Update on the $\frac{A(e,e'pp)}{A(e,e'p)}$ Analysis

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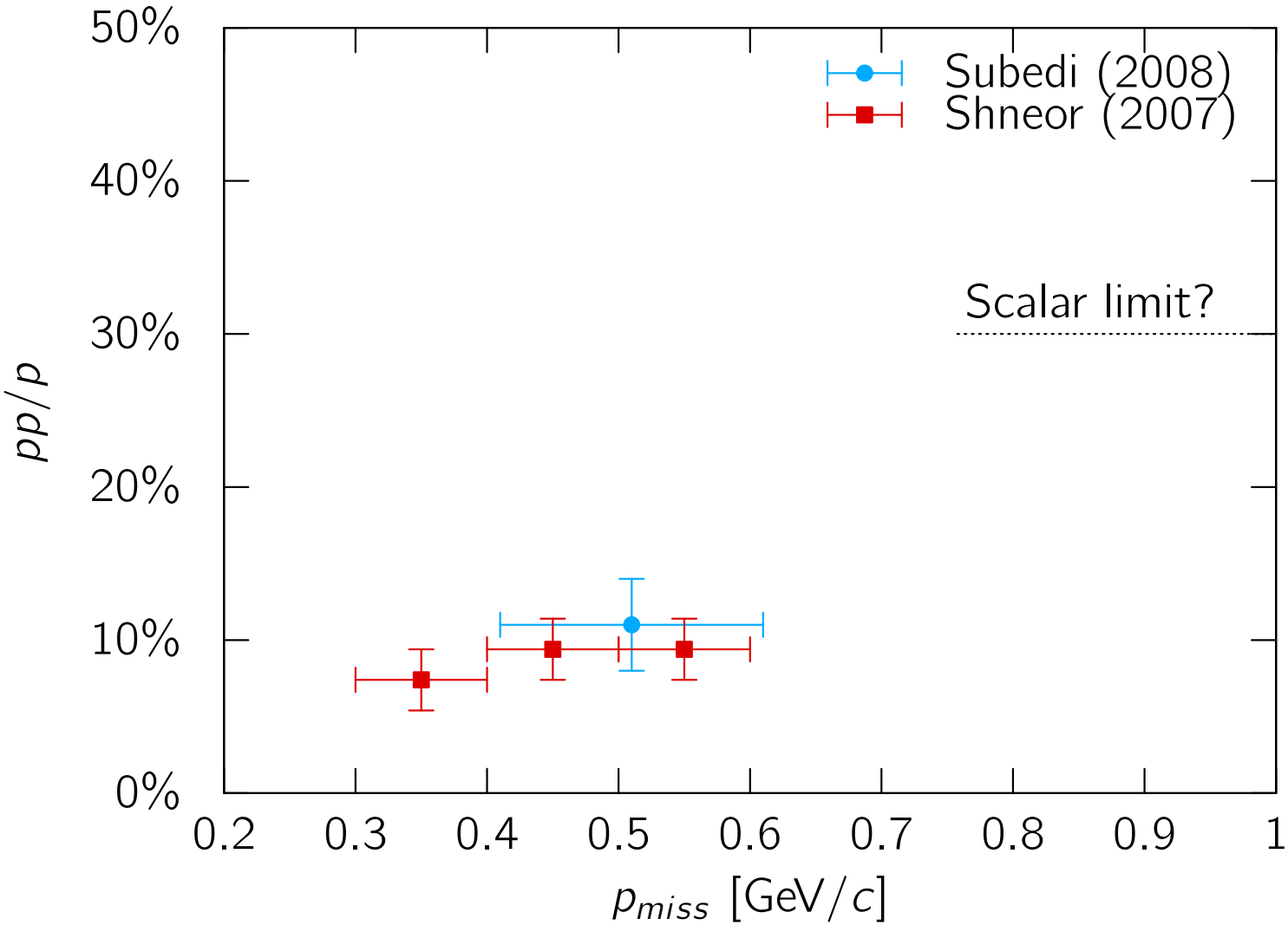
How does *np*-dominance evolve with momentum?



pp/p analysis using EG2 data

1. Select $A(e, e'p)$ events in which the p comes from an SRC pair.
   - Exact same root trees as Or and Erez use.

2. See how often there is an additional proton in coincidence.

pp/p analysis using EG2 data

$$\frac{pp}{p} = \frac{\sigma_{e'pp}}{\sigma_{e'p}}$$

pp/p analysis using EG2 data

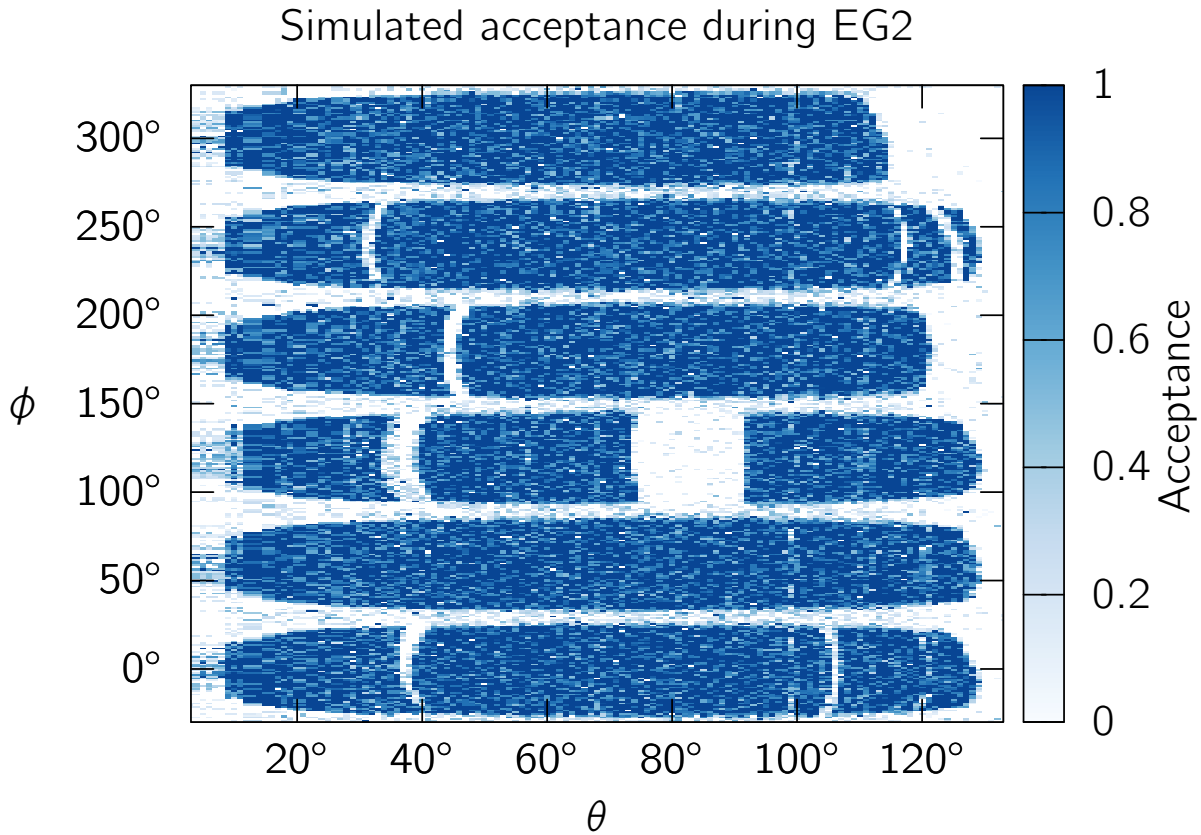
$$\frac{pp}{p} = \frac{\sigma_{e'pp}}{\sigma_{e'p}}$$
$$= \frac{N_{e'pp}}{N_{e'p}} \times \frac{A(e')A(p_{\text{lead}})}{A(e')A(p_{\text{lead}})A(p_{\text{recoil}})}$$

pp/p analysis using EG2 data

$$\begin{aligned}
\frac{pp}{p} &= \frac{\sigma_{e'pp}}{\sigma_{e'p}} \\
&= \frac{N_{e'pp}}{N_{e'p}} \times \frac{A(e')A(p_{\text{lead}})}{A(e')A(p_{\text{lead}})A(p_{\text{recoil}})} \\
&= \frac{N_{e'pp}}{N_{e'p}} \times \frac{1}{A(p_{\text{recoil}})}
\end{aligned}$$

The acceptance for recoil protons is non-trivial.

- Angular dependence



- Minimum momentum: 350 MeV/c

The acceptance for recoil protons is non-trivial.

1. Where do the recoil protons go?
2. $\rightarrow$ What is the SRC pair center-of-mass momentum distribution?

$$p_{C.M.} = p_{\text{miss}} + p_{\text{rec.}}$$

Erez showed that the longitudinal CM distribution has p_{miss} dependence.

Erez's 5-parameter model:
The CM distribution is a 3D Gaussian with μ, σ:

Longitudinal to p_{miss}:

- Width: $\sigma_{\parallel} = \mathbf{a}_1(p_{\text{miss}} - 0.6\ \text{GeV}) + \mathbf{a}_2$
- Mean: $\mu_{\parallel} = \mathbf{b}_1(p_{\text{miss}} - 0.6\ \text{GeV}) + \mathbf{b}_2$

Transverse to p_{miss}:

- Width: $\boldsymbol{\sigma}_{\perp}$
- Mean: $\mu_{\perp} = 0$

Data-driven likelihood estimate

Given a guess of $a_1, a_2, b_1, b_2, \sigma_\perp$:

1. For each $A(e, e'p)$ event in data:
   - Randomly sample many $\vec{p}_{CM}$ vectors using 3D Gaussian.
     - Test if $\vec{p}_{\text{recoil}}$ is accepted using simulated maps.

2. For each $A(e, e'pp)$ event in data:
   - Test against pseudodata distributions from step 1.

Data-driven likelihood estimate

Data:

Model:

$a1 = 0.185$

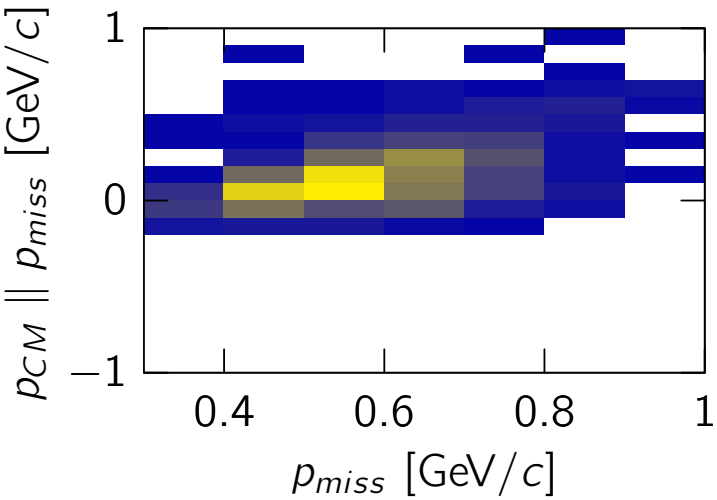
$a2 = 0.202$

$b1 = 0.713$

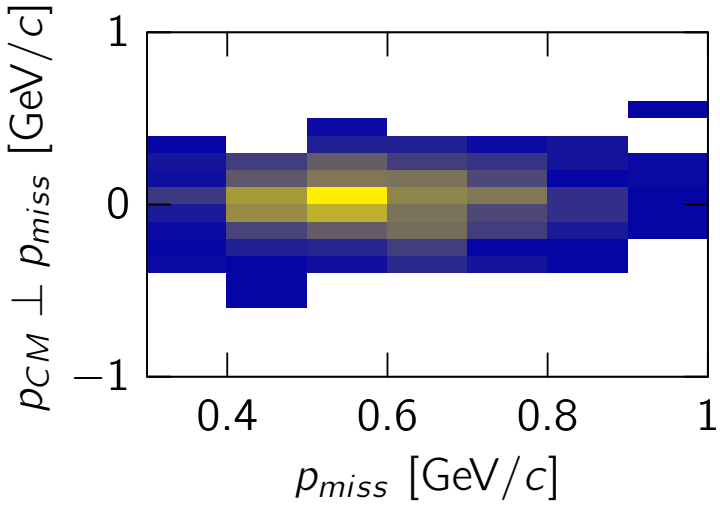
$b2 = 0.278$

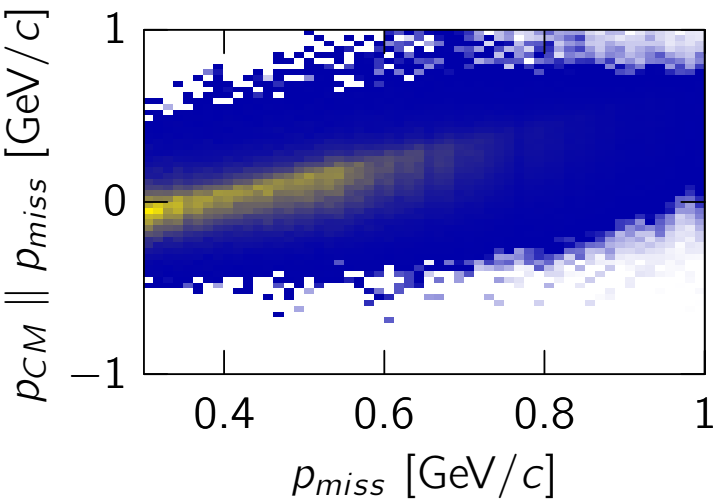
$\sigma_\perp = 0.151$

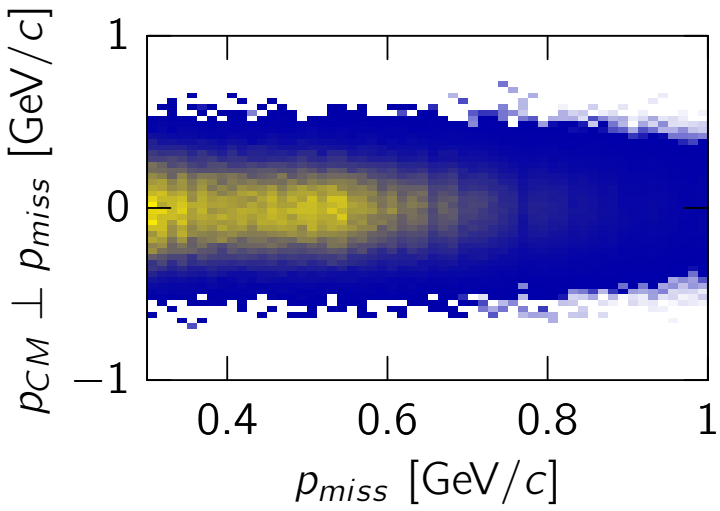
Longitudinal



Transverse



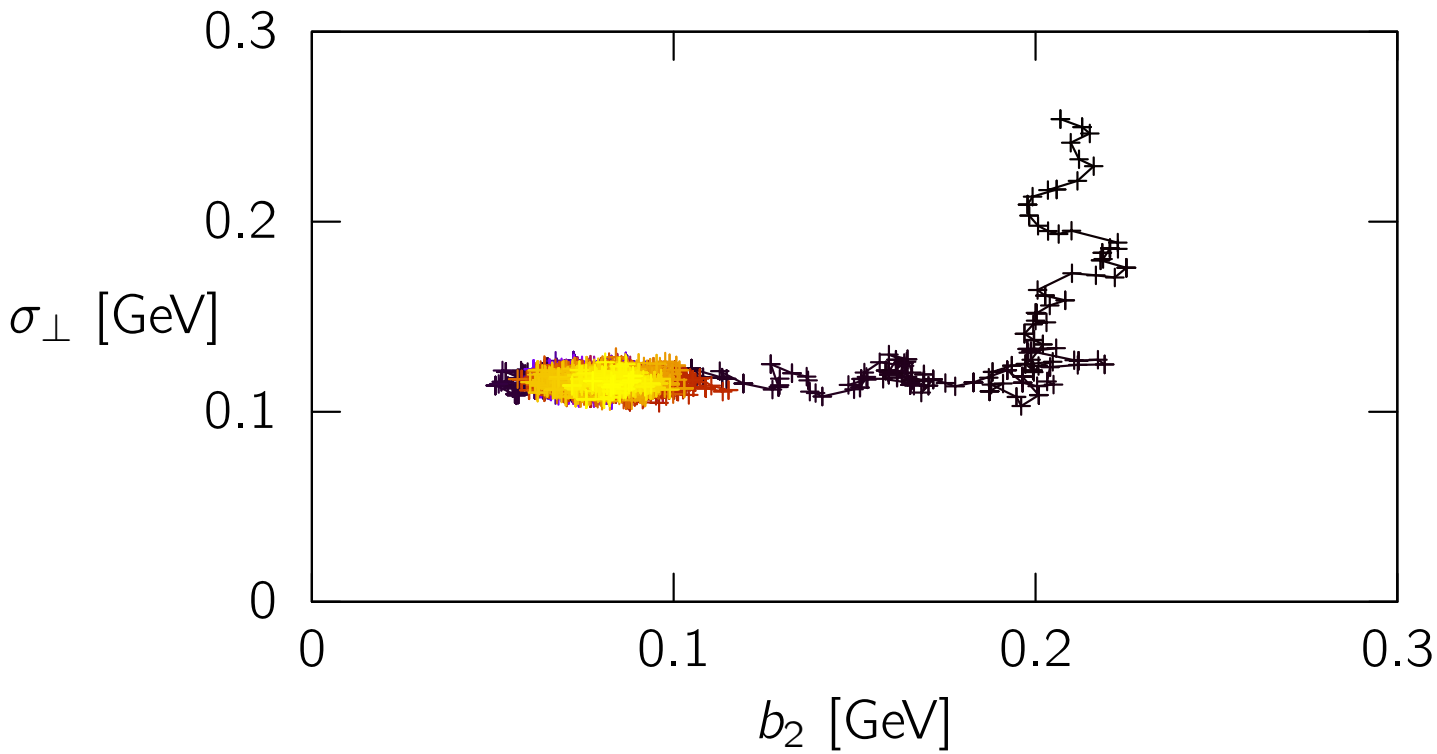




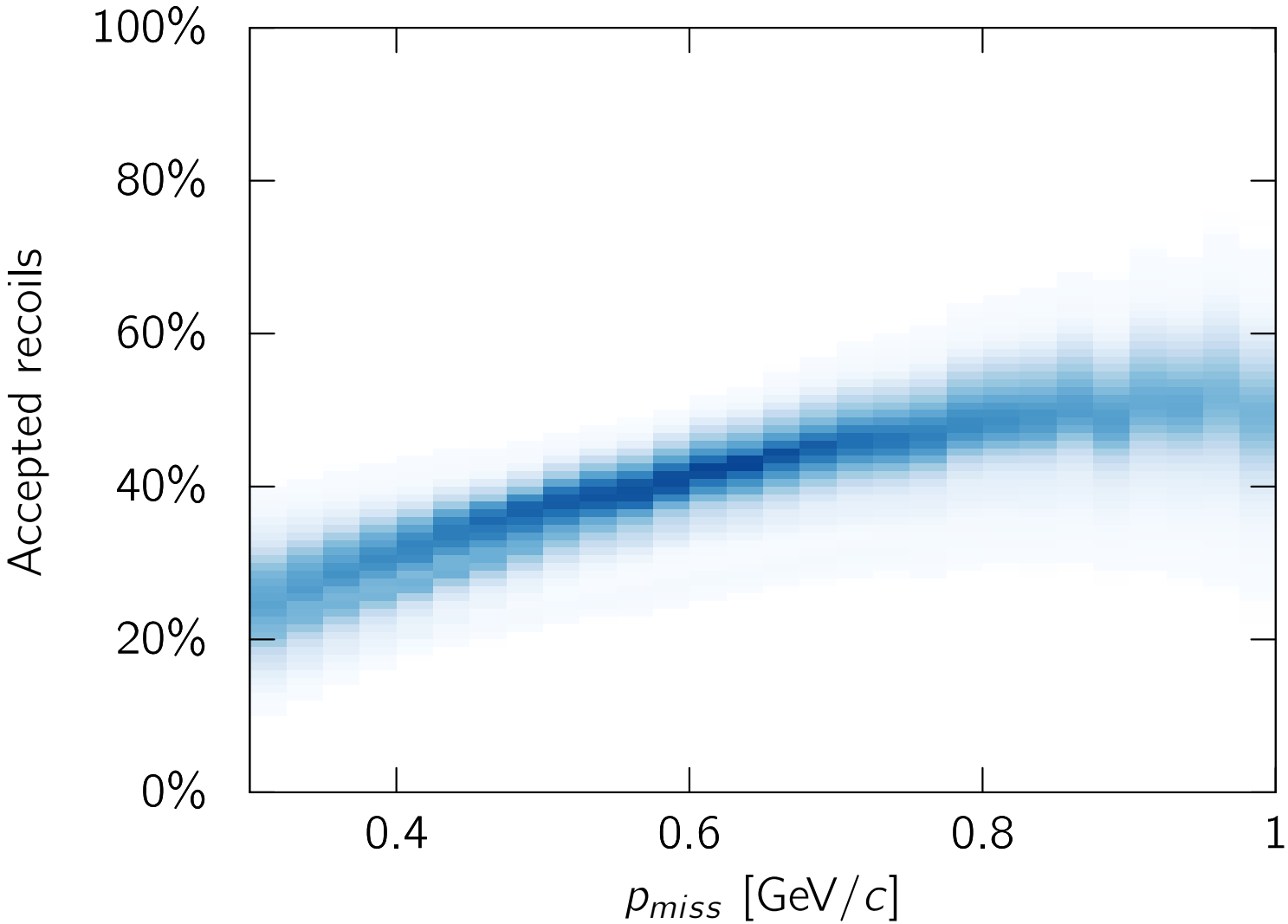
Markov Chain Monte Carlo will help us integrate.

Metropolis-Hastings Algorithm

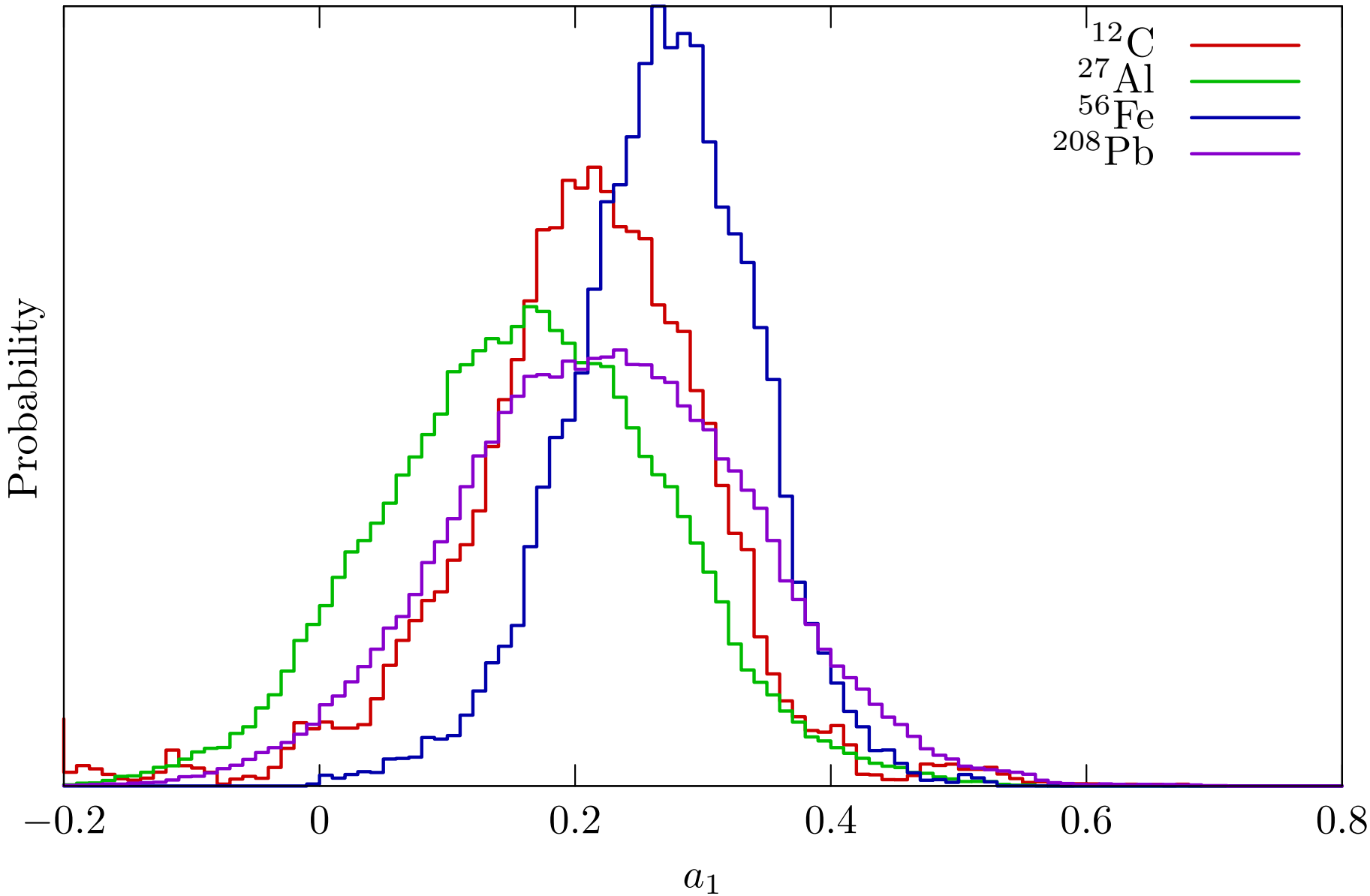
- Random walk in 5D $(a_1, a_2, b_1, b_2, \sigma_\perp)$ space
- Choose steps so that frequency $\sim$ probability



Each random walk point predicts one acceptance.



The results for each parameter:



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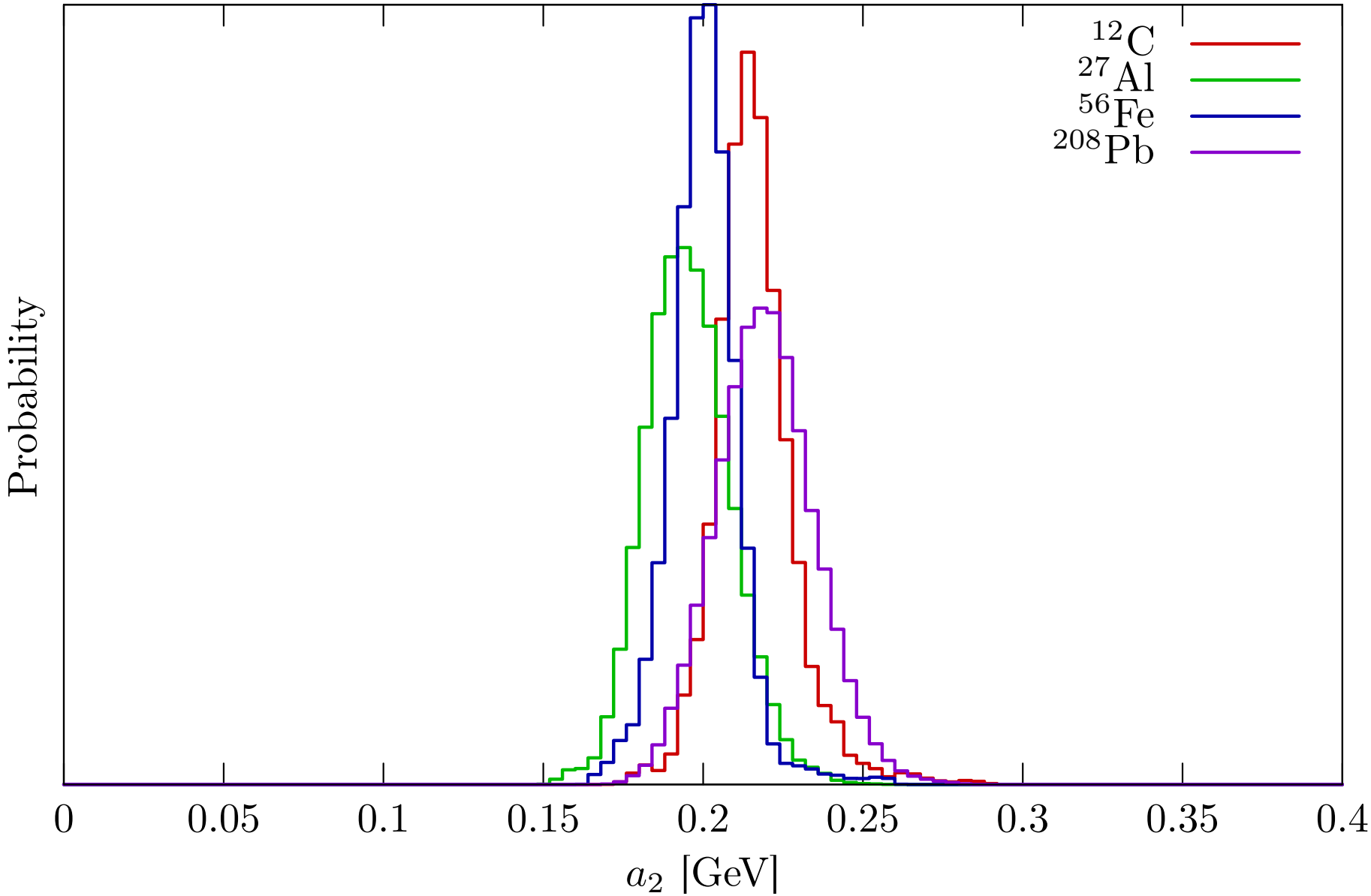

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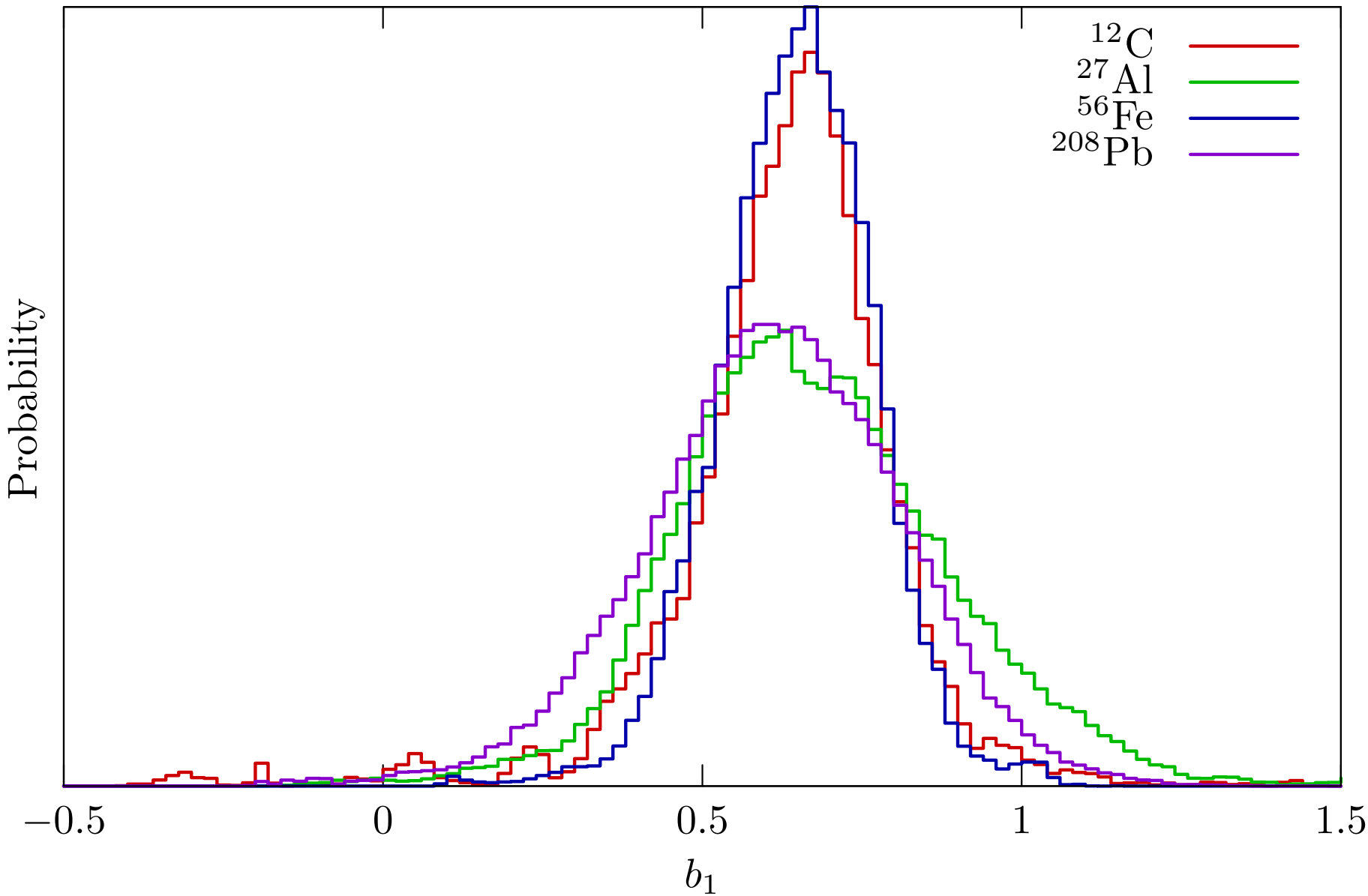

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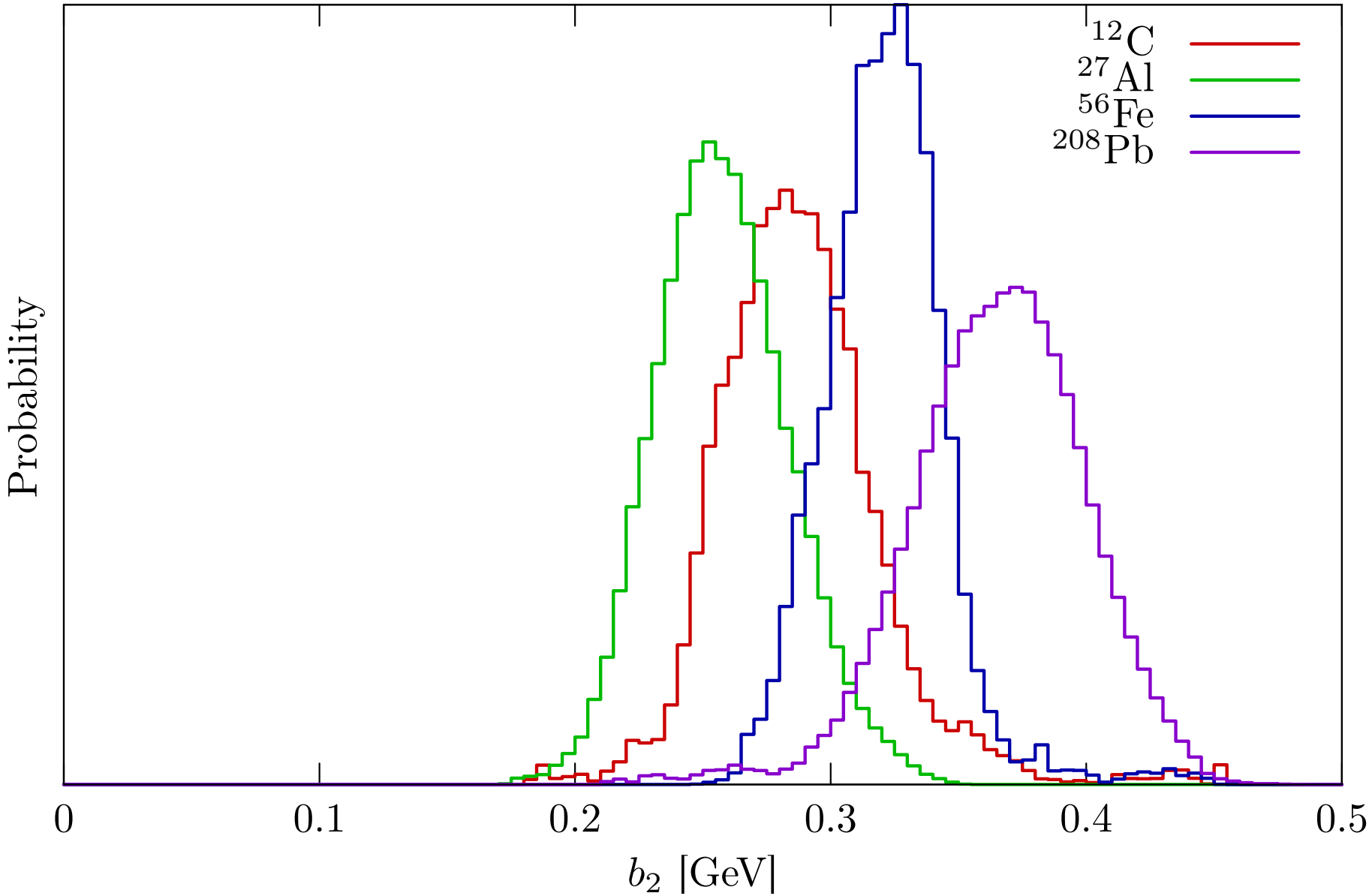

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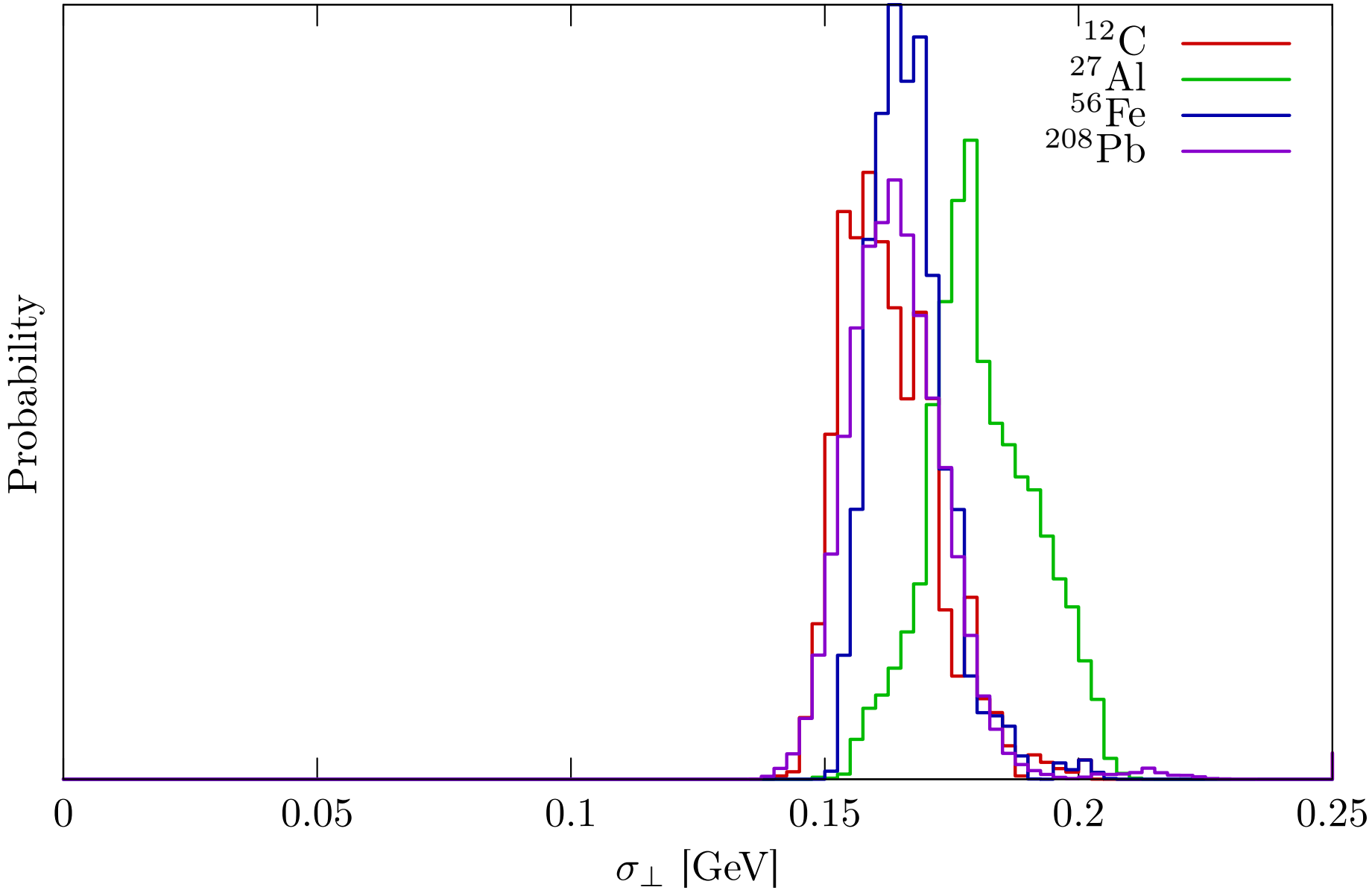
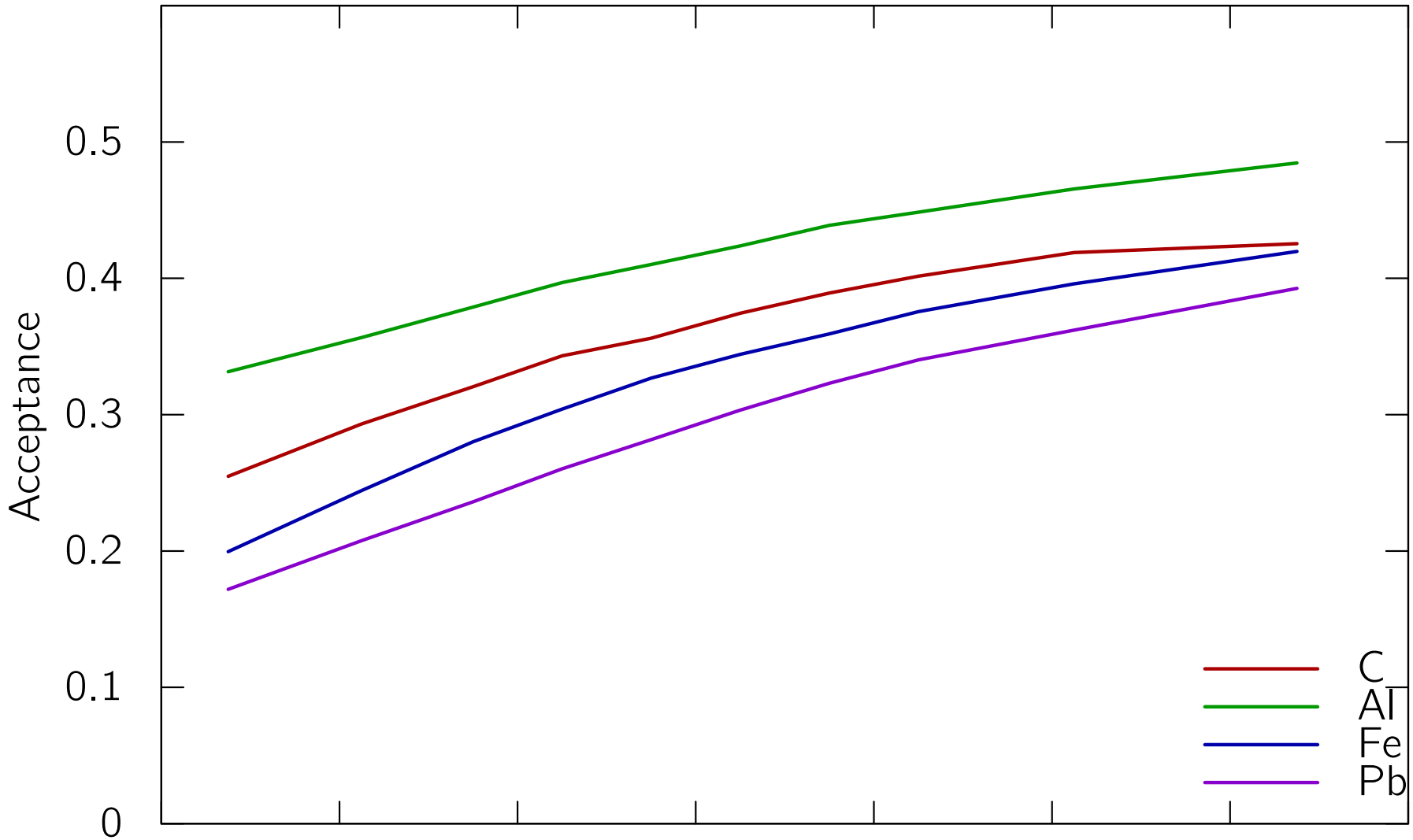
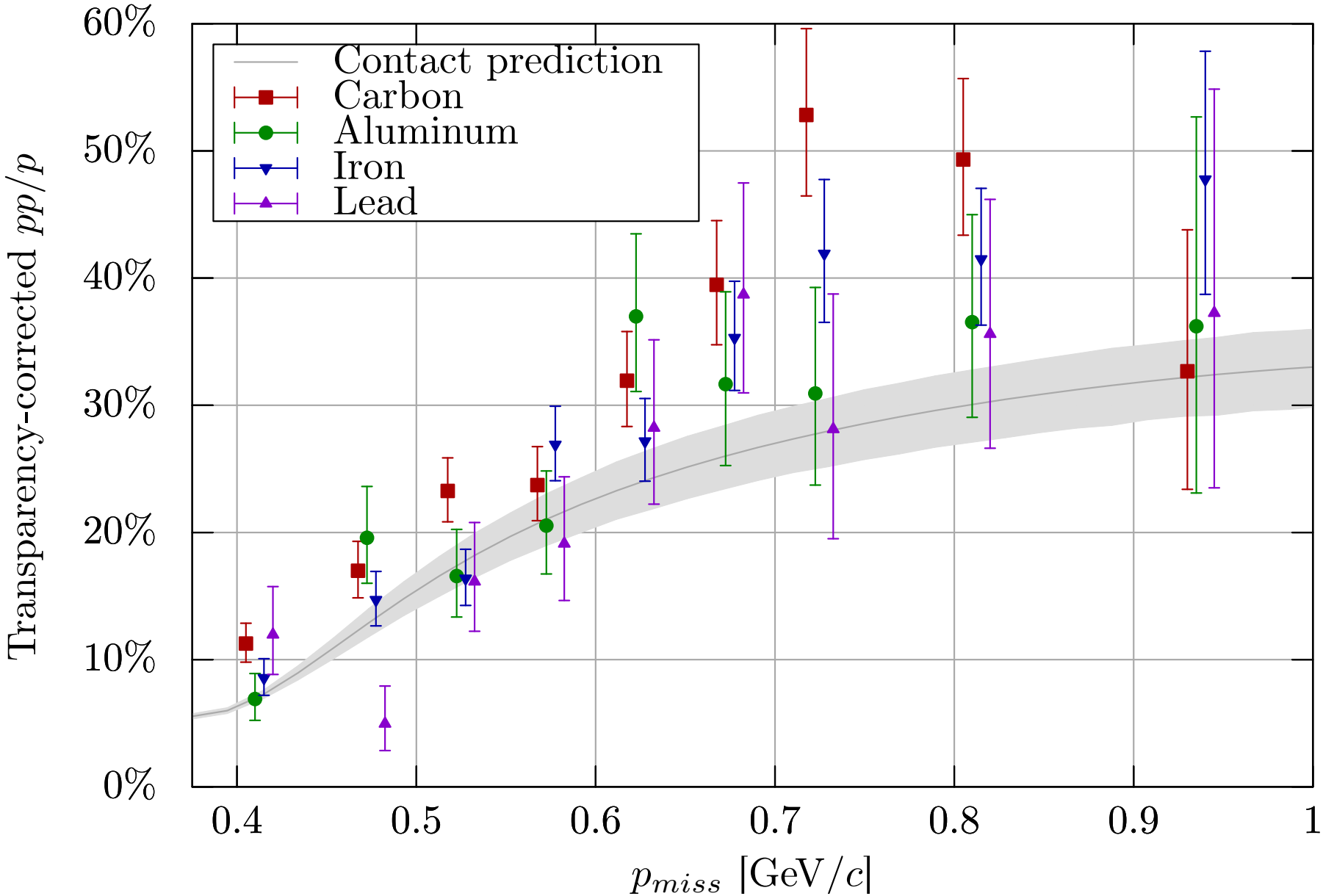


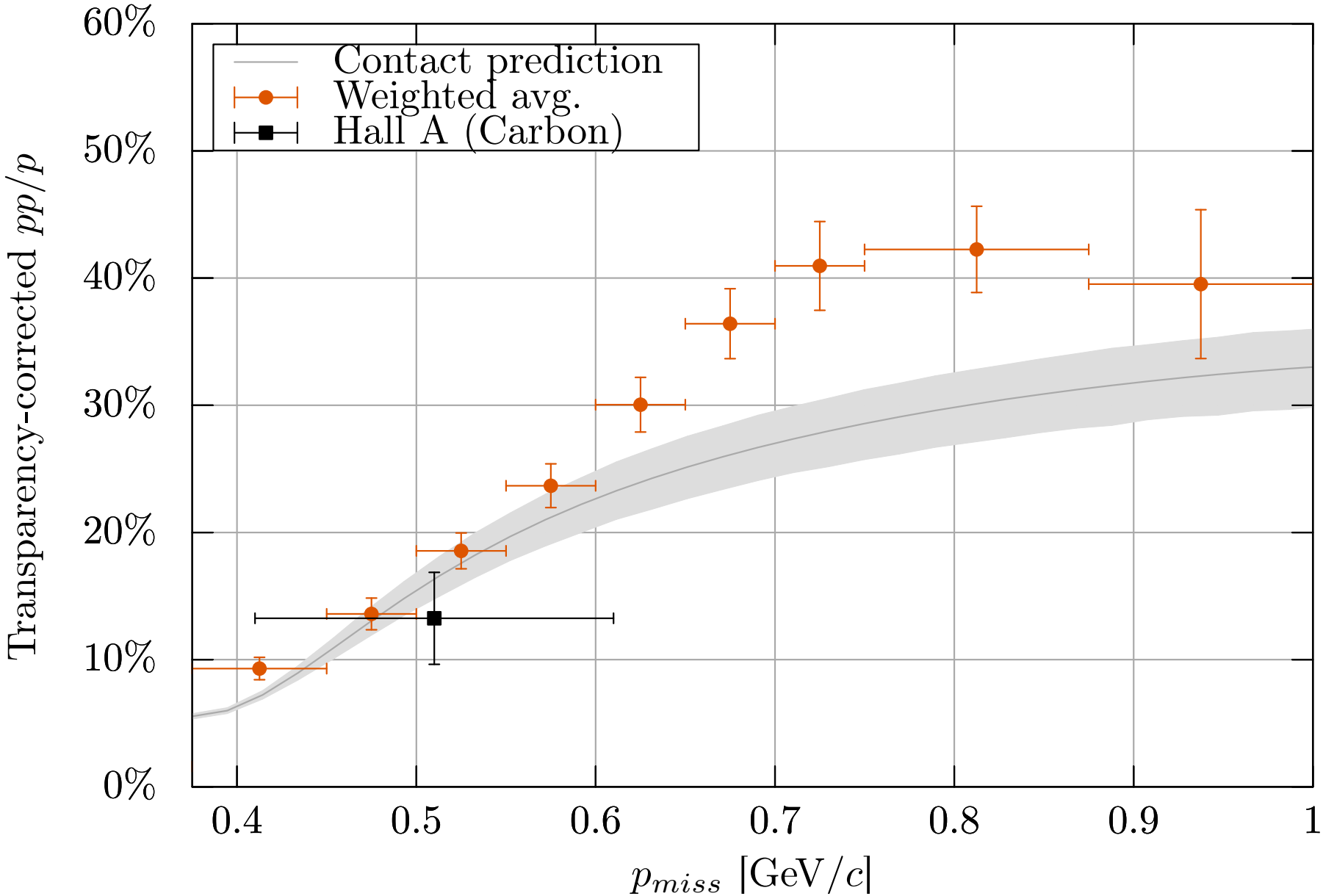
The most-likely correction factors for each nucleus.



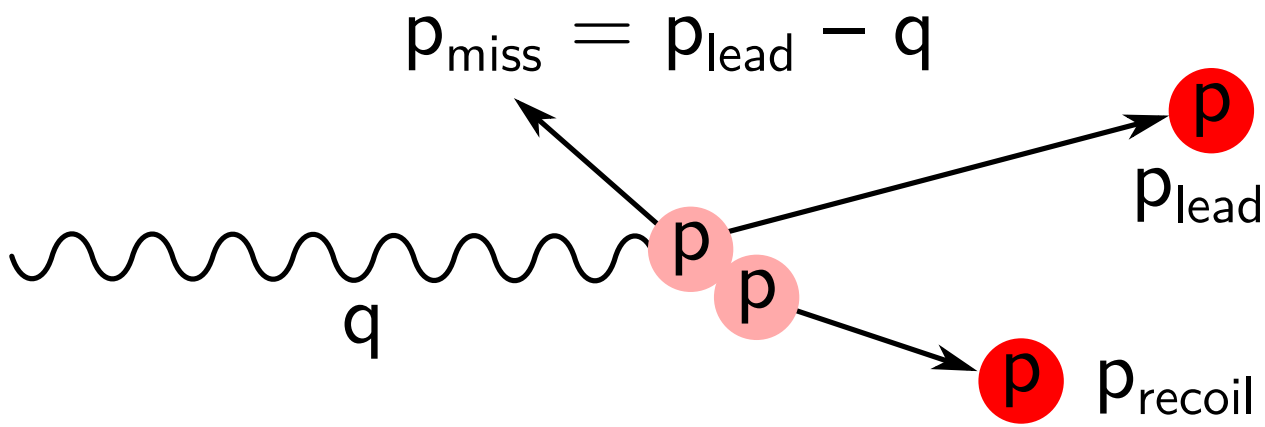
Results


Contact prediction
Carbon
Aluminum
Iron
Lead
60%
50%
40%
30%
20%
10%
0%
Transparency-corrected pp/p
0.4
0.5
0.6
0.7
0.8
0.9
1
p_{miss} [GeV/c]

Results


Contact prediction
Weighted avg.
Hall A (Carbon)
60%
50%
40%
30%
20%
10%
0%
Transparency-corrected pp/p
0.4
0.5
0.6
0.7
0.8
0.9
1
p_{miss} [GeV/c]

Acceptance is most sensitive to b_2.



b_2 encodes the mean in the longitudinal direction.

Since $\vec{p}_{miss}$ is anti-parallel to $\vec{q}$, large b_2 reduces recoil momentum below 350 MeV/c threshold.

What systematics do we need to consider, and how to estimate them?

- Minor stuff:
  - Vary hyper-parameters
  - Q^2 dependence, $\theta_{p_{\text{miss}}q}$ dependence
- Do we try to restrict b_2?

Preliminary closure test

Can the algorithm reproduce model parameters of our choosing?