**What is eRHIC?**

- **eRHIC** = Relativistic Heavy Ion Collider: Discovered the Quark-Gluon Plasma (QGP) & its Perfect Liquid property
- **eRHIC** = Puts an Electron accelerator into RHIC
- **Will collide** with ions, polarized p, and polarized heliums (He⁺)
- **Will continue to study the QGP**, the properties of gluons and the strong force, and detailed spin structure of the proton

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### RHIC Controls:

**A Distributed Object Model Architecture**

**RHIC Systems**
- 1740 superconducting magnets
- 396 Dipoles, 492 Quadrupoles, 72 Trim Quadrupoles, 285 Sextupoles, 492 Correctors
- Each ring is 2.5 miles in circumference
- 25 ft Helium refrigerator
- Operates at 4.5 K

**Controls Systems**
- >4000 control and data acquisition modules
- 58 miles of fiber optic cable (controls communication)
- > 420 front end systems
- > 100 waveform & function generators
- 70 networked buildings, 450 miles of fiber (general communication)
- 8550 switch ports, managed packet routing system

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### Evolution of RHIC Controls:

**Focus of changes over past 11 years**

**System**
- 2002
- 2013

**Data (Bytes) Written/Run**
- 1.1 TB
- 24.6 TB

**Total Data Stored**
- 1.8 TB
- 109 TB

**Number of Computer Code**
- 1.384GB, 3.763 MB

**# of C++ applications**
- 207
- 354

**# of C++ servers**
- 71
- 252

**# of Java applications**
- 12
- 135

**# of Java servers**
- 2
- 22

**# of Front end systems**
- 160
- 424

**# of legacy controllers**
- 50
- 3

**# of control point settings (operational)**
- 22,000
- 497,830

**# of control point measurements (operational)**
- 160,000
- 625,807

**# of named server entries**
- 1,367,504
- 6,970,584

**# of system servers (machines)**
- <20
- 111

### Better Monitoring and Diagnostic Tools

- **Alarm system upgrade**
- Expanded system monitoring
- Automated system diagnostics

### More Data, Better Analysis Tools

- More complete data logging
- Database driven archives of machine settings
- Saved history of all changes in settings
- Electronic logbooks
- Improved tools for generic viewing and analysis

### Modernization

- Injectors upgraded to RHIC style controls
- Modern network architecture & new router
- Embedded real time architecture (LLRF+)
- Injectors for collider
- New mirror control
- Electronic logbooks
- Saved history of all changes in settings
- Database driven archives of machine settings
- More complete data logging

### Cyber Security

- Keeping pace with new requirements
- Maintaining secure remote access
- Homegrown Screen Lock for authentication in control rooms

### Increased Automation

- Improved sequencing software
- Lots and lots of sequences!
- More feedback and feed-forward systems

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**Background Image:**

Elliptic and triangular flow in event-by-event (3+1)D viscous hydrodynamics

Bjoern Schenke, Sangyong Jeon, Charles Gale