PSEUDORAPIDITY SPECTRA OF SECONDARY PARTICLES EMITTED IN THE RELATIVISTIC NUCLEUS-NUCLEUS COLLISIONS

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XX ISHEPP (Dubna, October 4-9, 2010)

Fourier transformation &Maximum entropy methods (MEM) : Prof. *B. Z. Belashev* : belashev@krc.karelia.ru : *Belashev B Z. Int. J Microstructure and Materials Properties, 2009 4(3): 320{329; Journal of Applied Spectroscopy, 2001, 68(5): 838-846.*

to get an additional information about the structure of the pseudorapidity spectra – s- particles (with β > 0.7)

Au (at 11.6 A GeV) : Pb (at 158 A GeV)

visually some plateaus&shoulders : vs a number of *g*-particles -centrality.

- MEM could confirm the existence of the plateau&shoulder;
- it has extracted some selected values of pseudorapidity - η_c which could not be observed visually; a numbers of the η_c increased by the initial energy

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- 2 set of experimental data only;

- didn't have any quantitative results;

- didn't do any comparison with models.

XXI ISHEPP (Dubna, September 10-15, 2012)

-MEM s-particles (with $\beta > 0.7$) produced in:

Si+Em (at 4 A GeV);
Au+Em (at 11.6 A GeV);
Si+Em (at 14 A GeV);
Pb+Em (at 158 A GeV)

-the data were fitted using MATLAB to get some quantitative results (by B.Belashev);

- the results were compared by the ones coming from the Modified Cascade Model which was done by *Zhenis Musulmanbekov.*

He kept the next steps:

1.Cleaning up from noises (statistical fluctuations) using Wavelet cleaning up (package Wavelet Toolbox from «MATLAB» and procedure wdcbm).

2. Applying the MEM (package «MEMFR»)

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Abstract: The maximum entropy method (MEM) makes it easier to study the materials by simplifying experiments and making data processing more informative. MEM has been applied to determine the crystalline lattice parameters and the composition of the mixtures, to identify the close order type of amorphous conjugations, and to follow the details of matter transformations. As a result, new information on the materials investigated has been obtained.

MEM solves the inverse problem

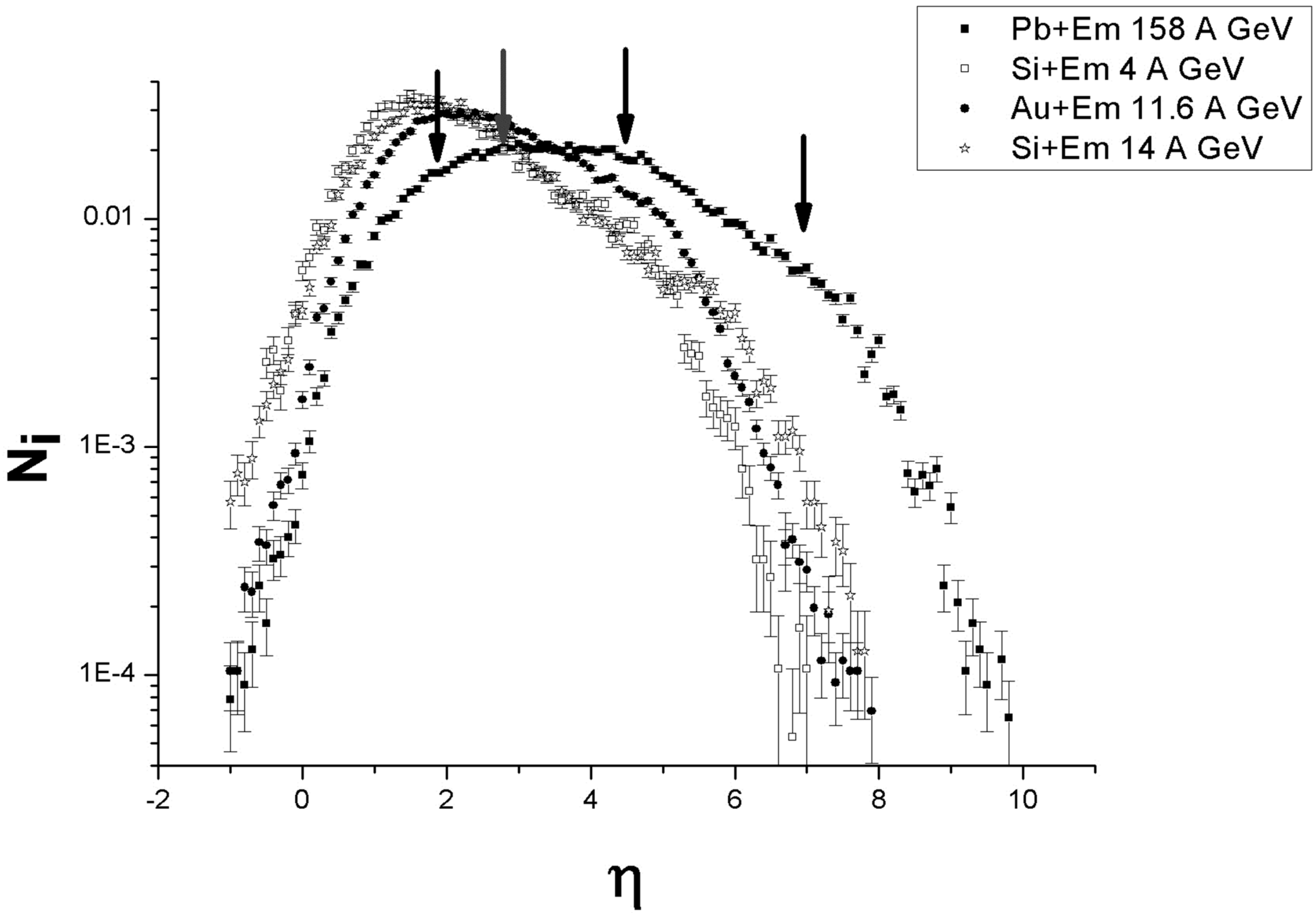
$$s(x) = \sum_{\xi=1}^{N} h(x,\xi)\cdot f(\xi) + n(x); \quad x = 1,2,\ldots,M \tag{1}$$

on the signal observed $s(x)$, $x = 1,2,\ldots, M$ and the blurring function $h(x,\xi)$. The solution $\hat{f}(\xi)$ and displaced noise $\hat{n}(x) = n(x) + B$ estimations maximise the entropy functional:

$$L = -\sum_{\xi=1}^{N} \hat{f}(\xi)\ln \hat{f}(\xi) - \rho\sum_{x=1}^{M} \hat{n}(x)\ln\hat{n}(x) - \sum_{x=1}^{M} \lambda(x)[\sum_{\xi=1}^{N} h(x,\xi)\hat{f}(\xi) + \hat{n}(x) - B - s(x)] \to \max \tag{2}$$

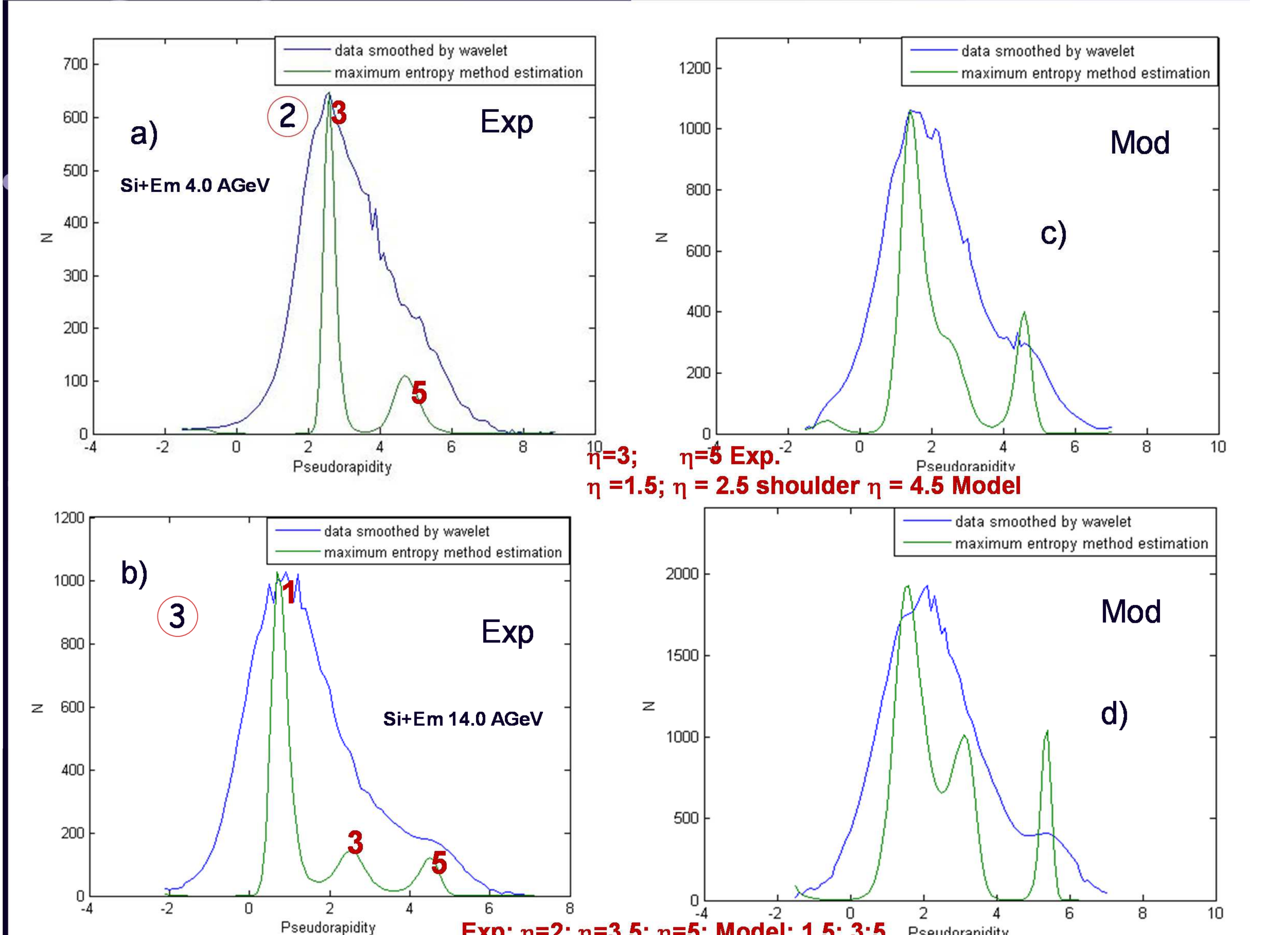
where coefficient ρ and the restrictions (1) are used with Lagrange multipliers $\lambda(x)$.

Experiment Distributions



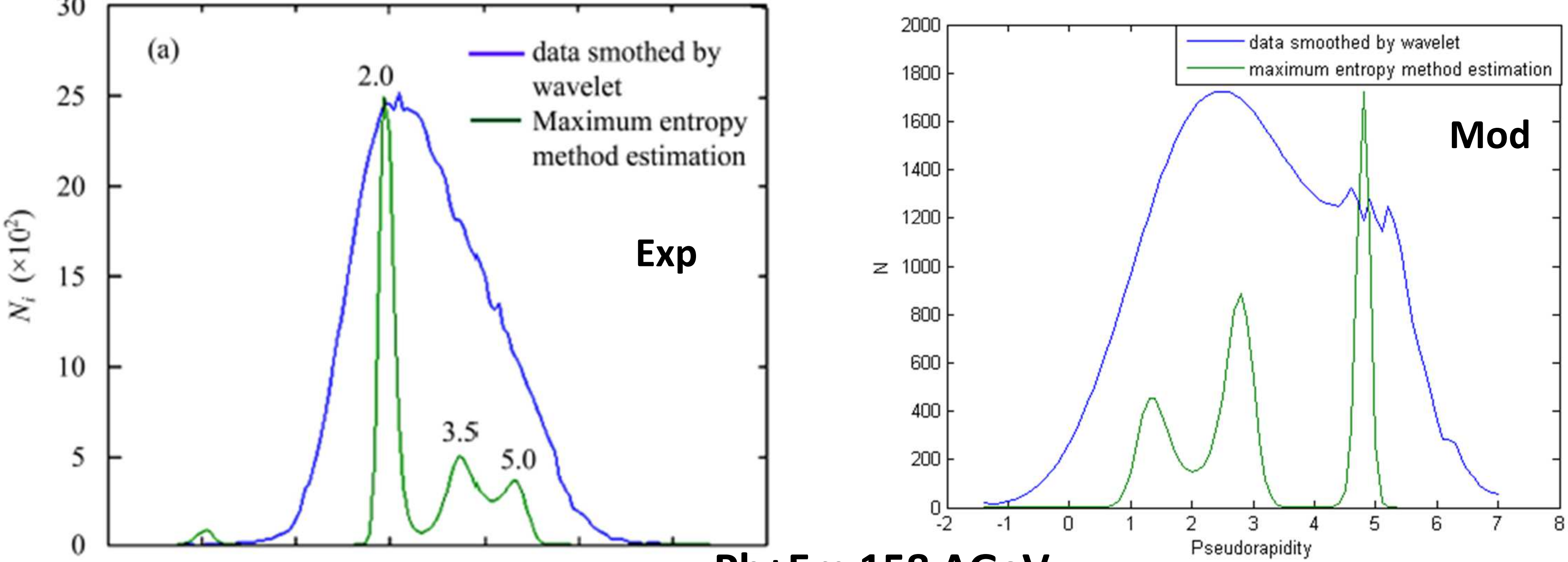
628
1322
1185
1093

Applying the Maximum Entropy Method.

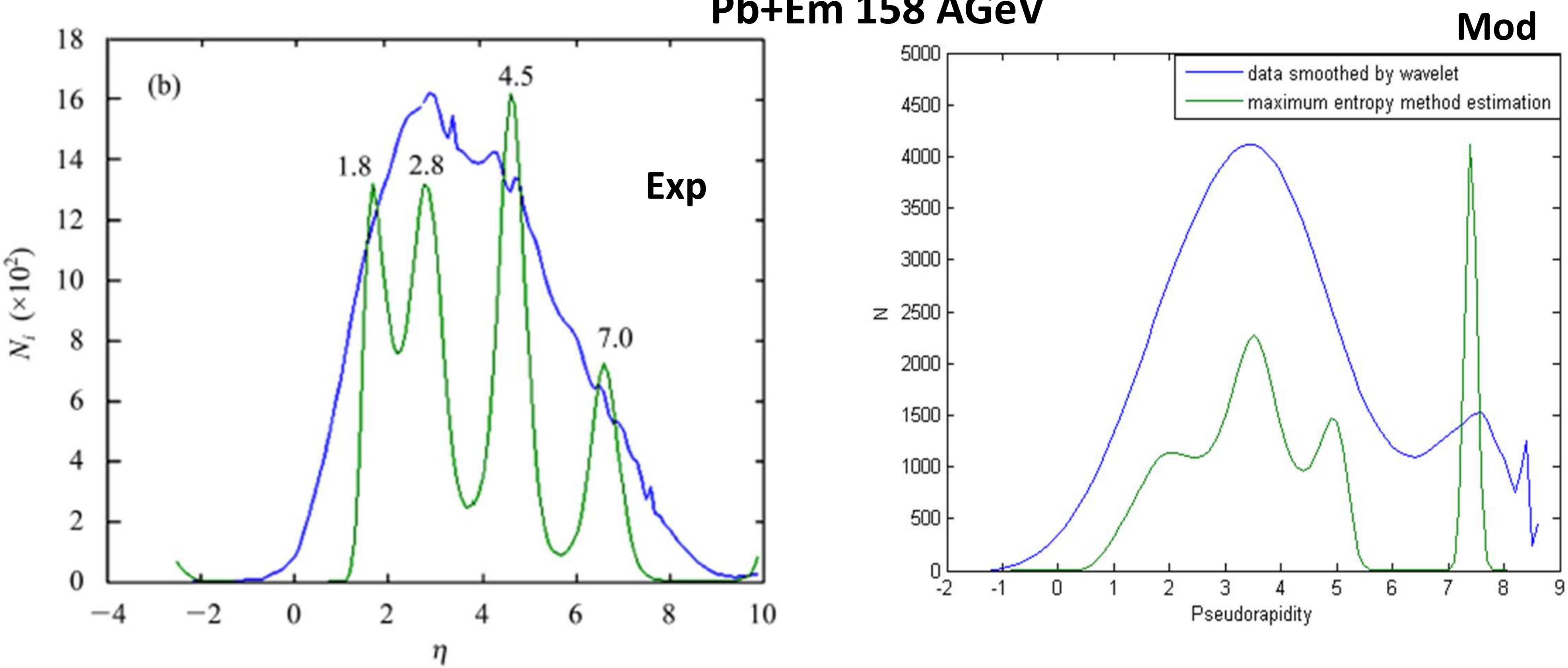


a)
Exp
Si+Em 4.0 AGeV
data smoothed by wavelet
maximum entropy method estimation
N
Pseudorapidity
2
3
5
c)
Mod
η=3; η=5 Exp.
η =1.5; η = 2.5 shoulder η = 4.5 Model
b)
Exp
Si+Em 14.0 AGeV
1
3
5
d)
Mod
Exp: η=2; η=3.5; η=5; Model: 1.5; 3;5

Au+Em 11.6 AGeV



Pb+Em 158 AGeV



Visual results:

- the number of extracted peaks by method increase with energy;

- η_c , W depends on the energy ; different :experimental&model.

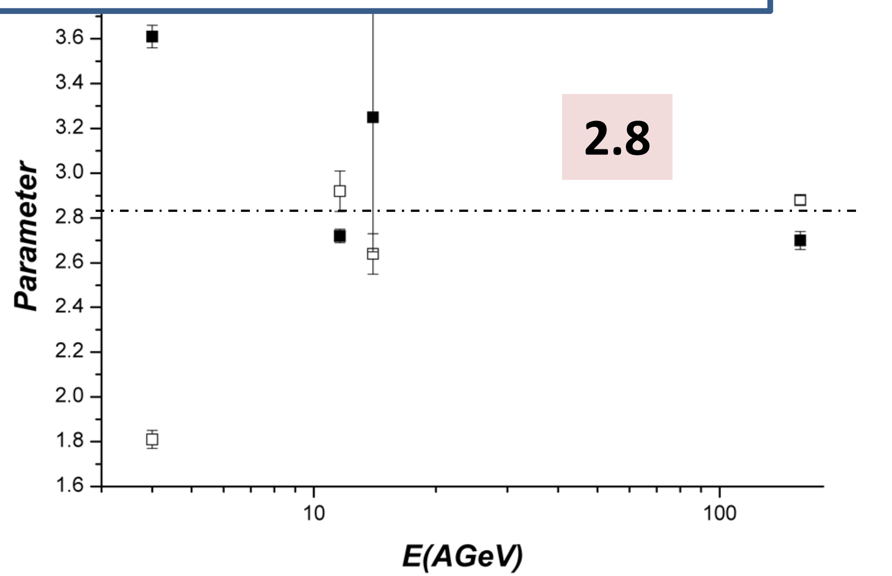
- the peaks were fitted (MATLAB by B.Belashev)
- the energy dependences: η_c; W and the ratios of the h experimental & model separately.

The values for the η_c (Para

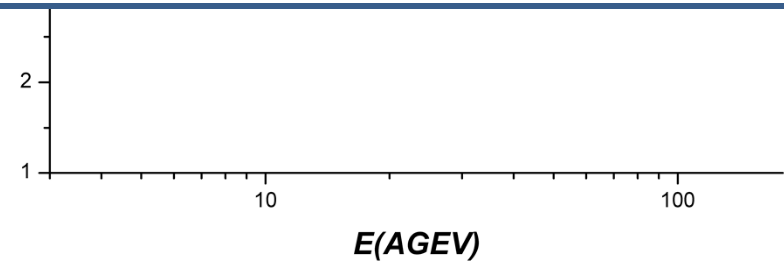
η_c (first peaks) parameter don't depend on the beam energy and could be described completely by the model.

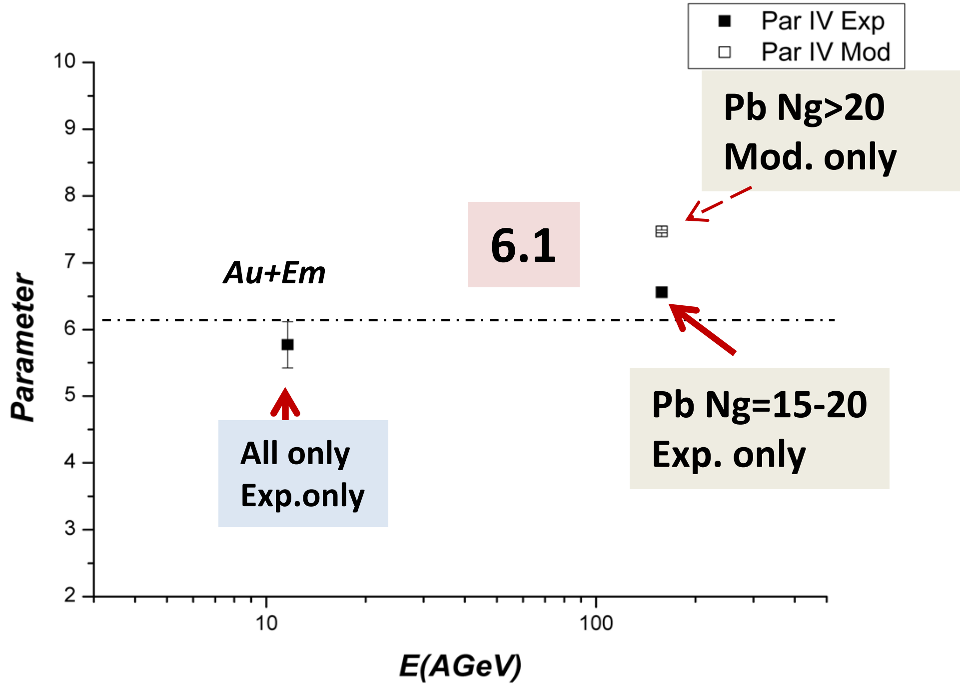
η_c (second peaks) depend on the beam energy in the region of E< 10 AGeV and could not be described completely by the model. In the region of E>10 AGeV they don't depend on the energy

η_c (third peaks): could not be described completely by the model (in the region of energy E>10 AGeV) In the region of E>10 AGeV they don't depend on the energy.



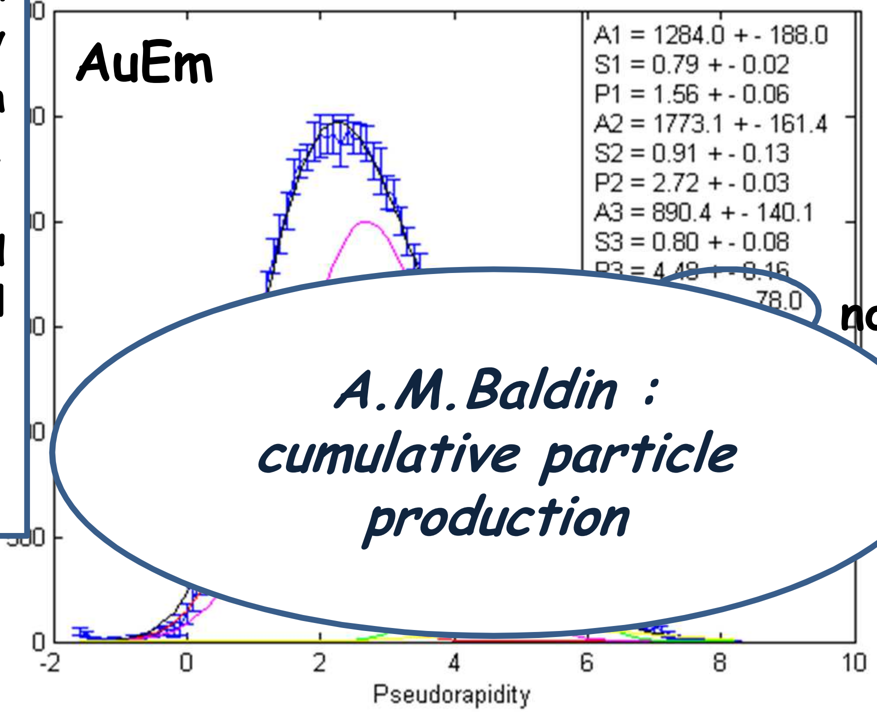
η_c (fourth peaks) -Au and Pb. For Pb +Em reactions at energy 158 AGeV it connects with events with Ng=15-20 and could not describe by the model. But in other hand model can also give 4[th] peak for the events with Ng>20.





The IV peak exists only for Pb+Em reactions at 158 AGeV and connects with events with Ng=15-20, central events. The result is some strange η_c ~ 6.5 - forward particles: striping (peripheral collisions).

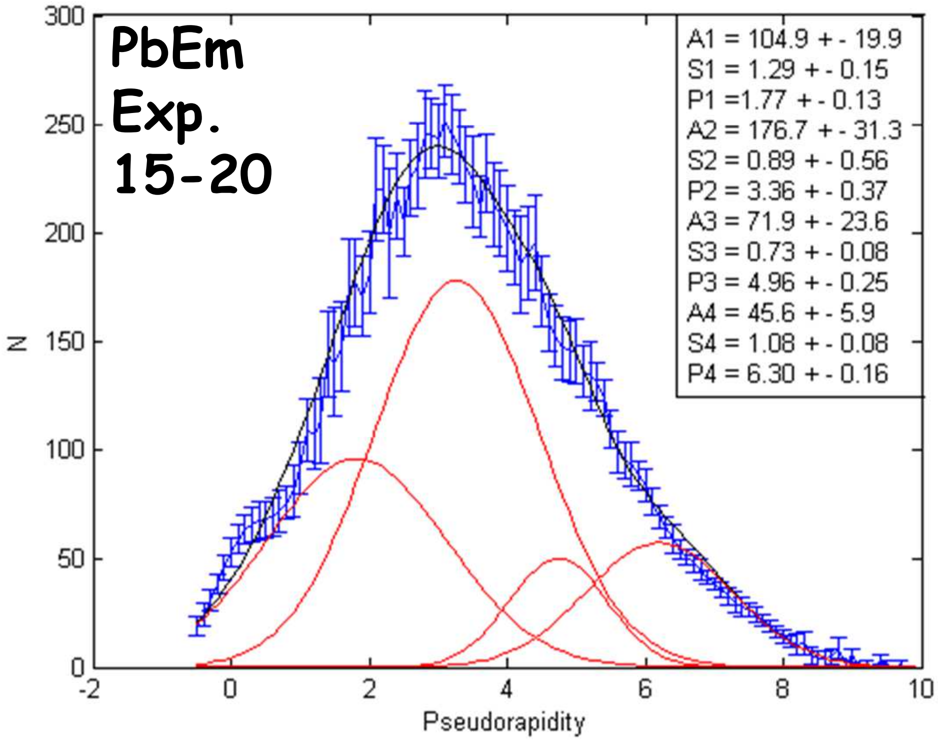
collective phenomenon



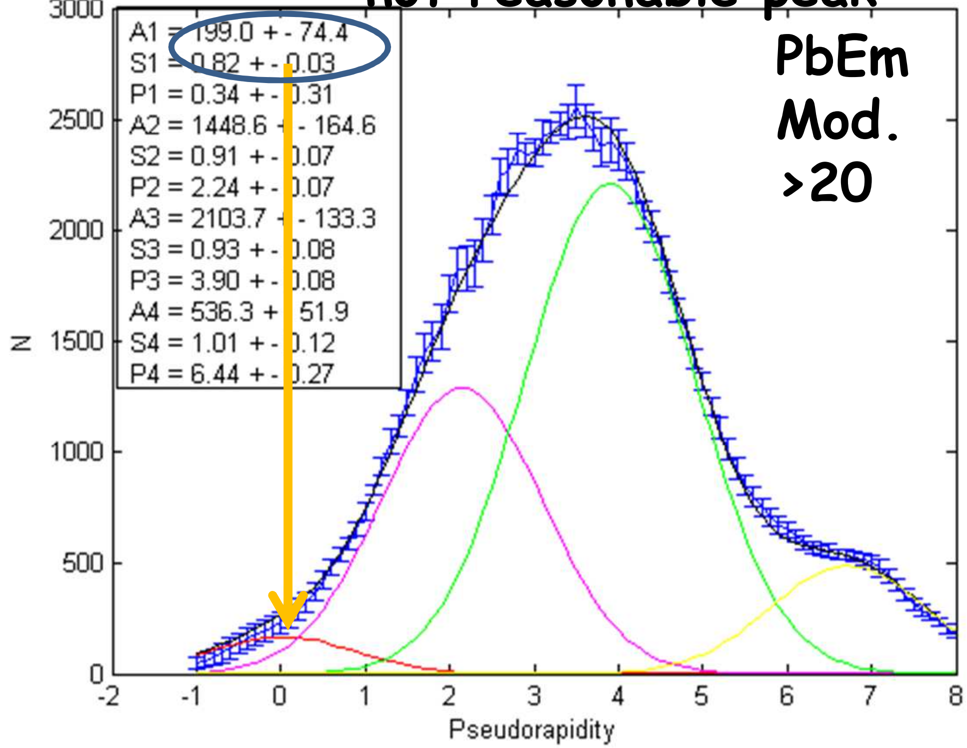
A.M.Baldin : cumulative particle production

not reasonable peak

reasonable peaks

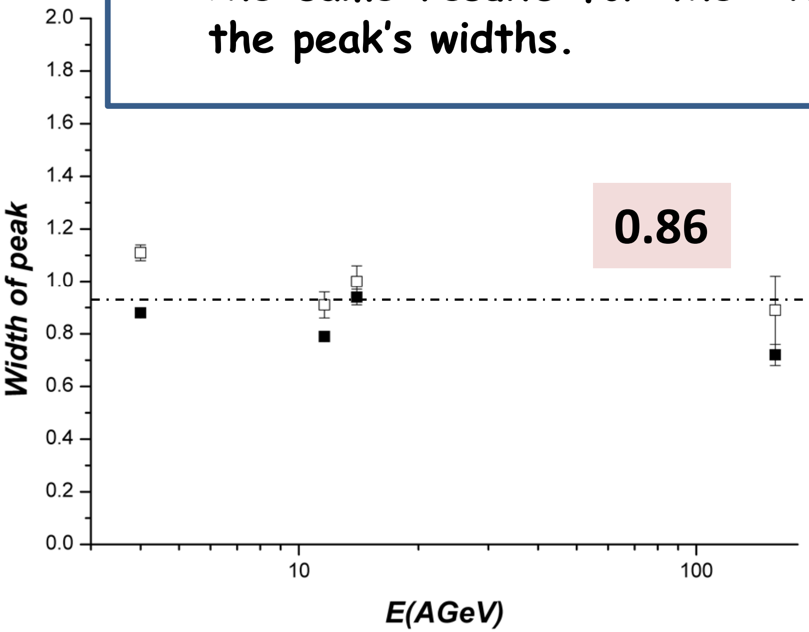


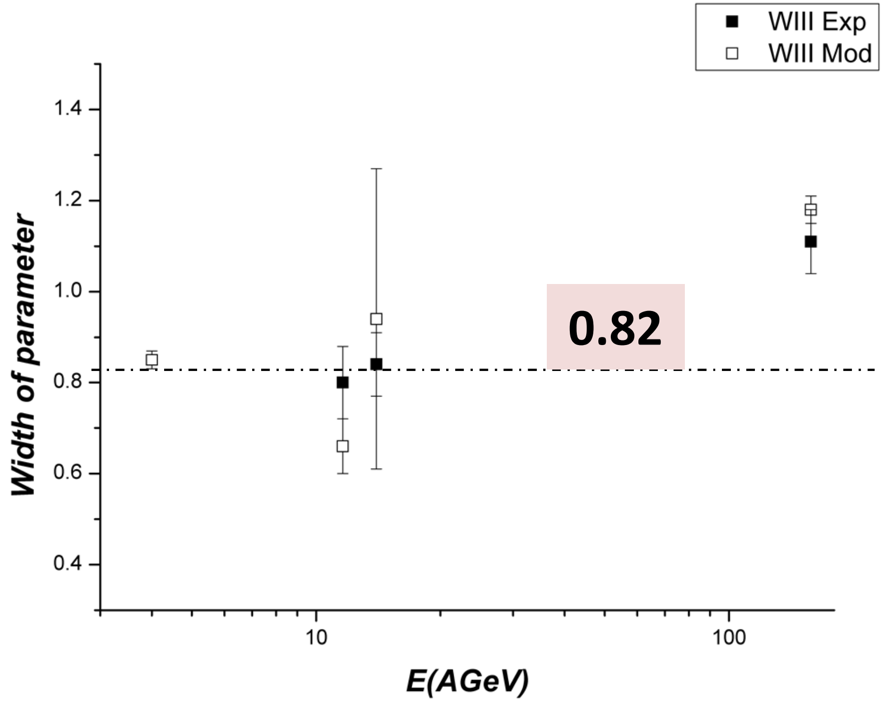
not reasonable peak

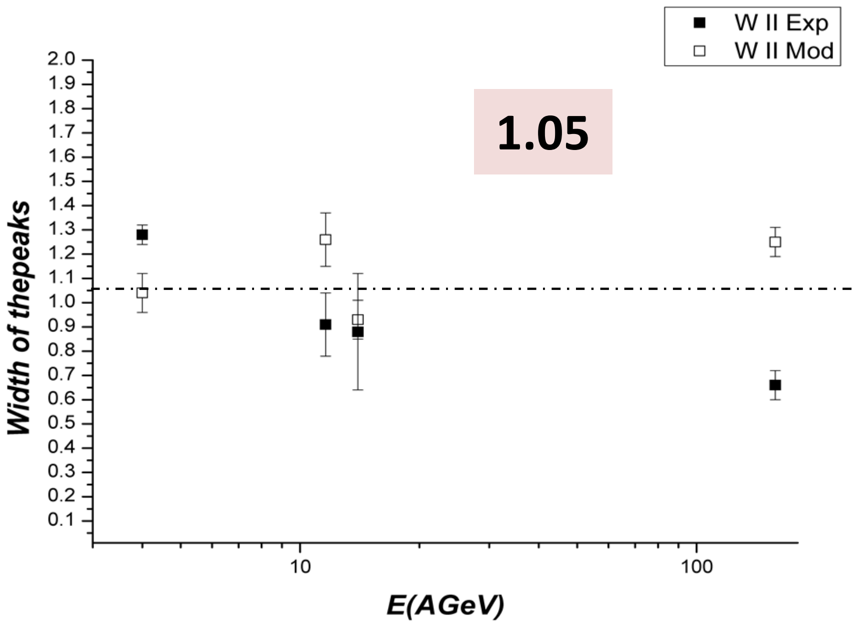


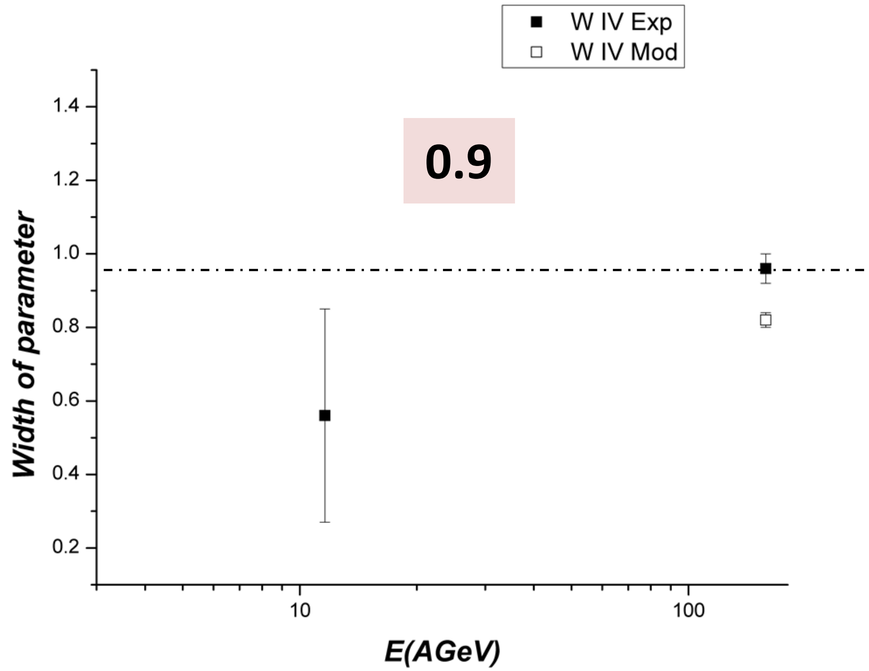
The values of the widths of the peaks as a function of the energy

The same results for the values of the peak's widths.





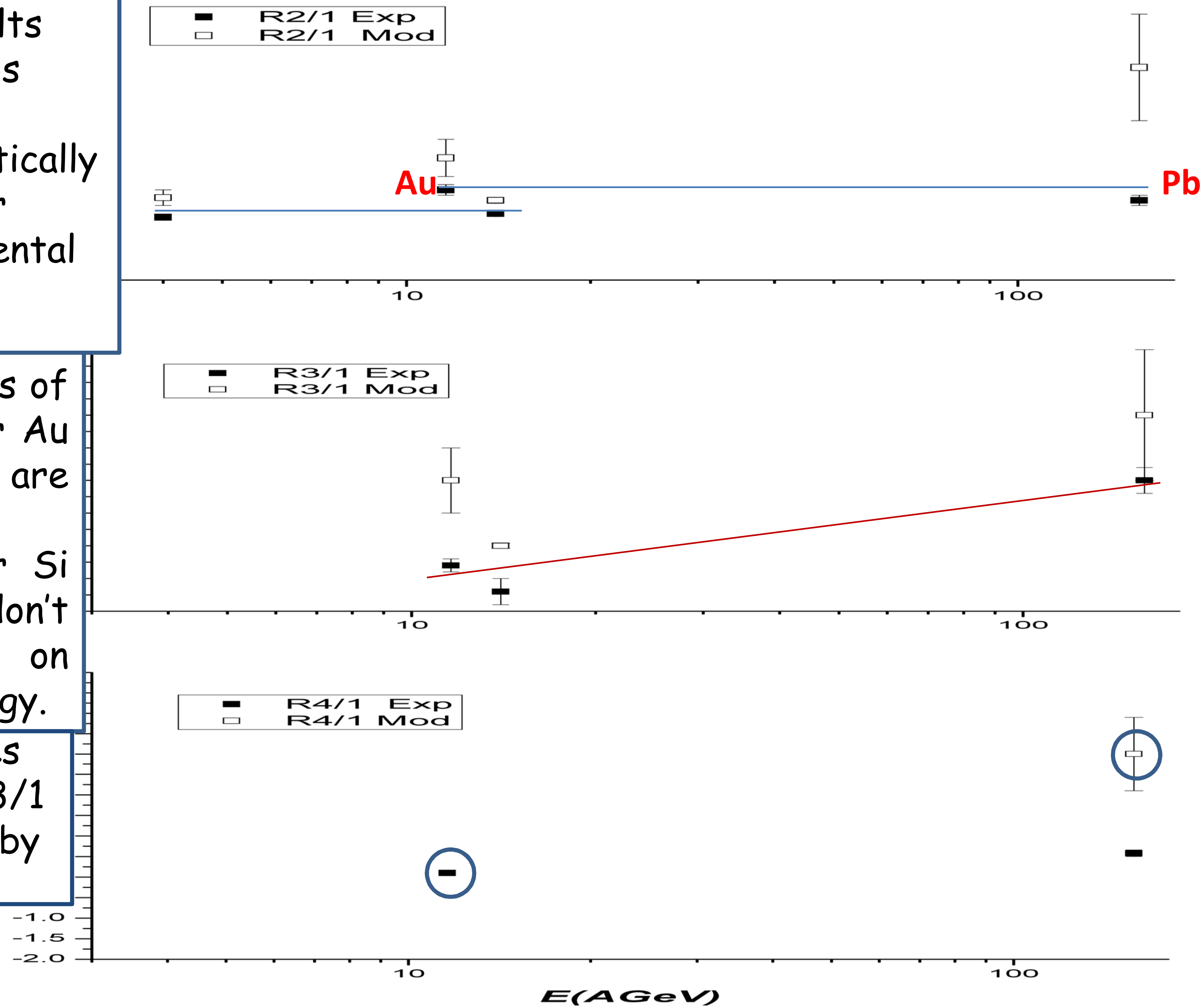




(1) model gives the results for ratios greater systematically than for experimental ones.

(2) the values of R2/1 for Au and Pb are greater that for Si and don't depend on the energy.

(3) The values of the R3/1 increase by energy



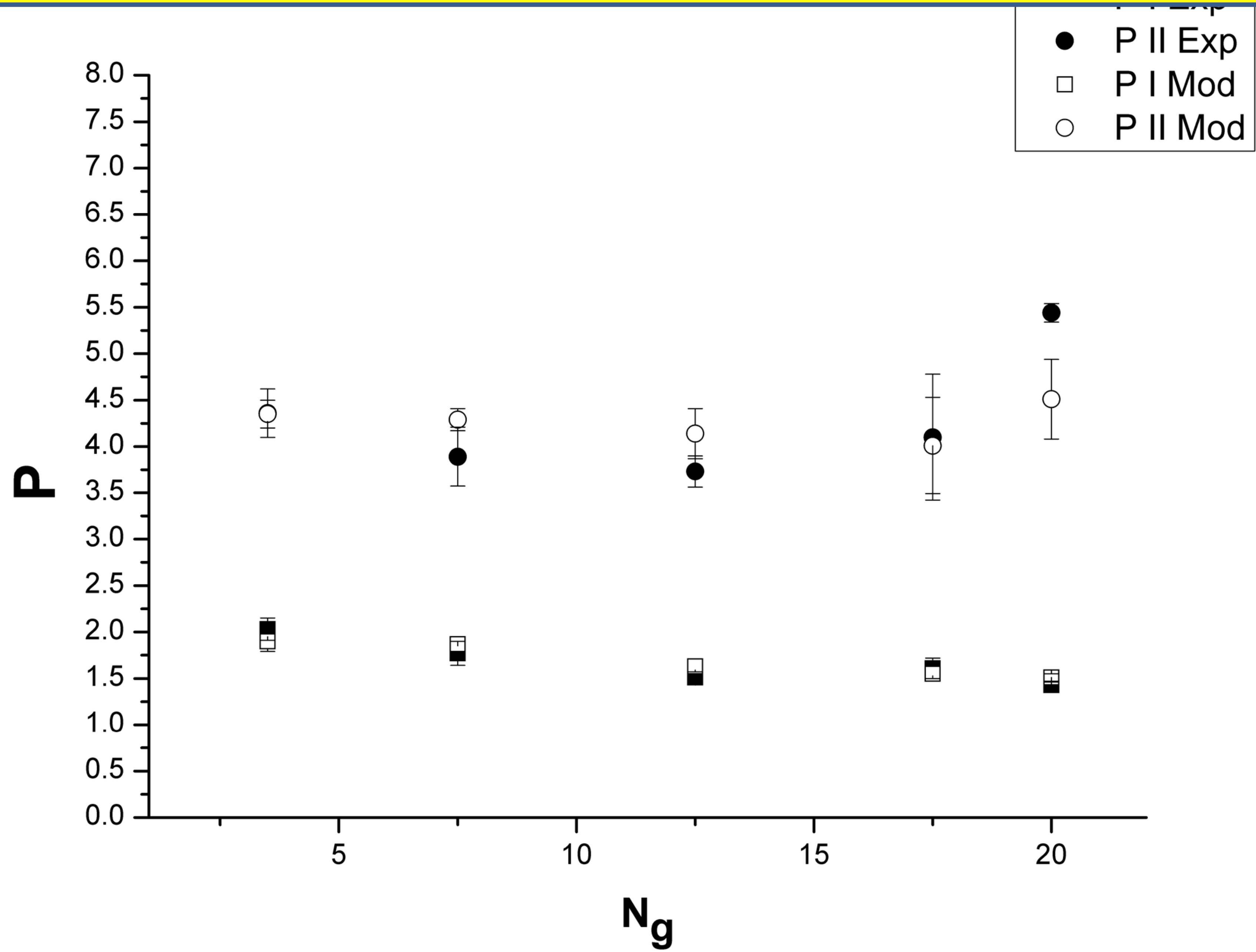
The

1-2 peaks - hadronic matter ;
3-4 peaks -mixed phase

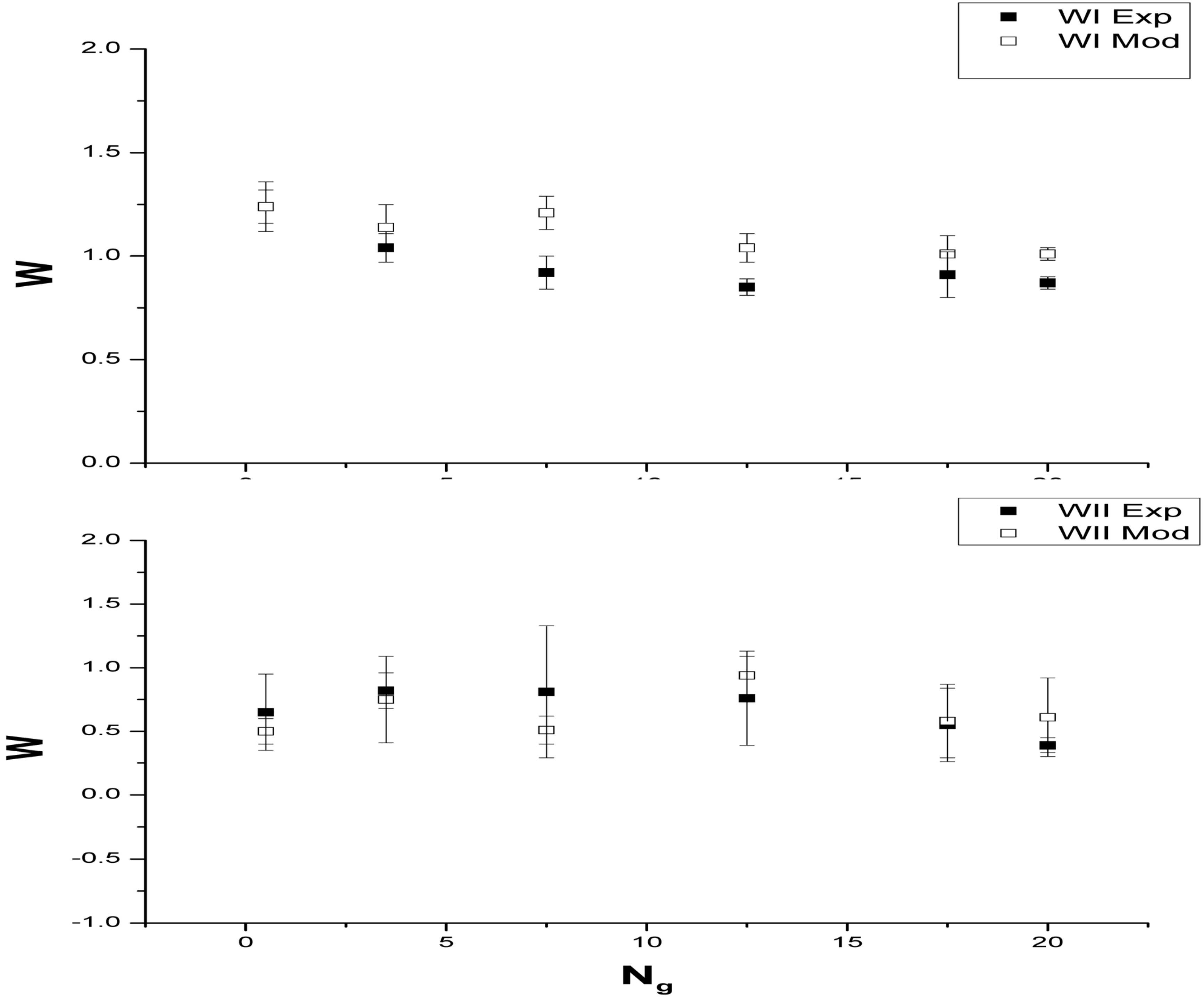
Centrality dependence - Ng

Maximum Entropy Method's results for the events with different number of Ng.

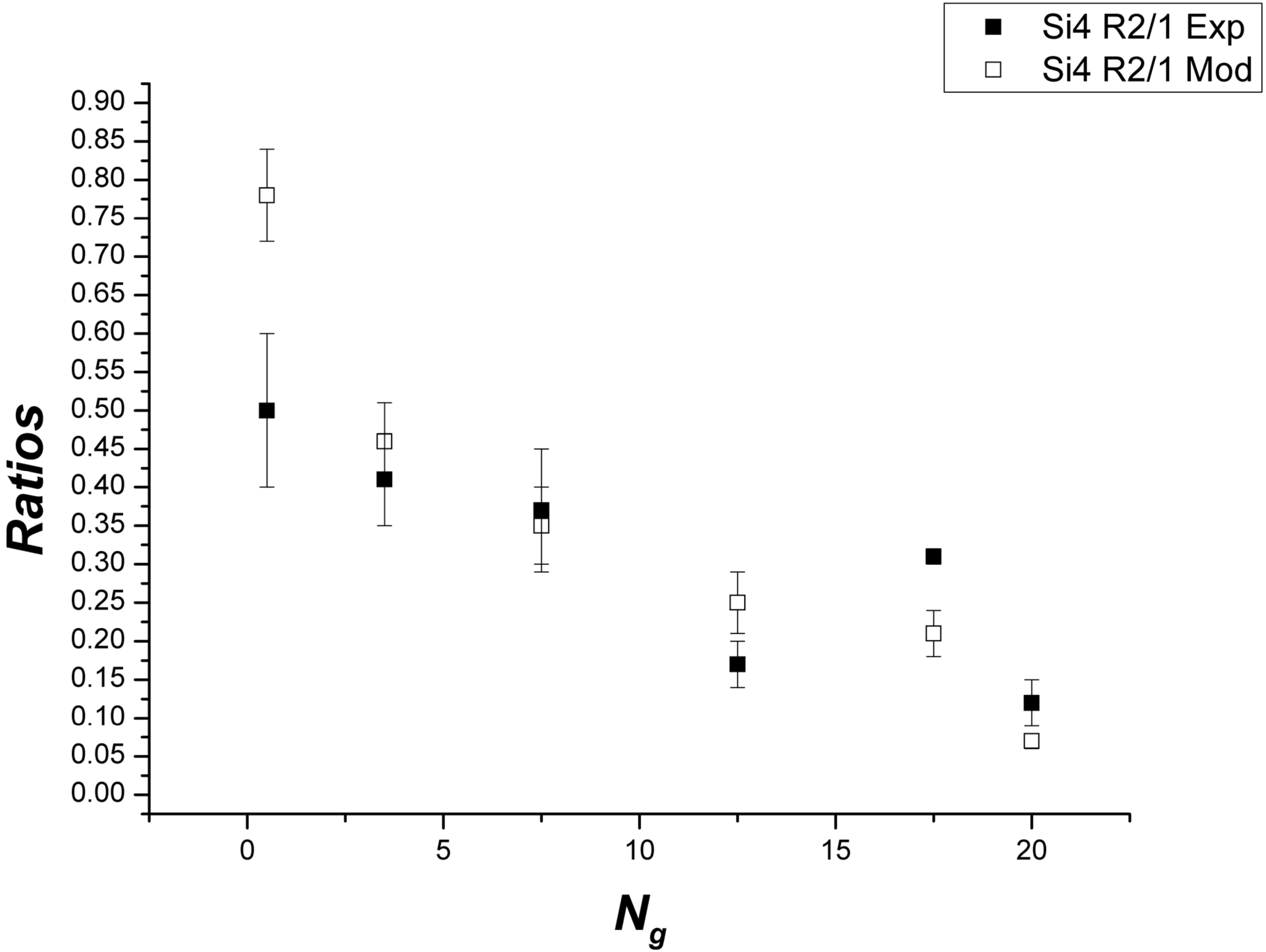
The method could extract 2 peaks, the values of η_c were described satisfactorily by the model.



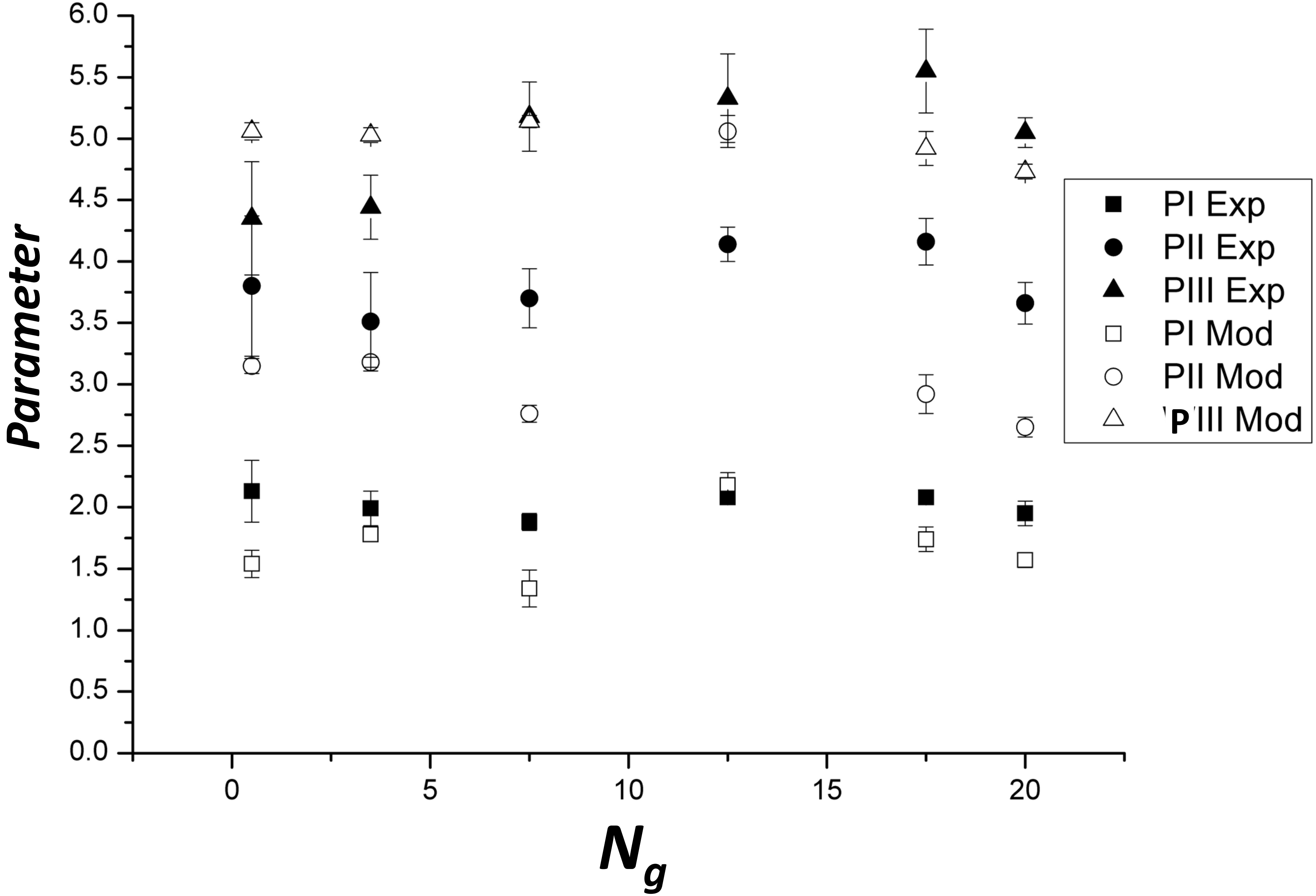
Si+Em 4 AGeV the values of the widths (W) of the peaks as a function of the N_g



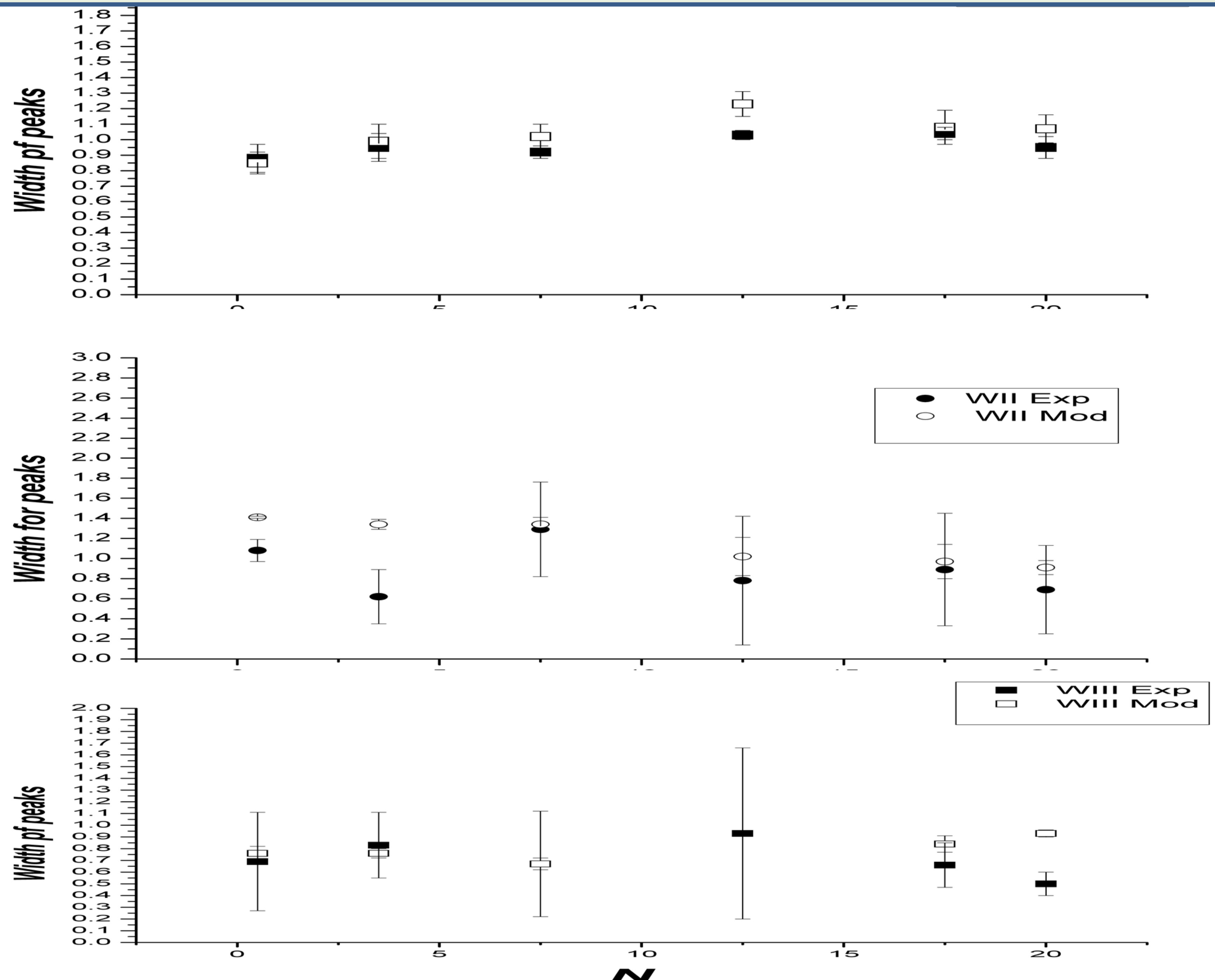
model - satisfactorily – η_c (I&II) ; W ; Ratios - Si+Em 4 AGeV.



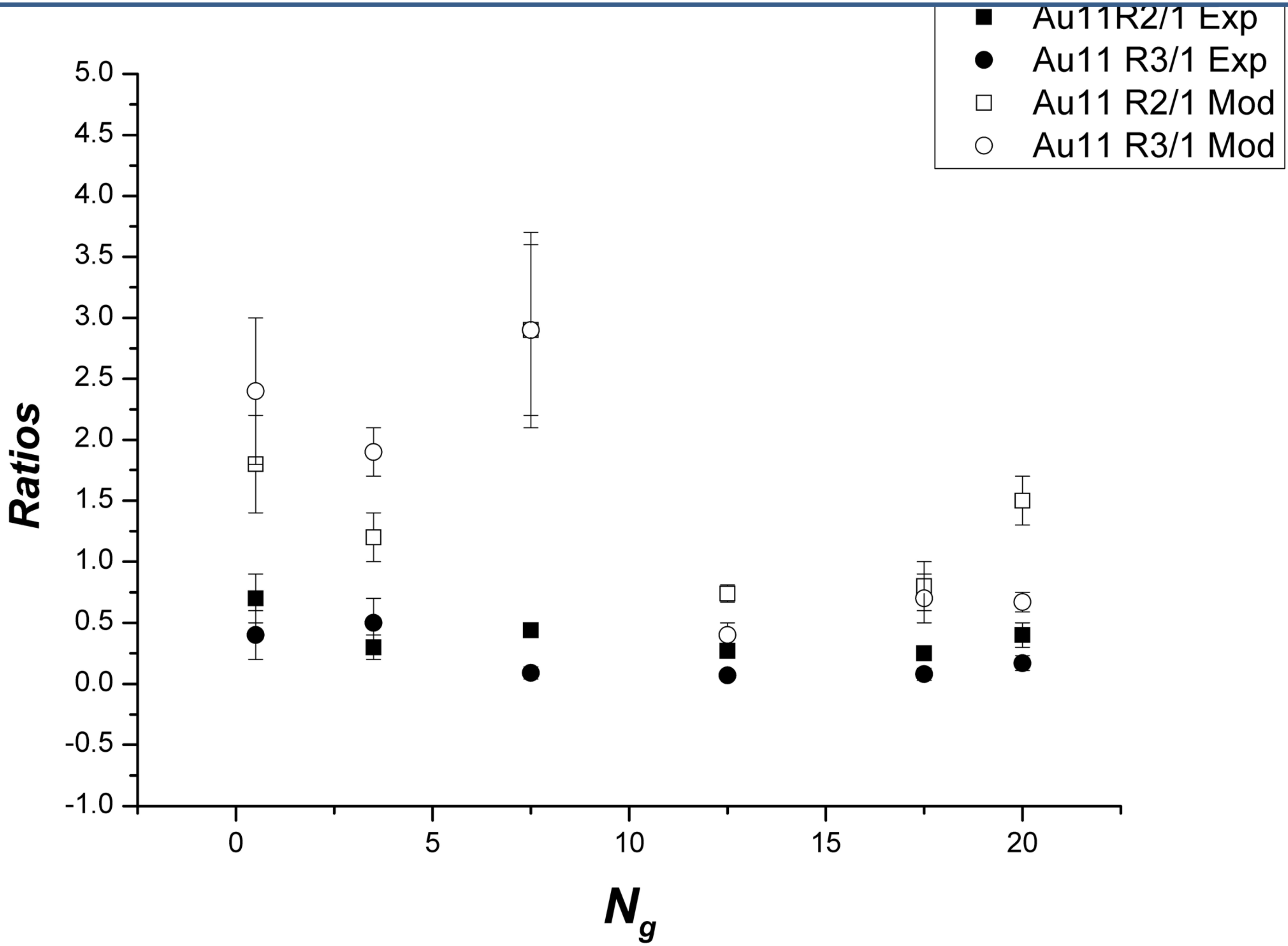
model - satisfactorily - η_c (I) ; η_c (II) {Ng< 5} ; η_c (III) completely; Au+Em 11.6 AGeV



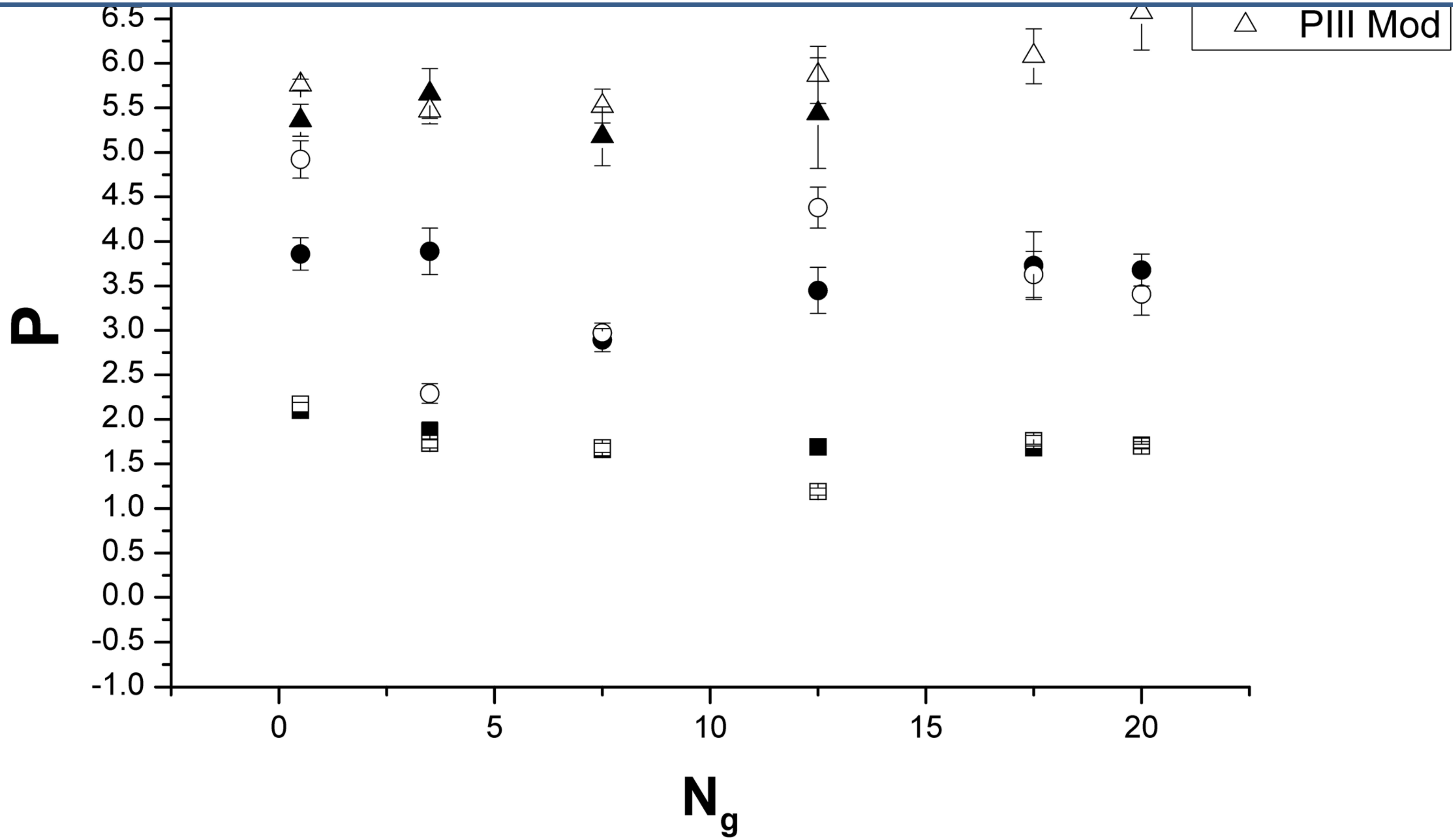
model – completely - W - **Au+Em-** reactions at **11.6 AGeV** .



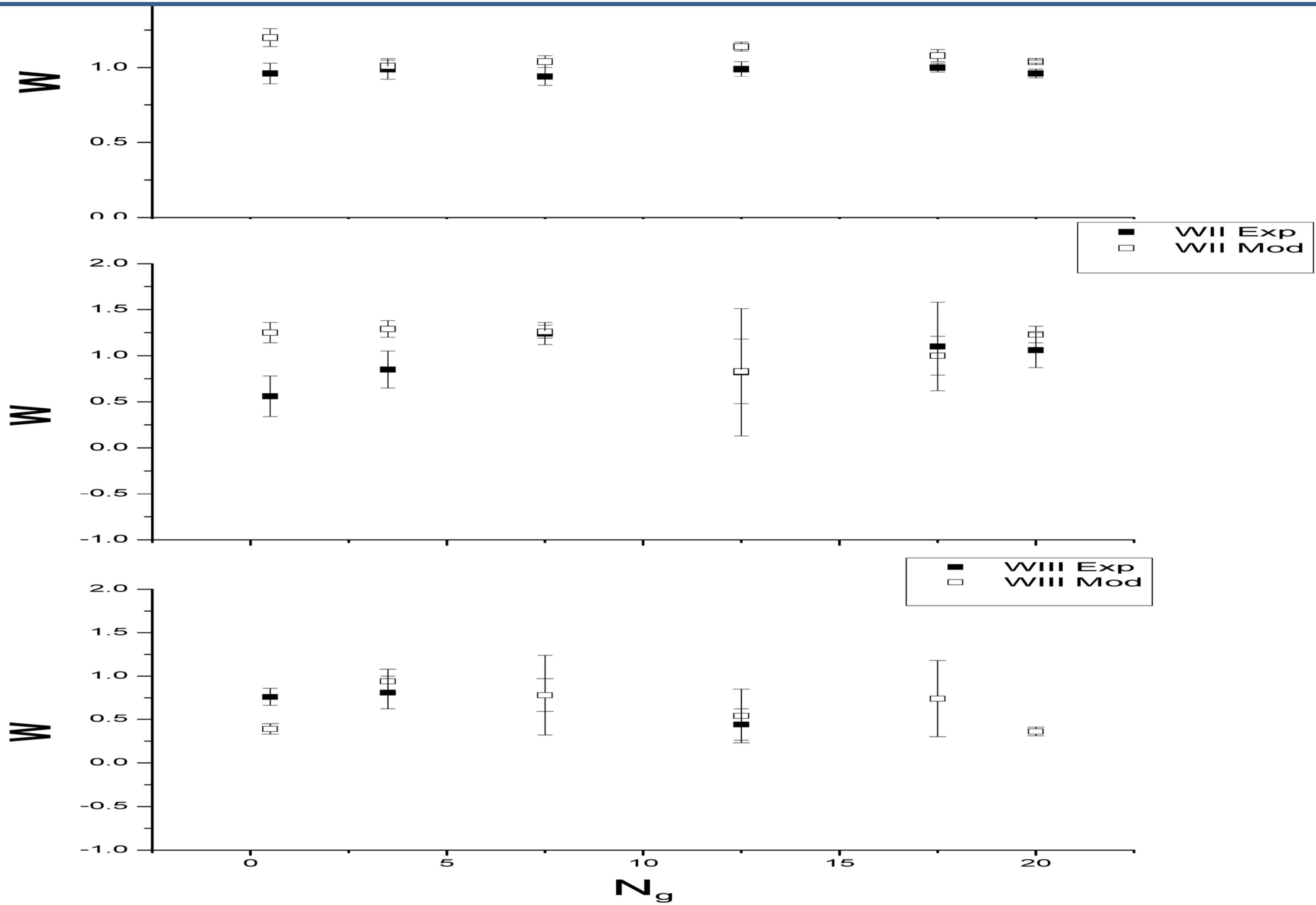
Model - cannot - Ratios :**Au+Em 11.6 AGeV** .



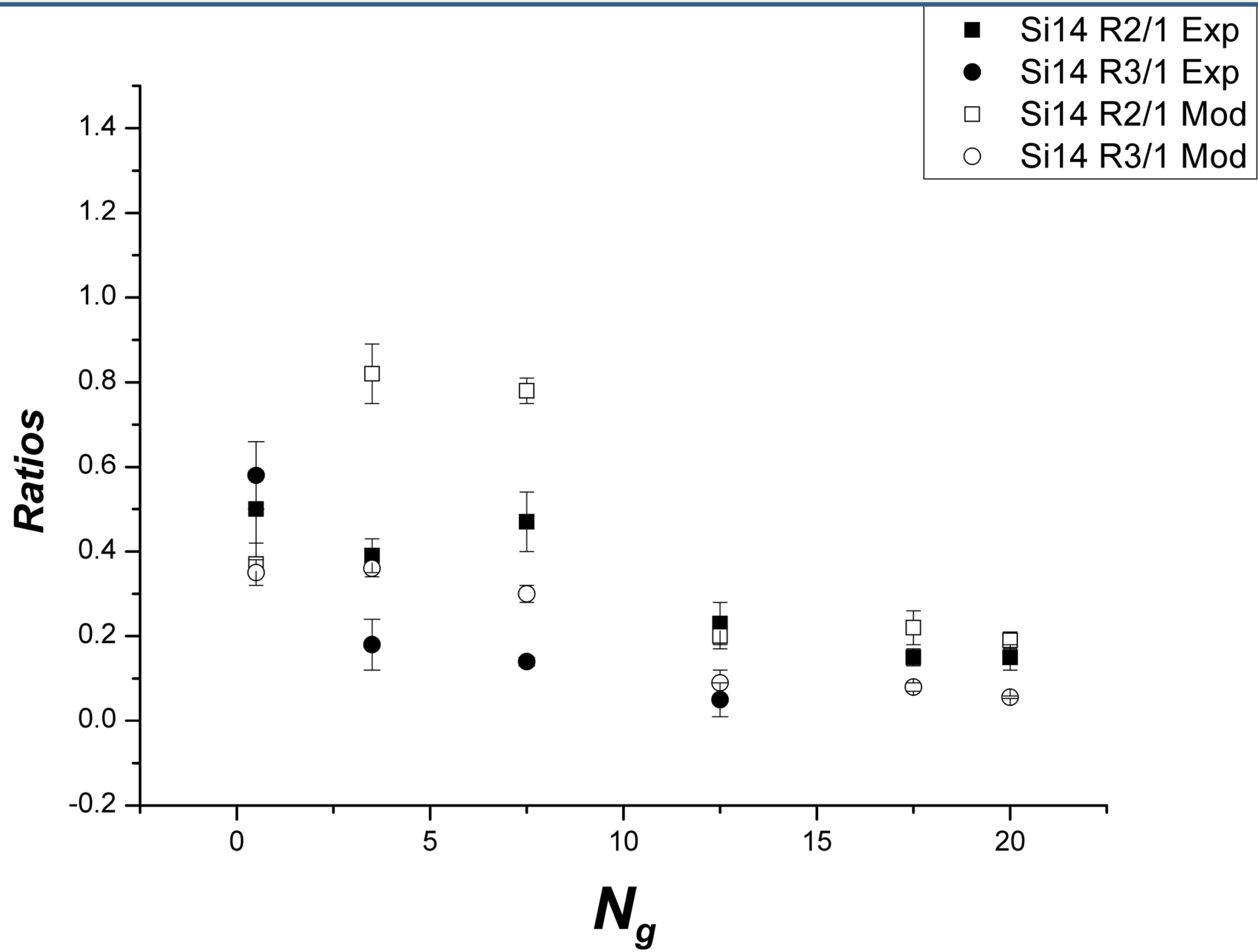
model - satisfactorily - η_c (I) ; η_c (II) {Ng> 5};
η_c (III) model - results {Ng>15} - are absent in the experiment
Si+Em 14 AGeV



model – satisfactorily W (I,II) ; W(III) {Ng>15} - are absent in the experiment. Si+Em 14 AGeV

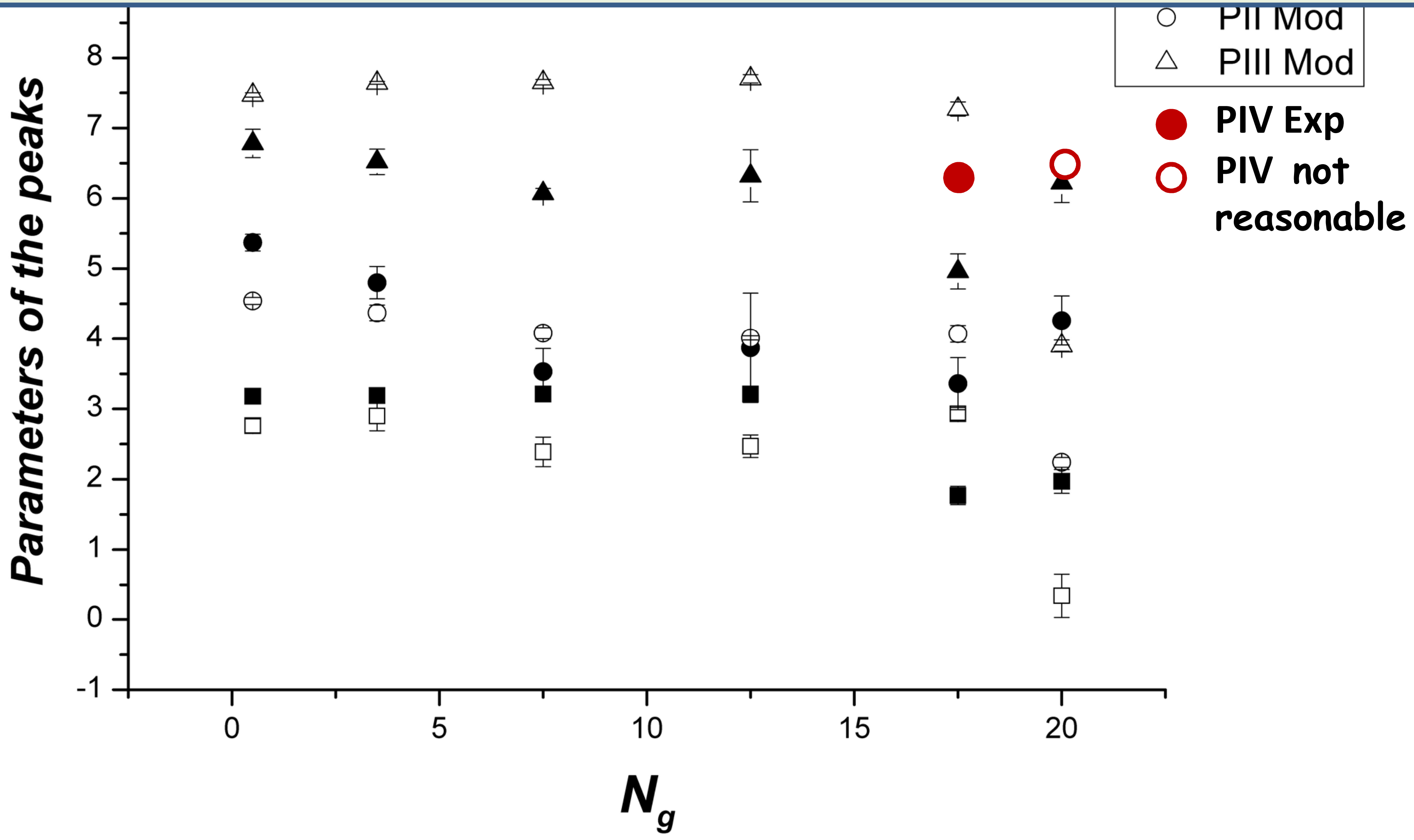


model - cannot describe completely ; Ratios: Si+Em 14 AGeV

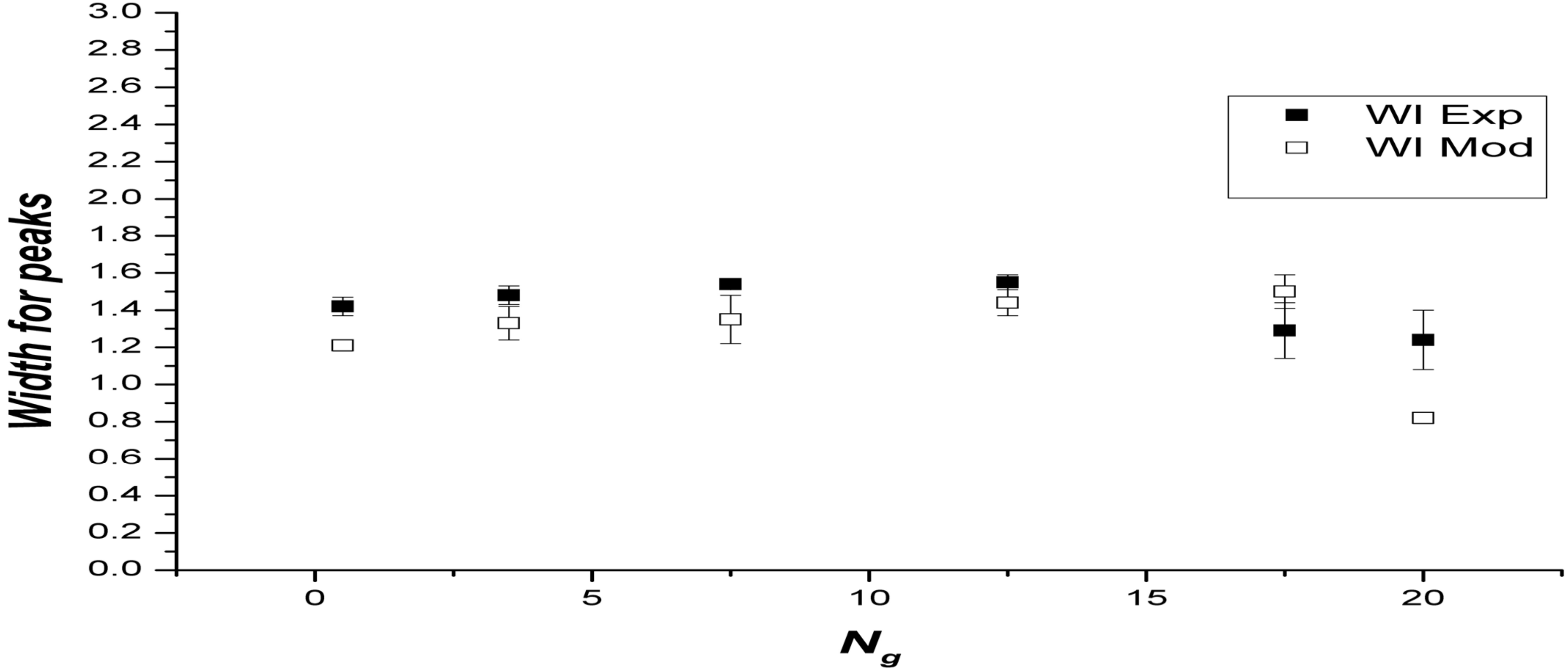


Pb+Em 158 AGeV : model - cannot η_c (I) {Ng>10} :
satisfactory η_c (II)

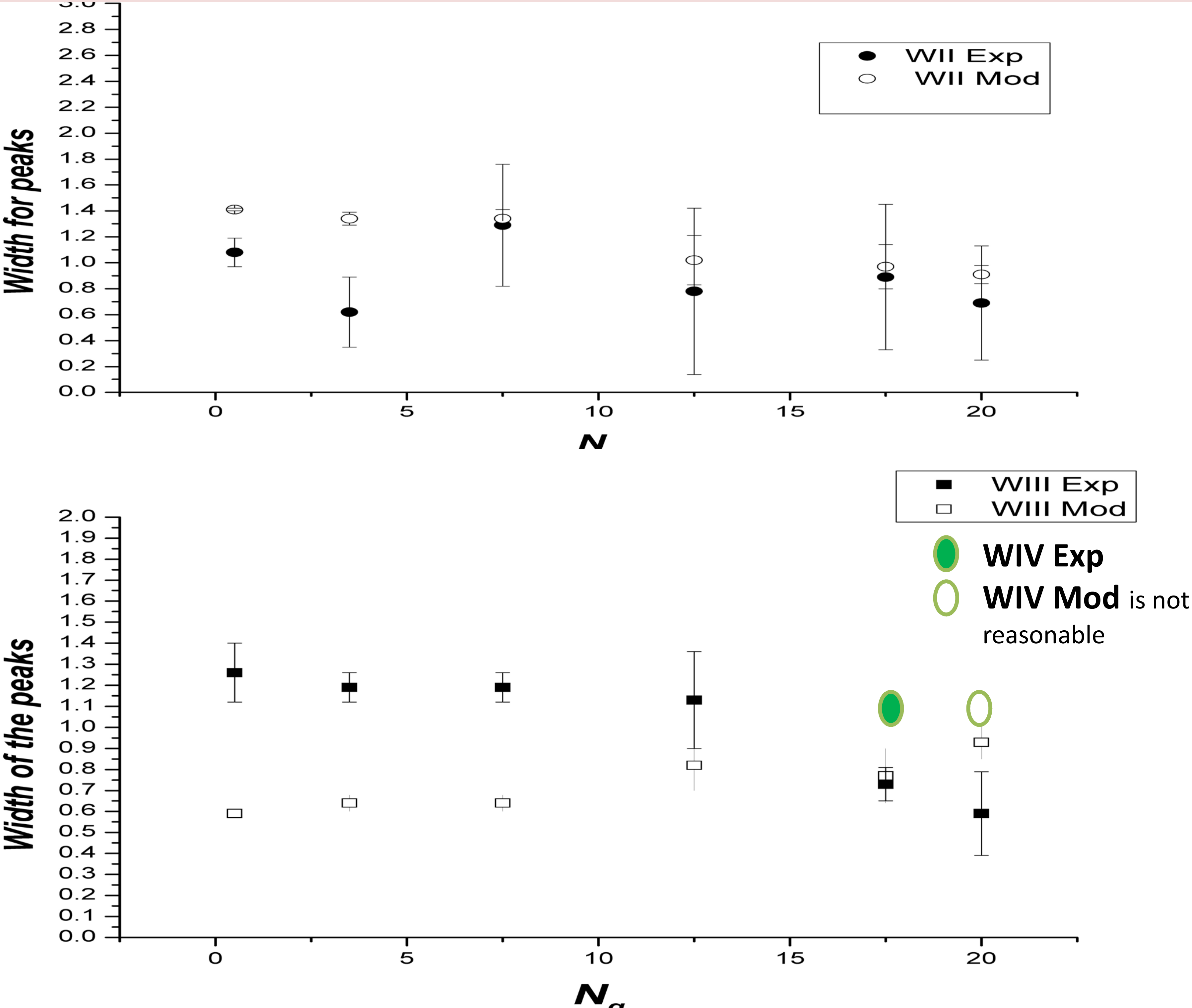
model -cannot η_c (III-IV)



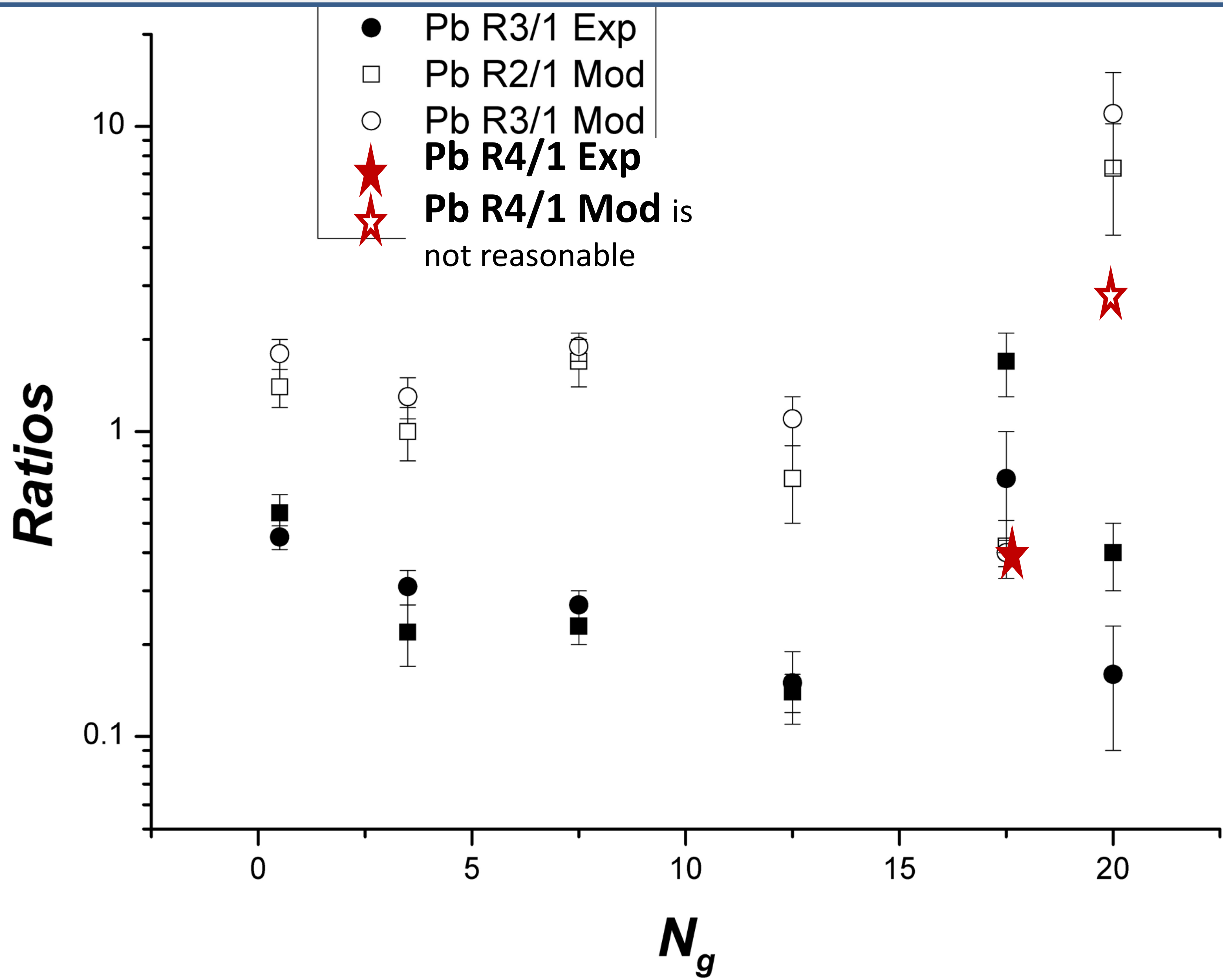
Pb+Em 158 AGeV the values of the widths of the peaks as a function of the N_g



Pb+Em 158 AGeV the values of the widths of the peaks as a function of the N_g



model - cannot Ratios : Pb+Em 158 AGeV . R2/1 ≈ R3/1 -decrease weakly {Ng<15} & saturate/ or decrease {Ng>15} ; R4/1.



Conclusion

- MEM - the η-spectra - s-particles (with β >0,7) : Si+Em (at 4 and 14A GeV); Au+Em (at 11.6 A GeV);Pb+Em (at 158 A GeV);

- the method produced several peaks - η_c from the spectrum, the number of which increases with energy from 2 to 4 depends on the characteristics of the reactions;

- to compare quantitatively the results coming from the experimental and from the Modified Cascade model, the peaks were fitted and the values of η_c at peaks , their heights , widths and ratios of the heights are defined;

- the energy and Ng (a number of g-particles, with $0.23<\beta<0,7$) dependences for the parameters of the peaks were analyzed for the experimental and the model data separately;

- third and fourth peaks could not describe completely by the model;

- the fourth parameter exists for Pb beam (158 AGeV) only and connects with events with Ng=15-20. The last result is some strange because for fourth parameter the values of $\eta \sim 6.5$, so it is forward particles and has to be a striping one from peripheral collisions mainly. It may be a signal on coherent prompt particle production in heavy ion collisions at relativistic energies. In any case it could be connected by collective phenomenon which could not exist in the model and which was predicted by A.M. Baldin

Thank you very much