Visualization and Analysis
of
Spectral Data Cubes
an
Hipe toolbox

Madrid 4-5 December 2008

Alain Gueguen MPE-Garching

agueguen@mpe.mpg.de

Goal of the tool

Display and analysis toolbox for the “spectral cubes” or tri-dimensional data (2 spatial + 1 spectral)

- Visualize spectral data cubes
- Navigate through cubes
- Help in a graphical way to identify interesting spectra,
- Extract spectra and prepare them for further analysis
  - export them
  - save them
  - send them directly to other tools (HCSS or not)
- Create sub cubes
- Analyse the spectra in the cube (e.g extract position-velocity diagrams)
- Written in JAVA

Requirements & Specifications

- User Requirements
  Livelink Herschel Wiki Pages (need to be registered)

- Data specifications
  Spectral Cube :SimpleCube,SpectralCube
  Spectrum :Spectrum1D
  Arrays :Double1D, Double3D
- See:
  - The user manual included in the user distribution
  - The developer manual (Javadoc), in the user distribution (developer oriented)

Design

“standalone” Main Graphical User Interface (GUI)

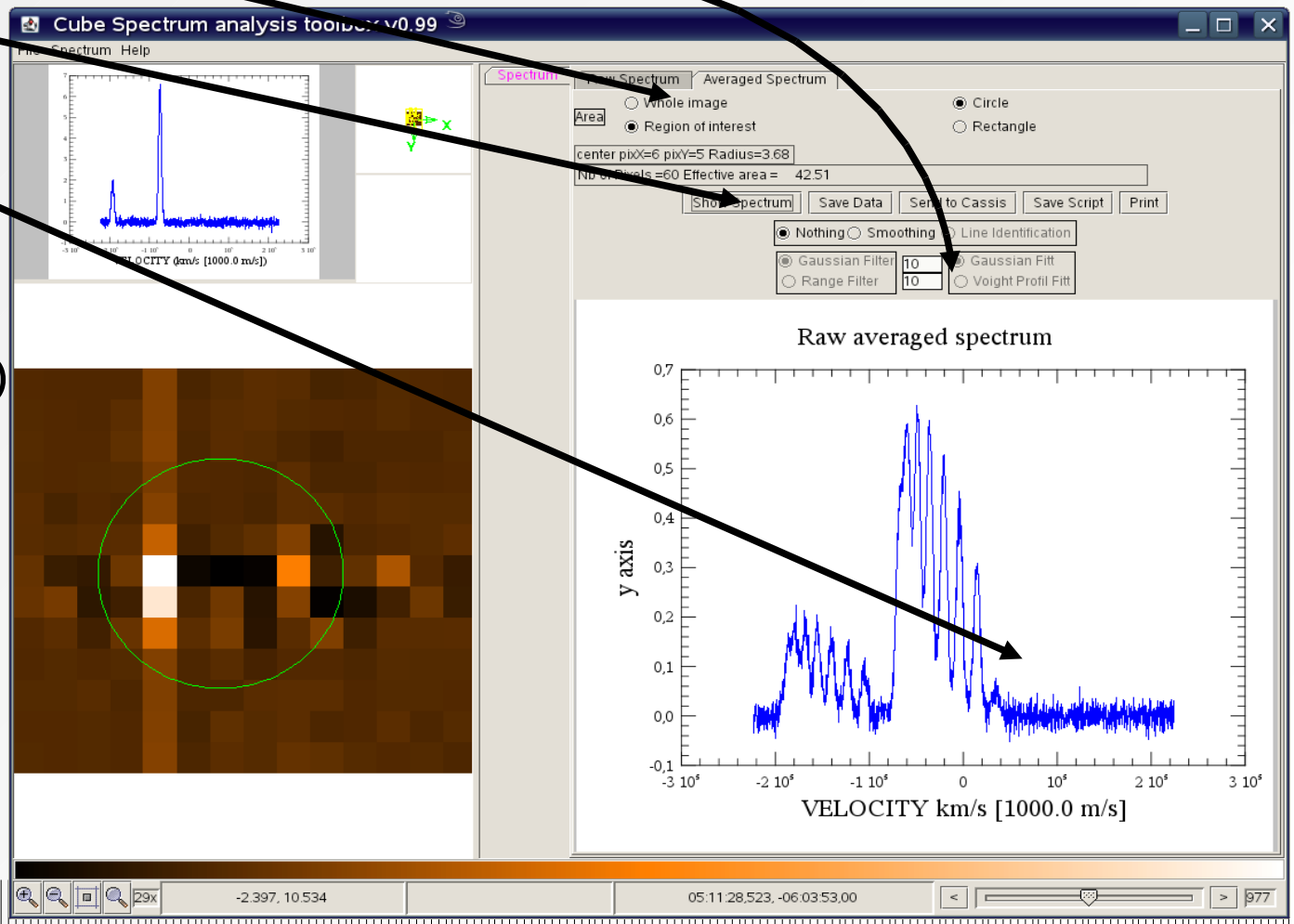
2 sided window:

- Left:
  - Original data cube
  - Spectrum of the current pixel
  - Zoom box
- Bottom
  - Status bar
    - Zoom bar
    - Slide bar
    - Color bar

Design
“standalone” Main GUI

2 sided window:

- Right: Multi tag section for the feature specific GUIs.
  Each of the tags displaying one feature:
  - The Input parameters
  - The command buttons
  - The results

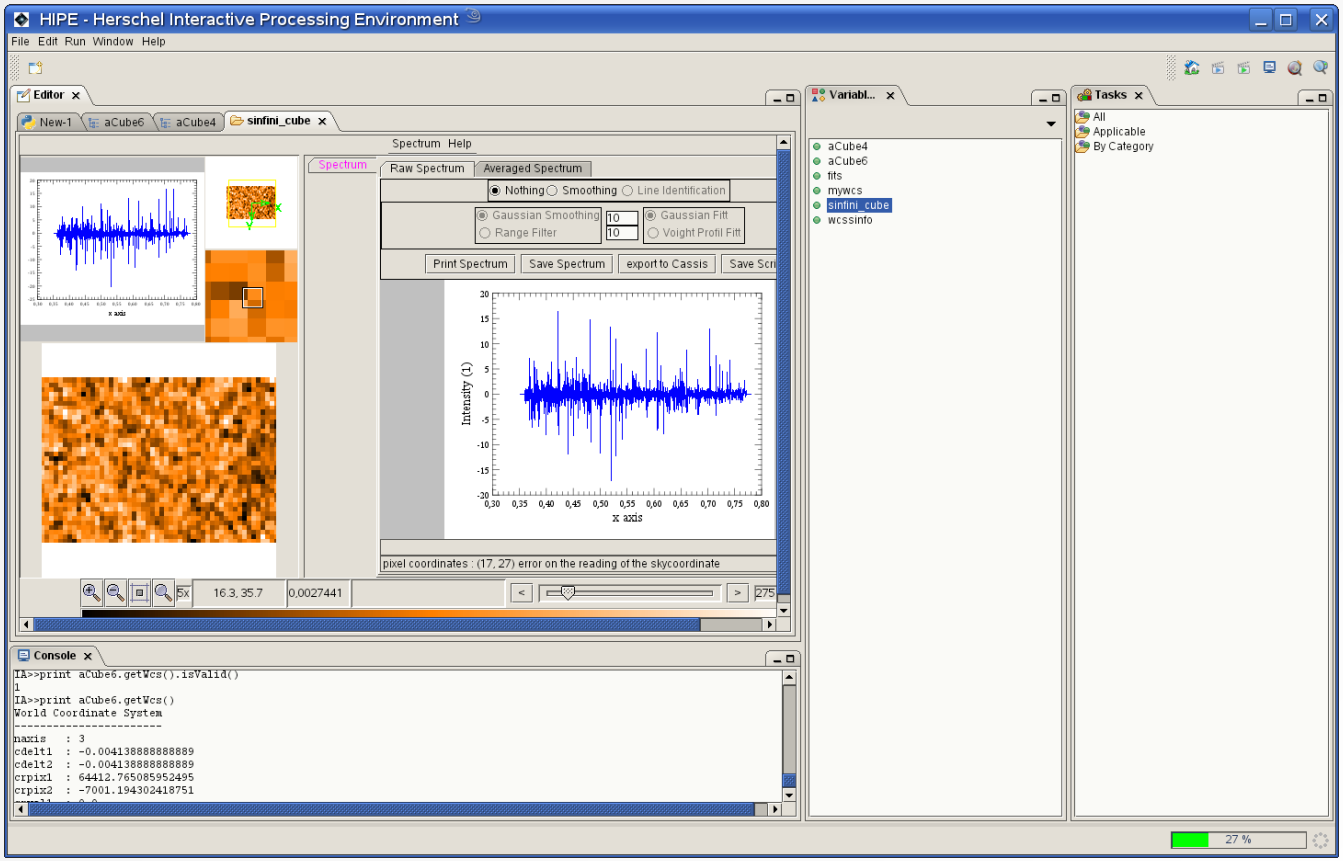


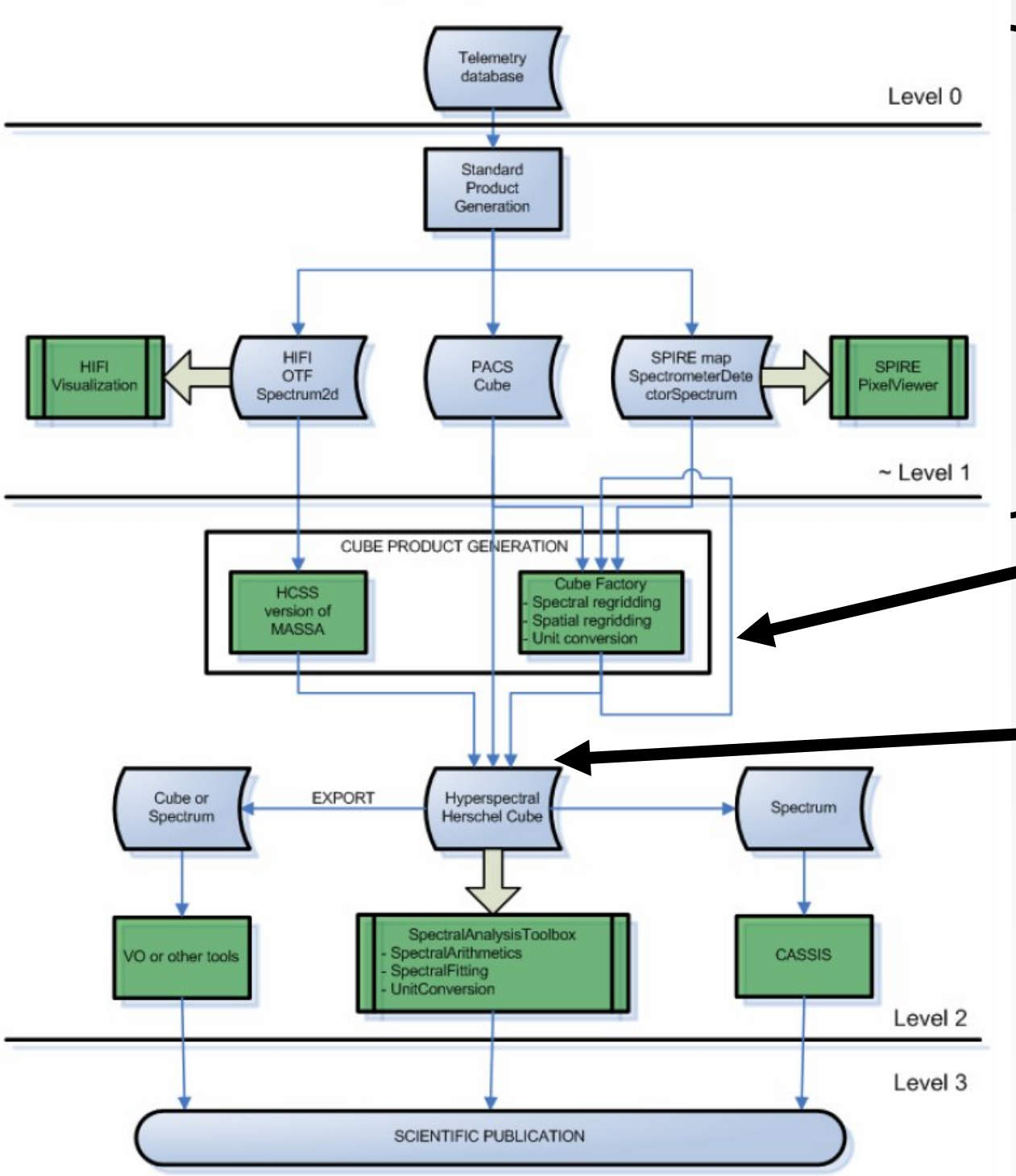
- Use many Hipe components (**Display**, PlotXY, spectrumPlotter) providing a common look & feel across Hipe tools.

- Allow to perform many analysis steps on one cube in the same window

Design
Hipe integration

The “Cube Spectrum Analysis Toolbox” is integrated in HIPE for the HCSS spectral cube. Therefore, it can be considered as a viewer or an explorer for these HCSS spectral cube.





PACS spectrometer PIPELINE

PACSCube

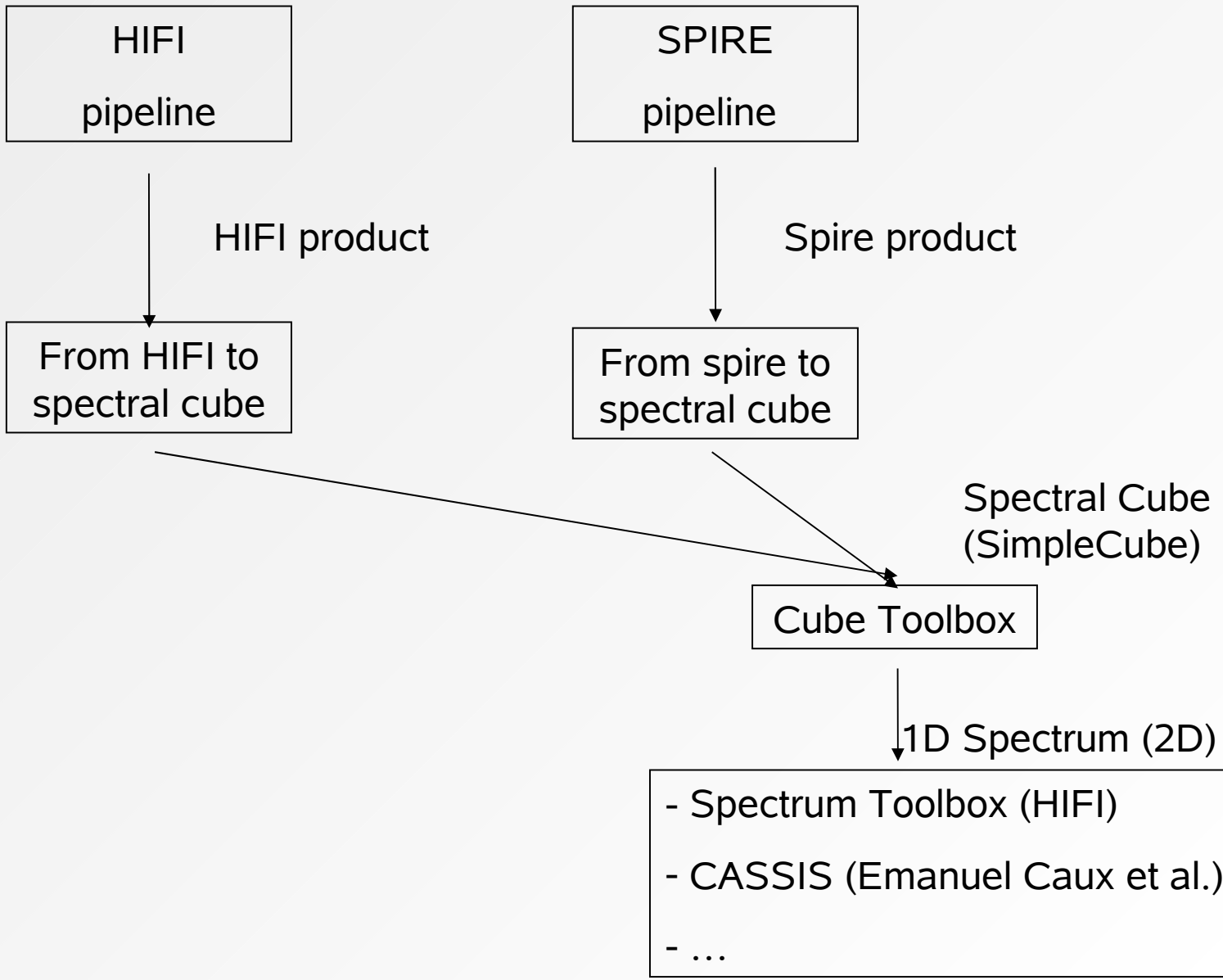
Cube Builder (Pacs)

Spectral Cube (SimpleCube)

Cube Toolbox

1D Spectrum (2D)

- Spectrum Toolbox (HIFI)
- CASSIS (Emanuel Caux et al.)
- …

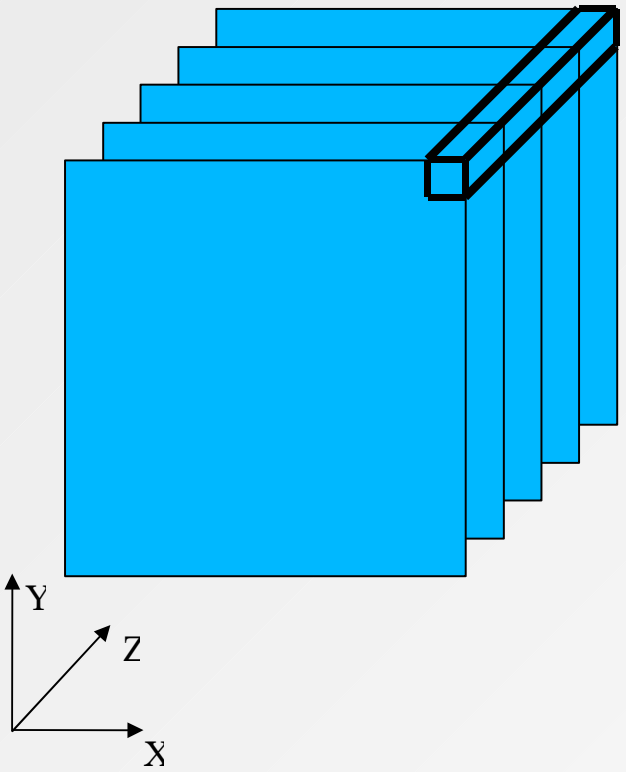

HIFI
pipeline
SPIRE
pipeline
HIFI product
Spire product
From HIFI to
spectral cube
From spire to
spectral cube
Spectral Cube
(SimpleCube)
Cube Toolbox
1D Spectrum (2D)
- Spectrum Toolbox (HIFI)
- CASSIS (Emanuel Caux et al.)
- …

Input Data
HCSS spectral Cube

- Astronomical content
  - Set of images aligned on the sky
  - One spectral value (wavelength, frequency, velocity) per image (layer)
  - WCS information
- Technical
  - From Pacs Pipeline: result of the CubeBuilder (P.Appleton, J.Jacobson)+ rebinned cube
  - For SPIRE (and maps from HIFI), an extra step of the pipeline will convert the data in a “simpleCube”

Spectral cube

- Cube of frames with spectral values (wavelength, frequencies, velocities)



- A frame = a sky image
- X,Y pixels coordinates & sky coordinates
  - Images aligned on the sky
- Z axis wavelength (or frequency, velocity) (in the WCS of the cube)
  - Available frame per frame (ImageIndex) or recomputed from the “classical third axis WCS properties
  - Equidistant from frame to frame or not (keyword)
- Spectrum directly accessible in a native method as a 1D Spectrum

=> All instrument specific work already done before this tool.

Compatibility with other data

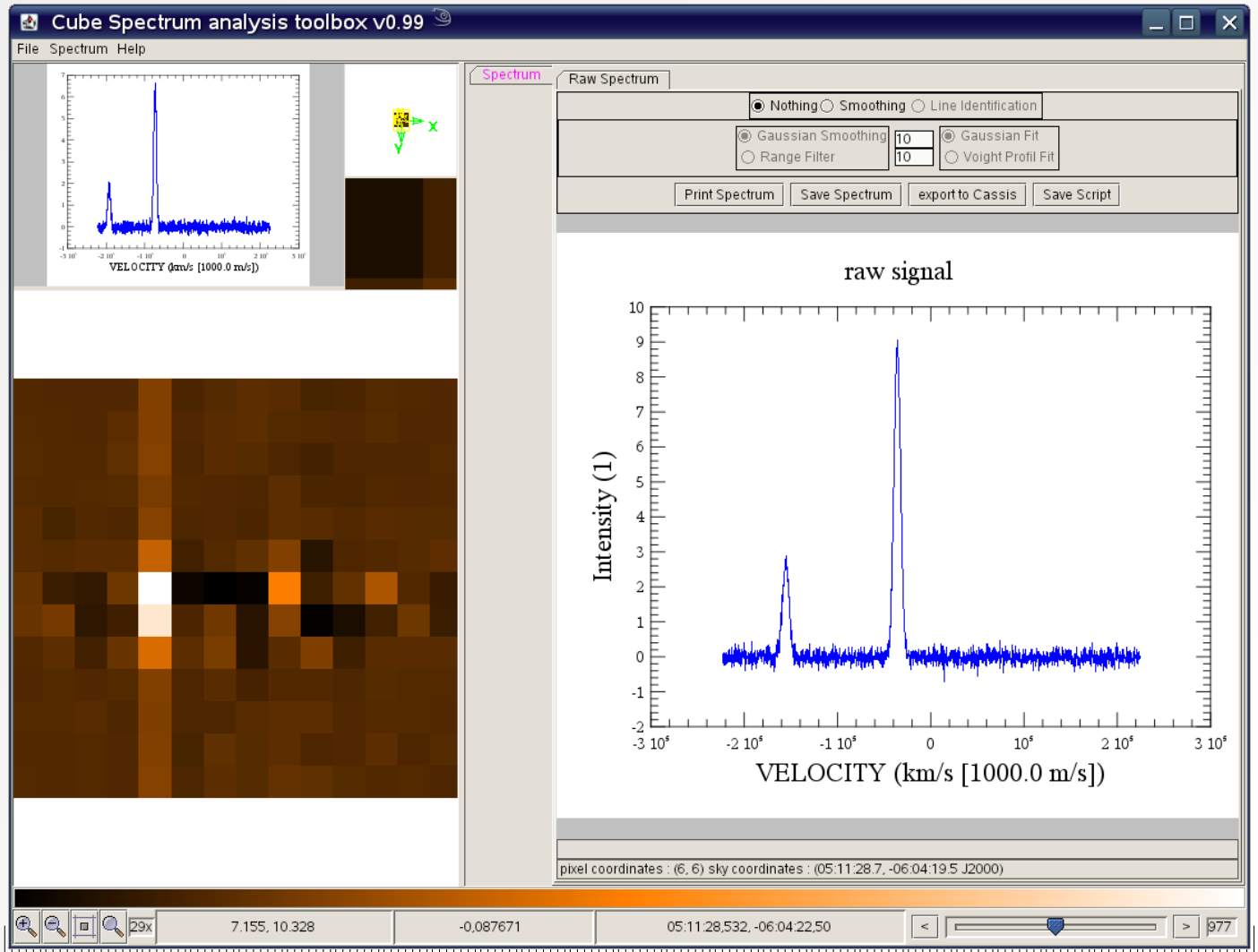
The visualisation and analysis toolbox can also work with specific data or non HCSS:

- "Natural" data
  - Each instrument can put its own raw data in a HCSS product, for instance
    - PACS RAW spectrum cube: 5*5*N pixels
      N = Nb of wavelength.
      Unit of the Z axis of the cube = wavelength
    - PACS "MAPs" I5*J5*N pixels
- Generic data Compatibility
  - Couple (cube of images + 1D array of wavelength values)
  - Couple (cube of images + ASCII list of frequency values)
    WITH SQUARE PIXELS !!
  - Non herschel spectral cube in fits file
- Precision
  - Double for the Frequencies

Features & snapshot 1/3

- Raw spectrum (“pixel source” spectrum)

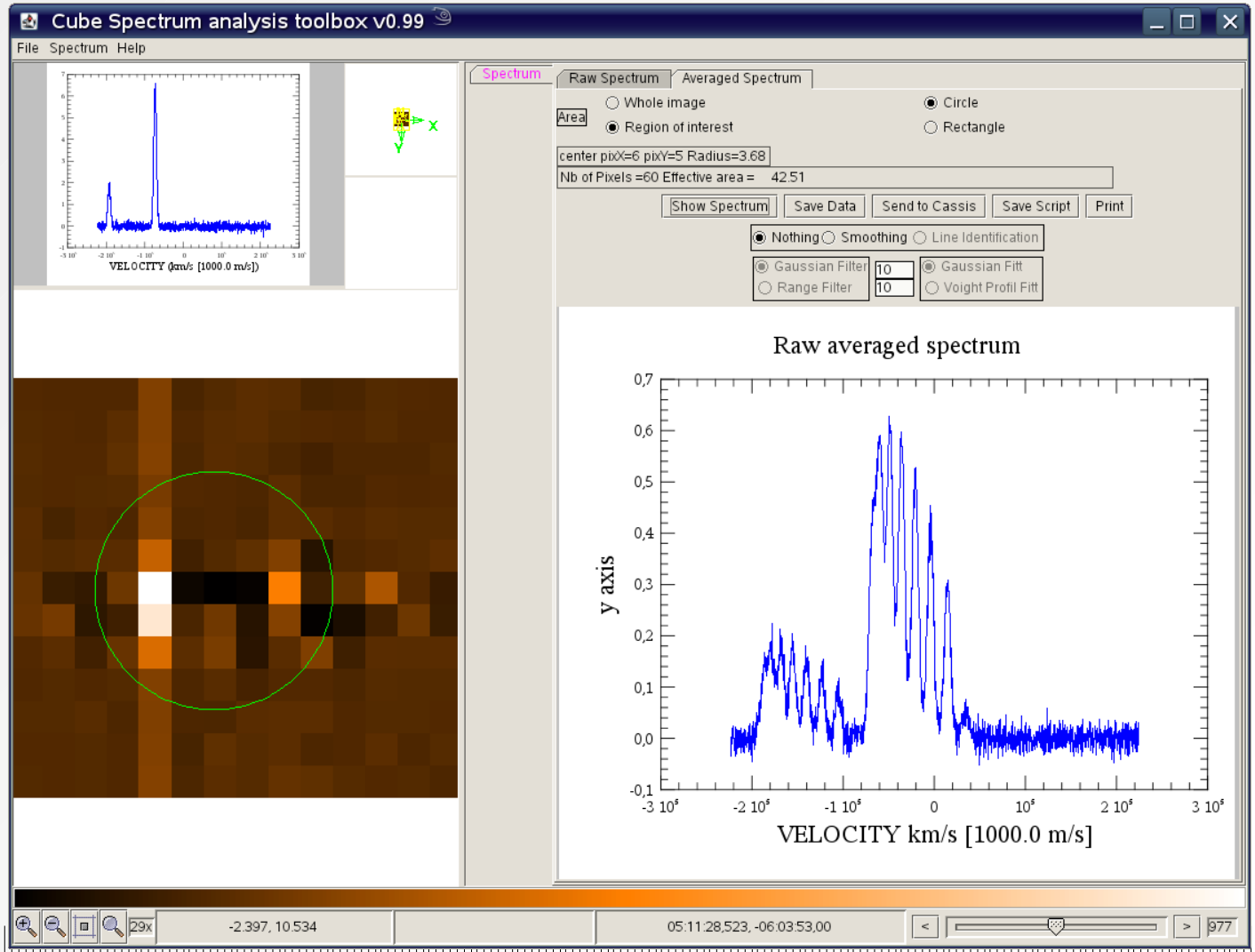
- Define the position by a click
- Extract the corresponding spectrum
- Display the spectrum



Features & snapshot 2/3

- “Averaged” spectrum

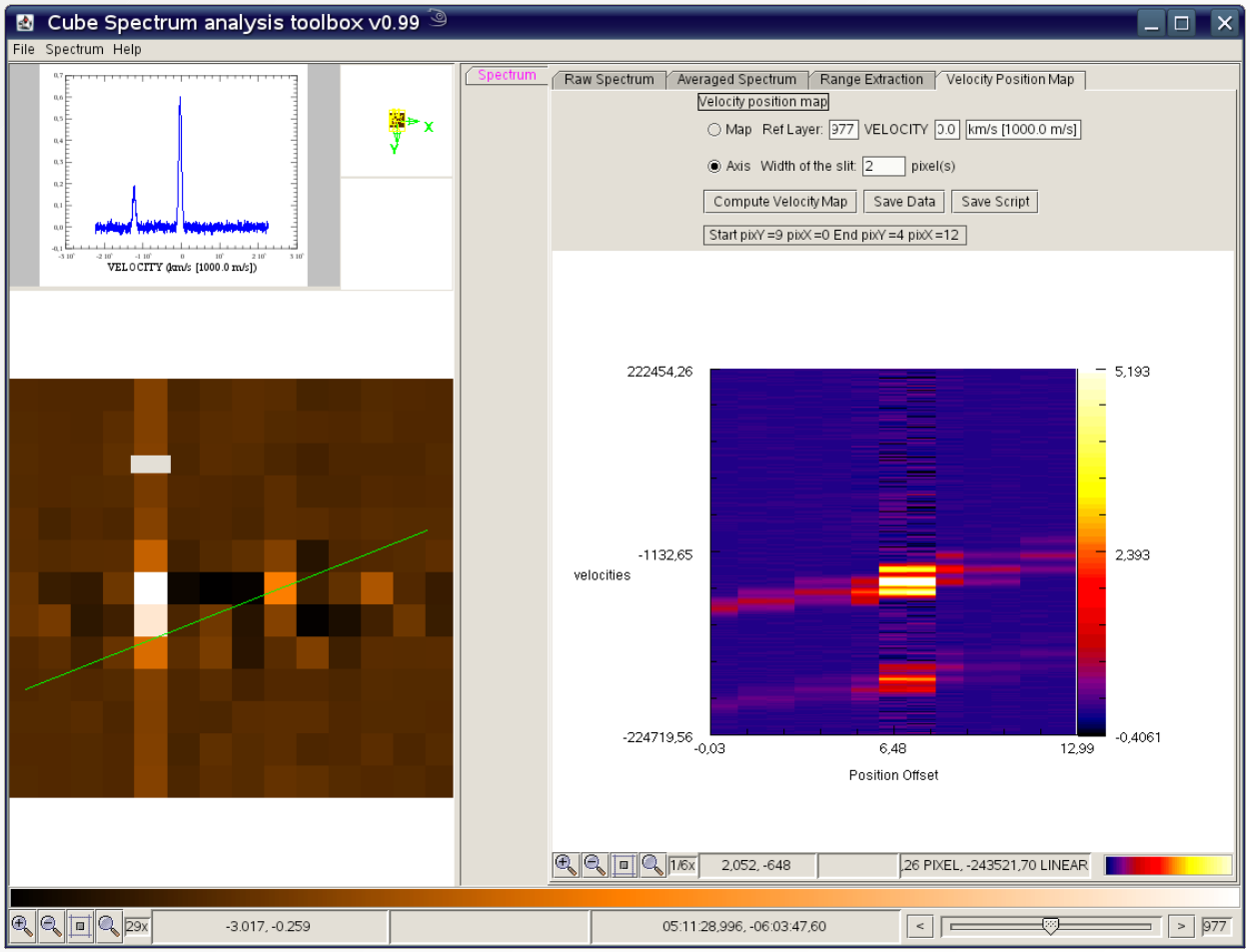
- Define a region or complete image (circles,rectangles)
- Extract the corresponding spectrum
- Display the spectrum



Features & snapshot 3/3

- Velocity position Map

- Define a line in the image with the mouse
- Show the coordinates of the line (start and end point in pixel and/or sky coordinates)
- Compute the complete axis on all the image (appropriately weighted)
- Compute the histogram spectrum (convert it in relative speed) along the axis and display it



Outputs

- Spectrum
  - Export as
    - Spectrum1D which will become the default format for the spectrum (need error & exposure)
      return to HIPE or to Cassis
  - Saves as
    - fits table
    - publishable format Postscript or EPS
    - jpg png (screenshot)
    - “hcss” format, Spectum1D
  - Print
- Maps (Images)
  - Export As
    - SimpleImage
  - Saves as
    - fits image
    - JPG PNG
    - Publishable format, postscript or EPS
    - “hcss” format (SimpleImage, SimpleCube, stack fo Images)
  - Print

Features

The spectral Cube visualisation and analysis toolbox offer the following features:

- Single pixel spectrum extraction
- Averaged on a region spectrum extraction
- Sub Range cube extraction
- Velocity position map / diagram position velocity

the following feature will be soon added or activated

- Integrated map
- Channel map

Additionnal user requirement / feed back are welcome