ϕ production in Pb-Pb collisions at 158 GeV/n, in NA50 experiment (preliminary results)

Laurence Villatte IPN Orsay

Introduction: why do we study ϕ production in UR heavy ion collisions ?

1) NA50 experimental set-up

2) Data analysis:

- experimental data processing
- simulation
- mass spectra fits

3) ϕ enhancement:

- $\left(\frac{\phi}{\rho+\omega}\right)_{\mu\mu}$ versus centrality and transverse mass M_T
- ϕ and $\rho+\omega$ multiplicities versus centrality

4) Cross sections: σ^{ϕ} and $\sigma^{\rho+\omega}$

$\rightarrow$ extraction of effective temperatures: T_{ϕ} and $T_{\rho+\omega}$

Conclusion

Why do we study ϕ production in UR heavy ion collisions?

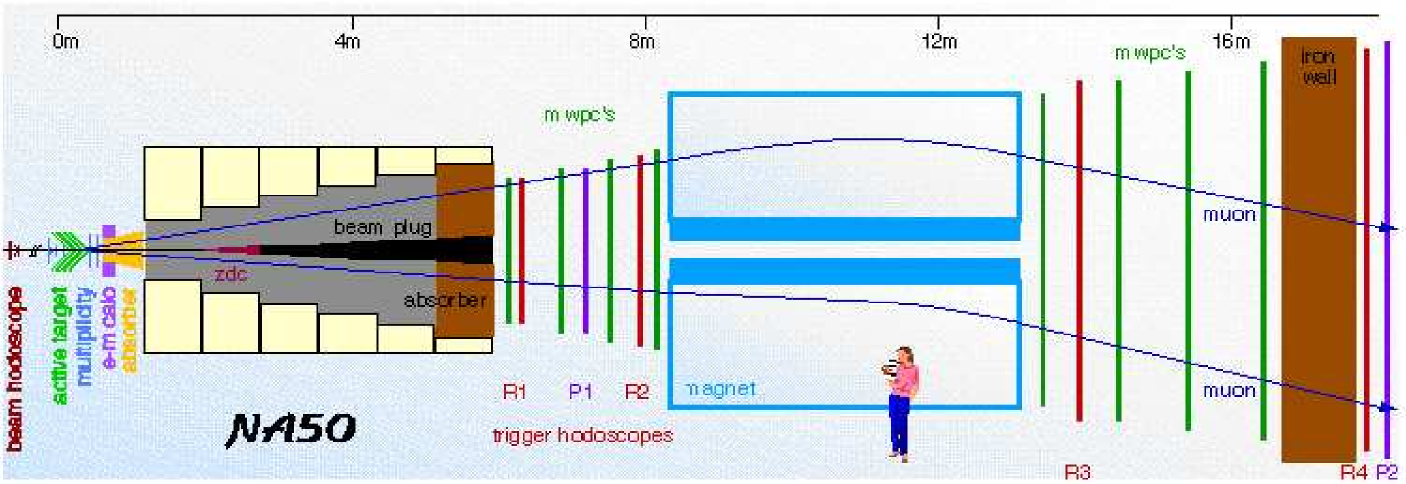
- aim of UR heavy ion collisions: search for Quark and Gluon Plasma (QGP)

- strange particles production enhancement predicted as a signal for the transition to QGP

→ in NA50 experiment: study of ϕ ($s\bar{s}$) production as compared to $\rho+\omega$ ($u\bar{u}$ and $d\bar{d}$ combinaison) production

(m_s=1019 MeV/c^2, m_ρ=770 MeV/c^2, m_ω=782 MeV/c^2)

Experimental set-up of NA50 experiment



Kinematical domains:

Rapidity: $$0 \leq y_{cm} \equiv \frac{1}{2}\ln\left(\frac{1+p_L}{1-p_L}\right) \leq 1$$

Angles (in Collins-Soper frame): $0 \leq \varphi \leq 2\pi$

and $-0.5 \leq \cos\theta \leq 0.5$

NA50 ψ set-up $\rightarrow$ for low mass region ($M \leq 2$ GeV/c^2),

significant acceptance for

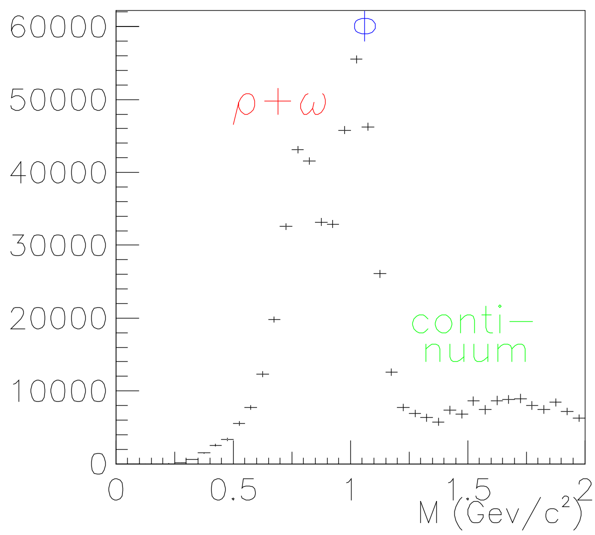
$M_T \equiv (M^2+p_T^2)^{1/2} \geq 1.5$ GeV/c^2

Experimental data processing

- data taking 1996: I ~ 5.10^7 Pb/burst $\rightarrow N_{inc} = 4.10^{12}$
- combinatorial background substraction from $\mu^+\mu^+$ and $\mu^-\mu^-$ pairs :

$$N_{signal}^{\mu^+\mu^-} = N^{\mu^+\mu^-} - 2\left(\sqrt{N^{\mu^+\mu^+} N^{\mu^-\mu^-}}\right)_{field+} - 2\left(\sqrt{N^{\mu^+\mu^+} N^{\mu^-\mu^-}}\right)_{field-}$$

- Signal mass spectrum:



4 components : ϕ, ρ, ω and continuum(Dalitz decay, semi leptonic decay of $D\overline{D}$, “Drell-Yan”,...)

<u>in resonance region:</u>

signal/$N^{\mu+\mu-}$ = 27 %

mass resolution ≈ 70 MeV/c^2 $\rightarrow \rho$ and ω no separable

- 9 transverse energy bins E_T ($\rightarrow$ centrality, N_{part})
- 5 transverse mass bins M_T

Simulation

Generation functions: for each component and $\neq$ variables

- mass distributions:

  ϕ and ω: Breit-Wigner shapes

  ρ: $\sigma(M)\times$"BW(M)" (as HELIOS/3 experiment)

  $\sigma(M)$ related to a non resonant background behavior under ρ

  continuum: $\frac{1}{M^{\alpha}}\exp(-M/\beta)$

- M_T distribution: $M_T^2 K_1(M_T/T)$ (Hagedorn)
- Rapidity distribution: $\exp(-y^2/2\sigma_y^2)$

generated events tracked through the set-up and reconstructed (same procedure as the exp. data)

$\rightarrow$ parameters of generation functions adjusted in order that reconstructed distributions reproduce exp. data

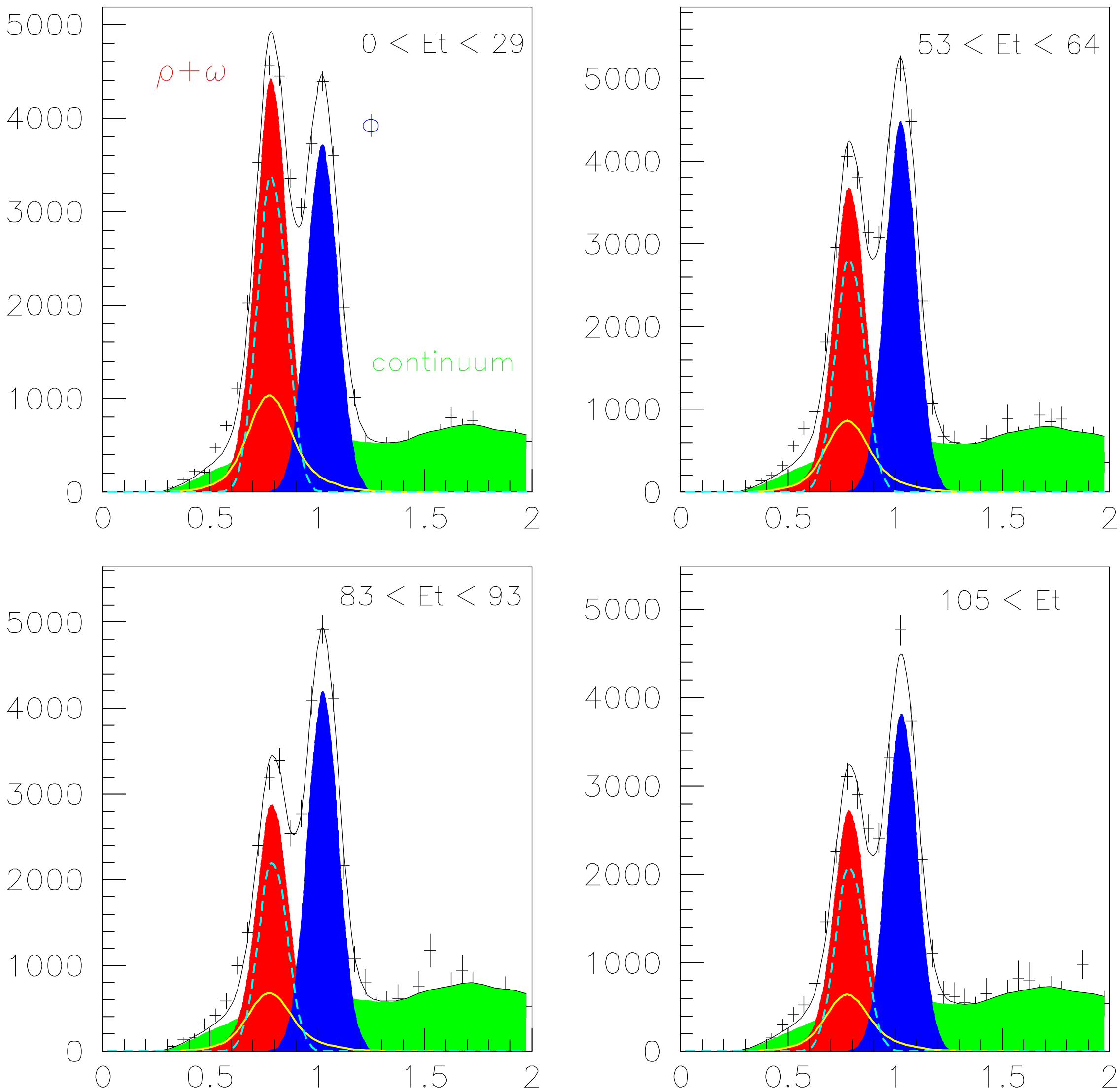
Mass spectra fits

$$\frac{dN}{dM_{\mu\mu}} = A_{\rho+\omega}\left[F_{\rho}(M_{\mu\mu}) + F_{\omega}(M_{\mu\mu})\right] + A_{\phi}F_{\phi}(M_{\mu\mu}) + A_{CNT}F_{CNT}(M_{\mu\mu})$$

5 free parameters: 3 amplitudes A and ϕ, ω mass positions

+ assumption $\sigma^{\rho}=\sigma^{\omega}$

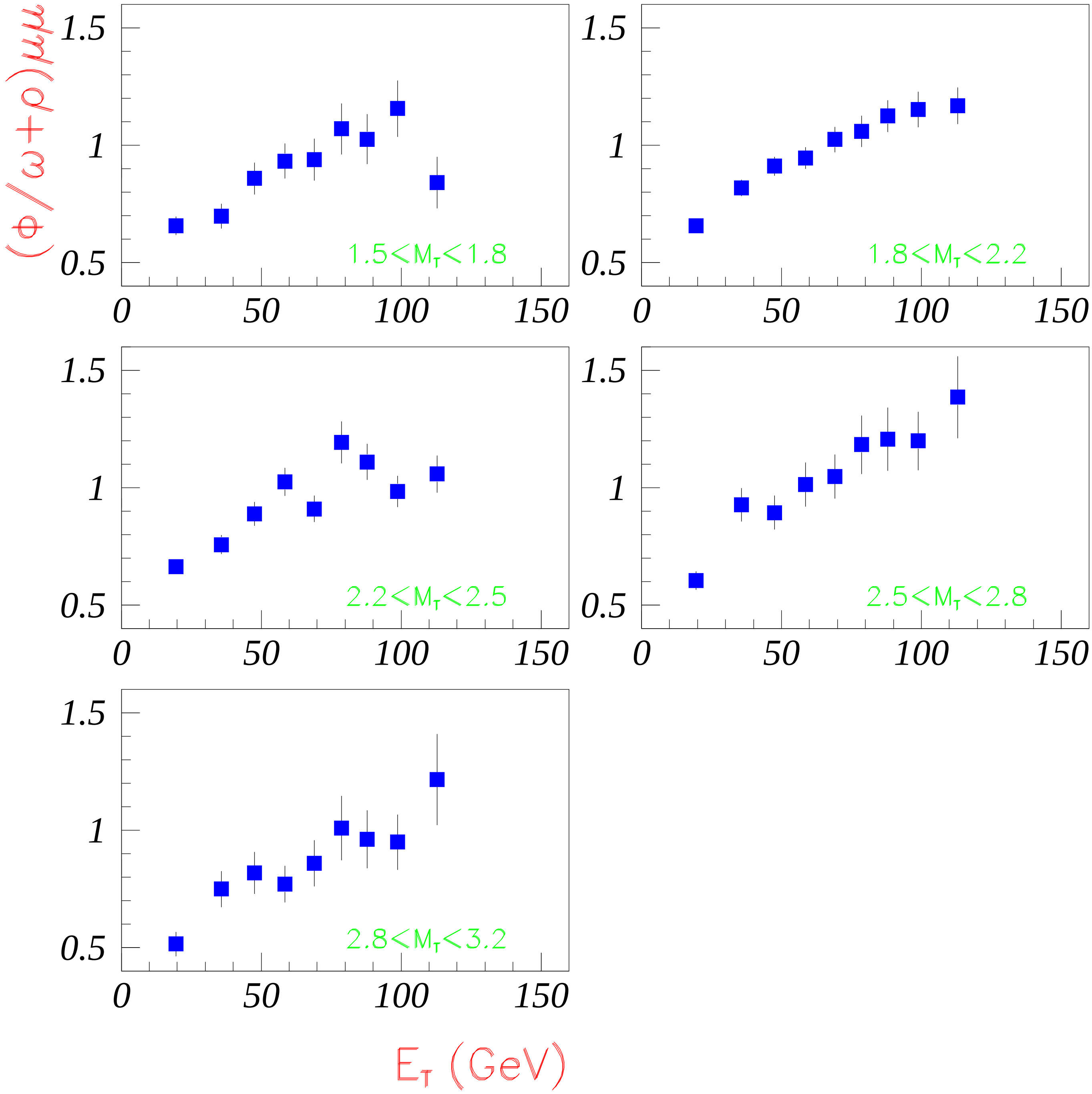
For $M_T \geq 1.5$ GeV/c^2:



→ ~ 130000 ϕ reconstructed (exp)

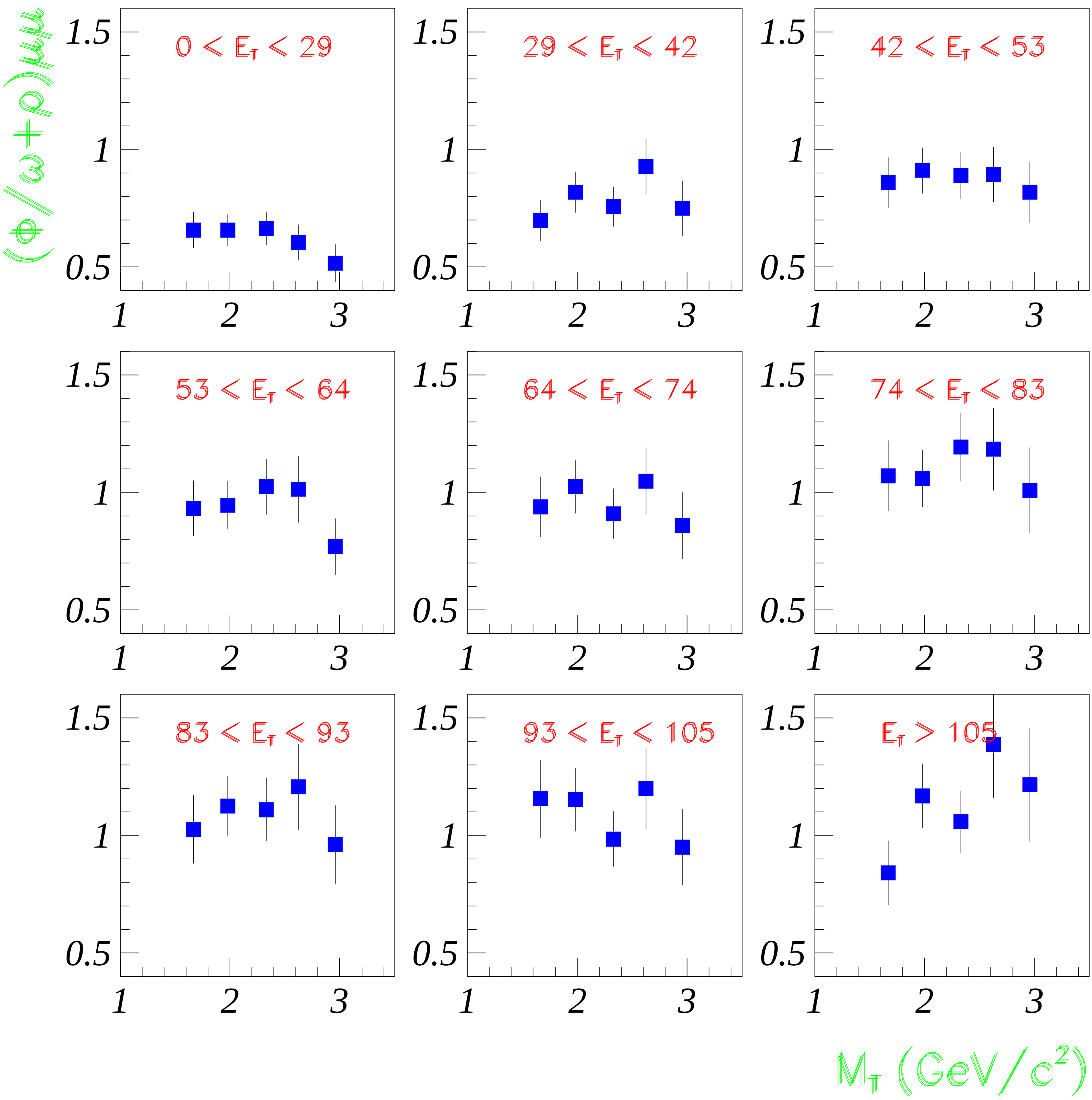
$(\phi/\rho+\omega)_{\mu\mu}$ versus centrality for $\neq M_T$ bins

$(\phi/\rho+\omega)_{\mu\mu} = N^{\phi}/N^{\rho+\omega}$ in $\mu^+\mu^-$ channel



$\rightarrow$ Increase of $(\phi/\rho+\omega)_{\mu\mu}$ as a function of centrality

$(\phi/\rho+\omega)_{\mu\mu}$ versus M_T for $\neq E_T$ bins

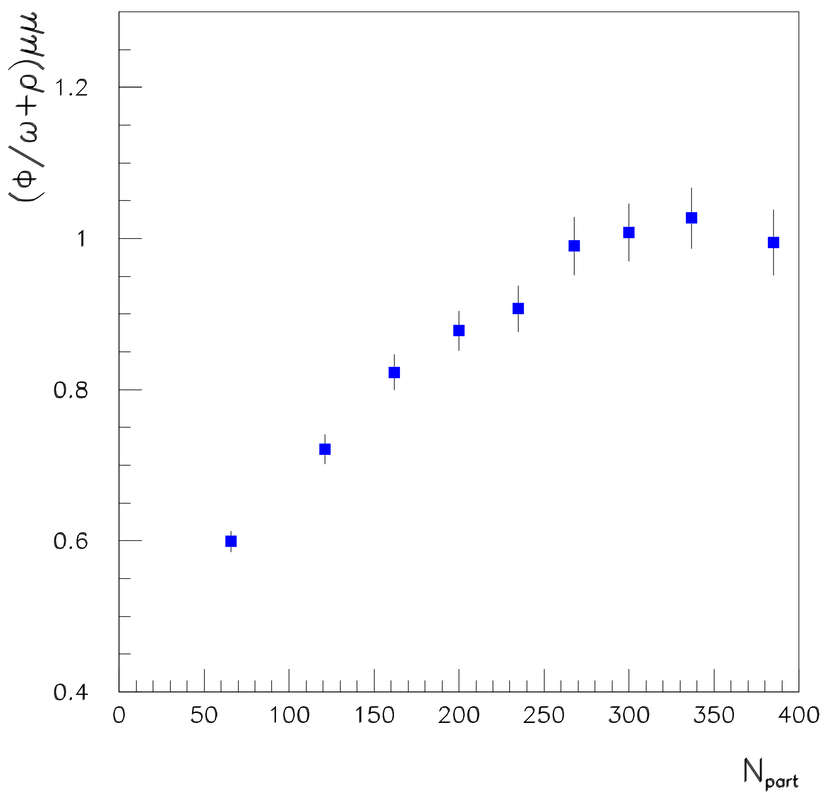


$\rightarrow$ ~ flat ratios

$\Rightarrow$ similar behavior in M_T for ϕ and $\rho+\omega$

$(\phi/\rho+\omega)_{\mu\mu}$ versus N_{part} for $M_T \geq 1.5$ GeV/c^2

N_{part} = number of participant nucleons in the collision



error bars: statistical error

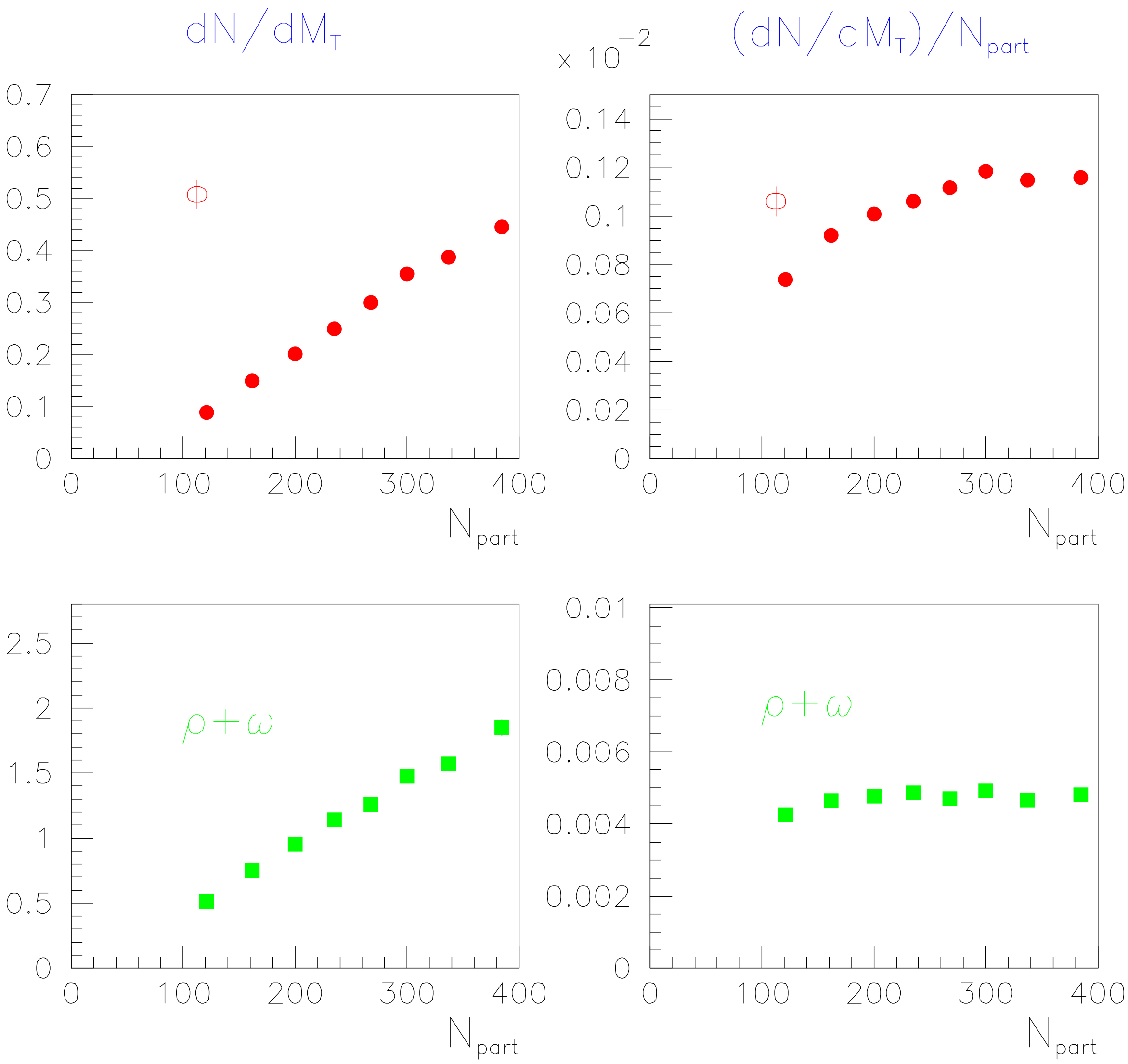
systematic error ≈ 9.5 %

→ smooth increase as a function of centrality

Multiplicities versus centrality

Multiplicity = number of produced particles per Pb-Pb collision

For $M_T \geq 1.5$ Gev/c^2:

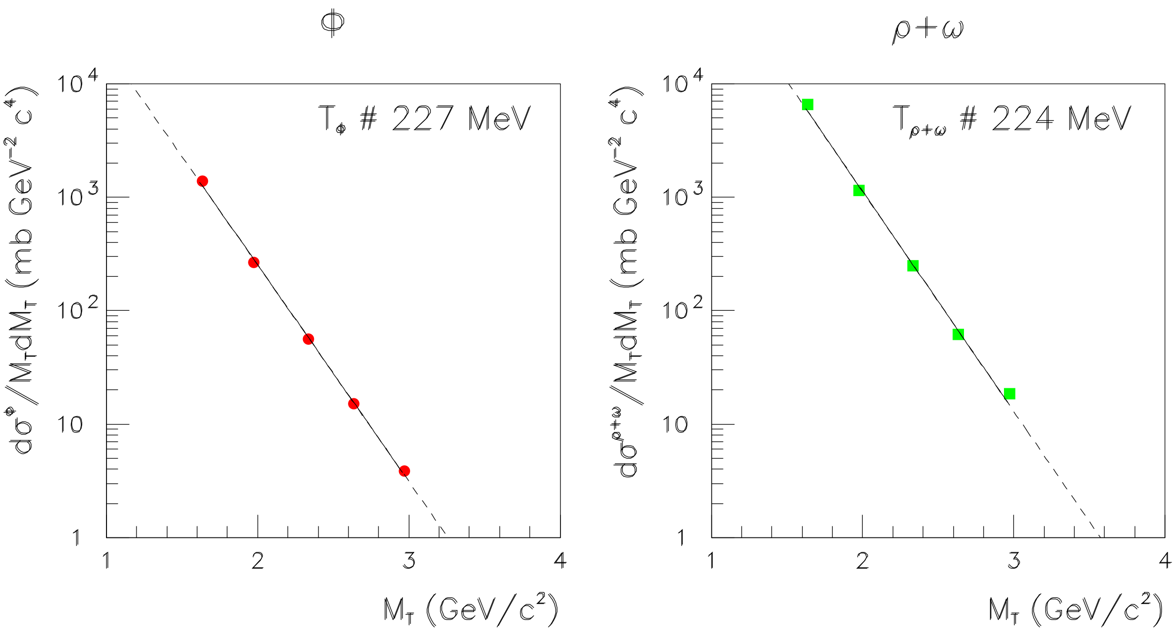


$\rightarrow$ Flat behavior of $\rho+\omega$ multiplicity/N_{part}

additional increase of ϕ multiplicity

Cross sections and effective temperatures

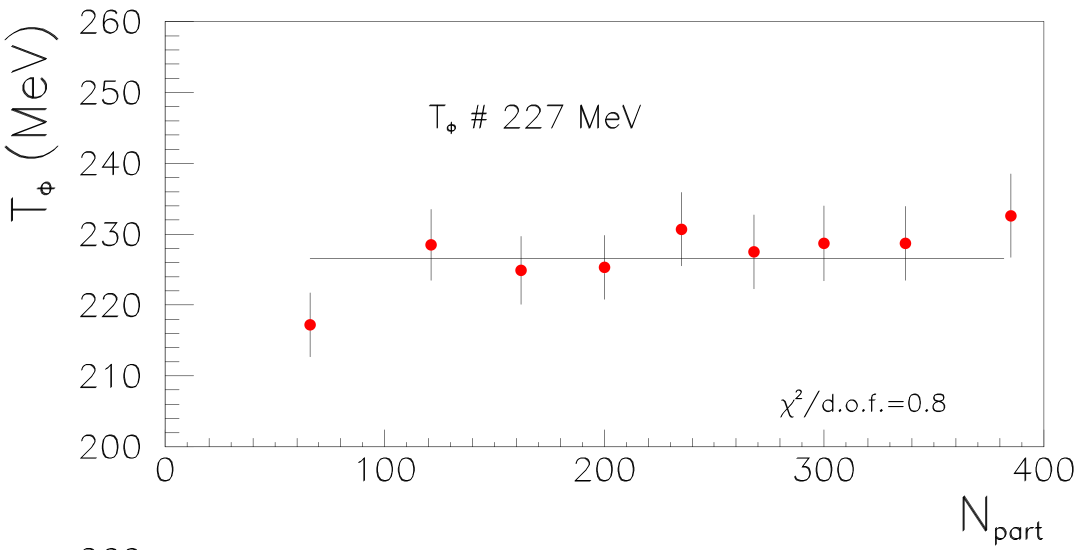
For all E_T:

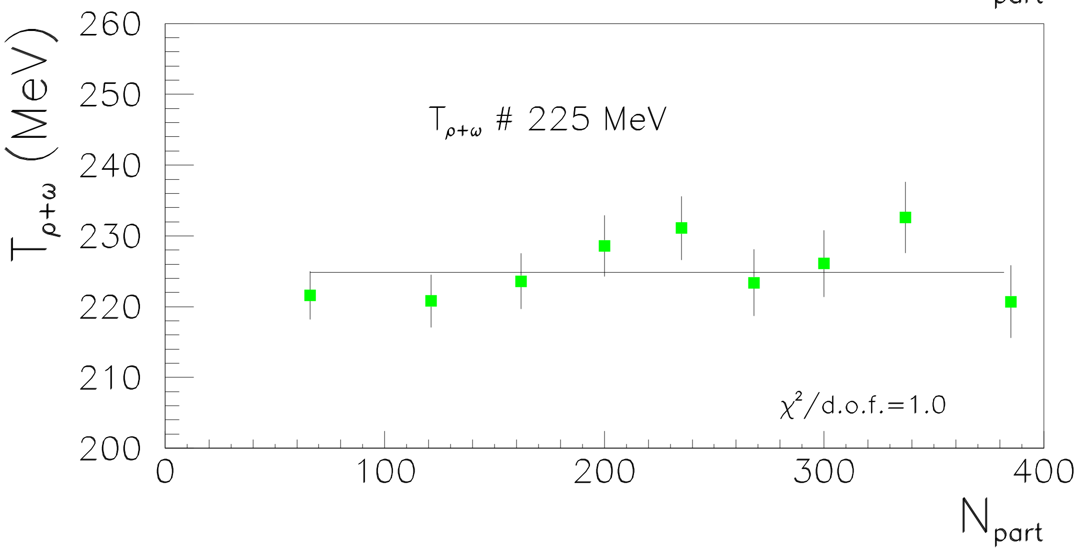


$d\sigma/dM_T$ fitted by $M_T.\exp(-M_T/T) \Rightarrow T$

$T_\phi = 227 \pm 10$ MeV and $T_{\rho+\omega} = 224 \pm 10$ MeV

Effective temperatures versus centrality





$\rightarrow T_\phi$ and $T_{\rho+\omega}$ constant with centrality

Conclusion

1) From $(\phi/\rho+\omega)_{\mu\mu}$:

increase of $(\phi/\rho+\omega)_{\mu\mu}$ with centrality in Pb-Pb system

2) From multiplicity studies:

linear behavior of $\rho+\omega$ production versus the number of participants (N_{part})

whereas a stronger increase versus N_{part} is observed for ϕ

3) From effective temperatures studies:

$T_{\phi} \approx 227$ MeV and $T_{\rho+\omega} \approx 224$ MeV