

Jet Propulsion Laboratory
California Institute of Technology

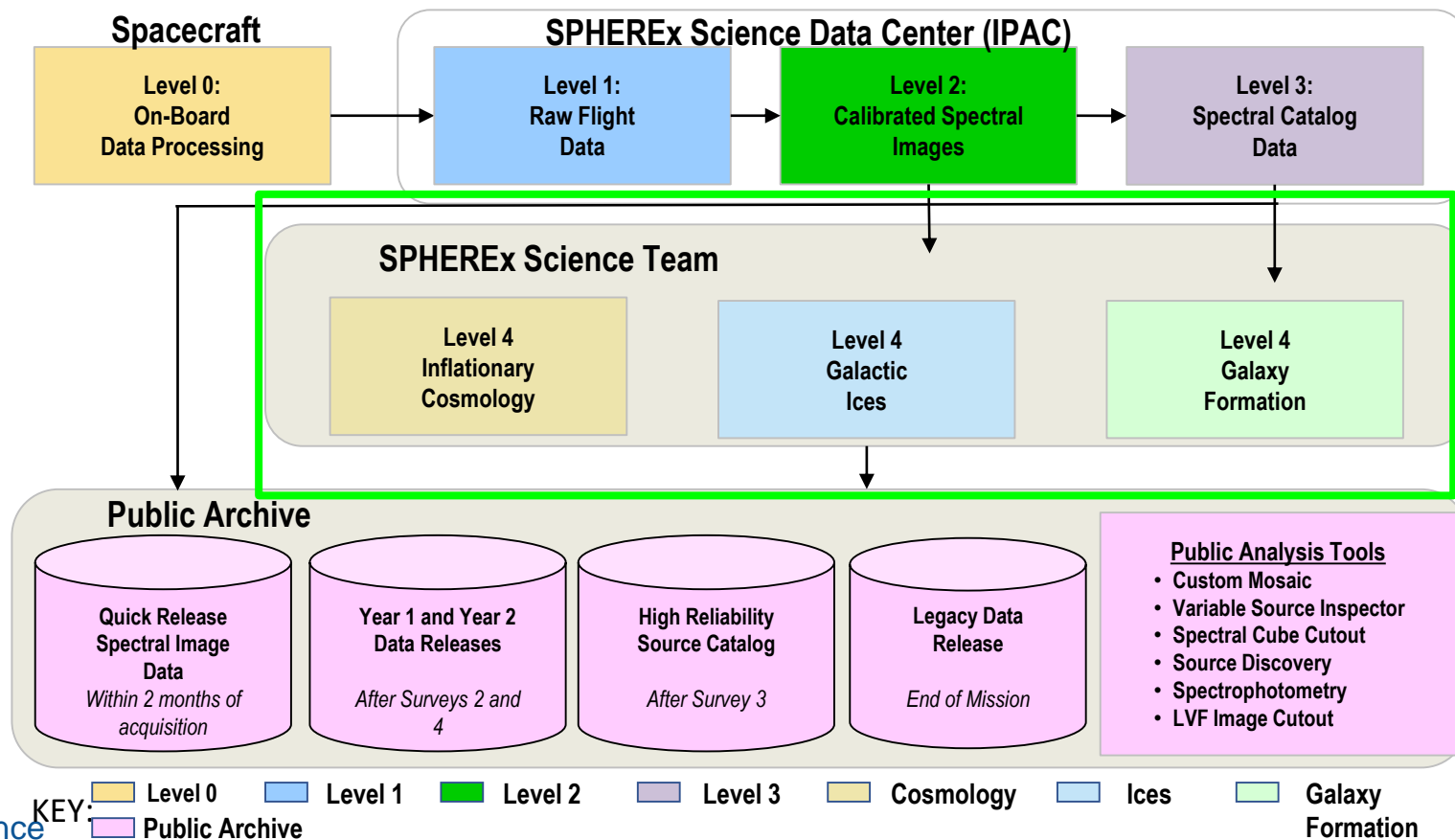
SPHEREx Level 4 CDR Science Peer Review
SPHEREx Level 1-3 Data Processing Overview
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Technology)

Oct 26-27, 2021

Science Data Processing overview

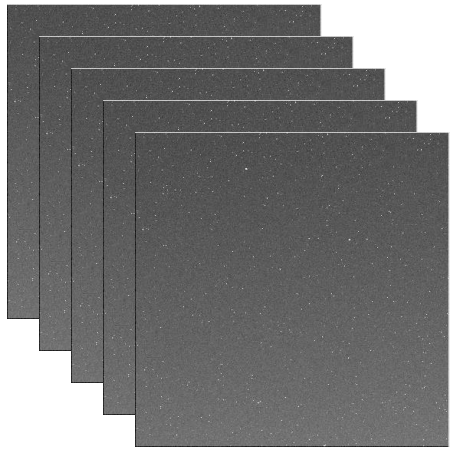


- SPHEREx data and data processing organized into levels:
 - Level 0: On-board sample-up-the-ramp processing
 - Level 1: Engineering image data
 - Level 2: Calibrated Spectral Images
 - Level 3: Spectral Catalog Data
 - Level 4: Science products
- Levels 1-3 occurs at the SPHEREx Science Data Center (IPAC), which processes the data as it comes in, and creates the inputs for the Science analysis (and public archive)
 - Peer review completed on Sept 2-3
- L1-3 data made available to the Science Team through a cloud-based system called the *sandbox*
 - The sandbox also allows the Science team to run a development version of the L1-3 pipeline for additional tests as needed
- Details of data format of L1-3 products specified in SSDC module design documents, developed with Science Team points of contact
- Outputs of L4 pipeline delivered to archive at IRSA
- Here we are reviewing Level 4 only

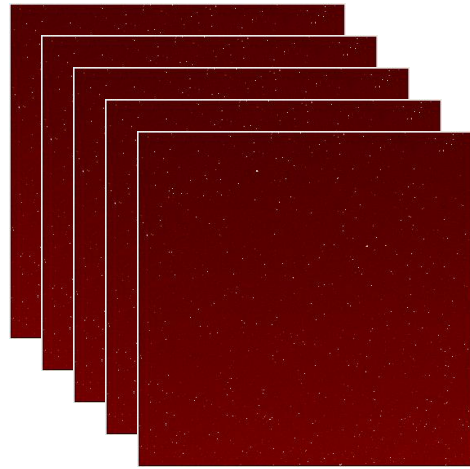


Data products available to Science Team

L1: Photocurrent images in engineering units

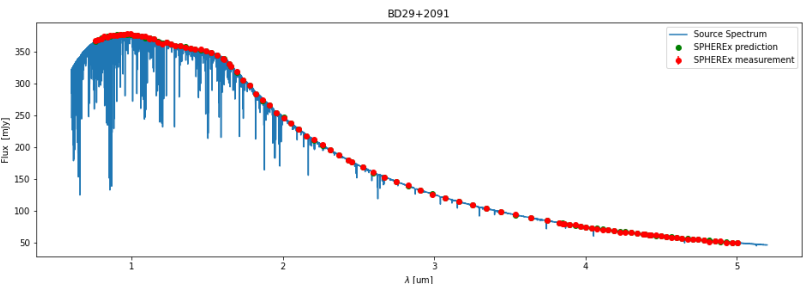


L2: Spectral Image Data



L3: All Sky Catalog Data

JD	RA	DEC	DETECTOR	WAVELENGTH	FLAG	UNIQUE_ID	FLUX	FLUX_ERR
	deg	deg		um		bool	mJy	
246001.5521698	161.84651041666663	28.398688888888888	1	1.064735913680336	False	0	373.7319715439654	0.74884403234747
246001.5521698	161.84651041666663	28.398688888888888	4	3.6393309464521453	False	1	89.16689675995762	0.37874975884662
246001.5530041	161.84651041666663	28.398688888888888	1	1.090770911840179	False	2	373.88914958516335	0.8250882451507
246001.5530041	161.84651041666663	28.398688888888888	4	3.7434294835022	False	3	84.34830856742028	0.36087731888058
246001.5550404	161.84651041666663	28.398688888888888	1	1.117429781949295	False	4	371.747256204126	0.82417259518253
246001.5550404	161.84651041666663	28.398688888888888	4	3.8502845423149295	False	5	79.78967397624219	0.3571274918048
246002.8158272	161.84651041666663	28.398688888888888	1	1.029329709460493	False	6	375.4388356627962	0.83399412037351
246002.8158272	161.84651041666663	28.398688888888888	4	5.5385246975156517	False	7	93.5643635022904	0.3736850633590
246002.8172615	161.84651041666663	28.398688888888888	1	1.0140179903127368	False	8	375.773086344117	0.82278479063339
24601.66.1008301	359.60329	51.38867	2	1.47850834073235	True	420	-0.017978422946913285	0.01758876992784
24601.66.1008301	359.60329	51.38867	5	4.252038203995678	True	421	2854503.8950261436	130.491003881084
24601.66.1022644	359.60329	51.38867	2	1.5140705613051827	False	422	0.0024039954858394284	0.01871132428554
24601.66.1022644	359.60329	51.38867	5	4.290515513775054	False	423	2801248.9031084133	125.591310084147
24601.66.167572	359.60329	51.38867	1	0.7381320186054874	False	424	0.010387429710177103	0.01897646340670
24601.66.167572	359.60329	51.38867	4	2.370562856223434	False	425	2986251.8782099984	67.7085706876447
24601.66.1890063	359.60329	51.38867	1	0.7962161583916382	False	426	0.0157502723179326	0.019151836832605
24601.66.1890063	359.60329	51.38867	4	2.4428961041355796	False	427	3137071.3545372086	72.051138759739
24601.66.1704407	359.60329	51.38867	1	0.7747457298017606	False	428	-0.038950702424781	0.01941387290954
24601.66.1704407	359.60329	51.38867	4	2.5128677681321225	False	429	2781780.8287771317	65.5186246287607



- Spectral Image Data updated daily as Pipeline Levels 1-2 are run on each downlink: available to science team in near-real-time
 - Spectral Image Data are the native SPHEREx format: H2RG photocurrent images, 6 per pointing, that include per-pixel wavelength variations due to the linear variable filter.
- Full reprocessing of Spectral Image Data and Catalog Data with latest calibration products occurring after end of Year 1 and Year 2
- Catalog Data is updated ~monthly as Level 3 pipeline is run in the cloud

Contents of Level 2 Spectral Image Data



A multi-HDU FITS file containing:

Image data:

- Sky signal calibrated into scientific units
- A per-pixel estimate of the variance
- Pixel mask:
 - saturated, cosmic ray detected, known source, persistence
- Zodi model
- Estimate of persistence signal

Metadata:

- World Coordinate System (WCS)
 - includes field distortion
 - stored as both a FITS WCS and a high-precision Generalized WCS
 - aberration correction included (transformation from SPHEREx-centric to barycentric coordinates)
- Other metadata
 - time stamp, housekeeping data like mean temperatures
 - estimate of pointing jitter during exposure
 - list of all L1-3 modules and version numbers that have been executed on this exposure

Ancillary data:

- PSF measurement
- Spectral response
 - measured once on the ground for each band

**Level 2 Spectral Image Data
constitutes the input to the L4
Galaxy Formation**

Contents of Level 3 All Sky Spectral Catalog



- Science Team provides the Reference Catalog to SSDC before launch, specifying target galaxies, stars, and solar system objects, prior to launch. Opportunity for updates at Year 1 & Year 2 reprocessing. Also includes astrometric and photometric calibration sources.
- SSDC Level 3 pipeline performs forced photometry at the specified locations and stores the results in an All Sky Catalog.
- Updated with new photometric measurements roughly monthly
- Catalog is a database containing one row per photometric measurement
- **All Sky Spectral Catalog provides input to L4 Cosmology and L4 Ices themes**

Table 1: Primary Catalog Output

Column Name	Notes
Unique ID	From input catalog.
Level 2 Image ID	To enable trace back to level 2 images.
x	x position on Level 2 image.
y	y position on Level 2 image.
Position Updated Flag	From optimal photometry tool.
RA	From optimal photometry tool.
DEC	From optimal photometry tool.
RA error	From optimal photometry tool.
DEC error	From optimal photometry tool.
Wavelength	From optimal photometry tool.
Wavelength error	From optimal photometry tool.
Flux	From optimal photometry tool.
Flux error	From optimal photometry tool.
Flags	From optimal photometry tool.