Configure XML Definition

Project name WEAVE

Release Draft/~~Final:~~ Version 0.20
Date: 7th November 2017

Author(s):	D Terrett
Owner:	Kevin Middleton
Client:	WEAVE Consortium
Document Number:	WEAVE-ICD-025

Document History

Document Location	Printed on Tuesday, 07 November 2017. The document can be found at : http://www.ing.iac.es/bscw/bscw.cgi/.....

Revision History

Revision date	**Version**	**Summary of Changes**	**Changes marked**
11-Dec-13	0.10	Document created	
24-Oct-14	0.11	Added target brightness specification	**Error! Reference source not found.**, 3.3
		Corrected names of program and catalogue elements	3.6, **Error! Reference source not found.**
13-Mar-15	0.12	Add calibration target type and limits on calibration and sky fibres.	
11-May-15	0.13	Add source list	
02-Jun-15	0.14	Renamed program survey and survey program	
04-Apr-16	0.15	Renamed sky_goal to num_sky_fibres and removed max_sky. Add conditions and HA limits to configure output Add achieved RA/Dec of each fibre to positioner output Add units of focal plane coordinates Removed items not to relevant to the positioner	
04-Jan-17	0.17	Replaced "survey" by "program" in the configure element in the examples. Add configure_version and config_file_version Define target orientation Catalogue and exposure_time removed photometry element added to target Renamed id to targid obscontraints, dithering and offsets added	
23-March-17	0.18	Document the "x" and "y" target attributes Corrected the name of the "fibre" attribute	

31-May-17	0.19	max_guide attribute added	
07-Nov-17	0.20	max_sky reintroduced.	

Approvals This document requires the following approvals.

Name	Title	Approval Date	Issue Date	Version

Distribution This document has been distributed to:

Name	Title	Issue Date	Version

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1 INTRODUCTION

WEAVE is a new wide-field spectroscopy facility proposed for the prime focus of the 4.2m William Herschel Telescope. The facility comprises a new 2 degree field of view prime focus corrector with a 1000-multiplex fibre positioner, a small number of individually deployable integral field units, and a large single integral field unit. The IFUs and the MOS fibres can be used to feed a dual-beam spectrograph that will provide full coverage of the majority of the visible spectrum in a single exposure at a spectral resolution of ~5000 or modest wavelength coverage in both arms at a resolution ~20000. The instrument is expected to be on-sky by 2017 to provide spectroscopic sampling of the fainter end of the GAIA astrometric catalogue, chemical labelling of stars to V~17, and dedicated follow up of substantial numbers of sources from the medium deep LOFAR surveys.

1.1 Abbreviations

The abbreviations and acronyms used in this document can be found in WEAVE-MAN-001.

1.2 Purpose

The purpose of this document is to define the XML that is prepared by the survey teams to describe a field they wish to observe and then flows through the configure tool, the survey planning system, the fibre positioner and the observatory control system. Information that defines the assignment of fibres to targets and then actual configuration of the fibres is added at the appropriate stage. No information is deleted so that the document retains a complete history of the field configuration process.

The XML document is permitted to contain additional elements not described in this document and these will be preserved throughout the processing chain.

Those not familiar with XML should note that the names of elements and attributes are case-sensitive and must be exactly as shown in this document.

N.B. XML comments (anything delimitated by <!-- and --!>) are not formally part of the XML content and may be removed at the whim of an XML parser so should not be used for anything that need to be preserved by the processing chain.

This document uses the terms survey and program with very specific meanings.

A **program** is a set of fields that share a common set of scheduling criteria and spectrograph configuration.

A **survey** is a set of target objects that are being observed to satisfy some common scientific goal. A single field may contain targets from more than one survey and the targets from a single survey will typically appear in many different fields.

1.3 References

[1] WEAVE-MAN-001 Abbreviations and Definitions

2 INFORMATION FLOW

Each field that a survey preparation team want to observe will be described by an XML document that defines the RA and Dec of the field centre and lists all the candidate science targets and guide stars and defines the position and sizes of objects to be avoided when allocating sky background fibres. The list of science targets will, quite probably, not contain all the possible targets in the field in order to keep the run time and memory consumption of the configure tool within reasonable limits – the practical maximum number of targets (including sky samples) is likely to be around 2000.

Each target is defined by a target element that specifies the object's name, position, proper motions etc., the type of the target (science, sky or guide star), the name of the survey it comes from and a priority that is used when selecting the optimum fibre allocation.

The areas of sky to be avoided when searching for positions for background sky fibres is defined by a list of masks (called the avoidance list). The only type of mask currently supported is a circle; these are similar to targets but can also define a radius. If not specified, a radius of 3 arcsec is used. The configure tool can read a list of masks from a separate file containing just masks in which case the masks are added to the output file. Science and calibration targets are not automatically avoided so the avoidance list would normally include masks corresponding to all the targets.

The document is then processed by the configure tool and the identifier of the fibre allocated to the target added to each target definition.

The output from configure is then passed to the survey management system which will create a matching observation block and eventually schedule it for execution by the OCS. When the observation block is executed, the XML document is passed from the OCS to the fibre positioner. The positioner calculates the position of each fibre in the focal plane (taking account of the predicted zenith distance at the mid-point of the observation and current meteorological conditions) and adds it, and the actual position (as measured by the positioner robots after the fibre has been placed on the plate), to the document. When the configuration of the plate is complete, the document is passed back to the OCS which uses it to prepare the FITS headers for the images from the spectrographs.

3 INPUT TO CONFIGURE

The input to the configure tool is structured as follows: the document must contain an element named "observation" (which can, but need not, be the root element). The observation element must contain a child element named "configure" that defines the plate that the field should be configured for and other parameters that control the behaviour of the configure tool, an (optional) "surveys" element that lists the surveys that the targets come from and a "field" element that lists the targets.

Surveys are described by “survey” elements and targets by “target” elements.

All parameters are encoded as attribute values; there are no text elements defined.

Each element is described in detail in the following tables; more information on the way the configure tool uses the individual attributes can be found in the configure user manual. Not everything marked as mandatory is needs to be present for configure to run and so a file that is accepted by configure is not guaranteed to be accepted by the WEAVE observation preparation system. These are marked with * in the following tables.

3.1 observation element

Attribute name	Data type	Mandatory	Meaning	Default
name	string	No	observation name	*none*
program*	string	Yes	program name	*none*
ob_priority	float	No	observing block priority	1.0
obs_type	string	Yes	“MOS”,”mIFU” or “LIFU”	*none*

The observation name is an arbitrary character string to help identify the observation in printed reports, interactions between the survey preparation team and survey manager etc. Program names are allocated by the survey manager and are used to implicitly define things like the acceptable seeing limits, spectrograph configuration etc. needed to construct the observing schedule and configure the WEAVE instrument.

There should only be one observation element in the document. Any duplicates may be silently ignored.

3.2 obsconstaints element

Attribute name	Data type	Mandatory	Meaning	Default
seeing_max	float	No	maximum acceptable seeing (arcsec)	*none*
skybright_max	float	No	maximum acceptable sky brightness (mag/arcsec^2)	*none*
elevation_min	float	No	minimum acceptable elevation (deg)	0.0
moondist_min	float	No	minimum acceptable distance from the moon (deg)	0.0
transparency_min	float	No	minimum acceptable transparency	

			(0.0-1.0)	

3.3 dithering element

Attribute name	Data type	Mandatory	Meaning	Default
apply_dither	int	No	1 if dithering should be applied or 0 if not.	*none*

3.4 offsets element

Attribute name	Data type	Mandatory	Meaning
offset_in _ra	float	No	offset step in RA (arcsec)
offset_in_dev	float	No	offset step in declination (arcsec)

3.5 configure element

Attribute name	Data type	Mandatory	Meaning	Default
plate	string	Yes	plate name (PLATE_A or PLATE_B)	
num_sky_fibres	non-negative integer	No	Number of fibres to reserve for sky	50
max_calibration	non-negative integer	No	Maximum number of calibration stars to allocate fibre too	no limit
max_guide	non-negative integer	No	Maximum number of guide stars to allocate fibre too	8
max_sky	non-negative integer	No	Maximum number of sky fibres to allocate	no limit
maximum_gate_angle	float	No	Limit on the angle that a MOS fibre is allowed to bend.	14.1 deg

There should only be one configure element in an observation. Any duplicates may be silently ignored. Note, that once an observation has been processed by configure, the plate cannot be changed. If a survey team wants a field to be observable by either plate it will have to define two observations with the same field centre.

3.6 surveys element

The surveys element is just a container for surveys and has no attributes.

There should be either zero or one surveys element in an observation. Any duplicates may be silently ignored.

3.7 survey element

Attribute name	Data type	Mandatory	Meaning	Default
name*	string	Yes	survey name	
priority	float	No	survey priority	1.0
max_fibres	non-negative integer	No	Maximum number of fibres to allocate to this survey	no limit

The priority is used to scale the priorities of each target that belongs to the survey. This enables the relative priorities of different surveys to be adjusted in order to get the desired balance of targets without having to edit the priorities of every individual target.

3.1 conditions element

Attribute name	Data type	Meaning
epoch	float	Epoch as a Julian Year
ha	float	Hour Angle (hours) used in refraction calculations
temperature	float	temperature (K) used in refraction calculations
pressure	float	pressure (mBar) used in refraction calculations
relative_humidity	float	relative humidity used in refraction calculations
tlr	float	tropospheric lapse rate used in refraction calculations

The conditions element (if present) specifies the observing conditions to be used in configure's astrometric and refraction calculations. These can be overridden with command line arguments or from the GUI (except for the tropospheric lapse rate, temperature and humidity which have a negligible effect on the differential refraction).

3.2 field element

Attribute name	Data type	Mandatory	Meaning	Default
RA	string (hh mm ss.sss)	Yes	ICRS Right ascension of field centre	
Dec	string (+/-dd mm ss.ss)	Yes	ICRS Declination of field centre	

RA_d	float		ICRS Right ascension of field centre in degrees	
Dec_d	float		ICRS Declination of field centre in degrees	

There should only be one field element in an observation and must have either an RA and a Dec attribute or an RA_d and a Dec_d attribute but not both.
. Any duplicates may be silently ignored. The field element contains targets (which are candidates for fibre placements) and an "avoidance_list" which defines places that are to be avoided when positioning sky fibres.

3.3 target elements

Attribute name	**Data type**	**Mandatory**	**Meaning**	**Default**
name	string	No	target name	*none*
RA	string (hh mm ss.sss)		ICRS Right ascension of object	
Dec	string (+/-dd mm ss.ss)		ICRS Declination of object	
RA_d	float		ICRS Right ascension of object in degrees	
Dec_d	float		ICRS Declination of object in degrees	
epoch	float	No	epoch of observation	2015.0
pm_1	float	No	proper motion in RA in mas/yr	0.0
pm_2	float	No	proper motion in Declination in mas/yr	0.0
parallax	float	No	parallax in arcsec	0.0
use	string	No	"science", "calibration", "sky" "guide" or "mIFU"	science
survey	string	No	Survey name	*none*
priority	float	No	Target priority	1.0
targid	string	No	Target identifier	*none*
cname*	string	Yes	Target CNAME	*none*

A target must have either an RA and a Dec attribute or an RA_d and a Dec_d attribute but not both.

The survey name can be omitted if the target is common to all the surveys in the observation (as is normally the case for guide stars, calibration stars and sky positions) otherwise it should name a survey defined in the surveys element.

The priority is used by the configure process. The higher the priority of a target the more likely it is to have a fibre allocated to it.

The id attribute is for internal use by the positioner software and is generated by configure.

Photometric data for a target can be specified in a photometry element.

3.4 photometry elements

Attribute name	Data type	Meaning	Default
mag_g	float	Magnitude estimate for the target in the SDSS(like) g band.	*none*
emag_g	float	The error in the magnitude estimate for the target in the SDSS(like) g band.	*none*
mag_r	float	Magnitude estimate for the target in the SDSS(like) r band	*none*
emag_r	float	The error in the magnitude estimate for the target in the SDSS(like) r band.	*none*
mag_i	float	Magnitude estimate for the target in the SDSS(like) i band	*none*
emag_i	float	The error in the magnitude estimate for the target in the SDSS(like) i band.	*none*
mag_gg	float	Gaia G band (available DR1)	*none*
emag_gg	float	Error on Gaia G band	*none*
mag_bp	float	Magnitude estimate for the target in the Gaia BP band	*none*
emag_bp	float	The error in the magnitude estimate for the target in the Gaia BP band.	*none*
mag_rp	float	Magnitude estimate for the target in the Gaia RP band	*none*

3.5 avoidance_list element

The avoidance list element contains mask elements that define areas of sky to be avoided when automatically placing sky fibres. The only shape of mask supported is a circle.

Configure can read an avoidance list from a separate file from the field definition and it will replace any existing list defined inside the field. When configure writes its output the list will be embedded in the field.

3.6 mask element

Attribute name	Data type	Mandatory	Meaning	Default
RA	string (hh mm ss.sss)		Right ascension of source	
Dec	string (+/-dd mm ss.ss)		Declination of source	
RA_d	float		ICRS Right ascension of source in degrees	
Dec_d	float		ICRS Declination of source in degrees	
epoch	float	No	Epoch of observation	2015.0
pm_1	float	No	proper motion in 1st axis	0.0
pm_2	float	No	proper motion in 2nd axis	0.0
parallax	float	No	parallax in arcsec	0.0
radius	float	No	radius of object (arcsec)	3.0

3.7 group element

A group element is used to group together a set of targets so that configure will only ever allocate one fibre to the group. This is typically used to define a group of close together sky targets.

4 OUTPUT FROM CONFIGURE

The document output by the configure tool is a copy of the input with a unique “id” attribute, generated internally by configure, added to each target.

A “fibre” attribute added to each target to which a fibre has been allocated.

An “x” and a “y” attribute containing the position of the target on the plate (mm) for the hour angle and atmospheric conditions the plate was configure for is added to each target.

The zenith distance is added to the “conditions” element.

An “hour_angle_limits” element that contains the hour angle limit that the configuration is valid for is added. These limits indicate the earliest and latest hour angle that the configuration can be used at without the repositioning of fibres due to refraction changes and field rotation causing any fibre collisions.

The field element may have additional sky targets added that have been created automatically by configure and missing attributes may get added set to their default values.

The version number of the configure program, its configuration file and the plate files are added to the configure element.

When run in batch mode, the number used to seed the random number generator used by the annealing is also added.

4.1 configure element

Attribute name	Data type	Meaning
configure_version	string	Configure program version number
config_file_version	string	Config file version number
plate_version	string	Plate definition version number
seed	integer	Random number seed

4.2 hour_angle_limits element

Attribute name	Data type	Meaning
latest	float	Latest HA (hours) that the field can be configured for without any fibre collision
earliest	float	Earliest HA (hours) that the field can be configured for without any fibre collision

5 OUTPUT FROM POSITIONER

When the positioner has finished configuring a plate it generates an XML document with a root element named “positioner_setup” which contains the entire document generated by configure plus a “fibres” element that contains “fibre” elements that describe the position etc. of every fibre and a “conditions” element describes the hour angle etc. used to calculate the fibre positions.

Note that the field orientation may be different from that in the configure element because small adjustments to the orientation are used to minimize the difference in fibre

positions between those calculated by configure for the nominal observing conditions and the positions calculated using the actual conditions.

5.1 fibres element

The fibres element is a container for fibre elements. It has no attributes.

5.2 fibre element

A fibre element describes the status and position of a fibre.

Attribute name	**Data type**	**Meaning**
id	integer	fibre identifier
enabled	integer	0 if the fibre has been disabled, 1 if it has not
type	string	the type of the fibre (Spectrograph or Guider)
target	integer	the identifier of the target the fibre has been allocated to
target_x	float	The x position (mm) on the plate of the target
target_y	float	The y position (mm) on the plate of the target
fibre_x	float	The x position (mm) of the fibre as measured by the positioner
fibre_y	float	The y position (mm) of the fibre as measured by the positioner
orientation	float	The orientation (deg) of the fibre with respect to the radial direction.
retries	integer	The number of times the fibre had to be re-positioned to get it within the position tolerance
RA	string	ICRS RA of the fibre as actually positioned
Dec	string	ICRS Declination of the fibre as actually positioned

Fibres that have not been allocated to a target (and are therefore parked) only have the id, enabled and type attributes.

Appendix A - Examples

These examples are for illustration only. They do not represent realistic configurations

5.3 Configure input example

```
<?xml version="1.0" encoding="utf-8" ?>
<observation name="tile 1" program="foo">
  <configure plate="PLATE_A" sky_goal="100", maximum_gate_angle=”10”/>
  <conditions ha="0" relative_humidity="0.2" tlr="0.0065"
              temperature="293" pressure="770"/>
  <surveys>
    <survey name="survey_one" priority="0.5” max_fibres="300"/>
    <survey name="survey_two" />
  </survey>
  <obsconstraints seeing_max="2.0" skybright_max="22.5
        elevation_min="20.0“ moondist_min="40"
        transparency_min="0.9"/>
  <dithering apply_dithering=“0"/>
  <offsets offset_step_ra=“1.0” offset_step_dec=“2.0”/>
<field RA="00 00 00.000" Dec="+60 00 00.00">
    <target name="UCAC4-020-123456" RA="23 46 16.931"
            Dec="+59 19 53.75" pm1="0.02" pm2="-0.1"
            priority="1" use="science" survey="survey_one"/>
    <target priority="1" RA="23 57 09.288" use="science"
            Dec="+59 40 27.19" name="target 2"
            pm1="0.0" pm2="0.0" survey="survey_two"/>
    <target RA="23 57 09.288" use="guide" Dec="+59 40 27.19"
            pm1="0.1" pm2="1.0" parallax="0.01"
      <photometry mag_g=”24” mag_r=”23.9”/>
    </target>
    <group>
      <target priority="1" RA="00 01 43.501" use="sky"
              Dec="+59 48 40.32" name="sky" />
      <target priority="1" RA="00 01 43.579" use="sky"
              Dec="+59 50 10.32" name="sky" />
    </group>
    <avoidance_list>
      <mask RA="23 45 30.0" Dec="+59 19 53.00">
      <mask RA="23 45 34.0" Dec="+59 18 53.22" radius="10.0">
    </avoidance_list>
  </field>
</observation>
```

5.4 Configure output example

```
<?xml version="1.0" encoding="utf-8" ?>
<observation name="tile 1" program="foo">
  <configure plate="PLATE_A" sky_goal="100", maximum_gate_angle=”10”/>
    <conditions ha="0" relative_humidity="0.2" tlr="0.0065"
                temperature="293" pressure="770"/>
    <hour_angle_limits earliest="-0.2" latest="0.25"/>
```

```
  <surveys>
    <survey name="survey_one" priority="0.5” max_fibres="300"/>
    <survey name="survey_two" />
  </surveys>
  <obsconstraints seeing_max="2.0" skybright_max="22.5
         elevation_min="20.0‟ moondist_min="40"
         transparency_min="0.9"/>
  <dithering apply_dithering=‟0"/>
  <field RA="00 00 00.000" Dec="+60 00 00.00">
    <target name="UCAC4-020-123456" RA="23 46 16.931"
            Dec="+59 19 53.75" pm1="0.02" pm2="-0.1"
            priority="1" use="science" survey="survey_one" id="1"
            fibre="123"> />
    <target priority="1" RA="23 57 09.288" use="science"
            Dec="+59 40 27.19" name="target 2"
            pm1="0.0" pm2="0.0" survey="survey_two" id="2"
            fibre="678"/>
    <target RA="23 57 09.288" use="guide" Dec="+59 40 27.19"
            pm1="0.1" pm2="1.0" parallax="0.01" id="3">
          <photometry mag_g=”24” mag_r=”23.9”
    </target>
<group>
      <target priority="1" RA="00 01 43.501" use="sky"
              Dec="+59 48 40.32" name="sky" id="4"/>
      <target priority="1" RA="00 01 43.579" use="sky"
              Dec="+59 50 10.32" name="sky" id="5"/>
    </group>
    <avoidance_list>
      <mask RA="23 45 30.0" Dec="+59 19 53.00">
      <mask RA="23 45 34.0" Dec="+59 18 53.22" radius="10.0">
    </avoidance_list>
  </field>
</observation>
```

5.5 Positioner output example

```
<?xml version="1.0" encoding="utf-8" ?>
<positioner_setup plate="PLATE_A" zenith_distance="70.0"
                  field_orientation="0.003">
  <conditions ha="-0.324" relative_humidity="0.27" tlr="0.0065"
              temperature="291" pressure="890"/>
  <observation name="tile 1" survey="foo">
    <configure plate="PLATE_A" sky_goal="100", program=”foo” ,
              maximum_gate_angle=”10”/>
      <conditions ha="0" relative_humidity="0.2" tlr="0.0065"
                  temperature="293" pressure="770"/>
      <hour_angle_limits earliest="-0.2" latest="0.25"/>
    <surveys>
      <survey name="survey_one" priority="0.5” max_fibres="300"/>
      <survey name="survey_two" />
    </surveys>
    <obsconstraints seeing_max="2.0" skybright_max="22.5
```

```
        elevation_min="20.0" moondist_min="40"
        transparency_min="0.9"/>
  <dithering apply_dithering="0"/>
  <offsets offset_step_ra="1.0" offset_step_dec="2.0"/>
  <field RA="00 00 00.000" Dec="+60 00 00.00">
      <target name="UCAC4-020-123456" RA="23 46 16.931"
              Dec="+59 19 53.75" pm1="0.02" pm2="-0.1"
              catalogue="UCAC4" priority="1" use="science"
              survey="survey_one" id="1" fibre="123"> />
      <target priority="1" RA="23 57 09.288" use="science"
              Dec="+59 40 27.19" name="target 2"
              pm1="0.0" pm2="0.0" survey="survey_two" id="2"
              fibre="678"> />
      <target RA="23 57 09.288" use="guide" Dec="+59 40 27.19"
              pm1="0.1" pm2="1.0" parallax="0.01"
              id="3">
          <photometry mag_g="24" mag_r="23.9"/>
        </target>
      <group>
        <target priority="1" RA="00 01 43.501" use="sky"
                Dec="+59 48 40.32" name="sky" id="4"/>
        <target priority="1" RA="00 01 43.579" use="sky"
                Dec="+59 50 10.32" name="sky" id="5"/>
      </group>

      <avoidance_list>

        <mask RA="23 45 30.0" Dec="+59 19 53.00">
        <mask RA="23 45 34.0" Dec="+59 18 53.22" radius="10.0">
      </avoidance_list>
  </field>
  </observation>
  <fibres>
    <fibre id="0" enabled="1" type="spectrograph"/>
    <fibre id="2" enabled="0" type="spectrograph"/>
    <fibre id="3" enabled="1" type="guider" target="3"
           target_x="100.130" target_y="346.262" fibre_x="100.137"
           fibre_y="346.260" retries="0" orientation="24.234"
           RA="23 57 09.2882" Dec="+59 40 27.197"/>
    <fibre id="3" enabled="1" type="spectrograph" target="1"
           target_x="130.130" target_y="546.262" fibre_x="130.137"
           fibre_y="546.260" retries="0" orientation="1.920"
           RA="23 46 16.9313" Dec="+59 19 53.755"/>
  </fibres>
</positioner_setup>
```