LONG RANGE CORRELATION ANALYSIS: PREPARATION OF ROOT LIBRARY

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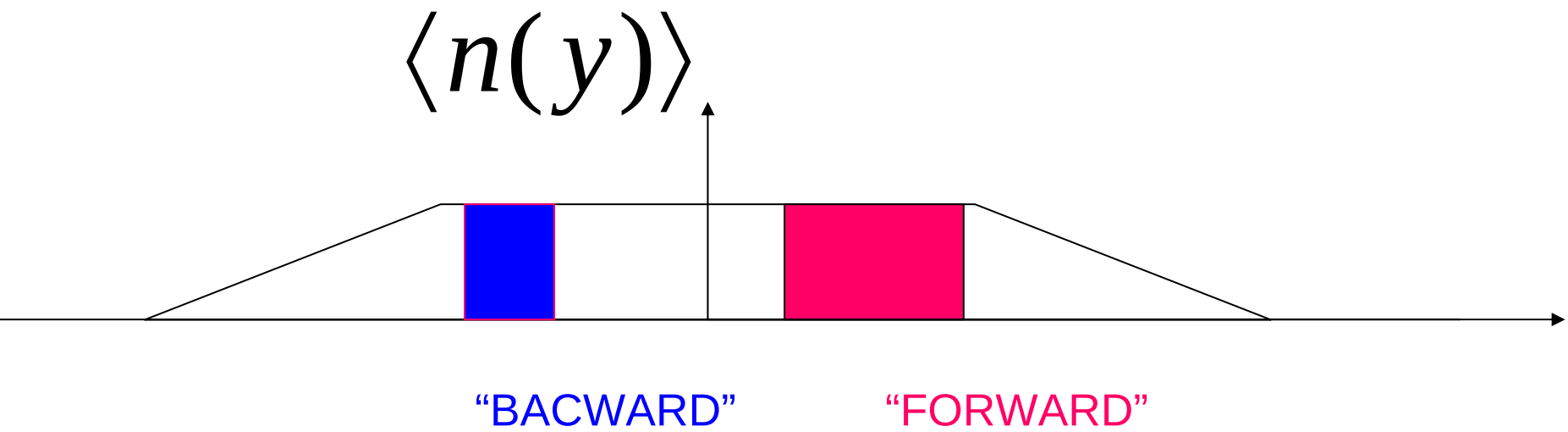
Long-Range Correlations*

CORRELATIONS BETWEEN OBSERVABLES MEASURED IN TWO RAPIDITY INTERVALS



***THEORY:**

- **A.Capella,A.Krzywicki, Phys.Rev. D18, no11,(1978),4120-4133**
- **A.Capella and J.tran Thanh Van, Z.Phys, C18(1983).85:**
- **A.Krzywicki, Phys.Rev. D29,No.5,(1984)1007-1009.**
- **N.S.Amelin, N.Armesto, M.A.Braun, E.G.Ferreiro and C.Pajares, Phys. Rev. Lett. {\bf 73} (1994) 2813.**
- **M.A.Braun and C.Pajares, Eur. Phys. J. {\bf C16} (2000) 349.**

M.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)

LONG RANGE CORRELATIONS:

Observables

For each event:

1) the event mean multiplicity **in BACKWARD or FORWARD rapidity windows:**

$$n_B \ , \ n_F$$

2) the event mean transverse momentum **for BACKWARD and FORWARD rapidity windows:**

$$p_{tB} = \frac{1}{n_B} \sum_{i=1}^{n_B} p_{tB}^{\ i} \qquad p_{tF} = \frac{1}{n_F} \sum_{i=1}^{n_F} p_{tF}^{\ i}$$

Event-by-event:

We define ***the mean value of the observable in one rapidity window*** **at the given value of another observable in the second window(regression), for example:**

$$\langle p_{tB} \rangle_{n_F} \quad or \quad \langle n_B \rangle_{n_F} \quad or \quad \langle p_{tB} \rangle_{p_{tF}}$$

Types of correlations:

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.

Usually: Correlation coefficients are defined (for **absolute** values of observables) as :

$$\langle n_B \rangle_{n_F} = a_{nn} + \beta_{nn} n_F$$

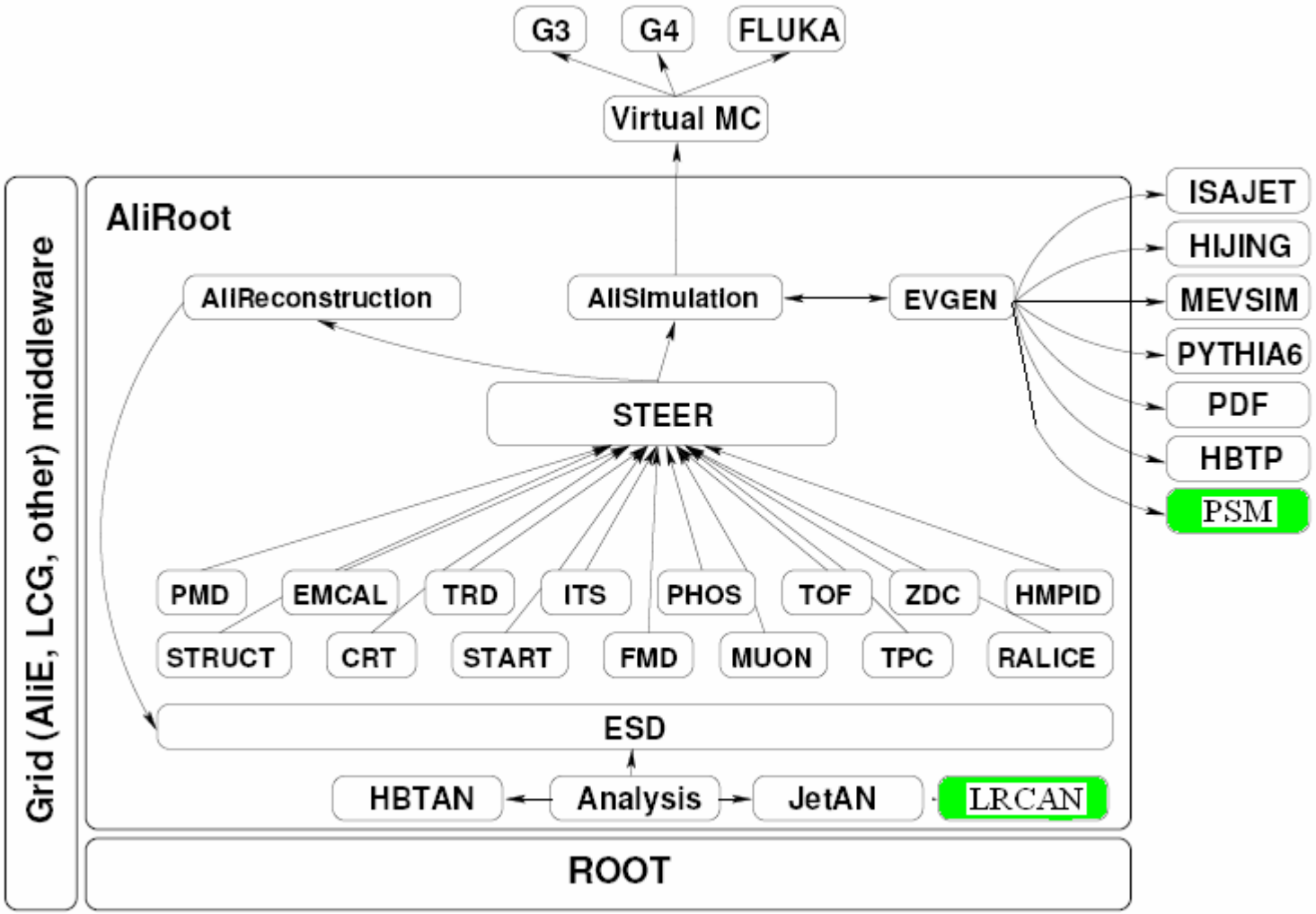
$$\langle p_{tB} \rangle_{n_F} = a_{p_t n} + \beta_{p_t n} n_F$$

$$\langle p_{tB} \rangle_{p_{tF}} = a_{p_t p_t} + \beta_{p_t p_t} p_{tF}$$

Correlation coefficients (for **normalized** observables), example:

$$\frac{\langle n_B \rangle_{n_F}}{\langle n_B \rangle} = a_{nn}^{\ N} + \beta_{nn}^{\ N} \frac{n_F}{\langle n_F \rangle}$$

ALICE/SPbSU Computing Model and LRC



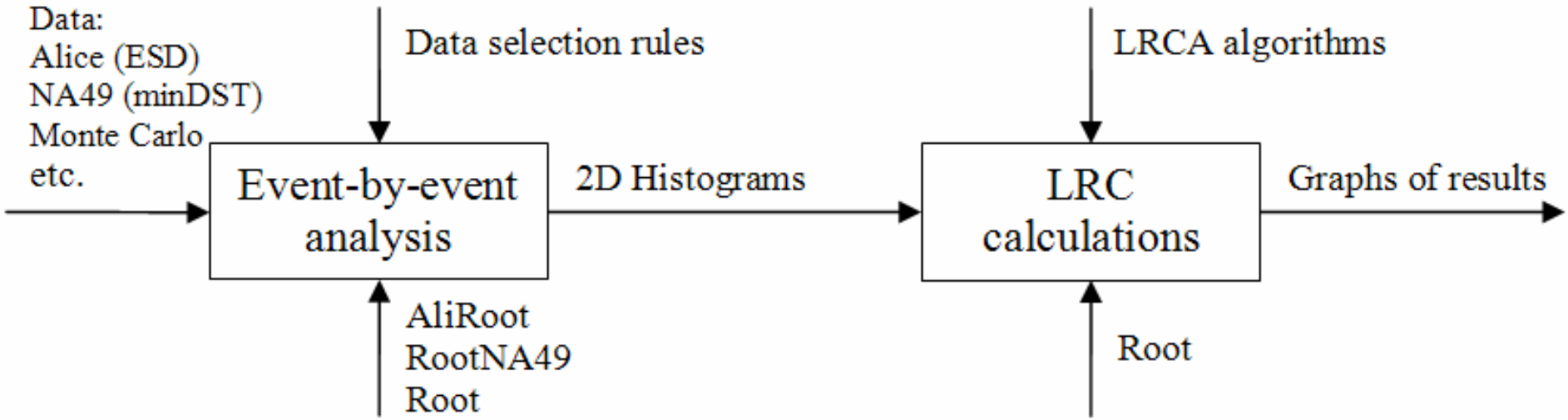
GOALS for PREPARATION OF universal LRC ROOT LIBRARY

- Encapsulate all Long Range Correlation (LRC) algorithms into programming classes
- Separate LRC calculations from event-by-event data processing
- Develop universal LRC ROOT library for different data sources (experimental data: ALICE, NA49, NA61, Monte Carlo data: PSM, PYTHIA etc)
- Provide easy to use interface to LRC algorithms

General Structure of the LRC universal ROOT Library

- different data sources: ALICE, NA49, NA61, Monte Carlo data (PSM, PYTHIA) etc
- event-by-event data processing with the account of specific experimental conditions: selection of events and tracks, rapidity intervals, p_t cuts, trigger, particle type, etc. -> 2 D plots
- LRC and new programming classes. LRC calculations -> results.

LRC model


Data:
Alice (ESD)
NA49 (minDST)
Monte Carlo
etc.
Data selection rules
Event-by-event analysis
2D Histograms
LRCA algorithms
LRC calculations
Graphs of results
AliRoot
RootNA49
Root
Root

LRC classes

TNN – encapsulates algorithms for n-n correlations

TPtN – encapsulates algorithms for p_t-n correlations

TPtPt – encapsulates algorithms for p_t-p_t correlations

Example of LRC n-n correlation (“toy model")

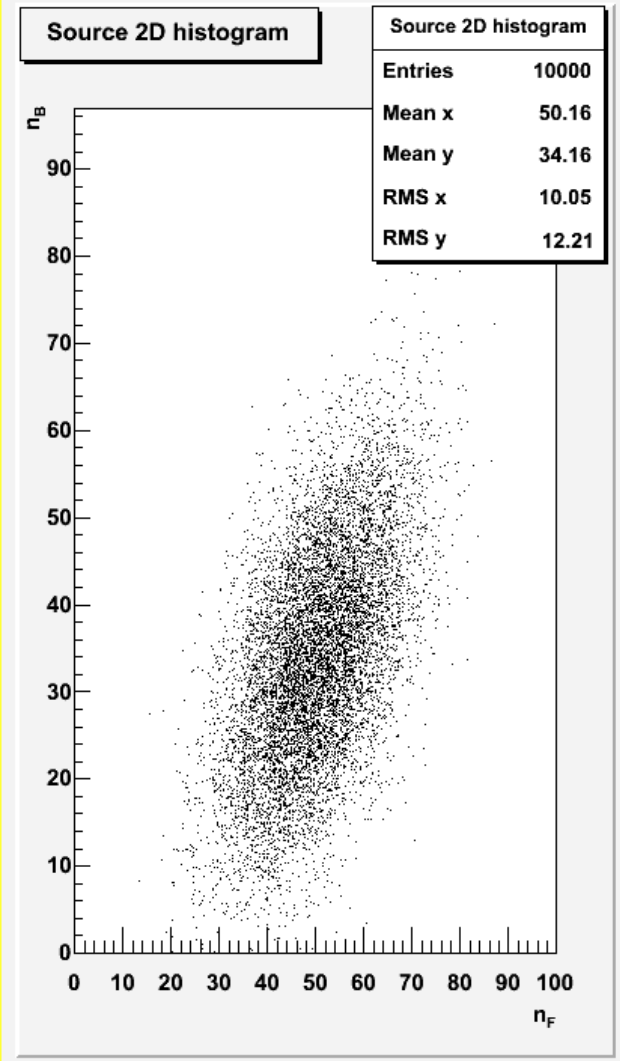
```
{
    #include "LRC.h"
    TCanvas *c1 = new TCanvas("c1","c1",800,1000);
    //Creating 2D source histogram with correlation coefficient 0.678 and Gauss error distribution
    TH1F *gaus = new TH1F("source","source hist",1000,-5,5);
    gaus->FillRandom("gaus",10000);
    TH2F *source = new TH2F("Source","Source 2D histogram",100,0,100,100,0,100);
    Double_t x, y;
    for (Int_t i=0;i<10000;i++)
    {
        x = 10 * (gaus->GetRandom() + 5);
        y = 0.678 * (x + gaus->GetRandom() * 15);
        //Fill source 2D histogram with correlation coefficient 0.678
        source->Fill(x,y);
    }
    //Creating TNN class encapsulates <n>-n correlation algorithms
    //2D histogram pass into TNN constructor
    TNN final1("name", source);
    c1->Divide(3);
    c1->cd(1);
    final->Draw();
    c1->cd(2);
    final1.Draw_abs();
    c1->cd(3);
    final1.Draw_rel();
    c1->cd();
}
```

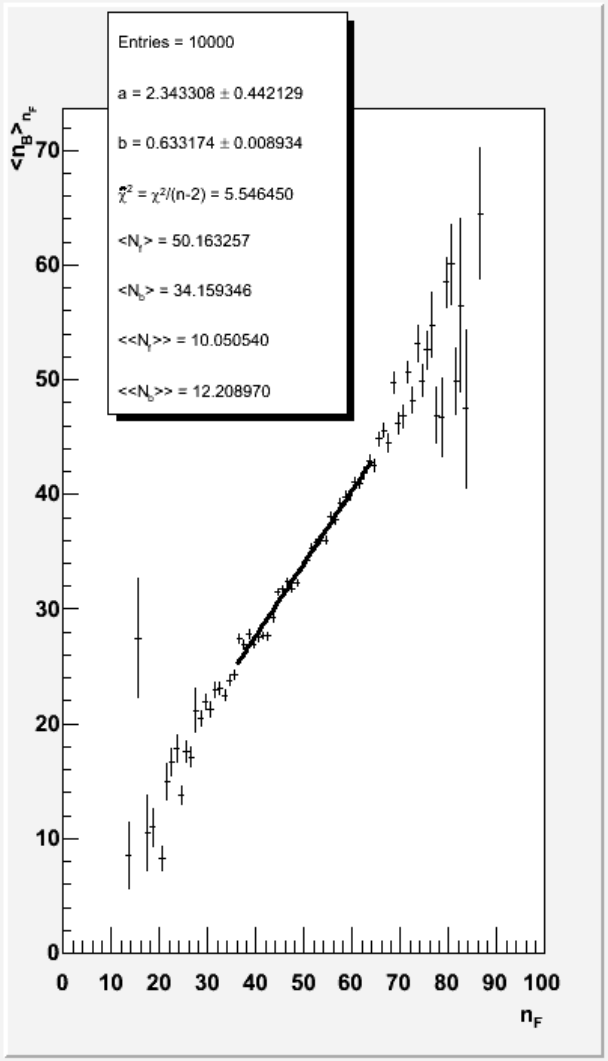
Results of LRC n-n correlation (“toy model"):

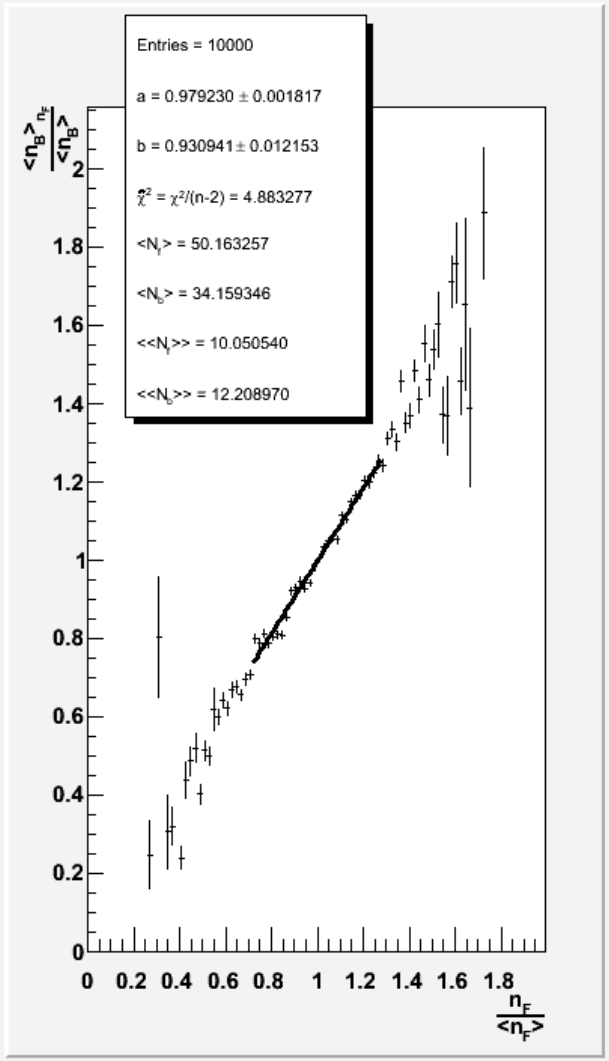
Fig.A. Raw 2D plot;

Fig.B. nn-correlation (abs. values of variables);

Fig.C. nn-correlation (normalized variables)



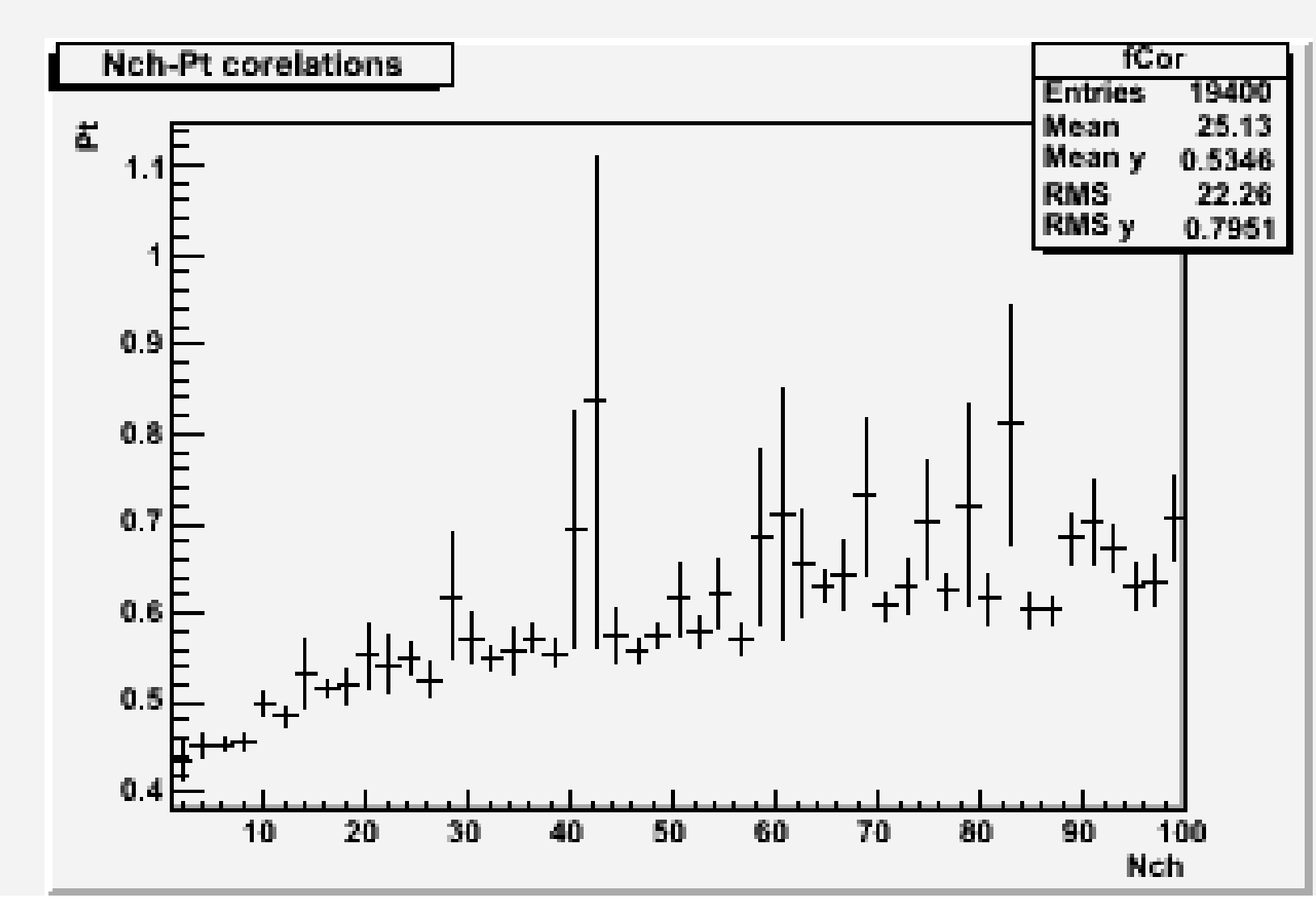




Example of LRC p_t-n correlation (PYTHIA-AliROOT)

- PDC06 events distributed on the CAF
- http://aliceinfo.cern.ch/export/sites/default/Offline/Analysis/CAF/v4-04-Rev-07/ESD100_110_v2.txt
- Data created with AliRoot v4-04-Release
- 14 TeV pp minbias collisions
- About 20000 events are analyzed
- Tracks were taken from TPC data
- Full TPC coverage was used for correlation analysis

Example of LRC p_t-n correlation (PYTHIA-AliROOT)



PDC06 data AliRoot v4-04-Release 14 TeV pp minbias

NEAR PLANS

- Implementation of this LRC Library with the AliROOT and NA61ROOT
- analysis of the PYTHIA data for p_t-n correlation in pp-collisions in case of a *single rapidity interval* (AliROOT/ ESD…) and comparison to experiment i
- *LRC* analysis of the PYTHIA data for n-n, p_t-n and p_t-p_t correlations in pp-collisions (AliROOT/ ESD…)