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Advancements in Encoding Gravitational-wave Sky Localizations: Virtual Observatory Standards and New Challenges for the Einstein Telescope

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The International Virtual Observatory Alliance (IVOA) plays a crucial global role in establishing technical standards necessary for realizing the Virtual Observatory (VO). Our discussion focuses on the extensive adoption of the Multi-Order Coverage map (MOC) data structure for encoding the localization regions of gravitational wave sources detected by the LIGO, Virgo, and KAGRA (LVK) collaborations. Through practical demonstrations, we will illustrate how the adoption of this standard facilitates planning and interoperability in multi-messenger activities across a network of telescopes.

In the era of the Einstein Telescope (ET), hundreds of thousands of alerts will need to be combined in real-time with the electromagnetic facilities available at that time. We present the latest advancements in expanding MOCs to handle spatial and temporal information simultaneously, highlighting their potential to manage the substantial data stream.

Primary author: GRECO, Giuseppe (INFN-Perugia)

Presenter: GRECO, Giuseppe (INFN-Perugia)

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