

SAPIENZA TeraHertz:

THz spectroscopic imaging system for basic and applied sciences

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SAPIENZA
UNIVERSITÀ DI ROMA

A close-up image of a blue microchip with intricate circuit patterns.

**«Presentazione alla
Comunità Sapienza delle Grandi
Attrezzature di Ateneo»**
13 maggio 2019, Aula Magna del Rettorato

SAPIENZA TeraHertz: project infos

- Grandi Attrezzature Scientifiche – Grandi Attrezzature 2018, involving 16 departments with 67 participants and >8 thematic areas.
- Laboratory site: SBAI-Dipartimento di Scienze di Base e Applicate per l'Ingegneria, Via A. Scarpa 14/16 Roma

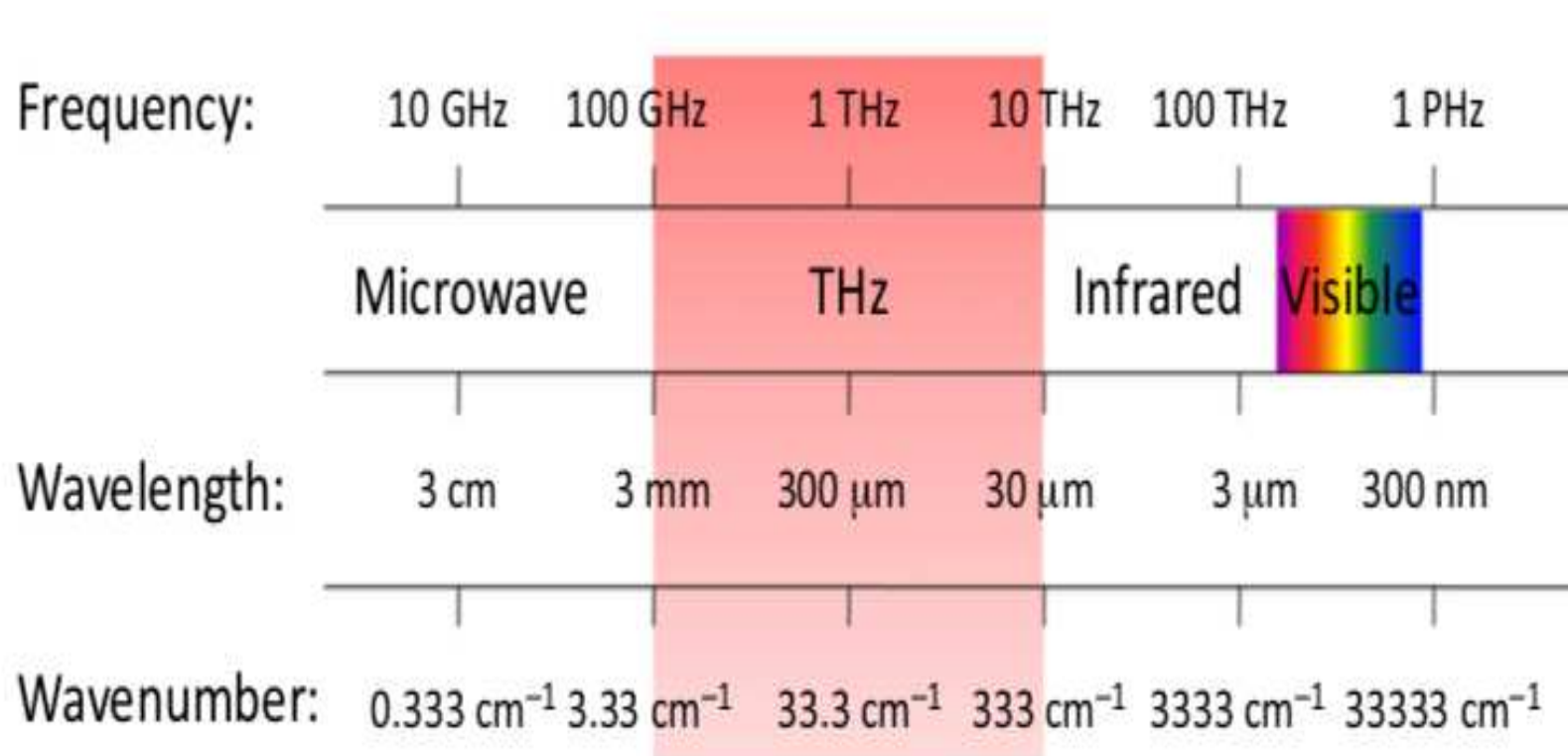
Installation forecast:

- 1st laboratory installation expected by end 2019
- 2nd laboratory installation expected by mid 2020
- Laboratory fully operational: end 2020.

SAPIENZA TeraHertz

- **An Interdepartmental facility with state of the art technology for THz imaging/ spectroscopy and THz technological development**, of interest for many fields of research.
- The system can be moved around for on-field experiments.
- Perspective: **A THz National facility**

ELECTROMAGNETIC SPECTRUM



1THz
frequency

300 μm
wavelength

300 cm^{-1}
wavenumber

4.1meV
energy

WHY THz

- THz interacts strongly with polar molecules (water)
- interacts weakly with non-polar molecules (plastic, ceramic)
- is reflected by most metals.
- fingerprints: rotations and vibrations of molecules
- non-ionising radiation

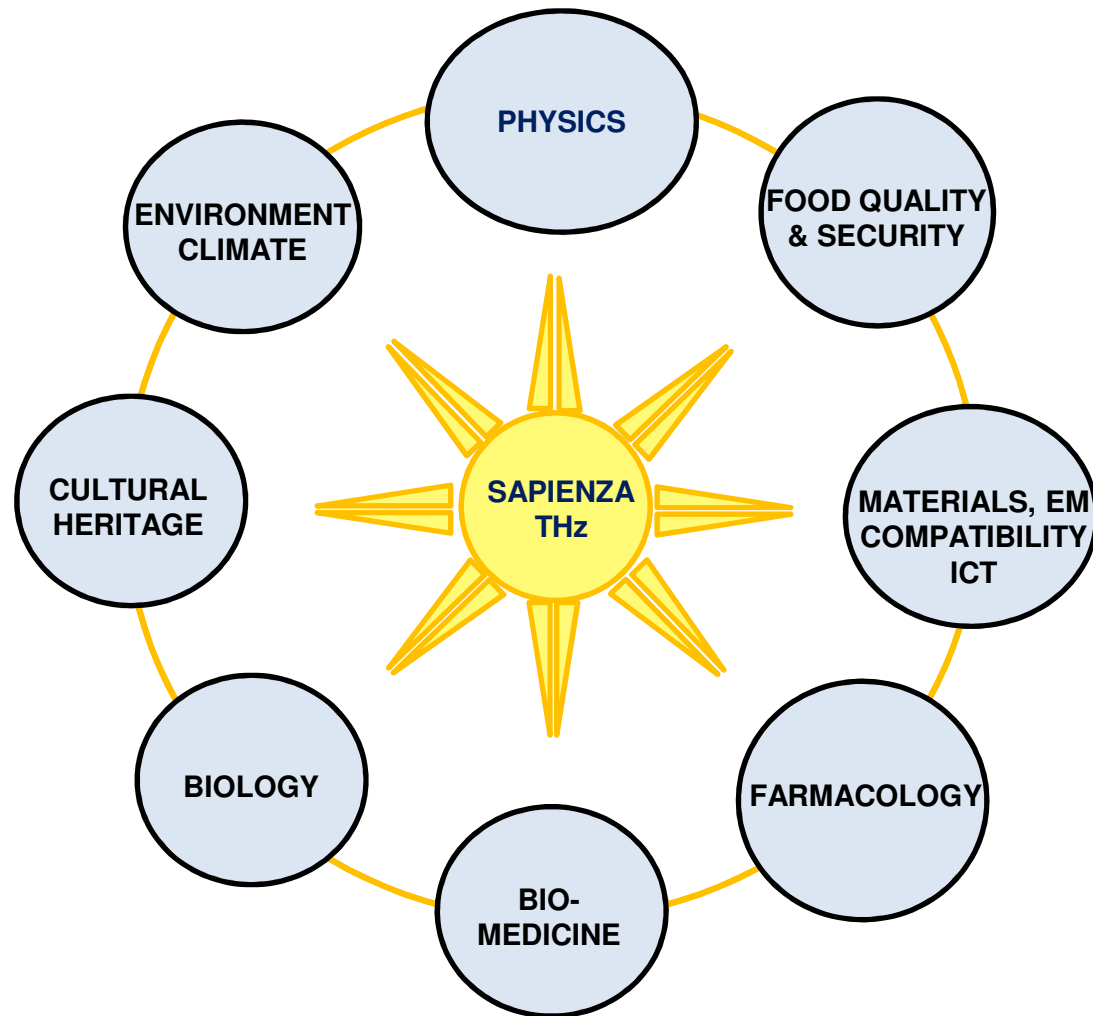
The interest in THz spectroscopy and imaging lies on the possibility to penetrate organic materials up to some millimeters, despite IR, MIR and VIS

THz can be used for non-destructive and through packaging diagnostics opening new promising investigation scenarios.

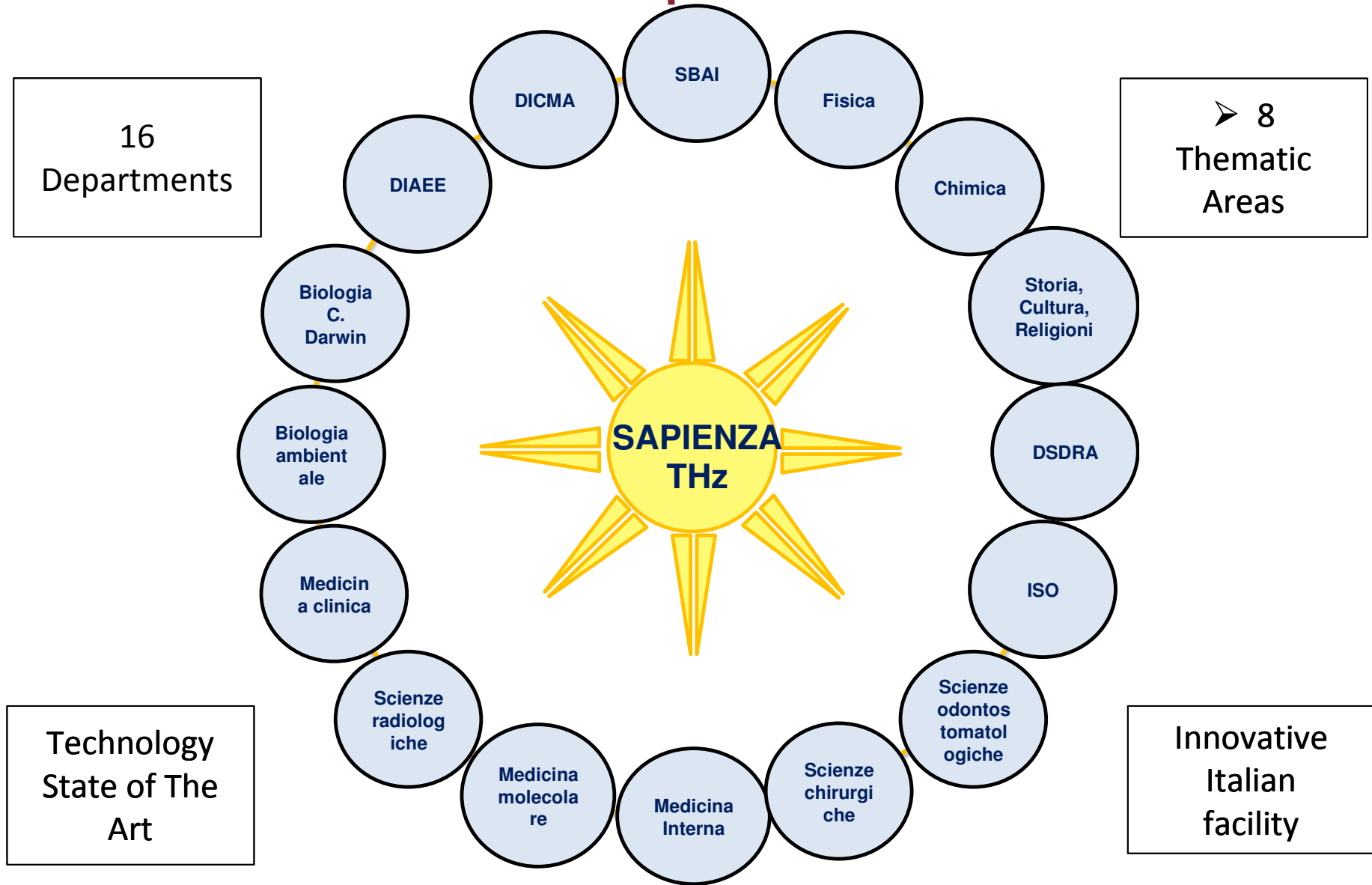


SAPIENZA TeraHertz: thematic areas

A state of the art technology for THz imaging/ spectroscopy, of interest for many fields of research:



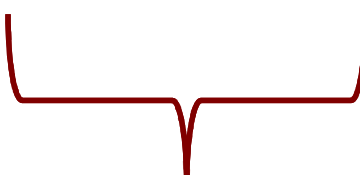
SAPIENZA TeraHertz: interdepartmental interest



SAPIENZA TeraHertz: innovative characteristics of the instrumentation

Quantum Cascade Laser (QCL) :
higher avg. power (~3mW)
compact
close-loop cooling
long lifetime

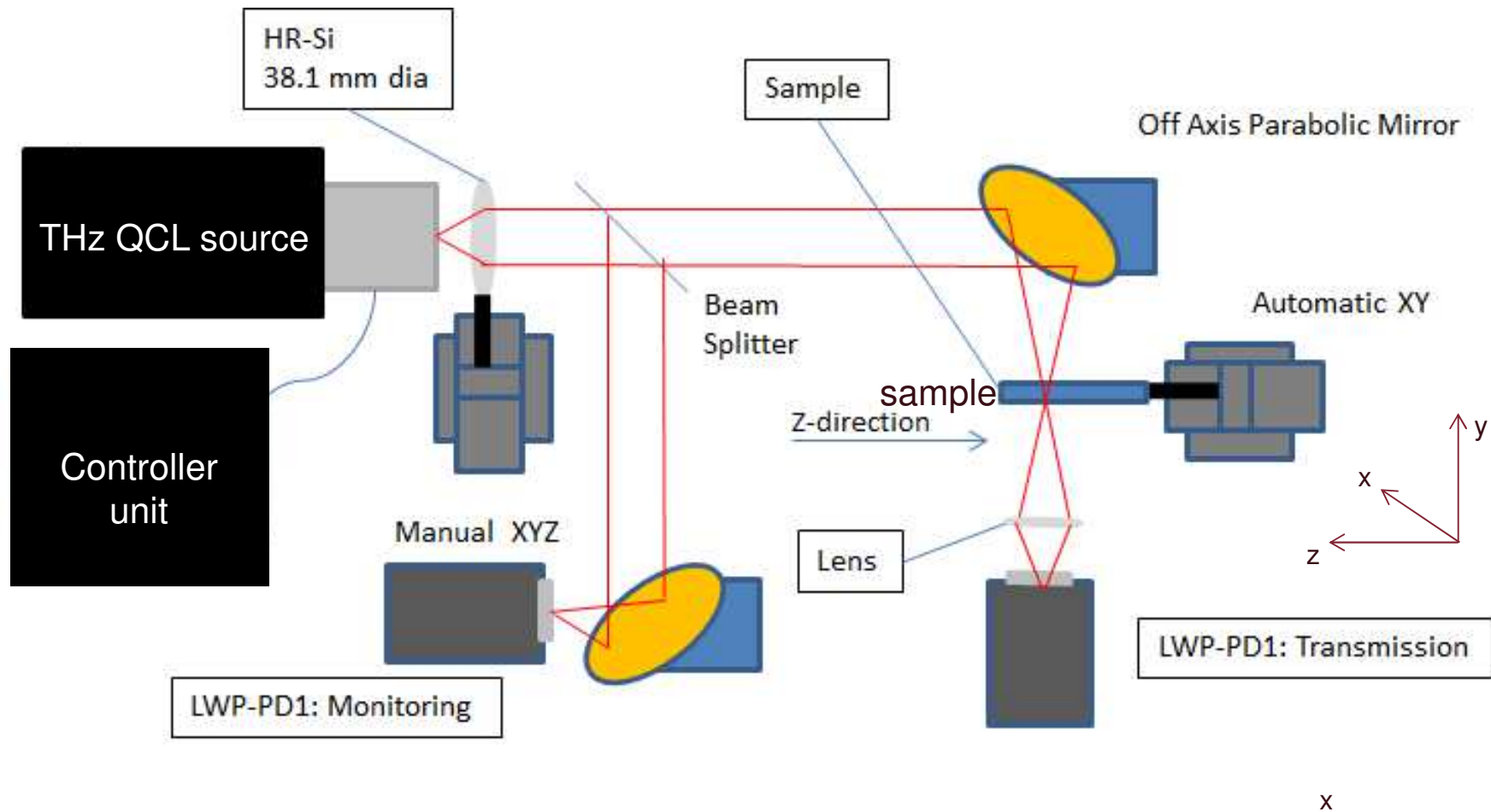
Uncooled Bolometer camera:
higher sensitivity
now uncooled
compact
large sensor area
high spatial resolution



The state of the art of the technology for both the
sources and detectors
NOW allows
*Spectroscopy Imaging **through** material **in real-time***

Sapienza will host the most powerful compact and commercially available source to develop THz Spectroscopy Imaging system with the highest spatial resolution (down to diffraction limit)

SAPIENZA TeraHertz: schematic layout



SAPIENZA TeraHertz Facility: regulation of use

- The use of the facility is open to the whole staff of La Sapienza, professors and researchers at any level, for the execution of approved research project and for educational purposes (~5% of facility operative time).
- The use facility is also granted to external entities (external researchers, other Universities, research institutions, industry) based on availability.
- The utilization of the facility might be granted at no-cost providing that the proposed experiment is of general interest and/or in the form of a scientific collaboration with the hosting Department.
- To access the facility, the application form have to be sent by the User/s via e-mail to the Scientific Committee.
- Daily costs for different scenario:
 - Sapienza users
 - Small and medium enterprises
 - Other external users

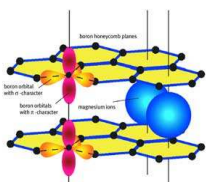
RESEARCH LINES:

THz Science Established by the European THz Roadmap 2017

Condensed Matter Physics

Superconductivity

Energy gap
Symmetry of the order parameter
Direct determination of the superfluid density
Dynamics of Cooper pairs



Low-dimensional materials

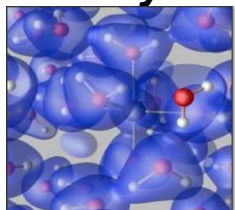
Dimensionality crossover
Non-Fermi liquid normal states
Broken symmetry ground states

Coherent Phase Transitions

Polarons
Structural Phase Transitions

Magnetic sub-ps Dynamics

Physical and Analytical Chemistry



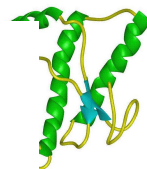
Polar liquids

Hydrogen bond
Van der Waals interactions
Acoustic-Optic phonon mixing in water

Solutions

Static and dynamic interactions between solvated ions and solvent

Life Sciences



Macromolecules conformation

Secondary and tertiary structure
Coherent dynamic development

Life and Environmental Science

Plant response to environmental changes
Detection of pollutants

Imaging

3D tomography of dry tissues
Biomedical Imaging of skin cancer
Near-field sub-wavelength spatial resolution
Cultural Heritage

New Technologies

THz technologies

Array THz detectors
Metamaterials

Medical diagnostic

Skin cancer detection

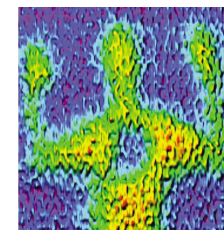
Industrial production

Material inspection
Production line monitoring

Defense industry/Homeland security

Detection of explosives and biohazards

Terahertz Wireless Communications



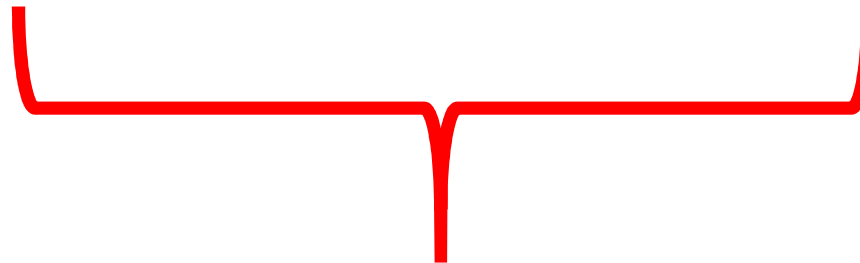
Future Perspectives

SapienzaTeraHertz

Continuous wave, High Average Power
→ Spectroscopy and Imaging

TERA@INFN

Sub-ps Source High E-field/Pulse
→ Time Resolved Spectroscopy
→ Prof. S. Lupi, Prof M. Petrarca, CALL CSN5-INFN-Roma1



A Unique National Facilities Including Imaging/Spectroscopy
and Time-Resolved Capabilities

CONTACTS

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