JUNO Offline Software System

- **SNIPER**: the framework for non-collider Physics experiments developed by JUNO Collaboration
- **Offline**: including event model, geometry, generators, simulation, reconstruction, etc.
- **External Libraries**: Interfaces to frequently used third-party software and tools

### Main Components of SNIPER

- **Modular Design**
  - Algorithm
  - Service
  - Task
  - SubTask
  - Incident
  - Data Buffer

### Data Processing Controlling

- **Task** manages its data buffer, algorithms, services and subtasks.
- **Task** performs sequential execution of its algorithms.
- **Incident** triggers SubTask to implement jump execution

### Multi-Task Mechanism

- Perform Event Mixing of the Inverse Beta Decay (IBD) with several Backgrounds.
- Simulate IBD Event Splitting

### Data Management with Buffer

- **Buffer** is a dynamically allocated memory to hold multiple events
- **Buffer** size is configured with the Time Window
- **Events in Buffer** are trimmed dynamically
- **Each Task** has its own Buffer

#### Multiple Events in Buffer

- Buffer supports physics correlation analysis between events
- **Multiple Buffers** and Multi-Task are suitable for multi-thread parallel computing to be implemented

### Event Data Model

- **Based on TObject of ROOT**
  - Commonly used in memory and root storage
- **Two-layer Scenario**
  - Header stores small and characteristic data
  - Event stores large and detailed data
  - Highly reduce I/O burden and speed up event selection
- **Event Object Correlation**
  - Correlations of event data at different stages with SmartRef
  - Correlation between events with Navigators
  - Correlations is able to be saved into Root Files and recovers when reading back

#### SmartRef

- A new mechanism for objects correlation
  - Similar with Tfix but supporting object correlation with different entry numbers
  - Correlate data objects in both memory and ROOT files
  - Support lazy loading of data objects very well

### Status and Outlook

- SNIPER is a new Software for Non-Collider Physics Experiment designed and developed by JUNO Experiment
- Some new functionalities are fully implemented such as Multi-Task, Data Buffers, flexible data processing controlling, etc.
- JUNO Data Model is based on ROOT and Event Correlations is implemented with a new type of pointer, SmartRef.
- JUNO detector simulation, digitization and reconstruction have been developed based on SNIPER and work very well.
- Software validation suite is in place and routinely runs before a new release.
- SNIPER Parallel Computing is under investigation and will be implemented soon.

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The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton liquid scintillator detector with multi-purpose measurements. The detector will be built in 700 m deep underground laboratory with primary physics goal for neutrino mass hierarchy determination.