# Introduction and survey results

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ESRF | The European Synchrotron

# OUTLINE

Motivation and program

Introduction to AT

Survey results

Open questions

# WHAT IS AT?

**AT was initially introduced by Terebilo (SLAC) as a toolbox to perform beam dynamics simulations in the late 90s:**

- the core of AT is a C tracking engine, based on the Pascal version of the Tracy code, that implements the integrators of the accelerator components
- the user interface was developed in MATLAB

**Then AT was integrated in MATLAB Middle Layer (MML), a MATLAB interface for control systems:**

- provides a framework and graphical interface for beam dynamics measurements and studies (optic, BBA, …)
- users scripts can be shared

**In 2015, it evolved into an international collaboration ATCOLLAB and AT2.0 was released:**

- Github repository (see L. Farvacque’s Talk)
- active development in C and MATLAB
- development of a python interface pyAT
- even though it was made compatible with AT2.0, MML is not integrated in this development effort

# WHY AN AT WORKSHOP?

**AT has a wide users community across many institutes worldwide**

**The last collaboration meeting was held in 2017, motivated by the creation of AT2.0 and the atcollab. Since then there has not been any general meeting uniting the users community and developers to (re)define a common roadmap**

**Development has nevertheless been very active with a major addition: the introduction of a python interface (pyAT) initiated by ESRF and DIAMOND**

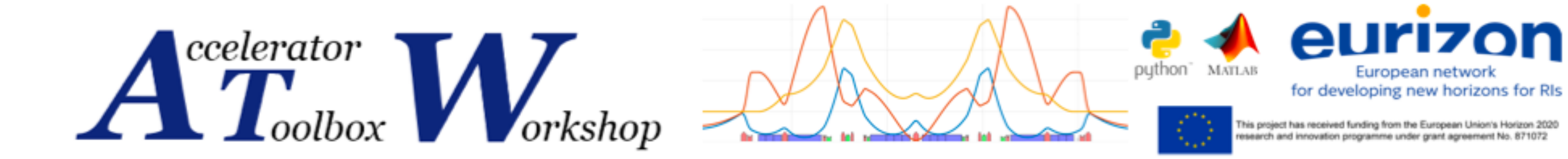
**Developments now mostly carried out by ESRF and L. Farvacque. We felt that feedback from the users community was necessary:**

- are the design choices in line with users needs?
- are the recent additions useful and used?
- is the documentation sufficient?
- are there missing features to be developed?
- is the development and integration process adequate?
- should we consider an upgrade of MML to pyML or a new MML?

**We hope that some answers will be provided during this workshop!**

# WORKSHOP ORGANISATION

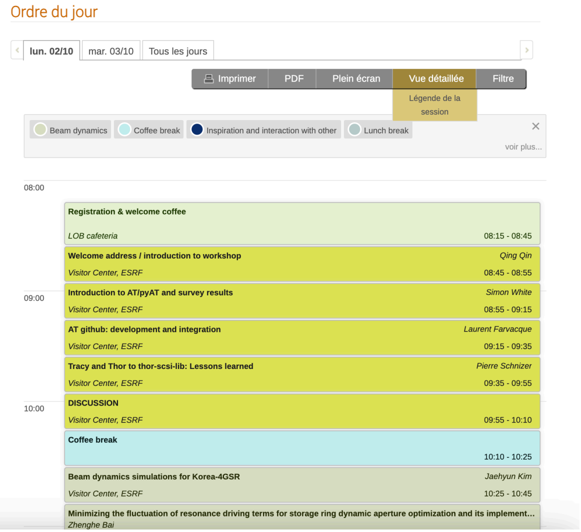
## The workshop is financed by the EURIZON European project


Accelerator Toolbox Workshop
python
MATLAB
eurizon
European network
for developing new horizons for RIs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072

## The program was put together and validated by a scientific committee, trying to represent as much as possible the institutes using AT

**Scientific Board**
Laurent Nadolski (SOLEIL)
Xiaobiao Huang (SLAC)
Zeus Marti (ALBA)
Boaz Nash (RADIASOFT)
Eugene Tan (Australian Synchrotron)
Laurent Farvacque (ESRF)



Ordre du jour

08:00

**Registration & welcome coffee**
*LOB cafeteria* 08:15 - 08:45

**Welcome address / introduction to workshop** *Qing Qin*
*Visitor Center, ESRF* 08:45 - 08:55

09:00

**Introduction to AT/pyAT and survey results** *Simon White*
*Visitor Center, ESRF* 08:55 - 09:15

**AT github: development and integration** *Laurent Farvacque*
*Visitor Center, ESRF* 09:15 - 09:35

**Tracy and Thor to thor-scsi-lib: Lessons learned** *Pierre Schnizer*
*Visitor Center, ESRF* 09:35 - 09:55

10:00

**DISCUSSION**
*Visitor Center, ESRF* 09:55 - 10:10

**Coffee break**
10:10 - 10:25

**Beam dynamics simulations for Korea-4GSR** *Jaehyun Kim*
*Visitor Center, ESRF* 10:25 - 10:45

**Minimizing the fluctuation of resonance driving terms for storage ring dynamic aperture optimization and its implement...**
*Zhenghe Bai*

Up to date program and material as well as practical information can be found on the indico page

# LATEST DEVELOPMENTS

**AT developments are integrated through the AT Github repository:**

- New release approximately every 6 months
- AT MATLAB/Python/C included, not MML

**Most developments are now added first to python and then translated in MATLAB when possible:**

- Passmethods made compatible for both interfaces
- Existing MATLAB functions ported to python: DA and lifetime (parallelized), ID kick maps, fast ring etc…
- 6D optics calculations now fully integrated in both interfaces:
  - major changes: interface of many functions adapted
  - backward compatibility broken: previous version allowed to compute 4D optics using 6D tracking data, **wrong**
- Parallelized tracking: OpenMP (MATLAB+Python), MPI, Python multiprocessing (Python only), GPU started (see J-L. Pons talk)
- Single and multi-bunch parallel collective effects (python only)

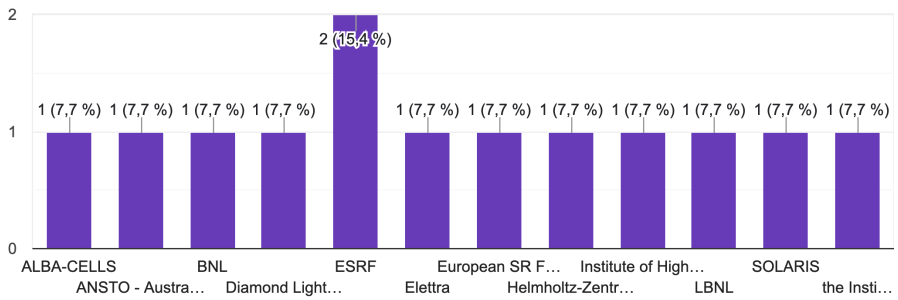
**The users community being very diverse it is not clear (at least to me) how these developments were integrated and used by the institutes**

# SURVEY RESULTS

**As a baseline for discussion we have included a short survey in the workshop registration: thanks for taking the time to answer these questions!**

(optional) For which research institute do you work?

13 réponses

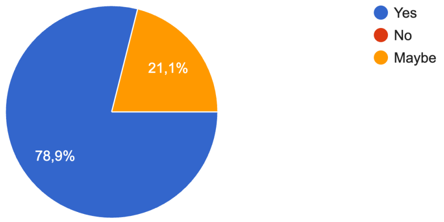


**Answers from 11 institutes received**

**No one thought this workshop was useless**

The last collaboration meeting took place several years ago (2017). AT has gone through major changes since then and a complete review could be ...ould be useful and would you like to participate?

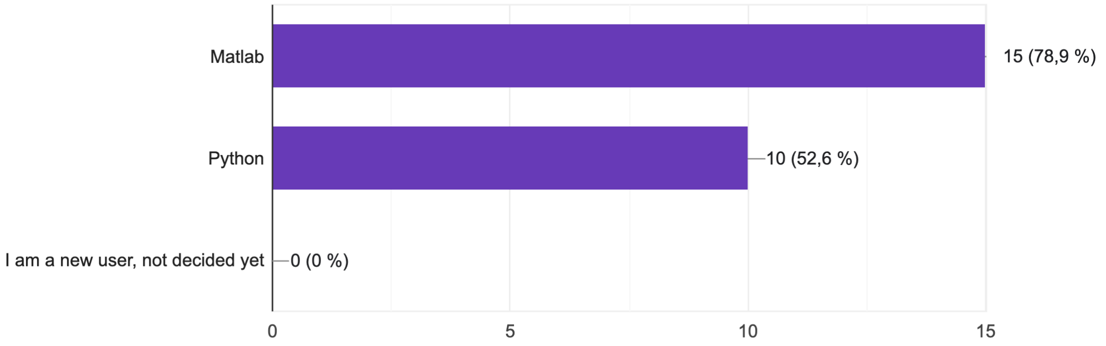
19 réponses



# WHICH AT VERSION IS USED?

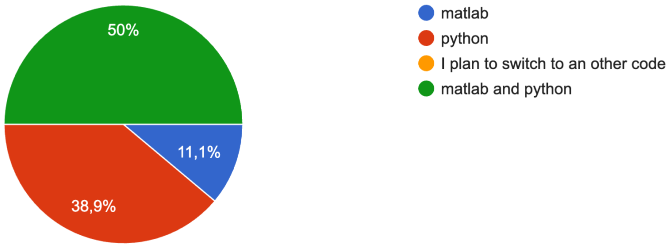
Do you use matlab or python AT?

19 réponses



Which AT do you plan to use in the future?

18 réponses



**pyAT widely adopted**
**MATLAB AT still strong, but MATLAB only users very few**

## Which version do you use?

**Modifed by G. Portman for SOLARIS**

**1.4**

**I'm not sure**

**2021**

**2.0**

**latest from repository**

**the latest version on github**

**I don' t know.**

**2.0 (since 2017)**

**Version 2.3**

**Master**

**AT2.0**

**AT1.2**

**pyAT latest**

**AT2015**

**the latest released (0.3.0) and github repo**

**master**

# HOW IS AT USED?

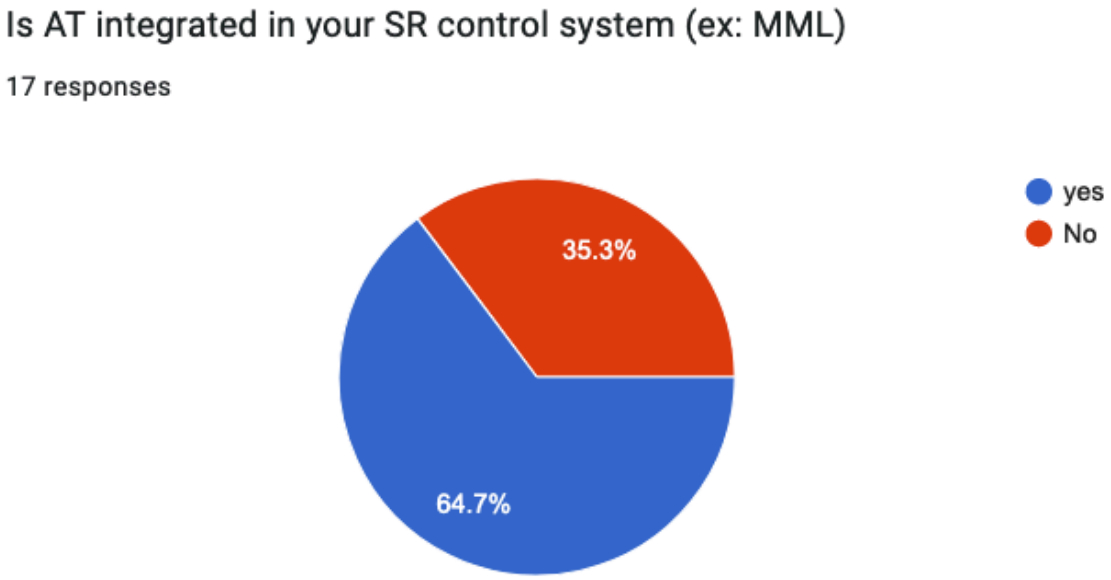
**AT main usage**

Simulations / modeling (17):

- Lattice design (7)
- Injection (4)
- Commissioning (2)
- Feedback (1)

Operation and control room (6)

AT development (1)



Is AT integrated in your SR control system (ex: MML)

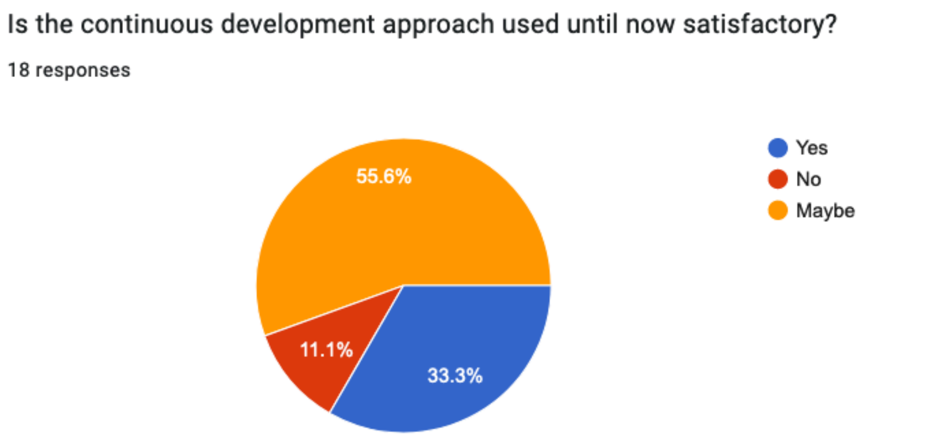
17 responses

**AT main usage is storage ring modelling**

**Approximately 65% integrate AT in the control systems (not specified whether MML is used or not)**

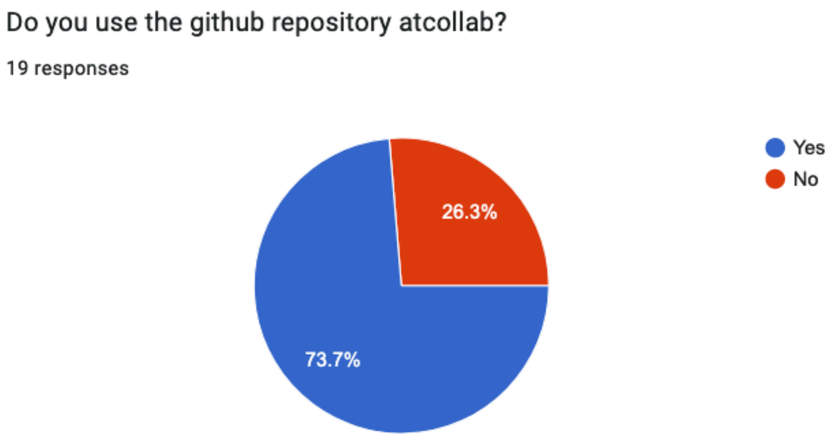
**Very few developers**

# DEVELOPMENT AND INTEGRATION



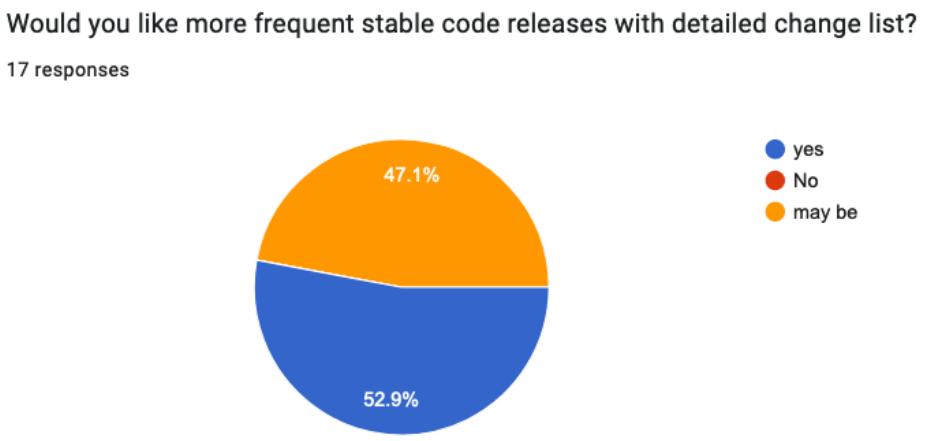
Is the continuous development approach used until now satisfactory?

18 responses



Do you use the github repository atcollab?

19 responses



Would you like more frequent stable code releases with detailed change list?

17 responses

**Most users are using the Github repository**

**Integration process would need to be improved:**

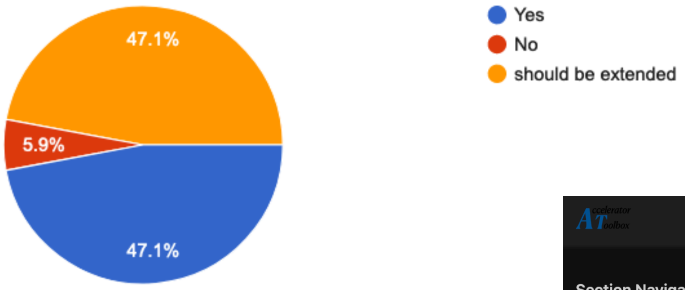
- more frequent releases
- improved reviewing process

**But we are lacking reviewers and ressources:** seek for external founding?

# DOCUMENTATION

Is the AT documentation (https://atcollab.github.io/at/index.html) satisfactory?

17 responses



**pyAT documentation automatically generated using sphinx**

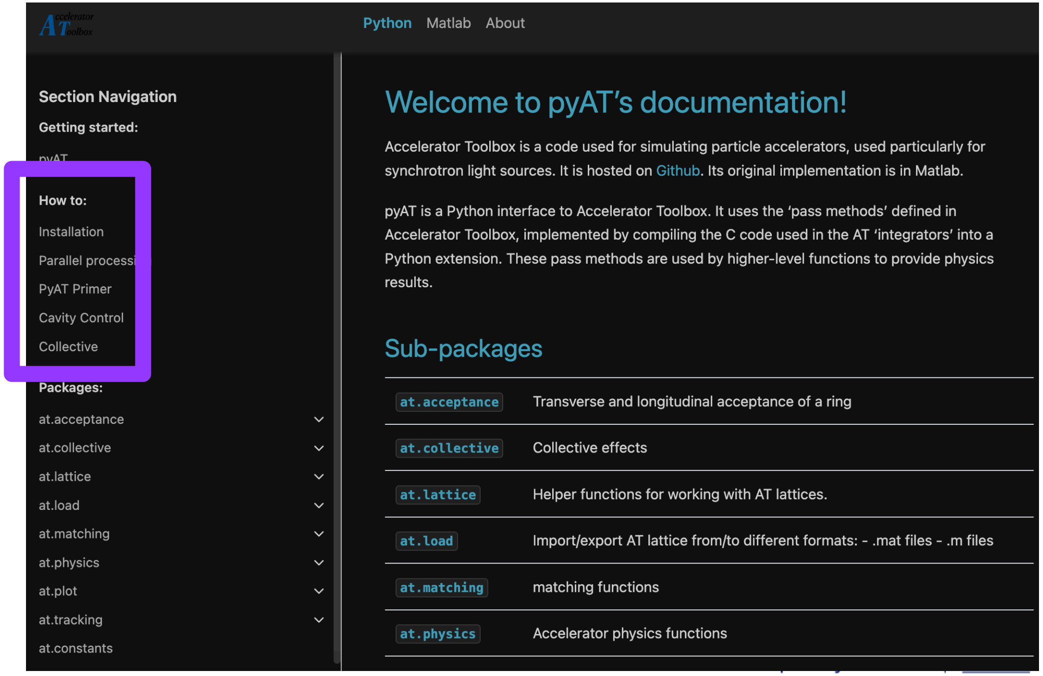
**Not done in MATLAB, all docstrings would need to be re-written**

**There seems to be a need to extend / improve the documentation**

**More detailed docstrings would be sufficient?**

**Is there a need for a real manual?**

**Started for some parts…**



Section Navigation

Getting started:

pyAT

How to:

Installation

Parallel processi

PyAT Primer

Cavity Control

Collective

Packages:

at.acceptance

at.collective

at.lattice

at.load

at.matching

at.physics

at.plot

at.tracking

at.constants

## Welcome to pyAT's documentation!

Accelerator Toolbox is a code used for simulating particle accelerators, used particularly for synchrotron light sources. It is hosted on Github. Its original implementation is in Matlab.

pyAT is a Python interface to Accelerator Toolbox. It uses the 'pass methods' defined in Accelerator Toolbox, implemented by compiling the C code used in the AT 'integrators' into a Python extension. These pass methods are used by higher-level functions to provide physics results.

## Sub-packages

| | |
|---|---|
| `at.acceptance` | Transverse and longitudinal acceptance of a ring |
| `at.collective` | Collective effects |
| `at.lattice` | Helper functions for working with AT lattices. |
| `at.load` | Import/export AT lattice from/to different formats: - .mat files - .m files |
| `at.matching` | matching functions |
| `at.physics` | Accelerator physics functions |

# FUTURE DEVELOPMENTS (WISH LIST FROM THE SURVEY)

**Lattice modeling:**

- Exact hamiltonian pass methods, improved magnets (dipole) model
- Insertion device model
- 3D field maps

**Linac modeling**

**Advanced modeling:**

- Intra-beam scattering and collective effects
- Strong coupling
- Advanced feedback systems
- Beam lines interface
- Non relativistic particles

**Functionalities:**

- Parallel computing / GPU
- Errors, corrections and optimisation tools

**User Interface:**

- Improved switching between radiation ON/OFF
- Improved ring parameters calculation interface, possibility to select parameters to compute
- Visualisation for Touschek losses

**Control room application:**

- PyML
- MML compatibility

**Development:**

- More stable code
- Extended documentation

# SUMMARY

**AT still has a large users base and is used in many institutes worldwide**

**Development is still very active**

**The python interface is being widely adopted**

**Many new features proposed: strong interest in further developing and support AT in the future**

**Nevertheless:**

**MATLAB Middle Layer does not seem to follow AT:**

- compatibility issue
- is it worth thinking of a replacement (pyML or new MML)?

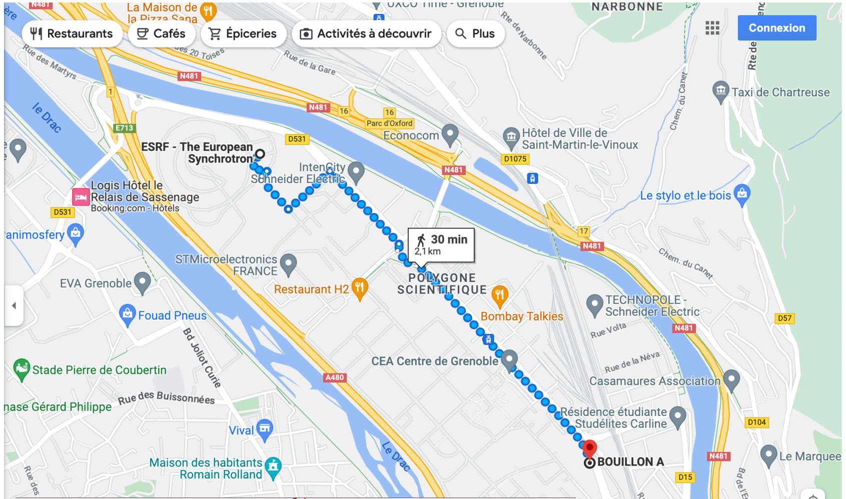
**The development is mostly done at ESRF:**

- limited ressources
- we are lacking developers and reviewers

**The MATLAB development relies on L. Farvacque and S. Liuzzo (reviewing) only:**

- is this adequate? Can this be sustained over the long term? Shouldn't we have someone attached to an institute following the MATLAB development?
- The risk is that pyAT starts to evolve much faster and diverge to a point where maintaining compatibility between the 2 interface becomes impossible….

# PRACTICAL INFORMATION


Restaurants
Cafés
Épiceries
Activités à découvrir
Plus
Connexion
NARBONNE
ESRF - The European Synchrotron
InterCity Schneider Electric
Econocom
Hôtel de Ville de Saint-Martin-le-Vinoux
Taxi de Chartreuse
Le stylo et le bois
Logis Hôtel le Relais de Sassenage
30 min
2,1 km
POLYGONE SCIENTIFIQUE
STMicroelectronics FRANCE
Restaurant H2
Bombay Talkies
EVA Grenoble
Fouad Pneus
TECHNOPOLE - Schneider Electric
CEA Centre de Grenoble
Casamaures Association
Stade Pierre de Coubertin
Résidence étudiante Studélites Carline
Vival
BOUILLON A
Maison des habitants Romain Rolland
Le Marquee
le Drac
Porte de France

BOUILLON

CUISINE SAINE ET GOURMANDE ACCESSIBLE AU PLUS GRAND NOMBRE

VIE LOCALE GOURMAND CUISINE MAISON

The workshop dinner will take place on Monday, 2nd October at 'Bouillon A' restaurant in Grenoble.

**Warning:** There is another restaurant called Le Bouillon downtown Grenoble, **it is not that one**

Lunches will be held at the EPN campus restaurant in the Guest dining room**.**

Workshop photo will be taken during the first coffee break, today at 10:10am

Tunnel visit will take place today during lunch break: please try to be on schedule since we have adapted our operation schedule to accommodate this visit

**Thanks and have a nice workshop!**