
Center for Nuclear Femtography Initiative

David Richards (Jefferson Lab)

“Computing Round Table, 12th Feb 2019”

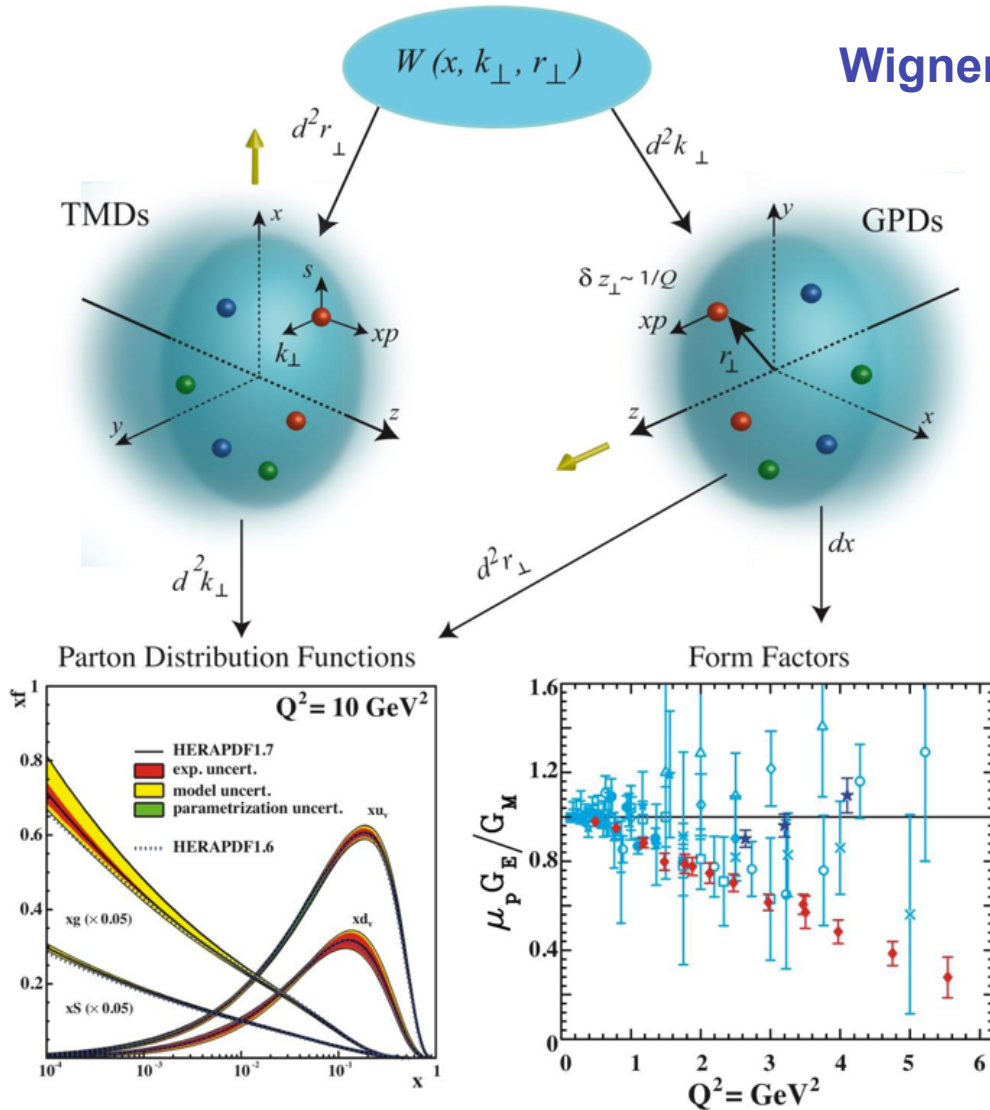
Why? 3D Imaging of Nucleon

5D

SIDIS
Drell-Yan

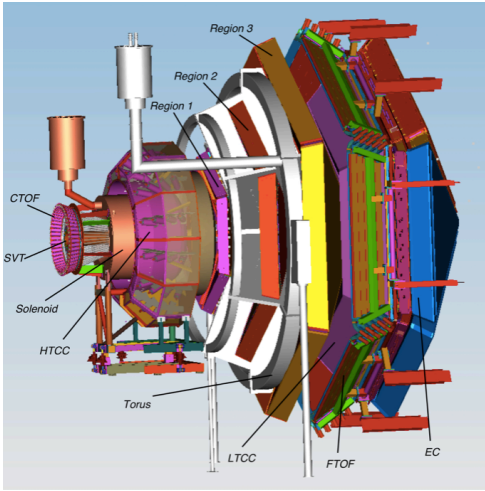
3D

1D



DVCS
DVMP
Exclusive
Drell-Yan

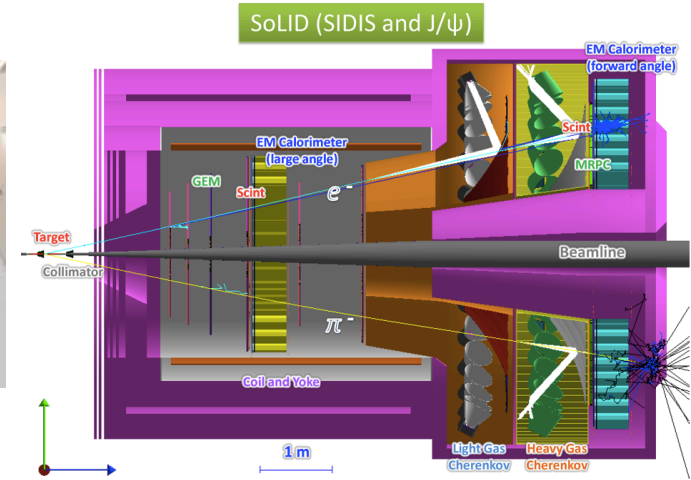
Why Now?



GPDs



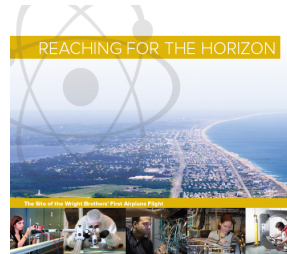
Lattice QCD



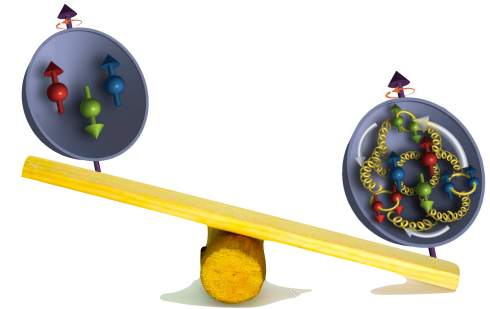
TMDs

Electron-Ion Collider

“Understanding the Glue That Binds Us All: The Next QCD Frontier in Nuclear Physics”



The 2015
LONG RANGE PLAN
for NUCLEAR SCIENCE



Virginia Center for Nuclear Femtography

- funded by Commonwealth to “.....to facilitate the application of modern developments in **data science** to the problem of imaging and visualization of sub-femtometer scale structure of protons, neutrons, and atomic nuclei”
- Multi-disciplinary, bringing together nuclear theorists and experimentalists, mathematicians, computer scientists,... .. and architects and artists!
- Workshop at University of Virginia

FEMTOGRAPHY 2018

Symposium on Imaging and Visualization in Science

December 10-11, 2018, University of Virginia

The Symposium on Imaging and Visualization in Science will be held at the University of Virginia December 10-11, 2018. This symposium will bring together scholars and researchers from Virginia universities and research institutes to discuss recent developments and future opportunities in the imaging and visualization of scientific data.



Multi-disciplinary

09:00 - 10:45

Plenary Session I: Stuart Henderson, Chair

Location: Pavilion I

Welcome: Bob Jones (UVa Physics dept. Chair) 15'

Opening Remarks: Jerry Draayer (SURA) 15'

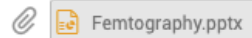
Speaker: Jerry Draayer (SURA)

Introduction to Symposium Themes: Bob McKeown (Jefferson LAB) 15'

Speaker: Bob McKeown (JLAB)

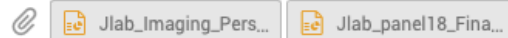
Introduction to Nuclear Femtography: Xiangdong Ji (University of Maryland) 30'

Speaker: Xiangdong Ji (University of Maryland)



Perspectives on Imaging for Scientific Breakthroughs: Nikos Chrisochoides (ODU) 30'

Speaker: Nikos Chrisochoides (ODU)



10:45 - 11:00

Coffee Break (Boar's Head Inn)

11:00 - 12:30

Plenary Session II: David Doughty, Chair

Location: Pavilion I

Perspectives on Visualization for Scientific Breakthroughs: Nicholas Polys (VPI) 30'

Perspectives on Computational Science for the Exascale Era: Xu Liu (W&M) 30'

Speaker: Xu Liu (William and Mary)

Perspectives on Data Science for Scientific Breakthroughs: Eric Field (UVA) 30'

Speaker: Eric Field (UVA)



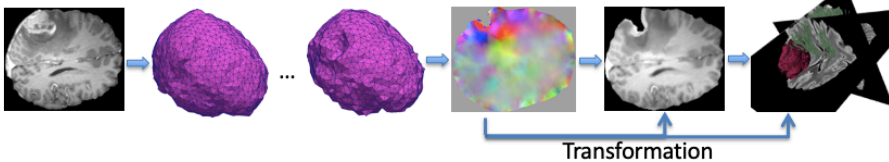
Incomplete Data and Inverse Problem

- Important issue across many areas of physics, biology, geophysics,...

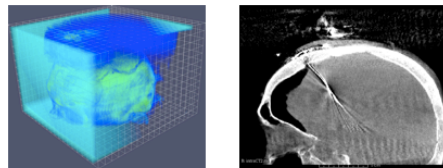
Slide from *Nikos Chrisochoides* (ODU)

Real-Time deformable registration for Image Guided Neurosurgery

- Deformable Registration for Brain Tumor Resection and Deep Brain Stimulation (with Harvard Medical School)



- Deep Brain Stimulation – CT Imaging obtained from Neurosurgical Section of SE PADRECC McGuire VAMC (with VCU)



- CRTC's niche:
Generate real-time and/or large-scale grids for field solvers using adaptive FEM on multi-node (multi-core and GPU) platforms.

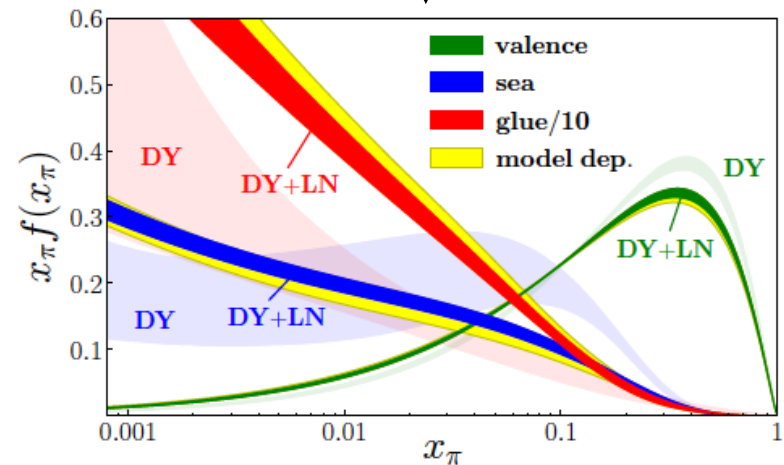


[1] Drakopoulos Fotis, Liu Yuxin, Fotinos Panagiotis, Chrisochoides Nikos P, Towards a Real Time Multi-Tissue Adaptive Physics Based Non-Rigid Registration Framework for Brain Tumor Resection, *Frontiers in Neuroinformatics*, 2024.
 [2] Fotis Drakopoulos and Nikos P. Chrisochoides, Accurate and fast deformable medical image registration for brain tumor resection using image-guided neurosurgery, *Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization*, Vol4, Iss2, 2020.
 [3] Fotis Drakopoulos, Michael Weisberger, Kathryn Holloway, Nikos Chrisochoides, VMASC Capstone Conference, Biomechanical Deformable Registration For Deep Brain Stimulation.

Measured Output

$$\sigma = \int H \otimes f_a \otimes f_b$$

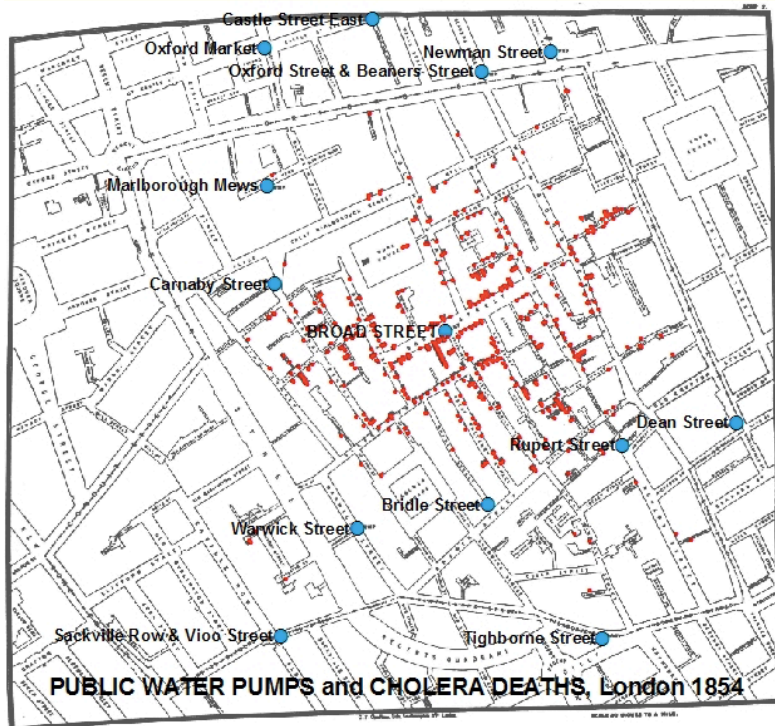
Barry et al, arXiv:
1804.01965



Visualisation

- Two roles
 - Gaining insight
 - Improving analysis

Dr Snow's 1854 Cholera Map



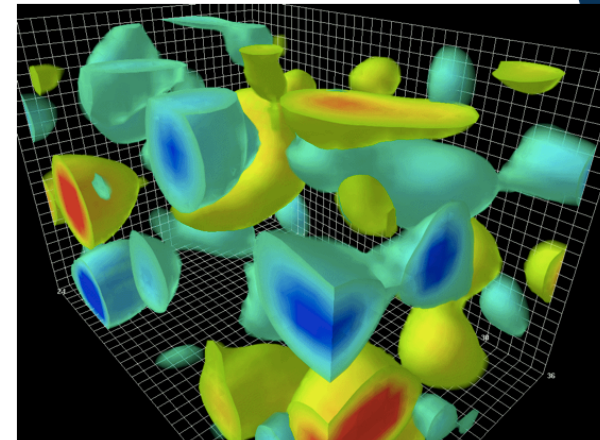
N Polys, VPI slide from Charles Hyde

How do we gain insight?

The best "Femto-Image" to-date

- Gluon vacuum fluctuations in a volume the size of two protons

<http://www.physics.adelaide.edu.au/theory/staff/leinweber/VisualQCD/QCDvacuum/>



12/11/2018

Femto-graphy C. Hyde

3

Machine Learning

- Already starting to use... ..e.g. NNPDFs, LQCD, *accelerate science*.

Classification: Wolf or a Husky?



Only 1 mistake!

We've built a snow detector...



Eric Field, School of Architecture, UVA

Current Activities - I

- **Steering Committee:** *L. Elouadrhiri (JLab), D. Richards (JLab), A. Accardi (HU), D. Doughty (CNU), C. Hyde (ODU), S. Liuti (UVA), R. McKeown (JLab), N. Polys (VPI), J. Qiu (JLab), A. Strathopoulos (WM), G. Triplett (VCU), R. Yoshida (JLab)*
- **Call for Proposals; Deadline 15th Feb, 2019**
 - < 50K, with PI at Virginia Institution
 - **Topics**
 - The construction of a QCD-inspired reference model for the nucleon, including that of the Wigner Distribution, that can serve as synthetic input for the activities below.
 - The development of images of the nucleon through fitting to experimental data with theoretical input, reflecting constraints arising from limitations both in experiment and theory.
 - The use of visualization, both as a means of imaging the nucleon and of refining our analysis methodology.
 - Applications of machine learning to data analysis, interpretation and classification.
 - The development and application of computational and mathematical methods and the associated computational infrastructure.

Current Activities - II

- Timeline is important!
 - Deliverable and mid-term report: 1st July, 2019
 - Deliverables and final report: 30th Sept, 2019.
- *Submit proposal to establish long-term future of CNF by end of summer, 2019.*
- Session on 3D Imaging at GHP Meeting in April
- **Workshops**
 - **PI Meeting:** centered on activities following CfP.
 - **Wigner Function:** in nuclear and atomic physics?
- Visitor Programme
- Development of Web Site

Aim is the world-leading center for the femtography of nucleons and nuclei.