WP3 - Advanced Software
- final Meeting -

Frank Gaede, Witek Pokorski

23.04.2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654168.

AIDA 2020 WP3 Milestones and Deliverables *in year 5*

Achieved on time

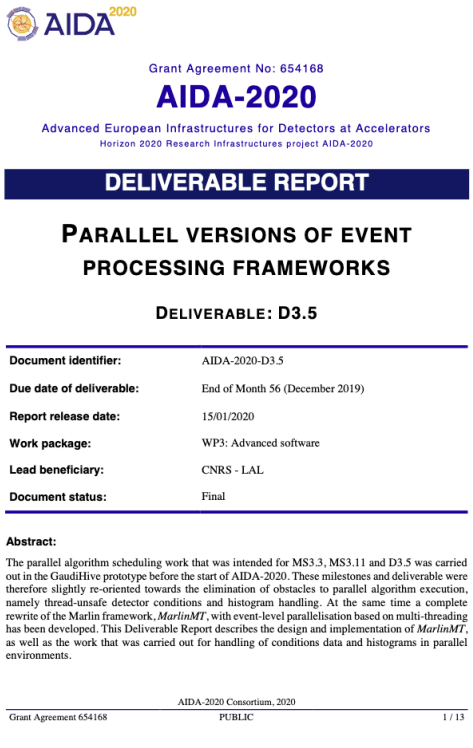
Postponed to Year 5

MS18	Design document for alignment Toolkit with tight coupling to DD4hep	Task 3.3	✓	3, 15	M14
MS19	Design document for Event Data Model toolkit	Task 3.4	✓	3, 5	M14
MS20	Design document for parallel algorithm scheduling mechanism	Task 3.4	✓	3	M14
MS39	Running prototype of USolids using SIMD instructions	Task 3.2	✓	3	M21
MS40	Running prototype for alignment Toolkit	Task 3.3	✓	3, 15	M21
MS41	Running prototype for parallel algorithm scheduling mechanism	Task 3.4	✓	3	M21
MS42	Running prototype for Geant4 based simulation toolkit	Task 3.2	✓	3	M21
MS88	Integration of USolids extensions for vectorisation in Geant4, ROOT and Geant Vector Prototype	Task 3.2	✓	3	M44
MS89	Application of alignment toolkit to external tracker for PCMAG	Task 3.3	✓	3, 15	M44
MS90	Application of Event Data Model toolkit with high performance I/O to Linear Collider	Task 3.4	✓	3, 5	M44
MS91	Integration of parallel algorithm scheduling mechanism in Gaudi, Marlin and PandoraPFA frameworks	Task 3.4		3	M44
MS92	Application of advanced Particle Flow algorithms to CMS and LBNE	Task 3.7	✓	3	M44

M58 <-

D3.1	✓	Implementation of extensions in USolids *(extended signature of classes, reviewed algorithms, well defined interfaces for Geant4, Root and Vector prototype)*	3	CERN	other	PU	M32
D3.2	✓	Implementation of DD4hep extensions *(added alignment functionality and thread safety)*	3	CERN	other	PU	M34
D3.3	✓	Alignment Toolkit *(generic toolkit with tight coupling to DD4hep)*	3	UNIMAN	other	PU	M36
D3.4	✓	Event Data Model toolkit *(creation of EDM model in C++ with high performance I/O)*	3	DESY	other	PU	M40
D3.5		Parallel versions of event processing frameworks *(validation of parallelisation of algorithms and event processing)*	3	CNRS	other	M56 <-	M42
D3.6	✓	Geant4 based simulation toolkit DDG4 *(modular and flexible toolkit based on DD4hep and Geant4)*	3	CERN	other	PU	M35
D3.7		Advanced Tracking tools*(implementation of advance parallel track finding and fitting algorithms)*	3	DESY	M56 <-	M50 <-	M39
D3.8	✓	Advanced Particle Flow algorithms *(implemented within the PandoraPFA framework)*	3	UCAM	other	PU	M38

Final Deliverables/ milestones



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AIDA-2020

Advanced European Infrastructures for Detectors at Accelerators

Horizon 2020 Research Infrastructures project AIDA-2020

DELIVERABLE REPORT

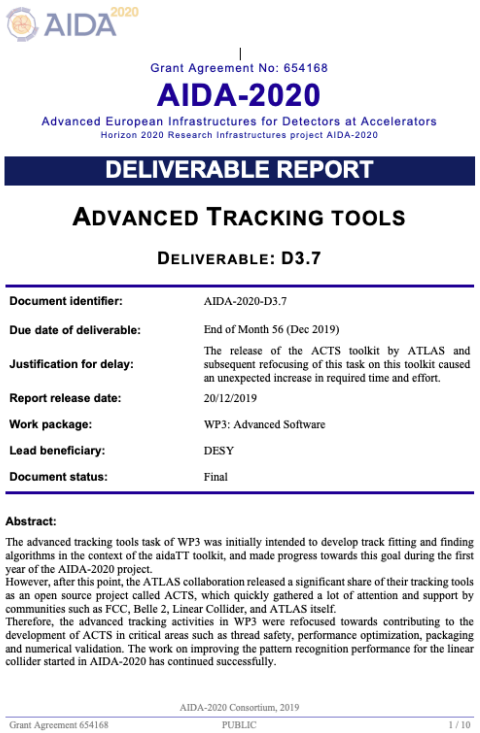
PARALLEL VERSIONS OF EVENT PROCESSING FRAMEWORKS

DELIVERABLE: D3.5

Document identifier:	AIDA-2020-D3.5
Due date of deliverable:	End of Month 56 (December 2019)
Report release date:	15/01/2020
Work package:	WP3: Advanced software
Lead beneficiary:	CNRS - LAL
Document status:	Final

Abstract:

The parallel algorithm scheduling work that was intended for MS3.3, MS3.11 and D3.5 was carried out in the GaudiHive prototype before the start of AIDA-2020. These milestones and deliverable were therefore slightly re-oriented towards the elimination of obstacles to parallel algorithm execution, namely thread-unsafe detector conditions and histogram handling. At the same time a complete rewrite of the Marlin framework, *MarlinMT*, with event-level parallelisation based on multi-threading has been developed. This Deliverable Report describes the design and implementation of *MarlinMT*, as well as the work that was carried out for handling of conditions data and histograms in parallel environments.



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DELIVERABLE REPORT

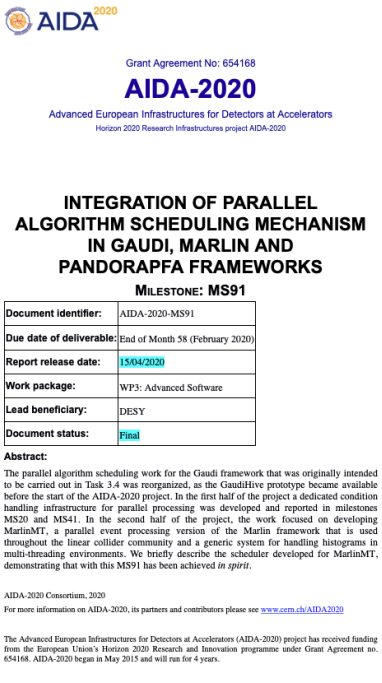
ADVANCED TRACKING TOOLS

DELIVERABLE: D3.7

Document identifier:	AIDA-2020-D3.7
Due date of deliverable:	End of Month 56 (Dec 2019)
Justification for delay:	The release of the ACTS toolkit by ATLAS and subsequent refocusing of this task on this toolkit caused an unexpected increase in required time and effort.
Report release date:	20/12/2019
Work package:	WP3: Advanced Software
Lead beneficiary:	DESY
Document status:	Final

Abstract:

The advanced tracking tools task of WP3 was initially intended to develop track fitting and finding algorithms in the context of the aidaTT toolkit, and made progress towards this goal during the first year of the AIDA-2020 project.
However, after this point, the ATLAS collaboration released a significant share of their tracking tools as an open source project called ACTS, which quickly gathered a lot of attention and support by communities such as FCC, Belle 2, Linear Collider, and ATLAS itself.
Therefore, the advanced tracking activities in WP3 were refocused towards contributing to the development of ACTS in critical areas such as thread safety, performance optimization, packaging and numerical validation. The work on improving the pattern recognition performance for the linear collider started in AIDA-2020 has continued successfully.



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INTEGRATION OF PARALLEL ALGORITHM SCHEDULING MECHANISM IN GAUDI, MARLIN AND PANDORAPFA FRAMEWORKS

MILESTONE: MS91

Document identifier:	AIDA-2020-MS91
Due date of deliverable:	End of Month 58 (February 2020)
Report release date:	15/04/2020
Work package:	WP3: Advanced Software
Lead beneficiary:	DESY
Document status:	Final

Abstract:

The parallel algorithm scheduling work for the Gaudi framework that was originally intended to be carried out in Task 3.4 was reorganized, as the GaudiHive prototype became available before the start of the AIDA-2020 project. In the first half of the project a dedicated condition handling infrastructure for parallel processing was developed and reported in milestones MS20 and MS41. In the second half of the project, the work focused on developing MarlinMT, a parallel event processing version of the Marlin framework that is used throughout the linear collider community and a generic system for handling histograms in multi-threading environments. We briefly describe the scheduler developed for MarlinMT, demonstrating that with this MS91 has been achieved *in spirit*.

AIDA-2020 Consortium, 2020

For more information on AIDA-2020, its partners and contributors please see www.cern.ch/AIDA2020

The Advanced European Infrastructures for Detectors at Accelerators (AIDA-2020) project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement no. 654168. AIDA-2020 began in May 2015 and will run for 4 years.

- have submitted the final deliverables/milestones postponed to year 5 ~on time:

- **D3.5 Parallel Versions of Event Processing Frameworks**
- **D3.7 Advanced Tracking Tools**
- **M91: Integration of parallel processing algorithms in Gaudi, Marlin and PandoraPFA**

Next Steps

- Last AIDA2020 Annual Meeting - Vidyo only:
  - parallel sessions: https://indico.cern.ch/event/858784/
  - plenary session: https://indico.cern.ch/event/911818/
    - all encouraged to participate

- Need to write last scientific report
  - period: May 2018-April 2020
  - already received some input - rest needs by end of the week

- Goals for today:
  - get an overview on status of all projects at the end of AIDA2020
  - will use material for final Summary report next week

Publications ?

MarlinMT - parallelising the Marlin framework

Remi Ete[1,*], *Frank* Gaede[1], *Julian* Benda[1], and *Hadrian* Grasland[2]

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[2]Université Paris-Saclay, CNRS/IN2P3, IJCLab, 91405 Orsay, France

Abstract. Marlin is the event processing framework of the iLCSoft [1] ecosystem. Originally developed for the ILC more than 15 years ago, it is now widely used also by other communities, such as CLICdp, CEPC and many test beam projects such as CALICE, LCTPC and EU-Telescope. While Marlin is lightweight and flexible it was originally designed for sequential processing only. With MarlinMT we now evolved Marlin for parallel processing of events on multi-core architectures based on multi-threading. We report on the necessary developments and issues encountered, within Marlin as well as with the underlying LCIO [4] event data model (EDM). A focus will be put on the new parallel event processing (PEP) scheduler. We conclude with first performance estimates, like the application speedup and a discussion on histogram handling in parallel applications.

DD4hep a community driven detector description for HEP

Frank Gaede[1,*], *Markus* Frank[2,**], *Marko* Petric[2,***], and *Andre* Sailer[2,****]

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Abstract. Detector description is an essential component in simulation, reconstruction and analysis of data resulting from particle collisions in high energy physics experiments and for the detector development studies for future experiments. Current detector description implementations of running experiments are mostly specific implementations. DD4hep [1] is an open source toolkit created in 2012 to serve as a generic detector description solution. The main motivation behind DD4hep is to provide the community with an integrated solution for all these stages and address detector description in a broad sense, including the geometry and the materials used in the device, and additional parameters describing e.g. the detection techniques, constants required for alignment and calibration, description of the readout structures and conditions data. In these proceedings, we will give an overview of the project and discuss recent developments in DD4hep as well as showcase adaptions of the framework by LHC and upcoming accelerator projects together with the road map of future developments.

PODIO: recent developments in the Plain Old Data EDM toolkit

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Abstract. PODIO is a C++ toolkit for the creation of event data models (EDMs) with a fast and efficient I/O layer. It employs plain-old-data (POD) data structures wherever possible, while avoiding deep object-hierarchies and virtual inheritance. A lightweight layer of handle classes provides the necessary high-level interface for the physicist. PODIO creates all EDM code from simple instructive YAML files, describing the actual EDM entities. Since its original development PODIO has been very actively used for Future Circular Collider (FCC) studies. In its original version, the underlying I/O was entirely based on the automatic streaming code generated with ROOT dictionaries. Recently two additional I/O implementations have been added. One is based on HDF5 and the other uses SIO, a simple binary I/O library provided by LCIO. We briefly introduce the main features of PODIO and then report on recent developments with a focus on performance comparisons between the available I/O implementations. We conclude with presenting recent activities on porting the well-established LCIO EDM to PODIO and the recent EDM4hep project.

- just submitted CHEP conference proceedings on AIDA2020 packages:
  - **DD4hep** detector description
  - **PODIO** EDM toolkit
  - **MarlinMT** processing framewor

Let us know of any AIDA2020 relevant publications