VERA C. RUBIN OBSERVATORY

Rubin Science Platform: cloud-first, VO-first

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Portal Notebooks APIs Documentation Support Community frossie

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.

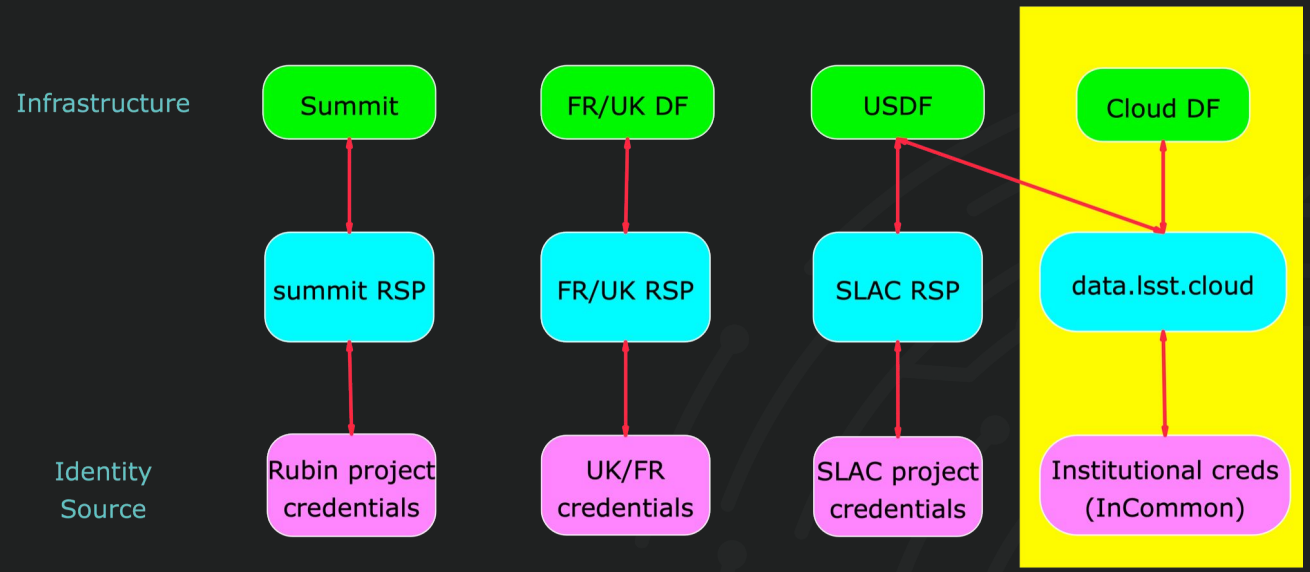
APIs

Learn how to programatically access data with Virtual Observatory interfaces

RSP On-prem & On-cloud k8s deployments

- Flagship deployment is and will now remain on Google Cloud
- Being sized for ~10K users
- Cloud choice made for:
  - Scalability
  - Elasticity
  - Isolation
  - Reliability
  - Dev velocity
  - Bringing together separate funding streams
  - Value for money

RSP instances now on 8 distinct sites/infrastructures



Data services available on data.lsst.cloud

Current:

- TAP/ObsTAP (CADC 🙏)
- Image services (implements SODA)
- HiPS (more later)
- DataLink (abstracts image access from ObsTAP results)
- Microservices bouncing TAP results into additional queries via DataLink descriptors (more later)

Planned:

- Registry (definitely)
- VOSpace (maybe/eventually)
- ObsLocTAP (probably)

Not Currently Planned:

- SSO Auth v1 (no bearer tokens)
- SSO Auth v2 (unsure as to benefits to our users, design choices unclear to us, need to understand better)

* *Rubin implementations in Python*

HiPS service (and GCS)

Constraints:

- Required to restrict access to data rights holders (at least for full resolution)
- Rubin primarily uses object storage
- Data is therefore in a non-public GCS bucket and cannot be served by a normal static file web server

Approach:

- Small Python service serving HiPS-tile files out of GCS (currently by retrieving the whole file and then returning it)
- Alternative was signed URLs, but were worried about problems with redirects
- HiPS list generated by a separate service

Future:

- Serve directly from GCS using Cloud CDN, Cloud Run, and an auth helper

SODA implementation

Design goals:

- Only image cutouts as the initial target
- Separate all image manipulation from the mechanics of the service so that it can be independently developed and tested by Rubin pipeline experts
- Build on a general framework that can be reused for other VO services
- GCS used for all storage

Implementation:

- Python FastAPI frontend using dramatiq with a Redis queue and sqlalchemy
- Cutouts performed in a separate worker container based on the Rubin stack
- Slightly complex queue design to separate UWS database operations from backend worker for strict separation of concerns
- Results stored in a temporary GCS bucket and returned with signed URLs

How the portal leverages the DL microservices

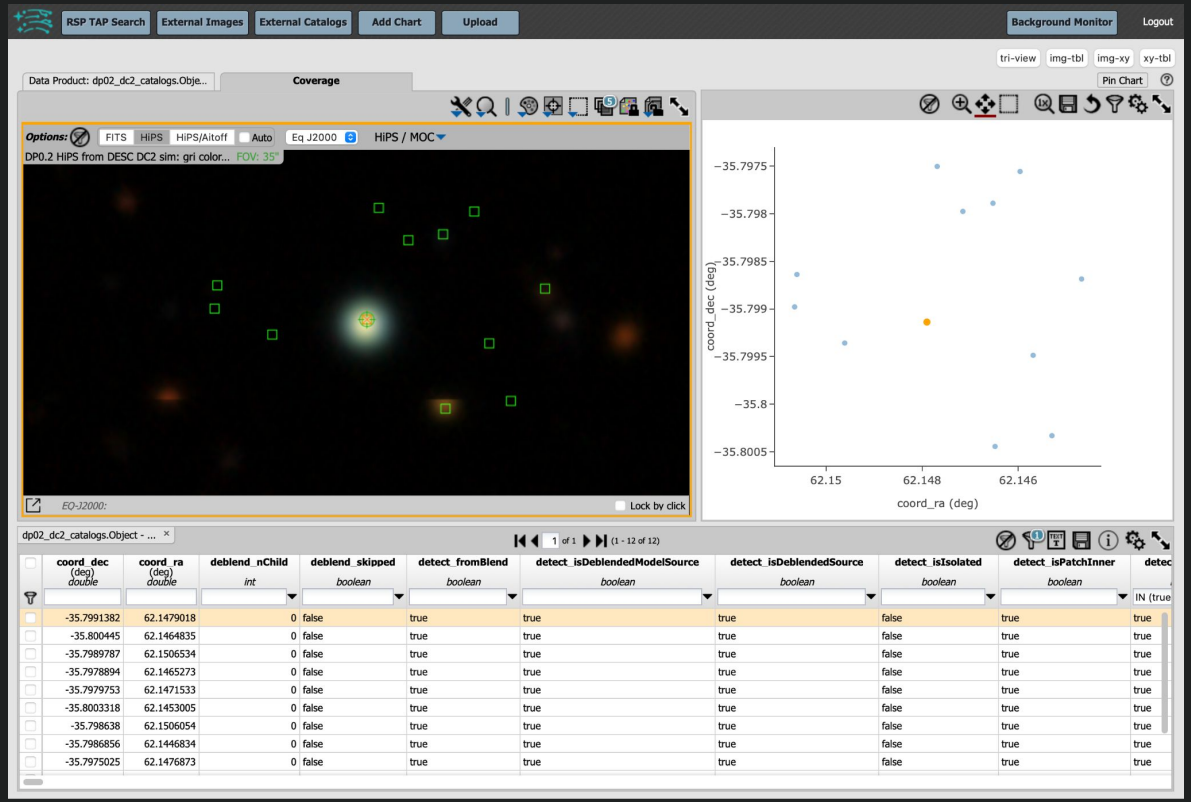
As seen from the Portal side:

- Uses VO-standard protocols to explore and visualize data
- Recognizes DataLink service descriptors in TAP results and adds a UI for that service to the result display
- Example: Retrieve a light curve for an object identified by a row in the results of a TAP query
- Recognizes and generates a UI for standard parameter types
  - Circle parameters for a cutout
  - Enumerated parameters such as filter band for a light curve

As seen from the API services:

- TAP service is configured to add DataLink service descriptors as needed to results containing designated columns
  - E.g., if Object.objectId is present, add a lightcurve-retrieval link
- Service descriptor points to a route in the datalinker service
- Parameters may be fixed in the URL or specified in the service descriptor if the user should be prompted for them
- Route in the datalinker service (in the current microservices) constructs and redirects to a TAP sync query

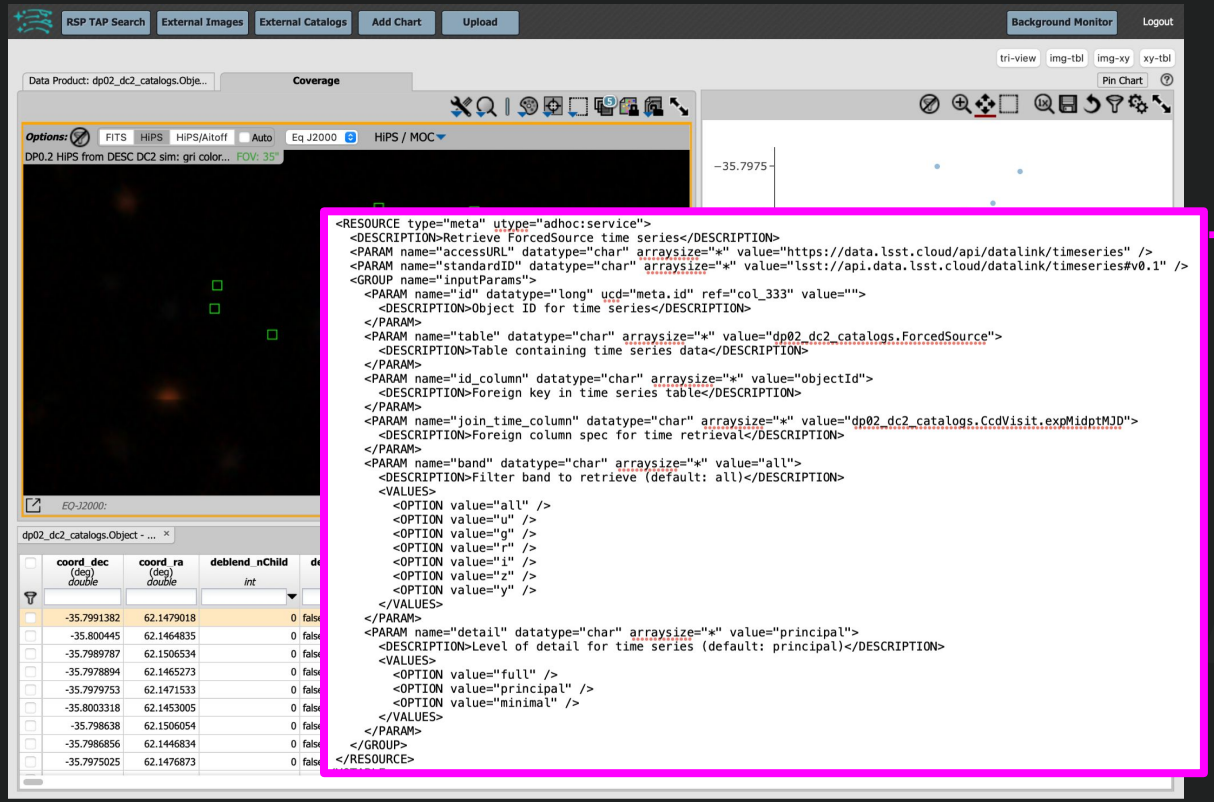
DataLink in action



1) Perform a search in the Rubin “Object” catalog

   (the target is a simulated RR Lyrae star in our Data Preview 0.2 system)

DataLink in action

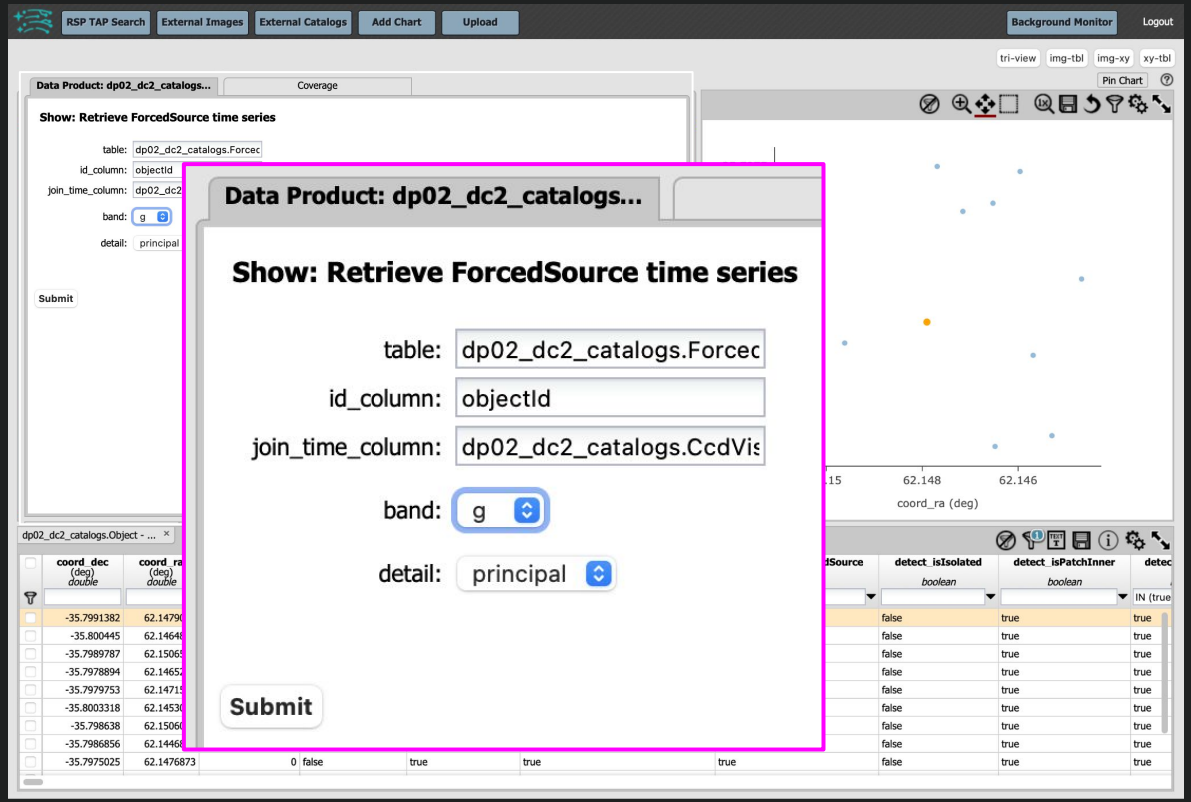



```
<RESOURCE type="meta" utype="adhoc:service">
  <DESCRIPTION>Retrieve ForcedSource time series</DESCRIPTION>
  <PARAM name="accessURL" datatype="char" arraysize="*" value="https://data.lsst.cloud/api/datalink/timeseries" />
  <PARAM name="standardID" datatype="char" arraysize="*" value="lsst://api.data.lsst.cloud/datalink/timeseries#v0.1" />
  <GROUP name="inputParams">
    <PARAM name="id" datatype="long" ucd="meta.id" ref="col_333" value="">
      <DESCRIPTION>Object ID for time series</DESCRIPTION>
    </PARAM>
    <PARAM name="table" datatype="char" arraysize="*" value="dp02_dc2_catalogs.ForcedSource">
      <DESCRIPTION>Table containing time series data</DESCRIPTION>
    </PARAM>
    <PARAM name="id_column" datatype="char" arraysize="*" value="objectId">
      <DESCRIPTION>Foreign key in time series table</DESCRIPTION>
    </PARAM>
    <PARAM name="join_time_column" datatype="char" arraysize="*" value="dp02_dc2_catalogs.CcdVisit.expMidptMJD">
      <DESCRIPTION>Foreign column spec for time retrieval</DESCRIPTION>
    </PARAM>
    <PARAM name="band" datatype="char" arraysize="*" value="all">
      <DESCRIPTION>Filter band to retrieve (default: all)</DESCRIPTION>
      <VALUES>
        <OPTION value="all" />
        <OPTION value="u" />
        <OPTION value="g" />
        <OPTION value="r" />
        <OPTION value="i" />
        <OPTION value="z" />
        <OPTION value="y" />
      </VALUES>
    </PARAM>
    <PARAM name="detail" datatype="char" arraysize="*" value="principal">
      <DESCRIPTION>Level of detail for time series (default: principal)</DESCRIPTION>
      <VALUES>
        <OPTION value="full" />
        <OPTION value="principal" />
        <OPTION value="minimal" />
      </VALUES>
    </PARAM>
  </GROUP>
</RESOURCE>
```

1) Perform a search in the Rubin “Object” catalog

→ TAP service returns result annotated with service descriptor for light-curve query based on objectId

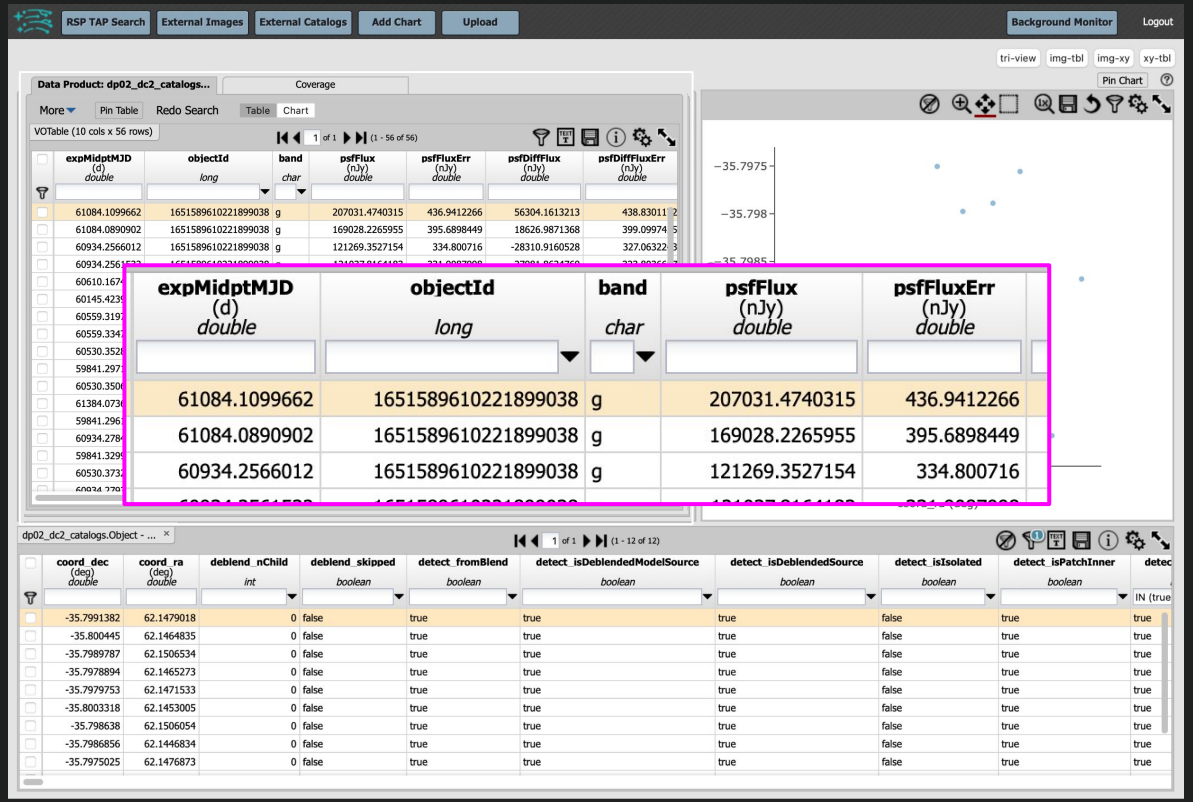
DataLink in action



1) Perform a search in the Rubin “Object” catalog

2) New tab in viewer provides auto-generated UI for light-curve query based on the selected row in the results table

DataLink in action

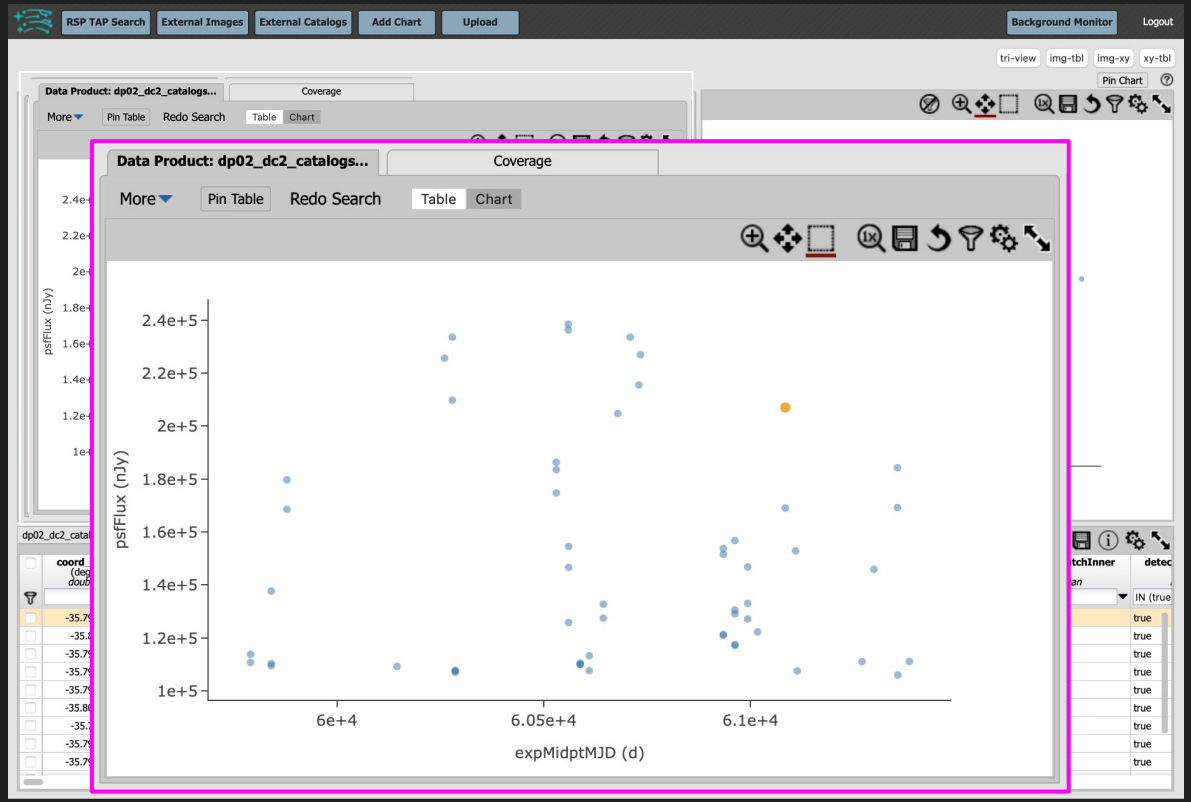


1) Perform a search in the Rubin “Object” catalog

2) New tab in viewer provides auto-generated UI for light-curve query

3) “Submit” yields a table…

DataLink in action



1) Perform a search in the Rubin “Object” catalog

2) New tab in viewer provides auto-generated UI for light-curve query

3) “Submit” yields a table and a corresponding plot

DataLink plans

Additional DataLink services will help users locate many kinds of related data

- Difference-imaging light curves
- Images on which an Object, or a transient, were detected
- Input images to a coadd
- Calibration data associated with the processing of an image
- Reconstructed PSFs at locations of detections

Each new feature requires:

- A simple addition to the TAP service configuration text files
- A corresponding (micro)service to return the data

Our IVOA service framework and “phalanx” Gitops-based deployment system make these easy to roll out incrementally.

New user-visible features appear without requiring changes to the RSP Portal (Firefly) application.

Rubin's VO Implementation experience

Good:

- Yay standards
- Standards documents are generally high quality
- Being able to reuse service code (CADC TAP)
- DataLink offers a great abstraction layer to both the data and generic UIs such as our Firefly-based RSP Portal

Could be better:

- XML rather than JSON
- Case-insensitive parameters
- Error reporting relatively underspecified
- Mixing GET and POST parameters in the same request
- Web Security concerns

Overall, developer experience is too different from current web service patterns and frameworks and is awkward to implement

We'd like to talk about these more in detail and discuss options at the next IVOA InterOp

Further Links

Documentation:

- Overall platform: phalanx.lsst.io
- Authentication: gafaelfawr.lsst.io

Implementation tech notes:

- Image cutouts: dmtn-208.lsst.io
- More SODA notes: sqr-063.lsst.io
- HiPS: dmtn-230.lsst.io
- DataLink: dmtn-238.lsst.io
- Authentication: dmtn-234.lsst.io

Repositories:

- RSP overall: github.com/lsst-sqre/phalanx
- Image cutouts: github.com/lsst-sqre/vo-cutouts
- HiPS server: github.com/lsst-sqre/crawlspace
- DataLink service: github.com/lsst-sqre/datalinker
- Authentication: github.com/lsst-sqre/gafaelfawr
- Schemas: github.com/lsst/sdm_schemas