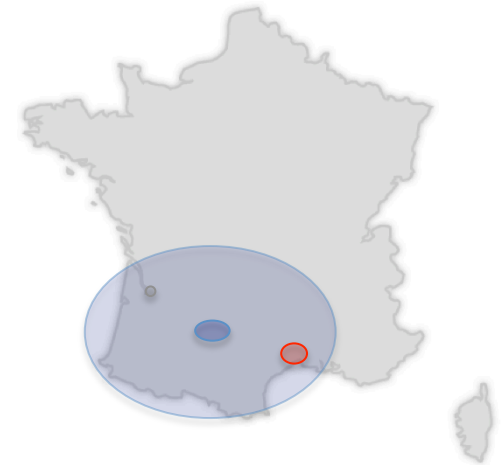




# Convolution Service : *SPECONVOL* use case : *SPECFLOW*

## **OV-GSO collaboration**

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Software engineers : Aurélien Emeras, Patrick Maeght  
Michèle Sanguillon



# Agenda



## The convolution service : ***SPEC CONVOL***

- Motivations and Objectives
- Implementation
- Data Model et Data Access

## The use case : ***SPEC FLOW***

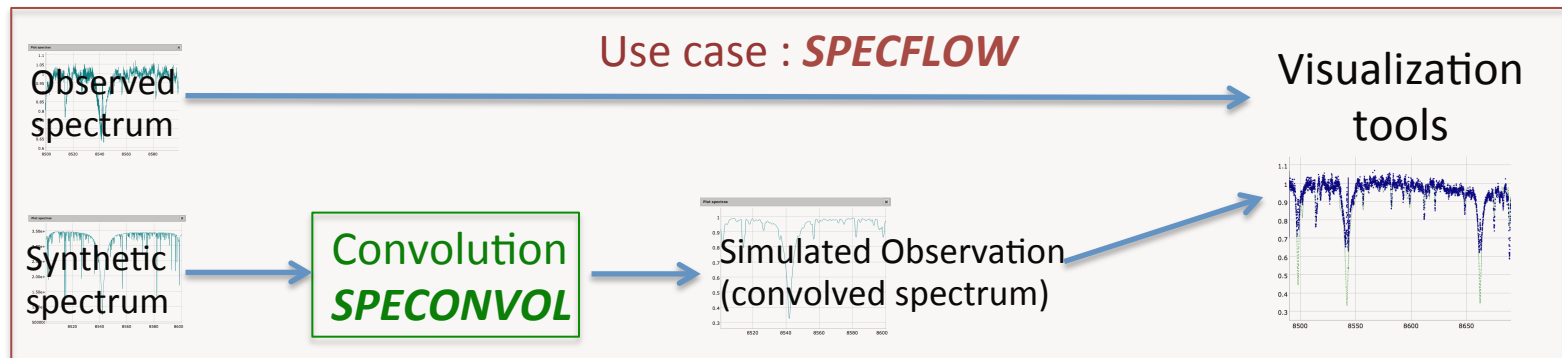
- Operating in the VO
- Demo

## Conclusions and Perspectives

# Motivations



- To be able to compare an observed spectrum with a synthetic one



- Useful to have a first approach to direct research
- Interesting for educational purpose
- Service for VO users and VO tools

# ***SPECONVOL*** : Objectives



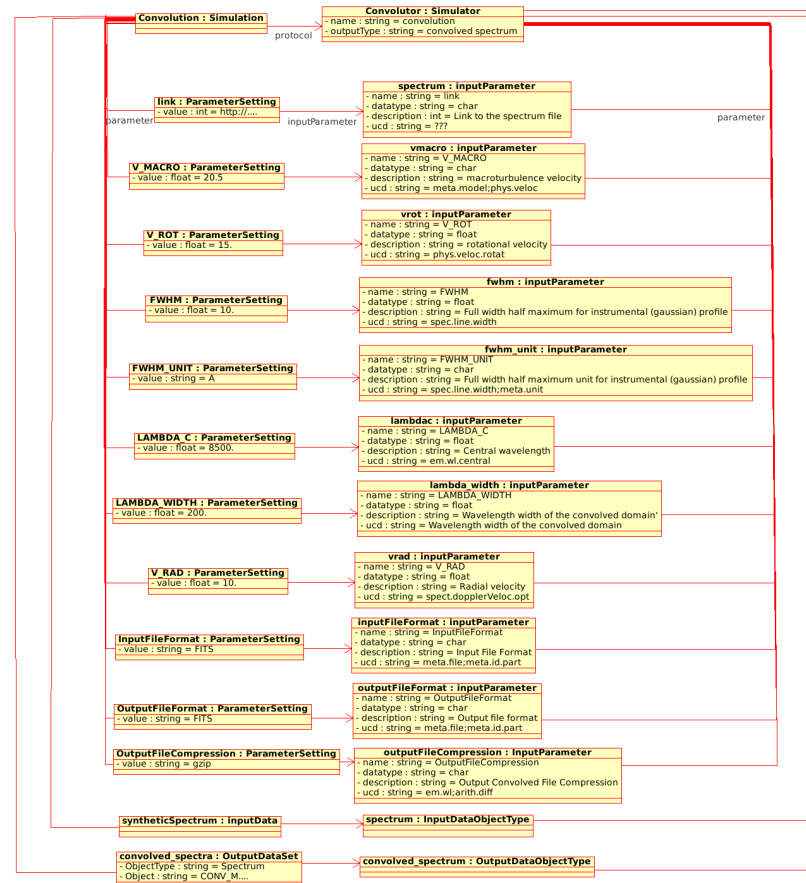
On a portion of a synthetic spectrum (from Pollux database) :

- Could apply corrections for :
    - Macro turbulence velocity (radial-tangent profile)
    - Rotational velocity (rotational profile)
    - Instrumental profile (gaussian profile)
  - Could also apply :
    - a radial velocity shift
  - Short response time
  - Deal with wavelength dependent parameters
- } ⇒ Part of spectrum and not full spectrum considered  
⇒ Interval defined by central wavelength and width

# SPECONVOL : Data Model



- SimDM ?



# ***SPECONVOL*** : Data Access Layer



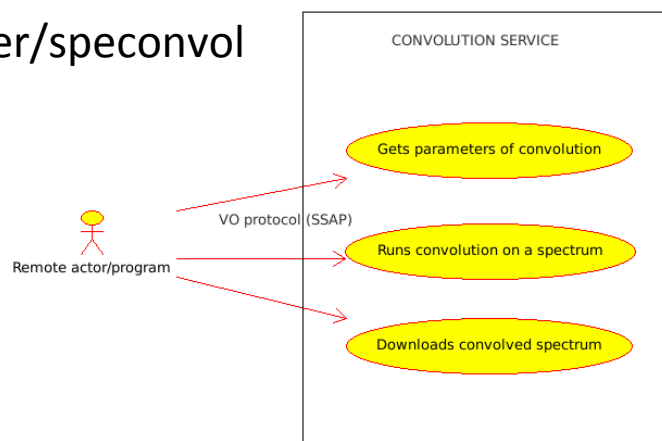
- Protocols
  - Not really spectra discovery but..  
... Link to spectrum provided
  - SimDAL : no document found
  - S3p, TSAP included in SSAP

} **SSAP used (?)**  
but registered as a service

- Queries

<http://ov-gso.lupm.univ-montp2.fr/ssaserver/speconvol>

- Parameters query :  
...?FORMAT=METADATA
- Convolution query :  
...?link=...&V\_MACRO=...&...
- Download query :  
...?Id=...



# SPECONVOL : Data Access Layer



<http://ov-gso.lupm.univ-montp2.fr/ssaserver/speconvol?FORMAT=METADATA>

```
-<VOTABLE version="1.1" xsi:schemaLocation="http://www.ivoa.net/xml/VOTable/v1.1 http://www.ivoa.net/xml/VOTable/VOTable-1.1.xsd">
- <RESOURCE type="meta">
  <DESCRIPTION> OV-GSO/LUPM CONVOLUTION SERVICE </DESCRIPTION>
  <INFO name="QUERY_STATUS" value="OK"/>
  - <PARAM datatype="float" name="INPUT:V_MACRO" ucd="meta.model;phys.veloc" unit="km/s"
    utype="SimDM:/resource/protocol/InputParameter" value="">
    - <DESCRIPTION>
      Macro turbulence velocity for radial tangential profile
    </DESCRIPTION>
  </PARAM>
  - <PARAM datatype="float" name="INPUT:V_ROT" ucd="phys.veloc.rotat" unit="km/s"
    utype="SimDM:/resource/protocol/InputParameter" value="">
    - <DESCRIPTION>
      Rotational velocity for rotational broadening
    </DESCRIPTION>
  </PARAM>
  - <PARAM datatype="float" name="INPUT:FWHM" ucd="spec.line.width" unit="km/s or mA"
    utype="SimDM:/resource/protocol/InputParameter" value="">
    - <DESCRIPTION>
      Full width half maximum for instrumental (gaussian) profile
    </DESCRIPTION>
  </PARAM>
  - <PARAM arraysize="*" datatype="char" name="INPUT:FWHM_UNIT" ucd="spec.line.width;meta.unit"
    utype="SimDM:/resource/protocol/InputParameter" value="">
    - <DESCRIPTION>
      Full width half maximum unit for instrumental (gaussian) profile
    </DESCRIPTION>
  - <VALUES>
    <OPTION value="mA"/>
    <OPTION value="km/s"/>
  </VALUES>
  </PARAM>
  - <PARAM datatype="float" name="INPUT:LAMBDA_C" ucd="em.wl.central" unit="A"
    utype="SimDM:/resource/protocol/InputParameter" value="">
    <DESCRIPTION> Central wavelength </DESCRIPTION>
  </PARAM>
  - <PARAM datatype="float" name="INPUT:LAMBDA_WIDTH" ucd="em.wl;arith.diff" unit="A"
    utype="SimDM:/resource/protocol/InputParameter" value="">
    <DESCRIPTION> Wavelength width of the convolved domain </DESCRIPTION>
  </PARAM>
  - <PARAM datatype="float" name="INPUT:V_RAD" ucd="spect.dopplerVeloc.opt" unit="km/s"
    utype="SimDM:/resource/protocol/InputParameter" value="">
    <DESCRIPTION> Radial velocity </DESCRIPTION>
```

SimDM:/resource/protocol/  
InputParameter

- V\_MACRO
- V\_ROT
- FWHM
- FWHM\_UNIT
- LAMBDA\_C
- LAMBDA\_WIDTH
- V\_RAD
- InputFileFormat
- OutputFileFormat
- link

# SPECONVOL : Data Access Layer



<http://ov-gso.lupm.univ-montp2.fr/ssaserver/speconvol?>

<link=http://pollux.graal.univ-montp2.fr/ssaserver/tsap?>

[Id=A\\_p10250g4.0z-0.5t2.0\\_a0.00c0.00n0.00o0.00r0.00s0.00\\_VIS.spec.FITS](Id=A_p10250g4.0z-0.5t2.0_a0.00c0.00n0.00o0.00r0.00s0.00_VIS.spec.FITS)

&V\_MACRO=45&V\_ROT=10

```
-----  
- <FIELD arraysize="*" datatype="char" name="InputFileFormat" ucd="meta.file;meta.id.part"  
  utype="SimDM:/resource/experiment/ParameterSetting.inputParameter">  
  <DESCRIPTION> Input File Format </DESCRIPTION>  
  </FIELD>  
- <FIELD arraysize="*" datatype="char" name="OutputFileFormat" ucd="meta.file;meta.id.part"  
  utype="SimDM:/resource/experiment/ParameterSetting.inputParameter">  
  <DESCRIPTION> Output Convolved File Format </DESCRIPTION>  
  </FIELD>  
- <FIELD arraysize="*" datatype="char" name="Id" ucd="meta.ref" utype="SimDM:/resource/experiment  
  /OutputDataSet.accessURL">  
  <DESCRIPTION> Link to the convolved spectrum file </DESCRIPTION>  
  </FIELD>  
- <DATA>  
  - <TABLEDATA>  
    - <TR>  
      - <TD>  
        http://pollux.graal.univ-montp2.fr/ssaserver/tsap?Id=A_p10250g4.0z-  
        0.5t2.0_a0.00c0.00n0.00o0.00r0.00s0.00_VIS.spec.FITS  
      </TD>  
      <TD> 45 </TD>  
      <TD> 10 </TD>  
      <TD> </TD>  
      <TD> </TD>  
      <TD> 8525.0 </TD>  
      <TD> 100.0 </TD>  
      <TD> </TD>  
      <TD> FITS </TD>  
      <TD> FITS </TD>  
    - <TD>  
      http://pollux.graal.univ-montp2.fr/convolverserver/convol?SAS=1399376263895125937789275603&  
      Id=CONV_T45R10_L8525.0_W100.0_A_p10250g4.0z-  
      0.5t2.0_a0.00c0.00n0.00o0.00r0.00s0.00_VIS.spec.FITS  
    </TD>  
  </TR>  
</TABLEDATA>  
</DATA>
```

- SimDM:/resource/experiment/  
ParameterSetting/InputParameter

**What about the description of  
the InputParameter (reference,  
unit) ?**

- SimDM:/resource/experiment/  
OutputDataSet.accessURL

- **What about the spectrum  
description (axis) ?**



# ***SPECFLOW*** : a use case of *speconvol*

Web tool (<http://bass2000.bagn.obs-mip.fr/specflow>)

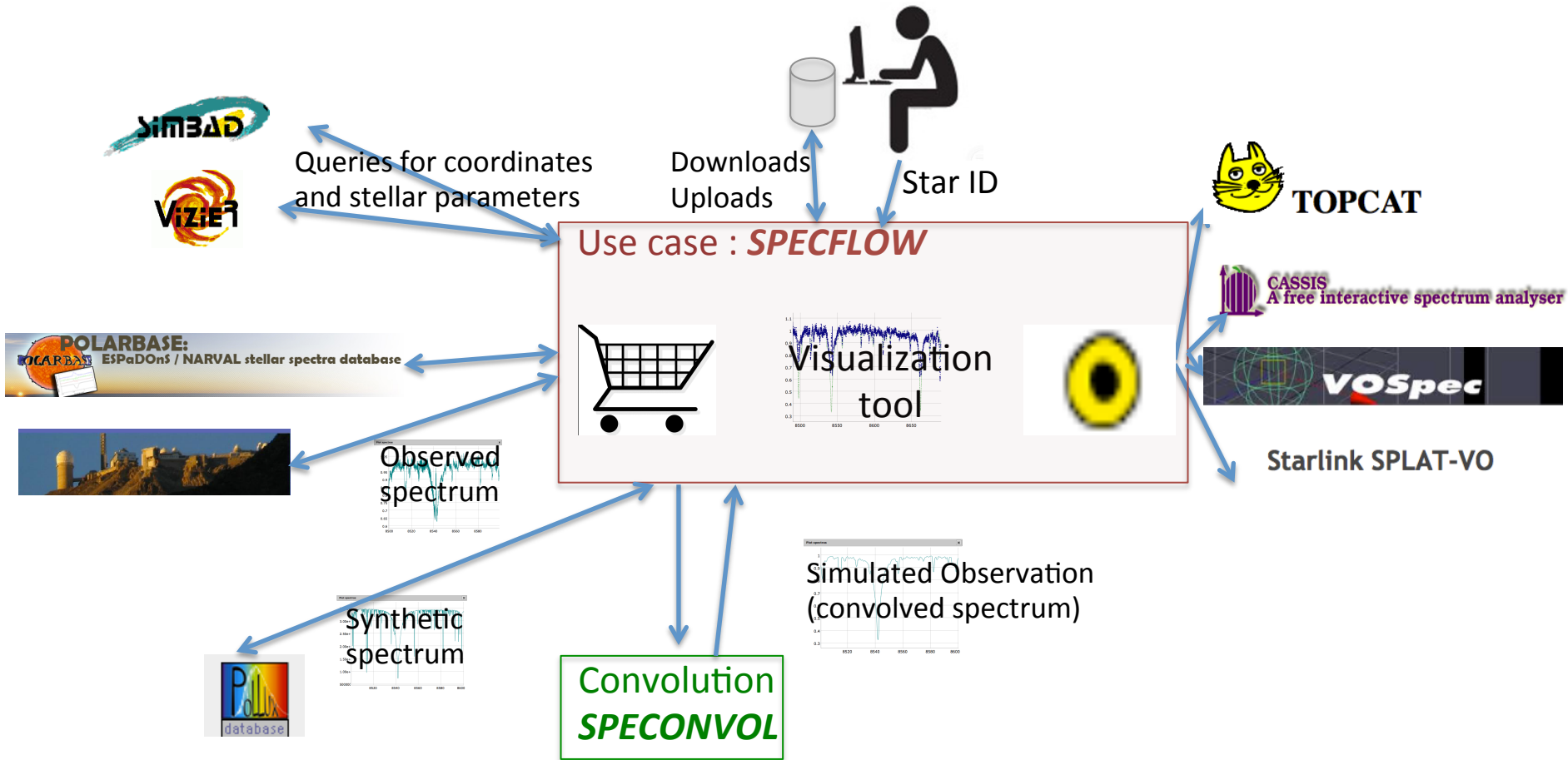
interacting with **VO** resources and tools (VizieR, Simbad, TBLegacy, PolarBase, Pollux, speconvol, TOPCAT, VOSpec, SPLAT-VO, CASSIS)

in order to **compare** two portions of spectra : one from an **observed** spectrum (from TBLegacy or PolarBase database) and the other from a **convolved synthetic** one (from Pollux database and then convolved).

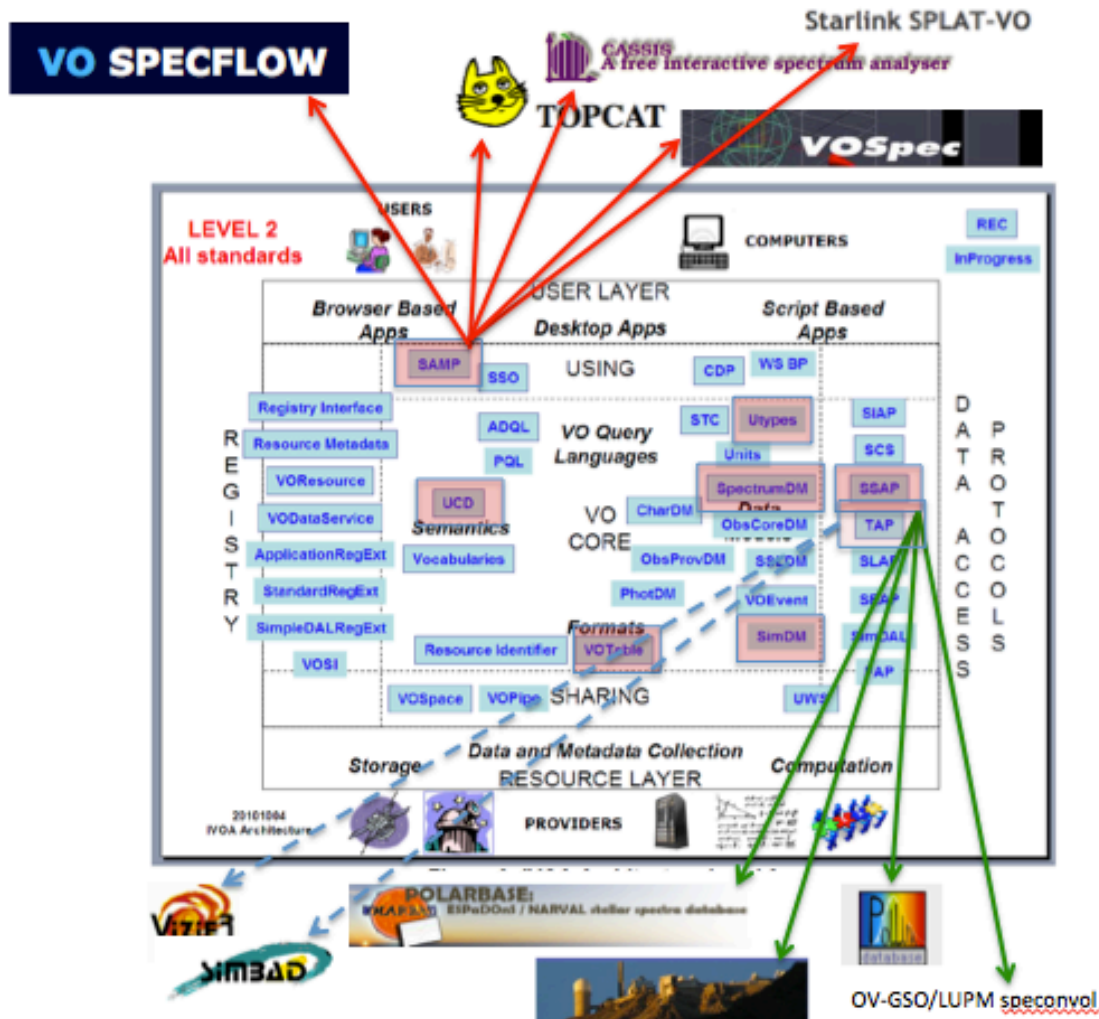
**Speconvol** : a convolution of normalized synthetic stellar spectra program

Up to 3 successive convolutions are allowed on a adjustable portion of the synthetic spectrum, in order to mimic the observable. These convolutions account for macroturbulence velocity, rotational velocity and instrumental profile. Finally, the output can be Doppler-shifted in order to take into account a stellar radial velocity.

# SPECFLOW : Operating



# SPECFLOW : in the VO



# SPECFLOW : Demo

<http://bass2000.bagn.obs-mip.fr/specflow>

The screenshot shows the SPECFLOW web application interface. At the top, there is a navigation bar with the logo "VO SPECFLOW" on the left and three tabs: "Home", "Observed spectra", and "Synthetic spectra". The "Observed spectra" tab is currently selected. Below the navigation bar, the main content area displays a "Welcome to SPECFLOW" message. This message explains that the application is designed to transform synthetic spectra (100 AA to 500 AA) into simulated observations for comparison with observed spectra. It details the process: performing a convolution of synthetic spectra with a rotation profile, an instrumental profile, and a turbulent microturbulence velocity profile, and then applying a Doppler shift based on the star's radial velocity. The interface also lists capabilities for both "Observed spectra" and "Synthetic spectra" tabs, including selecting stars from SIMBAD and VizieR, choosing parameters like temperature and metallicity, and storing or downloading spectra. A "CART" section on the right side of the page features a shopping cart icon with "DRAG" and "DROP" labels. Below the cart, a "TOOLS" section contains five buttons: "TOPCAT", "VOSpec", "Splat VO", "VOPlot", and "Cassis". At the bottom of the page, there is a footer with a "RESET" button, a set of color swatches, a font size selector (A-, A, A+), a small blue icon, and a timestamp: "Last update : Tuesday, May 6 2014 @ 14:55 (CEST +2:00)".

# SPECFLOW : Demo

**VO SPECFLOW** Home Observed spectra Synthetic spectra

▼ Search for stellar parameters

QUERY	RESULTS
<p>Star ID</p> <input type="text" value="hd232862"/>	<p><b>Simbad</b></p> <p>Source : Simbad query Description : meta.main : None src.class : ** pos.eq.ra;meta.main : 059.333275 pos.eq.dec;meta.main : +50.855156 PHYS.VELOC.ROTAT : None spect.dopplerVeloc.opt : -1.80 src.spType : G8II</p>
<p>Catalog</p> <p>All ▾</p> <p><b>Get parameters</b></p> <p><b>Show details</b></p>	<p><b>Vizier</b></p> <p><u>Average</u></p> <p>phys.temperature.effective : 4900.0 phys.gravity : None phys.abund.Fe : None phys.veloc.rotat : None phys.veloc.microTurb : None spect.dopplerVeloc.opt : None src.spType : None</p>

▸ Search for observed spectra

RESET      A- A A+ ⓘ

Last update : Wednesday, May 14 2014 @ 18:47 (CEST +2:00)

**CART**

DRAG DROP

**TOOLS**

TOPCAT

VOSpec

Splat VO

VOPlot

CASSIS

# SPECFLOW : Demo

The screenshot displays the VO SPECFLOW web interface. At the top, there are navigation tabs for 'Home', 'Observed spectra', and 'Synthetic spectra'. Below the navigation, there are search options: 'Search for stellar parameters' and 'Search for observed spectra'. The main content area is divided into two columns: 'QUERY' and 'RESULTS'. The 'QUERY' column contains a search form with fields for 'From' (set to 'Polarbase'), 'RA' (059.333275), 'DEC' (+50.855156), and 'SIZE' (0.016). There are 'Import' and 'Search' buttons. The 'RESULTS' column lists 20 file names, with the 10th file, 'hd232862\_narval\_27sep08\_int\_Normal\_I\_001\_tbl.fts', highlighted in black and labeled 'STORED'. On the right side, there is a 'CART' section with a shopping cart icon and a 'TOOLS' section with buttons for 'TOPCAT', 'VOSpec', 'Splat VO', 'VOPlot', and 'CASSIS'. At the bottom, there is a 'RESET' button, a color selection tool, and a status bar showing 'Last update : Tuesday, May 13 2014 @ 13:01 (CEST +2:00)'.

# SPECFLOW : Demo

The screenshot displays the VO SPECFLOW web interface. At the top, there are navigation tabs for 'Home', 'Observed spectra', and 'Synthetic spectra'. The main content area is divided into 'QUERY' and 'RESULTS' sections.

**QUERY Section:**

- Search for synthetic spectra
- From local disk: Import button
- From Pollux database
- Min/max range of stellar parameters: - +
- Teff: 4410 to 5390 (with - N + buttons)
- logg: 2 to 3 (with - N + buttons)
- metallicity: 0 to 0 (with - N + buttons)
- vturb: None to None (with - N + buttons)
- Search button

**RESULTS Section:**

- Pollux
- 6 files
- 6 file names: NORMFLUX\_M\_s5000g2.0z0.0t1.0\_a0.00c0.00n0.00o0.00r0.00, NORMFLUX\_M\_s5000g2.5z0.0t1.0\_a0.00c0.00n0.00o0.00r0.00, NORMFLUX\_M\_s5000g3.0z0.0t1.0\_a0.00c0.00n0.00o0.00r0.00, NORMFLUX\_M\_s5250g2.0z0.0t1.0\_a0.00c0.00n0.00o0.00r0.00, NORMFLUX\_M\_s5250g2.5z0.0t1.0\_a0.00c0.00n0.00o0.00r0.00, NORMFLUX\_M\_s5250g3.0z0.0t1.0\_a0.00c0.00n0.00o0.00r0.00
- One file is highlighted in black with the text 'STORED'.

**Right Sidebar:**

- CART: Shopping cart icon with DRAG and DROP labels.
- TOOLS: TOPCAT, VOSpec, Splat VO, VOPlot, CASSIS buttons.

**Footer:**

- RESET button
- Color calibration icons
- Zoom controls (A-, A, A+)
- Help icon (i)
- Last update: Wednesday, May 14 2014 @ 18:47 (CEST +2:00)

# SPECFLOW : Demo

The screenshot displays the VO SPECFLOW web interface. At the top, there are navigation tabs for 'Home', 'Observed spectra', and 'Synthetic spectra'. A search bar is present for synthetic spectra. The main content area is divided into 'QUERY' and 'RESULTS' sections.

**QUERY Section:**

- Synthetic spectrum selected from Pollux Database (FITS file): `NORMFLUX_M_s5250g2.5z0.0t1.0_a0.00c0.00n0.00`
- Central wavelength Line: CaII IR
- Central wavelength (Å): 8590
- Wavelength width (Å): 200
- Macroturbulence velocity: 2 km/s
- Rotational velocity: 27 km/s
- Instrumental profile: 105 mA
- Radial velocity (km/s): -1.80
- Output file format: FITS
- Process button

**RESULTS Section:**

- Convolution: `CONV_T2R27G105mA_L8590_W200_S-1.80_M_s5250g2.5z0.0t1.0_a0.00c0.00n0.00o0.00r0.00s0.00` STORED

**Cart Spectras Window:**

- Central wavelength: 8590, Wavelength width: 200
- Selected items:
  - CONV\_T2R27G105mA\_L8590\_W200\_S-1.80\_M\_s5250g2.5z0.0t1.0\_a0.00c0.00n0.00o0.00r0.00s0.00\_VIS.spec.FITS
    - normalizedconvolvedflux
  - NORMFLUX\_M\_s5250g2.5z0.0t1.0\_a0.00c0.00n0.00o0.00r0.00s0.00\_VIS.spec.FITS
    - flux
    - normalizedflux
  - hd232862\_narval\_26sep08\_int\_Normal\_I\_002\_tbl.fits
    - FLUX\_NOR
    - FLUX\_ERR
- Message Type:  votable (TOPCAT),  ssa (VOSpec)

**Plot Spectras Window:**

The plot shows flux versus wavelength (Å) from 8500 to 8650. The y-axis ranges from 0.3 to 1.1. The plot displays a spectrum with several absorption lines, notably a deep one around 8540 Å. The data points are blue, with some green points at the ends of the spectrum.



# SPECFLOW : Demo

The screenshot displays the SPECFLOW software interface, which is used for spectral analysis. It consists of several windows and panels:

- Data Loading:** Two windows at the top show the process of loading data files. The first window, 'Spectrum Analysis 2', has a 'Load' button and a file path `/var/folders/8l/t_r2mg3`. The 'Vlsr data' is set to `0.0 km/s` and the 'in' field is set to `SKY`. The 'Telescope' field is empty. The second window, 'Spectrum Analysis 1', has similar settings.
- Tuning:** Below the data loading windows, there are tuning controls. The 'Range min' and 'max' are set to `8540.02999` and `8639.98` respectively, with the unit set to `Angstrom`.
- Full Spectrum Plot:** The main window shows a plot of the full spectrum. The x-axis is labeled 'Wavelength [Angstrom]' and ranges from 8550 to 8625. The y-axis is labeled 'erg/cm^2/s/A' and ranges from 0.3 to 1.1. The plot shows a spectrum with several absorption lines. The 'Reference frequency: 349013522.18' is displayed at the bottom of the plot.
- InfoPanel:** On the right side of the plot, there is an 'InfoPanel' with tabs for 'Overlays', 'Species', 'Fit', and 'Tools'. It shows two analysis windows: 'Spectrum Analysis 2' (black line) and 'Spectrum Analysis 1' (blue line). Both are set to 'in: SKY Lo [MHz]: unknow' and 'vlsr: 0'. A 'Remove All' button is at the bottom.
- RESULTS:** A window titled 'RESULTS' shows the analysis results for 'Pollux'. It lists 9 files and shows the results for each file, including the file name and the number of channels. The results are: `NORMFLUX_M_s5000g2.5z0.0t1.0_a0.00c0.00n0.00o0.00r0.00`, `NORMFLUX_M_s5000g3.0z0.0t1.0_a0.00c0.00n0.00o0.00r0.00`, `NORMFLUX_M_s5250g2.5z0.0t1.0_a0.00c0.00n0.00o0.00r0.00`, `NORMFLUX_M_s5250g3.0z0.0t1.0_a0.00c0.00n0.00o0.00r0.00`, `NORMFLUX_M_s5500g2.5z0.0t1.0_a0.00c0.00n0.00o0.00r0.00`, and `NORMFLUX_M_s5500g3.0z0.0t1.0_a0.00c0.00n0.00o0.00r0.00`. The 'STORED' status is also shown.
- Cart Spectras:** A window titled 'Cart Spectras' shows the central wavelength and wavelength width. The central wavelength is set to `8590` and the wavelength width is set to `200`. It lists several files with checkboxes for 'normalizedconvolvedflux', 'flux', 'normalizedflux', 'FLUX\_NOR', and 'FLUX\_ERR'. The 'Message Type' is set to 'votable (TOPCAT)'. A 'Sending message 2' button is at the bottom.
- Console:** A console window on the right shows the output of the software, including the file names and the number of channels for each file.

# Conclusions

- The convolution service `speconvol` is currently available on the VO  
<ivo://ov-gso/ssap/speconvol>
- Do not hesitate to test and play with ***SPECFLOW***  
<http://bass2000.bagn.obs-mip.fr/specflow>
- Pollux content (<http://pollux.graal.univ-montp2.fr>)
  - New synthetic spectra are currently implemented
  - New release coming soon !

# Perspectives

- First step before ...
  - ***SPECONVOL*** :
    - Improve the description in SSAP
  - ***SPECFLOW***:
    - Improve some functionalities
    - Access to other databases :
      - Too few databases distribute **normalized** observed spectra
      - Theoretical databases often do not give enough information to describe their synthetic spectra (data generally not normalized to the continuum)

Thank you for your attention