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# SVO Filter Profile Service.

# Version 1.0

## *IVOA Note 2012 October 15*

**Interest/Working Group:**
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## Abstract

The aim of this document is to describe the Spanish VO Filter Profile Service, its content and the current ways to access it.

## Status of This Document

*This is an IVOA Note expressing suggestions from and opinions of the authors. It is intended to share best practices, possible approaches, or other perspectives on interoperability with the Virtual Observatory. It should not be referenced or otherwise interpreted as a standard specification.*

*A list of current IVOA Recommendations and other technical documents can be found at http://www.ivoa.net/Documents/.*

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# 1 Introduction

We describe here the Spanish VO Filter Profile Service, how it works, what kind of information it contains and how this information can be accessed.

The initial and main motivation for this work was the need of defining a well organized way to handle the information about many photometric filters to use it in VOSA (See Bayo et al 2008, 2012)[1]. VOSA, making a long story short, handles observed photometry (both in user files and VO services) and compares it with the corresponding synthetic photometry from theoretical models to infer physical properties for the observed objects.

In order to do this a lot of information is needed about the particular filters used to obtain the observed data. It's not enough having the photometric magnitude and some general characterization like “H band”.

Among other things, we need calibration information to be able to transform observed magnitudes into fluxes and filter transmission curves to calculate synthetic photometry.

With this information we have built services offering synthetic photometry for several theoretical model collections, applications so that users can calculate synthetic photometry for their own spectra, fitting services able to find the model parameters that fit best some observed data and VOSA as the main interface handling and comparing observed and theoretical photometry.

In this sense, the filter profile services is not only a repository of filter information. It must be useful as a reference point around which other services and applications can be built in a much easier way.

That's why it is important having not only a web interface (useful for user browsing) but also a VO interface so that other services and applications can use the Filter Profile Service as a reference when needed.

# 2 Description of the service

The service provides, right now, the transmission curve, algebraic and calibration properties for about 1800 astronomical filters, and it is designed to be compliant to the IVOA Photometry Data Model.

1 VOSA, VO SED Analyzer, Http://svo2.cab.inta-csic.es/theory/vosa

Most filter properties are calculated, by default, directly from the transmission curve using the adequate equation in each case. Nevertheless, in those cases where we are aware of the existence of a quantity directly provided by filter owners/developers (for instance a reference in the literature where an standard zero point is given), the service provides that value instead.

## 2.1 Filter ID's

Filter ID's are assigned to each filter so that they are unique within the Filter Profile Service.

In general, filter ID's tend to follow a predictable syntax as:

Category/Subcategory.Filter

In many cases, “Category” is a physical facility (for instance a telescope), “Subcategory” is the name of a given instrument and Filter is the name of a Band. For instance:

Paranal/NACO.J

In some other cases, we use the internal identifier within an observatory for naming those filters in the observatory collection, like:

CAHA/CAHA.353_41

In other cases, like in most surveys, we use the survey name both as category and subcategory, for instance:

2MASS/2MASS.J

And we also have created a “Generic” category for including standard filters as given in the literature without the need to associate them to any particular observatory. One of these cases would be:

Generic/Johnson.R

In everycase we have tried to choose unique, intuitive names to ease the users the filter identification.

## 2.2 Filter Description.

For each filter, when appropriate, we give some descriptive properties:

### 2.2.1 Description

A short human readable description of the filter.

PhotDM UTYPE: PhotometryFilter.description
UCD: meta.note
Example: “Herschel PACS blue filter”

### 2.2.2 Photometric System

Human readable short-text representation of the photometric system. It briefly describes the photometric system that contains a set of photometry filters. Photometry filters can be contained in a certain photometric system as part of the same observatory/telescope or as part of a known system.

PhotDM UTYPE: PhotometricSystem.description
Examples: SDSS, 2MASS, Bessell, Cousins, etc.

### 2.2.3 Detector Type

Detector type associated to this photometric system. It mainly implies how the transmission curve must be used to compute flux averages in, e.g., syntetic photometry calculations.

Energy Counters

$$f(\lambda_{eff}) = \frac{\int T(\lambda) f(\lambda) d\lambda}{\int T(\lambda) d\lambda}$$

Photon Counters

$$f(\lambda_{eff}) = \frac{\int T(\lambda) f(\lambda) \lambda d\lambda}{\int T(\lambda) \lambda d\lambda}$$

where:

T(λ) = filter transmission
f(λ) = flux of the spectrum

According to the Photometry Data Model, the value is 1 when the transmission curve corresponds to an Energy counter and 0 for Photon counters. It doesn't necessarily means that the original detector was of one type or the other, but what kind of transmission curve is provided by the service.

PhotDM UTYPE: PhotometricSystem.detectorType

### 2.2.4 Band Name

Standard representation of the spectral band associated to this filter when appropiate. It is useful in some cases for human interpretation but it is not very useful for discovery purposes as it is empty for many filters that do not correspond to any standard *band*.

PhotDM UTYPE: PhotometryFilter.bandName
Examples: B, J, v, Ks

### 2.2.5 Observational Facility

Observational facility corresponding to the filter when appropriate. In most cases it is the name of the observatory where the filter is used. In some cases it is the name of a Survey or a Space Mission.

UCD: instr.obsty
Examples: Paranal, 2MASS, Herschel, Spitzer

### 2.2.6 Instrument

Instrument where the filter is used, when appropriate.

UCD: instr
Examples: MIPS, VISIR, BUSCA

### 2.2.7 Comments

A text description of some aspects about the filter that can be interesting for the final user.

UCD: meta.note
Example: “WFCHARB, scratches in centre of filter. 3 fingerprints”

## *2.3 Algebraic properties.*

We call here “algebraic properties” to all those properties than can be calculated using the transmission curve.

The Filter Profile Service (FPS) calculates all these properties for every filter using the same equations. When filter owners have given their own values for some properties, those are the values given by default. If not, the ones calculated by the service are offered.

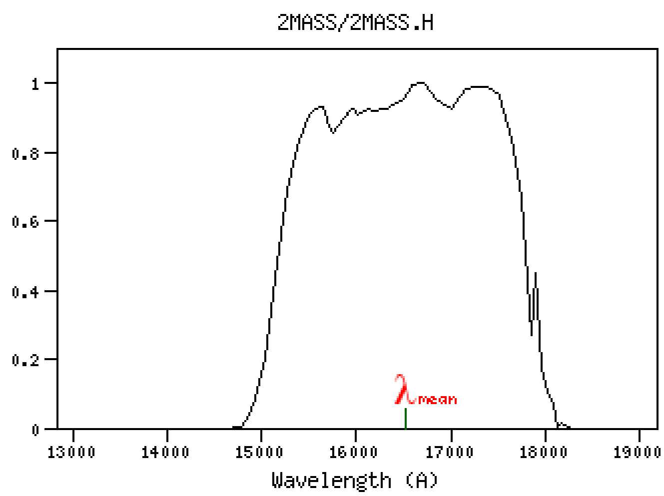
### 2.3.1 Mean wavelength

Calculated by the service as:

$$\lambda_{\rm mean} \equiv \frac{\int \lambda\, T(\lambda)\, d\lambda}{\int T(\lambda)\, d\lambda}$$

where:

T(λ) = filter transmission
for instance:



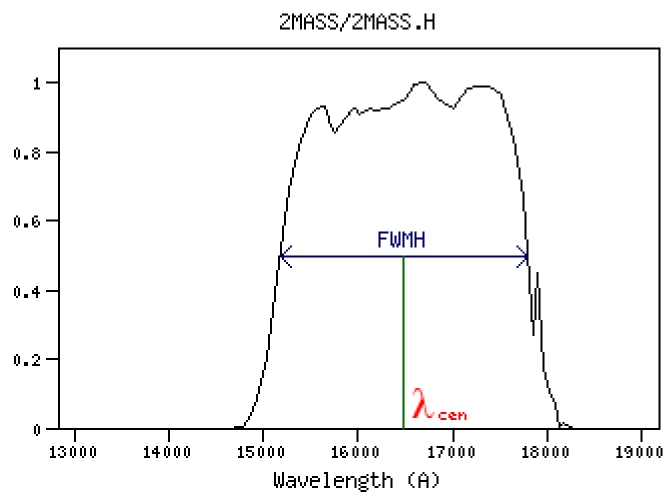

Although there are many possible choices for the main value of the wavelength range covered by the filter, this is the one that we have chosen to represent the corresponding utype in the Photometry Data Model. Other interesting values are also calculated by the service and are described below.

UNIT: Angstrom
UCD: em.wl
PhotDM UTYPE: PhotometryFilter.SpectralAxis.Coverage.Location.Value

### 2.3.2 Central wavelength

Calculated by the service as the central wavelength between the two wavelengths used to compute the Full Width at Half Maximum (FWHM).

For instance:




UNIT: Angstrom
UCD: em.wl

### 2.3.3 Effective wavelength

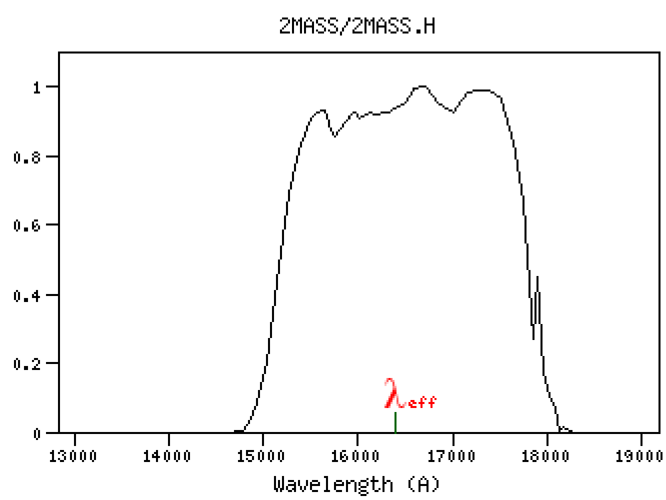
Calculated by the service as:

$$\lambda_{\rm eff} \equiv \frac{\int \lambda\, T(\lambda)\ {\rm Vg}(\lambda)\ d\lambda}{\int T(\lambda)\ {\rm Vg}(\lambda)\ d\lambda}$$

where:

T(λ) =  filter transmission
Vg(λ) = Vega spectrum

For instance:

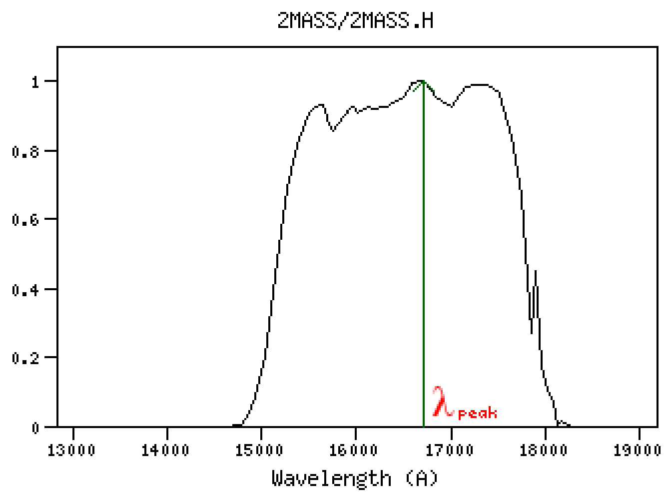


UNIT: Angstrom
UCD: em.wl

### 2.3.4 Peak wavelength

Calculated by the service as the wavelength value with larger transmission.

For instance:




UNIT: Angstrom
UCD: em.wl

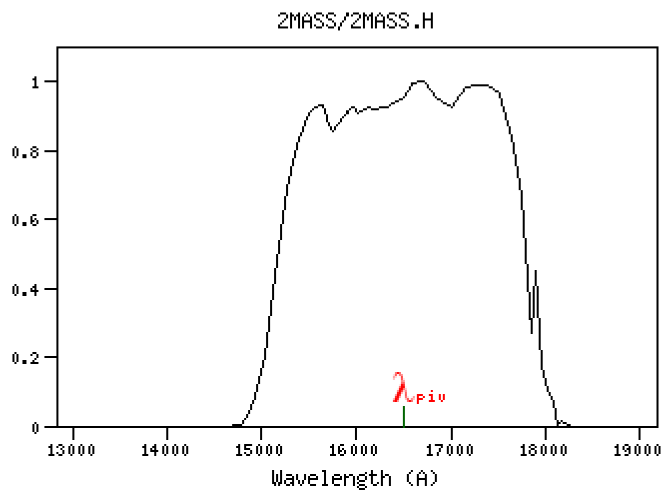
### 2.3.5 Pivot wavelength

Calculated by the service as:

$$\lambda_{\mathrm{pivot}} \equiv \sqrt{\frac{\int \lambda\, T(\lambda)\, d\lambda}{\int T(\lambda)\, d\lambda/\lambda}}$$

where:
T(λ) = filter transmission

For instance:



UNIT: Angstrom
UCD: em.wl

### 2.3.6 Photon distribution wavelength

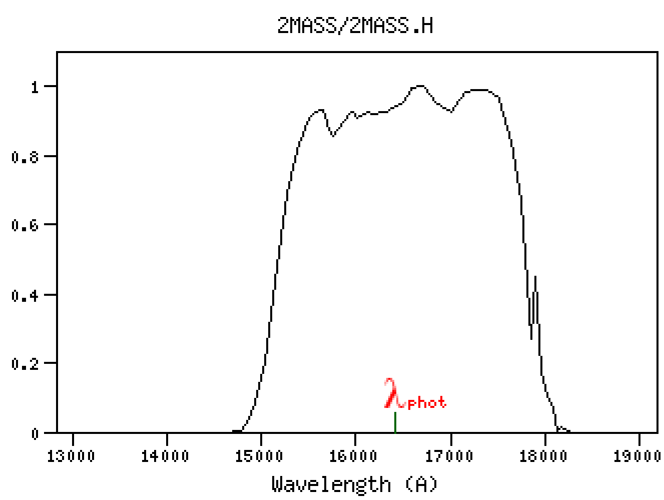
Photon distribution based effective wavelength. Calculated by the service as:

$$\lambda_{\rm phot} \equiv \frac{\int \lambda^2\, T(\lambda)\, {\rm Vg}(\lambda)\, d\lambda}{\int \lambda\, T(\lambda)\, {\rm Vg}(\lambda)\, d\lambda}$$

where:

T(λ) = filter transmission
Vg(λ) = Vega spectrum

For instance:

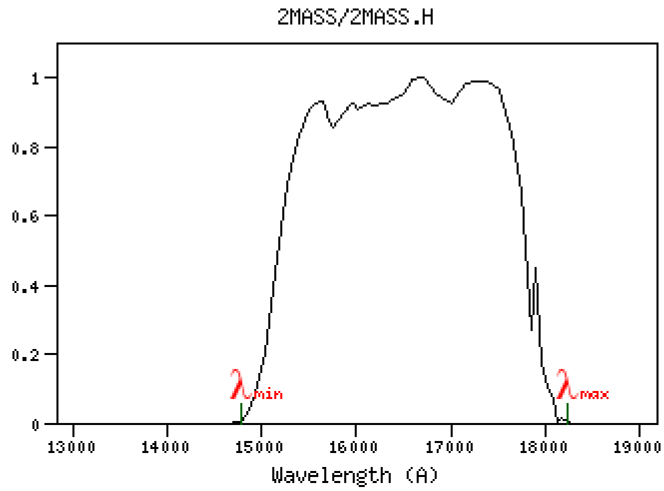



UNIT: Angstrom
UCD: em.wl

### 2.3.7 Minimum wavelength

Calculated by the service as the first wavelength value with a transmission at least 1% of maximum transmission.

For instance:




UNIT: Angstrom
UCD: em.wl;stat.min
PhotDM UTYPE: PhotometryFilter.SpectralAxis.Coverage.Bounds.Start

### 2.3.8 Maximum wavelength

Calculated by the service as the last wavelength value with a transmission at least 1% of maximum transmission.

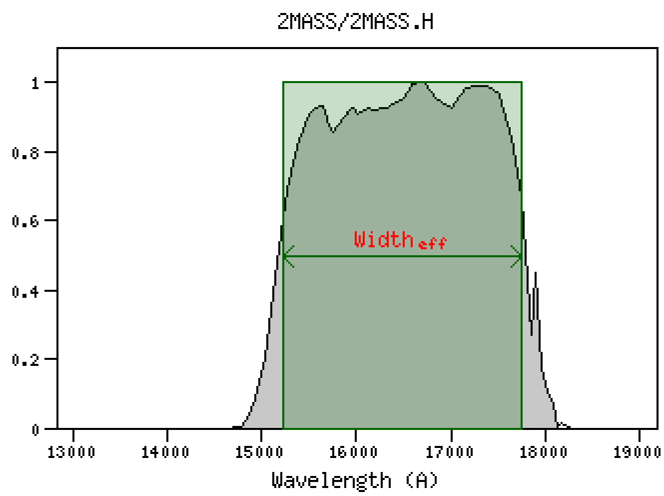
UNIT: Angstrom
UCD: em.wl;stat.max
PhotDM UTYPE: PhotometryFilter.SpectralAxis.Coverage.Bounds.Stop

### 2.3.9 Effective Width

Equivalent to the width of a rectangle with height equal to maximum transmission and with the same area that the one covered by the filter transmission curve. Calculated by the service as:

$$\mathrm{Width}_{\mathrm{eff}} \equiv \frac{\int T(\lambda)\, d\lambda}{Max(T(\lambda))}$$

For instance:

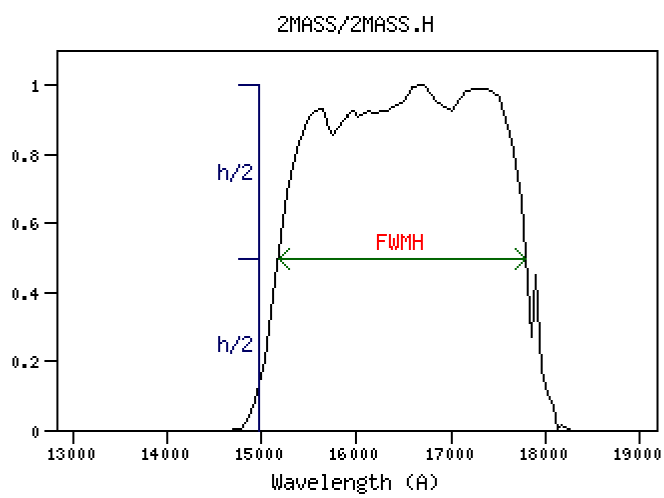



UNIT: Angstrom
UCD: instr.bandwidth
PhotDM UTYPE: PhotometryFilter.SpectralAxis.Coverage.Bounds.Extent

### 2.3.10 Full width at half maximum (FWHM)

Calculated by the service as the difference between the two wavelengths for which filter transmission is half maximum.

For instance:



UNIT: Angstrom
UCD: instr.bandwidth

### 2.3.11 Af/Av

Ratio between extinction at Effective Wavelength and visual extinction. Calculated by the service using the extinction law by Fitzpatrick (1999) improved by Indebetouw et al (2005) in the infrared.

## *2.4 Calibration Properties*

Strictly speaking, zero points, and other calibration properties, are not characteristics of the filter itself. They are related to the filter, but also to the particular observation and the way the obtained flux is represented as a magnitude.

We don't intend to deal, in any case, with particular values of zero points depending on night observing conditions. The service provides calculated standard values (or literature values when available) for the zero points corresponding to each filter for the most used magnitude systems: Vega, AB and ST, and following the approach given in the PhotCal class of the IVOA Photometric Data Model.

### 2.4.1 PhotCalID

For a given filter ID, the corresponding PhotCalID is defined as the filter ID followed by the system name, for instance:

2MASS/2MASS.H/Vega
2MASS/2MASS.H/AB
2MASS/2MASS.H/ST

For each filter, there are available calibration data for the three systems. Either those calculated by the service or the ones found in the literature (if any).

### 2.4.2 Zero Point.

The Zero Point in Vega System is calculated by the service as:

$$\mathrm{ZeroPoint} \equiv \frac{\int T(\lambda)\ \mathrm{Vg}(\lambda)\ d\lambda}{\int T(\lambda)\ d\lambda}$$

where:

$T(\lambda)$ = filter transmission
$Vg(\lambda)$ = Vega spectrum

For calculating the Zero Point in AB system, we make use of a reference spectrum of constant flux density per unit frequency equal to 3631 Jy. Thus, unless specified otherwise by filter owner, this implies:

$F_{0,v}(AB) = 3631$ Jy

For calculating the Zero Point in ST system, we make use of a reference spectrum of constant flux density per unit wavelength equal to 3.631e-9 erg/cm2/s/A. Thus, unless specified otherwise by filter owner, this implies:

$F_{0,\lambda}(ST) = 3.631e\text{-}9$ erg/cm$^2$/s/A

In every case, when transforming data between erg/cm2/s/A and Jy we use the relation:

$F_{0,v}(Jy) = (2.9979246)^{-1}\ 10^5 * \lambda_{eff}^2 * F_{0,\lambda}$ (erg/cm2/s/A)

### 2.4.3 Zero Point Type

For each magnitude system, together with the Zero Point value, we specify the type of the Zero Point with three possible values: Pogson, Asinh and Linear. This information must be used when transforming magnitudes to fluxes following the adequate rules:

**Pogson**

- $F = F_0 * 10^{-(mag-mag0)/2.5}$
- $mag = mag_0 - 2.5 \log(F/F_0)$

**Asinh**

- $F = F_0 * 10^{-(mag-mag0)/2.5} [ 1-b^2\ 10^{2(mag-mag0)/2.5}]$
- $mag = mag_0 - (2.5/\ln(10)) [ \text{asinh}(F/2bF_0) + \ln(b)]$

**Linear**

- $F = F_0 * mag/mag_0$
- $mag = mag_0 * F/F_0$

where:

$F_0$ = zero point value. Utype: PhotCal.ZeroPoint.Flux.value
$mag_0$ = reference magnitude, Utype: ZeroPoint.referenceMagnitude.value
b = softening parameter, Utype:AsinhZeroPoint.softeningParameter

# 3 Service VO interface

The service has two different main interfaces:

- A web page so that users can browse or search for filters with particular characteristics.
- A VO interface so that applications can query the service in different ways.

The web interface is quite self explanatory, so we will talk here about the

## *3.1 SSAP protocol*

Filter transmission curves are described by the IVOA Spectral Data Model and thus, SSAP is an adequate protocol to query the service. But remember that filters are not bounded to a position in the sky so the standard RA,DEC,SIZE query does not apply. In this case, queries should be done following the approach given in Appendix A of the SSAP standard for the "Theoretical Spectra Access Use Case".

This means that the service is able to answer three types of queries:

- **Capabilities**: what parameters are available for queries and which are the possible values for those parameters.
- **Search query**: get the available results for some values, or ranges of values, of those parameters.
- **Data query**: retrieve data for a particular filter.

### 3.1.1 Capabilities

http://svo2.cab.inta-csic.es/theory/fps/fps.php?FORMAT=metadata

will answer with a VOTable with a list of the parameters by which the database can be searched and the available values or ranges.

The currently available search parameters are:

- **WavelengthMean_min**
- **WavelengthMean_max**
- **WavelengthEff_min**

- **WavelengthEff_max**
- **WavelengthMin_min**
- **WavelengthMin_max**
- **WavelengthMax_min**
- **WavelengthMax_max**
- **WidthEff_min**
- **WidthEff_max**
- **FWHM_min**
- **FWHM_max**
- **Instrument** (value)
- **Facility** (value)
- **PhotSystem** (value)

More options could be added in the future, so it is always advisable to make this query to know the available options.

### 3.1.2 Search query

Any of the previous parameters (those provided by the metadata query) are available to make queries like:

http://svo2.cab.inta-csic.es/theory/fps/fps.php?param1=value1&param2=value2

For instance, to find narrow filters (WidthEff<100A) with a mean wavelength between 10000 and 20000A we would query for:

http://svo2.cab.inta-csic.es/theory/fps/fps.php?
WidthEff_max=100&WavelengthMean_min=10000&WavelengthMean_max=20000

and get a VOTable with a list of the available filters and the data access link to retrieve the filter properties and transmission curve.

It is also possible to use an alternative syntax for those parameters which name include the min,max sufixes. Instead of writing Param_min=value1 &Param_max=value2 it is possible to query just for Param=value1/value2. For instance:

http://svo2.cab.inta-csic.es/theory/fps/fps.php?
WidthEff=0/100&WavelengthMean=10000/20000

### 3.1.3 Data Query

For each filter, a data access link is provided in the form:

http://svo2.cab.inta-csic.es//theory/fps3/fps.php?ID=LaSilla/SOFI.NB106

This link will provide a VOTable with all the filter properties and the transmission curve.

## *3.2 Simple queries*

In practice, the most common use of the Filter Profile Service VO interface will probably be accessing properties of a filter just knowing its ID or asking for a particular calibration for a given filter knowing the PhotCalID.

### 3.2.1 Retrieving information about a filter knowing its ID

The same sintax used in "Data Query" above is available for every filter if its ID, within the SVO Filter Profile Service, is known:

http://svo2.cab.inta-csic.es//theory/fps3/fps.php?ID=LaSilla/SOFI.NB106

### 3.2.2 Retrieving information about a filter and its calibration knowing its PhotCalID

There are three possible calibrations available in the service for each filter, depending on which system is preferred (Vega, Ab or ST).

The PhotCalID for each case is build adding /Vega /AB or /ST to the filter ID.

For instance:

http://svo2.cab.inta-csic.es//theory/fps3/fps.php?PhotCalID=SLOAN/SDSS.u/AB

will provide the filter properties, the transmission curve and the calibration for this filter in AB system.

# 4 Use cases

In some cases it is enough to have values for photometric magnitudes associated to some filters to work with them. But some other details are needed in important cases. Sometimes it is enough to be able to transform magnitudes to fluxes, but in other cases it is necessary to know even the transmission curve of the filter used to obtained the observed data.

In practice, the SVO Filter Profile Service was developed at first as a practical way to administrate all the filter information that was necessary to handle in

VOSA[2], where we need to transform magnitudes to fluxes (both from user data files and VO catalogues), calculate synthetic photometry for theoretical spectra and compare both in several ways, make plots and so. It is clear that it isn't enough to use some fuzzy characterization of  photometric data, and we need to know as much as possible about the filters used to get the observed data, including the transmission curves.

### *4.1 Transforming catalog magnitudes into fluxes.*

Most catalogs give photometric values as magnitudes. Very often it is necessary to transform those magnitudes to fluxes, which is not usually trivial because of the lack of information regarding the photometric systems involved.

In order to do this, a catalog VOTable could include the corresponding calibration information according to the Photometry Data Model or it could just point to a Filter Profile Service giving the fllter PhotCalID that is more adequate for the data in the catalog.

For instance, an application could make a conesearch receving a catalog VOTable containing, among other information:

```
(...)
<TABLE>
       <PARAM name="FilterProfileService" ucd="meta.ref.ivorn"
              utype="PhotometryFilter.fpsIdentifier"
              value="ivo://svo/fps"/>
       <GROUP name="phot_IUE_2150">
          <PARAM name="IUE_2150_fid"
                 utype="PhotCal.identifier"
                 value="IUE/IUE.2150-2200/Vega"/>
          <FIELDref ref="IUE_2150_mag"/>
          <FIELDref ref="IUE_2150_err"/>
       </GROUP>
       <GROUP name="phot_IUE_2395">
          <PARAM name="IUE_2395_fid"
                 utype="PhotCal.identifier"
                 value="IUE/IUE.2395-2445/Vega"/>
          <FIELDref ref="IUE_2395_mag"/>
          <FIELDref ref="IUE_2395_err"/>
       </GROUP>
       <FIELD name="name" ucd="ID_MAIN" utype="" />
       <FIELD ID="IUE_2150_mag" utype="PhotometryPoint.Value.value"
           ucd="phot.mag" datatype="double"/>
       <FIELD ID="IUE_2150_err" utype="phdm:PhotometryPoint.Value.error"
           ucd="stat.error;phot.mag" datatype="double"/>
       <FIELD ID="IUE_2395_mag" utype="phdm:PhotometryPoint.Value.value"
           ucd="phot.mag" datatype="double"/>
       <FIELD ID="IUE_2395_err" utype="phdm:PhotometryPoint.Value.error"
           ucd="stat.error;phot.mag" datatype="double"/>
       (...)
       <TABLEDATA>
```

2 VO SED Analyzer: Http://svo2.cab.inta-csic.es/theory/vosa

```
      <TR>
         <TD>HD125451</TD>
         <TD>7.6814806802637</TD>
         <TD>0.11880488179846</TD>
         <TD>7.8263650995276</TD>
         <TD>0.092234213489216</TD>
         (...)
      </TR>

      </TABLEDATA>
</TABLE>
```

In this case we see that fields “IUE_2150_mag” and “IUE_2150_err” are magnitudes associated to a *PhotCal.identifier*=”IUE/IUE.2150-2200/Vega” while “IUE_2395_mag” and “IUE_2395_err” are magnitudes associated to a PhotCal.*identifier*=”IUE/IUE.2395-2445/Vega”. And these filters/calibration identifiers are defined in *PhotometryFilter.fpsIdentifier*=”ivo://svo/fps”.

To get more information about how to transform these magnitudes and errors into fluxes, we can go to the registry, get the URL for ivo://svo/fps and access it as, for instance:

[http://svo2.cab.inta-csic.es//theory/fps3/fps.php?PhotCal.identifier=IUE/IUE.2150-2200/Vega](http://svo2.cab.inta-csic.es//theory/fps3/fps.php?PhotCal.identifier=IUE/IUE.2150-2200/Vega)

to get all the relevant properties of the Vega calibration for this filter. For instance:

```
(…)
<TABLE>
    <PARAM name="filterID" value="IUE/IUE.2150-2200"
       ucd="meta.id"
       utype="photdm:PhotometryFilter.identifier"/>
    <PARAM name="WavelengthUnit" value="Angstrom"
       ucd="meta.unit"
       utype="PhotometryFilter.SpectralAxis.unit"/>
    <PARAM name="WavelengthUCD" value="em.wl"
       ucd="meta.ucd"
       utype="PhotometryFilter.SpectralAxis.UCD"/>
    <PARAM name="Description" value="IUE 2150-2200 A"
       ucd="meta.note"
       utype="photdm:PhotometryFilter.description"/>
    <PARAM name="WavelengthMean" value="2175" unit="Angstrom"
       ucd="em.wl"
       utype="photdm:PhotometryFilter.SpectralAxis.Coverage.Location.Value"/>
    <PARAM name="WavelengthMin" value="2149" unit="Angstrom"
       ucd="em.wl;stat.min"
       utype="photdm:PhotometryFilter.SpectralAxis.Coverage.Bounds.Start"/>
    <PARAM name="WavelengthMax" value="2200.99" unit="Angstrom"
       ucd="em.wl;stat.max"
```

```
      utype="photdm:PhotometryFilter.SpectralAxis.Coverage.Bounds.Stop"/>
    <PARAM name="WidthEff" value="51.0008" unit="Angstrom"
       ucd="instr.bandwidth"
      utype="photdm:PhotometryFilter.SpectralAxis.Coverage.Bounds.Extent"/>
    (...)
    <PARAM name="PhotCalID" value="IUE/IUE.2150-2200/Vega"
       ucd="meta.id"
       utype="photdm:PhotCal.identifier"/>
    <PARAM name="MagSys" value="Vega"
       ucd="meta.code"
       utype="photdm:PhotCal.MagnitudeSystem.type"/>
    <PARAM name="ZeroPoint" value="771.88" unit="Jy"
       ucd="phot.flux.density"
      utype="photdm:PhotCal.ZeroPoint.Flux.value" />
    <PARAM name="ZeroPointUnit" value="Jy"
       ucd="meta.unit"
      utype="photdm:PhotCal.ZeroPoint.Flux.unit"/>
    <PARAM name="ZeroPointType" value="Pogson"
       ucd="meta.code"
      utype="photdm:PhotCal.ZeroPoint.type "/>

    <TABLE utype="photdm:PhotometryFilter.transmissionCurve.spectrum">
      &lt;FIELD name="Wavelength" ucd="em.wl" unit="Angstrom"
            utype="spec:Data.SpectralAxis.Value"/&gt;
      &lt;FIELD name="Transmission" ucd="phys.transmission" unit=""
            utype="spec:Data.FluxAxis.Value"/&gt;
      &lt;DATA&gt;
        &lt;TABLEDATA&gt;
          <TR>
            <TD>2149</TD>
            <TD>0</TD>
          </TR>
          <TR>
            <TD>2150</TD>
            <TD>1</TD>
          </TR>
          <TR>
            <TD>2152</TD>
            <TD>1</TD>
          </TR>
         (...)
        &lt;/TABLEDATA&gt;
      &lt;/DATA&gt;
</TABLE>
```

*(some elements and attributes are not included for the sake of simplicity)*

The most important information for this use case, so that magnitudes can be converted into fluxes, are the zero point value and type.

## 4.2 Computing synthetic photometry from theoretical models or observed spectra

It is common that we want to compare observed photometry with the one corresponding to theoretical models in order to try to infer physical properties for the observed objects.

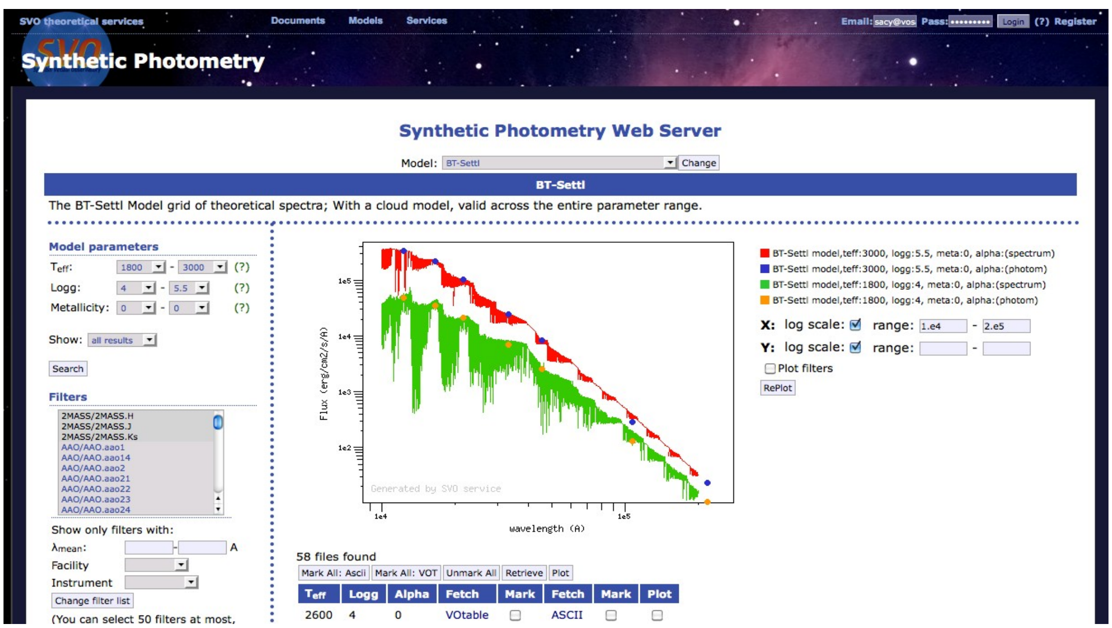
But in order to do this, we need to calculate first the synthetic photometry corresponding to the theoretical spectra using the right equation, for instance:

$$f(\lambda_{eff}) = \frac{\int T(\lambda) f(\lambda) \lambda d\lambda}{\int T(\lambda) \lambda d\lambda}$$

and, to do this, we need to know the filter transmission curve T(λ).

For instance, we offer the synthetic photometry for more than 20 collections of theoretical models in

http://svo2.cab.inta-csic.es/svo/theory/newov/syph.php




and the calculations have been made using the information from the Filter Profile Service. And this synthetic photometry is used later to analyze observed data in VOSA.

It is also useful to calculate synthetic photometry for observed spectra. We also need to know the transmission curves. VOSpec, for instance, uses the SVO Filter Profile service information to offer users the possibility to calculate synthetic photometry for observed spectra and those filters they are interested in. A similar thing can be done in

http://svo2.cab.inta-csic.es/svo/theory/myspec/

The procedure is simple:

- Given an observed spectrum, the application queries the Filter Profile Service for filters with a wavelength range that is included within the observed range (so that integrals can be computed) and offers those filters to the user (with as much information as the application wants).

- For each filter chosen by the user, the application queries the Filter Profile Service for the transmission curve (and other relevant information, for instance, if the curve corresponds to a photon or energy counter).

- The application calculates the corresponding integrals and gives the results (the synthetic photometry) to the user.

## *4.3 Comparing observed and synthetic photometry*

As we already commented above, comparing observed photometry and the synthetic photometry for theoretical models is very useful because it helps to infer physical properties for the observed objects.

But in order to do this, we need to be able to relate, in a not ambiguous way, the observed photometric point with the synthetic photometric point corresponding to the same filter (in fact, the same transmission curve). It's not enough having the photometric value and some general characterization like “H band” (there are many possible filters that could correspond to such a description).

In practice, “comparing” synthetic and observed photometry usually involves a fitting process where the observed data must be compared, in one way or another, with the synthetic values corresponding to, probably, all the theoretical spectra included in a given collection. And calculating all those values is not usually something that can be done “on the fly” because it typically requires a lot of computing time. It is much better to calculate the synthetic values in advance and store them.

In order to do all this, the filter profile service can be used as a common reference framework. It provides

- a unique label for each filter
- the transmission curve for each filter so that synthetic calculations can be performed
- the properties for each filter so that data can be handled (or plotted) adequately (mean wavelength value, range, width...)

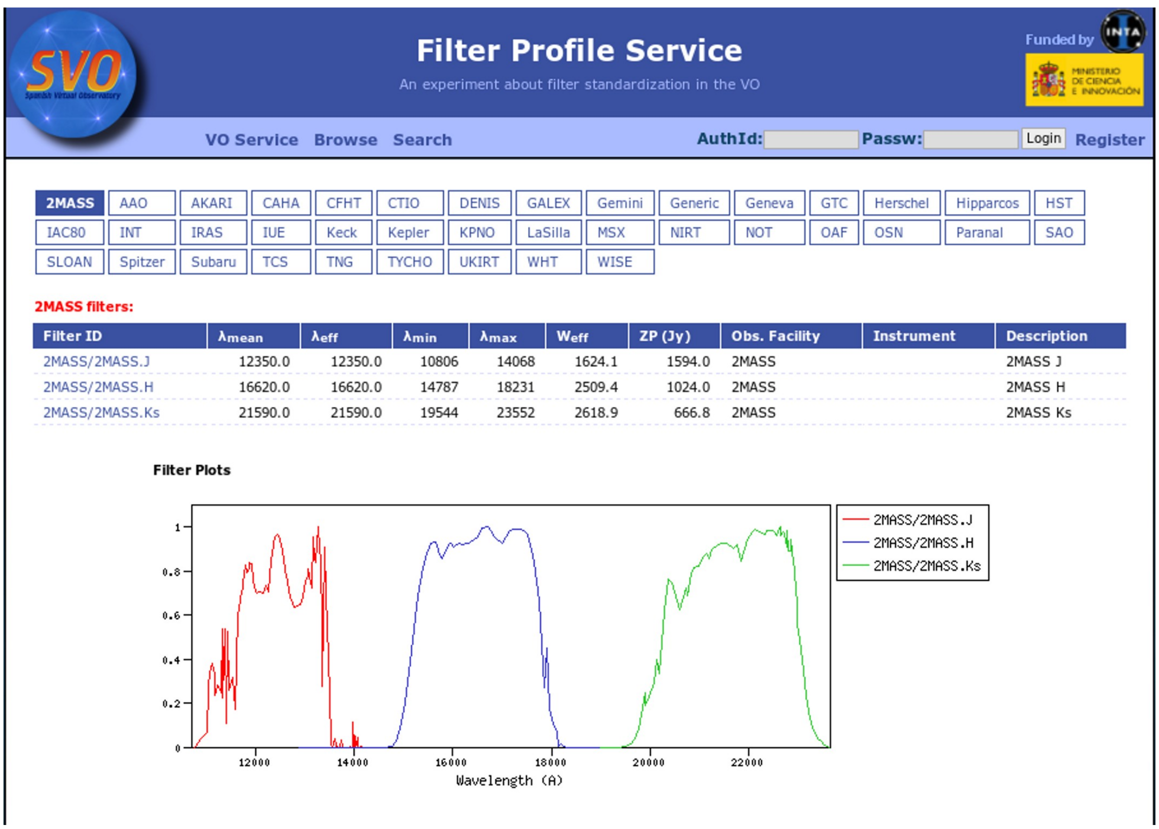
- the calibration information so that observed magnitudes can be transformed into fluxes.

Everything available within the VO (so that applications can query and use the information) and compliant with the Photometry Data Model.

# 5 Web interface.

The Filter Profile Service also offers a web interface for the human user benefit. [Http://svo2.cab.inta-csic.es/theory/fps](Http://svo2.cab.inta-csic.es/theory/fps)

Filters are organized in the categories that correspond to the filter identifiers giving a summary of their properties




| Filter ID | λmean | λeff | λmin | λmax | Weff | ZP (Jy) | Obs. Facility | Instrument | Description |
|---|---|---|---|---|---|---|---|---|---|
| 2MASS/2MASS.J | 12350.0 | 12350.0 | 10806 | 14068 | 1624.1 | 1594.0 | 2MASS | | 2MASS J |
| 2MASS/2MASS.H | 16620.0 | 16620.0 | 14787 | 18231 | 2509.4 | 1024.0 | 2MASS | | 2MASS H |
| 2MASS/2MASS.Ks | 21590.0 | 21590.0 | 19544 | 23552 | 2618.9 | 666.8 | 2MASS | | 2MASS Ks |

It is also possible to search for those filters with some properties.

# Filter Profile Service

An experiment about filter standardization in the VO

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VO Service   Browse   Search        AuthId:   Passw:   Login   Register

## Search filters

10000 < λmean < 12000 | Facility: --- | Instrument: --- | Descrip ~ | Search

| Filter ID | λmean | λeff | λmin | λmax | Weff | ZP (Jy) | Obs. Facility | Instrument | Description |
|---|---|---|---|---|---|---|---|---|---|
| CFHT/CFHT.cfh1101 | 10086.6 | 10061.4 | 9276 | 10980 | 755.5 | 2115.4 | CFHT | | cfh1101 Corion |
| TNG/DOLORES.SDSS_z | 10129.1 | 9805.7 | 8147 | 12000 | 3644.3 | 2034.5 | TNG | DOLORES | DOLORES SDSS z' |
| TNG/OIG.SDSS_z | 10129.1 | 9805.7 | 8147 | 12000 | 3644.3 | 2034.5 | TNG | OIG | OIG SDSS z' |
| CFHT/Megaprime.z | 10140.7 | 9808.4 | 8009 | 12000 | 3646.8 | 2030.6 | CFHT | Megaprime | Megaprime z' |
| Paranal/HAWKI.Y | 10201.6 | 10171.8 | 9488 | 11004 | 1015.7 | 2092.9 | Paranal | HAWK-I | HAWK-I Y |
| Gemini/Flamingos2.Y | 10201.8 | 10174.3 | 9551 | 10825 | 893.2 | 2093.6 | Gemini | Flamingos2 | Flamingos2 Y |
| Paranal/VISTA.Y | 10211.2 | 10184.2 | 9427 | 10977 | 905.3 | 2087.3 | Paranal | VIRCAM | VISTA Y filter |
| AAO/AAO.aao93 | 10236.3 | 9935.3 | 8143 | 12003 | 3504.9 | 2022.3 | AAO | | AAO #93, z t, z |
| Gemini/NIRI.Y-G0241w | 10237.7 | 10211.5 | 9591 | 10877 | 943.6 | 2082.5 | Gemini | NIRI | NIRI Y, G0241w |
| Subaru/MOIRCS.Y | 10243.7 | 10218.1 | 9604 | 10899 | 978.8 | 2079.6 | Subaru | MOIRCS | MOIRCS Y |
| KPNO/KP4in.Gunn_z | 10250.9 | 9952.1 | 8148 | 12000 | 3463.5 | 2020.2 | KPNO | KP4in | Gunn z |
| TNG/NICS.1mic | 10255.3 | 10208.2 | 9389 | 11168 | 1204.3 | 2070.2 | TNG | NICS | NICS 1mic |
| CFHT/Wircam.Y | 10258.8 | 10221.3 | 9386 | 11134 | 1084.2 | 2073.3 | CFHT | Wircam | Wircam Y |
| CFHT/CFHT.cfh8002 | 10258.8 | 10221.3 | 9386 | 11134 | 1084.2 | 2073.3 | CFHT | | cfh8002 Y |
| CFHT/CFHT.cfh1810 | 10295.4 | 10007.0 | 8281 | 12000 | 3354.3 | 2015.2 | CFHT | | cfh1810 General Purpose |
| UKIRT/UKIDSS.Y | 10318.7 | 10289.4 | 9635 | 11025 | 1004.4 | 2057.2 | UKIRT | WFCAM | UKIDSS Y |
| WHT/LRIS.Z | 10334.3 | 10326.4 | 9698 | 10927 | 507.1 | 2063.7 | WHT | LRIS | LRIS Z |
| CTIO/ISPI.I_id81 | 10337.3 | 10184.7 | 8811 | 12487 | 1871.3 | 2037.9 | CTIO | ISPI | ISPI I, #81 |
| CAHA/Omega2000.Y | 10339.3 | 10327.6 | 9819 | 10863 | 720.4 | 2045.7 | CAHA | Omega2000 | Omega2000 Y |
| UKIRT/WFCAM.Y | 10367.8 | 10339.1 | 9648 | 11126 | 999.1 | 2040.9 | UKIRT | WFCAM | WFCAM Y |
| CTIO/ISPI.Y_id191C | 10386.1 | 10323.1 | 9479 | 11275 | 1393.8 | 2027.5 | CTIO | ISPI | ISPI Y, #191C |
| CTIO/ISPI.Y_id191A | 10386.9 | 10323.9 | 9480 | 11275 | 1391.6 | 2027.2 | CTIO | ISPI | ISPI Y, #191A |
| CTIO/ISPI.Y_id191B | 10389.3 | 10326.3 | 9482 | 11278 | 1393.7 | 2026.7 | CTIO | ISPI | ISPI Y, #191B |
| WHT/INGRID.Z | 10396.2 | 10385.2 | 9913 | 10873 | 665.5 | 2037.4 | WHT | INGRID | INGRID Z |

And additional details about any filter can be also obtained

**2MASS filters:**

| Filter ID | λmean | λeff | λmin | λmax | Weff | ZP (Jy) | Obs. Facility | Instrument | Description |
|---|---|---|---|---|---|---|---|---|---|
| 2MASS/2MASS.J | 12350.0 | 12350.0 | 10806 | 14068 | 1624.1 | 1594.0 | 2MASS | | 2MASS J |
| 2MASS/2MASS.H | 16620.0 | 16620.0 | 14787 | 18231 | 2509.4 | 1024.0 | 2MASS | | 2MASS H |

X

## 2MASS/2MASS.H

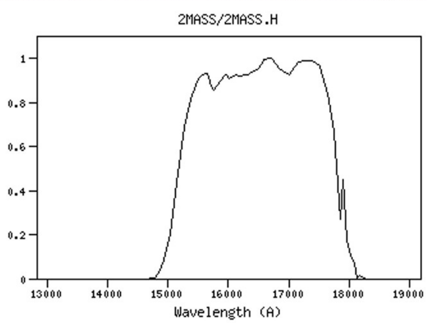
### Filter Description

| | |
|---|---|
| Filter ID (?) : | 2MASS/2MASS.H |
| Description (?) : | 2MASS H |
| Phot.System (?) : | 2MASS |
| Detector Type (?) : | Energy counter |
| Band Name (?) : | H |
| Obs. Facility (?) : | 2MASS |
| Instrument (?) : | ------ |
| Comments (?) : | ------ |

### Mathematical properties

| Property | Calculated | Specified | Unit |
|---|---|---|---|
| $\lambda_{mean}$ (?) : | 16513.67 | 16620 | (Angstrom) |
| $\lambda_{cen}$ (?) : | 16487.19 | ------- | (Angstrom) |
| $\lambda_{eff}$ (?) : | 16386.10 | 16620 | (Angstrom) |
| $\lambda_{peak}$ (?) : | 16710.00 | ------- | (Angstrom) |
| $\lambda_{pivot}$ (?) : | 16494.95 | ------- | (Angstrom) |
| $\lambda_{phot}$ (?) : | 16423.76 | ------- | (Angstrom) |
| $\lambda_{min}$ (?) : | 14787.38 | ------- | (Angstrom) |
| $\lambda_{max}$ (?) : | 18231.02 | ------- | (Angstrom) |
| $W_{eff}$ (?) : | 2509.40 | ------- | (Angstrom) |
| FWHM (?) : | 2609.65 | ------- | (Angstrom) |
| $A_f/A_v$ (?) : | 0.19 | ------- | () |

### Transmission curve




Data file: ascii, VOTable

Reference for transmission curve: 2MASS at IPAC documentation

### Calibration properties

**Vega System**

| Property | Specified | Calculated | Unit |
|---|---|---|---|
| Zero Point (?) : | 1.133e-10 | 1.144e-10 | (erg/cm2/s/A) |
| | 1024 | 1024.74 | (Jy) |
| ZP Type (?) : | Pogson | | |
| PhotCal ID (?) : | 2MASS/2MASS.H/Vega | | |

**AB System**

| Property | Specified | Calculated | Unit |
|---|---|---|---|
| Zero Point (?) : | ------- | 4.054e-10 | (erg/cm2/s/A) |
| | ------- | 3631.00 | (Jy) |
| ZP Type (?) : | Pogson | | |
| PhotCal ID (?) : | 2MASS/2MASS.H/AB | | |

**ST System**

| Property | Specified | Calculated | Unit |
|---|---|---|---|
| Zero Point (?) : | ------- | 3.631e-9 | (erg/cm2/s/A) |
| | ------- | 32520.47 | (Jy) |
| ZP Type (?) : | Pogson | | |
| PhotCal ID (?) : | 2MASS/2MASS.H/ST | | |

Reference for calibration: Cohen 2003

| Filter ID | λmean | λeff | λmin | λmax | Weff | ZP (Jy) | Obs. Facility | Instrument | Description |
|---|---|---|---|---|---|---|---|---|---|
| 2MASS/2MASS.Ks | 21590.0 | 21590.0 | 19544 | 23552 | 2618.9 | 666.8 | 2MASS | | 2MASS Ks |

# 6 References

[1] J. Salgado et al, Photometry Data Model,
http://www.ivoa.net/Documents/PHOTDM/index.html

[2] D. Tody et al, Simple Spectral Access Protocol
http://www.ivoa.net/Documents/latest/SSA.html

[3] Bayo et al (2008) A&A 492, 277

[4] Bayo et al (2012) submitted to A&A

[5] Fitzpatrick E.L (1999) PASP 111, 63

[6] Indebetouw et al (2005) ApJ 619, 931