ORBS and ORCS
Reduction and analysis of SITELLE's data

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SITELLE (at **CFHT** since fall **2015**) is an Imaging Fourier Transform Spectrometers (**IFTS**) with an **11'x11' field of view** operating in the **visible band (350 - 1000 nm)**. It delivers cubes of **4 millions spectra at R ~1500 - 5000** with a **spatial resolution of 0.32"** (filling factor of 100%). The input light, modulated by a **Michelson interferometer**, is collected by two 2k x 2k CCD cameras. **SITELLE's data is reduced with ORBS (first data release, March 2016) and analyzed with ORCS.**

ORBS is the data reduction software of SITELLE.

- **Fully automated** and **robust**
- **Parallelized** at 90%
- **Easy to use** (one command line to run it)
- **Scalable**, works on any modern computer

Process 64 Gb of row data in < 7 hours

ORCS is a fitting engine for SITELLE.

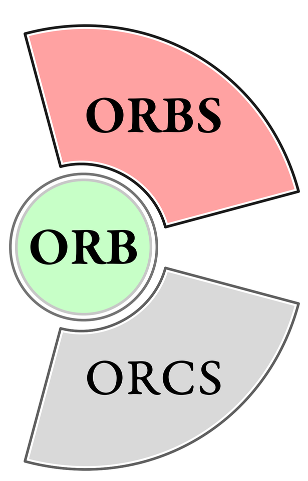
- **A wide variety of models**: emission lines, continuum, filter, model grids
- **Multiply constrained**
- **Parallelized** at 100%

General architecture

Data reduction module
(13 000 lines)

Core module
(23 000 lines)

Data analysis tools
(4 000 lines)

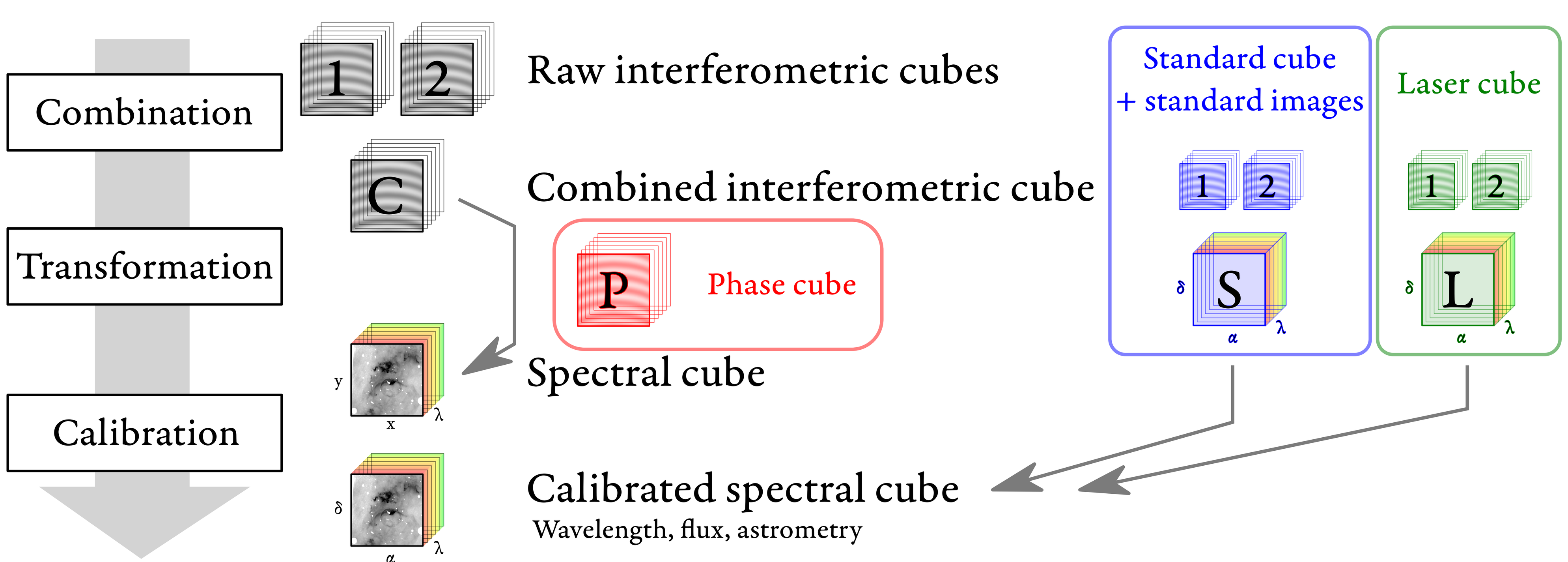


Written in **Python**
Free software
Object-oriented
Fully **documented**

sources @ https://sourceforge.net/u/thomasorbs/profile/

Reduction steps

INPUT: **2 x 32 Go of raw data** + calibration data (~40 Go)



OUTPUT: 2k x 2k x 1k calibrated **spectral cube**

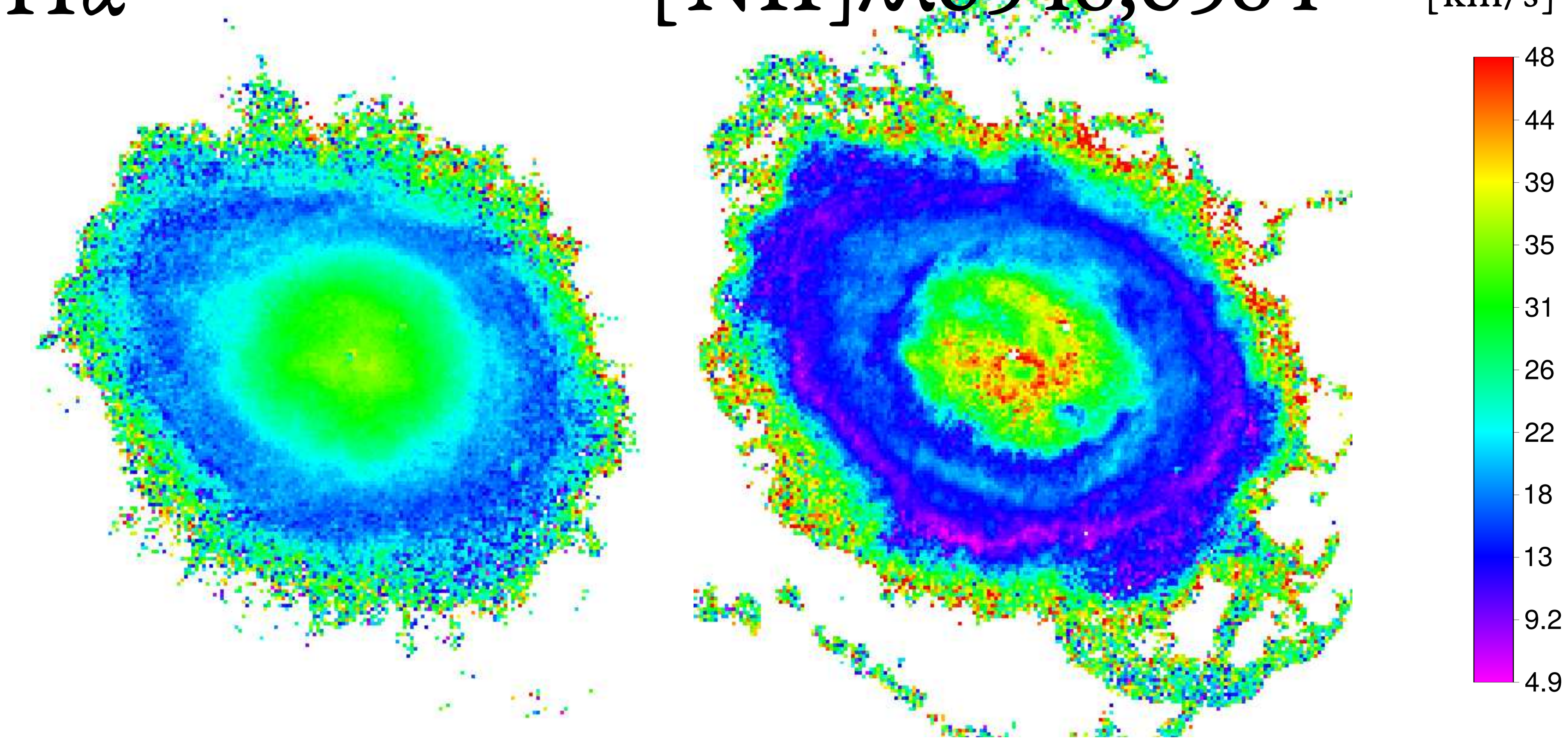
= **4 millions spectra** on **11'x11'**

A new implementation of the Gaussian-Sinc convolution

A better implementation of the Gaussian-Sinc convolution function using the **Dawson integral** has been found. **Now we can perfectly fit multiple lines with Gaussian broadening.**

$$SG(x)_{\text{Dawson}} = A\frac{D(ia+b)\,e^{2iab} + D(ia-b)\,e^{-2iab}}{2D(ia)}\,.$$

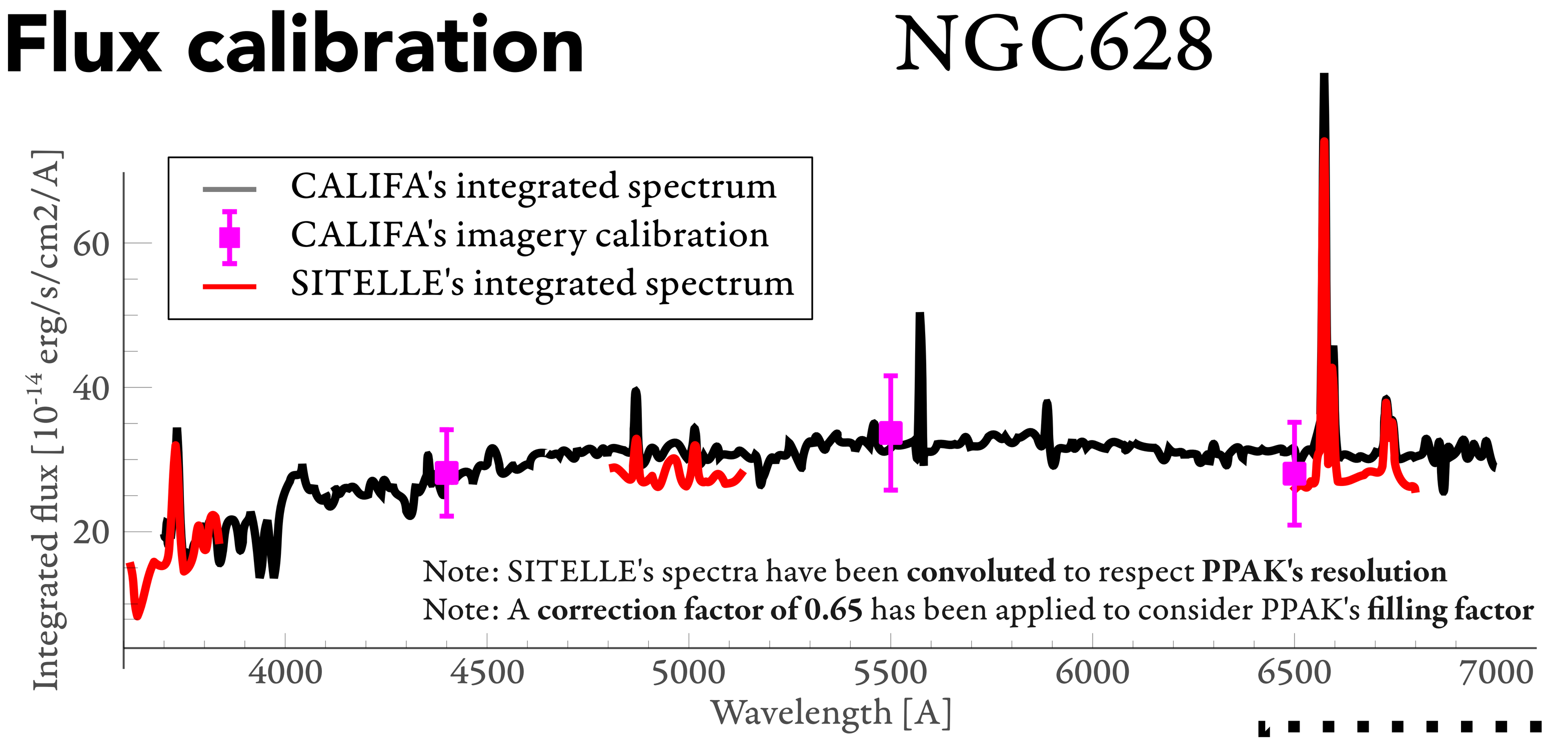
M57 velocity dispersion

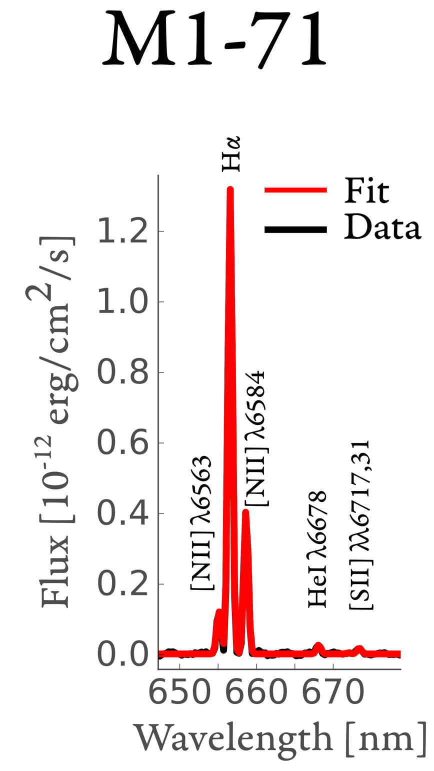


We have measured the line broadening of Hα and the [NII] lines. The smoothness of the hydrogen bubble is due to its homogeneous distribution whereas the very thin [NII] shell reflects the geometry of the PDR.

Data Release 1

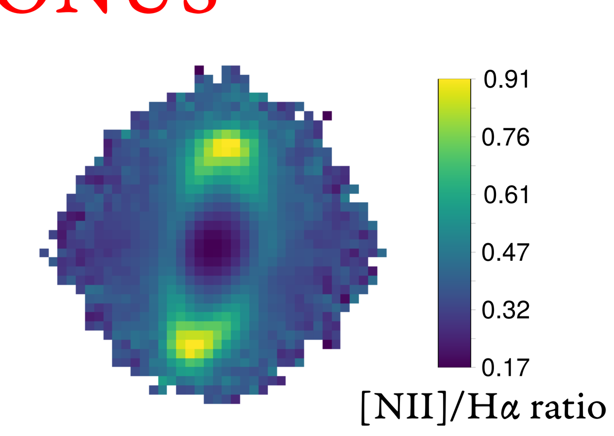
Flux calibration





NGC3344 (Rousseau-Nepton et al.)	Hα vs SpIOMM	-4% ±2%
	Hα + [NII]λ6584 vs SpIOMM	-4% ±3%
M1-71	Hα vs Wright (2005)	-7% ±3%
	[NII]λ6584 vs Wright (2005)	-11% ±3%
NGC628	SN1 vs CALIFA	-6% ±6%
	SN2 vs CALIFA	-7% ±6%
	SN3 vs CALIFA	-9% ±6%
HETDEX Field (Drissen et al.)	Lyα flux of ~20 high redshift galaxies	-5%±7%

BONUS



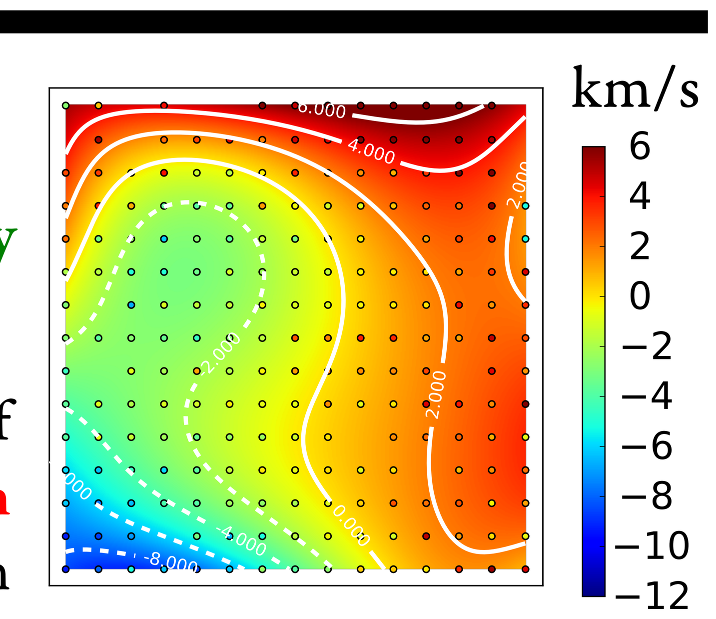
M1-71 bipolarity revealed !

Flux calibration has been checked against various sources. A bias of -5% has been discovered (and corrected). **The overall precision of the flux calibration is < 5%.**

Wavelength calibration

On Fourier transform spectra the velocity zero point is the only uncertainty.

Absolute calibration is done via the observation of a laser source. It can be improved up to a **precision of 0.3 km/s by fitting sky lines** with **ORCS** which are present everywhere in the FOV of most cubes.



Relative velocity map

Zero point can change from one pixel to another: a zero point map can be computed by **ORCS to improve the pixel-to-pixel precision up to 0.5 km/s**