ATLAS ITk Production Database use and tools



CHEP 2024, Oct 19-25

Monika Wielers (STFC – RAL) on behalf of the ATLAS ITk collaboration



Overview of the ATLAS ITk Detector

- ITk is the new ATLAS all-silicon inner tracking detector being build for running at the highluminosity LHC
 - New detector ~3 × larger than the current one
- All parts used in detector (front-end chips, sensors, modules, supports, services) to be tracked and QC/QA test results recorded (including prototypes and pre-production items)
- Total production period is ~5 years.
 - ~100 institutes from 22 countries
 - This also includes industry partners
- In total ~10⁶ parts to be produced
 - Need for a database to store this information, monitor production and allow data-mining in case issues occur during build process or operation



New (current) inner detector

Project	Staves	Modules	Sensors	FE Chips
pixels	354	9464	9464	34292
strips	776	17888	17888	233856

Production Database: Introduction

Production database was developed by vendor for ITk



- Designed to allow up to 50 users can use the database simultaneously
- Component information to be retained during construction and 10 years of data-taking

Production Database Technical Setup

- The ITk Production Database based on mongoDB
- Two parts
 - User interface (front-end)
 - Server side (back-end)
- Based on the uuApp Framework developed by vendor
 - Framework is based primary on opensource technologies
 - Fully designed as a cloud-based application
 - Operated in uuCloud, which is powered by MS Azure
- Terminology
 - A server-side functionality is called uuCmd and is represented by an endpoint
 - The API can be called via HTTP requests (GET or POST method)
- Front End (scripts/web apps) is developed by the wider ITk community



Database Component/Test Set-up

- Database store production history per component including QC/QA tests
 - A hierarchical component structure reflects complex assembly
- Component information:
 - Essential: e.g. type, manufacturer, creation date & origin
 - Contingent: e.g. location, stage, defects
 - Related objects: parents, children, tests
- Test information:
 - Essential: e.g. pass/fail, date, location, user
 - Contingent: e.g. test parameters
 - Related objects: components
 - Note: tests done in different stages only needs to be set-up once
- Shipment information:
 - Sender, recipient, courier, tracking number, parts list
- Currently >400 component and >2000 test types defined

Sub- project	component types	test types
Strips	~200	~1000
Pixels	~200	~1100

21/10/2024

Monika Wielers (RAL)

Production Database Interactions

User interface

ATLAS ITk Production Database Te	t					Monics Wielers - +40		
CERNY	My Component List @					Save view Manage views		
	Actions				ATLAS SN Q	Register component Q		
Dashboard	Filters 🔿 Dummy 🔿 Trashed 🕒	Add filter						
14. 0	Sorting Current location Ascending ×	Add sorting				Reset sorters		
my components	Showing 673 of 675					Select all		
My Institute Components	Component	Serial Number	Current stage	Current location 15	Registered			
	Bare Module - Single bare module	200PGB12200027	Reception at TIK Institute	SEAC National Accelerator Labor	ratory 22/03/2023 12:0	13		
My Test Results	🗋 😳 📑 test module monika - quad module	200PGY20000005	Incarrier	STEC Butherford Appleton Labor	ratory 26/09/2024 15:1	10		
My Batches	Dig Test Monika - Dummy	200PGZZ1100004	Reception	STFC Rutherford Appleton Labor	atory 14/08/2024 10:1	18		
	i to i lest Monika - Dummy	200PGZ21100003	Reception	The STFC Rutherford Appleton Labor	atory 08/08/2024 10:5			
My Institute Shipping to Receive	Dig Test Monika - Dummy	200PGZZ1100002	Reception	STFC Rutherford Appleton Labor	ratory 08/08/2024 10:5	54		
My Institute Shipping to Send	Bare Module - Tutorial bare module	200PGXB1200307	Bare module assembly	STFC Rutherford Appleton Labor	ratory 28/05/2024 15:0	JZ		
	Bare Module - Tutorial bare module	200PGXB1200306	Bare module assembly	STFC Rutherford Appleton Labor	ratory 28/05/2024 15:0	J2		
Components	Bare Module - Tutorial bare module	200PGXB1200206	Bare module assembly	STEC Butherford Appleton Labor	ratory 28/05/2024 15:0			
	C C Interock Module - Dummy	200022000002	Assembly	STEC Butherford Appleton Labor	ratory 28/05/2024 14:4	···		
Test Results	D D Mezzanine Card - DUMMY	2000EXC9000002	Reception at 11k Institute	T STFC Ruthenford Appleton Labor	alory 28/05/2024 14:4	13 L		
Batches	D to Interiock Module - Dummy	200CEXM9000001	Assembly	STEC Butherford Appleton Labor	ratory 27/05/2024 17:5	"comp	onent" : ""	
	🗋 🕸 🖬 Mezzanine Card - DUMMY	20UCEXC9000001	Reception at ITK Institute	STFC Rutherford Appleton Labor	ratory 27/05/2024 17:4	"test	Type": "ADC_TEST"	
Shipping	test chip monika - test chip	200PGZ20001013	reception test	T STFC Rutherford Appleton Labor	atory 25/04/2024 13:2	u Urinet		
Delivery Requests	🗌 🖓 👹 test chip monika - test structure	200PGY23000053	reception test	STFC Rutherford Appleton Labor	ratory 11/12/202317:2		itution": ""	
	test chip monika - test structure	200PGY23000052	reception test	T STFC Rutherford Appleton Labor	alory 11/12/2023 17:2	"runN	umber":""	
Component Types	test chip monika - test structure	200PGYZ3000051	reception test	STFC Rutherford Appleton Labor	ratory 11/12/2023 17:2	"date	": "2024-10-02T09:3	2:49.343Z"
Test Taxos	test chip monika - test structure	200PGY23000050	reception test	T STFC Rutherford Appleton Labor	alory 11/12/2023 17:2	29		
rest types	test chip monika - test haltmoon	200PGYZ3000049	reception test	STEC Butherford Appleton Labor	ratory 11/12/2023 17:2	"pass	ed":true	
Batch Types	🗋 😳 📑 test chip monika - test chip	200PGZ20001012	reception test	STEC Butherford Appleton Labor	ratory 11/12/2023 17:2	"prob	lems" : false	
	test chip monika - test chip	200PGZ20001011	reception test	STFC Rutherford Appleton Labor	ratory 11/12/2023 17:2	29 ••••••••••••••••••••••••••••••••••••	oportios" · 1	
Institutes	🗋 🕡 📑 test chip monika - test chip	2009GZZ0001010	reception test	The STEC Rutherford Appleton Labor	alory 11/12/2023 17:2	29 PT	opercies . i	
Clusters	test water monika - test type	200PGZ20100003	reception test	STEC Butherford Appleton Labor	ratory 11/12/2023 17:2	²⁹ "A	NALYSIS_VERSION" :	NULL
	🕞 🕫 📷 test module - OE module	20UPEZ20000014	Reception rest	STEC Butherford Appleton Labor	ratory 04/09/2023 12:1	}		
Users	u or a sare module - rutorial bare module	200PGAB0000120	bare module assembly	The Stree Rutherford Appleton Labor	uz/08/2023 13:0		sults": {	
About ITk PD	Career and Chine Works	200PGXM1000100	bare module to module PCB assembly	STEC Butherford Appleton Labor	atory 02/08/2023 12:5		USTNE CRATNER CALT	DATTON
ADDUTTKPD	Dummy NTEST-02H0	enshot	water probing test	and STEC Redienord Appleton Labor	07/07/2023 13:3	24	"FINE_GRAINED_CALIE	SRAIION":

API commands

- Mostly often used in our community
 - Allows development of custom scripts/web apps for data uploads

Allows

"ADC_CHANNEL_STATUS" : true

"ADC_OFFSET" : 0

"ADC_GAIN" : 0 "TEMPERATURE" : 0

}

- Batch upload via csv/excel files or google sheets
- Machine output can be converted to format needed for DB uploads
- Sanity checks help avoiding human mistakes
- Uploads done using json format
- ITk community also developed api wrappers (itkdb, dbAccess) "FINE_GRAINED_CALIBRATION" : {}
 - Eases script developments

Tools to interact with Production Database

- General purpose tools and tools for dedicated tasks developed by ITk collaboration
 - These use modern interface tools for GUIs, webapps, notebooks and command-line scripts
- Usage depends on subgroup/institutes
 - Important to tailor tools to needs in diverse community (technicians, engineers, physicists)

Streamlit (multi-purpose tool) hosted

on CERN OpenShift in docker

Tools distributed via CERN's IT platforms & licences

via git



able options, &JSON to print the registration at any time	Select app by theme: CoffeeApp commonApp		toggle debug for details	
Laboratory)	 genericApp interlockApp Select page: Authenticate Manage Crate 		Select component Select input method: © Enter identifier	Flask f CERN
	Broom Cupboard	_	Select from inventory Enter identifier	ASICs You are logged in as: Mo Your institue is: RAL (P) Change institute:
	RAL Project:	×	Enter component identifier	Workflow view
	CE	•	ruei neuritei m Berromboueur unorugaon	FE chip version



Ŭ			P 0'				• ••		.9.
	ASICs								
	You are log Your institu	ged in as: Monica Wieler te is: RAL (P)	3						
	Change ins	titute: United Kingdo	om v	RAL ~ Chang	e project: P v				
	Workfl	ow view - Modu	les						
	Create new	component							
	FE chip	version	flags		type				
	selec	t v v		v s	select	*			
	Select	Serial number	Creation date	Bare module Serial Number	Flex Serial Number	FE ASIC Serial Numbers	Flex attach	Vis. Insp.	Mass
		20UPGXM0000122	2024-02-12				1.1		
		20UPGX19110541	2023-08-25	20UPGBR9900001	20UPGPQ2110541			1.1	1.0
		20UPGX19110507	2023-08-25	20UPGBR9900004	20UPGPQ2110507		1.1	1.1	=
Monika Wieler	้ว เเ					20UPGXF1009289			

Token already exists in shell environment. O]\$ Updating list of institutions.]\$ To always print the available input options for codes, please type 'y/Y' or t

[INFO]\$ Running ITk Production Database component registration interface.

'n/N' to suppress this output:

Getting token.

O]\$ Use escape codes &PRINT to print the available ent JSON for your component, or &CANCEL to cancel T]\$ Enter your institution code: RAL

Python scripts distributed via git

monika.wielers@HEPDOCK213 production_database_scripts % python3 registerComponent.py

[INFO]\$ Using code: RAL (STFC Rutherford Appleton

Database Usage

Current information in database

Note: production for many parts has not yet started

# regis	sterea	comp	onents	

Hus all to real a survey and the

Project	# components	# institute	# user
Pixel	~130k	~60	~300
Strips	~820k	~60	~450

# uploaded tests	# shipments
~9.5·10 ⁶	~8000

- Number of requests sent to database
 - Reading out data far outstrips inputting

Top 3 commands

getTestRun	39%
getComponent	21%
listComponents	12%



21/10/2024

Reporting (done outside database)

÷	Common	tools to	create	reports
---	--------	----------	--------	---------

- Flattening
- Visualisation (tables, reports)
- Distribution (creation of data panels)
- Type of reports
 - On-demand reports
 - Scheduled reports
 - Alerts in case parts do not fulfill specifications
- Reports make use of CERN licenses and platforms
 - Reporting (python) code stored on gitLab
 - Automated reports run in containers on Openshift
 - Generated reports uploaded to EOS
 - Website generated via GitLab I and collected in central repository
- Meta-data includes creator, code, upload timestamp 21/10/2024

	ITk Production Database Reporting Hub	
	Links	>
	Reports	~
	common_electronics	>
	common_mechanics	>
	other	>
	pixels	~
	2.1.10_Data_Trans	
	2.1.11_DAQ_&_DCS	
	2.1.1_Sensors	
	2.1.2_FEs	
	2.1.3_Hyb_&_A'bly	
	2.1.4_Services	
	2.1.5_Loc_Sups	
	2.1.6_Global_Tools	
	2.1.7_Integration	
	010 010 -1-1	
Uploaded 2024-07-01		
Report type: test		
Uploaded on: 2024-07-01 @ 10:24 by doyeong		
Source code: https://gitlab.cern.ch/atlas-itk/pixel	//module/module-qc-statistical-too	ls
(optional) manual WBS code: 2.1.3		

Upload History

basic-gc-plots-ANALOG_READBACK

Uploaded 2024-07-01

Monika Wielers (RAL)

9

>

Reporting

- Various generation scripts with common principles
 - Public (to users): Reports visible to ITk members
 - Accessible: common (user) access to reports, without common (developer) format.
 - Credited: who, how, when

Different types of reports target different audiences

- Different level of details needed for sub-project coordinators, production management group, subproject analysers, institute level
- Reporting being done for
 - Checking data consistency
 - Monitoring of parts location and production rates
 - Monitoring of production quality and yields
- Reporting takes up lots of resources and soon will move to backup copy hosted at CERN in OpenStack

Testing temperature in cold/warm



Timeline of mass measurement



21/10/2024

Data Mining

- Important to look at data in case issues during production/operations arise
 - Try to find correlations in data
 - In which area of the component did the problem occur
 - Does it affect one batch only
 - Does it affect parts from one vendor only
 - Which test results does it affect
 - Does it affect certain production version
 - Does it happen at the same stage in the production flow

ë

- Successfully used database for these purposes in strips and pixel sub-projects
 - Database data-mining essential to understand issues!

Conclusions

- ATLAS ITk production database is a fully functional distributed data management system in use for the last 4 years by ~100 institutes
- Database heavily used for registration and test uploads
 - $\sim -10^6$ components registered and nearly 10×10^6 test results in database
- Vital tool for monitoring production to ensure detector build on time and to specifications
- Database will be operational for the remaining years of construction and during HL-LHC operation
 - Long-term maintenance of database and the front-end tools used for reporting needed