# ESRF high pressure laboratory: present and future

**G. Garbarino, J. Jacobs, M. Mezouar, S. Bauchau, A. Rosa, R. Jarnias, O. Hignette**

**ESRF, Grenoble, France**

# OUTLINE

**Present status**

- Staff and services
- Advanced instrumentation available
- Off line facilities

**Developments in view of EBS**

# HIGH PRESSURE AT ESRF USING DAC

**ID06, ID15B, ID27, ID10:** X-ray Diffraction – Structure, Crystallography, Strain, Deformation, …

**ID18:** Nuclear Resonance Scattering - Magnetism, Phonons

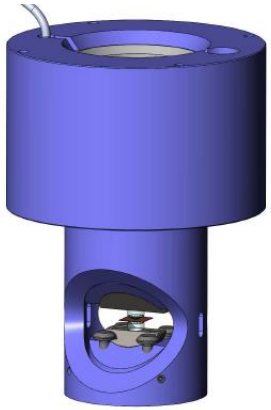
**ID20:** Resonant Inelastic X-ray Scattering - Electronic and Magnetic Structure

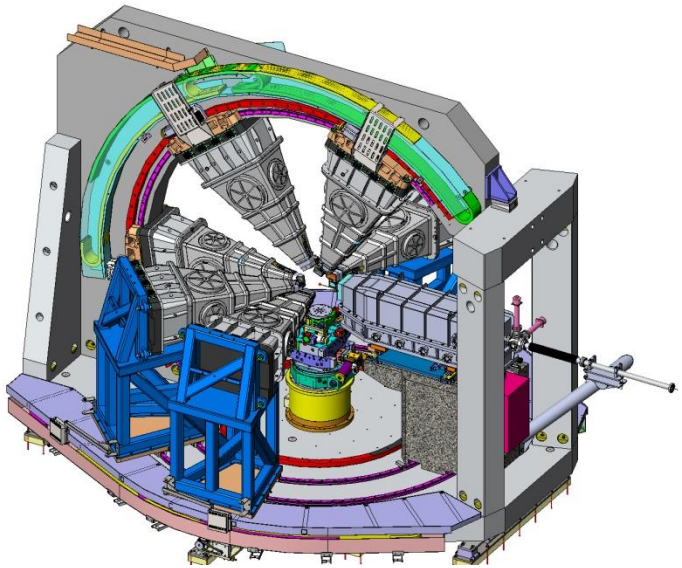
**ID28:** Inelastic X-ray Scattering, Diffuse Scattering – Phonons

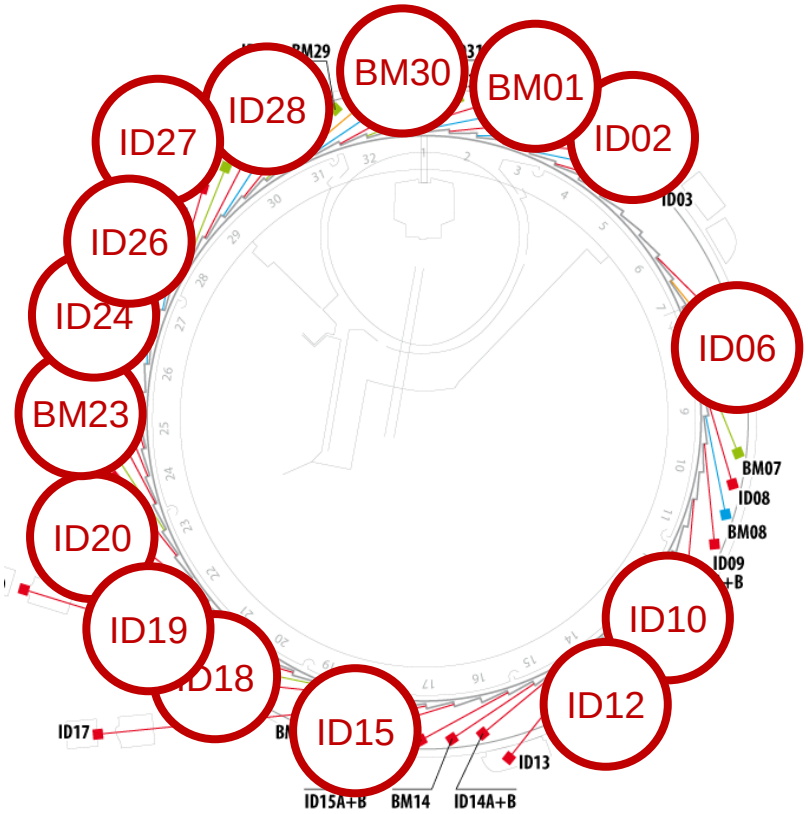
**ID12, BM23, ID24:** XAS, XMCD - Local and electronic structure, Magnetism,

**ID10:** XPCS

**ID02, ID26, BM01, BM30, ID09B, ID19, ….**







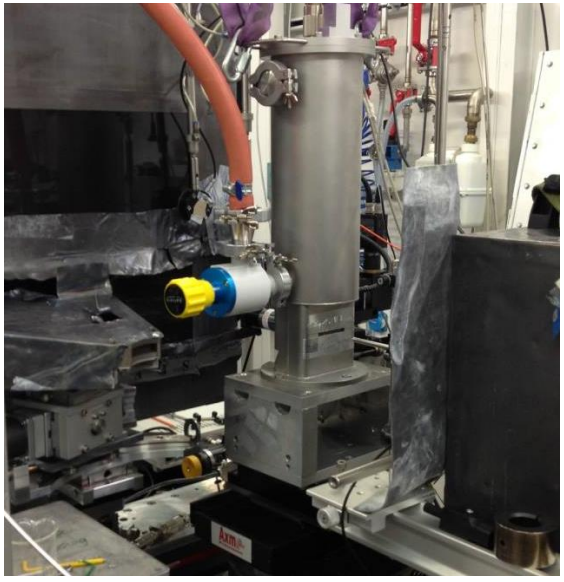

ID20: 72 Analysers and Panoramic DAC

# HIGH PRESSURE AT ESRF USING DAC

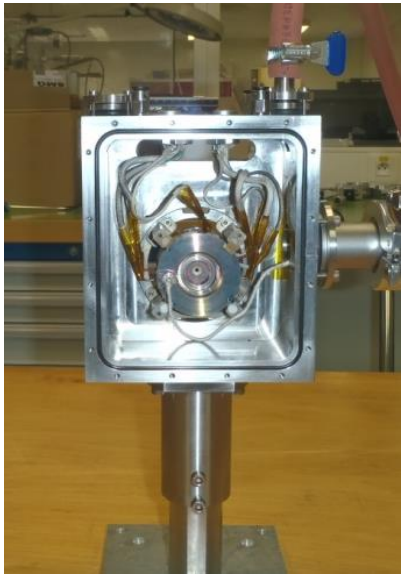
## LeToullec type DAC (P>200GPa)

## Magnetic field (H < 8 T)

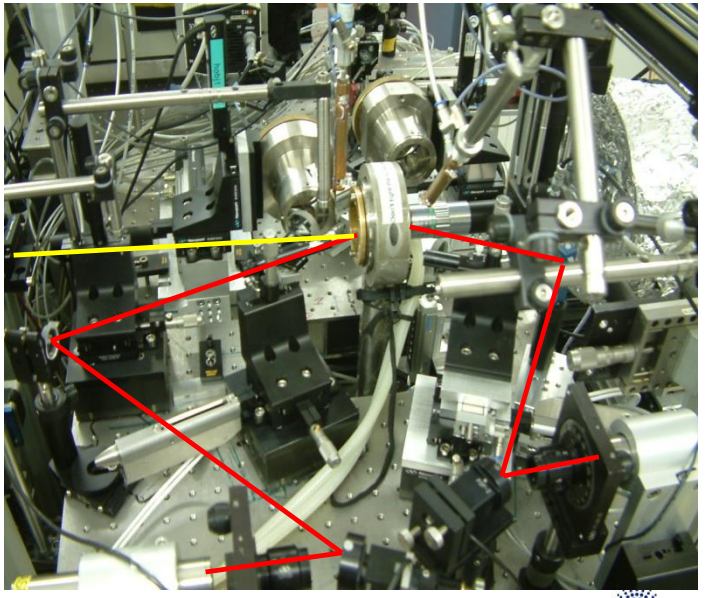
## Cryostat (T > 2.7 K)



## Resistive heating (T < 1300 K)

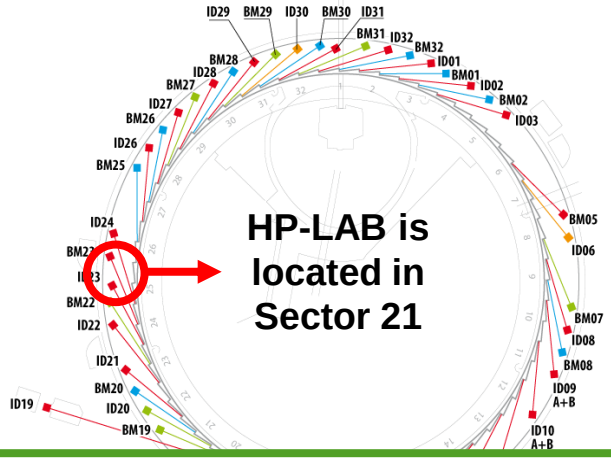


## Laser heating (T > 5000 K)



# HP LAB: STAFF AND SERVICES

**STAFF:**
- Jeroen Jacobs
- Gaston Garbarino



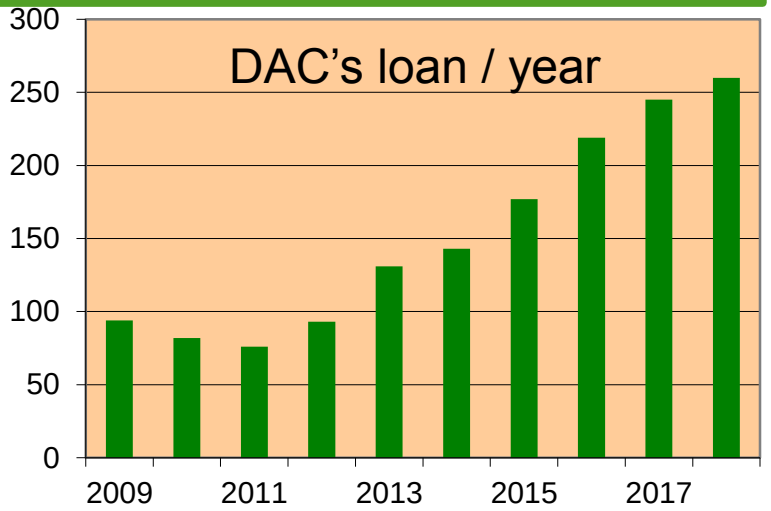

**US**

**HP**

- **High pressure activity is growing every year**
- **Strong collaboration with beamlines**
- **Involved in several pioneering and strategic developments**

- **LOAN POOL** with all equipment for DAC experiments

- **DEVELOPMENT** of extreme condition equipment requested from beamlines




**COMMERCIAL ACTIVITY:**

Around 5 DAC's sold per year

# HP LAB: ADVANCED INSTRUMENTATION AVAILABLE

## EQUIPEMENT AVAILABLE FOR USERS:

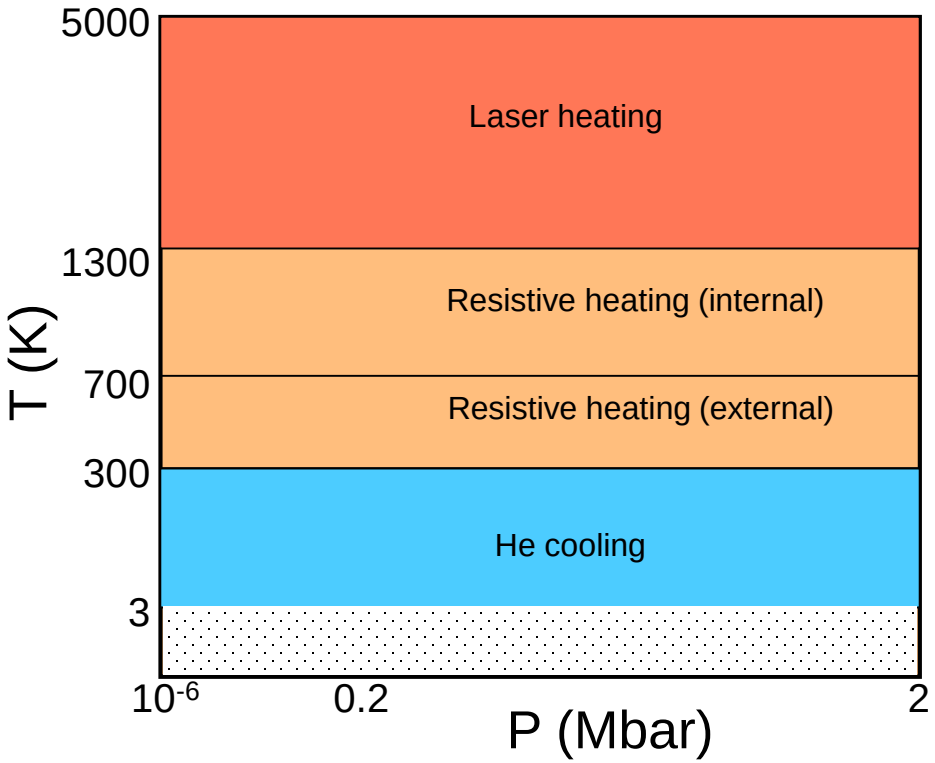
DAC's ready to use:

- Standard - Panoramic - Large opening

Temperature

T>~1000K: laser heating (YAG, $CO_2$)
T<1300K: internal heating
T<700K: external heating
T>3K: CuBe alloy (Non magnetic)

- High T vacuum chamber
- High T inert atmosphere chamber
- Automatic pressure drivers



# HP LAB: ADVANCED INSTRUMENTATION AVAILABLE

**AVAILABLE SPACE: FOUR DEDICATED ROOMS**

- user dedicated space (21.0.12, 21.0.13)
- super-user space (21.0.09)
- gas loading space (21.0.11)

**AVAILABLE EQUIPEMENT:**

- Microscopes

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- Laser drilling machine

- Gas loading machine

- **Very positive impact on the quality of the produced data**

- **Increase the number of successful experiments due to the possibility to load / reload onsite**

# HP LAB: ADVANCED INSTRUMENTATION AVAILABLE

## CHEMISTRY AND MICROIMAGING LABORATORY

### CHEMISTRY LAB (H. Muller):

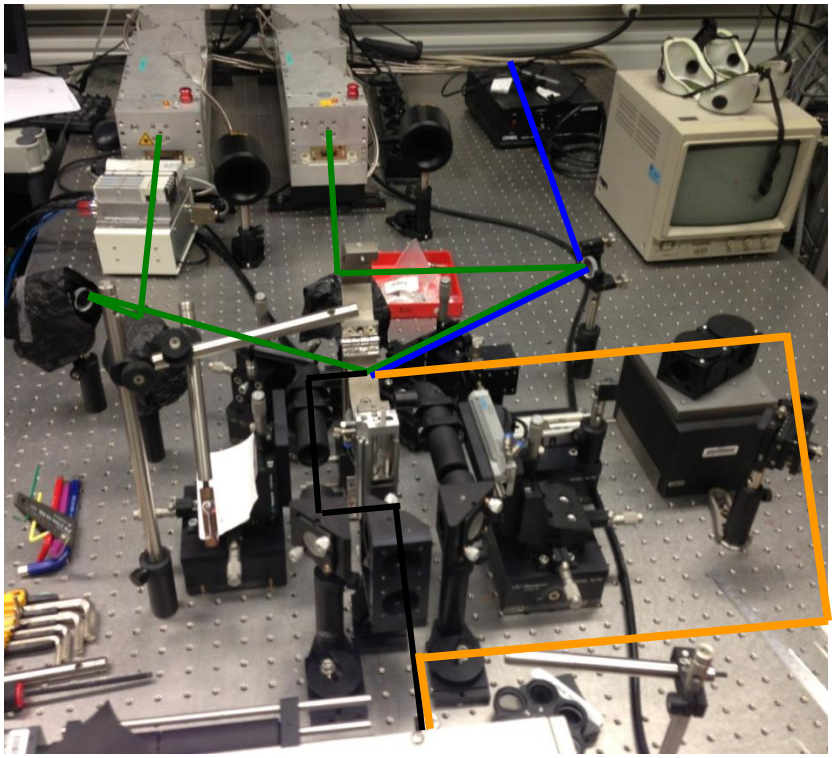
- Inert atmosphere sample manipulation, DAC loading
- Possibility to use glove box equipped with microscope ...

### MICROIMAGING AND SAMPLE PREPARATION LAB (I. Snigireva)

- Sample preparation, polishing, cutting


# OFF-LINE FACILITIES

## OFF-LINE LASER ANNEALING (BEL.0.02, 14.0.09)



**Present:**

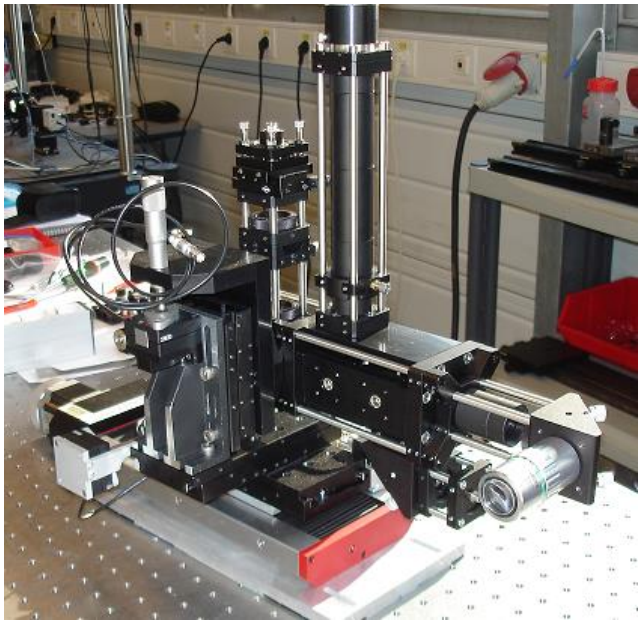
- YAG laser (2 x 50Watts)
- Temperature measurement

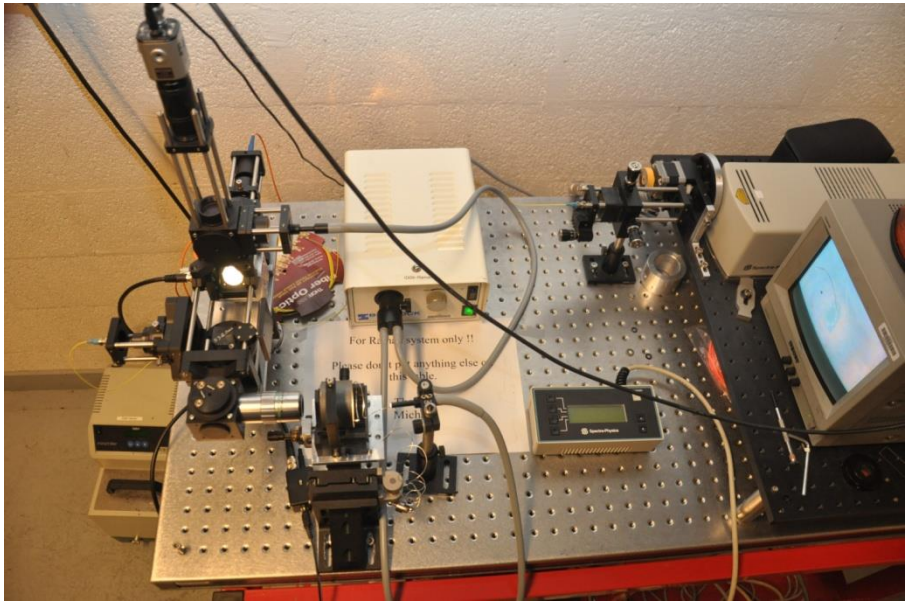
**Upgrade:**

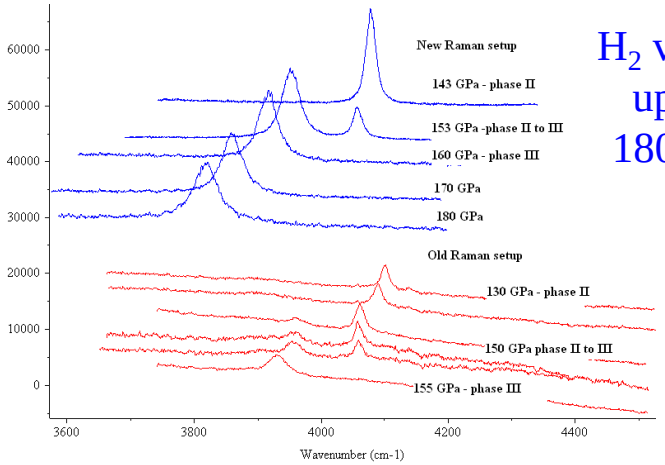
- $CO_2$ laser
- Raman spectroscopy
- YAG fiber (1 x 100 Watts)

# OFF-LINE FACILITIES

## OFF-LINE RAMAN SPECTROMETER (BEL.0.02, 14.0.09, 07.0.12)








$H_2$ vibron up to 180GPa

# OFF-LINE FACILITIES

## OFF-LINE CRYOGENIC CAPABILITES (BEL.0.02, 14.0.09, 07.0.12)

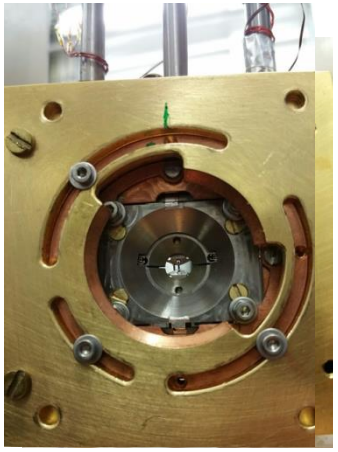
**SES Pool**
- Cryostream ($LN_2$)
- Helijet (He)

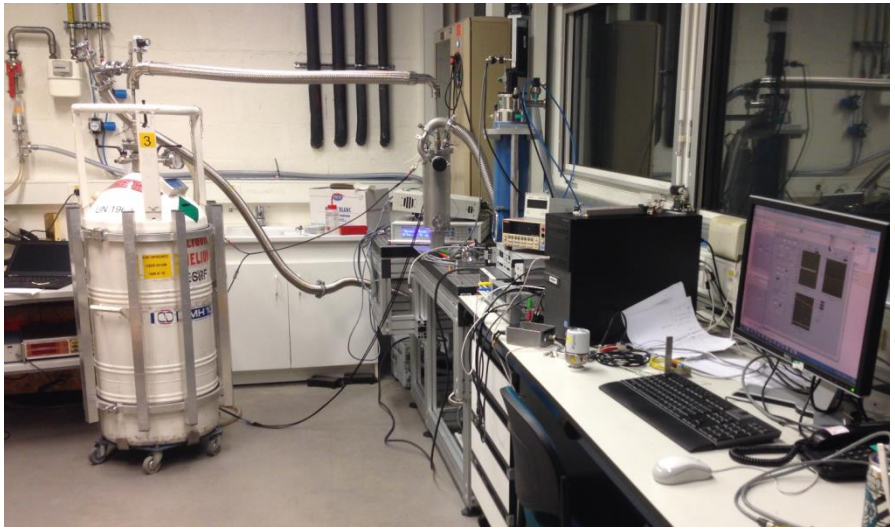
**Available at ID15B - ID27**
- Oxford “blue” cryostat
- In-house made cryostats (x3)
- Designed to develop coupled techniques

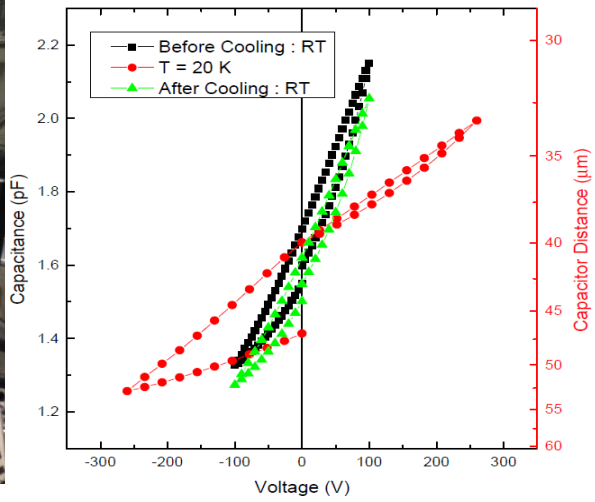
**Raman spectroscopy, Magneto-transport**

**EXAMPLE: Test of strain device at low temperature**

- Developed for $\chi$, $\rho$, XRD, IXS, RIXS… Tested and characterized at room T “at home”
- Tested and characterized at low T “at ESRF” in same experimental conditions as on beamline
- Improved thermal contact and performances to be ready for beamtine on ID28-ID32-ID27








(Credits M. Soulliou, M Le Tacon group)

# OUTLINE

**Present status**

- Staff and services
- Advanced instrumentation available
- Off line facilities

**Developments in view of EBS**

# DEVELOPMENTS IN VIEW OF EBS

**NEW AVAILABLE SPACE:**

- user dedicated space (21.0.13)

**NEW AVAILABLE EQUIPEMENT:**

- Fume-hood for Be manipulation

- Mouse controlled Micromanipulator

# DEVELOPMENTS IN VIEW OF EBS

**AVAILABLE SPACE:**

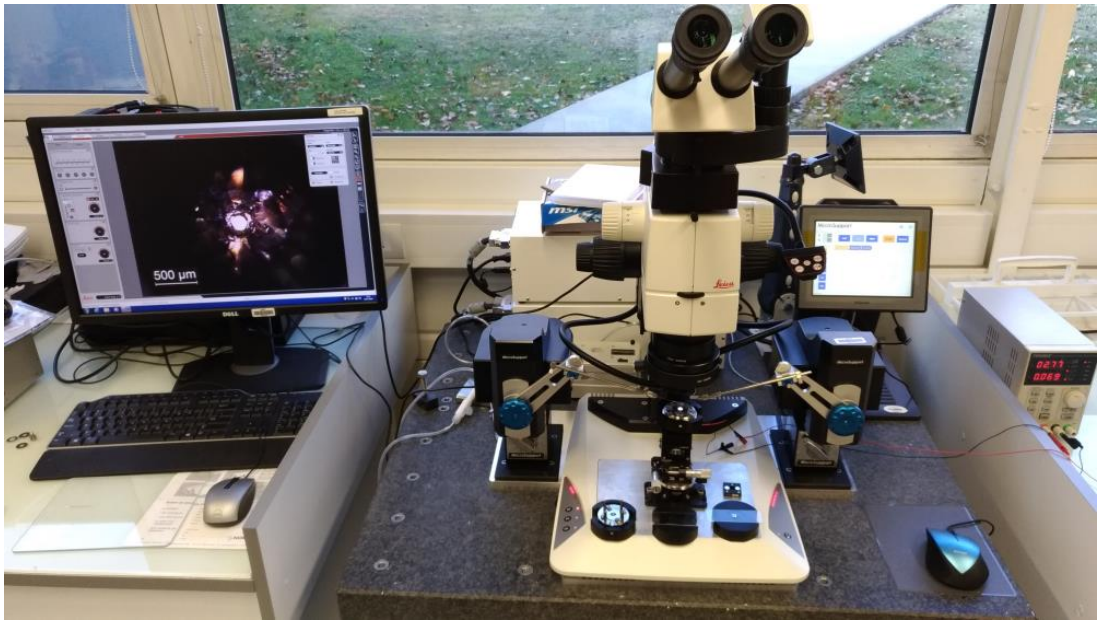
- three user dedicated space
  (21.0.09, 21.0.12, 21.0.13)
- gas loading space (21.0.11)

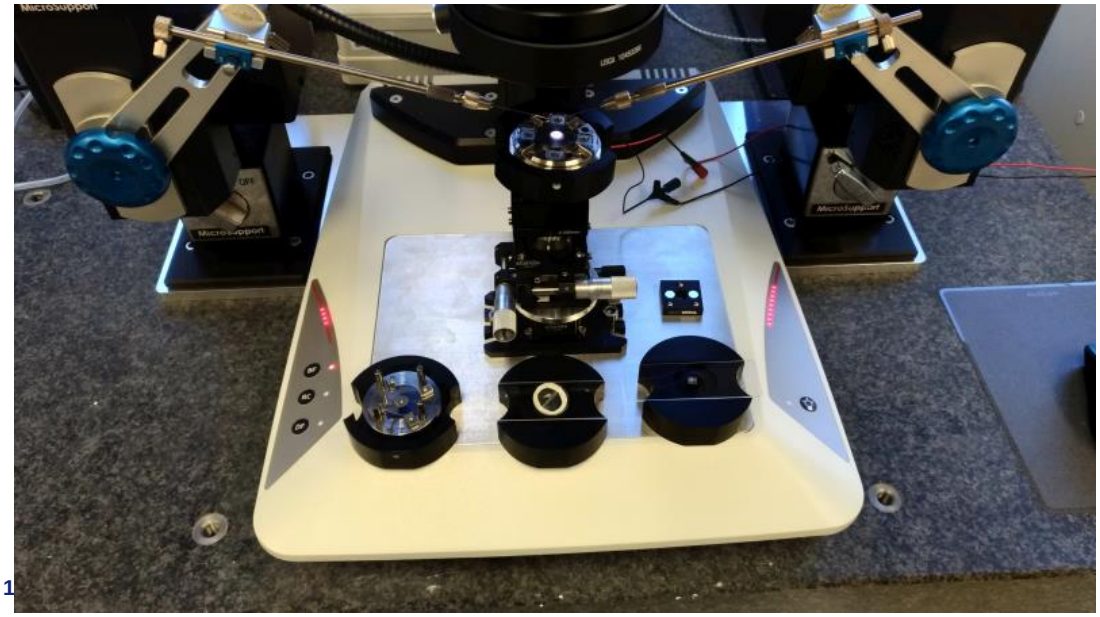
**LOAN POOL**

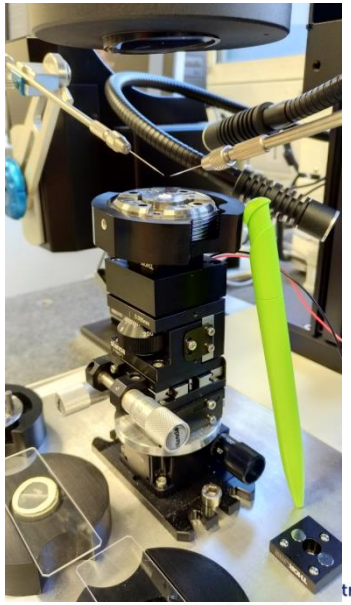
- Improvement external/internal
  DAC heating system (Rosa - Jarnias)

**EQUIPMENTS DEVELOPMENTS**

- Improvement Micromanipulator



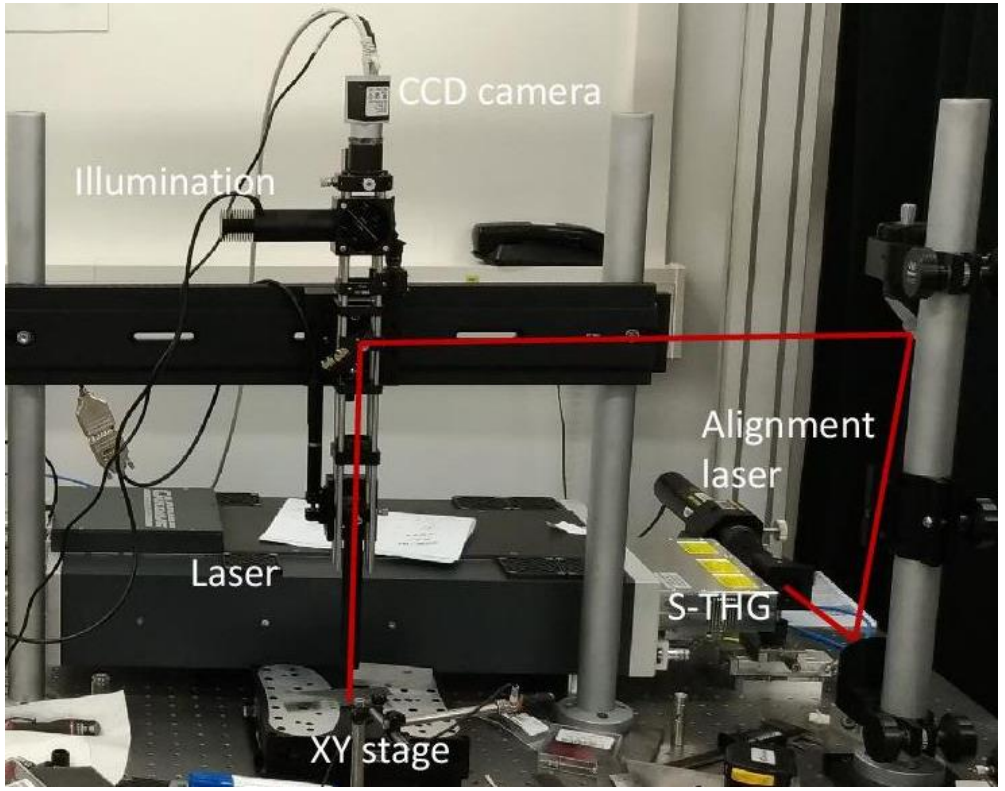


# DEVELOPMENTS IN VIEW OF EBS

## FEMTOSECOND LASER DRILLING MACHINE

**Laser:**
- λ = 343, 515, 1030 nm
- Energy per pulse ~80uJ @ 1030nm
- Pulse length >240fsec

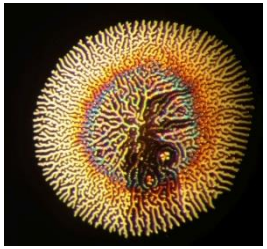
**Advantages:**
- femto-sec pulse laser (ablative regime)
- fast, precise and large xy stage (100mm x 100mm)
- visualization




**Capabilities:**
- User friendly
- Sample preparation
- Gasket drilling
- Completely automatized laser machining
- Available for staff / users
- Other possible application consequence of drilling/machining in ablative regime

(Credits O. Hignette, P van der Linden)

**Optimization:**
- Damaged focusing achromat
- beam expander
- objective (replace lenses)
- visualization



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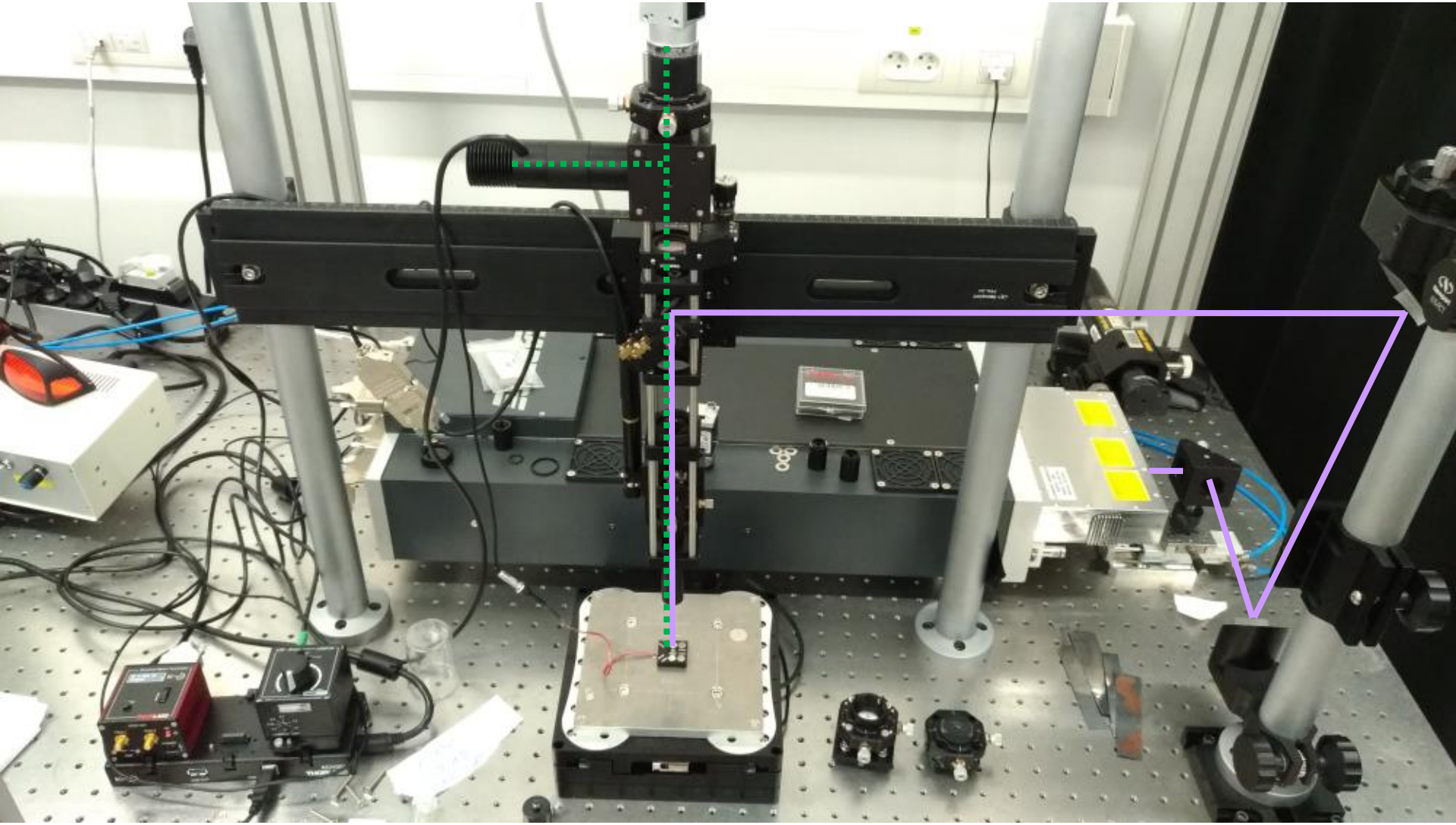
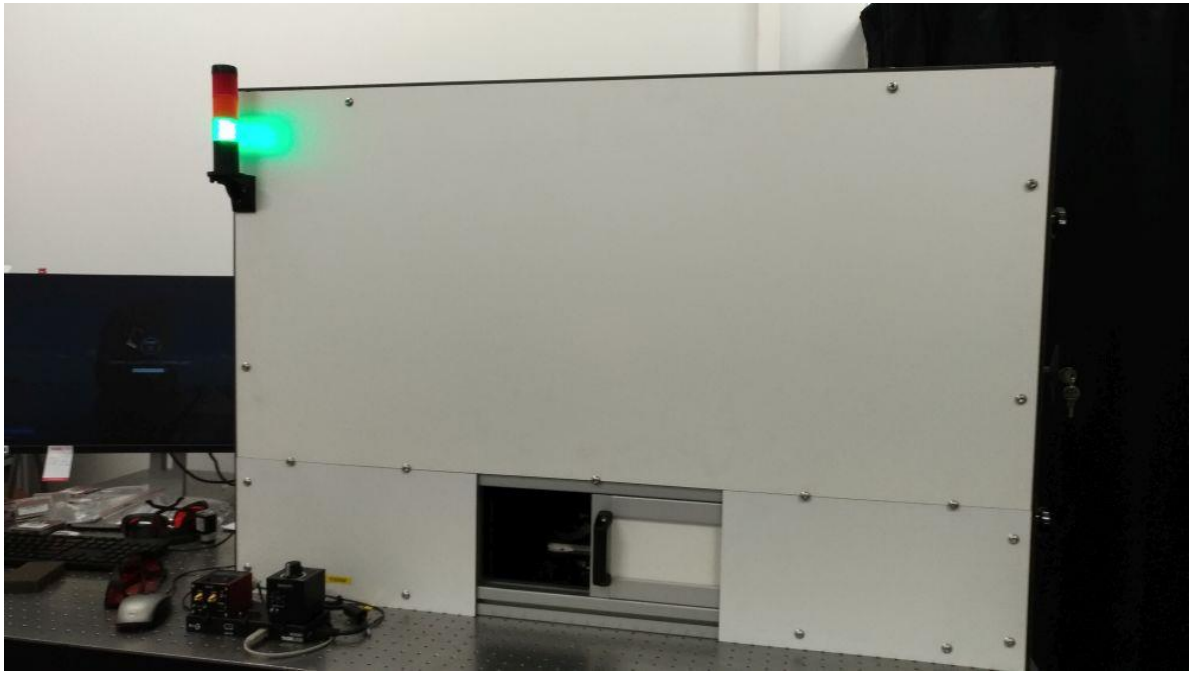


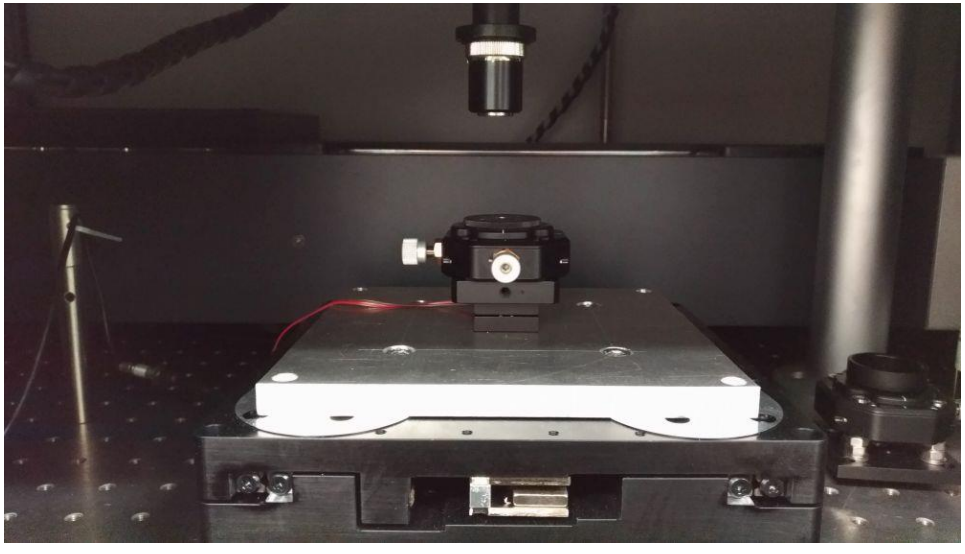
Credits to O. Hignette, S. Bauchau

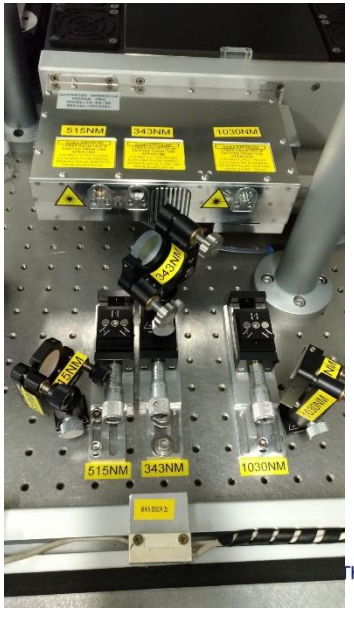
# DEVELOPMENTS IN VIEW OF EBS

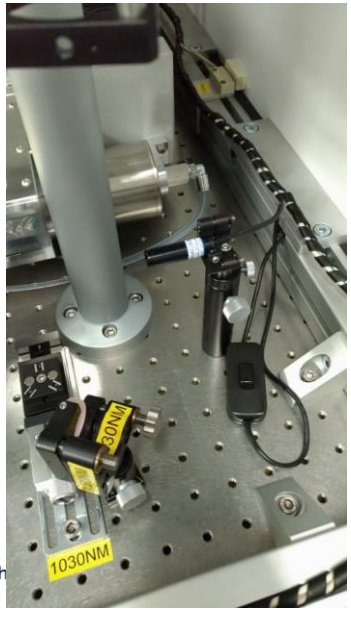
## FEMTOSECOND LASER DRILLING MACHINE

Credits to O. Hignette, S. Bauchau







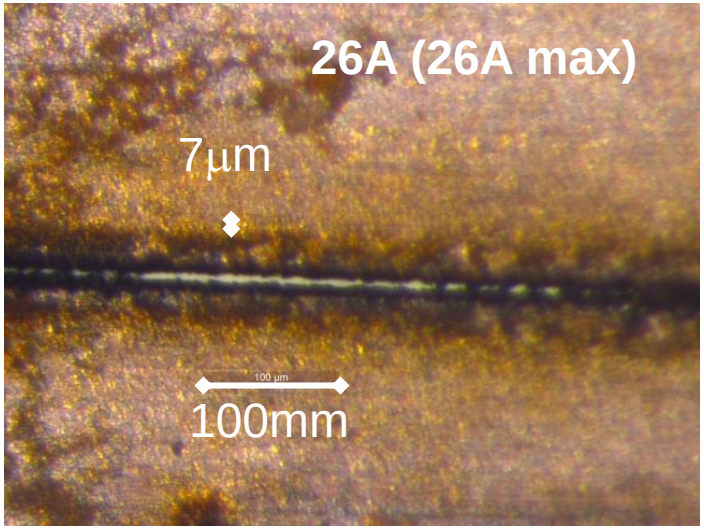



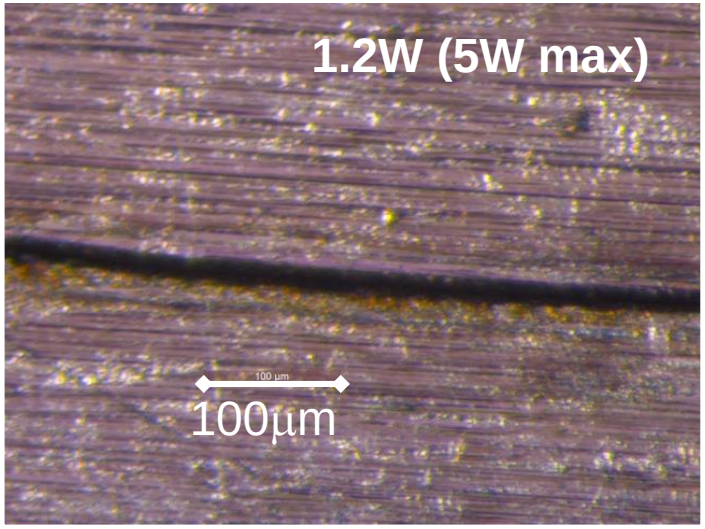
# DEVELOPMENTS IN VIEW OF EBS

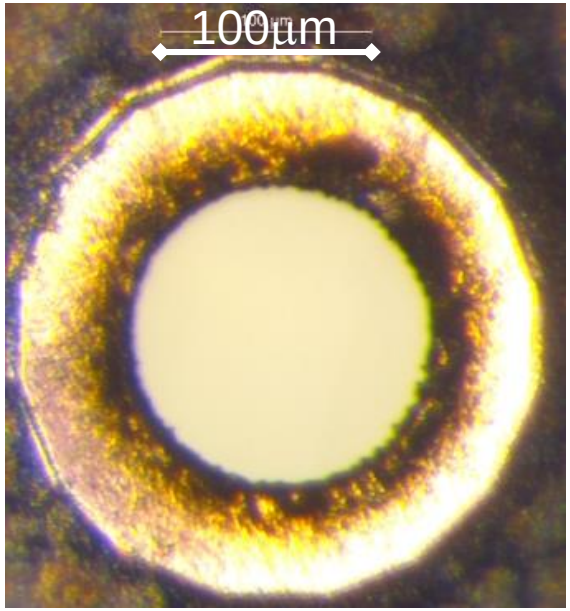
## NANOSECOND LASER DRILLING

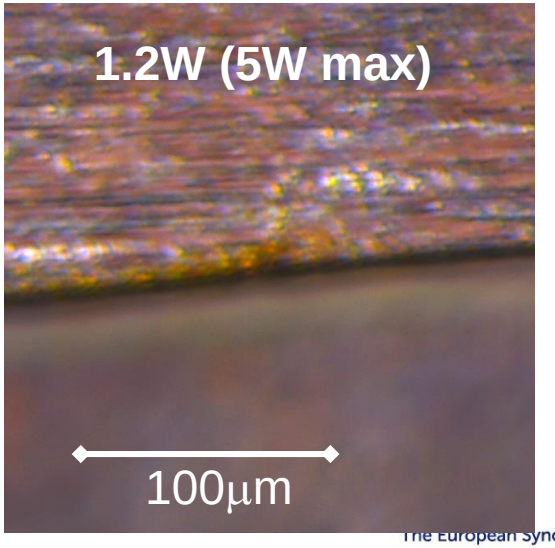
## FEMTOSECOND LASER DRILLING

**50μm STST foil**



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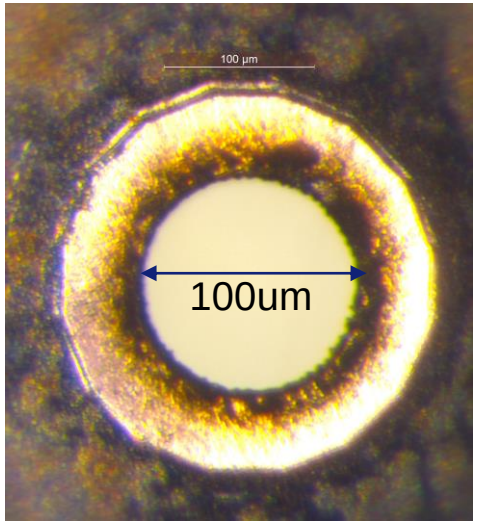
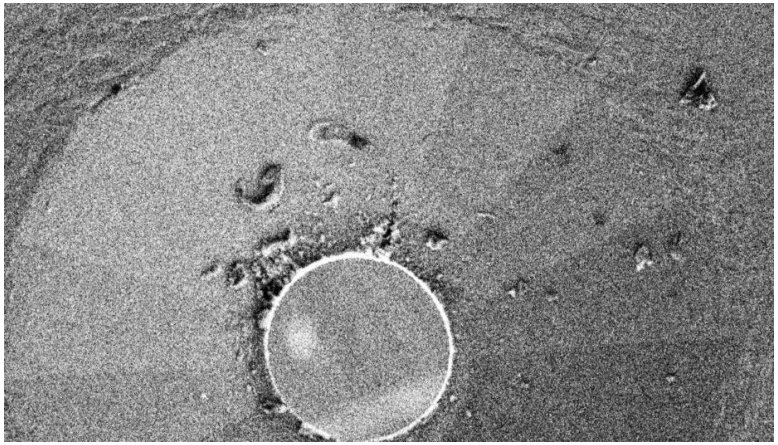
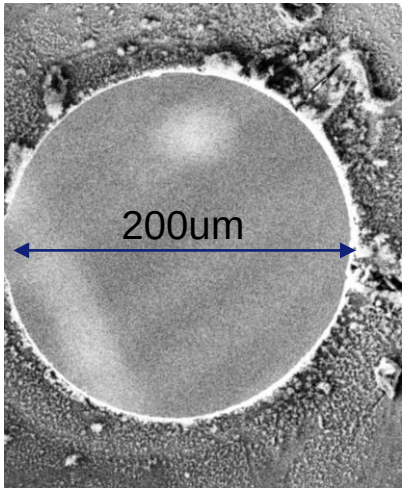
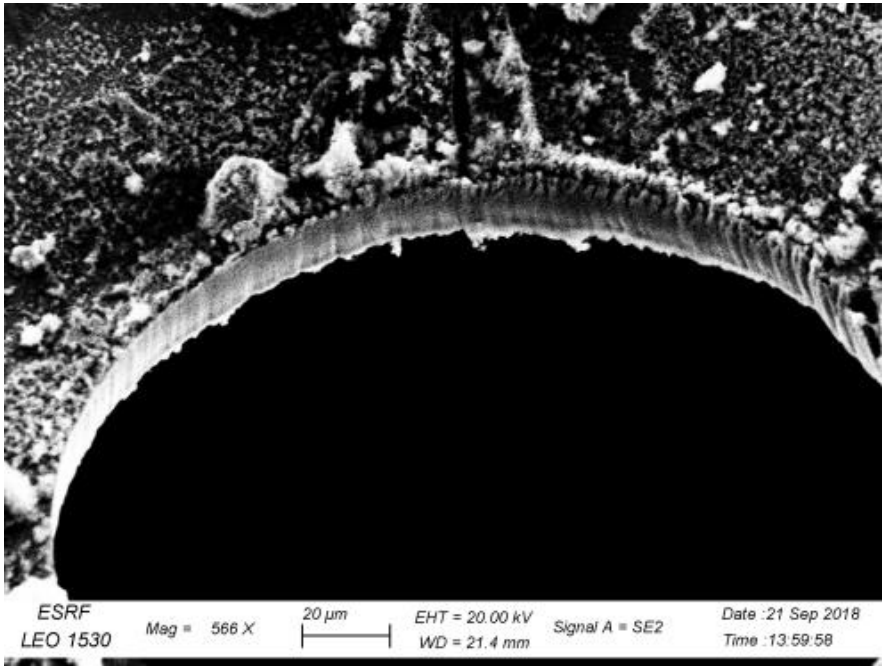



## FEMTOSECOND LASER DRILLING





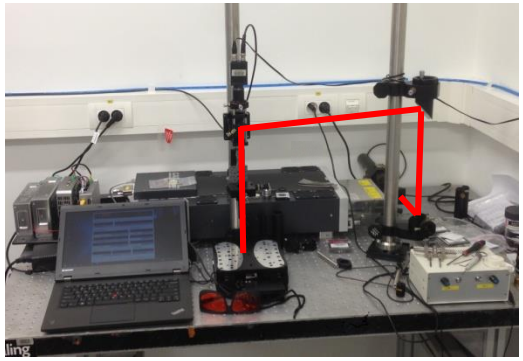




Credits to I. Snigireva

# HIGH PRESSURE AT ESRF: CAPABILITIES

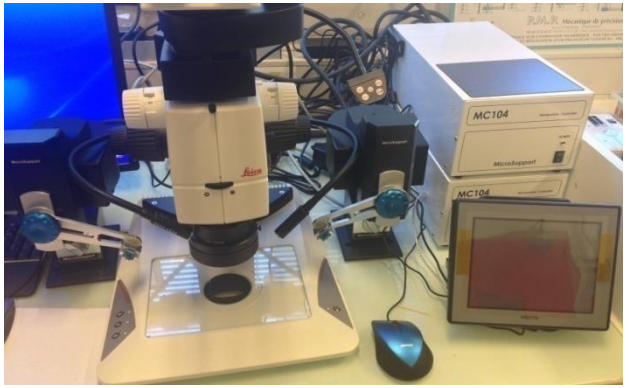
Importance of high level offline and online equipments
to perform the most challenging DAC loadings and experiments on-site

High pressure laboratory



Laser drilling

+



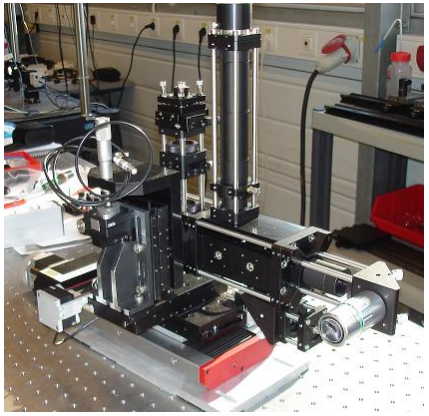

Sample manipulation

Inert atmosphere
sample manipulation
and preparation

+

Gas loading

+



Off-line characterization
Raman spectroscopy, laser annealing,
magnetic and transport prop .

# CONCLUSIONS - ACKNOWLEDGMENTS

- **Importance of high level offline and online facilities to perform the most challenging extreme conditions experiments at ESRF**

- **HP-lab has a key role and is Involved in several pioneering and strategic scientific instrumental developments**

- **Projects and motivation to keep ESRF high-pressure programme at the forefront of the field within ESRF - EBS.**


## Acknowledgements

**J. Jacobs, M. Mezouar,**
**S. Bauchau, A. Rosa,**
**R. Jarnias, O. Hignette,**
**…**


**Thank you for your attention**