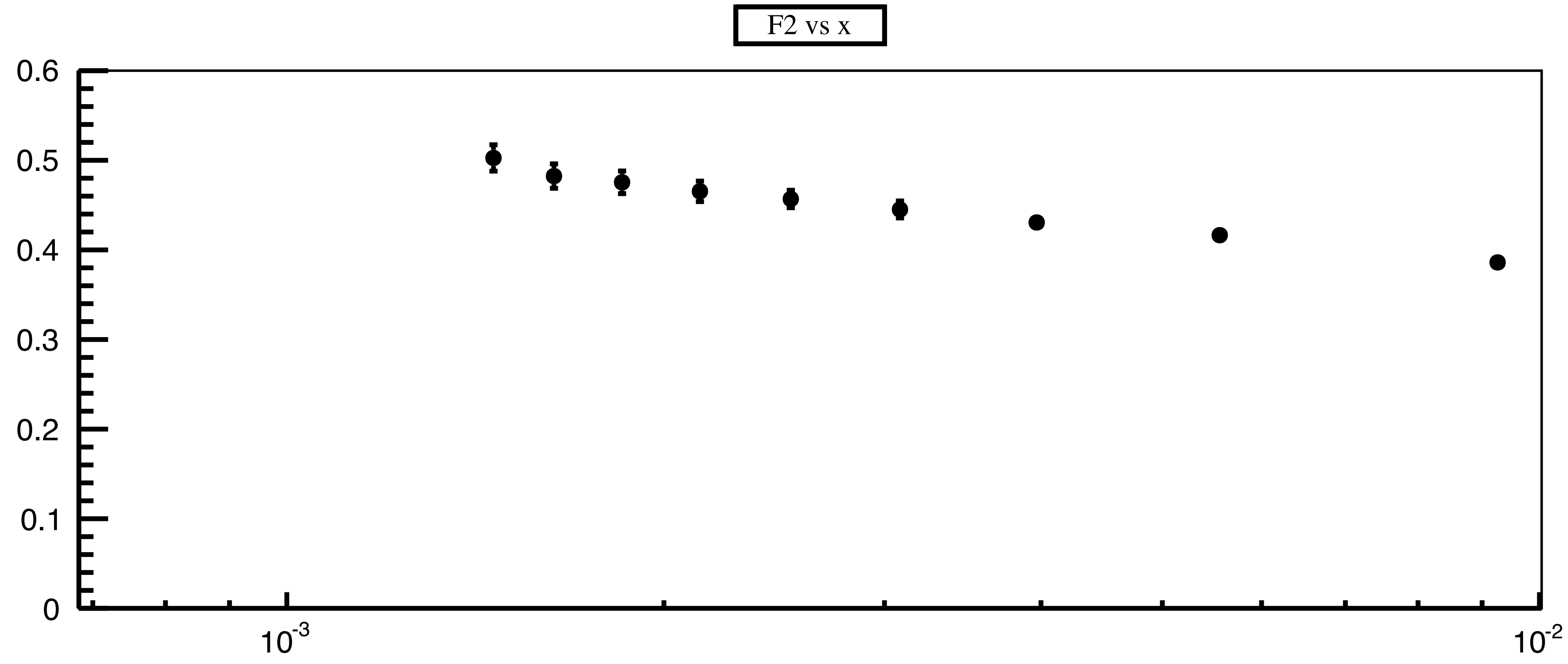

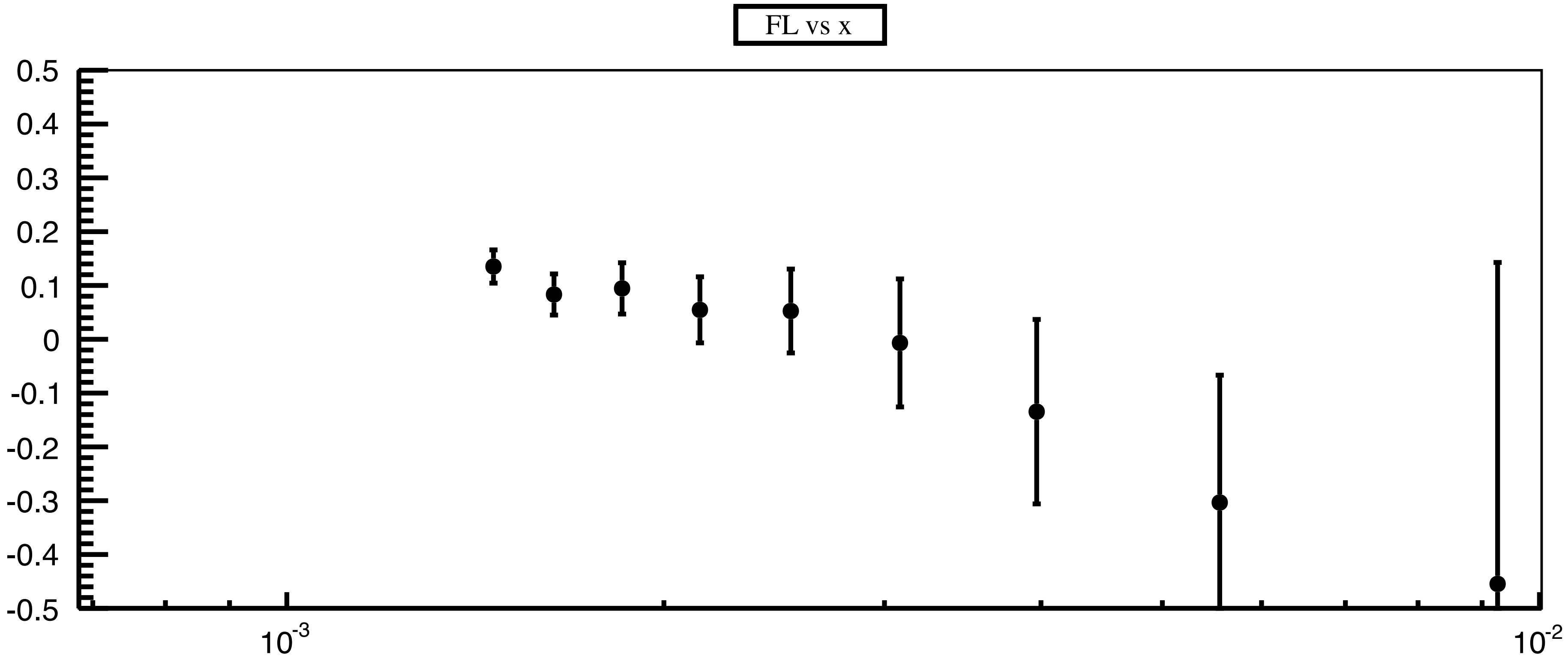

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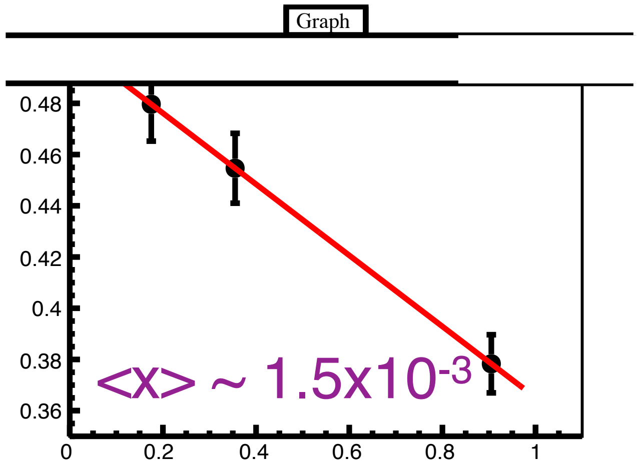

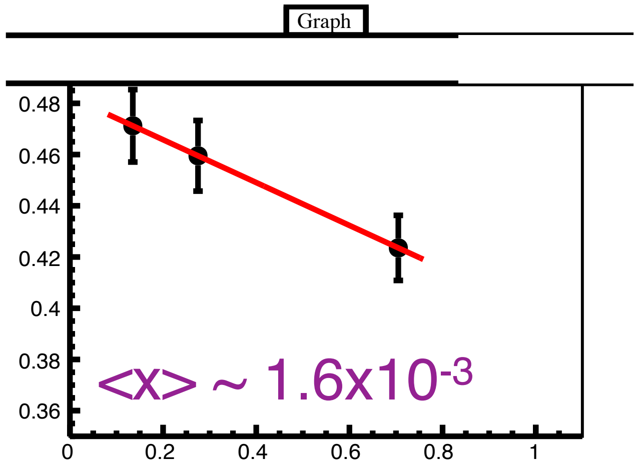

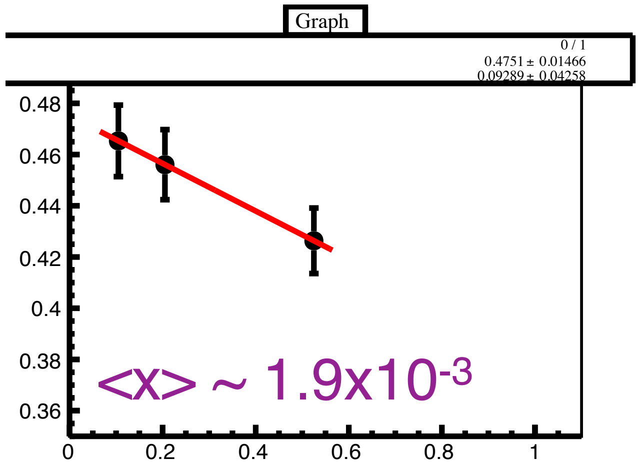

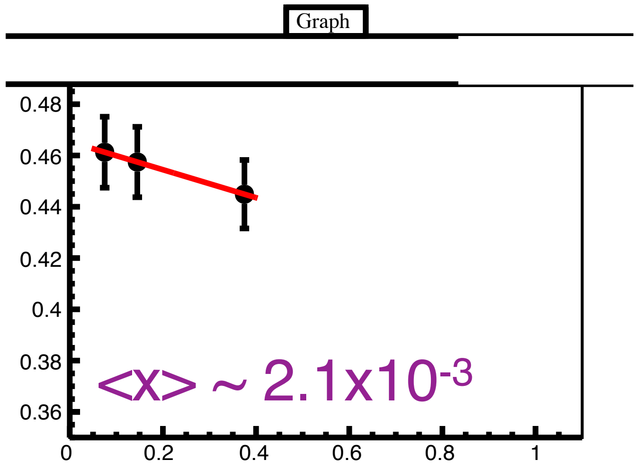

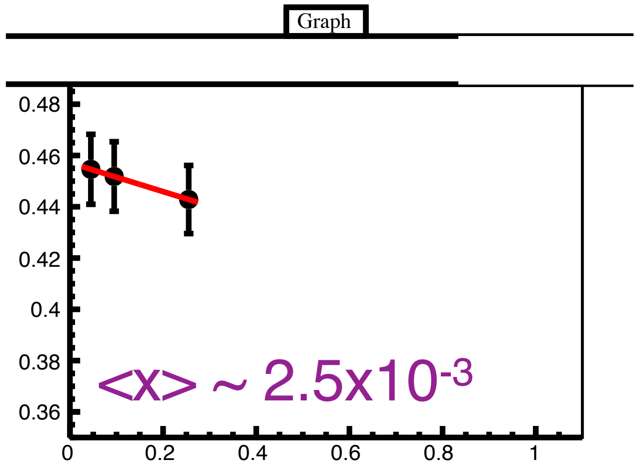

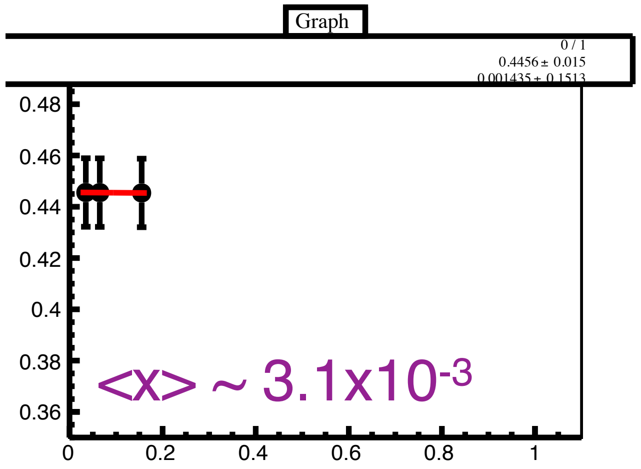

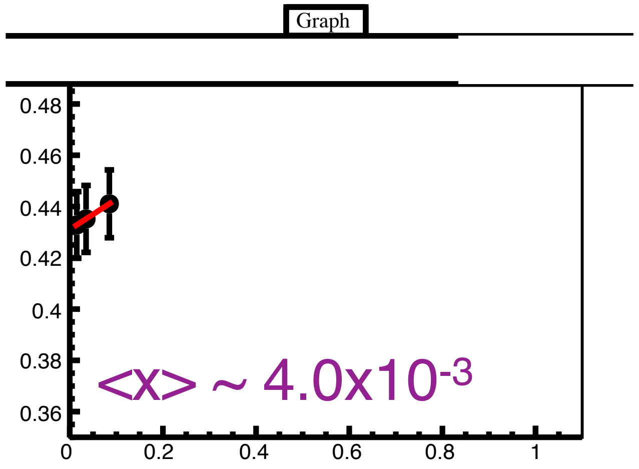

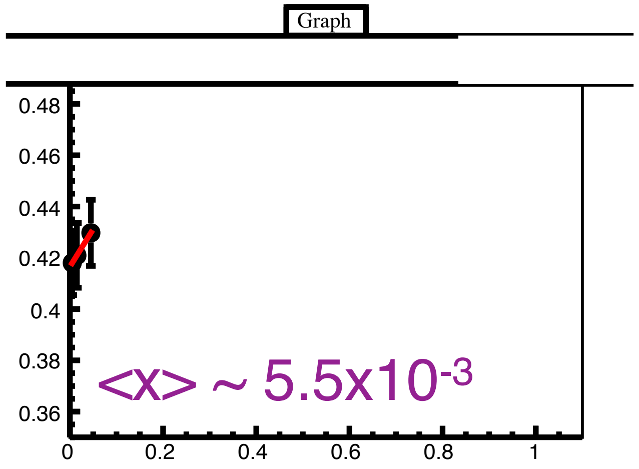

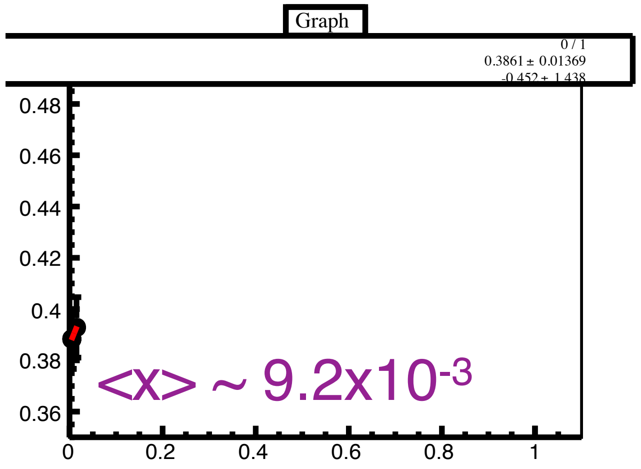

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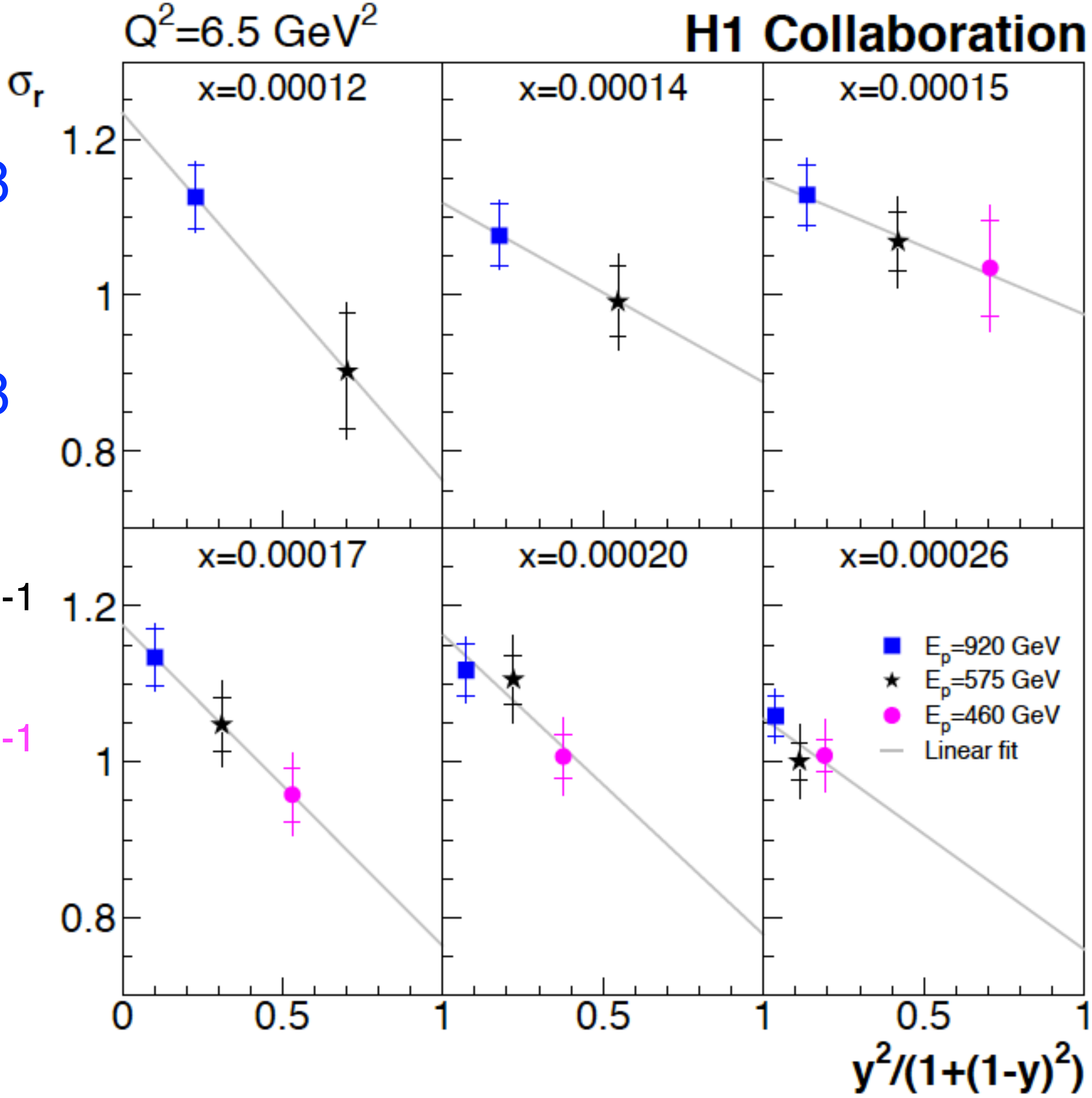
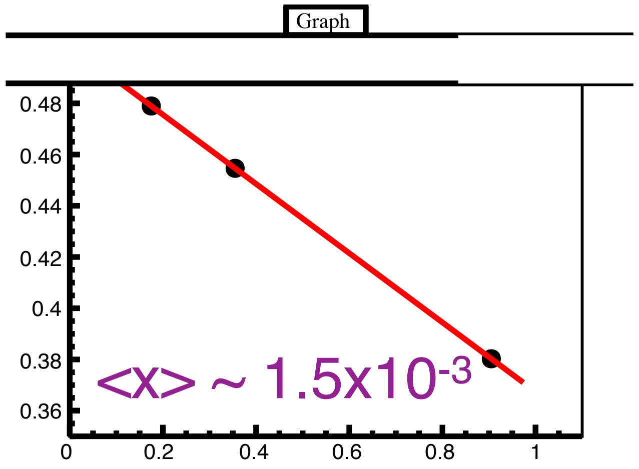
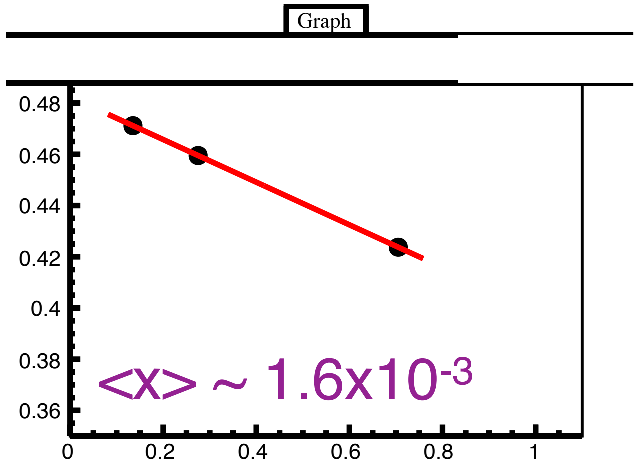
E_p = 575 GeV: 4.9 pb^{-1}

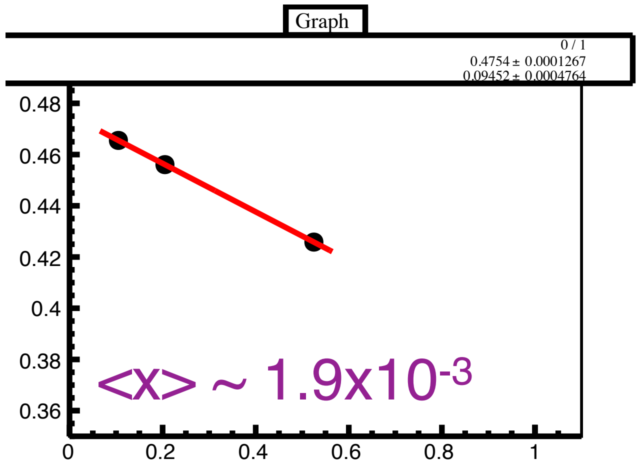
E_p = 46 GeV: 12.2 pb^{-1}

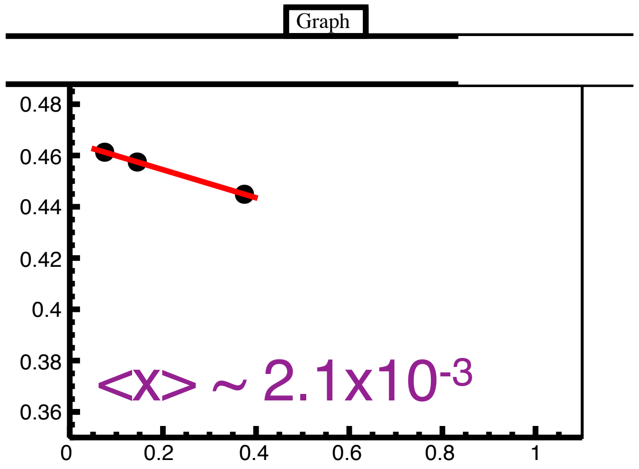


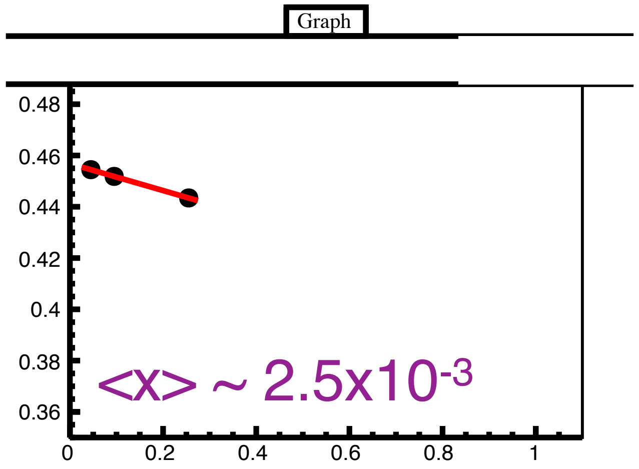
1 < Q^2 < 1.778: Reduced Cross-sections e+Au: $\int Ldt = 10\ fb^{-1}$

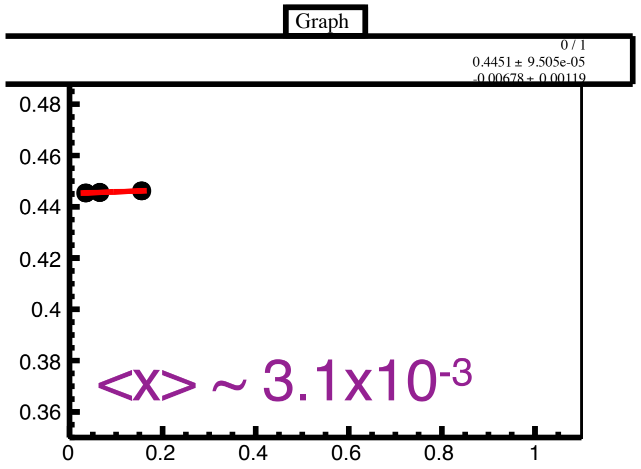


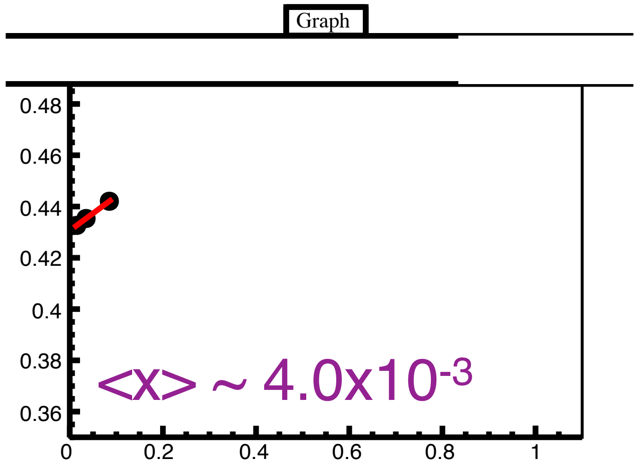


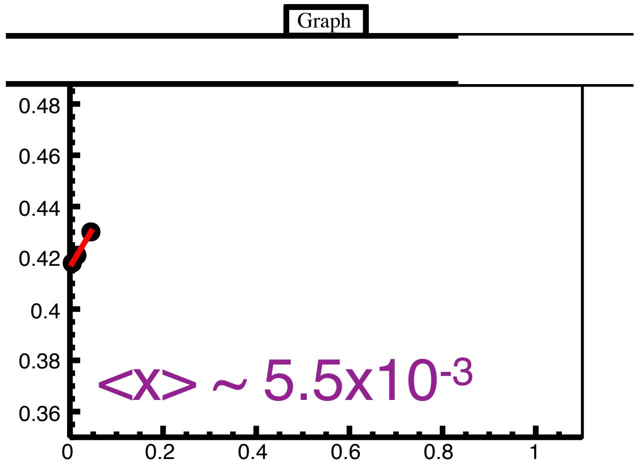


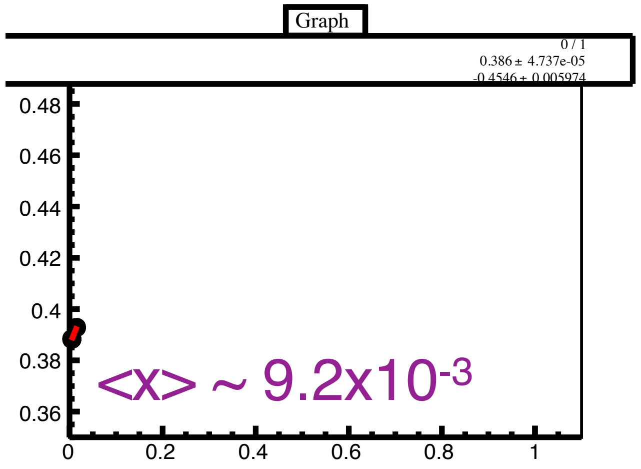




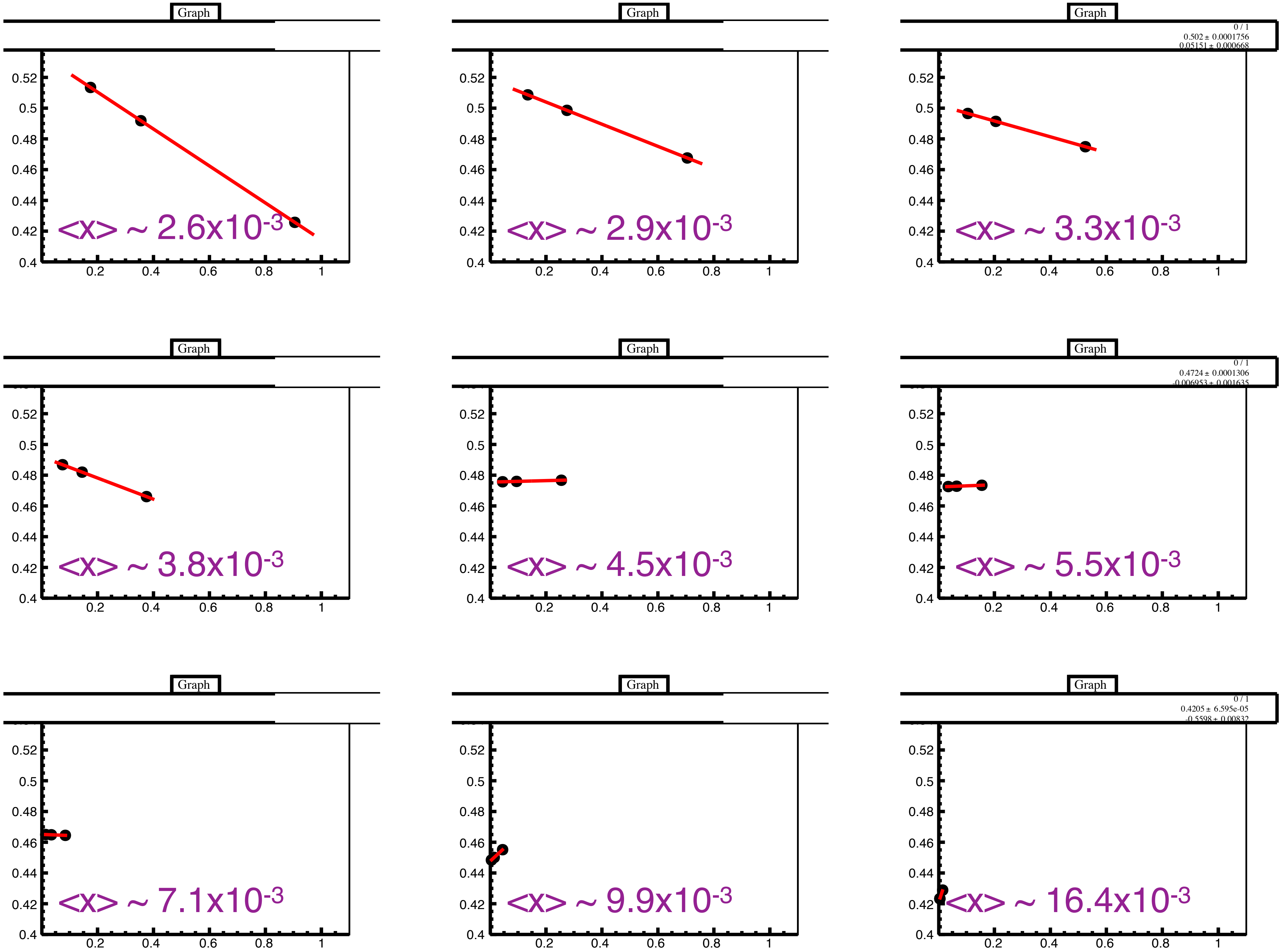




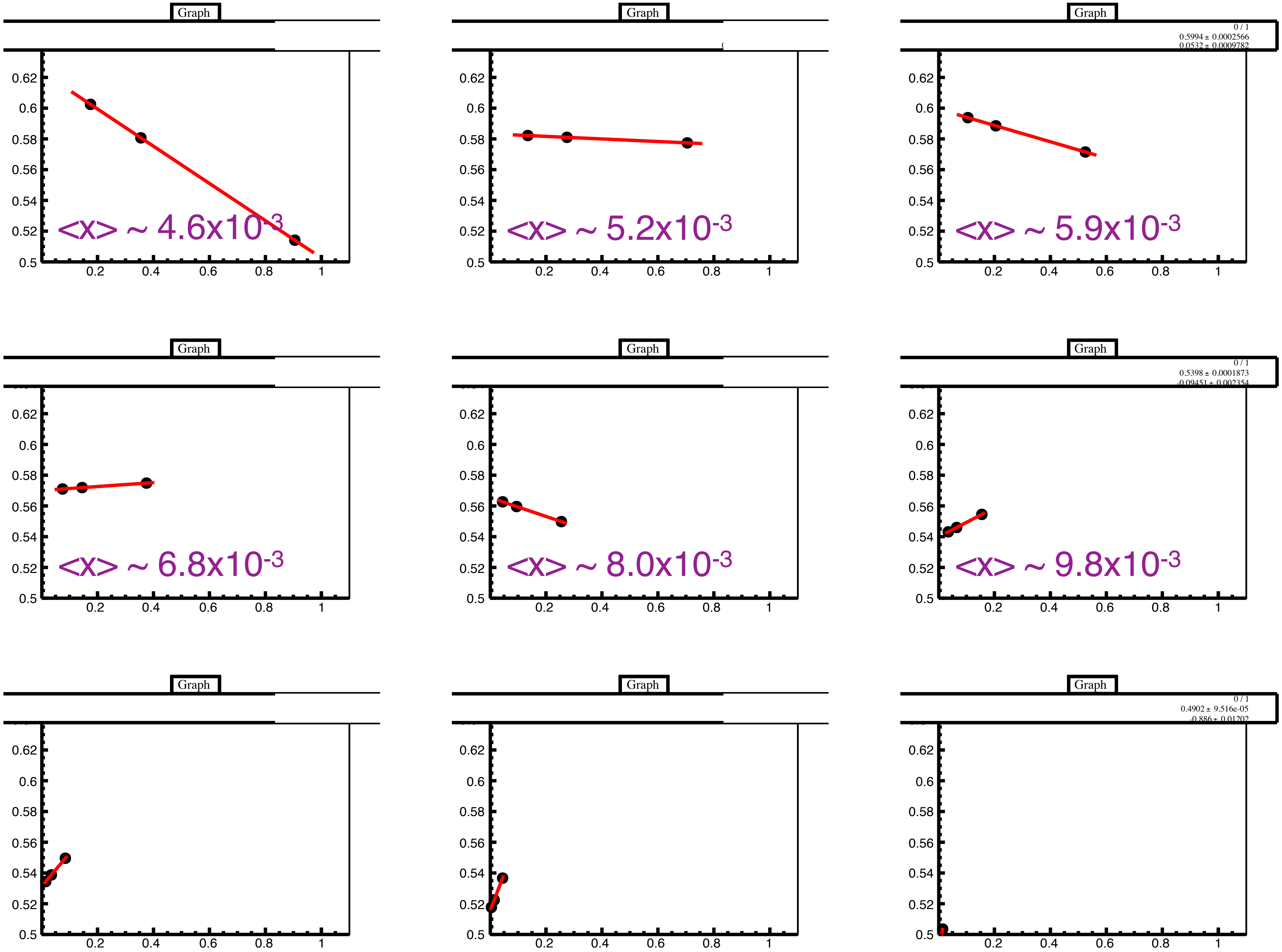




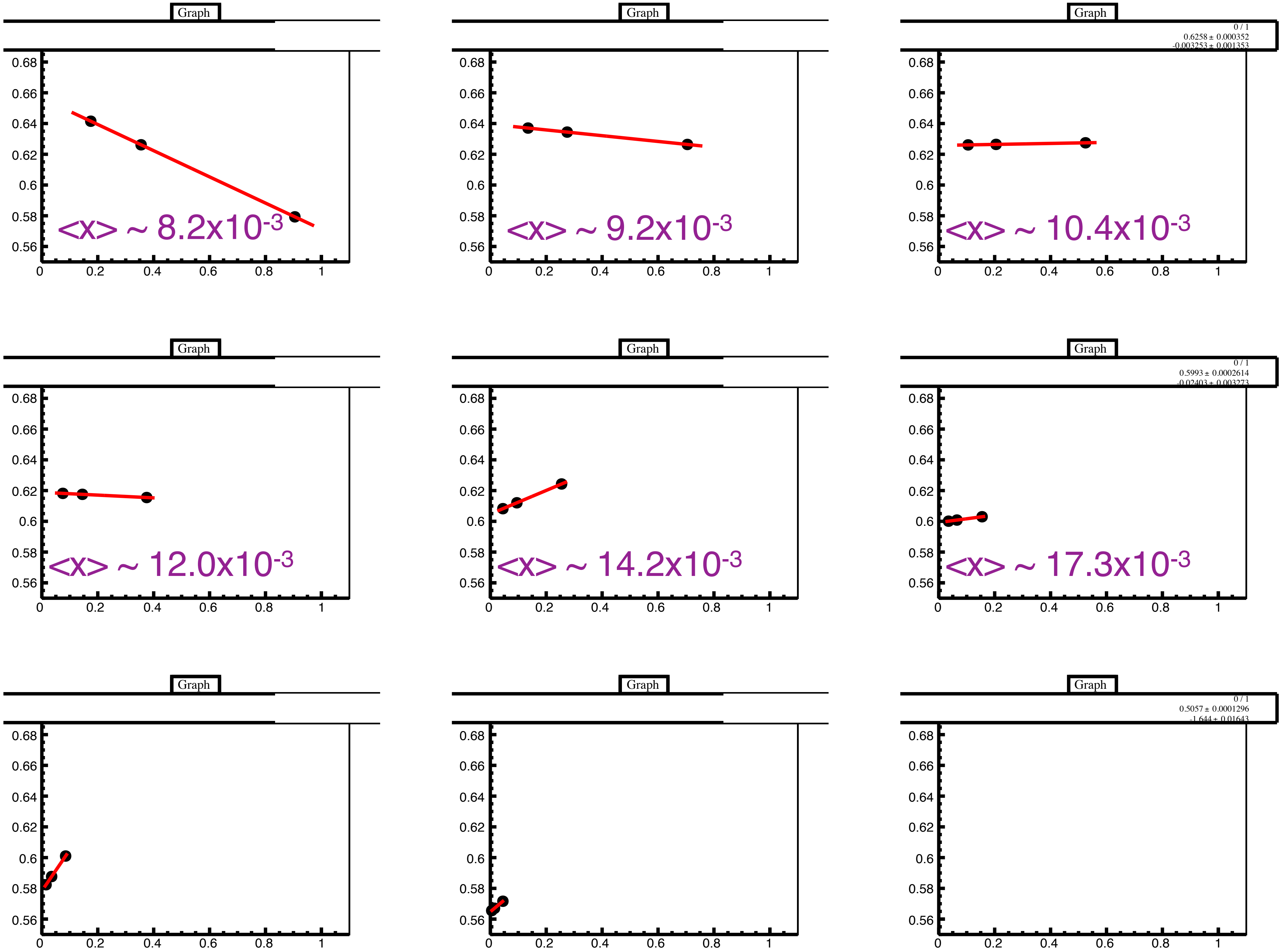
$1.778 < Q^2 < 3.162$: Reduced Cross-sections e+Au: $\int L dt = 10\ \mathrm{fb}^{-1}$



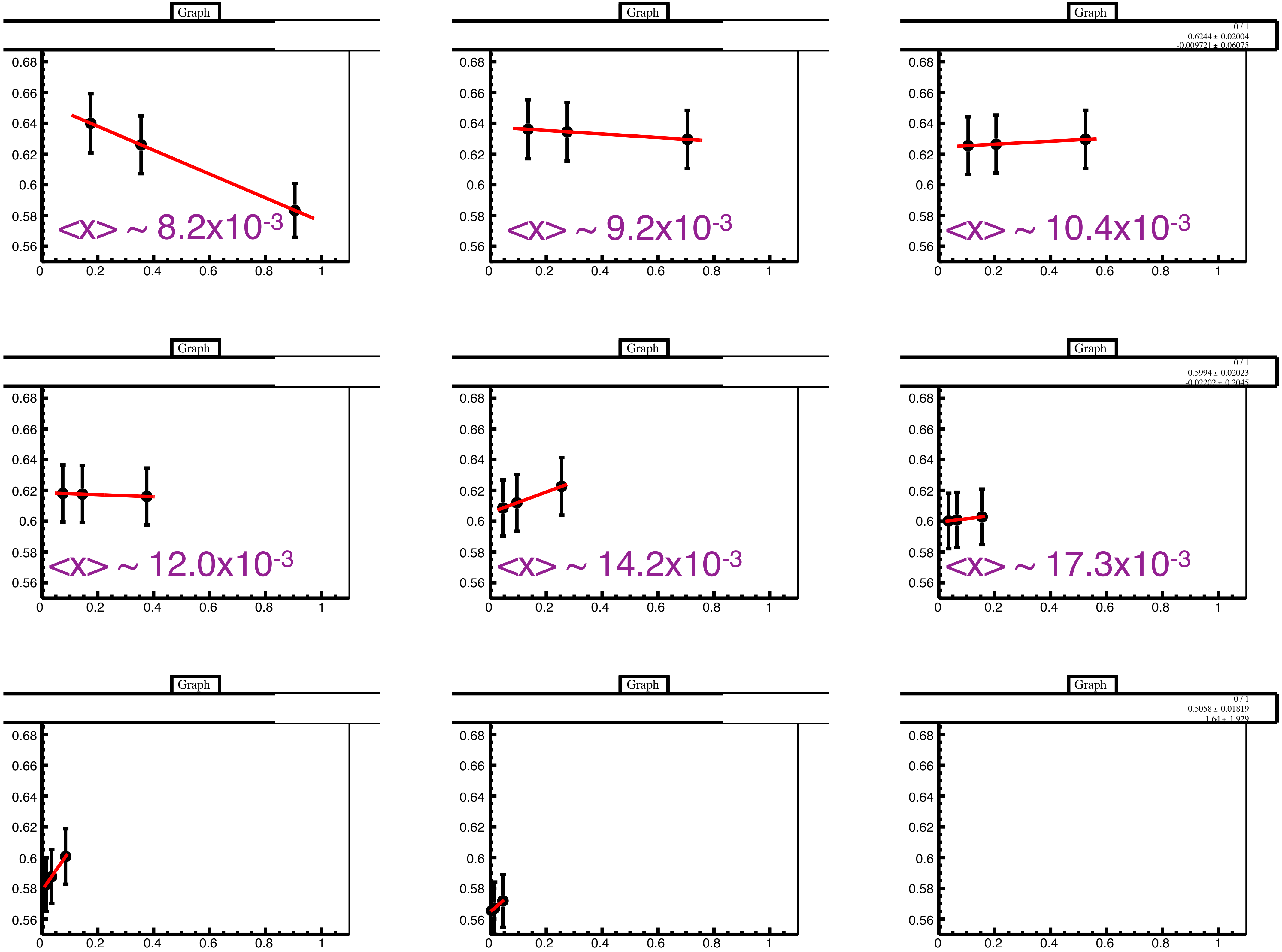
$3.162 < Q^2 < 5.623$: Reduced Cross-sections e+Au: $\int Ldt = 10\ \mathrm{fb}^{-1}$



$5.623 < Q^2 < 10$: Reduced Cross-sections e+Au: $\int Ldt = 10\ fb^{-1}$

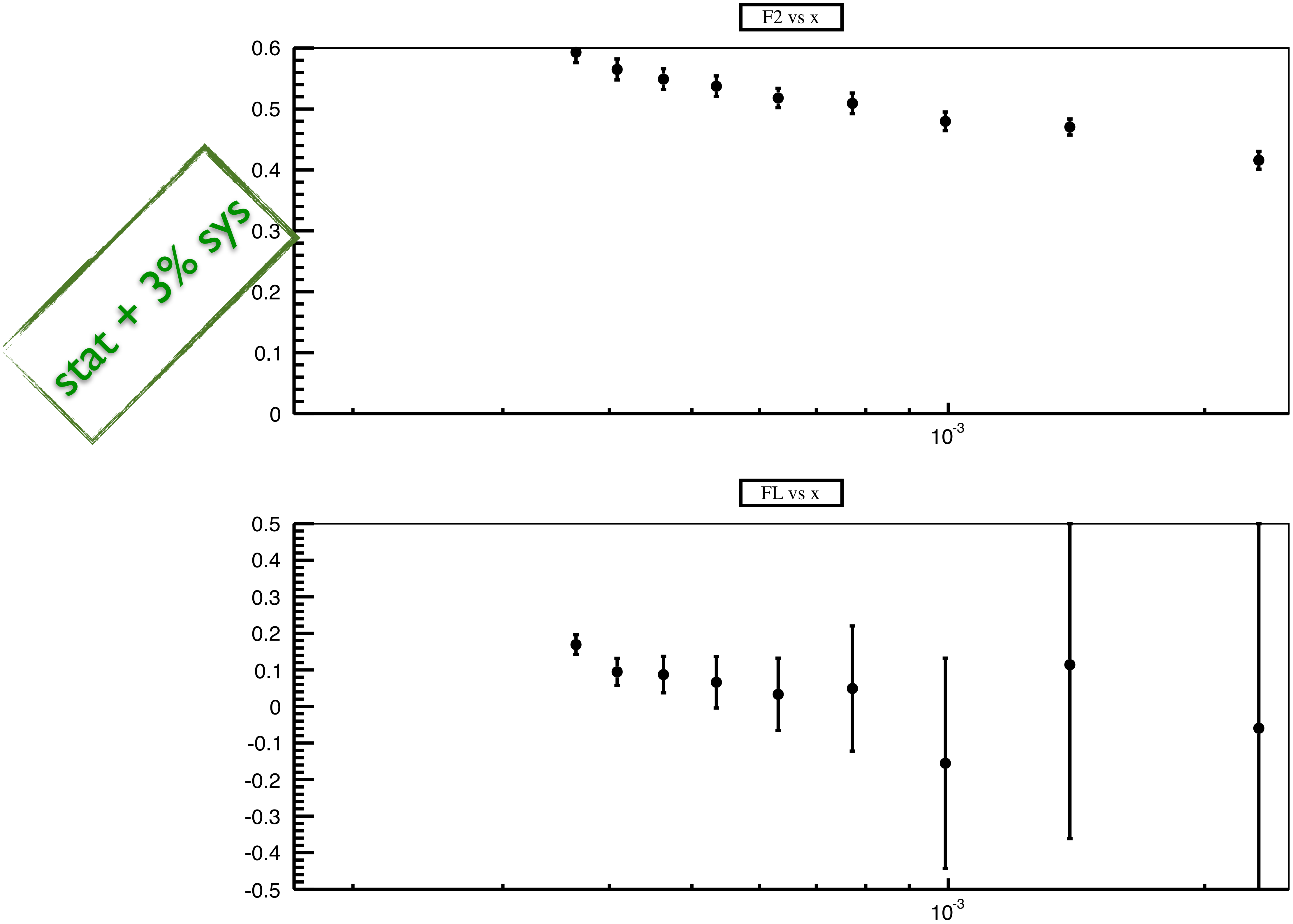


$5.623 < Q^2 < 10$: Reduced Cross-sections e+Au: $\int L dt = 10\ fb^{-1}$



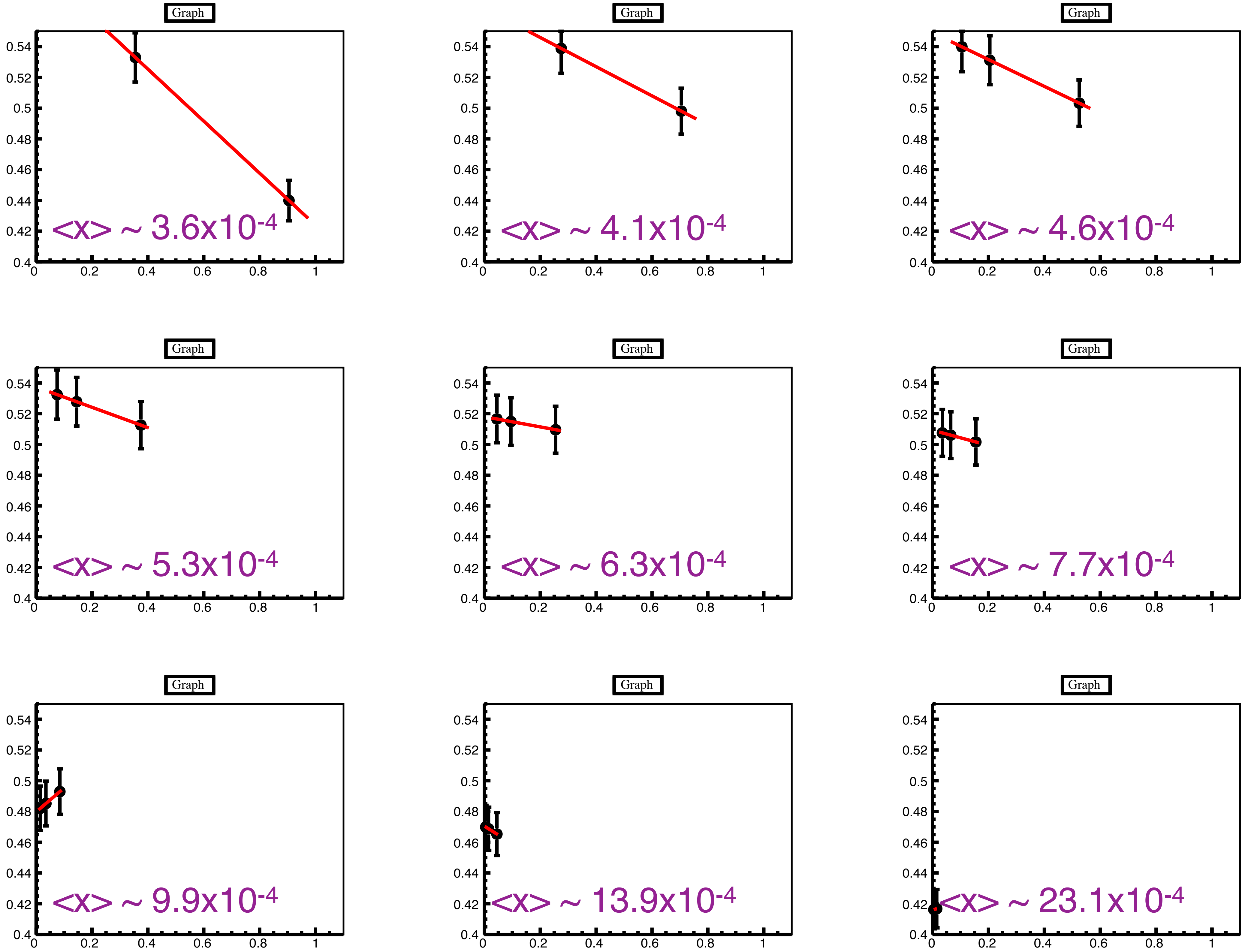
To go lower in x, need to go to higher energy (20 GeV e^- beams)

Extracted F_2 and F_L: $A\int L\,dt = 10\ \mathrm{fb}^{-1}$

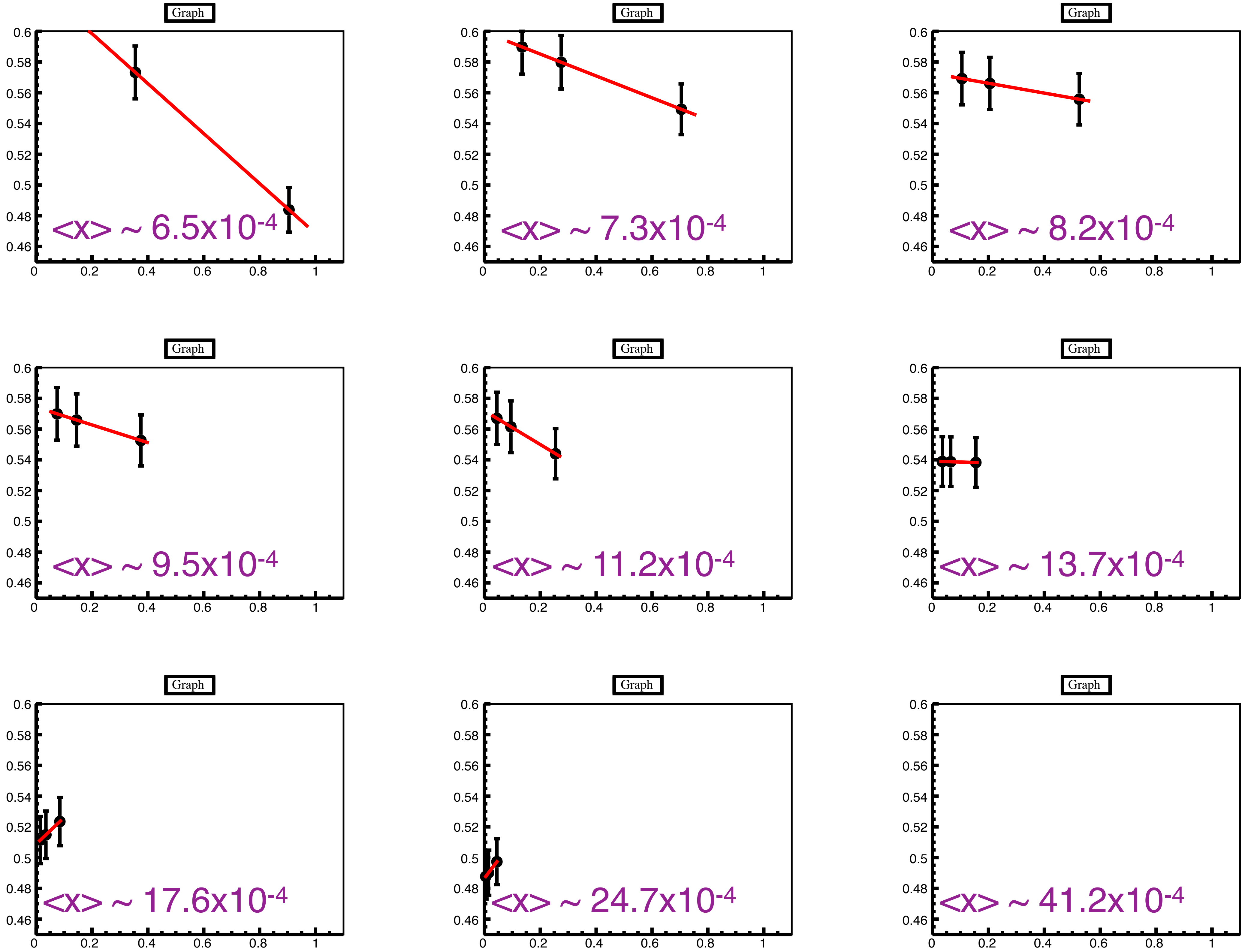


stat + 3% sys

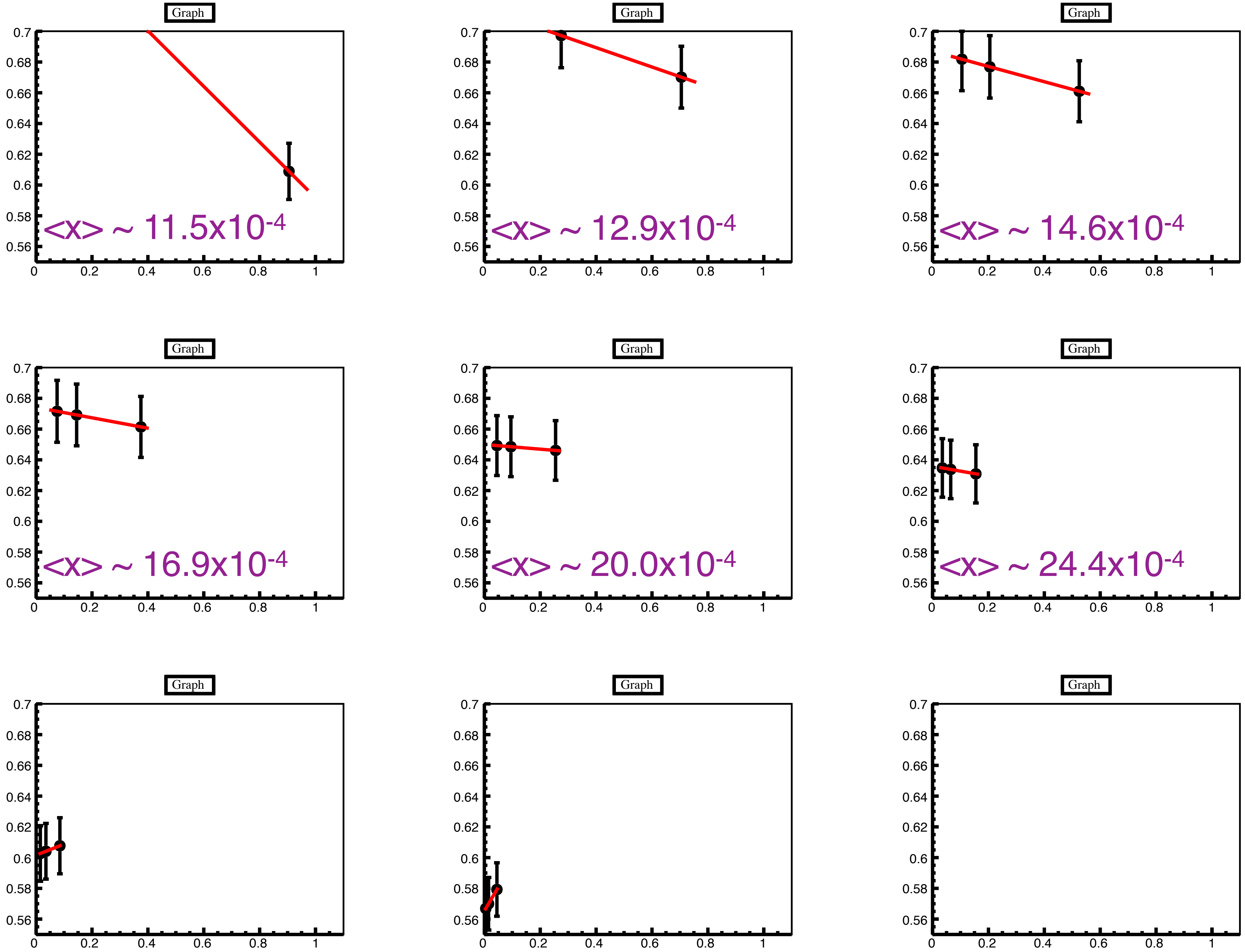
$1 < Q^2 < 1.778$: Reduced Cross-sections e+Au: $\int L dt = 10\ \mathrm{fb}^{-1}$



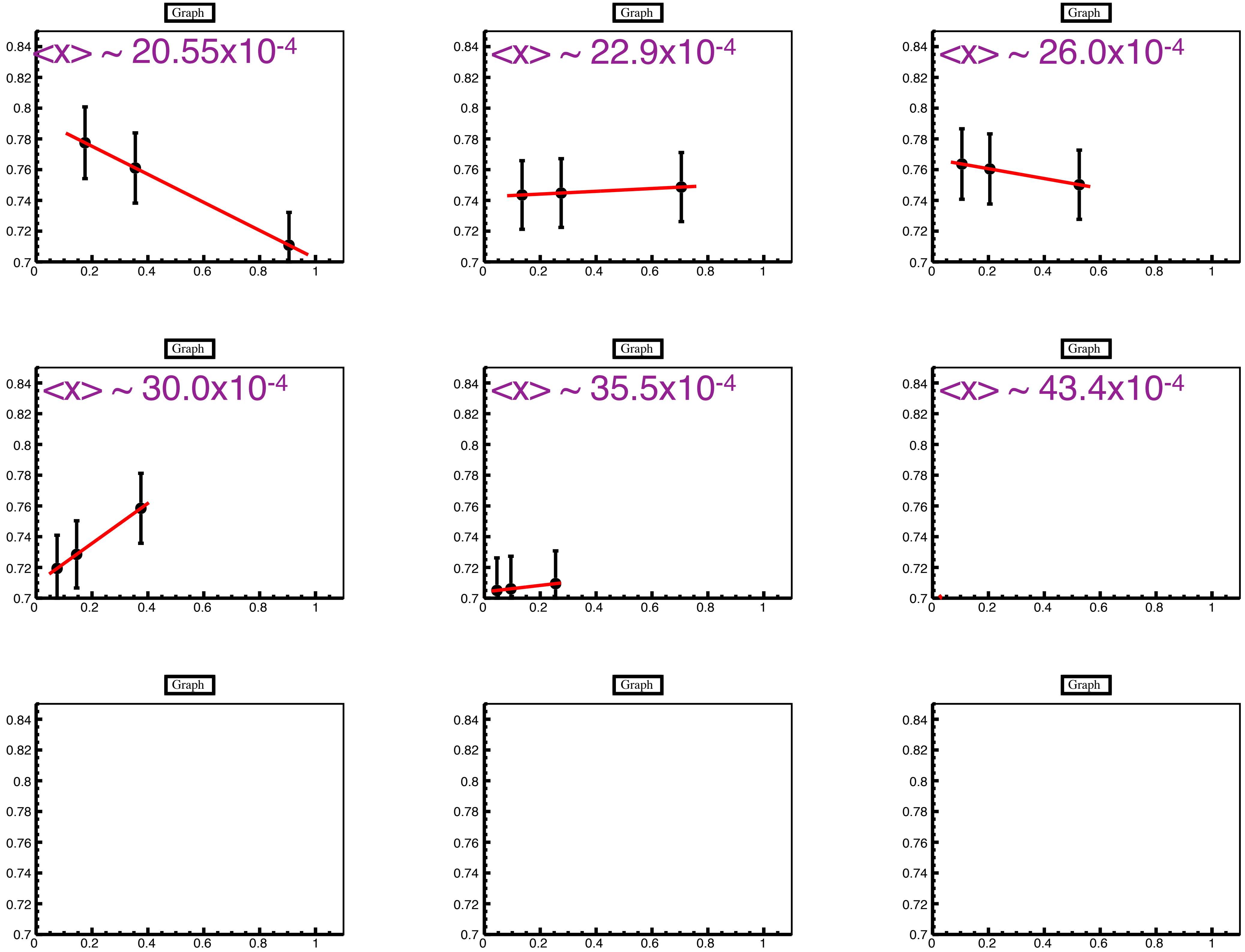
$1.778 < Q^2 < 3.162$: Reduced Cross-sections e+Au: $\int L dt = 10$



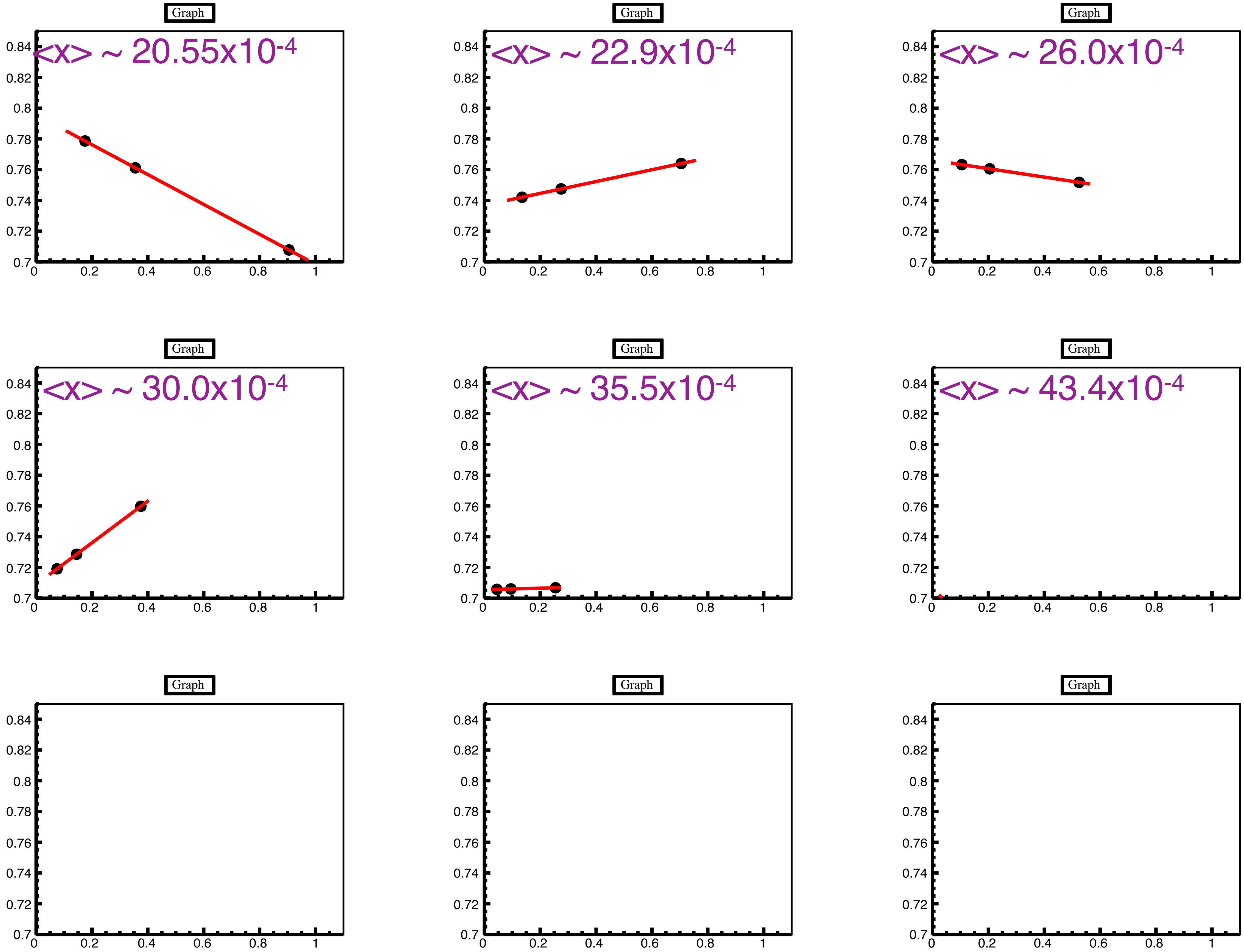
3.162 < Q^2 < 5.623: Reduced Cross-sections e+Au: ∫Ldt = 10



$5.623 < Q^2 < 10$: Reduced Cross-sections e+Au: $\int Ldt = 10\ fb^{-1}$



5.623 < Q^2 < 10: Reduced Cross-sections e+Au: ∫Ldt = 10 fb^{-1}



Summary and conclusions

- Bug fixed!
- F_2 and F_L calculation is NOT luminosity dependent!
  - ➡ Systematic uncertainties drive the measurement
    - Need to be understood as well as possible
  - ➡ Acceptance (and hence beam energy) is crucial for getting into a regime where we can have x and Q^2 dependence of F_2, F_L.