Supporting Information

Design, Function, and Implementation of China’s First LIBS Instrument (MarSCoDe) on the Zhurong Mars Rover

Xiong Wan, a,b,∗ Chenhong Li, b Hongpeng Wang, b Weiming Xu, b,e,∗ Jianjun Jia, b,e,c,∗ Yingjian Xin, b
Huanzhen Ma, e Peipei Fang, e and Zongcheng Ling d

a Key Laboratory of Systems Health Science of Zhejiang Province, Hangzhou Institute for Advanced Study, University of Chinese Academy of Sciences, Hangzhou 310024, P.R. China
b Key Laboratory of Space Active Opto-Electronics Technology of the Chinese Academy of Sciences, Shanghai Institute of Technical Physics, Shanghai 200083, P.R. China
c Shanghai Research Center for Quantum Sciences, Shanghai 201315, P.R. China
d Shandong Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment, School of Space Science and Physics, Institute of Space Sciences, Shandong University, Weihai, Shandong 264209, P.R. China
∗ Hangzhou Institute for Advanced Study, UCAS, Hangzhou 310024, P.R. China

Corresponding authors
Xiong Wan, wanxiong@mail.sitp.ac.cn;
Jianjun Jia, jianjunjia_sitp@163.com;
Weiming Xu, xuwm@mail.sitp.ac.cn

LIBS Laser

Fig. S1 LIBS laser head.
The LIBS laser of the MarSCoDe has two parts: (1) laser head, shown in Fig. S1, which is inside the optical head and includes optical and mechanical components. The other is inside the cabin, which mainly consists of related electronics. The typical parameters of the laser are shown in Table S1.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength (nm)</td>
<td>1064</td>
</tr>
<tr>
<td>Pulse width (ns)</td>
<td>4.5</td>
</tr>
<tr>
<td>Pulse energy (mJ)</td>
<td>23</td>
</tr>
<tr>
<td>Repetition rate (Hz)</td>
<td>1-3</td>
</tr>
<tr>
<td>Mass (kg)</td>
<td>0.65</td>
</tr>
<tr>
<td>Volume (mm$^3$)</td>
<td>142 × 80 × 60</td>
</tr>
</tbody>
</table>

The optical structure of the laser head is shown in Fig. S2. The laser head consists of a slab crystal, a Q-switched crystal, a reflector, an output mirror, and a bar array of pump laser diodes (LDs). The slab crystal adopts Nd:YAG medium, which has good mechanical and thermal properties. The pump LDs are Vertical Cavity Surface Emitting Laser (VCSEL) diodes, which have a wide working temperature range of 20 °C. The Q-switched crystal uses Cr: YAG material.

Fig. S2 Optical structure of the laser head.
The laser head uses a thermal-electric cooler (TEC) to adjust the temperature, which adheres to the shell of the laser head. The framework adopts invar steel material, which has high rigidity.

**CNN**

The output of the CNN are the predicted contents of the main elements, namely Si, O, C, S, H, Na, Ca, Mg, Mn, Fe, Al, and Ti, as shown in Fig. S3. Then the detected object can be classified according to the alkali silica ratio.

![Classification chart of alkali silica ratio.](image)

*Fig. S3* Classification chart of alkali silica ratio.