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# **Overview of Fusion Research Activities in China**

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*Dr. LUO Delong*

*Direct-General, CNDA, MOST*

*Virtual Meeting, March 23, 2021 presented at 10<sup>th</sup> MFCW*



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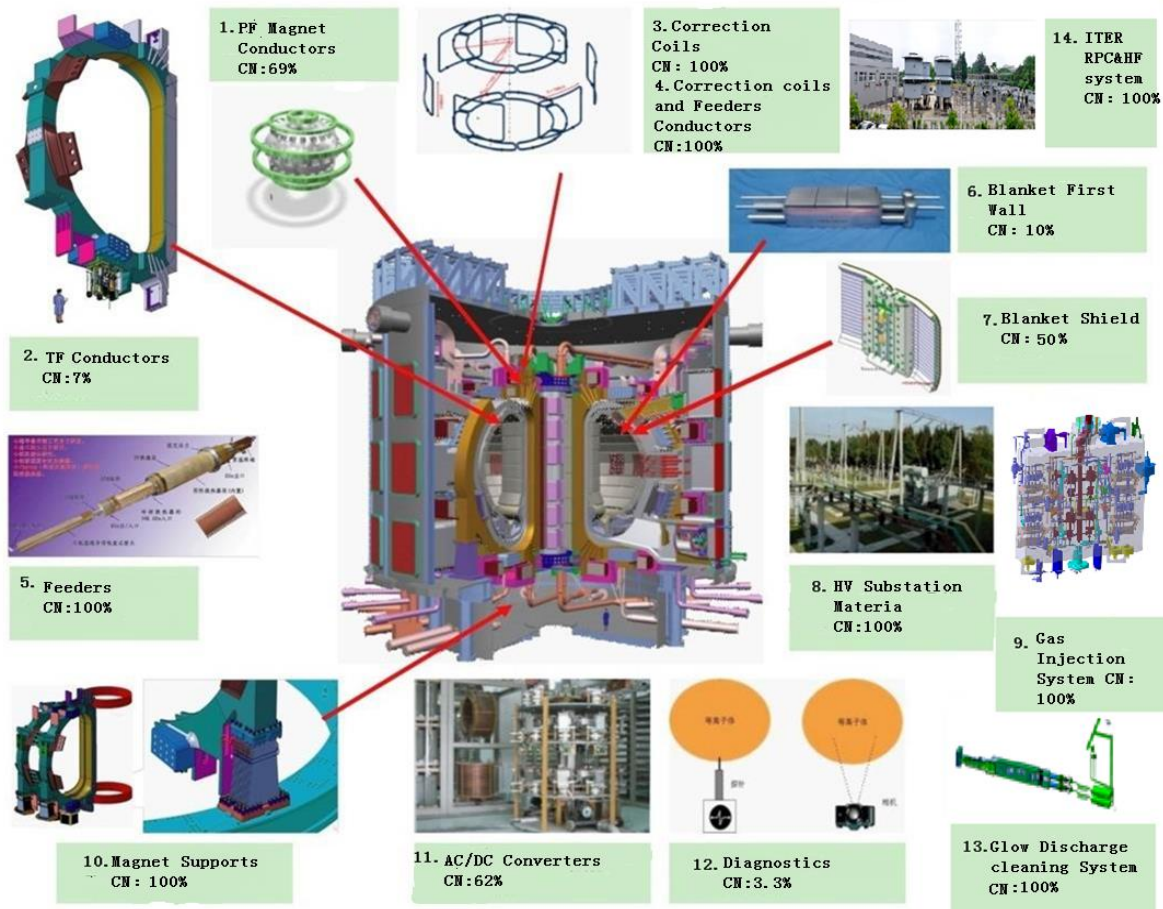
**01 Progress of ITER Implementation in China**

**02 Progress of Domestic R&D in Fusion Energy Research in China**

**03 Progress of Fusion Research International Cooperation in China**



## China's In-Kind Contribution to the ITER Machine



Total: 269.565 kIUA

Activity completion: 71.24%

14 PAs and 4 amendments have been signed for magnets, blanket, power supply, diagnostic system etc.



## CNDA PA Highlights

Feeder ICF delivery



Feeder CTBs assembly



Feeder TF CFT FAT



CC packing



CC case laser welding

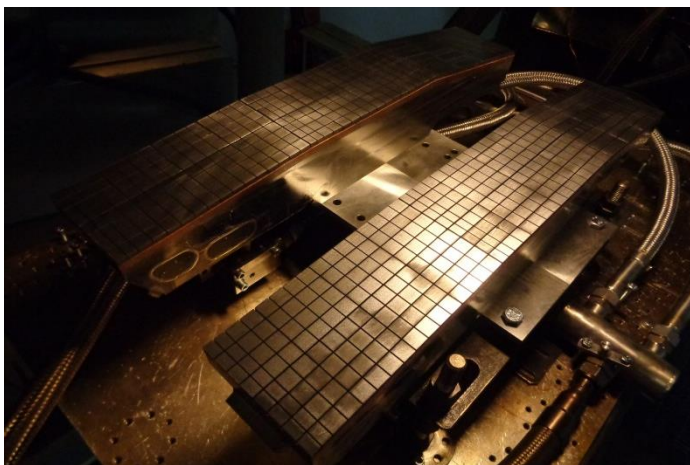


CC winding

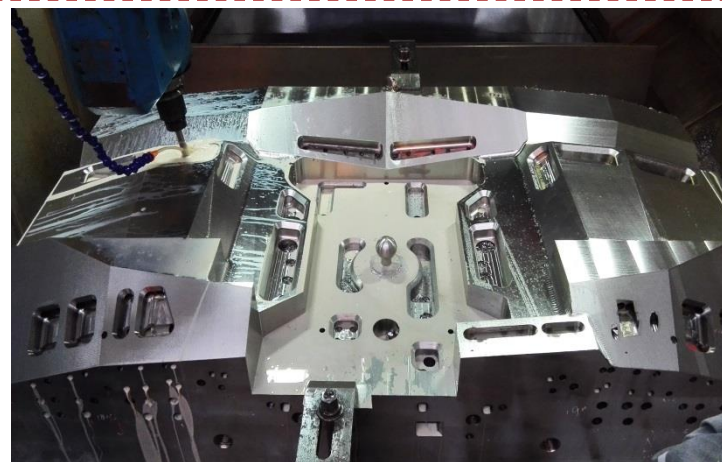




## CNDA PA Highlights



Qualified Semi-Prototype FW(5MW/m<sup>2</sup>)



Qualified Shield Block Prototype



Unique HHLT facility for ITER (10<sup>-10</sup> Pa · m<sup>3</sup>/s)



PF5, PF6, and 1<sup>st</sup> CC supports delivered





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## CNDA PA Highlights-CC Delivery Ceremony



Ceremony for the Delivery of the First Batch of ITER CC Coils, September 22, 2020



# The Start of Machine Assembly of ITER, July 28th 2020.





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## The Start of Machine Assembly of ITER, July 28th 2020.

### 习近平向国际热核聚变实验堆计划 重大工程安装启动仪式 致贺信

国际热核聚变实验堆（ITER）计划重大工程安装启动仪式7月28日在法国该组织总部举行。国家主席习近平致贺信。

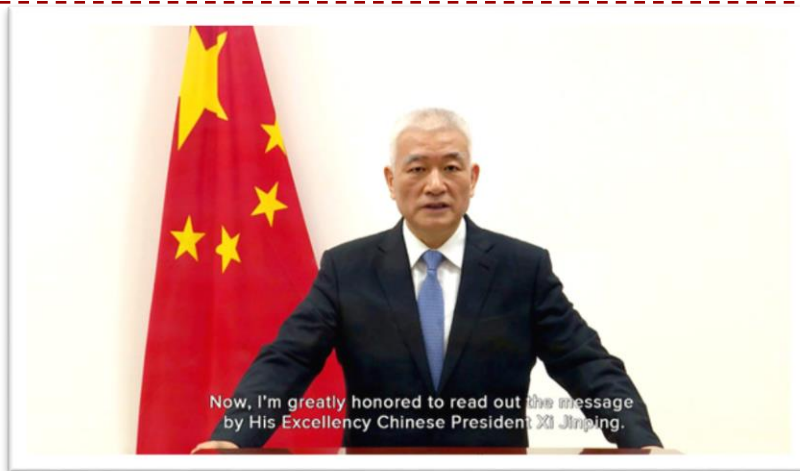
习近平指出，科学无国界，创新无止境。国际科技合作对于应对人类面临的全球性挑战具有重要意义。国际热核聚变实验堆计划承载着人类和平利用核聚变能的美好愿望，计划实施以来，中方始终恪守国际承诺，中国企业和科研人员勇挑重担，与国际同行齐心协力，为计划的顺利推进贡献了中国智慧和力量。十多年来的积极探索和实践充分证明，开放交流是探索科学前沿的关键路径。

习近平强调，当前，全球正面临新冠肺炎疫情带来的严峻挑战，人类比以往任何时候都更需要携手前行、共克时艰。中方愿继续同各方加强科研交流合作，合力突破重大关键科学和技术，推进全球科技创新，为增进各国人民福祉、实现全球可持续发展不断作出新贡献。

国际热核聚变实验堆计划是当今世界规模最大、影响最深远的国际大科学工程，我国于2006年正式签约加入该计划。

新华社发

**Congratulatory Message  
from President XI Jinping,  
the People's Republic of China**



Now, I'm greatly honored to read out the message  
by His Excellency Chinese President XI Jinping.

**Minister of Science and Technology,  
WANG Zhigang read out the Message.**



**Vice Minister of MOST, HUANG Wei  
joined the on-line event.**





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## Domestic MCF R&D Program

### Scope & Objectives

Obtain ITER key technologies after its construction

Effectively participate in research activities on the ITER device

Promote basic fusion physical research and expand talent pool

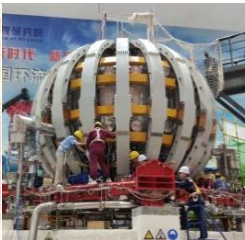
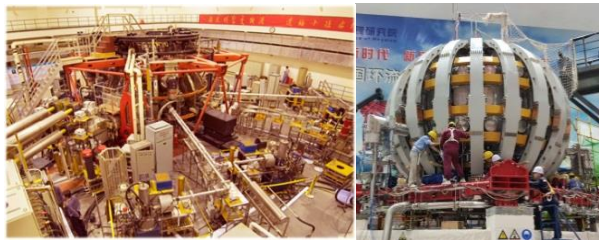
Assignments deployed to DEMO's design and R&D



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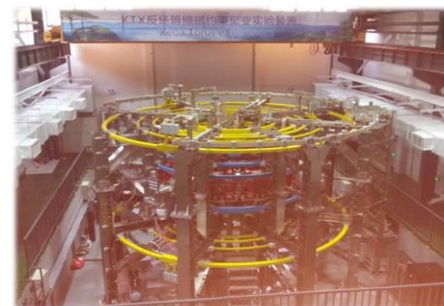
## Domestic MCF Facilities in China



Chengdu, SWIP, HL-2A/2M



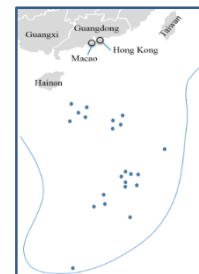
Hefei, ASIPP, EAST



Hefei, USTC, KTX



Wuhan, HUST, J-TEXT





## Research Institutes, Universities & Enterprises

- Southwestern Institute of Physics (SWIP)
- Institute of Plasma Physics, CAS (ASIPP)
- China Academy of Engineering Physics (CAEP)
- University of Science and Technology of China
- Huazhong University of Science and Technology
- Tsinghua University
- Peking University
- University of Science and Technology Beijing
- Sichuan University
- Beihang University
- Dalian University of Technology
- Harbin Institute of Technology
- Western Superconducting Technologies Co., Ltd
- Advanced Technology & Materials Co., Ltd (AT&M)
- Xiamen Honglu Tungsten Molybdenum Industry Co., Ltd
- ...

Nearly 60 entities in China have contributed to MCF R&D since 2008.



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## Highlights on Domestic Fusion Activities

**China Fusion Energy Conference (CFEC 2019) & Fusion Energy Activities Week**



**November, 2019**  
**>1200 attendees**

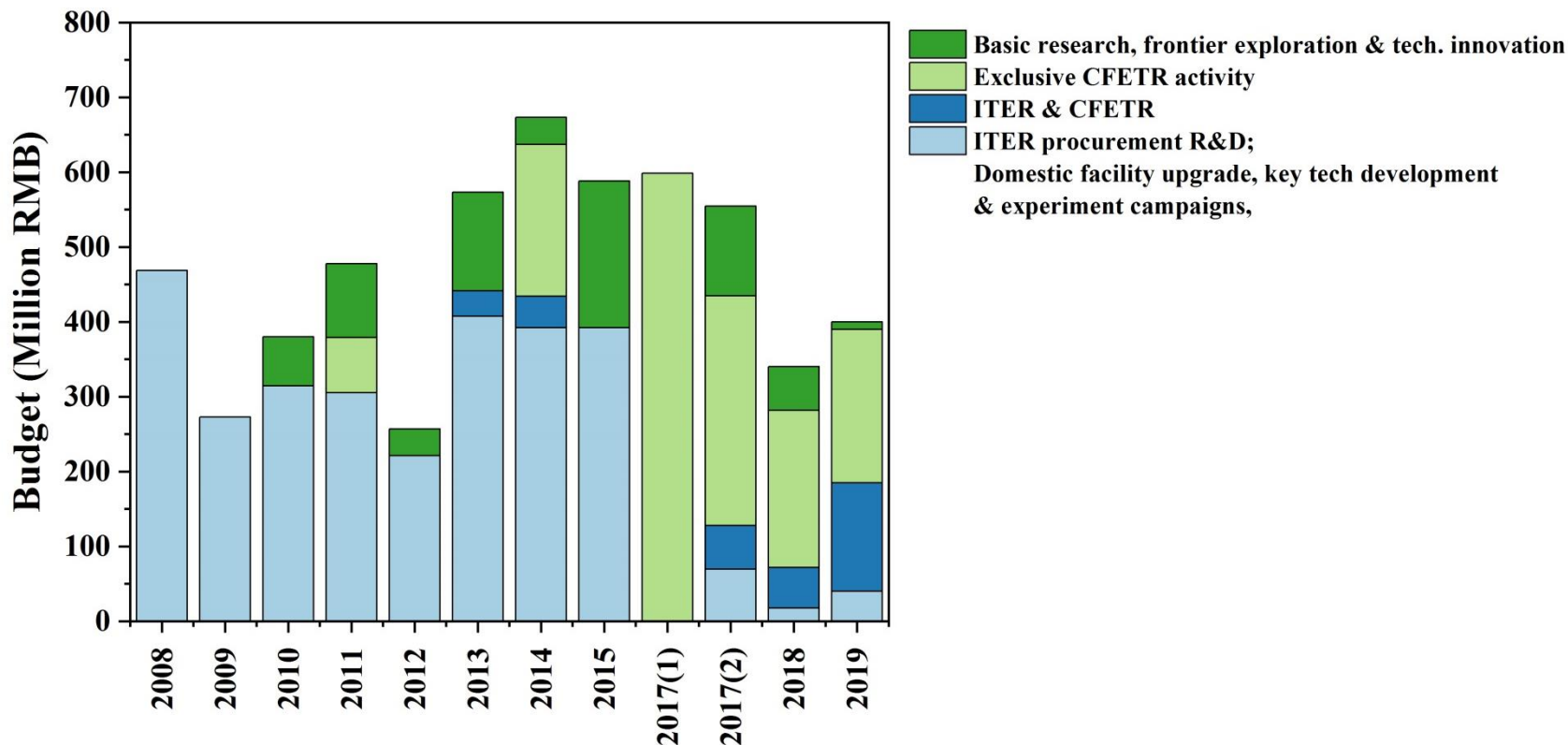
**Highlights:**  
**CFEC 2021**  
**Hefei, China**





## Funding and Activities

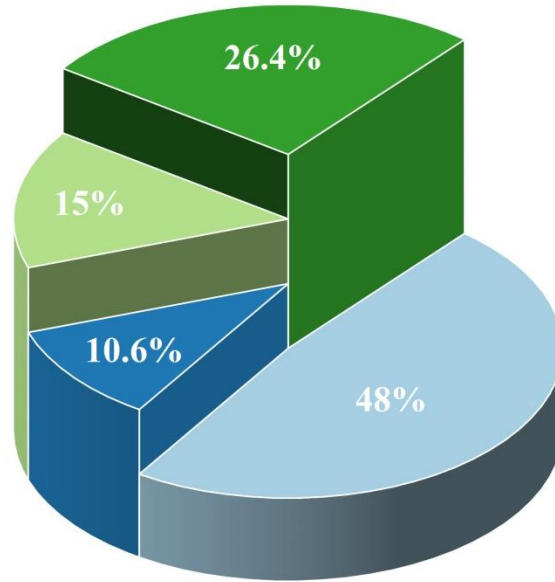
A total budget of **5581 M RMB (678 M Euros)** has been enacted between 2008 and 2019, to support ITER procurement R&D, domestic facility upgrade/key technology development/experiment campaigns, exclusive CFETR activity and so on.





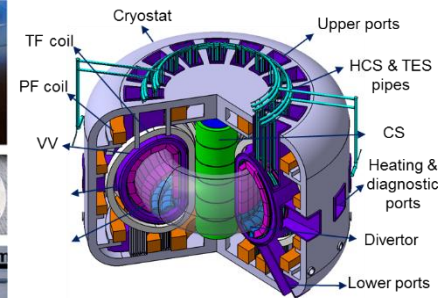
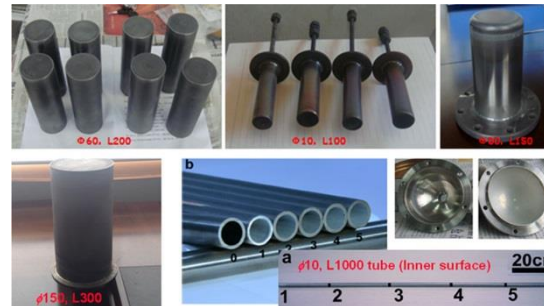
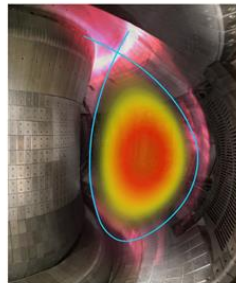
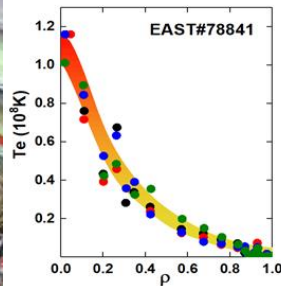
## Funding and Activities

China's domestic MCF R&D program has funded **four key areas** over the past decade, up to a total of **160** research projects between 2008 and 2018.



\*\*The FY2019 budget plans to support 30 projects.

- Burning plasma science
- Tritium fuel cycle tech.
- Materials for fusion
- Other important items





## Recent Progress and Highlights

### EAST Tokamak, ASIPP, Hefei.

- 1) 101.2 s! The longest plasma charge duration.
- 2) A promising high-confinement regime for steady-state fusion (EAST grassy ELM regime)
- 3) A new criterion for ELM control based on multimode plasma response
- 4) Steady-state fast-ion confinement & Alfvén Eigen modes instability
- 5) EAST has achieved >1 mins steady-state high-performance scenario in support of the CFETR 1GW scenario.
- 6) ITER equivalent high-power auxiliary heating and current driving capability.
- 7) International collaborators from more than 10 countries and 20 institutes contributed in more than 50% experiment proposals, while 4 international proposal weeks were scheduled in 2020 EAST campaign.







## Recent Progress and Highlights

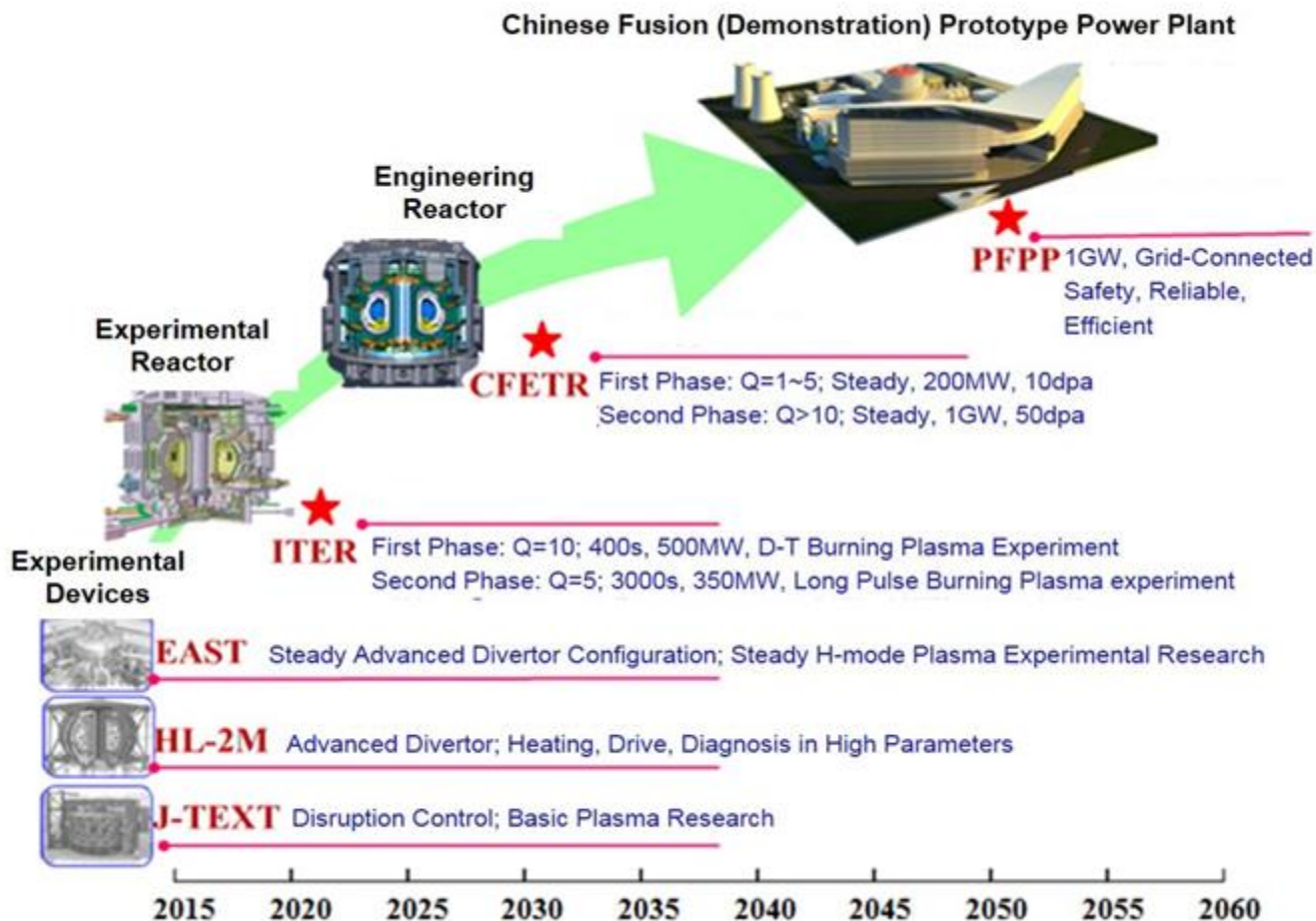


14:02, December 4th, 2020, HL-2M obtained its first plasma.



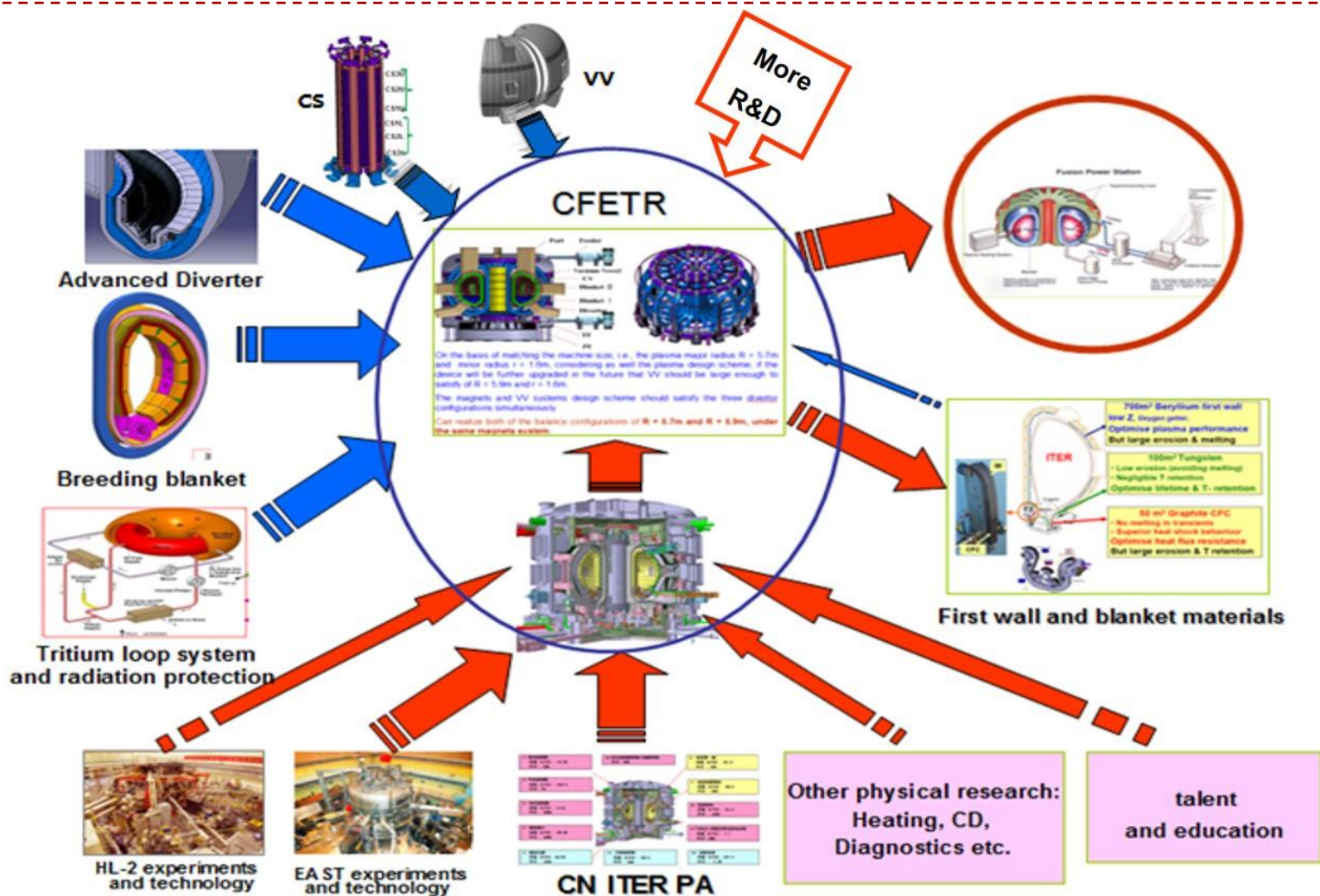
## Roadmap towards Fusion Energy

- proposed by the Chinese fusion research community





## CFETR: R&D Strategy



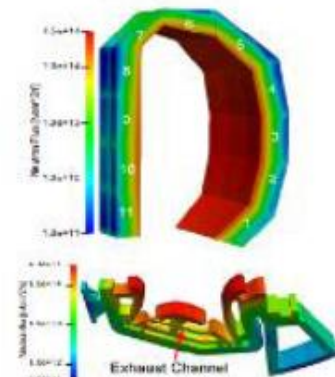
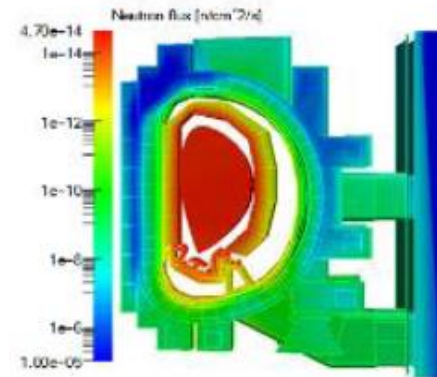
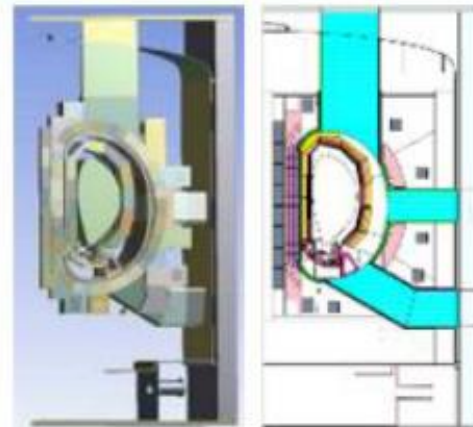


## CFETR Progress Updates

Concept design of CFETR (2011–2014, MCF R&D Program Funded Project)

Integration engineering design of CFETR (2017–2020, MCF R&D Program Funded Project)

- CFETR physics design and parameter optimization
- CFETR nuclear safety framework
- Overall integration of engineering design of CFETR
- Design of CFETR auxiliary systems
- CFETR database system





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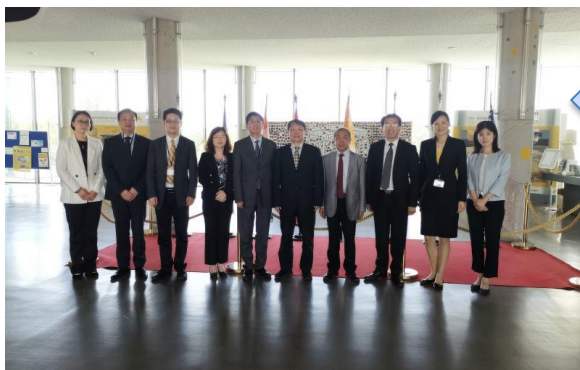
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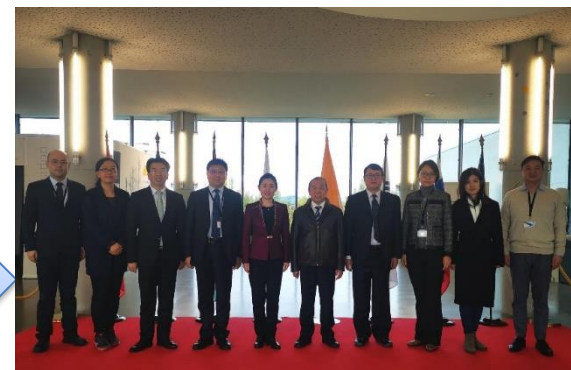


## Highlights between China and ITER



IC-24 June 20 2019  
Cadarache, France

IC-25 November 20 2019  
Cadarache, France



IC-26, June 18, 2020, Virtual Meeting



IC-27, November 18, 2020, Virtual Meeting



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## Highlights between China and ITER



MAC-27 May 22 2019  
Cadarache, France

MAC-28 October 23 2019  
Cadarache, France



MAC-29, May 18, 2020, Virtual Meeting



MAC-30, October 20, 2020, Virtual Meeting



## Highlights in 2020/2021

### Medical Supplies Donation for COVID-19



**“United we shall overcome”  
Donated by CNNC (CNPE-CNI23-SWIP)**

**ASIPP Donated 60000 Masks to IO**





## Highlights between China and IEA



### China's Participating in IEA-FPCC-TCPs

1	<b>Fusion Materials, FM-TCP</b> Southwestern Institute of Physics (SWIP)	Since 1998
2	<b>Nuclear Technology of Fusion Reactors, NTFR-TCP</b> Institute of Nuclear Energy Safety Technology (INEST)	Since 2010
3	<b>Environmental, Safety and Economic Aspects of Fusion Power, ESEFP-TCP</b> Institute of Nuclear Energy Safety Technology (INEST)	Since 2011
4	<b>Co-operation on Tokamak Programmes, CTP-TCP</b> China International Nuclear Fusion Energy Program Execution Center	Since 2011
5	<b>Spherical Tori, ST-TCP</b> Tsinghua University (THU)	Since 2020
6	<b>Stellarator-Heliotron Concept, SH-TCP</b> Southwest Jiaotong University (SWJTU)	Since 2020
7	<b>Reversed Field Pinches, RFP-TCP</b> University of Science and Technology of China (USTC)	Under Consideration
8	<b>Plasma Wall Interaction, PWI-TCP</b> Institute of Plasma Physics, Chinese Academy of Science (ASIPP)	Under Consideration



# Highlights between China and IEA



**IEA Academy**  
**Today in the Lab-Tomorrow in Energy**  
**October 8, 2020**



**IEA FPCC, February 24, 2021**





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## Highlights between China and US



**9<sup>th</sup> US-PRC Magnetic Fusion Collaboration Workshop**  
**June 5-7, 2018 Xi'an, China**

**9<sup>th</sup> US-PRC Magnetic Fusion Collaboration Workshop**  
June 5-7, 2018, Xi'an, China





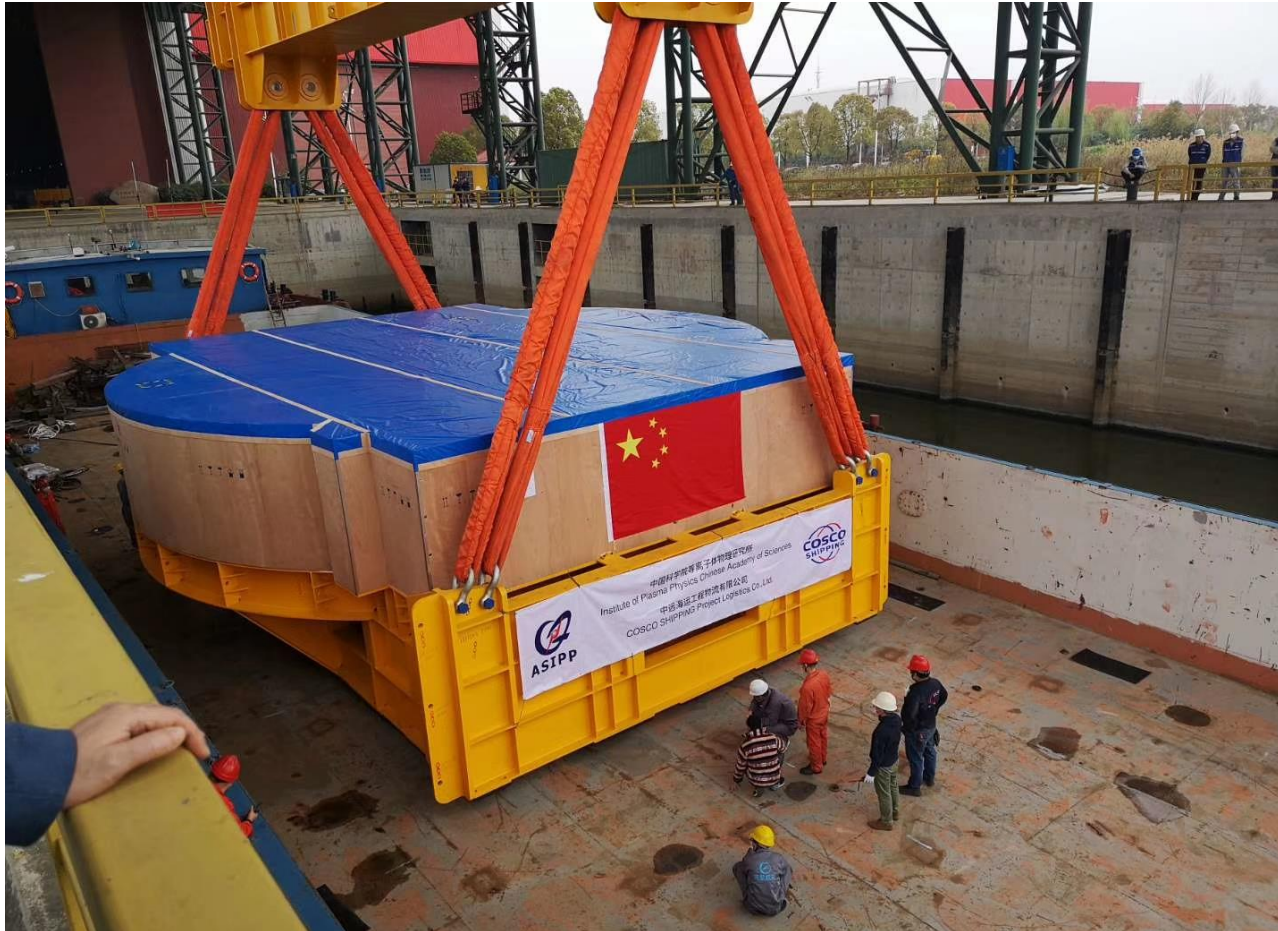
## Highlights between China and EU



- Under the China-EU Joint Steering Committee on S&T Cooperation and R&D Cooperation in the Peaceful Uses of Nuclear Energy(PUNE), CN-EU cooperation has been on-going well for the past few years.
- Bilateral Meeting between MOST & F4E was held in September, 2017.
- TMP-1 working group meeting was held in Jan, 2018 in Chengdu, China.
- FU-7 was held in October, 2018 in India.



# Highlights between China and EU



PF6 on board  
March, 2020



# Highlights between China and France



## SIFFER

## Sino-French Fusion Energy centerR (China and France)

### Key mission:

- 1) Support to ITER Organization and partners.
- 2) Develop and validate key components and technologies of magnetic fusion devices (CFETR, DEMO).
- 3) Fusion science and experimental physics research.



**SIFFER BoD-7**  
March 5, 2020, Beijing, China



**SIFFER GB-3**  
December 16th, 2020, Beijing, China



# Highlights between China, Japan and Korea



CJK-6 Trilateral meeting, 1-2, August, 2019, Seoul, Korea.



JCM-8, December 7-8, 2020, Xi'an, China



JWG-13, December 18, 2020, Beijing, China



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**THANKS !**