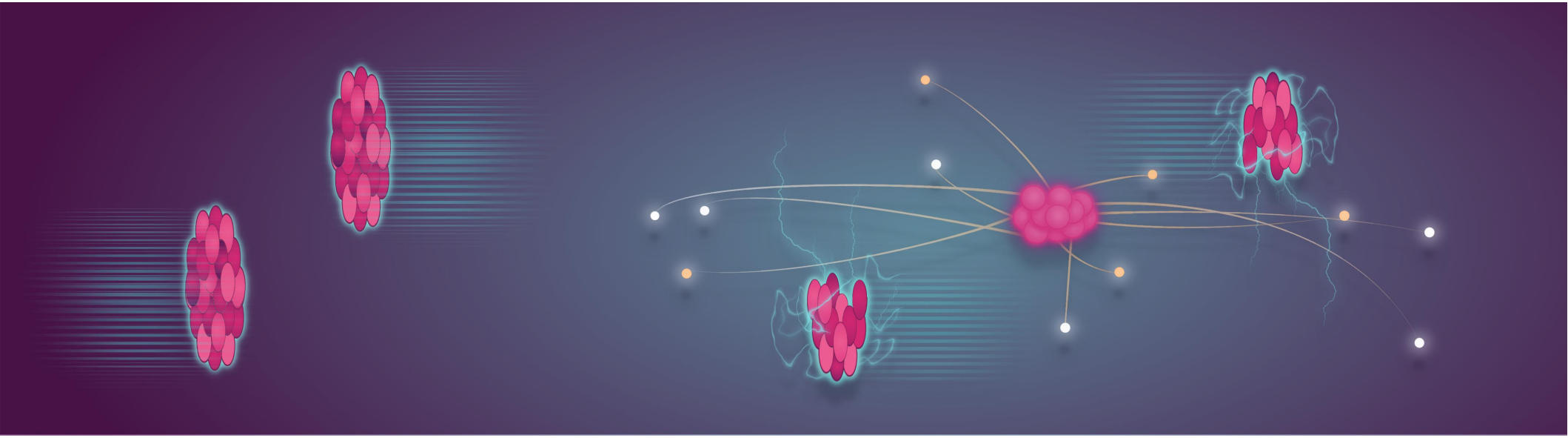
Iwona Sputowska

Spectator-induced EM effects on charged meson ratios in heavy ion collisions

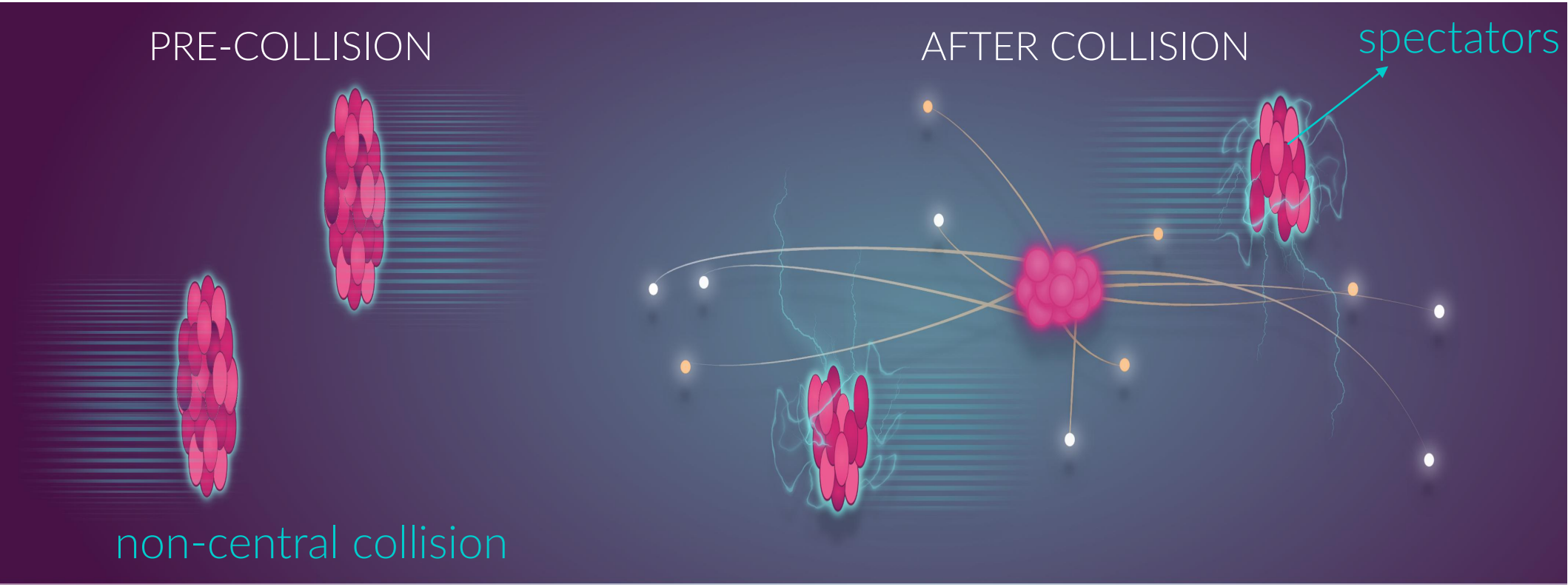


Outline

The aim of this talk: General introduction to spectator induced electromagnetic effects in context of:
→ new data from NA61/SHINE (M. Kiełbowicz talk);
→ role of the spectator system (K. Mazurek talk);

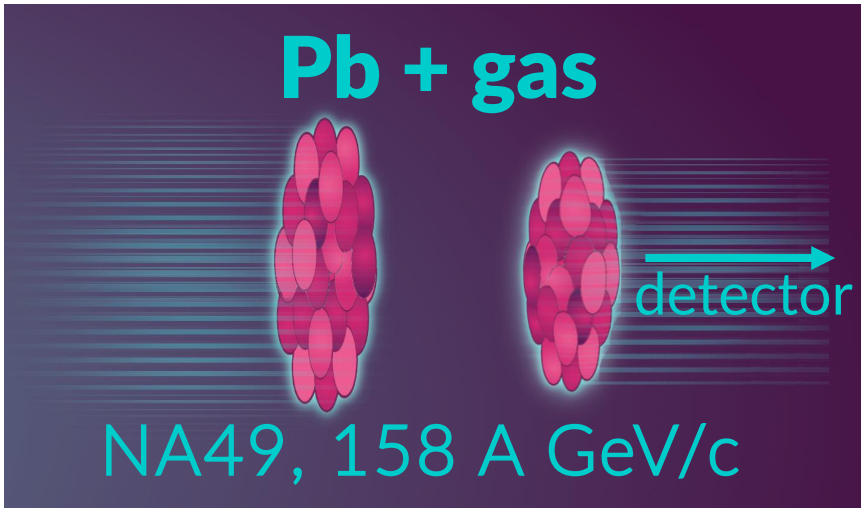
1. Introduction: Spectator induced electromagnetic effects;
2. EM effects in Pb+gas collisions;
3. Space-time evolution of the system;
4. EM effects & spectator system expansion;
5. Summary.

Introduction: spectator induced EM effects

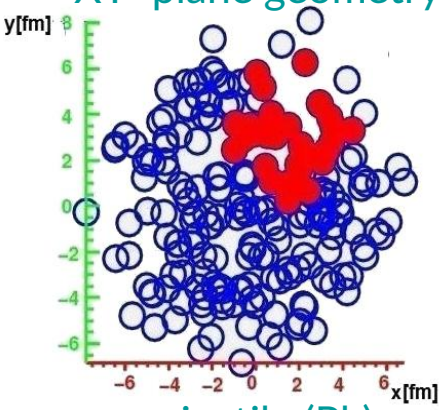


- Charged spectators in non-central collisions generate **electromagnetic fields.**
- We use them as a new source of information on the space-time evolution of the system… → see e.g. A. Rybicki WPCF 2015

EM effects in Pb+gas collisions



XY- plane geometry

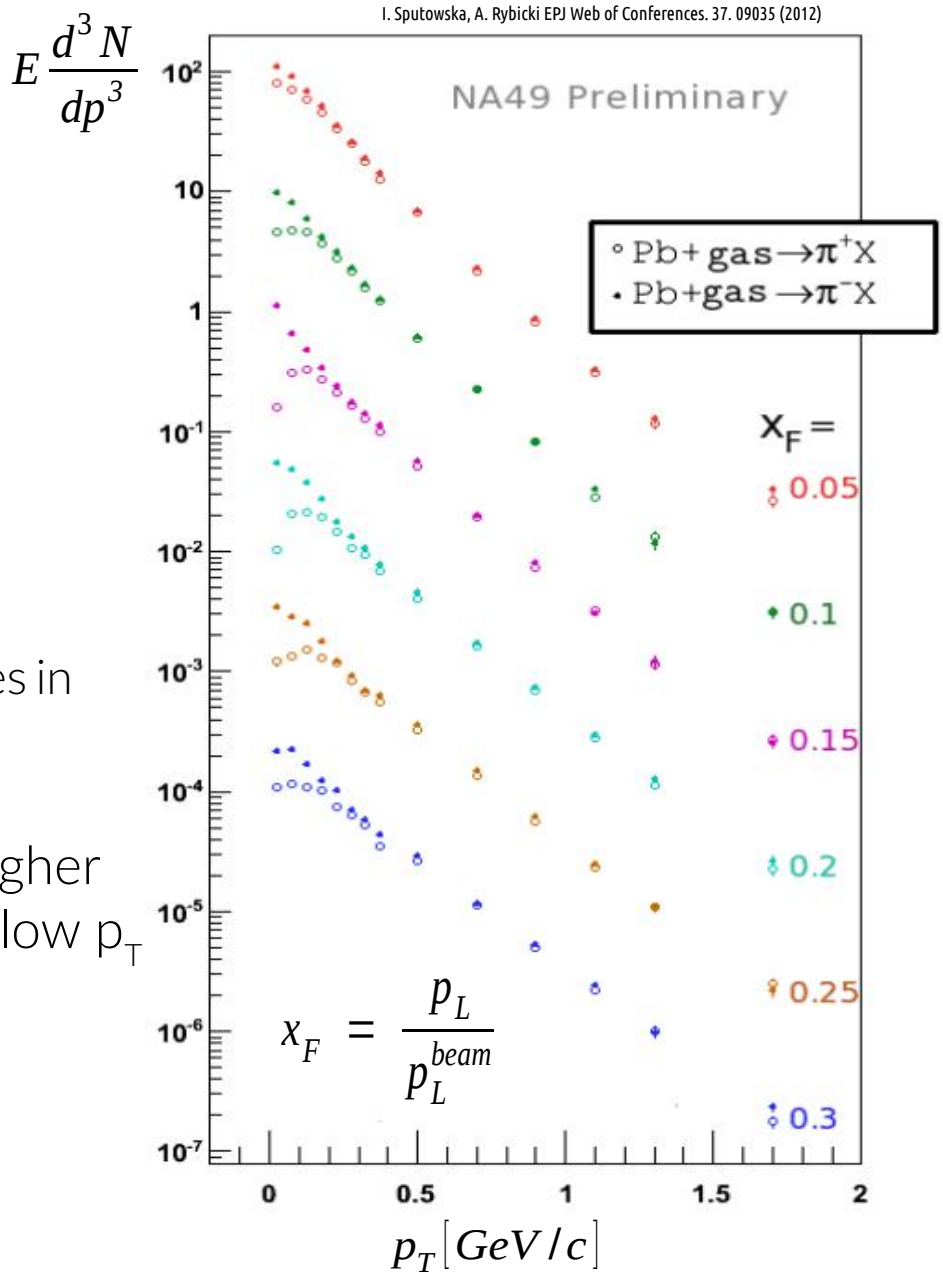


projectile (Pb)

1) Characteristic structures in pions spectra.

2) $\pi^+ < \pi^-$ observed for higher p_T and, dramatically, at low p_T

?



EM effects in Pb+gas collisions

π^+/π^- ratio

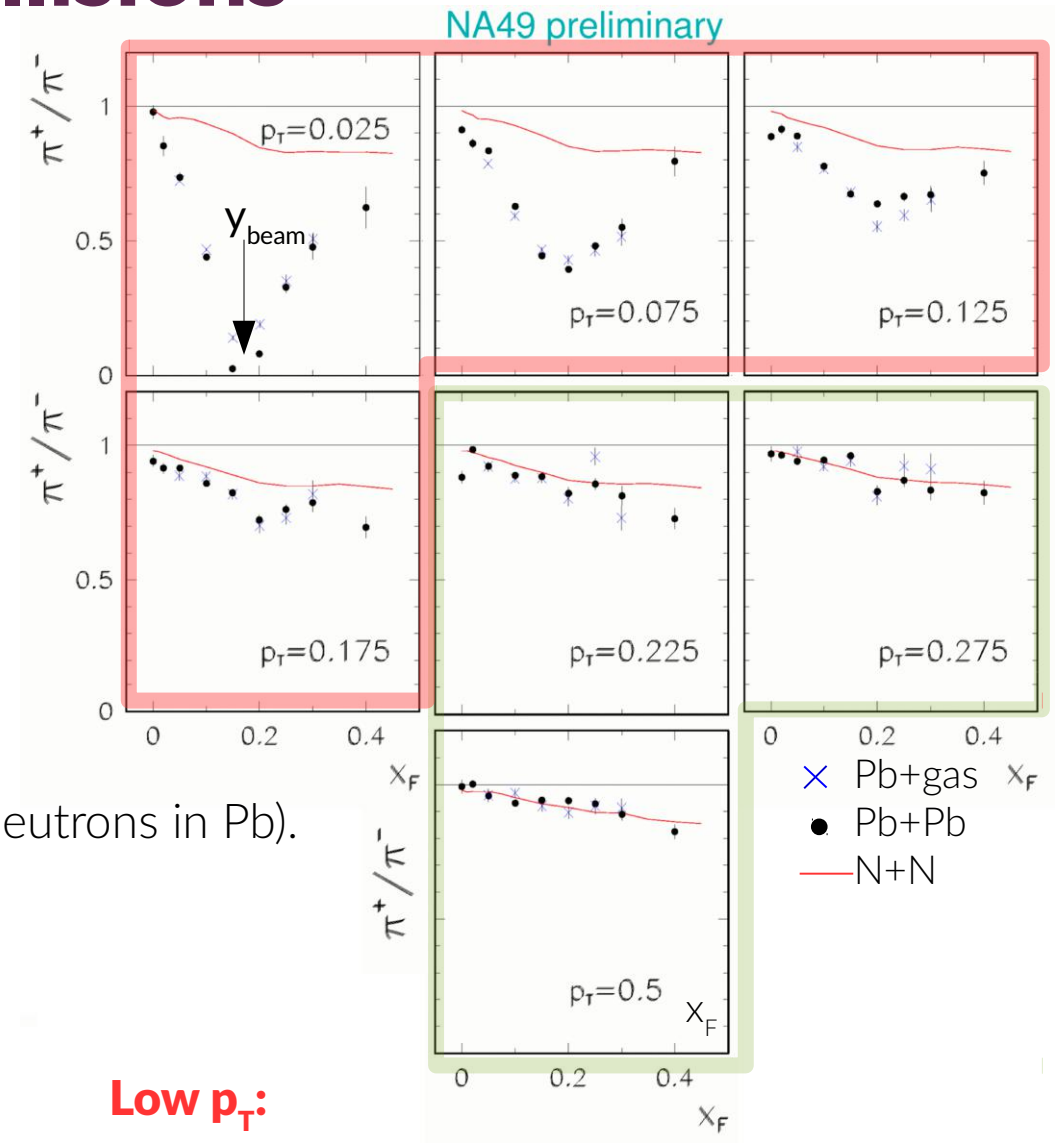
➞ Pb+gas are compared to Pb+Pb and to superposition of nucleon+nucleon (N+N) collisions

➞ Neutron fragmentation is obtained from p+p data:

$n \rightarrow \pi^+ = p \rightarrow \pi^-$

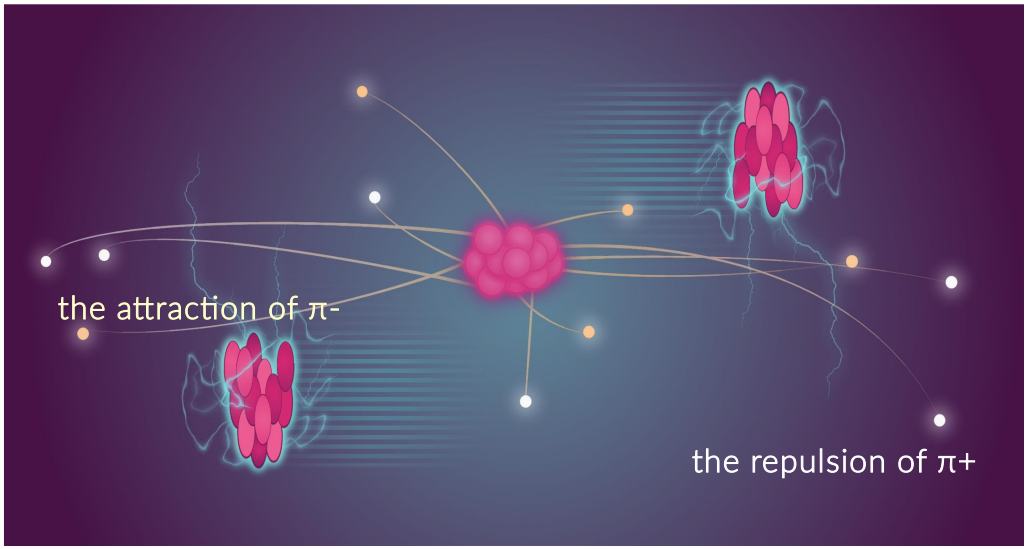
$n \rightarrow \pi^- = p \rightarrow \pi^+$

"**N+N**": 40% protons, 60% neutrons



Higher p_T :

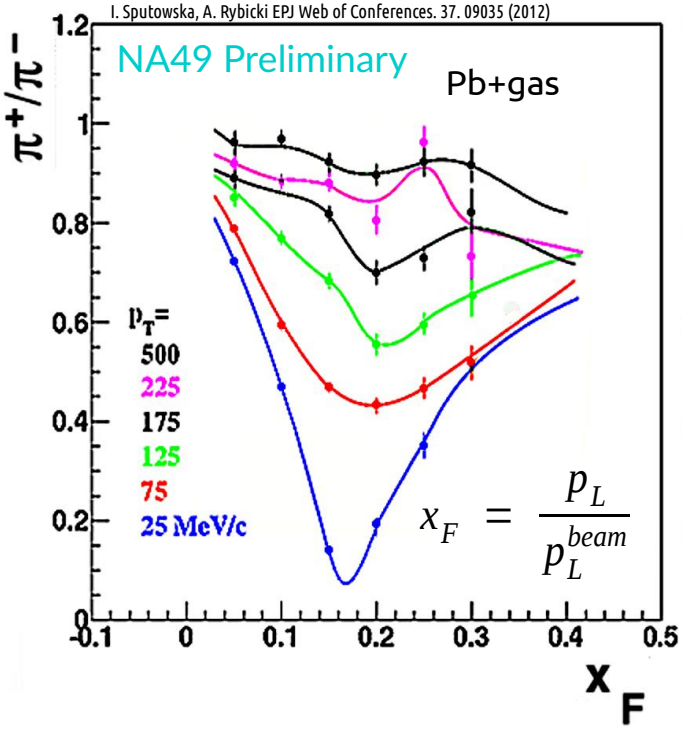
→ π^+/π^- <1 → result of the isospin effect (more neutrons in Pb).

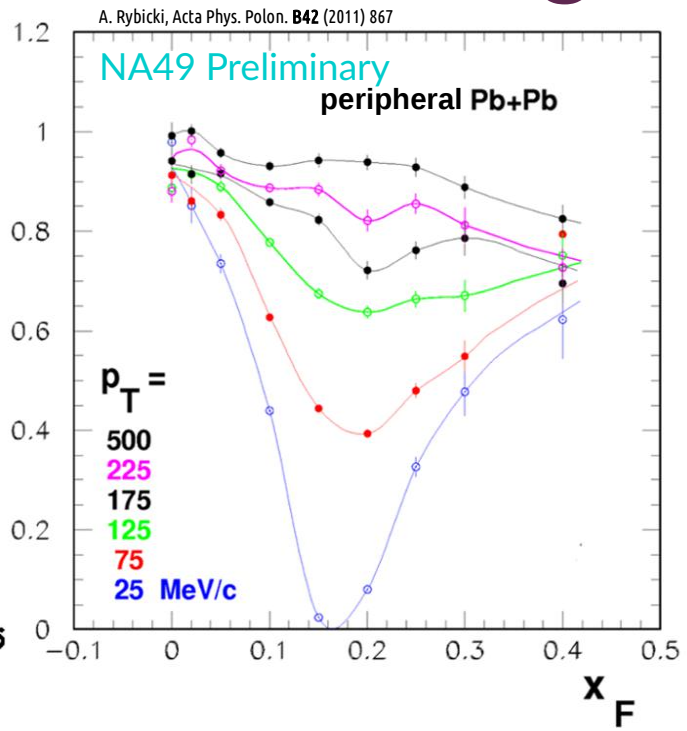


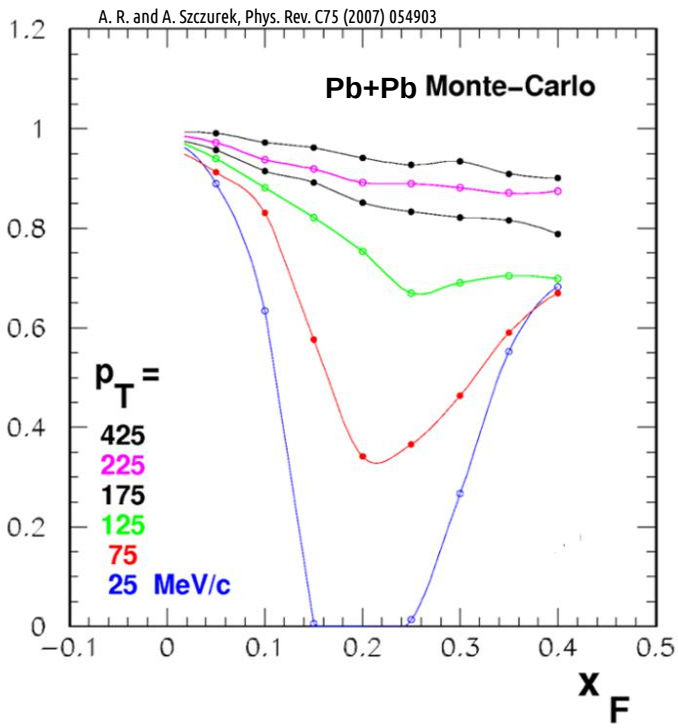
Low p_T:

← π^+/π^- <<1 → isospin effect is not enough to describe the data...

EM effects in Pb+gas collisions

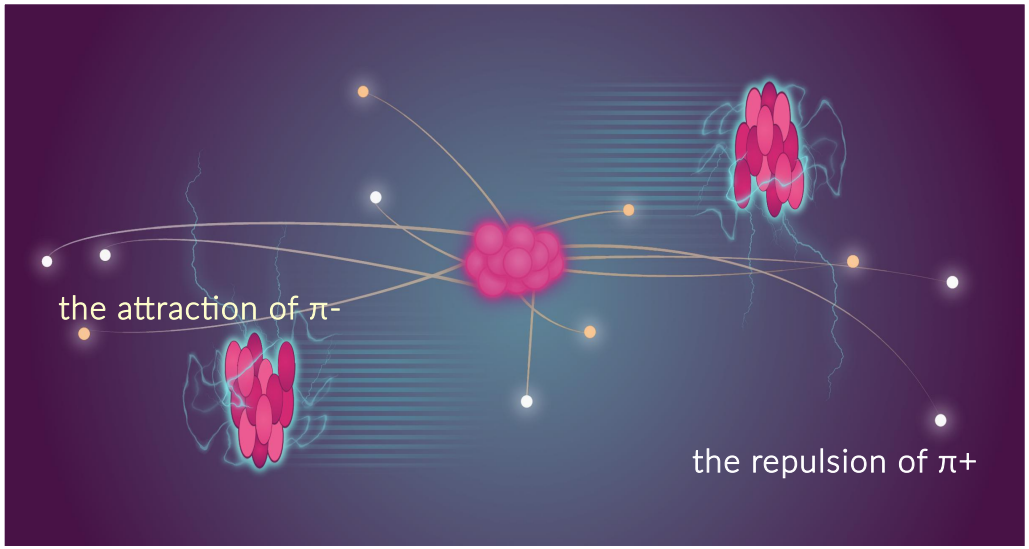


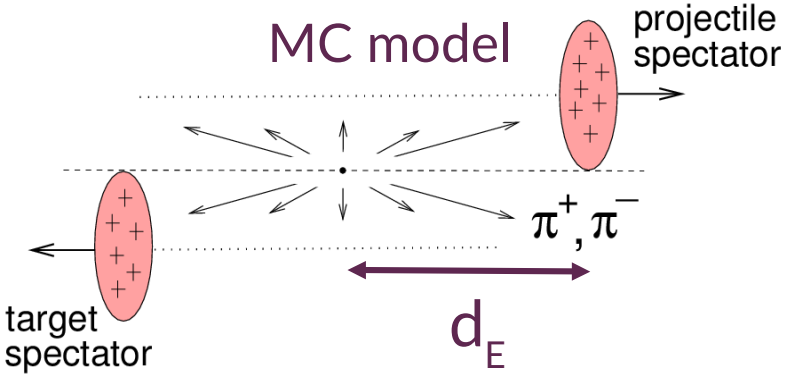




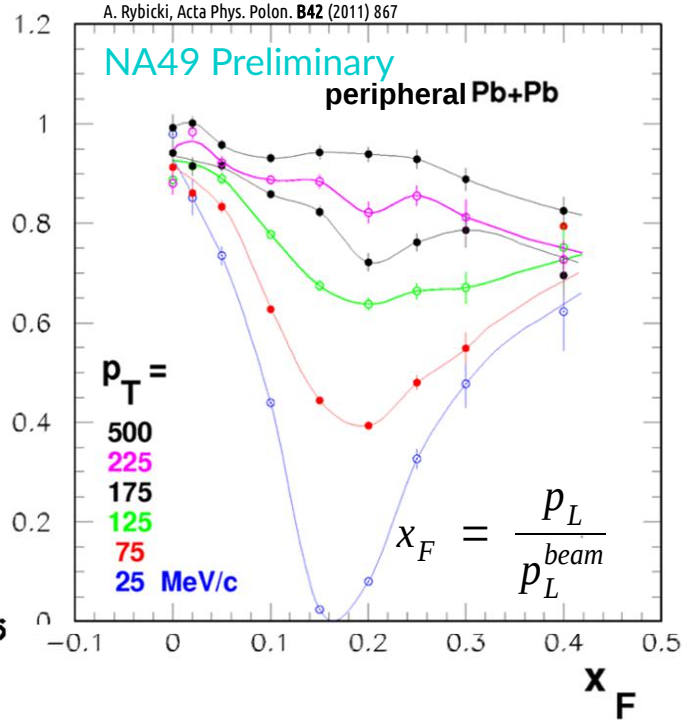
Characteristic dependence of π+/π- ratios on x_F and p_T

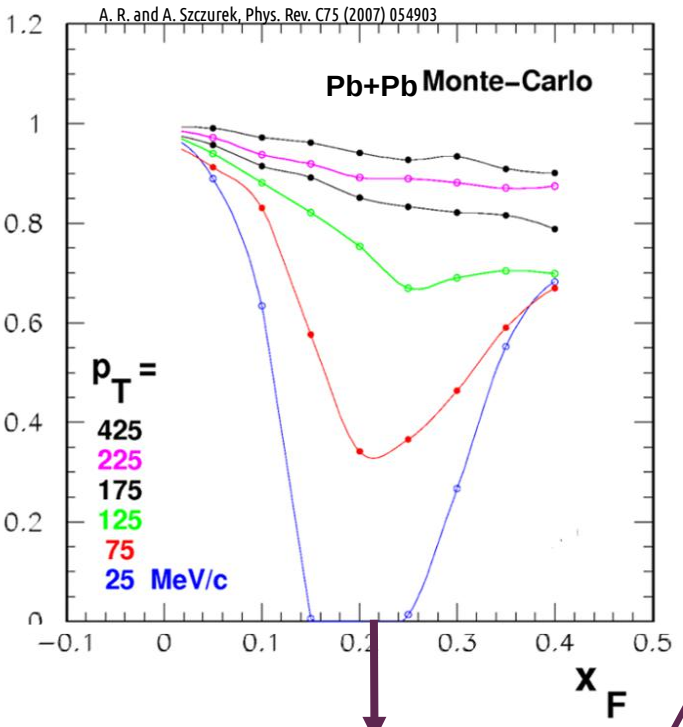
Decrease of π^+/π^- ratio at $x_F=0.15=m_\pi/m_p$

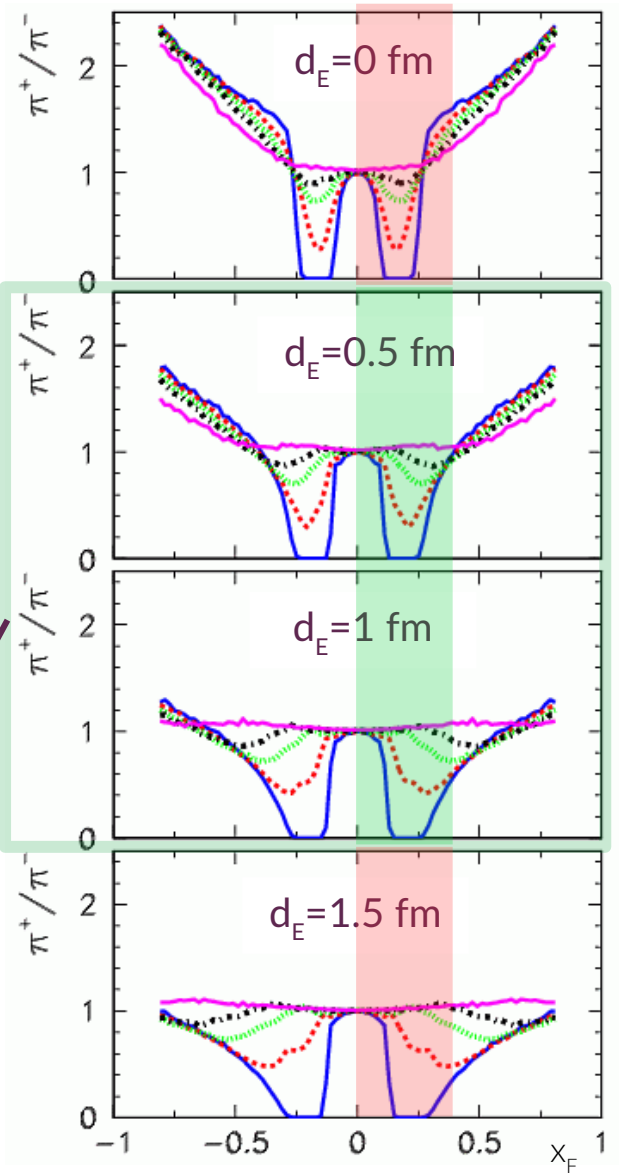




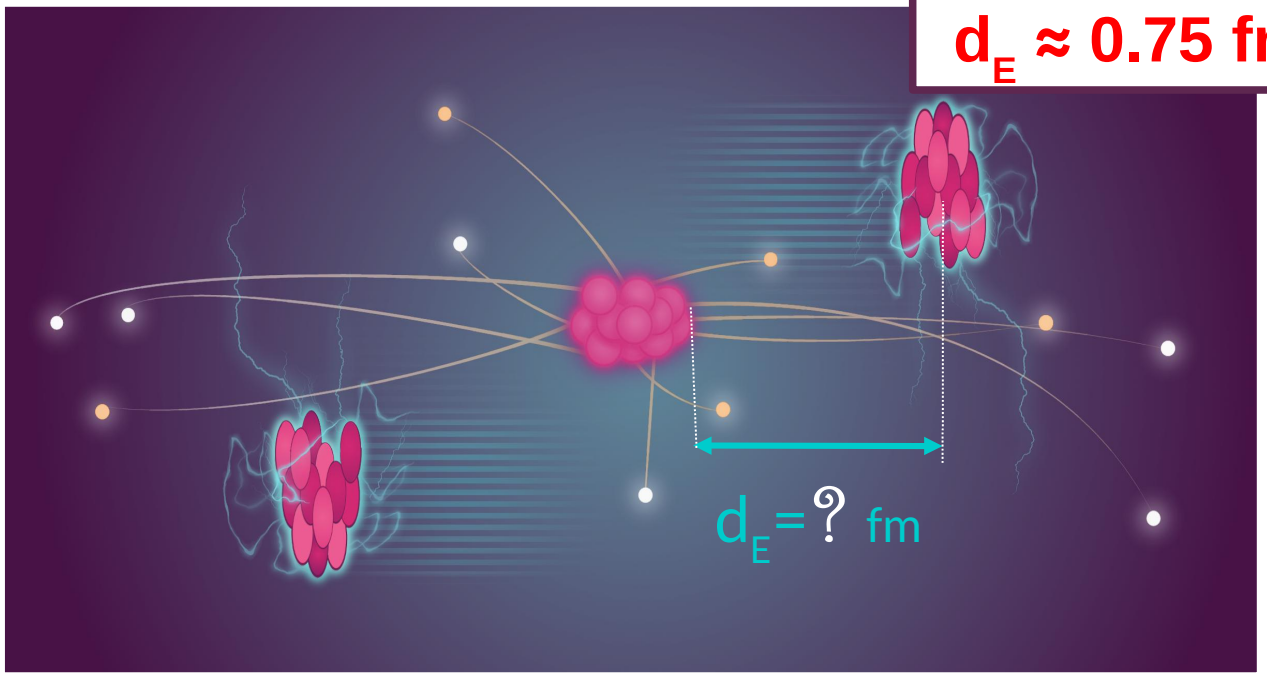
Space-time evolution of the system...







$d_E \approx 0.75$ fm !

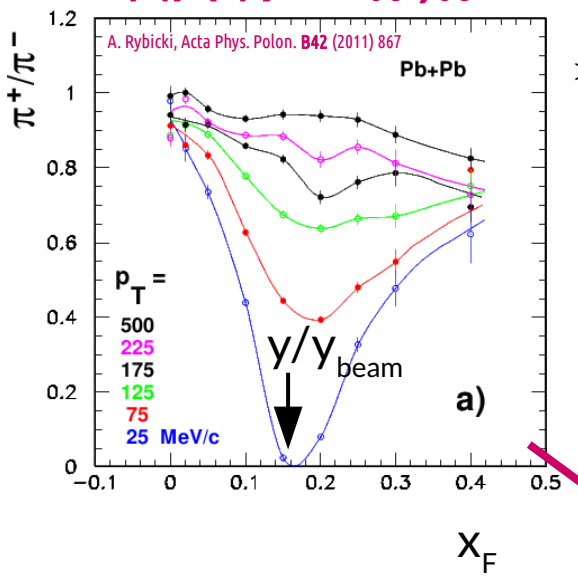


$d_E \rightarrow$ Information on the space-time evolution of particle production!

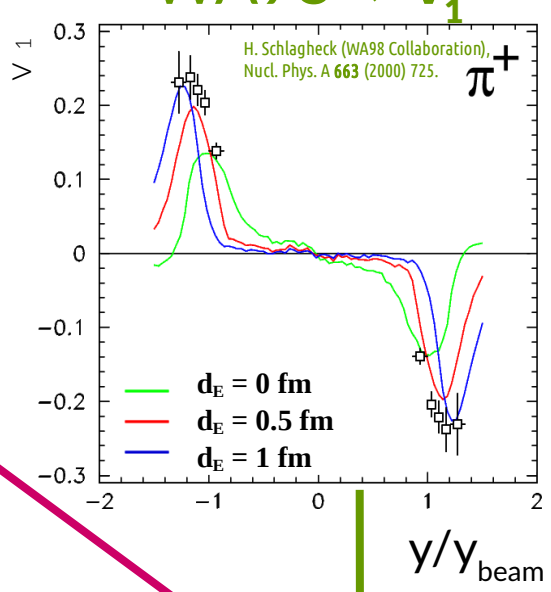
Space-time evolution of the system...

Input data:

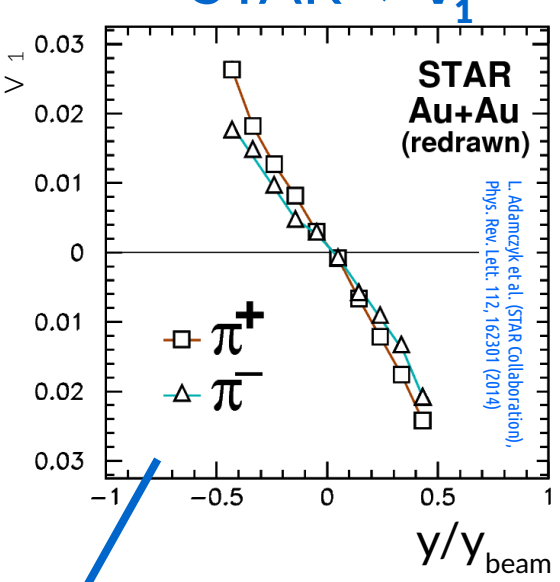
NA49→ π^+/π^-



WA98→ v_1

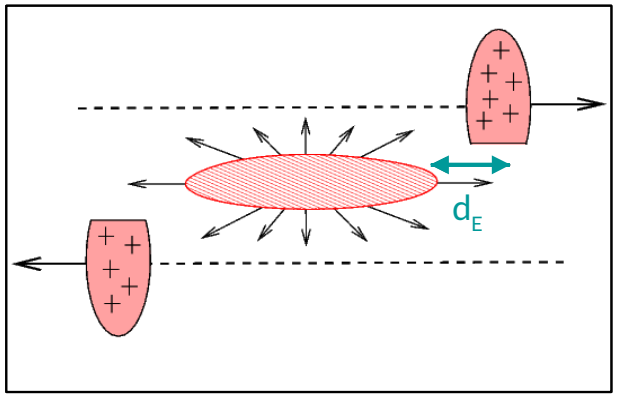


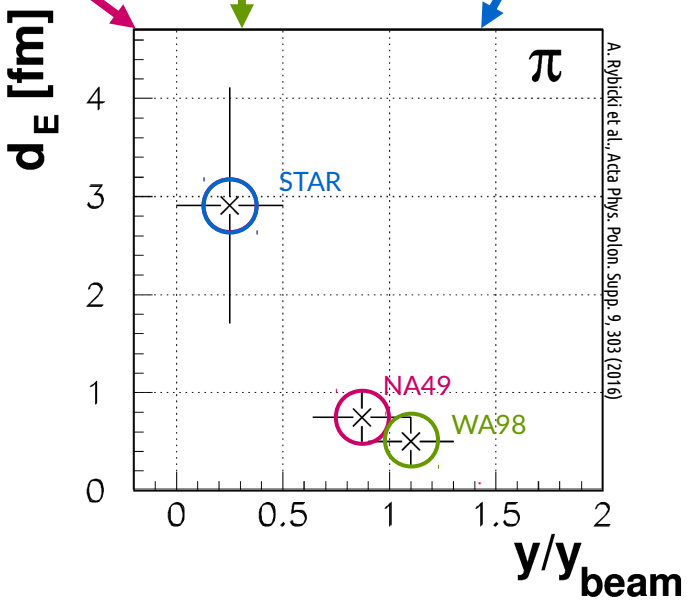
STAR→ v_1



Directed flow:
$v_1 = \langle \cos(\phi - \Psi_{RP}) \rangle$

Output:

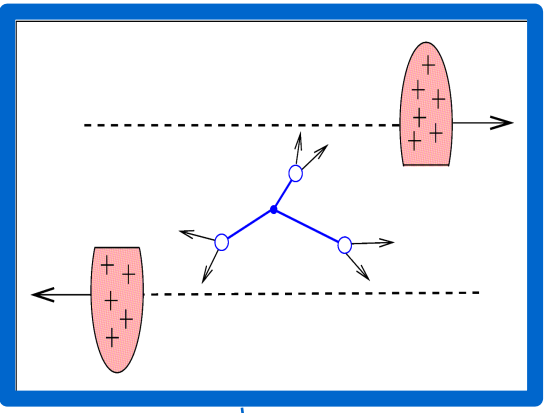




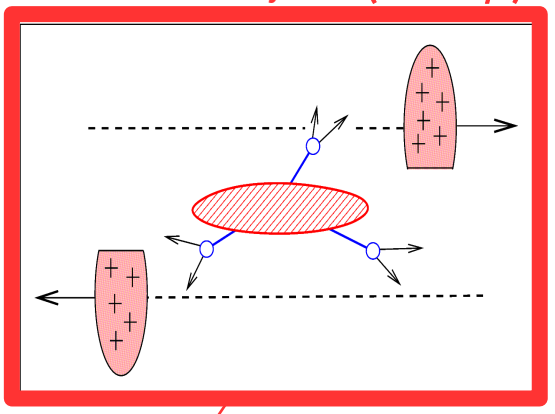
Space-time evolution of the system...

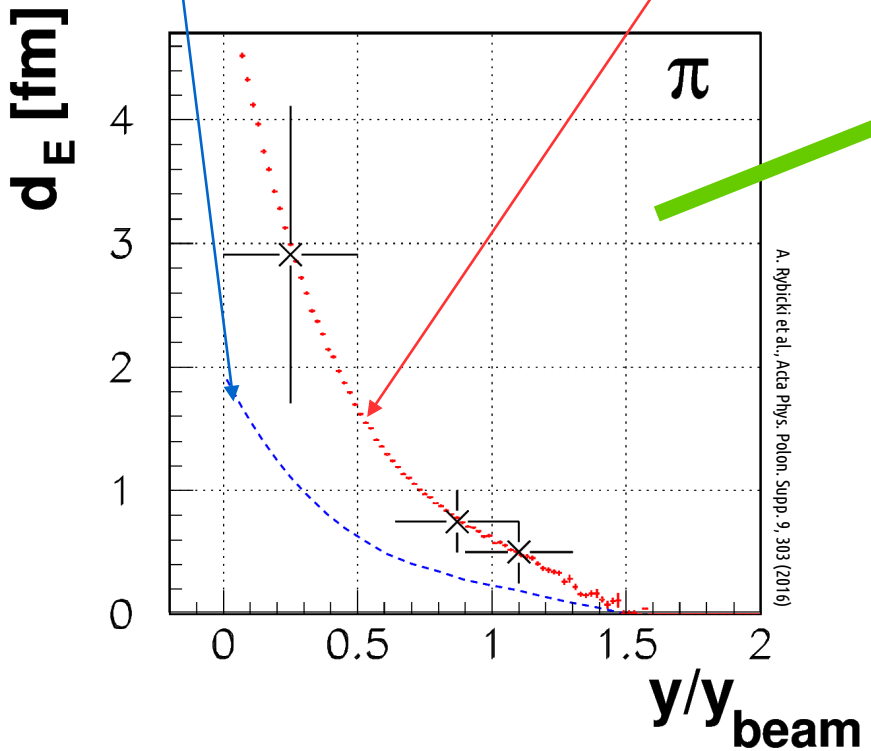
A. Rybicki WPCF 2015

Resonances produced instantly at the moment of the collision (τ = 0 fm/c)

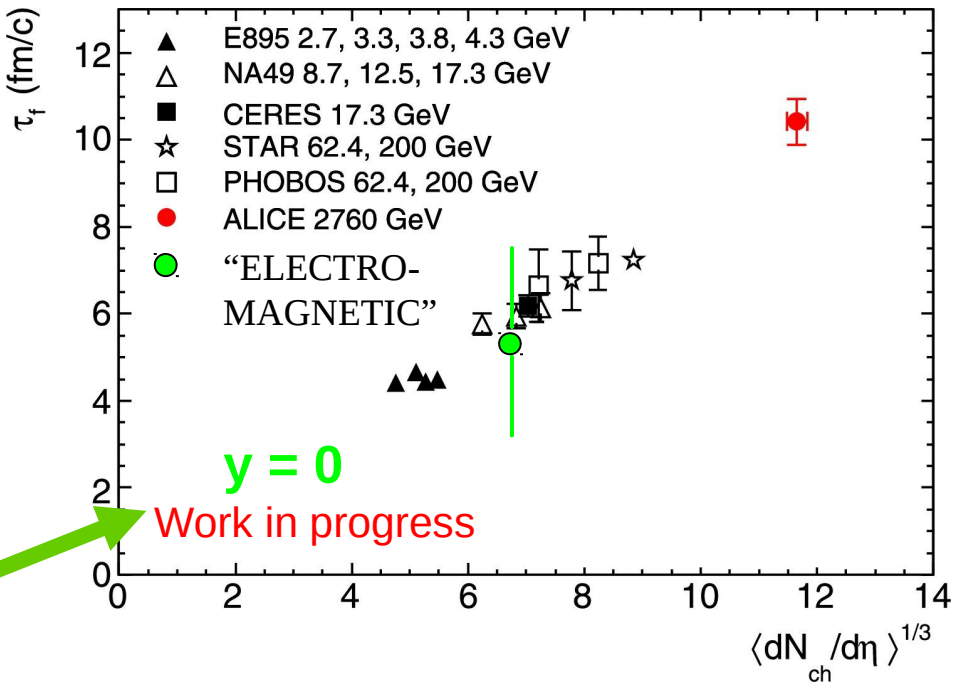


Resonances produced from an intermediate system (τ >0 fm/c)





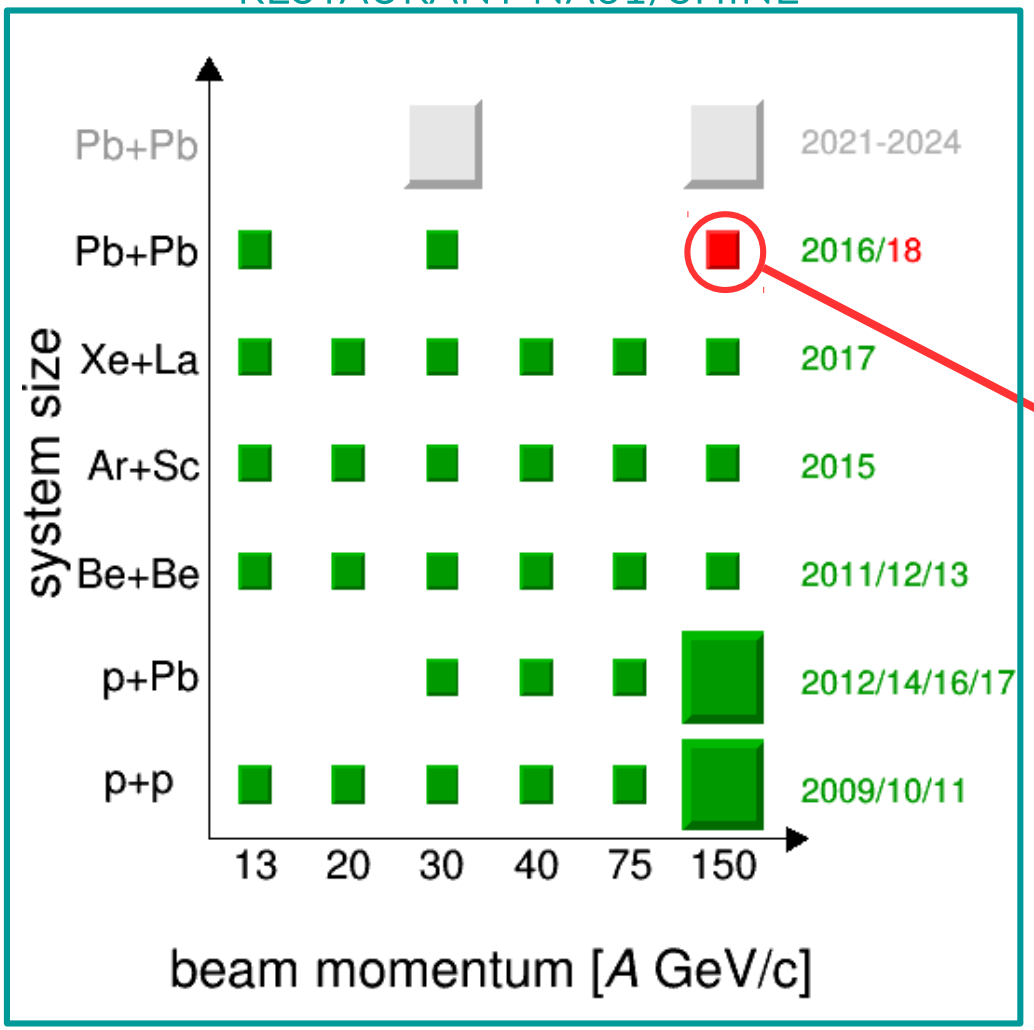
Original plot from:
K. Aamodt et al. (ALICE Collab.),Phys. Lett. B **696**(2011) 328



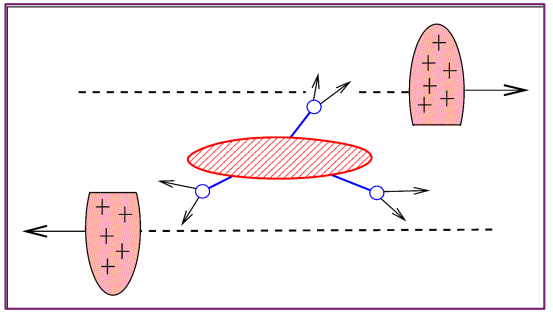
The spectator-induced EM effects → provide information about space-time evolution of the system created in heavy ion collisions→ comparable to HBT - **"a new femtoscopy ?"**

Space-time evolution of the system...

REACTION MENU
RESTAURANT NA61/SHINE



...further studies...



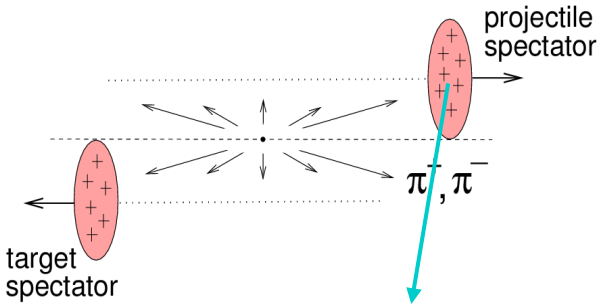
A. Rybicki & A. Szczurek say:
The spectator-induced EM effects → "new femtoscopy?"

Some results have been obtained so far...(from NA49)

...but what will happen when we go once we go to other systems?

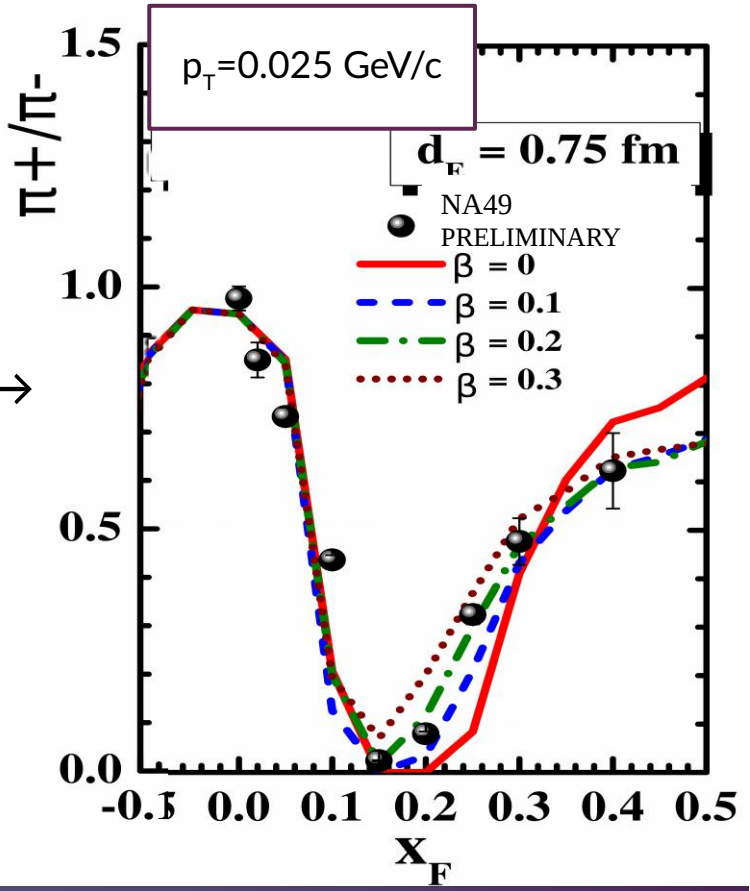
Predictions may fail → up till now they "forgot" **the evolution of the spectator system itself!**

EM effects & spectator systems expansion



radial expansion of the spectator system with a given surface velocity
β=0, 0.1, 0.2, 0.3

- EM effects are sensitive to spectator evolution (in space and time);
  - d_E=0.75 fm, β=0.2 optimally describes the data.
  - original conclusion of A. Rybicki and A. Szczurek about d_E=0.75 fm appears OK.
- A. Rybicki and A. Szczurek were very lucky…
- … it will go wrong for Ar+Sc (→ see M. Kiełbowicz talk)



Simulations by
Vitalii Ozvenchuk

Summary

The presence of EM fields in the heavy ion collision results in charge-dependent effects on various observables.

These effects are sensitive to the distance d_E between the pion emission site and the spectator(s).

They can be used as a new source of information on the longitudinal space-time evolution of the system. ("New femtoscopy?"😱)

There is sensitivity to the space-time evolution of the spectator system which has to be taken into account → next talks: M. Kiełbowicz, K. Mazurek

Thank you!

Acknowledgments.

This work was supported by the National Science Centre, Poland (grants no. 2011/03/B/ST2/02634 and 2014/14/E/ST2/00018).