Tile-in-One:

An integrated system for data quality and conditions assessment for the ATLAS Tile Calorimeter

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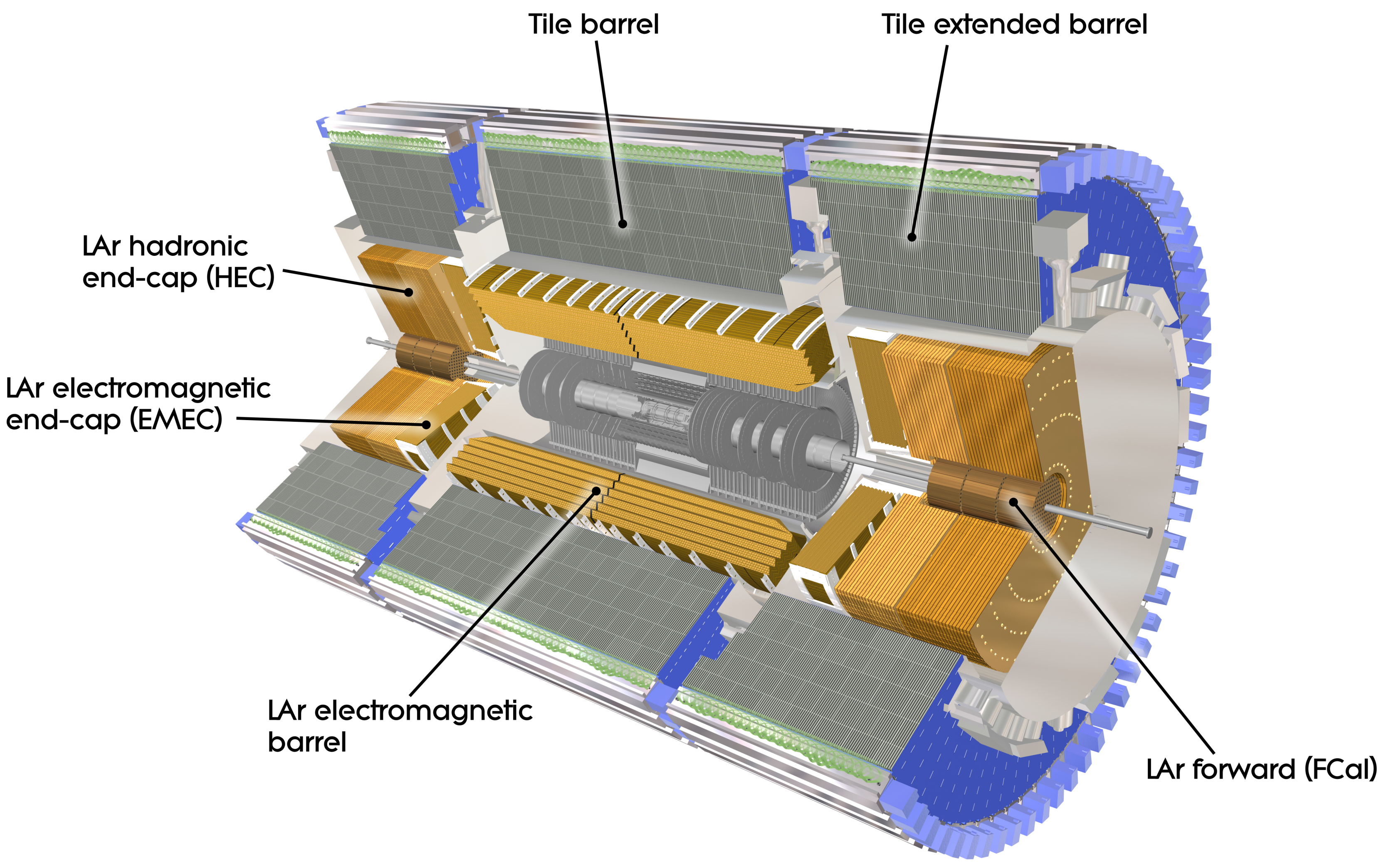
ATLAS Tile Calorimeter


Tile barrel
Tile extended barrel
LAr hadronic end-cap (HEC)
LAr electromagnetic end-cap (EMEC)
LAr electromagnetic barrel
LAr forward (FCal)

ATLAS detector [1] is a large general-purpose detector at the Large Hadron Collider (LHC) at CERN. The LHC started its operation in 2008 and since then it has gone through several gradual upgrades of beam energy and luminosity.

Last year marked the end of the second round of operation at the LHC (run II) and the total recorded luminosity in pp collisions at center of mass energy of 13 TeV since 2015 was 156 fb^{-1} [2].

The ATLAS detector investigates a wide range of physics, from the study of Higgs boson and Standard Model phenomena on one side to the searches of the extra dimensions and particles that could make up the dark matter on the other.

The Tile Calorimeter (TileCal) [3] is part of the ATLAS hadronic calorimeter an is located in its central section. It detects hadrons, jets and taus, while also contributing to the jet energy and missing transverse energy E_T reconstruction, as well as assisting the spectrometer in the identification and reconstruction of muons.

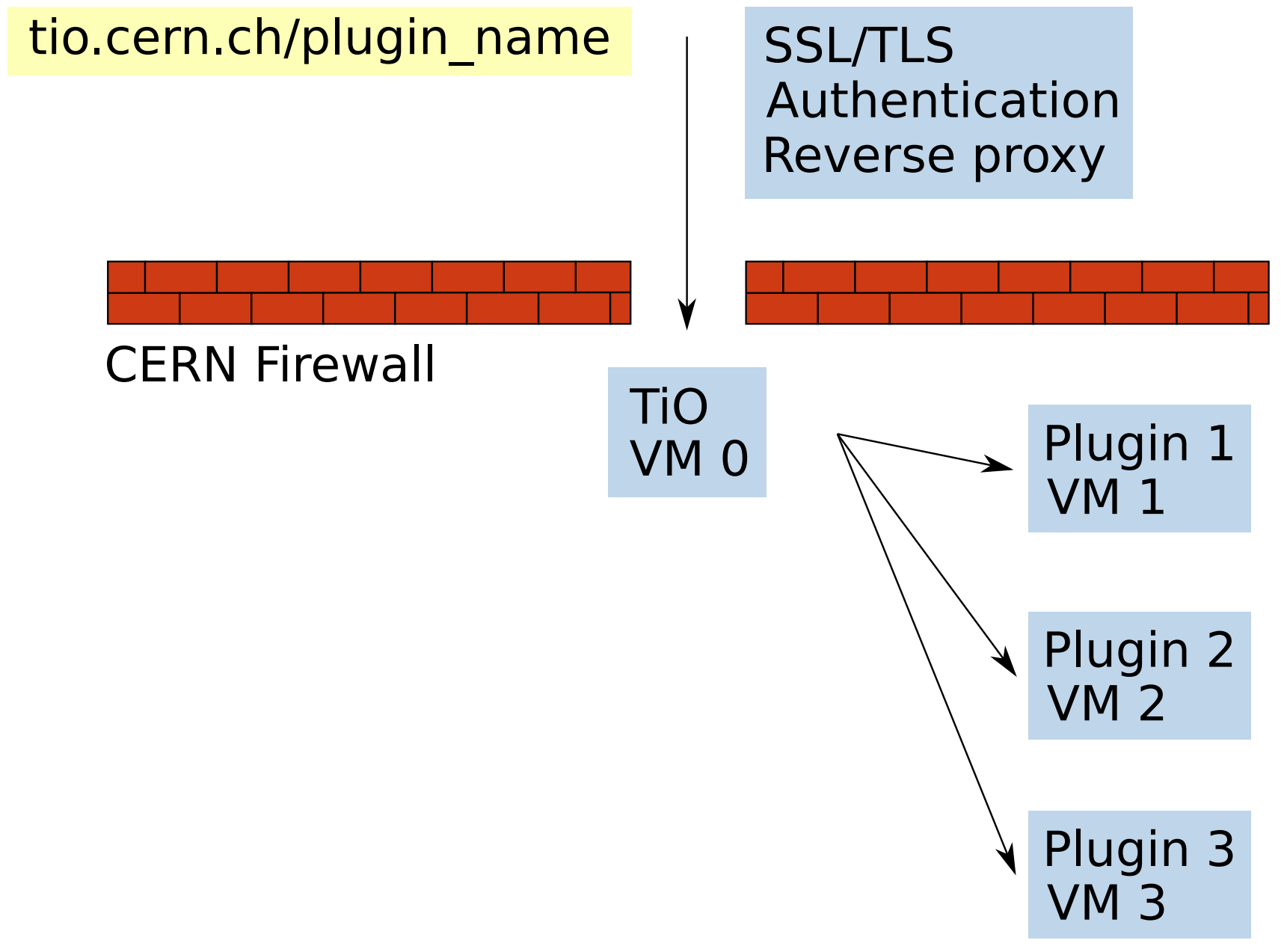
The TileCal is a sampling calorimeter using plastic scintillating tiles as the active medium and steel plates as the absorber. It covers the pseudorapidity range up to $|\eta| < 1.7$ with one central Long Barrel (LB) and two Extended Barrels (EB). The total number of calorimeter cells is 5182, while the number of channels is $\sim$10000, as most cells are read by two PMTs.

TileCal Software

Over the years, several web tools were developed mainly during the commissioning of the TileCal and first LHC run. The development was done by different groups to support several TileCal data monitoring and maintenance activities. That is why, those tools make use of distinctive technologies, data sources require different forms of data recovery, collaborators have to browse among several tools in order to perform a given task, and documentation is not well consolidated. Consequently, the use, maintenance and enhancement of existing functionalities becomes time consuming and costly work.

Tile-in-One (TiO) aims to integrate different TileCal web tools into one common platform. In order to share the computing infrastructure and access to common data and services inside or outside TileCal Collaboration, e.g. access to different databases, user authentication, commonly used libraries. This is done to not repeat the same functionality and to encourage collaborators to integrate their tools in TiO.

Platform Architecture


tio.cern.ch/plugin_name

SSL/TLS
Authentication
Reverse proxy

CERN Firewall

TiO
VM 0

Plugin 1
VM 1

Plugin 2
VM 2

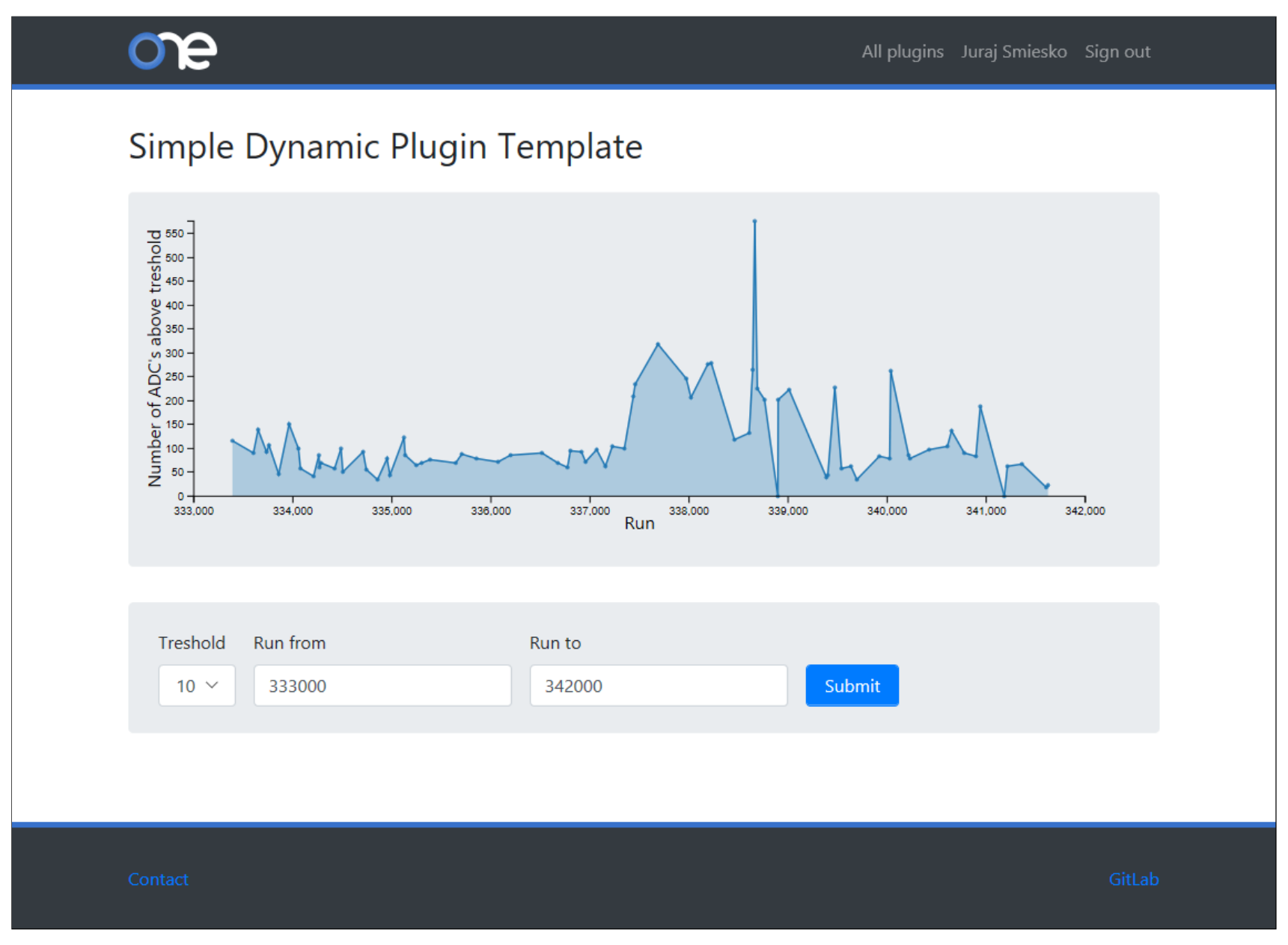
Plugin 3
VM 3

The TiO platform is designed with the flexibly and ease of maintenance in mind. The flexibility is a key requirement, because there is a large collection of data sources to be integrated, and the ease of maintenance is required by the fact that the platform is usually developed by the students, who spent only about a year developing a specific feature and then leave the project.

The design of TiO platform is based around one light main server, which is in charge of the secure connection to the platform, authentication of users and routing of the user request. Behind this server, machines which host the Data Quality (DQ) web tools, called plugins, receive the user's requests, process them and return the outcome back to the user. The key elements of the TiO design are the following:

- Main server is just a bridge
- Plugin is an independent web application
- Plugin runs in its own Virtual Machine (VM)
- Plugin is based on a template provided by the platform
- Source code is version controlled with Git
- There is a person or a group responsible for the maintenance of the plugin

Plugins

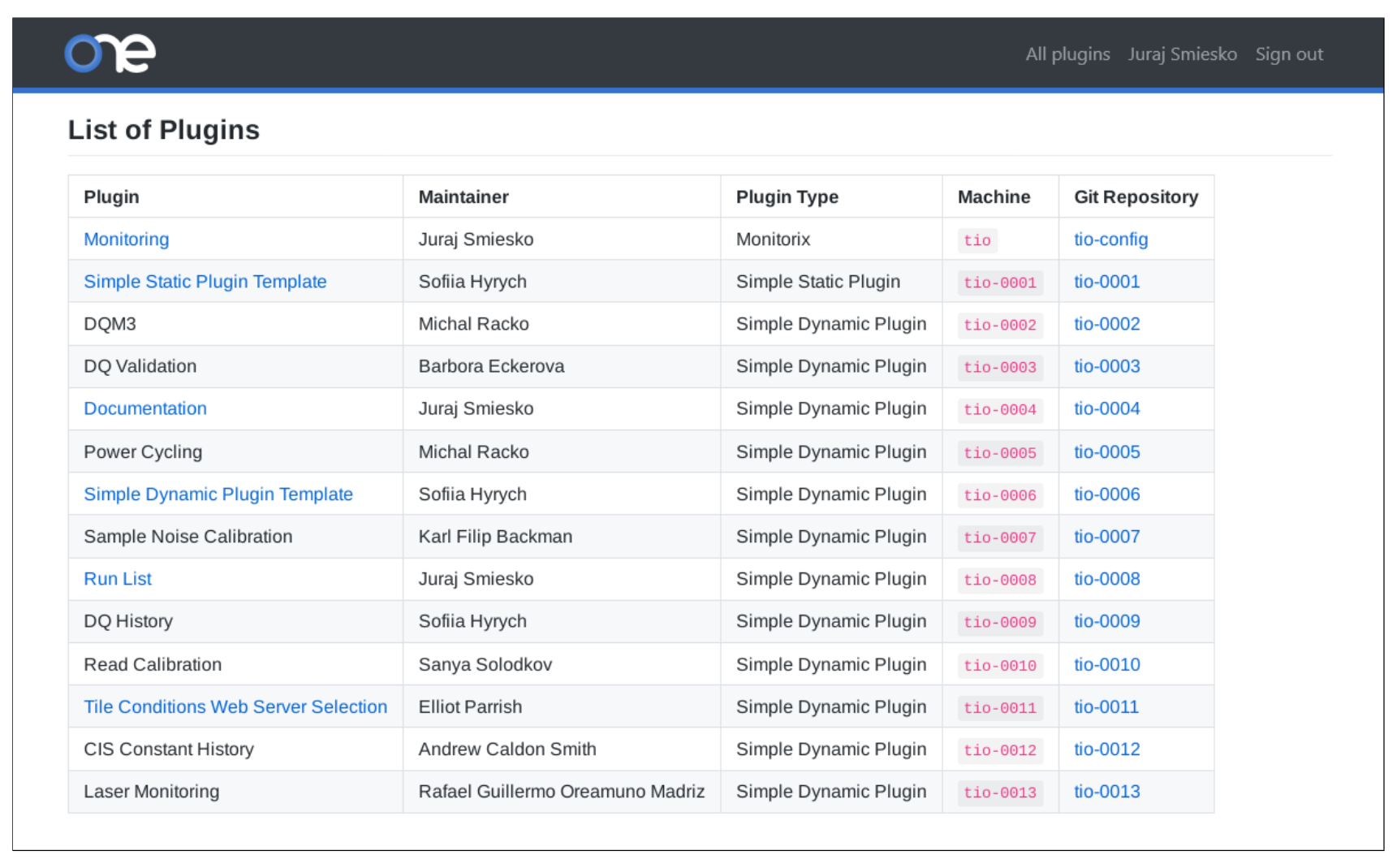


Simple Dynamic Plugin Template

Treshold: 10
Run from: 333000
Run to: 342000

Since the majority of the plugin developers are not skilled in the web development the platform provides several templates, which can be used as a starting point in the plugin development. So far the platform provides two templates:

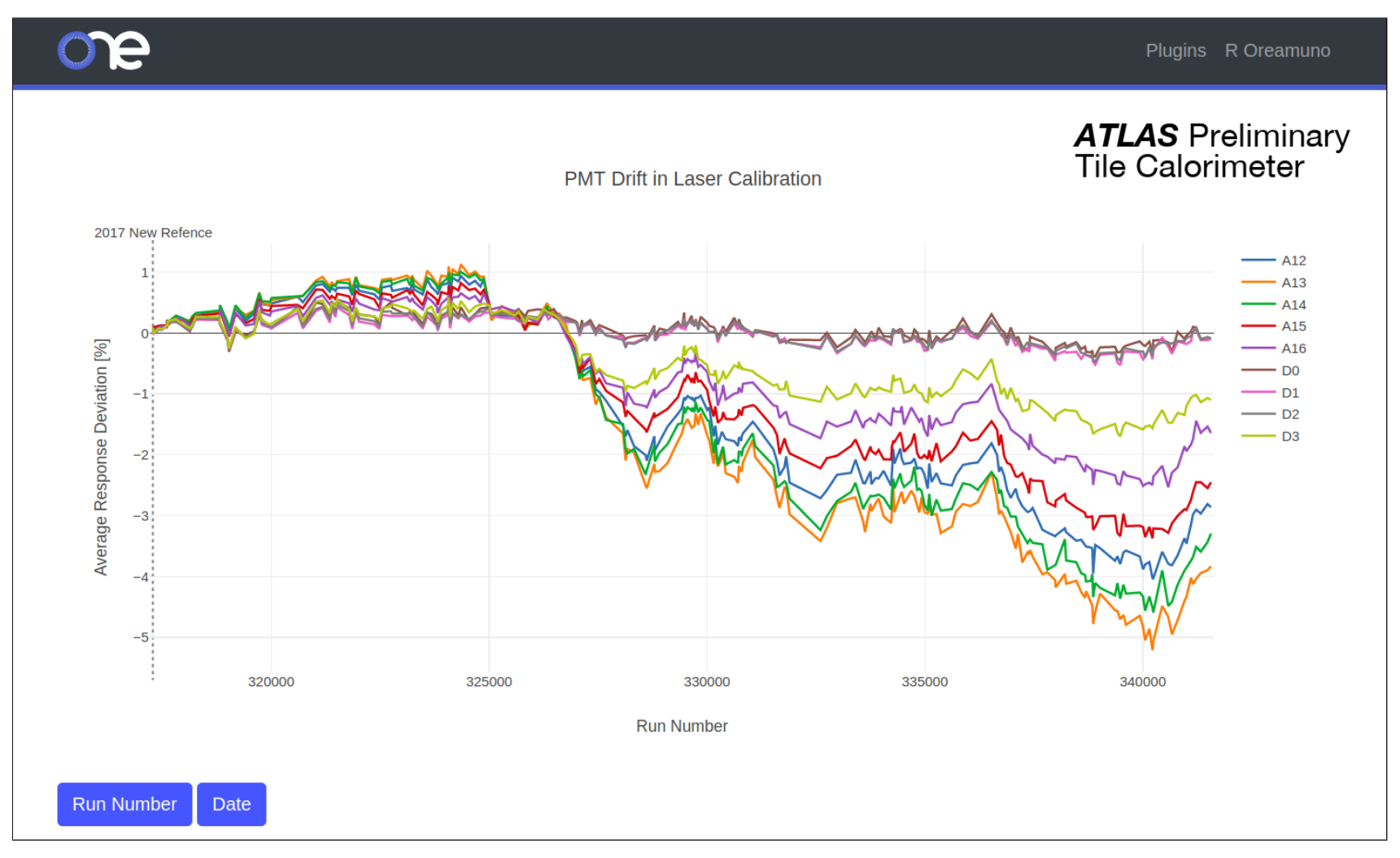
- Simple Static Plugin Template
  - Dynamic elements on the user side
  - Server runs cron jobs to update data files
  - Implemented with HTML, CSS, JavaScript
- Simple Dynamic Plugin Template
  - All of the Static Plugin
  - Processes parameters on server side
  - Implemented with Python and Bottle



List of Plugins

Plugin	Maintainer	Plugin Type	Machine	Git Repository
Monitoring	Juraj Smiesko	Monitorix	tio	tio-config
Simple Static Plugin Template	Sofiia Hyrych	Simple Static Plugin	tio-0001	tio-0001
DQM3	Michal Racko	Simple Dynamic Plugin	tio-0002	tio-0002
DQ Validation	Barbora Eckerova	Simple Dynamic Plugin	tio-0003	tio-0003
Documentation	Juraj Smiesko	Simple Dynamic Plugin	tio-0004	tio-0004
Power Cycling	Michal Racko	Simple Dynamic Plugin	tio-0005	tio-0005
Simple Dynamic Plugin Template	Sofiia Hyrych	Simple Dynamic Plugin	tio-0006	tio-0006
Sample Noise Calibration	Karl Filip Backman	Simple Dynamic Plugin	tio-0007	tio-0007
Run List	Juraj Smiesko	Simple Dynamic Plugin	tio-0008	tio-0008
DQ History	Sofiia Hyrych	Simple Dynamic Plugin	tio-0009	tio-0009
Read Calibration	Sanya Solodkov	Simple Dynamic Plugin	tio-0010	tio-0010
Tile Conditions Web Server Selection	Elliot Parrish	Simple Dynamic Plugin	tio-0011	tio-0011
CIS Constant History	Andrew Caldon Smith	Simple Dynamic Plugin	tio-0012	tio-0012
Laser Monitoring	Rafael Guillermo Oreamuno Madriz	Simple Dynamic Plugin	tio-0013	tio-0013

There are several plugins, which complement the TiO platform. One of them is the plugin is used for monitoring of the VMs on which plugins and main servers run. The plugin is based on the Monitorix [5] tool, and provides detailed information on the health of the VMs and the network. Another notable one is the plugin for hosting of the platform documentation, which is based on Simple Dynamic Plugin Template and allows users to write documentation in Markdown. It's screenshot shows all currently maintained/developed plugins.



Because the TiO platform is web based it allows relatively easy creation of interactive plots/lists. Among notable plugins are Run List, which shows information about runs taken in the last 30 days. The plugin which shows how many times there was an power cycle over a defined period of time, its name is Power Cycling. Then there are plugins which show drifts in Laser and CIS calibration constants over set period of time (plugins CIS Constant History and Laser Monitoring). And finally, there is a plugin which will serve as an replacement for the current system which compares data quality histograms from two different runs, called DQ Validation.

Tools Employed

There were several requirements on the technologies/software used to build the TiO platform, since it tries to connect two different worlds, on one hand there is requirement to be robust and stable (detector software) and on the other ever changing world of the web.

In the end the key requirements were: technology/software should be widely adopted, stable over long period of time, open source and easily replaceable.

Service/Feature	Technology/Implementation
Secure connection	CERN CA
Reverse proxy	Nginx
Authentication	CERN OAuth2 & oauth_proxy [4]
User management	oauth_proxy & TiO plugin
Source code hosting	CERN GitLab
Plugin templates	Static sites, Python & Bottle
Monitoring	Monitorix
Virtual Machine	OpenStack

References & Contact

[1] ATLAS Colaboration. In: JINST 3 (2008), S08003.

[2] https://twiki.cern.ch/twiki/bin/view/AtlasPublic/LuminosityPublicResultsRun2 (visited: Oct 2019)

[3] Tile Calorimeter Technical Design Report, CERN/LHCC/9642

[4] https://github.com/bitly/oauth2_proxy (visited: Oct 2019)

[5] https://www.monitorix.org/ (visited: Oct 2019)

If you are a CERN personel, you can visit us at `https://tio.cern.ch` or send us an email to `tileweb@cern.ch`

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