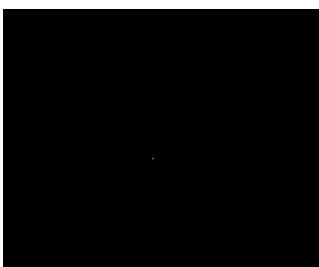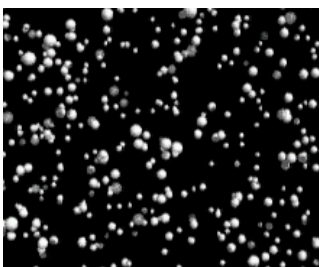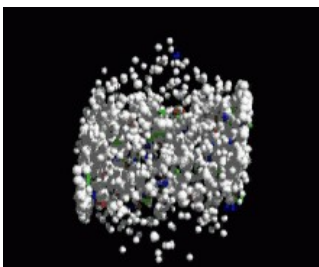# Recent Results from CERES

D. Miśkowiec, GSI Darmstadt
Hirschegg, January 2002

- Experiment

- Electrons at 40 GeV

- Hadrons at 40,80,158 GeV

- Current activities and plans

Sources of e⁺e⁻ pairs

Drel – Yan

$$q\bar{q} \to \gamma^* \to e^+ e^-$$
$$qg \to q\gamma^* \to qe^+ e^-$$
$$q\bar{q} \to g\gamma^* \to ge^+ e^-$$

0 fm/c

QGP radiation

$$q\bar{q} \to \gamma^* \to e^+ e^-$$

2 fm/c

pion annihilation

$$\pi\pi \to e^+ e^-$$

8 fm/c

meson decays

$$\rho \to e^+ e^-$$ 10 fm/c

$$\omega \to e^+ e^-, \quad e^+ e^- \pi^o$$ 30 fm/c

$$phi \to e^+ e^-$$ 50 fm/c

$$\eta' \to e^+ e^- \gamma$$ 1 pm/c

$$J/\Psi \to e^+ e^-$$ 2 pm/c

$$Ups \to e^+ e^-$$ 4 pm/c

$$\eta \to e^+ e^- \gamma$$ 0.2 nm/c

$$\pi^o \to e^+ e^- \gamma$$ 25 nm/c

open charm

$$c\bar{c} \to D\overline{D}, D \to e^+ X, \overline{D} \to e^- Y$$
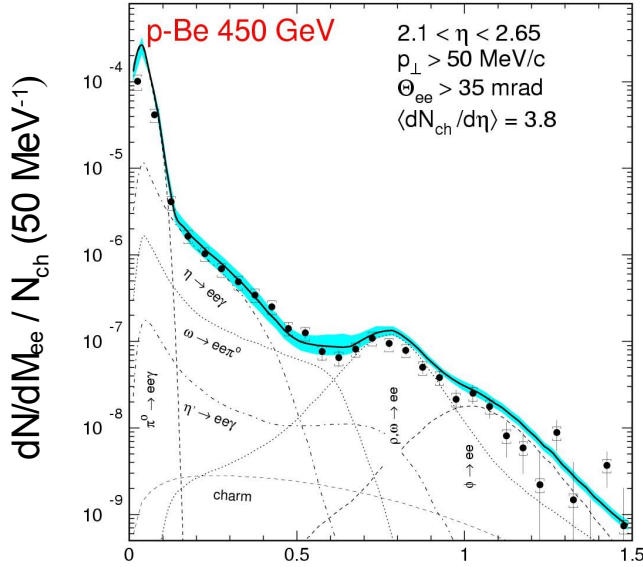
0.1 mm/c

gamma conversion

$$\gamma X \to e^+ e^- X$$

10 cm/c

CERES results 92-96

Eur. Phys. J C4 (1998) 231

p-Be 450 GeV

$2.1 < \eta < 2.65$
$p_\perp > 50$ MeV/c
$\Theta_{ee} > 35$ mrad
$\langle dN_{ch}/d\eta \rangle = 3.8$

Eur. Phys. J C4 (1998) 231

p-Au 450 GeV

$2.1 < \eta < 2.65$
$p_\perp > 50$ MeV/c
$\Theta_{ee} > 35$ mrad
$\langle dN_{ch}/d\eta \rangle = 7.0$
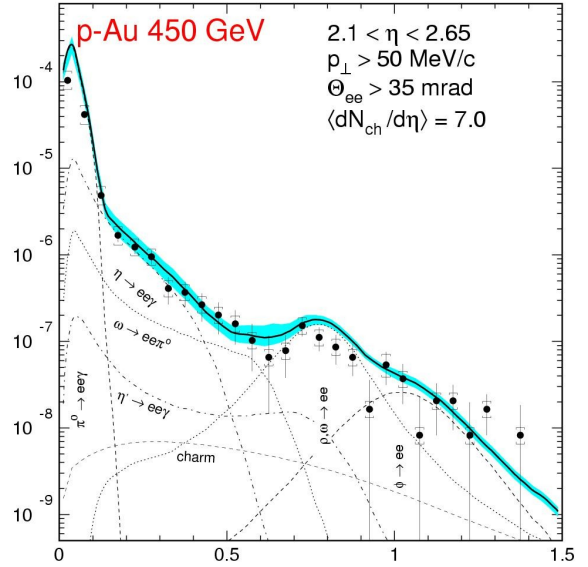
Phys. Rev. Lett. 75 (1995) 1272

CERES/NA45   S-Au 200 GeV/u

$2.1 < \eta < 2.65$
$p_\perp > 200$ MeV/c
$\Theta_{ee} > 35$ mrad
$\langle dN_{ch}/d\eta \rangle = 125$

Nucl.Phys. A661 (1999) 23c

CERES/NA45   Pb-Au 158 A GeV

□ 95 data
● 96 data

$\sigma_{trig}/\sigma_{tot} \sim 35$ %
$p_\perp > 200$ MeV/c
$\Theta_{ee} > 35$ mrad
$2.1 < \eta < 2.65$
$\langle N_{ch} \rangle = 250$
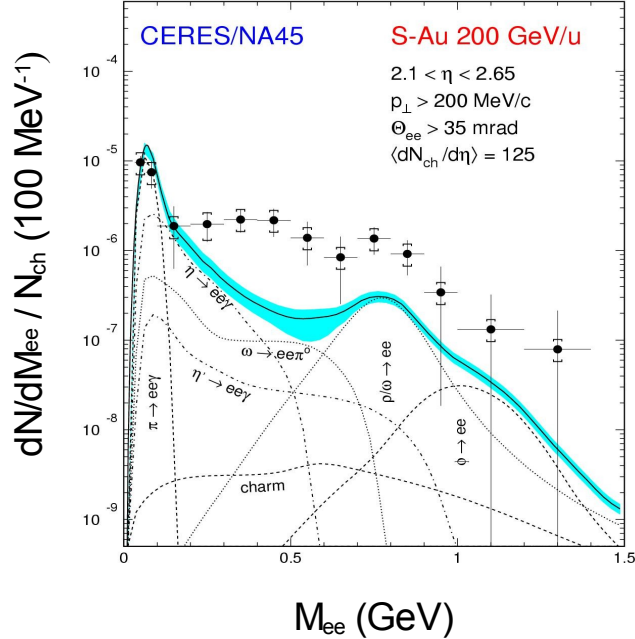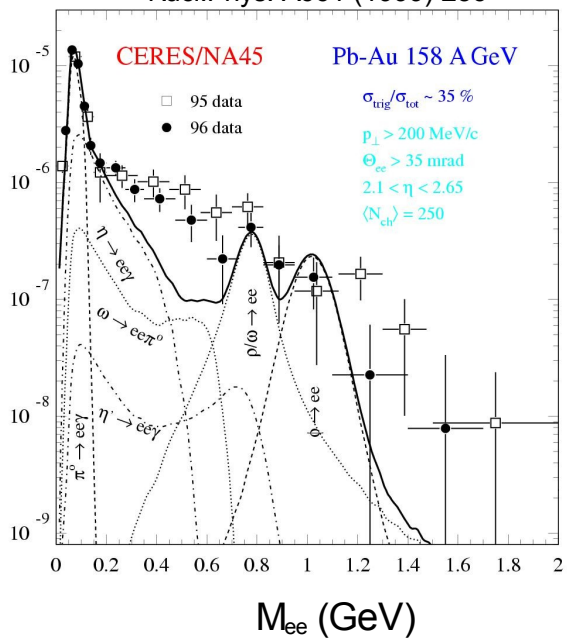
$\rightarrow$ excess of e^+e^- pairs in heavy ion collisions

GENESIS

particle	relative abundance	decays
π⁰	1.0	π⁰ → γe+e–
η	0.053	η → γe+e–
η'	0.009	η' → γe+e–
φ	0.0033	φ → e+e–
ρ	0.065	ρ → e+e–
ω	0.065	ω → e+e– ω → γe+e–

$$dN/dy \sim \cosh^{-2}[0.75/\sigma(y-yo)]$$
$$dN/dp_t \sim Ae^{-Bm_t} + C(1-0.0682\ m_t)^{7.9}/(1+m_t^2)^4$$

CERES run history

|		
1990	installation	
1991	completed	
1992	200 GeV S+Au	4M central 3M pairs
1993	450 GeV p+Be 450 GeV p+Au	10M pairs 3M pairs
1995	158 GeV Pb+Au	10M central
1996	158 GeV Pb+Au	50M central
1997	TPC construction	
1998	TPC installation	
1999	40 GeV Pb+Au	10M central
2000	80 GeV Pb+Au 158 GeV Pb+Au	1M central 30M central
2002 ?	20 GeV Pb+Au ? 30 GeV Pb+Au ?	

2000 run of CERES

Total events vs time
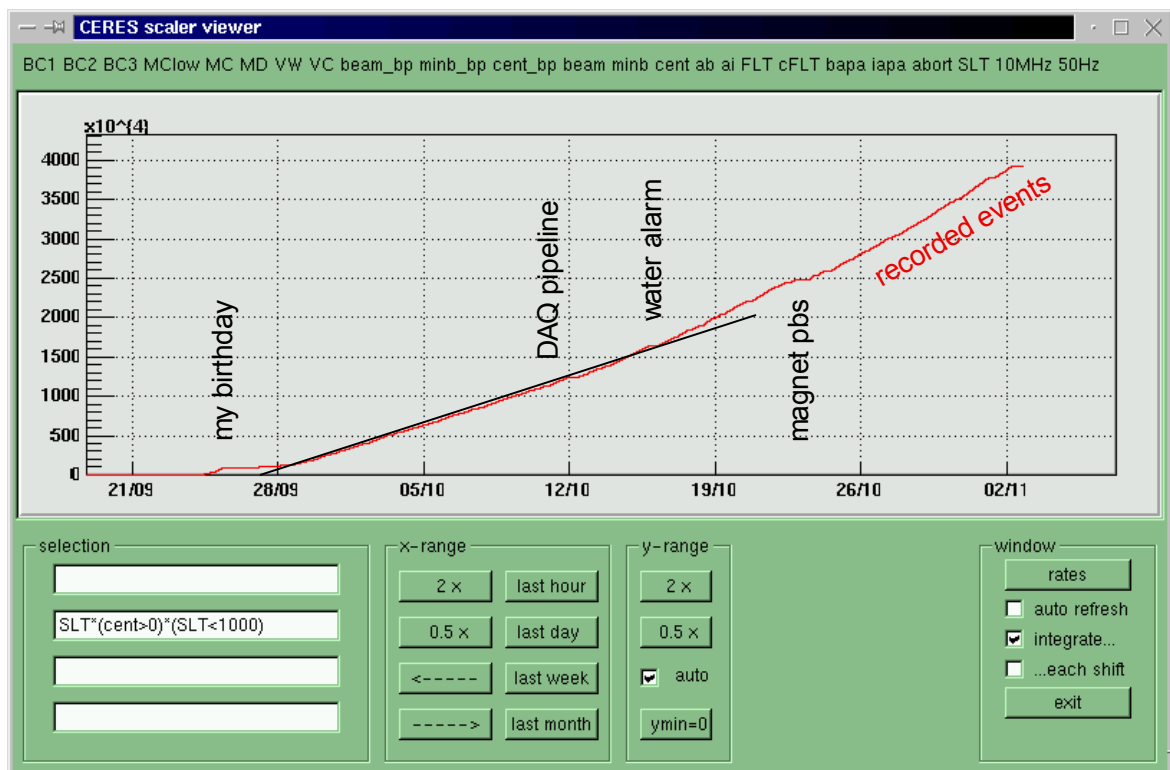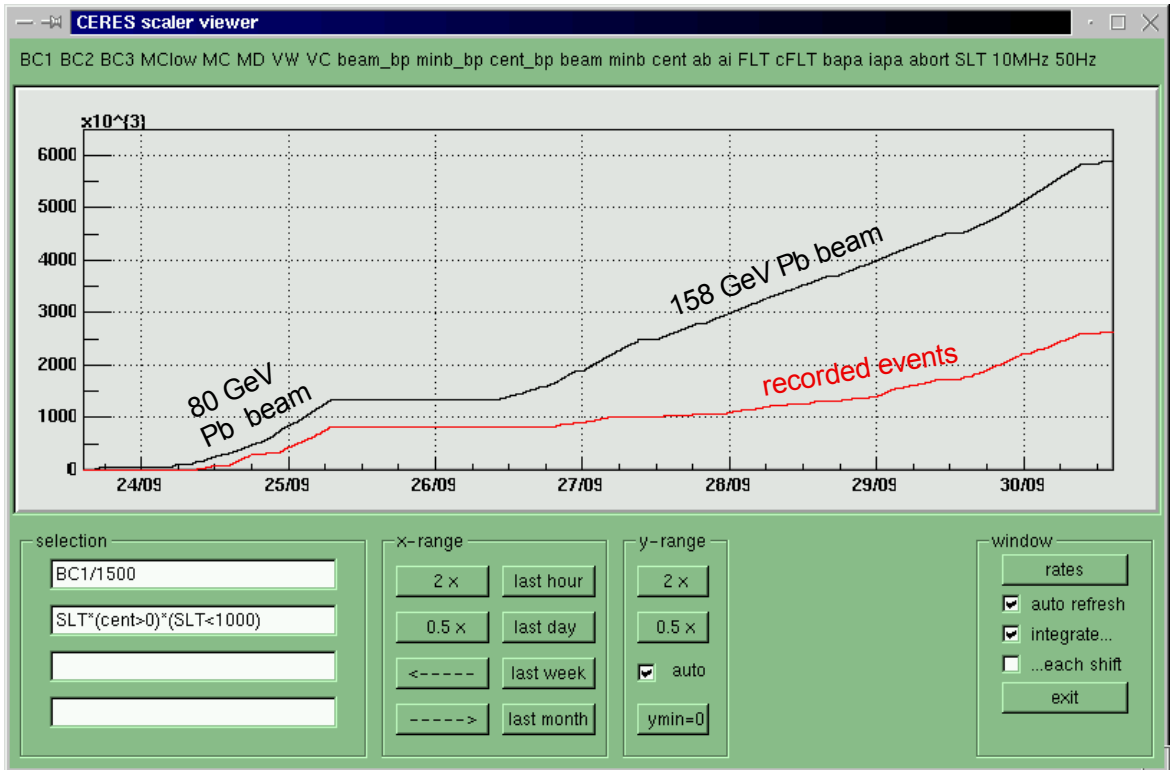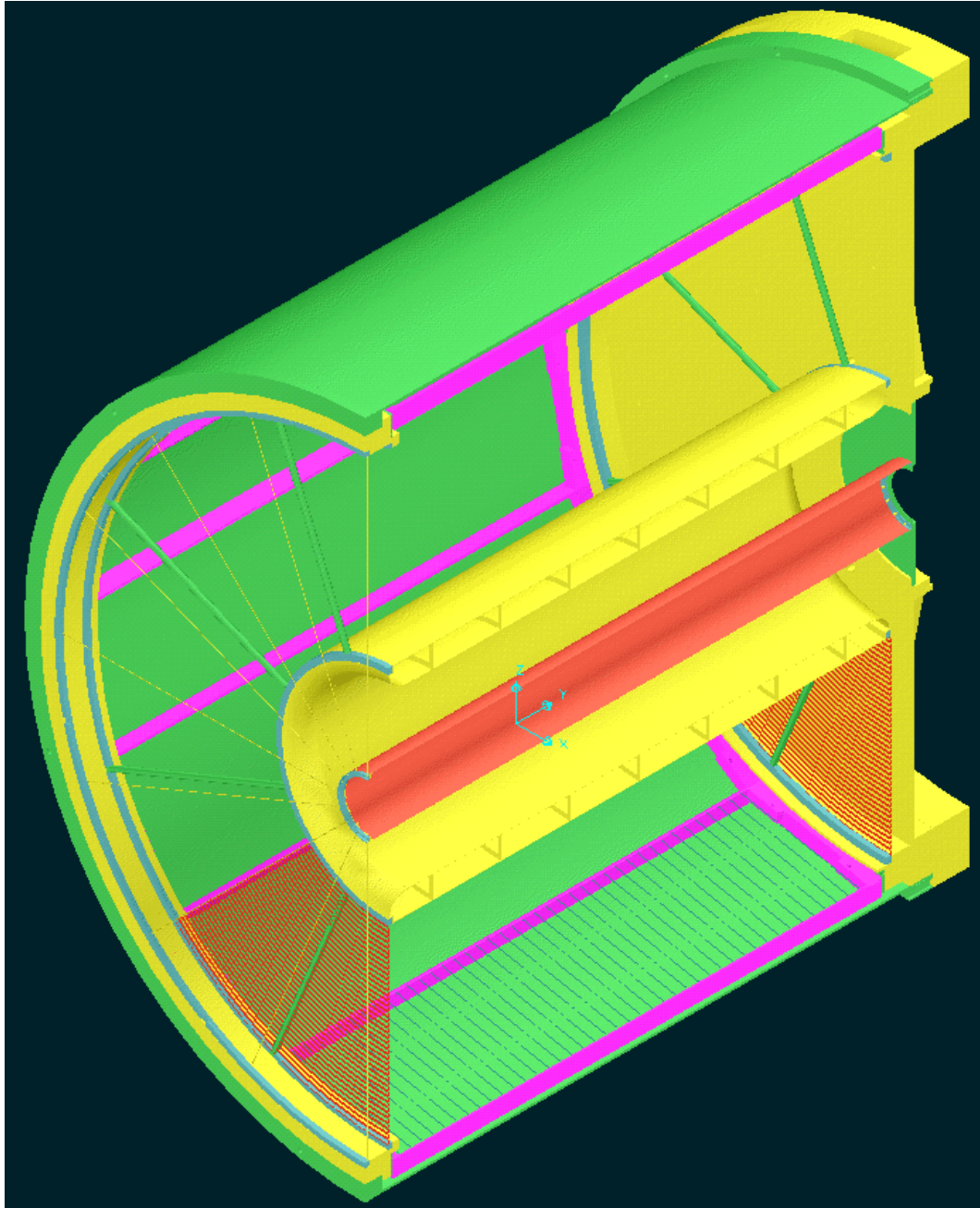
CERES setup 1999-2000
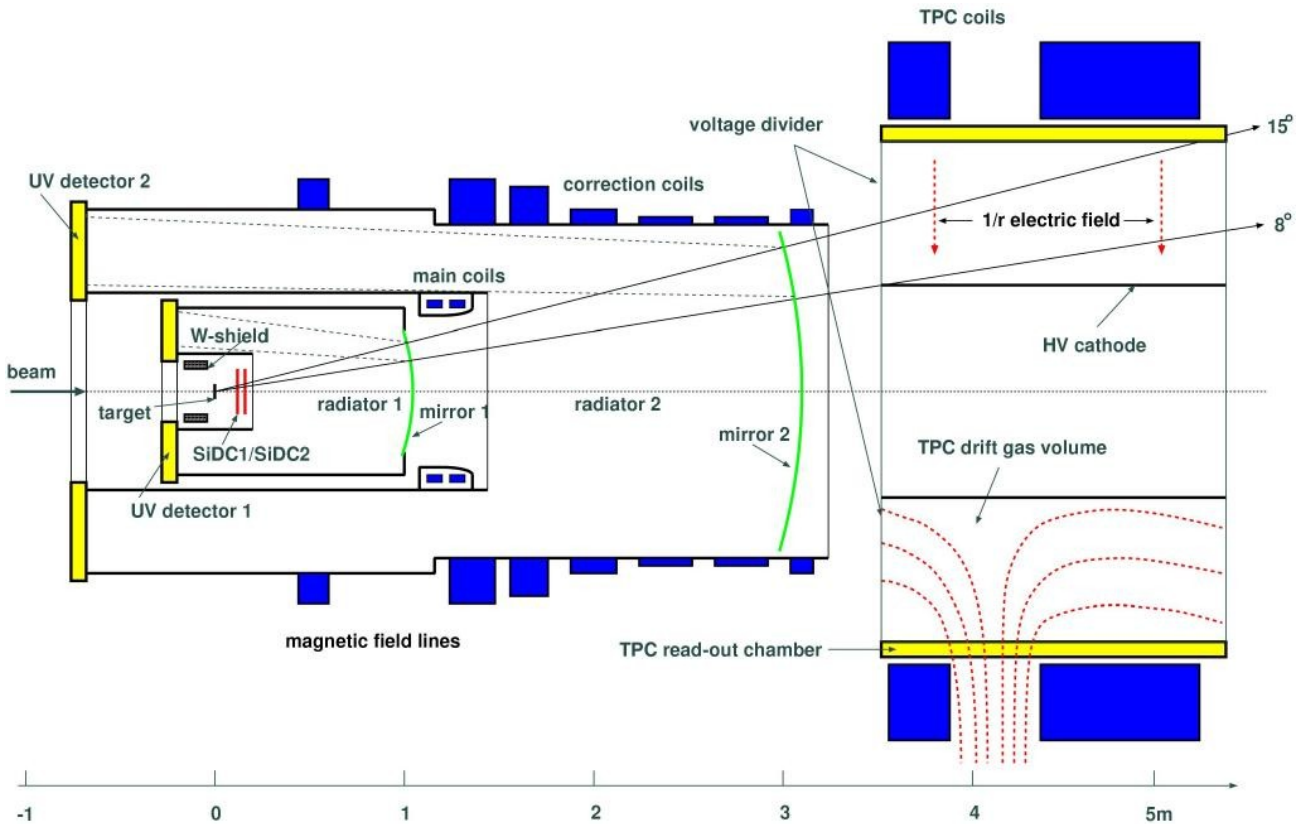
| SD's: angle | RICH's: electron PID | TPC: momentum, dE/dx |

- better mass resolution (2% at ω mass)
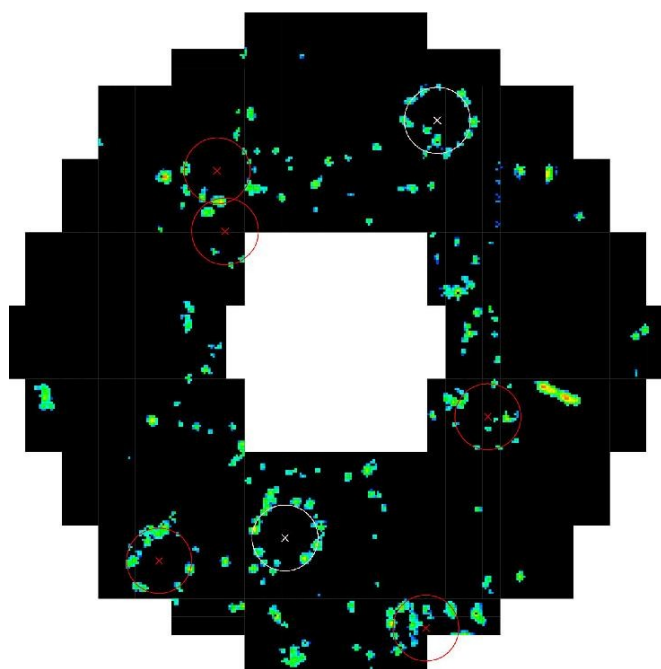- better electron PID
- hadron measurement

CERES TPC

- cylinder Φ 2.6 m x 2 m
- gas Ne:CO_2 (80:20)
- radial E-field $E_R \sim 1/r$ with E=200-600 V/cm
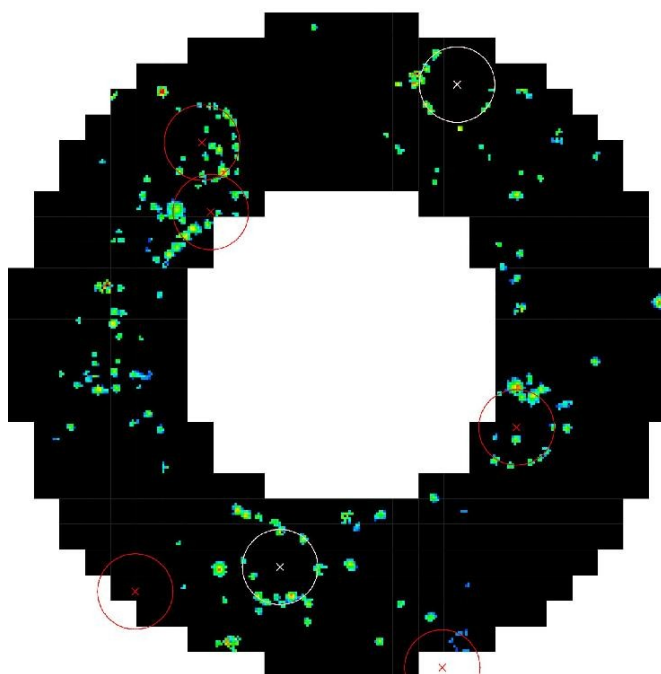- radial drift with v=0.7-2.4 cm/μs

CERES 1999-2000 Pb+Au results

- 40 GeV dileptons

- 40 GeV hadrons vs centrality
- 40 GeV Λ
- 40,80,158 GeV pt fluctuations
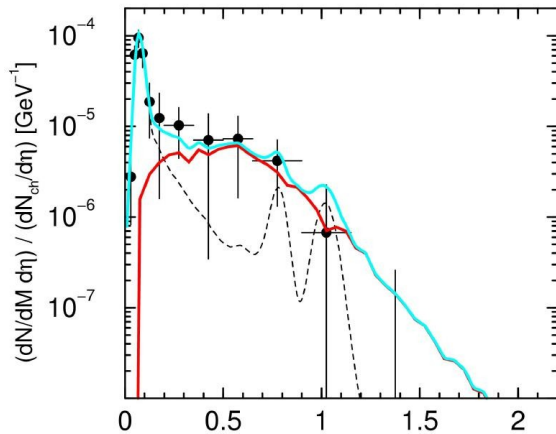- 158 GeV charge fluctuations

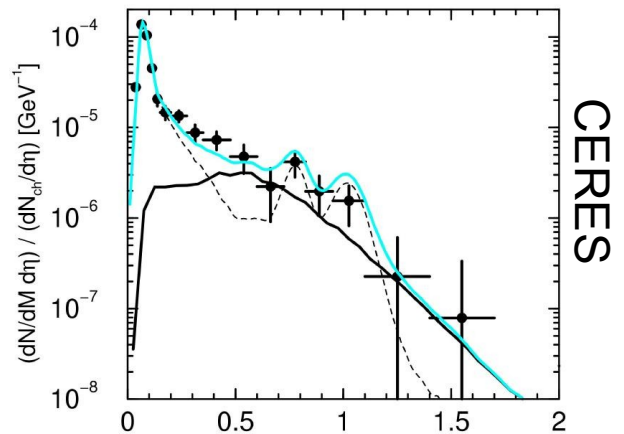# Event in RICH

RICH 1

RICH 2
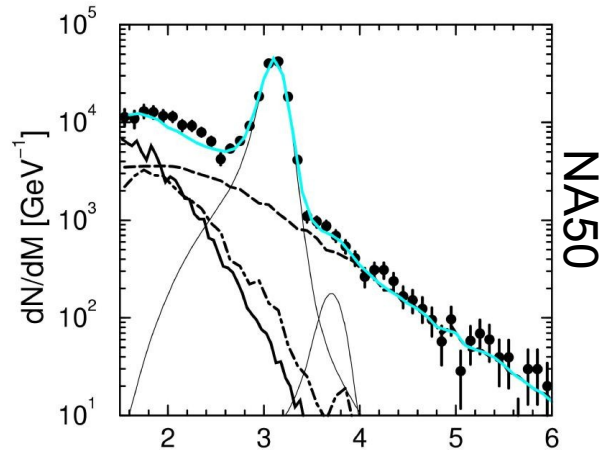
Thermal radiation from QGP

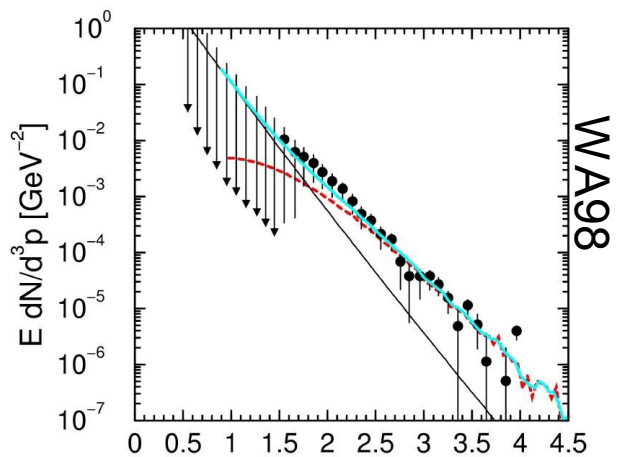(B. Kämpfer et al, hep-ph/0102192, Feb. 2001)
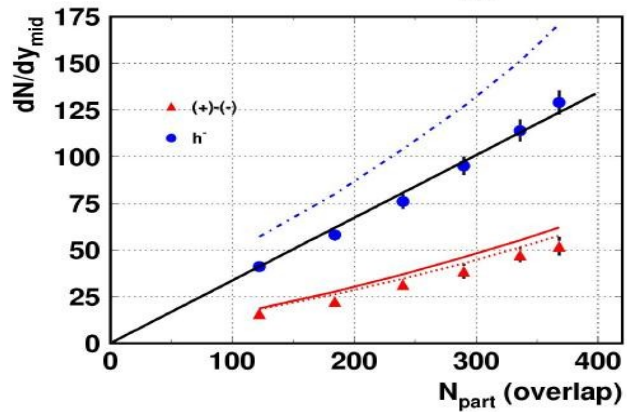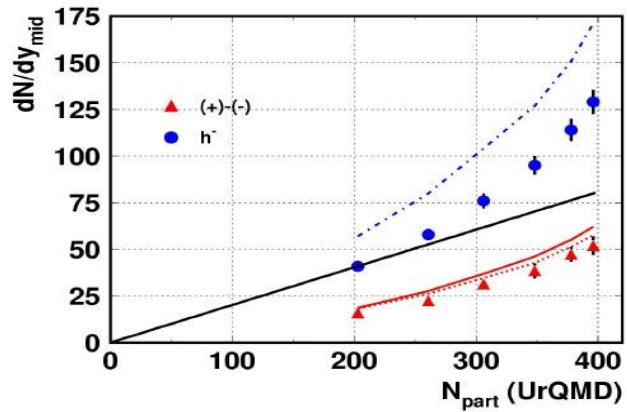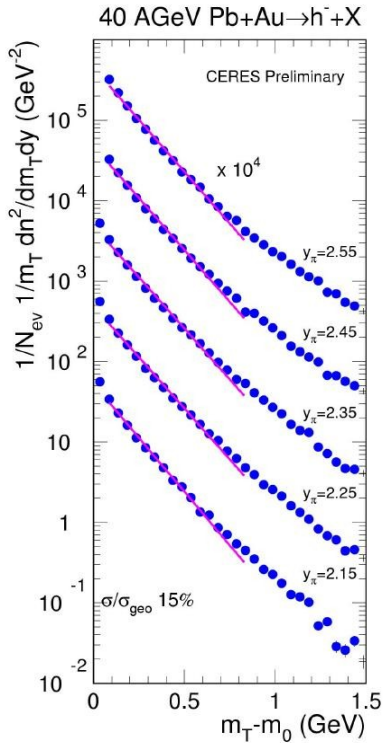

40 GeV per nucleon

160 GeV per nucleon

CERES

NA50

WA98

40 GeV h⁻ spectra

Harry Appelshäuser

40 AGeV Pb+Au→h⁻+X

CERES Preliminary

$\times 10^4$

$y_\pi = 2.55$

$y_\pi = 2.45$

$y_\pi = 2.35$

$y_\pi = 2.25$

$y_\pi = 2.15$

σ/σ_{geo} 15%

$1/N_{ev}\ 1/m_T\ dn^2/dm_T dy$ (GeV^{-2})

$m_T - m_0$ (GeV)

dN/dy_{mid}

(+)-(-)

h⁻

N_{part} (UrQMD)

dN/dy_{mid}

(+)-(-)

h⁻

N_{part} (overlap)

VERY PRELIMINARY

http://www.gsi.de/~misko/overlap

Nuclear overlap via web

Web interface for a nuclear overlap calculation code

This nuclear overlap code will calculate the number of participants and the number of binary collisions in an nucleus–nucleus collision via the mass distribution within the two colliding nuclei. Please enter the input parameters below.

A: [208] (mass number of the projectile nucleus)

B: [208] (mass number of the target nucleus)

Which density profile do you want?
- sharp sphere
- Woods–Saxon

sigma: [42] (inelastic NN cross section in mb, recomended values are 30 for 10–200 GeV LAB, 37, 41, 42, 60 for s=56, 130, 200, 5500 GeV, respectively)

Statistics: [1000] (number of trials per integral, 1000 is good for a quick test)

[Submit]

A lead lead collision calculation takes typically 10 seconds per thousand trials.

Average number of participants and collisions

from: b= [0] fm or [0] centrality

to: b= [4.8] fm or [.10266] centrality
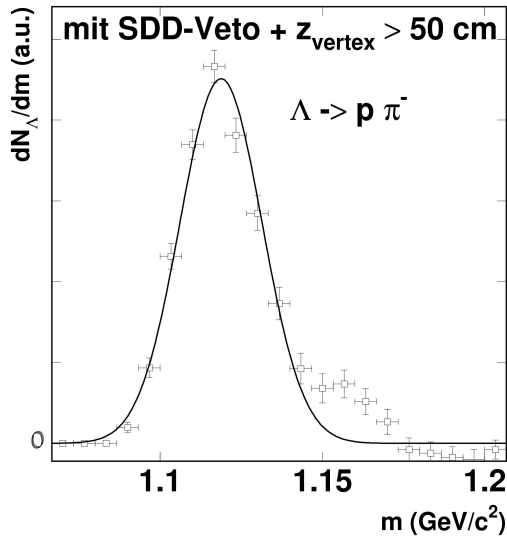
[calculate]

Number of participants: [324.4]

Number of collisions: [748.8]

Λ Production at 40 GeV
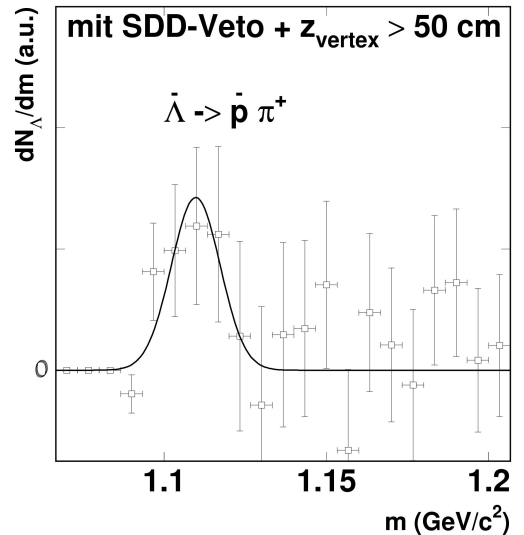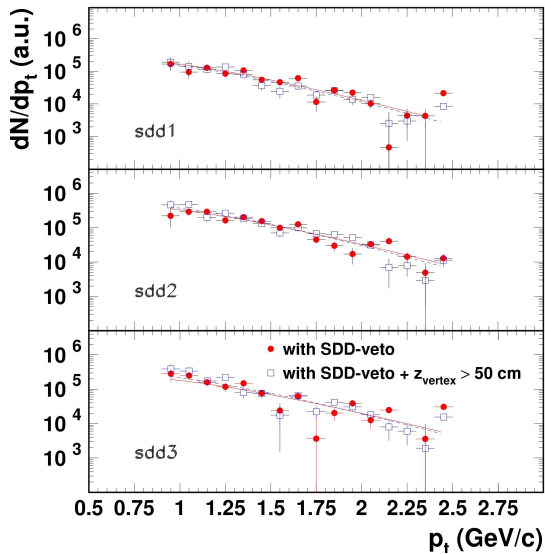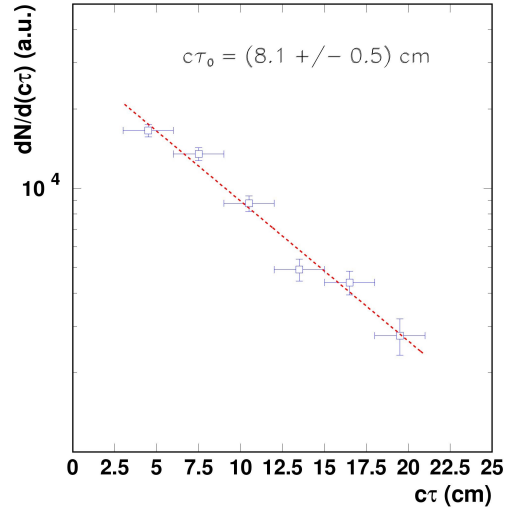
Λ Production at 40 GeV
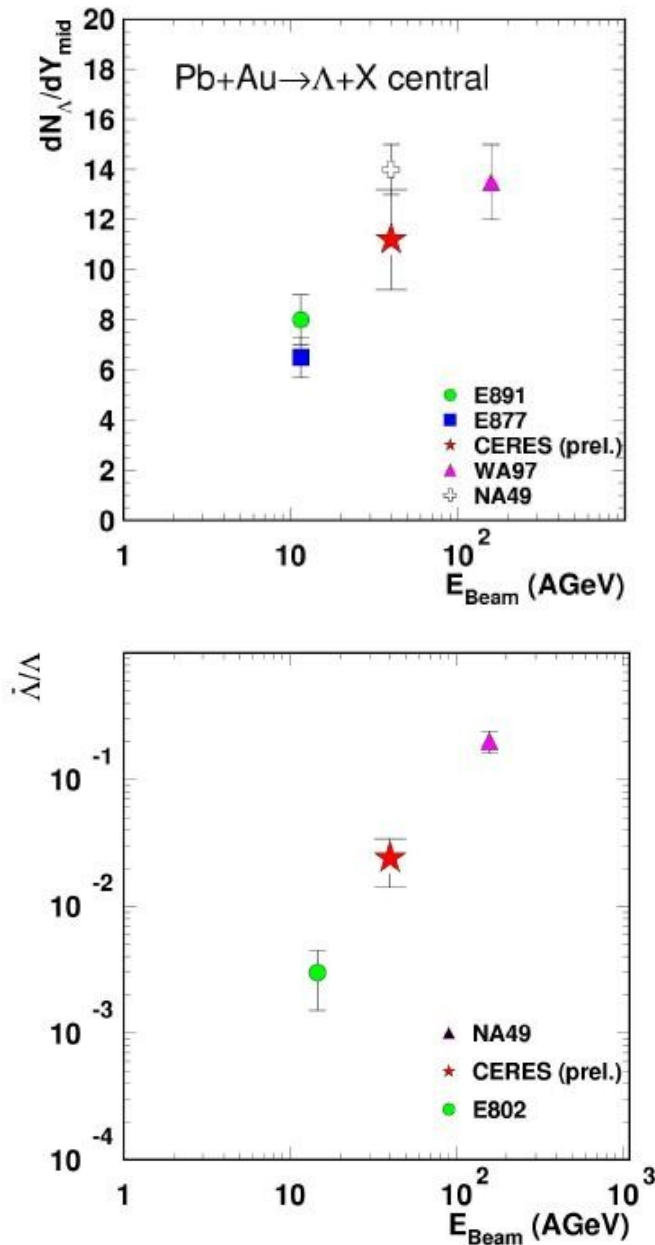
→ Λ and anti-Λ yields fit into the beam energy systematics

Event by event mean pt

Pb+Au σ/σ$_{geo}$ 6.5%
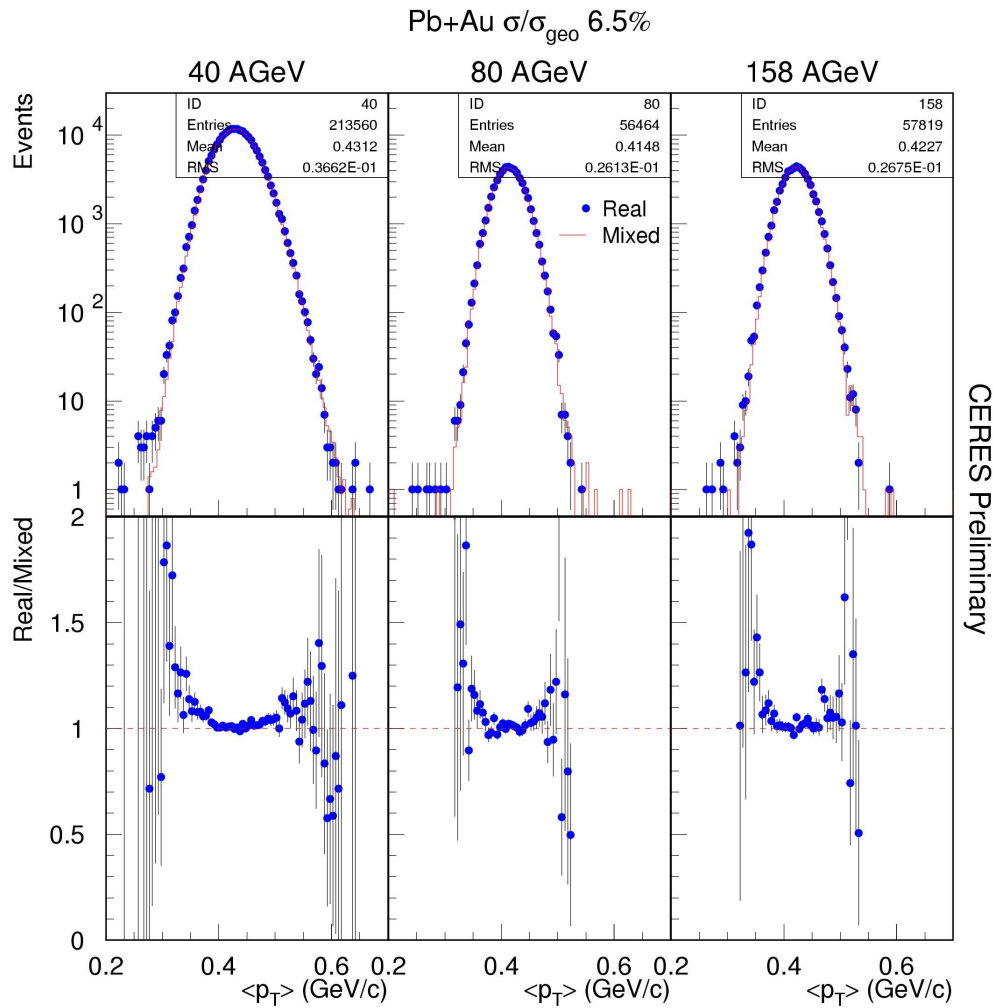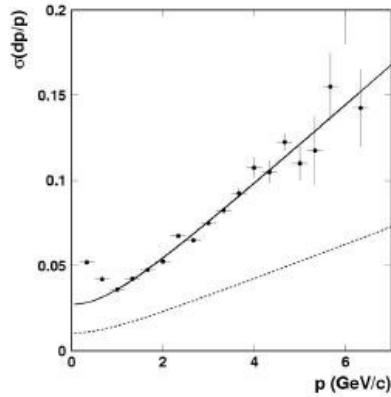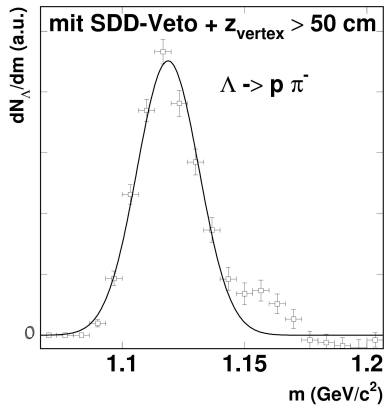

→ Non-zero event-by-event fluctuations

Current activities

λ at 40 GeV

λ peak too wide
→ Δp too high
→
better calibr-
ation needed

calibration of 2000 data

- TPC detailed calculation of E-field
- TPC detailed calculation of B-field
- TPC new hit finding algorithm
- TPC improved tracking algorithm
- RICH event by event monitoring
- SD careful drift velocity calibration
- new 3-d event display

Summary and outlook

- ❖ excess in low mass e+e- spectrum at 40 GeV
- ❖ no enhanced Lambda production at 40 GeV
- ❖ over-statistical pt fluctuations at 40-158 GeV but less than expected around critical point
- ❖ charge fluctuation like for pion gas

- ❖ High precision 158 GeV data under way
- ❖ 20/30 GeV in 2002 to be accepted