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## Different ways of exposing data through VizieR's votable output



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## 2 levels of description to describe a table

- Description applied to individual column:  
→ type, unit, description & name, UCD
- Global description :
  - associate columns together according to a common purpose  
e.g.: error on a position
  - Fit the whole table description into a model  
adopt VO-standards for photometry, ObsCore

=> Difficult for VizieR to fit all tables into a pre\_defined Data model

however, we can identify some common topics – but how to provide ?

# □ Basic adopted conventions



## Take advantage of the columns nomenclature

- VizieR adopts a nomenclature (in particular for columns) for column description  
<http://cdsarc.u-strasbg.fr/vizieR/catstd/catstd-3.3.htx>  
ex: RAJ2000, DEJ2000, Epoch  
Bmag, Vmag..
- Adopted also by AAS as an author recommendation for MRT table.

### Machine Readable Tables



It is in the best interest of both the author and the reader for lengthy tables to appear in a machine readable table format. Machine readable tables (MRTs) consist of structured ASCII (non-binary) data with a meta-data header. Those MRTs published in the AAS Journals utilize very similar standards and styles as [CDS's VizieR tables](#). Indeed, VizieR harvests AAS Journal MRTs and makes these data discoverable and searchable via [Virtual Observatory](#) protocols, which is another benefit to using this data format.

## Link columns together with *one-letter-underscore-prefix* : e\_, l\_, ...

- Positions: RAJ2000 , e\_RAJ2000 (error)
- Photometry: Bmag, e\_Bmag (error), l\_Bmag (limit)

# □ Basic adopted conventions



Describe columns association using the nomenclature convention



A parameter has frequently associated values, and we have adopted the rule of association with the *one-letter-underscore prefix*: if a column is obviously associated to another one — typically mean errors or uncertainty flags — we use one of the *underscore prefixes* listed in prefix.

### Conventions used for label prefixes

Symbol	Explanation	Default Limits
a_label	aperture used for parameter label	>=0
B_label	for an upper bound (maximal value) on parameter label	
b_label	for a lower bound (minimal value) on parameter label	
D_label	for a difference ( $\Delta$ ) on parameter label (e.g. (O-C))	
d_label	for a number of degrees of freedom or for number of digits on parameter label	>0
E_label	mean error (upper limit) on parameter label	>=0
e_label	mean error ( $\sigma$ ) on parameter label	>=0
f_label	flag on parameter label	
L_label	Likelihood on parameter label	
l_label	limit flag on parameter label	[<>]
m_label	multiplicity index on parameter label to resolve ambiguities	
n_label	note (remark) on parameter label	
o_label	number of observations on parameter label	>=0
q_label	quality on parameter label	
r_label	reference (source) for parameter label	
s_label	dispersion ( $\sigma$ ) on parameter label (the $\sigma$ of a mean of N values is asymptotically equal to the dispersion divided by $\sqrt{N}$ )	>=0
u_label	uncertainty flag on parameter label	[ : ]
w_label	weight of parameter label	>=0
x_label	unit in which parameter label is expressed	

Usual mathematical functions may be specified in the label, with parentheses or a dot; for instance, the logarithm of the effective temperature could be labelled  $\log(T_e)$  or  $\log.T_e$ .

```
-<TABLE ID="J_ApJ_788_125_table2" name="J/ApJ/788/125/table2">
  <DESCRIPTION>Photometry</DESCRIPTION>
  +<FIELD name="l_Bmag" ucd="meta.code.error" datatype="char" arraysize="1"></FIELD>
  +<FIELD name="Bmag" ucd="phot.mag;em.opt.B" datatype="float" width="5" precision="2" unit="mag"></FIELD>
  +<FIELD name="l_Vmag" ucd="meta.code.error" datatype="char" arraysize="1"></FIELD>
  +<FIELD name="Vmag" ucd="phot.mag;em.opt.V" datatype="float" width="5" precision="2" unit="mag"></FIELD>
  +<FIELD name="l_Jmag" ucd="meta.code.error" datatype="char" arraysize="1"></FIELD>
  +<FIELD name="Jmag" ucd="phot.mag;em.IR.J" datatype="float" width="5" precision="2" unit="mag"></FIELD>
  +<FIELD name="f_Jmag" ucd="meta.code" datatype="char" arraysize="2"></FIELD>
```

# □ Positions description



## Meta-data related to positions in VizieR

- meta-data applied to the whole table  
e.g. : system (ICRS, Galactic, FK4..), equinox, epoch
- meta-data associated to positions  
e.g. : epoch, proper motion, parallax



## Several systems possible in the same table in VizieR!

→ define a main position (UCD pos.eq.ra;meta.main)  
including pos., err., prop mot., plx.

Main positions enables to gather all positions columns  
(In vizieR this is possible only for main position!)

# □ Positions description

## VOTable output

- Put meta.main only on columns position (RA,DEC)
- Use <COOSYS> in the output

Positions

COOSYS

```
-<RESOURCE ID="yCat_1022003603" name="J/other/NewA/36.70">
-<DESCRIPTION>
  Astrometry of 3 vdBH open clusters (Orellana+, 2015)
</DESCRIPTION>
<COOSYS ID="J2000" system="eq_FK5" equinox="J2000"/>
-<TABLE ID="j_other_NewA_36_70_table2" name="j/other/NewA/36.70/table2">
-<DESCRIPTION>
  Centre coordinates, mean proper motion, number of members N and diameters of the clusters
</DESCRIPTION>
+<FIELD name="RAJ2000" ucd="pos.eq.ra;meta.main" ref="J2000" datatype="double" width="9" precision="5" unit="deg"></FIELD>
+<FIELD name="e_RAJ2000" ucd="stat.error;pos.eq.ra" datatype="double" width="8" precision="5" unit="deg"></FIELD>
+<FIELD name="DEJ2000" ucd="pos.eq.dec;meta.main" ref="J2000" datatype="double" width="9" precision="5" unit="deg"></FIELD>
+<FIELD name="e_DEJ2000" ucd="stat.error;pos.eq.dec" datatype="double" width="8" precision="5" unit="deg"></FIELD>
+<FIELD name="pmRA" ucd="pos.pm;pos.eq.ra" ref="J2000" datatype="float" width="5" precision="2" unit="mas/yr"></FIELD>
+<FIELD name="e_pmRA" ucd="stat.error;pos.pm;pos.eq.ra" datatype="float" width="5" precision="2" unit="mas/yr"></FIELD>
+<FIELD name="pmDE" ucd="pos.pm;pos.eq.dec" ref="J2000" datatype="float" width="5" precision="2" unit="mas/yr"></FIELD>
+<FIELD name="e_pmDE" ucd="stat.error;pos.pm;pos.eq.dec" datatype="float" width="5" precision="2" unit="mas/yr"></FIELD>
```

# □ Photometry output

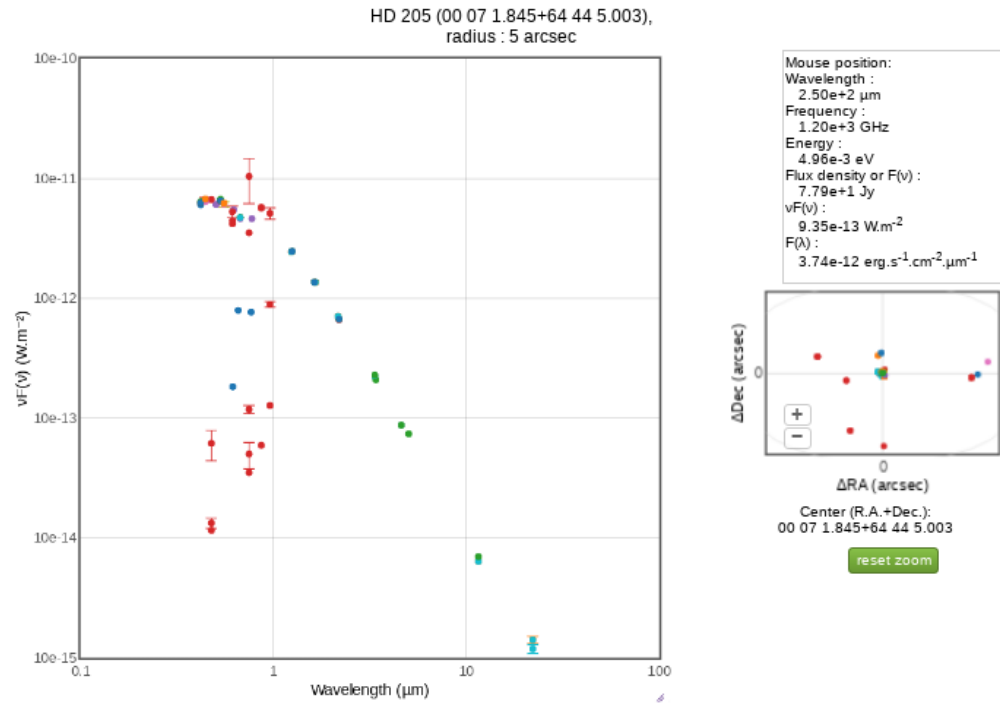


The VizieR photometry viewer is a global output of VizieR tables for which documentalists found filters used in observation (or similar filter)

Photometry

## Photometry meta-data

→ A reference table of filters (SVO) applied to magnitudes columns



# □ Photometry output



## VOTable output

- Use the Photometry Model (IVOA note)  
“Providing Photometric Data Measurements Description in VOTables” (S.Derriere)

Photometry

Utype  
+  
group

 Not a standard

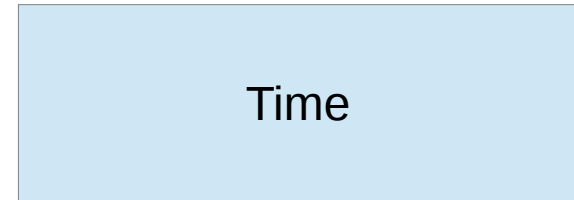
```
-<RESOURCE ID="VizieR_S610644484" name="VizieR(2019-05-08T15:28:04)">
-<DESCRIPTION>
  VizieR database maintained by CDS, see http://vizier.u-strasbg.fr
</DESCRIPTION>
<COOSYS ID="H_1991.250" system="ICRS" epoch="1991.250"/>
<COOSYS ID="J2000" system="eq_FK5" equinox="J2000"/>
-<TABLE ID="VizieR_0" name="allVizieR">
  <DESCRIPTION>all VizieR catalogues</DESCRIPTION>
  -<GROUP ID="gsed" name="_sed" ucd="phot" utype="spec:PhotometryPoint">
    -<DESCRIPTION>
      The SED group is made of 4 columns: mean frequency, flux, flux error, and filter designation
    </DESCRIPTION>
    <FIELDref ref="sed_freq" utype="photdm:PhotometryFilter.SpectralAxis.Coverage.Location.Value"/>
    <FIELDref ref="sed_flux" utype="spec:PhotometryPoint"/>
    <FIELDref ref="sed_eflux" utype="spec:PhotometryPointError"/>
    <FIELDref ref="sed_filter" utype="photdm:PhotometryFilter.identifier"/>
  </GROUP>
  +<FIELD name="_RAJ2000" ucd="pos.eq.ra" ref="J2000" datatype="double" width="14" precision="10" unit="deg"></FIELD>
  +<FIELD name="_DEJ2000" ucd="pos.eq.dec" ref="J2000" datatype="double" width="14" precision="10" unit="deg"></FIELD>
  +<FIELD name="_tablename" ucd="meta.table" datatype="char" arraysize="32*"></FIELD>
  +<FIELD name="_ID" ucd="meta.id" datatype="char" arraysize="64*"></FIELD>
  +<FIELD ID="sed_freq" name="_sed_freq" ucd="em.freq" unit="GHz" datatype="double" width="10" precision="E6"></FIELD>
  +<FIELD ID="sed_flux" name="_sed_flux" ucd="phot.flux.density" unit="Jy" datatype="float" width="9" precision="E3"></FIELD>
  +<FIELD ID="sed_eflux" name="_sed_eflux" ucd="stat.error:phot.flux.density" unit="Jy" datatype="float" width="8" precision="E2"></FIELD>
  +<FIELD ID="sed_filter" name="_sed_filter" ucd="meta.id;instr.filter" unit="" datatype="char" width="32" arraysize="32*"></FIELD>
+<DATA></DATA>
```



# □ Time output



- For a year, documentalist assigns Time description to time-column according to the IVOA spec. :
    - scale (TDB, TAI, GMT...)
    - frame (BARYCENTER, HELIOCENTER, ...)
    - systematic\_error, offset, uncertainty
  - Meta-data applied to the whole table on times columns
  - Several time columns possible in the same table (with different meta-data) e.g. Gaia DR2 :  
<http://vizier.unistra.fr/viz-bin/VizieR-3?-source=I/345/transits>
- gather columns related to each time description possible in VizieR





[I/345](#) [Gaia DR2 \(Gaia Collaboration, 2018\)](#) [acknowledge and cite Gaia DR2](#) [timeSerie](#) [Similar Catalogs](#)  
[Post annotation](#)  
 I.I/345/transits Calibrated FoV transit photometry for CU5, consolidated and provided by CU7 for variable stars in Gaia  
 names in green) (17712391 rows)

Time

Submit Reset All

Simple Constraint List Of Constraints

Query by Constraints applied on Columns (Output Order: + -)

Standard Original

Show	Sort	Column	Clear	Constraint	Unit	Column	Constraint
<input type="checkbox"/>	<input type="radio"/>	recno				Record number assigned to each row for identification. ( <a href="#">meta_record</a> )	
<input checked="" type="checkbox"/>	<input type="radio"/>	Source			(i) Source Identifier (ID) for identification. ( <a href="#">meta_record</a> )		
<input checked="" type="checkbox"/>	<input type="radio"/>	TransitID			Transit Identifier assigned to each transit. ( <a href="#">meta_id</a> )		
<input checked="" type="checkbox"/>	<input type="radio"/>	TimeG			d (n) Transit averaged G band flux (g_transit_flux) ( <a href="#">Note 2</a> ) (phot_flux;stat_mean;em_opt)		
<input checked="" type="checkbox"/>	<input type="radio"/>	FG			e-/s (n) Transit averaged G band flux (g_transit_flux) ( <a href="#">Note 2</a> ) (phot_flux;stat_mean;em_opt)		
<input checked="" type="checkbox"/>	<input type="radio"/>	e_FG			e-/s (n) Error on the transit averaged G band flux (g_transit_flux_error) (stat_error;phot_flux;stat_mean)		
<input type="checkbox"/>	<input type="radio"/>	RFG			(n) Transit averaged G band flux divided by its error (g_transit_flux_over_error) (arith_ratio)		
<input checked="" type="checkbox"/>	<input type="radio"/>	Gmag			mag (n) Transit averaged G band magnitude (converted from G band flux) (g_transit_mag) (phot_mag;stat_mean;em_opt)		
<input checked="" type="checkbox"/>	<input type="radio"/>	e_Gmag			mag (n) Error on transit averaged G band magnitude (converted from G band flux) (g_transit_mag_error) (stat_error;phot_mag;em_opt B)		
<input checked="" type="checkbox"/>	<input type="radio"/>	TimeBP			d (n) BP CCD transit observation time (Note 1) (time_epoch)		
<input checked="" type="checkbox"/>	<input type="radio"/>	FBP			e-/s (n) BP band flux (bp_flux) (phot_flux;stat_mean)		
<input type="checkbox"/>	<input type="radio"/>	Reset All	Clear		(n) indicates a possible blank or FGB column		(i) indexed column Submit
<input checked="" type="checkbox"/>	<input type="radio"/>	e_FBP			e-/s (n) Error on the BP band flux (bp_flux_error) (stat_error;phot_flux;stat_mean)		
<input type="checkbox"/>	<input type="radio"/>	RFBP			(n) BP band flux divided by its error (bp_flux_over_error) (arith_ratio)		
<input checked="" type="checkbox"/>	<input type="radio"/>	BPmag			mag (n) BP band magnitude (converted from BP band flux) (bp_mag) (phot_mag;stat_mean;em_opt B)		
<input checked="" type="checkbox"/>	<input type="radio"/>	e_BPmag			mag (n) Error on the BP band magnitude, added by CDS (bp_mag_error) (stat_error;phot_mag;stat_mean)		
<input checked="" type="checkbox"/>	<input type="radio"/>	TimeRP			d (n) RP CCD transit observation time (Note 1) (time_epoch)		
<input checked="" type="checkbox"/>	<input type="radio"/>	FRP			e-/s (n) RP band flux (rp_flux) (phot_flux;stat_mean)		
<input checked="" type="checkbox"/>	<input type="radio"/>	e_FRP			e-/s (n) Error on the RP band flux (rp_flux_error) (stat_error;phot_flux;stat_mean)		
<input type="checkbox"/>	<input type="radio"/>	RFRP			(n) RP band flux divided by its error (rp_flux_over_error) (arith_ratio)		

Scale: TCB  
 Frame: BARYCENTER  
 Offset: 2455197.50  
 Uncertainty: 44

Scale: TCB  
 Frame: BARYCENTER  
 Offset: 2455197.50  
 Uncertainty: 5

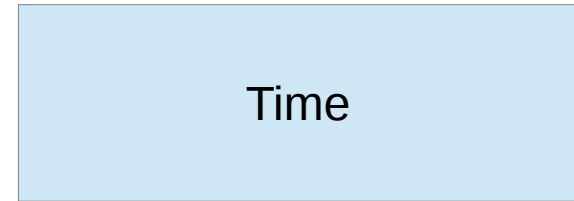
Scale: TCB  
 Frame: BARYCENTER  
 Offset: 2455197.50  
 Uncertainty: 5

# □ Time output



## Votable 1.4 in beta-release

- Use <TIMESYS>
- Gather columns related to the same time-column with GROUP
- Note: particular case for columns having a Coordinate+Time description



needs 2 ref. (<COOSYS>+<TIMESYS>)  
not possible yet with XSD schema : update asked..?

# Time

```
-<RESOURCE ID="yCat_1345" name="I/345">
<DESCRIPTION>Gaia DR2 (Gaia Collaboration, 2018)</DESCRIPTION>
-<TABLE ID="I_345_transits" name="I/345/transits">
-<DESCRIPTION>
  Calibrated FoV transit photometry for CU5, consolidated and provided by CU7 for variable stars in Gaia DR2 (epoch_phot)
</DESCRIPTION>
```

```
<TIMESYS ID="time_1" reposition="BARYCENTER" timeorigin="2455197.500000" timescale="TCB"/>
```

```
-<GROUP name="time-group" ref="time_1">
  <FIELDref ref="tab13_3">TimeG</FIELDref>
  <FIELDref ref="tab13_4">FG</FIELDref>
  <FIELDref ref="tab13_5">e FG</FIELDref>
  <FIELDref ref="tab13_7">Gmag</FIELDref>
  <FIELDref ref="tab13_8">e_Gmag</FIELDref>
</GROUP>
-<GROUP name="time-group" ref="time_1">
  <FIELDref ref="tab13_9">TimeBP</FIELDref>
  <FIELDref ref="tab13_10">FBP</FIELDref>
  <FIELDref ref="tab13_11">e FBP</FIELDref>
  <FIELDref ref="tab13_13">BPMag</FIELDref>
  <FIELDref ref="tab13_14">e_BPMag</FIELDref>
</GROUP>
-<GROUP name="time-group" ref="time_1">
  <FIELDref ref="tab13_15">TimeRP</FIELDref>
  <FIELDref ref="tab13_16">FRP</FIELDref>
  <FIELDref ref="tab13_17">e FRP</FIELDref>
  <FIELDref ref="tab13_19">RPMag</FIELDref>
  <FIELDref ref="tab13_20">e_RPMag</FIELDref>
</GROUP>
```

TIMESYS  
+  
group

 No DM  
available yet

```
<!-- Definitions of GROUPs and FIELDs -->
```

```
+<FIELD name="reco" ucd="meta.record" datatype="long" width="10" type="hidden"></FIELD>
+<FIELD name="Source" ucd="meta.id;meta.main" datatype="long" width="19"></FIELD>
+<FIELD name="TransitID" ucd="meta.id" datatype="long" width="17"></FIELD>
+<FIELD name="TimeG" ucd="time.epoch" ref="time_1" id="tab13_3" datatype="double" width="13" precision="8" unit="d"></FIELD>
+<FIELD name="FG" ucd="phot.flux;stat.mean;em.opt" id="tab13_4" datatype="double" width="15" precision="E8" unit="e/s"></FIELD>
+<FIELD name="e FG" ucd="stat.error;phot.flux;stat.mean" id="tab13_5" datatype="double" width="15" precision="E8" unit="e/s"></FIELD>
+<FIELD name="Gmag" ucd="phot.mag;stat.mean;em.opt" id="tab13_7" datatype="double" width="9" precision="6" unit="mag"></FIELD>
+<FIELD name="e_Gmag" ucd="stat.error;phot.mag;em.opt" id="tab13_8" datatype="double" width="9" precision="6" unit="mag"></FIELD>
+<FIELD name="TimeBP" ucd="time.epoch" ref="time_1" id="tab13_9" datatype="double" width="13" precision="8" unit="d"></FIELD>
+<FIELD name="FBP" ucd="phot.flux;stat.mean;em.opt.B" id="tab13_10" datatype="double" width="15" precision="E8" unit="e/s"></FIELD>
+<FIELD name="e FBP" ucd="stat.error;phot.flux;stat.mean" id="tab13_11" datatype="double" width="15" precision="E8" unit="e/s"></FIELD>
+<FIELD name="BPMag" ucd="phot.mag;stat.mean;em.opt.B" id="tab13_13" datatype="double" width="9" precision="6" unit="mag"></FIELD>
+<FIELD name="e BPMag" ucd="stat.error;phot.mag;stat.mean" id="tab13_14" datatype="double" width="12" precision="E5" unit="mag"></FIELD>
+<FIELD name="TimeRP" ucd="time.epoch" ref="time_1" id="tab13_15" datatype="double" width="13" precision="8" unit="d"></FIELD>
+<FIELD name="FRP" ucd="phot.flux.density;em.opt.R" id="tab13_16" datatype="double" width="15" precision="E8" unit="e/s"></FIELD>
+<FIELD name="e FRP" ucd="stat.error;phot.flux;stat.mean" id="tab13_17" datatype="double" width="15" precision="E8" unit="e/s"></FIELD>
+<FIELD name="RPMag" ucd="phot.mag;stat.mean;em.opt.R" id="tab13_19" datatype="double" width="9" precision="6" unit="mag"></FIELD>
-<FIELD name="e_RPMag" ucd="stat.error;phot.mag;stat.mean" id="tab13_20" datatype="double" width="12" precision="E5" unit="mag">
```

# □ Conclusion



- Different ways to expose data
- No possible to fit every table in DM due to the VizieR heterogeneity
- VizieR is open for all VOTable serialisation if meta-data are findable!  
→ not always available in literature !
- Each (new) meta-data (like Time, photometry, ObsCore for images/spectra) is a significant effort asked to CDS  
=> it has a cost!



→ Needs a method to associate columns in VOTable  
e.g. : error on columns, flags on columns...

## Enriched grammar suggestion applied on attributes in FIELDS

Associate columns with attributes : *is\_error\_of* , *is\_related\_to*...

- associate <FIELDS> together
- semantic to describe the <FIELDS> relationships

(grammar inspired from DOI XML schema : *is\_referenced\_to*, *is\_part\_of*...)

```
-<RESOURCE ID="yCat_18540158" name="J/ApJ/854/158">
+<DESCRIPTION></DESCRIPTION>
-<TABLE ID="J_ApJ_854_158_pgqsos" name="J/ApJ/854/158/pgqsos">
+<DESCRIPTION></DESCRIPTION>
+<FIELD name="Name" id="name" ucd="meta.id;meta.main" datatype="char" arraysize="11"></FIELD>
+<FIELD name="qPAH" id="qpah" ucd="phys.mass;arith.ratio" datatype="float" width="5" precision="2" unit="%"></FIELD>
+<FIELD name="e_qPAH" is_error_of="qpah" ucd="stat.error" datatype="float" width="5" precision="2" unit="%"></FIELD>
+<FIELD name="E_qPAH" is_upper_error_of="qpah" ucd="stat.error;stat.max" datatype="float" width="5" precision="2" unit="%"></FIELD>
+<FIELD name="l_logMd" is_limit_of="logmd" ucd="meta.code.error" datatype="char" arraysize="1"></FIELD>
+<FIELD name="logMd" id="logmd" ucd="phys.mass" datatype="float" width="5" precision="2" unit="[Msun]"></FIELD>
+<FIELD name="e_logMd" is_error_of="logmd" ucd="stat.error" datatype="float" width="5" precision="2" unit="[Msun]"></FIELD>
+<FIELD name="f_Name" is_flag_of="name" ucd="meta.code" datatype="char" arraysize="3"></FIELD>
+<FIELD name="Fj" id="fj" ucd="phot.flux.density;em.IR.J" datatype="float" width="5" precision="2" unit="mJy"></FIELD>
+<FIELD name="e_Fj" is_error_of="fj" ucd="stat.error" datatype="float" width="5" precision="2" unit="mJy"></FIELD>
+<FIELD name="FH" id="fh" ucd="phot.flux.density;em.IR.H" datatype="float" width="5" precision="2" unit="mJy"></FIELD>
+<FIELD name="e_FH" is_error_of="fh" ucd="stat.error" datatype="float" width="5" precision="2" unit="mJy"></FIELD>
```