

CRMhs

A CIDOC CRM Extension for Documenting Heritage Science

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CRMhs: a bit of story



2016: “PARTHY” Task Force for Scientific Data (CNR-INO, INFN, PIN)

Survey of **international metadata standards and vocabularies** for scientific research

CERIF (EU recommended format), **OBOE** (scientific observation and measurement), **NeXus** (neutron and x-ray), **AVM** (astronomical images), **CIF** (crystallography), CHAracterisation METHodology Ontology (**CHAMEO**), **EMMO** (Elementary Multi-perspective Material Ontology), [...]

CRMsci (CIDOC CRM extension)

Survey of **local formats** developed for internal use by international labs

2017: E-RIHS Project: requirements for an ontological model for the development of DIGILAB

First draft of the model created by CNR-INO, INFN, PIN and other Italian labs

2018: Scientific Data Working Group in **ARIADNEplus** project

Cyl, FORTH, HNM, INFN, LNEC, OEAW, PIN

Used as Application Profile for Scientific Data in **ARIADNEplus** model

CRMhs: a bit of story



2021-2023: used in **4CH Project** for modelling Heritage Science data

Tested by KNAW, INFN, LNEC and other partners involved in material sciences

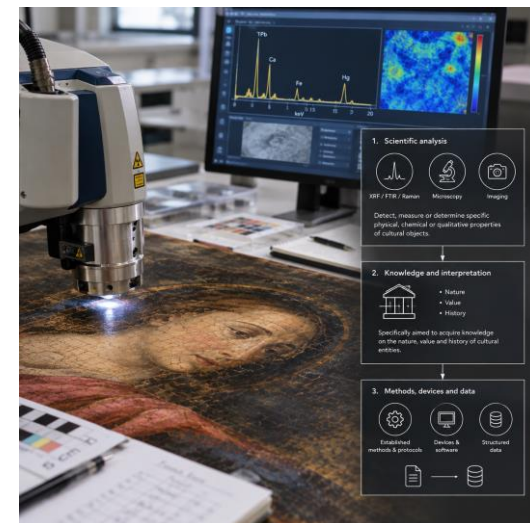
From 2025: used in **ARTEMIS Project** for integrating heritage science data in within the **Heritage Digital Twin** framework

HSDS (UK DIGILAB hub for E-RIHS), INFN, KIK-IRPA, LNEC

Maintained by **VAST-LAB PIN** with support from **ARIADNE** and **ARTEMIS** communities

Version 1.2 published

Version 1.3 in preparation



CRMhs complements CRMsci by ...

Tailoring the scientific framework of CRMsci to the **specific needs** of Heritage Science

Specialising CRMsci adding the **procedural** and **operational** layer required by Heritage Science

sampling, preparation, methods, protocols, device configurations [...]

Remaining **fully interoperable** with the CIDOC CRM ecosystem

Heritage Science: bridging different worlds



*“The interdisciplinary domain of **scientific study** of **cultural** and **natural heritage**, focused on enhancing **understanding**, **care**, and **sustainable** use of heritage so that it **enriches people’s lives** today and in the future”*

Investigates cultural heritage through its **material**, **historical**, **social**, and **environmental** dimensions

movable → paintings, manuscripts, archaeological artefacts, ...

immovable → monuments, historic buildings, archaeological sites, ...

Uses **methods** inherited from **conservation** practice, **natural sciences**, **engineering** and the **humanities**

composition and structure of objects, provenance of materials, manufacturing techniques, mechanisms of deterioration, [...]

Heritage Science investigations



Object-centered purpose: knowledge is directed towards the understanding, interpretation, conservation and sustainable management of specific **heritage entities ...**

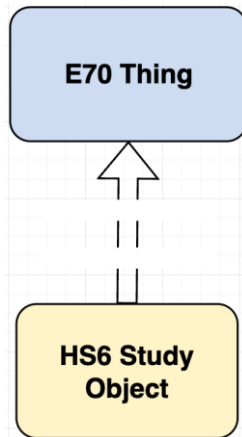
... rather than studying a phenomenon within a single disciplinary framework

Unique, heterogeneous and historically situated objects ...

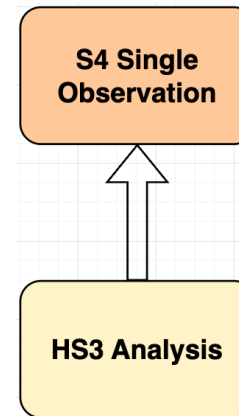
... where the **material, historical, cultural** and **social** dimensions are **inseparable**

CRMhs focuses on

**Characterisation of
investigated objects**



**Characterisation of
analytical operations**



Heritage Science investigated objects

HS6 Study Object

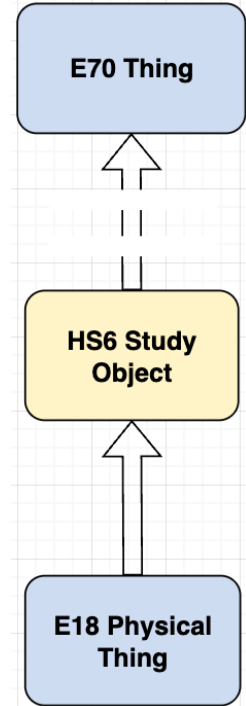
Declared as superclass of E18 Physical Thing

Physical objects **intentionally selected** as the **primary subjects** of a **heritage science investigation**

Preserves the conceptual distinction between **natural** and **human-made** entities

human remains, natural specimens, other organic or inorganic materials

archaeological finds, artworks and artefacts



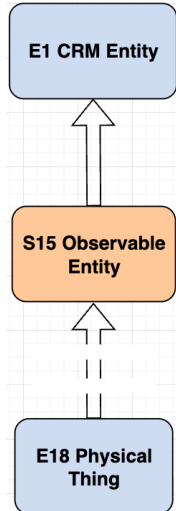
Heritage Science investigated objects

S15 Observable Entity

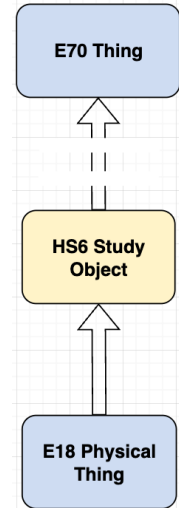
Events or Material Substantials
having the **potential to be observed**

HS6 Study Object

Physical (cultural) things
having the **potential to be studied**



... actuated when specifically selected for
heritage science investigations aimed at
acquiring knowledge about them



Heritage Science analytical operations

Non-invasive diagnostic imaging and mapping

e.g. MA-XRF, hyperspectral imaging, 3D scanning

Structural and physical investigation

e.g. non-destructive testing, thermography, structural monitoring

Micro-sampling and micro-invasive analysis

e.g. microscopy, gas chromatography-mass spectrometry

Dating, Provenance and Archaeometric Studies

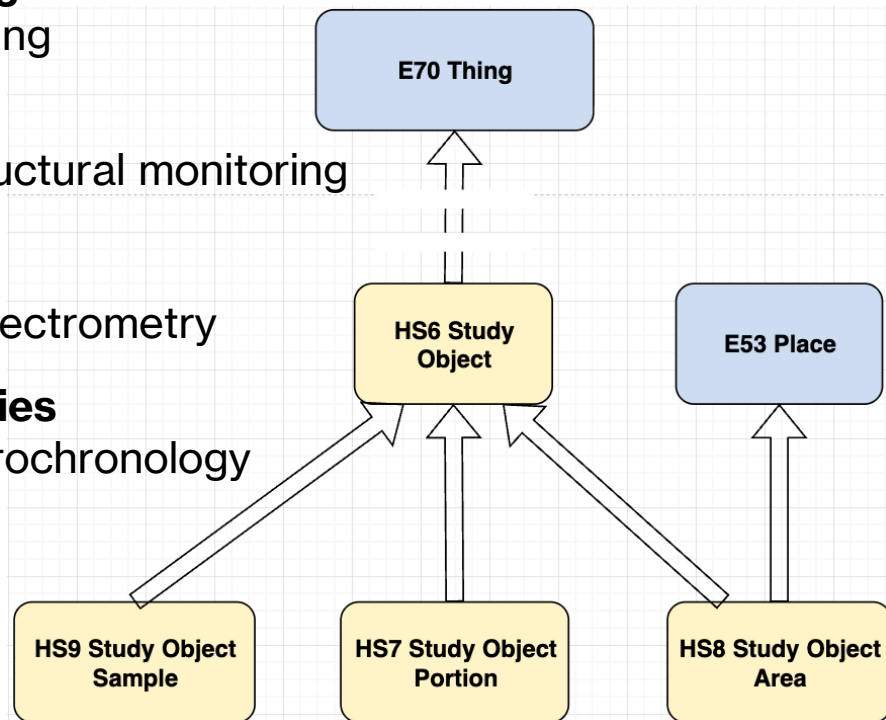
e.g. radiocarbon dating, isotope analysis, dendrochronology

Heritage Science investigates

entire objects

parts and **areas** of the objects

samples taken from the objects



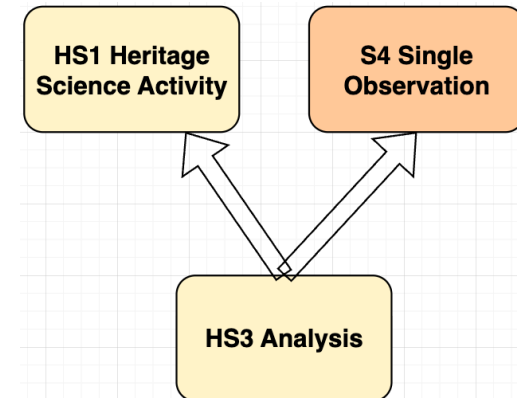
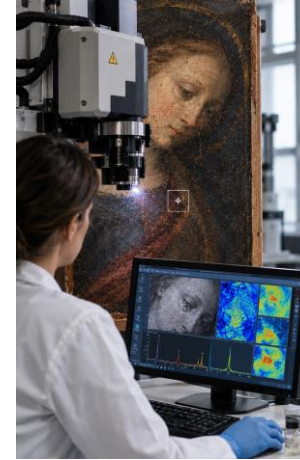
HS3 Analysis

Specialisation of of S4 Single Observation

Scientific activities carried out to **detect**, **measure**, or **determine** specific physical, chemical, or qualitative **properties** of **heritage objects**

Specifically aimed to acquire knowledge on the **nature**, **value**, **history** and **value** of **heritage entities**

Involve the application of established **methods** and **protocols**, the use of **devices** and **software**, and the **production** of **structured data**



Analyses on portions of cultural objects



Location is part of the result

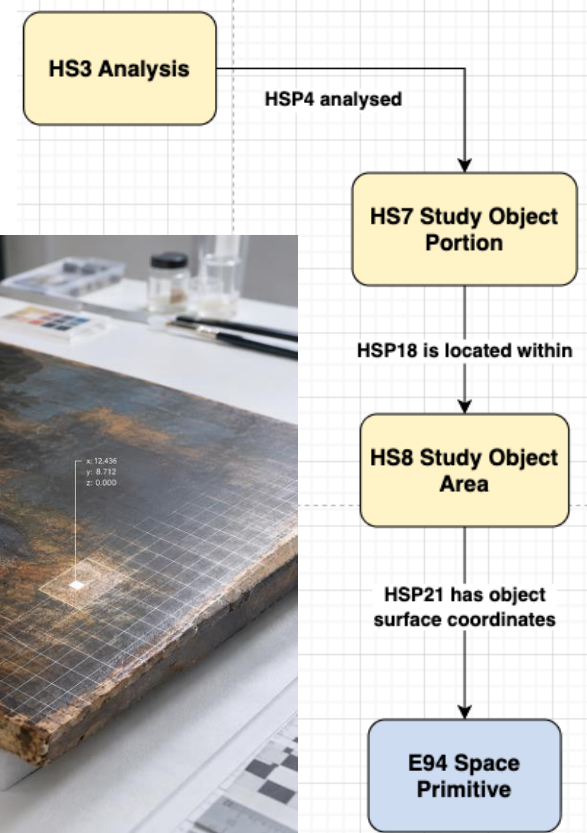
Analyses produce different results depending on the investigated areas

Position of measurements are recorded by scholars

coordinates, reference points, grids, photographs, spatial annotations

Results linked to the investigated area

Traceability between heritage object and investigated location



Sampling in Heritage Science

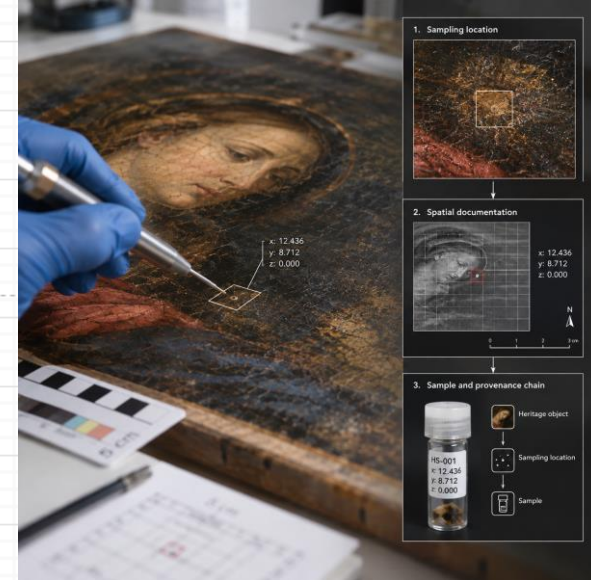
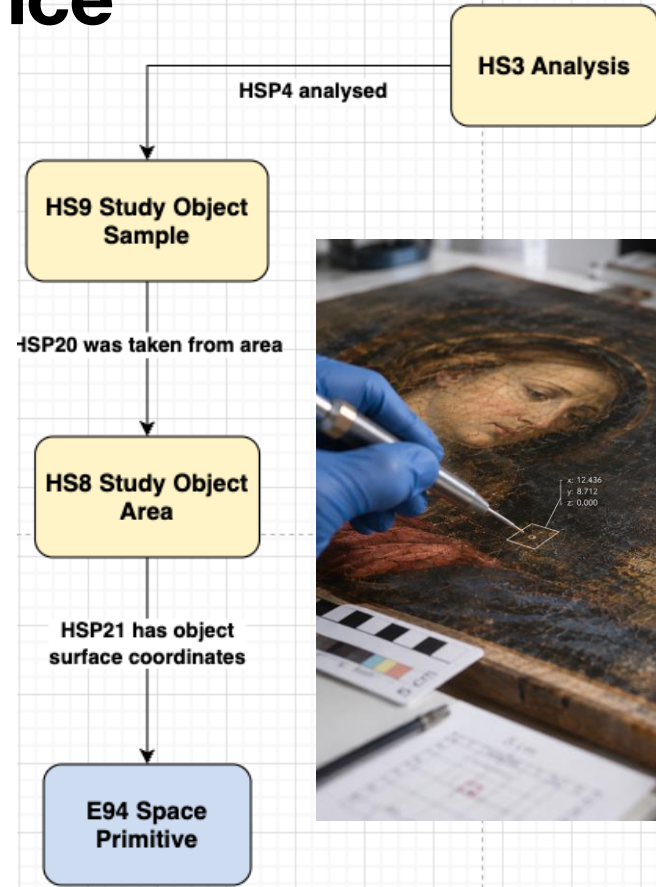
Analytical value of a sample depends on where it was taken from the heritage object

Sampling requires spatial documentation

Exact position of sampling recorded using coordinates, grids and other reference systems

Samples retain provenance chain

Relationship between heritage object, sample and sampling location should remain traceable



HS10 Sample Preparation

Specialisation of of E11 Modification

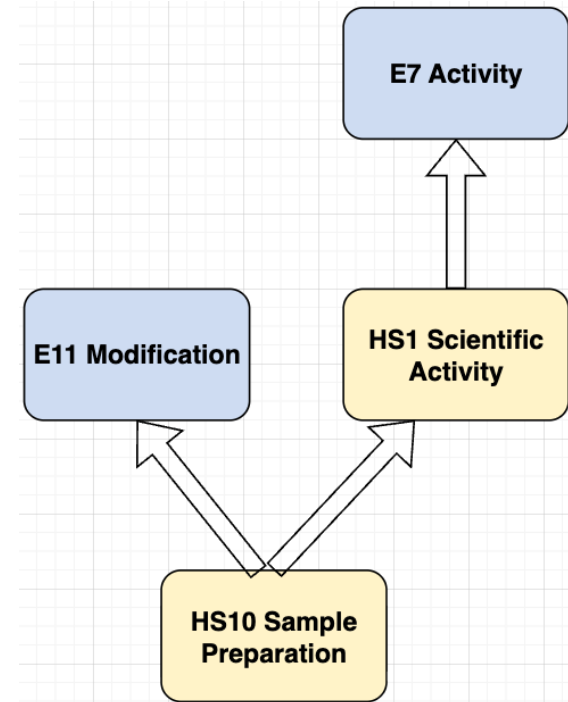
To prepare material samples for heritage science operations

To bring the sample into a condition suitable for analysis, measurement, observation, or device processing

to enhance the accessibility, stability, or compatibility of the sample with specific analytical techniques,

to minimise contamination or degradation

Include cleaning, drying, grinding, polishing, filtering, mounting on supports



Methods and protocols

Specialisation of of E29 Design or Procedure

HS4 Method

Scientific or technical procedure, independent of a particular execution.

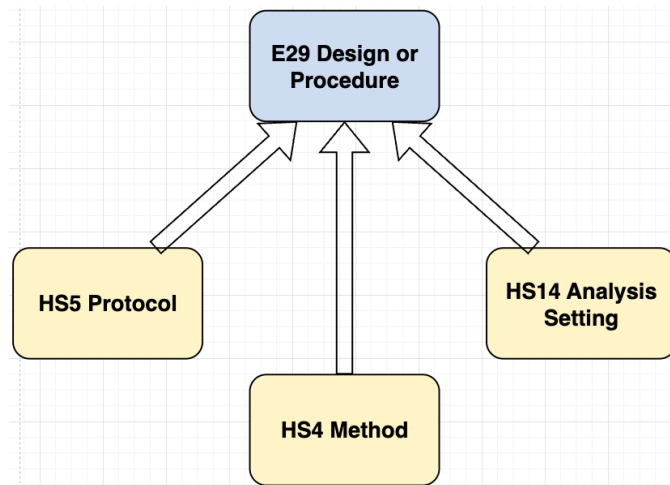
e.g. radiocarbon dating, Raman spectroscopy, PCA

HS5 Protocol

Formalised and prescriptive specification of how a method is to be carried out in a particular analysis

e.g. laboratory SOP for chemical pretreatment of a sample

A method defines **what kind of procedure** is applied; a protocol defines **how it is concretely performed**, including steps, devices, parameters and conditions



CRMhs properties

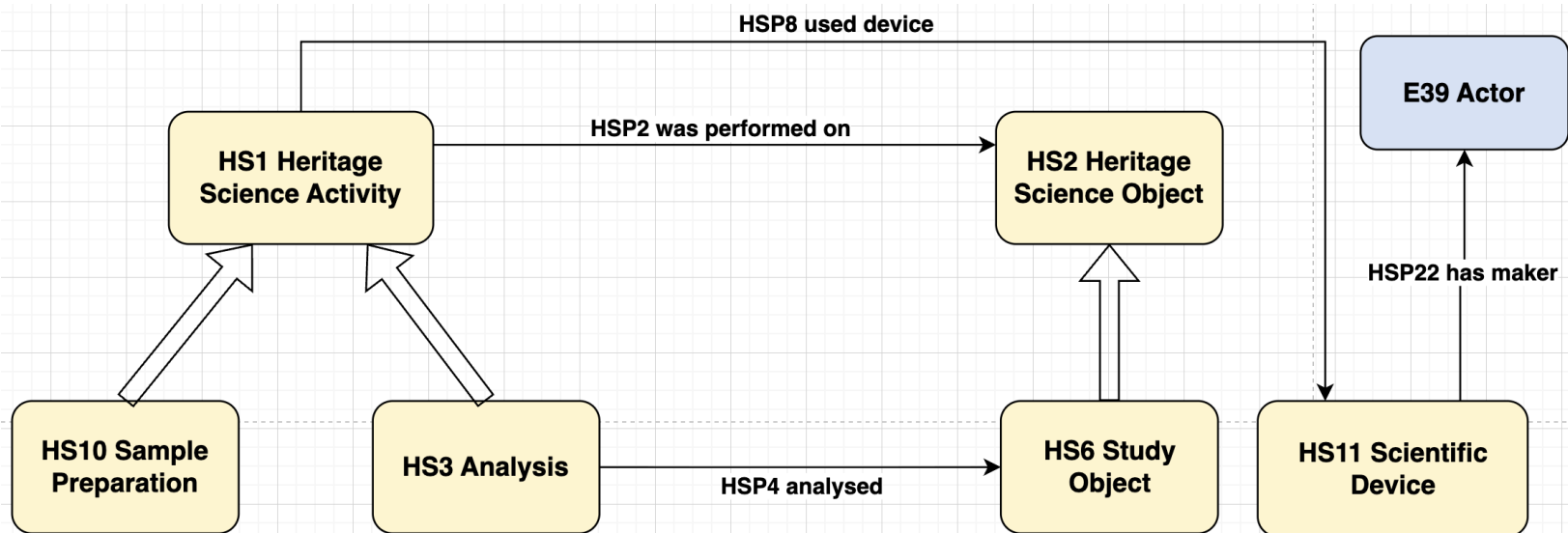
High-level classes for properties propagation

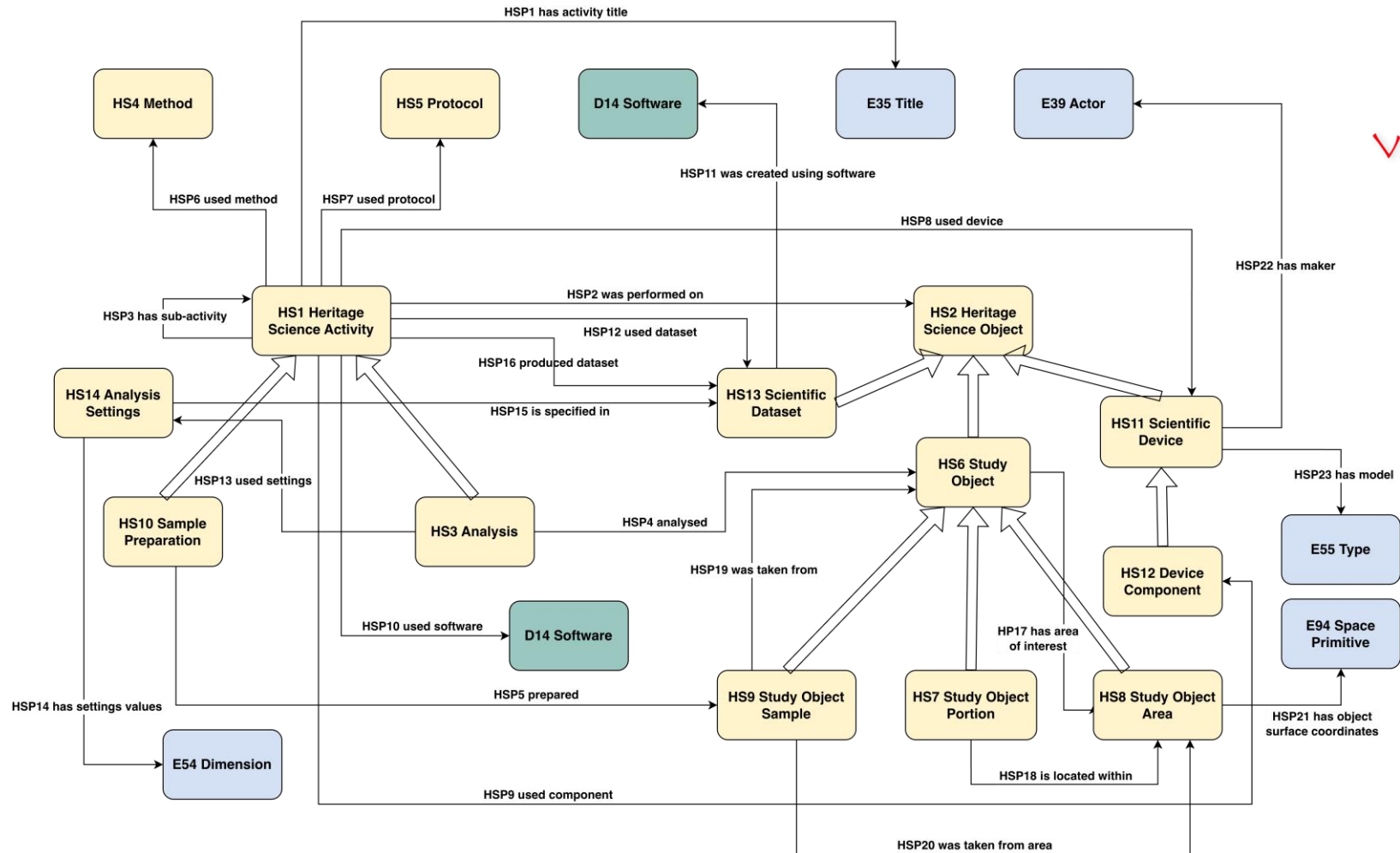
General and specific properties

HSP2 was performed on
HSP4 analysed
HSP8 used device

Shortcuts

HS22 has maker





The future of CRMhs



Initial attempt to capture the essence of Heritage Science

Requires refinement as the understanding of the field evolves

Contributions, criticisms and new directions from SIG and anyone willing to help shape it are welcome

Towards an open model in the hands of the community ...

... should the community see value in evolving CRMhs into a shared model for Heritage Science

References

Niccolucci, F.; Meghini, C.; Felicetti, A.; Pezzati, L. *Condivisione dei dati sui beni culturali: DIGILAB, l'esperienza di ARIADNE e di E-RIHS*. In Proceedings of the Data Way to Science. Conferenza GARR_17 (Venezia, 15–17 Novembre 2017); Selected Papers; GARR: Roma, Italy, 2017; pp. 129–132. <http://dx.doi.org/10.26314/GARR-Conf17-proceedings-24>

Niccolucci, F.; Felicetti, A. *A CIDOC CRM-based Model for the Documentation of Heritage Sciences*. In Proceedings of the 2018. 3rd Digital Heritage International Congress (DigitalHERITAGE) Held Jointly with 2018 24th International Conference on Virtual Systems & Multimedia (VSMM 2018), San Francisco, CA, USA, 26–30 October 2018; pp. 1–6. <http://dx.doi.org/10.1109/DigitalHeritage.2018.8810109>

Castelli, L.; Felicetti, A.; Proietti, F. *Heritage Science and Cultural Heritage: Standards and Tools for Establishing Cross-Domain Data Interoperability*. Int. J. Digit. Libr. 2021, 22, 279–287. <http://dx.doi.org/10.1007/s00799-019-00275-2>

Felicetti, A.; Murano, F. *Bridging “Nature” and “Spirit”: The CRMhs Ontology for the Integration of Heritage Science and Cultural Heritage Data*. Heritage 2026, 9, 186. <https://doi.org/10.3390/heritage9050186>

CRMhs documentation

Version 1.2 published

Github: <https://github.com/vastlab-dev/CRMhs>

Zenodo: <https://doi.org/10.5281/zenodo.18956181>

Classes and properties declaration: <https://vast-lab.org/crmhs/>

Version 1.3 in preparation

