

La collaborazione tra ENEA e Chinese Academy of Sciences

Fulvio Zonca and ENEA Contributors

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ENEA collaboration with CAS



Italian National Agency for New Technologies, Energy and Sustainable Economic Development

2012 ENEA signs a Memorandum of Understanding with Hefei Institutes of Physical Science at CAS

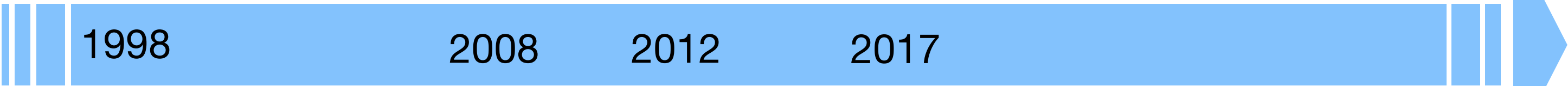
2008 China and the European Atomic Energy Community sign a cooperation agreement

2017 ENEA extends the Memorandum of Understanding with Hefei Institutes of Physical Science at CAS

1998 China and Italy sign a general Agreement on science and technology



中国科学院
CHINESE ACADEMY OF SCIENCES

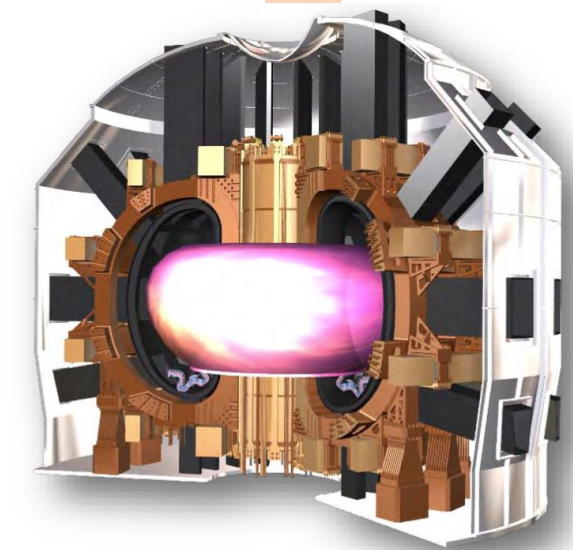
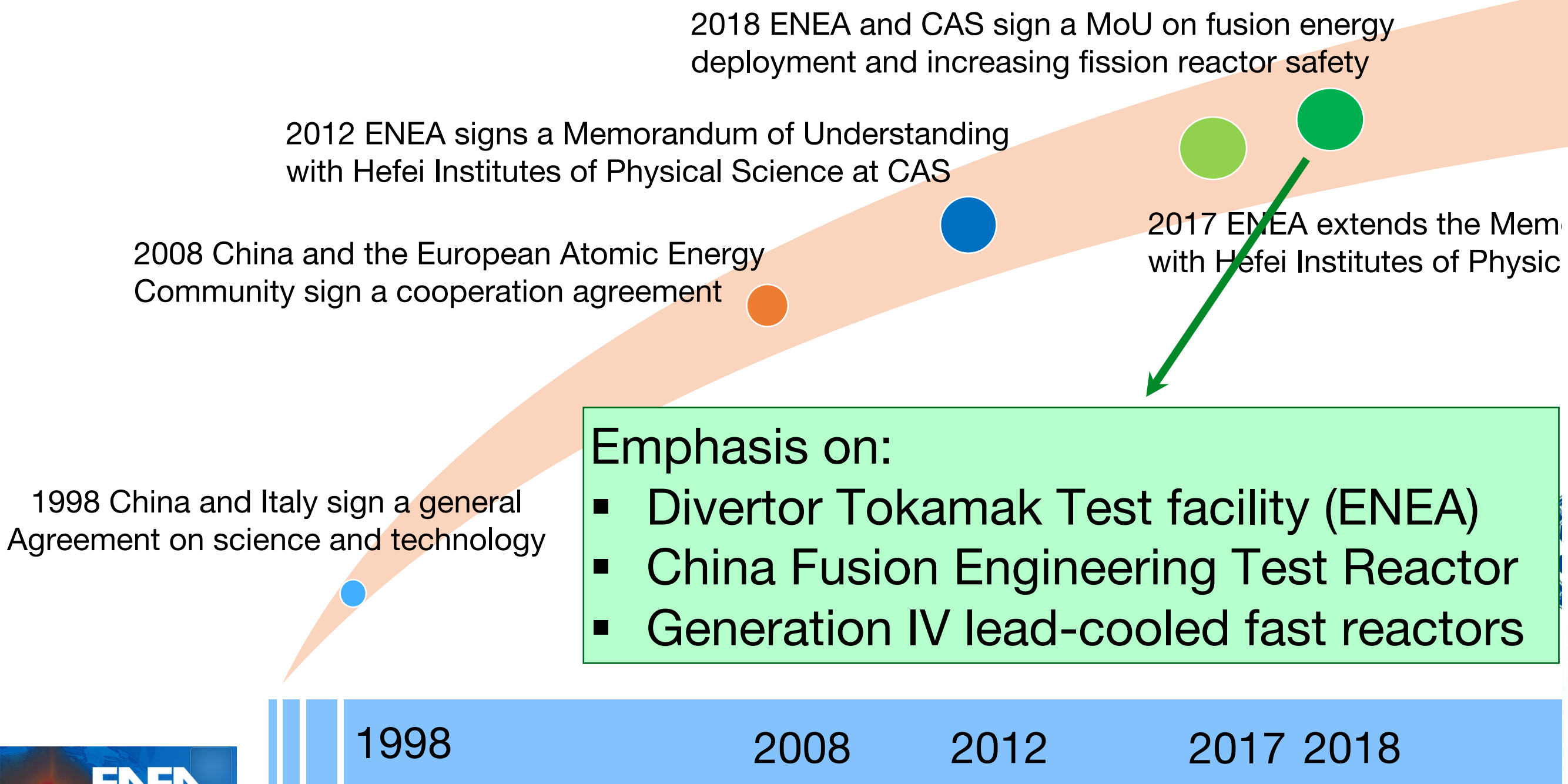


ENEA collaboration with CAS

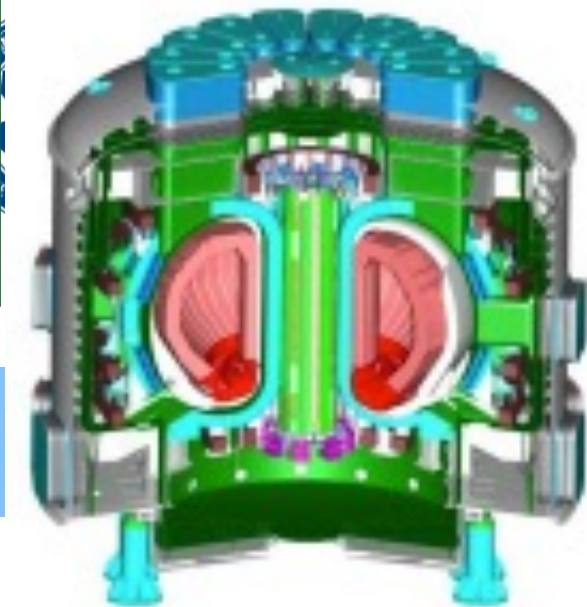
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Italian National Agency for New Technologies, Energy and Sustainable Economic Development



DTT

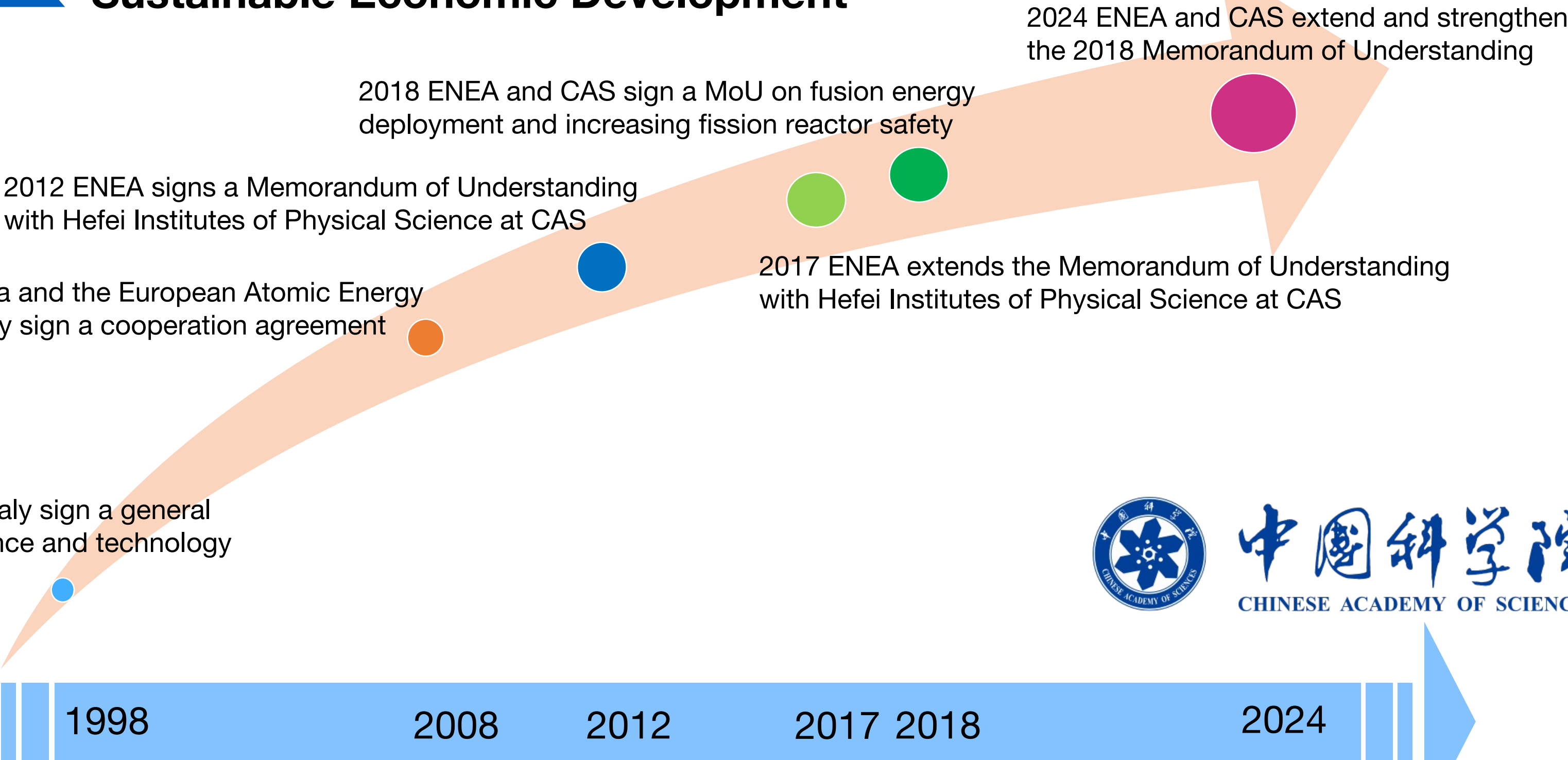


CFETR

ENEA collaboration with CAS



Italian National Agency for New Technologies, Energy and Sustainable Economic Development



中国科学院
CHINESE ACADEMY OF SCIENCES



- ❑ Establish a framework for joining knowledge and experience aiming at developing technologies for the deployment of fusion energy and increasing reactor safety

Particular emphasis on



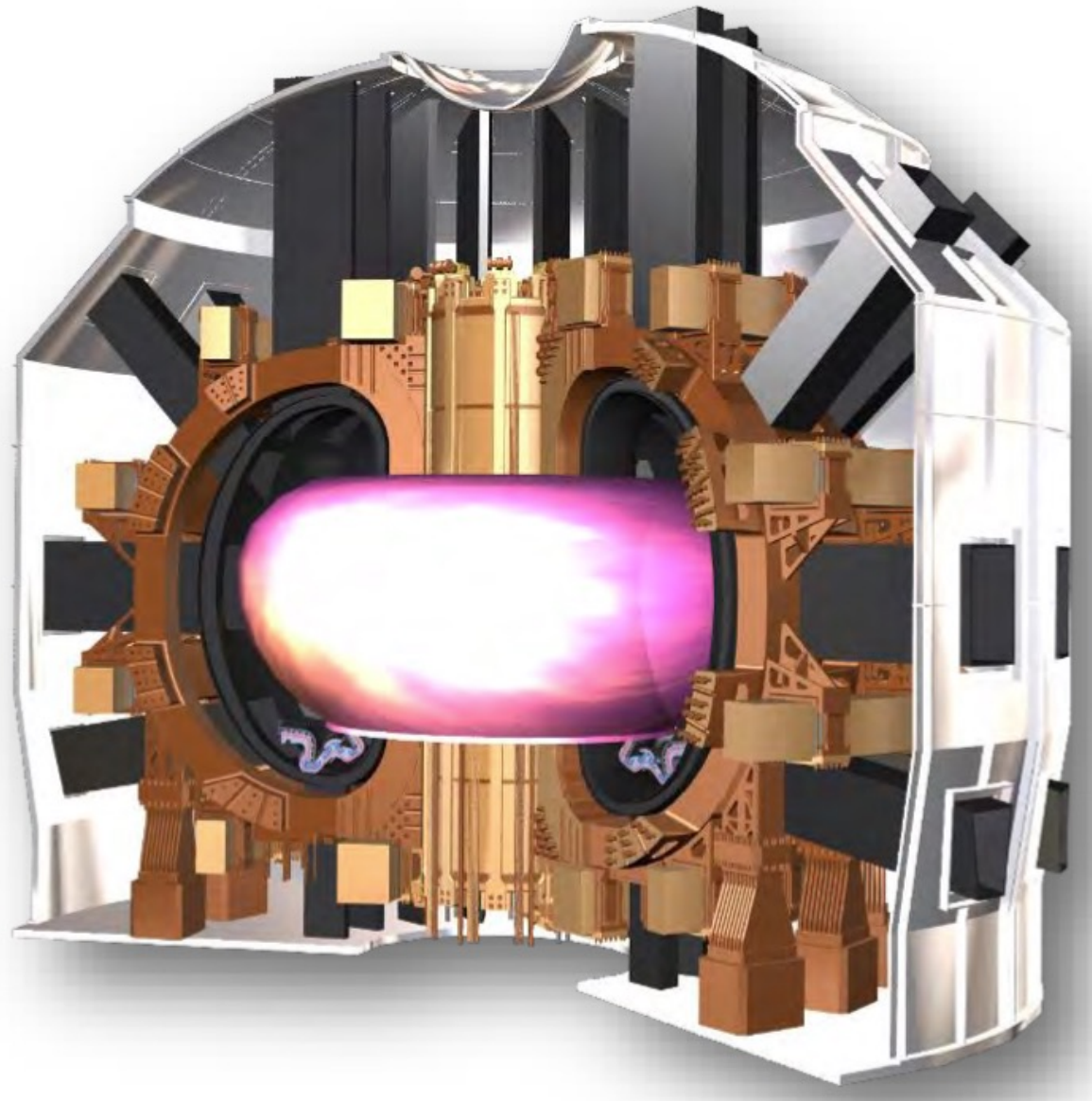
- The Divertor Tokamak Test (DTT) facility
- The demonstrative Chinese fusion reactor CFETR
- The Burning Experimental Superconducting Tokamak (BEST)

- ❑ Establish a framework for joining knowledge and experience aiming at developing technologies for the deployment of fusion energy and increasing reactor safety

Particular emphasis on

- The lead cooled Gen-IV fission reactors

Divertor Tokamak Test (DTT) facility



EXPECTED COST ~ 750M €

**Superconducting tokamak
Construction at ENEA Labs in
Frascati (Rome), Italy**

First plasma expected 2032

**Focus on power
particle exhaust**



DTT – ASIIPP collaboration

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- Prof. Jiangang Li, member of Chinese Academy of Engineering and also member of the DTT Technical and Scientific Committee since its establishment
- Exchange of information in the design and fabrication of superconducting magnets in particular with regard to the hybrid solution (LTS and HTS) adopted for BEST and to be exported in DTT
- Exchange of information in the design and fabrication of plasma facing components
- Exchange of information for possible collaboration between on the feasibility study on a MMC power supply for NBI.
- Exchange of information for possible collaboration in the field of remote handling for DTT and CRAFT, the Comprehensive Research Facility for Fusion Technology, especially with regard to the pipe cut and welding.



Courtesy of Gian Mario Polli

In the EUROfusion framework, since 2020, ENEA has signed a collaboration agreement with ASIPP to develop the **HTS technology for fusion magnets**.

EUROfusion institutions: ENEA, EPFL, Uni. Twente, IPPLM, IAP, CEA, KIT

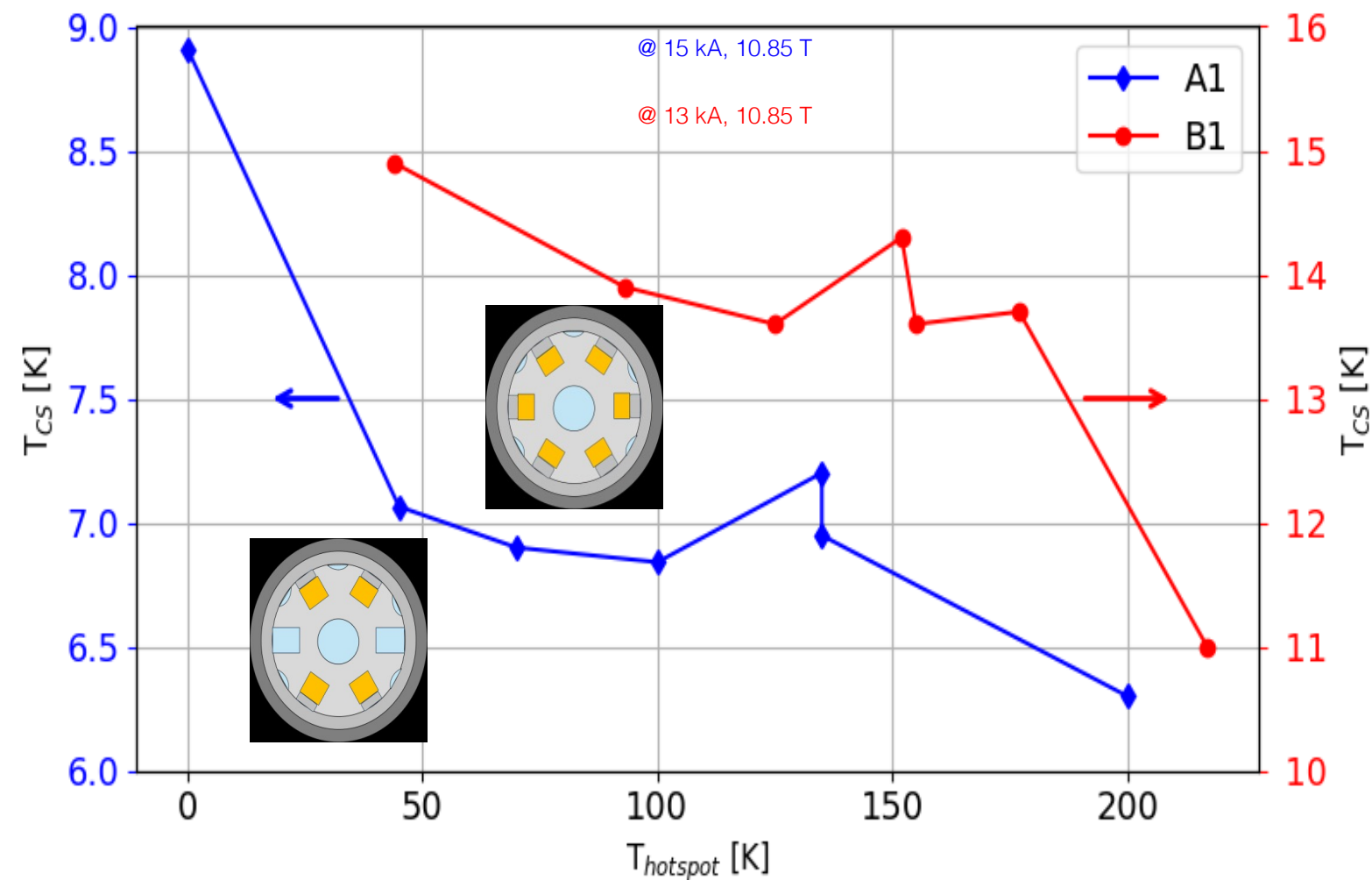
Chinese institution: ASIPP

- The aim is to cooperate on High Temperature Superconducting (HTS) technologies for EU-DEMO, BEST and CFETR magnet systems to maximize the probability of success of these projects.
- Exchange of personnel (including hosting PhD students and visiting researchers) is organized between ASIPP and EU Institutions.
- Recently, the collaboration for defining the BEST Research Plan has started.



Experiment to study the quench propagation on HTS conductors.

to quantify quench propagation velocity and effects of localized hot spot temperature

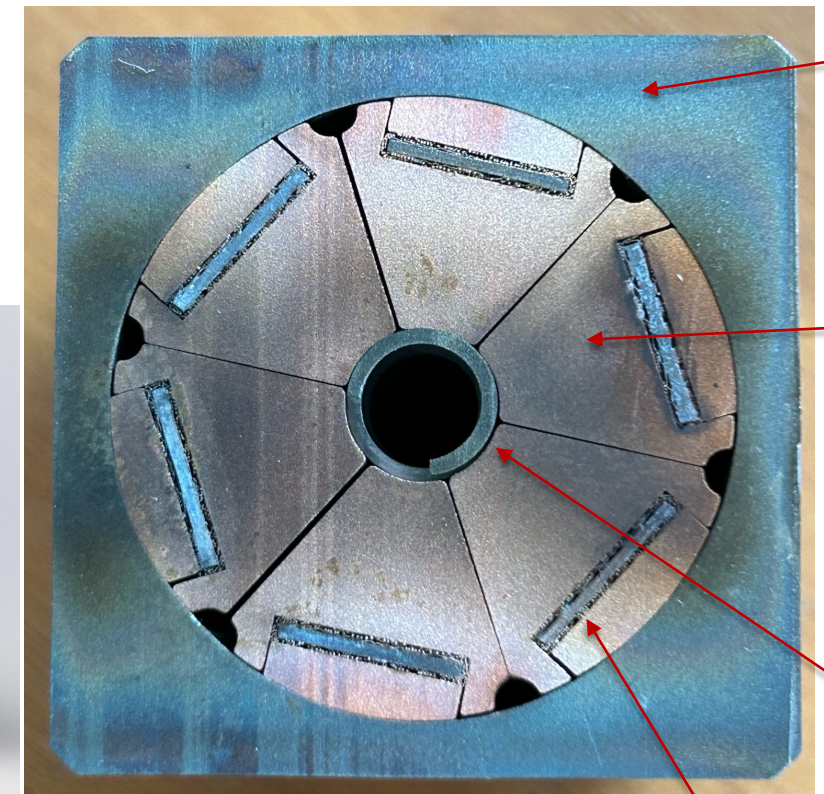
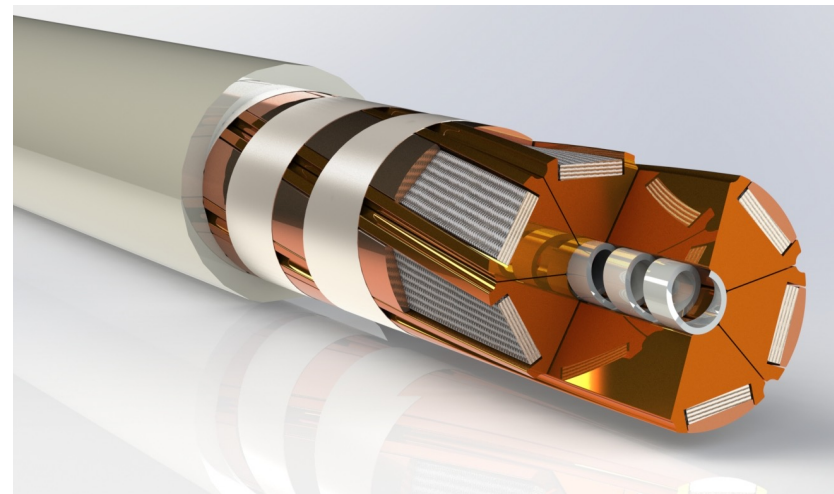


Courtesy of Giuseppe Celentano



Assess the performance of HTS conductors with electromagnetic cycles (60kA, 18T, 4.5K).

SECTor ASsembled conductor

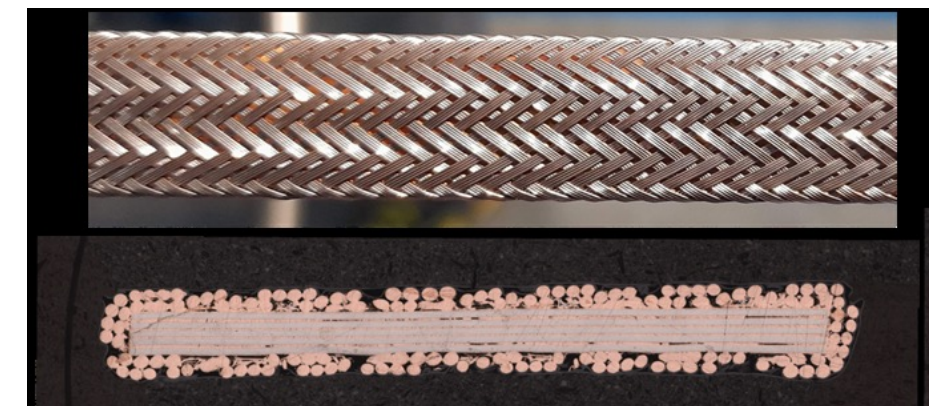


Steel Jacket

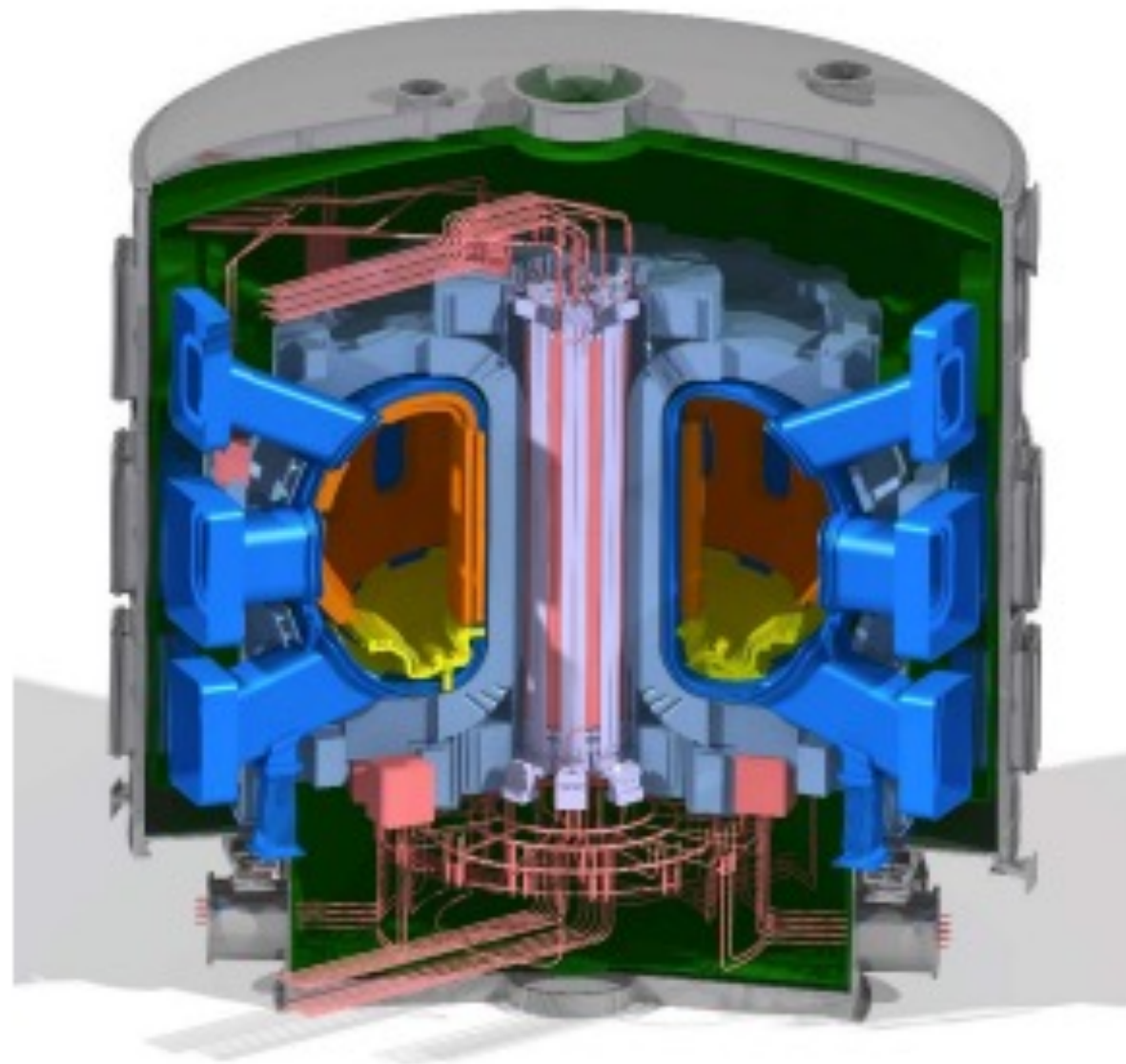
Cu profile

Steel Spiral

BRAided STAckS (BRAST) of REBCO tapes



Burning plasma Experimental Superconducting Tokamak



EXPECTED COST ~ 8.5B CNY ~ 1.1B€

**Superconducting tokamak
Construction at ASIPP Labs in
Hefei, China**

First plasma expected 2028

**Focus on D-T fuel cycle
and demonstration of
burning plasma conditions**

- ❑ Programme developed with EUROfusion participation.
- ❑ ENEA contributes with two experts; ENEA hosts one of the leading groups in burning plasma physics and also leading groups in fusion technologies
- ❑ Results will support ITER and DTT physics, creating strong synergy between the devices.

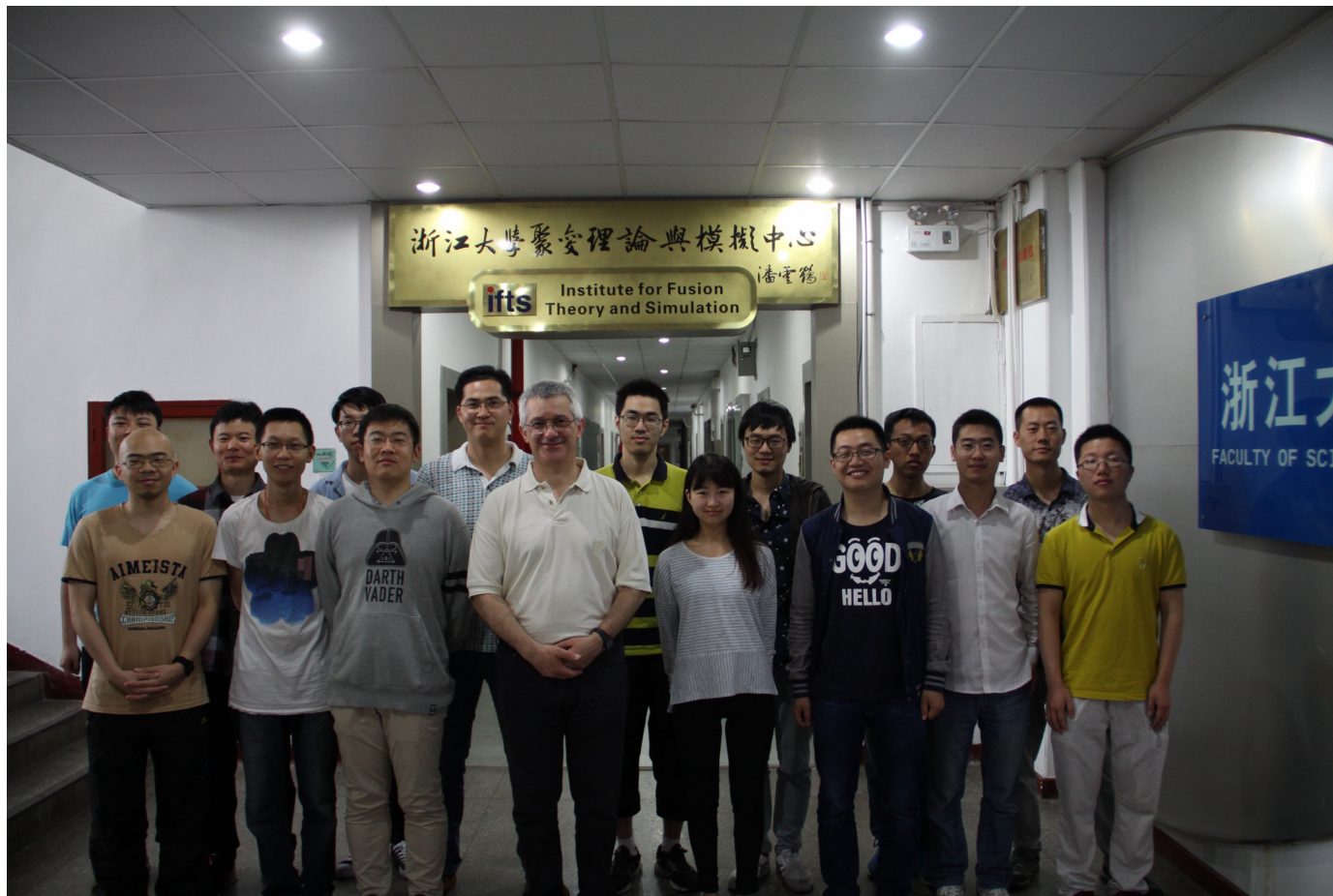


Opportunities, training and education

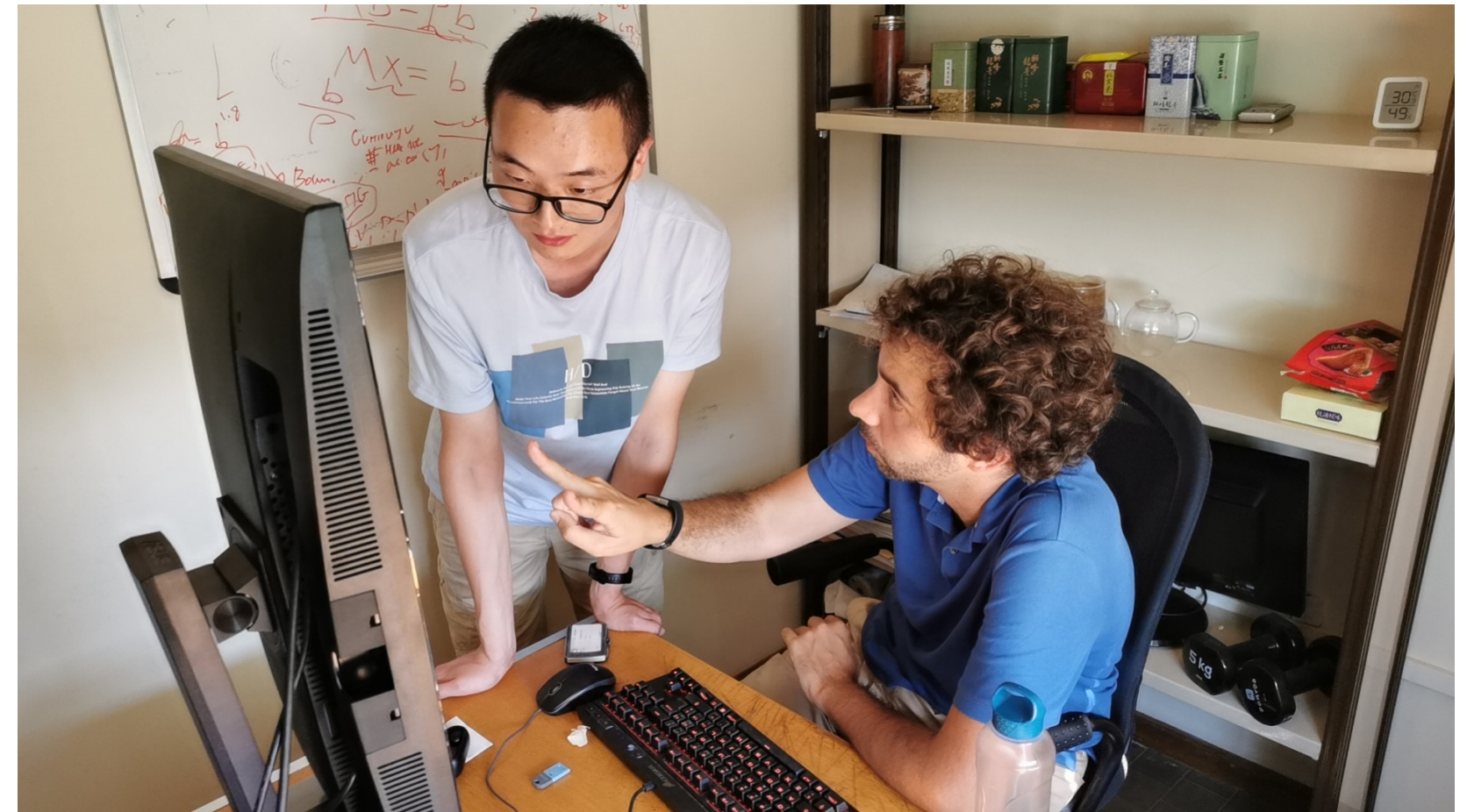
- ❑ Deployment of fusion energy and research of Gen-IV fission reactors offers great opportunities of collaboration with China, involving National Labs., Universities and public-private partnership
- ❑ This is carried out under the 2008 China–Euratom cooperation agreement
- ❑ Long term commitment in these activities emphasizes the crucial importance of training and education as fundamental elements for promoting cooperation.
- ❑ Training and education, as well as promotion of researcher mobility and of joint research and collaboration framework is specifically targeted by the Center for Nonlinear Plasma Science.

❑ Center for Nonlinear Plasma Science (CNPS) @ ENEA Frascati:

- Established in 2020 as "Virtual Center" based on two hubs, one located at the ENEA Frascati Research Center and another at the University of Science and Technology of China, Hefei (CAS) and Institute for Fusion Theory and Simulation (School of Physics) at Zhejiang University, Hangzhou
- To promote a joint research and collaboration network



Teaching at ZJU (since 2009)



Mentoring at ENEA

□ Recent extensions and new CNPS hubs

- Southwestern Institute of Physics, Chengdu, China, 2022
- CREATE Consortium, Naples, Italy, 2022
- Korea Institute of Fusion Energy, Daejeon, August 2023

□ Recent strengthening of CNPS collaboration at ASIIPP:

- Strong link with Key Laboratory of Frontier Physics in Contr. Nucl. Fusion
- Strong collaboration with Theory Group on burning plasma physics
- Project on “Turbulence and transport in burning plasmas” supported by MAECI and NSFC (2023-25)

□ Focus of future collaboration:

- Development of predictive modelling of reactor relevant burning plasmas
- Theory and simulation of EAST, BEST, DTT, CFETR



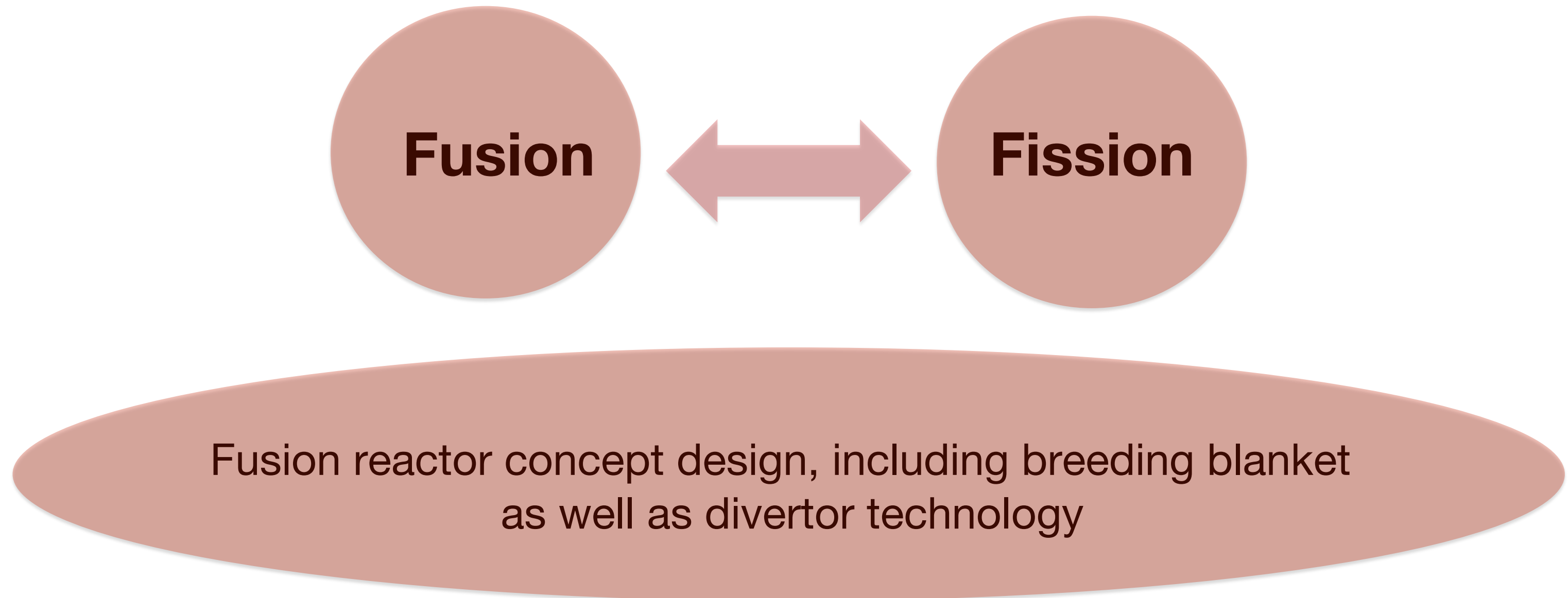
This work was supported in part by the Italian
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Fusion and Fission

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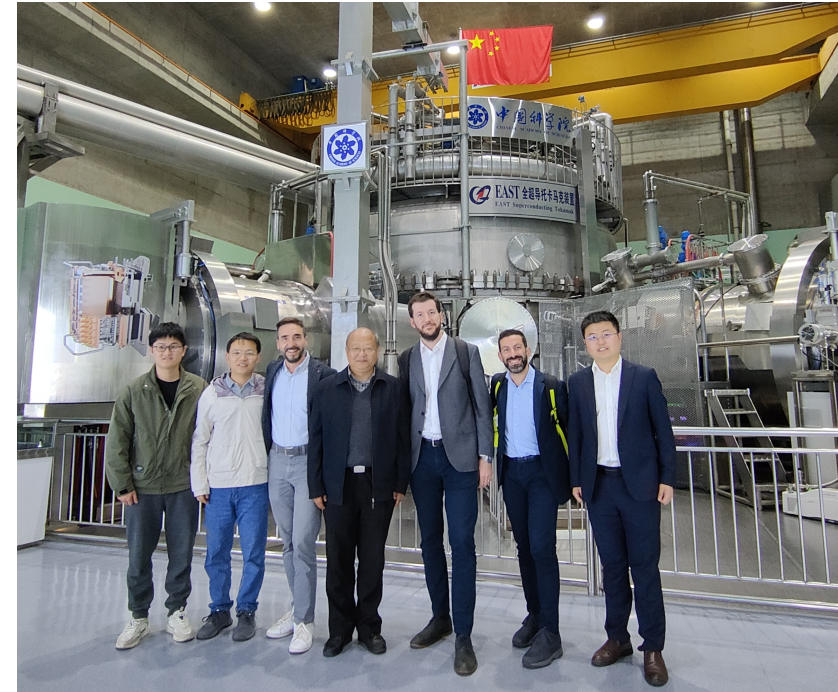
- ❑ Establish a framework for joining knowledge and experience aiming at developing technologies for the deployment of fusion energy and increasing reactor safety



- EUROfusion – EU-China cooperation
 - **ENEA – ASIPP** cooperation since 2017
 - **Breeding Blanket** (*and also BoP and safety*)
 - Focus on new experimental infrastructures for testing components and mock-ups
 - Objective: 1) Maximize/optimize the use of experimental infrastructures (complementary experiments). 2) Exchange of information for accelerating development of technologies and validation of design.

- ENEA C.R. Brasimone: experimental platform W-HYDRA (Water-Loop, STEAM and LIFUS5/Mod4 in construction)

- ASIPP- CRAFT campus, Hefei: PbLi loop and 2 Water-Loops constructed and commissioned



Italian and Chinese delegations - visit to EAST in Hefei (2024)



Water Loop 2x1700kW electrical heaters

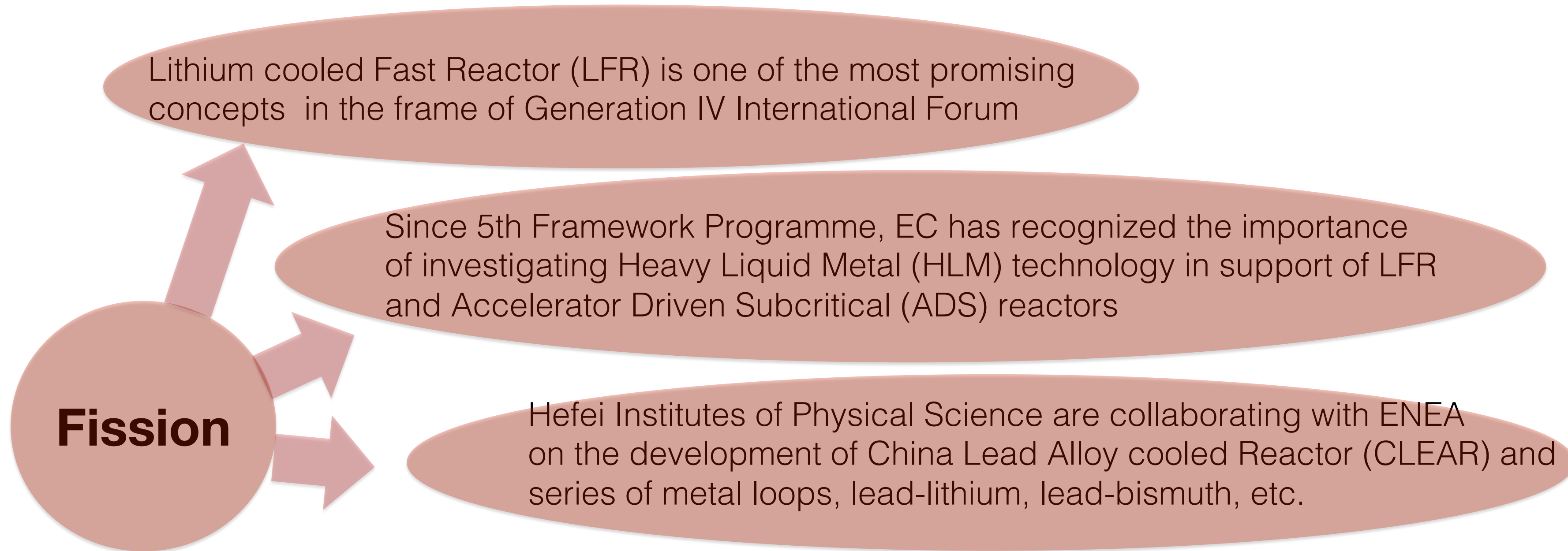


View on the Chinese Water-Loop in Hefei



Courtesy of Alessandro Del Nevo

- ❑ Establish a framework for joining knowledge and experience aiming at developing technologies for the deployment of fusion energy and increasing reactor safety



Collaboration on Heavy Liquid Metal technology for Gen-IV Lead-cooled Fast Reactor development

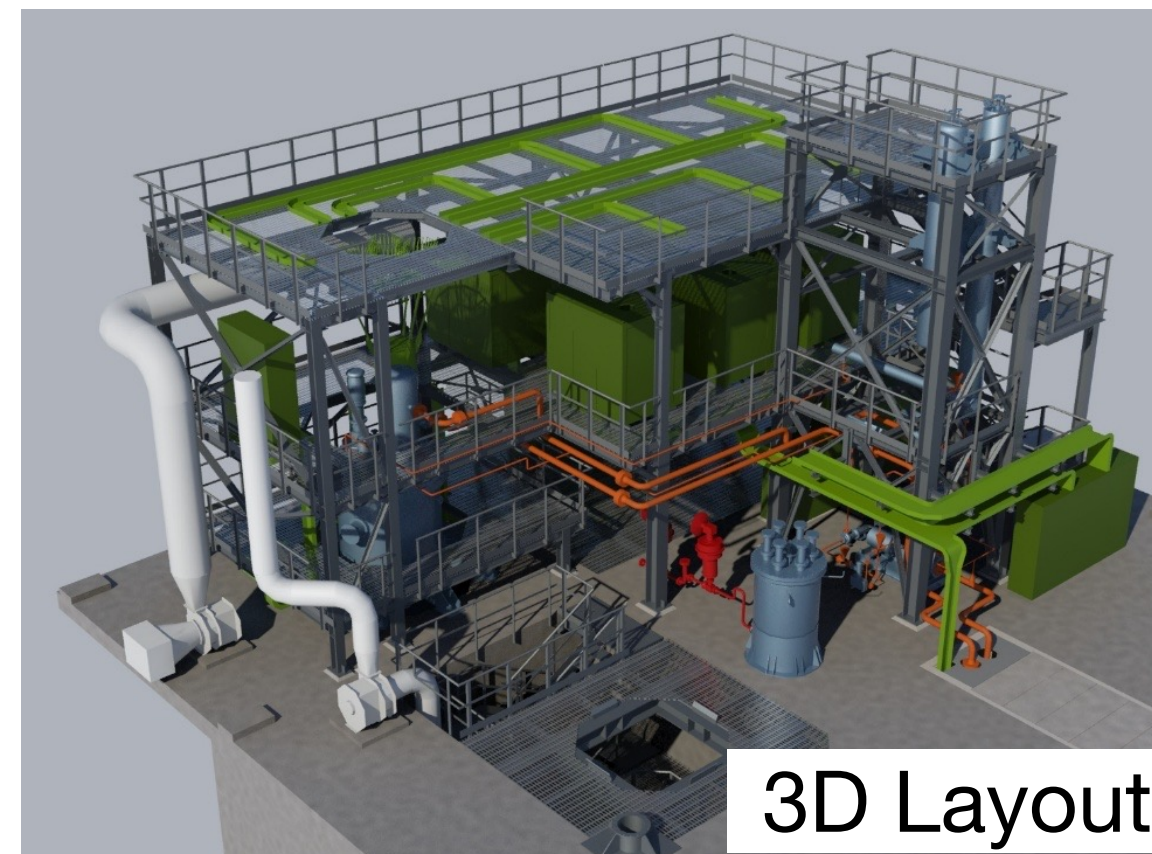
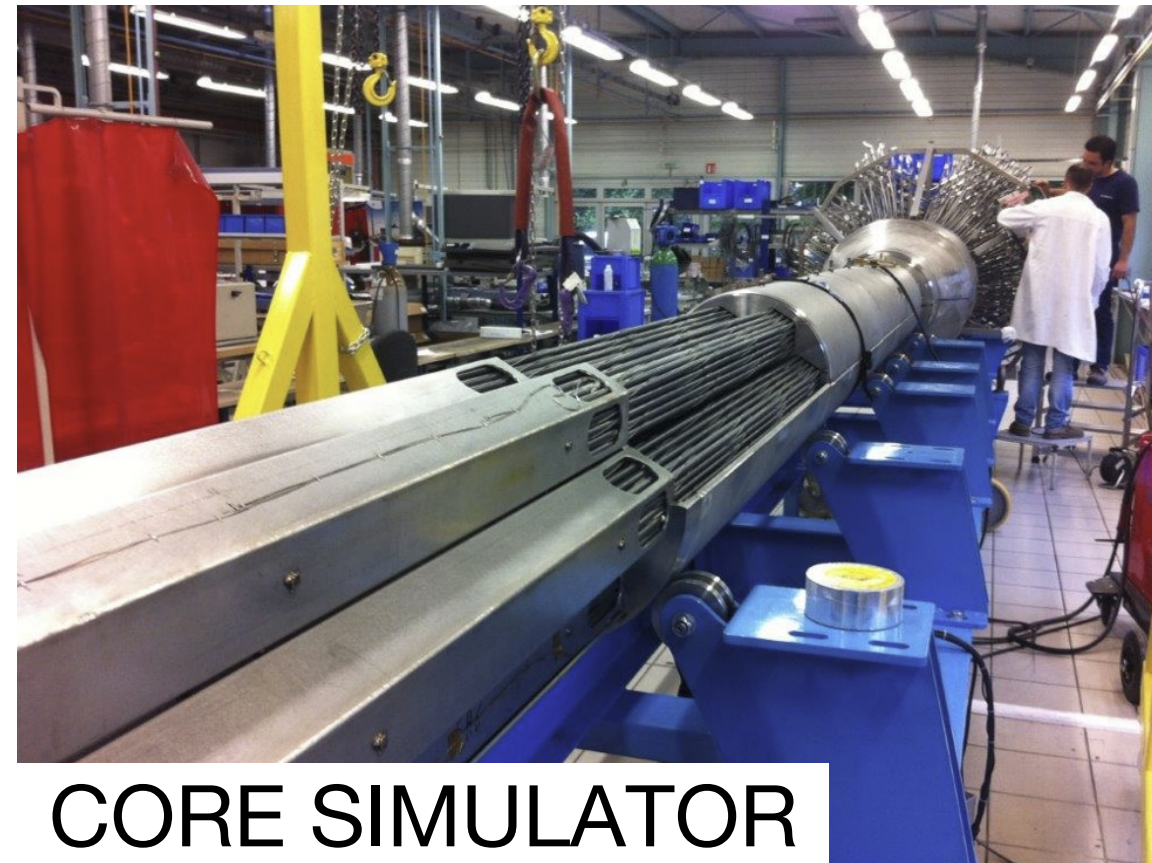
- Lead-Bismuth/Lead technology
- Components & Systems Qualification
- Thermal-Hydraulics
- Materials & Chemistry
- Numerical Tools
- Training
- Research Infrastructure Development

Courtesy of Mariano Tarantino

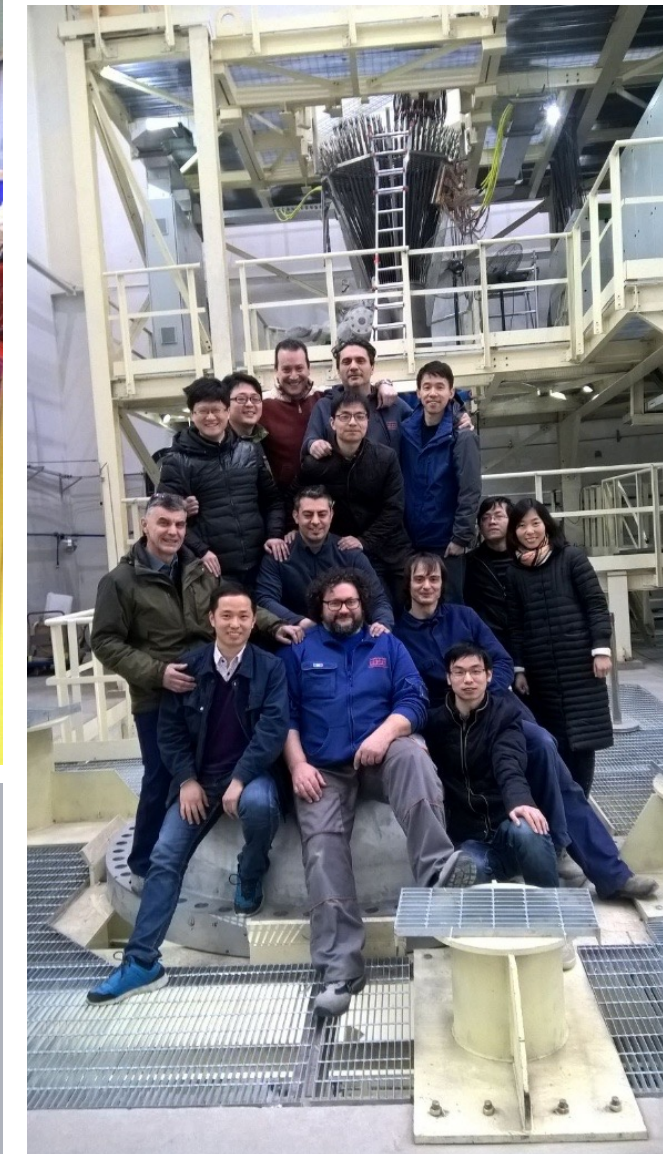
CLEAR-S Facility

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- Ⓢ LBE pool-type facility
- Ⓢ 400 tons of LBE
- Ⓢ 2,5 MW Thermal Power
- Ⓢ LBE flowrate 250 kg/s
- Ⓢ Operating Temperature 250-550°C
- Ⓢ Secondary Side with pressurized water @100 bar
- Ⓢ Unique Facility in China
- Ⓢ Strong involvement of Italian Supply Chain with SRS as Industrial Architecture



Test Section



Courtesy of Mariano Tarantino

CLEAR-M1x Facility

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- @ LBE pool-type facility (movable facility installed on truck)
- @ > tons of LBE
- @ 2,5 MW Thermal Power
- @ LBE flowrate 250 kg/s
- @ Operating Temperature 250-550°C
- @ Secondary Side with pressurized water @100 bar
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Test Section

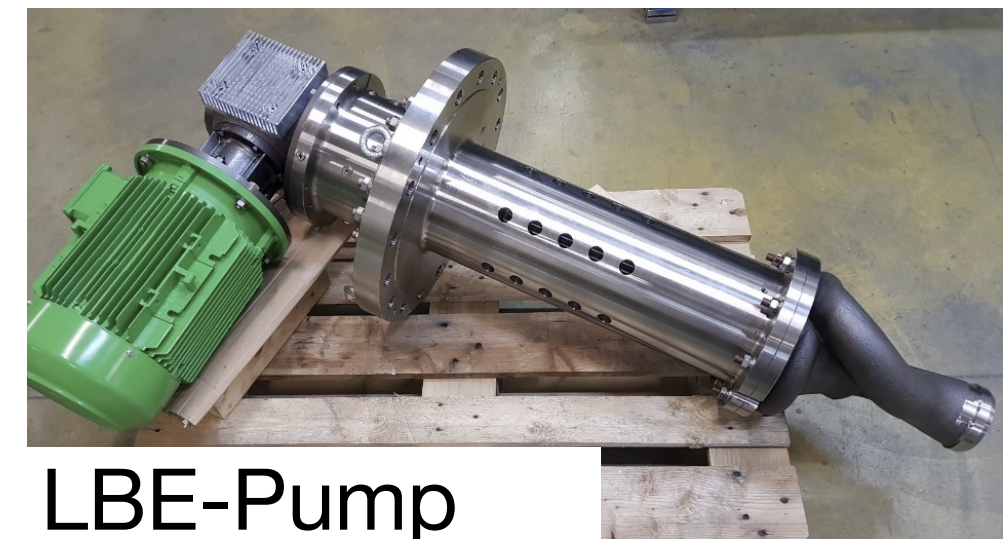


Innovative Steam Generator



Facility Overview

F. Zonca et al. — CELRIC 2026



LBE-Pump

Courtesy of Mariano Tarantino

- Collaboration between ENEA and CAS traces back more than two decades and encompasses scientific and technology research in the fields of controlled thermonuclear fusion and next generation fission reactors.
- Existing collaborations focus on the realization of experimental infrastructures, such as BEST (ASIPP, Hefei) and DTT (Frascati), and studies of Gen-IV fission reactors
- Common research projects offer rich opportunities for National Laboratories, Universities as well as public-private-partnership
- Long term commitment in these activities emphasizes the crucial importance of training and education as fundamental elements for promoting cooperation.