# EMMI RRTF HF Meeting
# Procedures used by the UrQMD group

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GSI - Darmstadt,
December, 14$^{\mathrm{th}}$, 2016

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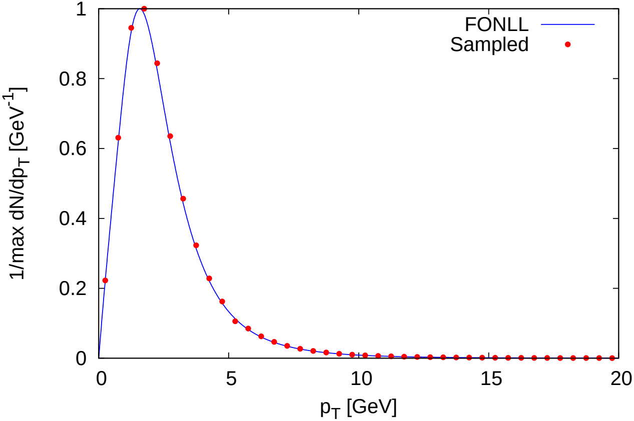
# The initial c-quarks sampling

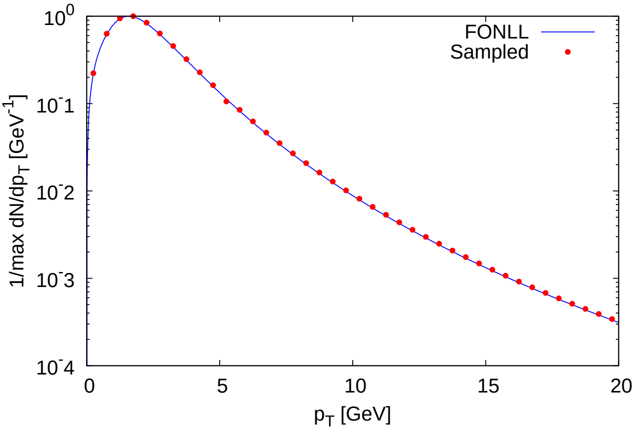
- To sample the initial c-quarks we used a linear interpolation of a FONLL distribution, computed at intervals of 0.01 GeV.
- We sampled the initial c-quarks up to 30 GeV, although final plots were drawn only up to 20 GeV.
- We added, but actually we did not use, the possibility of oversampling different $p_T$ ranges taking into account the different statistical weights at the end.

# Preliminary checks - 1




Preliminary check whether we sampled correctly the initial c-quark distribution

# Preliminary checks - 2




Preliminary check whether we sampled correctly the initial c-quark distribution

# Initial c-quark configuration

- We run UrQMD a first time to find a set of collision points (we selected all those where two particles collided at $\sqrt{s} > 5\mathrm{GeV}$).
- We run again UrQMD using the same impact parameter to produce the medium
- We iterated 100-300 times over this set of collision points and at each iteration we associated a C-quark to each of them, with a transverse momentum sampled from a linearly interpolated FONLL distribution, while the longitudinal momentum is: $p_z = p_T \sinh(\eta)$, with $\eta$ randomly sampled between $\pm 0.5$.
- The C-quarks propagated along straight lines (i.e. without any scattering process) from their formation time to the hydro starting time.

# Impact parameter

- Centrality class 0-10%: 0 - 4.94 fm
- Centrality class 30-50%: 8.55 - 11.04 fm

The data for the impact parameter have been taken from table I in PHYSICAL REVIEW C 88, 044909 (2013) (ALICE collaboration). The impact parameter is weighted quadratically (higher values are favoured).

# Other parameters

- Hydro phase starts at 0.5 fm/c
- cell size dx during fluid evolution: 0.1 fm, doubled whenever the energy loss is > 0.1 %
- number of cells per dimension: 200
- initial rapidity cut for fluid-dynamical description: 2.0
- maximum value of energy density to stop hydro: $\varepsilon_0 = 150 MeV/fm^3$
- minimum temperature to perform Langevin propagation: 160 MeV, corresponding to $1.728 \cdot \varepsilon_0$
- fluid EoS: chiral+hadron gas incl. deconfinement (J.Steinheimer, S.Schramm and H.Stöcker, Phys. Rev. C 84, 045208 (2011))

# Langevin propagation

$$\mathrm{d}x_j = \frac{p_j}{E}\mathrm{d}t,$$
$$\mathrm{d}p_j = -\Gamma p_j \mathrm{d}t + \sqrt{\mathrm{d}t} C_{jk}\rho_k.$$

where

$$C_{jk} = C_{jk}(t, \boldsymbol{x}, \boldsymbol{p} + \xi \mathrm{d}\boldsymbol{p}).$$

$\xi = 0$ pre-point Ito
$\xi = \frac{1}{2}$ mid-point Stratonovich-Fisk
$\xi = 1$ *post-point Ito* (or Hänggi-Klimontovich)

$$Ap_j = \Gamma p_j - \xi C_{lk}\frac{\partial C_{jk}}{\partial p_l},$$
$$C_{jk} = \sqrt{2B_0}P^{\perp}_{jk} + \sqrt{2B_1}P^{\parallel}_{jk},$$
$$\text{with} \quad P^{\parallel}_{jk} = \frac{p_j p_k}{\boldsymbol{p}^2}, \quad P^{\perp}_{jk} = \delta_{jk} - \frac{p_j p_k}{\boldsymbol{p}^2}.$$

# Hadronization procedure

## Initial C-quarks

Only Peterson fragmentation:

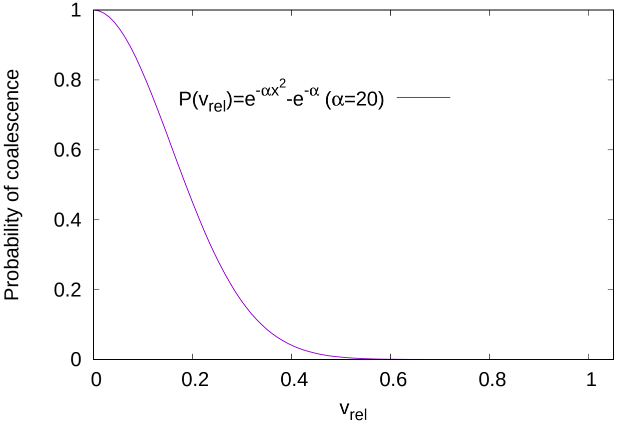
$$D_Q^H(z) = \frac{N}{z[1 - (1/z) - \epsilon_Q/(1-z)]^2}$$

$\epsilon = 0.05$

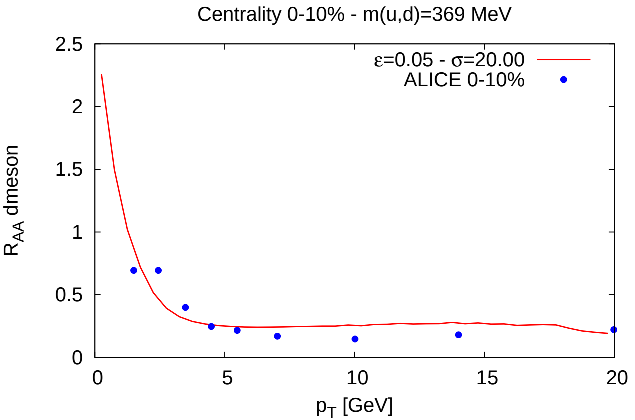
## Final C-quarks

When the temperature of the fluid cell is < 160 MeV:
hadronization by Peterson fragmentation ($\epsilon = 0.05$) or coalescence, with a probability which depends on the relative velocity:
$v_r = \sqrt{\frac{(v_1 - v_2)^2 - (v_1 \times v_2)^2)}{1 - v_1 \cdot v_2}}$ between the fluid and the particle.

# Probability to hadronize by coalescence

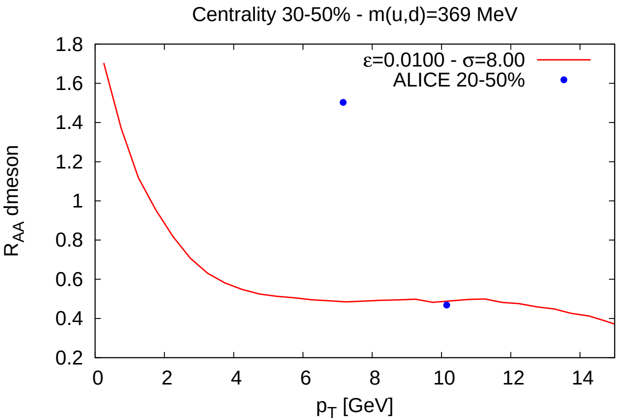


# Tuning of the probability to coalescence




Experimental points taken from https://arxiv.org/pdf/1509.07287.pdf

# Tuning of the probability to coalescence - periph. coll.

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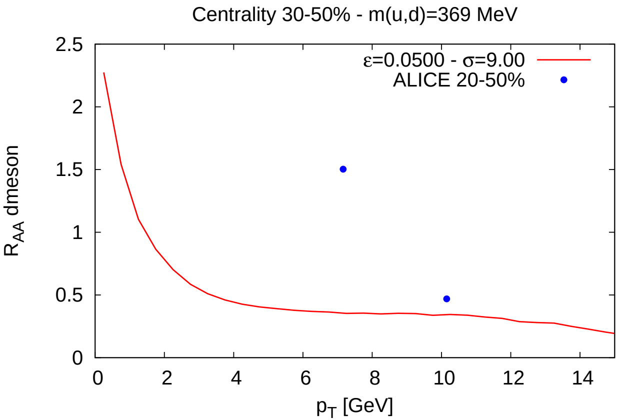
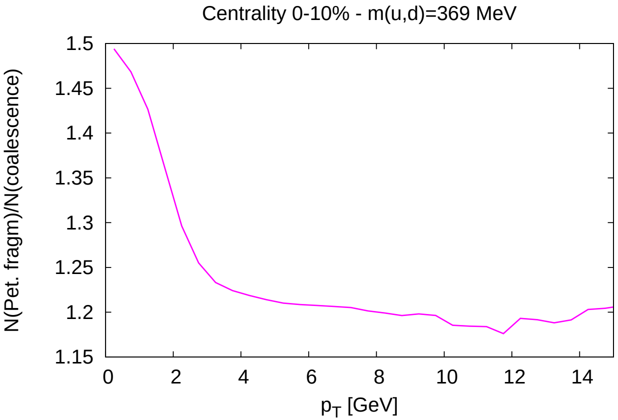
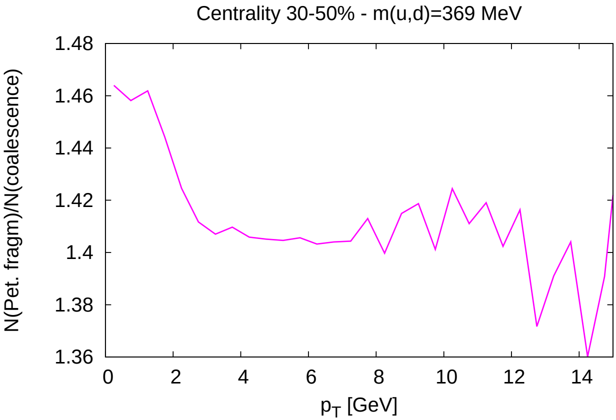



Experimental points taken from https://arxiv.org/pdf/1509.07287.pdf

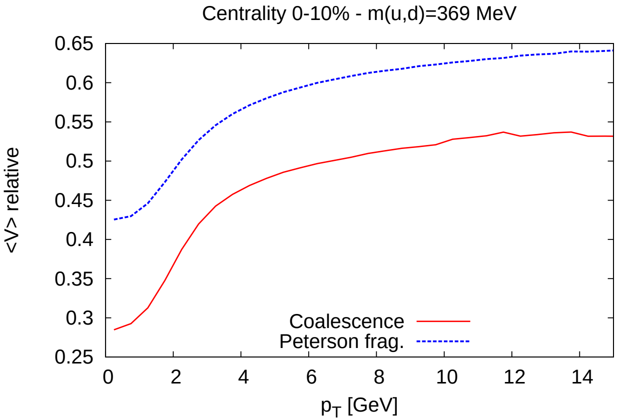
# Ratios between hadron. channels for central collisions



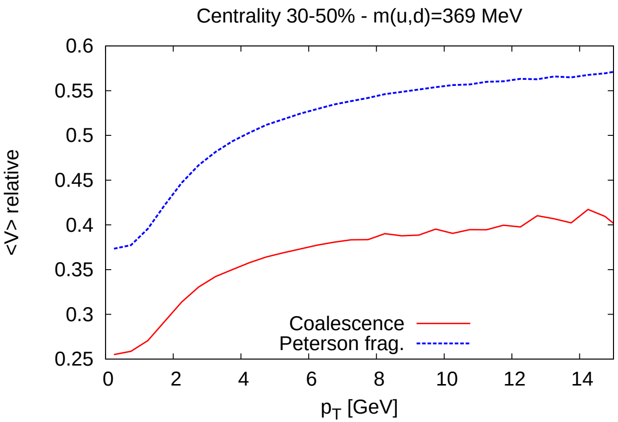
# Ratios between hadron. channels for peripheral collisions



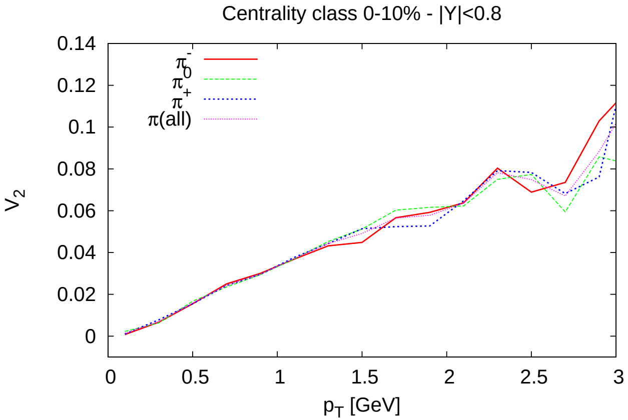
# Rel. velocity charm quarks-fluid at hadron. - central coll.



# Rel. velocity charm quarks-fluid at hadron. - periph. coll.



# The bulk evolution for central collisions



# The bulk evolution for peripheral collisions