

Central University of Haryana

<https://phonebook.sdcc.bnl.gov/eic/client/>



★ Central University of Haryana

Department of Physics and Astrophysics, Central University of Haryana
Mahendergarh -123031

District Mahendergarh, Haryana 123031

INDIA 

Collaboration members:

Ramandeep Kumar, Meenu Thakur

Institution representative(s) on EIC User Group Council: **Meenu Thakur**

- 140 km from National Capital: New Delhi
- 300 km from State Capital: Chandigarh

- 34 Departments & ~5k Students
- Diverse campus (students from almost all Indian states & few countries)

Courses:

1. Integrated B.Sc. M.Sc. (Physics) [Five-year]
2. M.Sc. (Physics) [Two-year]
3. Ph.D.

Student Contribution:

- One PhD student and two or more MSc students (for one semester dissertation work) may join
- Looking forward to involvement of few undergrad students with good programming skills

Faculty Profile



Dr. Meenu Thakur
PhD: Panjab Univ.
PDF: Florida State Univ.

Previous Work:

- Detector instrumentation for detection of low energy neutrons produced in inverse kinematics using RESONEUT setup at FSU, US
- Fission studies of super-heavy nuclei: mass gated neutron multiplicity measurements performed using India's largest neutron detector array (NAND) at IUAC, New Delhi

Skills (Hardware & Software):

- Tools: FORTRAN, C, C++, ROOT, FLUKA, GEANT4
- Target fabrication and characterization
- Hands on experience with different detector systems and related electronics
- Experience of using NIM, CAMAC, and VME based DAQ systems

Previous Work:

- Fabrication & Characterization of Resistive Plate Chambers (for CMS detector)
- Study of Double Parton Scattering processes using CMS data at the LHC
- DPS studies (phenomenological) using jet fragmentation properties

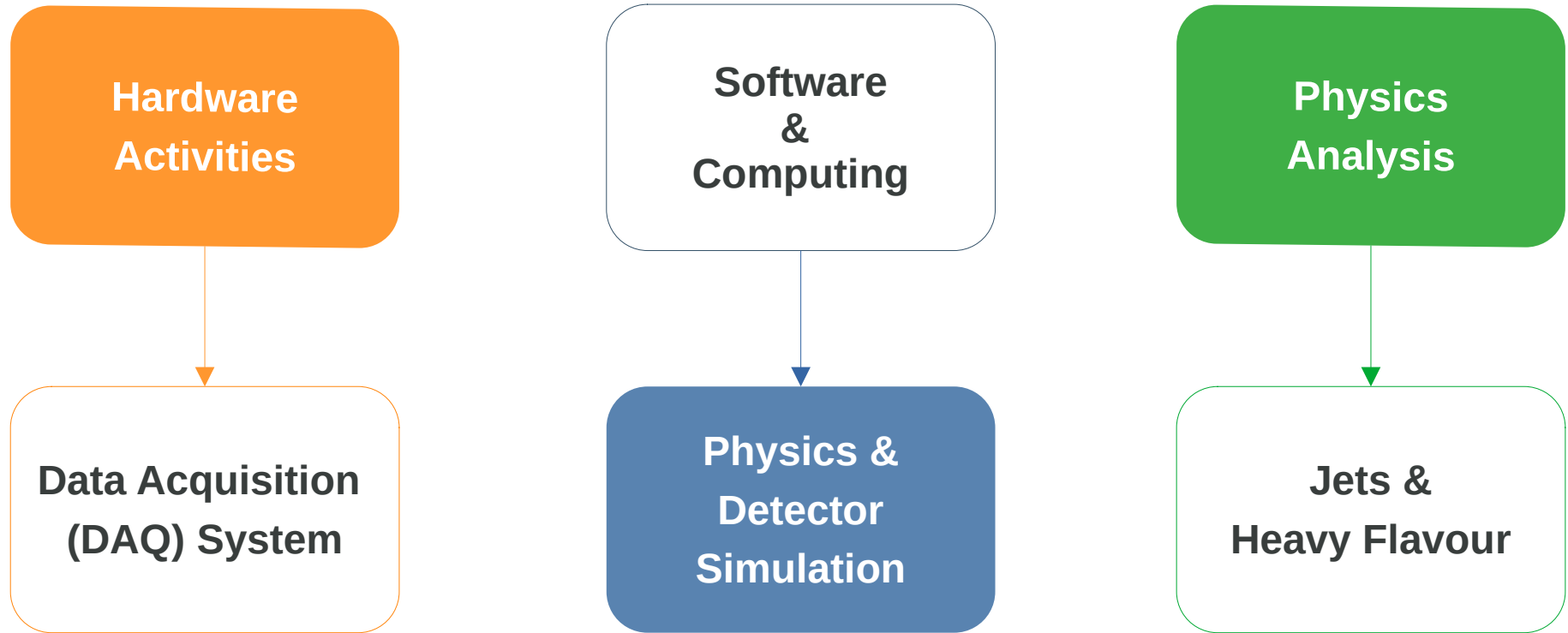
Skills:

- Tools: C++, Python, ROOT
- MC Event Generators: PYTHIA8, MADGRAPH, SHERPA, POWHEG, HERWIG++



Dr. Ramandeep K.
PhD: Panjab Univ.

Possible Contribution to ePIC



Study of DPS in pp collisions in W + dijet (CMS)

Study of double parton scattering using W + 2-jet events in proton-proton collisions at $\sqrt{s} = 7$ TeV



The CMS collaboration

E-mail: cms-publication-committee-chair@cern.ch

ABSTRACT: Double parton scattering is investigated in proton-proton collisions at $\sqrt{s} = 7$ TeV where the final state includes a W boson, which decays into a muon and a neutrino, and two jets. The data sample corresponds to an integrated luminosity of 5 fb^{-1} , collected with the CMS detector at the LHC. Observables sensitive to double parton scattering are investigated after being corrected for detector effects and selection efficiencies. The fraction of W + 2-jet events due to double parton scattering is measured to be 0.055 ± 0.002 (stat.) ± 0.014 (syst.). The effective cross section, σ_{eff} , characterizing the effective transverse area of hard partonic interactions in protons is measured to be 20.7 ± 0.8 (stat.) ± 6.6 (syst.) mb.

KEYWORDS: Jet physics, Hadron-Hadron Scattering, QCD

ARXIV EPRINT: 1312.5729

JHEP03(2014)032

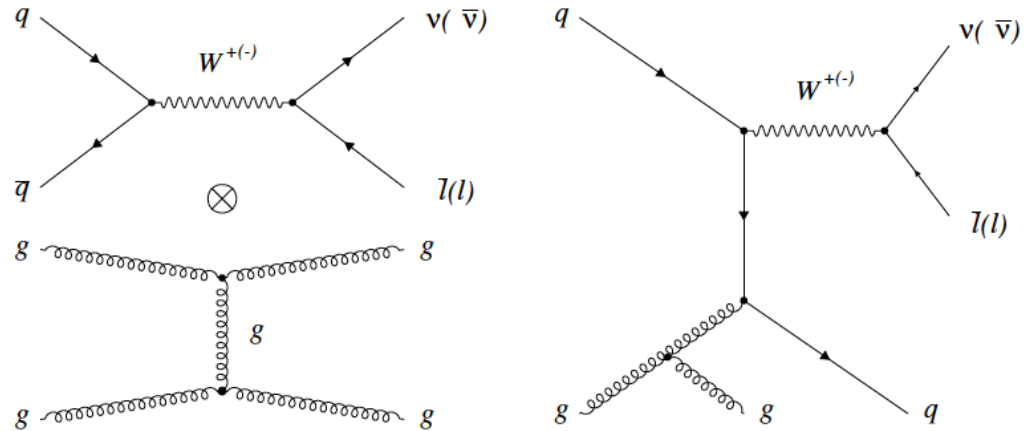


Figure 1. Feynman diagrams for W + 2-jet production from (left) double parton scattering and (right) single parton scattering.

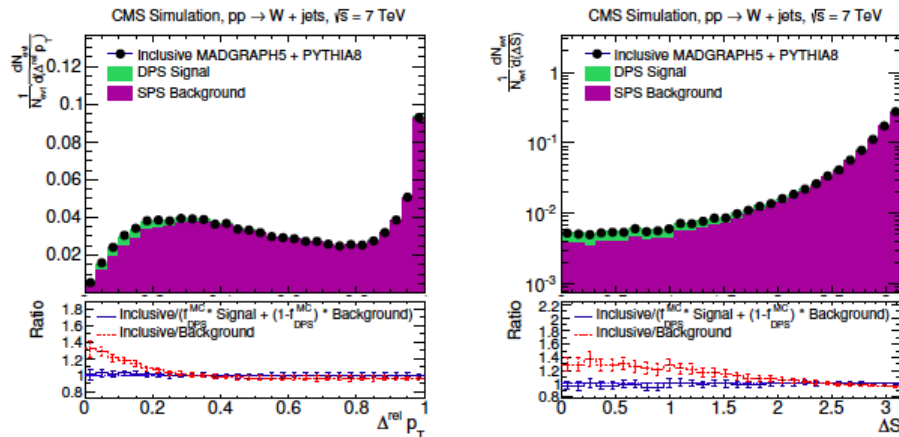


Figure 6. Fit results for the DPS-sensitive observables $\Delta^{\text{rel}} p_T$ (left) and ΔS (right) using signal and background templates. The distributions of the simulated W + 2-jet events are fitted with signal and background templates. The bottom panels show the ratio of the distributions to the fit results. Here, the term “inclusive” means the simulation also includes the DPS contribution.

- the relative p_T -balance between the two jets, $\Delta^{\text{rel}} p_T$, defined as:

$$\Delta^{\text{rel}} p_T = \frac{|\vec{p}_T(j_1) + \vec{p}_T(j_2)|}{|\vec{p}_T(j_1)| + |\vec{p}_T(j_2)|}$$

- The azimuthal angle between the W-boson and the dijet system, ΔS , defined as:

$$\Delta S = \arccos \left(\frac{\vec{p}_T(\mu, E_T) \cdot \vec{p}_T(j_1, j_2)}{|\vec{p}_T(\mu, E_T)| \cdot |\vec{p}_T(j_1, j_2)|} \right)$$

$$f_{\text{DPS}} = 0.055 \pm 0.002 \text{ (stat.)} \pm 0.014 \text{ (syst.)}$$

Study of DPS in pp collisions in W + dijet (CMS)

$$f_{\text{DPS}} = 0.055 \pm 0.002 (\text{stat.}) \pm 0.014 (\text{syst.})$$

$$\sigma_{\text{eff}} = 20.7 \pm 0.8 (\text{stat.}) \pm 6.6 (\text{syst.}) \text{ mb}$$

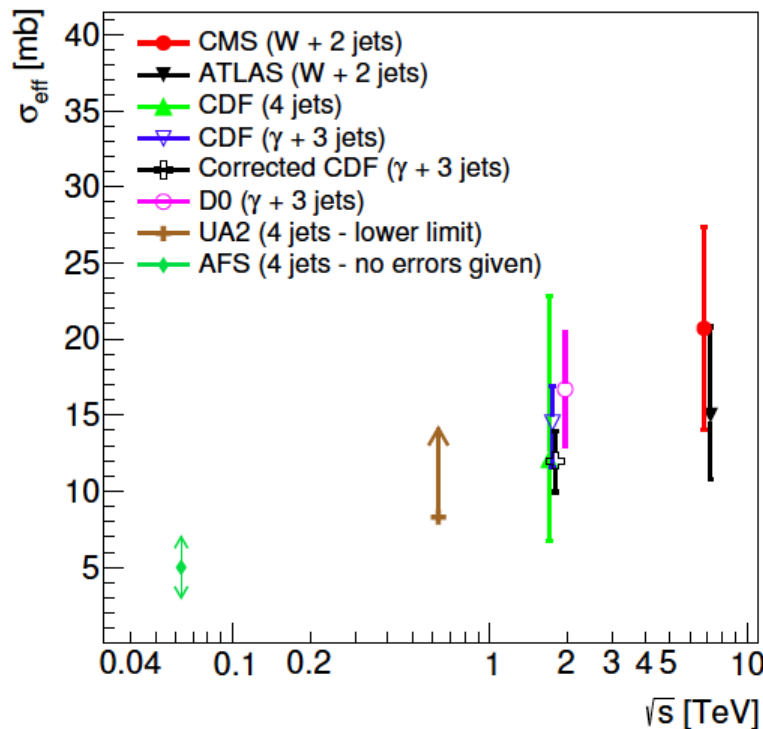


Figure 8. Centre-of-mass energy dependence of σ_{eff} measured by different experiments using different processes [8–12, 21]. These measurements used different approaches for extraction of the DPS fraction and σ_{eff} . The “Corrected CDF” data point indicates the σ_{eff} value corrected for the exclusive event selection [23].

Effective cross-section

- Effective transverse area of hard partonic interactions in collisions between protons
- Measurement using W+2-jet final state using pp collisions @7TeV
- Within uncertainty range, value is consistent with model predictions and other measurements
- Large systematic uncertainties: hinders to make a conclusion on invariance of effective cross-section
- Important to reduce the associated uncertainties

New variables and phase-space to explore DPS

PHYSICAL REVIEW D **93**, 054019 (2016)

New observables for multiple-parton interactions measurements using $Z + \text{jets}$ processes at the LHC

R. Kumar[†]

Panjab University, Chandigarh 160014, India

M. Bansal

D.A.V. College, Sector 10, Chandigarh 160010, India

S. Bansal* and J. B. Singh

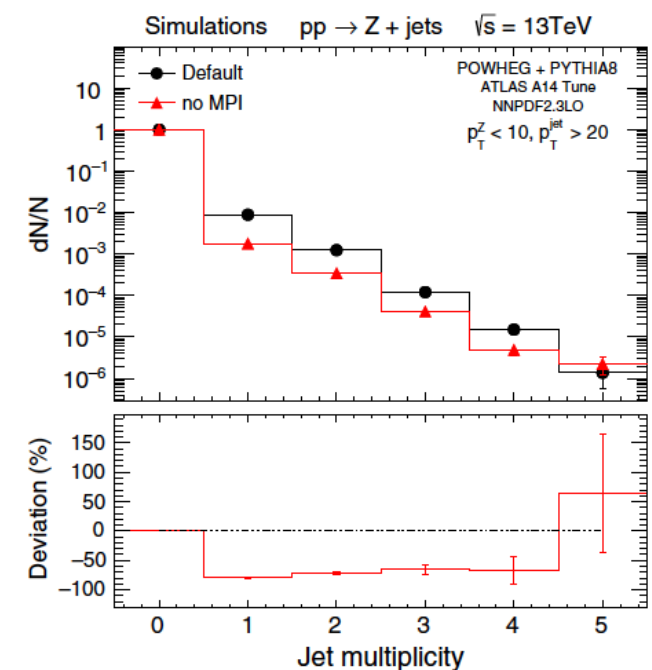
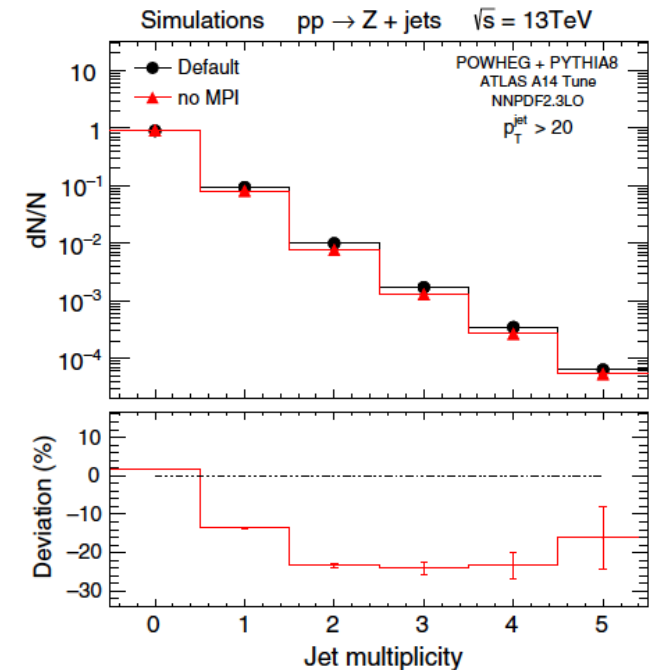
Panjab University, Chandigarh 160014, India

(Received 30 January 2016; published 9 March 2016)

Multiple-parton interactions (MPI) play a vital role in hadron-hadron collisions. This paper presents a study of the MPIs with simulated $Z + \text{jets}$ events in proton-proton collisions at a center-of-mass energy of 13 TeV. The events are simulated with POWHEG, followed by hadronization and parton showering using PYTHIA8. The events with dimuon invariant mass in the range of 60–120 GeV/ c^2 are selected for the analysis. The charged particle jets having a minimum transverse momentum of 5 GeV/ c and an absolute pseudorapidity less than 2 are used to construct the observables for measurements of the MPIs. The proposed observables and phase-space region presented in this paper are found to have enhanced sensitivity to MPIs. The increased sensitivity to MPIs will lead to precise constraints on the parameters of the MPI models.

DOI: [10.1103/PhysRevD.93.054019](https://doi.org/10.1103/PhysRevD.93.054019)

- The jet multiplicity distribution associated with the Z boson can be used to perform the inclusive MPI measurements at the LHC and to constrain MPI model parameters with better precision.
- The sensitivity to the presence of MPIs increases significantly by requiring an upper cut on the p_T of the Z boson.



Jet Fragmentation as a tool to study DPS

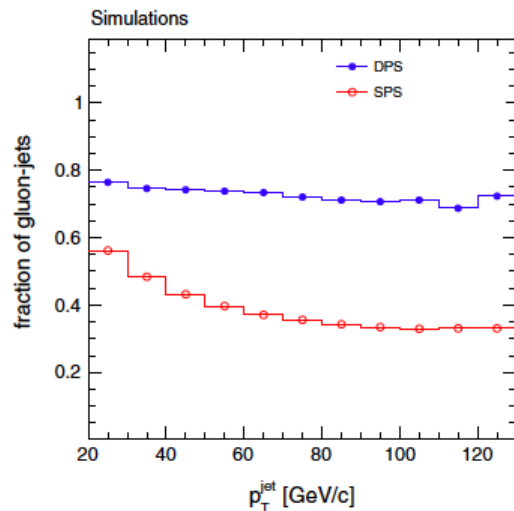
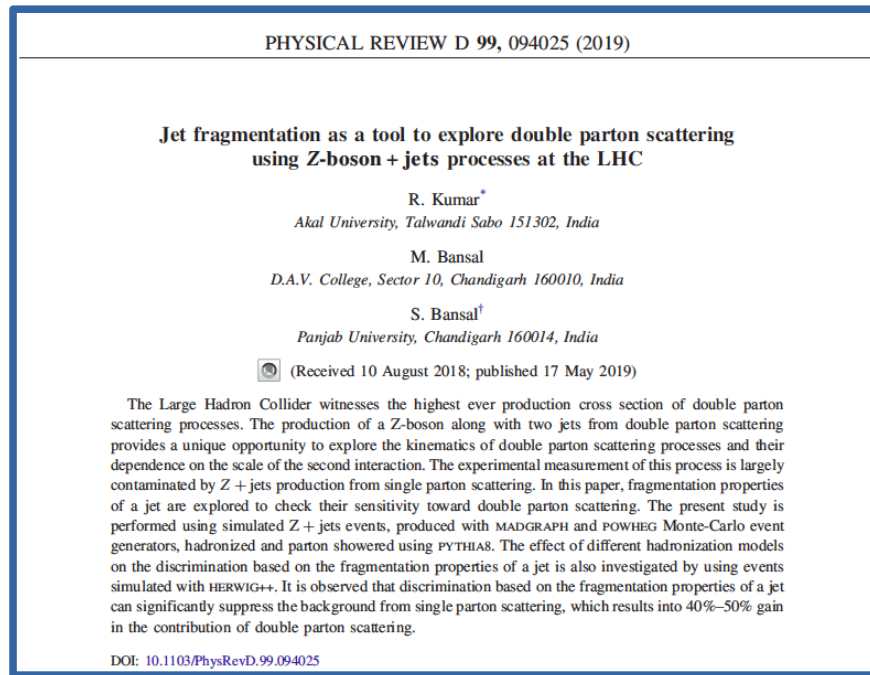


FIG. 1. The fraction of gluon-initiated jets as a function of the jet p_T in the simulated DPS (blue solid circle markers) and SPS (red hollow circle markers) events.

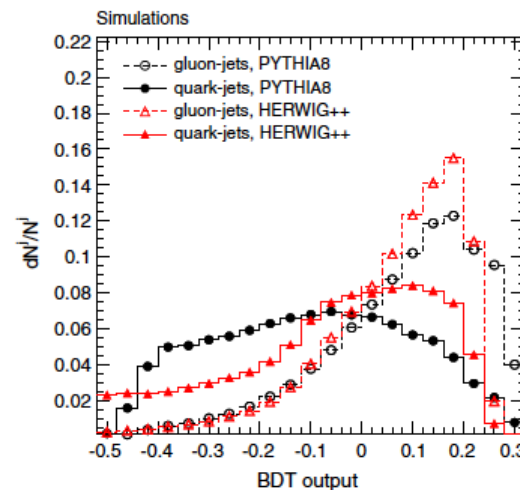


FIG. 3. BDT output for gluon-initiated (hollow markers) jets and quark-initiated jets (solid markers) in case of dijet events produced with PYTHIA8 (black colored markers) and HERWIG++ (red colored markers).

- The study of the Z + jets events to explore the possibility to enhance DPS sensitivity by suppressing SPS background with the use of differences in the fragmentation properties of jets initiated by quarks and gluons.
- Different observables (jet size, jet constituents multiplicity, and jet fragmentation function), defining the fragmentation behaviour of a jet, are used as input for the multivariate analysis and subsequently used to tag a jet as gluon-initiated or quark-initiated.
- It is observed that with the discrimination of gluon- and quark-initiated jet, it is possible to suppress SPS background up to 52% resulting in a 40%–50% gain in Z + 2-jets events produced by DPS.

Importance of Jet substructure studies in ePIC context

Nuclear Physics B (Proc. Suppl.) 191 (2009) 121–130

- Jet substructure provides a powerful tool to make stringent tests of pQCD:
 - Stringent tests of pQCD beyond LO
 - Comparison of properties of quark- and gluon-jets
 - Comparison of pattern of QCD radiation in different hard scattering processes
 - Determination of strong coupling
 - Study of dynamics of underlying subprocesses
 - Study of pattern of parton radiation

Summary

- Central University of Haryana is proposing to join ePIC with a plan to contribute for physics studies specifically in “Jets and Heavy Flavour” subgroup
- A brief introduction to the institution and faculty members (interested to join ePIC) including their previous works is presented
- Primary interest for physics analysis: study of jet substructure
- Open to contribute as per requirements of the subgroup

thank you