

Comments of the centrality determination in high energy nucleus-nucleus collisions (motivated by the JINR FT and collider programs)

- The goal and definitions
- ● The current solution (NA61)
- ● ● Problems to be solved for future
collider and low energy FT experiments



The goal and definitions

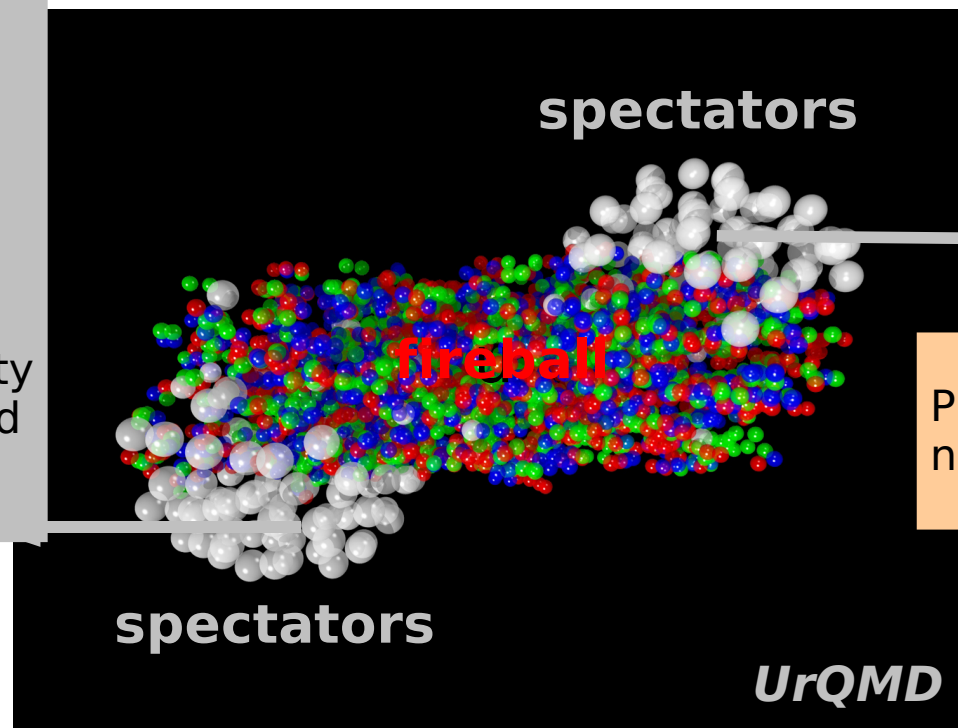
The goal: fix extensive (B, Q, E ...) parameters of the created fireball without biasing its properties

In principle, the goal can be reached using conservation laws (baryon number, charge, energy) provided a clear separation between fireball /non-fireball particles (spectators) is possible and spectator properties can be measured event-by-event, e.g.

$$B(\text{fireball}) = B(\text{total}) - B(\text{spectators})$$

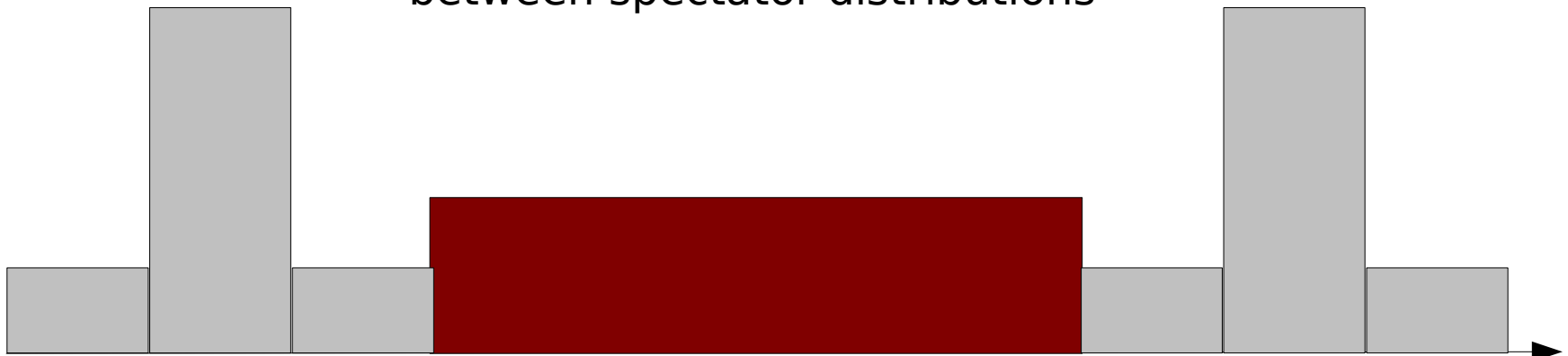
Spectators (model):
nucleons which did not
interact or interacted
elastically

Spectators (experiment):
nucleons shifted in rapidity
by less than 0.5 + forward
going fragments

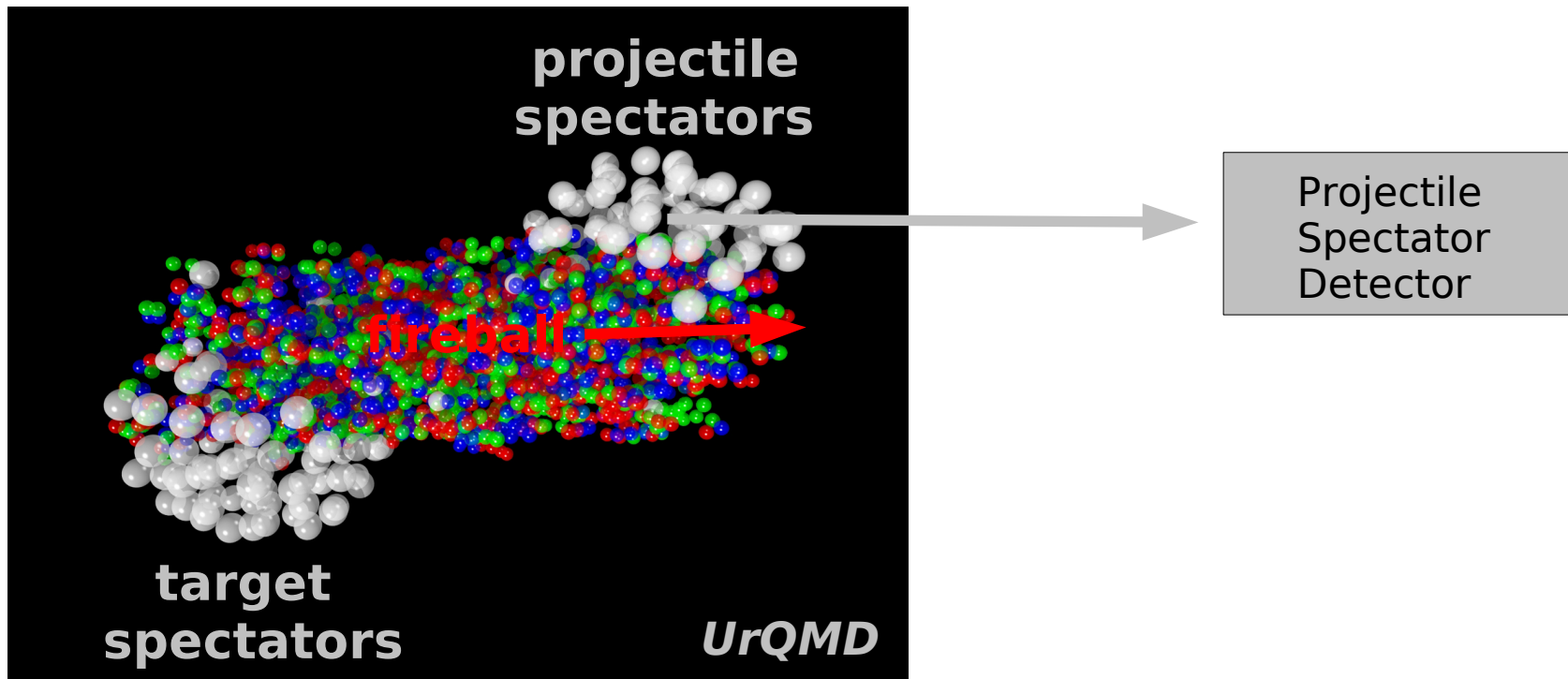


Participants:
non-spectators

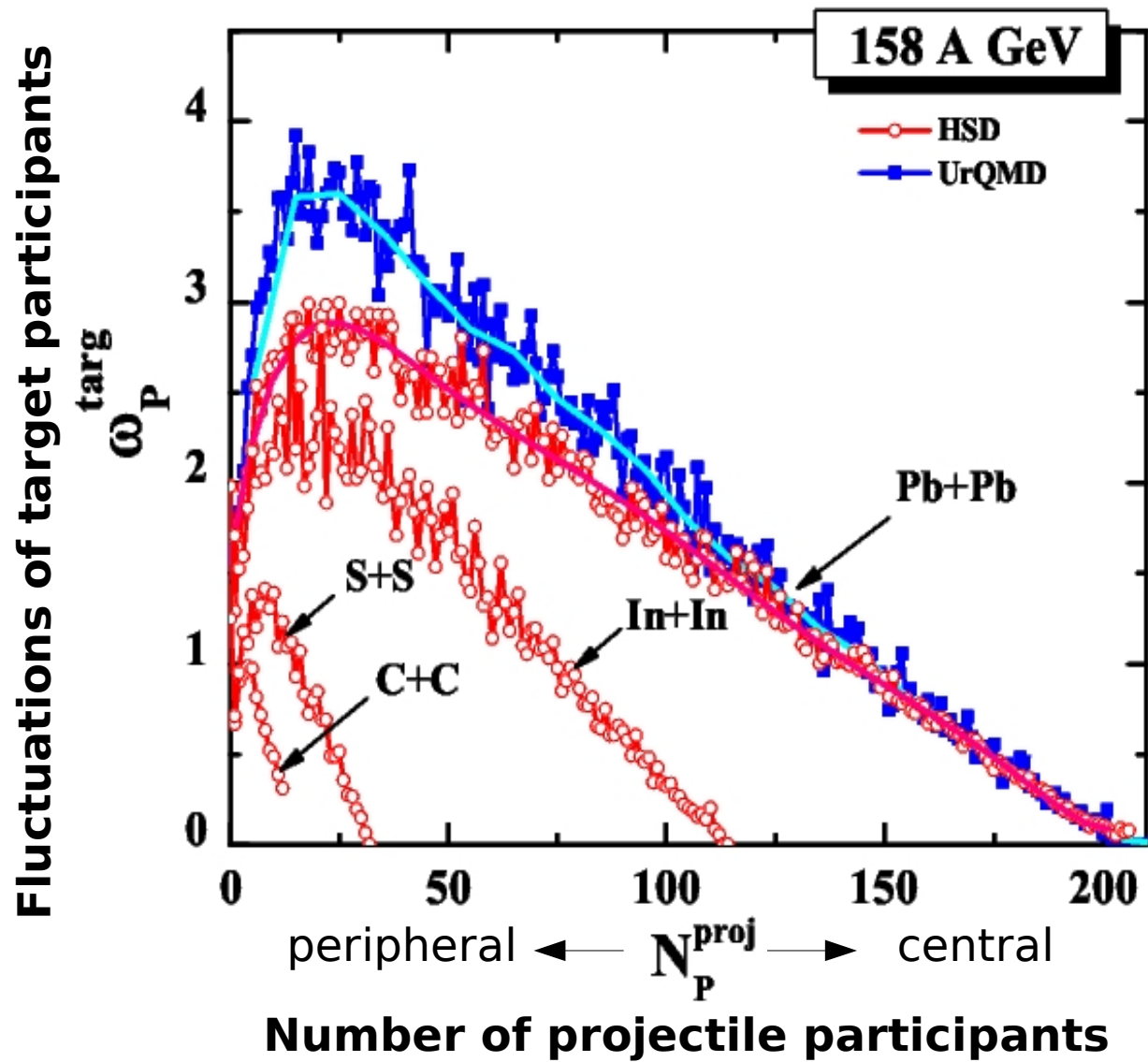
Separation between spectators and
participants is possible only at high
energies, where there is a sufficient gap
between spectator distributions



The current solution (NA61)
Fixed target experiment at high energy



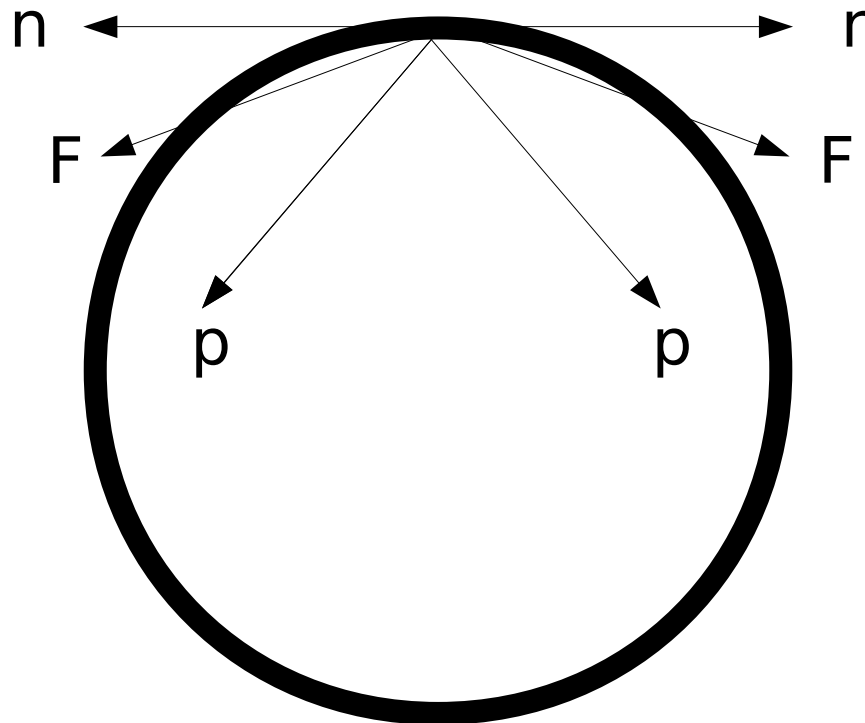
Energy of projectile spectators is measured by PSD,
energy of target spectators is not measured (absorption
in the target material),
**but for zero projectile spectators,
the number of target spectators is close to zero.**



Problems to be solved for future collider and low energy FT experiments

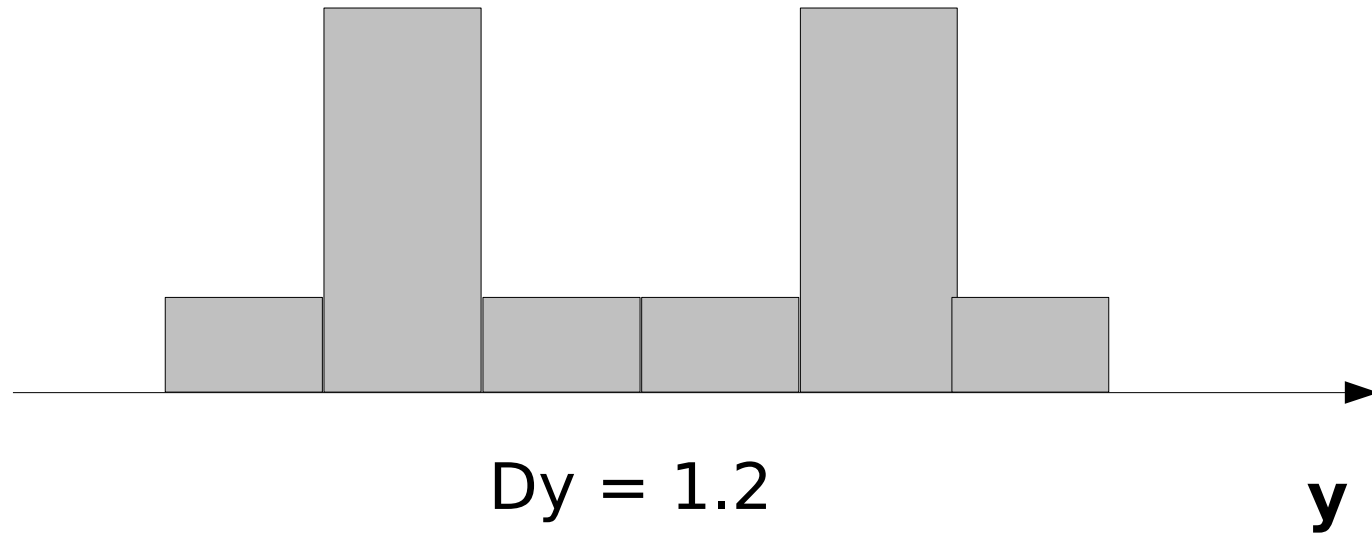
Collider (NICA, RHIC, LHC) problem:

-spectator neutrons and protons separate from the ion beams, whereas spectator fragments ($A > 1$) approximately follow ion beams. They are difficult (impossible?) to measure



● ● **Low energy (NICA, FT at JINR) problem:**

-spectator and participant nucleons are not well separated/defined



$p(\text{LAB}) = 1.5 \text{ GeV}/c$

Possible solution of both problems:

-measure $Z/A = 0.5$ spectator fragments (d+...),
in addition to spectator neutrons and protons:

-help for low energy problem:

d+... -> better/good separation of spectators
and participants,

-help for collider problem:

d+... have significantly smaller (by 20%) rigidity (p/Z)
than heavy (Pb) ion beam -> and thus can be measured

**Detailed simulations needed using a MC code which
properly describes the fragmentation process
(e.g. SHIELD from the INR Moscow)**