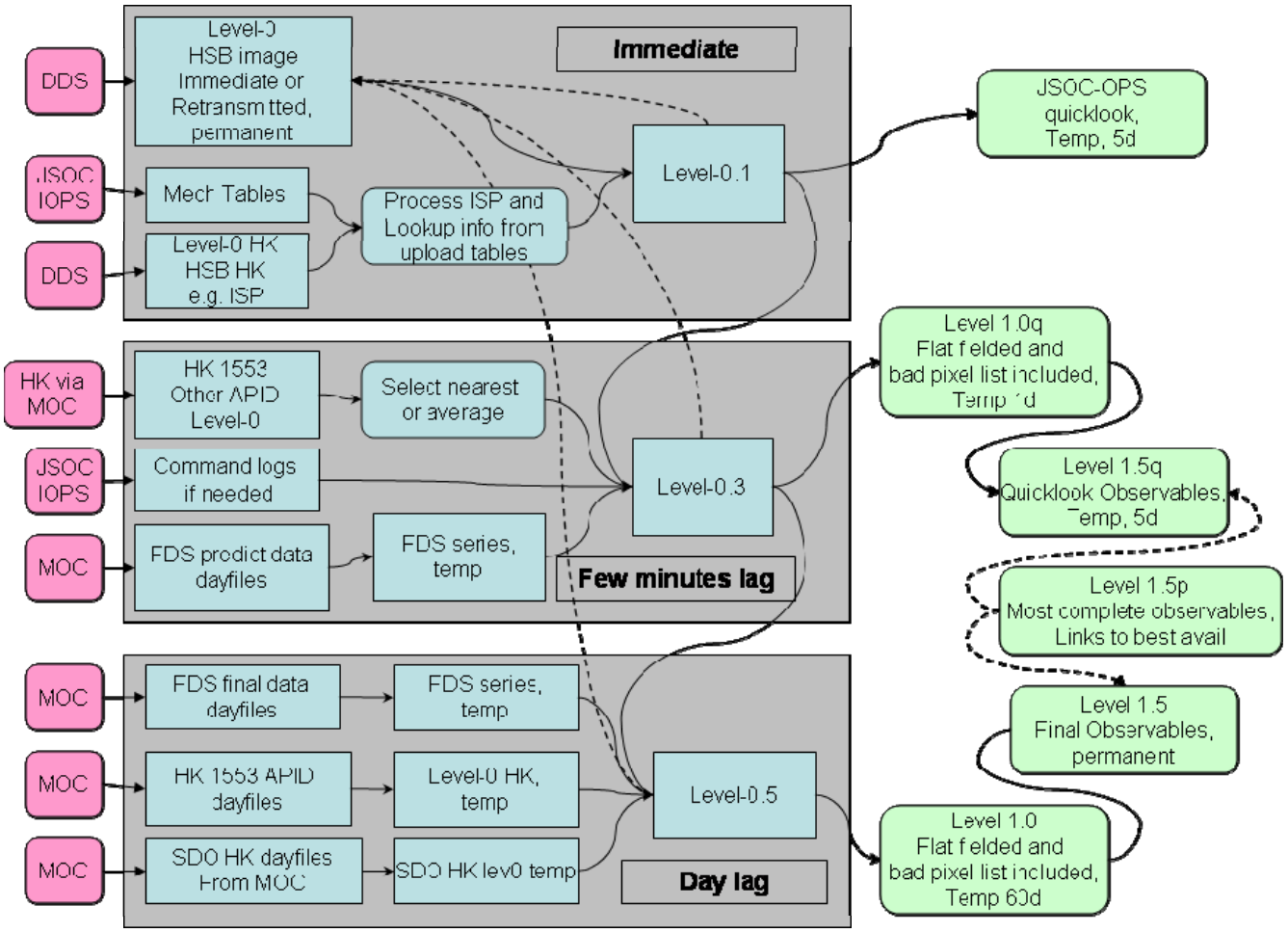
Processing Plan for Level-0



JSOC Processing Concept for Level-0 to Level-1. The pink boxes on the left are input sources. The leftmost blue column dataseries are described in the Level-0 Processing Functional Specification document. Series labeled “transient” are expected to be created and exist only within a single DRMS Session. Series labeled “Temp xx days” will not be archived but will have an xx day retention time. Series labeled “permanent” will be archived. Dashed lines indicate links to segments in earlier generation series.

Level-0

Level-0 dataseries will be created both for the images and for housekeeping and flight dynamics quantities. In both cases level-0 can be characterized as the lowest level at which the data is

available in JSOC as normal dataseries. In no case will extra processing be done other than extracting the data from the imported files and transferring it to internal format "images" or keyword records. Keyword names may be changed to internal forms where necessary and some keywords may be added.

Level-0 Image Data

For what we refer to as "level-0" data, only pixel addresses have any meaning. Level-0 is intended to provide the user with the pixel values that were captured by the CCD with telemetry encoding and compression removed, crop information applied and the pixel values placed in the original locations in the camera. The metadata carried with the level-0 images consists solely of the keywords that arrive with the image data or are supplied by on-ground lookup tables as identified by values carried with the images. I.e. no other telemetry except the high speed bus image data is needed to extract level-0 images from the telemetry stream. The image is tagged with a time supplied by the processing which will usually be slightly later than the time at which the image was taken. The prime index will be [FSN].

HMI Level-0 data will be 4096x4096 or possibly a bit smaller 2-D arrays of shorts.

AIA Level-0 data will be one of two formats. In the normal case (most of the time) it will be as with HMI, 2-D arrays of shorts. In cases where a "Region of Interest" is specified the data in Level-0 will be stored as a 1-D array with the information to extract 1 or 2 or even 3 rectangular patches as 2-D images contained in the keywords as described in the document AIA02840. Note that data likely to be visible to a user or observer will be exported from Level-0.1 via an AIA provided function which will produce 1, 2, or 3 arrays as AIA determines. With this model, the level-0.1 ROI frames will not be directly viewable without further processing.

Level-0 Housekeeping Data

In addition to the level-0 images are various housekeeping telemetry packets such as the image status packet which contain information crucial to using the images. In the JSOC this data is stored in separate data series cross indexed by the unique Frame Sequence Number (FSN) associated with the instrument. AIA and HMI will have independent FSN series. One special HK packet type, the Image Status Packet (ISP) contains the FSN, image time, exposure time, and other information needed to use the image. A matching ISP must be present to use an image. The time in the ISP is used to cross-reference needed information in other HK packet types. The ISP series will have prime index [FSN].

The housekeeping data is organized in the telemetry by "Application Identification" codes (APID). The APID and time are the primary locators for HK data. The HK data will be collected and stored in "dayfiles" each of which contains all the data for a particular APID for a UT day. Most (or all) other HKI APID types will be extracted from dayfiles as needed and will have prime index [T_PACKET]. Series names include APID and version number.

The level-0 images and HK dayfiles will be archived to tape and constitute the primary data used for all subsequent processing.

We are evaluating the benefits and cost of keeping the HK per packet series online indefinitely. This would simplify handling at the cost of some (about 25Gbytes/year) disk space.

Level-0 Flight Dynamics and Spacecraft HK Data

In addition to HMI and AIA generated data, we will fetch and archive SDO HK data for some parameters and flight dynamics data (FDS) as needed. The raw level for this data will be the files as brought from the SDO MOC. Level-0 will be keyword extracted into a series. In many cases this level-0 data will be in transient dataseries so that the few needed parameters can be easily extracted and included in level 0.1 and above dataseries.

Level-0.1

A JSOC dataseries will be created for each type of data via links to level-0 images and metadata values extracted from the HK ISP files and ground tables. Level-0.1 data is intended for quick-look viewing by instrument operators and as such it must be able to be created on-the-fly using high-speed bus provided ISP packets only, in addition to the level-0 images. All level-0 keywords are carried into level-0.1. Ground tables are used to resolve ISP keywords that are indexes into instrument state tables. This is the lowest level that has sufficient ancillary information to make it sensible to export at e.g. FITS files. Some keywords can be updated based on values in the ISP. E.g. **CDELTi** may be set now since darks and normal images can be differentiated. The internal form will be a dataseries with keywords extracted from the matching ISP as indexed by FSN. The data segment will be via a dynamic link to the level0 series (hmi.level0 or aia.level0). ISP derived and other metadata will be copied, not linked. Level-0.1 is created from the same stream as level-0 and is thus available within a minute or so of observation time. The prime index will be [FSN]. We should reconsider the isolation of level-0.1 from level-0.0. Perhaps it is not so hard to skip the lev0.1 distinction and simply produce a full lev0 which contains the ISP and derived quantities.

Level-0.3

Associated with each image is ancillary information about instrument pointing, spacecraft pointing and roll, spacecraft location and velocity, the time of the observation w.r.t. the spacecraft or instrument clock, and the known errors in such clocks. Also information concerning the state of the instrument and where possible the intent of the settings as a part of a sequence of images designed to be combined to generate an “observable”.

As a first step to tag the images with quick-look coordinate information we will generate a “level-0.3” set of keywords that add information based on expected values from commanded conditions, orbit info, etc. The image data and many keywords will be via a dynamic link to the matching level-0.1 data record. The level-0.3 may draw information from other HK packet types such as the sequencer packets. It will also draw from Flight Dynamics Data (FDS) that has been previously made to obtain orbit predict information. It will have access to command intent information (indexed by info in sequencer packets probably) to identify the type of observation.

Since FDS data will be available at this level, it is possible to set **CTYPEi** to SOLARX and SOLARY and add **CRPIXj**, **CRVALi** and **CROTAj** estimates assuming the image is centered on the CCD. This will allow display software to show images nearly right-side-up.

The level-0.3 data will be appropriate for computing quick look higher level data products such as magnetograms and farside and other helioseismology products. The level-0.3 data should normally not lag the level-0.1 data by more than a few minutes. The level-0.3 data can be used by the level-1 generating observable programs to produce quick-look data products. The prime index will be [FSN].

Level-0.5

Level-0.5 data is a delayed but more complete version of level-0.3. It is the source data for level-1.0 and all final observable calculations and may lag real time by hours up to a day. It will have the final versions of SDO HK roll info and FDS data so will lag after an orbit correction by needed time to get correct info. The set of keyword names in level-0.3 and level-0.5 will be the same.

All data in level-0.1 through level-0.5 will be dynamic links to the segments stored in level-0.

Level-1.0q

Level-1.0q is in intermediate, "quicklook" temporary dataseries created to facilitate quicklook observable computations. Level-1.0q is generated from level-0.3 as soon as possible so it will be lagged from real time by at most a few minutes. The primary purpose of level-1.0q is to generate flat-fielded copies of the level-0 images and perform an initial bad-pixel identification and limb fit (for HMI). Level-1.0q will not be archived and will have a retention time of 2 or 3 days, just long enough for level-1.5q data to be generated. At this level finally we can set **CTYPEi**, **CRPIXj**, **CRVALi**, **CDELTi**, **CROTAj** (or PCi_j) to meaningful and nearly correct values. For HMI the keywords **R_SUN**, **D_SUN**, **X0**, **Y0**, **XCEN**, and **YCEN** will also be added. **CTYPEi** will be "SOLAR_X" and "SOLAR_Y". Level-1.0q will have the same keyword set as level-1.0. Some keywords that may not be yet well defined will be set to "missing data" default values.

Level 1.0

Level-1.0 is similar to level-1.0q but is held (not archived) for up to 60 days. It is generated on demand from level-0.5 if it is requested and not present but level-0.5 is present. It has the best possible flat field applied and bad pixels are identified. The bad pixel list is in a second segment and carried along with the image segment. Level-1.0 data is fed into the level-1.5 prime observable calculations. The best possible **R_SUN** and limb positions will be obtained in level-1.0 processing. Normally level-1.0 data will be produced in the same DRMSSESSION that produces level-1.5 observables. Level-1.0 will have the same keyword set as level-1.0q.

NOTE on prime indexes

Within the DRMS environment the primary keys used to identify data are the FSN, T_OBS, T_REC and T_PACKET values. T_OBS is the TAI time of the center of the observation. As such it is rarely and only by chance at some "nice" time value. T_PACKET is the TAI time of the telemetry packet containing HK data or for the first data packet of an image. The primary access to level-0 data is expected to be by FSN. For level-1.5 and above observables which are calculated from a set of FSN both an updated T_OBS (again for the center of the observable representative interval) a T_REC time on a "nice" slotted time step can be provided. For observable series on say a 48 or 45 second cadence T_REC could be computed as a base epoch plus a "slot" count. This is very useful for seismological studies but may also be useful for AIA normal mode data. When a reference epoch for T_REC is defined the records can be indexed by integers, once the DRMS name parser looks for keywords T_REC_EPOCH and T_REC_STEP.

Level-1.5q and above

In the scheme in the diagram above, we would make a "quick-look" observable from the level-1.0q filtergrams. These would be temporary segments in a permanent series. These would be created as soon as possible from the levwl-1.0q as it becomes available.

The best possible observable HMI data would be called level-1.5 and would be delayed by something like a day to allow for best calibrations, data completeness, post-maneuver FDS data, etc. This data would be input the level-2 data products pipeline.

An intermediate preliminary product, e.g. level-1.5p could be created as linked segments pointing to first level-1.5q then lev1.5 as it becomes available. This data could be used to generate quick look level-2 products such as the farside data that needs an extended time series ending as late as possible with quick-look data, but which may as well use the best available data when reaching back in time. This puts constraints on how "sloppy" we can be with the lev1.5q data. It must look "seamless" with the lev1.5 data in terms of detrending, calibrations, etc.