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Alliance

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Abstract

The Object Visibility Simple Access Protocol (ObjVisSAP) is an IVOA Data Access protocol which defines the standard for retrieving object constraint-free visibility time intervals through a uniform interface within the VO framework for given object coordinates to be observed by a given Astronomical Observatory. The ObjVisSAP services can be registered in an IVOA Registry of Resources using the VOResource, Extension standard, having a unique ResourceIdentifier in the registry. The ObjVisSAP interface is meant to be reasonably simple to be implemented by service providers. A basic query will be done introducing a set of sky coordinates and a given time period (optional). The service returns a list of constraint-free visibility time intervals formatted as VOTable. Thus, an implementation of the service may support additional search parameters (some of which may be custom to that particular service) to more finely control the selection of the visibility periods. The specification also describes how the search on extra parameters has to be done.

Status of this document

This is an IVOA Working Draft for review by IVOA members and other interested parties. It is a draft document and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use IVOA Working Drafts as reference materials or to cite them as other than "work in progress".

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

Contents

Acknowledgments

The authors acknowledge the comments from Observatories members and from the IVOA members in general.

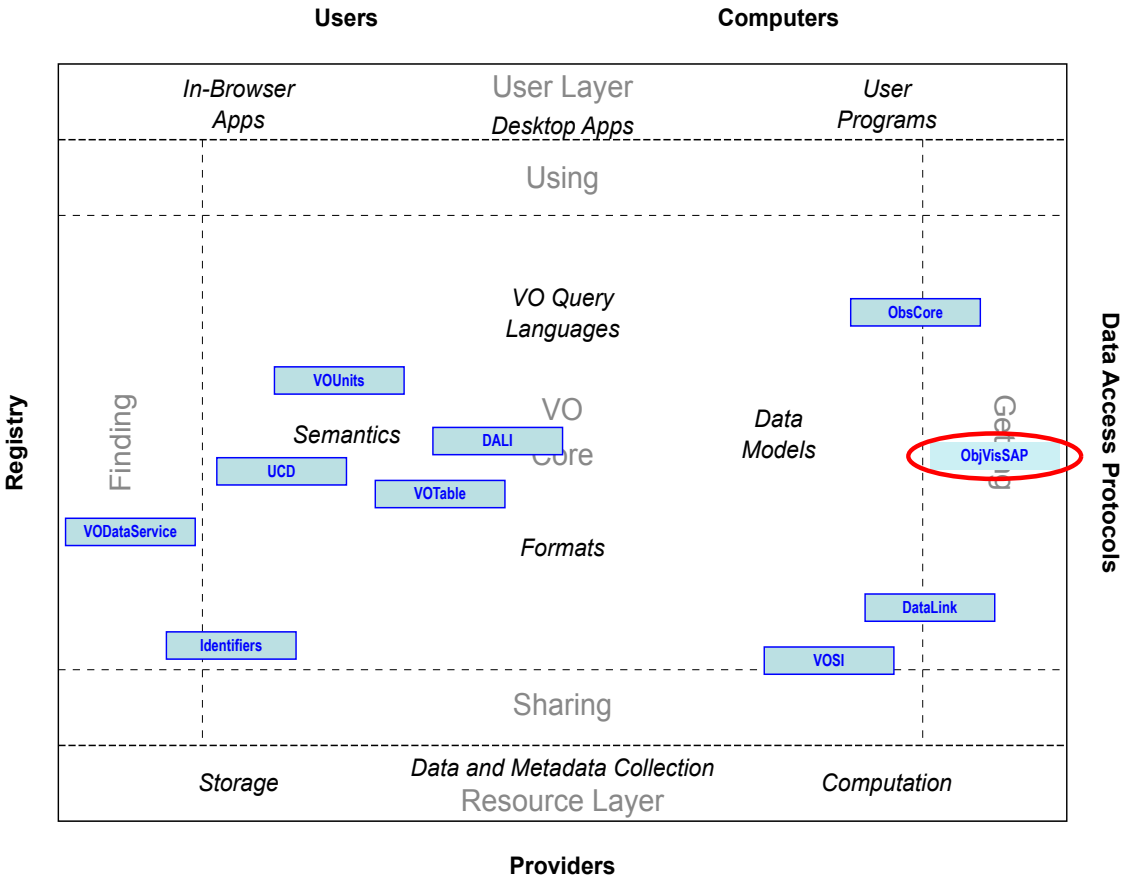
Conformance-related definitions

The words "MUST", "SHALL", "SHOULD", "MAY", "RECOMMENDED", and "OPTIONAL" (in upper or lower case) used in this document are to be interpreted as described in IETF standard RFC2119 ((Bradner, 1997)).

The *Virtual Observatory (VO)* is a general term for a collection of federated resources that can be used to conduct astronomical research, education, and outreach. The International Virtual Observatory Alliance (IVOA) is a global collaboration of separately funded projects to develop standards and infrastructure that enable VO applications.

Link to IVOA Architecture

The figure below shows where ObjVisSAP protocol fits within the IVOA architecture:


Users
Computers
In-Browser Apps
User Layer
Desktop Apps
User Programs
Using
VO Query Languages
ObsCore
VOUnits
Registry
Finding
Semantics
DALI
VO Core
Data Models
Getting
Data Access Protocols
UCD
ObjVisSAP
VOTable
VODataService
Formats
DataLink
Identifiers
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Sharing
Storage
Data and Metadata Collection
Resource Layer
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Providers

1 Introduction

The Object Visibility Simple Access Protocol (ObjVisSAP henceforth) specifies in a standard format the services to retrieve object visibility from astronomical observatories.

The ObjVisSAP interface has intentionally been made similar to the SSAP (Tody and Dolensky et al. (2012)) and SIAP v2.0 (Tody and Plante (2009)) through the adoption of current IVOA Data Access Layer Interface (DALI) and Observation Data Model Core Components (Louys and Bonnarel et al. (2011)) and its implementation in the Table Access Protocol. ObjVisSAP services also support VOSI-availability and VOSI-capabilities resources.

- queries encoded as URLs,
- the use of VOTable for encoding search results,
- the mechanism for handling errors, and
- the retrieval of service metadata.

1.1 The Role in the IVOA Architecture

ObjVisSAP specifies standardID values (Demleitner and Plante et al., 2015) for each capability, as defined by VODataService (Plante and Benson et al., 2008). ObjVisSAP services may be registered in an IVOA Registry using the SimpleDALRegExt (**?**) extension schema.

2 Requirements for Compliance

The object visibility query web method **MUST** be supported as in this section. Through this web method, clients search for visibility periods based on given sky coordinates and a time period (optional). The response is a VOTable that describes the constraint-free visibility time windows. Other output formats can be specified by the RESPONSEFORMAT parameter (see).

2.1 Compliance

The keywords **MUST**, **REQUIRED**, **SHOULD**, and **MAY** as used in this document are to be interpreted as described in RFC 2119.

An implementation is compliant if it satisfies all the **MUST** or **REQUIRED** level requirements for the protocols it implements. An implementation that satisfies all the **MUST** or **REQUIRED** level and all the **SHOULD** level requirements for its protocols is said to be "unconditionally

compliant"; one that satisfies all the **MUST** level requirements but not all the **SHOULD** level requirements for its protocols is said to be "conditionally compliant".

3 Resources

The purpose of the object visibility query is to allow users/clients to check if a given set of sky coordinates are visible for a given time period. We define " visible" as the time interval suitable to perform scientific observations. We therefore, leave to the observatories to define when exactly an object is visible for scientific observations.

The most basic query parameters will be the sky coordinates (Right Ascension and Declination), both coordinates must be expressed following the ICRS coordinate system and the start time and stop time for the visibility checks (optional). Any additional parameters may be used to customize the visibility checks.

The ObjVisSAP service have been designed to follow the DALI-sync specification.

resource type	**resource name**	**required**
{query}	service specific	yes
DALI-examples	/examples	no
VOSI-availability	/availability	yes
VOSI-capabilities	/capabilities	yes

Table 1: ObjVisSAP service resources

The ObjVisSAP service must have at least one {query} resource.

3.1 {query} resource

The {query} resource is a synchronous web service resource that follows the DALI-sync description . The name and the path of the resource is up to the implementer. The functionality to find the resource path will be implemented using the VOSI-capabilities resource.

As a DALI-sync resource, the parameters for a request may be submitted using an HTTP GET (query string) or POST action.

Object Visibility services advertise their availability as described in the DALI standard. This system must provide mechanisms to fully characterize the service, including its non-compulsory and additional parameters.

All parameters for the {query} resource are described below. Some of these parameters are **MANDATORY** and others not, depending on the astronomical facility characteristics. For example, **elevation** input parameter may only be used for ground-based observatories.

Parameters may appear in any order. If the same parameter appears multiple times in a request, the operation is undefined (if alternate values for a parameter are desired, the range-list syntax may be used instead). Parameter names are case-insensitive. Parameter values are case-sensitive unless defined otherwise in the description of an individual parameter.

The following subsections define reserved parameters. In addition to the description of the functional role the parameter plays in constraining a query, each definition also includes, when applicable, a UCD and/or UType that indicates the semantic meaning of the parameter. The UType names refer to those defined in the ObsCore Data Model .

Some of the parameters proposed in this standard are not described in the ObsCore Data Model document , such as; min_vis, max_vis, elevation, moon_sep. We tried to describe these parameters following the ObsCore standard.

3.1.1 Required parameters

A service must support the input parameters described in this section. That means that the service must accept them as valid ones without raising an error, and the parameters must be properly used to constrain the query.

As described in this section, the only mandatory parameters are the Right Ascension and Declination of the point in the sky to check for constraint-free time intervals. In this case, the service will return all possible time intervals where the point in the sky is visible. The time span covered by each astronomical observatory will depend on the characteristics of each scientific instrument. For example, time spam covered by ground based optical telescopes will be larger than time spam covered by Low Earth Orbit observatories, where the satellite orbital elements changes frequently.

- **MAXREC**
  MAXREC parameter is defined in DALI and allows the client to limit the number or records in the response. A service implementation may also impose default and maximum values for this limit. However, the limit is determined, if the output is truncated due to the limit the server must indicate this using an overflow (section 4.1) indicator except in the special case of MAXREC=0, where the service respond with metadata-only (normal output document with no records).

- **UPLOAD**
  DALI UPLOAD parameter is not used by this version of ObjVisSAP. The use case of uploading lists of coordinates is covered by the multiple-valued parameters values.

- **POS**
  Position in the sky to check the visibility. The coordinate values are

specified in list format (comma separated) with no embedded white space.
Example:

```
POS=52,-27.8
```

POS defaults to right-ascension and declination in decimal degrees in the ICRS coordinate system. This parameter has been defined in line with other IVOA S*APs protocols although the optional coordinate system has been removed for simplicity.

- **T_MIN**
  The service **MUST** support the **T_MIN** parameter, to specify the start time to check for object visibility. The **T_MIN** parameter has to be specified following ObsCore data model. The unit of **T_MIN** parameter must be expressed in MJD. If the query does not specify **T_MIN**, the service should default to NOW.

- **T_MAX**
  The service **MUST** support the **T_MAX** parameter, to specify the end time to check for object visibility. The **T_MAX** parameter has to be specified following ObsCore data model. The unit of **T_MAX** parameter must be expressed in MJD.
  to query for object visibility of the coordinate (10.68,41,27) and end

```
http://xmmvischeck.esac.esa.int:8080/objvissap/query?
POS=10.68,41.27&T_MAX=59522
```

time for the periods minor than 11-April-2021.

Calculation of the visibility by different observatories is only defined for a certain future time range. That implies that there could be **a T_MAX hard limit** defined by the service that could be smaller than the **T_MAX** value invoked by the client. If this is the case, the information of the use of this T_MAX hard limit MAY be included in a certain <INFO> VOTable tag in the service response like:

```
<INFO name="T_MAX_HARD_LIMIT" value="61231"/>
```

See *Successful Response* section for more info about valid VOTable responses.

3.1.2 Non-compulsory Parameters

The next list of non-compulsory parameters may be implemented on the server side. These parameters should be treated as reserved keywords.

- **VIS_MIN**
  A service **MAY** have a search parameter called **VIS_MIN**. This parameter would constrain the visibility check to those time periods with at least the minimum visibility specified in the parameter. The unit of **VIS_MIN** parameters must be expressed in seconds.

  Example: The input parameter listing below from the Object Visibility Simple Access Protocol shows that in addition to supporting the required parameters (POS, T_MIN, T_MAX), it also supports the free parameter VIS_MIN.

```
<?xml version="1.0" encoding="UTF-8"?>
<VOTABLE xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="xmlns:http://www.ivoa.net/xml/
VOTable/VOTable-1.1.xsd"
xmlns:ovdm="http://www.ivoa.net/xml/ObjectVisibilityDM/
ObjectVisibilityDM-v1.0.xsd" version="1.0">
<RESOURCE type="results">
<DESCRIPTION>
Object Visibility Simple Access Protocol
</DESCRIPTION>
<INFO name="QUERY_STATUS" value="OK"/>
<PARAM name="INPUT:POS" datatype="char" arraysize="*"
value="10.68">
<DESCRIPTION>
Specify the right ascension and declination coordinate.
To be specified in Equatorial Coordinates J2000.
</DESCRIPTION>
</PARAM>
<PARAM name="INPUT:T_MIN" ucd="time.start"
utype="Char.TimeAxis.Coverage.Bounds.Limits.StartTime"
datatype="double"
unit="d" value="58171.45833">
<DESCRIPTION>
Specify the Start Time to check for visibility.
To be specified in MJD.
</DESCRIPTION>
</PARAM>
<PARAM name="INPUT:T_MAX" ucd="time.end"
utype="Char.TimeAxis.Coverage.Bounds.Limits.StopTime" unit="d"
datatype="double" value="58321.958333">
<DESCRIPTION>
Specify the Stop Time to check for visibility.
To be specified in MJD.
</DESCRIPTION>
```

```
</PARAM>
<PARAM name="INPUT:VIS_MIN" ucd="time.duration"
utype="Char.TimeAxis.Coverage.Duration" unit="s"
datatype="double">
<DESCRIPTION> Minimum visibility interval interval
</DESCRIPTION>
</PARAM>
... ... ... ...
```

3.2 Availability: VOSI-availability

A web service with ObjVisSAP capabilities (Grid and Web Services Working Group, 2017) must have a VOSI-availability resource as described in DALI (Dowler and Demleitner et al., 2013).

3.3 Capabilities: VOSI-capabilities

A web service with ObjVisSAP capabilities must have a VOSI-capabilities resource as described in DALI. The standardID for the {query} capability is:

`ivo://ivoa.net/std/ObjVisSAP#query-0.3`

All DAL services must implement the */capabilities* resource. The following capabilities document shows the minimal metadata and does not require a registry extension schema:

```
<?xml  version="1.0"  encoding="UTF-8"?>
<vosi:capabilities
 xmlns:vosi="http://www.ivoa.net/xml/VOSICapabilities/v1.0"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:vs="http://www.ivoa.net/xml/VODataService/v1.1">
 <capability standardID="ivo://ivoa.net/std/VOSI#capabilities">
  <interface xsi:type="vs:ParamHTTP" version="1.0">
   <accessURL use="base">
     http://example.com/ObjVisSAP/capabilities
   </accessURL>
  </interface>
 </capability>
 <capability standardID="ivo://ivoa.net/std/VOSI#availability">
  <interface xsi:type="vs:ParamHTTP" version="1.0">
   <accessURL  use="full">
    http://example.com/ObjVisSAP/availability
   </accessURL>
  </interface>
```

```
 </capability>
 <capability standardID="ivo://ivoa.net/std/ObjVisSAP#query-0.3">
  <interface xsi:type="vs:ParamHTTP" role="std" version="0.3">
   <accessURL>
    http://example.com/ObjVisSAP/query
   </accessURL>
  </interface>
<!-- service details from extension schema could go here -->
 </capability>
</vosi:capabilities>
```

Note that the {query} resource does not have to be named as shown in the access URL(s) above.

4 {query} response

4.1 Successful Query

The response from a successful call to the {query} resource is a VOTable, or a different format following the RESPONSEFORMAT definition. The ObsCore data model specifies all the VOTable (Ochsenbein and Williams et al., 2013) field names, utypes, UCDs, and units to use in the response, as well as which fields must have values and which are allowed to be empty. The {query} response must contain the required ObsCore (Louys and Bonnarel et al., 2011) fields and may contain additional fields or custom fields from the service provider. Examples are provided in Section 5.

Successfully executed requests should result in a response with HTTP status code 200 (OK) and a response in the format requested by the client or in the default format for the service. The default output format is VOTable. Other output formats can be specified by the RESPONSEFORMAT parameter (Dowler and Demleitner et al., 2017).

The service should set the following HTTP headers to the correct values where possible.

Content-Type	mime-type of the response
Content-Encoding	encoding/compression of the response (if applicable)

Table 2: Recommended HTTP Response Headers

Since the {query} response is usually dynamically generated, the Content-Length and Last-Modified headers cannot usually be set.

The output returned by a ObjVisSAP service is a VOTable , an XML table format, returned with a MIME-type of "application/x-votable+xml".

The table lists all the visibility periods computed for the given coordinates and time period in the server. The following requirements are placed on the contents of the table when the query successfully returns a list of visibility periods:

1. The VOTable **MUST** contain a RESOURCE element identified with the tag type="results" should contain TABLE element which contains the results of the query. The VOTable is permitted to contain additional RESOURCE elements, but the usage of any such elements is not defined here. If multiple resources are present it is recommended that the query results be returned in the first resource element.

2. The RESOURCE element **MUST** contains an INFO element with name="QUERY_STATUS". Its value attribute should be set to "OK" if the query executed successfully, regardless of whether any visibility period for the given coordinates were found.

Examples:

```
<INFO name="QUERY_STATUS" value="OK">
<INFO name="QUERY_STATUS" value="OK">Successful Checks</INFO>
```

3. Each table row represents a different visibility period.

4. Each record of the output VOTable **MUST** contain value for each FIELD.

5. Every FIELD **SHOULD** contain a utype reference to the object visibility Data Model whenever possible.

6. A standard column **MUST** have a defined utype and a defined UCD as described in next section

7. A standard column could appear multiple times with different units. The way to uniquely identify one standard column is the following:

   - When a standard column can appear multiple times with the same utype but different units, the column is uniquely identified by its utype and unit.
   - Otherwise, a standard column is uniquely defined by its utype.

8. The VOTable **MUST** contain a reference to the OVDM namespace

```
xmlns:ovdm="http://www.ivoa.net/xml/ObjectVisibilityDM/
ObjectVisibilityDM-v1.0.xsd"
```

4.1.1 Standard output fields

A detailed reference of the data model can be found in Appendix A

- One field **MUST** have a name="**t_validity**" with utype=" **Char.TimeAxis.Coverage.Time**" with datatype="double" ucd="time.validity", unit="d" containing the date when the visibility calculations will change.

- One field **MAY** have a name="**validity_accuracy** " with datatype="char" and arraysize="*" containing the level of confidence of the validity range, with one of the following allowed values: HIGH, MEDIUM, LOW.

- One field **MAY** have a name=" **validity_predictor**" with datatype="char" and arraysize="*" with an identifier of the software used to calculate the visibility.

- One field **MUST** have a name="**t_start**" with utype="**Char.TimeAxis.Coverage.Bounds.Limits.StartTime**" with datatype="double" ucd="time.start", unit="d" containing the start visibility period.

- One field **MUST** have a name="**t_stop**" with utype="**Char.TimeAxis.Coverage.Bounds.Limits.StopTime**" , with datatype="double", ucd="time.end" and unit="d" containing the end visibility period.

- One field **MUST** have a name="**t_visibility**" with utype="**Char.TimeAxis.Coverage.Support.Extent**" , with datatype="double", ucd="time.duration" and unit="s", containing the visibility window duration in seconds.

- Exactly one field **MAY** have a name="**pos_angle** " with utype="**Char.SpatialAxis.Coverage.Location.Coord.Position2D.Value2.C3**" with datatype="double", ucd="pos.eq.pos_angle" and unit="deg" , containing the spacecraft position angle.

- Exactly one field **MAY** have a name="**em_min**" with utype="**Char.Spectral.Axis.Energy.Min**" with datatype="double", ucd="em.energy" and unit="keV" , containing the low energy bound for this particular sky position and visibility time interval.

- Exactly one field **MAY** have a name="**em_max**" with utype="**Char.Spectral.Axis.Energy.Max**" with datatype="double", ucd="em.energy" and unit="keV" , containing the high energy bound for this particular sky position and visibility time interval.

- Exactly one field **MAY** have a name=" **elevation_min**" with utype="**Char.Position.Axis.Min**" with datatype="double", ucd="angle.validity" and unit="degrees" , containing the minimum elevation for this particular sky position and visibility time interval.

- Exactly one field **MAY** have a name=" **elevation_max**" with utype="**Char.Position.Axis.Max**" with datatype="double", ucd="angle.validity" and unit="degrees" , containing the maximum elevation for this particular sky position and visibility time interval.

- Exactly one field **MAY** have a name=" **moon_sep_min**" with datatype="double", ucd="angle.validity" and unit="deg" , containing the minimum Moon separation for this particular sky position and visibility time interval.

- Exactly one field **MAY** have a name=" **moon_sep_max**" with datatype="double", ucd="angle.validity" and unit="deg" , containing the maximum Moon separation for this particular sky position and visibility time interval.

- Exactly one field **MAY** have a name=" **sun_sep_min**" with datatype="double", ucd="angle.validity" and unit="deg" , containing the minimum Sun separation for this particular sky position and visibility time interval.

- Exactly one field **MAY** have a name=" **sun_sep_max**" with datatype="double", ucd="angle.validity" and unit="deg" , containing the maximum Sun separation for this particular sky position and visibility time interval.

4.1.2 ObjVisSAP {query} Service Descriptor

The DataLink specification describes a mechanism for describing a service within a VOTable resource and recommends that services can describe themselves with a special resource with name="this". ObjVisSAP {query} responses should include a descriptor describing both standard and custom

query parameters (if applicable). The descriptor for a service with standard parameters (see 3.1) would be:

```
<RESOURCE type="meta" utype="adhoc:service" name="this">
<PARAM name="standardID" datatype="char" arraysize="*"
    value="ivo://ivoa.net/std/ObjVisSAP#query-0.3"/>
<PARAM name="accessURL" datatype="char" arraysize="*"
    value="http://example.com/ObjVisSAP/query"/>
 <GROUP name="inputParams">
  <PARAM name="s_ra" datatype="double" arraysize="*" unit="deg"/>
  <PARAM name="s_dec" datatype="double" arraysize="*" unit="deg"/>
  <PARAM name="t_min" datatype="char" arraysize="*" unit="d"/>
  <PARAM name="t_max" datatype="double" arraysize="*" unit="d"/>
  <PARAM name="min_vis" datatype="double" arraysize="*" unit="s"/>
  <PARAM name="max_vis" datatype="double" arraysize="*" unit="s"/>
 </GROUP>
</RESOURCE>
```

This VOTable resource should be included in the output from all queries; it is especially useful for MAXREC=0 queries since inclusion of the self-descriptor would mean that all inputs and outputs would be fully described

5 Output Example

```
<?xml version="1.0" encoding="UTF-8"?>
<VOTABLE xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:noNamespaceSchemaLocation="
xmlns:http://www.ivoa.net/xml/VOTable/VOTable-1.1.xsd"
xmlns:ssldm="http://www.ivoa.net/xml/
ObjectVisibilityDM/ObjectVisibilityDM-v1.0.xsd"
version="1.0">
<RESOURCE type="results">
<DESCRIPTION>
European Space Astronomy Centre. XMM-Newton SOC -
Object Visibility Simple Access Protocol (ObjVisSAP)
</DESCRIPTION>
<INFO name="QUERY_STATUS" value="OK"/>
<INFO name="SERVICE PROTOCOL" value="1.0">
ObjVisSAP
</INFO>
<INFO name="REQUEST" value="queryData"/>
<INFO name="POS" value="10.68, 41.27"/>
<INFO name="T_MIN" value="58171.45833"/>
```

```
<INFO name="T_MAX" value="58321.958333"/>
<TABLE>
<FIELD name="t_start" ucd="time.start"
utype="Char.TimeAxis.Coverage.Bounds.Limits.StartTime"
datatype="double" unit="s"/>
<FIELD name="t_stop" ucd="time.end"
utype="Char.TimeAxis.Coverage.Bounds.Limits.StopTime"
datatype="double" unit="s"/>
<FIELD name="t_visibility"
utype="Char.TimeAxis.Coverage.Support.Extent"
ucd="time.duration" datatype="double" unit="s"/>
<DATA>
<TABLEDATA>
<TR>
<TD>58297.123611</TD>
<TD>58297.436806</TD>
<TD>27036</TD>
</TR>
<TR>
<TD>58298.534028</TD>
<TD>58299.438194</TD>
<TD>78126</TD>
</TR>
... more lines data ...
</TABLEDATA>
</DATA>
</TABLE>
</RESOURCE>
</VOTABLE>
```

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Appendix A ObjVisSAP data model summary

Name	UTYPE	UCD	Description	DataType	Unit
t_validity	**Char.TimeAxis.Coverage.Time (MUST)**	time.validity	Date when the visibility calculation will change (MJD)	Double	d
validity_accuracy	**(MAY)**		Level of confidence of the validity range Accepted values= HIGH, MEDIUM, LOW	char, *	
validity_predictor	**(MAY)**		Identifier (string free representation) of the software used to calculate the visibility	char, *	
t_start	**Char.TimeAxis.Coverage.Bounds. Limits.StartTime (MUST)**	time.start	Visibility window start time (MJD)	double	d
t_stop	**Char.TimeAxis.Coverage.Bounds. Limits.StopTime (MUST)**	time.end	Visibility widow end time (MJD)	double	d
t_visibility	**Char.TimeAxis.Coverage. Support.Extent (MUST)**	time.duration	Visibility duration window	double	s
pos_angle	**Char.SpatialAxis.Coverage.Location. Coord.Position2D.Value2.C3 (MAY)**	pos.eq.pos_angle	Satellite position angle	double	deg
em_threshold	**Char.Spectral.Axis.Energy.Threshold (MAY)**	em.energy	Energy threshold for this particular sky position and visibility time interval	double	keV
target_name	**Target.Name (MAY)**	meta.id;src	Target Name	string	unitless
em_min	**Char.Spectral.Axis.Energy.Min (MAY)**	em.energy	Energy minimum for this particular sky position and visibility time interval	double	keV
em_max	**Char.Spectral.Axis.Energy.Max (MAY)**	em.energy	Energy maximum for this particular sky position and visibility time interval	double	keV
elevation_min	**Char.SpatialAxis.Coverage. Extent.angular_distance (MAY)**	phys.angDist	Minimum elevation for this sky position and visibility time interval	double	deg
elevation_max	**Char.SpatialAxis.Coverage. Extent.angular_distance (MAY)**	phys.angDist	Maximum elevation for this sky position and visibility time interval	double	deg
moon_sep_min	**(MAY)**	phys.angDist	Minimum Moon separation for this sky position and visibility time interval	double	deg
moon_sep_max	**(MAY)**	phys.angDist	Maximum Moon separation for this sky position and visibility time interval	double	deg
sun_sep_min	**(MAY)**	phys.angDist	Minimum Sun separation for this sky position and visibility time interval	double	deg
sun_sep_max	**(MAY)**	phys.angDist	Maximum Sun separation for this sky position and visibility time interval	double	deg