Strangeness and In-Medium Effects in HIC @ SIS Energies

Signs for transition towards partially restored chiral symmetry ?

J.P. Alard, A. Andronic, R. Averbeck, Z. Basrak, N. Bastid, A. Bendarag, G. Berek, R. Čaplar, N. Cindro, P. Crochet, A. Devismes, P. Dupieux, M. Dželalija, M. Eskef, C. Finck, Z. Fodor, A. Gobbi, Y. Grishkin, N. Herrmann, K.D. Hildenbrand, B. Hong, J. Kecskemeti, Y.J. Kim, M. Kirejczyk, P. Koczon, M. Korolija, R. Kotte, M. Kowalczyk, T. Kress, R. Kutsche, A. Lebedev, K.S. Lee, Y. Leifels, A. Mangiarotti, V. Manko, H. Merlitz, D. Moisa, W. Neubert, A. Nianine, D. Pelte, M. Petrovici, C. Plettner, F. Rami, V. Ramillien, W. Reisdorf, B. de Schauenburg, D. Schűll, Z. Seres, B. Sikora, K.S. Sim, V. Simion, K. Siwek-Wilczyńska, A. Somov, M. Stockmeier, G. Stoicea, M. Vasiliev, P. Wagner, K. Wiśniewski, D. Wohlfarth, J.T. Yang, I. Yushmanov, A. Zhilin

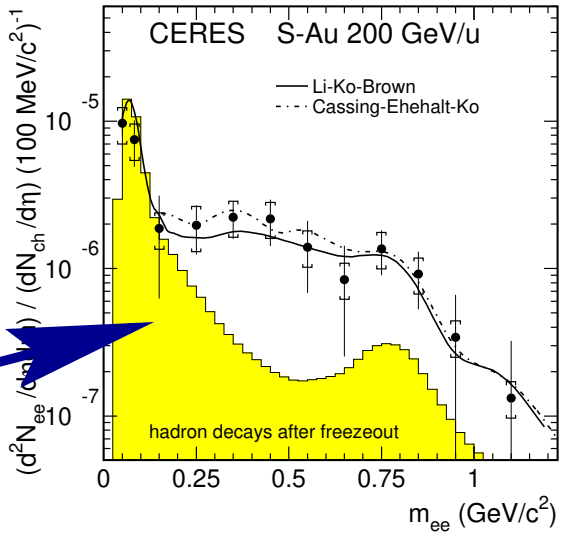
IPNE Bucharest, Romania
ITEP Moscow, Russia
CRIP/KFKI Budapest, Hungary
Kurchatov Institute, Moscow, Russia
LPC Clermont-Ferrand, France
Korea University Seoul, Korea
GSI Darmstadt, Germany
IReS Strasbourg, France
FZ Rossendorf/Dresden, Germany
Univ. of Warsaw, Poland
Univ. of Heidelberg, Germany
RBI Zagreb, Croatia

FOPI

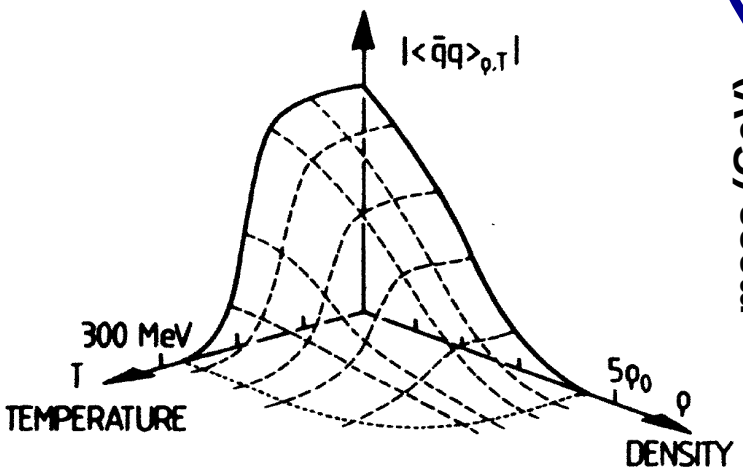
1. Kaons in dense nuclear matter
2. $\mathbf{K^-/K^+}$ ratio
3. $\mathbf{K^+}$ sideward flow

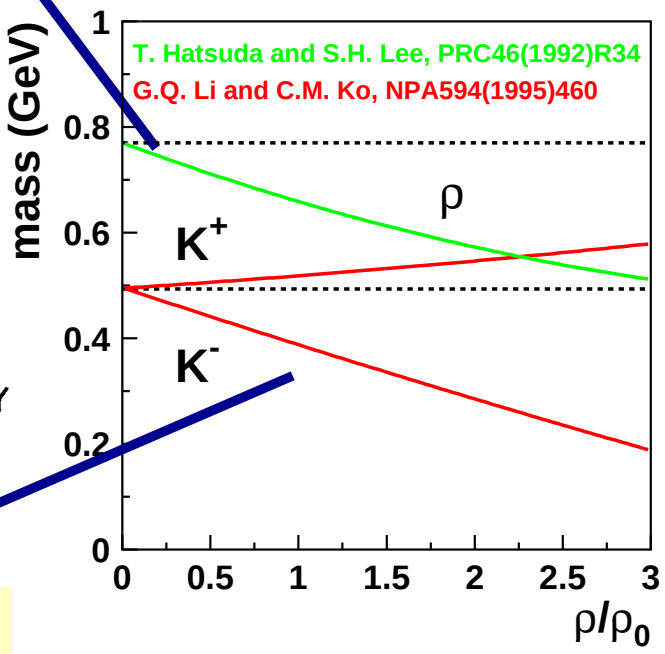
Ni+Ni @ 1.93 AGeV & Ru+Ru @ 1.69 AGeV

Chasing In-Medium Effects in Hot and Dense Nuclear Matter



Dilepton yield



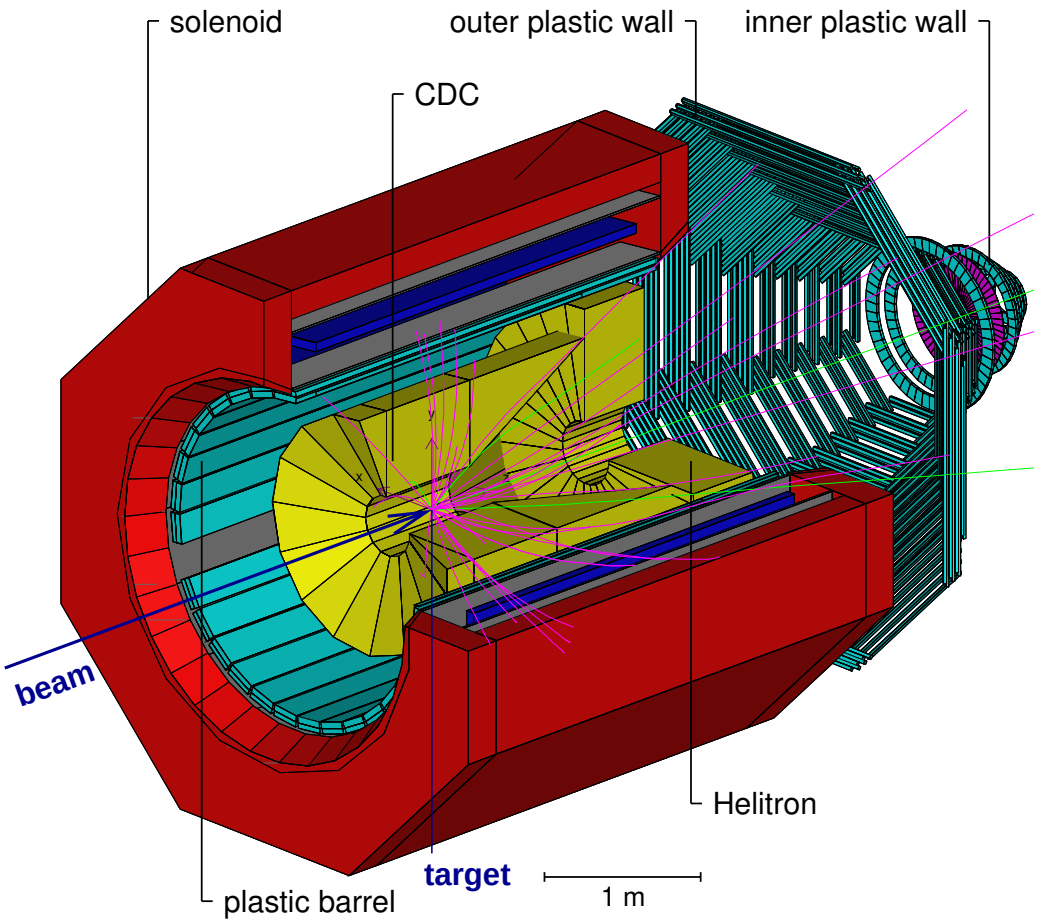


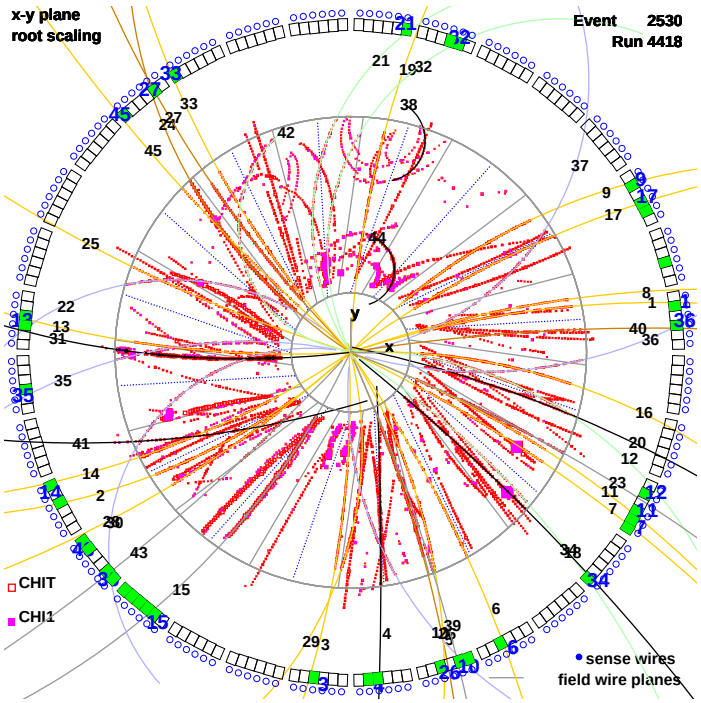
Kaon production & propagation @ close-to-threshold energies

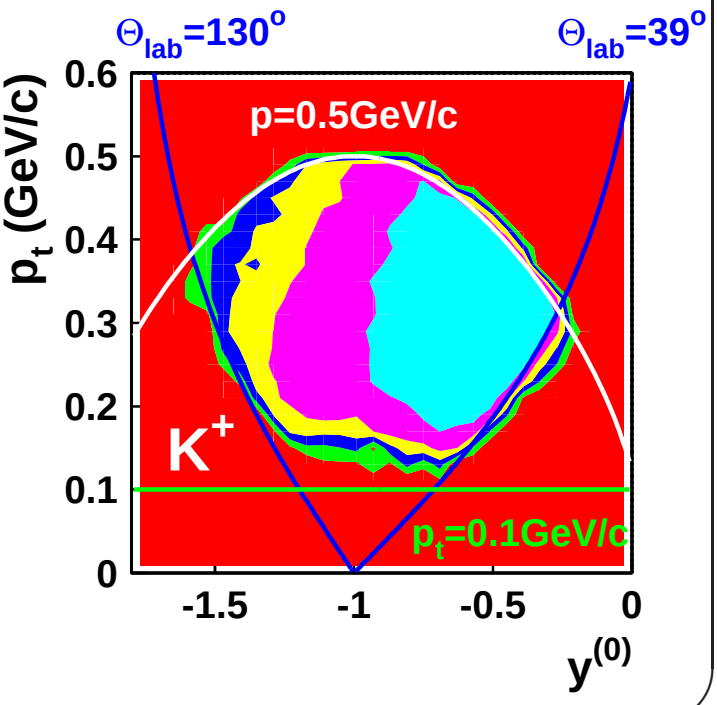
		with in-medium effects	
	$E_{threshold}$ (GeV)	yield	momentum
K^-	2.5	↗	↘
K^+	1.6	↘	↗
	probe	K^-/K^+ ratio	K flow

W. Weise, Nucl.Phys. A610(1996)35c, C.H. Lee, Phys.Rep. 275(1996)255
W. Cassing and E.L. Bratkovskaya, Phys.Rep. 308(1999)65
C.M. Ko, V. Koch and G. Li, Ann.Rev.Nucl.Part.Sci. 47(1997)

FOPI detector @ GSI





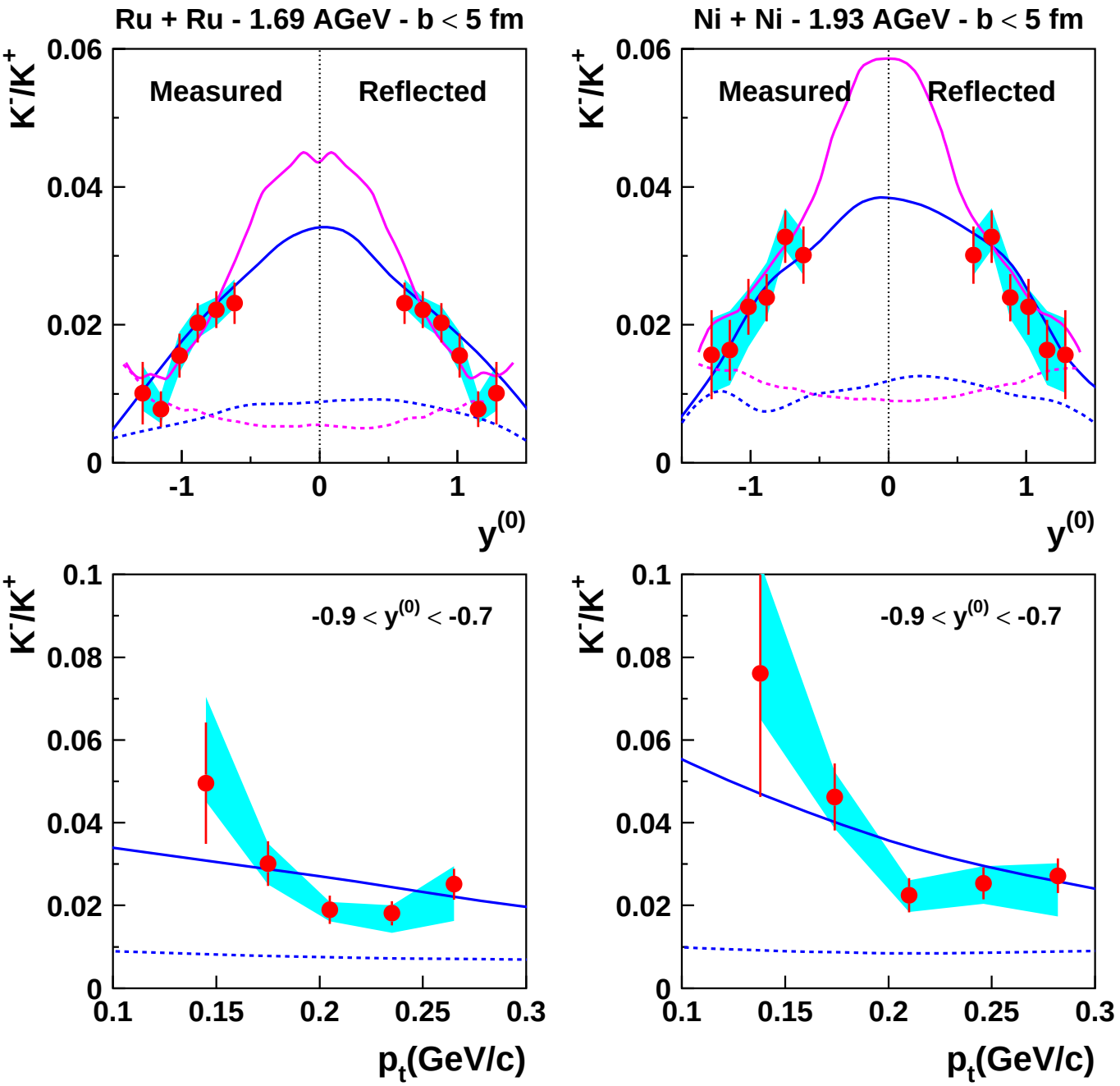


K^-/K^+ Ratio *versus* $y^{(0)}$ and p_t

DATA Syst. errors

RBUU in-medium effects — G.Q. Li and G.E. Brown, PRC58(1998)1698

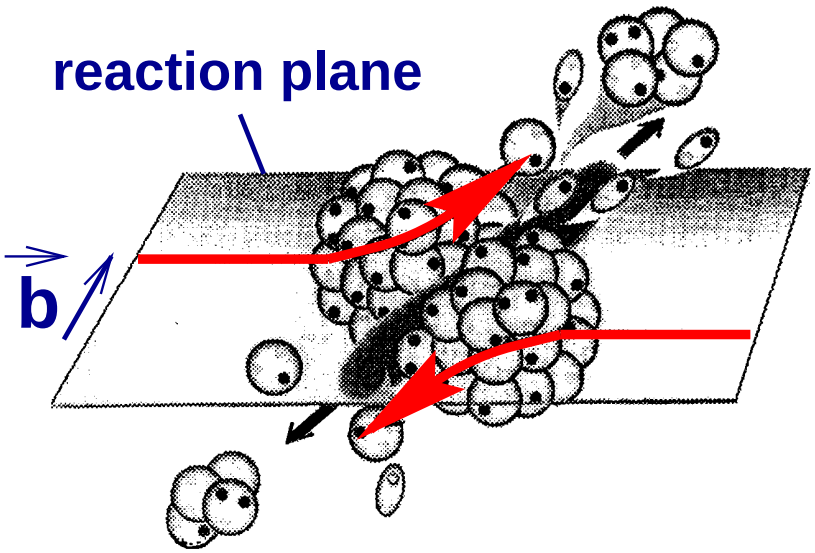
RBUU no medium effects — W. Cassing and E.L. Bratkovskaya, PR306(1999)65

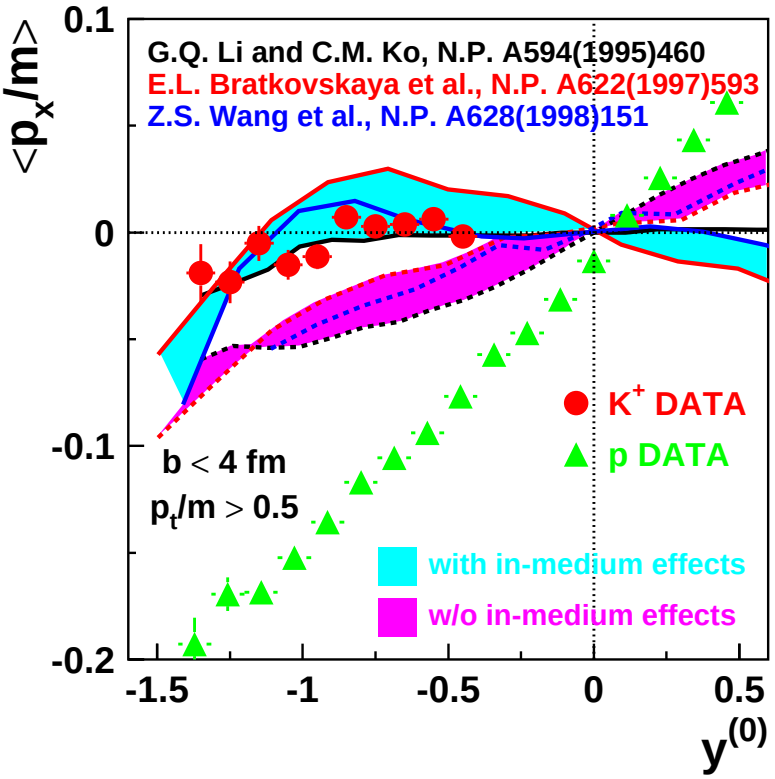


Data favour in-medium effects

K. Wiśniewski et al., GSI-report (1997), submitted to Phys. Rev. Lett.

K^+ Sideward Flow in Central Ni+Ni @ 1.93AGeV





$3 \neq$ models favour in-medium potential for K^+

BUT influence of :

production channels :
C. David et al., N.P.A650(99)358

momentum dependent potential :
C. Fuchs et al., P.L.B434(98)245

J. Ritman et al., Z.Phys. A352 (1995) 156, GSI report (1996)

K^+ flow vs. p_t
Ru+Ru @ 1.69 AGeV

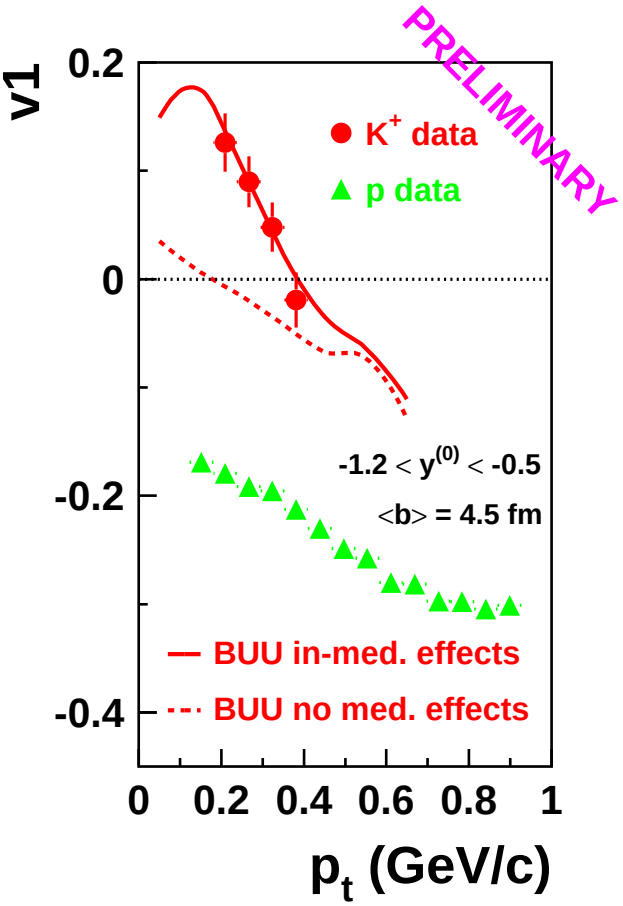
First Fourier coefficient :

$$v_1 = < p_x / p_t >$$

K^+ anti-flow at low p_t

data favour IME
sensitivity to IME at low p_t

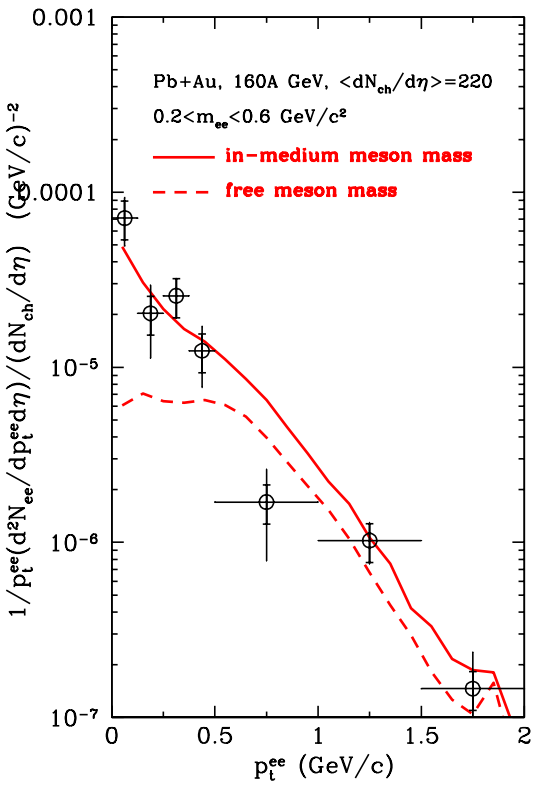
BUU by W. Cassing and E.L. Bratkovskaya



Dilepton Yield vs. p_t
Pb+Au @ 160 AGeV

CERES data : Phys.Lett. B422(1998)405

data favour IME
sensitivity to IME at low p_t



G.E. Brown et al., Acta.Phys.Pol. B29(1998)2309

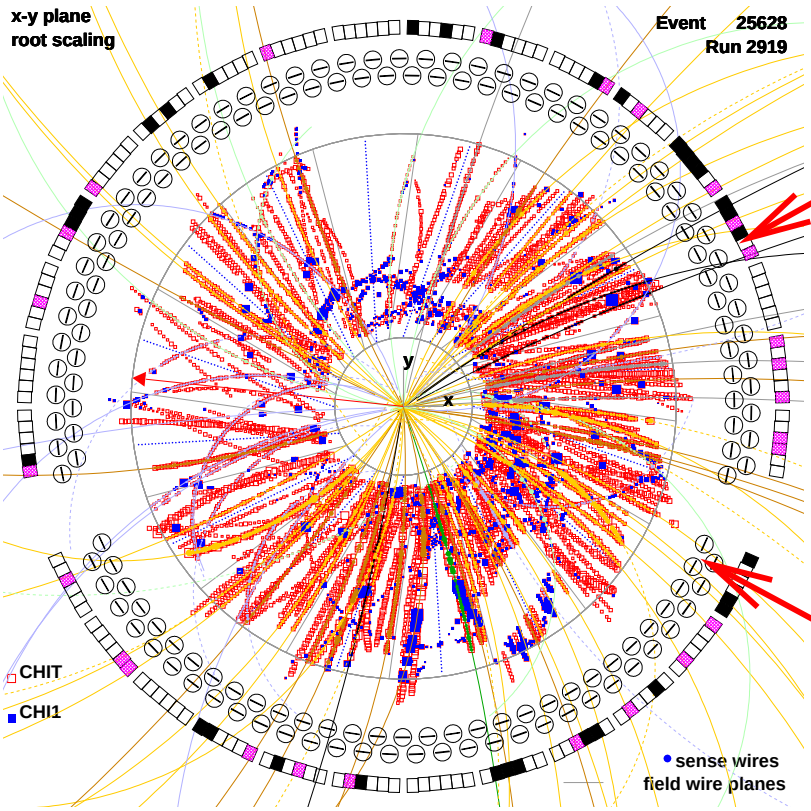
Summary & Outlooks

Experimental data on
$\mathbf{K^-/K^+}$ ratio and $\mathbf{K^+}$ sideward flow
in Ni+Ni @ 1.93 AGeV and Ru+Ru @ 1.69 AGeV
need in-medium modification of kaon properties
to be satisfactory reproduced by transport models

Open questions : { alternative scenario ?
systematical errors

FOPI-2000 : ToF system upgrade

Au + Au @ 1.5 AGeV



Existing plastic scint. barrel
- granularity : **180**
- resolution $\sim$ **300 ps**

Pestov spark counters barrel
- granularity : **830**
- resolution $<$ **100 ps**