

Forward Neutron Production in Fragmentation of High-Energy Heavy Nuclei

Vladimir Yurevich

Joint Institute for Nuclear Research, Dubna

Neutron production in high-energy reactions with heavy nuclei

p + Pb, C + Pb

Decay of nuclear system and neutron emission

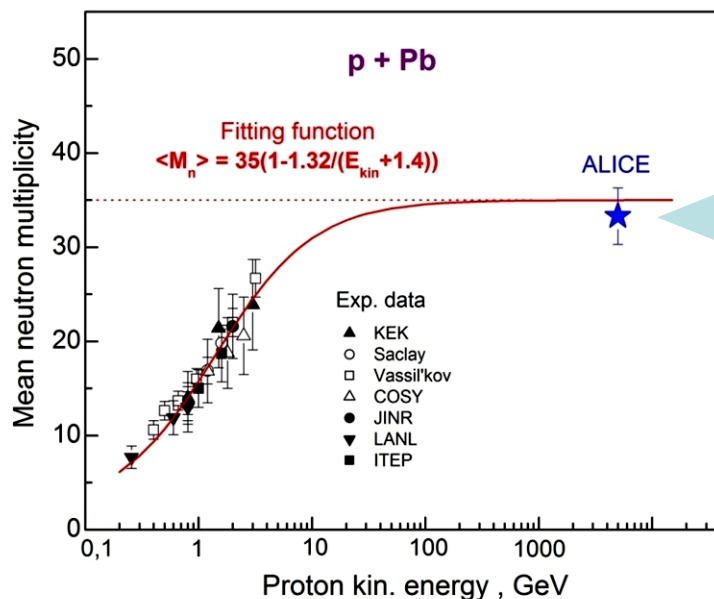
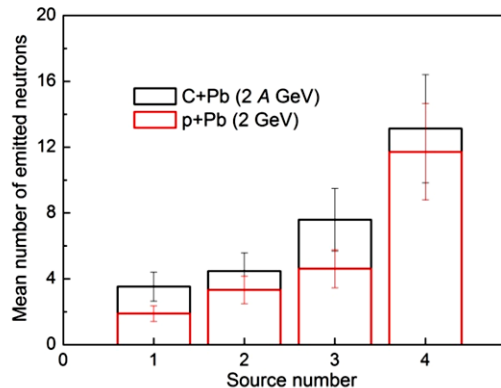
Source 1 – Cascade stage

Source 2 – Hot source decay

Source 3 – Multifragmentation

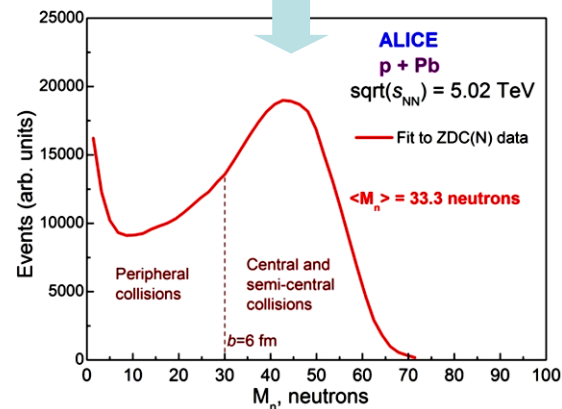
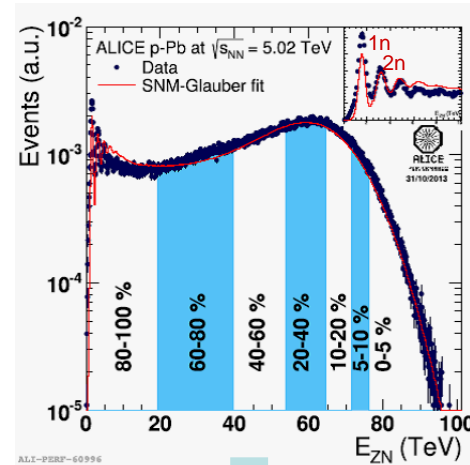
Source 4 – Evaporation

V.I. Yurevich, Phys. Part. & Nuclei V.41 (2010) 778.

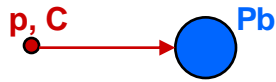


Recent result of measurement with ALICE neutron ZDC at LHC energy

C. Oppedisano, Nucl. Phys. A932 (2014) 399.
 J. Adam et al., Phys. Rev. C91 (2015) 064905.



Neutron energy and angular distributions



Lorentz transformation

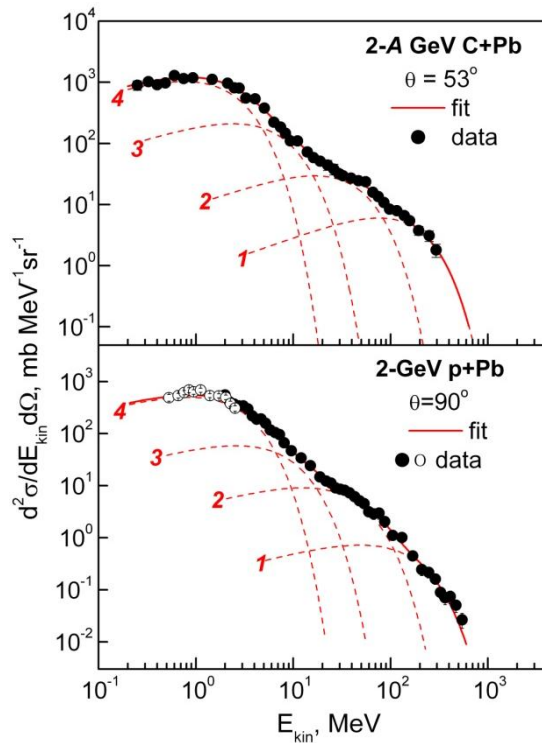


Moving Source Model fit

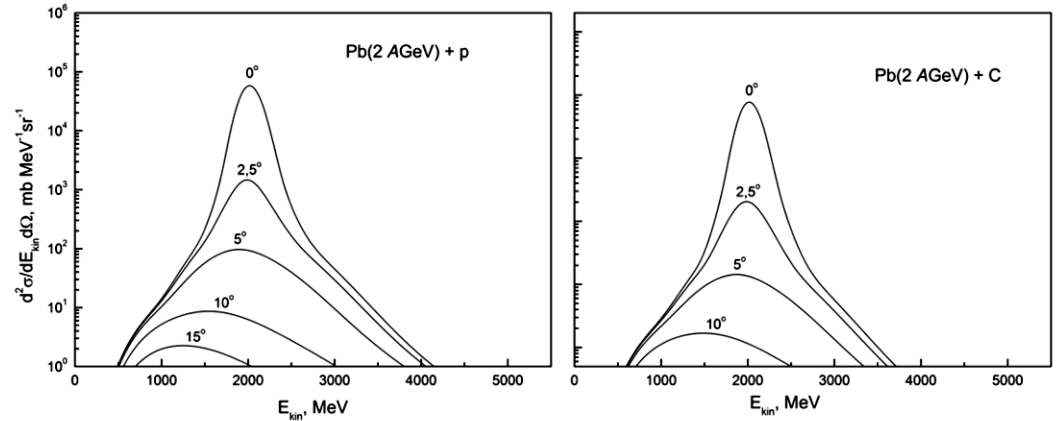
with 4 decay stages (neutron sources)

$$\frac{d^2\sigma}{dE_{kin}d\Omega} = \sum_{i=1}^4 pA_i \exp\left\{-\left(\frac{E_{kin} + m - p\beta_i \cos\theta}{(1-\beta_i^2)^{1/2}} - m\right)/T_i\right\}$$

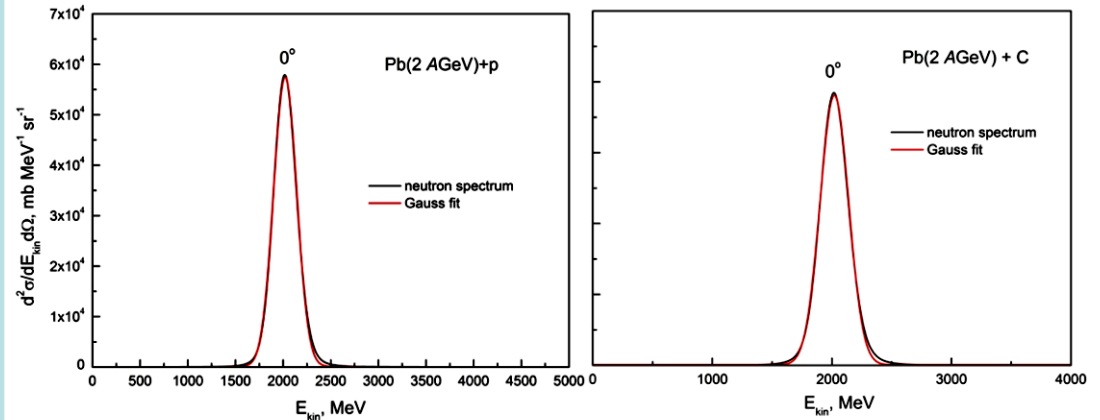
Parameters: A_i – amplitude, T_i – temperature, $\beta_i = v/c$



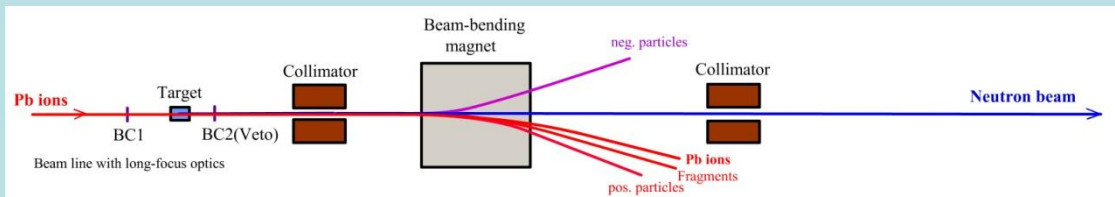
Angular distribution becomes narrow with energy and peaked at 0°



Gaussian-like energy distribution with $\sigma_E/E \leq 4\%$ for neutron energies $E > 6$ GeV



Beam of high-energy neutrons



A scheme of neutron beam line

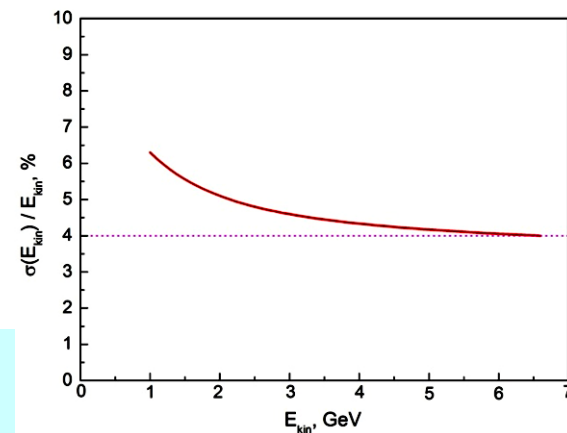
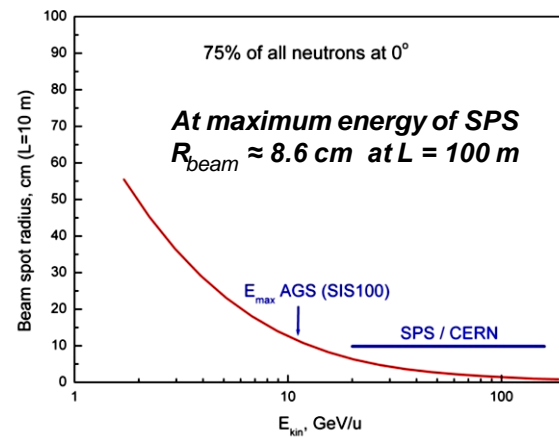
Available HI beams at AGS and SPS

AGS/BNL – beam of Au ions with energy of 11 A GeV
 SPS/CERN – beam of Pb ions with energies of 20 – 158 A GeV

Example

Pb ion beam intensity = 1×10^6 ion/s (SPS energy)
 5%-target (1.4-mm carbon or 1.9-mm polyethylene)
 Trigger of central and semi-central collisions, $\epsilon \approx 0.6$
 Rate of neutron pulses = 3×10^4 pulses/s
 Neutrons in pulse (in beam spot) $\langle Mn \rangle \approx 34$ n/pulse
 Neutron beam intensity $\approx 1 \times 10^6$ n/s
 Picosecond time duration of neutron pulse

Picosecond pulses of GeV neutrons at 0° with energy resolution $\sigma_E/E \leq 4\%$ can be realized with available beams of Pb and Au ions at SPS/CERN and AGS/BNL. The interaction rate in neutron production target defines the rate of neutron pulses.



Application in experiments

Parasitic neutron beams at HI accelerators