BRAHMS commissioning and first year running.

Notes by

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Used in presentations to RHIC endgame task force

Since this summer RHIC have established a new endgame taskforce which similar to the work done two years ago examines the commissioning phase of the of the accelerator in regard to overall schedule, available resources at the laboratory , and the readiness of the detectors. This task force in addition is reviewing the first years run plans and expectations.

Dana and I are participating in this work. The committee is supposed to finish its work with a report shortly. The following section presents some of the material we have presented on behalf of BRAHMS. I also see this as the beginning of an internal discussion what we should strive for in the first RHIC year. The plan presented below is really only an outline the actual execution depends of course on how much is ready in the fall of 99, and how smooth the accelerator startup is.

The text is divided in two sections

1. Brahms installation schedule
2. Run plans for first year.

BRAHMS installation schedule

The BRAHMS detector, situated in the 2 o'clock IR, consists of 3 major components:

- The Front Forward Spectrometer (FFS) consisting of 2 magnets, D1 and D2, and associated detectors
- The Back Forward Spectrometer (BFS) consisting of 2 magnets, D3 and D4 and associated detectors.
- The Mid Rapidity Spectrometer (MRS) consisting of a single magnet D5 and associated detectors.

The installation schedule is driven by the time involved in manufacture, assembly and mapping of the magnets before they are installed on the platforms, and also on access to the IR. The original schedule presented in the BRAHMS management plan had the magnets D3 and D4 assembled in May/June of 99. This was the result of the funding profile. An attempt to have the cores for D3 and D4 manufactured during this fiscal year is being developed. The schedules described below reflects this. The D3 coil has been ordered. This will allow for assembly and mapping of D3 and D4 earlier with completion in January 99. The main access to the IR (i.e. the roll-up door) must be open for the magnets to be installed. This requires the removal of shield blocks, a task which can be performed in about one day. All of the detector components (excepting the RICH) are of size and weight as can be installed if necessary via the labyrinth access.

The installation is discussed separately for the 3 major components.

<u>MRS</u>

The magnet D5 is being assembled and mapping is expected to start in December 97. The pivot and platform will be ready by April 98, and installation of D5 on the platform is expected to take place in the summer of 98. The detectors for MRS will be installed on the platform in late 98 before the close-up in late December 98.

<u>FFS</u>

The platforms for the front forward spectrometer will be procured and installed by summer 98, such that installation of D1 and D2 can take place in November/December 98. Both D1 and D2 should be assembled and mapped by end of summer 98.

<u>BFS</u>

The installation of D3 and D4 takes 2 months in the IR. They must be assembled in situ on the platform due to crane load limits. If the early completion of D3 and D4 is achieved installation can take place before the June 99 commissioning run. It is likely that the hook-up and testing will be done in the 99 summer shutdown. At this time the BFS tracking ,time-of-flight and RICH detector will be installed.

As has been known for a long time the BRAHMS installation schedule is very aggressive due to a late funding. The magnet installation jobs have to be performed sequentially due to access to appropriate technical groups. The order of installation though can be interchanged, particular in calendar year 99 after procurement. There is a risk that the schedule put forward here will have to be adjusted , and assessment will be done at regular intervals.

BRAHMS year 1 running

- Commissioning and engineering run
- Initial Survey of Au Au rapidity distributions
- Discussion in collaboration started during August 97 meeting.
- Loose triggers during first year
- Limitations to physics program come from
    - Detector capabilities
    - Luminosity restrictions

Initial detector configuration

- FS(1) magnets D1,D2, T1, T2, H1 C1
  Ready by June; Magnets installed by November. Some commissioning during June/July running
- MRS magnet D5 TP1, TP2 TOFW.
  ready by June. commissioning during June/July running
- FS(2) D3, D4 DC RICH and H2
  installed during the summer shutdown
- BB & trigger
  installed June (maybe earlier)
- Centrality (Si-detectors August/September 99); mainly due to position near beam pipe.

GOALS

- Commissioning of full detector system i.e. Get detectors operational in the IR, read out data..
    - detectors
    - magnet settings, movements
    - trigger & DAQ
- Engineering. Operations of detector system with beams

Beam conditions

Detectors backgrounds

Run conditions

Trigger (Beam Beam counters and Multiplicity array)

- Physics Running

  Global multiplicity distributions

  Survey of AuAu y-pt distributions at a small number of selected rapidities (e.g. 0, (0.5) 1, 1.5, 2. 3. (3.50 ((2.5)) up to pt of about 1 GeV/c, restricted by magnetic fields and PID. One Question is what integrated luminosity is needed for this program. Initial addressed below.

Acceptance

In earlier work by Moskowitz the acceptance and rates were studied in detail. The acceptance was calculated for several angle and magnetic field settings. The are displayed below for pions, kaons and protons. Each Box represents a given magnet and angle setting.

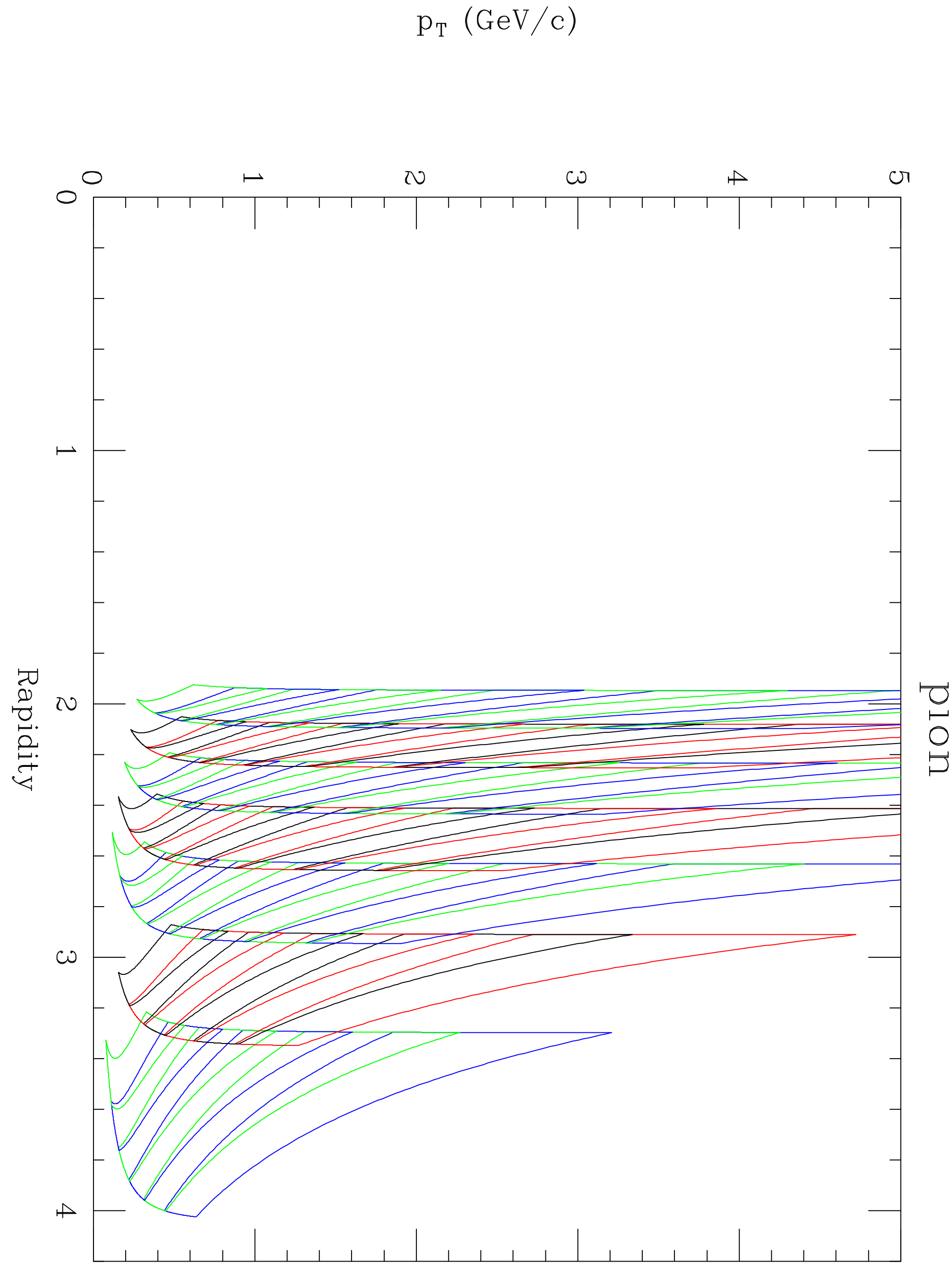
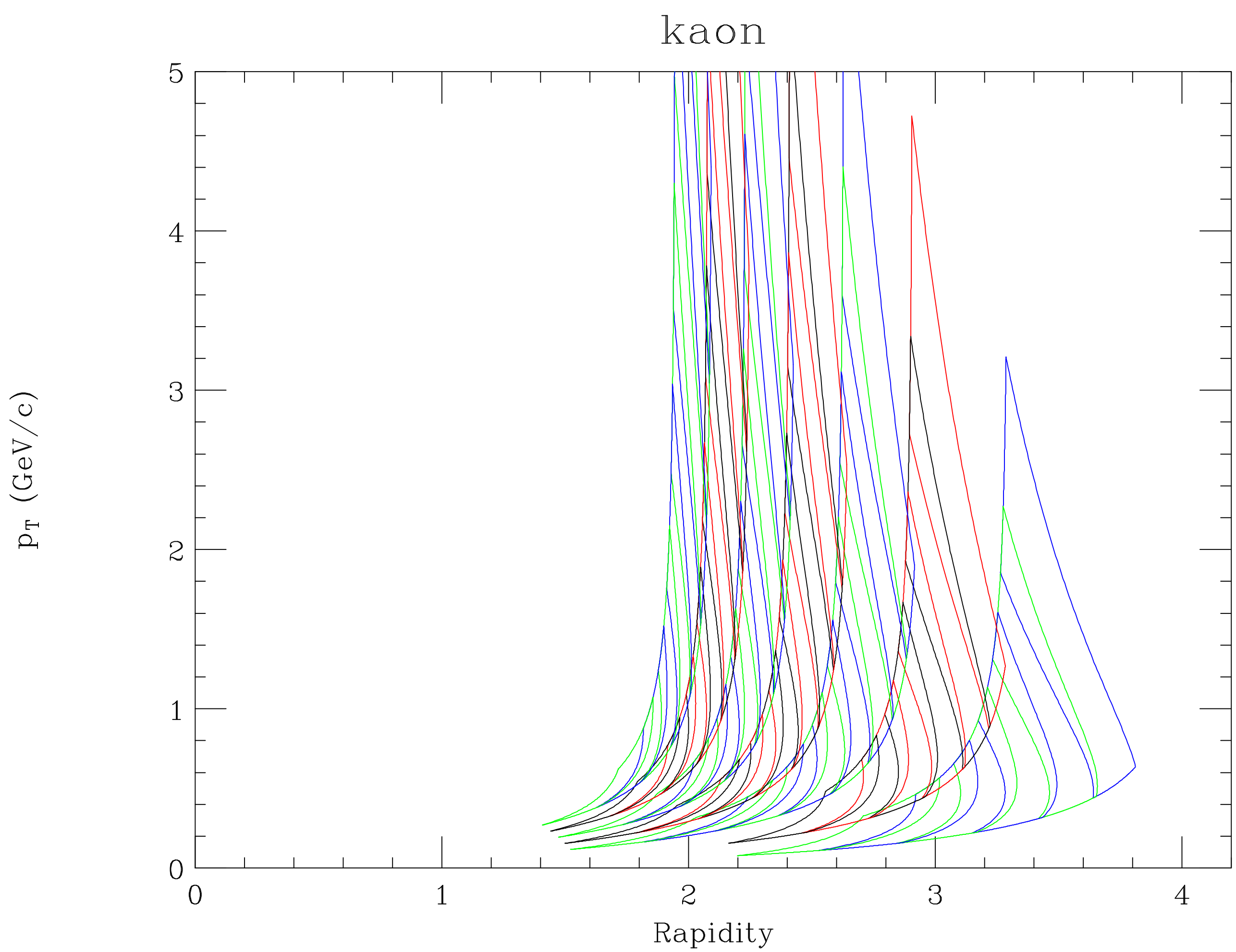
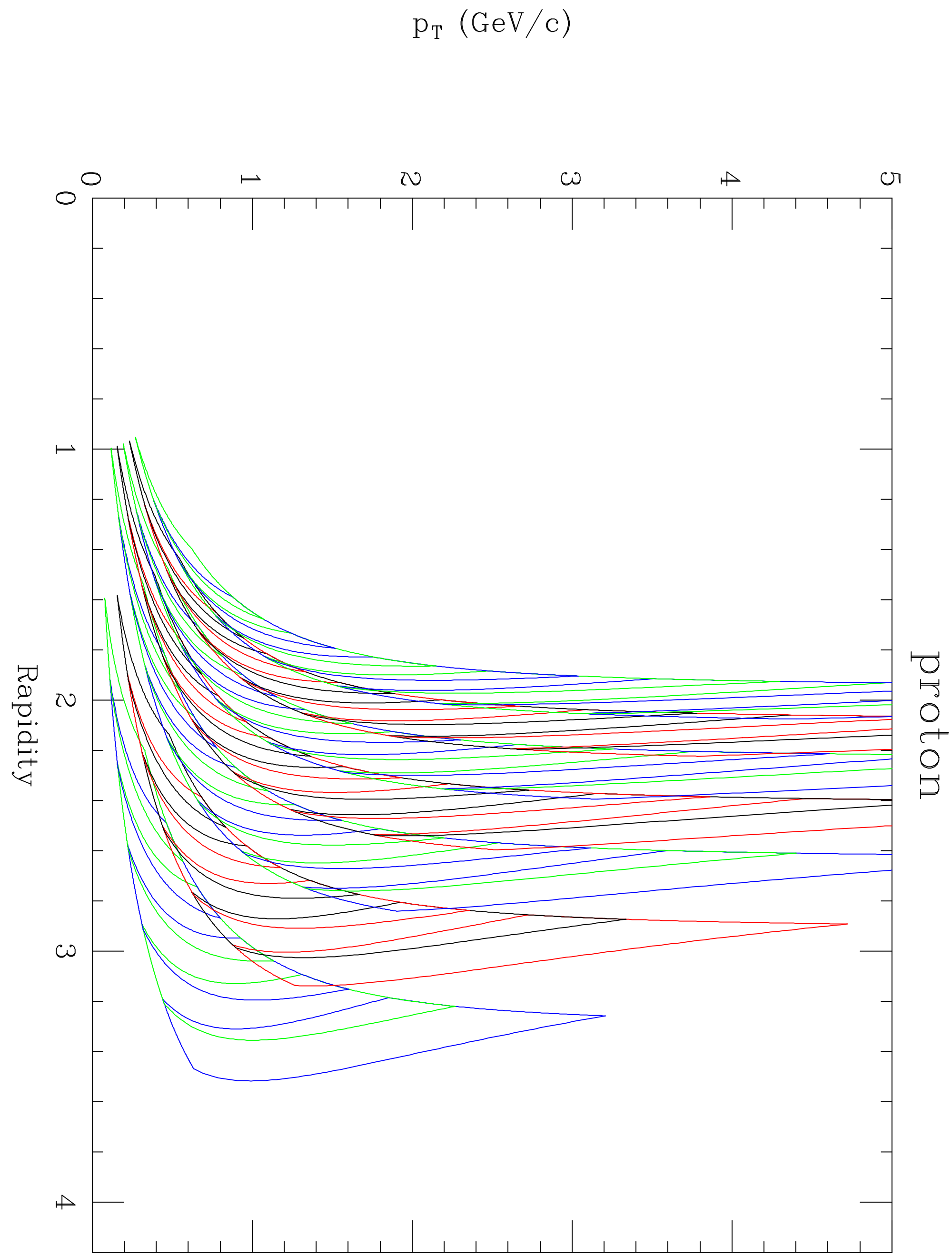


Fig Acceptance of π in forward spectrometer.


kaon
p_T (GeV/c)
Rapidity
0
1
2
3
4
5

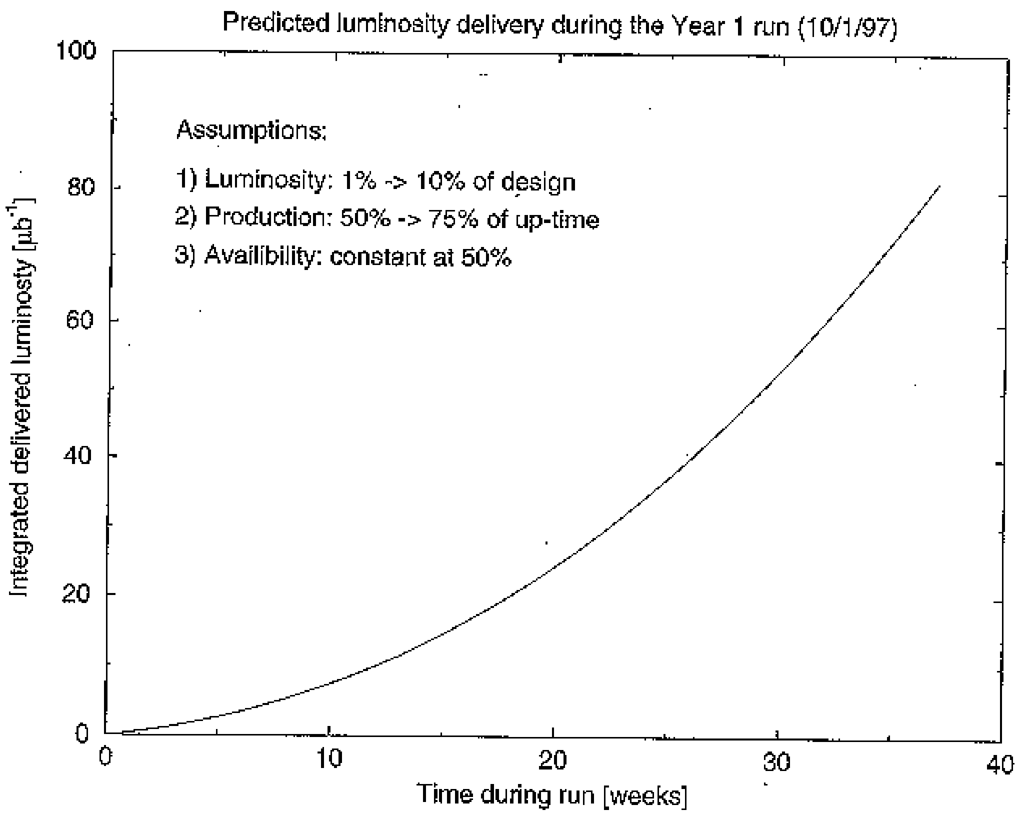


The running scenario for first year from the machine point of view is included in the table below. It can be summarized as outlined by Steve Peggs.

1. Luminosity 1%->10% of design value
2. Production i.e. quiet time for experiment: 50%->75% of uptime
3. Available about 50% of the time.

The predicted integrated luminosity for first year running is 80 inverse μbarns for AuAu of which about half will be delivered in the last 10 weeks of running.

In the nominal year the luminosity will be design value i.e. 2.0.10**26 cm-2sec-1. Production will be about 90% but down at or about 50% level. S. Peggs has made a evaluation of the expected integrated luminosity which can be expected in the first year of running. The following scanned figure shows this.



The following table evaluates the rates that can be expected during the first year of running.

	Initial	Year end
Machine studies	50%	20%
quiet time	50%	80%
Down	50%	50%
Luminosity	1%	10%
Experiment down time	40%	40%

Au Au Collisions per week in IR[1]	1,844,640	29,514,240
Useful MB / week[2]	553,392	8,854,272
Useful central / week	55,339	885,427
Useful Central / sec	0.5	4.9

34 running weeks	Useful	All
Collisions	533,100,960	
Recorded Min Bias Au+Au	159,930,288	319,860,576
Recorded Central	15,993,029	

Experiment downtime

includes

- Turning magnets on after filling of ring
- Dead time of DAQ (15-20%)
- Change of configurations (angles & fields)

Equipment repairs

remember 80% duty factor at AGS is very good

Useful data accounts for middle +-15cm of vertex.

The table summarizes the goals described both in the CDR and at the TAC for achieving good quality spectra. The table above had set central collisions to be 10% of cross section. When the following tables were prepare a 6% has been assumed, as well as a 50% experimental efficiency.

Another way to think about yields is to express them in term of integrated luminosity. It comes simply as

N(counts) = ε (expriment) $L\ \sigma$

[1] Average number of collisions per week taking into account the machine down time, machines studies. The AuAu cross section is set to 6 barn.

[2] Average number of events within the middle part of the vertex and including an experiment uptime of 60%

where is σ the cross section in μbarn and L the luminosity in $\mu barn^{-1.}$ As an example with the expected year one integrated luminosity of 80 , a central cross section of 300mb and experimental efficiency/acceptance of 30% one will get $0.3*80*.3*10^6 = 7.2$ M events in year one. This is the assumption in the tables below.

Charged hadron p_t spectra/particle abundance's

y=1.2 (34°)	Yield	triggers	% integrated luminosity for first year (for 6% central)
	3k k-	0.6M	9%
	9Kπ +	0.05M	1%
	100Kπ π	.7M	10%
Y=0			
	3k k-	1.8M	25%
	9K π +	.15M	2%
	100Kπ π	7M	~100%

program for MRS

y=0,0.5,1 2 polarities per angle setting i.e. feasible in year one.

FS Rate has been estimated by B. Moskowitz in Brahms note#6 (1995)

y=2 (14deg) 1000 π at pt=1.0GeV/c (40Mev/c bin)

using several settings 2.5M triggers

y=3 (4deg) also 2M triggers

pt>=1GeV/c difficult to achieve in first year both at some rapidities due to luminosity, and at others (the highest) due to limitation in magnetic field settings.

Summary

With assumed scenario i.e. increase in L from 1->10% and 30wk. of AuAu running BRAHMS may accomplish the following

- Engineering and commissioning of detector
- survey for selected rapidities y (0-1.3 and 2-3.5).This is not what's is opted for in the CDR; less bins less pt coverage.
- π± p, p-bar K± up to 1 GeV/c in pt < 1.2 GeV/c
- cannot complete this modest program if other ions/energies are commissioned in year one.
- program allows for some weeks of proton machine commissioning. It is not obvious that BRAHMS would take any data in such a period due to the necessary reconfiguration of triggers, tof-start counters etc.