Interdisciplinary Nuclear Femtography center

- Next steps
- 5 year horizon
- 10, 25 year horizon
- Science case
Next steps

0.5 million $ to scope the center

- Organizational structure

- Define the model for engagement/hiring of staff
  - Will it hire permanent research staff?
  - Engage faculty from other institutions via joint appointment?
  - Visitor’s program
  - Fellowship program
  - Graduate student program?
  - Application-driven recruitment?

- Define development model ($2 million yearly budget for next 5 years?)
  - Growth target
  - Funding model to grow interdisciplinary interactions e.g. support mostly interdisciplinary projects/collaborations?
  - How to benefit from developments in other disciplines beyond computer science and applied mathematics?

- Define research plan
  - 5 year plan
  - 10 to 25 year plan

- Define infrastructure needs
Science case for nuclear femtography center

Strong community in lattice QCD with large growth potential based on advanced computing technologies - compute and data driven → Low-hanging fruit
5-year horizon: Prepare for exascale era

- Pre-exascale computers are becoming available in the US and in a couple of years in Europe
- Need the development of algorithms
- Multi-grid essential for physical point calculations but not good scalability

→ Need to collaborate with applied Mathematicians and computer scientists
An example of a complete lattice QCD calculation: Low-lying spectrum

Several lattice spacings $\rightarrow$ continuum extrapolation
Several volumes $\rightarrow$ infinite volume limit
Example of an exascale problem: Proton charge radius

Compute electromagnetic form factors using simulations with physical values of the quarks masses and disconnected contributions

→ Need to do the full program
Proton charge radius

- Three lattice spacing for continuum extrapolation
  
  \[ a \approx 0.08 \text{ fm on } 64^3 \times 128 \text{ (done), } a \approx 0.07 \text{ fm on } 80^3 \times 160 \text{ and } a \approx 0.055 \text{ fm on } 96^3 \times 192 \text{ corresponding to similar physical volumes } \Rightarrow 225 \text{ million Pascal GPU-hours and 1.5 Pb of data} \]

- Three volumes for estimating volume effects
Exascale multi-year problem: Parton (generalized) distribution functions

- Theoretical developments
- Scalable algorithms, noise reduction

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10 year horizon

- Precision hadron physics
- Resonances
- Scattering properties

Need exascale enabled algorithms, data management/mining and scalable visualization

Data approaches such as machine and deep learning to probe correlations, extract more information from lattice QCD data, plan simulations?