Rubin Science Platform on Google Cloud: The story so far

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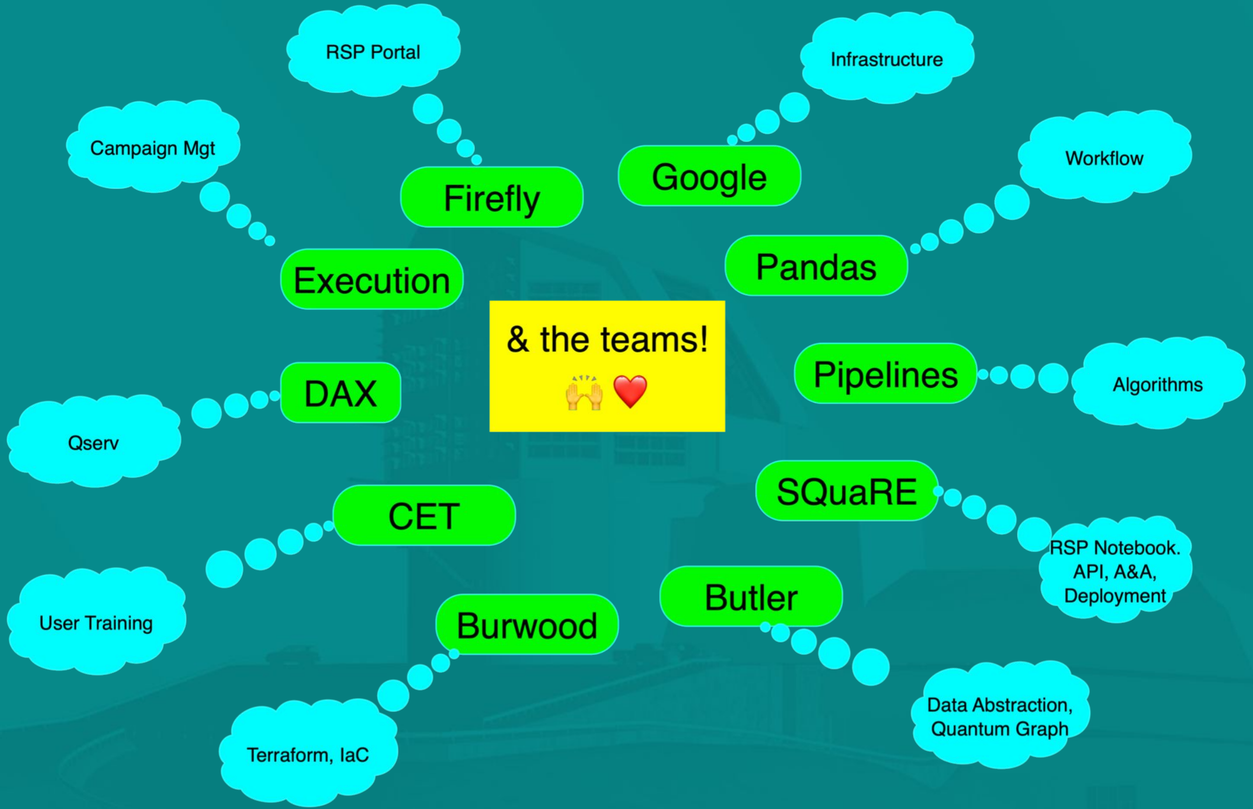
Flora Huang *(Google)*
Dan Speck *(Burwood)*

... AND ...

VERA C. RUBIN OBSERVATORY



& the teams! 🙌 ❤️

Firefly
RSP Portal

Execution
Campaign Mgt

Google
Infrastructure

Pandas
Workflow

Pipelines
Algorithms

DAX
Qserv

CET
User Training

SQuaRE
RSP Notebook. API, A&A, Deployment

Butler
Data Abstraction, Quantum Graph

Burwood
Terraform, IaC

NSF AURA U.S. DEPARTMENT OF ENERGY SLAC CHARLES AND LISA SIMONYI FUND FOR ARTS AND SCIENCES LSST CORPORATION

It takes a village

Rubin and LSST in a nutshell

An optical/near-IR survey of half the sky in ugrizy bands to r 27.5 (36 nJy) based on 825 visits over a 10-year period: deep wide fast.

- 90% of time spent on uniform survey: every 3-4 nights, the whole observable sky scanned twice per night
- 100 PB of data: about a billion 16 Mpix images, enabling measurements for **40 billion objects!**

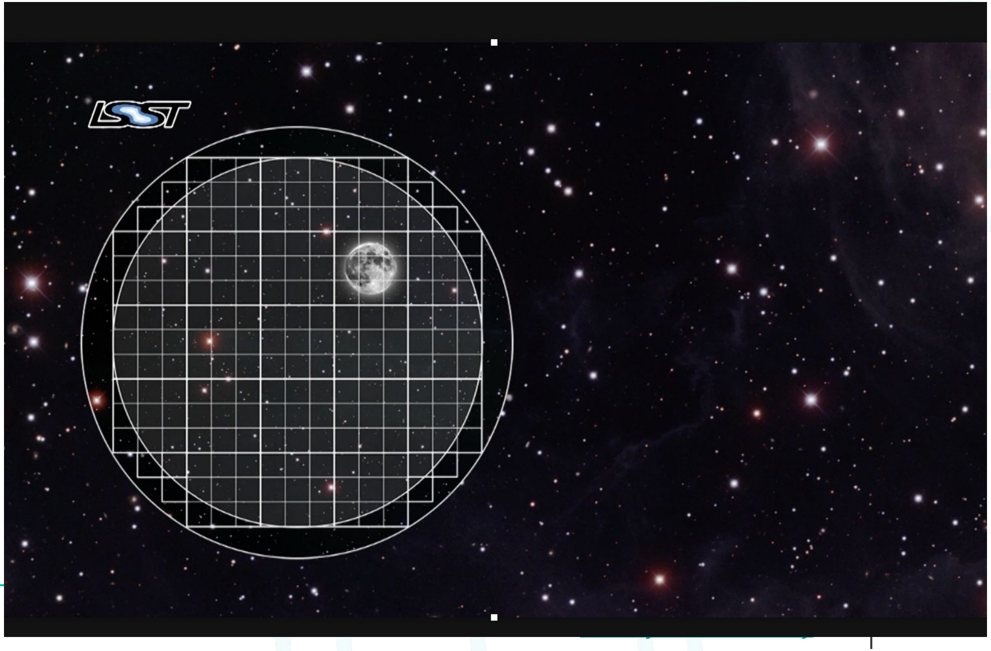
see also http://www.lsst.org

Ivezic´et al. (2019)-arXiv:0805.2366

https://www.lsst.org/scientists/keynumbers

Situated on Cerro Pachón Chile (2647m)

Largest Camera ever (3.2 Gpixels)



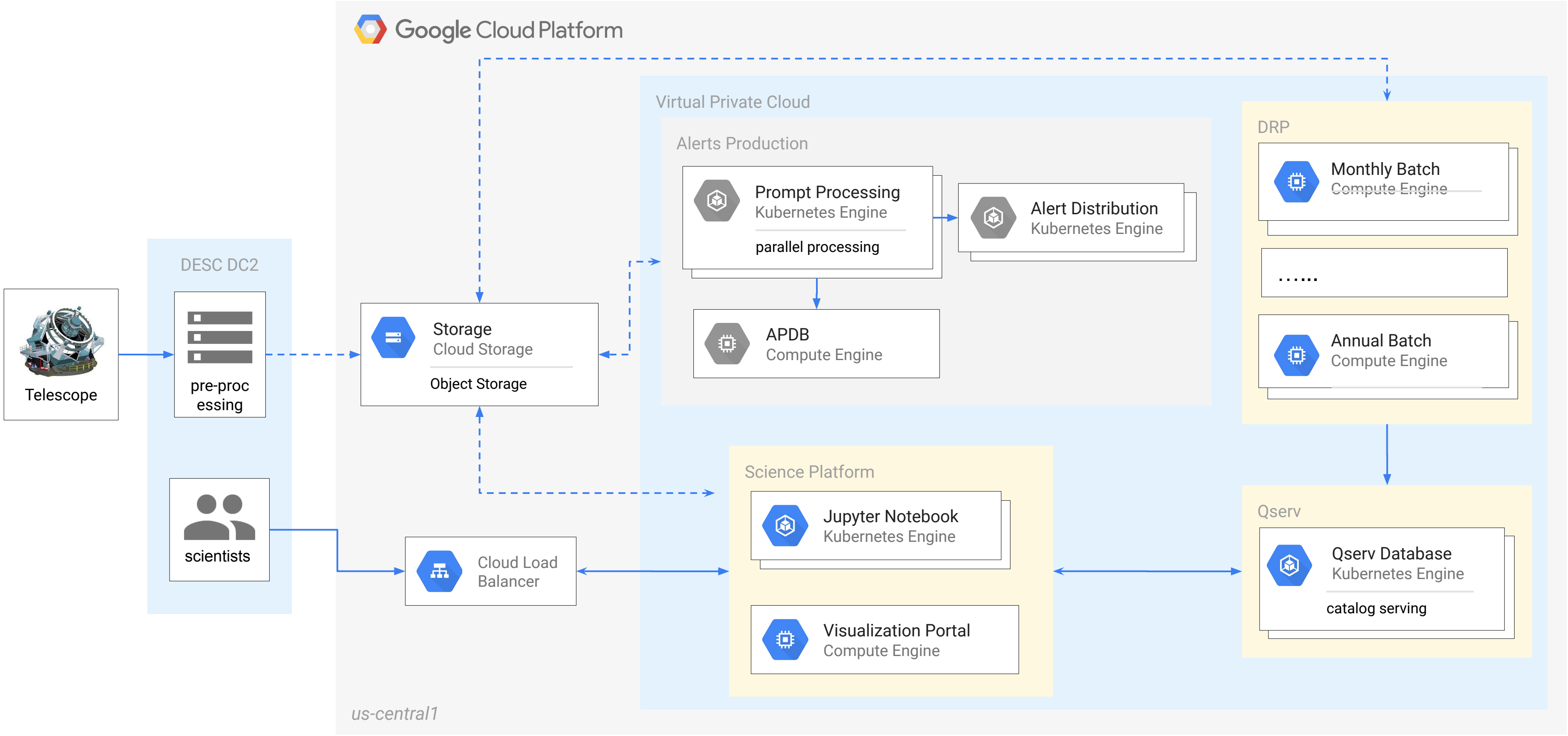
Interim Data Facility on Google Cloud

- Due to a change in the funding landscape, what was conceived as the LSST Data Facility in construction became the US Data Facility in operations - only for a while we had no idea where that would be
- We set up an Interim Data Facility (IDF) on Google Cloud as a way of bridging the gap between on-prem data facilities and servicing early users through our Data Preview program
- **This is not a toy or proof of concept; it is a full-scale production environment** without fall-back or dependance on on-prem for its released into production functions
- Contract signed October 2020, infrastructure essentially complete March 2021, production services aimed at external users released for the first time in June 2021
- Running services at scale allows for a high degree of readiness for Data Production activity in full survey operations

Slide: Hsin-Fang Chiang

IDF - Architecture

Slide: Flora Huang



Google Cloud Platform

Telescope

DESC DC2

pre-processing

scientists

Storage
Cloud Storage
Object Storage

Cloud Load Balancer

Virtual Private Cloud

Alerts Production

Prompt Processing
Kubernetes Engine
parallel processing

Alert Distribution
Kubernetes Engine

APDB
Compute Engine

DRP

Monthly Batch
Compute Engine

……

Annual Batch
Compute Engine

Science Platform

Jupyter Notebook
Kubernetes Engine

Visualization Portal
Compute Engine

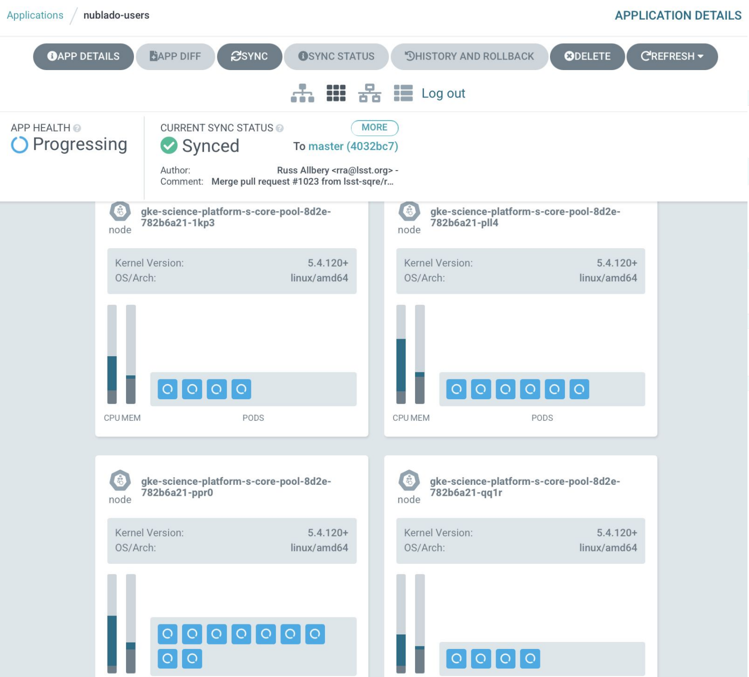
Qserv

Qserv Database
Kubernetes Engine
catalog serving

us-central1

IDF deployment of Rubin Science Platform + friends

- No Google console operations: clusters managed by terraform for reproducibility and traceability (Infrastructure as Code)
- Services running on Kubernetes and managed by ArgoCD
- Only developers have infrastructure (Google) accounts; users authenticate to services through the Rubin Science Platform authentication and authorization service (currently backed by Github Oauth for this deployment)
- Data access is through our Gen3 Butler data abstraction layer, at the IDF this is backed by the Google Cloud Storage object store; posix home spaces via Google Filestore
- Our in-house high performance database service (Qserv) is also deployed on Kubernetes; Gen3 registry uses CloudSQL



APP HEALTH: Progressing

CURRENT SYNC STATUS: Synced To master (4032bc7)

Author: Russ Allbery <rra@lsst.org> -
Comment: Merge pull request #1023 from lsst-sqre/r...

gke-science-platform-s-core-pool-8d2e-782b6a21-1kp3
Kernel Version: 5.4.120+
OS/Arch: linux/amd64

gke-science-platform-s-core-pool-8d2e-782b6a21-pll4
Kernel Version: 5.4.120+
OS/Arch: linux/amd64

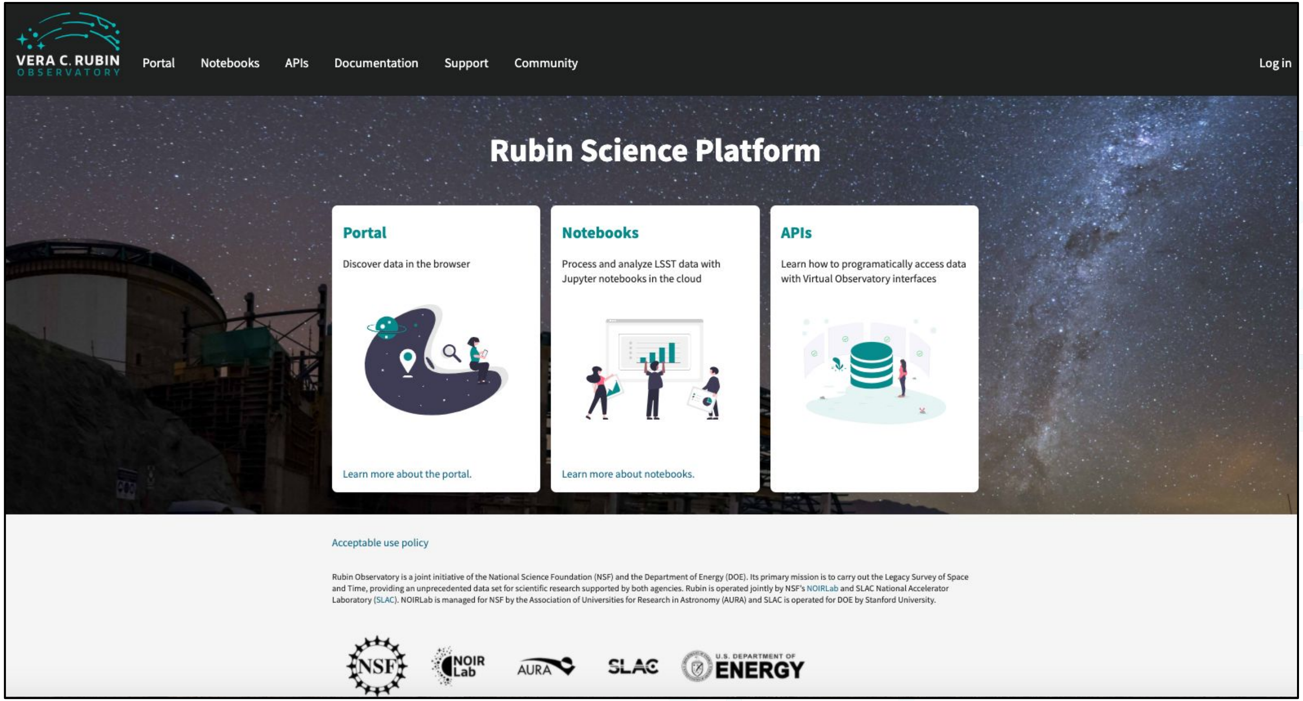
gke-science-platform-s-core-pool-8d2e-782b6a21-ppr0
Kernel Version: 5.4.120+
OS/Arch: linux/amd64

gke-science-platform-s-core-pool-8d2e-782b6a21-qq1r
Kernel Version: 5.4.120+
OS/Arch: linux/amd64

Slide: Hsin-Fang Chiang

Data Preview 0.1! June 2021

- Pre-Operations Activity for Rubin and the community based on DESC simulations
- Science platform is up as planned on Google Cloud IDF data.lsst.cloud
- Data product documentation from Community Engagement Team (CET): dp0-1.lsst.io
- Delegates (users) gained access in June!



Rubin Science Platform

Portal

Discover data in the browser

Learn more about the portal.

Notebooks

Process and analyze LSST data with Jupyter notebooks in the cloud

Learn more about notebooks.

APIs

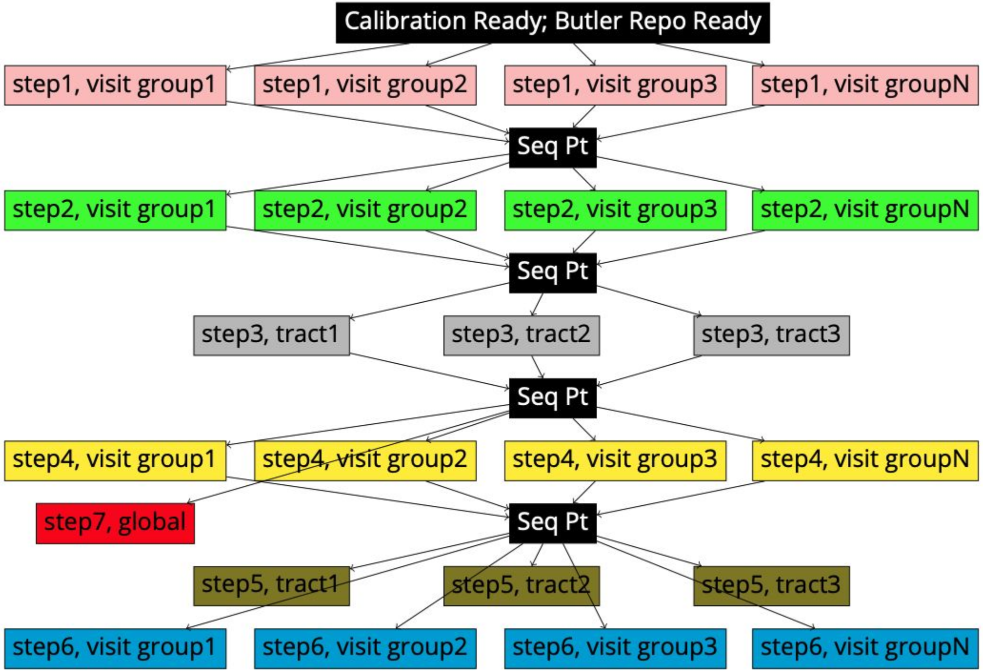
Learn how to programatically access data with Virtual Observatory interfaces

Acceptable use policy

Rubin Observatory is a joint initiative of the National Science Foundation (NSF) and the Department of Energy (DOE). Its primary mission is to carry out the Legacy Survey of Space and Time, providing an unprecedented data set for scientific research supported by both agencies. Rubin is operated jointly by NSF's NOIRLab and SLAC National Accelerator Laboratory (SLAC). NOIRLab is managed for NSF by the Association of Universities for Research in Astronomy (AURA) and SLAC is operated for DOE by Stanford University.

DP0.2 - June 2022

- Reprocess the DESC data (DP0.1) with Pipelines V23
  - generate a fully self-consistent data release
  - Demonstrate portable set of cloud enabled tools based on Butler Gen3 and PanDA
  - Produce and load Catalogs
  - FIrst Operations Rehearsal for Data Release Production
- Pipelines to run stepwise
  - This is an experiment
  - Flow chart on right.
- our middleware with PanDA
  - Data processing split between USDF🇺🇸, FRDF🇫🇷, UKDF🇬🇧



Calibration Ready; Butler Repo Ready

step1, visit group1
step1, visit group2
step1, visit group3
step1, visit groupN

Seq Pt

step2, visit group1
step2, visit group2
step2, visit group3
step2, visit groupN

Seq Pt

step3, tract1
step3, tract2
step3, tract3

Seq Pt

step4, visit group1
step4, visit group2
step4, visit group3
step4, visit groupN

step7, global

Seq Pt

step5, tract1
step5, tract2
step5, tract3

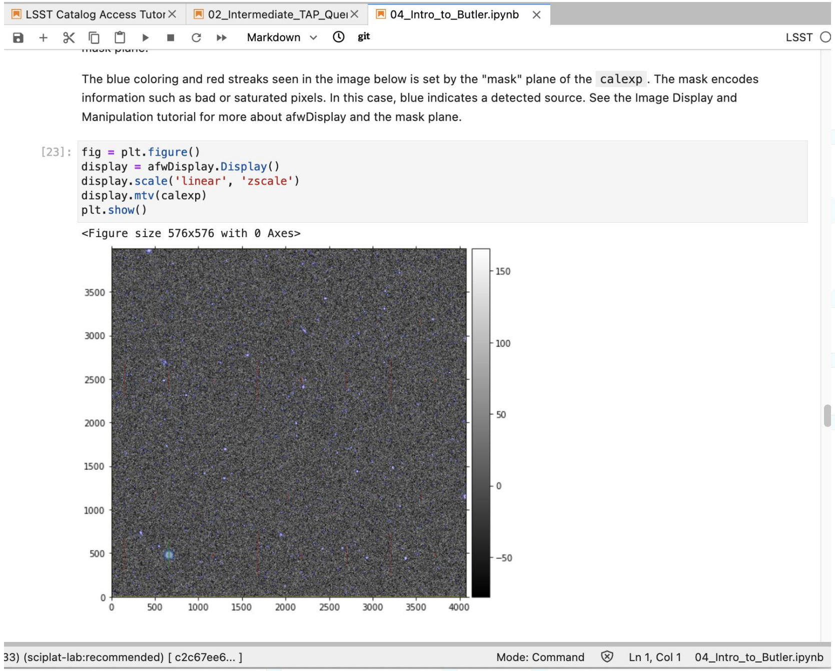
step6, visit group1
step6, visit group2
step6, visit group3
step6, visit groupN

Community Engagement in Data Preview 0

~ 250 “DP0 Delegates”, scientists and students from the Rubin community, are participating in DP0.1 (ops users estimated at ~ 10K)

Resources and activities provided by the Rubin Community Engagement Team (CET), such as:

- biweekly virtual “Delegate Assemblies” with hands-on demonstrations
- the full suite of DP0 documentation available at ls.st/dp0-1 (and tutorial Notebooks)
- a dedicated Community.lsst.org category: “Support -- Data Preview 0”
- all of which is publicly accessible



The blue coloring and red streaks seen in the image below is set by the "mask" plane of the `calexp`. The mask encodes information such as bad or saturated pixels. In this case, blue indicates a detected source. See the Image Display and Manipulation tutorial for more about afwDisplay and the mask plane.

```
[23]: fig = plt.figure()
      display = afwDisplay.Display()
      display.scale('linear', 'zscale')
      display.mtv(calexp)
      plt.show()

<Figure size 576x576 with 0 Axes>
```

33) (sciplat-lab:recommended) [c2c67ee6...]   Mode: Command   Ln 1, Col 1   04_Intro_to_Butler.ipynb

Slide:Melissa Graham

Things we learned along the way

Users need a lot of guidance if we are to be efficient:

- Qserv (ADQL) which is SQL is powerful but not everyone knows how to use it
  - E.g. can build great histograms (minutes for full dataset) in SQL (Qserv)
  - Users in notebooks tend to do this by pulling in all the data and binning in python
- Users will find ways to consume all your available resources; have a plan!
- AutoScale really works - but its not really fast, takes **minutes** to spin up new node - **eons** as far as users concerned!

You need management buy-in :

- Proof of concepts helped a lot
  - Six months with Google 2018/2019 (DMTN-125)
  - Six months with Amazon 2019 (DMTN-137)
- Still prepare for lots of explaining and cost modeling.

Summary

- Where we were prepared by having design and built cloud-ready services, transition was fast and painless (Kubernetes Will Save Astronomy ™)
- Tangible benefits to working with a highly popular toolchain
- Ideal way to mitigate schedule risk for on-prem computing delivery
- Not cheap but great value for money
- Developers love the self-serve aspect (and their velocity shows it)
- Vendor lock-in is not the issue; the working style to which you become accustomed (and not wanting to give it up) is the issue
- We are seriously evaluating whether an on-prem/cloud hybrid model is actually the best way forward permanently
- From a technical perspective, use of commodity computing is a no-brainer

The End

Questions?

Blast 20 Cerro Pachón April 2011

Rubin Observatory July 2021

http://www.lsst.org

http://community.lsst.org