Multiplicity and net-charge fluctuations in system size and energy scan of NA61/SHINE

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System-size and energy dependence

Presented results:

- multiplcity fluctuations of charged unidentified hadrons: h^-;
- net-electric charge (refered as net-charge): $h^+ - h^-$

in p+p, Be+Be and Ar+Sc interactions at $\sqrt{s_{NN}} = 6.1 - 17.3$ GeV.

These results refer to charged hadrons produced in inelastic interactions by strong interaction processes and in electromagnetic decays of produced hadrons. Biases of other effects are either corrected for (p+p) or estimated and indicated as arrows (A+A).

Quantitative measures of fluctuations - intensive quantities:

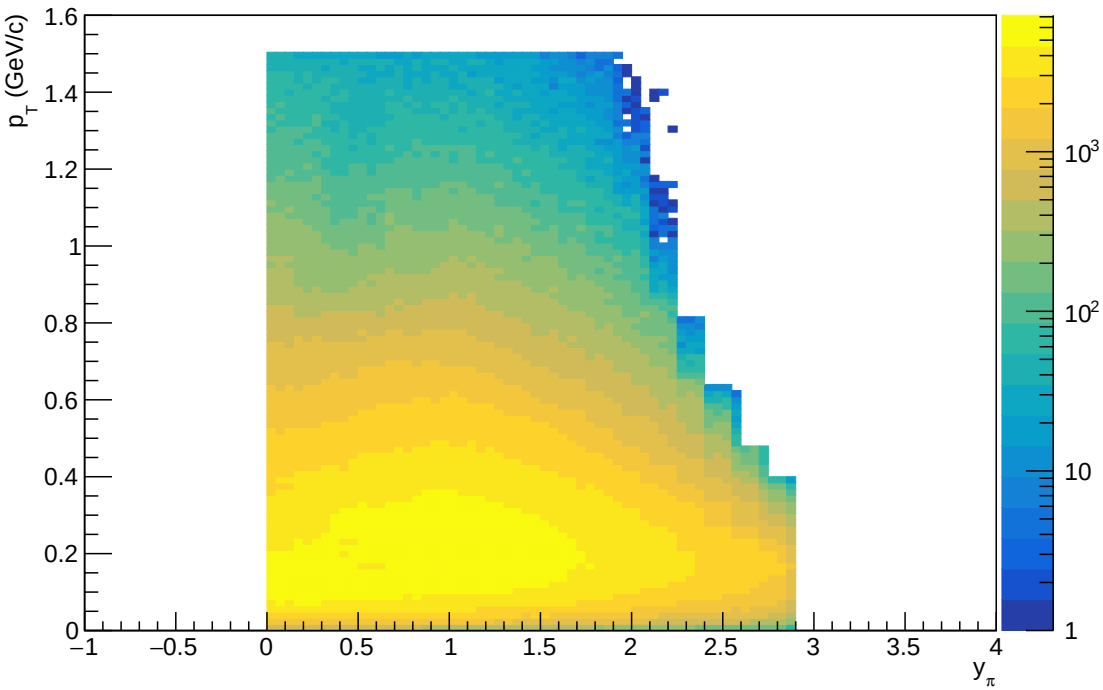
$$\frac{\kappa_2[A]}{\kappa_1[A]} = \omega[A] \quad \frac{\kappa_3[A]}{\kappa_2[A]} = S\sigma[A] \quad \frac{\kappa_4[A]}{\kappa_2[A]} = \kappa\sigma^2[A],$$

where $\kappa_i[A]$ is ith cumulant of a given distribution.

Phase-space acceptance

Fluctuations are not corrected for limited detector acceptance thus it has to be included as part of results:

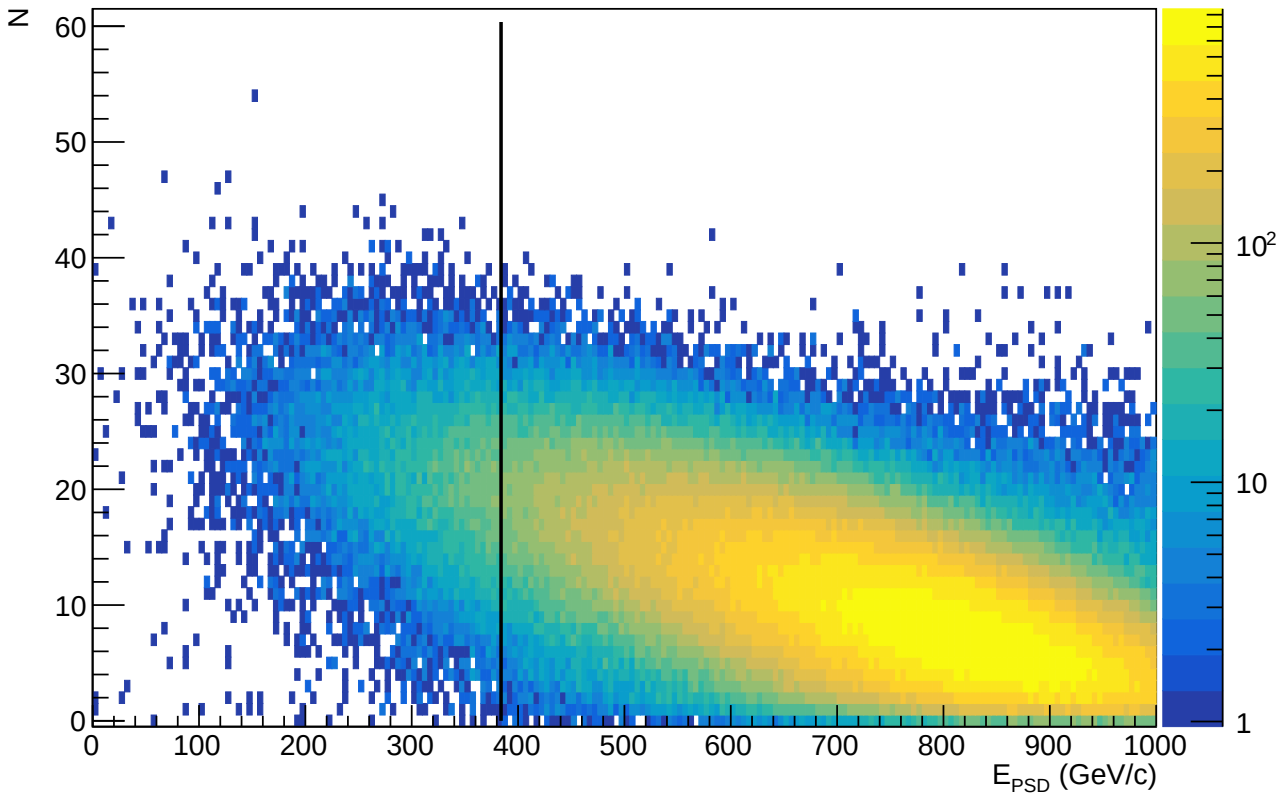
NA61/SHINE detector acceptance + rapidity cut ($0 < y_\pi^{CMS} < y_{beam}$)



For p+p: $x = \frac{\langle n \rangle}{\langle N \rangle} = 0.27, 0.3, 0.3, 0.4, 0.5$ at $\sqrt{s_{NN}} = 6.3, 7.6, 8.7, 12.3, 17.3$ GeV

Centrality selection in A+A collisions

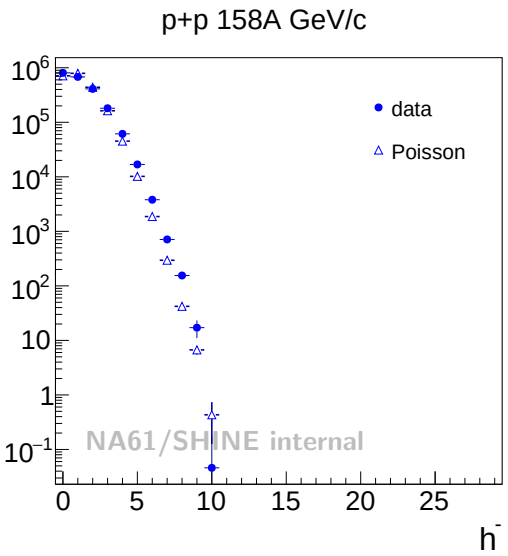
NA61/SHINE uses a lead/scintillator calorimeter (Projectile Spectator Detector) to measure forward energy (mostly spectators). Based on this energy 1% of most central events was selected for the analysis[1].

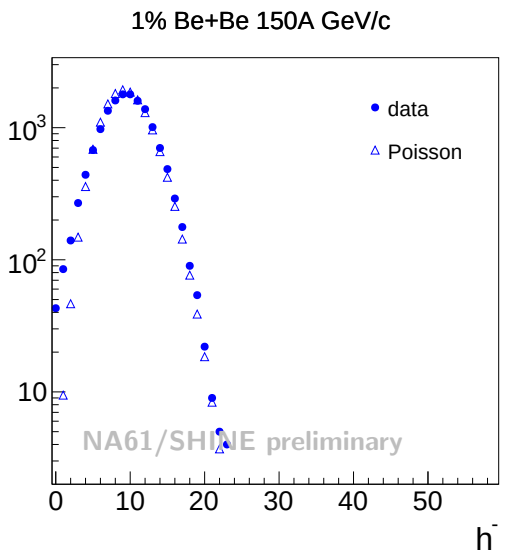


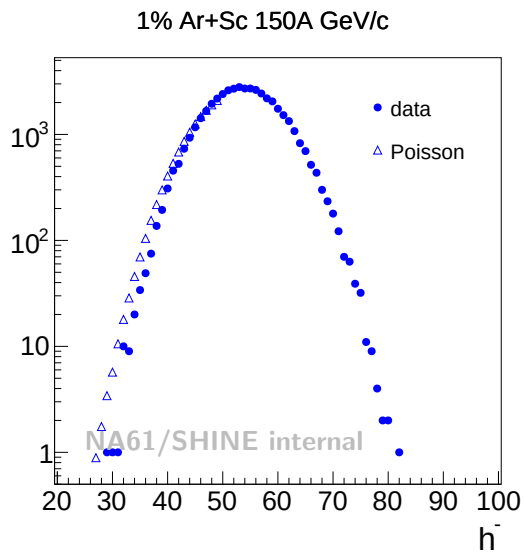
[1] https://edms.cern.ch/document/1867336/1

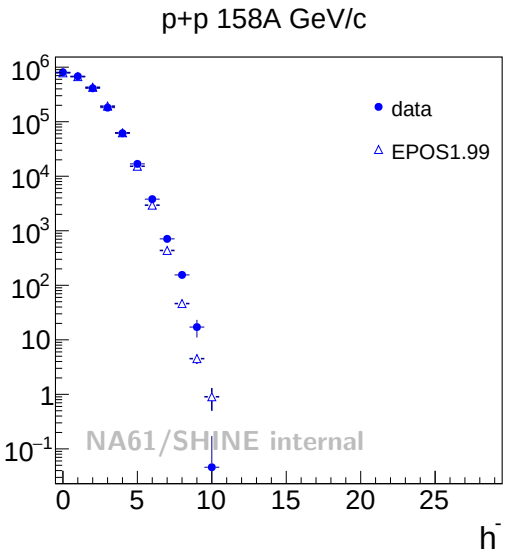
Multiplicity distributions

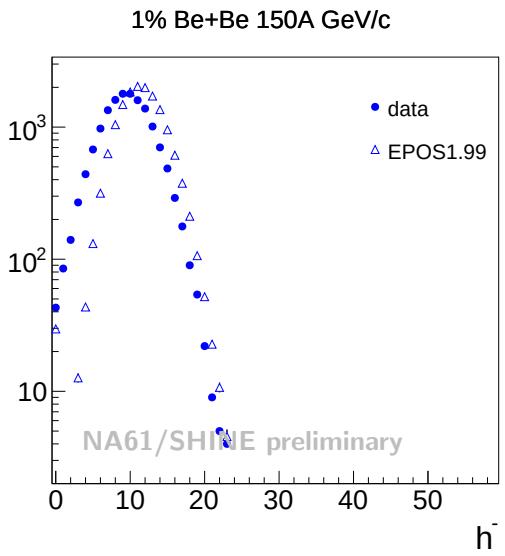
Multiplicity distributions of h^- at 16.8(17.3) GeV - model comparison

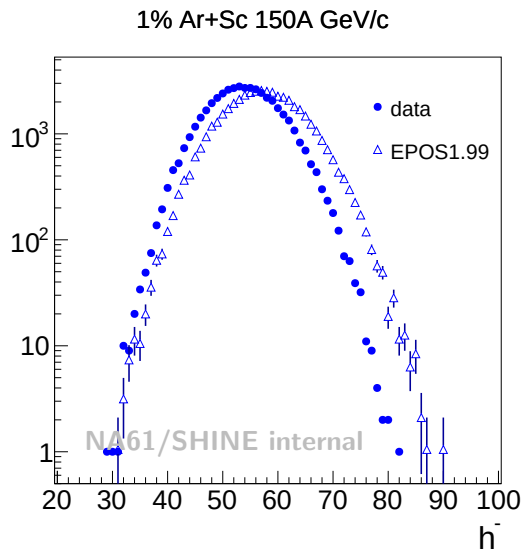




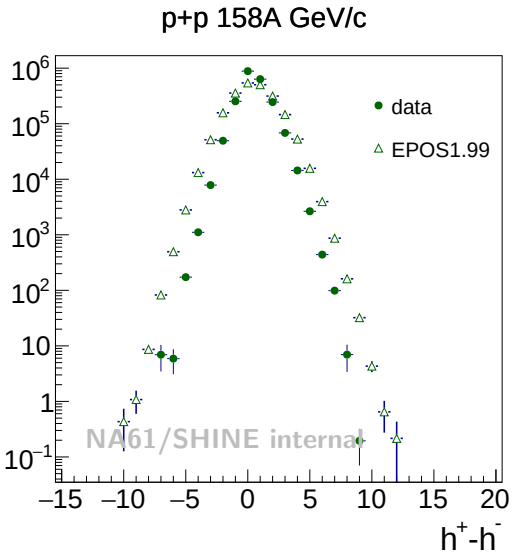


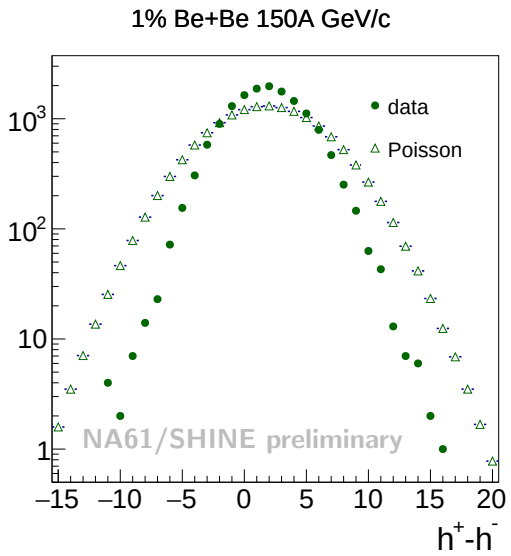


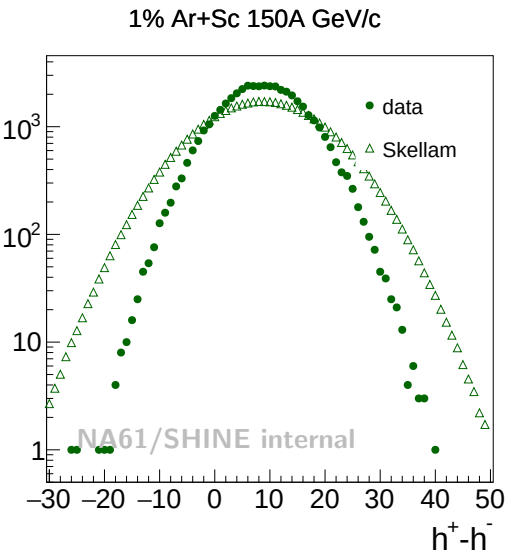


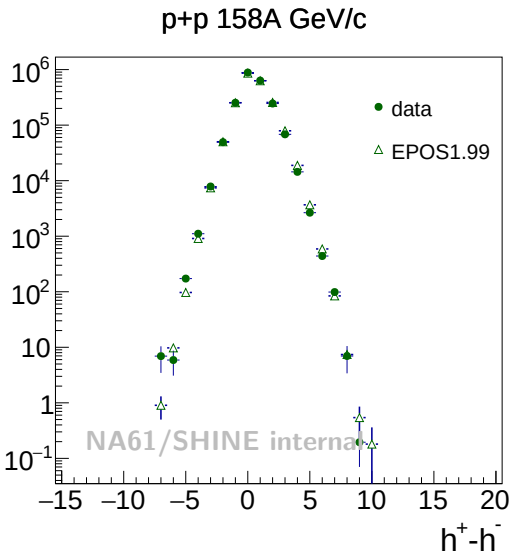


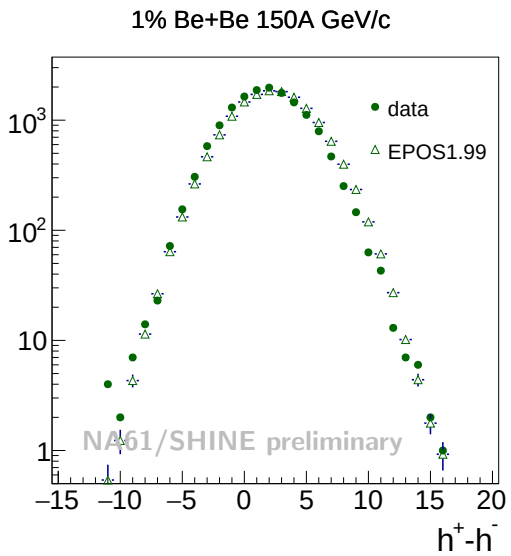
Net-charge distributions at 16.8(17.3) GeV - model comparison

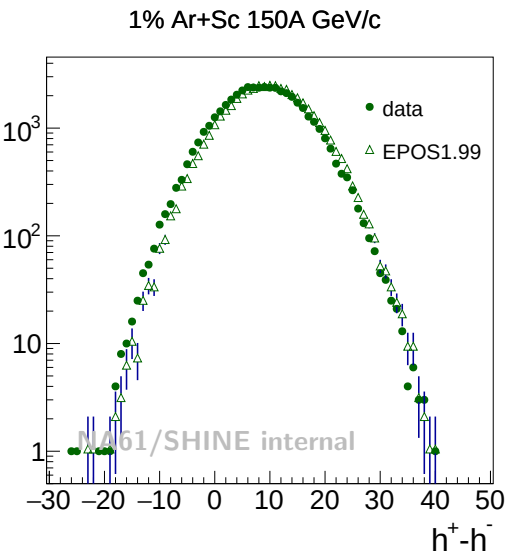






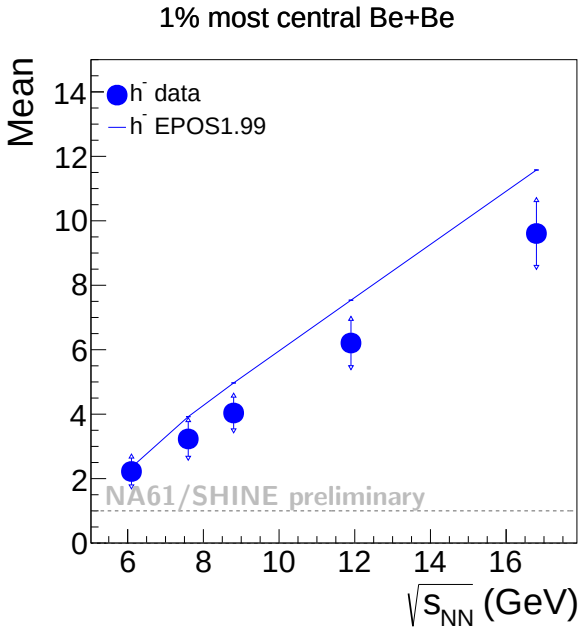


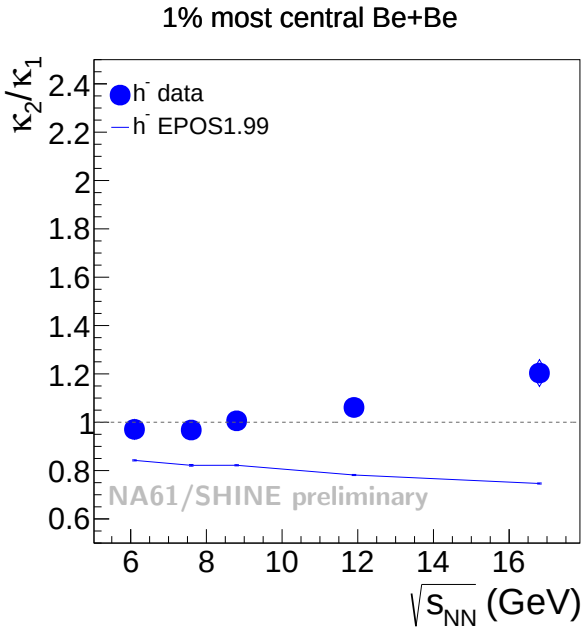


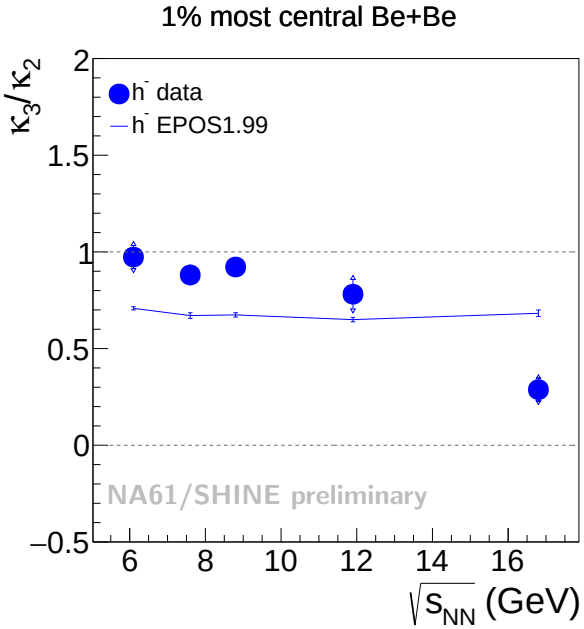


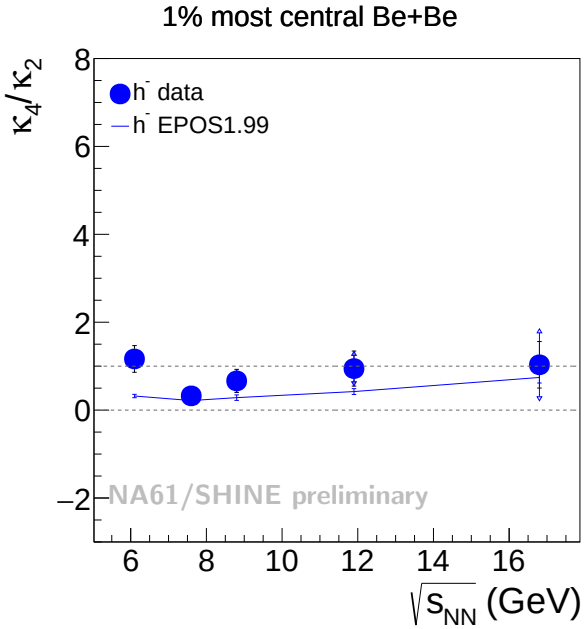
Intensive quantities

Energy dependence of h^- - comparison with EPOS

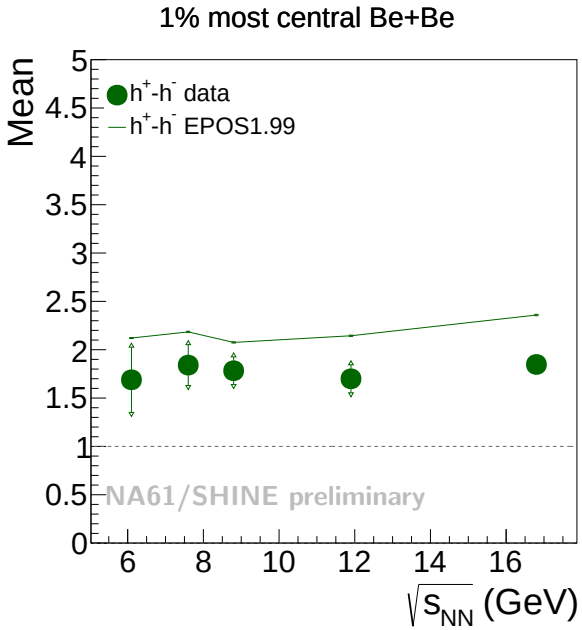


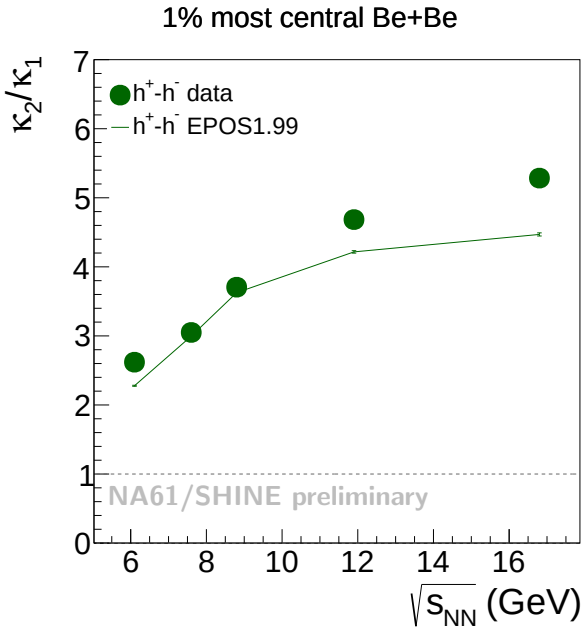


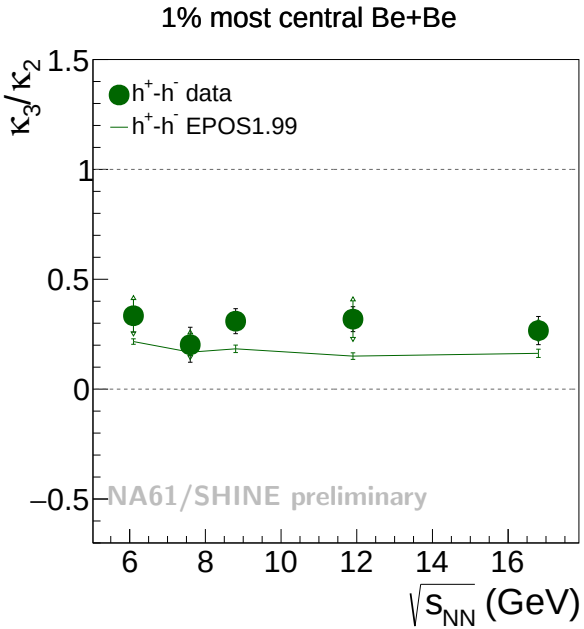


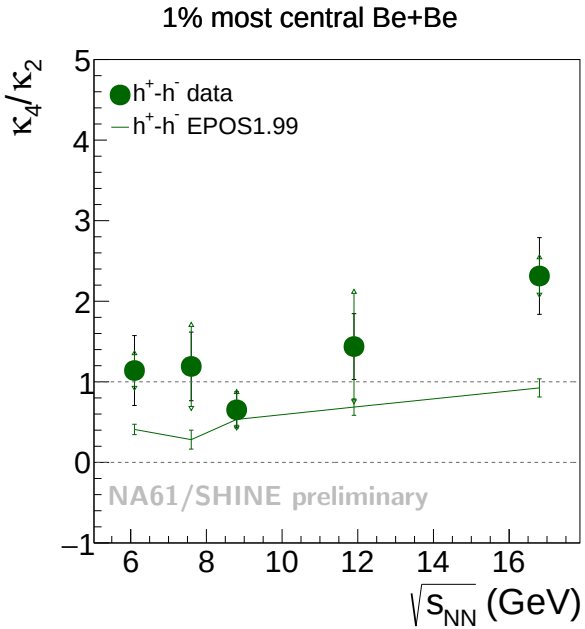


Energy dependence of net-charge - comparison with EPOS

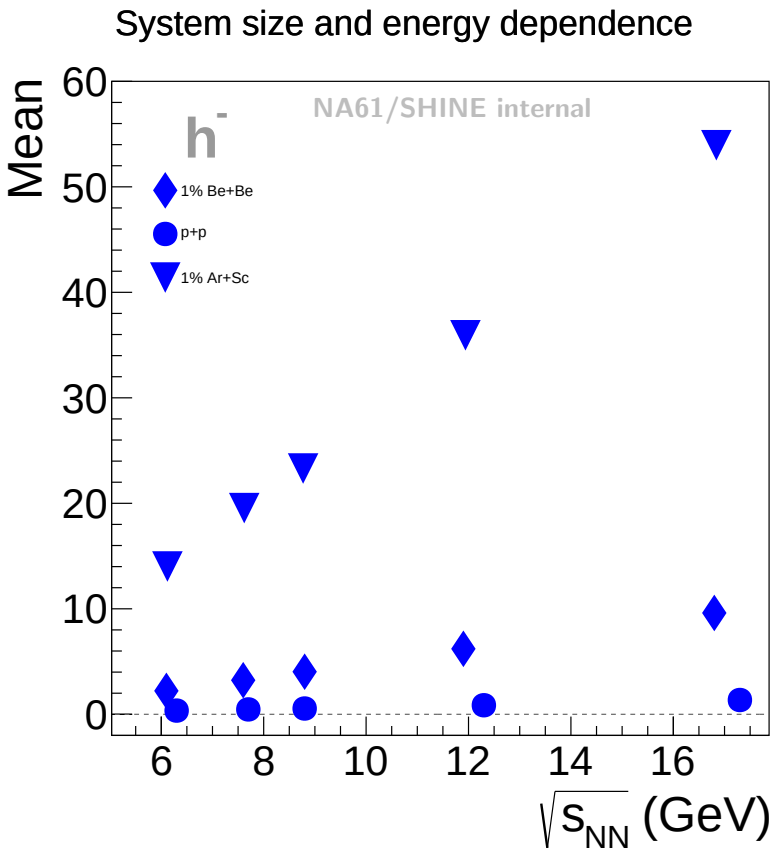


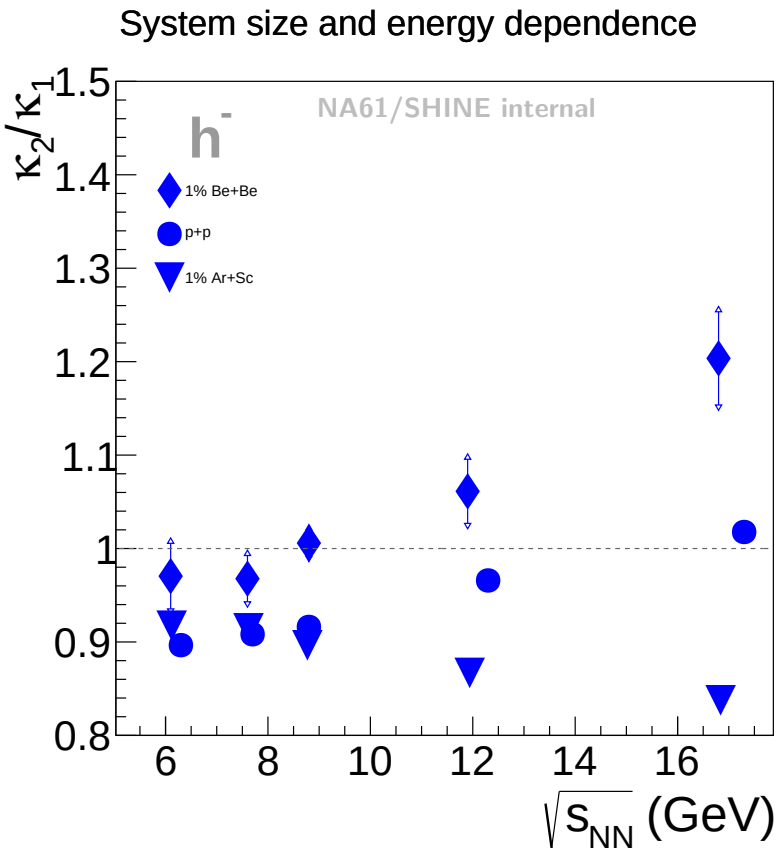




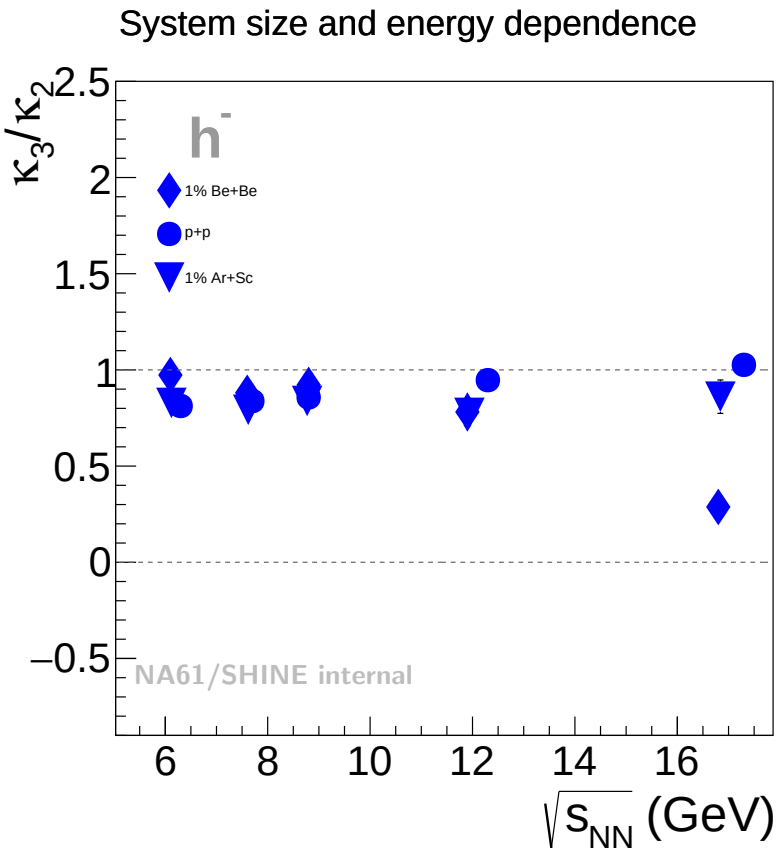


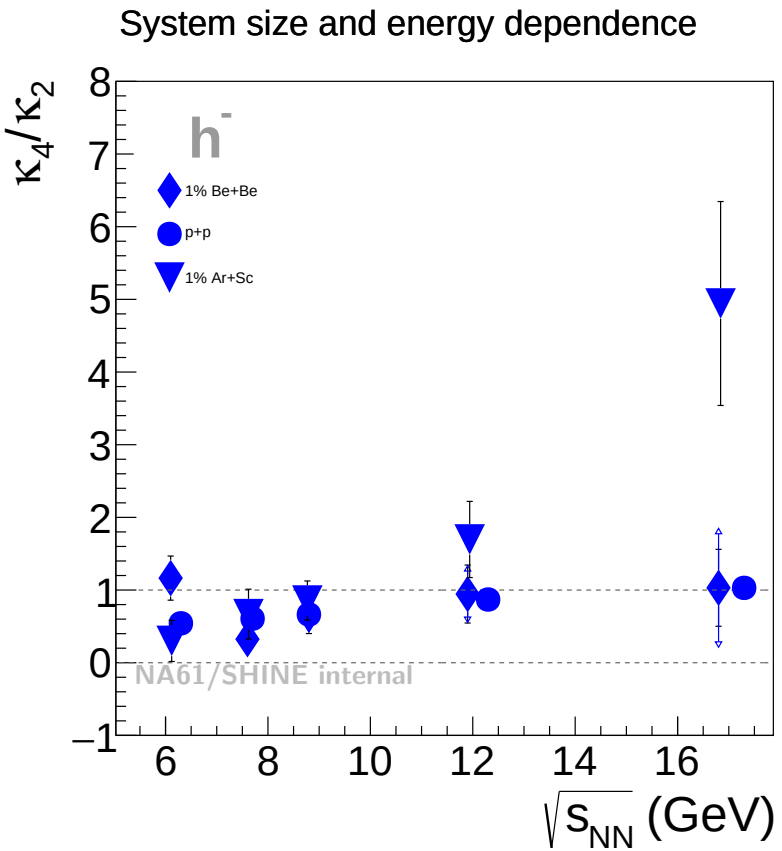
System size and energy dependence of h^-



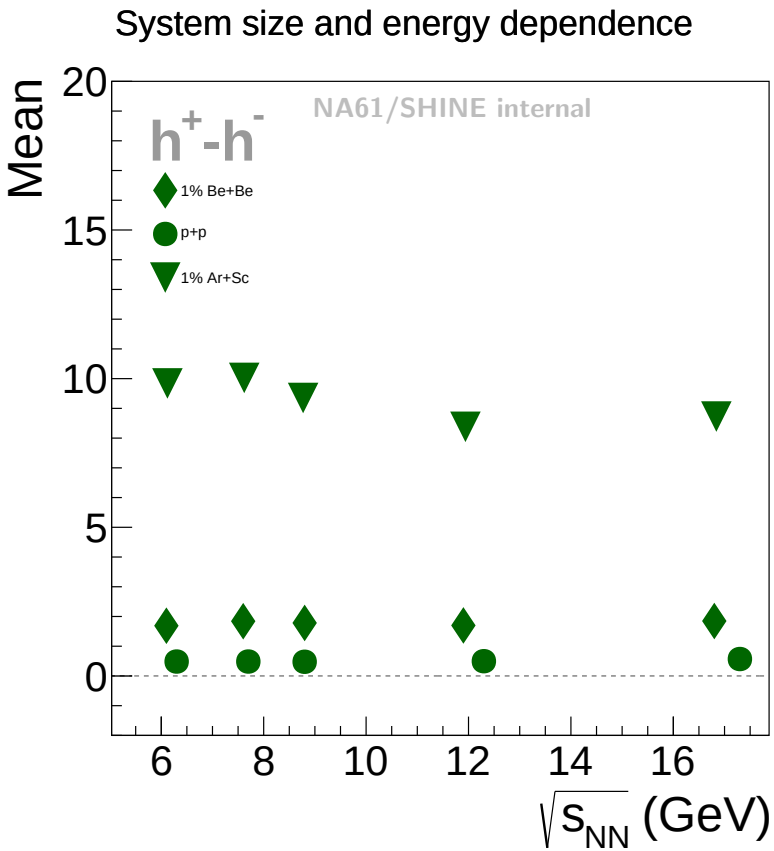


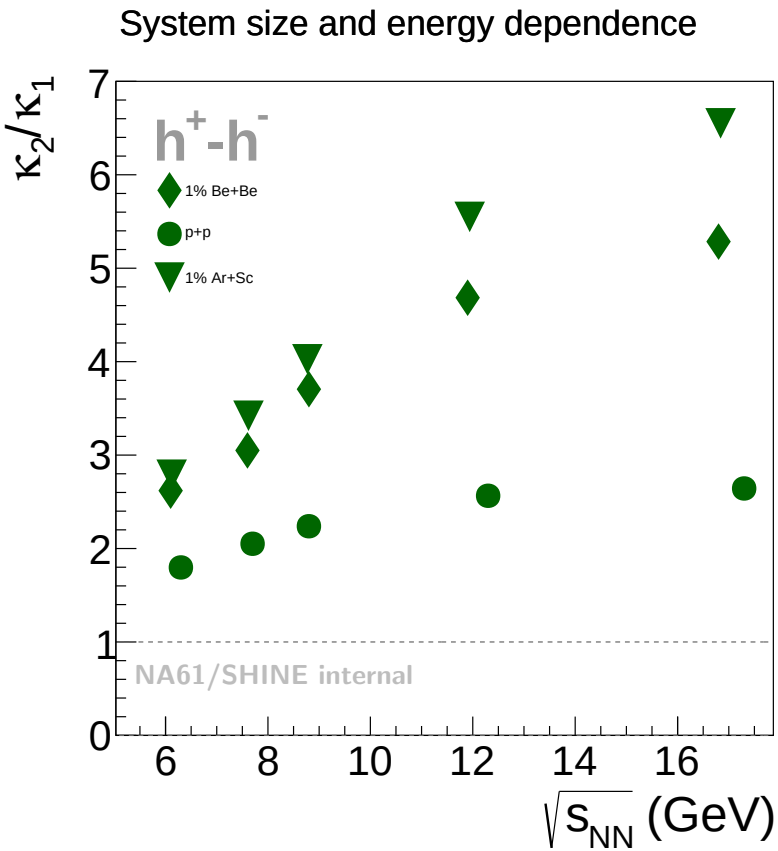
System size and energy dependence of h^-



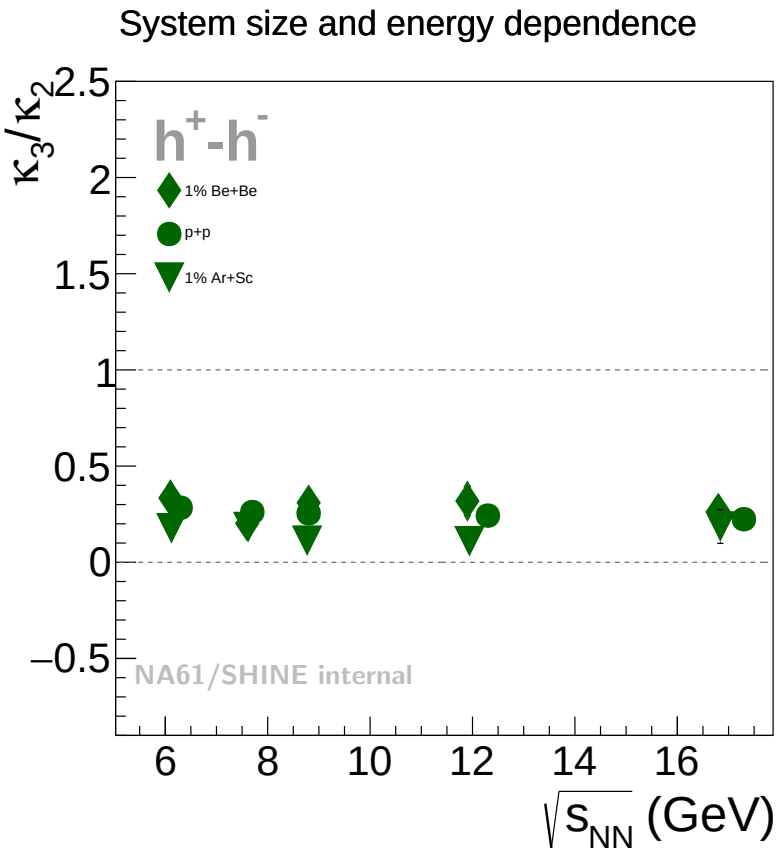


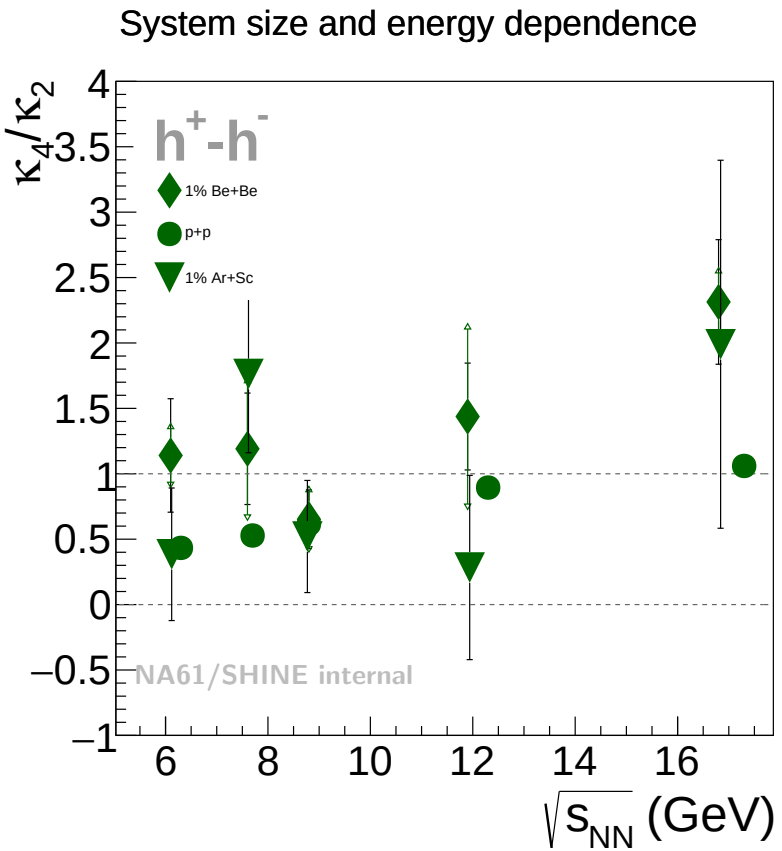
System size and energy dependence of net-charge





System size and energy dependence of net-charge





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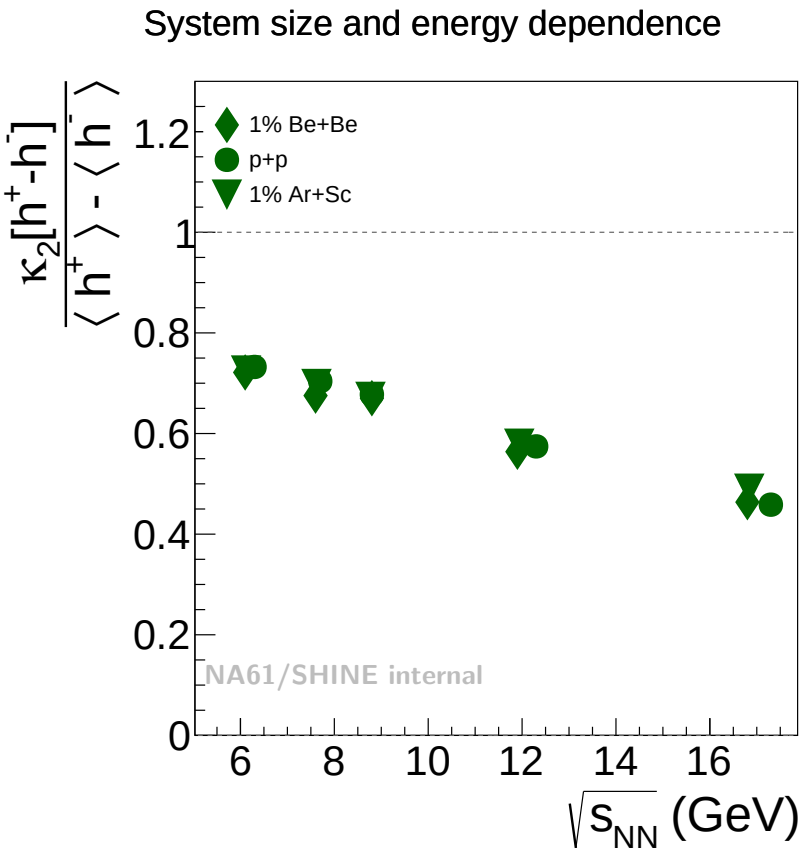
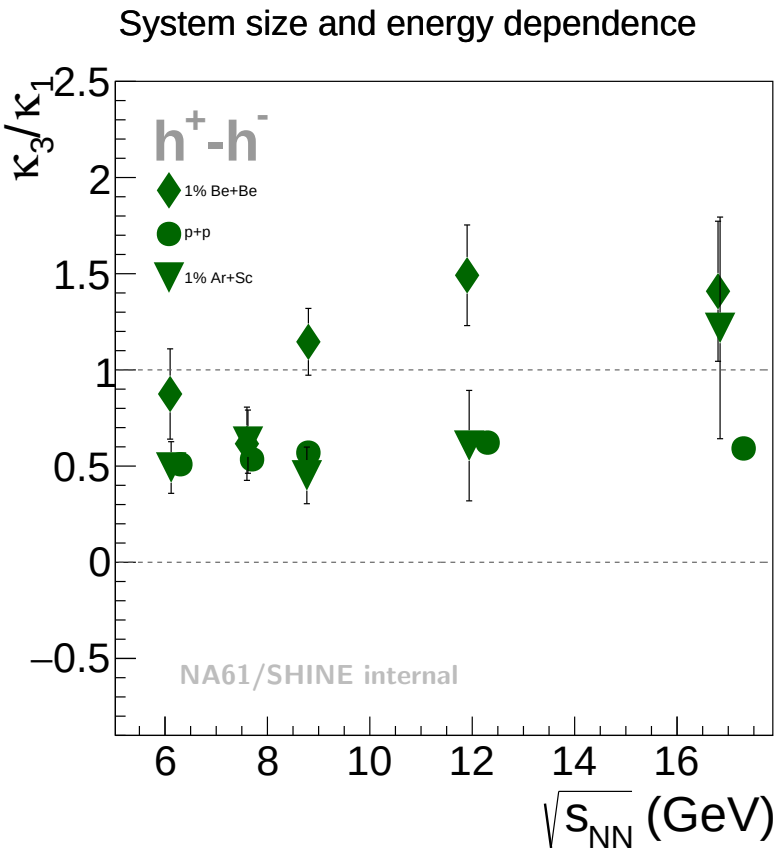
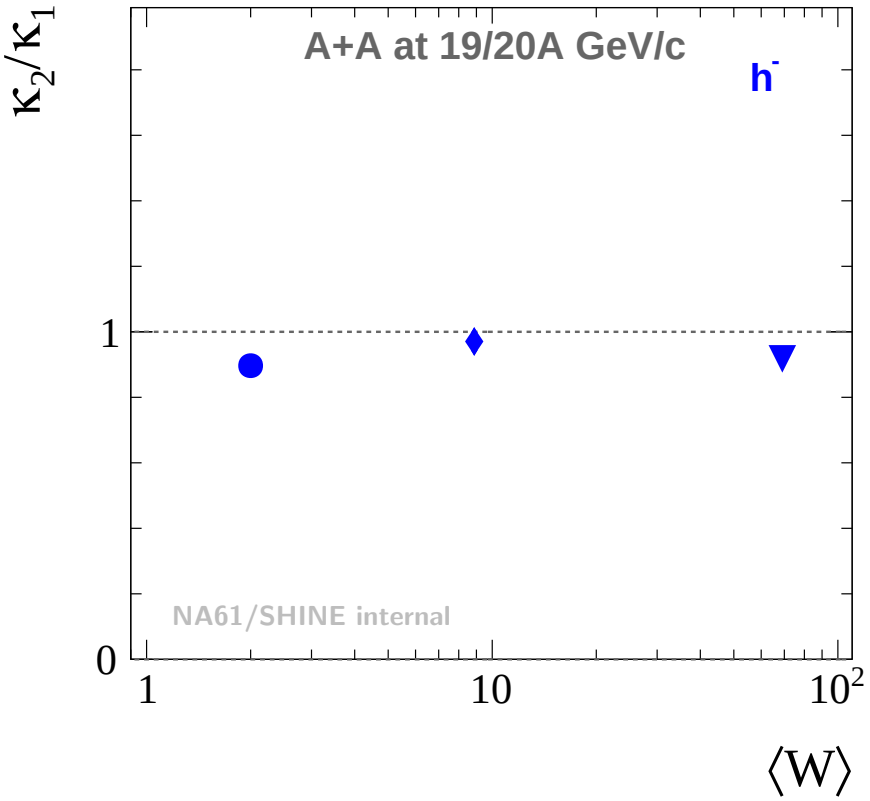
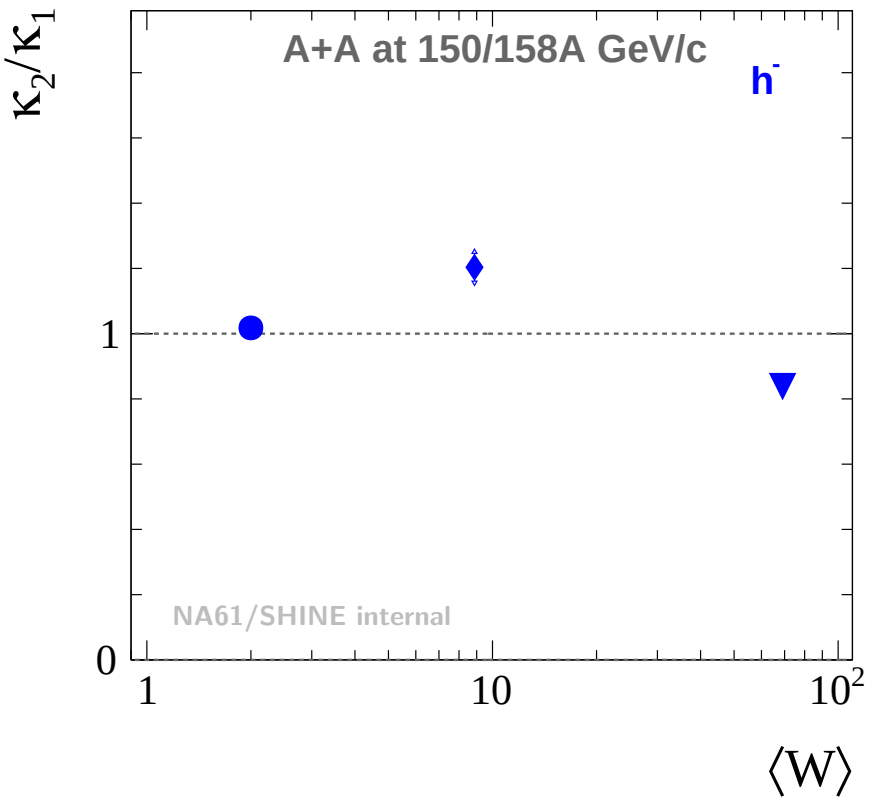


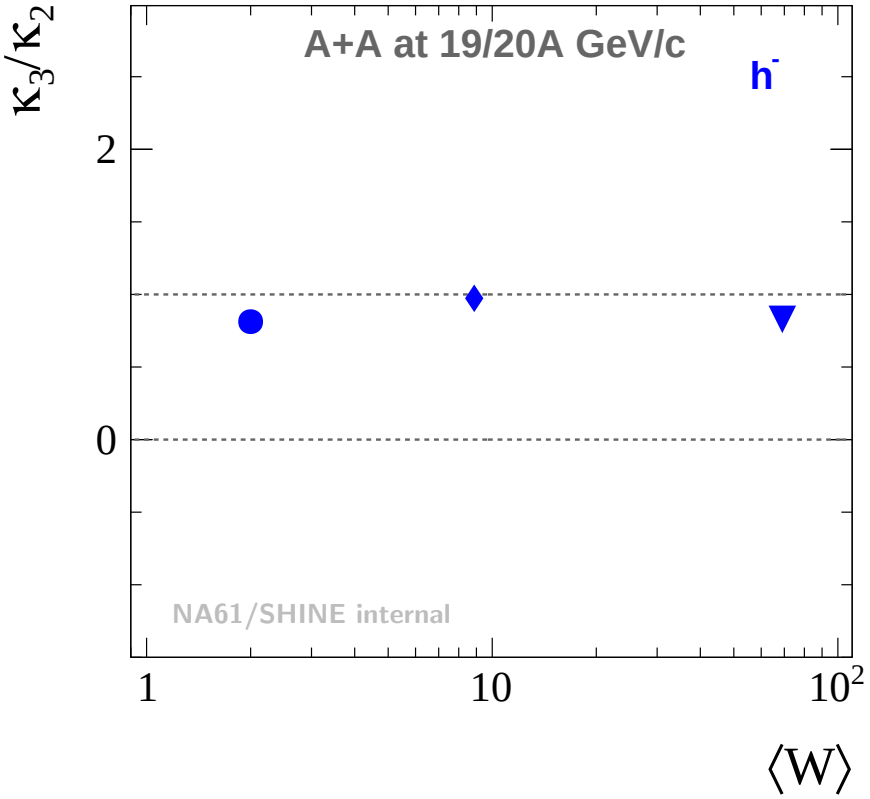


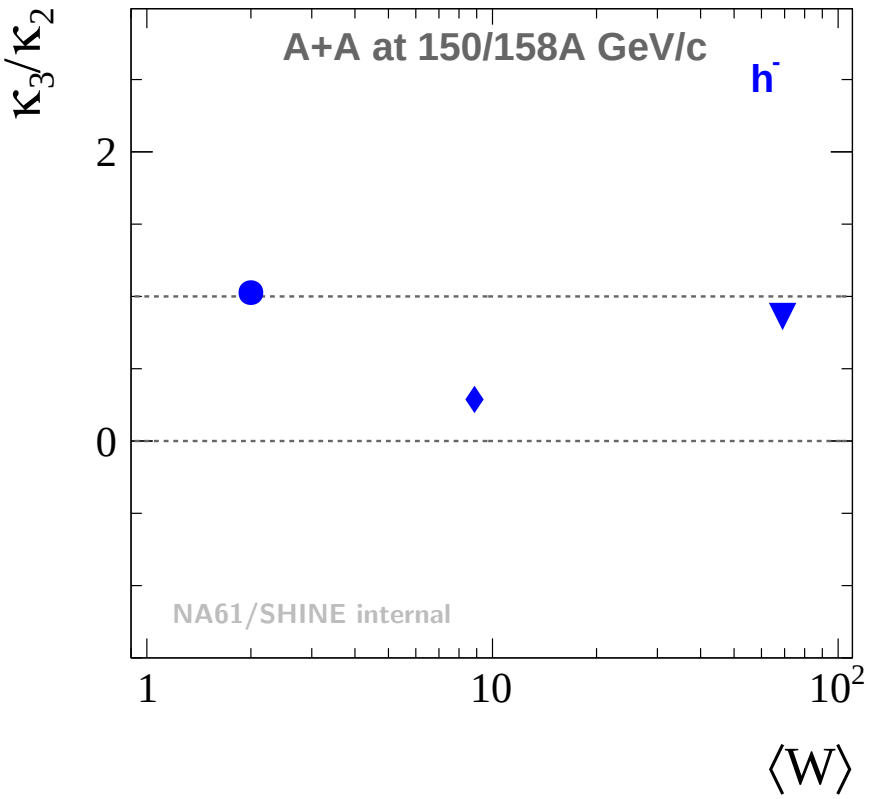
System size dependence of h^-



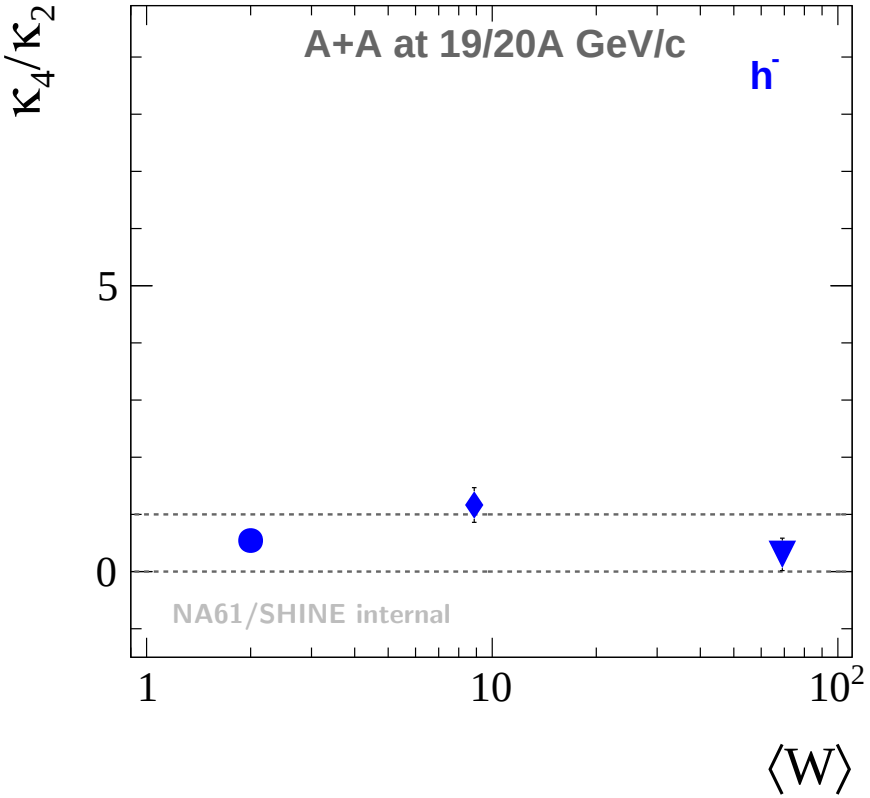


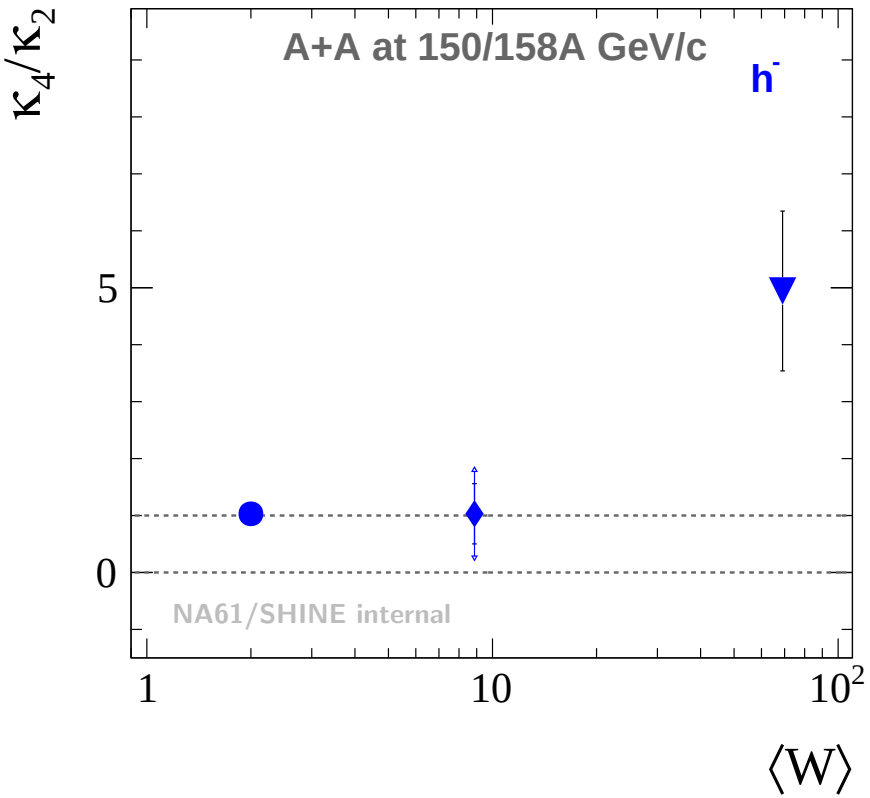
System size dependence of h^-



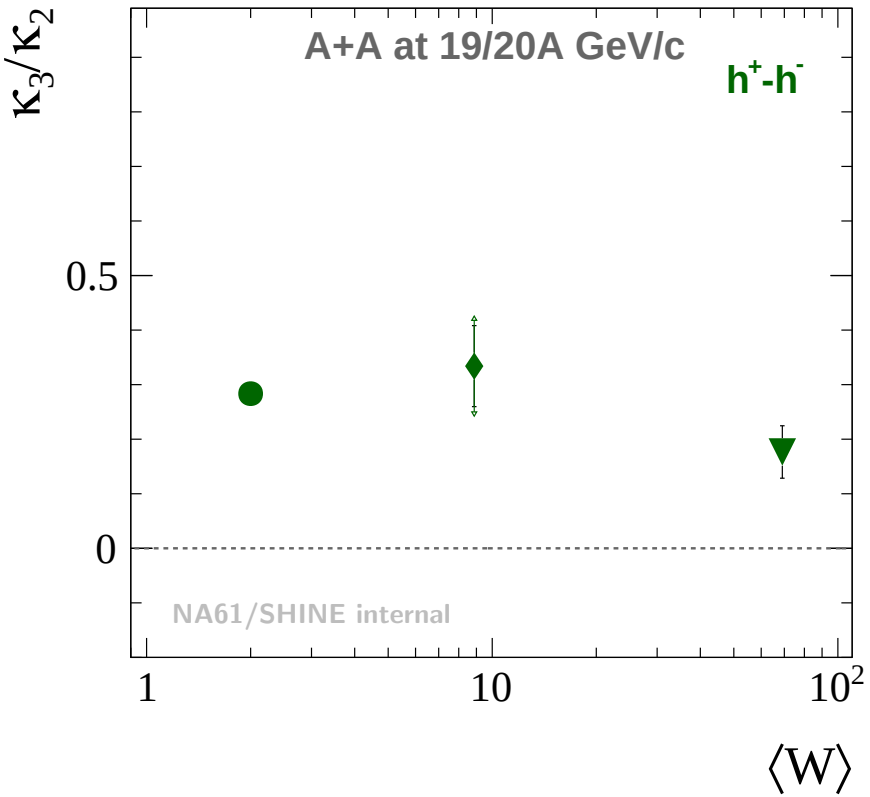


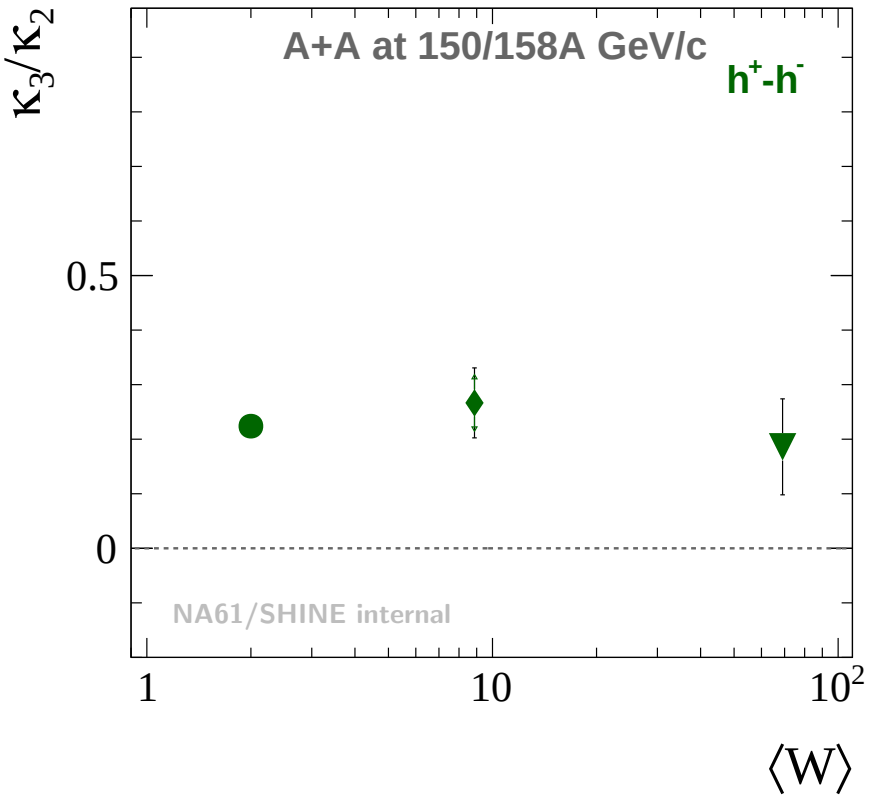
System size dependence of h^-



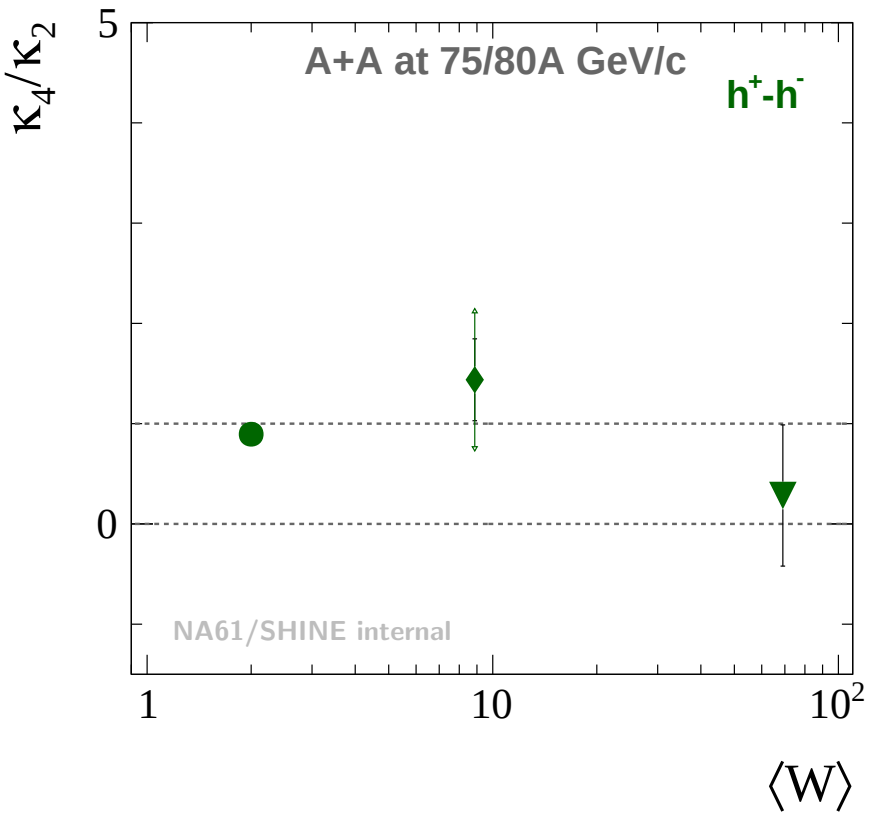


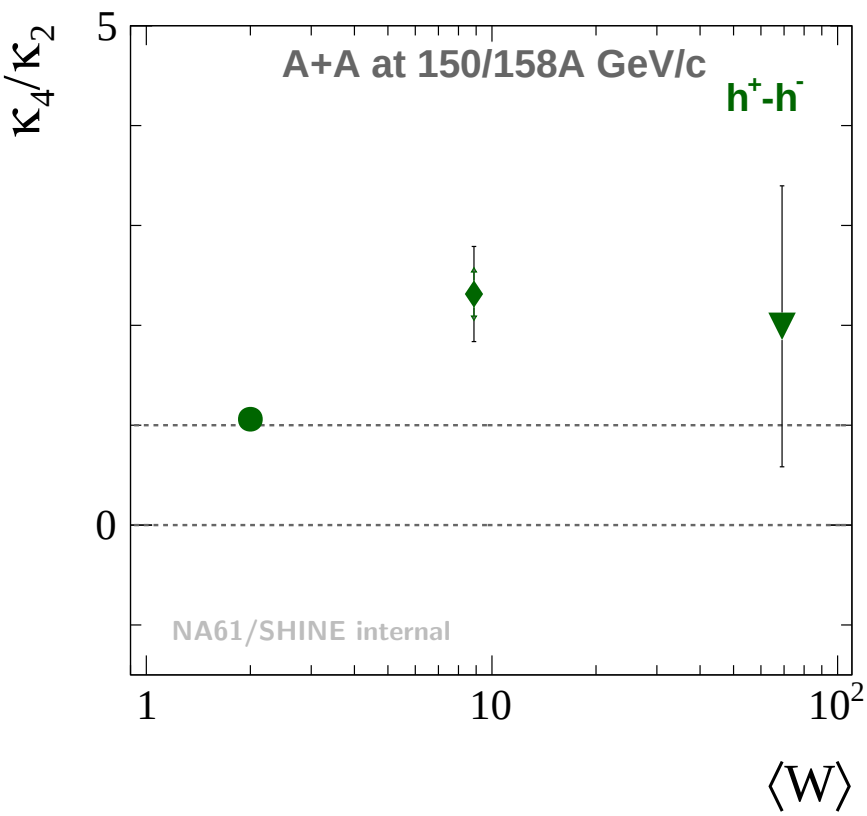
System size dependence of net-charge



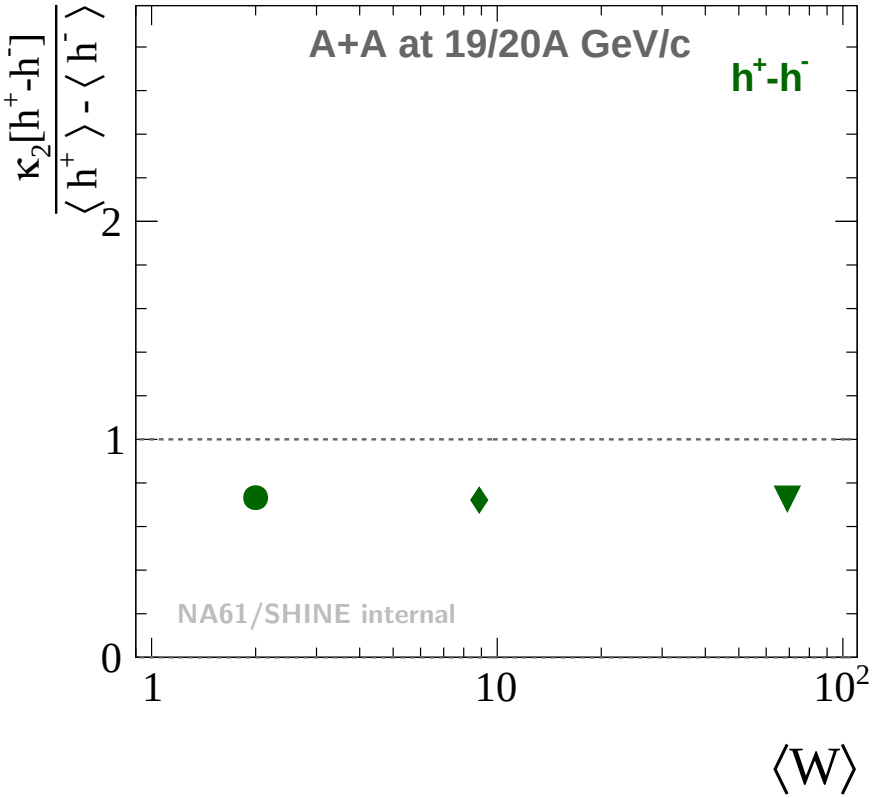


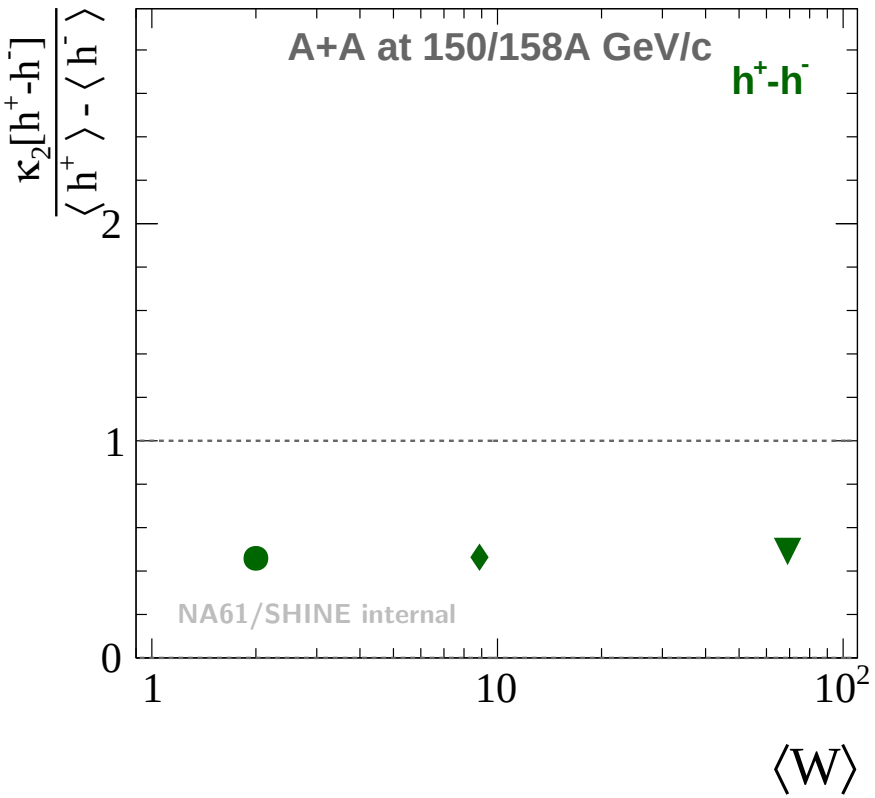
System size dependence of net-charge



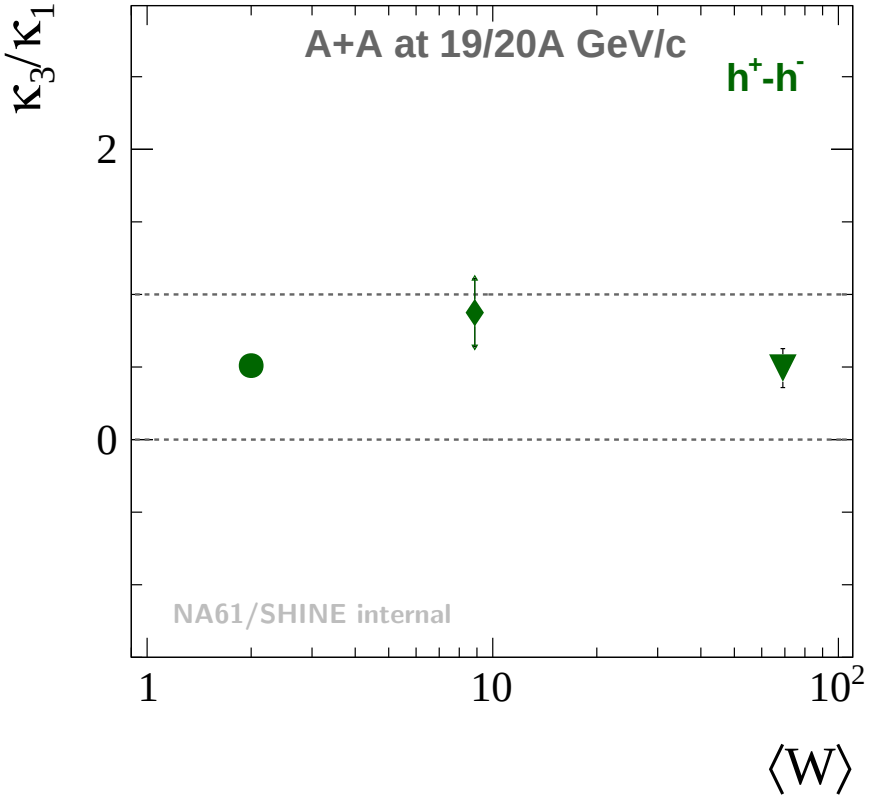


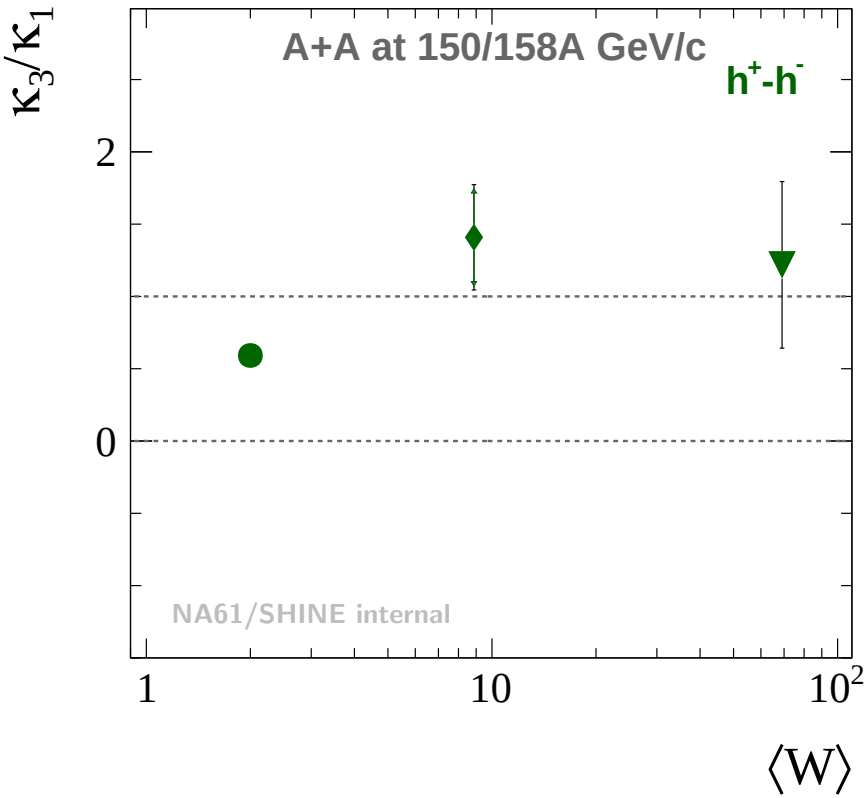
System size dependence of net-charge





System size dependence of net-charge



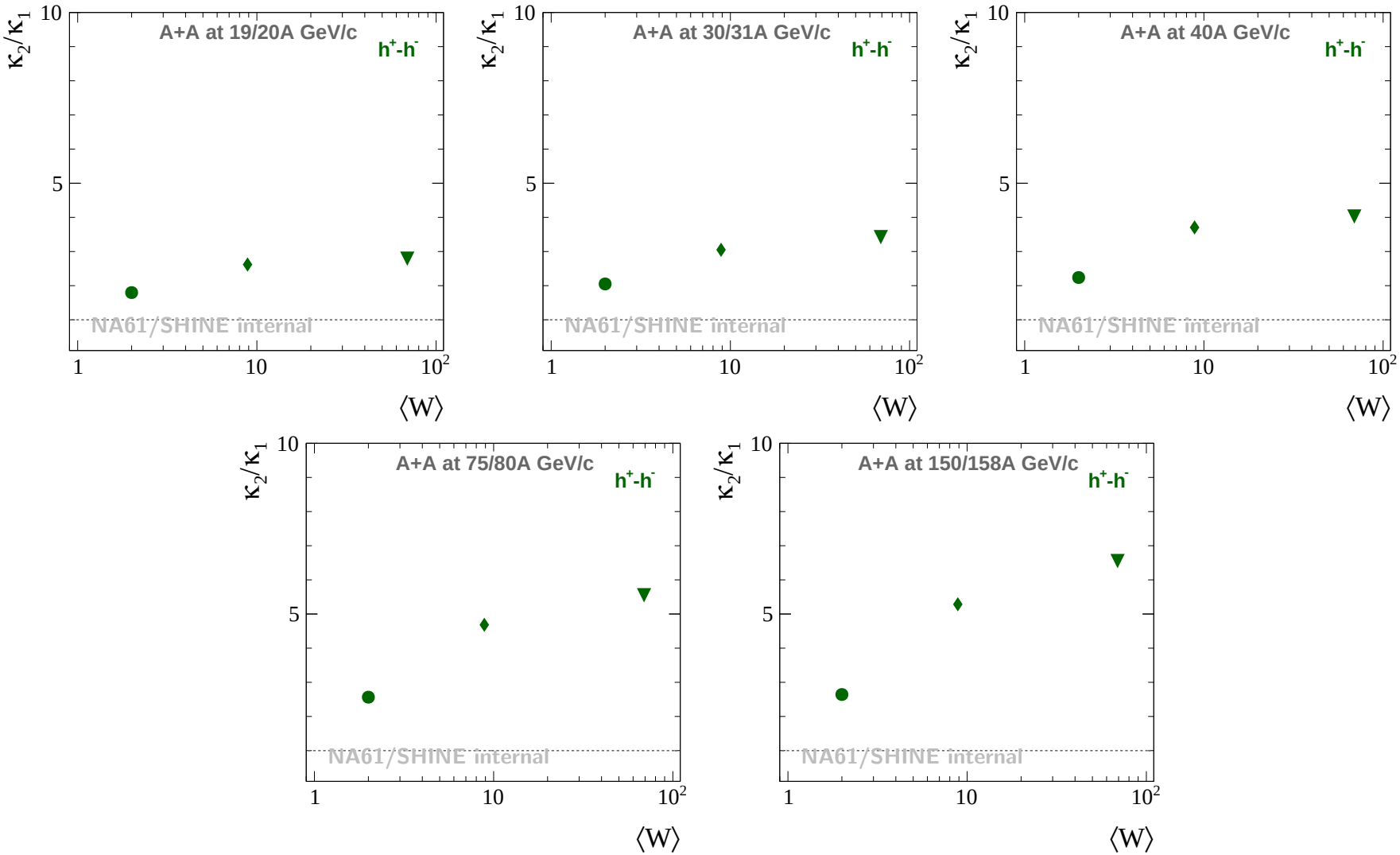


Summary

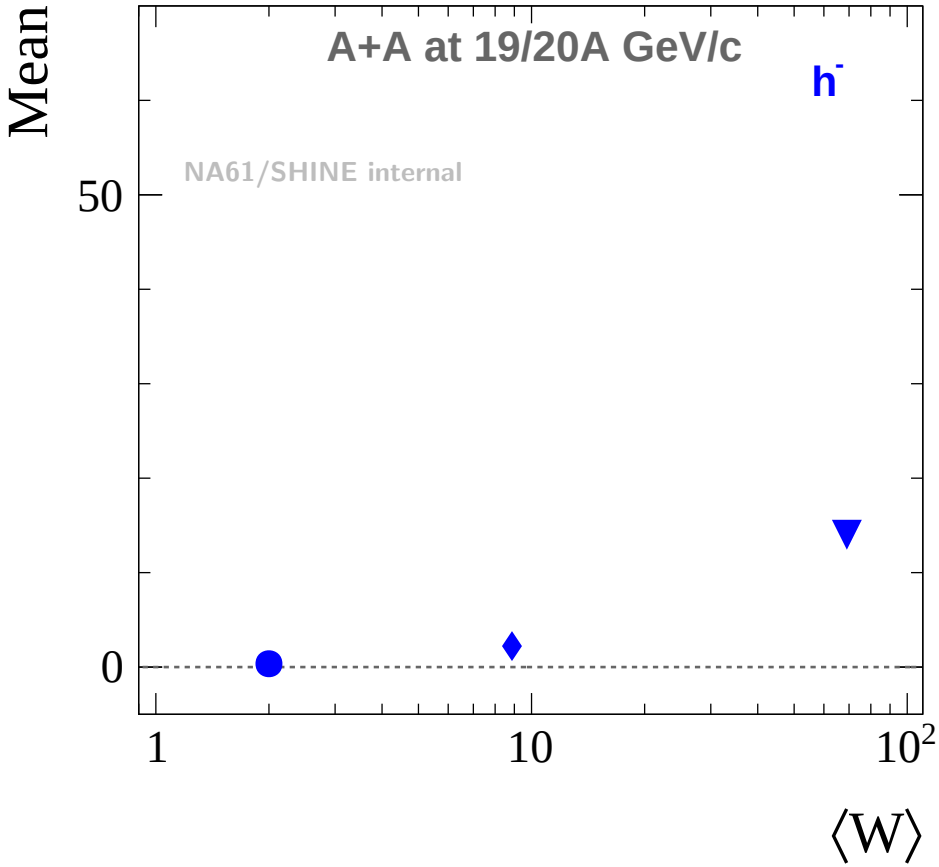
- net-charge: there is no or very weak system size dependence
- net-charge: in most cases weak energy dependence (exception $\kappa_2/(\langle h^+\rangle - \langle h^-\rangle)$
- h^-: there is a clear system size and energy dependence
- h^-: $\kappa_3/\kappa_2[h^-]$ in Be+Be depends on energy differently then p+p or Ar+Sc. Possible explanation: shape of Be nucleus

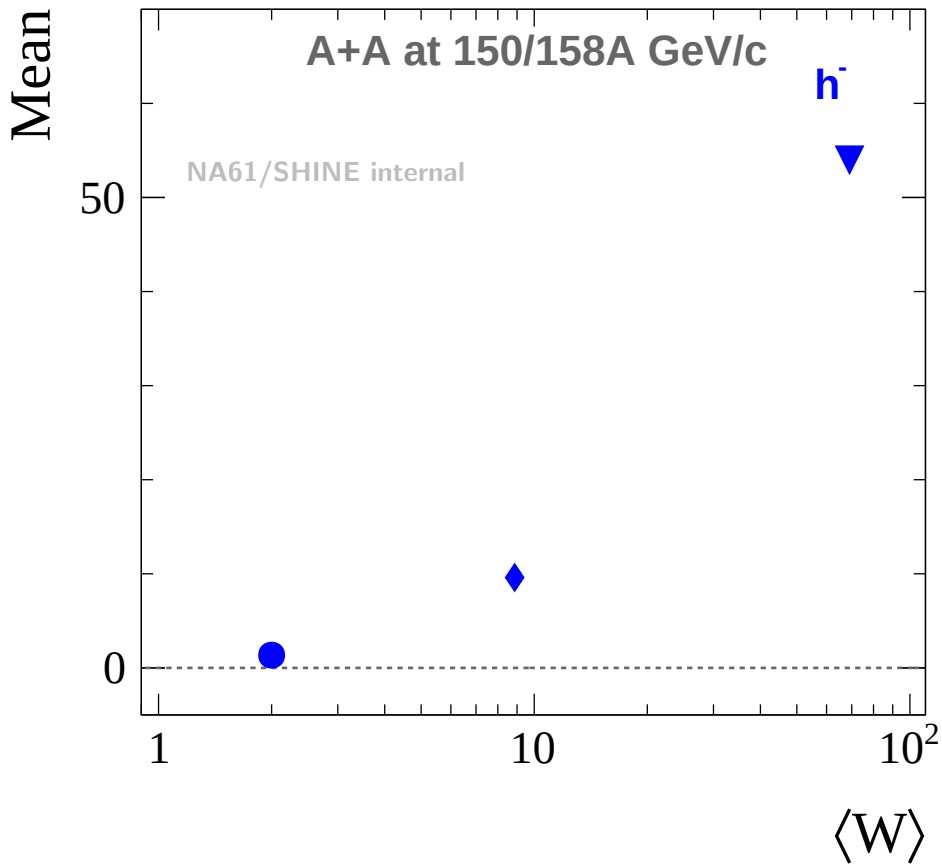
Thank you

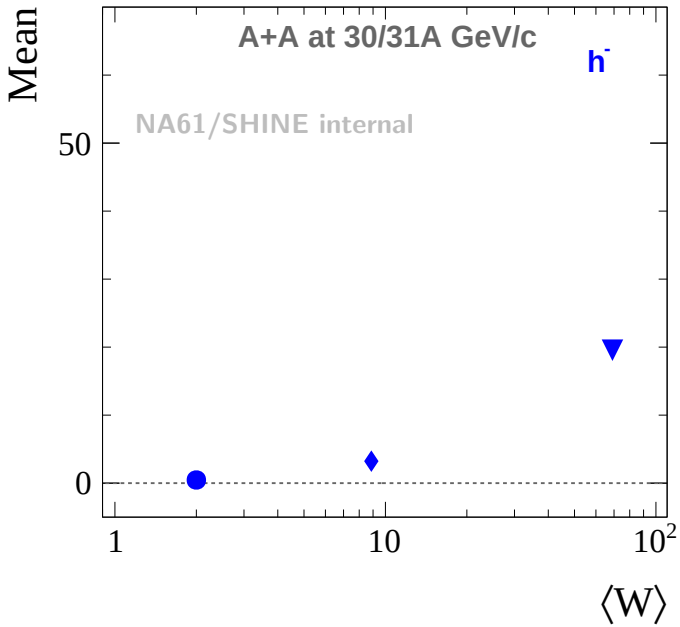
System size dependence

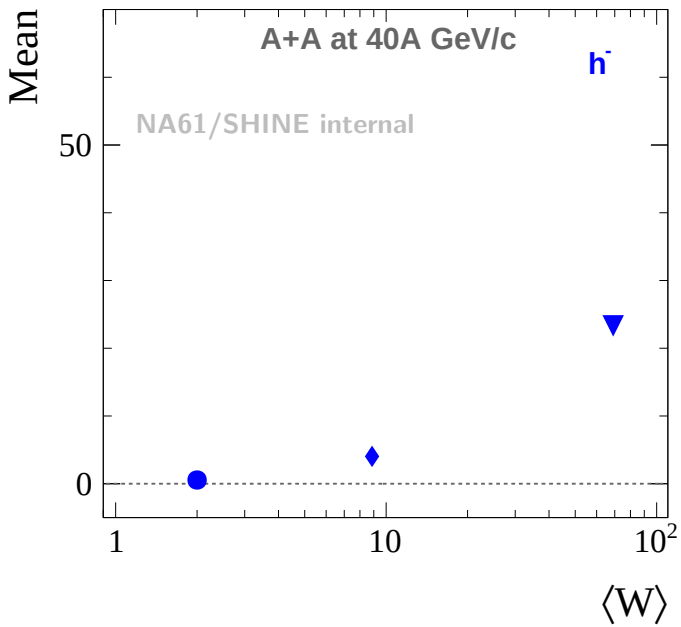


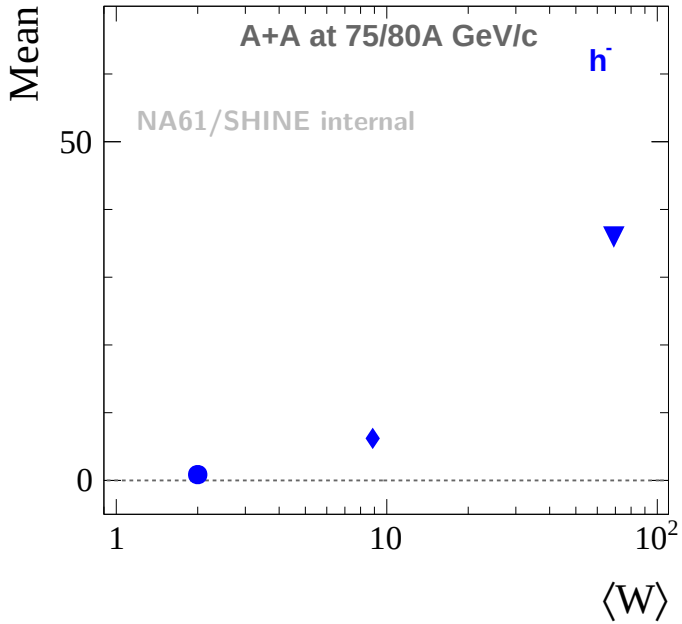
System size dependence



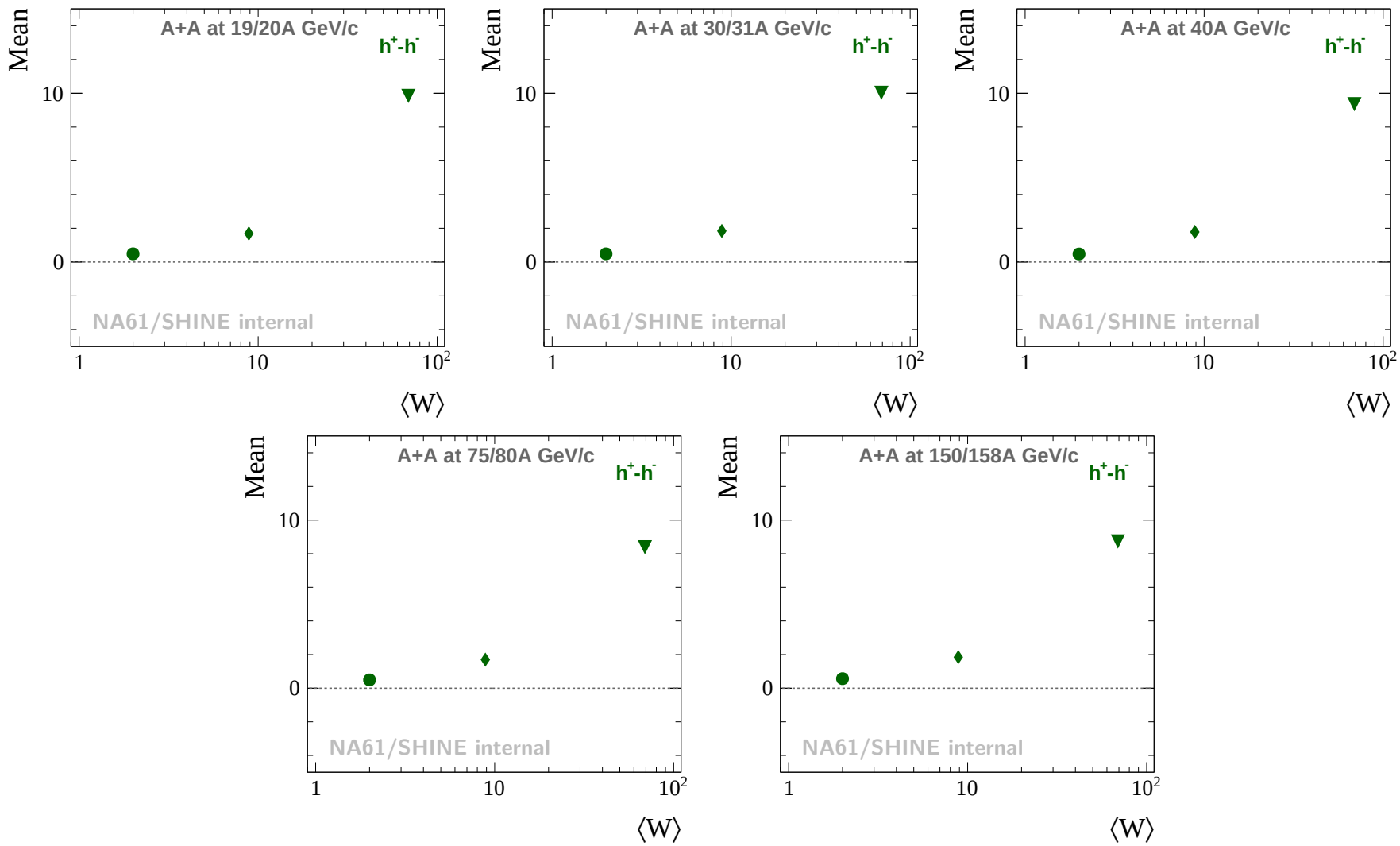


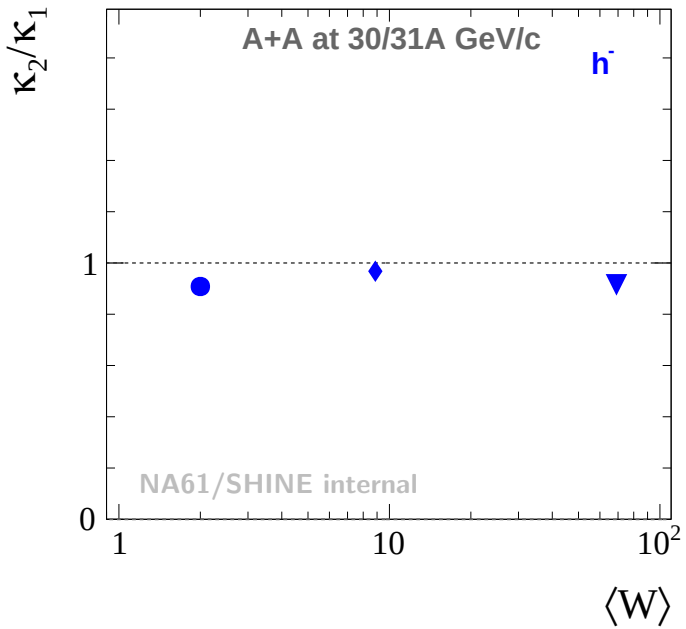

A+A at 30/31A GeV/c
h-
NA61/SHINE internal
Mean
50
0
1
10
10^2
⟨W⟩

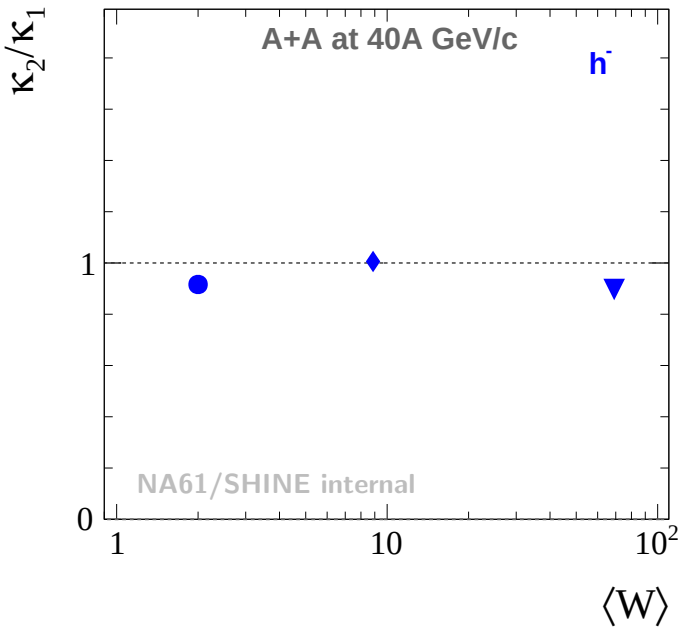

A+A at 40A GeV/c
h-
NA61/SHINE internal
Mean
50
0
1
10
10^2
⟨W⟩

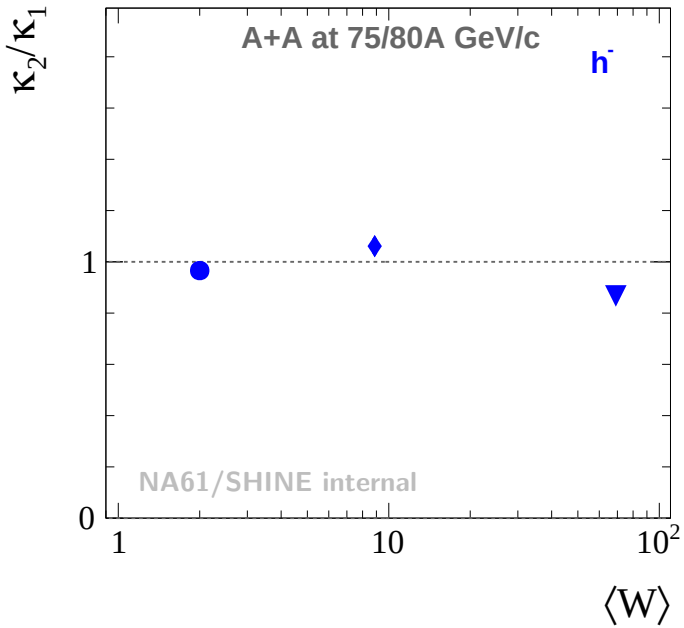

A+A at 75/80A GeV/c
h-
NA61/SHINE internal
Mean
50
0
1
10
10^2
⟨W⟩

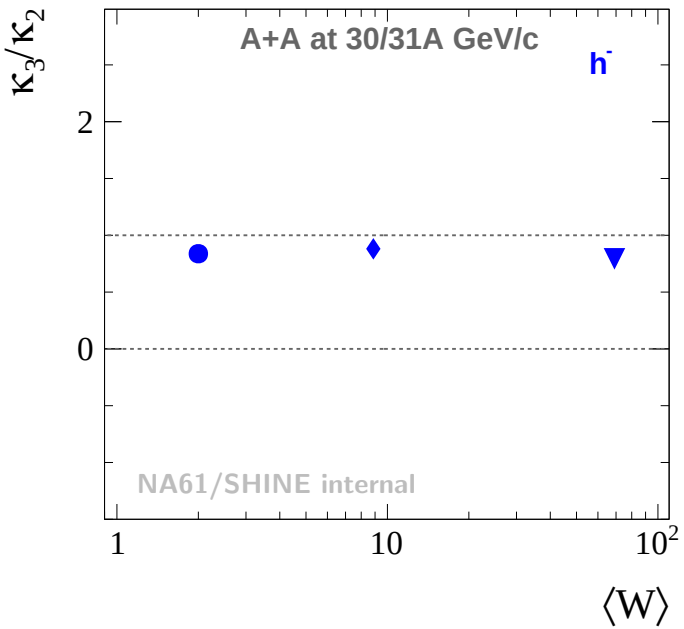
System size dependence

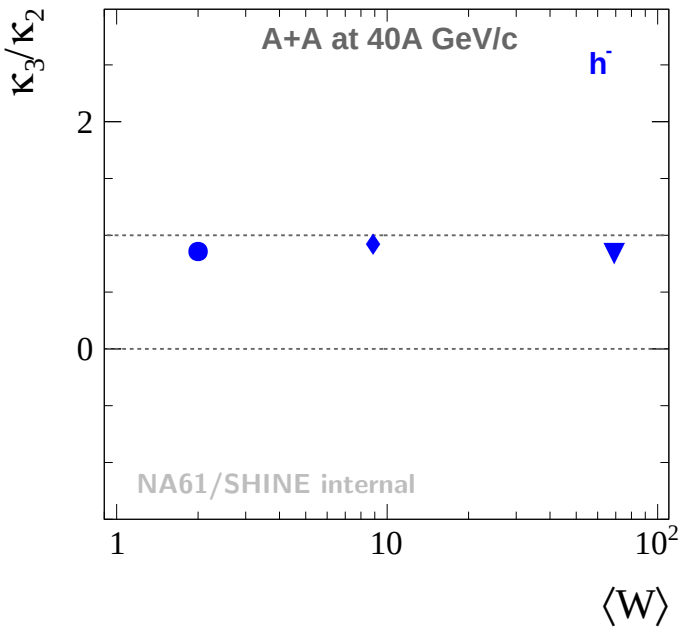


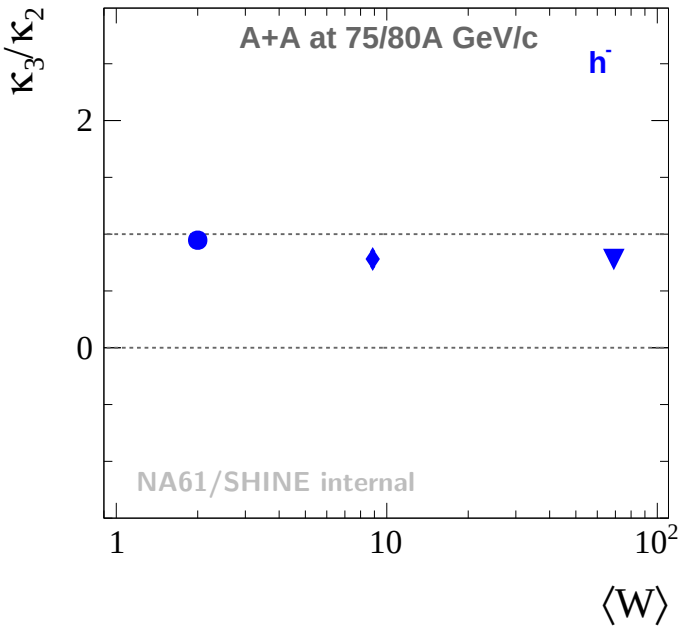

A+A at 30/31A GeV/c
h-
NA61/SHINE internal
κ2/κ1
⟨W⟩

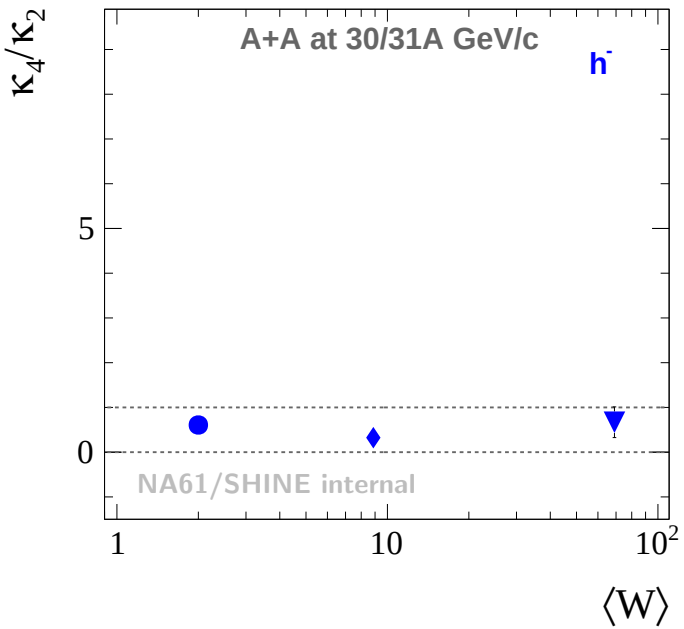

A+A at 40A GeV/c
h-
NA61/SHINE internal
κ2/κ1
⟨W⟩

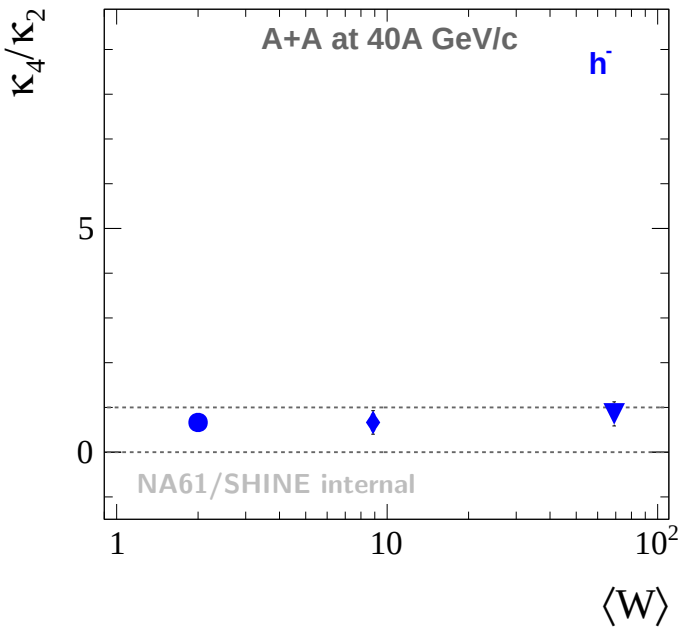

A+A at 75/80A GeV/c
h-
NA61/SHINE internal
κ2/κ1
⟨W⟩

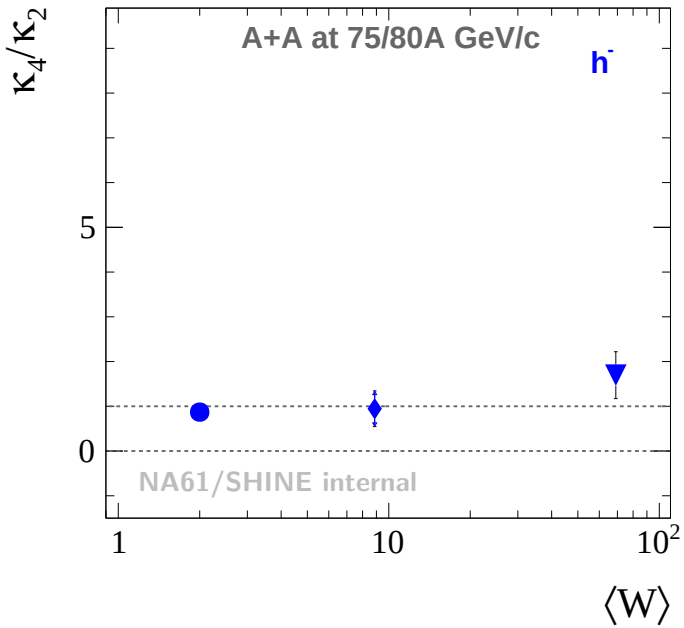

A+A at 30/31A GeV/c
h-
NA61/SHINE internal
κ3/κ2
2
0
1
10
10^2
⟨W⟩

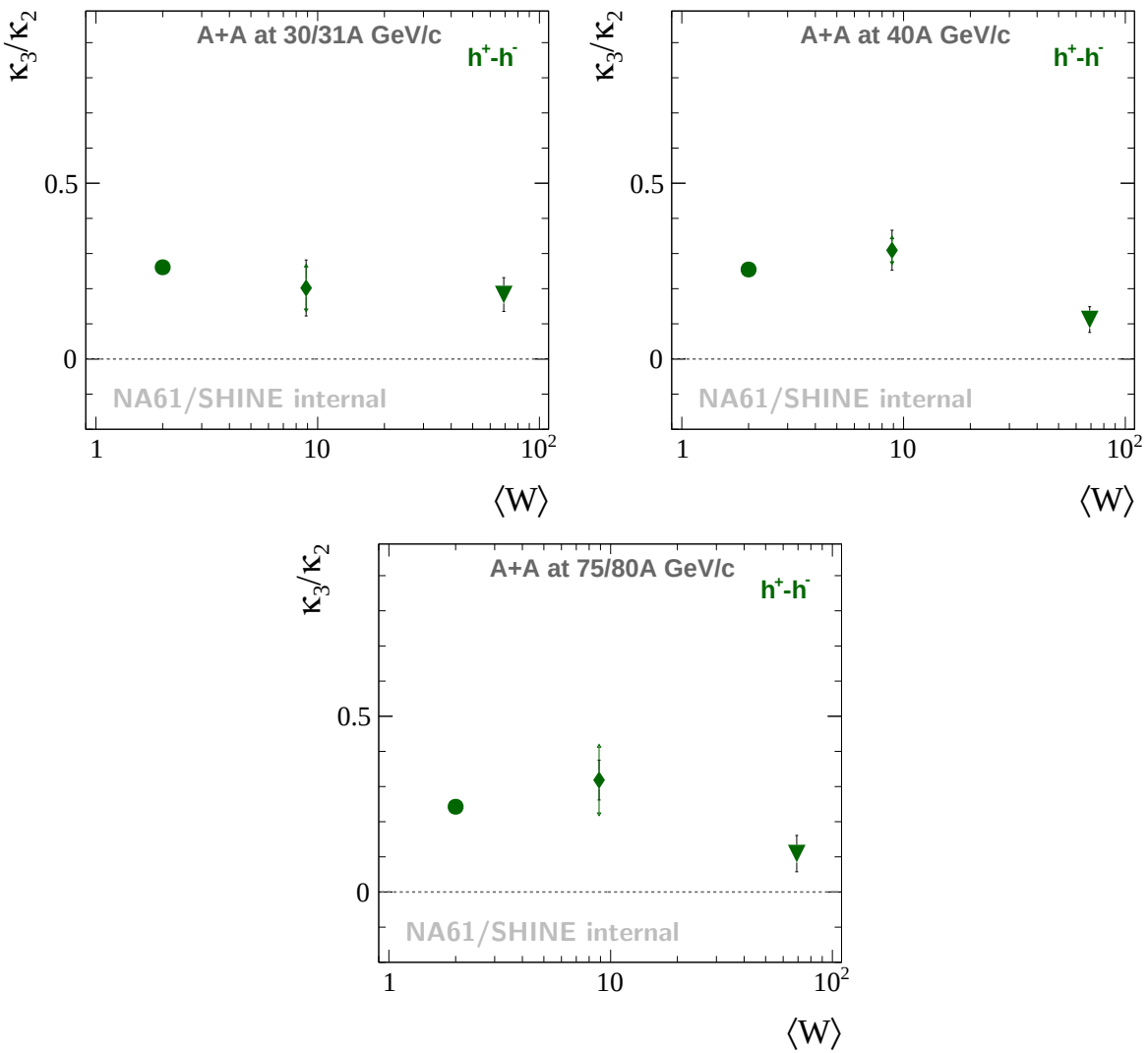

A+A at 40A GeV/c
h-
NA61/SHINE internal
κ3/κ2
2
0
1
10
10^2
⟨W⟩

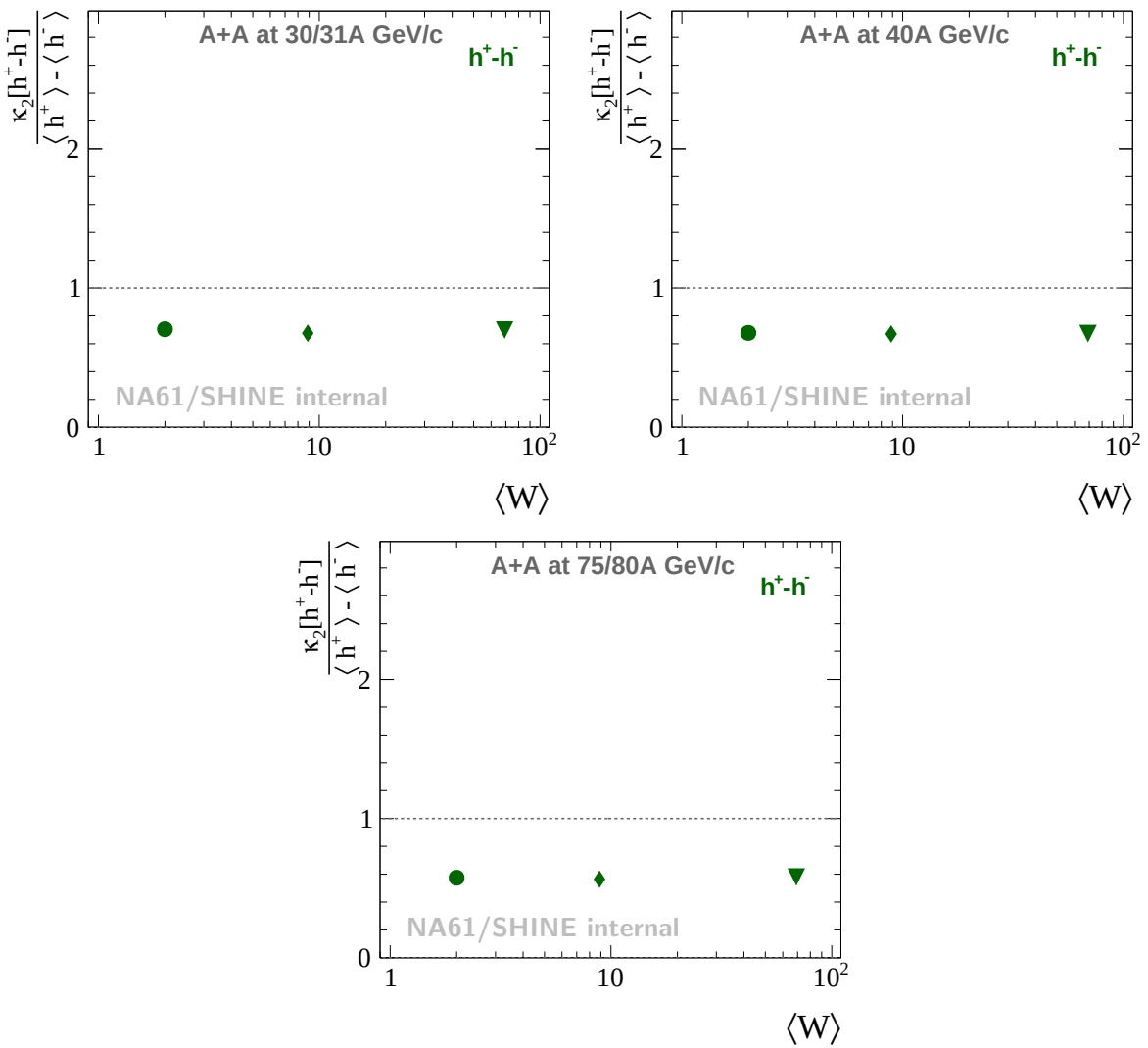

A+A at 75/80A GeV/c
h-
NA61/SHINE internal
κ3/κ2
2
0
1
10
10^2
⟨W⟩

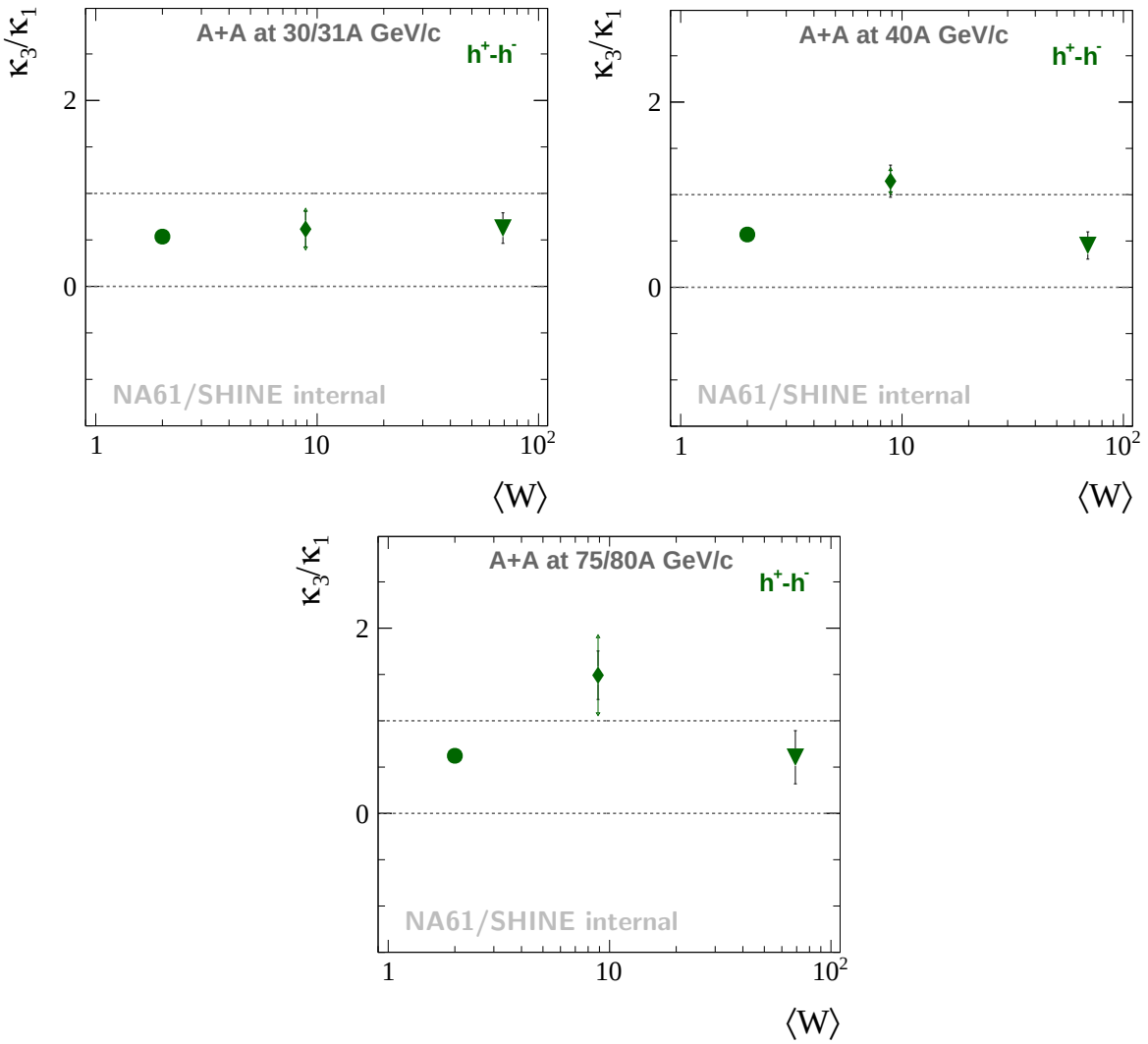

A+A at 30/31A GeV/c
h-
κ4/κ2
5
0
NA61/SHINE internal
1
10
10^2
⟨W⟩


A+A at 40A GeV/c
h-
κ4/κ2
5
0
NA61/SHINE internal
1
10
10^2
⟨W⟩


A+A at 75/80A GeV/c
h-
κ4/κ2
5
0
NA61/SHINE internal
1
10
10^2
⟨W⟩


A+A at 30/31A GeV/c
h+-h-
NA61/SHINE internal
κ3/κ2
⟨W⟩
A+A at 40A GeV/c
h+-h-
NA61/SHINE internal
κ3/κ2
⟨W⟩
A+A at 75/80A GeV/c
h+-h-
NA61/SHINE internal
κ3/κ2
⟨W⟩


A+A at 30/31A GeV/c
h+-h-
NA61/SHINE internal
A+A at 40A GeV/c
h+-h-
NA61/SHINE internal
A+A at 75/80A GeV/c
h+-h-
NA61/SHINE internal
⟨W⟩


A+A at 30/31A GeV/c
h+-h-
NA61/SHINE internal
κ3/κ1
⟨W⟩
A+A at 40A GeV/c
h+-h-
NA61/SHINE internal
κ3/κ1
⟨W⟩
A+A at 75/80A GeV/c
h+-h-
NA61/SHINE internal
κ3/κ1
⟨W⟩