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# WP2 RESEARCH INFRASTRUCTURES

## Task 2.3 Unlocking the collaborative potential of EDUC Research Infrastructures

## Advancing healthcare using the Research Infrastructure CeSAR of UniCa: Nutrition during the first two years of life

Cagliari, 23th and 24th November 2023

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017526

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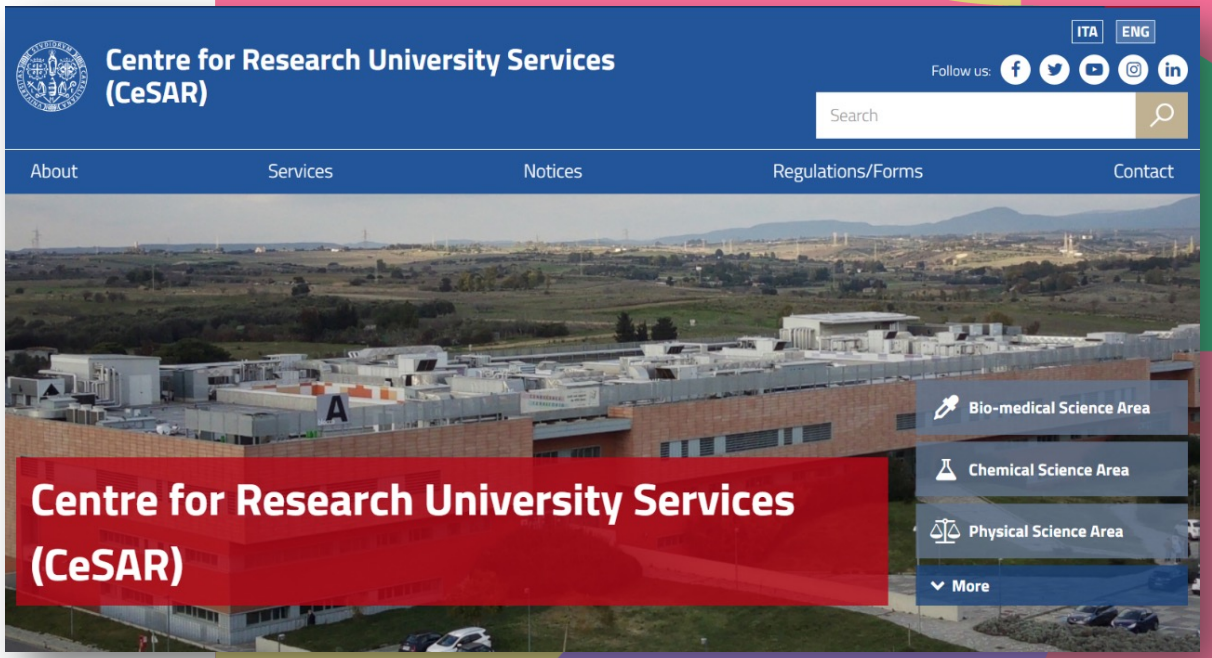
# Presentation of the Research Infrastructure CeSAR and its facilities





## Sabrina Giglio MD, PhD

*Director of Cesar*


**Cagliari, 23th and 24th November 2023**


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017526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# Innovation - Expertise - Collaboration - Education

Are the **keywords** that define the mission and nature of CeSAR

**Is a Core Facility of the Cagliari University structured in high-tech interdisciplinary laboratories equipped with cutting-edge instruments, capable of developing and applying research.**

# Innovation

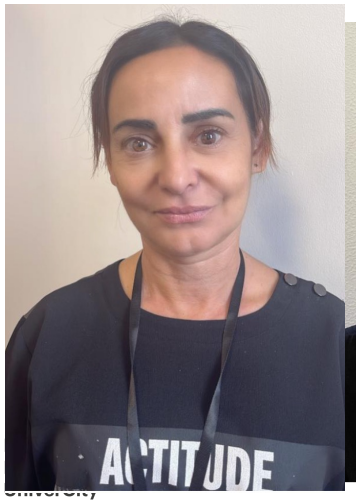
CeSAR has innovative and cutting-edge technologies

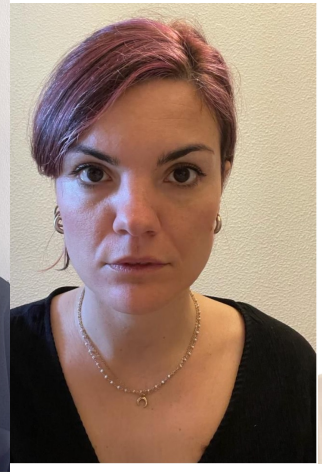
The University puts them at their service, at their disposal, with a strategically winning action.

Research arises from interactions fostered in centers at research universities

# Competence

Our technical and administrative staff with excellent professional qualifications operate at the CeSAR **to interact and collaborate with users and to allow the application of the different platforms and technologies**

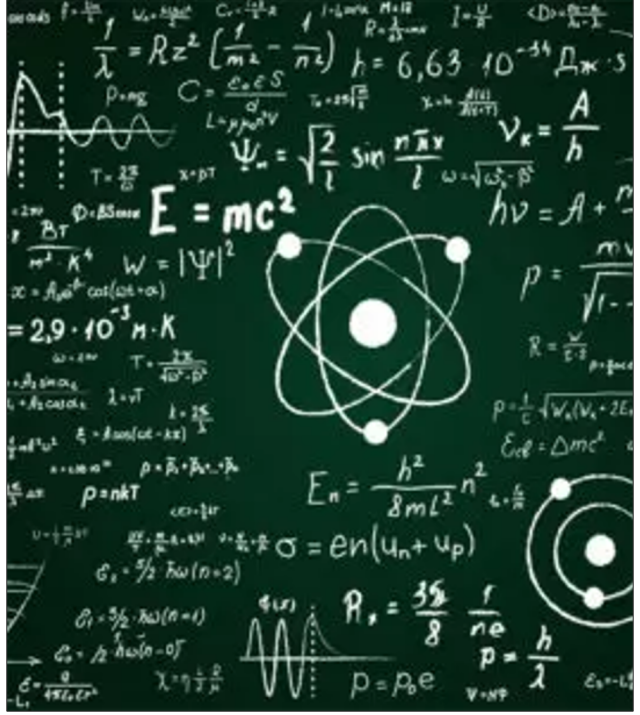




# Collaboration & Education

The technical staff guides researchers and teachers in using this equipment, providing all the technical information, and accompanying them along the path of their scientific activity.

CeSAR can provide strong support to the educational mission of our university through educational programs for a wide variety of trainees.




CeSAR
Centro Servizi d'Ateneo per la Ricerca

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# Physics Facilities

experiments, techniques, tools, support expertise in  experimental solid state physics

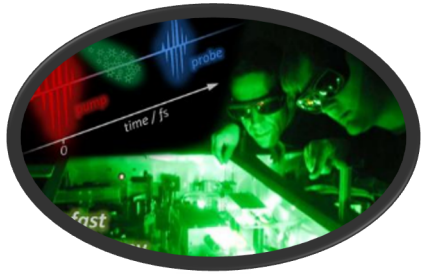
***Staff***:

**Marco Marceddu**
supervisor
ultrafast optical spectroscopy ,
SEM , Raman, cryogenics

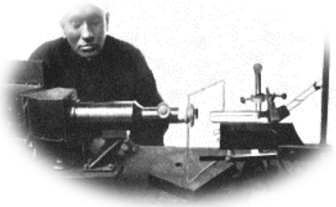
**Giovanni Piredda**
non linear optics and microscopy,
Raman, solid state properties

**Andrea Simoncini & Massimo Farris**
cryiogenics and logistics

**Ultrafast Optical Spectroscopy**




**Raman Spectroscopy**



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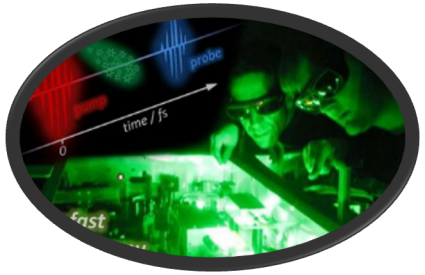
# Characterizing materials with light

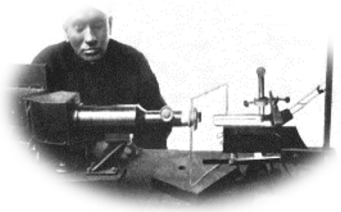
## Ultrafast Optical Spectroscopy




Excite a system with an ultrashort light pulse and track relaxation processes
- taking ultrafast snapshots
- resolving photoemission in time

Current investigations: science of multifunctional materials, photophysics of photovoltaics, novel light emitters. Many more applications are possible (e.g. study of electron transfer, optoelectronics, plasmonics)

## Raman Spectroscopy



Observe molecular vibrational states of materials through light scattering: spatially-resolved identification of materials and of their states. Extremely wide range of applications, from fundamental to applied science to medicine to the control of industrial processes

# Visualization; measurement of physical properties

## Scanning Electron Microscopy

Our Equipment: Environmental Scanning Electron Microscopy (ESEM):  FEI Quanta 200
Imaging and elemental composition analysis down to the few-nanometer scale.
Environmental mode, enabling analysis of wet (biological) and insulating samples.


**Quantum Design PPMS DynaCool: an integrated system for the characterization of thermal, electrical and magnetic properties of materials**

Fully automated, cryogen free measurement system for electrical, magnetic and thermal properties of solid-state materials in a thermally (1,8 to 400 K) and magnetically (0 to 8 T)-controlled experimental chamber

# Chemistry Facilities

***Staff***:
Dr. Sandrina Lampis
Dr. Andrea Ardu
Dr. Enrico Podda

The Chemical Sciences division includes the following facilities:

- Nuclear Magnetic Resonance (NMR);
- X-Ray Diffraction (XRD) for both powder and single-crystal;
- Transmission Electron Microscopy (TEM & HR-TEM);
- Laser granulometry

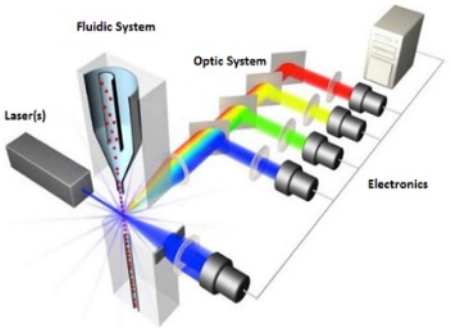
# Bio-Medical Sciences Facilities

**Staff**:
*Dr. Marta Costa*
*Dr. Giulio Ferino*
*Dr. Rita Pillai*
*Dr. Federica Cannas*
*Dr. Stefano Mocci*

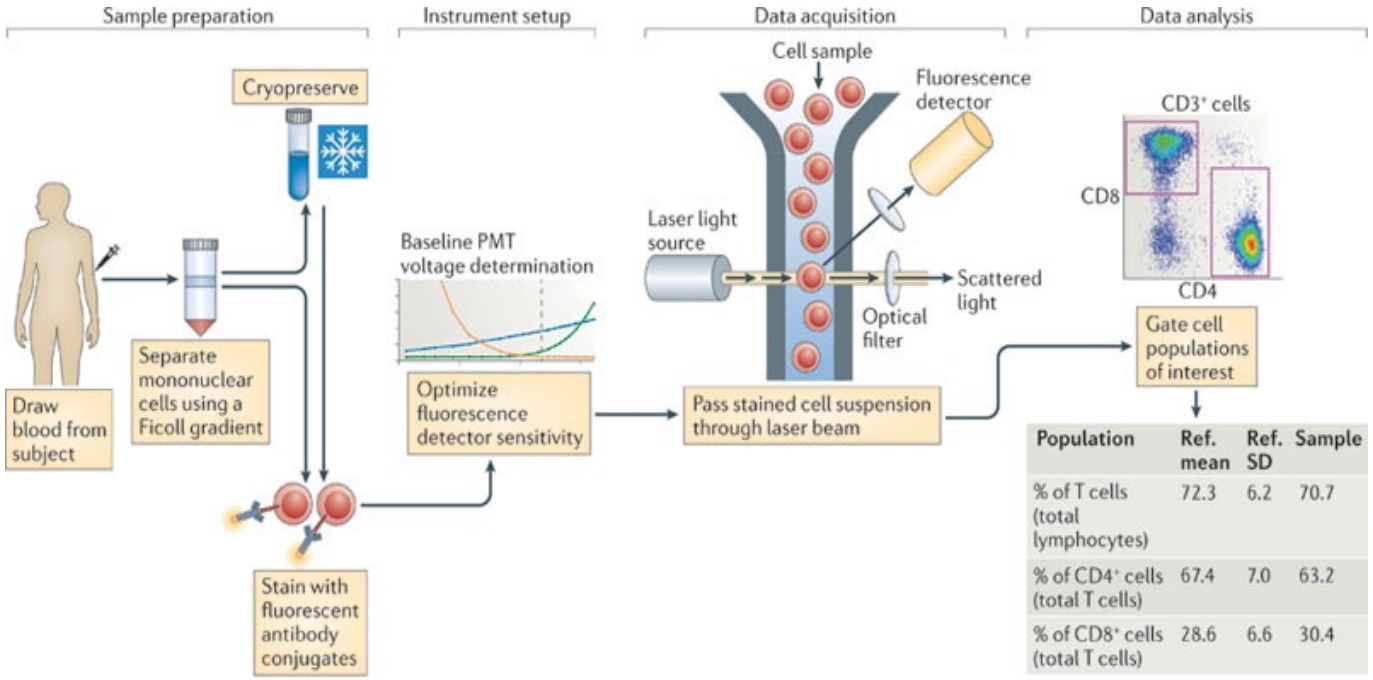
The Bio-Medical Sciences division includes the following facilities:

- **Sequencing**
- **Microarray**
- **Droplet Digital PCR**
- **Mass Spectrometry**
- **Flow Cytometry and Cell Sorting**

# Flow cytometry (FC) and cell sorting

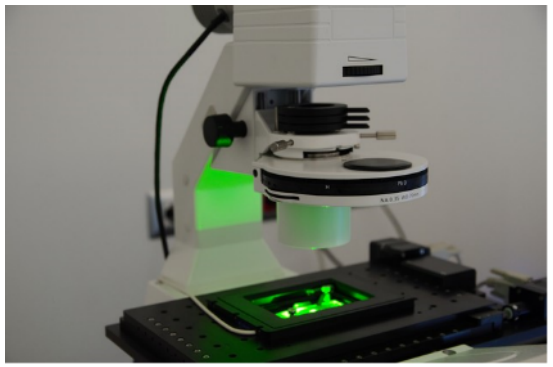



A technique that integrates electronics, fluidics, optics, laser technology and computer analysis in a single platform, allowing for simultaneous multiparametric analysis of physical/chemical/biological characteristics of particles at the single-cell level by detecting fluorescence intensity as they travel in suspension one by one past a sensing point.




| Population | Ref. mean | Ref. SD | Sample |
|---|---|---|---|
| % of T cells (total lymphocytes) | 72.3 | 6.2 | 70.7 |
| % of CD4⁺ cells (total T cells) | 67.4 | 7.0 | 63.2 |
| % of CD8⁺ cells (total T cells) | 28.6 | 6.6 | 30.4 |

# Fluorescence Microscopy

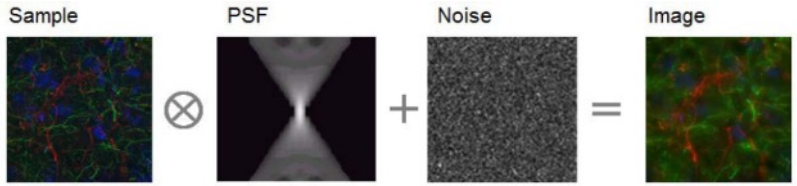


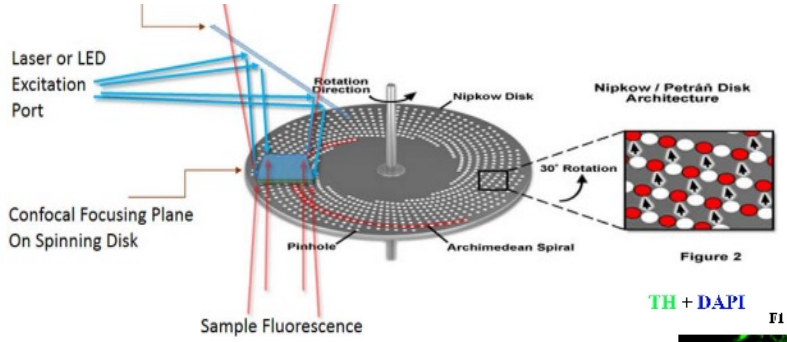
Inverted widefield fluorescence spinning disk microscope, Crisel Instruments

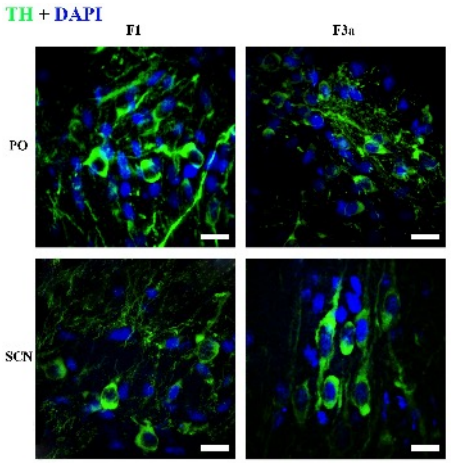
The lab is equipped with an inverted fluorescence widefield microscope, with a confocal spinning disk, an interesting compromise between scanning confocal systems (high spatial resolution) and wide-field microscopes (high acquisition speed and low photobleaching). The system allows simultaneous acquisition at different wavelengths, even on fresh samples, to reduce photo-toxicity.

***Applications:***

- *rapid dynamic studies*
- *3D localization*
- *Z stack*
- *time-lapse*
- *multiple positions:*

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# Sequencing


MiSeq NextSeq 2000


G400

**Illumina and MGI short-read sequencers** achieve high levels of throughput and cost-effectiveness sequencing.
Millions of reads produced per sample at 50 bp to 300 bp read lengths.
Support for the multiplexing of 96 bar-coded samples into a single lane.

**Main applications:** exome-seq, mRNA and Total RNA-seq, small RNA-seq, single-cell RNA-seq, 16S, cfDNA-seq.

## Oxford Nanopore Technologies (ONT) Long-Read sequencer:

ONT can analyze native DNA or RNA in real-time and sequence any length of fragment to achieve short (20 bases) to ultra-long read lengths (up to 4 Mbases), with accuracies (Q20) over 99%.

**Main applications:** *de novo* genome assembly, haplotype resolution, structural variant detection, DNA epigenetic modification direct detection), full-length transcript sequencing and splicing isoform detection


MinIon

PromethION
(coming soon)

# Droplet Digital PCR


The Bio-Rad QX200 droplet digital PCR system provides extremely accurate quantification of DNA and RNA. It uses limiting dilutions of the target in up to 20,000 sub-nanoliter droplets. It is used for applications such as CNV analyses, viral load detection, NGS library quantification, gene expression analysis, rare mutation and sequence detection, etc..

The instrument can use:

- Taqman assays with two color detection (FAM and VIC/HEX) on a single sample
- Evagreen assays with only a pair of PCR primers.

# Mass Spectrometry

The Mass Spectrometry facility in the CeSAR center provides support for the analysis of a wide range of molecules using mass spectrometry-based techniques. From low molecular weight compounds to proteins structural information studies and quantification can be performed starting from different complex matrices.

**Aplications**: biochemical clinical, organic chemistry, environmental and food, toxicology...
**Features:** speed, versatility, sensibility, selectivity

## Agilent GC-MS

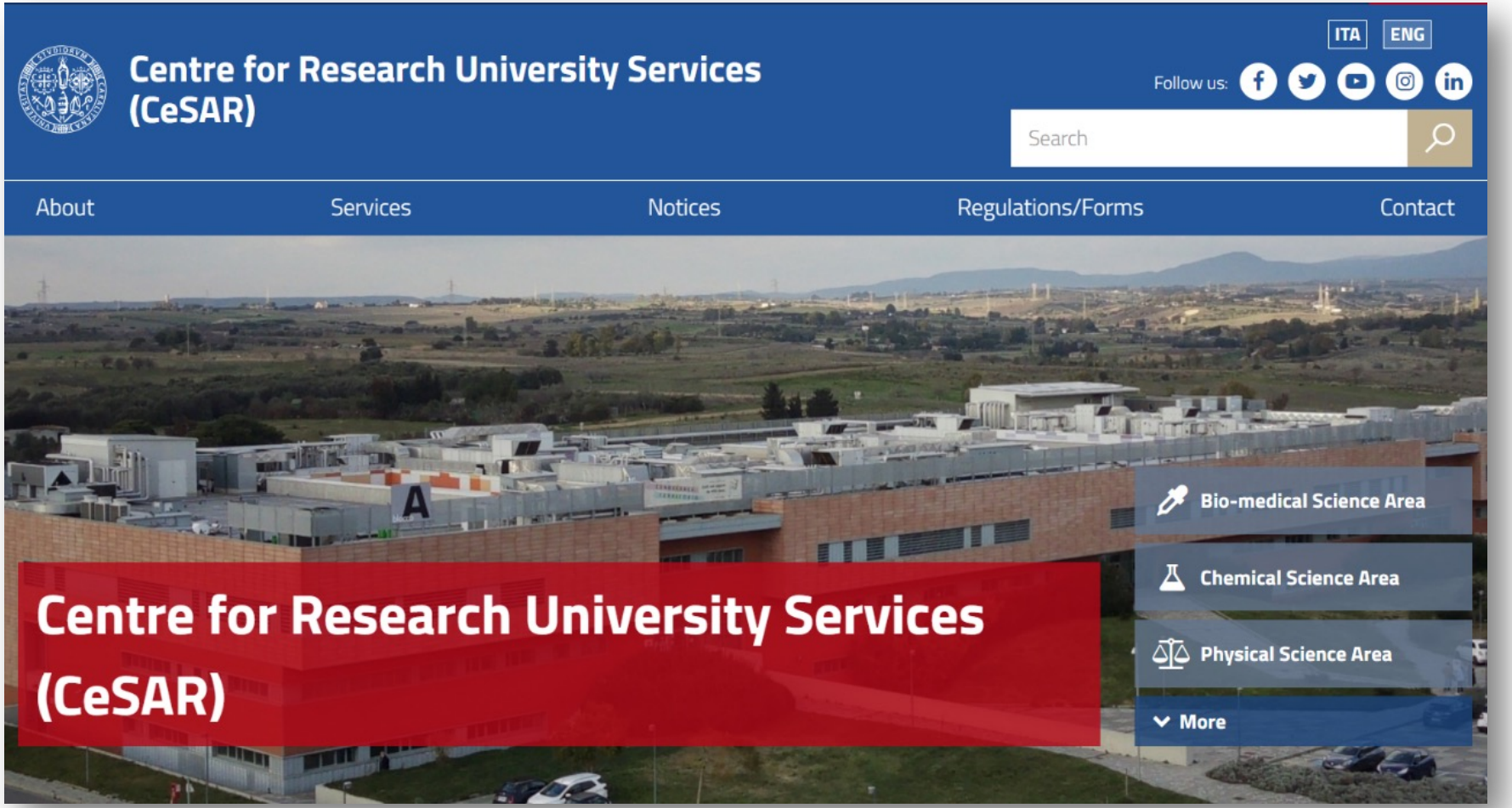
- Non-polar or low polar molecules with M.W. ≤1kDa
- Used for targeted and untargeted metabolomics
- Direct injection in E.I. source using a quick probe

## Agilent Ion Mobility LC/Q-TOF

- High resolution Ion mobility mass spectrometer
- The separation occurs based on the collision cross-section, which is a function of the molecular ions size and shape
- Used for metabolomics, lipidomics and plants extract characterization

## Thermo Fisher Orbitrap Elite LC-MS

- High resolution mass spectrometer (240000 FWHM)
- Used for structural studies of molecules
- Nano-ESI source for proteomics studies




https://web.unica.it/unica/en/cesar.page

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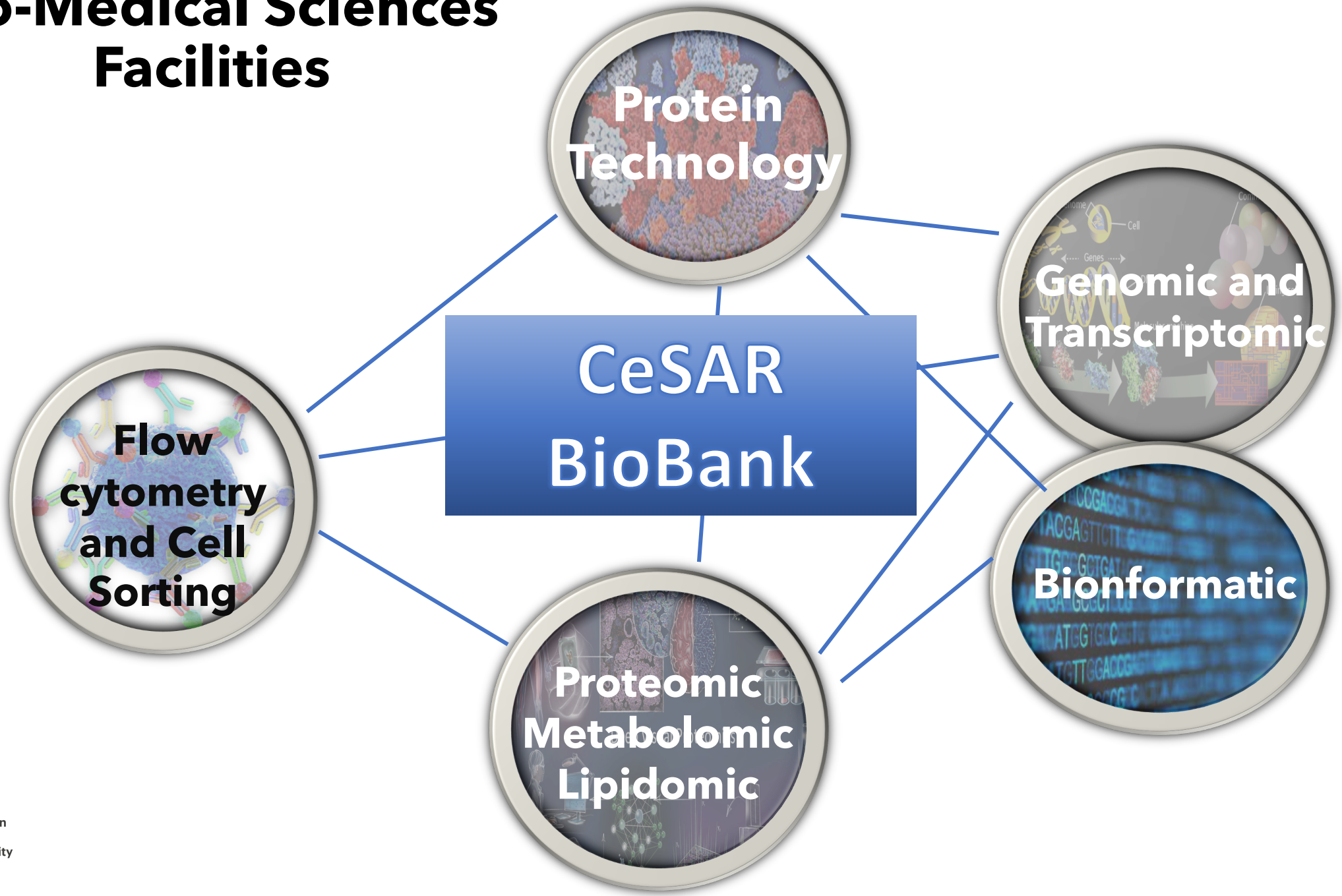
# Bio-Medical Sciences Facilities

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# Strategic turning points in CeSAR's activity

**Openness towards the outside, towards other universities, research Centers and the clinical world, including IRCSS, local health authorities, Hospitals and private companies.** A clear sign from the territory and politics for our activities comes from the fact that our Center has been included among the research infrastructures of regional relevance

**Assist researchers and users in drafting research projects to be presented in the context of competitive tenders to find funding for research and to strengthen this aspect of the university's activity**

The CeSAR, which is characterized by its interdisciplinarity and versatility, can allow all our researchers to carry out excellent research and, at the same time, collaborate with industry to develop new diagnostic and/or therapeutic systems.

We also believe that working in a Core Facility means being ready to address technical issues and **the ethical and social issues of science, open accessibility, and open science between researchers** and in relations with national or international institutions, companies and citizens.


•Thank you

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