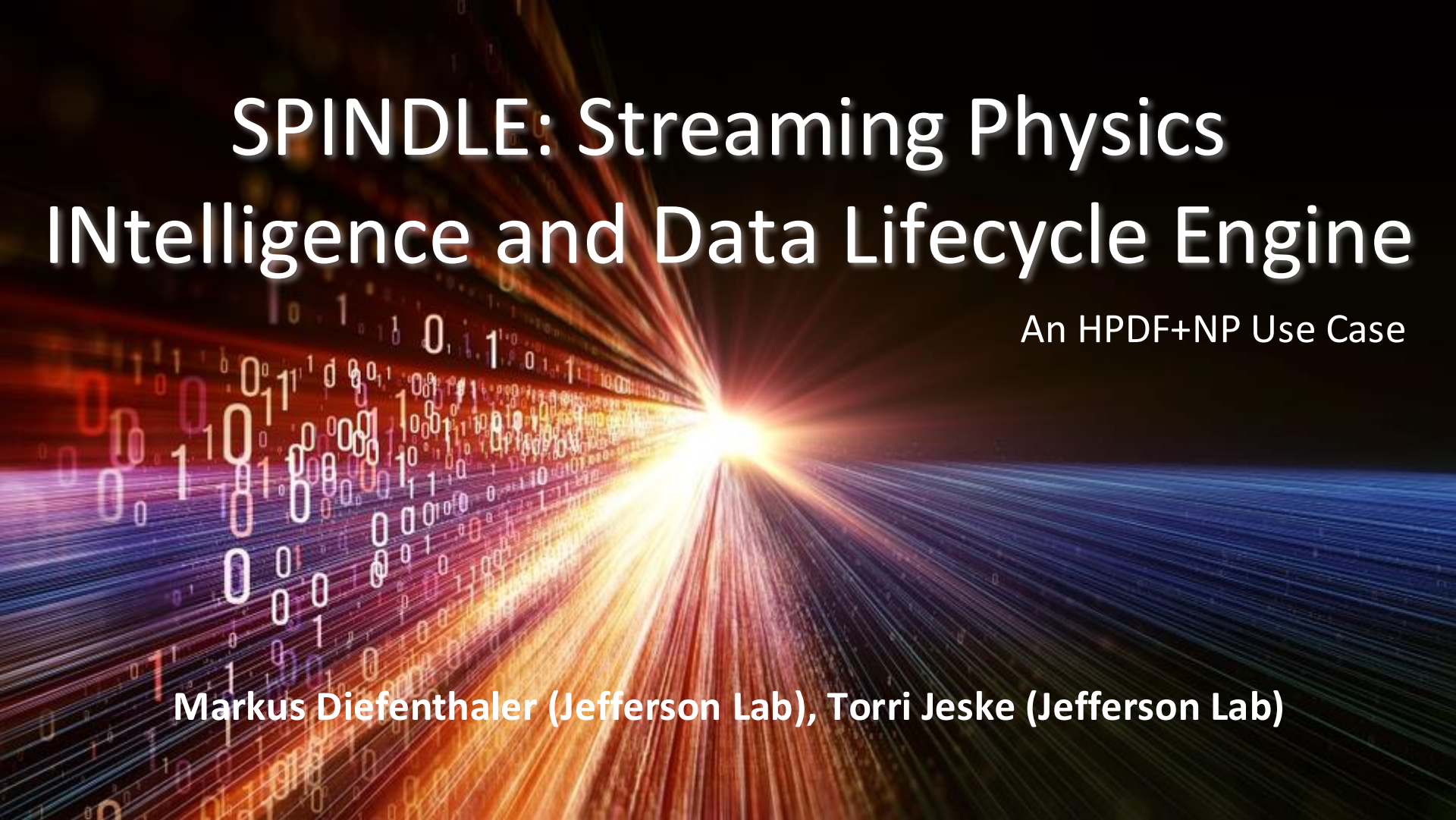


The background is a dark, abstract image featuring a perspective view of a digital tunnel. On the left side, there are numerous binary digits (0s and 1s) in various colors (white, yellow, orange, red) that appear to be floating or moving towards the center. A bright, glowing light source is positioned at the center of the tunnel, creating a strong lens flare and illuminating the scene. The right side of the image shows a blue, textured surface that recedes into the distance, suggesting a horizon or a path. The overall effect is one of high-speed data flow and digital technology.

SPINDLE: Streaming Physics INtelligence and Data Lifecycle Engine

An HPDF+NP Use Case

Markus Diefenthaler (Jefferson Lab), Torri Jeske (Jefferson Lab)

Jefferson Lab's Science and Technology Vision

Nuclear Physics at CEBAF

Electron-Ion Collider Partnership

Data and Computational Science, and HPDF

Accelerator Science & Technology



- This talk highlights the NP-ASCR interplay at Jefferson Lab.
- Specifically, I would like to discuss how the High Performance Data Facility (HPDF) can enhance NP use cases and its data pipelines, and how NP use cases can in turn guide HPDF evolution.

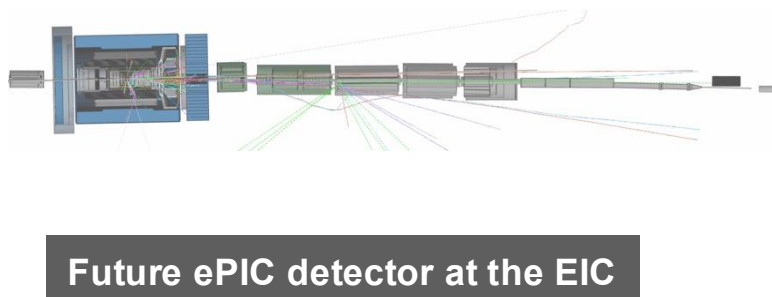
HPDF Vision

- HPDF will be a unique “data first facility” that treats data as a first-class asset and provides capabilities needed to extract maximum scientific value
- AI-driven science requires production-quality data services, a capability that does not exist today at the needed scale
- HPDF will continuously evolve to be the leading facility of its kind with a scalable, modular approach for providing a mix of compute and storage types tailored for
 - Real time computing
 - Changing science needs
 - Rapid response to industry directions



HPDF and DOE Facilities

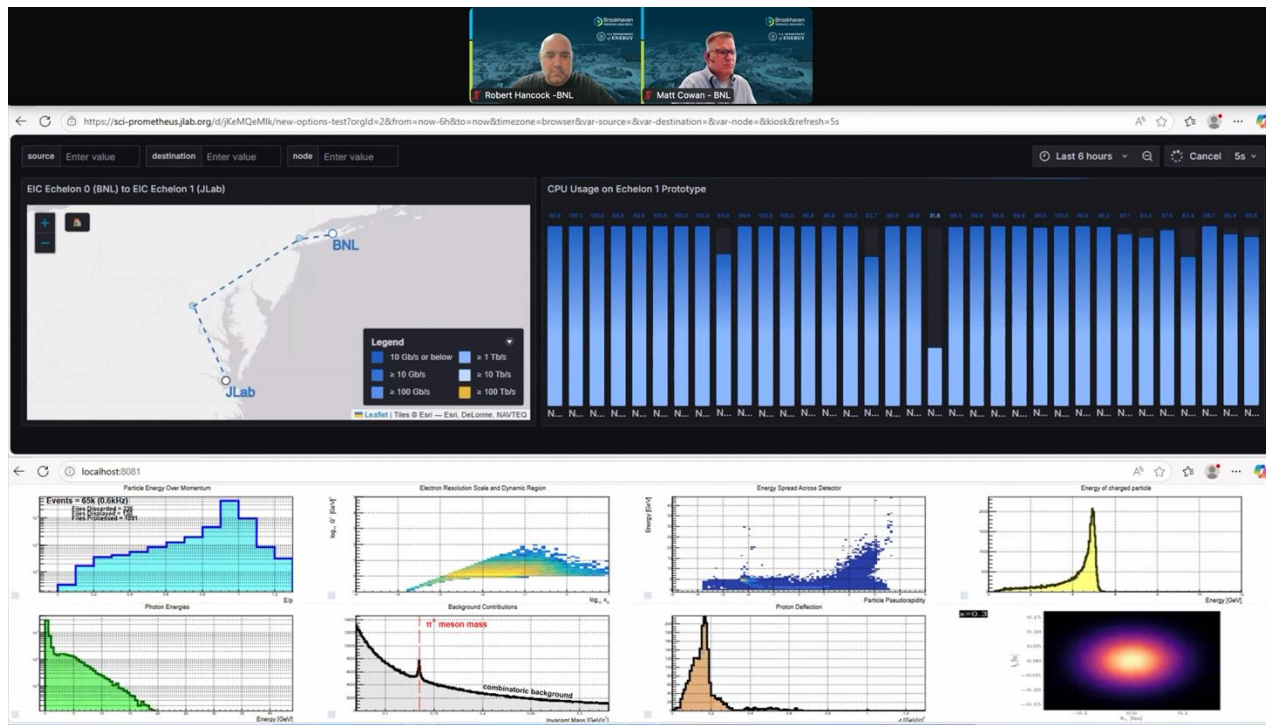
- The DOE ecosystem is unique; its user facilities provide an opportunity for HPDF services to participate in all parts of the data lifecycle.
- HPDF is partnering with science programs to co-develop capabilities
- HPDF is partnering with CEBAF and EIC experiments to investigate how HPDF can solve practical problems where data is processed continuously as it is collected
 - Real time data movement
 - Real time data cataloging and curation
- *Early successes already demonstrated!*



Building on the Streaming Data Processing Demonstration



Secretary Wright's Visit to Jefferson Lab on August 21



We successfully showcased **real-time data transfer from BNL to JLab** using the ESnet-JLab FPGA Accelerated Transport (EJFAT) Load Balancer and its **real-time processing at JLab**.

We Did It Again: Demonstration for Under Secretary Dario Gil

Dario Gil, Under Secretary for Science and Genesis Mission Director, visited Jefferson Lab on June 12 for the groundbreaking of the Jefferson Lab Data Center, the future home of the HPDF.



Graham Heyes presented the status and plans for HPDF and its connection to the Genesis Mission and JLab.



David Lawrence and Markus Diefenthaler demonstrated detector-computing co-design based on streaming readout and AI through streaming data transfer from BNL to JLab and real-time processing.

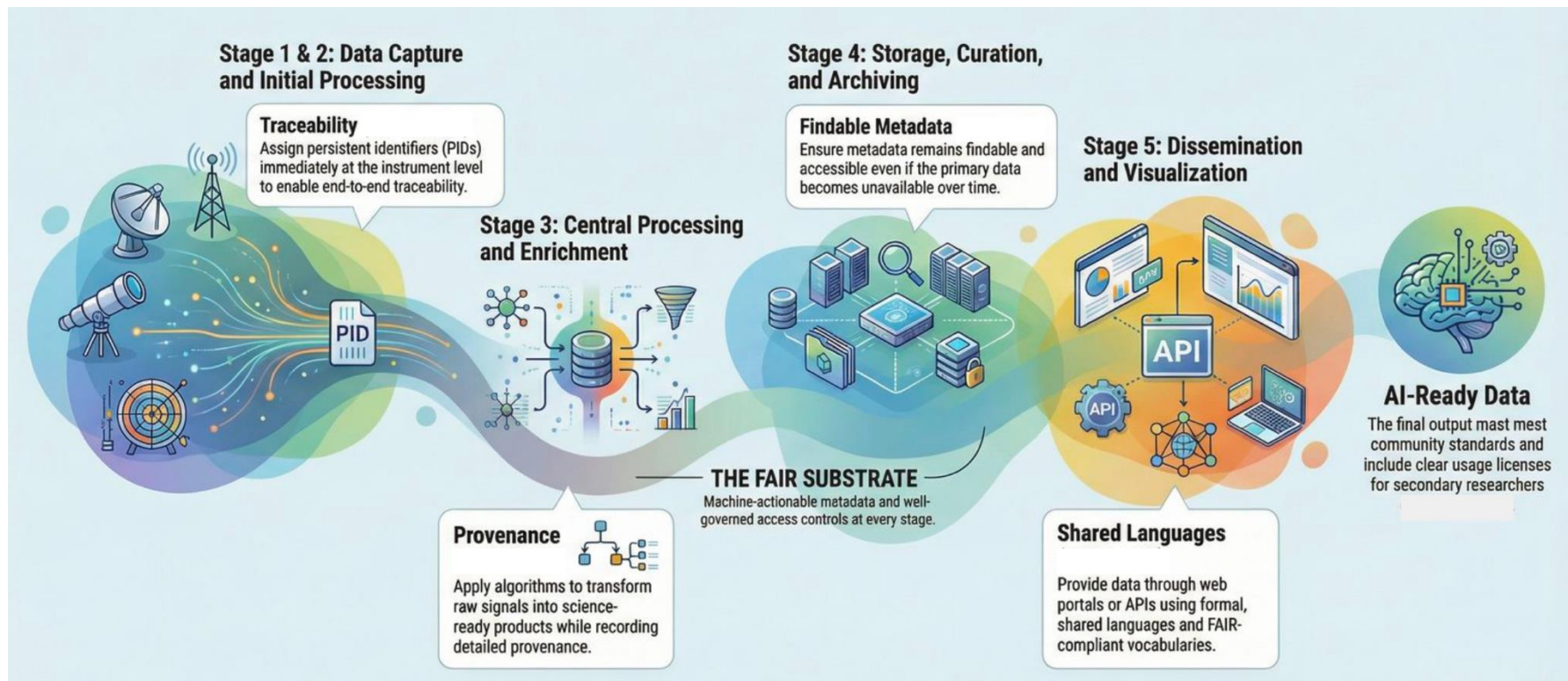


Dario Gil emphasized the role of closed-loop experimental approaches, and we highlighted how continuous readout and AI integration can enable them.

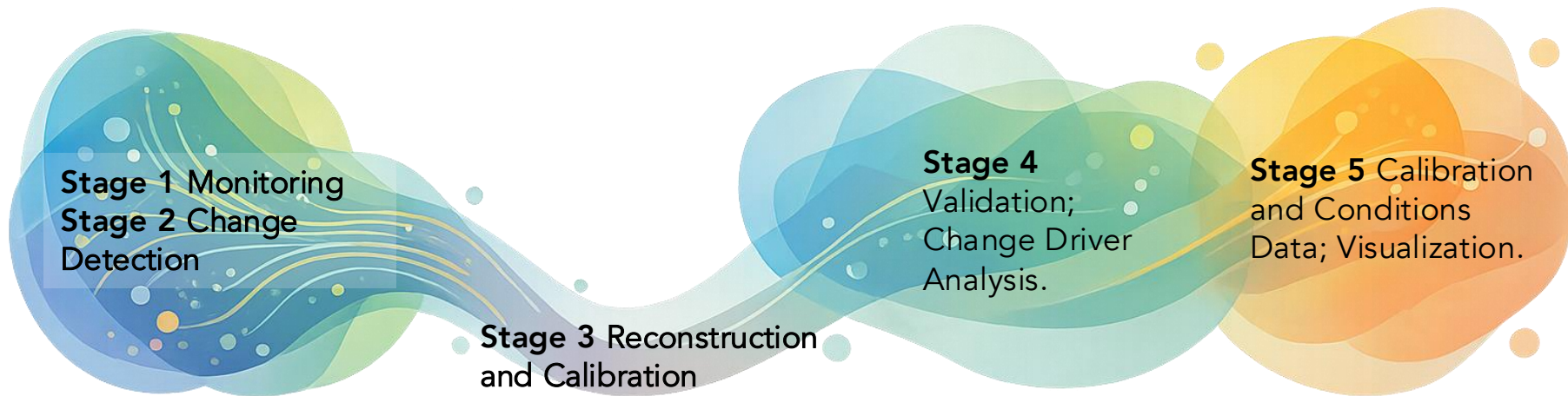
HPDF and NP

- We aim to build on the streaming data processing demonstration.
- We reviewed streaming computing vision at Jefferson Lab.
- We identified technology gaps: Streaming Orchestration.
 - This is needed for both streaming readout-based experiments and HPDF.
 - Streaming orchestration refers to workflow and workload management for streaming data, or in HPDF terms, time sensitive patterns.
- We aim to highlight how HPDF can enhance the NP use case and its data pipelines, and how the NP use case can in turn guide HPDF evolution. This connects to the data lifecycle and FAIR principles.
- We defined an NP use case for HPDF that builds on the: **Online Calibrations.**

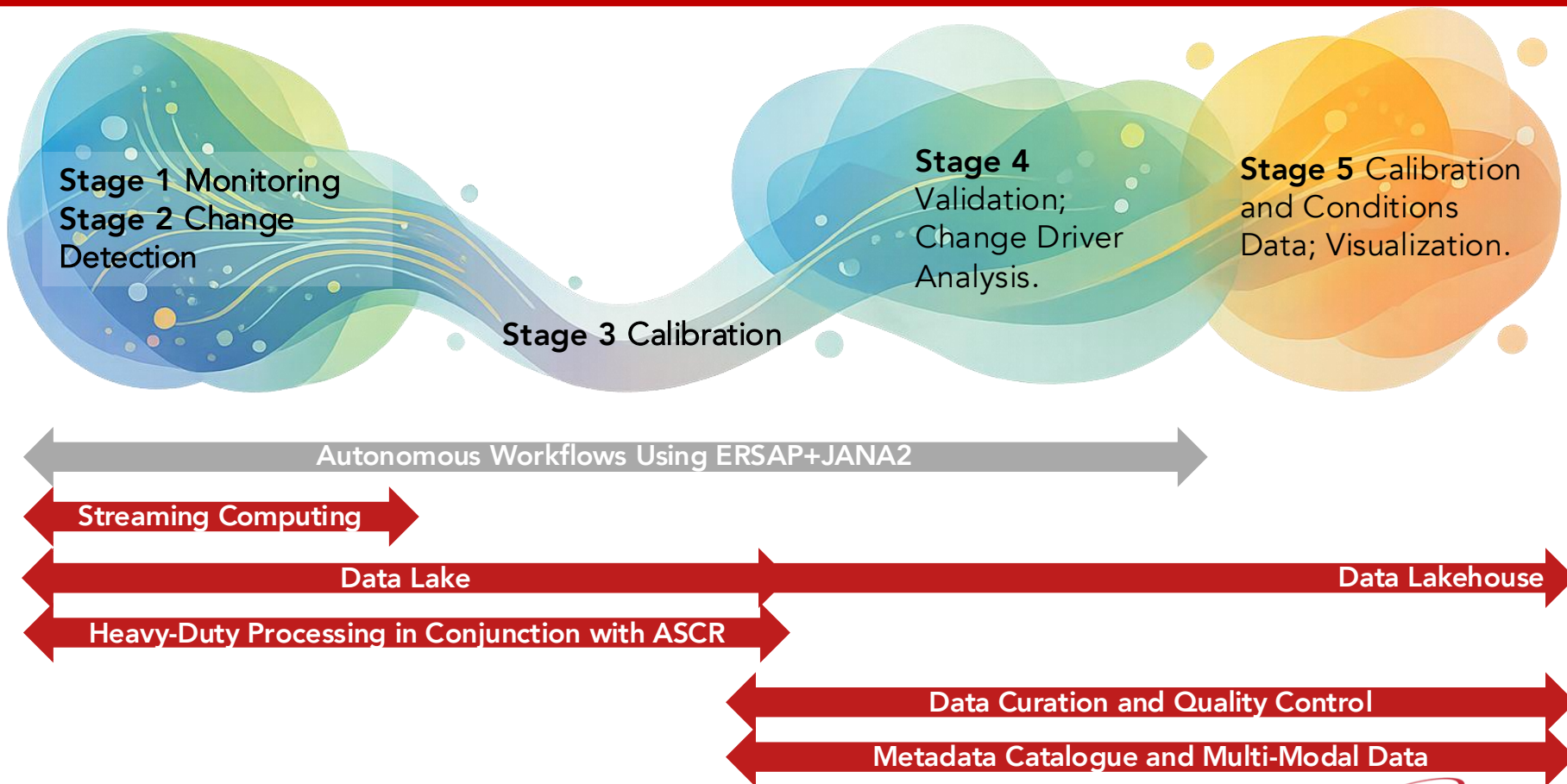
Data Lifecycle and FAIR



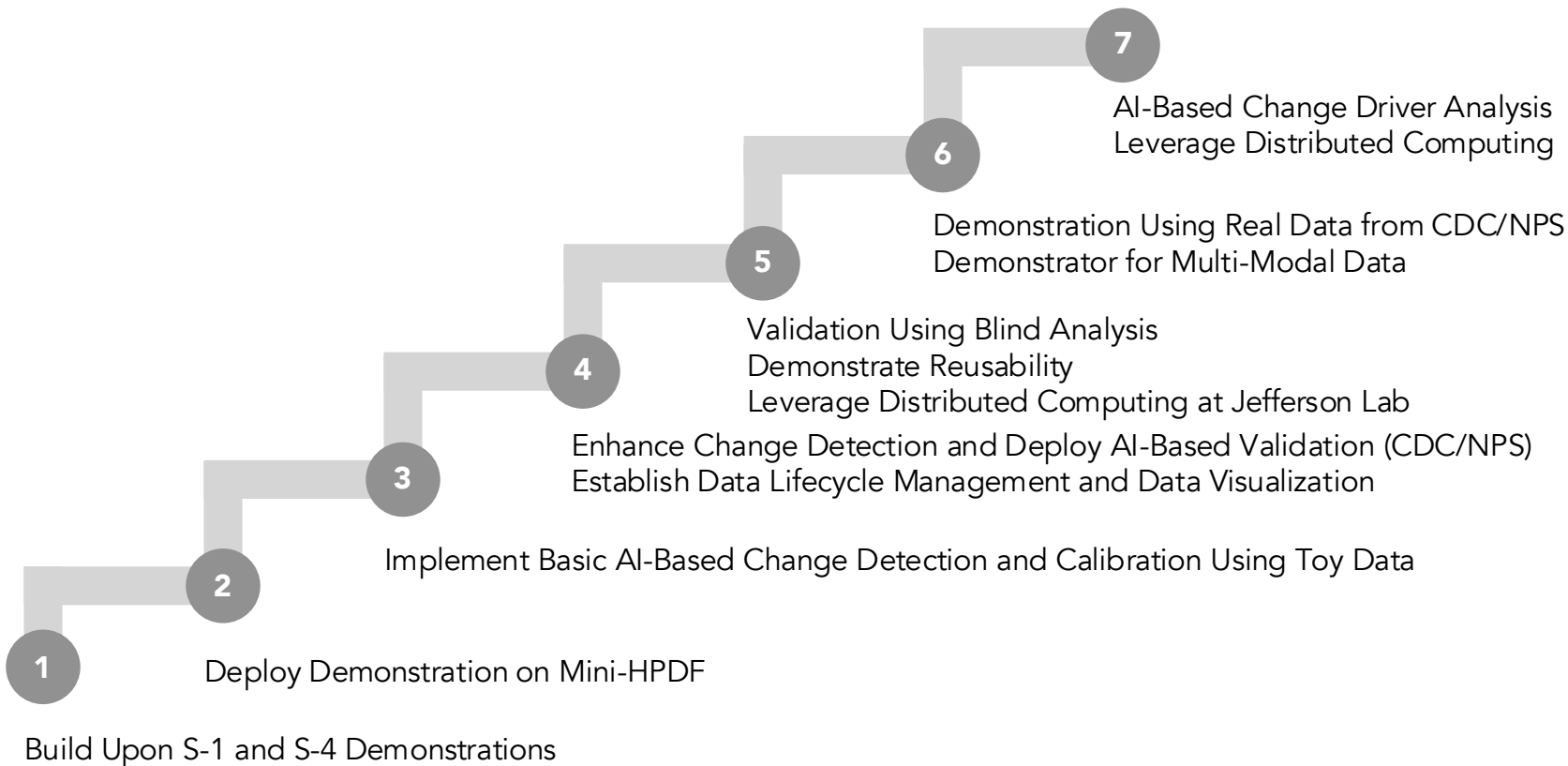
Online Calibrations and the Data Lifecycle



HPDF Features that Enhance the Use Case



Roadmap: Start Simple, Scale Up

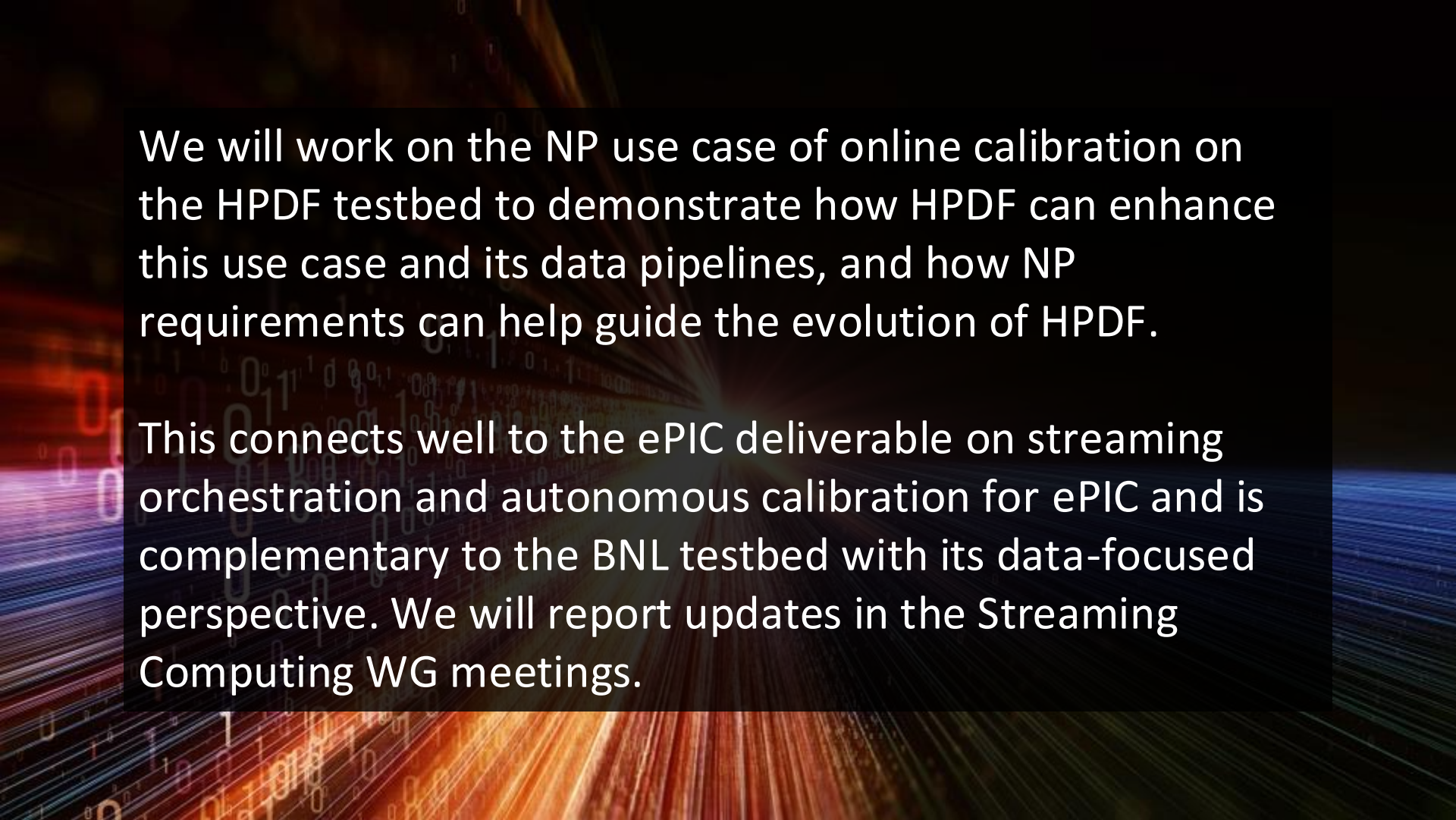


SPINDLE Team

- Jefferson Lab
 - CEBAF
 - David Abbott
 - DCS
 - Laura Biven
 - Nathan Brei
 - Vardan Gyurjyan
 - Torri Jeske
 - David Lawrence
 - Brad Sawatzky
 - Fundamental Physics
 - Markus Diefenthaler
 - Rolf Ent

- HPDF
 - Ilya Baldin
 - Amitoj Singh



The background of the slide is a dark, abstract composition. It features a central perspective view of a road or tunnel that recedes into the distance, illuminated by a bright light source at the horizon. The walls of the tunnel are composed of numerous vertical lines of varying colors, including red, orange, yellow, and blue, creating a sense of depth and motion. Scattered throughout the scene are binary digits (0s and 1s) in various colors, some appearing to float or be part of the tunnel's structure. The overall effect is a high-tech, digital atmosphere.

We will work on the NP use case of online calibration on the HPDF testbed to demonstrate how HPDF can enhance this use case and its data pipelines, and how NP requirements can help guide the evolution of HPDF.

This connects well to the ePIC deliverable on streaming orchestration and autonomous calibration for ePIC and is complementary to the BNL testbed with its data-focused perspective. We will report updates in the Streaming Computing WG meetings.