IRAM Information Flow

IRAM & Jérôme Pety

ASOV

Mar. 28th-29th 2023 - Paris

Towards a modern information flow at IRAM

Bits and pieces have been prepared for the last 15+ years.

Next step To nimbly glue all this together.

A manageable amount of additional resources (manpower, internet bandwidth) is required because of all the preparatory work.

This presentation Available bits and pieces with an emphasis on the current and future work.

Timescales Regular releases over the next 5 years. Additional IRAM manpower (1 software engineer) will speed things up.

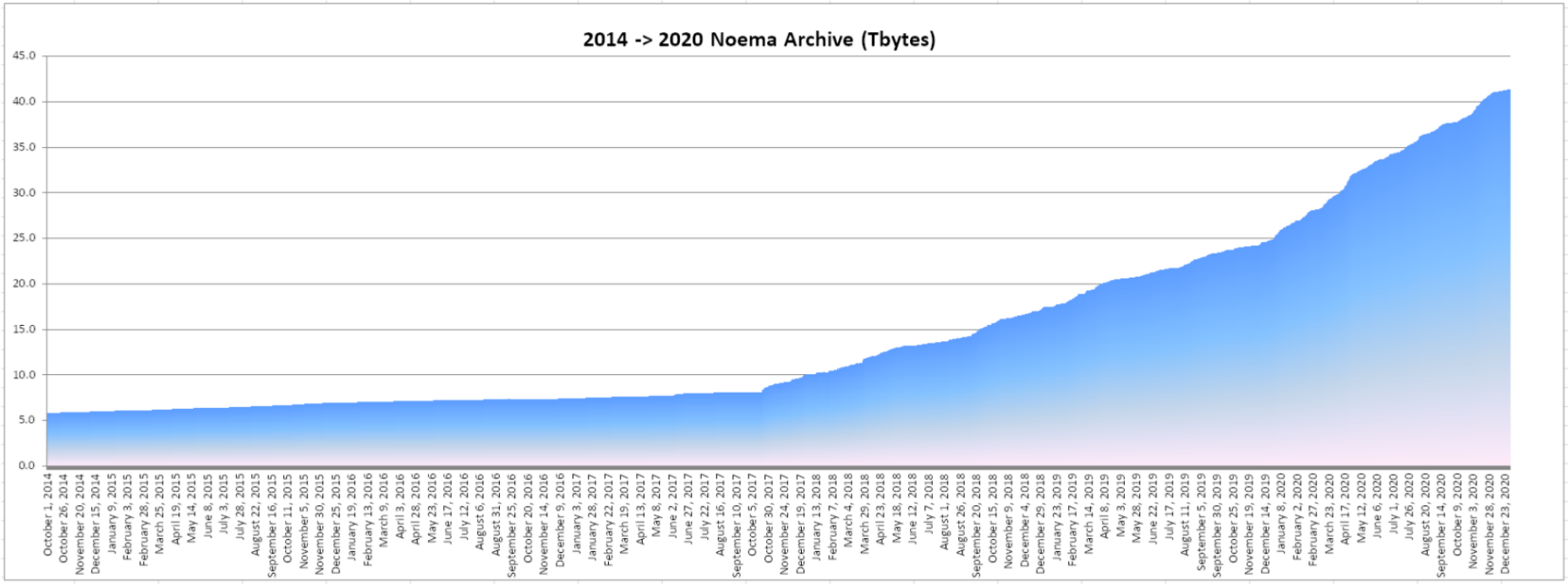
Data rates

NOEMA

Data rate about 40 TiB per year, still increasing.

30M

Data rate About 28 TiB per year.



Observation Management System: I. Goals

Handling of IRAM projects

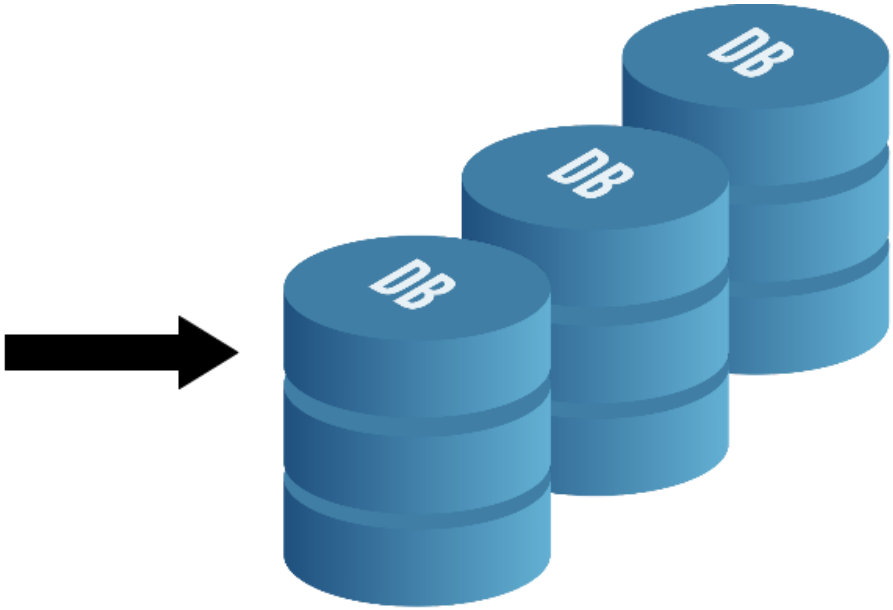
Proposals More than 200 proposals every 6 months.
Observations 24/24 hours, 7/7 days operation on 2 sites.

State before OMS

- Various independent prototypes developed by astronomers.
- Much manual housekeeping.

OMS aims

- Optimize the end-to-end handling of science projects.
- Gather and rationalize prototypes with new implementation by software engineers.
- Automate as many tasks as possible.
- Minimize maintenance and simplify upgrades $\Rightarrow$ keep room for innovation.



Observation Management System: II. Overview

Set of independent tools (databases)

- Multi-user environment.
- Factorized tools.
- Web interface with similar look and feel.
- Interfact with `GILDAS` astronomical engines.

Already in operation

Proposal Management System

- Proposal submission and program committee.
- NOEMA & 30m.

Setup Management System

- Preparation of observing procedures.
- NOEMA.

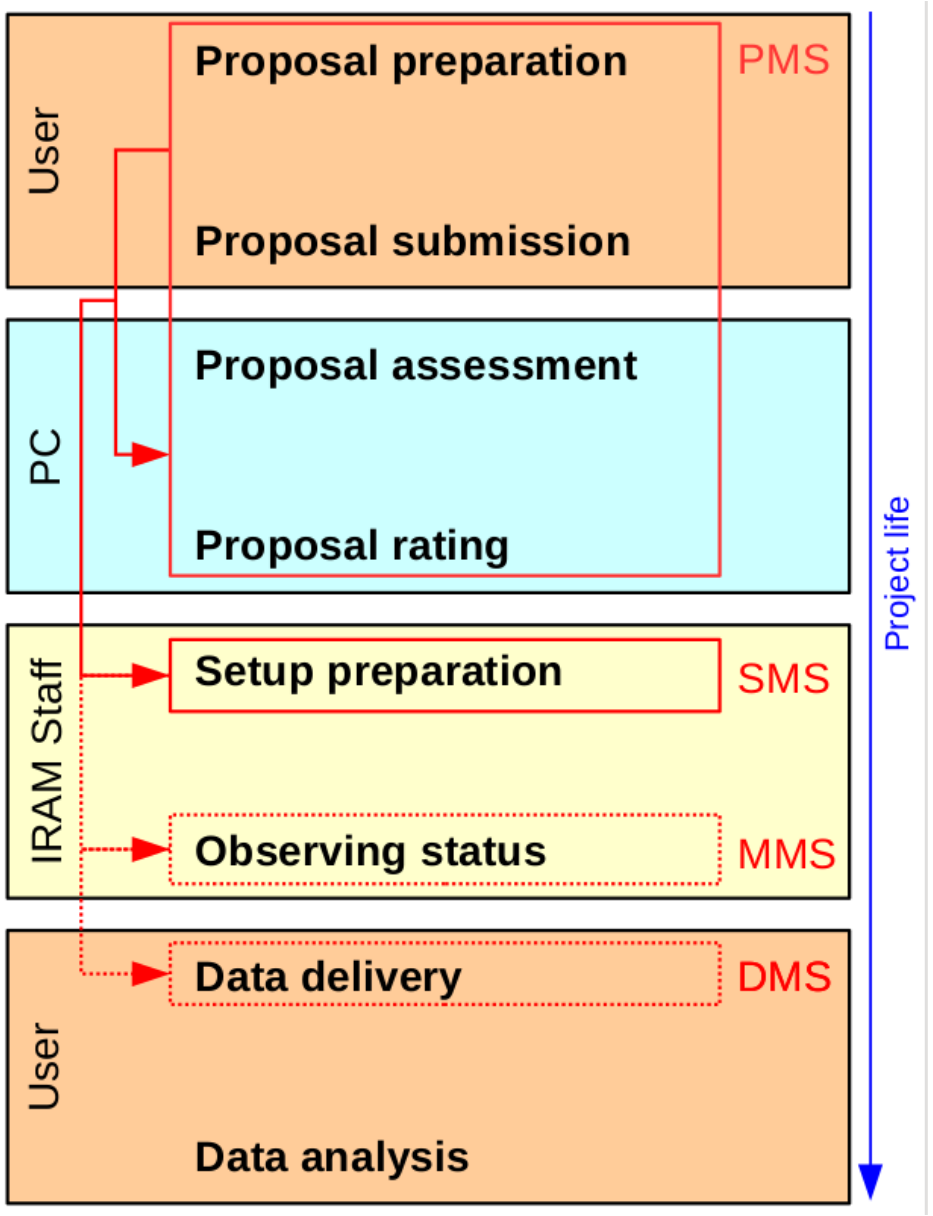
Monitoring Management System

- Schedule and monitor observations.
- 30m.

Existing prototypes that still need to be collected in the same professional framework.

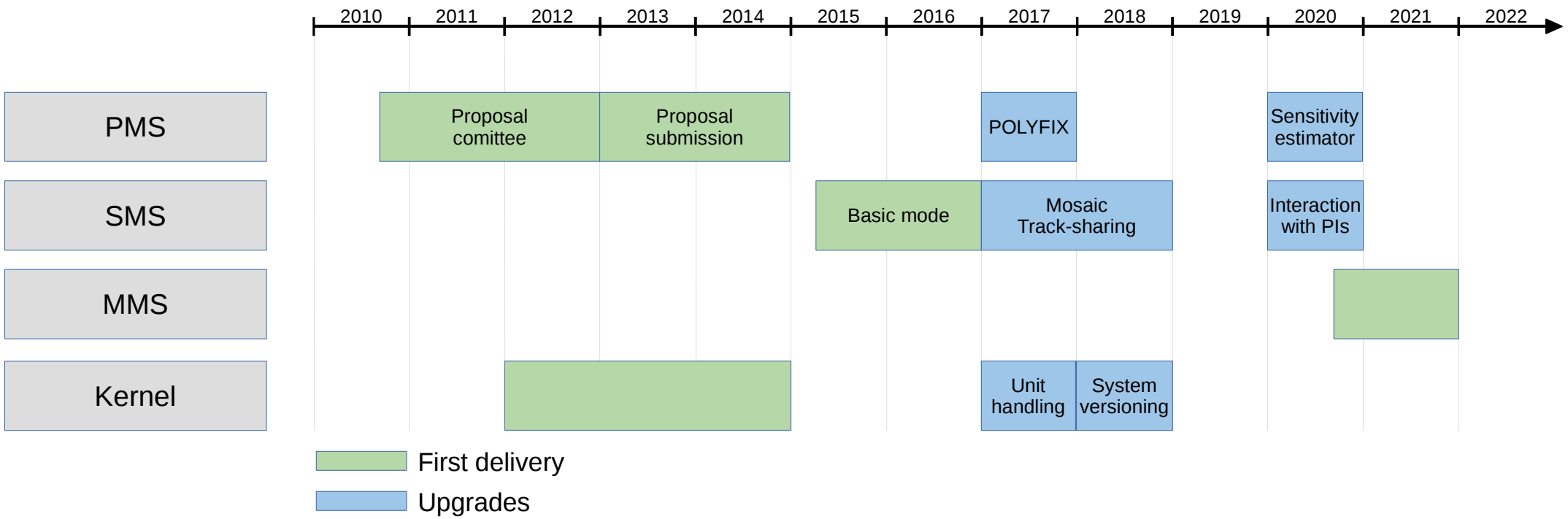
Data Management System

- Database of actual observations and associated calibration reports.
- Import and expand the searchable index on all completed observations currently existing at CDMS (Strasbourg).

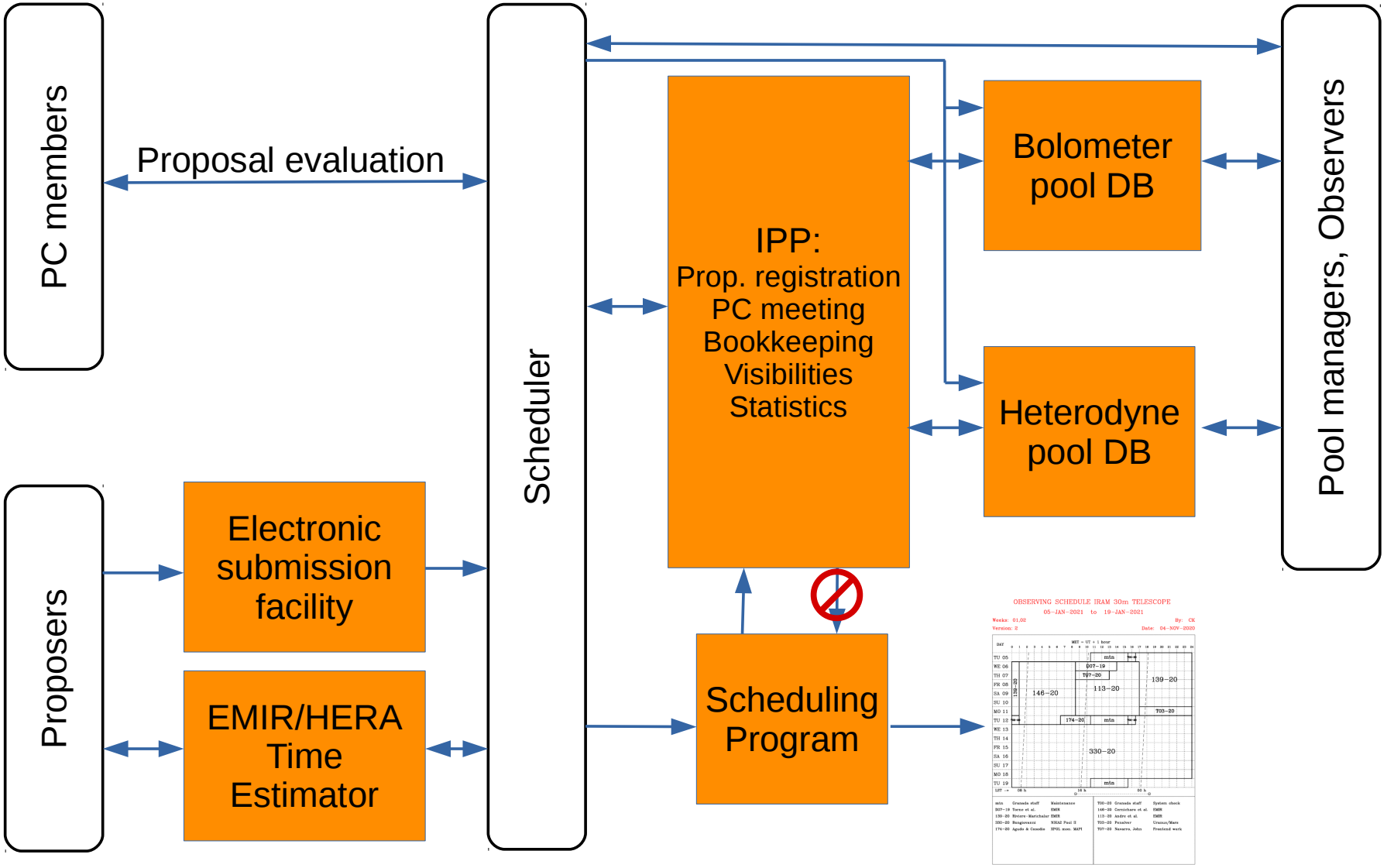


Observation Management System:

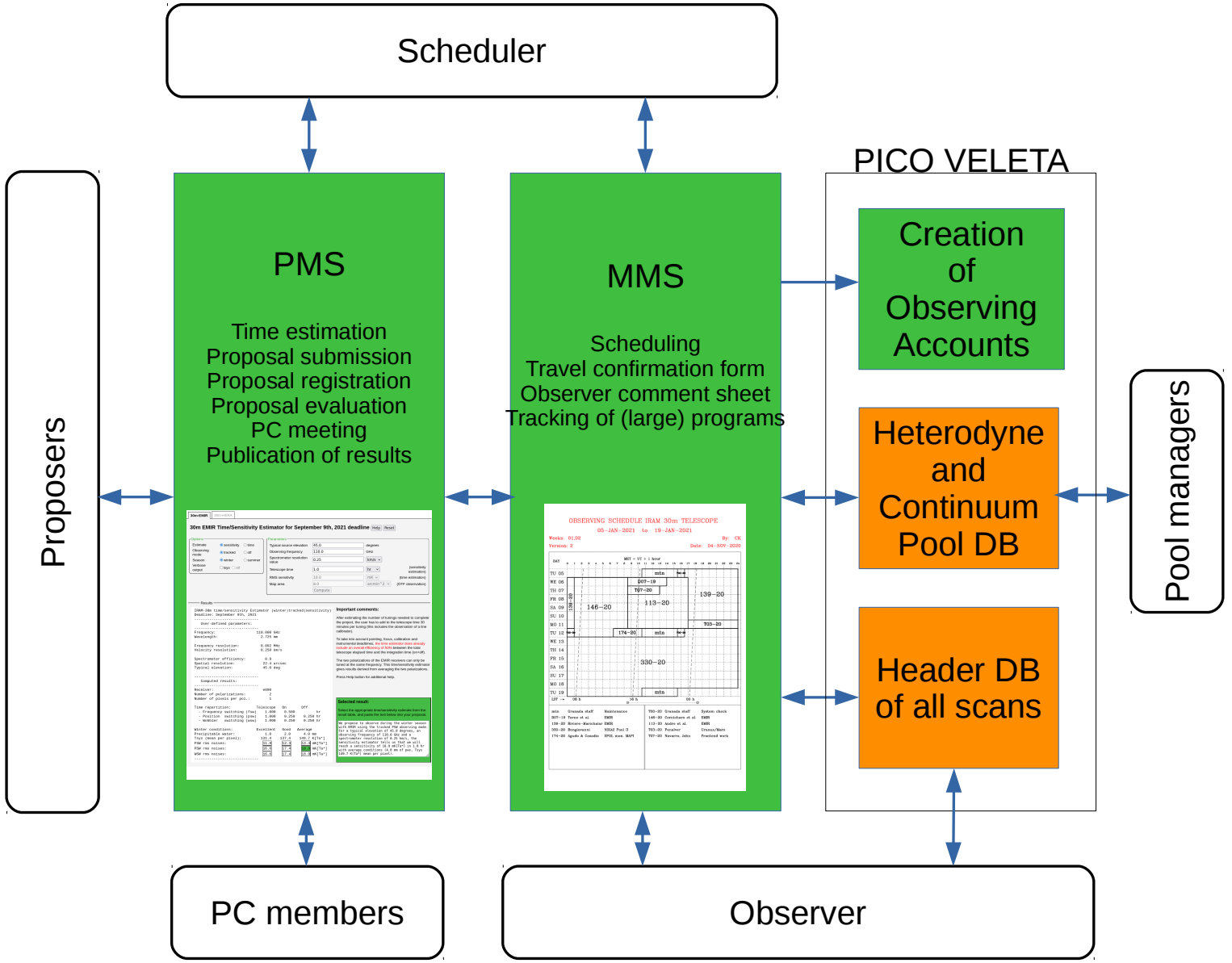
III. Timescales



30m status before OMS, ie, before 2010

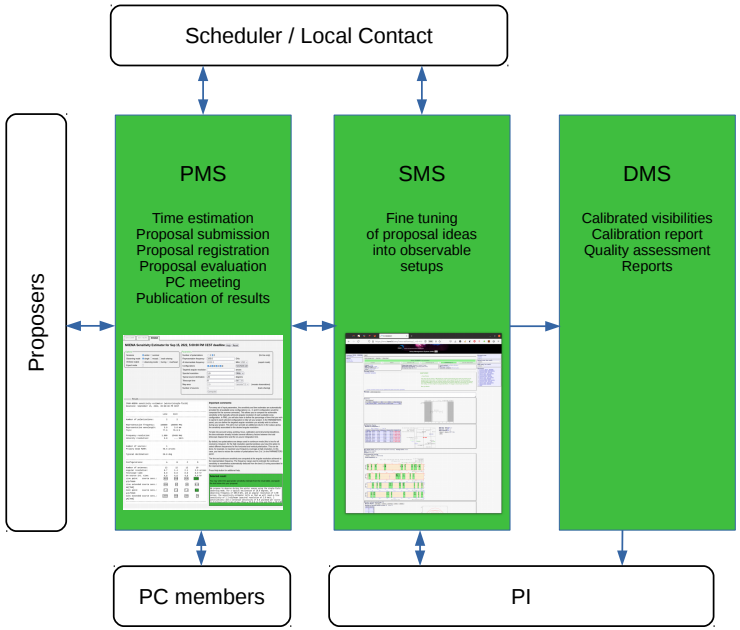


30m status at end of 2021

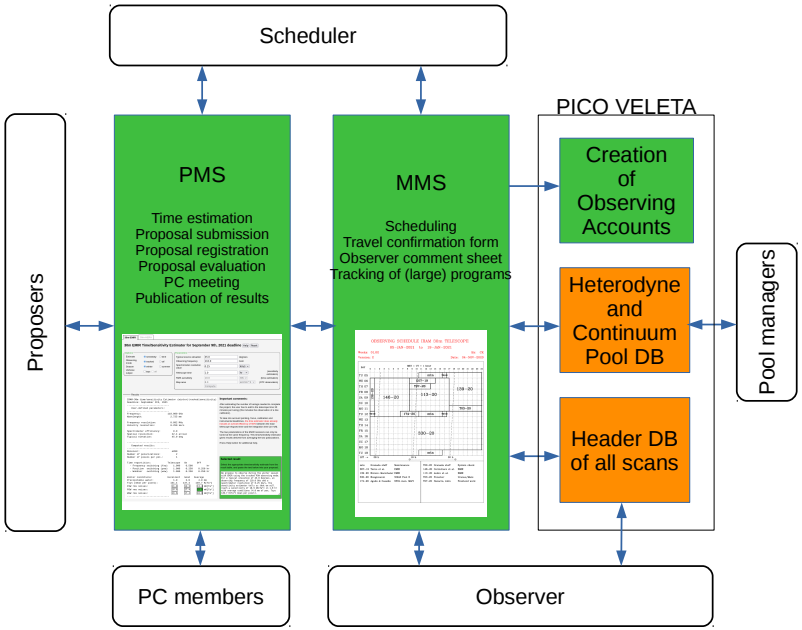


Two imbricated workflows

NOEMA

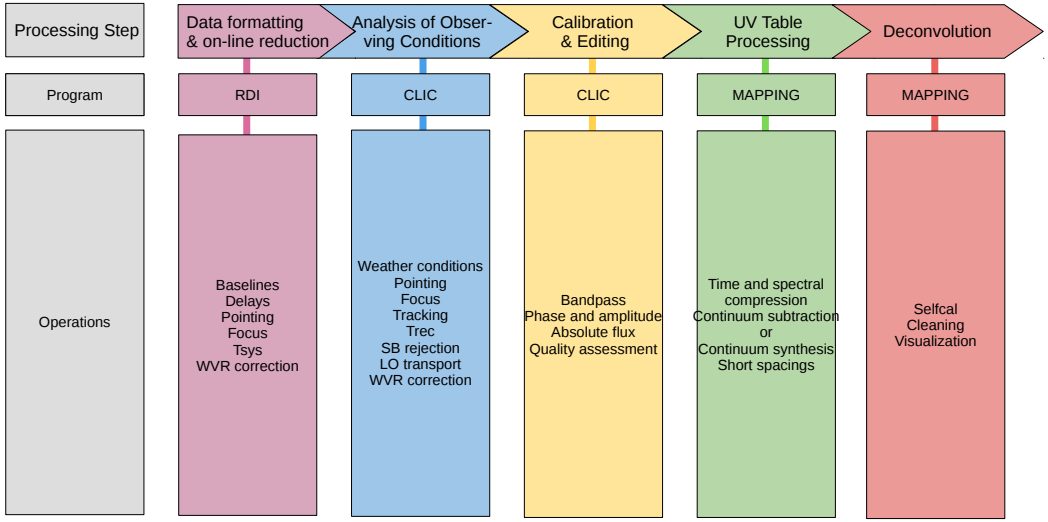


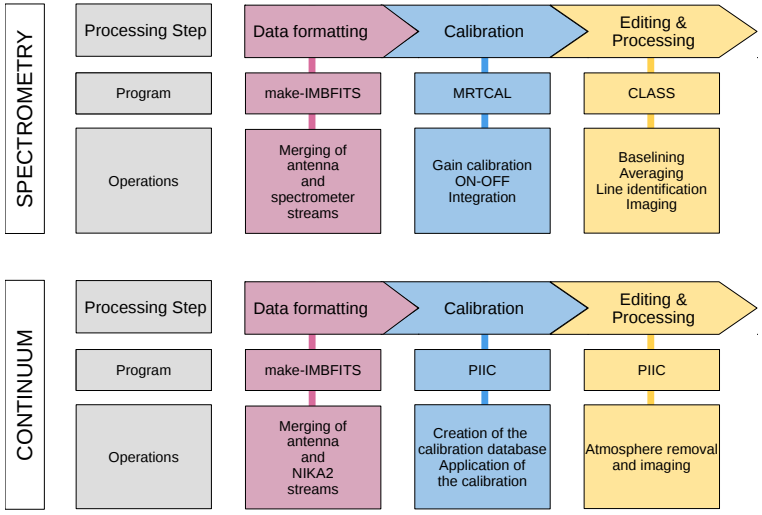
30M



Project

Data





Assessment and evaluation of data

NOEMA

Calibration and quality assessment pipeline reports are stored with the data.

30M

Observers are invited to log useful information.

Operators and AODs reports technical problems during the observations.

On-line calibration results are stored in TAPAS.

Continuum processing delivers a calibration database that is shipped with the software $\Rightarrow$ Automatic selection of good data.

Data formats

NOEMA

Raw data
IPB and HPB since 1990.
Calibrated data
UV tables since 1990.
Deconvolved data
LMV cubes in GDF since 1990?
⇒ **Institute-defined binary containers**
But final products can be easily converted into FITS files.

30M

Raw data
IMBFITS since 2007.
Calibrated spectral data
30m CLASS files since 1987.
Calibrated continuum data
FITS format since 2005.
⇒ **A combination of institute-defined and FITS binary containers**

All calibrated data can still be read today!
We are going towards using only FITS for science-ready data products.

Metadata, and data reuse

Metadata

- IRAM has documented and standardized metadata.
- IRAM ensures that all instruments comply with these standards.

Data reuse

- Standard procedures to get data from the archive.
- But it still requires human operations.

Data discovery, identification, interoperability

Data discovery

- A catalog of all IRAM observations is available at CDS.
- All NOEMA observation from 1990-on and all 30m observations from Oct. 2009 are available.
- IRAM Large Program Database IRAM will soon get a VO-compliant gateway.

Identification

- All data are tagged by their unique project number.
- IRAM recommends that the community cite the project number in publications.
- This number is not (yet) a digital object identifier (DOI).

Interoperability

- Automatic exchange of metadata between IRAM databases.
- Well-defined APIs that can be automatically tested when new functionality is added to one of the databases.

Data curation

Integrity and authenticity

- Archive mirroring.
- Checksum of files.
- Provider ID is checked for the submission of (large program) reduced products.

Data quality

- Once the raw data is stored, it is never edited to preserve integrity. Additional meta-data are archived in different data files to add a posteriori calibration information. These are automatically ingested by the software when reprocessing the raw data.
- At NOEMA, quality assessment is applied to all calibrated data and (only) good visibilities with detailed reports on the calibration and filtering are distributed to the PI.
- At the 30m, all observation comments are stored in a database.
- Work is being done to compare different versions of the processed data.
- No mechanism is (yet) provided to link articles using the data.

Infrastructure organization

Licenses

- No license. Is it a problem?

Confidentiality/Ethics

- Access to databases needs authentication. It is based on role (PI, local contacts, AODs, schedulers, ...)
- No other sensitive data.

Expert advise

- SAC.
- CDS advise for VO port ($\Rightarrow$ link with IVOA).

Continuity access

- IRAM partner agreement up to 2034.

Governance and business model

- IRAM has resources to acquire, process, and archive data.
- No complete business model yet for the FAIR distribution of data. But
  - One additional software engineer will be recruited.
  - IRAM participates in ACME proposal to next EU infrastructure call.

Sensitivity Estimation

30m-EMIR | 30m-HERA | **NOEMA**

NOEMA Sensitivity Estimator for Sep 9, 2021, 5:00:00 PM CEST deadline Help Reset

Options

Sessions: ◉ winter ○ summer
Observing mode: ◉ single ○ mosaic ○ track-sharing
Verbose output: ☐ observing mode ☐ tuning ☐ overhead
Expert mode: ☐

Parameters

Number of polarizations	○ 1 ◉ 2		(for line only)
Representative frequency	100.0	GHz	
At intermediate frequency	6000.0	MHz USB	(expert mode)
Configurations	☑ A ☑ C ☑ D	Uncheck all	
Targeted angular resolution		arcsec	
Spectral resolution	1.0	MHz	
Typical source declination	20	degrees	
Telescope time	8	hr	
Map area	2.0	arcmin^2	(mosaic observations)
Number of sources	1		(track sharing)
	Compute		

Results

```
IRAM-NOEMA sensitivity estimator (winter|single-field)
Deadline: September 09, 2021, 05:00:00 PM CEST

-------------------------------------------------------------
                               Line     Cont
-------------------------------------------------------------
Number of polarizations:          2        2

Representative frequency:    100000   100000 MHz
Representative wavelength:      3.0      3.0 mm
Tsys:                          77.6     76.9 K

Frequency resolution:         1.000    15488 MHz
Velocity resolution:            3.0      --- km/s
-------------------------------------------------------------

Number of sources:                1
Primary beam FWHM:             49.5 arcsec

Typical declination:           20.0 deg

-------------------------------------------------------------
Configurations:                   A        C        D
-------------------------------------------------------------
Number of antennas:              11       11       11
Angular resolution:             1.0      2.0      3.9 arcsec
Telescope time:                 8.0      8.0      8.0 hr
On-source int. time:            4.6      4.6      4.6 hr
Line point    source sens.:    1000     1000     1000 µJy/beam
Line extended source sens.:     120       30      8.0 mK[Tmb]
Cont point    source sens.:     7.9      7.9      7.9 µJy/beam
Cont extended source sens.:     970      240       64 µK[Tmb]
-------------------------------------------------------------
```

Important comments:

For every set of input parameters, the sensitivity and time estimates are automatically provided for all available array configurations (i.e., C and D configuration would be computed for the summer semester). This allows you to compare the achievable sensitivity at the typically achieved angular resolution of each available array configuration. In PMS, you will also have to define the percentage of time that you wish to spend in each selected configuration to fully set your project. In the PARAMETERS panel, you can define the targeted angular resolution you actually wish to achieve during your project. This will in turn provide an additional column in the output, giving the sensitivity associated to this desired angular resolution.

To take into account tuning, pointing, focus, calibration and instrumental deadtimes, the time estimator already includes several efficiency factors between the total telescope elapsed time and the on-source integration time.

By default, two polarizations are always used in continuum mode (this is true for all receivers). However, for the high resolution spectral windows you have the option to select different frequencies for the horizontal and vertical polarization. This can be done, for example, to maximize your frequency coverage at high resolution. In this case, you have to reduce the number of polarizations from 2 to 1 in the PARAMETERS panel.

The line and continuum sensitivity are computed at the angular resolution achieved at the representative frequency. The frequency range used to estimate the continuum sensitivity is nevertheless automatically deduced from the best LO tuning associated to the representative frequency.

Press Help button for additional help.

Selected result:

You may select the appropriate sensitivity estimate from the result table, and paste the text below into your proposal.

```
We propose to observe during the winter season using the single-field observing mode. For a typical declination of 20.0 degrees, an observing frequency of 100.0 GHz, and an angular resolution of 3.90 arcsec, the sensitivity estimator tells us that we will reach a line sensitivity of 1000 µJy/beam (spectral resolution of 3.0 km/s, 2 polarizations) and a continuum sensitivity of 7.9 µJy/beam per source in 8.0 hours with 5 mm of pwv (Tsys = 77.6 K in line and Tsys = 76.9 K in continuum).
```

Proposal Management System

History → Data Management System / Show programs / ORION-B / 124-16

Print | Save as PDF | Resubmit this proposal

Proposal 124-16 (pdf)

Title: ORION B: The anatomy of a Giant Molecular Cloud

PIs: Jérôme Pety, Maryvonne Gerin

CoIs: Emeric Bron, Viviana Guzman Veloso, Jan Orkisz, Sebastien Bardeau, Javier R. Goicoechea, Pierre Gratier, Franck Le Petit, François Levrier, Harvey Liszt, Karin Öberg, Nicolas Peretto, Evelyne Roueff, Albrecht Sievers, Pascal Tremblin

Total requested time: 550.0 (Emir)

Continuation: 019-13, 022-14, 145-14, 122-15, 018-16

Proposal history:

The proposal committee granted us about 300 hours of IRAM 30-meter time to map slightly more than 1.5 square degree in the western edge of the Orion B molecular cloud (projects 019-13, 022-14, 145-14, 122-15, and 018-16) from 72 to 80 GHz and 84 to 116 GHz, i.e., almost all the 3 mm band. A first set of 4 papers analyzing the data set acquired in 2013 and 2014 are either published or submitted. The first results were presented in the ISM symposium in Zermatt on September 2015, EWASS on July 2016, Exeter on August 2016, and we will continue to advertise them in the coming year. These works made high use of the number of detected species and the high spectral resolution. The region mapped up to now is strongly illuminated in far UV with a mean G0 = 45 (ISRF, Habing 1968), since massive stars illuminate the molecular cloud both from the outside and from the inside. The reached conclusions are thus biased towards such conditions. In order to broaden our conclusions, we now propose to observe the same frequency ranges in both filamentary structures (1.5 square degree) and translucent gas (another 1.5 square degree) that are in much quieter regions with a typical G0 ~ 4. This will help improve our understanding of the chemistry and physics at stake in the Orion B molecular cloud.

Abstract:

Molecular emission often provides the best and sometimes only constraints on the physical processes that govern star formation. Common molecules like CO (isotopologues), HCO+, HCN, N2H+, CH3OH, H2CO, DCO+, NDH+, DCN provide constraints on density, temperature and illumination structures. The utility of these molecular probes is currently limited, however, by lack of comprehensive data sets that connects emission patterns with small and large-scale physical structures quantitatively. To address this we have acquired a 3 mm spectral-image cube of the UV illuminated western edge of the Orion B molecular cloud. We here propose to extend the spatial coverage from 15 to 45% of Orion B, in order to sample the full range of physical conditions characterizing high-mass star forming regions, instead of being biased towards the high UV illumination of the western edge. The ultimate goal of this project is to develop Orion B as a template for galactic and extra-galactic studies by correlating chemical and physical structures across the full 3mm band. This will allows us to calibrate popular molecular probes, developing their full potential as tools to understand star formation, near and far.

Sources and setups

Sources: Download sources

Id [?]	Epoch	RA	DEC	Vlsr (km/s)
Horsehead	J2000	05:40:54.270	-02:28:00.000	10.5

Technical sheets:

Emir — Rec. time: 550.0 — Grade: A — view

Time: 550.00 hours

Frontend/Backend setups:

Setup	Band [?]	Species/Transition	Frequency [?] GHz	Receiver band [?]	T_A^* [?] mK	Rms [?] mK	ΔV [?] km/s	Backends [?]
1	E0 (3mm)	Any	76.5	LI	> 300.0	120.0	0.764	FTS200
2	E0 (3mm)	Any	90.0	LI	> 300.0	103.0	0.65	FTS200
3	E0 (3mm)	Any	97.5	LI	> 300.0	102.0	0.6	FTS200

Observing parameters:

Setup	Observing mode	Size X	Size Y	Switch mode	PWV [?] mm	Time [?] hours	Repetition [?]	Remark
1	OTF	103.9	103.9	PSw	4	130.0	1	
2	OTF	103.9	103.9	PSw	4	180.0	1	
3	OTF	103.9	103.9	PSw	4	220.0	1	

Number of receiver tunings: 40

Session: Winter 2016 - 30m

Proposal category: Large program

Scientific category: High-mass star formation, Intermediate-mass star formation, Low-mass star formation, Pre-stellar cores, Infra-Red Dark Clouds (IRDC), Astrochemistry, Inter-Stellar Medium (ISM)/Molecular clouds, Photon-Dominated Regions (PDR)/X-Ray Dominated Regions (XDR), HII regions

Scheduling constraints:

We definitely need stable weather and we thus ask to avoid foggy spring afternoons when the snow melts.

PI note:

This project is part of the PhD thesis of Jan Orkisz under the direction of Jérôme Pety and Maryvonne Gerin. Emeric Bron and Viviana Guzman are two post-docs who devote a significant fraction of their time on the project.

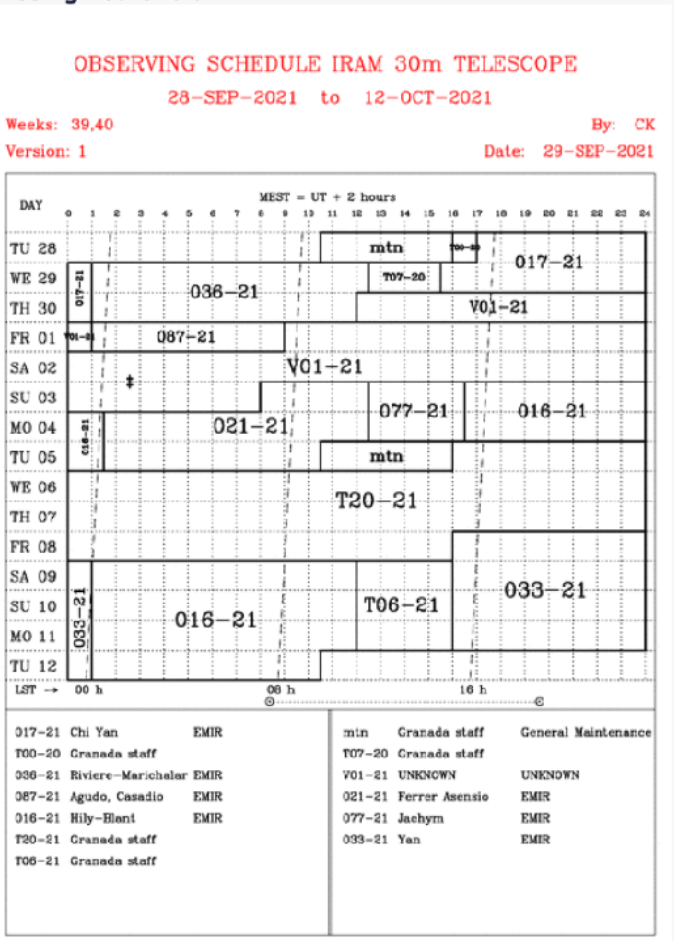
Date: 2016-09-15 12:26:36

Back

Monitoring Management System:
Scheduling a two-weeks period

Back | Previous | Next | Save as PDF | Create a scheduling unit | Add a marker | Update public version | Refresh graphic | Edit

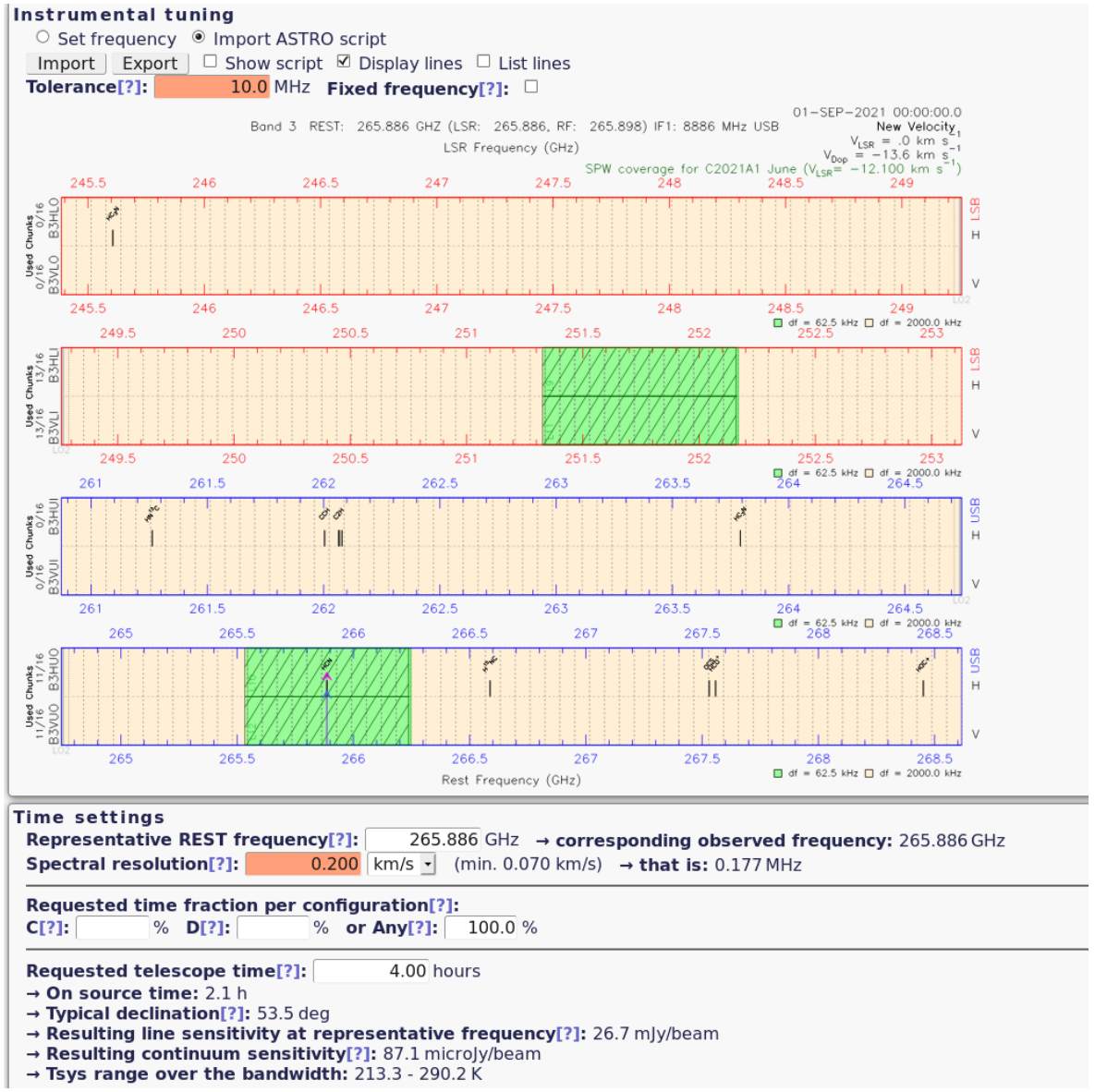
Sep 28 - Oct 12, 2021
From: 2021-09-28 10:30:00
To: 2021-10-12 10:30:00
Semester: Summer 2021
Comment: Imported from data/mms/sched30m/21/wk39v1.dat
Missing hours: 0.0



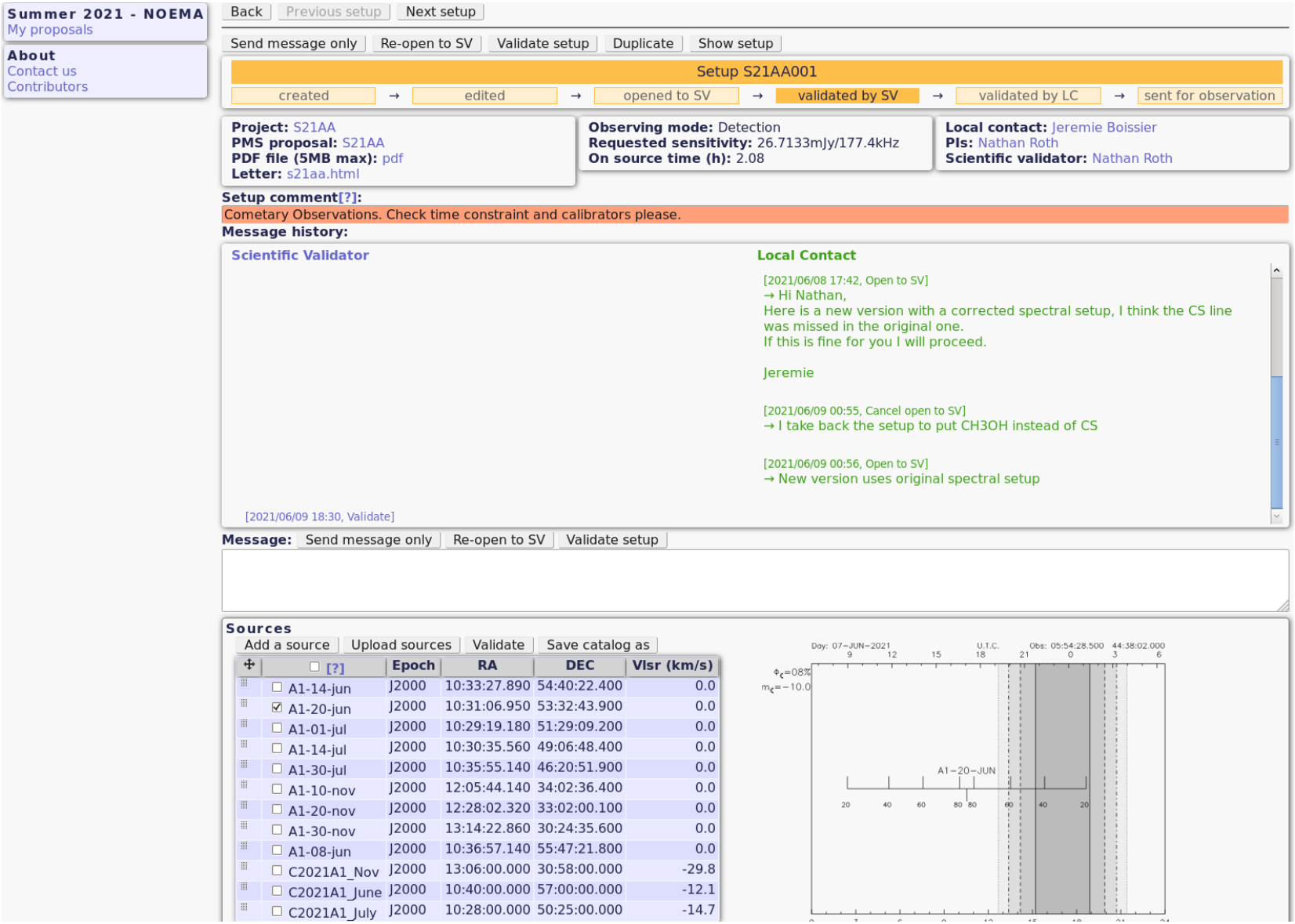
Scheduling units
Edit slots[?]:

Project↑	Unit	Hours	Status [?]	Observer	Observing mode	Funding	Mission sent [?]	
mtn	on Tuesday 28 (from 10:30 to 16:00)	5.5	Validated					edit/delete
	on Tuesday 5 (from 10:30 to 16:00)	5.5	Validated					edit/delete
016-21	from Sunday 3 (16:30) to Tuesday 5 (01:30)	18.0	Validated					edit/delete
	from Saturday 9 (01:00) to Tuesday 12 (10:30)	42.5	Validated					edit/delete
017-21	from Tuesday 28 (17:00) to Thursday 30 (01:00)	17.5	Validated					edit/delete
021-21	from Sunday 3 (08:00) to Tuesday 5	24.5	Validated					edit/delete

Setup Management System: Fine tuning



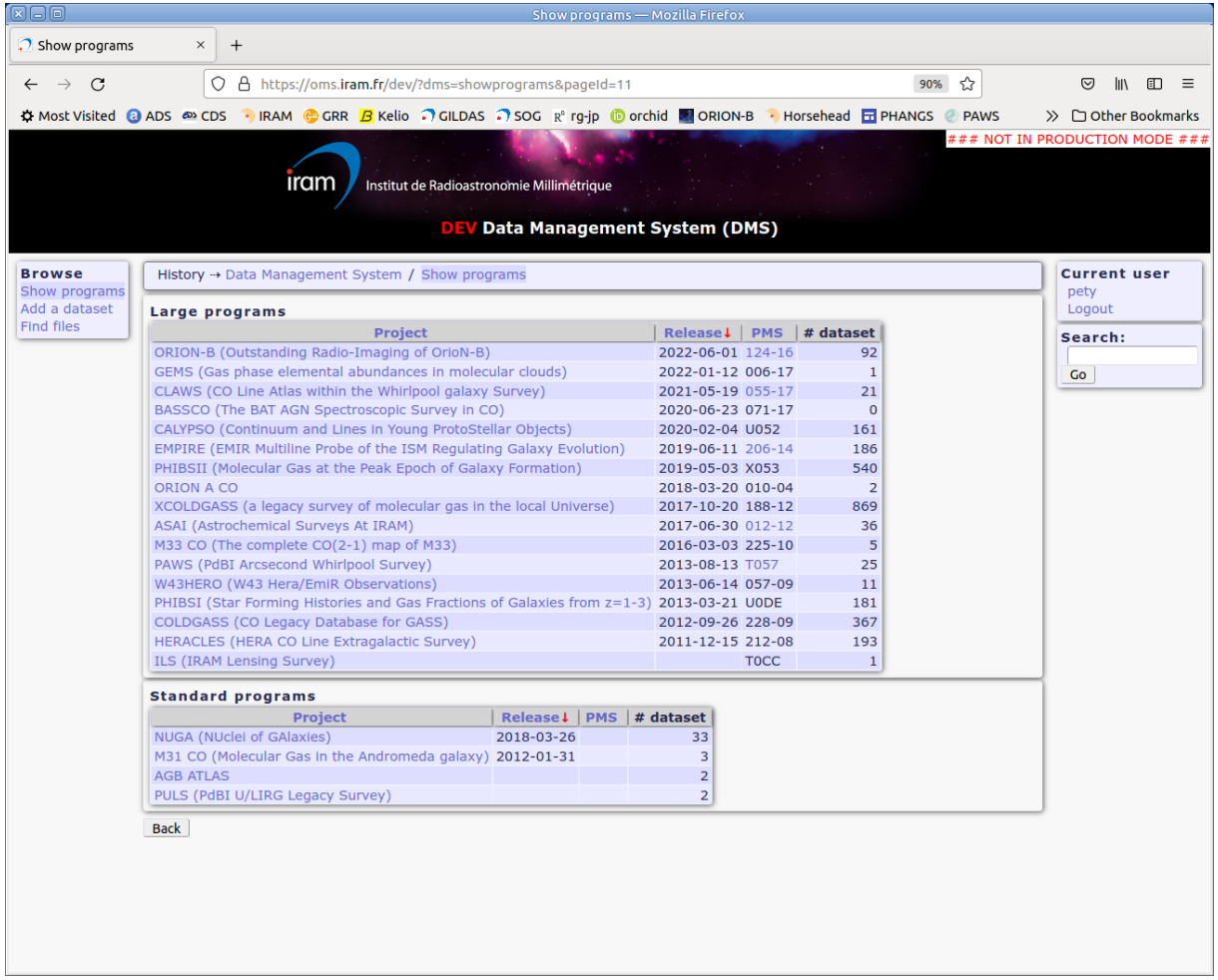
Setup Management System: Workflow
Local Contact - Scientific Validator - Scheduler



Next step: Data Management System

Indexation/visualization/distribution of data products

- First version will deliver science ready data products of completed IRAM Large Programs.
- Collaboration with Obs. de Paris to use the YAFITS tool.
- Started early 2021.
- To be delivered this year.



DMS: Search for “young stellar objects”

History ⇢ Data Management System / Find Files / Search

Projects:

Previous Next Expand First Last

Project	SMS project	Status	# dataset
ASAI (Astrochemical Surveys At IRAM)		created	36
CALYPSO (Continuum and Lines in Young ProtoStellar Objects)		created	161
W43HERO (W43 Hera/EmiR Observations)		created	11

Back

DMS: Search for “ISM”

History ⇢ Data Management System / Find Files / Search

Projects:

Previous Next Expand First Last

Project	SMS project	Status	# dataset
ORION-B (Outstanding Radio-Imaging of OrioN-B)		created	92
PAWS (PdBI Arcsecond Whirlpool Survey)		created	25

Back

DMS: Search for “M51”

History ⇢ Data Management System / Find Files / Search

Projects:

Previous Next Expand First Last

Project	SMS project	Status	# dataset
CLAWS (CO Line Atlas within the Whirlpool galaxy Survey)		created	21
EMPIRE (EMIR Multiline Probe of the ISM Regulating Galaxy Evolution)		created	186
PAWS (PdBI Arcsecond Whirlpool Survey)		created	25

Back

DMS: Search for “redshift”

History ⇢ Data Management System / Find Files / Search

Projects:

Previous Next Expand First Last

Project	SMS project	Status	# dataset
BASSCO (The BAT AGN Spectroscopic Survey in CO)		created	0
PHIBSII (Molecular Gas at the Peak Epoch of Galaxy Formation)		created	540
XCOLDGASS (a legacy survey of molecular gas in the local Universe)		created	869
PHIBSI (Star Forming Histories and Gas Fractions of Galaxies from z=1-3)		created	181
COLDGASS (CO Legacy Database for GASS)		created	367
ILS (IRAM Lensing Survey)		created	1
HERACLES (HERA CO Line Extragalactic Survey)		created	193

Back

DMS: Indexation based on standardized FITS and VO keywords

Fits header

SIMPLE	1
BITPIX	-32
NAXIS	3
NAXIS1	325
NAXIS2	434
NAXIS3	80
EXTEND	1
DATAMIN	-1.8345071
DATAMAX	65.57428
BUNIT	K (Tmb)
CTYPE1	RA---ARC
CRVAL1	85.226125
CDELT1	-0.002499999938946
CRPIX1	290.2036383598
CROTA1	14
CUNIT1	deg
CTYPE2	DEC--ARC
CRVAL2	-2.466666666667
CDELT2	0.002499999938946
CRPIX2	131.4116126225
CROTA2	14
CUNIT2	deg
CTYPE3	VRAD
CRVAL3	10500
CDELT3	500
CRPIX3	40.5
CROTA3	0
CUNIT3	m
OBJECT	ORION-B
RADESYS	FK5
RA	85.226125
DEC	-2.466666666667
EQUINOX	2000
ALTRPIX	40.5
ALTRVAL	115267164714.9
LINE	12CO(1-0)
RESTFREQ	115271202000
IMAGFREQ	92228430704.19
VELREF	257
SPECSYS	LSRK
BMAJ	0.008611110970294
BMIN	0.008611110970294
BPA	0
TELESCOP	30M
ORIGIN	GILDAS CUBE
DATE	2023-02-28T11:35:42.428

VO header

software_version	dev
dataproduct_type	cube
dataproduct_subtype	???
calib_level	3
access_format	image/fits
access_estsize	44078
target_name	ORION-B
s_ra	85.48280605537744
s_dec	-2.180881551542907
s_fov	1.351999714865601
s_region	ICRS (Polygon 86.0 -2.6 85.2 -2.8 85.0 -1.8 85.7 -1.6)
s_xel1	325
s_xel2	434
s_resolution	30.99999949305836
s_pixel_scale	8.999999780205600
em_ucd	em.freq
em_min	115263608058.9960
em_max	115278795941.0040
em_res_power	599584.9160000000
em_xel	80
pol_states	/I/
facility_name	IRAM

DMS: Workflow between PI team and IRAM to import dataset and document them

DMS: Automated link with proposal information

History → Data Management System / Show programs / ORION-B / 124-16

Print | Save as PDF | Resubmit this proposal

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The proposal committee granted us about 300 hours of IRAM 30-meter time to map slightly more than 1.5 square degree in the western edge of the Orion B molecular cloud (projects 019-13, 022-14, 145-14, 122-15, and 018-16) from 72 to 80 GHz and 84 to 116 GHz, i.e., almost all the 3 mm band. A first set of 4 papers analyzing the data set acquired in 2013 and 2014 are either published or submitted. The first results were presented in the ISM symposium in Zermatt on September 2015, EWASS on July 2016, Exeter on August 2016, and we will continue to advertise them in the coming year. These works made high use of the number of detected species and the high spectral resolution. The region mapped up to now is strongly illuminated in far UV with a mean G0 = 45 (ISRF, Habing 1968), since massive stars illuminate the molecular cloud both from the outside and from the inside. The reached conclusions are thus biased towards such conditions. In order to broaden our conclusions, we now propose to observe the same frequency ranges in both filamentary structures (1.5 square degree) and translucent gas (another 1.5 square degree) that are in much quieter regions with a typical G0 ~ 4. This will help improve our understanding of the chemistry and physics at stake in the Orion B molecular cloud.

Abstract:

Molecular emission often provides the best and sometimes only constraints on the physical processes that govern star formation. Common molecules like CO (isotopologues), HCO+, HCN, N2H+, CH3OH, H2CO, DCO+, N2D+, DCN provide constraints on density, temperature and illumination structures. The utility of these molecular probes is currently limited, however, by lack of comprehensive data sets that connects emission patterns with small and large-scale physical structures quantitatively. To address this we have acquired a 3 mm spectral-image cube of the UV illuminated western edge of the Orion B molecular cloud. We here propose to extend the spatial coverage from 15 to 45% of Orion B, in order to sample the full range of physical conditions characterizing high-mass star forming regions, instead of being biased towards the high UV illumination of the western edge. The ultimate goal of this project is to develop Orion B as a template for galactic and extra-galactic studies by correlating chemical and physical structures across the full 3mm band. This will allows us to calibrate popular molecular probes, developing their full potential as tools to understand star formation, near and far.

Sources and setups

Sources: Download sources

Id [?]	Epoch	RA	DEC	Vlsr (km/s)
Horsehead	J2000	05:40:54.270	-02:28:00.000	10.5

Technical sheets:

Emir — Rec. time: 550.0 — Grade: A — view

Time: 550.00 hours

Frontend/Backend setups:

Setup	Band [?]	Species/Transition	Frequency [?] GHz	Receiver band [?]	T_A^* [?] mK	Rms [?] mK	ΔV [?] km/s	Backends [?]
1	E0 (3mm)	Any	76.5	LI	> 300.0	120.0	0.764	FTS200
2	E0 (3mm)	Any	90.0	LI	> 300.0	103.0	0.65	FTS200
3	E0 (3mm)	Any	97.5	LI	> 300.0	102.0	0.6	FTS200

Observing parameters:

Setup	Observing mode	Size X	Size Y	Switch mode	PWV [?] mm	Time [?] hours	Repetition [?]	Remark
1	OTF	103.9	103.9	PSw	4	130.0	1	
2	OTF	103.9	103.9	PSw	4	180.0	1	
3	OTF	103.9	103.9	PSw	4	220.0	1	

Number of receiver tunings: 40

Session: Winter 2016 - 30m

Proposal category: Large program

Scientific category: High-mass star formation, Intermediate-mass star formation, Low-mass star formation, Pre-stellar cores, Infra-Red Dark Clouds (IRDC), Astrochemistry, Inter-Stellar Medium (ISM)/Molecular clouds, Photon-Dominated Regions (PDR)/X-Ray Dominated Regions (XDR), HII regions

Scheduling constraints:

We definitely need stable weather and we thus ask to avoid foggy spring afternoons when the snow melts.

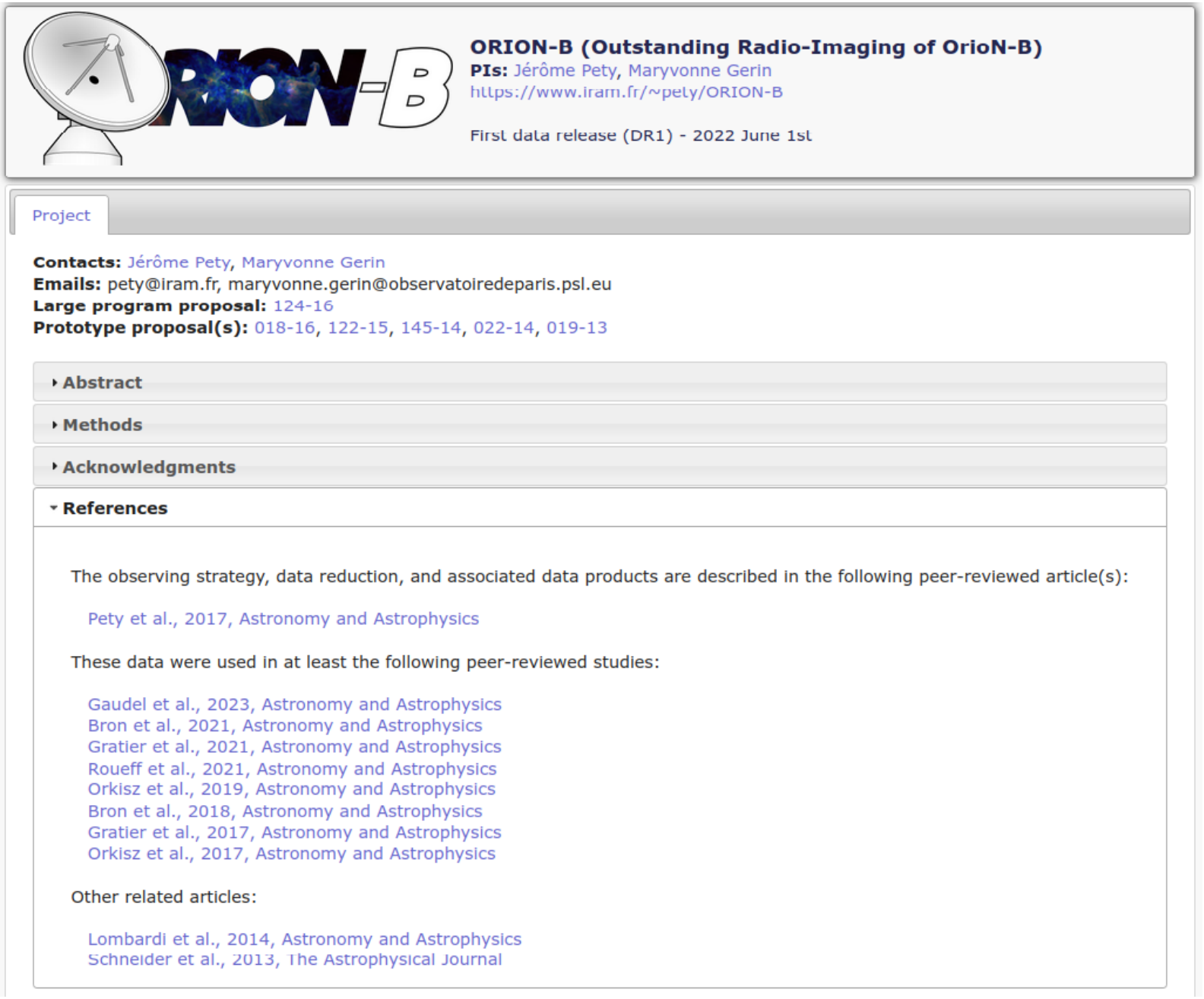
PI note:

This project is part of the PhD thesis of Jan Orkisz under the direction of Jérôme Pety and Maryvonne Gerin. Emeric Bron and Viviana Guzman are two post-docs who devote a significant fraction of their time on the project.

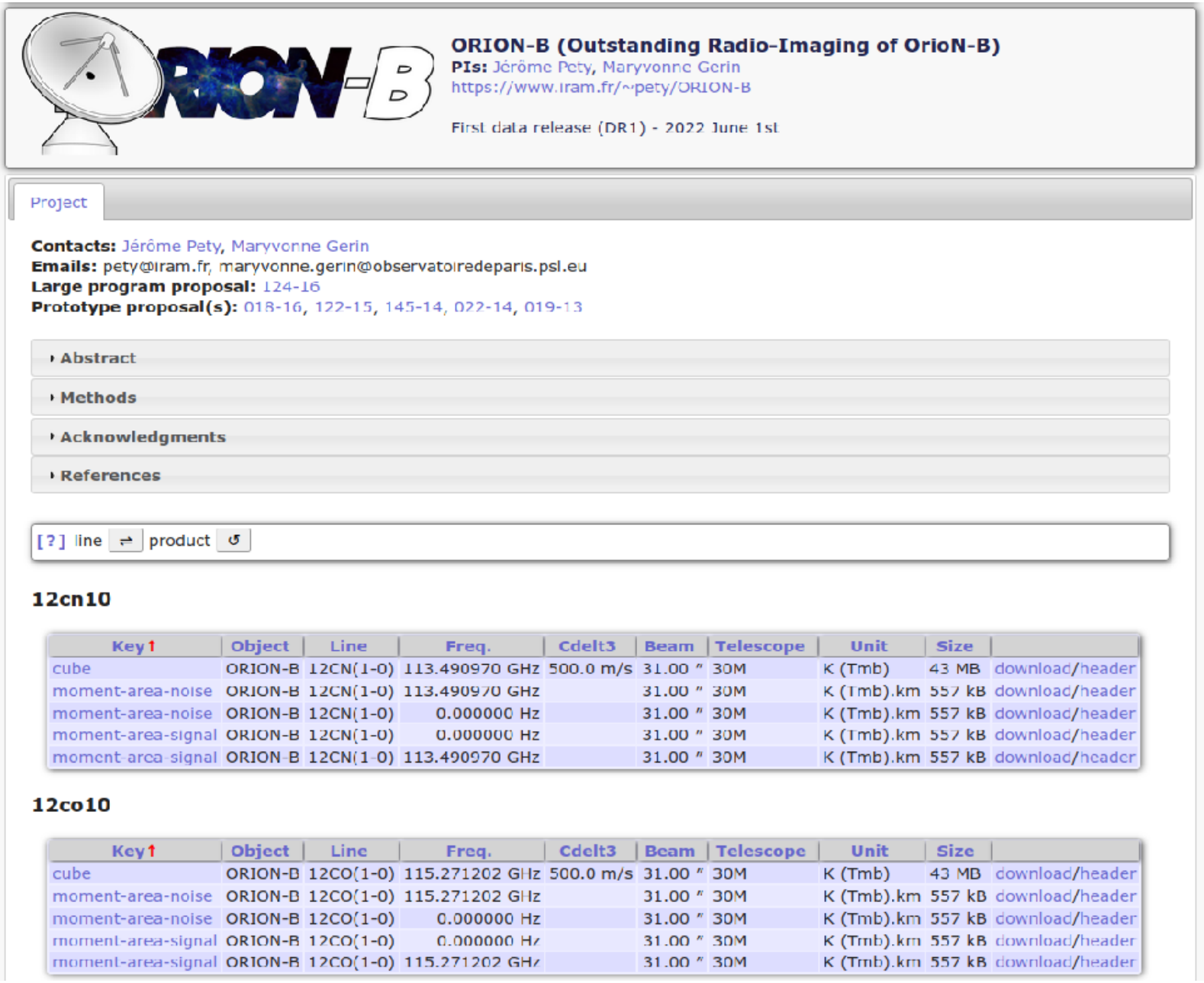
Date: 2016-09-15 12:26:36

Back

DMS: PI can link publication DOIs



DMS: List of products for potential downloads



ORION-B (Outstanding Radio-Imaging of OrioN-B)
PIs: Jérôme Pety, Maryvonne Gerin
https://www.iram.fr/~pety/ORION-B

First data release (DR1) - 2022 June 1st

Project

Contacts: Jérôme Pety, Maryvonne Gerin
Emails: pety@iram.fr, maryvonne.gerin@observatoiredeparis.psl.eu
Large program proposal: 124-16
Prototype proposal(s): 018-16, 122-15, 145-14, 022-14, 019-13

- Abstract
- Methods
- Acknowledgments
- References

[?] line ⇌ product ↺

12cn10

Key↑	Object	Line	Freq.	Cdelt3	Beam	Telescope	Unit	Size	
cube	ORION-B	12CN(1-0)	113.490970 GHz	500.0 m/s	31.00 "	30M	K (Tmb)	43 MB	download/header
moment-area-noise	ORION-B	12CN(1-0)	113.490970 GHz		31.00 "	30M	K (Tmb).km	557 kB	download/header
moment-area-noise	ORION-B	12CN(1-0)	0.000000 Hz		31.00 "	30M	K (Tmb).km	557 kB	download/header
moment-area-signal	ORION-B	12CN(1-0)	0.000000 Hz		31.00 "	30M	K (Tmb).km	557 kB	download/header
moment-area-signal	ORION-B	12CN(1-0)	113.490970 GHz		31.00 "	30M	K (Tmb).km	557 kB	download/header

12co10

Key↑	Object	Line	Freq.	Cdelt3	Beam	Telescope	Unit	Size	
cube	ORION-B	12CO(1-0)	115.271202 GHz	500.0 m/s	31.00 "	30M	K (Tmb)	43 MB	download/header
moment-area-noise	ORION-B	12CO(1-0)	115.271202 GHz		31.00 "	30M	K (Tmb).km	557 kB	download/header
moment-area-noise	ORION-B	12CO(1-0)	0.000000 Hz		31.00 "	30M	K (Tmb).km	557 kB	download/header
moment-area-signal	ORION-B	12CO(1-0)	0.000000 Hz		31.00 "	30M	K (Tmb).km	557 kB	download/header
moment-area-signal	ORION-B	12CO(1-0)	115.271202 GHz		31.00 "	30M	K (Tmb).km	557 kB	download/header

DMS: Interactive pre-visualization ⇒ YAFITS