

Particle Production in proton-proton collisions

5th Egyptian high energy physics school

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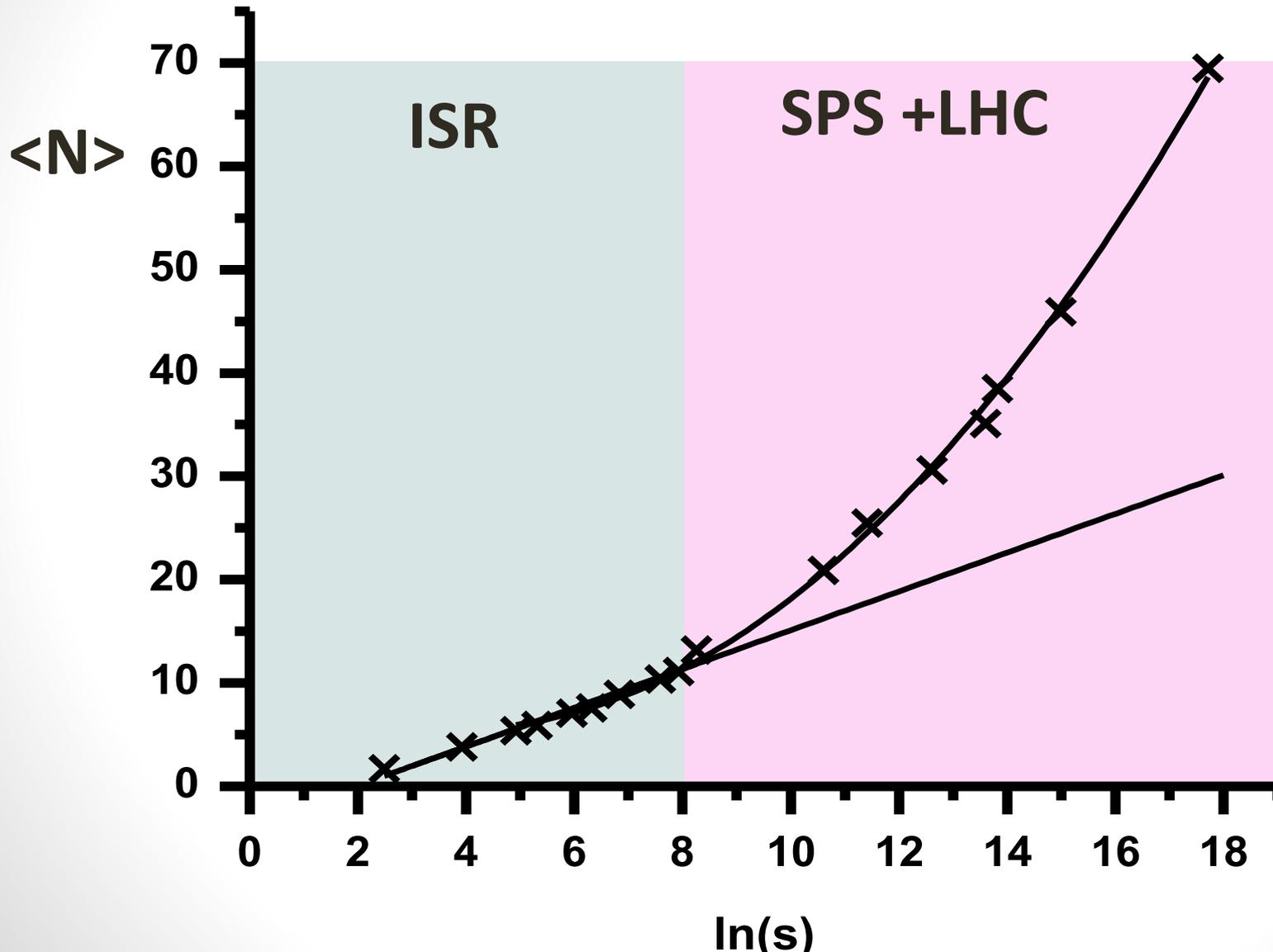
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Objectives:

**Particle creation process in proton-proton collisions over energy range:
from few GeV up to several TeV
through analyzing the multiplicity
and rapidity of the produced
particles.**

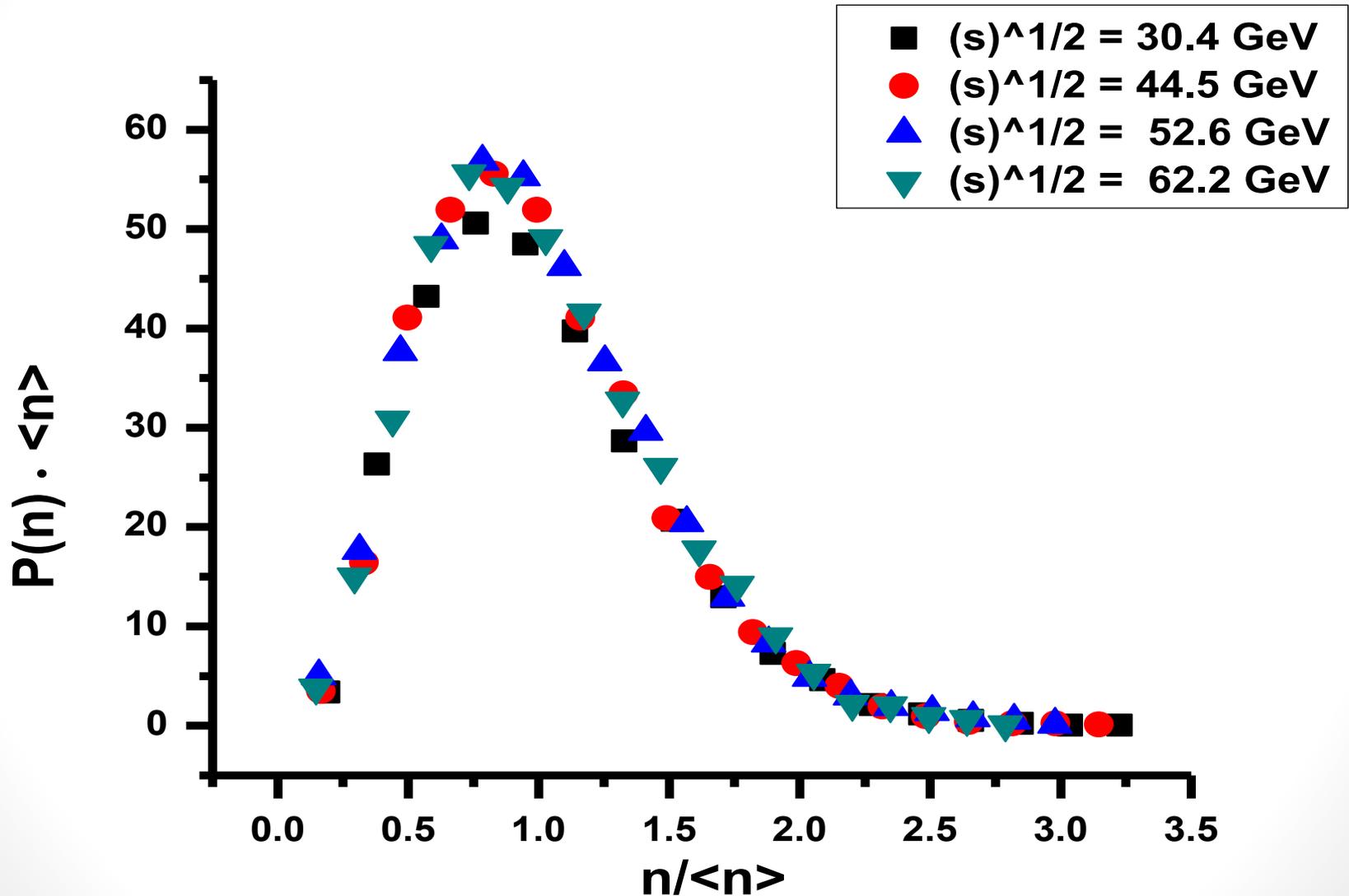
$$\langle N \rangle = 0.36 \ln^2(s) - 3.48 \ln(s) + 16.64$$

$$\langle N \rangle = -3.66 + 1.87 \ln(s)$$



Soft mechanism

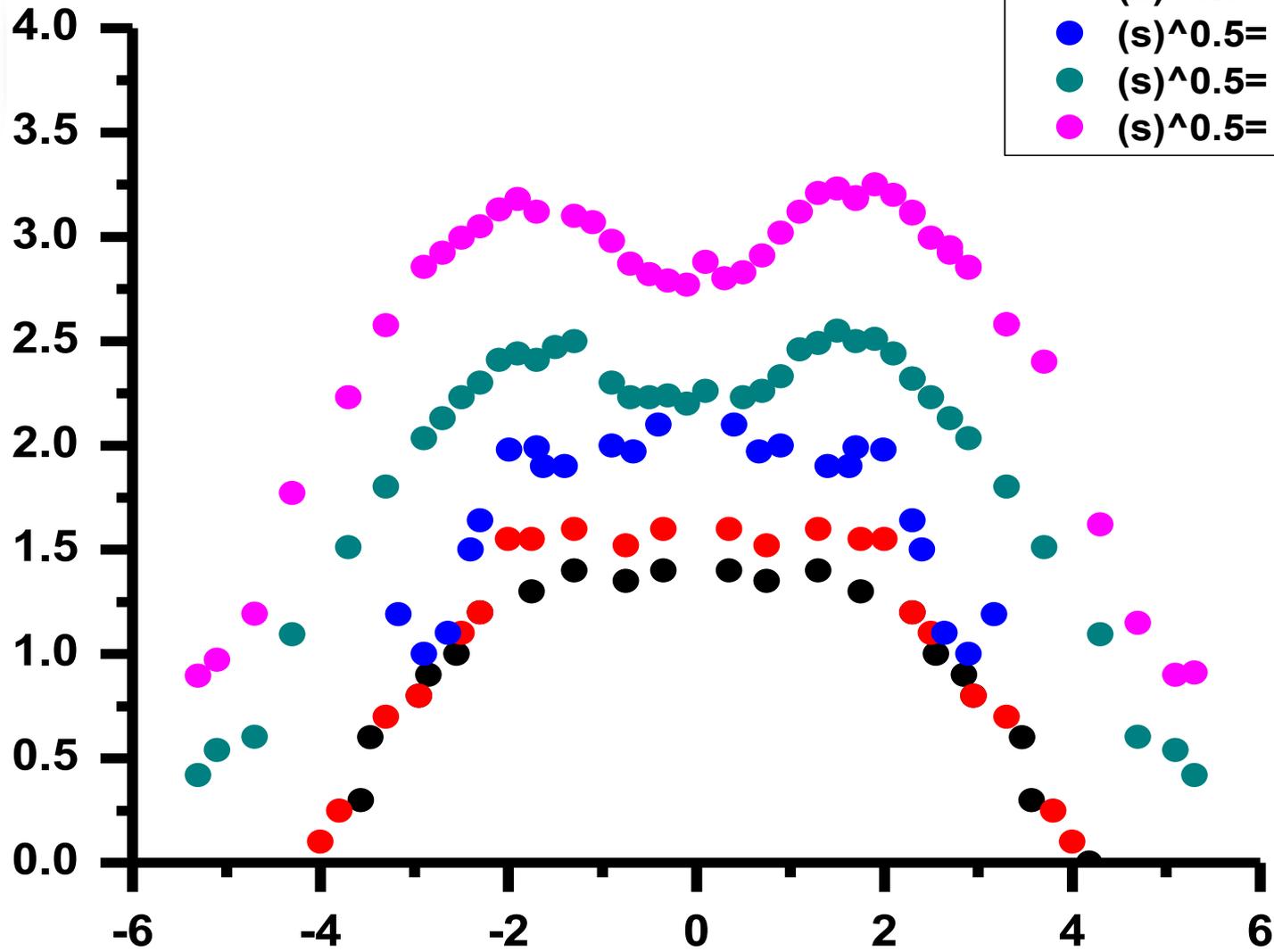
Up to ISR energy ($\sqrt{s} \leq 63$ GeV)



Soft mechanism

Up to ISR energy ($\sqrt{s} \leq 63$ GeV)

- Multiplicity follows Poisson distribution : Particle emitted independently in the final-state.
- Feynman scaling: the created particles are uniformly distributed in rapidity space.
- The source of production is mostly generated from valence quarks interactions .

$\frac{dn}{d\eta}$  η

Semi-hard mechanism

(Hundreds GeV's energy region)

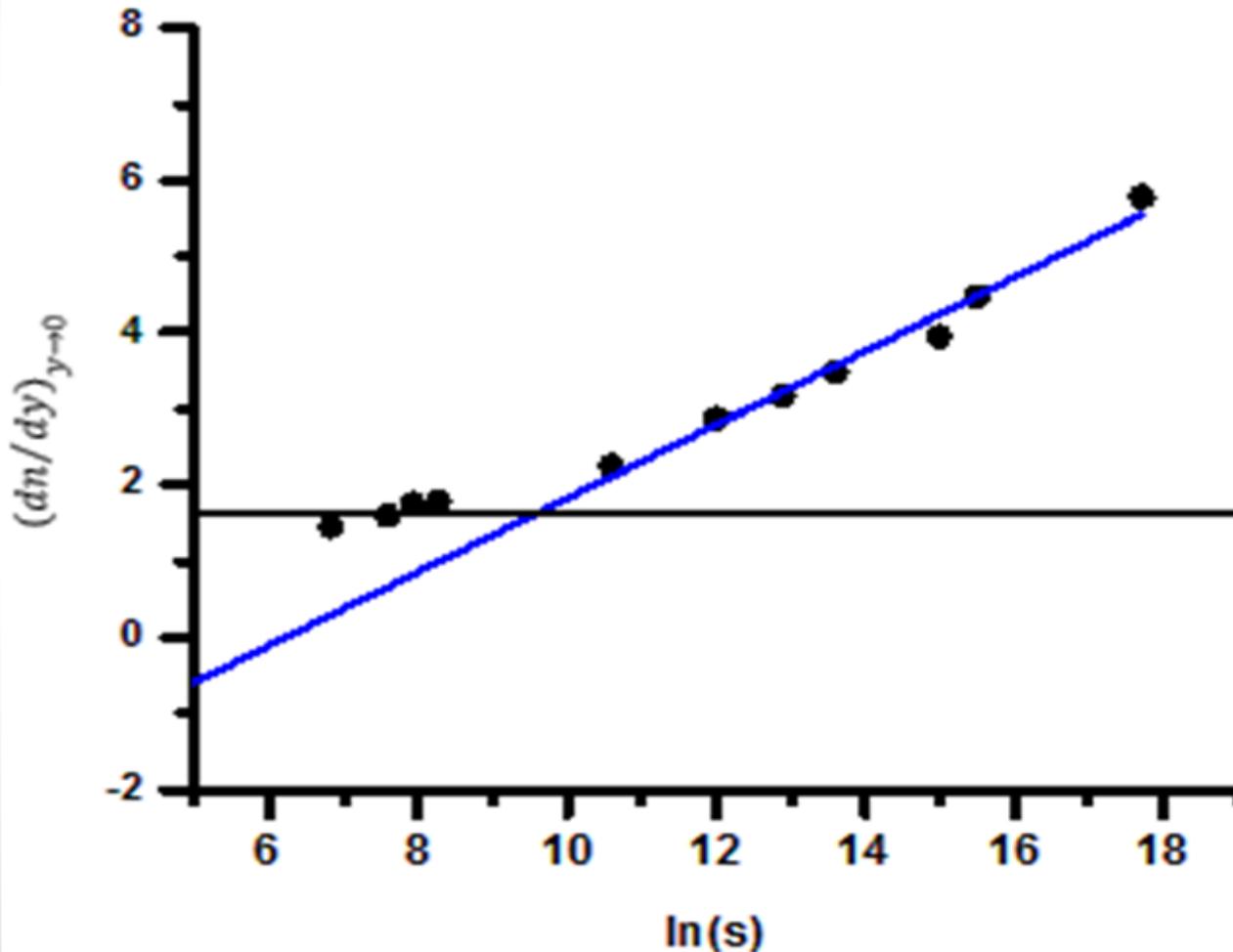
- ❑ The ability of a particle to emit additional particles, as cascading mechanism by fragmentations.

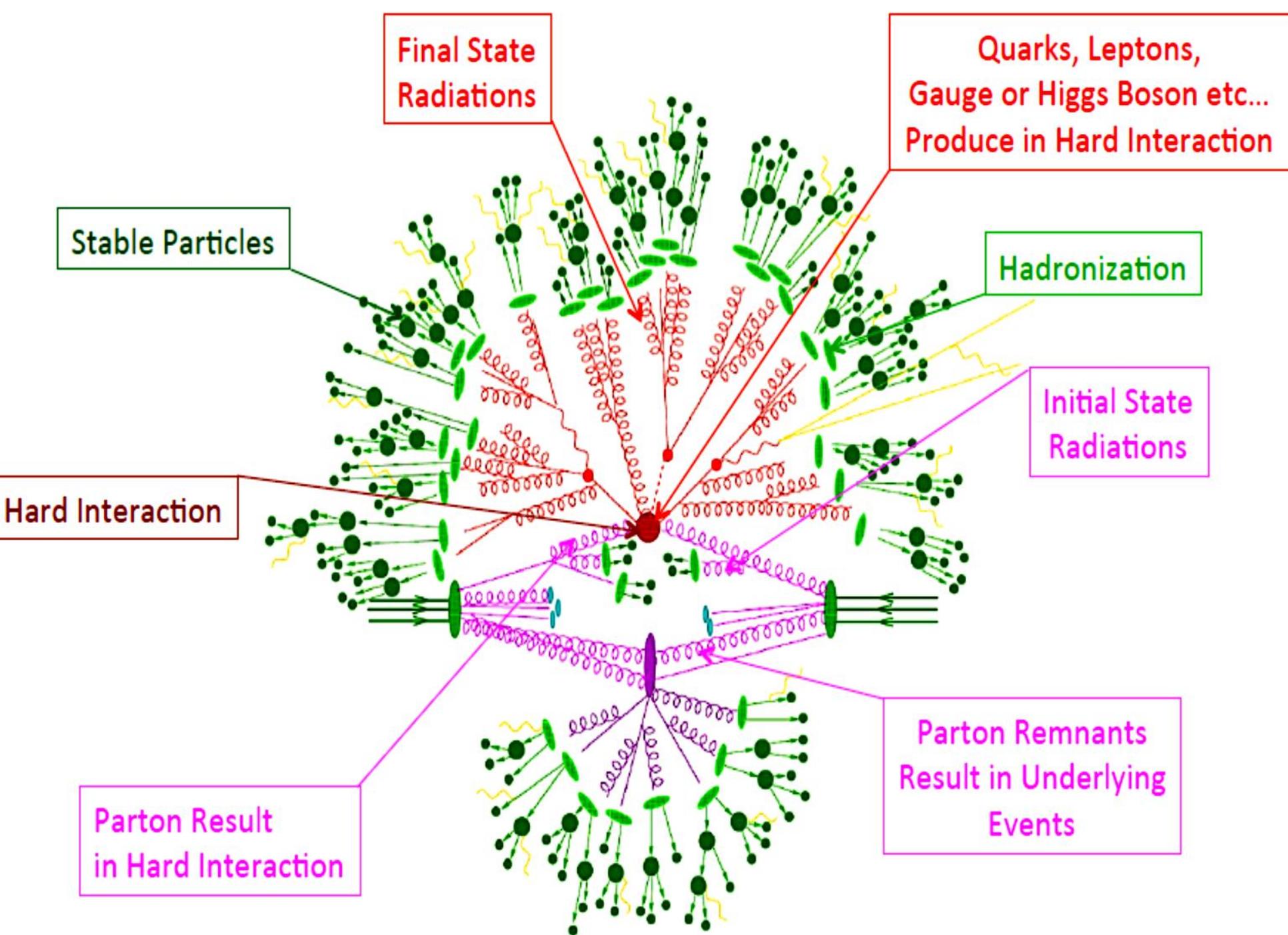
- ❑ The multiplicity distributions of produced particles follow Negative Binomial Distributions (NBD).
 - ❑ Mini-jet production.

- ❑ Resulting mostly from the sea quarks and the quark-gluon interactions at central rapidity region .

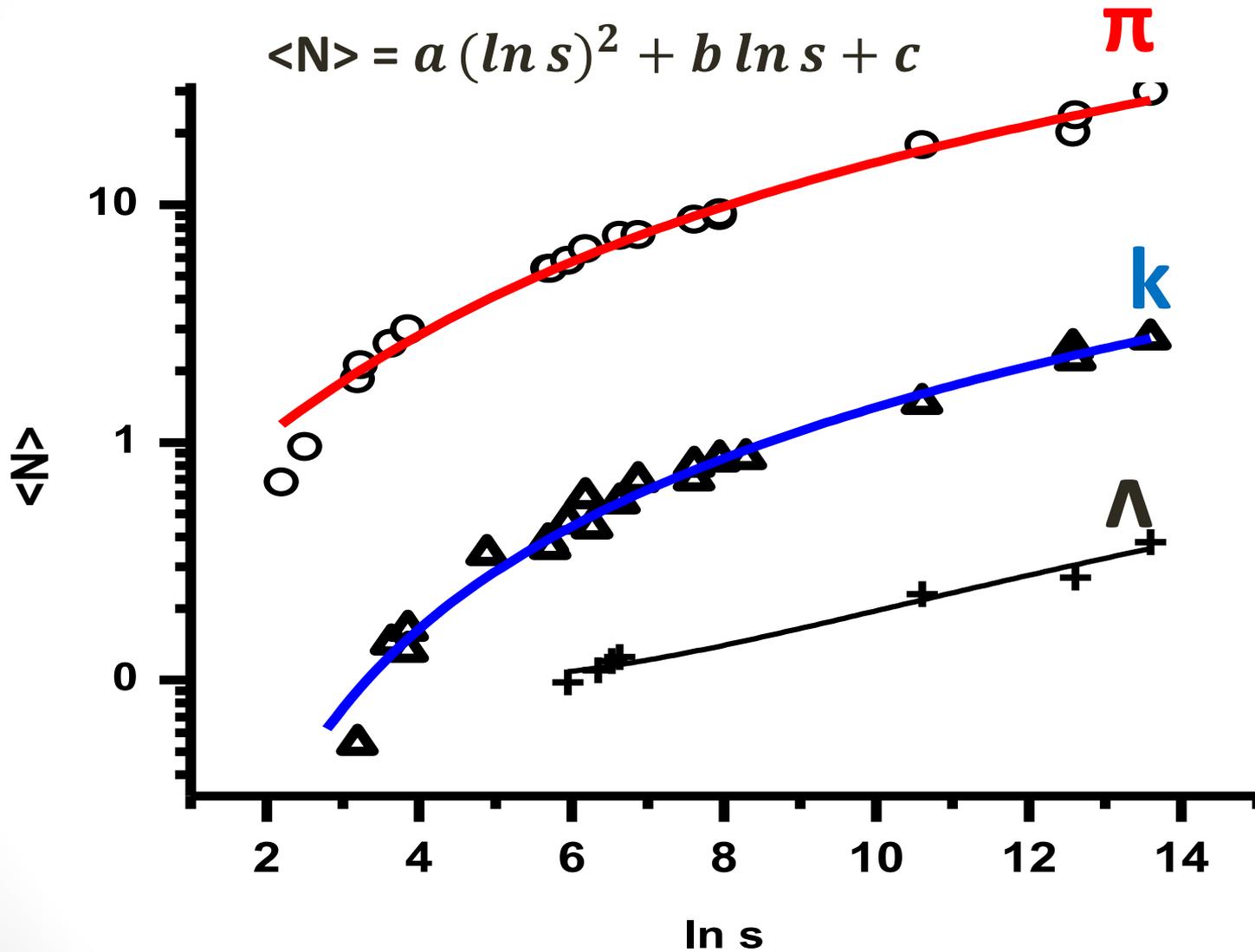
Violation of Feynman scaling at high energy

$$(dN/d\eta)_{\eta \rightarrow 0} = 0.48 \ln(s) - 3.01$$





Heavy particles creation:



Heavy particles creation II

Created particle	Fitting parameters			Chi-Square
	A	B	C	χ^2
Pions (red curve)	0.15	-0.001	0.49	98.17%
Keons (blue curve)	0.02	-0.03	0.02	99.11%
Lambdas (black line)	0.003	-0.03	0.16	95.31%

Conclusions

Along the studied energy range, the particle creation mechanism is divided into three components: soft, semi-hard and hard. These mechanisms have about three main sources of creation; valance quark-quark, quark-gluon and gluon- gluon interactions with different contributions with raising the energy.



Thank You

BACK UP



The proton-proton (pp) interactions :

The physical nature of pp interactions varies with energy as a result of the decrease of the strong coupling constant with energy raising. So that, the interactions are classified as soft, semi-hard and hard depending up on the interaction energy. Resulting from these three different interaction events, three particle creation mechanisms (soft, semi-hard and hard).

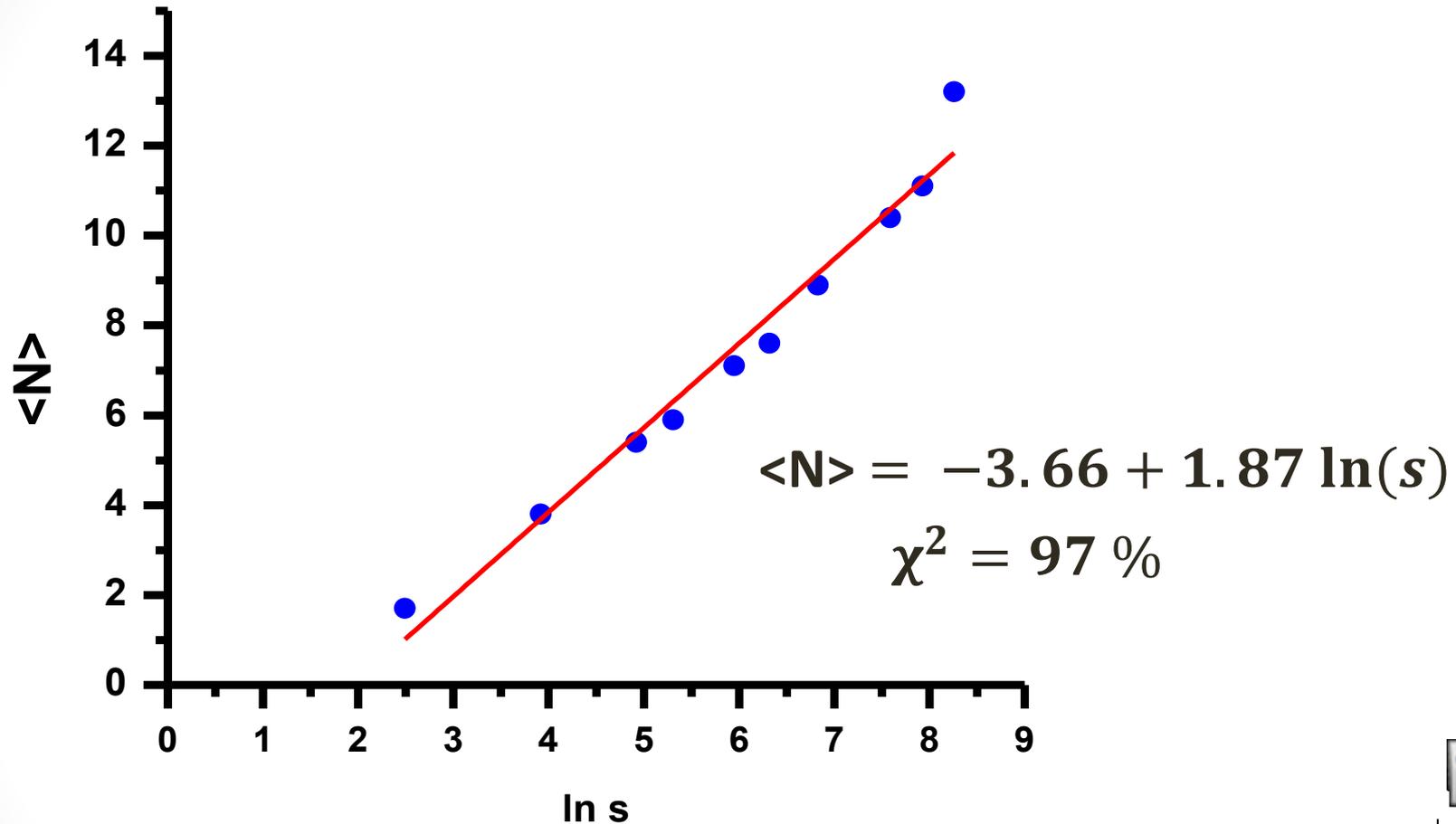
Semi-hard mechanism II

(Hundreds GeV's energy region)

- ❑ The multiplicity distribution fitted as a superposition of two single NBD's up to 1.8 TeV in full phase space.
- ❑ KNO scaling violation: multiplicity distribution doesn't favor the universal scaling law.
- ❑ Resulting mostly from the sea quarks and the quark-gluon interactions at central rapidity region .

1-Soft mechanism

Up to ISR energy ($\sqrt{s} \leq 63$ GeV)



ready pions.flv

- $\langle N \rangle$: the average multiplicity of the created particles
- s : the square of the center of mass energy.

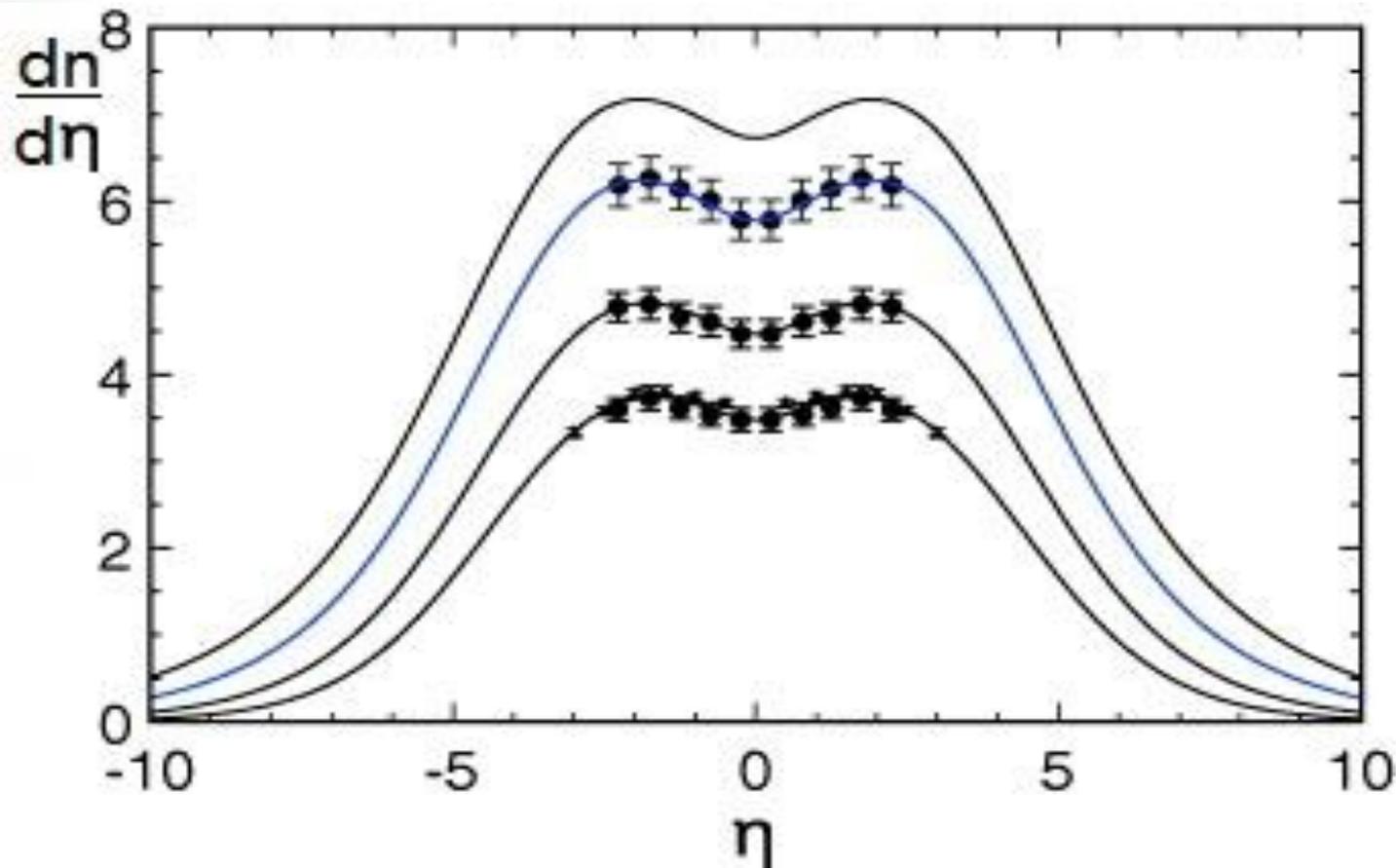
3- Hard mechanism

(TeV region)



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- Described by perturbative quantum chromo-dynamics.
- Jet is a cone of hadronic final states at high transverse momentum.
- Hard events originate from the gluon-gluon interactions, besides the high energy quark interactions.
- The hard mechanism is characterized by a high multiplicity and a broad angular distribution.



The pseudo-rapidity distributions at $\sqrt{s}=0.9, 2.36, 7$ and 14 TeV (bottom to top). Blobs are experimental points while solid lines are calculations according to the Relativistic Diffusion Model.