



**2019 International Clean Energy  
Science & Technology Summer School  
and World Forum on  
New Energy Science & Technology  
Worldwide Energy Universities Network**



**Authors: Dr Mark S. D. Read**  
*University of Birmingham*  
*Director of the Sino-British Cooperative Programme*

**Prof. Jun Yao ( 姚俊 )**  
*China University of Petroleum - Beijing*  
*Deputy Secretary General, WEUN Secretariat*

**Summary Report**

**July 2019**

**Organiser:** Of ce of International Cooperation and Exchange  
College of Mechanical and Transportation Engineering  
College of Safety and Ocean Engineering

# Contents

<b>1</b>	<b>Executive Summary</b>	<b>4</b>
<b>2</b>	<b>Introduction</b>	<b>4</b>
2.1	Background to the Summer School . . . . .	4
2.2	Aims and objectives . . . . .	5
<b>3</b>	<b>Lectures</b>	<b>6</b>
3.1	Technical Energy Topics . . . . .	6
3.2	Chinese Culture . . . . .	6
<b>4</b>	<b>World Forum on New Energy Science and Technology</b>	<b>7</b>
<b>5</b>	<b>Prof. Jun Yao - Research Group Seminar</b>	<b>7</b>
<b>6</b>	<b>Field Trips</b>	<b>9</b>
6.1	Background to China's nuclear incentive . . . . .	9
6.2	Nuclear Sites . . . . .	9
6.2.1	Fuqing Nuclear Power Plant ( ) . . . . .	10
6.2.2	China Museum of Nuclear Science and Technology . . . . .	12
6.2.3	Institute of Nuclear and New Energy Technology - Tsinghua University . . . . .	12
6.2.4	China Institute of Atomic Energy, Beijing . . . . .	12
6.3	Chinese Cultural Tours . . . . .	13
6.3.1	Tulou . . . . .	13
6.3.2	Gulangyu Island . . . . .	14
6.3.3	The Great Wall . . . . .	14
6.3.4	Forbidden City, Emperor's Palace . . . . .	15
6.3.5	Ming's Tombs . . . . .	15
<b>7</b>	<b>Acknowledgements</b>	<b>15</b>
<b>8</b>	<b>Appendices</b>	<b>17</b>
8.1	WEUN/CESE Delegates . . . . .	17
8.2	CESE Programme Schedule . . . . .	17

---

8.3	111 project and WEUN overview . . . . .	20
8.3.1	111 Project Background Presentation . . . . .	22
8.3.2	Field Trip Location Maps . . . . .	23
8.4	Photographs . . . . .	25
8.4.1	Tulou visit - 15/06/19 . . . . .	25
8.4.2	Gulangyu visit - 16/06/19 . . . . .	26
8.4.3	Fuqing Nuclear Power Plant visit - 18/06/19 . . . . .	27
8.4.4	Xiamen University . . . . .	28
8.4.5	CUPB, WEUN Beijing . . . . .	29
8.4.6	Beijing Cultural Activities . . . . .	30
8.4.7	WEUN Opening Ceremony - 22/09/18 . . . . .	31

# 1 Executive Summary

Hosted jointly between Xiamen University (XMU) and China University of Petroleum - Beijing (CUPB), the 2019 International Clean Energy Science & Technology Summer School was held successfully from 9<sup>th</sup> to 29<sup>th</sup> June 2019, providing excellent opportunities for students from the U.K. (Universities of Birmingham (UoB) and Leeds (UoL)), U.S. (University of Michigan (UOM)), and other Western universities to experience excellent research.

Symposium Prof. Jun Yao invited the Universities of Birmingham and Leeds to join the International Summer School programme to further strengthen the collaborative links formed in 2013. In 2018 the scope of the programme was widened with the second half of the Summer School being hosted by the China University of Petroleum - Beijing, providing additional nuclear facilities for field trips and other energy topics. To date, over 250 international students have attended this programme, producing fruitful international collaboration between Universities and promoting positively the related network.

## 2.2 Aims and objectives

In 1988 construction started on the last Nuclear Power Plant (NPP) to be built in the U.K., Sizewell B, a Pressurised Water Reactor (PWR), started generating and supplying 1198MW to the national grid in 1995. The last two NPPs to be built in the U.S. were the Watts Bar plant (constructed between 1973 and 1990) becoming operational in 1996 and the River Bend plant, built in 1977 and going online in 1986. Hence, in both countries, there has been no nuclear build for over 20 years which means that the majority of current faculty staff members lecturing on the topic of nuclear energy and the fuel cycle have not witnessed or seen the construction of a NPP! This Summer School provides the unique opportunity to visit sites such as the Fuqing Nuclear Power Plant ( ) in Fuqing, Fujian Province, China. The station currently has four 1089MW CPR-1000 PWRs which are an advanced PWR design developed by China from the Areva-designed PWRs at the Daya Bay Nuclear Power Plant (visited in previous years). The plant was jointly constructed and is operated by China National Nuclear Corporation (51%), China Huadian Corp. (39%) and the Fujian Investment & Development Co Ltd. (10%).

Construction of the first unit in Fuqing began on 21 November 2008 and was completed in 2014. First concrete for Unit 2 was poured on 17 June 2009 and the unit started in October 2015. Unit 3 began construction on 31 December 2010 and Unit 4 was planned to begin in 2011, but was delayed until November 2012 by China's nuclear safety review after the Japanese nuclear accident at the Fukushima Daichi NPP. Unit 3 was completed in Phase II on 24 October 2016. In November 2014 it was announced that units 5 and 6 would be of the Hualong One (updated CPR-1000) design, with unit 5 scheduled to be in operation about 2019. The first concrete was poured for Fuqing 5 on 7 May 2015. This timeline aligns conveniently with that of the Summer School and thus provides faculty staff and students with the unique opportunity to see different stages of NPP construction in one location.

The aims of the Summer School are threefold: Firstly, to provide an understanding of the associated theory and technical requirements of 'clean energy production' in conjunction with relevant historical influences through formal lectures and workshops. Secondly, to appreciate the practical application and realisation of this theory *via* field trips to relevant nuclear and energy related sites. Thirdly, to learn and experience the rich and diverse culture of the hosting country China and for students to have the opportunity to receive formal lessons on these topics.

## 3 Lectures

### 3.1 Technical Energy Topics

The Summer School schedule comprises three sections. As in previous years, the first section is arranged for UoM students as part of an accredited module. From 13<sup>th</sup> May to 9<sup>th</sup> June UoM students attended lectures including Physical Electronics (taught by School of Physics and Electrical Engineering, XMU) and Chinese culture. The second section ran from 10<sup>th</sup> to 20<sup>th</sup> June for UoB, UoL and UoM students where the programme includes lectures covering “Clean Energy Science and Engineering - I” (CESE) arranged and hosted by the College of Energy at XMU. On 20<sup>th</sup> June, the U.K. students transferred to Beijing, the second hosting institution, CUPB. Here, students attended the Worldwide Energy Universities Network World Forum on New Energy Science and Technology Conference. In addition to attending conference presentations, the students subsequently participated in the second half of the Summer School, “Clean Energy Science and Engineering - II” hosted by the International Department of CUPB (CUPB-ID).

CESE is designed for students from a variety of science and engineering disciplines and covers the majority of aspects of clean energy science and engineering, including nuclear, solar, bioenergy, chemistry energy and energy efficiency. The lectures are delivered by faculty members from the College of Energy at XMU and U.K. and U.S. academics attending the summer school. Previously employed by National Nuclear Laboratories, two of the Western academics (Prof. Ron Fleming and Dr Mark Read) have direct experience of the nuclear industry, which greatly informs their technical lectures and provides an authoritative source of knowledge during the nuclear site visits, in addition to impromptu extra-curricula discussions.

## 4 World Forum on New Energy Science and Technology

Following on from the 111 Opening Ceremony and establishment of the WEUN during the Signing Ceremony last September, described in further detail in Section 8.3, CUPB hosted the “2019 World Forum on New Energy Science and Technology”. The forum was officially opened by Prof. Li Gensheng, Vice President of CUPB with distinguished guests including:

- Prof. Sun Xudong, Vice Principal of CUPB Karamay campus/WEUN Secretary General
- Prof. Duan Menglan, Dean of College of Safety and Ocean Engineering
- Prof. Liu Weifeng, Dean of College of Information Science and Engineering
- Prof. Yongxue Zhang, Dean of College of International Education
- Prof. Wang Wei, Deputy Dean of College of Mechanical and Transportation Engineering

This conference provided an ideal opportunity for WEUN members to network, be appraised of progress from both the WEUN Secretary General (Prof. Sun Xudong) and key academics in the programme, the names of whom and schedule of which is listed in Table 1. Attendance to the conference gave the summer school students excellent experience of an academic meeting in addition to access to further talks on the latest research in a variety of energy topics. This year, the emphasis happened to be focussed on computer modelling, from “Human Machine Interface”, through “simulating the corrosion chemistry of energy materials” to the crucial and underpinning role of “Supercomputing architecture and applied application”. Fruitful discussions and workshops were held providing excellent opportunities for delegates to network and discuss potential collaboration.

## 5 Prof. Jun Yao - Research Group Seminar

*Extra mural* to the WEUN Forum and Summer School, but under the 111 collaborative agreement, Dr Mark Read was invited to attend and present at Prof. Jun Yao’s research group meeting. One of the most relevant talks was given by PhD student Mr Liu Yufa entitled “Experimental Study: Two Phase Flow Erosion Corrosion of X80 Pipeline Steel” in which an overview of the project and summary of the most recent results were detailed. Dr Read delivered a presentation providing an overview of the computational chemistry techniques applicable to simulating corrosion and catalysis on surfaces along with industrial relevant examples (ICI Katalco, AWE *etc.*). Ensuing discussion identified areas of mutual interest and future collaboration to be pursued further and realised with Prof. Jun Yao with whom contact will be maintained *via* our 111 project and WEUN network. The possibility of Sino-British PhD student exchanges to learn new techniques and work collaboratively was also discussed eagerly.

Table 1: WEUN Clean Energy Science &amp; Technology Forum Programme

<b>q 1 I L P T 2 M B M ; * 2 ` 2 K Q M v</b> (Chaired by: Prof. Li Yongfeng)	
0900 - 0905	Invited Guests Introduction
0905 - 0910	Welcome Address by CUPB Vice President (Prof. Li Gensheng)
0910 - 0915	Speech by the Representative of International Students
0915 - 0920	Speech by the Representative of International Lecturers (Prof. Morten Lind / Technical University of Denmark)
0920 - 0935	WEUN Secretariat Working Report by WEUN Secretary General (Prof. Sun Xudong)
0935 - 1000	Photo and coffee break
<b>* H 2 1 M M 2 ` ; v a + B 2 M + 2 h 2 + ? M Q H Q ; v 6 Q</b> (Chaired by: Prof. Jun Yao)	
1000 - 1025	Prof. Morten Lind (Technical University of Denmark) "Challenges of Supervision Human Machine Interface"
1025 - 1050	Prof. Degen Farid Estefen (Federal University of Rio de Janeiro) "Technology Transition from Subsea Production Systems for Oil & Gas to Ocean Renewable Energy"
1050 - 1115	Dr Mark Read (University of Birmingham) "Advanced Modelling Techniques for Simulating Materials Corrosion"
1115 - 1140	Prof. Weifeng Liu (China University of Petroleum - Beijing) "Supercomputing and its Applications"
1140 - 1230	Lunch buffet (First Floor of Cuigong Hotel)
1230 - 1800	Technical workshops and discussions
1800 - 2000	Dinner (Cuigong Hotel)



## 6 Field Trips

### 6.1 Background to China's nuclear incentive

The majority of mainland China's electricity is produced from fossil fuels, predominantly coal (73% in 2015). Two large hydro projects are recent additions: Three Gorges of 18.2 GWe and Yellow River of 15.8 GWe. Wind capacity in 2016 was 9.1% of the total installed generating capacity. Rapid growth in demand has given rise to power shortages, and the reliance on fossil fuels has led to significant air pollution. The economic loss due to pollution is estimated to be 6% of GDP by the World Bank, thus from March 2013 the new leadership has prioritised measures that address this issue.

In August 2013 the State Council reported that China should reduce its carbon emissions by 40-45% by 2020 from 2005 levels, and would aim to boost renewable energy to 15% of its total primary energy consumption by 2020. In 2012 China was the world's largest source of carbon emission, 2626 MtC (9.64 Gt CO<sub>2</sub>), and its increment that year comprised about 70% of world total increase. In March 2014 the Premier said that the government was declaring "war on pollution" and would accelerate closing coal-fired power stations.

In November 2014 the Premier announced that China intended about 20% of its primary energy consumption to be from non-fossil fuels by 2030, at which time it intended its peak of CO<sub>2</sub> emissions to occur. This 20% target is part of the 13th Five-Year Plan and was reiterated by the president at the Paris climate change conference in December 2015, along with reducing CO<sub>2</sub> emissions by 60 to 65% from 2005 levels by 2030. This means that China's energy growth has entered a 'new normal' phase including environmental protection, and to address this, **vigorous development of nuclear power is required**. By 2030 nuclear capacity will be 120 to 150 GWe, and nuclear will provide 8% to 10% of electricity.

### 6.2 Nuclear Sites

To augment the lectures given in this programme, another important part of the international summer school is to reinforce theory with practical application and thus the visiting of Nuclear facilities in China including a nuclear power plant (NPP, Fuqing NPP), nuclear power research laboratory (Tsinghua High Temperature Gas-Cooled Reactor Experimental Reactor) and a nuclear power institute (Atomic Energy Research Institute).

The growth of nuclear power in China has been characterised by the evolution of several domestic and imported reactor designs. The mainstay of the Chinese reactor programme has been and remains the PWR. There are a number of different Chinese-developed PWR models under construction, with more advanced versions in the design stage.

Mainland China has approximately 45 nuclear power reactors in operation, a further 15 under construction and more about to be built. The government's long-term target for nuclear generated electricity, as outlined in its Energy Development Strategy Action Plan 2014-2020, is for 58 GWe capacity by 2020, with 30 GWe more under construction. The impetus for nuclear power in China is increasingly due to air pollution from coal-fired plants.

China's policy is to have a closed nuclear fuel cycle, thus nuclear fuel reprocessing is now being considered. China has become largely self-sufficient in reactor design and construction, as well as other aspects of the fuel cycle, but is making full use of western technology while adapting and improving it (*e.g.* from the CPR-1000 to the new HPR1000). Relative to the rest of the world, a major strength of China lies within the nuclear supply chain. Interestingly, China's current policy is to 'go global' with exporting nuclear technology including heavy components in the supply chain.

Indeed, China has a determined policy at NDRC level of exporting nuclear technology, based on development of the CAP1400 reactor (an enlarged version of the AP1000 PWR), and subsequently the Hualong One reactor, with Chinese intellectual property rights and backed by full fuel cycle capability. The 'go global' policy is being pursued at a high level politically, utilising China's economic and diplomatic influence. In January 2015 the cabinet announced new incentives and financing for industry exports, particularly nuclear power and railways, on the back of \$103 billion outbound trade and investment in 2014. In May 2017 the Belt & Road Initiative (BRI) was formally launched, with much publicity, to boost global connectivity and trade and inviting countries to become partners in the BRI. Projects in Pakistan, Indonesia, eastern Europe and northern Africa were mentioned along with Chinese funding of \$75 billion from banks, \$20 billion through a new Silk Road Fund, and \$12 billion as aid.

CNNC and SPIC/SNPTC are focused on the export potential of the CAP1400, and SNPTC aims at "exploration of the global market" from 2013, particularly in South America and Asia. The Hualong One reactor is also intended for export, with CGN focusing on Europe and CNNC elsewhere, particularly Pakistan and South America.

Within the U.K., following Toshiba's decision last year to withdraw from its nuclear new-build project in the UK and to wind up NuGen, China General Nuclear is ready to ramp-up its plans for a new plant at Bradwell based on its HPR1000 (Hualong One) design in order to keep the U.K.'s nuclear power programme on track! Thus, another pertinent and excellent reason for the U.K. students to see the current HPR1000 (Hualong One) in Fuqing undergoing commissioning.

### 6.2.1 Fuqing Nuclear Power Plant ( )

It is exceptionally rare to see six reactors under three different stages of construction, however, Fuqing provides this unique opportunity and is a "living textbook" for the entire progress of a nuclear power plant from construction through to commissioning. The six reactor types are listed in Table 2 along with the construction and operation start dates respectively.

#### CPR-1000

The CPR-1000 (improved Chinese PWR) is a Generation II+ PWR, based on the French 900MW three cooling loop design (M310) imported in the 1990s, improved to have a net power output of 1000MW (1080MW gross) and a 60-year design life. Built and operated by the China General Nuclear Power Group (CGNPG), formerly known as China Guangdong Nuclear Power. Progressively more Chinese manufactured components were used in the units; the second unit built had 70% of its equipment manufactured in China, with a 90% Chinese content target for later builds.

Table 2 The Fuqing Nuclear Power Plant comprises 4 operational and 2 reactors under construction.

Unit	Type	Construction start	Operation start
<b>Phase I</b>			
Fuqing 1	CPR-1000	21 Nov 2008	22 Nov 2014
Fuqing 2	CPR-1000	17 June 2009	16 Oct 2015
<b>Phase II</b>			
Fuqing 3	CPR-1000	31 Dec 2010	24 Oct 2016
Fuqing 4	CPR-1000	17 Nov 2012	17 Sep 2017
Fuqing 5	Hualong One	7 May 2015	2019
Fuqing 6	Hualong One	22 Dec 2015	2020

### Hualong One

The Hualong One, or HPR 1000, is a Chinese PWR design developed by the China General Nuclear Power Group (CGNPG) and the China National Nuclear Corporation (CNNC) based on the ACPR 1000 and the ACP 1000 designs. Both are three-loop systems originally based on the same French design.

In December 2015 China Guangdong Nuclear Power Group (CGN) and China National Nuclear Corporation (CNNC) agreed to create Hualong International Nuclear Power Technology Co. as a joint venture to promote the Hualong One in overseas markets, which was officially launched in March 2016. On 19 January 2017 the United Kingdom Office for Nuclear Regulation (ONR) started their Generic Design Assessment process for the Hualong One, expected to be completed in 2021, in advance of possible deployment at the Bradwell nuclear power station site. On 16 November 2017 the ONR and the Environment Agency announced they are progressing to the next phase of their Generic Design Assessment of the UK HPR 1000 reactor. Step 2 formally commenced on this day and is planned to take about 12 months. The targeted timescale for the UK HPR 1000 GDA process is about five years from the start of Step 1.

At the time of our visit, cold hydrostatic testing had begun at unit 5 marking the first time the reactor systems are operated together with the auxiliary systems. Cold functional tests are carried out to confirm whether components and systems important to safety are properly installed and ready to operate in a cold condition. The main purpose of these tests is to verify the leak-tightness of the primary circuit and components, such as pressure vessels, pipelines and valves of both the nuclear and conventional islands, and to clean the main circulation pipes. The tests at Fuqing 5 began on 27 April. CNNC reported this was 50 days ahead of schedule and marks the transition of the unit from the installation phase to the commissioning phase. After a tour of the facilities and informative historical exhibition, CNNC gave an overview presentation on progress and future plans and very obligingly held an excellent questions and answer session enabling the students to ask technical questions to the operational staff and management. The entire day was extremely well planned, organised and ran very smoothly. Both students and staff were impressed at the scale of the NPP, the comprehensive tour and the vast amount of knowledge gained. Our hosts were most welcoming and it was encouraging for the students to see such enthusiasm, determination and concrete realisation of China's nuclear ambitions!

### 6.2.2 China Museum of Nuclear Science and Technology

The 2018 student cohort were fortunate enough to visit this excellent museum, charting China's nuclear history with a comprehensive array of models and exhibits. Further details and photographs were reported last year. Unfortunately, for operational reasons the exhibition halls were unavailable to this year's summer school students.

### 6.2.3 Institute of Nuclear and New Energy Technology - Tsinghua University

In 2018, members of the summer school visited the laboratory of high-temperature gas-cooled reactor (HTGCR) experimental reactor at Tsinghua University in Changping, Beijing. Supported by the National 863 Program, Tsinghua University began research and development of a 10MW HTGCR experimental reactor in 1986. The 10MW HTGCR-test Module (HTR-10) is a graphite-moderated helium gas-cooled reactor. As the first gas-cooled reactor in China, construction of HTR-10 was started in 1995 with the completion of basic design and safety review. It reached its criticality in December 2000 and was operated in full power condition in January 2003. About 100 commissioning

p

h

oig

I feJanHTRrograf! · in h

B dc A o ina E

> ~fety a fher e ahI hh~ 8~ .. A oK oled in e e ~ oK oS

Corporation (CNNC). Founded in 1950 as the “Second Department of Modern Physics”, it conducts research in the fields of nuclear physics, nuclear engineering, radiochemistry and in the development of nuclear science and technology as well as the innovative bases for the research of national nuclear defence and energy development.

The CIAE houses China’s Experimental Fast Reactor (CEFR) which is China’s first fast nuclear reactor. It aims to provide China with fast-reactor design, construction and operational experience, and will be a key facility for testing and researching components and materials to be used in subsequent fast reactors. The reactor achieved first criticality on 21<sup>st</sup> July 2010 and started generating power a year later on 21<sup>st</sup> July 2011. On October 2012 Xinhua announced that the CEFR had passed official checks. The CEFR was brought to full power at 1700 on 15<sup>th</sup> December 2014 and operated at this level continuously for three full days.

CEFR is a 65MW thermal, 20MW electric, sodium-cooled, pool-type reactor with a 30-year design lifetime and a target burnup of 100 MWd/kg. The CEFR was built by Russia’s OKBM Afrikanov in collaboration with OKB Gidropress, NIKIET and Kurchatov Institute.

The CEFR project was approved by the Chinese State Council in 1992, with final approval given in 1995 and is one of the major energy projects under the national high-tech research and development program of China’s “National 863 Program”.

In 2018, the summer school group visited the fast reactor, ion accelerator and small nuclear reactor. Due to the fast reactor working on a critical experiment, entry to the laboratory was not allowed. However, access to the impressive exhibition hall containing models of accelerators and small nuclear reactors was permitted where a comprehensive tour and description was given by technical staff. Unfortunately, for operational reasons this visit was cancelled for this cohort but the principles of the fast breeder were covered in the associated lectures.

## 6.3 Chinese Cultural Tours

To augment the formal Chinese culture workshops, several activities were arranged to facilitate further appreciation of Chinese culture by the western students. Notably, visiting the world cultural heritage centres: Tulou and Gulangyu provided the opportunity to learn about the local “South Fujian Culture”. Indeed, Tulou and Gulangyu have been characterised as world cultural heritage centres. The second part of the summer school was hosted by CUPB where visits were arranged to the Imperial Palace and Great Wall and Ming’s Tombs. These are highly representative of Chinese cultural history steeped in a long history containing Chinese wisdom.

### 6.3.1 Tulou

Fujian Tulou is a property of 46 buildings constructed between the 15<sup>th</sup> and 20<sup>th</sup> centuries over 120km in south-west of Fujian province, inland from the Taiwan Strait. Set amongst rice, tea and tobacco fields the Tulou are earthen houses. Several storeys high, they are built along an inward-looking circular or square floor plan as housing for up to 800 people each. They were built for defence purposes around a central open courtyard with only one entrance and windows to the outside only above the first floor. Housing a whole clan, the houses functioned as village units and were known as “a little kingdom for the family” or “bustling small city.” They feature tall fortified

mud walls capped by tiled roofs with wide over-hanging eaves. The most elaborate structures date back to the 17<sup>th</sup> and 18<sup>th</sup> centuries. The buildings were divided vertically between families with each comprising two or three rooms on each floor. In contrast with their plain exterior, the inside of the tulou were built for comfort and were often highly decorated. They were inscribed in 2008 by UNESCO as World Heritage Site, as “exceptional examples of a building tradition and function exemplifying a particular type of communal living and defensive organization, and, in terms of their harmonious relationship with their environment, an outstanding example of human settlement.”

An amusing piece of historical trivia originates from the Cold War era when the U.S. first received satellite photos (initially, with poor resolution) from this area. Intelligence analysts spotted many fairly large circular structures in this region, not far from Taiwan and thought that they might be missile silos. Eventually, the structures were confirmed as houses by ‘visitors’ on the ground.

### 6.3.2 Gulangyu Island

The Gulangyu, Gulang Island or Kulangsu is a pedestrian-only island of the coast of Xiamen, Fujian Province in southeastern China. A UNESCO World Cultural Heritage Site, the island is about 2km<sup>k</sup> in area, and is reached by a 8min ferry ride from Xiamen centre. Although only about 20000 people live on the island, Gulangyu is a major domestic tourist destination, attracting more than 10 million visitors per year, and making it one of China’s most visited tourist attractions. Gulangyu not only bans cars, but also bicycles. The only vehicles permitted are small electric buggies and electric government service vehicles.

For a time, Gulangyu had the peculiarity of having constituted the only international settlement on Chinese soil apart from the more celebrated International Settlement at Shanghai. Soon after Xiamen became a treaty port resulting from China’s loss in the First Opium War and the Treaty of Nanking in 1842, foreign residents on the island established an informal organisation that became formally organized several decades later when its Land Regulations were approved by the government of China in May 1902. Eventually 13 countries, including Great Britain, France, The Netherlands and Japan, were to enjoy extraterritorial privileges there and take part in the Kulangsu Municipal Council that administered the settlement. As with the Shanghai International Settlement, the British played a predominant role in the administration and Sikh policemen from British India were charged with the policing of the Settlement. The consulates, churches, hospitals, schools, police stations, *etc.* built by those foreign communities explain the predominantly Victorian-era style architecture that can still be seen throughout Gulangyu. Japanese occupation of the island began in 1942, and lasted until the end of World War II. The Hokkien dialect is spoken on the island, as it is in Xiamen.

### 6.3.3 The Great Wall

The Great Wall of China is the collective name of a series of fortification systems generally built across the historical northern borders of China to protect and consolidate territories of Chinese states and empires against various nomadic groups. Several walls were being built from as early as the 7th century BC by ancient Chinese states; selective stretches were later joined together by Qin Shi Huang (220-206 BC), the first Emperor of China. Little of the Qin wall remains. Later

on, many successive dynasties have built and maintained multiple stretches of border walls. The most currently well-known of the walls were built by the Ming dynasty (1368–1644).

Apart from defence, other purposes of the Great Wall have included border controls, allowing the imposition of duties on goods transported along the Silk Road, regulation or encouragement of trade and the control of immigration and emigration. Furthermore, the defensive characteristics of the Great Wall were enhanced by the construction of watch towers, troop barracks, garrison stations, signalling capabilities through the means of smoke or fire, and the fact that the path of the Great Wall also served as a transportation corridor.

#### 6.3.4 Forbidden City, Emperor's Palace

The Forbidden City palace complex in central Beijing houses the Palace Museum, and was the former Chinese imperial palace from the Ming dynasty to the end of the Qing dynasty (1420 to 1912). The Forbidden City served as the home of emperors and their households as well as the ceremonial and political centre of Chinese government for almost 500 years.

Constructed from 1406 to 1420, the complex consists of 980 buildings and covers 72 hectares. The palace exemplifies traditional Chinese palatial architecture and has influenced cultural and architectural developments in East Asia and elsewhere. The Forbidden City was declared a World Heritage Site in 1987 and is listed by UNESCO as the largest collection of preserved ancient wooden structures in the world.

#### 6.3.5 Ming's Tombs

The Ming Xiaoling is the mausoleum of the Hongwu Emperor, the founder of the Ming dynasty. It lies at the southern foot of Purple Mountain, located east of the historical centre of Nanjing. Legend says that in order to prevent robbery of the tomb, 13 identical processions of funeral troops started from 13 city gates to obscure the real burying site.

The construction of the mausoleum began during the Hongwu Emperor's life in 1381 and ended in 1405, during the reign of his son the Yongle Emperor, with a huge expenditure of resources involving 100,000 labourers. The original wall of the mausoleum was more than 22.5km long. The mausoleum was built under heavy guard of 5000 troops.

## 7 Acknowledgements

The authors would like to thank and acknowledge all those who were instrumental in helping to make the 2019 Clean Energy Science and Technology Summer School and WEUN Forum so successful. To the host institutions, XMU and CUPB, the "111 project" for supporting the provision of transport and accommodation costs for the member International Foreign Experts. All faculties and students at CUPB, XMU, UoB, UoL and UoM for their engagement which contributed to the programme's success and their academic lecturers who delivered the technical classes. Huge appreciation to the local Chinese student volunteers for tirelessly ensuring that international students had such an excellent experience of China, from acting as guides to

translating! Finally, a enormous debt of gratitude is owed to Prof. Jun Yao for his tireless energy and good humour whilst arranging the programme, liaising with local and overseas institutions and being such an excellent host. He also arranged such interesting cultural activities and visits to provide the students with a rich and diverse experience of China.



## 8 Appendices

### 8.1 WEUN/CESE Delegates

Table 3: WEUN Clean Energy Science & Technology Delegates

Forename	Surname	Country	Institution
Segen Farid	Estefen	Brazil	Federal University of Rio de Janeiro
Morten	Lind	Denmark	Technical University of Denmark
Mark	Read	U.K.	University of Birmingham
Mary Ann	Lundteige	Norway	Norwegian University of Science and Technology
Yiliu	Liu	China	Norwegian University of Science and Technology
Jing	Wu	China	Technical University of Denmark
Sua	Lee	Canada	University of Alberta
Adam	Birchall	U.K.	University of Birmingham
Robert	Heymer	U.K.	University of Birmingham
Billy	Plant	U.K.	University of Birmingham
Jack	Trainor	U.K.	University of Birmingham
Alexandre	Souchet	France	University of Birmingham
Shah	Iqra	U.K.	University of Leeds
Dominic	Raborokgwe	Botswana	University of Leeds
Mohammed	Ali	U.K.	University of Leeds
Abhay	Sharma	U.K.	University of Leeds
Serish	Hussain	U.K.	University of Leeds
Milyausha	Sufyanova	Russia	Gubkin Russian State University
Marta	Corella	Spain	Technical University of Denmark
Johan	Hjorth	Norway	Norwegian University of Science and Technology
Eduado	Marendaz	Brazil	Federal University of Rio de Janeiro
Xiaolin	Wang	China	CUP-Beijing
Liang	Ma	China	CUP-China East
Jiaseng	Yan	China	China University of Mining and Technology
Li	Li	China	Xiamen University

### 8.2 CESE Programme Schedule

Table 4: Summer School Course Schedule &lt; Energy Sci. &amp; Eng.&gt; for WEUN Students

City	Date	Time	Location	Topic	Lecturer	
Xiamen	20190610	9:00-12:00	Jime 204	Nuclear Engineering R&D, New Systems and Fuel Cycles	Ning LI	
	20190611	9:00-12:00	Jime 204	Safety barrier engineering and management	Yiliu Liu	
	20190612	9:00-12:00	Jime 204	Computer Modelling of Nuclear Materials	Mark Read	
	20190613	9:00-12:00	Jime 204	Introduction to Nuclear Power, Challenges to Nuclear Engineering Materials	Lumin WANG	
	20190614	9:00-12:00	Lianxing 202	Modelling of Complex Systems	Morten Lind	
	20190615	7:00-19:00		Visit Tulou	Jun YAO	
	20190616	16:00-20:00		Visit Gulangyu	Jun YAO	
	20190617	9:00-12:00	Lianxing 202	Nuclear Energy Safety	Ron Fleming	
	20190618	7:00-19:00	Fuqing	NPP Tour : Fuqing Nuclear Power Plant	Jianxiang ZHENG	
	20190619	9:30-12:30	College of Energy	Dean' s Welcome, Student Presentation, Lab Tour	Qixun GU O	
		14:00-17:00	College of Energy	Party, Dewang Library Tour	Qixun GUO	
	Beijing	20190620	8:00-13:00	-	Xiamen-Beijing	Jun YAO
			14:00-18:00		Visit the Ming Tombs	Jun YAO

Table 5: Summer School Course Schedule &lt; Energy Sci. &amp; Eng &gt; for WEUN Students

City	Date	Time	Location	Topic	Lecturer	
Beijing	20190621	9:00-12:00	Worldwide Energy Universities Network Summer School Opening Ceremony and World Forum on New Energy Science and Technology	Worldwide Energy Universities Network Summer School Opening Ceremony and World Forum on New Energy Science and Technology	International Department of CUPB(CUPB-ID)	
		14:00-17:00				Lecture 1: Technology Transition from Subsea Production Systems for Oil & Gas to Ocean Renewable Energy, Segen Farid, Estefen Lecture 2: Challenges of Supervision Human Machine Interface, Morten Lind Lecture 3: Advanced Modelling Techniques for Simulating Materials Corrosion, Mark Read Lecture 4: Supercomputing and its Applications, Weifeng Liu
	20190622	Sat	9:00-15:00	Visit Great wall	CUPB-ID	
	20190623	Sun	9:00-15:00	Visit the Summer Palace	CUPB-ID	
	20190624	Mon	9:00-12:00	108	Lecture 6: Safety Issues in Engineering Systems	Morten Lind/Jing Wu
			14:00-17:00	Univ.	Visit Nuclear Research Institute @ QingHua	CUPB-ID
	20190625	Tue	9:00-12:00	108	Lecture 7: From Subsea Production Systems for Oil & Gas to Ocean Renewable Energy	Segen Farid, Estefen
			14:00-17:00	Activities with CUPB students	CUPB-ID	
	20190626	Wed	9:00-12:00	108	Lecture 8: Advanced Modelling Techniques for Energy Materials	Mark Read
			14:00-17:00	Visit Atomic Energy Research Institute	CUPB-ID	
	20190627	Thu	9:00-12:00	108	Lecture 9: Water Injection Performance Monitoring and Operation	Jing Wu
			12:00-18:00	Visit National Key Laboratories	CUPB-ID	
	20190628	Fri	9:00-12:00	End - Summer School Closing Ceremony	CUPB-ID	
			14:00-18:00	Visit the Imperial Palace	CUPB-ID	

### **8.3 111 project and WEUN overview**

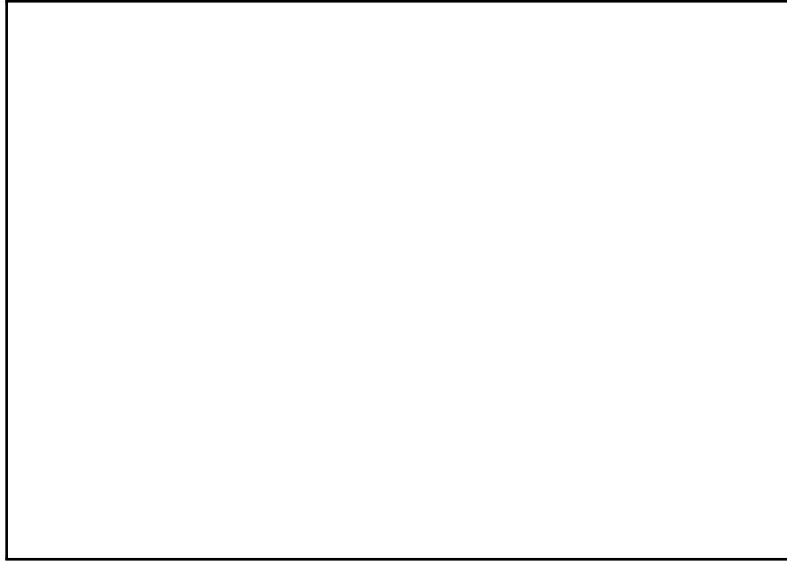
Following a successful Higher Education Discipline Innovation Project (111) bid, funded and

### Mission

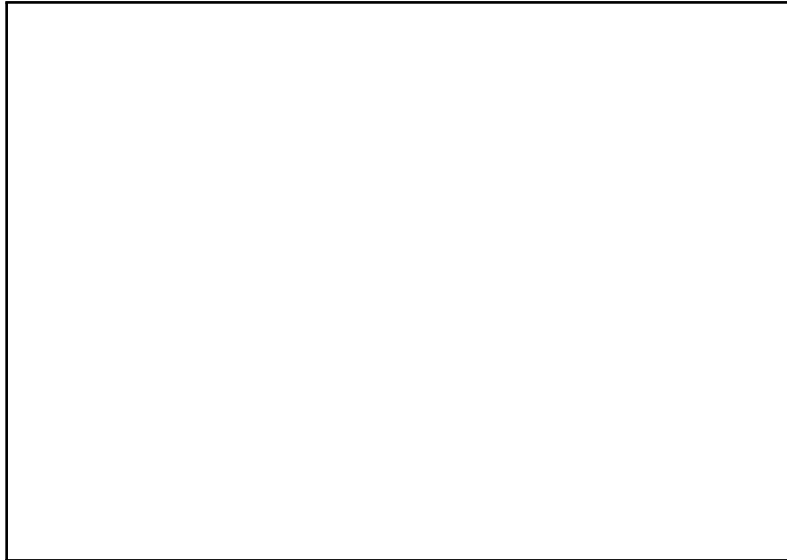
- To build a platform for the exchange of educational information, best practices and academic resources on energy-related issues.
- To leverage access to expertise and facilities and collaborate on basic and applied research in the field of energy and to set up joint labs or centres as interests grow.
- To coordinate energy related international cooperation in joint degree education, student and faculty exchange, summer courses or schools and training programmes.
- To promote and advertise member universities within the countries of other member universities to improve their visibility and recognition and enhance their prestige in those countries.
- To organise academic conferences or seminars to address challenges facing the energy world and energy education.

WEUN was established at a conference on the 22<sup>nd</sup> Sep. 2018 in Beijing initiated by its founder CUPB, through the representatives of the first cohort of 28 founding member universities. Dr Mark S. D. Read (Director of the Sino-British Cooperative Programme), Prof. Martin Freer (HoS Physics & Astronomy) and Dr Bing Liu (Director of International Relations) participated in the opening of the Worldwide Energy Universities Network in Beijing with 27 other universities from across the globe. The signing ceremony was broadcast on China Central Television.

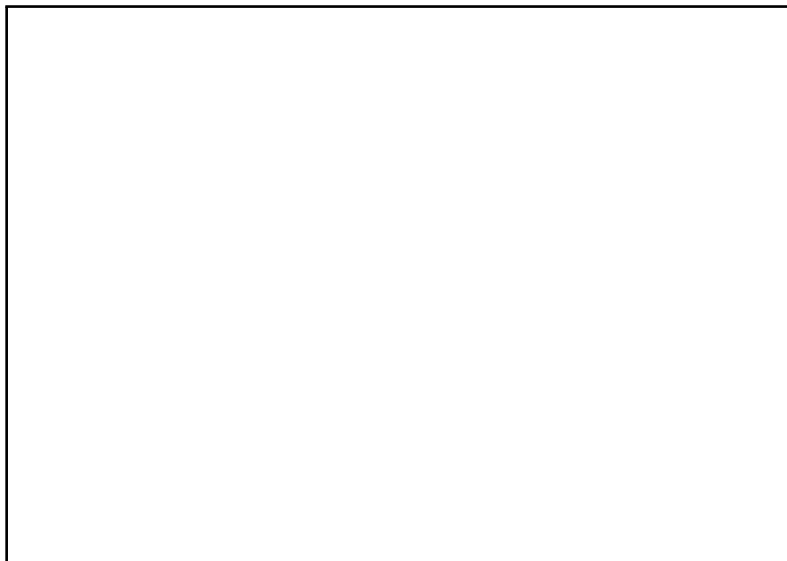
### 8.3.1 111 Project Background Presentation



U V

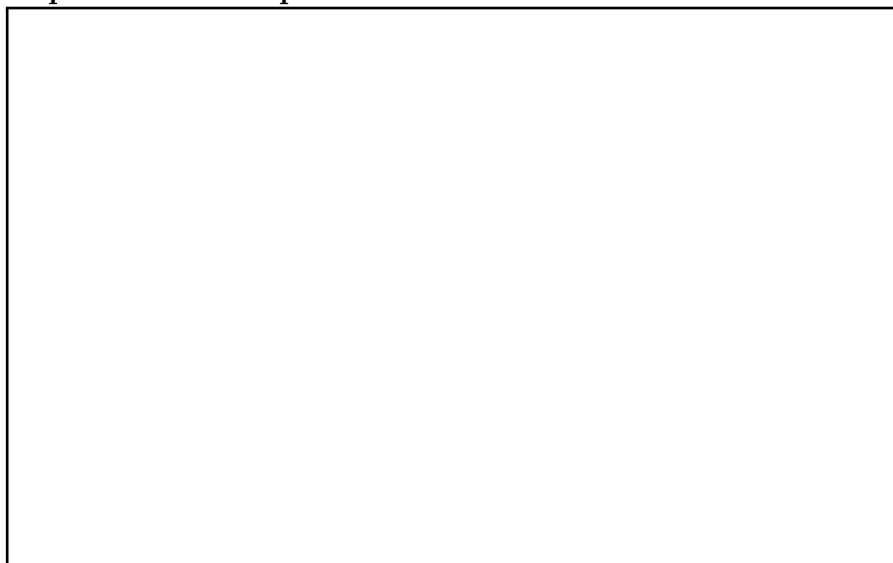


U # V

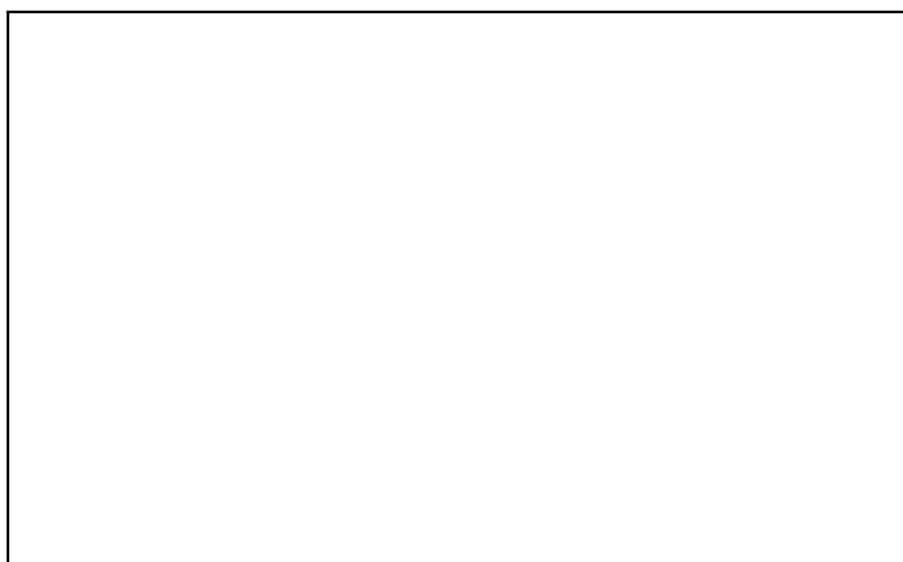


U + V

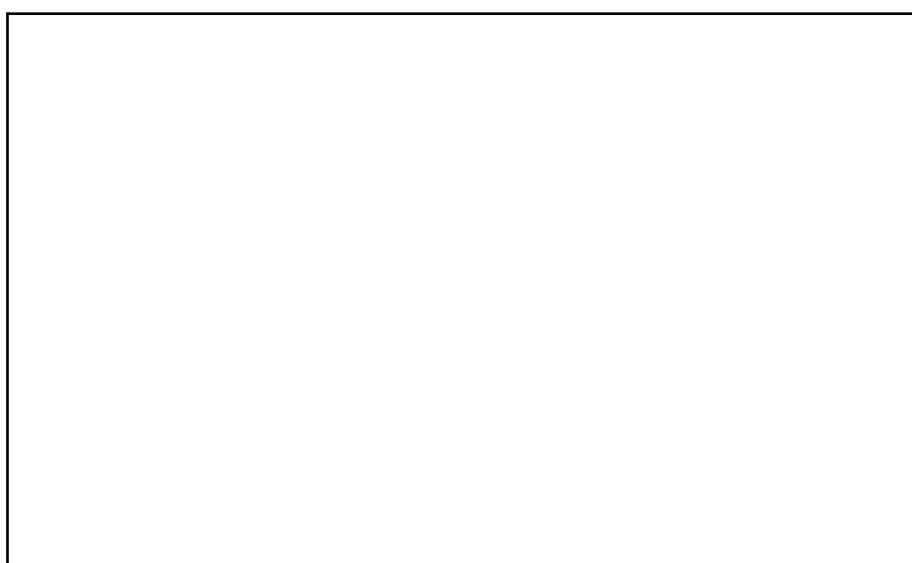
8.3.2 Field Trip Location Maps



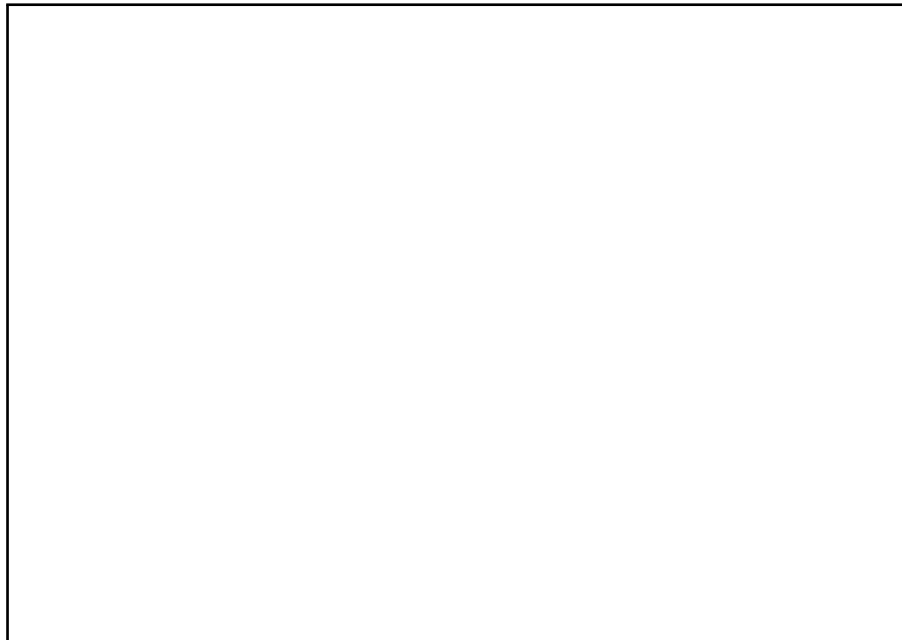
U V



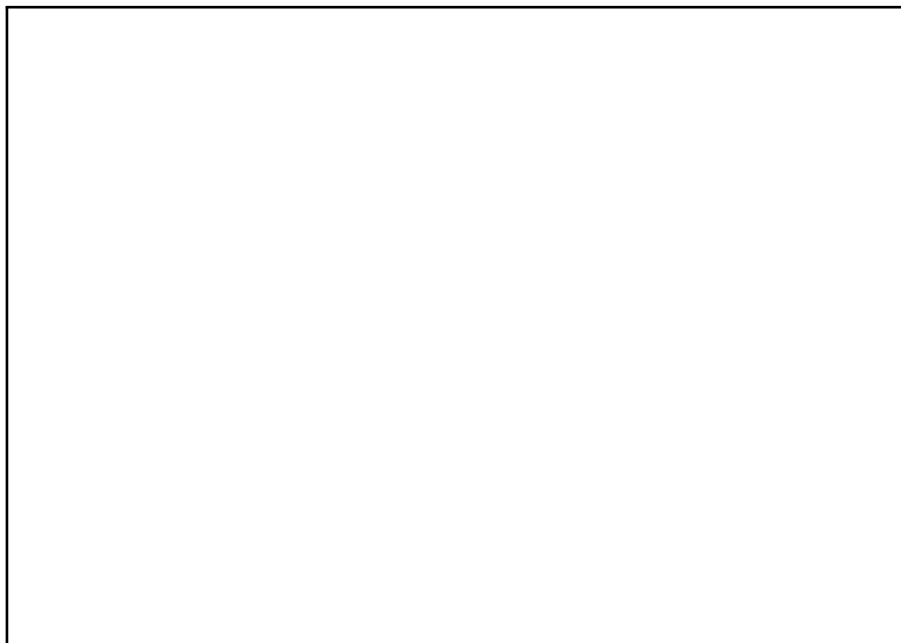
U # V



U + V



U / V

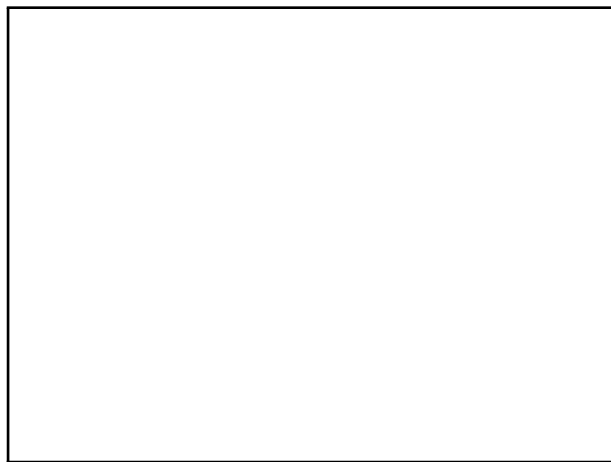


U 2 V

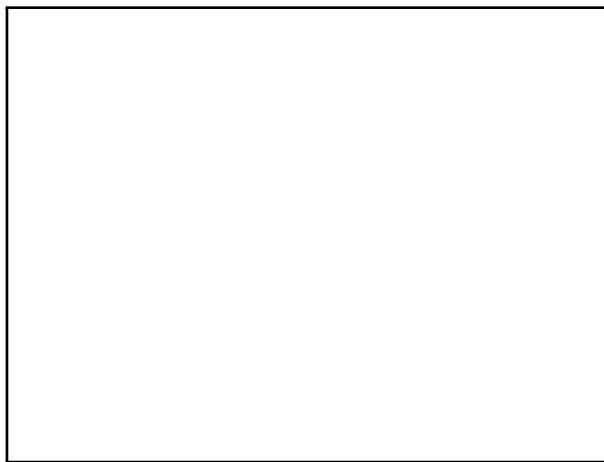


## 8.4 Photographs

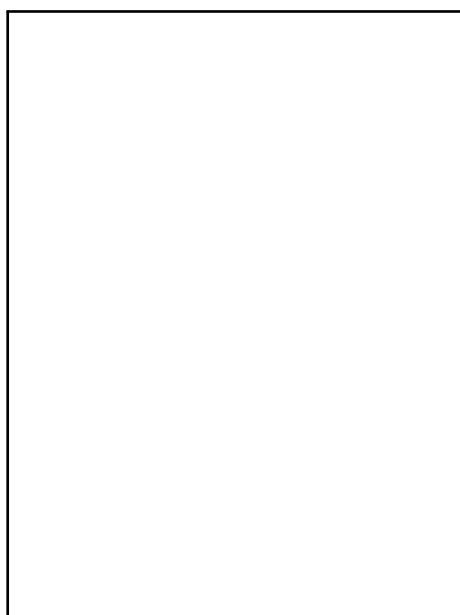
### 8.4.1 Tulou visit - 15/06/19



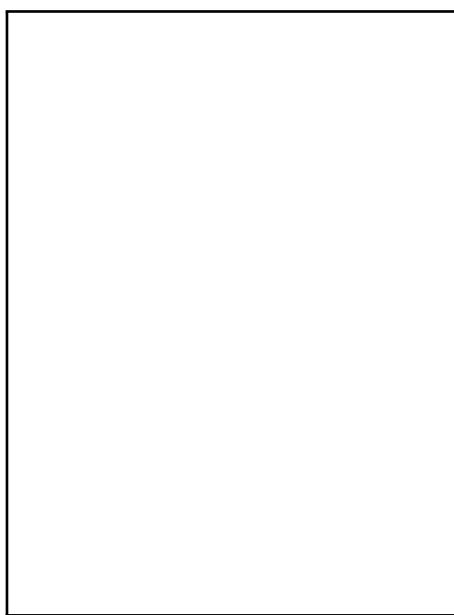
U V



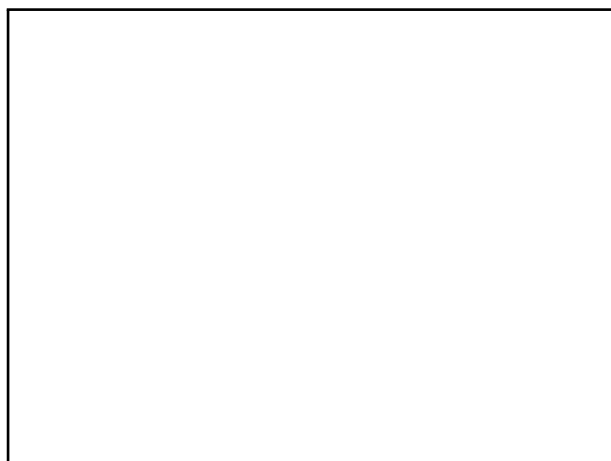
U # V



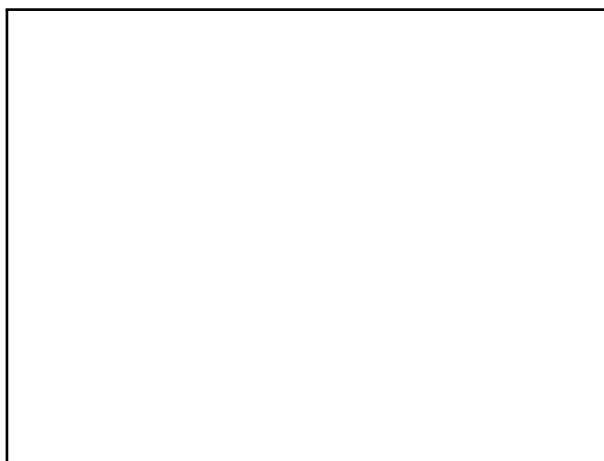
U + V



U / V



U 2 V



UV

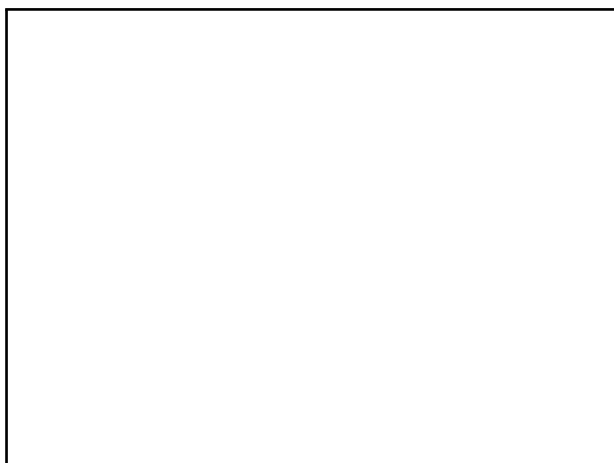
8.4.2 Gulangyu visit - 16/06/19



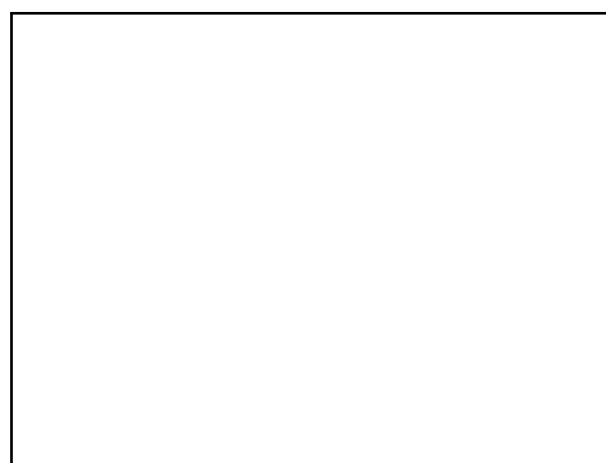
U V



U # V



U + V



U / V

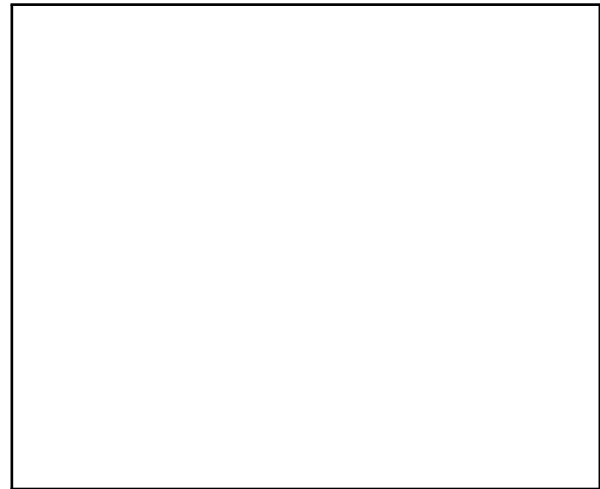
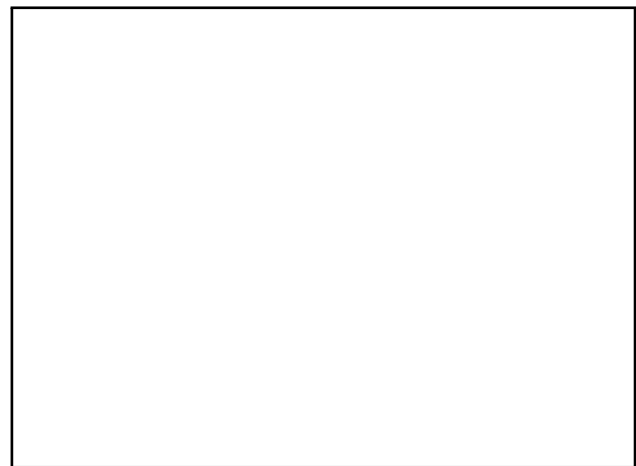
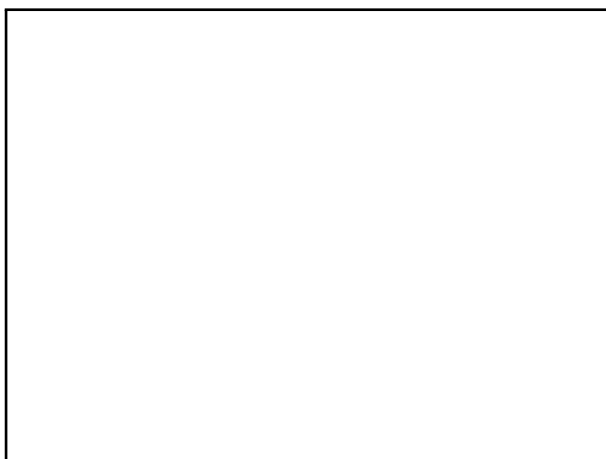
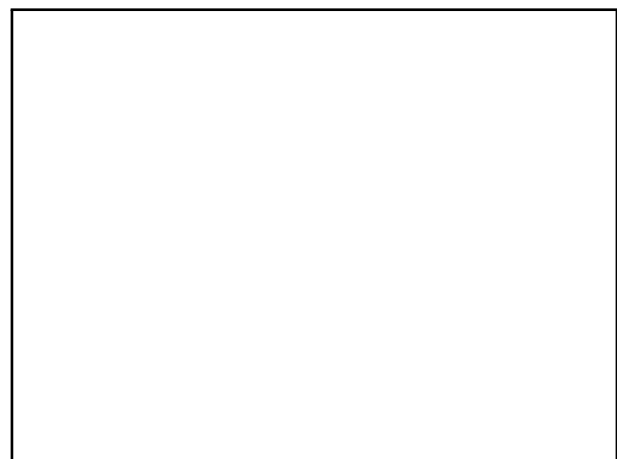


U 2 V

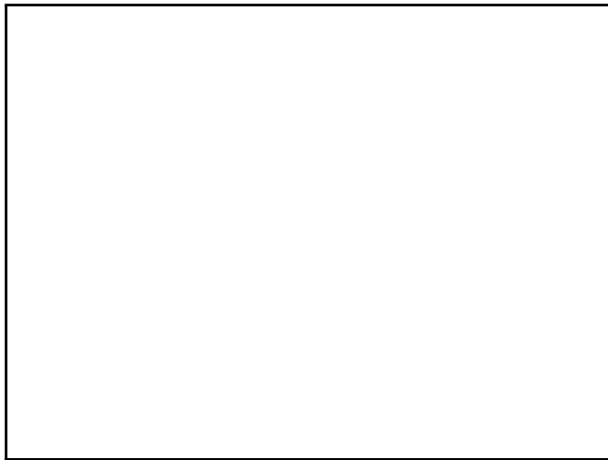


UV

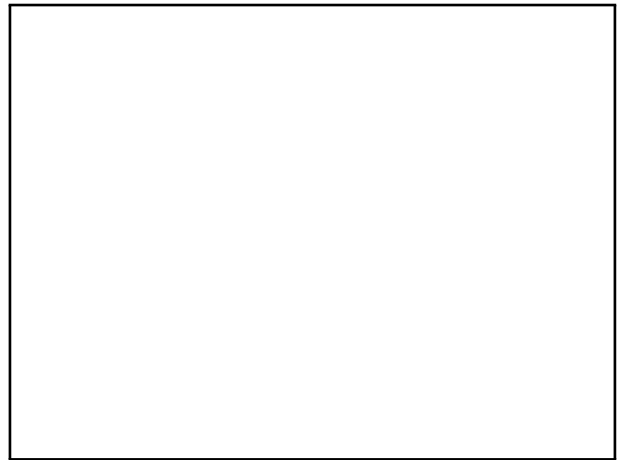
## 8.4.3 Fuqing Nuclear Power Plant visit - 18/06/19

 $U \ V$  $U \# \ V$  $U + V$  $U / V$  $U \ 2 \ V$  $U \ \nabla \ V$

## 8.4.4 Xiamen University



U V



U # V



U + V



U / V



U 2 V



U V

(c) and (d) Farewell Banquet - Xiamen University

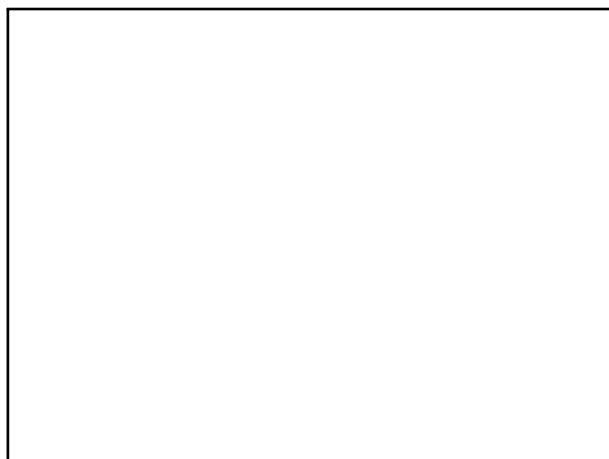
8.4.5 CUPB, WEUN Beijing



U V



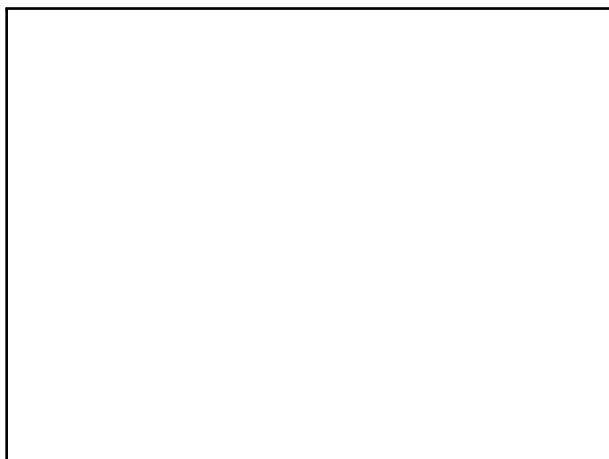
U # V



U + V



U / V

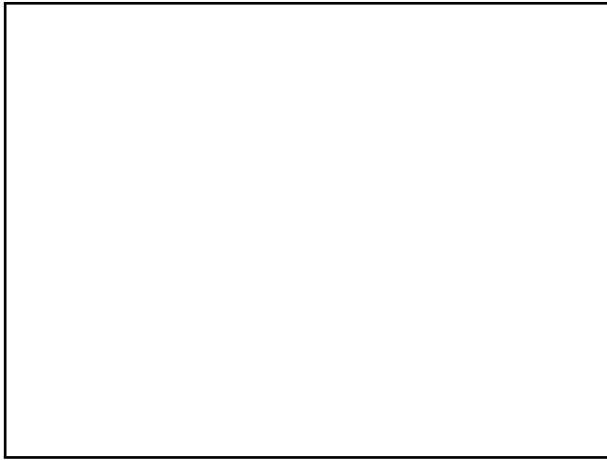
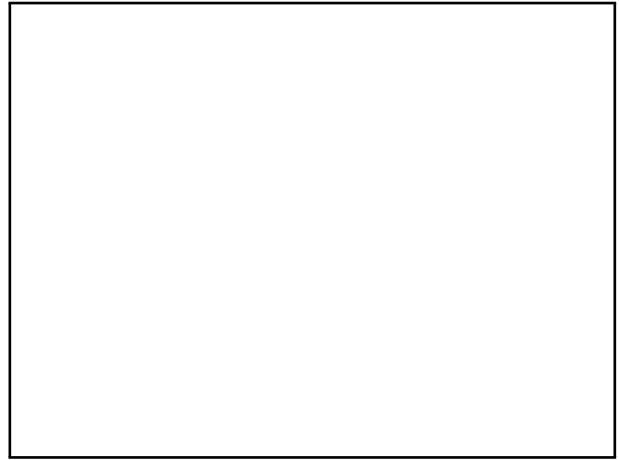
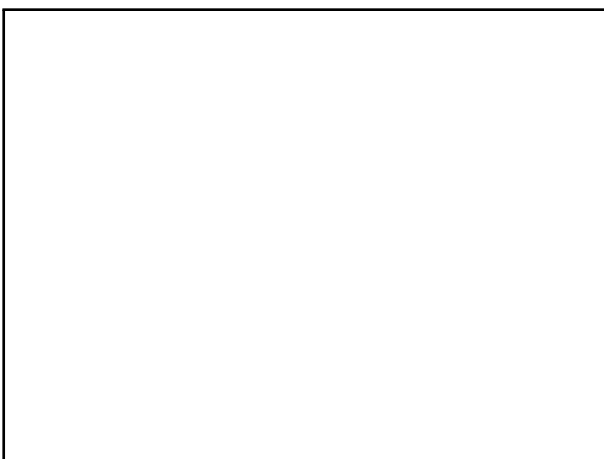


U 2 V

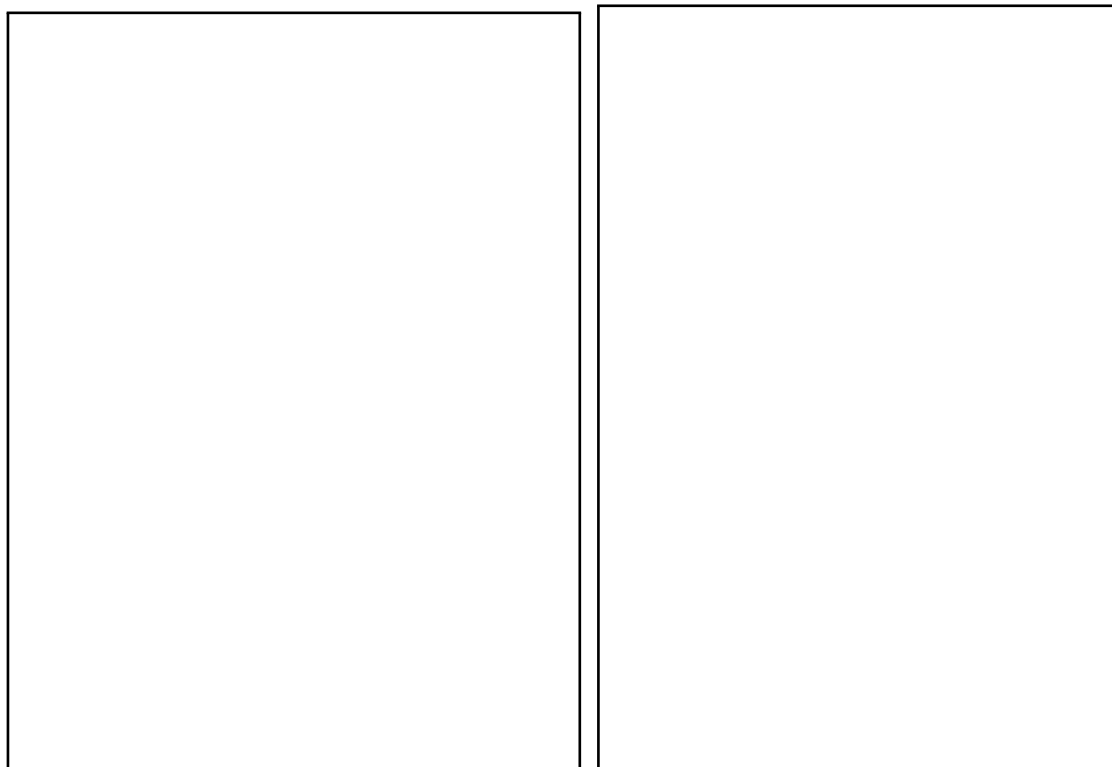


U V

#### 8.4.6 Beijing Cultural Activities

 $U V$  $U \# V$  $U + V$  $U / V$  $U 2 V$  $UV$

## 8.4.7 WEUN Opening Ceremony - 22/09/18



U V

U # V



(a)

U + V

Certificate awarded to Dr Mark S. D. Read by CUP President, Prof. Zhang Laibin; (b) Dr Mark S. D. Read (Director of the Sino-British Cooperative Programme), Prof. Martin Freer (HoS Physics & Astronomy) and Dr Bing Liu (Director of International Relations)