



cern.ch/allpix-squared

Collaborative Coding

The Example of Allpix Squared

Simon Spannagel, DESY

2nd Allpix Squared User Workshop

19 August 2021

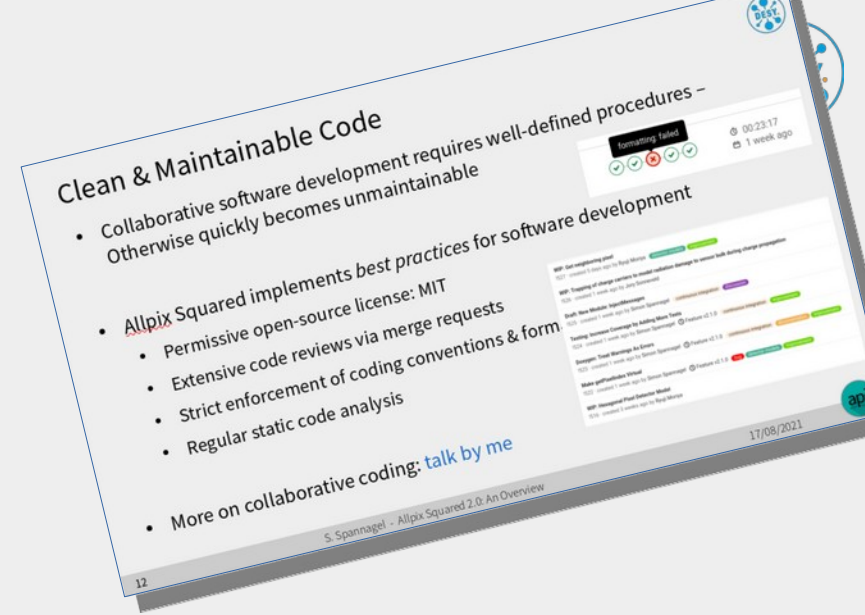
Challenges of Collaborative Coding

Scientific software thrives in collaboration – diverse ideas, inputs, use cases, applications

Contributors have different...

- Levels of experience in the given language
- Coding styles / editor settings (e.g. indentation)
- Ideas on “what looks nice” / naming conventions
- Expectations to the software, different levels of scrutiny

...but in the end there should be one coherent “product”



What We Are Trying to Avoid

- Random indentation
- Comments of unknown relevance
- Non-functional code
- Unused code / variables
- Code that only works on specific platforms / with specific 3rd-party library versions

```

118     const double dr0x = (*itrAlignmentConstant).second->getXOffset();
119     const double dr0y = (*itrAlignmentConstant).second->getYOffset();
120     const double dr0z = (*itrAlignmentConstant).second->getZOffset();
121
122     const double posLocalDiff[3] = {dr0x, dr0y, dr0z};
123     double delta_r0[3];
124     geo::gGeometry().local2MasterVec(sensorID, posLocalDiff, delta_r0); //Here we transform the local alignment
125     const double posTest[3]={1,0,0};
126     double posTestOutput[3];
127     geo::gGeometry().local2Master(sensorID, posTest, posTestOutput);
128     streamlog_out(MESSAGE9) << "Here we have the test for sensor " << sensorID << std::endl;
129     streamlog_out(MESSAGE9) << posTestOutput[0] << " " << posTestOutput[1] << " " << posTestOutput[2] << endl;
130     const double angleLocalDiff[3]={dalpha, dbeta, dgamma};
131     double delta_angle[3];
132     //IMPORTANT: Note the transformation of the angles assumes that they transform like a vector. This is not
133     geo::gGeometry().local2MasterVec(sensorID, angleLocalDiff, delta_angle); //Here we transform the local ali
134
135
136
137     //      delta_r0 *= invR;
138
139     // #ifdef GEAR_MAJOR_VERSION
140     // #if GEAR_VERSION_GE( 17,4)
141     // ZY and ZX rotations are calculated wrongly yet, do not implement:
142     // XYZ shifts and XY rotation seems to be correct
143     //
144     geo::gGeometry().alignGlobalPos(sensorID, xplane + delta_r0[0], yplane + delta_r0[1], zplane + delta_r0[2] );
145
146     // #endif
147     // #endif
148
149     streamlog_out(MESSAGE9) << "Input and output alignment shift (translations) for sensor:
streamlog_out(MESSAGE4) << setw(10) << "Align Translations (Local) x,y,z " << setw( 8) << " " ;

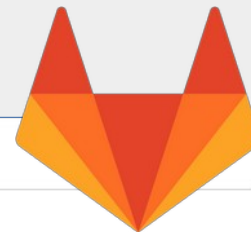
```


Development of Allpix Squared

- Meant as community-driven project
 - Many contributions from “core team” (+ code reviews)
 - Increasing number of external contributors (~40 by now)
- Fully GitLab-centered development
 - Issue tracking, merge requests, continuous integration
- All development is performed “in the open”
 - Full repository public, including issues
 - Subscribers receive information on all actions
- Semantic versioning:
Major.Minor.Patch = Framework.Features.Bugfixes

v2.0.1	2021-07-09
v2.0	2021-06-10
v1.6.2	2021-04-01
v1.6.1	2021-01-28
v1.6	2020-10-29
v1.5.2	2020-09-14
v1.5.1	2020-07-26
v1.5	2020-04-14
v1.4.4	2020-03-10
v1.4.3	2020-01-10
v1.4.2	2019-11-26
v1.4.1	2019-09-13
v1.4	2019-07-09
v1.3.4	2019-06-07
v1.3.3	2019-04-13
v1.3.2	2019-02-21
v1.3.1	2018-12-17
v1.3	2018-11-21
v1.2.3	2018-11-13
v1.2.2	2018-09-07
v1.2.1	2018-08-02
v1.2	2018-06-13
v1.1.2	2018-04-25
v1.1.1	2018-03-08
v1.1	2018-01-11
v1.0	2017-08-08

GitLab as Nerve Center for Development



ap² Allpix Squared

Project information

Repository

Issues 27

Merge requests 16

CI/CD

Security & Compliance

Deployments

Monitor

Infrastructure

Packages & Registries

Analytics

Settings

Allpix Squared > Allpix Squared

ap² Allpix Squared

Project ID: 14102 [Leave project](#)

Unstar 24

Fork 50

6,301 Commits

26 Branches

56 Tags

4.5 MB Files

11.2 GB Storage

31 Releases

Generic Pixel Detector Simulation Framework - <https://cern.ch/allpix-squared/>

pipeline passed

coverity passed

DOI 10.5281/zenodo.3550935

master

allpix-squared / +

History

Find file

Web IDE

Clone

Merge branch 'py3-brackets' into 'master' ...

✓

955e960a

README

MIT License

CONTRIBUTING

CI/CD configuration

Add Kubernetes cluster

Name	Last commit	Last update
.ci	CI: attempt tun change for Big Sur	4 months ago
.github/workflows	GitHub Actions: update to LCG_99 and Apple...	4 months ago



Code Review via Merge Requests

- No new code lands in *master* without review by another party
 - Using GitLab's approval feature
 - Extensive discussions about code, but also style, naming schemes
- Proven to be **very effective**
 - Several bugs found before the merge
 - New users appreciate guidance
- Proven to be **labor-intensive**
 - Read (and understanding) every change
 - Always be supportive, positive

...just some of them

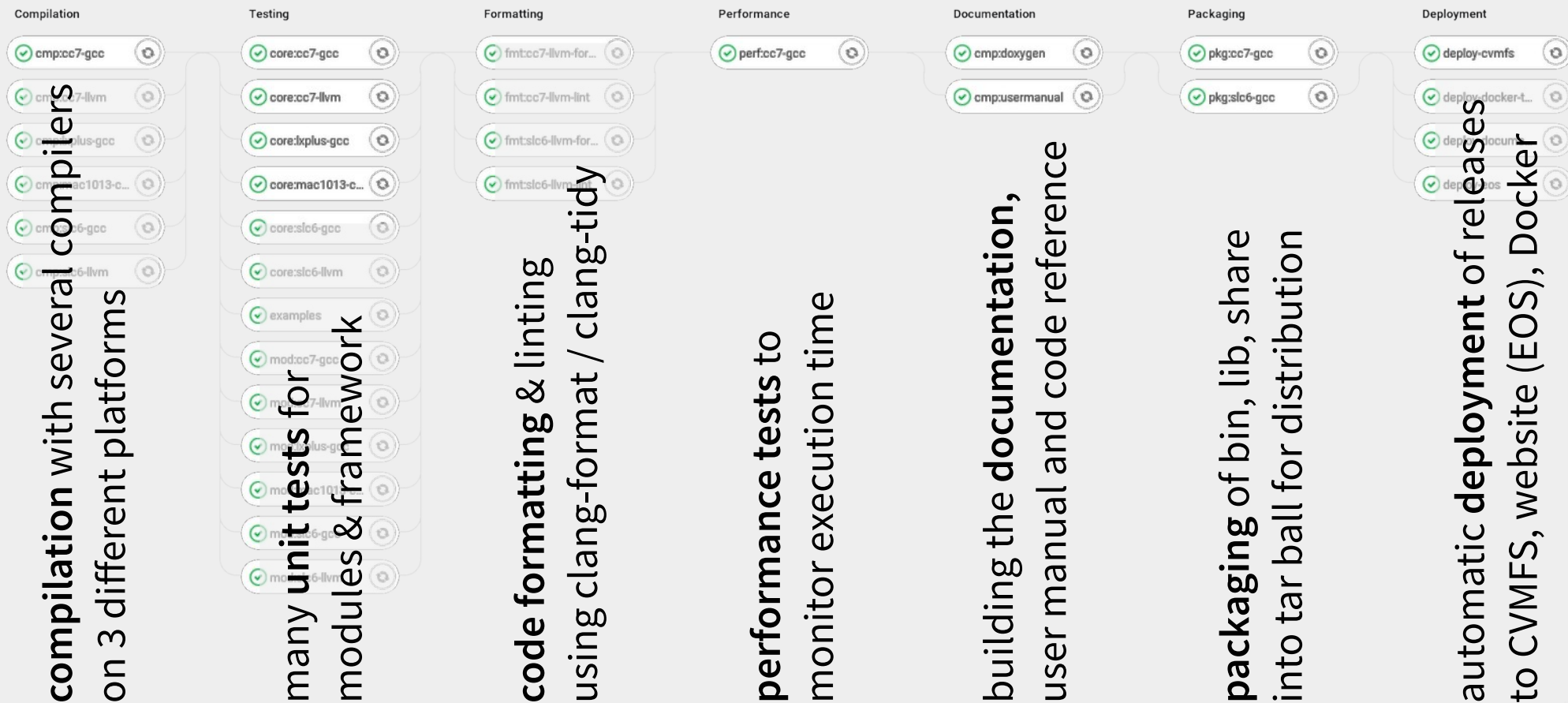
Python macro to read output objects TTree !191 · opened 2 months ago by Sebastien Murphy	MERGED ✓ 18 updated 1 week ago
Revamp MeshConverter: Change interpolation & improve performance !200 · opened 3 weeks ago by Simon Spannagel	MERGED ✓ 5 updated 1 week ago
Write full Proteus configuration in RCEWriter !203 · opened 2 weeks ago by Moritz Kiehn	MERGED ✓ 12 updated 1 week ago
Invert Detector Rotations !164 · opened 6 months ago by Simon Spannagel	MERGED ✓ 8 updated 2 weeks ago documentation detector models bug
RCEWriter: fix Proteus geometry output !202 · opened 2 weeks ago by Moritz Kiehn	MERGED ✓ 3 updated 2 weeks ago
FieldParser: be more careful about units !201 · opened 3 weeks ago by Simon Spannagel	MERGED ✓ 1 updated 2 weeks ago
Add option for a depletion from the backplane !198 · opened 3 weeks ago by Paul Schutze	MERGED ✓ 11 updated 3 weeks ago physics improvement
New Field File Format APF & common FieldParser/FieldWriter !197 · opened 1 month ago by Simon Spannagel	MERGED ✓ 11 updated 3 weeks ago
New Module: DepositionPointCharge !194 · opened 1 month ago by Simon Spannagel	MERGED ✓ 12 updated 1 month ago



CI/CD

Continuous Integration & Deployment

Continuous Integration Pipeline



Automated Testing

```

1  [Allpix]
2  detectors_file = "detector_rotate_misaligned.conf"
3  log_level = "TRACE"
4  number_of_events = 0
5  random_seed = 0
6  random_seed_core = 0
7
8  [GeometryBuilderGeant4]
9
10 ~ #PASS (DEBUG)  misaligned: (8.72466deg,171.099deg,178.504deg)

```

```

Test project /builds/allpix-squared/allpix-squared/build
  Start 53: test_core/test_01-1_globalconfig_detectors.conf
  Start 54: test_core/test_01-2_globalconfig_modelpaths.conf
  Start 55: test_core/test_01-3_globalconfig_log_format.conf
  Start 56: test_core/test_01-4_globalconfig_log_level.conf
1/22 Test #53: test_core/test_01-1_globalconfig_detectors.conf ..... Passed    0.81 sec
  Start 57: test_core/test_01-5_globalconfig_log_file.conf
2/22 Test #56: test_core/test_01-4_globalconfig_log_level.conf ..... Passed    2.11 sec
3/22 Test #55: test_core/test_01-3_globalconfig_log_format.conf ..... Passed    2.11 sec
  Start 58: test_core/test_01-6_globalconfig_missing_model.conf
  Start 59: test_core/test_01-7_globalconfig_random_seed.conf
4/22 Test #57: test_core/test_01-5_globalconfig_log_file.conf ..... Passed    1.11 sec

[...]

100% tests passed, 0 tests failed out of 22

```

- Automatically re-run simulations with known outcomes and check them
- Framework & module tests
- Each test is a configuration file:
 - Run single event with fixed seed
 - Reproduces same output
 - Matching regular expressions
- Single change (1e difference) fails test
→ adaptation of test in case of expected change
- Invaluable for monitoring framework
→ catching issues before merging code

Warnings, Strict Formatting & Code Linting

- In order to maintain a high code quality, we
 - Enabled many compiler warnings, with **-Werror**
 - Require strict adherence to code formatting (indentation, brace positions...)
 - Clang-tidy is used to spot e.g. missing `&`, `std::move()` or `NamingConventionViolations`
- A bit painful for newcomers
CI fails many times, users need to be taught how to read failed job logs
- Particularly useful: `/etc/git-hooks`
 - **pre-commit-clang-format-hook** – checks formatting before committing
 - **pre-push-tag-version-hook** – check for pre-release things (update version)
- CMake suggests installing hooks (suggests update on changes)

Automated Deployment of Tagged Versions

- After release, new version needs to be distributed
- CI automatically deploys new version:
 - Deployment to **website**
Binary tarball packages placed on EOS
 - Deployment as **Docker image**
available via GitLab's Docker repository
 - Deployment to **CVMFS** (Cern Virtual Machine File System)
ready for use on LXPlus or HTCondor submission

```

deploy-docker-tag:
  stage: deployment
  tags:
    - docker-image-build
  dependencies: []
  only:
    - tags
  script:
    - "echo" # unused but this line is required by GitLab CI
  variables:
    T0: gitlab-registry.cern.ch/allpix-squared/allpix-squared:${CI_COMMIT_TAG}

```

```

$ source /cvmfs/clicdp.cern.ch/software/allpix-squared/2.0.1/x86_64-centos7-gcc10-opt/setup.sh
$ allpix --version
Allpix Squared version v2.0.1
      built on 2021-07-09, 09:26:08 UTC

```

User Manual & Code Documentation

- Source code documentation for every class & method
 - Doxygen markup for code reference
 - CI checks for complete & correct documentation
 - Deployed to the website for every release
- User Manual (currently) in LaTeX
 - Module documentation as Markdown
 - Document module parameters, algorithms
 - Included in manual via Pandoc
 - Manual automatically compiled by CI
 - Deployed to the website for every release

```
namespace allpix {  
  
/**  
 * @brief Instantiation of the detector model  
 *  
 * Contains the detector model  
 * (like the electric field). All model specific  
 * properties are stored in its DetectorModel instance  
 */  
class Detector {  
    friend class GeometryManager;  
  
public:  
    /**  
     * @brief Constructs a detector in the geometry  
     * @param name Unique name of the detector  
     * @param model Model of the detector  
     * @param position Position in the world frame  
     * @param orientation Rotation matrix representing the detector  
     */  
    Detector(std::string name,  
             std::shared_ptr<DetectorModel> model,  
             ROOT::Math::XYZPoint position,  
             const ROOT::Math::Rotation3D& orientation)  
  
    /**  
     * @brief Get name of the detector  
     * @return Detector name  
     */  
    std::string getName() const;  
};
```

The screenshot shows the Allpix^2 v2.0.1 website. The top navigation bar includes links for Main Page, Modules, Classes, and Files. The main content area is titled "allpix::Configuration Class Reference" and lists the classes and public member functions. The classes listed are AccessMarker and parse_node. The public member functions listed are Configuration, has, count, and count. The right sidebar contains a search bar and a list of configuration parameters. The bottom of the page shows a "Usage" section with a list of configuration parameters and their values.

How to Contribute

A Cookbook

```
Module {
    ...
end class ModuleManager;
end class Messenger;

// Base constructor for unique modules
// param config Configuration for this module
Module(Configuration& config);

// Base constructor for detector modules
// param config Configuration for this module
// param detector Detector bound to this module
// Note: Detector modules should not forget to forward their detector to the base class
// \ref InvalidModuleStateException will be raised if the module failed to so
Module(Configuration& config, std::shared_ptr<Detector> detector);

// Essential virtual destructor.
// This destructor has all delegates linked to this module
virtual ~Module();

// ...

// ... in a module is not allowed
Module& = delete;
Module(const Module&) = delete;

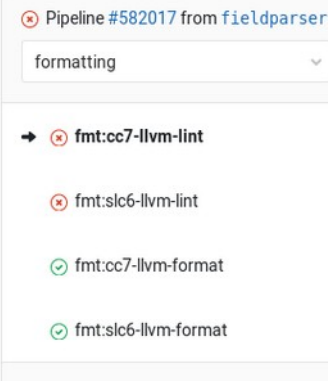
// ... have behaviour (not possible with references)
Module& = delete;
Module&&) noexcept = delete;
```

How To Contribute – A Cookbook

- **Get in touch** – mail, forum, issue tracker, ...
Let's discuss the idea, maybe we have input, maybe others are working on it already
- **Fork the repository**
Creating your own copy of the code with which you can mess as much as you want
- **Start hacking**
Implement the desired functionality, come back to us when you have doubts or questions
- **Make sure the CI passes**
Enable the CI in your fork and publish your new code there – check that the CI works!
- **File a Merge Request**
This provides us a central point to discuss and review all your code changes
- **See your code being merged and published!**

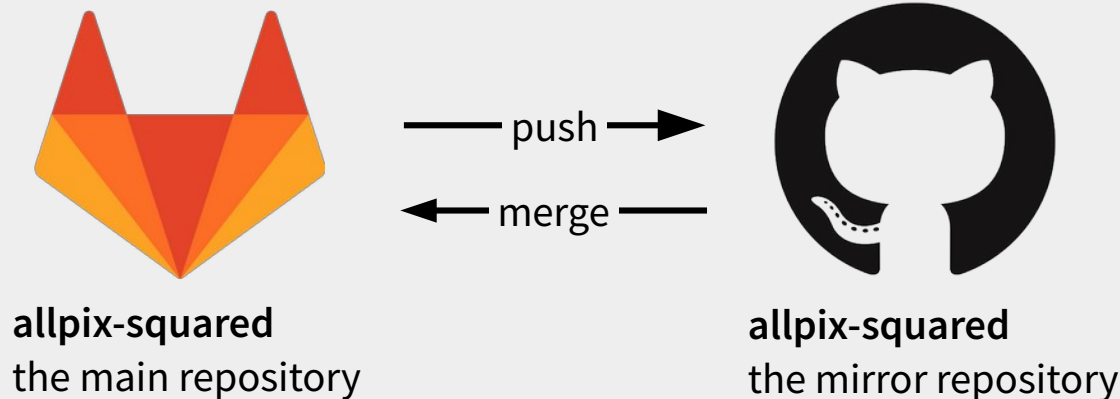
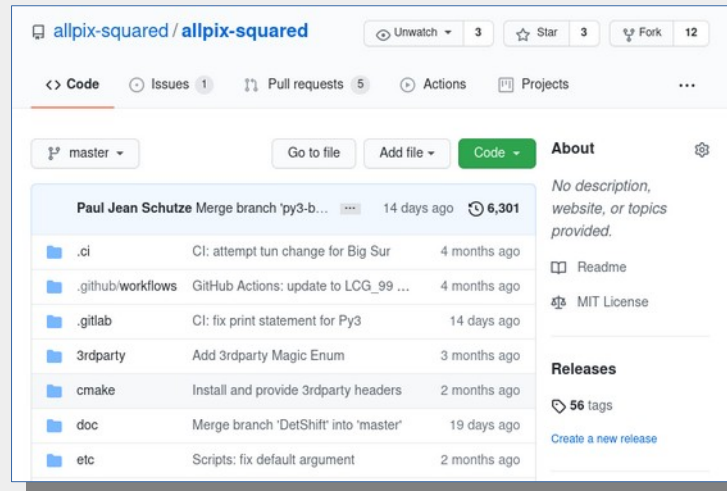


```
3 warnings treated as errors
/builds/allpix-squared/allpix-squared/src/core/geometry/Detector.cpp:185:29: error:
parameter 'field' is passed by value and only copied once; consider moving it to avoid
unnecessary copies [performance-unnecessary-value-param,-warnings-as-errors]
    electric_field_.setGrid(field, sizes, scales, offset, thickness_domain);
                           ^
                           std::move( )
/builds/allpix-squared/allpix-squared/src/core/geometry/Detector.cpp:191:33: error:
parameter 'function' is passed by value and only copied once; consider moving it to avoid
unnecessary copies [performance-unnecessary-value-param,-warnings-as-errors]
    electric_field_.setFunction(function, thickness_domain, type);
                              ^
                              std::move( )
/builds/allpix-squared/allpix-squared/src/core/geometry/DetectorField.hpp:51:27: error:
member initializer for 'field_type_' is redundant [modernize-use-default-member-init,-
warnings-as-errors]
    DetectorField() : field_type_(FieldType::NONE){};
                    ^
```



No CERN Affiliation – no GitLab – no Problem

- We rely on CERN's GitLab CI (and our own runners)
 - Allows to run extensive CI and adjust to our needs
 - Requires full CERN account for write access
- Our solution: ping-pong mirror to GitHub
Follow the same cookbook...



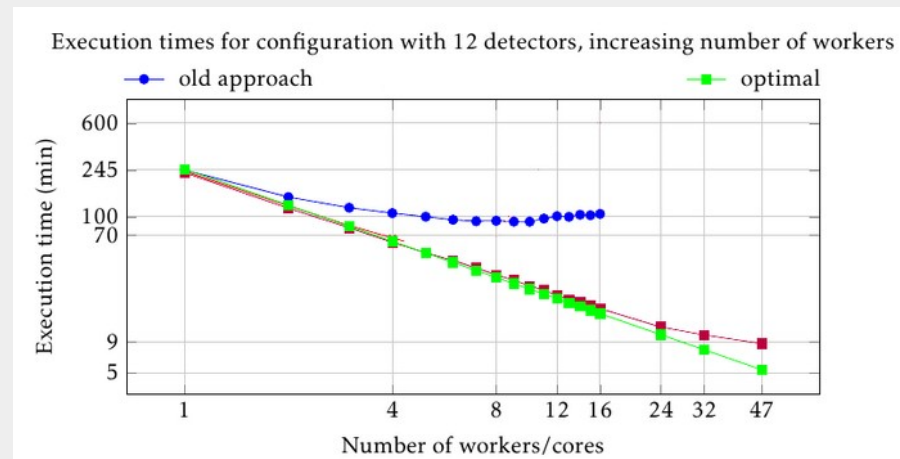


Google Summer of Code



- Participated twice in GSoC through HEP Software Foundation / CERN
 - Students work over summer months on FOSS project and get stipend paid by Google
 - Project: Event-based Multi-Threading for Allpix Squared
 - Quite intricate (seeding, race conditions, ... – see K. Wolter's talk)
- Students were very active and motivated
 - Restructured parts of core framework
 - Implemented first working version
 - Did first benchmarks
- Interesting observation:

Students were expecting direct instructions,
we expected scientific collaboration → worked out well after discussing!



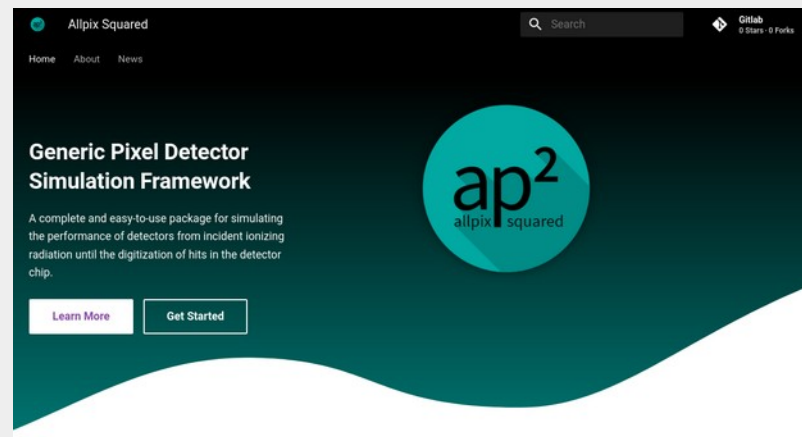


Google Season of Docs



...is **not** Google Summer of Code!

- Scholarship for experienced technical writers to work on documentation of open source projects
- Allpix Squared participated through HEP Software Foundation / CERN
- Technical writer worked for three months on documentation/website
 - Goal: revision of online appearance
 - Focus on integration of online user manual
 - Improvements to tutorials/examples
- Finalization still pending, lined up for next feature release



Summary

- Common conventions are important for collaborative software projects
- Allpix Squared implements
 - Strict formatting and naming conventions
 - Code review through merge requests
 - Automated testing and deployment
- Continuous Integration is a powerful tool to ensure consistency & functioning
- Contributions possible & welcome through CERN GitLab or GitHub repositories!

Allpix Squared Resources



Website

<https://cern.ch/allpix-squared>



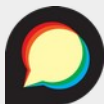
Repository

<https://gitlab.cern.ch/allpix-squared/allpix-squared>



Docker Images

https://gitlab.cern.ch/allpix-squared/allpix-squared/container_registry



User Forum:

<https://cern.ch/allpix-squared-forum/>



Mailing Lists:

allpix-squared-users <https://e-groups.cern.ch/e-groups/Egroup.do?egroupId=10262858>

allpix-squared-developers <https://e-groups.cern.ch/e-groups/Egroup.do?egroupId=10273730>



User Manual:

<https://cern.ch/allpix-squared/usermanual/allpix-manual.pdf>

