Monte Carlo Generator DCM-SMM

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Content

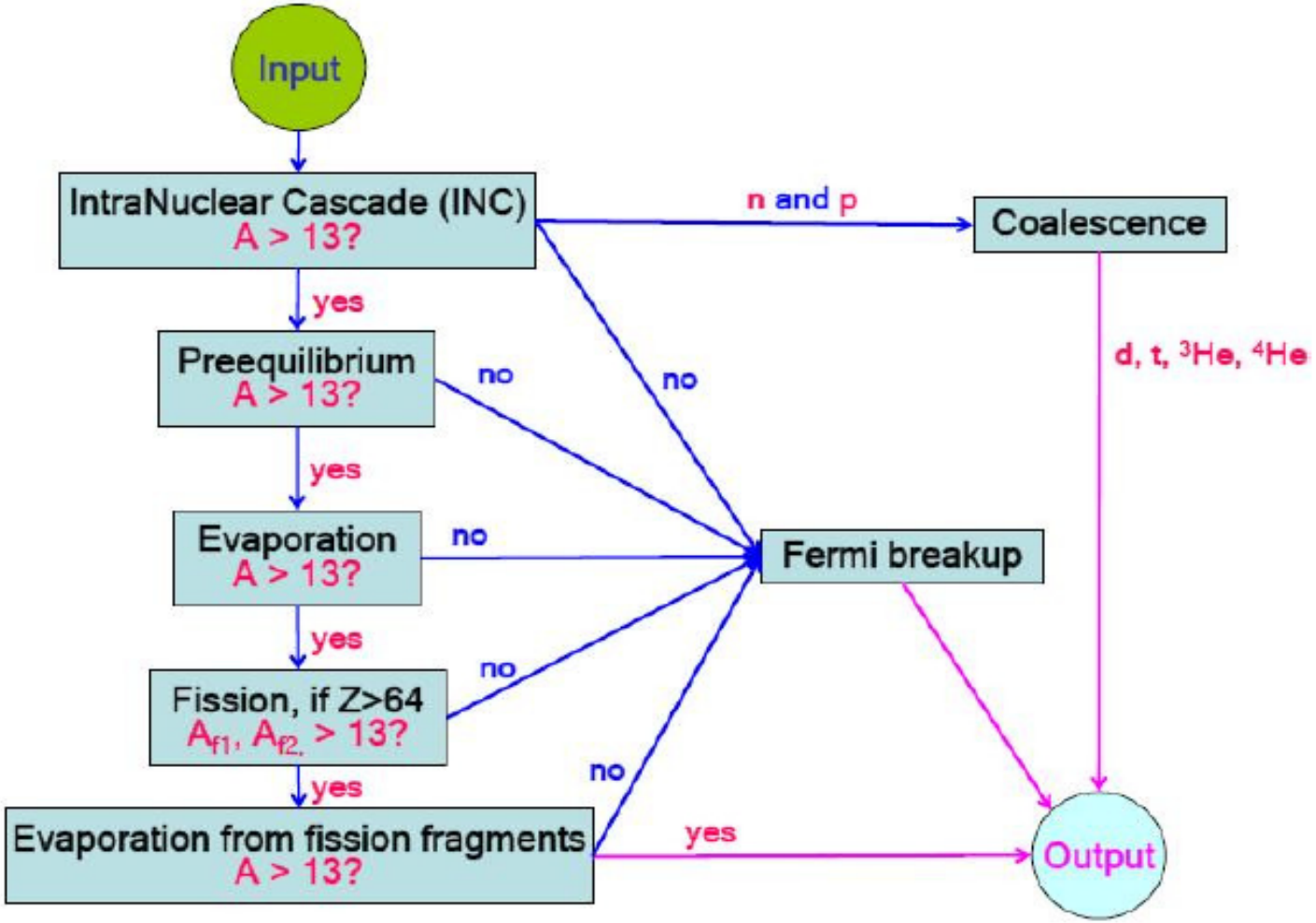
- Modified DCM–QGSM – current generator
- DCM–SMM: modified DCM-QGSM + SMM
- Conclusions

DCM-QGSM

DCM-QGSM – Dubna Cascade Quark-Gluon-String-Model

- DCM
  - + coalescence
  - + prequilibrium
  - + Fermi break-up
  - + GEM (Generalized evaporation + fission)
  - + Light hyperfragments production at coalescence stage
- QGSM (E_{Lab} > 4.5AGeV)

Scheme of DCM calculations



DCM-SMM: DCM-QGSM + SMM

SMM – Statistical Multifragmentation Model

A. Botvia et al, Nucl. Phys. A584 (1995) 737-756.

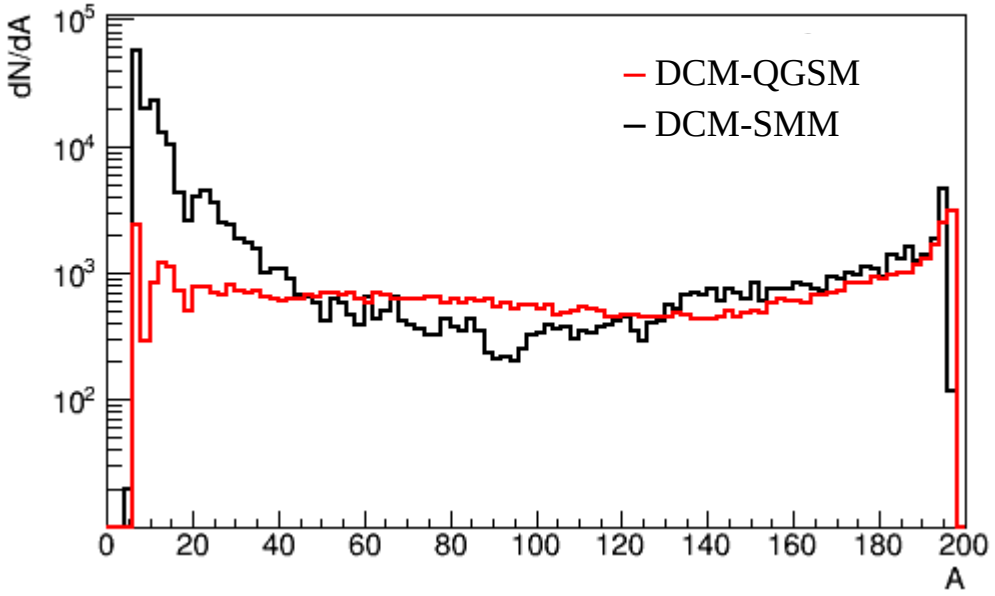
J.P. Bondorf, A.S. Botvina, A.S. Ilinov, I.N. Mishustin, K. Sneppen, Phys.Rep. 257 (1995) 133-221

- Statistical break-up of excited nuclear residuals
- Light and medium mass fragments formation

Multifragmentation

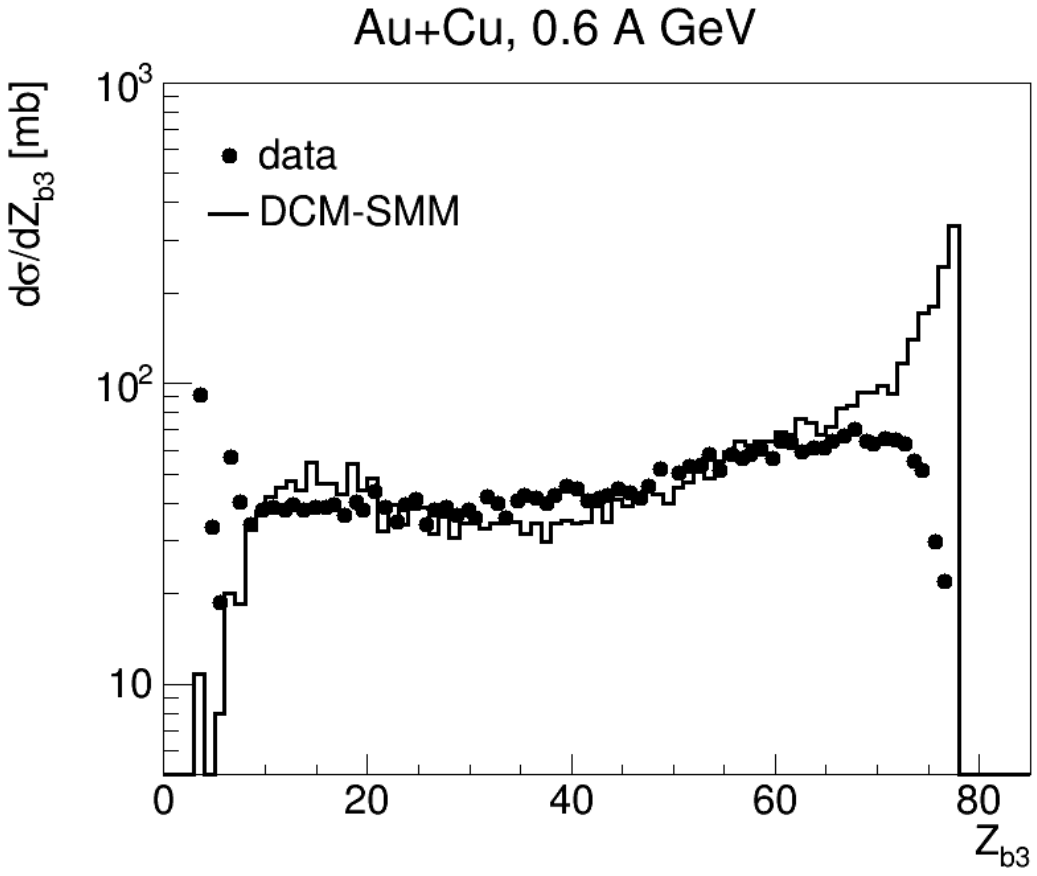
Comparison **DCM-QGSM** and **DCM-SMM**

Au+Au, $\sqrt{s_{NN}}$ = 5 GeV



Multifragmentation

Comparison **DCM-SMM** with data

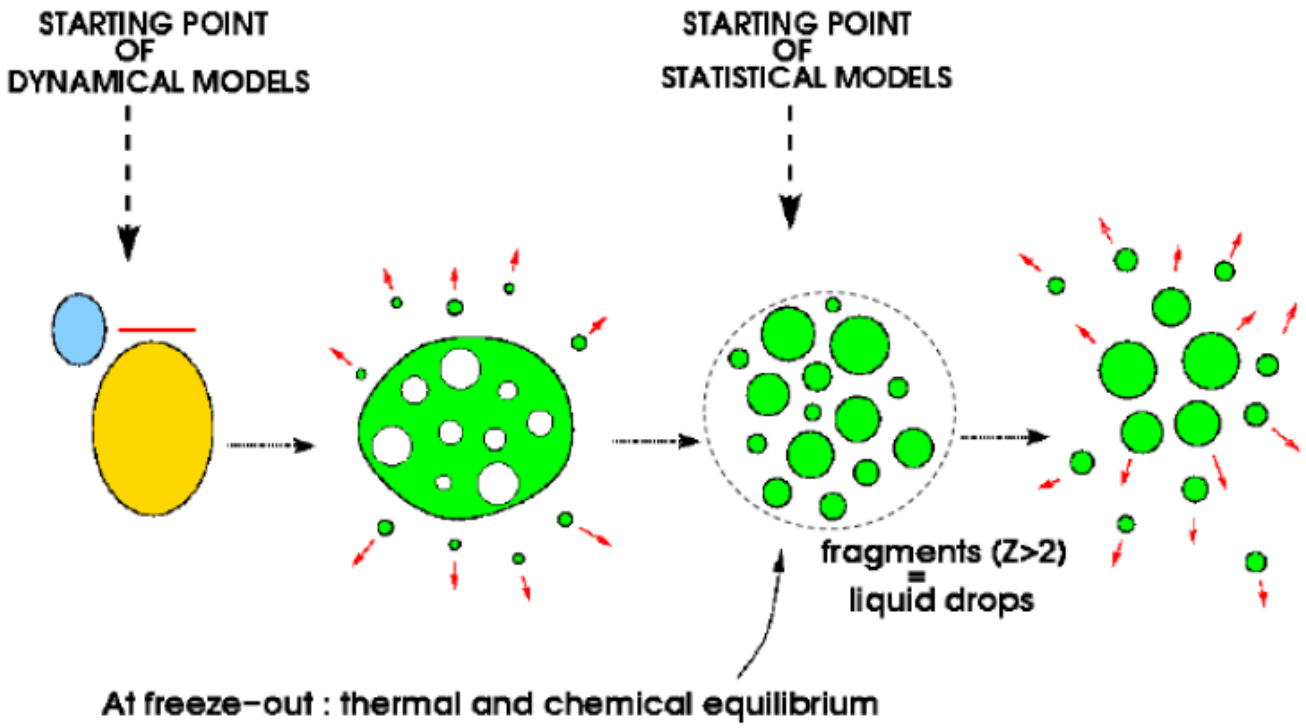


SMM

Multifragmentation in intermediate and high energy nuclear reactions

Experimentally established:

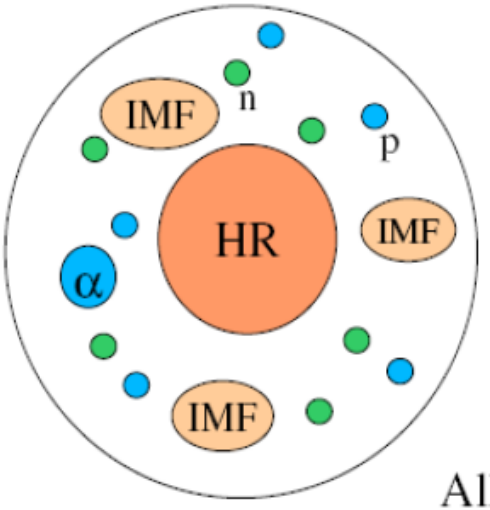
1) few stages of reactions leading to multifragmentation,
2) short time ~100fm/c for primary fragment production,
3) freeze-out density is around $0.1\rho_0$,
4) high degree of equilibration at the freeze-out,
5) primary fragments are hot.



SMM

Statistical Multifragmentation Model (SMM)

J.P.Bondorf, A.S.Botvina, A.S.Iljinov, I.N.Mishustin, K.Sneppen, Phys. Rep. **257** (1995) 133



Ensemble of nucleons and fragments
in thermal equilibrium characterized by

neutron number N_0

proton number Z_0, $N_0+Z_0=A_0$

excitation energy $E^*=E_0-E_{CN}$

break-up volume $V=(1+\kappa)V_0$

All break-up channels are enumerated by the sets of fragment multiplicities or partitions, $f=\{N_{AZ}\}$

Statistical distribution of probabilities: $W_f \sim \exp\{S_f(A_0, Z_0, E^*, V)\}$

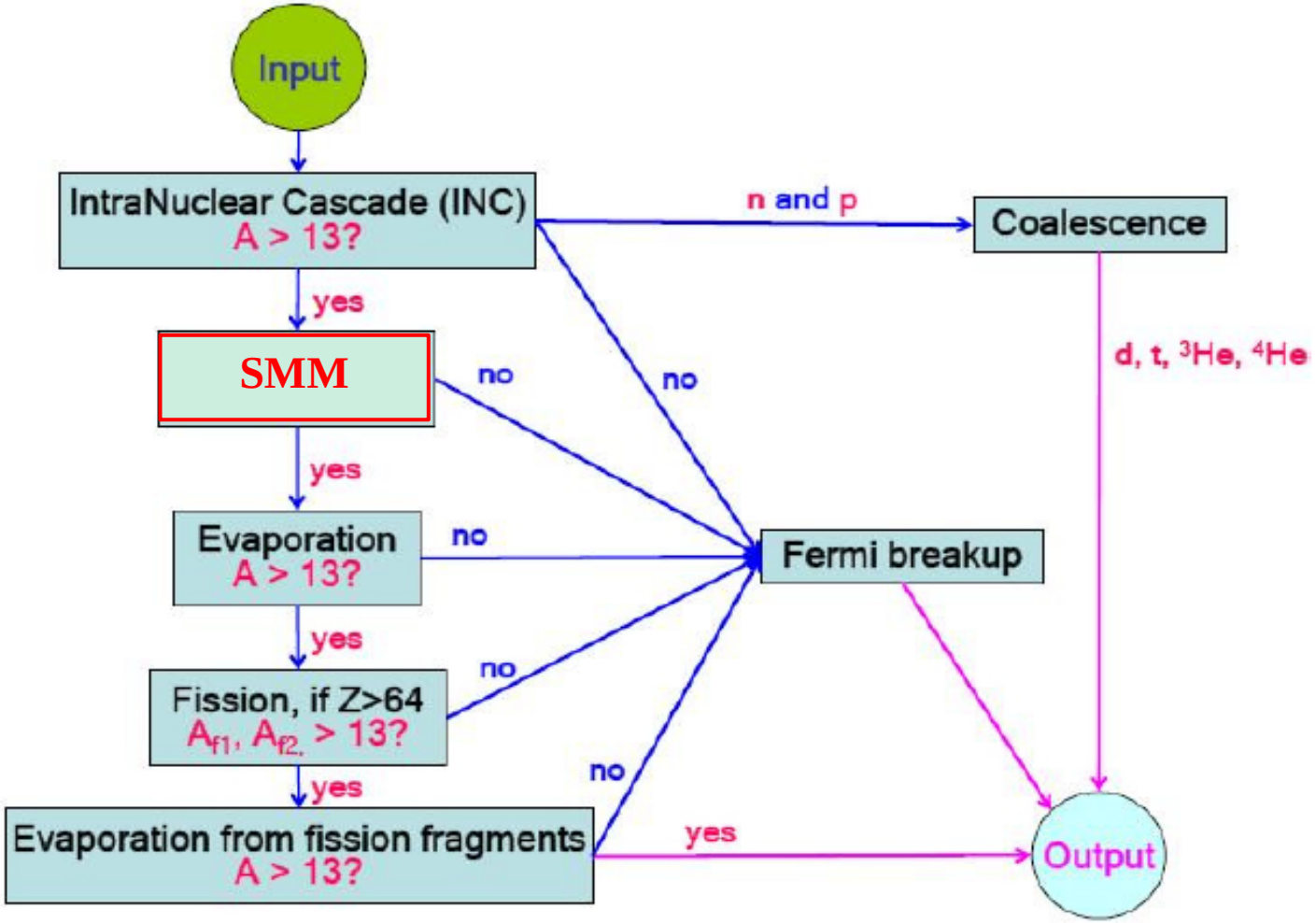
under conditions of baryon number (A), electric charge (Z) and energy (E*) conservation, including compound nucleus.

DCM-SMM

DCM-QGSM – Dubna Cascade Quark-Gluon-String-Model

- DCM
  + coalescence
  + ~~prequilibrium~~
  + Fermi break-up
  + SMM
  + GEM (Generalized evaporation + fission)
  + Light hyperfragments production at coalescence stage
- QGSM (E_{Lab} > 4.5AGeV)

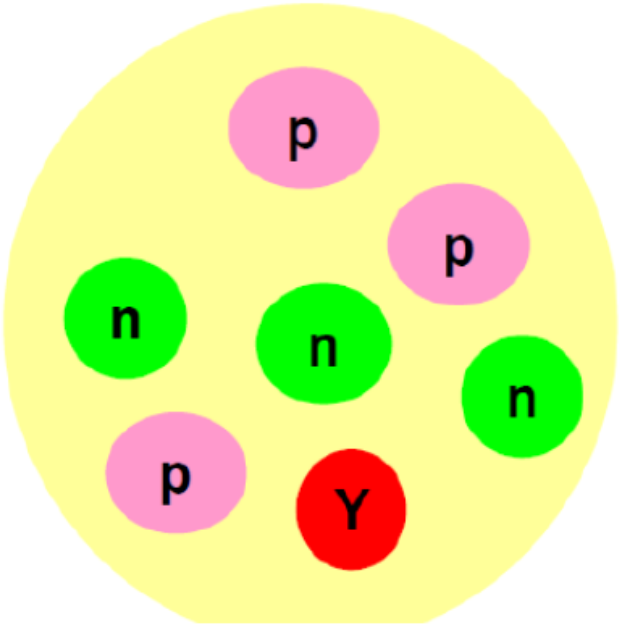
Scheme of DCM-SMM



Further Modification of DCM-SMM

Hypernucleus: Hyperons Bound in Nuclei

Hypernucleus: consists of nucleons (n, p) + hyperon (Y)



Notation:

$$ {}_{Y}^{A}Z $$

Y = Hyperon

$Z = Z_p + (N_Y \cdot q_Y)$

$A = N_n + N_p + N_Y$

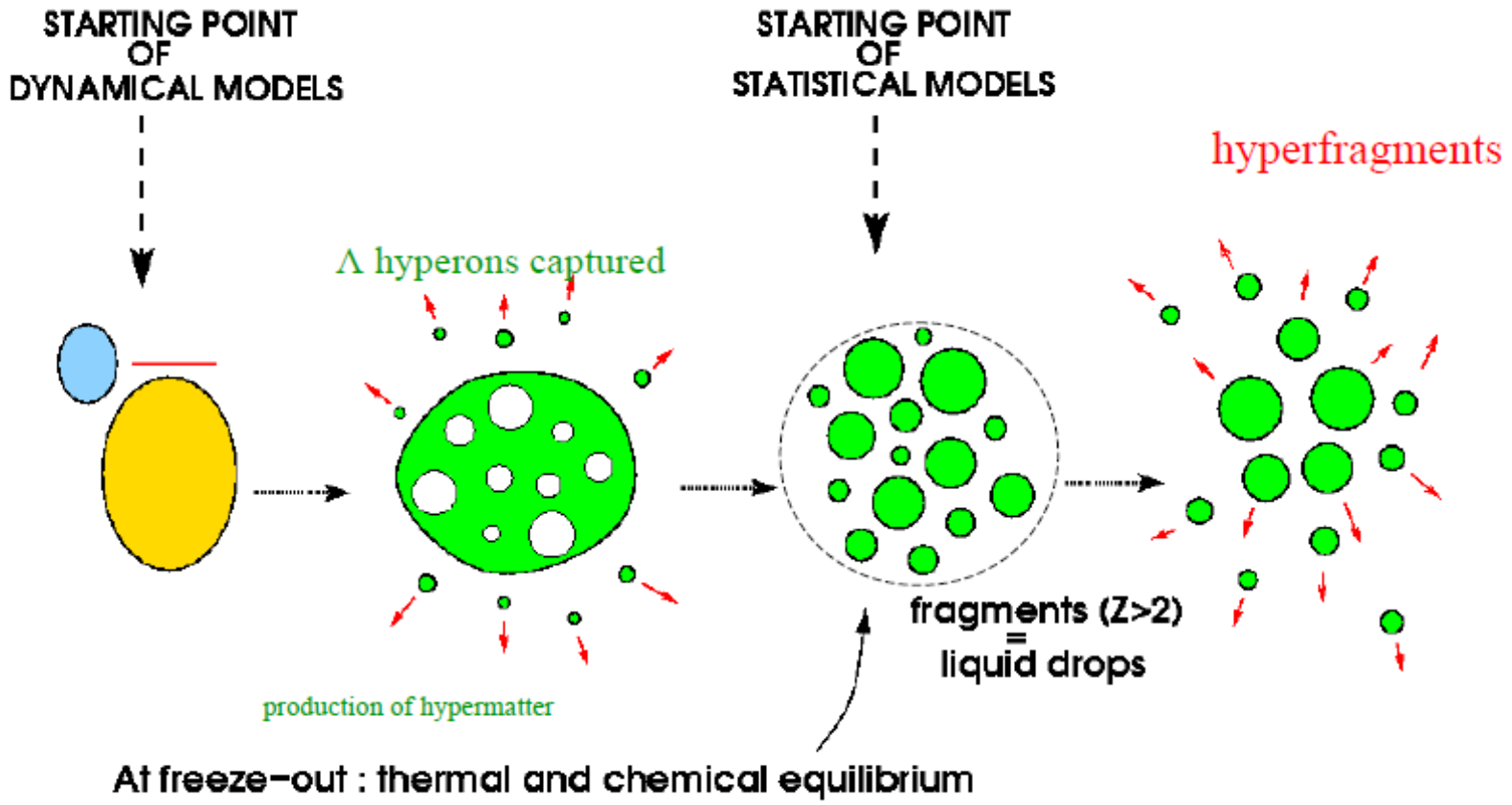
A.S.Botvina and J.Pochodzalla, Phys. Rev.C76 (2007) 024909

Generalization of the statistical de-excitation model for nuclei with Lambda hyperons

In these reactions we expect analogy with

multifragmentation in intermediate and high energy nuclear reactions

+ nuclear matter with strangeness



Further Modification of DCM-SMM

Hyperfragment production

A.S. Botvina, K. K. Gudima, J. Steinheimer, M. Bleicher, and I. N. Mishustin, PHYSICAL REVIEW C ***84****, 064904 (2011)*

J. Steinheimer, K.K. Gudima, A.S. Botvina, I.N. Mishustin, M. Bleicher, H. Stocker, Phys. Lett. ***B714****, 85 (2012).*

Generalized Statistical Fragmentation model

- Coalescence mechanism in central region
- Multifragmentation in forward and backward regions:

  - capture of hyperons by spectator fragments in non-central heavy ion collisions

  - capture criterium: $E_H < |V_\Lambda|$

$$V_\Lambda(\rho) = -\alpha \frac{\rho}{\rho_0}\left[1 - \beta\left(\frac{\rho}{\rho_0}\right)^{2/3}\right],$$

Plan for future

- Correction of formation time concept
- Generalized Multifragmentation Model
- Implementation of the mechanism of enhancement of strangeness
- Implementation of the mechanism of enhancement of dilepton yield
- Further development

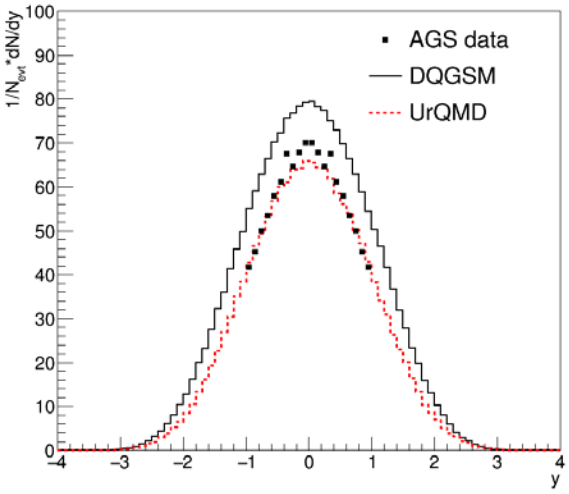
Thank you!

Backups

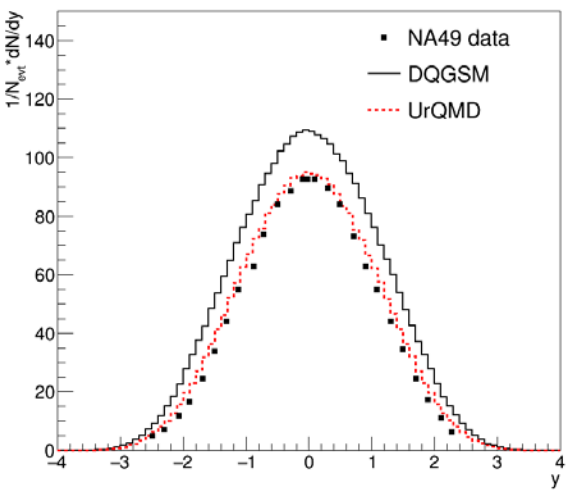
DCQGSM vs Experiment: **AGS**, Au+Au; **NA49**, Pb+Pb

π^- - rapidity distributions

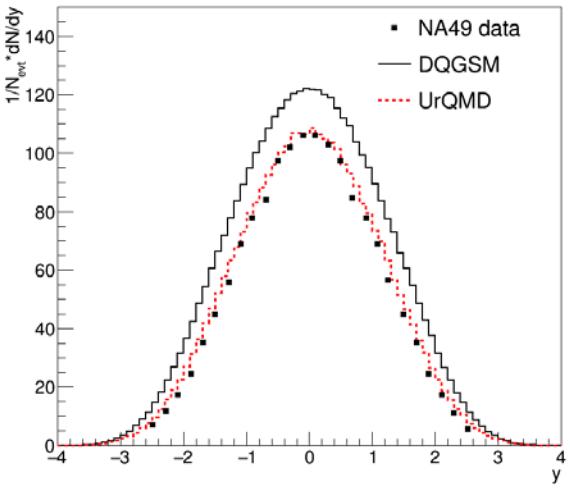
10.6 AGeV



20 AGeV



30 AGeV



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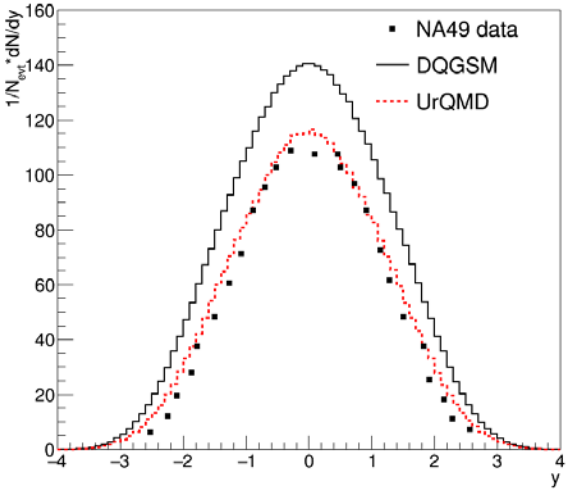
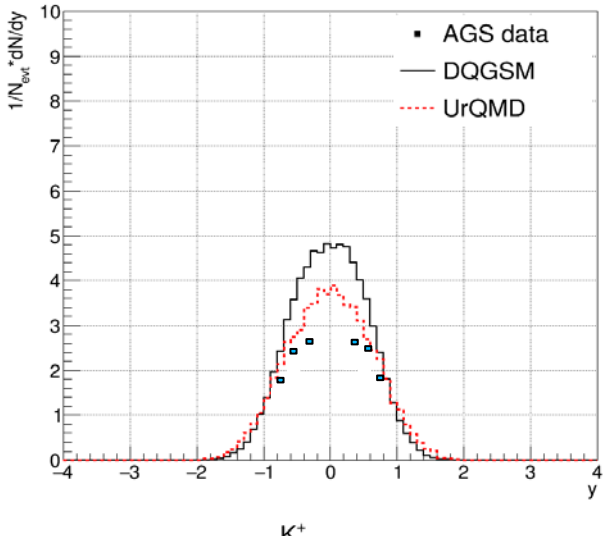


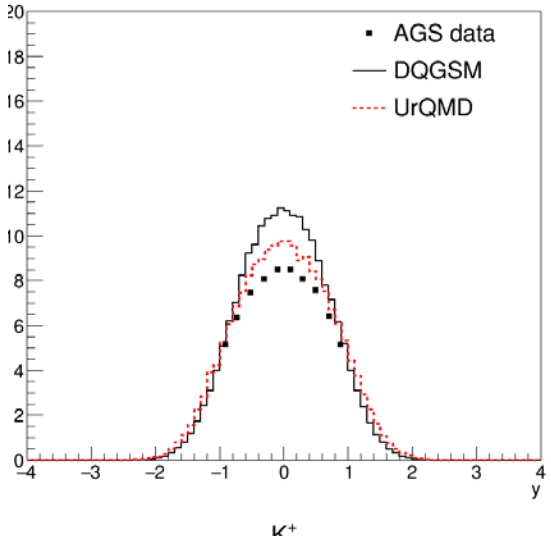
DCQGSM vs Experiment: **AGS**, Au+Au; , **NA49,** Pb+Pb

K^+- rapidity distributions

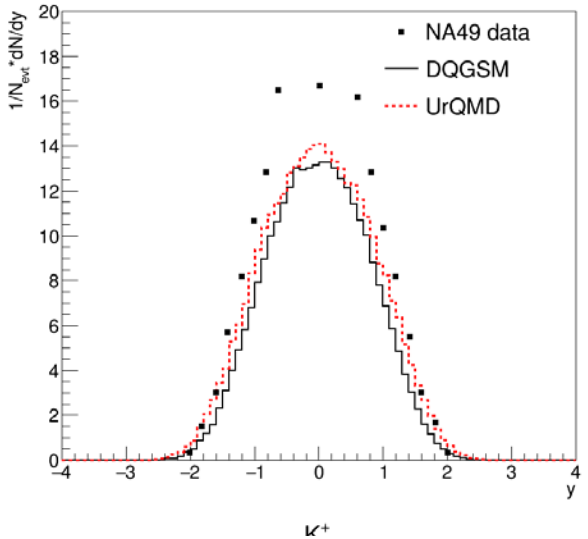
4 AGeV



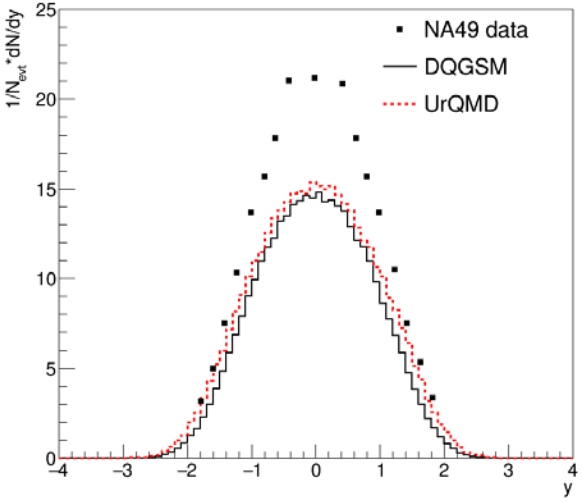
10.6 AGeV



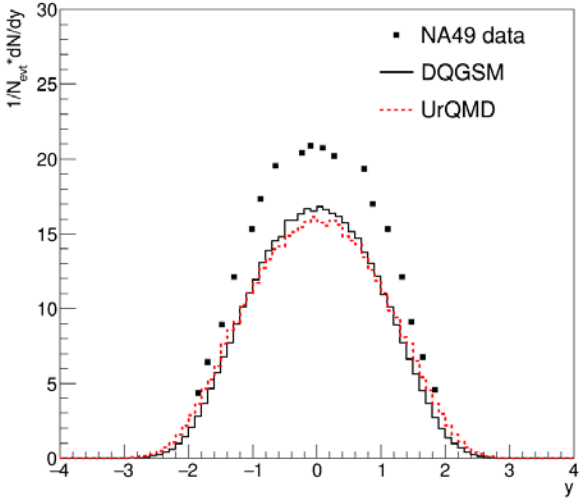
20 AGeV



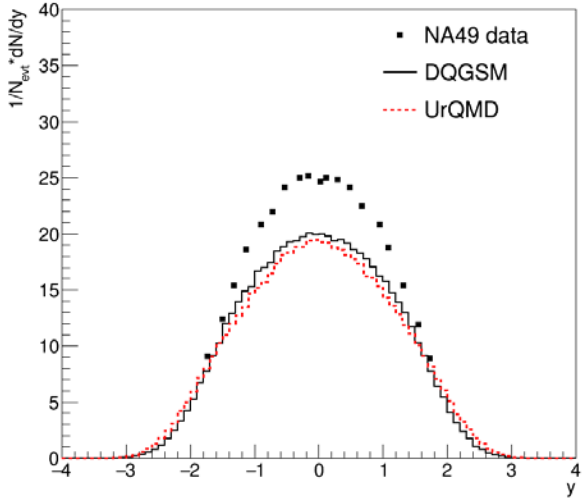
30 AGeV



40 AGeV

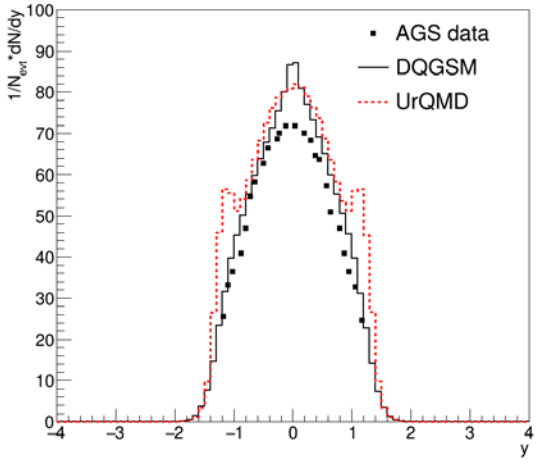


80 AGeV

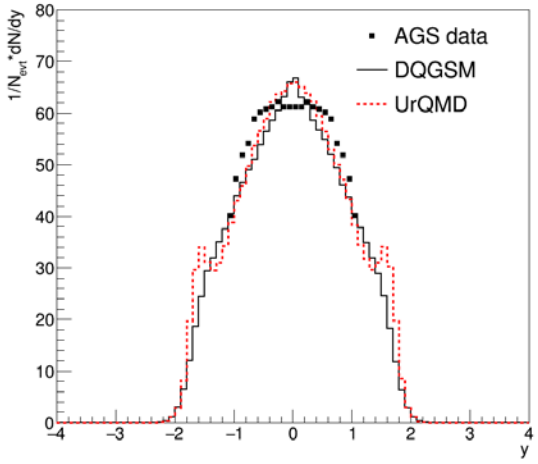


DCQGSM vs Experiment: **AGS**, Au+Au; , **NA49,** Pb+Pb
proton - rapidity distributions

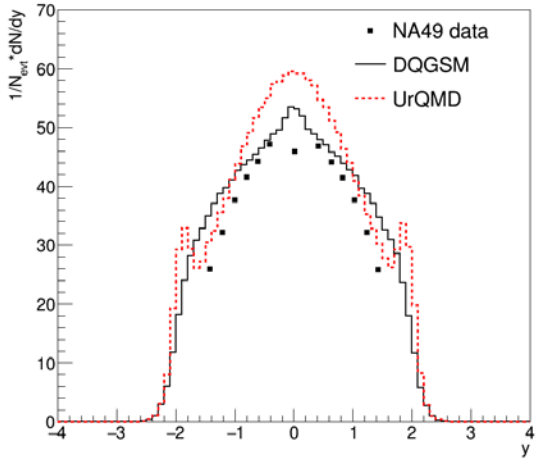
4 AGeV



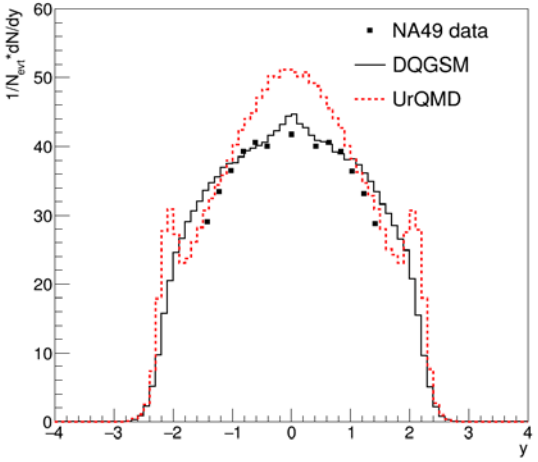
10.6 AGeV



20 AGeV



30 AGeV



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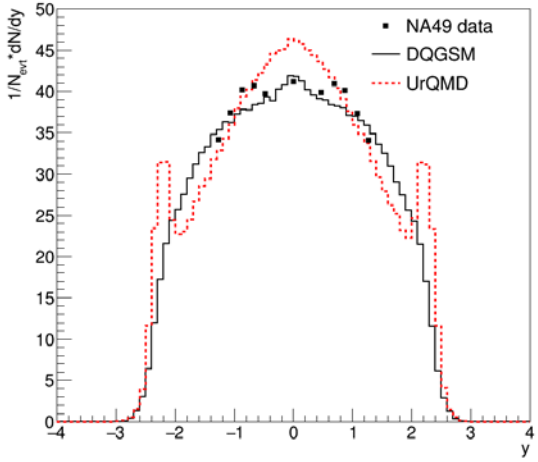

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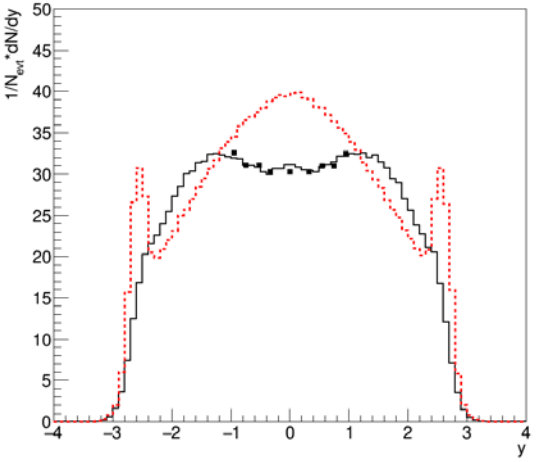
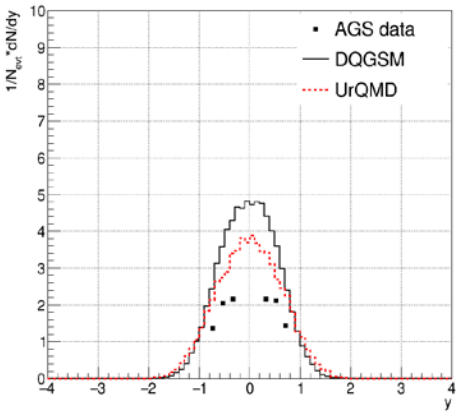


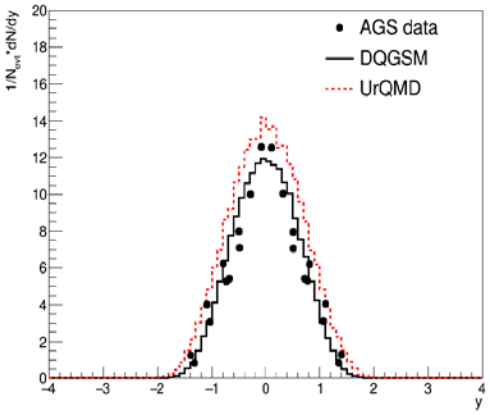
DCQGSM vs Experiment: AGS, Au+Au; **NA49,** Pb+Pb

Λ - rapidity distributions

4 AGeV



10.6 AGeV



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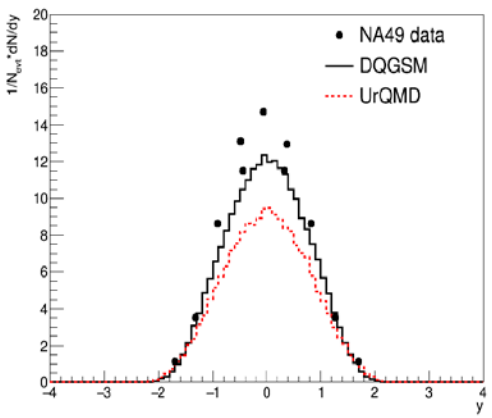

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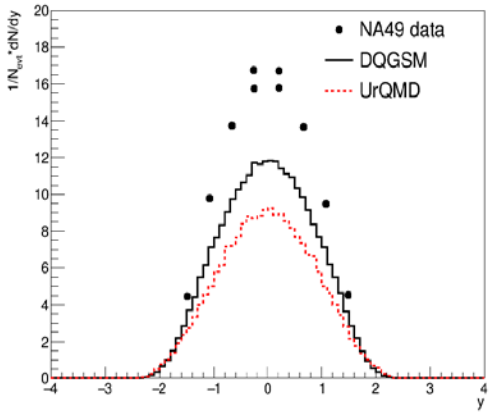

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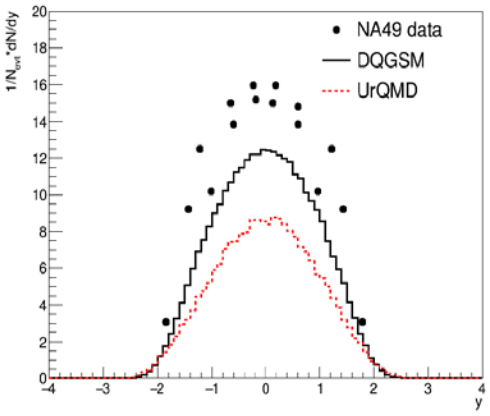

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