# Update on SoLID Software

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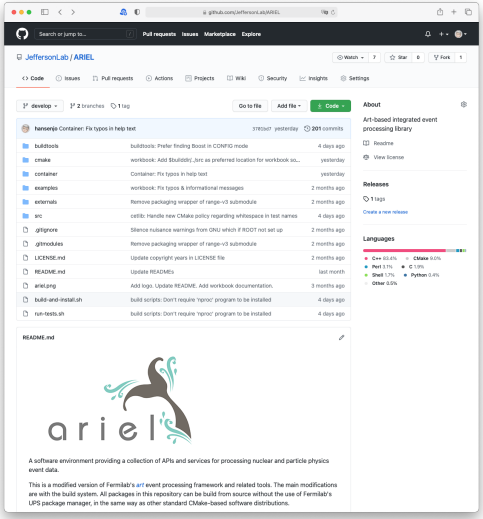
SoLID Collaboration Meeting
January 8, 2021

# Prototype Framework Implementation: ARIEL

- "*art* made usable": Easy-to-install bundle of entire *art* suite, independent of custom Fermilab package manager. Installable from source.
- Most recent *art* version 3.06.03 (Aug 2020) plus dependency packages, integration tests, examples (toyExperiment, art-workbook), container defn's
- Task-based event-level multithreading (TBB)
- Supported on Linux & macOS w/C++17
- Recommended use: Singularity container (see next)
- `https://github.com/JeffersonLab/ARIEL`



# ARIEL Containers

## Singularity Container on CUE

```
ifarm1901> module load singularity
ifarm1901> singularity run /group/solid/apps/ARIEL.sif
Singularity> art --version
art 3.06.03
Singularity> ^D
ifarm1901>
```

- Intended as runtime and development environment for SoLID code
- Ubuntu 20.04 LTS base w/gcc 9.3.0. ROOT 6.22.06 built with C++17 support.
- See container help text for instructions:

```
singularity run-help ARIEL.sif
```

- Download: `https://solid.jlab.org/files/ARIEL.sif` (775 MB)
- Docker version planned

# Last Meeting's "Next Steps"

- Further evaluate `ARIEL`: Write test modules & benchmark
- Evaluate `JANA2` features
- Develop plan to port simulations to `ARIEL` with input from `GEMC`, `artg4` and ANL's `NPDet/DD4hep`
- Investigate deployment on cluster and grid for future simulations (GlueX experience)

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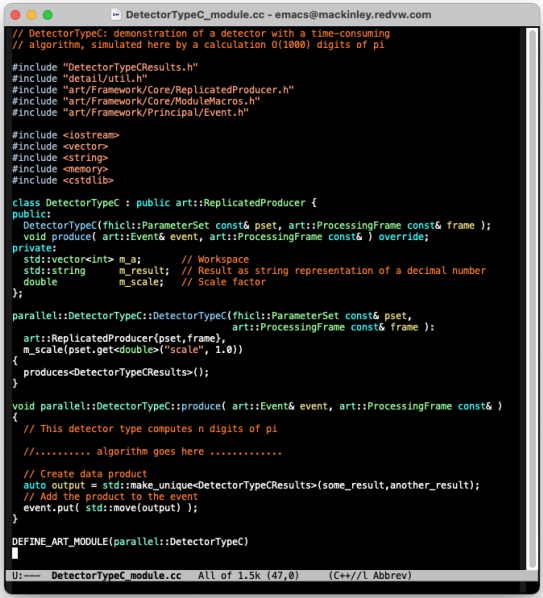
# A Simple Prototype Module

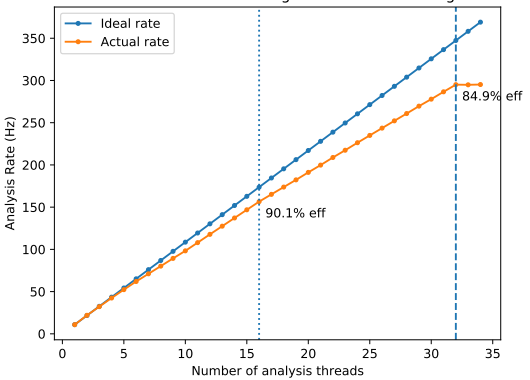
- Ported benchmarking algorithm from my "parallel Podd" toy analyzer.
- Minimal framework overhead (see screenshot). $< 1$ hour of beginner-level work.
- This example algorithm implements a CPU-intensive calculation of $\pi$ [1]

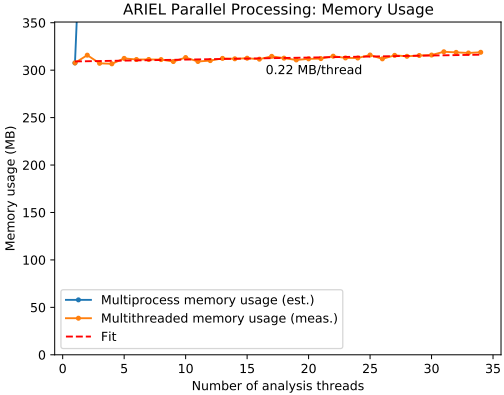



[1] Rabinowitz and Wagon, American Mathematical Monthly, 102 (3), 195-203 (March 1995), doi:10.2307/2975006

# ARIEL Parallel Processing Benchmark

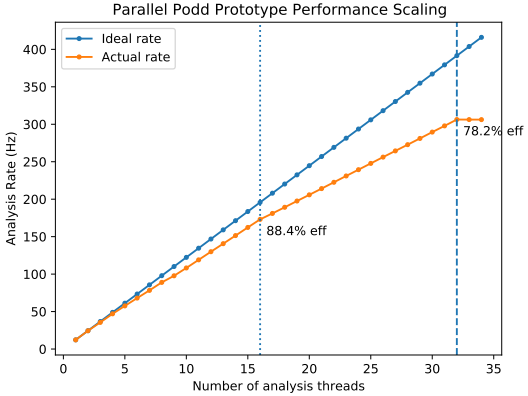
- Run on `aon11` (16 hyperthreaded cores, Intel Xeon E5-2650 v2 @ 2.60GHz), idle conditions
- Admittedly an extreme example: maximally CPU-bound (negligible I/O & memory use)

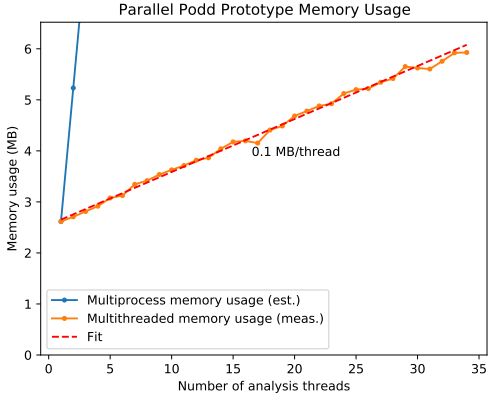


# Comparison: ToyPodd Parallel Processing Benchmark

- Small standalone toy analyzer with hand-implemented multithreading.
- Exact same algorithm & hardware as benchmarked with ARIEL.



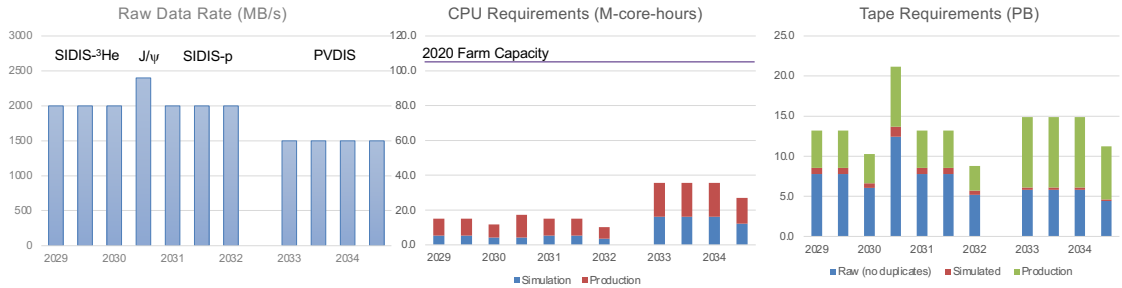
# Next few months: Continue Prototyping ARIEL

- Custom file format input source module
- `DD4hep` service (geometry and conditions database), with guidance form ANL's `NPDet`
- `Geant4` producer module (adopted form `artg4`)
- Rough sketch of data model
- Add *art*'s "studio" SDK & **user documentation**
- Port of `SoLID-GEMC` simulations to `ARIEL`

# Estimated SoLID Computing Requirements — preliminary

| Run period | | 2029 | | 2030 | | 2031 | | 2032 | | 2033 | | 2034 | | Sum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | |
| Estimated data taking time | calendar days | 90 | 90 | 70 | 120 | 90 | 90 | 60 | 0 | 90 | 90 | 90 | 68 | |
| | | | | | | | | | | | | | | |
| Main Experiment | | SIDIS-3HeT | SIDIS-3HeT | SIDIS-3HeL | J/Psi | SIDIS-p | SIDIS-p | SIDIS-p | - install - | PVDIS | PVDIS | PVDIS | PVDIS | |
| | | | | | | | | | | | | | | |
| Event rate | kHz | 100 | 100 | 100 | 60 | 100 | 100 | 100 | 0 | 600 | 600 | 600 | 600 | |
| Event size | kB | 20 | 20 | 20 | 40 | 20 | 20 | 20 | 0 | 2.5 | 2.5 | 2.5 | 2.5 | |
| Uptime | | 50% | 50% | 50% | 50% | 50% | 50% | 50% | 0% | 50% | 50% | 50% | 50% | |
| Raw events | $10^9$ | 389 | 389 | 302 | 311 | 389 | 389 | 259 | 0 | 2333 | 2333 | 2333 | 1763 | |
| Raw data rate | MB/s | 2000 | 2000 | 2000 | 2400 | 2000 | 2000 | 2000 | 0 | 1500 | 1500 | 1500 | 1500 | |
| | | | | | | | | | | | | | | |
| **Raw data to tape** | **PB** | **7.8** | **7.8** | **6.0** | **12.4** | **7.8** | **7.8** | **5.2** | **0.0** | **5.8** | **5.8** | **5.8** | **4.4** | **76.7** |
| | | | | | | | | | | | | | | |
| Simulated events per raw event | | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 10% | 5% | 5% | 5% | 5% | |
| Simulation time per event per core | ms | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | |
| Time to analyze one event per core | ms | 30 | 30 | 30 | 50 | 30 | 30 | 30 | 30 | 10 | 10 | 10 | 10 | |
| Number of passes though data | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | |
| Production data reduction factor | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 2 | 2 | 2 | 2 | |
| Percentage of data to be processed at JLab | | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% | |
| | | | | | | | | | | | | | | |
| **Simulation CPU requirement** | **M-core-hours** | **5.4** | **5.4** | **4.2** | **4.3** | **5.4** | **5.4** | **3.6** | **0.0** | **16.2** | **16.2** | **16.2** | **12.2** | **94.6** |
| **Production CPU requirement** | **M-core-hours** | **9.7** | **9.7** | **7.6** | **13.0** | **9.7** | **9.7** | **6.5** | **0.0** | **19.4** | **19.4** | **19.4** | **14.7** | **138.9** |
| Total CPU for current experiment (sim+prod) | M-core-hours | 15.1 | 15.1 | 11.8 | 17.3 | 15.1 | 15.1 | 10.1 | 0.0 | 35.6 | 35.6 | 35.6 | 26.9 | **233.4** |
| | | | | | | | | | | | | | | |
| **Simulated data to tape** | **PB** | **0.8** | **0.8** | **0.6** | **1.2** | **0.8** | **0.8** | **0.5** | **0.0** | **0.3** | **0.3** | **0.3** | **0.2** | **7** |
| **Production data to tape** | **PB** | **4.7** | **4.7** | **3.6** | **7.5** | **4.7** | **4.7** | **3.1** | **0.0** | **8.7** | **8.7** | **8.7** | **6.6** | **66** |
| Total data to tape (raw+sim+production) | PB | 13.2 | 13.2 | 10.3 | 21.2 | 13.2 | 13.2 | 8.8 | 0.0 | 14.9 | 14.9 | 14.9 | 11.2 | **149** |

# Estimated SoLID Computing Requirements (II) — preliminary




- Raw data rate comparable to GlueX & CLAS12 ($\sim$2 GB/s).
- Estimated CPU requirements already manageable with today's farm resources.
- Tape requirements (25–30 PB/yr) significantly higher than current experiments $\longrightarrow$ cannot keep all data, should develop data management plan
- J/$\Psi$ has $\sim$50% higher storage requirements due to larger event size (3-fold coincidence)

# Summary

- Design & development of SoLID software ecosystem in progress
- Actively evaluating prototype implementations
- Anticipated computing resource needs seem mostly manageable at this time