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# Parity Analysis Software

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# Workflow

- **Decoding “engine”**

- First step - DAQ buffer -> processed data.
- through difference calculation
- may include correlation / correction calculations
- online/feedback/prompt
- feeds “post-engine” steps
- tree, histogram, text outputs

- **Regression**

- correlation and correction calculations
- use trees, flexible configuration
- compatible (“friendable”) tree output
- some functions can absorb into engine

- **Beam Modulation**

- use output of correlation data, aggregating across multiple runs
- fit modulation responses
- calculate correction slopes
- diagnostic output, slope output

- **“WAC”**

- Aggregate and Summarize decoding + post-engine Outputs
- WAC (weekly analysis coordinator)
- Recent, history, summary outputs

- **Macros and tools**

- Calibration
- Beam tests / configuration
- support investigations

Tables & Histos, Trees (run, history) for dynamic analysis

# Analysis “Engine”

## Engine

- configuration (lookup + override)
- Decoding
- Helicity sorting
- Cut flags (extended)
- difference calculations
- outputs/summaries

## Online

- real-time data stream
- near 100% duty factor
- data validity
- rolling histogram updates
- updating summary text
- flexible (dynamic?) output definition

## Feedback

- real-time data stream
- near 100% duty factor
- Flexible parameters
- output / log configuration and results
- scripts/drivers to apply settings

## Prompt

- file from disk
- better than real time speed
- log configuration
- correlation calculations
- outputs for dynamic “post-engine” analysis (trees)
- summary outputs (text, histograms)

# Regression

## Regression

- accumulate sums over “minirun”
- calculate correlations
- central value subtraction (two pass)?
- Requires flexible input
- output results
- also trees for pair/multiplet studies
- unclear if should incorporate into engine or just kept as post-processing only

## Examples:

### Post-Pan

- H-2 era regression from Bryan Moffit
- trees in / trees out
- flexible input
- may be compatible with correction alias (PREX era) so no separate tree required

### Ben Gilbert “regressionClass”

- “universal” regression tool
- full correlation matrix from tree
- flexible “tree-less” regression results

### LinRegBlu

- Qweak regression tool
- trees in / trees out
- flexible input

# Beam Modulation

## Modulation

- aggregate modulation cycle results over multiple runs
- calculate modulations responses
- calculates correction coefficients
- diagnostic outputs
- apply as:
  - “corrected” tree
  - in Engin
  - as macro/alias on existing tree
- requires configuration inputs

## Examples:

### Postpan

- does not aggregate over runs
- central value subtraction (two pass)?
- Requires flexible input
- output results
- also trees for pair/multiplet studies
- assumes PREX-I BeamMod interface

### Qweak Analysis

- not suitable for routine use, but many tools/tricks might be needed
- assumes of Qweak BeamMod interface

# Blinding Considerations

## Relatively easy for PREX/CREX!

- only 4 detectors, only 1  $Q^2$
- Must update between measurements.
- Must automatically blind on Target position (no non-physics target blinding)
  - Fail-safe (loudly fail if target position or blind state uncertain)
- Asymmetries only
  - Applied in engine
  - 2 parameters: hash-string + offset (at 10-sigma)
  - raw events not modified. No helicity sorting of raw data
- Must be robust, but also easy to disable for transverse runs (unblinded)

# QwAnalysis

Will be basis for Hall A parity analyzer engine

Significant advantages over PAN (but, improvements possible)

- More dynamically configurable
- Potentially more efficient though more formally object-oriented
- Utilizes similar mechanisms for online/feedback event stream processing
- At some points, sophistication overwhelms simplicity
- Doesn't match Hall A DAQ buffer
- Some design decisions could be unwrapped to improve usability...
- More maintainable, preferred direction for expertise

“new” analyzer?

- Needs update to DAQ buffer - some moderate architecture changes may be necessary to accommodate
- output changes for beam modulation
- other improvements are possible, but probably not necessary

# Summary

## **New Engine**

- based on QwAnalysis
- scope of work is still being determined
- plan: first attempt by June (read Hall A buffers, analyze beam data)

## **Online engine**

- online monitoring and feedback are critical
- now chance to “practice” before run, testing required

## **Post-processing tools**

- regression, beam modulation
- depend on engine outputs

## **WAC chain**

- Scripts require improvement, simplification

## **Testing, qualification**

- Data from beam studies, injector, PREX-I (compare outputs to PAN)
- Mock data (esp for post-processing)

### **Next steps:**

- First attempt at updated engine (June),
- continue planning/spec'ing other tools