

LIBS

SINCE 2004 @ OUC

OUC-LIBS was initiated in **2004** with the research interest focused on improving the LIBS capability and flexibility for ocean application. Several approaches called “*Guided Conversion*”, “*Ultrasonic Nebulizer Assisted LIBS*” and “*sampling with a paper substrate*” were tried to enhance the sensitivity of heavy metal element in water solution.

2004

2021

LIBSea @ 2021



OUC-LIBS
2004 - 2021



The new version of LIBS system deployed on **ROV “Haima”** has reached the working depth of **3200 m**, at **Aug.26, 2020**. Then in **Dec.**, the system had its another sea trial on **HOV “Jiaolong”**.

2nd LIBSea @ 2018

2019-2021

Since **2016**, with the support from **National Key R&D Program of China**, development of a compact upgraded **LIBSea** system was undergoing. The first sea trial to the system had been taken in **2018**.



1st LIBSea @ 2015

2016-2018



Since the first deep-sea Raman system being built in 2009, many efforts had been made on “**Sending LIBS equipment to deep-sea**”. It was until 2015, the first underwater LIBS system, named **LIBSea**, was developed and deployed at the depth of **1800m**.

@ 2011 The 1st Chinese symposium on LIBS was hosted by Ocean University of China.

2011-2015

2006-2010

With the supports from **NSFC** and **National High-Tech R&D Program**, extensive investigations to LIBS under high pressure condition and the effect of ocean environment were being made to evaluate the feasibility of applying LIBS to deep-sea detection.

海纳百川 取则行远



Our Ages

We have been working on LIBS/RamanS *in/under water* at the pressure of **1 - 400 atm** for Ocean Applications



鱼山 Yushan



OUC's LIBS and RamanS were born for Ocean Applications

浮山 Fushan

- Ablation age for R Zheng**
29, since 1992
- LIBS age for OUC**
17, since 2004
- RamanS age for OUC**
15, since 2006



崂山 Laoshan

RLA for surface analysis @ Laser Ionisation Studies group in Glasgow Univ. in UK.

Working on LIBS in water and underwater Raman system.

Built up a deep sea Raman system operating at **4000m** depth, in 2009.

- A deep sea LIBS-Raman system is building for hydrothermal vent investigation.
- Try to make LIBS work efficiently as Raman does.



Back to 2011 不忘初心

OUC-LIBS @2011

• Impact Articles? Strong Applications? Or for Both?

- ✓ Fusion for more information;
- ✓ Understanding for effective collaboration

科学家与技术人员的相互理解和支持



— That is the way we have always followed.

Casually in Operation 兴趣导向

- ✎ Poor in funding, Rich in imagination
- ✎ Without deadlines, Full of enjoyments
- ✎ Sharing and making progress with other developments

Full of Fusions 学科交叉 / 技术融合

- ✎ Technique Fusion in many ways
- ✎ Ocean Science and LIBS technology
- ✎ Scientists and Engineers

Destiny with Ocean

服务于海洋的使命感

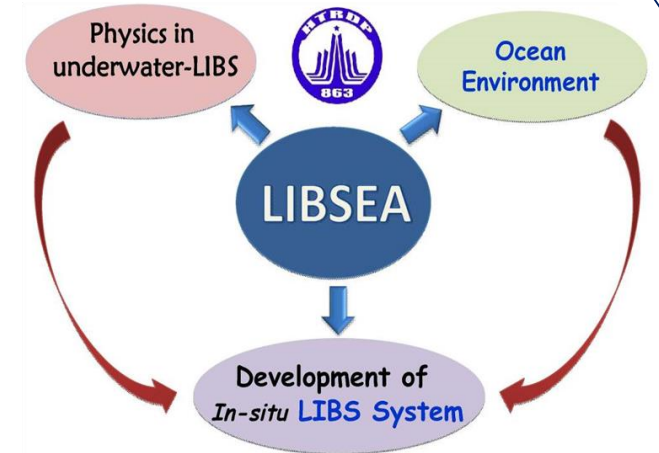
- ✎ Sensors to make sense of the sea



The 1st Chinese symposium on LIBS was organized by OUC-LIBS group in March 25-27, 2011.

Micro-LIBS

for OCEAN APPLICATION ?



Sending LIBS Equipment to Deep-sea__in-situ LIBS

Tracking ocean environment by **mapping** the sample brought to shore

@2014 —Micro-LIBS

The 1st LIBS-Raman mapping system, in micro spatial resolution, was developed by Dr Yuan Lu, and used for surface analysis of seashell in 2014.



Publications

The publications of OUC-LIBS in recent 10 years are listed as follows, from LIBS fundamental, method, to instrumentation and applications.

☛ You can right-click and open the file on the new tab for multiple views.

Mapping and instrumentation

- [Sensors](#), 2020, **20**(24): 7341.
- [Appl. Spectrosc](#), 2020, **74**(5): 563-570.
- [Appl. Opt.](#), 2018, **57**(13): 322937.
- [Plasma Sci. Technol.](#), 2017, **19**: 025501.
- [Appl. Opt.](#), 2017, **56**: 303639.
- [Spectrochimica Acta Part B](#), 2015, **110**: 63-69.

Signal enhancement for liquid

- [Opt. Express](#), 2019, **27**(21): 29896-29904.
- [Front. Phys.](#), 2016, **11**(4): 114202.
- [Appl. Spectrosc](#), 2015, **69**(12): 1412-1416.
- [Appl. Spectrosc](#), 2014, **68**(9): 1039-1045.
- [Appl. Opt.](#), 2010, **49**(13): C75-C79.

Data processing and other

- [J. Anal. At. Spectrom.](#), 2021, doi 10.1039/d1ja00266j.
- [Appl. Opt.](#), 2021, **60**(6): 1595-1602.
- [J. Anal. At. Spectrom.](#), 2020, **35**(2): 366-376.
- [Spectrochimica Acta Part B](#), 2020, **175**: 106027.
- [Appl. Opt.](#), 2019, **58**(1684): 3886-3891.
- [Appl. Spectrosc](#), 2019, **73**(11): 1277-1283.
- [Spectrochimica Acta Part B](#), 2014, **102**: 52-57.
- [Appl. Spectrosc](#), 2014, **68**(9): 1085-1092.

Single-pulse underwater LIBS

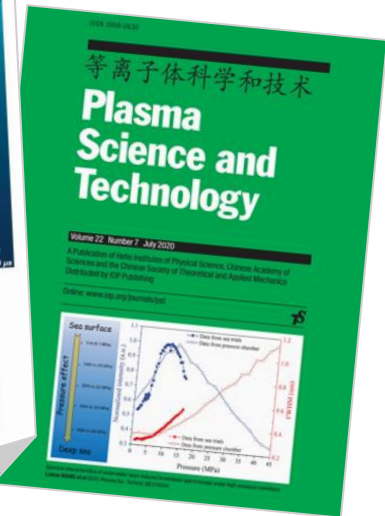
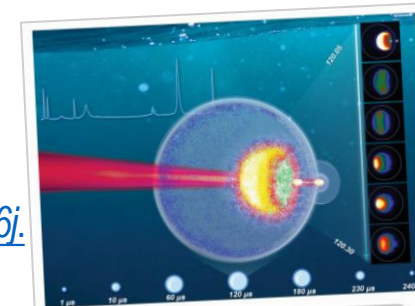
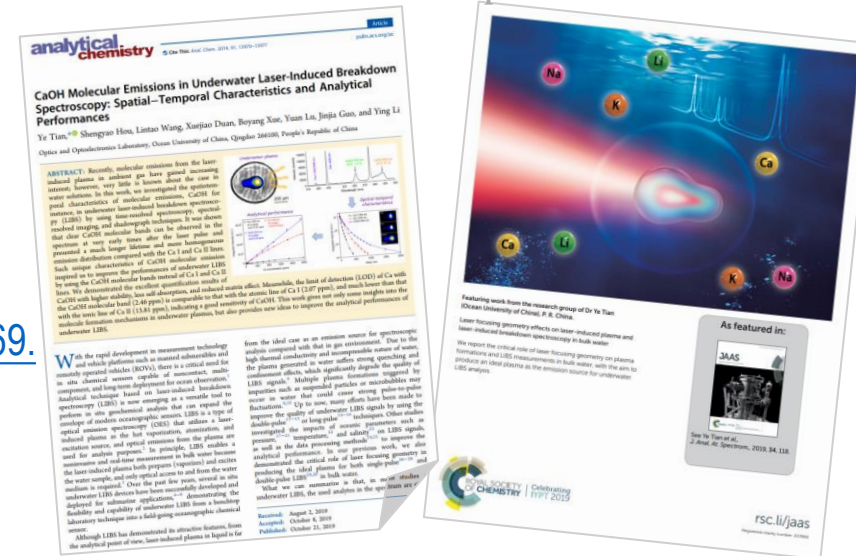
- [Anal. Chem.](#), 2019, **91**: 13970-13977.
- [J. Anal. At. Spectrom.](#), 2019, **34**(1): 118-126.
- [Appl. Opt.](#), 2018, **57**(7): 309777.
- [Appl. Phys. Express](#), 2017, **10** (7): 072401.
- [Appl. Phys. Lett.](#), 2016, **109**(6): 061104.
- [Appl. Phys. Lett.](#), 2015, **107**(11): 111107.

Double-pulse underwater LIBS

- [J. Anal. At. Spectrom.](#), 2020, **35**: 2880-2892.
- [J. Anal. At. Spectrom.](#), 2020, **35**: 2351-2357.
- [Spectrochimica Acta Part B](#), 2019, **151**: 20-25.
- [Appl. Phys. Lett.](#), 2017, **110**: 101102.

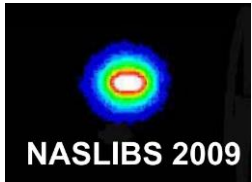
High pressure LIBS

- [Opt. Express](#), 2021, DOI 10.1364/OE.444232.
- [J. Anal. At. Spectrom.](#), 2021, **36**: 644-653.
- [Opt. Express](#), 2020, **28**(12): 18122-18130.
- [Plasma Sci. Technol.](#), 2020 **22**(7): 074004.
- [Plasma Sci. Technol.](#), 2019, **21**: 034022.
- [J. Anal. At. Spectrom.](#), 2014, **29**(1): 169-175.
- [Appl. Phys. Express](#), 2014, **7**(3): 032402.



☛ 你可点右键，在新标签页打开文件进行多篇浏览

Contributions in LIBS Conference



R. Zheng & Y. Li attended **NASLIBS 2009**, New Orleans, USA, to contribute **1 invited** talk and **1 poster** presentation.



R. Zheng & S.L. Zhong attended **LIBS 2010**, Memphis, USA, to

contribute **1 invited** talk and **2 poster** presentations.



R. Zheng, Y. Lu, Y. Li, Y. Tian & J.J. Song together with number of

volunteer students attended **LIBS 2014**, Beijing, China, to contribute **2 oral** and **3 poster** presentations. Y. Tian recieved the **Best Poster** award in third-class.



R. Zheng, Y. Lu, B.Y. Xue & Y. Zhang attended **ASLIBS 2015**,

Wuhan, China, to contribute **1 Invited**, **1 oral** and **3 poster** presentations. B.Y. Xue on behalf of J.J. Song recieved the **Best Poster** award in second-class.



Y. Lu, J.J. Guo, K. Cheng, B.Y. Xue & Y. Tian attended

LIBS 2016, Chamonix-Mont-Blanc, France, to contribute **1 oral** and **7 poster** presentations.



Y. Li & N. Li attended **ASLIBS 2017**, Tokushima, Japan, to contribute **2 oral** and **2 poster** presentations. N. Li recieved the Young Researcher **Best oral** award.



R. Zheng, Y. Lu & Y. Tian attended **ASLIBS 2019**, Jeju, Republic of Korea, to contribute **3 oral** presentations



R. Zheng, Y. Tian, W.Q.Ye & B.Y. Xue attended **EMSLIBS 2019**, Brno, Czech Republic, to contribute **1 Invited** and **5 poster** presentations. B.Y. Xue recieved the **Best Poster** award.



R. Zheng, Y. Lu, B.Y. Xue, C.H. Liu & Z. Liu attended **LIBS 2020**, Kyoto, Japan (Web), to contribute **1 Invited** talk, **3 oral** and **1 poster** presentations. B.Y. Xue recieved the **Best PhD** award.

◆ Joint PhD students



BAM — *Federal Institute for
Materials Research
and Testing (BAM),
Germany*

Bundesanstalt für
Materialforschung
und -prüfung

- **Boyang Xue** (2018-2019)



- **Yuan Lu** (2010-2012) • **Jiaojian Song** (2016-2017)
 - **Huaming Hou** (2012-2014) • **Boyang Xue** (2018)
- Lawrence Berkeley National Laboratory (LBNL), USA

Lyon 1 University, France

Université Claude Bernard  Lyon 1

- **Junshan Xiu** (2012-2013)
- **Ye Tian** (2014-2016)



京都大学

KYOTO UNIVERSITY , *Japan*

- **Nan Li** (2019-2021)

◆ Joint project cooperations



徳島大学 , *Japan*
TOKUSHIMA UNIVERSITY



**BRNO
UNIVERSITY
OF TECHNOLOGY** , *Czech Republic*



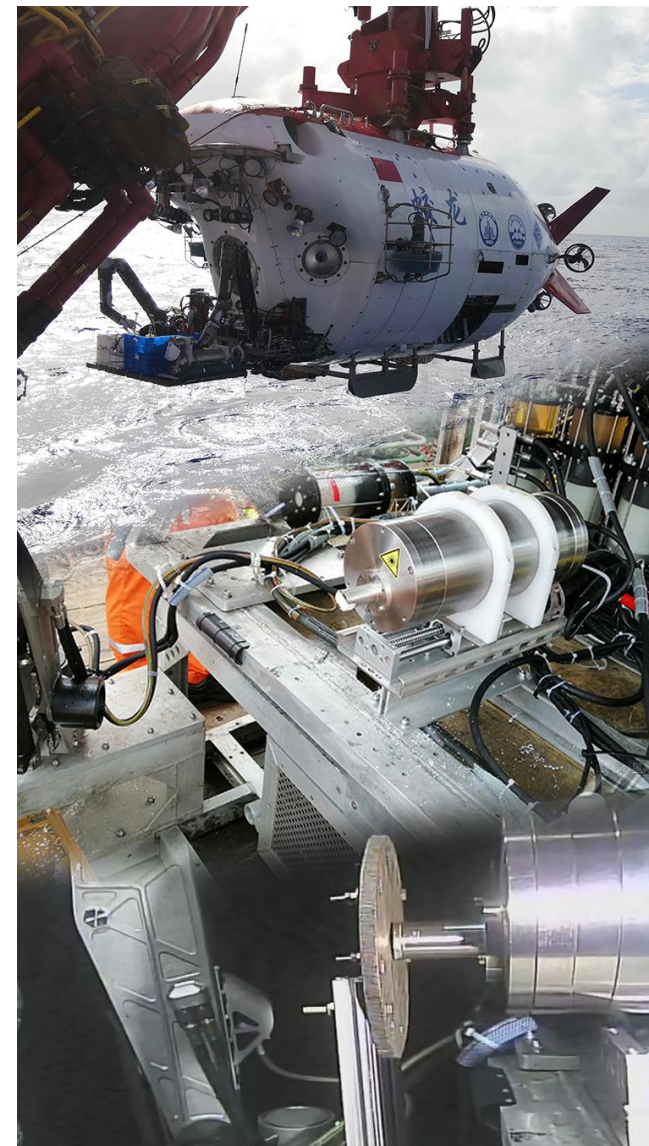
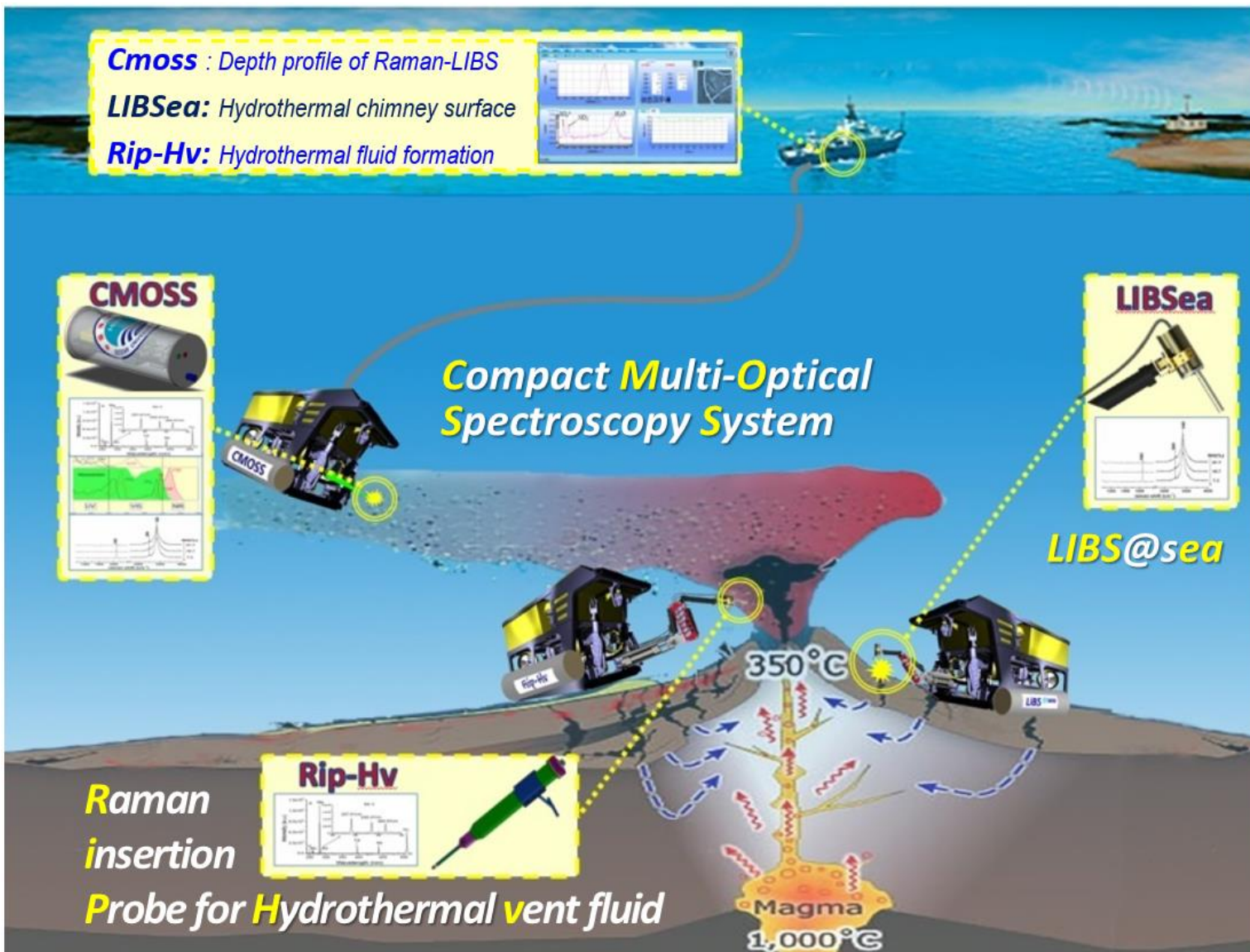
Our Honor

Supported by **National Key R&D Program of China**, based on LIBS and Raman spectral techniques, number of deep-sea systems **Cmoss**, **LIBSea** and **Rip-Hv** are developed. The contributions have been highly recognized.

服务于海洋
的使命

Destiny with Ocean

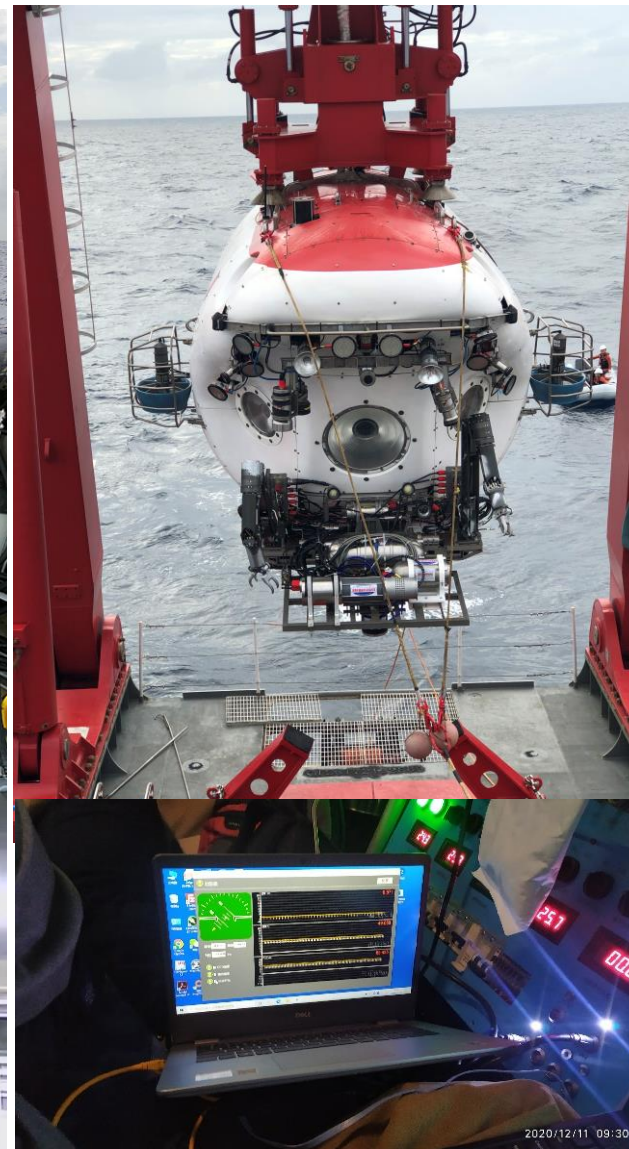
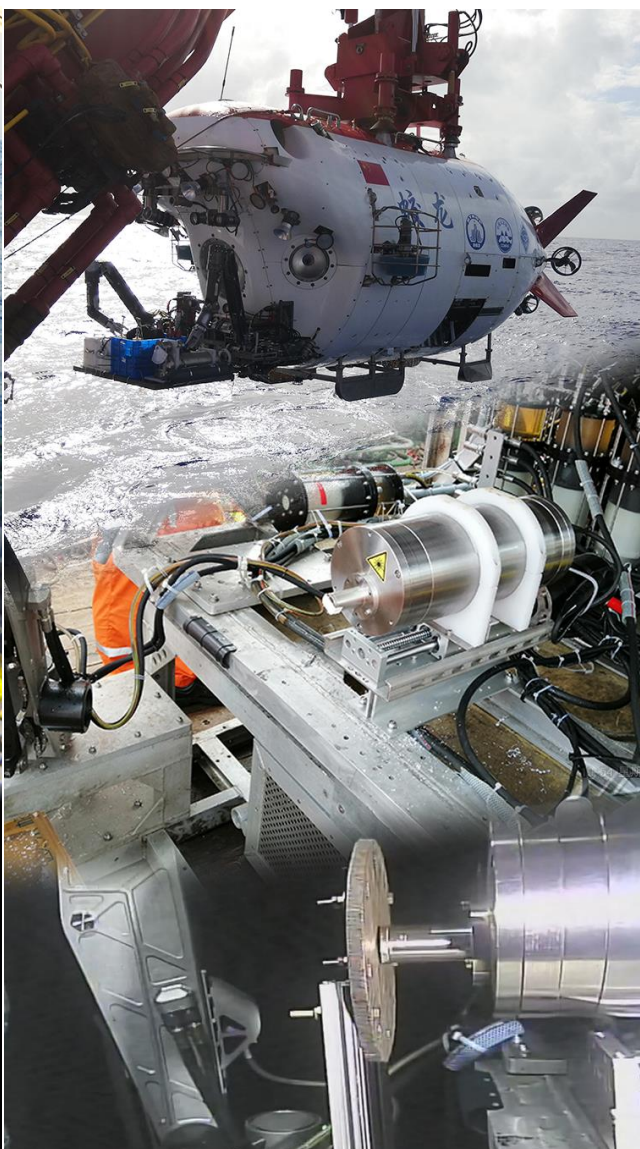
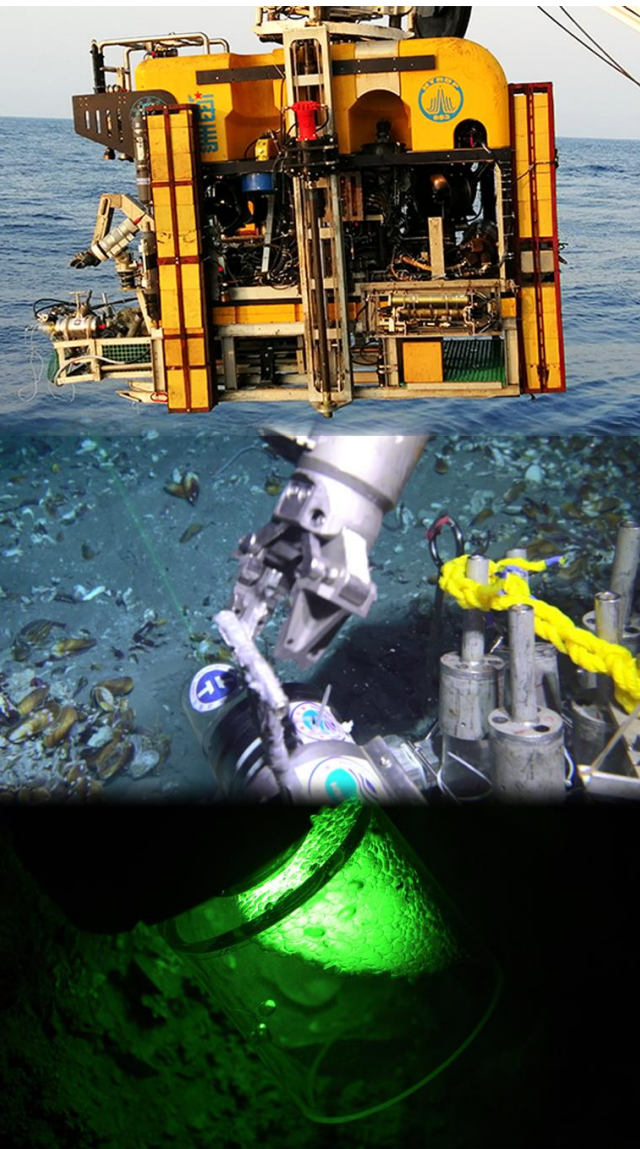
Sensors to make sense of the sea





深海热液化学场多光谱联合原位综合探测系统

2016YFC0302100
Cross/LIBSea/RiP-Hv



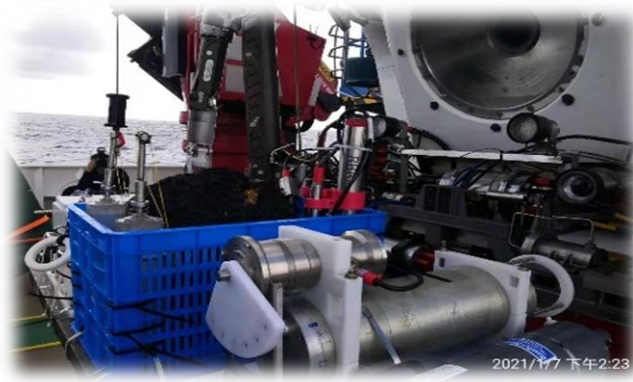
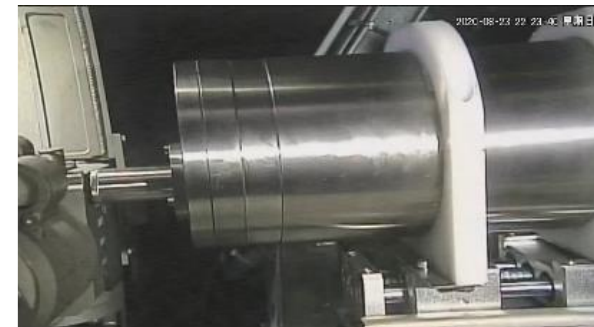
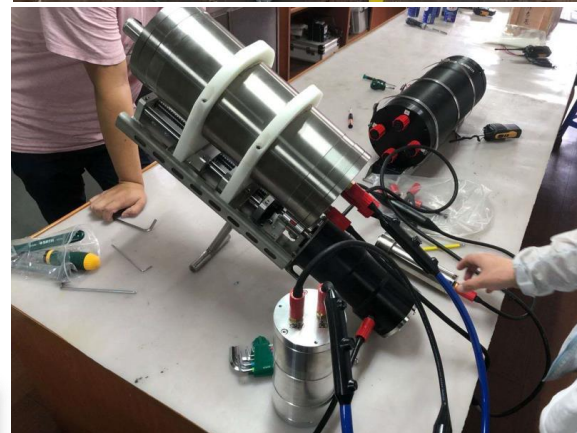
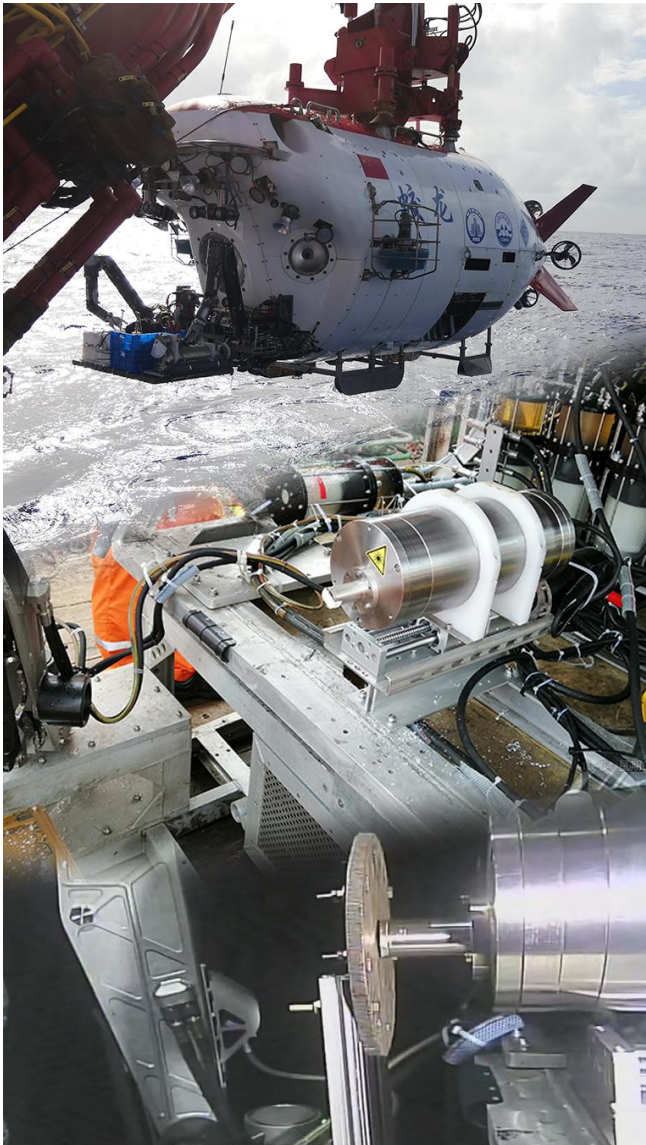
2020/12/11 09:30

LIBSea to make sens of the sea

2016YFC0302102



可精准定位的深海
LIBS金属元素探测系统

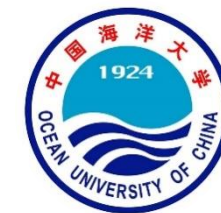


Lambda Group in OUC

updated @September, 2021



✓ 科学家与技术人员的相互理解和支持至关重要
— Understanding for effective collaboration is the way we have always followed.



Dr. Ronger ZHENG 郑荣儿
Professor & Head of Group
Email: rzheng@ouc.edu.cn
Tel: (86) 532 6678 1211 (O)
/138 5322 8865 (mobile)



Dr. Jinjia GUO 郭全家 正高工
Prof. & Chief Engineer of Group
Email: opticsc@ouc.edu.cn
Tel: (86) 185 6167 2029



Dr. Ying LI 李颖
Professor
Email: liyings@ouc.edu.cn
Tel: (86) 532 6678 1390



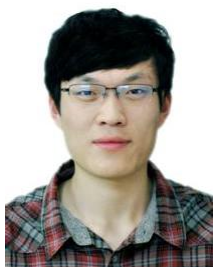
Prof. Fujun QI 齐夫军 正高工
Senior Engineer in Electronics
Email: fujunqi@ouc.edu.cn
Tel: (86) 138 0542 1534



Dr. Yuan LU 卢渊
Associate Professor
Email: luyuan@ouc.edu.cn
Tel: (86) 182 5320 1226



Dr. Kai CHENG 程凯
Senior Engineer in Mechanics
Email: chengkai@ouc.edu.cn
Tel: (86) 532 6678 1234



Dr. Ye Tian 田野
Associate Professor
Email: ytian@ouc.edu.cn
Tel: (86) 150 5329 5136



Dr. Wangquan Ye 叶旺全
Lecturer in Optoelectronics
Email: yewangquan@ouc.edu.cn
Tel: (86) 131 7687 1157

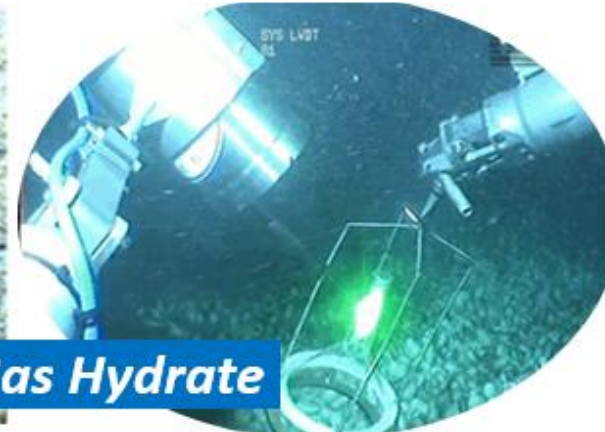
- ◆ **PhD Sts. in Marine Science**⁸
— N Li, Z Luo; *C Chen*, ZH Zhang;
N Li; S Liu, MD Sui, ZW Jia.
- ◆ **PhD Sts. in Marine Technology**⁸
— QS Liu; *CF Li, LH Ren*; SJ Li;
YB Hu, *CQ Li, JB Liu*; LN Song.
- **MPh Sts in Optical Eng.**¹⁰
— CC Fan, D Li, Z Liu; BB Wang,
HT Wang, QX Yan; SX Hu,
YP Qin, CX Zhai, XB Zhang.
- **MEng Sts. in Optoelectronic Eng.**²⁹
— AD Kong, ZH Wei, XY Yang, QY Yu;
YW Chao, L Chen, JW Han, C Meng, H Shi,
Q Wang, SY Wang, LL Wu, JT Xiao, HL Yu,
T Yang, SH Zhao; BX Chen, JJ Dong, B Gui,
T Li, X Li, HX Liu, Q Lv, YX Sun, HY Tian,
GX Wang, GR Xu, ZX Zang, ZY Zhang.



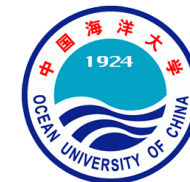
Hydrothermal vent



Cold seep



Gas Hydrate



OUC-LIBS
2004 - 2021



Raman on Observatory



2015-2020

Raman probe

2015-2020



RV Kexue, ROV Faxian

Cross on ROV/HOV



2018-2020 2019-2020



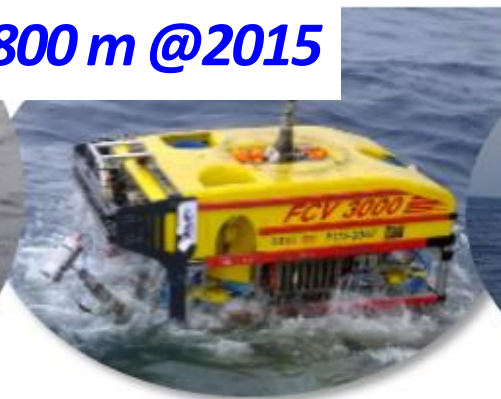
40 MPa



OUC-Raman



1800 m @2015



3200 m @2020



ROV Haima

OUC-Lambda
任重道远

We hope someday in near future, it is possible to make LIBS work efficiently as Raman does.

For oceans & for LIBS → the challenge & the opportunity

OUC - LAMBDA

We are moving on.....

Qingdao • China
October, 2021



OUC - LAMBDA



rzheng@ouc.edu.cn
13853228865, OUC_ZRe

