Comments from the Slack Channel

Thanks for all the lively discussions and great posters! I enjoyed this session much more than expected. Cheers!

-Dustin McNulty

I am really getting into this .. the videos are really well done!

-Ciprian Gal

"We found that all the posters were of very high quality and it was difficult to select the top two."

-Elton Smith

Lots of great videos! The judges have their work cut out for them!

-Lorelei Carlson

Special thanks to:

OUR JUDGES

Scott Barcus
Mark Dalton
Wouter Deconinck
Sean Dobbs
Dave Gaskell
Keith Griffioen
Doug Higinbotham
Yordanka Ilieva
Sebastian Kuhn
Dave Mack
Chris Monahan
Kostas Orginos
Will Phelps
Julie Roche
Elton Smith
Justin Stevens

OUR PLANNING COMMITTEE

Amy Schertz
Lorelei Carlson
Ed Brash
Kent Paschke
Julie Roche
Yordanka Ilieva
Susan Schadmand

...and our sponsor JSA!

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Top 8 Finalists

Pierre Chatagnon

Brandon Clary

Brandon Kriesten

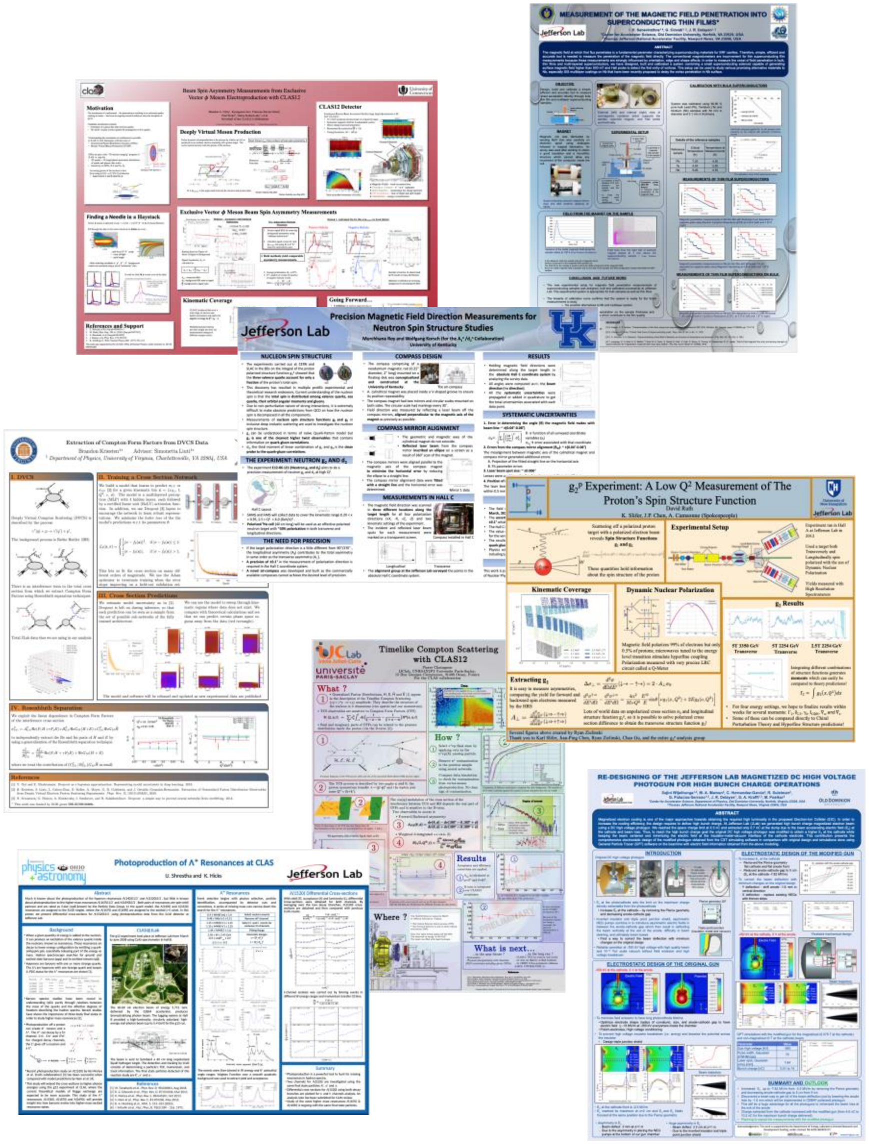
Murchhana Roy

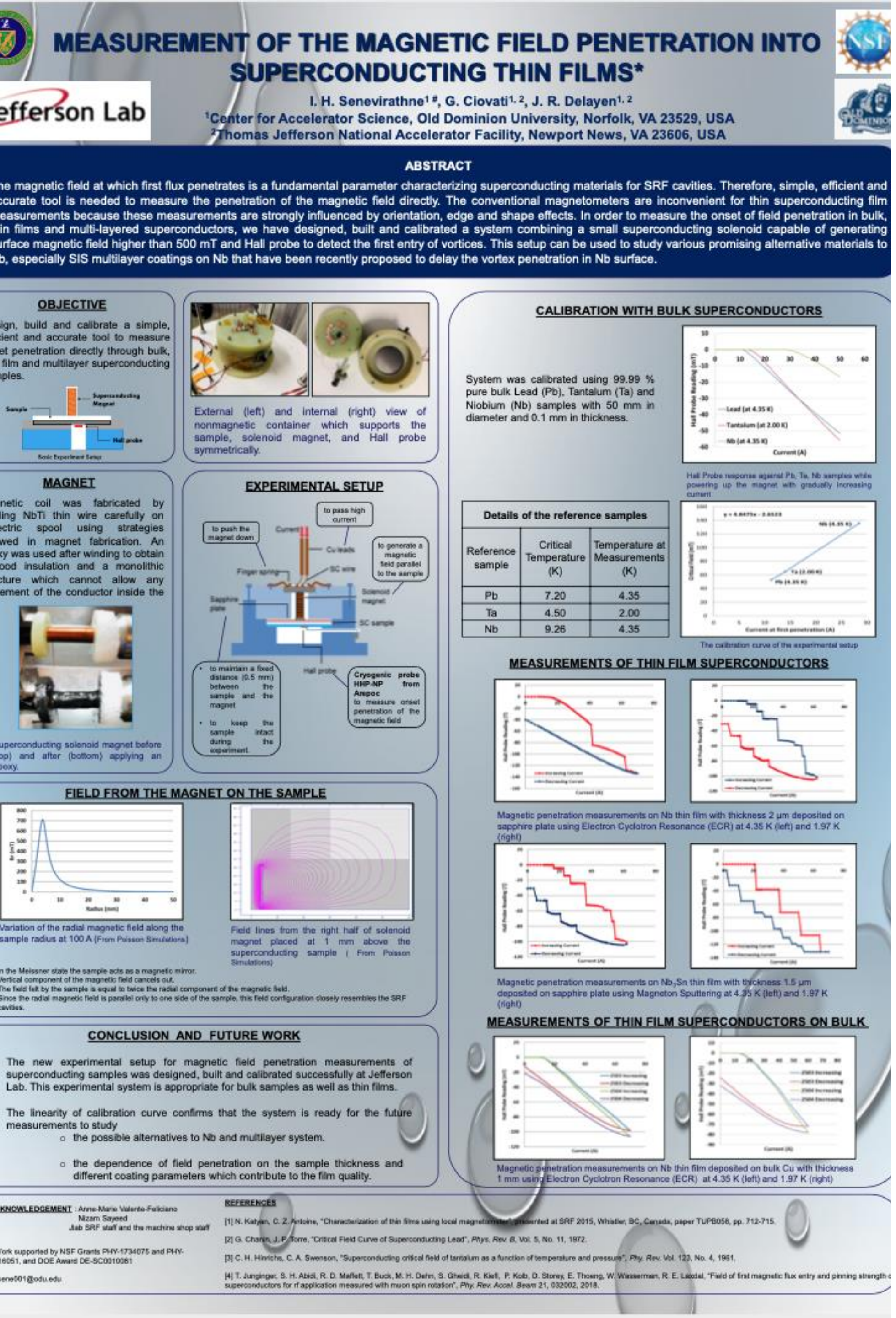
David Ruth

Iresha Harshani Senevirathne

Utsav Shrestha

Sajini Wijethunga





Iresha Harshani Senevirathne

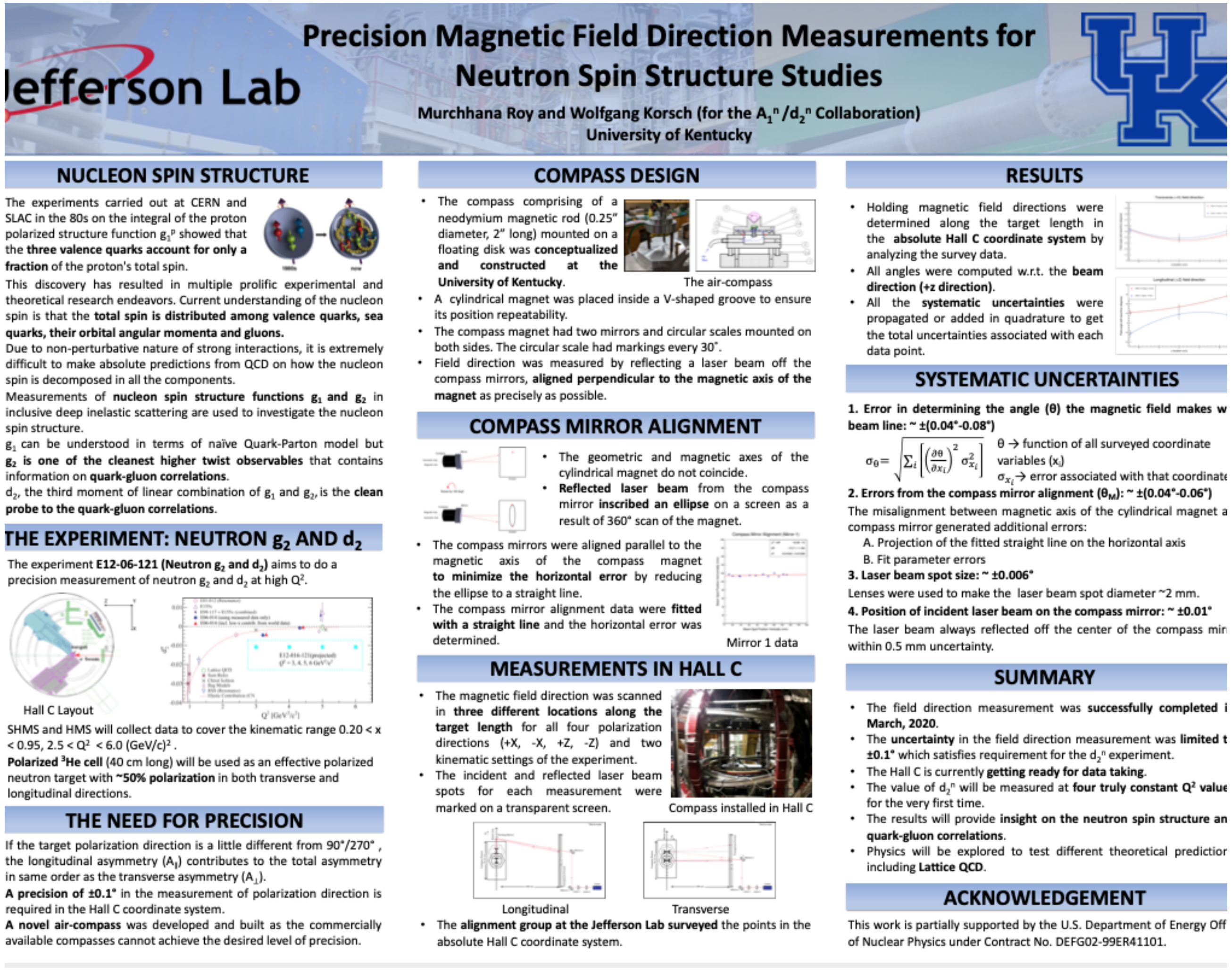
Old Dominion University

Measurements of the Magnetic Field Penetration into Superconducting Thin Films

Murchhana Roy

University of Kentucky

Precision Magnetic Field Direction Measurements for Neutron Spin Structure Studies



Jefferson Lab

Precision Magnetic Field Direction Measurements for Neutron Spin Structure Studies

Murchhana Roy and Wolfgang Korsch (for the A_1^n/d_2^n Collaboration)
University of Kentucky

NUCLEON SPIN STRUCTURE

The experiments carried out at CERN and SLAC in the 80s on the integral of the proton polarized structure function g_1^p showed that the **three valence quarks account for only a fraction** of the proton's total spin.

This discovery has resulted in multiple prolific experimental and theoretical research endeavors. Current understanding of the nucleon spin is that the **total spin is distributed among valence quarks, sea quarks, their orbital angular momenta and gluons.**

Due to non-perturbative nature of strong interactions, it is extremely difficult to make absolute predictions from QCD on how the nucleon spin is decomposed in all the components.

Measurements of **nucleon spin structure functions g_1 and g_2** in inclusive deep inelastic scattering are used to investigate the nucleon spin structure.

g_1 can be understood in terms of naïve Quark-Parton model but **g_2 is one of the cleanest higher twist observables** that contains information on **quark-gluon correlations**.

d_2, the third moment of linear combination of g_1 and g_2, is the **clean probe to the quark-gluon correlations.**

THE EXPERIMENT: NEUTRON g_2 AND d_2

The experiment **E12-06-121 (Neutron g_2 and d_2)** aims to do a precision measurement of neutron g_2 and d_2 at high Q^2.

Hall C Layout

SHMS and HMS will collect data to cover the kinematic range $0.20 < x < 0.95$, $2.5 < Q^2 < 6.0$ (GeV/c)^2.

Polarized ^{3}He cell (40 cm long) will be used as an effective polarized neutron target with **~50% polarization** in both transverse and longitudinal directions.

THE NEED FOR PRECISION

If the target polarization direction is a little different from 90°/270°, the longitudinal asymmetry ($A_\parallel$) contributes to the total asymmetry in same order as the transverse asymmetry ($A_\perp$).

A precision of ±0.1° in the measurement of polarization direction is required in the Hall C coordinate system.

A novel air-compass was developed and built as the commercially available compasses cannot achieve the desired level of precision.

COMPASS DESIGN

- The compass comprising of a neodymium magnetic rod (0.25" diameter, 2" long) mounted on a floating disk was **conceptualized and constructed at the University of Kentucky.**

The air-compass

- A cylindrical magnet was placed inside a V-shaped groove to ensure its position repeatability.
- The compass magnet had two mirrors and circular scales mounted on both sides. The circular scale had markings every 30°.
- Field direction was measured by reflecting a laser beam off the compass mirrors, **aligned perpendicular to the magnetic axis of the magnet** as precisely as possible.

COMPASS MIRROR ALIGNMENT

- The geometric and magnetic axes of the cylindrical magnet do not coincide.
- **Reflected laser beam** from the compass mirror **inscribed an ellipse** on a screen as a result of 360° scan of the magnet.
- The compass mirrors were aligned parallel to the magnetic axis of the compass magnet **to minimize the horizontal error** by reducing the ellipse to a straight line.
- The compass mirror alignment data were **fitted with a straight line** and the horizontal error was determined.

Mirror 1 data

MEASUREMENTS IN HALL C

- The magnetic field direction was scanned in **three different locations along the target length** for all four polarization directions (+X, -X, +Z, -Z) and two kinematic settings of the experiment.
- The incident and reflected laser beam spots for each measurement were marked on a transparent screen.

Compass installed in Hall C

Longitudinal

Transverse

- The **alignment group at the Jefferson Lab surveyed** the points in the absolute Hall C coordinate system.

RESULTS

- Holding magnetic field directions were determined along the target length in the **absolute Hall C coordinate system** by analyzing the survey data.
- All angles were computed w.r.t. the **beam direction (+z direction).**
- All the **systematic uncertainties** were propagated or added in quadrature to get the total uncertainties associated with each data point.

SYSTEMATIC UNCERTAINTIES

1. Error in determining the angle (θ) the magnetic field makes w[ith the] beam line: ~ ±(0.04°-0.08°)

$$\sigma_\theta = \sqrt{\sum_i \left[\left(\frac{\partial\theta}{\partial x_i}\right)^2 \sigma_{x_i}^2\right]}$$

θ → function of all surveyed coordinate variables (x_i)

σ_{x_i} → error associated with that coordinate

2. Errors from the compass mirror alignment (θ_M): ~ ±(0.04°-0.06°)

The misalignment between magnetic axis of the cylindrical magnet a[nd] compass mirror generated additional errors:

A. Projection of the fitted straight line on the horizontal axis

B. Fit parameter errors

3. Laser beam spot size: ~ ±0.006°

Lenses were used to make the laser beam spot diameter ~2 mm.

4. Position of incident laser beam on the compass mirror: ~ ±0.01°

The laser beam always reflected off the center of the compass mir[ror] within 0.5 mm uncertainty.

SUMMARY

- The field direction measurement was **successfully completed i[n] March, 2020.**
- The **uncertainty** in the field direction measurement was **limited t[o] ±0.1°** which satisfies requirement for the d_2^n experiment.
- The Hall C is currently **getting ready for data taking.**
- The value of d_2^n will be measured at **four truly constant Q^2 value[s]** for the very first time.
- The results will provide **insight on the neutron spin structure an[d] quark-gluon correlations.**
- Physics will be explored to test different theoretical predictio[ns] including **Lattice QCD.**

ACKNOWLEDGEMENT

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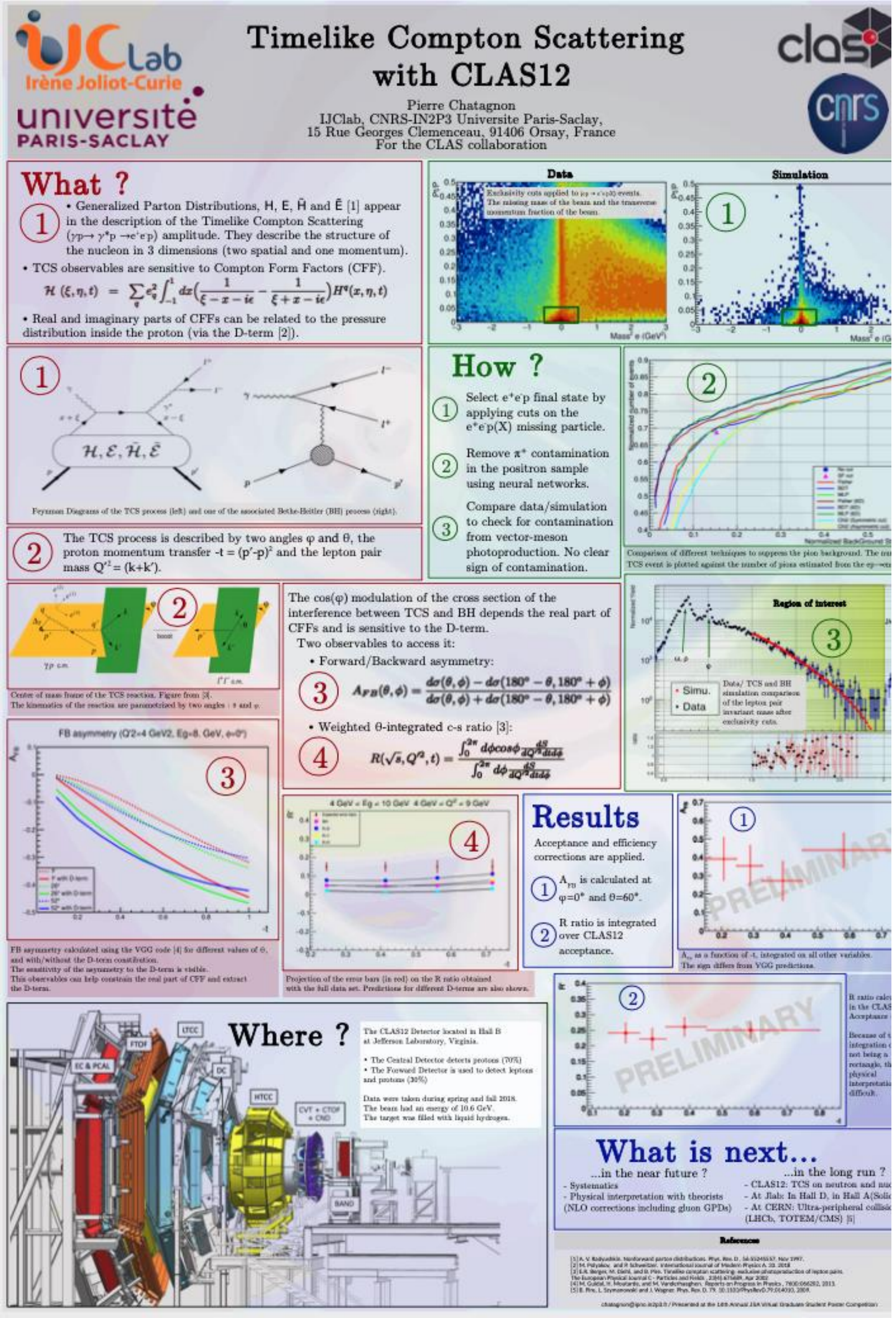

Pierre Chatagnon

IJC lab/ Université Paris-Saclay

Timelike Compton Scattering with CLAS12