Day-1/Year-1/Endgame

- Endgame task force
- update on PHENIX year-1 physics capabilities
- issues

Barbara Jacak
Dec. 6, 1997

Endgame Task Force

- Members
  - T. Ludlam (chair)
  - Y. Makdisi, J. Mills, S. Peggs, A. Pendzick, P. Pile, T. Roser, A. Stevens)RHIC,AGS)
  - T. Throwe (RCF)
  - M. Marx, B. Jacak (PHENIX)
  - W. Christie, T. Hallman, J. Thomas (STAR)
  - D. Beavis, F. Videbaek (BRAHMS)
  - G. Stephans (and M. Baker) (PHOBOS)
  - J. Harris, W. Zajc (ex-officio)

- working on report
  - working groups
    - machine studies and detector roll-in (M. Marx)
      - scheduled downtime or run until it breaks?
    - Technical manpower needs (M. Marx)
      - NB: the experiments want more in sum than exists
    - ES&H/Accelerator & Operations readiness (B. Jacak...)
    - Day-1 physics and first year running scenario (B. Jacak)

Rates

- Event collection defined by
  - 20 MB/s taping rate
  - approx. 0.4 MB/central Au + Au event
    - smaller for less central, smaller systems

- For initial running (all year-1?) beam limited
  - write less than 20 MB/s initially
    - take ALL Au + Au events until we reach 1/20-1/10 of design luminosity
    - -> exact number depends on final event size & background levels
    - -> need good minimum bias sample to study backgrounds, performance, etc.

Low luminosity run

- early in year-1
  - approximately 1% of design luminosity
  - PHENIX takes ALL events
    - interaction trigger only
  - central event rate to tape = 100K per day
    - beam limited
    - write approx. 2 MB/sec to tape
    - run time at 1% luminosity is 2-4 weeks

Integrated luminosity needed - part 1

physics	# evts central	Integ. L	Int. L with 0.5 DF for PHENIX
multiplicity/ET	200K	$0.35\mu b^{-1}$	$0.7\mu b^{-1}$
charged hadrons	200K	$0.35\mu b^{-1}$	$0.7\mu b^{-1}$
HBT	1M	$1.7\mu b^{-1}$	$3.4\mu b^{-1}$
inclusive photon	1M	$1.7\mu b^{-1}$	$3.4\mu b^{-1}$
pi-zero	3M	$5.2\mu b^{-1}$	$10.4\mu b^{-1}$

Day-1 physics (higher luminosity)

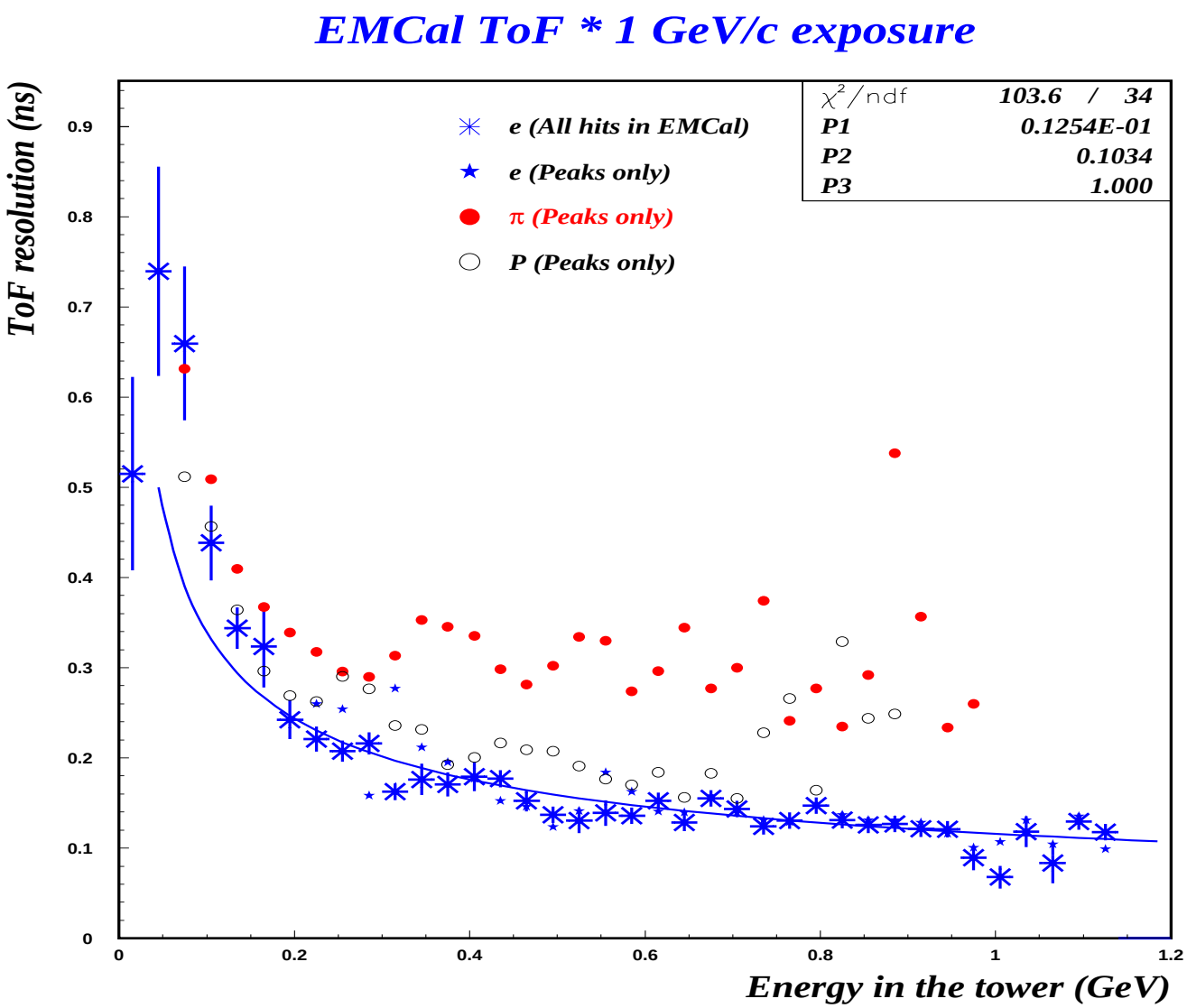
- ϕ -> KK
  - mass, width, yield
    - require global tracking, TOF for high K momentum
    - EMCAL time-of-flight to increase acceptance
  - ONE central arm
- single high p_t leptons from charm decay
  - require same as above plus EMCAL, RICH MUTR and MUID
- J/ψ -> muon pairs
  - require muon arm

Statistics for higher L goals

- for 30M central events on tape
  - 1 month taping at 10% design luminosity
    - write ~1M events per day
- ϕ -> KK
  - ~11K ϕ -> KK into TOF with p_t>0.8 GeV/c
  - 100-200K into EMCAL
  - S/B from 1/20 to 1/100
    - (depends on p_t, aperture)
- single high p_t leptons from charm decay
  - 180K single electrons with p_t>1 GeV/c
  - single high pt muons also. number?
- J/ψ -> muon pairs
  - 2-5 K dimuons (depends on suppression)
  - S/B = 2.7
  - can look at centrality dependence

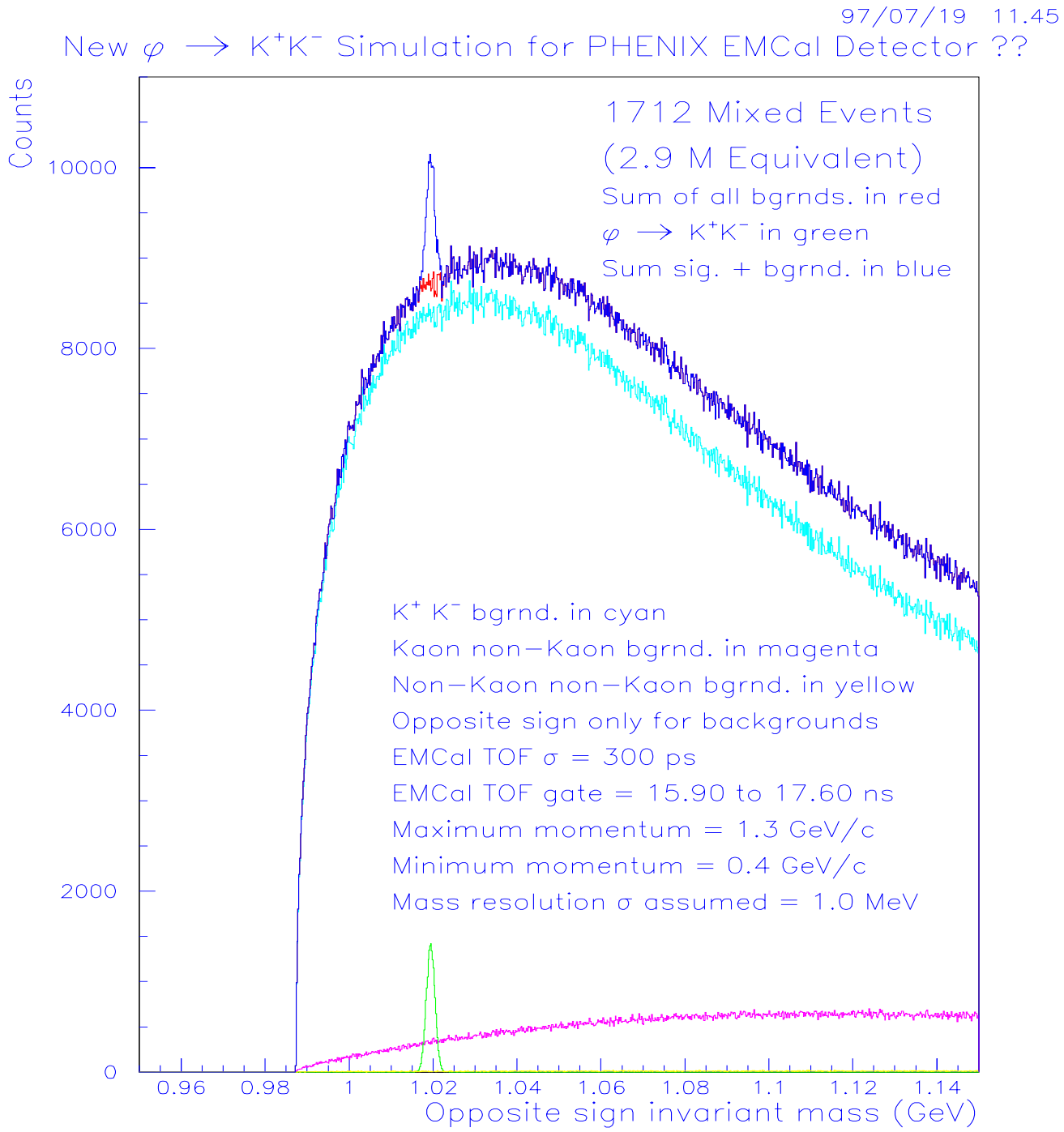
EMCAL TOF

Edward Kistenev



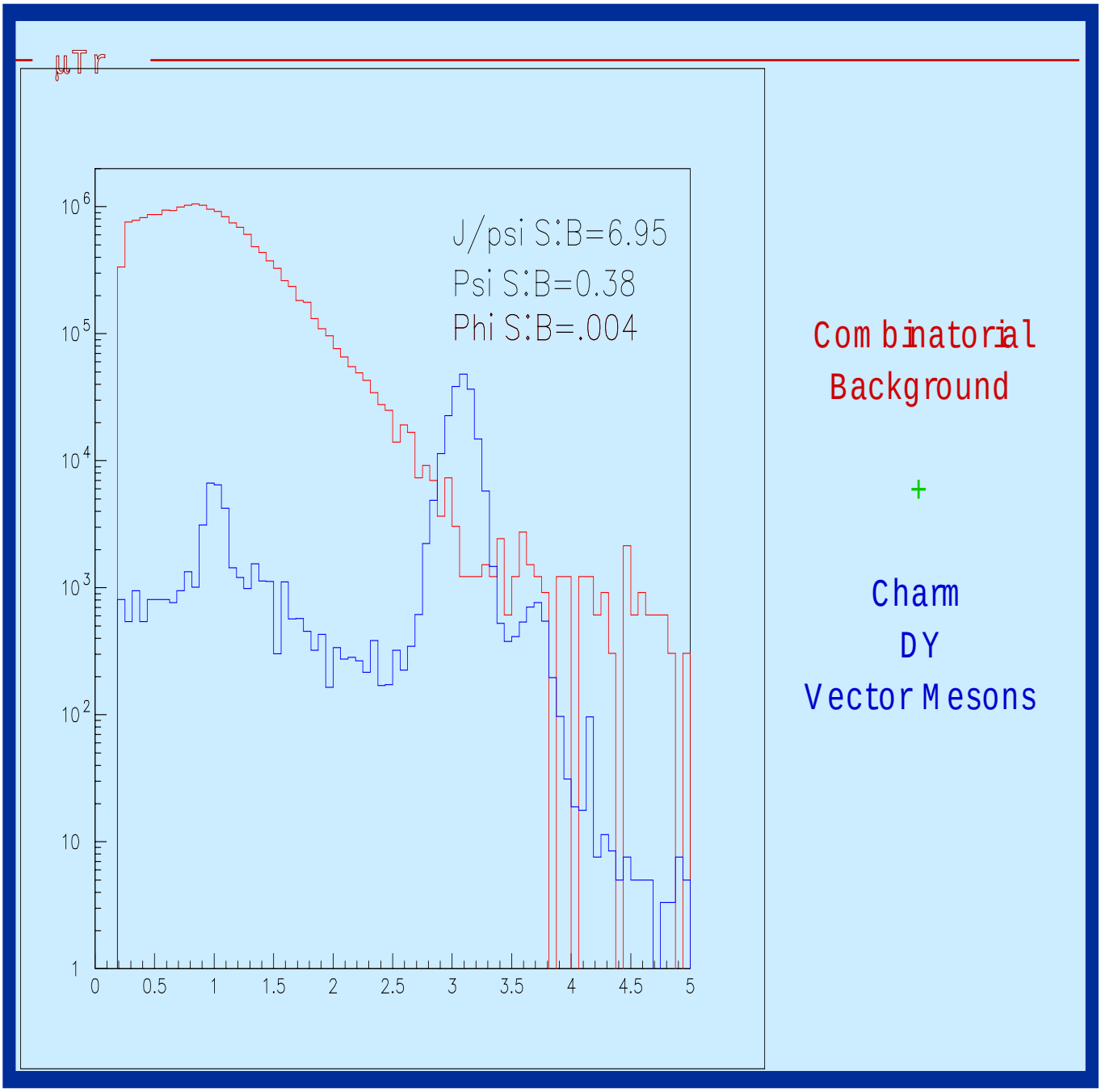
Phi to K pairs using EMCAL

Charlie Maguire



Dimuon performance

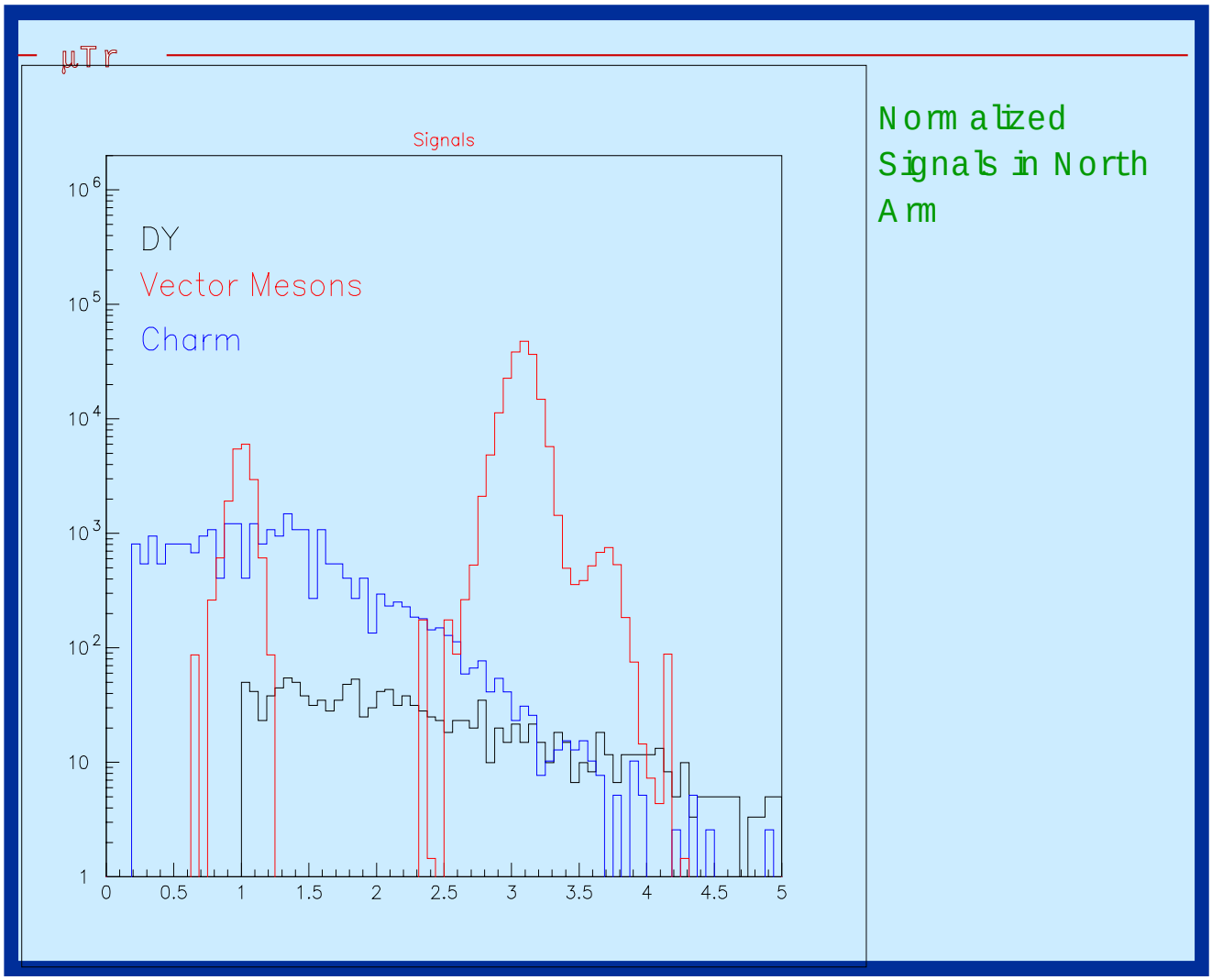
Melynda Brooks



corresponds to 1 year @ BB luminosity

Dimuon signal rates

Melynda Brooks



Normalized Signals in North Arm

Dimuon signal mass spectrum

Melynda Brooks

μTr

Signals

J/psi: NORTH ARM

BR*σ = 9×10^{-27} cm^2 MINIMUM BIAS, Au-Au

L = (2×10^{26} $cm^{-2} s^{-1}$)(1.08×10^7 sec)

PISA/PISORP accept = 0.043

MB Events = 8.4×10^5

CentralEvents = 1.88×10^5/year

φ: NORTH ARM

BR*σ = 6.09×10^{-27} cm^2 MINIMUM BIAS

L = (2×10^{26} $cm^{-2} s^{-1}$)(1.08×10^7 sec)

PISA/PISORP accept = 0.0058

MB Events = 7.6×10^4

CentralEvents = 1.8×10^4/year

one year at blue book luminosity

Background generation

Melynda Brooks

μTr

Combinatorial Background

Run Charlie's 9105 PISA events through PISORP analysis
Keep tracks which:
- --pass through at least 7/9 Tracking chambers
- --reach at least plane 3 of the muID
- --pass momentum depth cut (from Ken Read)
- --point back to vertex from Station 1
- --pass trigger road cut (from Ken Read)

Count number of opposite-sign dimuons/9105 events --> acceptance of dimuons from central events

Mix 9105x9105 events to get better statistics in mass spectrum. Normalize using σ(Central)*dimuon acceptance

σ(Central) = 612 mbarns

Drell-Yan rates

Melynda Brooks

μTr

Signals

Drell-Yan: NORTH ARM

σ = 29.95 nbarns, M>1 GeV, pp, all angles

k = 2

L = $(2\times10^{26}\ cm^{-2}x^{-1})(1.08\times10^{7}\ sec)$ (1 RHIC yr, blue book)

CentralEvents = $(L)(\sigma)(k)(10^{-33})(A^{4/3})$ = 1.5×10^{5}/RHIC yr.

θ = (5,45) accept = 0.112

PISA/PISORP accept = 0.0876

totalpairs/Centralevent = $(1.5\times10^{5})(0.112)(0.0876)$

= 1.47×10^{3}/year

so for year 1,

J/ψ to Drell Yan is not a good choice

Charm

Melynda Brooks

μTr

Signals

Charm : NORTH ARM

σ = 200 μbarns, single charm, pp, all angles

$L = (2 \times 10^{26}\ cm^{-2} s^{-1})(1.08 \times 10^{7}\ sec)$

CentralEvents = $(L)(\sigma)(10^{-30})(A^{4/3}) = 4.95 \times 10^{8}$

DIMUONS, $[\theta = (5,45)*(BR)]^2$ accept = 0.0027

PISA/PISORP accept = 0.0185

totalpairs/Centralevent = $(4.95 \times 10^{8})(0.0027)(0.0185)$

$= 2.5 \times 10^{5}$/year

Higher luminosity run

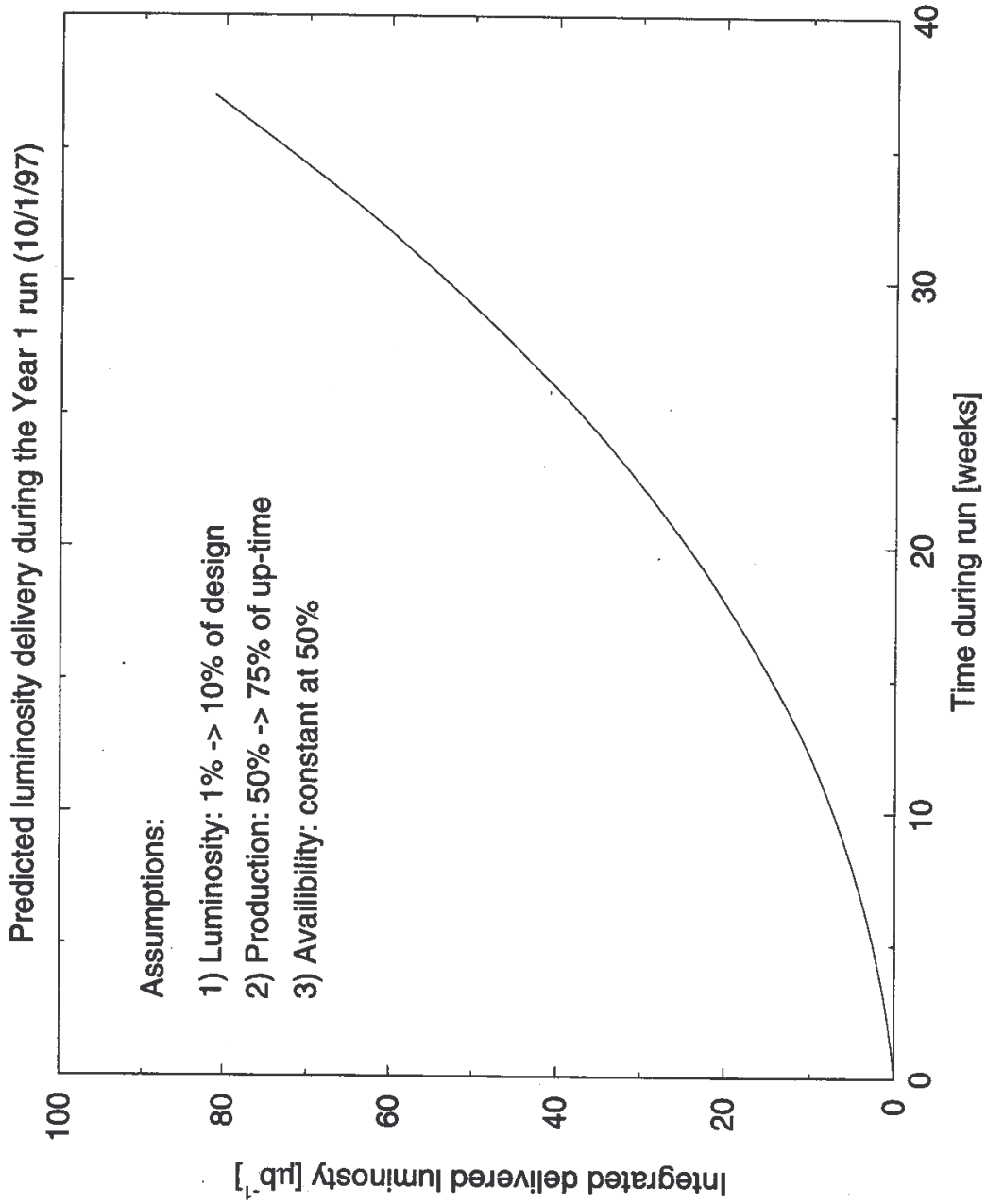
- latter part of year-1
- Integrated luminosity
  - 52 μb^{-1} on tape
  - 104 μb^{-1} delivered from RHIC
    - if PHENIX duty factor is 50%
  - data sample of 30M central events
- at 10% of design luminosity
  - approximately 1 month of taping
  - so approximately 2 months of running
- near rate where PHENIX is tape limited
  - write 1M central collisions per day
  - trigger requirements minimal

Other beams/energies

- PHENIX priorities for year-1
  1) collect both data sets
     need 52 μb^{-1} ON TAPE
  2) aim for polarized p+p in year-2
     ensure required machine studies in year-1

- can do physics with other Au + Au energies or other ion species
  need at least several inverse microbarns, prefer 10-20 μb-1
  need ~100 μb-1 for lepton physics

Projected RHIC L growth



Run Issues

- Will we get enough integrated luminosity?
- What do 4 weeks of spin commissioning imply?
  "cost" is 20% of the integrated luminosity
- PHENIX stated goals
  1. Accomplish both sets of physics goals with full energy Au + Au
  2. Commission polarized beam

Year-1 physics goals and workshop groups

	electrons	hadrons	photons	muons	spin
multiplicity & ET		X	X		
charged hadron singles		X			
HBT		X			
inclusive $\gamma/\pi 0$		X	X		
ϕ ->K+K-	(X)	X		(X)	
charm/ single leptons	X			X	
J/ψ -> $\mu+\mu-$	(x)			X	
ΔG			X		X

EMCAL occupancies

Gabor David

Photon ID in the PbSc

Boring details – occupancies

1. Results based on 120 Au+Au HIJING events
2. No DC shield
3. 1 MeV tracking threshold
4. Energy means calibrated energy (*)
5. Primary: the particle that **deposited** most of the energy, irrespective of its momentum

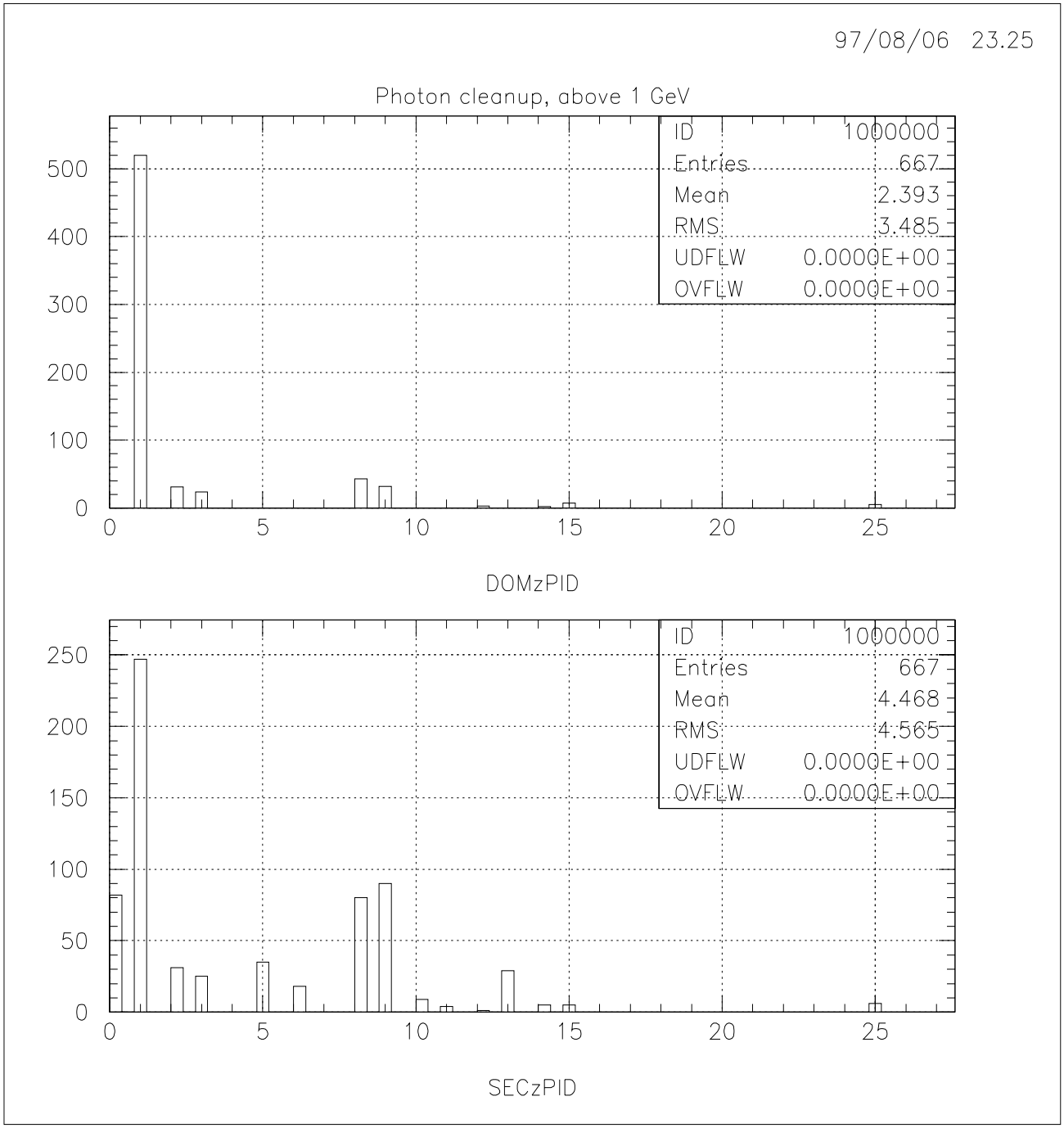
Occupancies (number of towers hit)

Parent	Cut	All hits	Vertex	Non-vertex
All	None	26.81%	21.29%	5.52%
	2 MeV	15.00%	9.89%	5.11%
	8 MeV	11.02%	7.37%	3.65%
	20 MeV	7.53%	5.12%	2.41%
Photon	None	7.53%	5.43%	2.10%
	2 MeV	6.89%	5.03%	1.86%
	8 MeV	4.67%	3.56%	1.11%
	20 MeV	2.86%	2.31%	0.55%

Single and multiple hit towers, E > 20 MeV

Primary ID	Prim>20MeV	Sec<20MeV	Sec<8MeV	Sec<2MeV	No sec.
All	98.28%	10.08%	6.01%	1.21%	83.86%
Photon	97.84%	9.70%	5.87%	1.20%	84.30%

Columns 3-6 always assume that the primary particle deposited at least 20 MeV

Cluster - track overlaps

Gabor David