Development of Electro-Optical Payloads for Low-Cost Planetary Missions at LEOS-ISRO: A Case Study

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Abstract. The new challenging scientific goals combined with the variety and complexity of instruments are increasingly dictating the system and mission design of space missions in general and of planetary exploration missions in particular. In all disciplines of the space sciences except planetary exploration, scientific problems currently are addressed by missions that range in cost, complexity and rigid schedules. There is an utmost urge to balance cost, performance and schedules. During the last decade, the traditional approach to planetary spacecraft design driven almost solely by performance characteristics and high reliability to meet mission objectives, with cost and schedule as secondary concerns, has been completely reversed. A program of low-cost mission could play a valuable role in planetary exploration and can focus on specific, well-defined scientific objectives with the expectation that definitive results will be produced. However, the success of such missions will depend in part on the availability of low-cost, miniaturized, promising instruments. Innovation in miniaturization of the payload instrumentation is one way in advancement of low-cost planetary missions, because the principal constraint of a planetary mission is payload mass. ISRO has tremendous expertise in space research and one of the leading space agencies worldwide. The organization has witnessed the possibility of low-cost planetary mission, with its first highly successful interplanetary mission to moon, Chandrayaan-1. 'Lunar Laser Ranging Instrument' (LLRI) a laser payload aboard Chandrayaan-1 payload suite was developed at Laboratory for Electro-Optics Systems (LEOS) by adopting all possible miniaturization approaches. Realization and development of such a payload suggested us the level of science that can be accomplished within the confines of the mission program. For India's second lunar mission, Chandrayaan-2, LEOS is developing a very small instrument (< 1kg) for understanding the lunar geochemistry from vicinities by performing in-situ measurements. The instrument named 'Laser Induced Breakdown Spectroscope-LIBS' will be housed on Chandrayaan-2 rover. The instrument has been conceptualized and a development model of LIBS is under realization with a great emphasis on miniaturization without compromising the functionality and/or quality of desired science. Several innovative approaches have been chalked out and implemented successfully, especially in the design, material selection, electronics miniaturization, manufacturing and integration towards reducing the cost per gram of delivered hardware. Through this paper, authors would like to share all such aspects in addition to the instrument’s conceptualization and design; and also on the latest proposed miniaturized payloads of mass on the order of 1 to 2 kg, for the India’s next ambitious mission to the red planet, Mars.