Implementing the HiPS and MOC requirements

The (DMSR) requirements:

- All-Sky Visualization of Data Releases, DMS-REQ-0329 (Priority: 2) – parent
    - Produce All-Sky HiPS Map, DMS-REQ-0379 (Priority: 1b)
    - HiPS Service, DMS-REQ-0380 (Priority: 1b)
    - HiPS Linkage to Coadds, DMS-REQ-0381 (Priority: 2)
    - HiPS Visualization, DMS-REQ-0382 (Priority: 1b) – basically DONE (Firefly)
    - Produce MOC Maps, DMS-REQ-0383 (Priority: 1b)
    - Export MOCs As FITS, DMS-REQ-0384 (Priority: 1b)
    - MOC Visualization, DMS-REQ-0385 (Priority: 1b) – mostly done, could be improved (Firefly)

HiPS Production

- Produce All-Sky HiPS Map, DMS-REQ-0379 (Priority: 1b)
  - Data Release Production shall include the production of an all-sky image map for the existing coadded image area in each filter band, and at least one pre-defined all-sky color image map, following the IVOA HiPS Recommendation.

    Discussion: … It is expected that the HiPS tiles will be generated by resampling the existing coadds, not by performing an independent coaddition. …

  - Do we do this ourselves, or with "hipsgen", or with Montage?
    - CDS hipsgen: does everything, but: slow, no control over projection code and overlap resolution, sometimes produces pretty disappointing results, no support for hue-preserving color generation (last time I checked), not really open-source, requires an external job-control processing framework to handle HiPS generation at the scale we're talking about
    - Montage: does an excellent job (at least at the visualization level) with background-matching, very slow, seems to require a lot of expert attention for all-sky-scale map production
    - Ourselves: only way to get tiles that reflect the quality of our image-processing tooling, only way to integrate with our data production tooling

      Related to Frossie's concern – to be expressed elsewhere in this meeting – about scalability of user access to (coadd) images for context – the highest-resolution tiles, in FITS form, could satisfy many requests for images.

HiPS Production – doing it ourselves

What's needed:

- Generation of the highest-resolution layer
  - HEALPix sky tiling, allowing a Gen3 QuantumGraph for the production of tiles for the HiPS map (graph has to map patches onto HEALPix tiles) – tiles are likely 1.7' on a side, 512*512, 0.2" pixels, total ~25M for 20K sq. deg.
  - Implementation of HPX WCS, allowing reprojection of the coadds into HEALPix space
  - Resolution of overlaps between patches into an "authoritative" flux for each HEALPixel (is background-matching at patch edges an issue?)
- Generation of the lower-resolution layers
  - Algorithm for binning up pixels hierarchically by linear factors of two: i.e., 4 pixels -> 1
- Generation of the static 3-color HiPS content from the above data
- Production of the required data structures
  - Ability to write out the data into the required (simple!) HiPS directory hierarchy (can we figure out how to do this within Gen3, or is this an afterburner?)
  - Creation of HiPS metadata (ASCII, simple)
  - Creation of a MOC, in FITS form, for the coverage of the map (but see also DMS-REQ-0383)

DMS-REQ-0379, HiPS production – full Discussion (from LSE-61)

- The maximum resolution of the image maps is TBD; however, it would be desirable for it to be at least close to the underlying coadded image resolution, in order not to give a poor impression of the data quality. It is possible that the highest-resolution HiPS tiles could be provided on-demand from the LSST cutout service. It is expected that the HiPS tiles will be generated by resampling the existing coadds, not by performing an independent coaddition. This requires work from Science Pipelines on resolving the ambiguities in overlap regions. Whether the lower-resolution levels of the HiPS tiles will be generated by existing community tools (i.e., hipsgen) or by LSST code is also TBD. The color map being "pre-defined" means that the choice of bands will be made by the LSST Project as part of the configuration of a Data Release. This does not preclude the Science Platform additionally providing means for interactive generation of other colorizations from the single-band HiPS maps.

- By the terms of the HiPS Recommendation, a HiPS image map should include a corresponding MOC. This may or may not be the same as the MOCs for the survey envisioned under DMS-REQ-0383 elsewhere in this document, depending on choices made for data selection.

- The Project should produce a technical note, during the construction era, detailing which of the optional components of the HiPS standard will be supported.

- This requirement specifically calls for making HiPS maps from the standard coadds and therefore whatever policies are used for the inclusion of Special Programs data in the standard coadds will also automatically apply here. If there are both main-survey-depth and full-depth coadds for the deep drilling fields, then, it is a separate question as to whether HiPS maps will be generated for those fields.

Annotation with IDs of the underlying coadd patch images

- This is a really important part of the original vision, allowing drilling down from a HiPS context image to the underlying data: first to the corresponding coadd, then (via DataLink) to the underlying single-epoch images.

- "HiPS Progenitors" extension to the standard has been proposed by CDS and implemented in Aladin (not Aladin Lite)

- Relatively simple metadata scheme that follows the static HiPS-map file hierarchy

- Resolves to URLs for access to the underlying images (i.e., references to our image service)
    - Not yet supported by Firefly, but definitely on the roadmap and supported by IRSA plans

- Production of this metadata based on already-planned Gen3 provenance tooling?

HiPS Service

- A statically-generated HiPS map can be served statically, from a trivial Apache/nginx web server

- We have previously agreed that the highest-resolution layer is subject to data rights control, so we need an A&A wrapper for the service, but that should be pretty trivial
  - Firefly can readily handle passing along the authorization token from the RSP
  - Unclear how people attempting to use Aladin Lite (or Aladin) would get the token; the same problem is being worked on by TOPCAT at the moment (expecting reports at this week's IVOA mtg.)
  - Need to decide whether we apply A&A at the file level, allowing the same HiPS hierarchy to be used by authorized and non-authorized users (requires client tools to behave politely when users drill all the way down, or our reputation will suffer), or whether we advertise two different HiPS maps (which could share their actual file contents, e.g., via symlinks)

- HiPS-discovery is a bit of a weakness in the standard, but at least we would submit our maps to the CDS-maintained global directory of HiPS maps
  - Firefly already allows us to supply a locally-curated list of HiPS maps in addition to providing access to all the maps in the CDS directory (whether they live at CDS or not).