Blast wave fits with resonances to p_t spectra from nuclear collisions at the LHC

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Motivation

- characterize the freeze-out state (temperature and transverse expansion) of the fireball by fits to p_t spectra of various species
- analyse Pb+Pb collisions at $\sqrt{s_{NN}} = 2.76\,TeV$
- Data from ALICE collaboration
  - π, K, p:
    B. Abelev *et al.* [ALICE collaboration], Phys. Rev. C **88**, 044910 (2013)
  - K_0, Λ:
    B. Abelev *et al.* [ALICE collaboration], Phys. Rev. Lett. **111**, 222301 (2014)
  - Ξ, Ω:
    B. Abelev *et al.* [ALICE collaboration], Phys. Lett. B **728**, 216 (2014)
  - K^*, ϕ:
    B. Abelev *et al.* [ALICE Collaboration], arXiv:1404.0495 [nucl-ex]
- Scenario with two freeze-outs, chemical and kinetic:
  $T_{critical} \geq T_{chemical} \geq T_{kinetic}$
- Analysis includes resonance decays, given by $T_{chemical}$
- Blast-wave model Monte Carlo implementation DRAGON

DRAGON

Monte Carlo implementation of the emission function with 277 resonances

$$\frac{dN}{dy\, d^2p_t} = \int d\Sigma_\mu p^\mu \frac{1}{\exp\frac{p_\mu u^\mu}{T} \pm 1} = \int d^4x S(x,p)$$

$$S(x,p)d^4x = \delta(\tau - \tau_{\rm fo})\, m_t\, \cosh(\eta_s - y)\, \Theta(R - r) \times \frac{1}{\exp\frac{p_\mu u^\mu}{T} \pm 1} \tau\, d\tau\, d\eta_s\, r\, dr\, d\varphi$$

transverse expansion (like ALICE, unlike Cracow)

$$v_t = \eta_f \left(\frac{r}{R}\right)^n$$

Freeze-out at constant proper time (like ALICE, unlike Cracow)
Chemical composition determined by $T_{ch} = 152$ MeV and $\mu_B = 1$ MeV
In the fits variation of: T, η_f (or $\langle v_t \rangle$), n.

Comparison of DRAGON fits with ALICE fits to π, K, p

ALICE: no resonances, but fits only in fiducial intervals

$0.3\,\text{GeV} < p_t(protons) < 3\,\text{GeV}$

$0.5\,\text{GeV} < p_t(pions) < 1\,\text{GeV}$

$0.2\,\text{GeV} < p_t(kaons) < 1.5\,\text{GeV}$

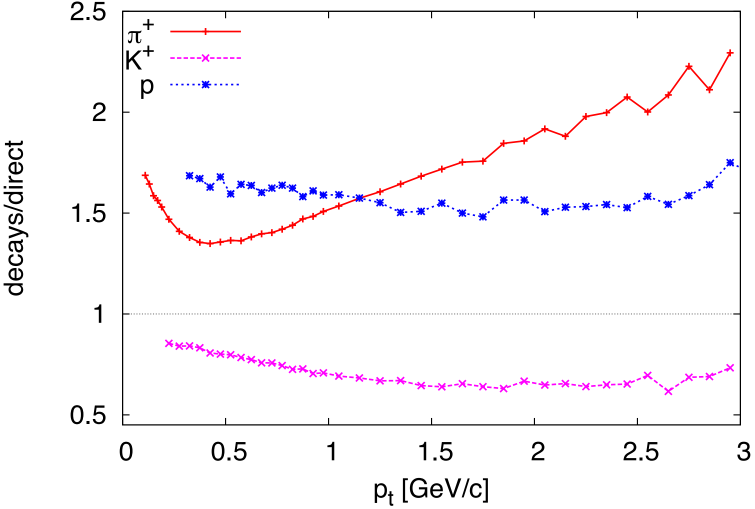
DRAGON fits followed ALICE procedure (just to cross-check)

	ALICE			no resonances			with resonances		
centrality	T (MeV)	$\langle v_t \rangle$	n	T (MeV)	$\langle v_t \rangle$	n	T (MeV)	$\langle v_t \rangle$	n
0–5%	95	0.651	0.71	98	0.645	0.73	82	0.662	0.69
5–10%	97	0.646	0.72	98	0.645	0.73	94	0.654	0.69
10–20%	99	0.639	0.74	102	0.637	0.73	90	0.649	0.71
20–30%	101	0.625	0.78	102	0.624	0.79	98	0.633	0.75
30–40%	106	0.604	0.84	110	0.605	0.81	102	0.616	0.79
40–50%	112	0.574	0.94	110	0.572	0.97	118	0.581	0.89
50–60%	118	0.535	1.10	122	0.527	1.15	126	0.541	1.03
60–70%	129	0.489	1.29	126	0.484	1.39	146	0.489	1.23
70–80%	139	0.438	1.58	142	0.439	1.51	170	0.423	1.55

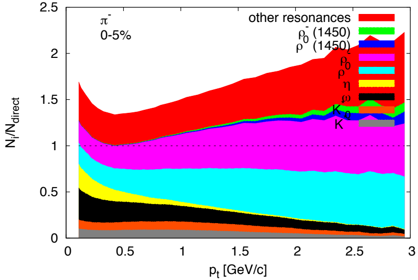
shifts in temperature when resonances are included

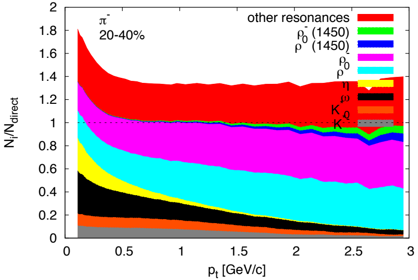
DRAGON: resonances contributions

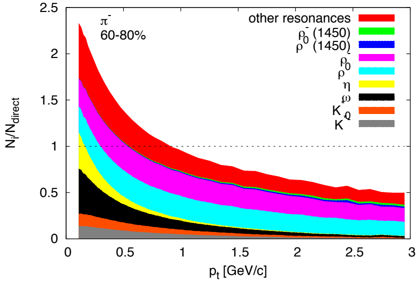
$T = 98$ MeV, $\eta_f = 0.88$, $n = 0.69$,



Spectra anatomy for pions





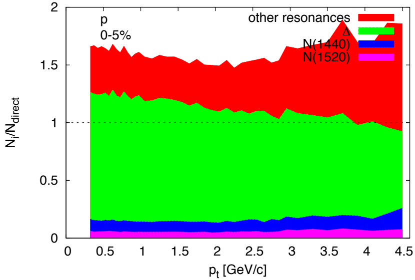


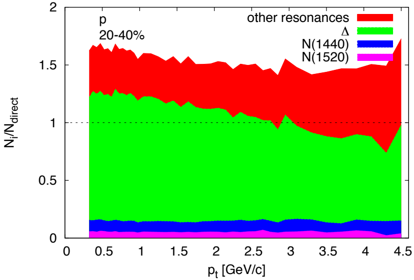
dependence on T and $\langle v_t \rangle$

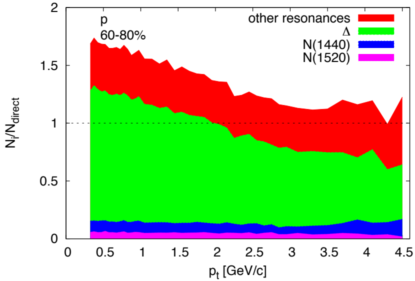
central: low temperature and strong flow $\Rightarrow$ kicks to pions from ρ decays

peripheral: higher temperature and more thermal momentum to pions

Spectra anatomy for protons



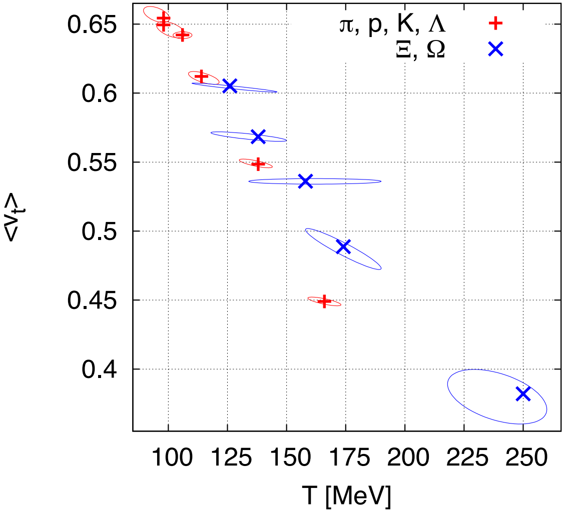




dependence on T and $\langle v_t \rangle$

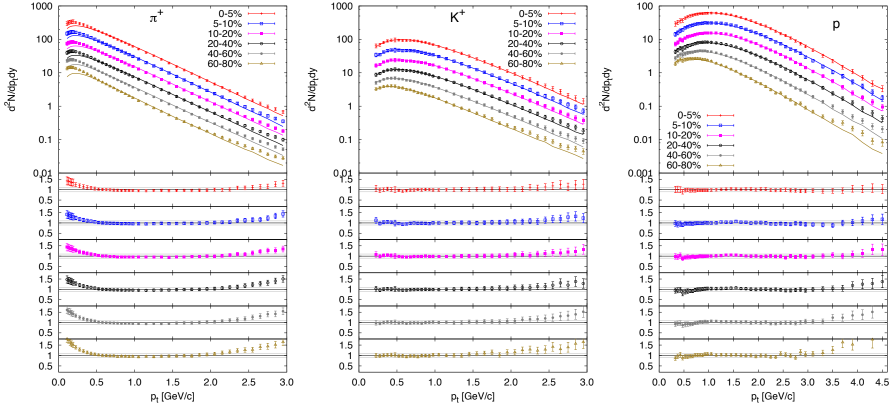
low p_t contribution from Δ's

Fit results summary

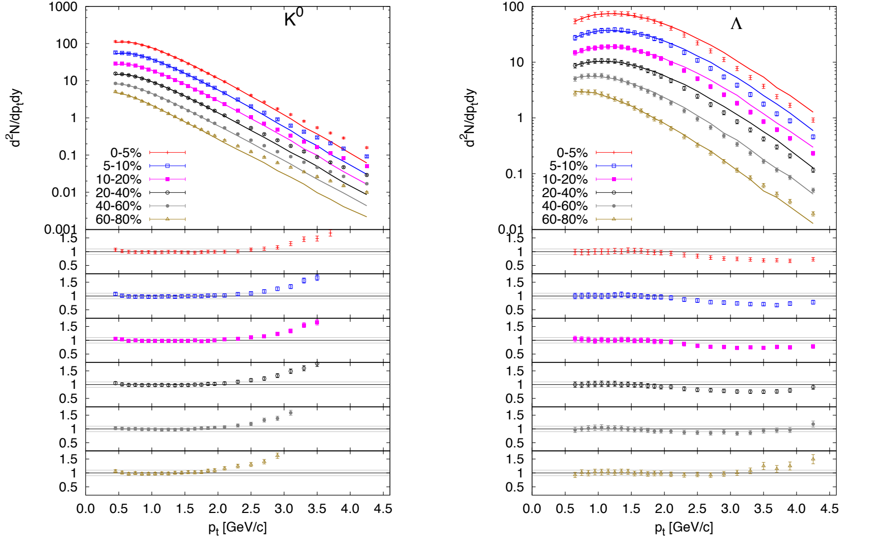


Fits limited to $0.9 < N_i^{exp}/N_i^{MC} < 1.1$, for pions $p_t > 400$ MeV

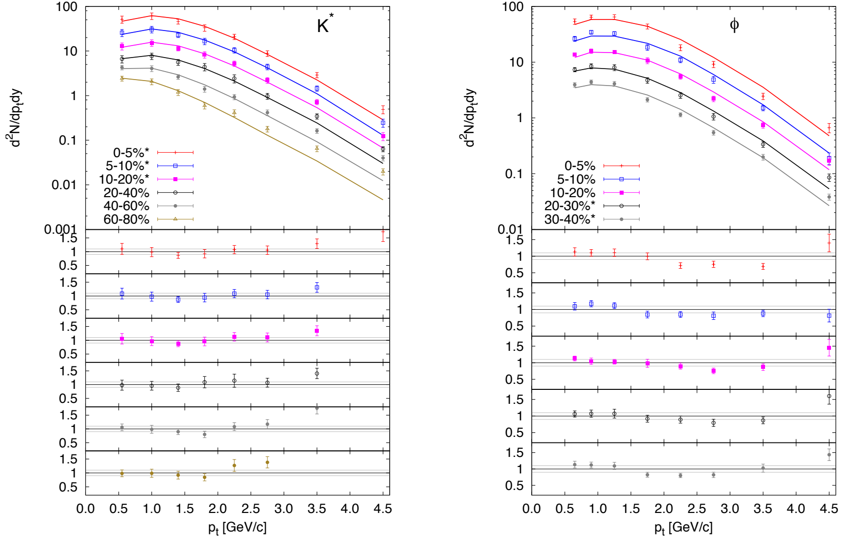
Fits to pions, kaons and protons



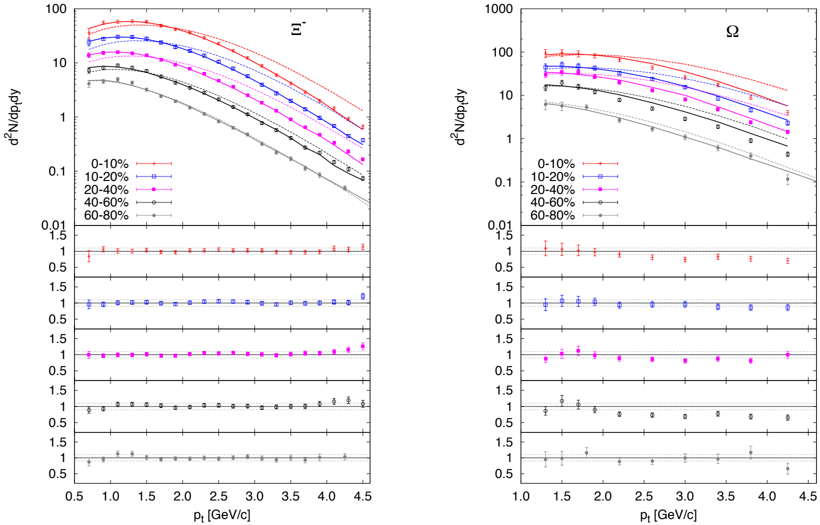
Fits to K^0 and Λ



Comparisons with K^* and ϕ



Fits to Ξ and Ω



Conclusions

- p_t spectra ae seriously influenced by contributions from resonance decays (MC tool DRAGON was used to fit single hadron pt spectra)
- Resonances induce downward shifts $\leq$10 MeV in T_{kin} for central collisions and upward shifts $\leq$25 MeV for peripheral collisions
- Multistrange baryons show freeze-out at higher temperature and weaker transverse flow.
- To have the abundances at thermal freeze-out correct, chemical potentials inclusion currently under way