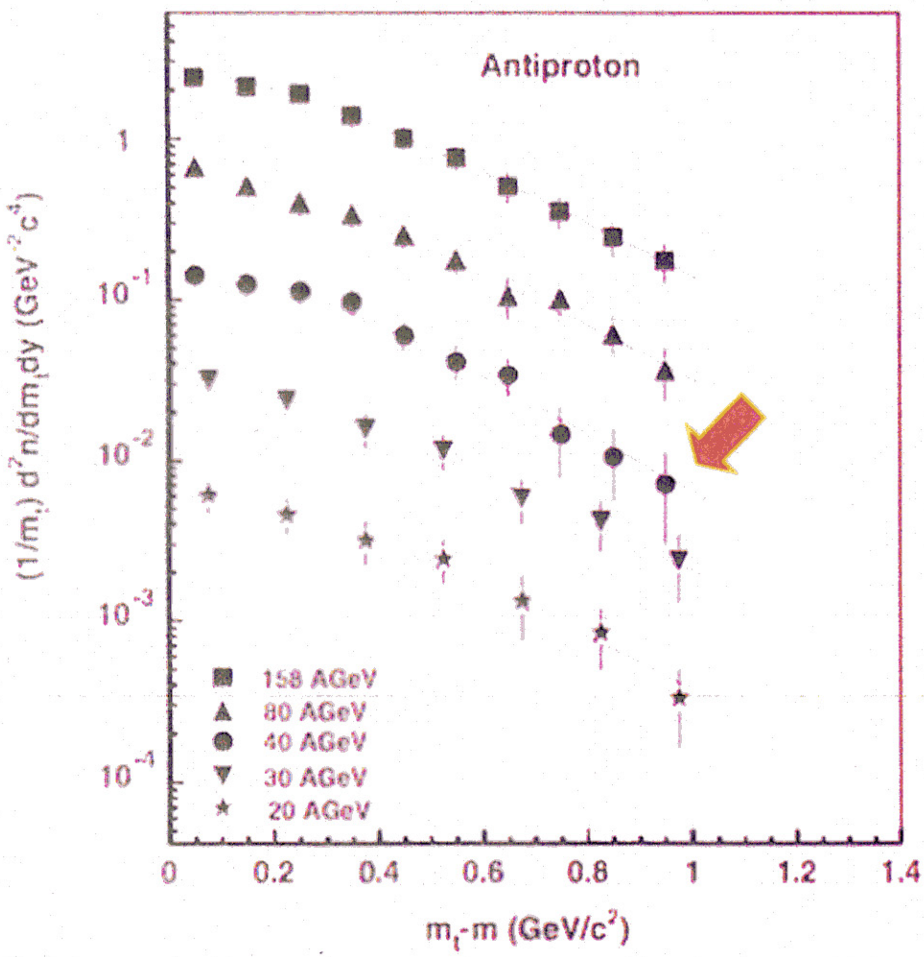
Result of One Temperature Fit



NA49, PRC73, 044910(2006)

	E_{beam} (A GeV)	dn/dy	T (MeV)	$\langle m_t \rangle - m$ (MeV/c^2)
$\bar{p}$	158	1.66 ± 0.17	291 ± 15	384 ± 19
	80	0.87 ± 0.07	283 ± 30	385 ± 41
	40	0.32 ± 0.03	246 ± 35	355 ± 51
	30	0.16 ± 0.02	290 ± 45	395 ± 60
	20	0.06 ± 0.01	279 ± 64	394 ± 60
p	158	29.6 ± 0.9	308 ± 9	413 ± 13
	80	30.1 ± 1.0	260 ± 11	364 ± 16
	40	41.3 ± 1.1	257 ± 11	367 ± 16
	30	42.1 ± 2.0	265 ± 10	362 ± 14
	20	46.1 ± 2.1	249 ± 9	352 ± 13

- Only one experimental result for $\bar{p}$ slope
- Still error bar is large

- A newly proposed signature, qualitatively distinct from the fluctuation signatures.
- Deserves careful scrutiny by theorists and experimentalists alike.
- Plotting $\bar{p}/p$ ratio vs p_T and looking for nonmonotonic $\sqrt{s}$ dependence of this plot could be instructive
- Error bars still likely too large to get intrigued... But, let's push on this and see...

How is the experimental team doing in the race?

- intriguing anomaly in K/π fluctuation
- newly proposed signature in $\bar{p}/p$ vs. p_T as function of $\sqrt{s}$.
- new experiments to come
  - NA61. Lighter ions → shorter duration hadron gas phase
  - critRHIC → last few slides
  - CBM@FAIR

Best case is NA61/critRHIC discover critical point, making it possible for CBM to look for non Gaussian fluctuations from 1st order transition.

CAN RHIC FIND THE CRITICAL POINT?

what I learned at a March 2006 workshop with this title:

- Advantages of using a collider vs. fixed target machine to study event-by-event fluctuations at varying $\sqrt{s}$:
  - ~ same acceptance
  - same detectors
  - less change in track density

  } as $\sqrt{s}$ changes
- With 10^6 min bias events per energy, STAR with its TOF upgrade can reduce statistical and systematic errors on K/π fluctuations each by factor of 4.
- No show stoppers on the accelerator side

WHAT RANGE OF $\sqrt{s}$, ie μ_B

- RHIC should, and can, explore $\mu_B < 500$ MeV
- Want to test NA49 observation of K/π fluctuations at $\mu_B \sim 400-450$ MeV
- If $\mu_B^{\bullet} < 3T_c \sim 500$ MeV, plausibly the different lattice calculations will converge as each improves. If $\mu_B^{\bullet} > 500$ MeV, quantitative comparison with theory will be hard.
- If $\mu_B^{\bullet} > 500$ MeV, also tough to find experimentally. (Low $T_{freezeout}$; equilibration ???)
- A scan with steps $\lesssim 100$ MeV apart in μ_B should allow to make discoveries.
- In the vicinity of a discovery, will want μ_B's spaced by ~50 MeV.

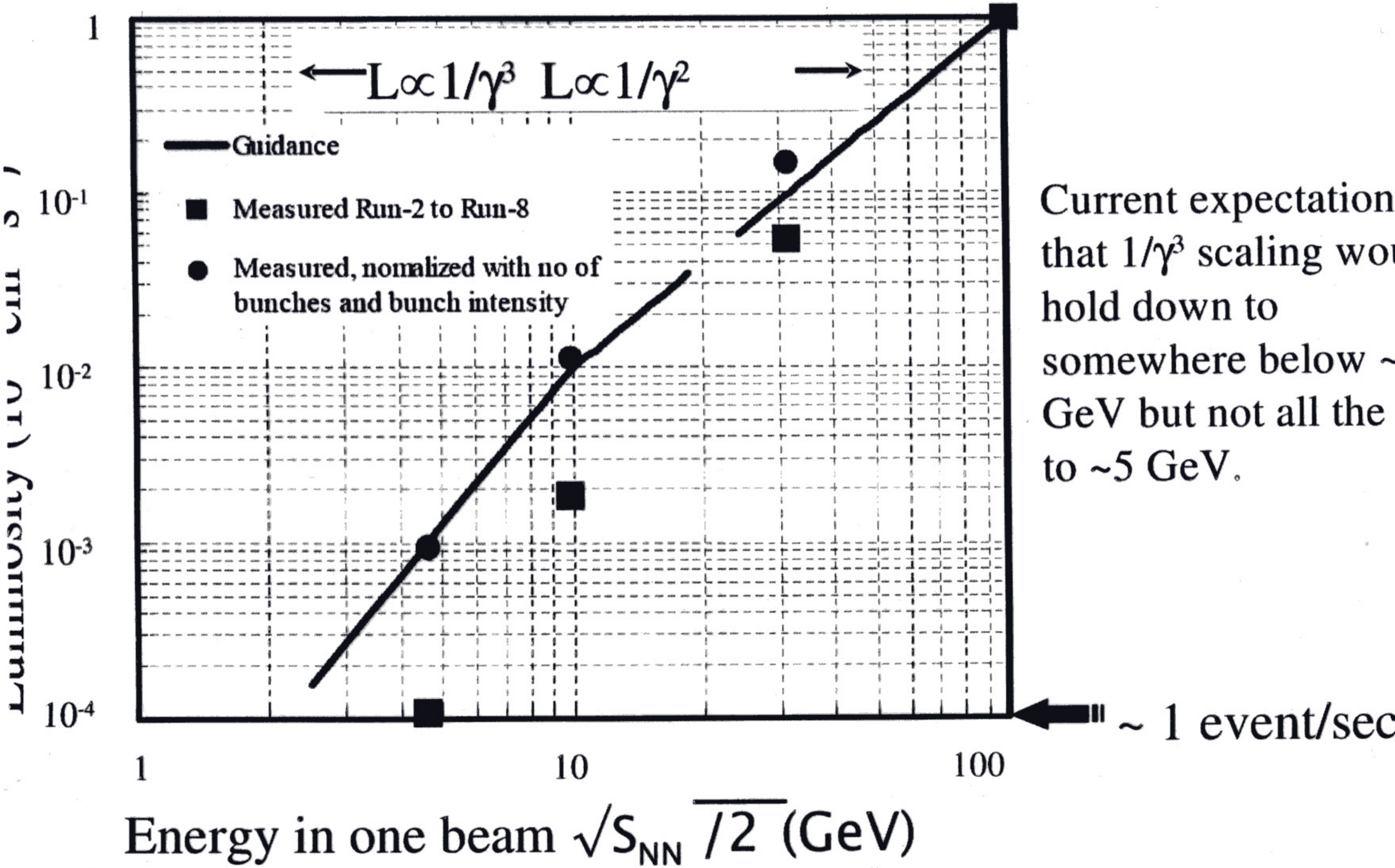
A "STRAW MAN" CHOICE OF ENERGIES

	$\sqrt{s}$ (AGeV)	μ_B (MeV)*	10 hr days per 10^6 events†
	5	550	20
largest K/π fluctuations	6.27	480	9
	7.62	425	5
	9.4	365	3
	12.3	300	1
	18	220	0.4
	24	170	0.2
	36	120	0.1
done	60	75	
	130	40	
	200	25	

* from Cleymans et al's 2005 empirical fit to compilation of data

† from Roser's "guidance" luminosity vs. $\sqrt{s}$ curve

Actual Luminosity Scaling With Energy



Current expectation is that $1/\gamma^3$ scaling would hold down to somewhere below ~9 GeV but not all the way to ~5 GeV.

ɟe courtesy of T. Roser

WHAT NEED BE MEASURED AT EACH ENERGY

- Enough <particle ratios> to first evaluate μ_B. You have to know where on the phase diagram you are freezing out.
- Event-by-event fluctuations in:
  - $\langle p_T \rangle$, with equal or smaller error bars as in NA49 data
  - $\langle K \rangle / \langle \pi \rangle$ and $\langle p \rangle / \langle \pi \rangle$ with smaller error bars than in NA49 data
  - All fluctuation analyses done for $p_T < p_T^{cut}$ for several choices of p_T^{cut} down to 500 MeV
- $\bar{p}/p$ vs. p_T

CAN WE DISCOVER THE QCD CRITICAL POINT AT RHIC?

Yes, IF:

- Accelerator & detector capabilities permit measurement of the event-by-event fluctuations of the hadronic observables I described, at a sequence of energies like that I described
- Nature is kind, and puts $\mu_B^\circ < 500$ MeV

If YES:

- The landmark discovered. Our map of the QCD phase diagram then anchored by experiment.
- Assuming reasonable progress in lattice QCD, quantitative comparison between theory & experiment for μ_B°
- FAIR (and RHIC) can study the first order phase transition.