UNIVERSITY CLUSTER RU-SPBSU INTEGRATED INTO RUSSIAN SEGMENT OF WLCG: INSTALLATION AND PERFORMANCE

G.A. Feofilov, A.S. Ivanov, P.A. Nauomenko, A.K. Zarochentsev

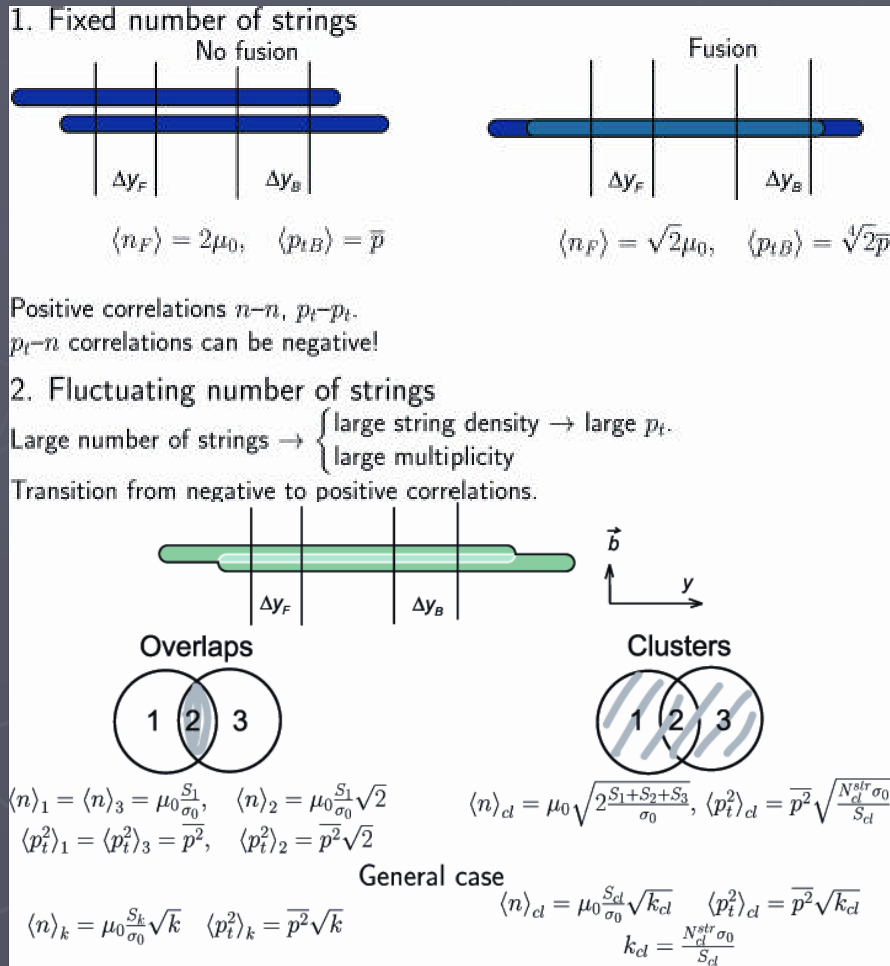
Laboratory of Ultra-High Energy Physics, St.Petersburg State University, 198504, St.Petersburg, Russia

CONTENT:

- Scientific research program of SPbSU in ALICE experiment
- Challenges of distributed analysis of ALICE data
- Data analysis strategy of SPbSU
- Idea of joined GRID and PROOF analysis facility
- SPbSU cluster in WLCG: installation and performance
- Future plans for integrating joined PROOF and GRID analysis facility at SPBSU

Scientific research program of SPbSU in ALICE experiment[1]

- Our physics motivation is based on the String-Fusion Model predictions (Braun, Pajares)[2] where the effects of string interaction are taken into account in the form of fusion or percolation, that might result in long-range n-n p_t-n or p_t-p_t correlations.
- The presence of the long-range correlations can be also considered as one of the signatures of the early stages of quark-gluon plasma formation. Experimental studies of the long-range correlations in pp and AA collisions are proposed for ALICE at the LHC and NA61(SHINE) experiments at the SPS, CERN.



1. ALICE collaboration "ALICE: Physics Performance Report, Volume II" J. Phys. G: Nucl. Part. Phys. 32 (2006) 1295-2040 (Section: 6.5.15 - Long-range correlations, p.1749)].
2. M.A.Braun and C.Pajares, Phys. Lett. B287 (1992) 154; Nucl. Phys. B39}(1993) 542, 549;

Search for long-range correlations in ALICE experimental data

- We are interested in event-by-event processing of reconstructed experimental or simulated data (ESD)
- More accurate results needs bigger statistics so more data needs to be processed
- All ALICE data will be stored in GRID but it is possible to copy some data to local PC and work with it locally
  - Local analysis is best way for debugging
  - Unfortunately it become insufficient for debugging of physics logic for Pb-Pb data and p-p rare processes
- There are 3 main software packages used in ALICE to work in LCG: ROOT, ALIROOT, ALIEN

Distributed analysis of ALICE data

Amount of processed data

Local

Advantages:

•Interactive

•No l

•Easy
funct

Disa

•Impo
statis
see any physical effects. Especially for ion-ion collisions.

•Impossible to debug physical analysis logic

PROOF

Advantages:

•Interactivity

•Very low (about 10s.)

Disadvantages:

•Insufficient statistics for final results

GRID

Advantages:

•Possibility of processing full datasets.

ID data

es:

Long
ially
when one needs latest software versions

•Uneasy to debug

There is AliAnalysisTask class an ALIROOT
that allows to run ONE physics code in all three cases transparently

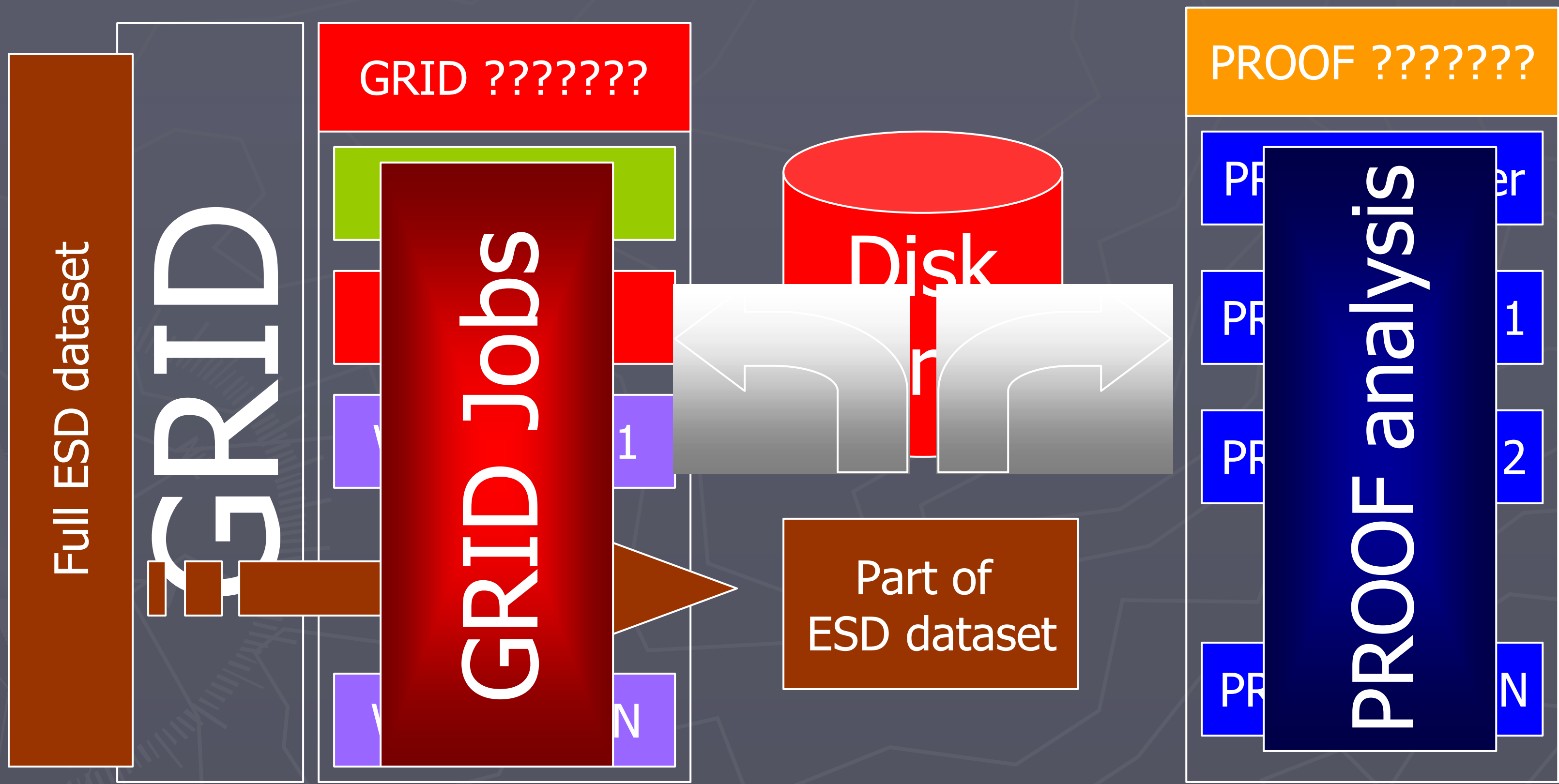
Data analysis strategy of SPbSU

- Local
  - Debugging of new analysis functionality
    - Coding errors
    - Most runtime errors
  - Debugging support to new ALIROOT versions when there is no backward compatibility in ALICE software
- PROOF
  - Debugging of physics logic
    - Check spectra to look like they are to be
  - Checking thresholds
  - Ensuring histogram limits
- GRID on local cluster
  - GRID debugging
  - Performance optimization
- Distributed GRID on partial data
  - Last check of physics logic
  - Some tests for high statistics (sometimes it leads to overflows of even double in calculation of standard deviation)
- Distributed GRID analysis on full dataset
  - Final results

Long-range correlation analysis package

- According to this "strategy" Long-Range correlations analysis package was developed in framework of AliAnalysisTask.
- LRC analysis package consists of:
  - LRC histogram processing library
  - Event processing code basing on AliAnalysisTask
  - Three launchers (for Local, PROOF and GRID analysis)
- ALIROOT part of code was submitted to ALICE collaboration (PWG2)
  - It was accepted in May 2008
  - Will be a part of ALIROOT | PWG2 | Event-By-Event code

Joined PROOF and GRID analysis architecture for HEP research institutes



RU-SPbSU LCG site after upgrade at October 2007

CE

VO-BOX

LFC

MON

Woker Nodes

32 cpu Intel(R) Xeon(R) E5345 @ 2.33GHz

SE-DPM

16 x 0.5 TB disks =
6 TB raid massive 5 – Storage
1 TB raid massive 1 - Sistem

- Total available through WLCG 40 KS2K CE and 6 TB SE
- SLC 4.5 x86_64 and Glite 3.1 installed on all worker nodes
- SLC 4.5 i386 and Glite 3.1 installed on all servers

Additional software

- Ganglia monitoring – local resource monitoring
- DPM-xrootd –file transfer protocol used by ALICE

RU-SPbSU site

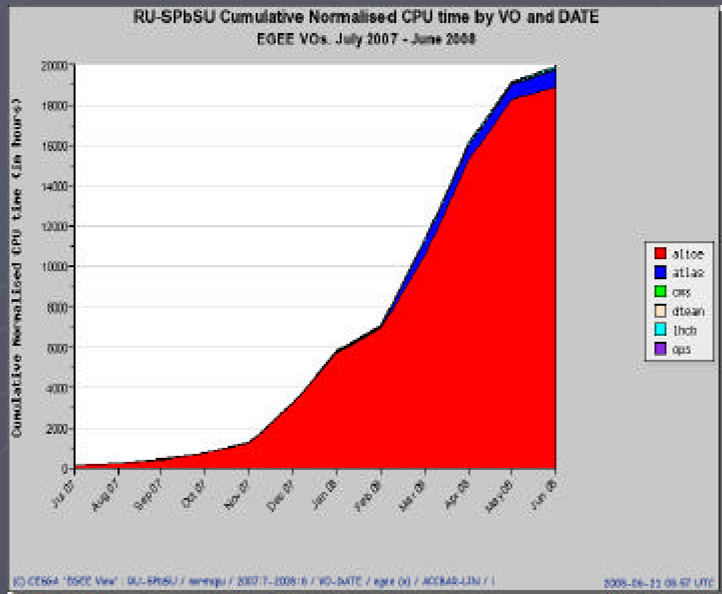
SPbSU resources available through the alien.
The table below is a live status of all GRID storage elements available for users.

Storage elements

SE Name	AliEn name	Description	SE Status	Size	Used	Free	Usage
1. Prague - Disk2	ALICE::Prague::Disk2	xrootd (disk), general use	Not responding	-	-	-	-
2. Subatech - DPM	ALICE::Subatech::DPM	DPM (disk), general use	OK	40.04 TB	4.7 TB	35.34 TB	11.74%
3. SPbSU - DPM	ALICE::SPbSU::DPM	DPM (disk), general use	OK	5.402 TB	28.47 GB	5.374 TB	0.515%
4. Catania - DPM	ALICE::Catania::DPM	DPM (disk), general use	OK	45.63 TB	14.94 TB	30.7 TB	32.73%
5. JINR - dCache	ALICE::JINR::dCache	dCache (disk), general use	OK	51.76 TB	132.9 GB	51.63 TB	0.251%
6. ISS - File	ALICE::ISS::File	xrootd (disk), general use	OK	4.581 TB	215.6 GB	4.37 TB	4.596%
7. Bari - dCache	ALICE::Bari::dCache	dCache (disk), general use	OK	9.77 TB	1.214 TB	8.556 TB	12.42%
8. CERN - se	ALICE::CERN::se	xrootd (disk), OCDB master, application packages	OK	5.588 TB	1.44 TB	4.148 TB	25.78%
9. GSI - se	ALICE::GSI::se	xrootd (disk), general use	OK	35.01 TB	20.69 TB	14.32 TB	59.1%
10. Legnaro - dCache	ALICE::Legnaro::dCache	dCache (disk), general use	OK	13.04 TB	12.37 TB	687.4 GB	94.85%
11. NDGF - dcache	ALICE::NDGF::dcache	dCache (disk), general use	OK	68.36 TB	21.67 TB	46.69 TB	31.7%
12. NIHAM - File	ALICE::NIHAM::File	xrootd (disk), general use	OK	39.12 TB	4.261 TB	34.85 TB	10.89%
13. Prague - Disk	ALICE::Prague::Disk	xrootd (disk), general use	OK	1.267 TB	1.267 TB	1 KB	100%
14. Torino - DPM	ALICE::Torino::DPM	DPM (disk), general use		-	-	-	-
Total			14	319.6 TB	82.91 TB		

http://aliceinfo.cern.ch/Offline/Activities/Analysis/GRID_status.html
http://pcalimonitor.cern.ch/stats?page=SE%2Fusertable

Chart showing the Cumulative Normalised CPU time grouped by VO and DATE



http://www3.egee.cesga.es/gridsite/accounting/CESGA/egee_view.php?query=ExecutingSite%3DRU-SPbSU

SUN cluster

Our near plans are to use the SUN cluster and SUN class provided in-kind by the SUN Microsystems for SPbSU scientific and educational processes for PROOF analysis of ALICE data.

Some parameters of cluster:

- 6 Worker Nodes
  - CPU 2 x Quad-Core Intel Xeon E5440 processor (2x6MB L2, 2.83GHz, 1333MHZ FSB, 80W)
  - RAM 4 x 4GB PC2-5300 667MHz ECC FB-DIMM Kit (2x 2GB)
- Storage
  - 1.5 TB

Conclusions

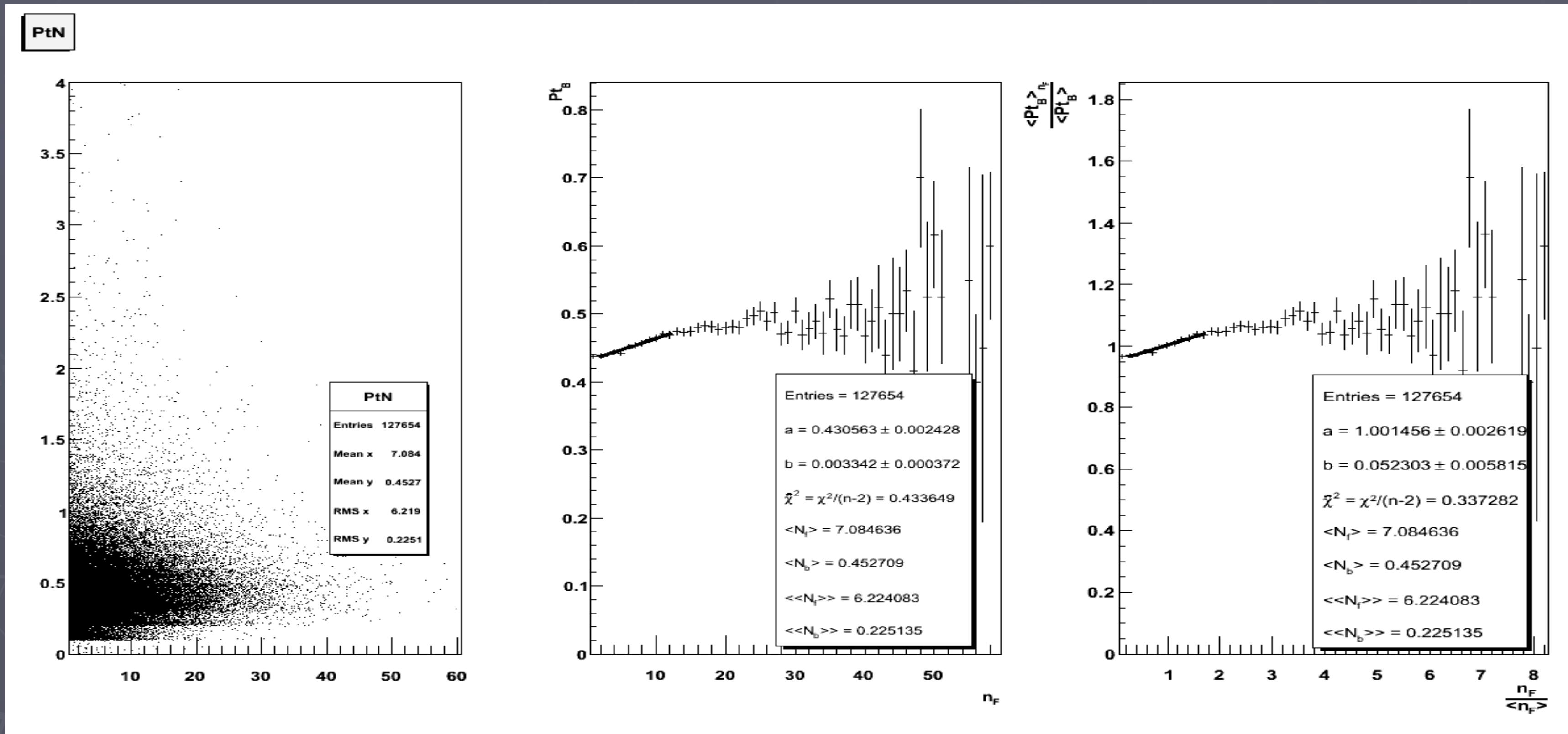
- New 40 ksi2k GRID cluster with 6 Tb of storage was successfully installed at SPbSU. This cluster is fully configured and integrated to WLCG
- This experience in GRID provides our successful application of AliROOT scripts for analysis of Long-Range correlations and search of new physics phenomenon in ALICE at the LHC

Acknowledgements

- Job was supported by the LOT No.5, Rosnauka, 2007
- Partially supported by the grant 2.2.2.2 No.1547 of Russian Ministry of Education and Science

Thank you...

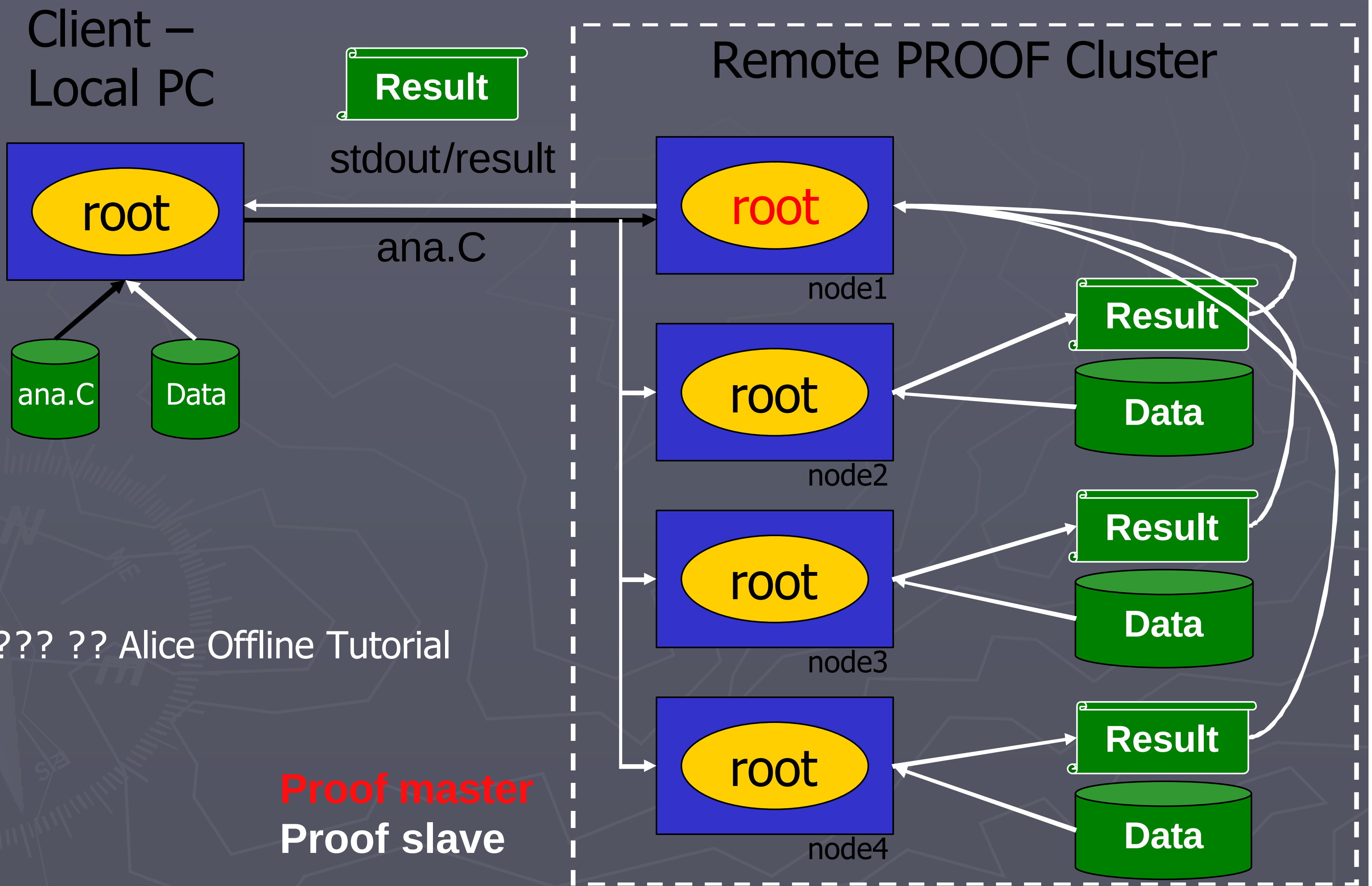
Example of long-range correlations in simulated pp 900GeV data



Long-range Pt-Nch correlations. Forward rapidity window [1..0] ,
Backward rapidity window [0..-1].

BACKUP

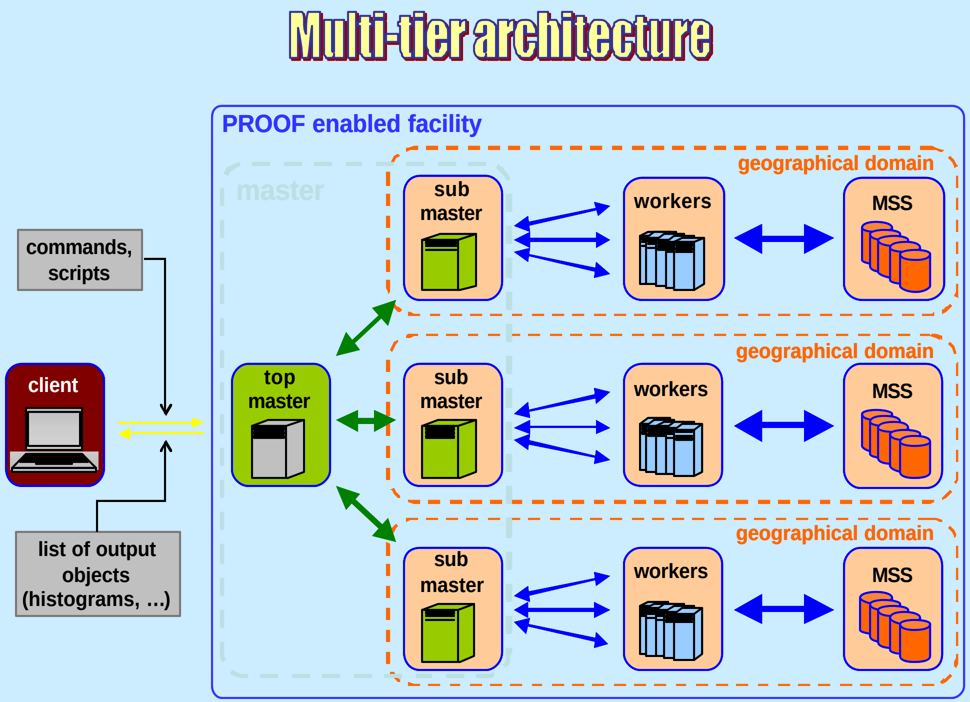
PROOF Schema



????? ?? Alice Offline Tutorial

??????? ??????????????? ????????????????
???????? PROOF

??????????? ????????   http://root.cern.ch/twiki/bin/view/ROOT/PROOF

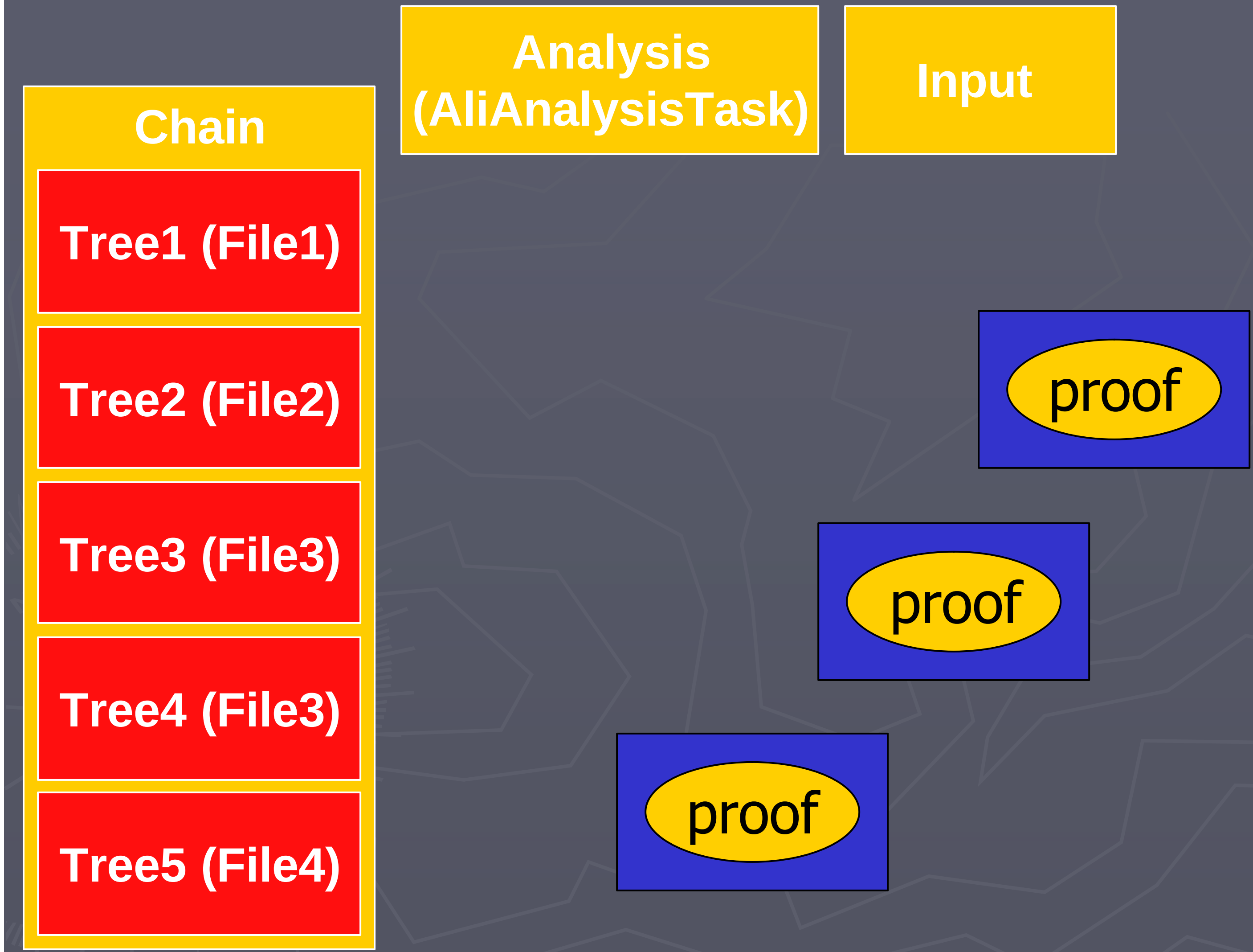


Connection lay-out set up via dedicated daemons in charge of authenticating the clients and spawning the server applications. XROOTD [2] has been instrumented for this purpose.

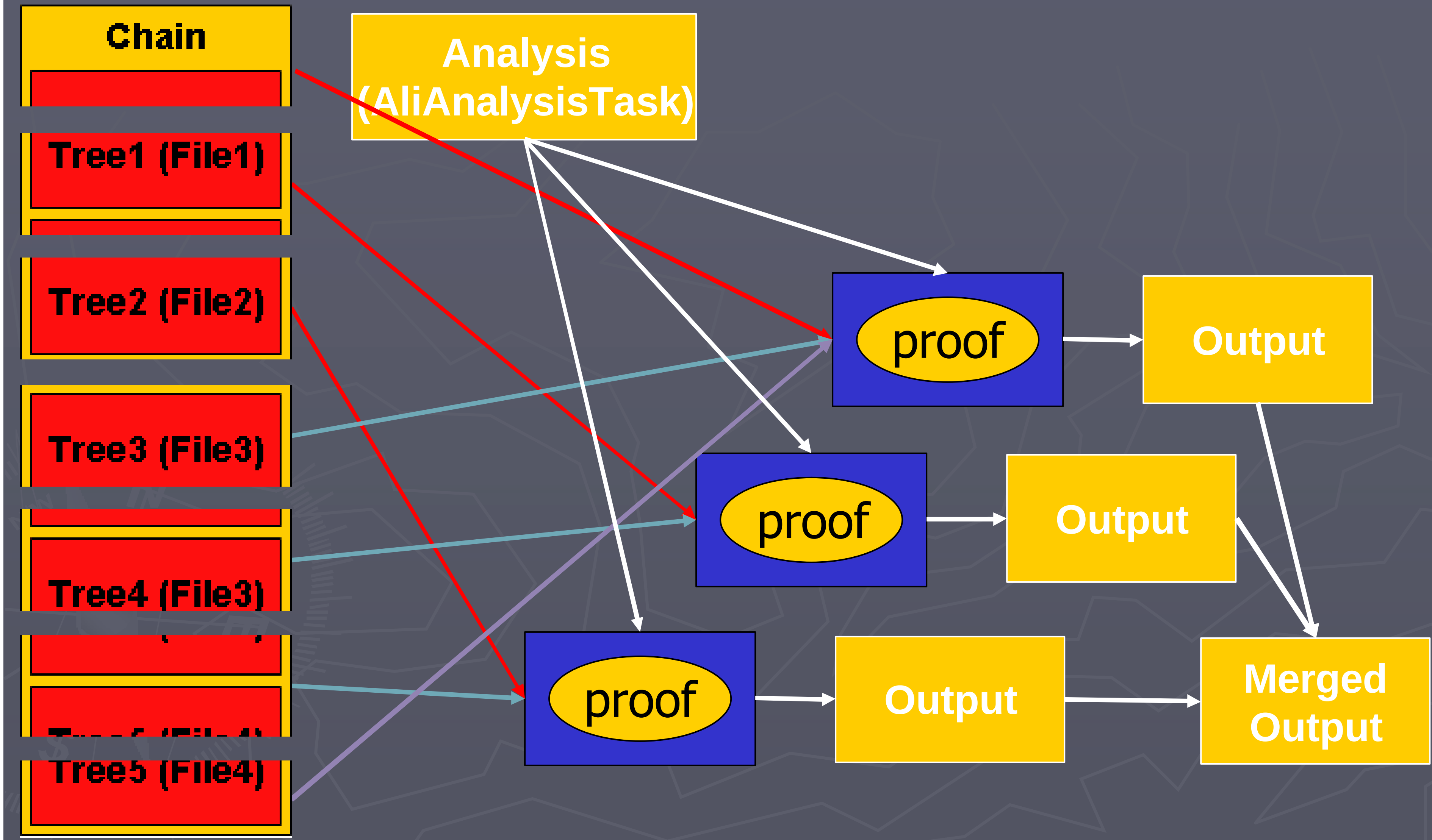
???????? ?? ???????????

B. Bellenot, R. Brun, G. Ganis, J. Iwaszkiewicz, F. Rademakers, *CERN, Geneva, Switzerland*,
M. Ballintijn, *MIT, Cambridge, MA, USA*

Workflow Summary



Workflow Summary



Introduction: Long-Range Correlations as a Method to search for a new physical phenomenon of color strings fusion

Two stage scenario

A.Capella, U.P.Sukhatme, C.--I.Tan and J.Tran Thanh Van, Phys. Lett. **B81** (1979) 68; Phys. Rep. **236** (1994) 225.
A.B.Kaidalov, Phys. Lett., **116B** (1982) 459;
A.B.Kaidalov K.A.Ter-Martirosyan, Phys. Lett., **117B** (1982) 247.

- **At the first stage** a certain number of colour strings are formed stretched in rapidity space between the incoming partons
- **At the second stage** these strings decay into the observed secondary hadrons.

String fusion

- M.A. Braun and C. Pajares, Phys.Lett.**B287 (**1992)154; Nucl. Phys.**B390(**1993) 542, 549

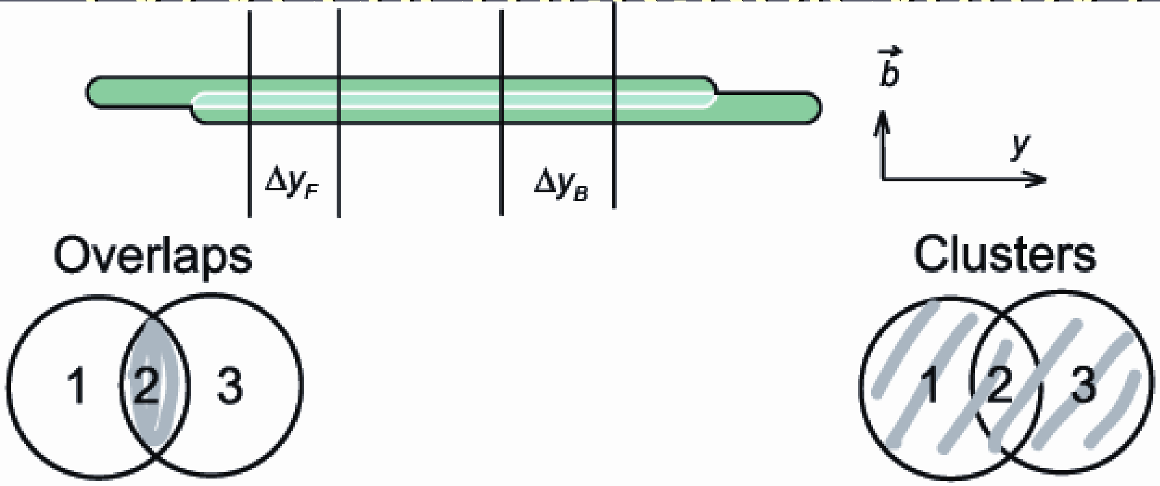
String Fusion as a source of Long Range correlations

- N.S. Amelin, N. Armesto, M.A. Braun, E.G. Ferreiro and C. Pajares,Phys. Rev. Lett.**73(**1994) 2813.

SPbSU Programme for studies of LRC in ALICE at the LHC :

- ALICE Collaboration, Journ.Phys.G: Nuclear and Particle Phys., 2006, 733 pages

Fusion Scenarios (V.Vecherni,R.Kolevatov)



$$\langle n\rangle_1 = \langle n\rangle_3 = \mu_0\frac{S_1}{\sigma_0}, \quad \langle n\rangle_2 = \mu_0\frac{S_1}{\sigma_0}\sqrt{2}$$

$$\langle p_t^2\rangle_1 = \langle p_t^2\rangle_3 = \overline{p^2}, \quad \langle p_t^2\rangle_2 = \overline{p^2}\sqrt{2}$$

$$\langle n\rangle_{cl} = \mu_0\sqrt{2\frac{S_1+S_2+S_3}{\sigma_0}}, \ \langle p_t^2\rangle_{cl} = \overline{p^2}\sqrt{\frac{N_{cl}^{str}\sigma_0}{S_{cl}}}$$

General case

$$\langle n\rangle_k = \mu_0\frac{S_k}{\sigma_0}\sqrt{k} \quad \langle p_t^2\rangle_k = \overline{p^2}\sqrt{k}$$

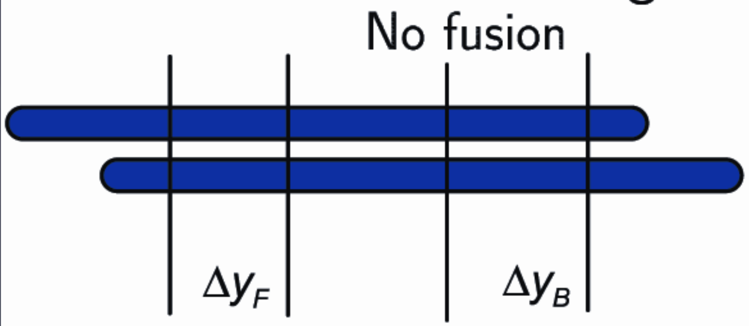
$$\langle n\rangle_{cl} = \mu_0\frac{S_{cl}}{\sigma_0}\sqrt{k_{cl}} \quad \langle p_t^2\rangle_{cl} = \overline{p^2}\sqrt{k_{cl}}$$

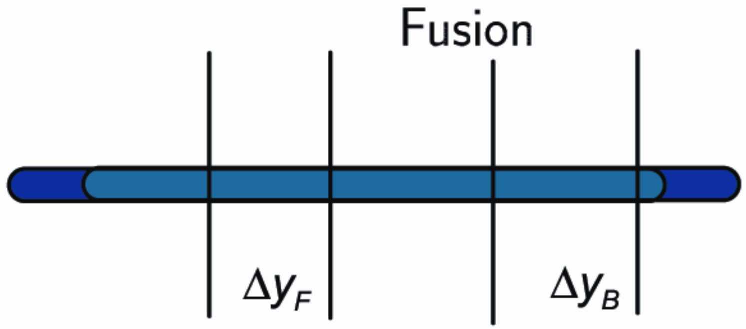
$$k_{cl} = \frac{N_{cl}^{str}\sigma_0}{S_{cl}}$$

- The rapidity intervals must exclude fragmentation regions to exclude the influence of pt of the parent partons
- Fusion affects particle production in both rapidity windows

Fusion Scenarios (V/Vecherni,R.Kolevatov)

1. Fixed number of strings





$$\langle n_F \rangle = 2\mu_0, \quad \langle p_{tB} \rangle = \overline{p}$$

$$\langle n_F \rangle = \sqrt{2}\mu_0, \quad \langle p_{tB} \rangle = \sqrt[4]{2}\overline{p}$$

Positive correlations n–n, p_t–p_t.
p_t–n correlations can be negative!

2. Fluctuating number of strings

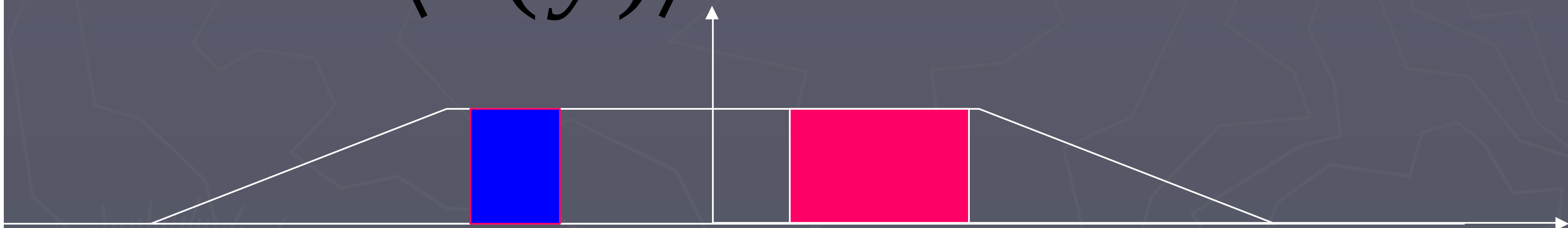
Large number of strings $\rightarrow$ $\begin{cases} \text{large string density} \rightarrow \text{large } p_t. \\ \text{large multiplicity} \end{cases}$

Transition from negative to positive correlations.

Long-Range Correlations*

CORRELATIONS BETWEEN OBSERVABLES MEASURED IN TWO RAPIDITY INTERVALS

$$\langle n(y) \rangle$$



1) **n-n** - the correlation between the charged particle multiplicities in backward and forward rapidity intervals
2) **p_t-n** - the correlation between the event mean transverse momentum obtained in the backward (B) rapidity window and the event mean transverse momentum in the forward (F) rapidity window
3) **p_t-p_t** - the correlation between the event mean transverse momentum in one rapidity interval and the charged particle multiplicity in another interval.

M.A.Braun and C.Pajares, Eur. Phys. J. {\bf C16} (2000) 349..A.Braun,R.S.Kolevatov,C.Pajares.V.V.Vechernin, "Correlations between multiplicities and everage transverse momentum in the percolatin color strings approach", Eur.Phys.J.C.32.535-546(2004