THE UPCOMING RE-ENTRY OF THE OSIRIX-REx RETURN CAPSULE: PLANS FOR A COORDINATED SEISMO-ACOUSTIC OBSERVATIONAL CAMPAIGN. E. A. Silber[1], S. Albert[1], E. M. Berg[1], D. C. Bowman[1], F. K. Dannemann-Dugick[1], [1]Sandia National Laboratories, Albuquerque, NM, USA (esilbe@sandia.gov).

Introduction: Upon entering the Earth's atmosphere at hypervelocity, meteoroids and asteroids (>1 m in diameter) undergo complex processes (e.g., sputtering, heating, ablation, fragmentation, hyperthermal and equilibrium chemical reactions with the ambient atmospheric gas) as they encounter denser regions of the atmosphere [1,2]. The resultant visual phenomenon is called a meteor, with very bright meteors known as fireballs and bolides [1]. Meteoroids and asteroids are of broad scientific interest, from planetary sciences to hypersonic physics. However, impacts into the Earth's atmosphere, especially by asteroids in a meter-size range, are sporadic and unannounced, making it impractical to plan a dedicated multi-instrument observation campaign aimed at studying and characterizing these objects. Thus, well-documented scientific observations of asteroids are rare and generally happen by chance [3]. In these cases, many parameters of interest (e.g., composition, size, porosity, rotation, ablation rate, shock characteristics, hyperthermal chemical processes) remain poorly defined, and scientific analyses largely rely on assumptions and predictions derived from the theoretical domain [1,2].

Artificial meteors: Since the end of the Apollo era, only four instances of a hypersonic re-entry of an artificial body from interplanetary space with an incident speed of 11-12 km/s have been observed and studied (Table 1). These were the Sample Return Capsules (SRCs) that brought physical samples of extraterrestrial material back to Earth. Arriving from interplanetary space at hypervelocity, SRCs are considered analogues for low velocity meteoroids and asteroids impacting the Earth's atmosphere [e.g., 4], and as such provide unprecedented and unique opportunities to perform detailed studies of meteor phenomena, test and calibrate sensors, and validate and improve models. The next opportunity will present itself on 24 September 2023 with the re-entry of OSIRIX-REx SRC that will bring samples of the carbonaceous near-Earth asteroid Bennu [5].

Table 1: List of SRC re-entries.

	Genesis[1]	Stardust[2]	Hayabusa 1[3]	Hayabusa 2[4]	OSIRIX-REx[5]
Date	8-Sep-04	15-Jan-06	13-Jun-10	5-Dec-20	24-Sep-23
Entry speed* (km/s)	11	12.9	12.2	12	~12
Entry angle (°)	8	8.2	12	12	~8
Landing site	UTTR	UTTR	WPA	WPA	UTTR
Mass (kg)	225	45.8	18	16	46
Diameter (m)	1.52	0.811	0.4	0.4	0.81

*at ~135 km altitude; [1]ReVelle, et al., 2005; [2]ReVelle & Edwards, 2007; [3]Yamamoto et al., 2011; [4]Sansom et al., 2022; [5]Lauretta et al., 2017

OSIRIX-REx: The OSIRIX-REx asteroid sample return mission was launched in 2016 with the aim to collect samples from the near-Earth asteroid Bennu and bring those samples back to Earth in pristine condition. Bennu was chosen because it is a readily accessible, primitive, carbonaceous asteroid, and it is also one of the most potentially hazardous known near-Earth objects [5]. OSIRIX-REx SRC is identical to that of the Stardust SRC; that includes the mechanical design, and all aspects of re-entry. Landing is planned for 24 September 2023, over the region enclosed by an 80km long and 20km wide ellipse at the Utah Test and Training Range (UTTR), Utah, USA [5]. The final descent will be tracked in real-time to derive a landing position to within ten meters. The return will consist of several phases, including the hypersonic, transonic, main parachute, and landing phases. The atmospheric flight will last 8 minutes before the SRC reaches the altitude of 36 km and assumes dark flight.

Seismo-acoustic observational campaign: The OSIRIX-REx re-entry presents a unique and exceptional opportunity to observe a well-defined artificial meteor, to perform detailed studies of hypersonic entry and event characterization, to test sensors, and validate and improve models. We will organize and lead multi-instrument observations of the OSIRIX-REx SRC re-entry. The instruments will include infrasound and seismic sensors strategically positioned in the immediate and extended region around the projected re-entry trajectory to maximize the scientific output. Data collected during this observational campaign will be made freely available to the broad scientific community following publication.

References: [1] Ceplecha Z. et al. (1998) *Space Science Rev.*, 84:3/4, 327-471. [2] Silber E. A. et al. (2018) *ASR*, 62:3, 489 - 532. [3] Brown P. et al. (2013) *Nature*, 503:7475, 238-241. [4] ReVelle D.O. and Edwards W. (2007) *MAPS*, 42 :2, 271-299. [5] Lauretta et al. (2017) *Space Sci.*, 212:1:925-984.

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