- Michael Sidonio
- An Australian
- An award winning amateur astronomer
- Claimed to be the world’s strongest astronomer
- ... demonstrated with a 153 kg sandstone sphere

IMC 2010, Armagh, Northern Ireland, 16th-19th September 2010

Hypervelocity Artificial Meteoroid Experiment (HAM•E)
Brief overview of a mission concept

David Cullen[1], Jorgina Busquets Corominasa[2],
Guillaume Mathon-Margueritte[2] & Peter Roberts[2]

[1]Cranfield Health & [2]School of Engineering, Cranfield University, UK,

Recent history

- HAM•E evolved from discussions between
  - David Cullen (Cranfield) and Peter Roberts (Cranfield) in mid 2008
  - Cullen, Monica Grady (Open University) and Jason Hatton (ESA) in late 2009

- Mission concept and options study
  - Two individual MSc research projects within Cranfield's MSc in Astronautics & Space Engineering in late spring / summer 2010
  - Jorgina Busquets Corominasa – *Hypervelocity Artificial Meteoroid Experiment (HAM•E) – A Feasibility Study*
  - Guillaume Mathon-Margueritte – *Hypervelocity Artificial Meteoroid Experiment (HAM•E) – Atmospheric Entry and Trajectory Options*

Further background / context

- No observed meteor event where the starting (boundary) conditions of the associated meteoroid are fully known ... even 2008 TC3
- Therefore current understanding of meteoric science severely limited
- Number of recent hypervelocity atmospheric entry observation campaigns for the entry of man-made objects
  - Stardust, Genesis and Hayabusa, ESA's ATV-1 "Jules Verne"
  - 1960's NASA ~1g artificial metal meteor studies using sounding rockets and shaped charge accelerators
- Detailed observational campaigns requires knowledge of entry location and time and trajectory
  - Not possible for natural meteor events for multi-kilogram bodies

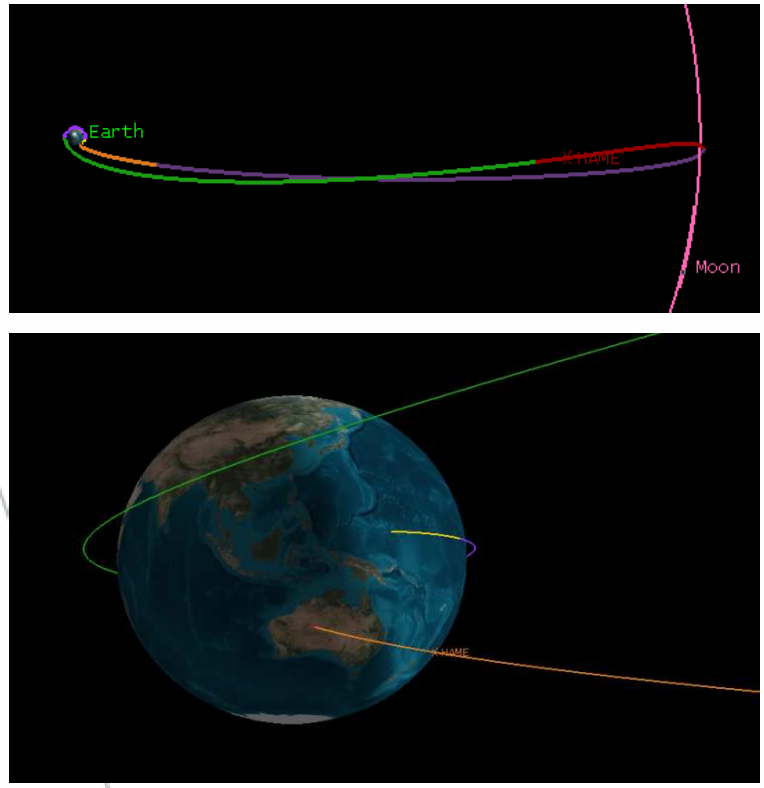
Hypervelocity Artificial Meteoroids Experiment (HAM•E)

- Objectives
  - To deliver one, or more, fully characterised artificial meteoroids into the Earth's atmosphere with combined mass of ~175kg
  - To enter meteoroids into Earth's atmosphere at a velocity ≥ 11 km/s and at a pre-determined time and location
  - To couple meteoroid(s) entry with an extensive, space, airborne and ground based observation campaign

Hypervelocity Artificial Meteoroids Experiment (HAM•E)
Lunar free-return option - part 1

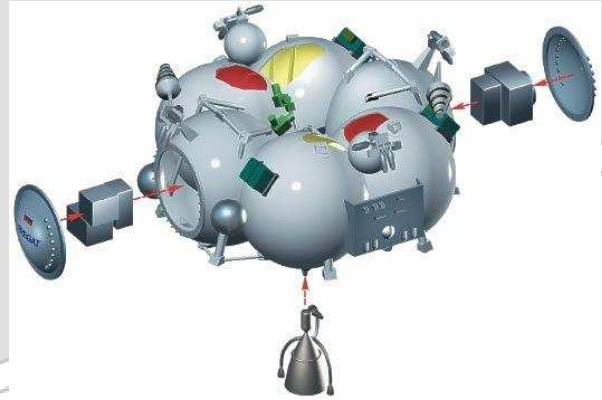
153 kg sandstone sphere ... or combination of bodies

Soyuz with Fregat upper stage



Lunar free-return trajectory

Hypervelocity Artificial Meteoroids Experiment (HAM•E)
Lunar free-return option - part 2



Existing Fregat upper stage with interface for meteoroids and their ejection

Entry over Woomera Prohibited Area at >11km/s, 38° entry

Picture 1

Picture 2

Picture 3

Space and airborne and ground based observation campaign

Key known's

- Known entry location
- Known entry time
- Known meteoroid trajectory* & velocity*
- Known meteoroid mass
- Known meteoroid shape
- Known meteoroid internal structure
- Known meteoroid mineralogy
- Known meteoroid organic content
- Known “Life” content
- Known ... “please inset” ...

- **How many natural event cases are the above known?**

Other mission scenarios

- Other trajectories
  - Lunar free return
  - Lunar flyby from GTO
  - High elliptical orbit from GTO
  - GTO
  - Interplanetary mission (Flyby to Venus and Earth)
- Artificial meteoroid bodies possible parameters
  - Mineralogy – basaltic, sedimentary
  - Organics content
  - Microbial content
  - Mass
  - Shape
  - Internal structure / faulting
  - First re-flight of an existing meteorite?

Outline science objectives

- Top level science objectives
  - Validation and calibration of models and techniques
  - Reappraisal of existing Earth meteorite record
  - Addressing question of the evolution of the Early Earth including the emergency of Life
    - *i.e.* delivery of material to the Early Earth
    - *i.e.* general environmental impact
  - Understanding the current and future threat of Near Earth Objects
- Key pragmatic question
  - can proposed science returns justify dedicated launch ...
  - ... or only financially viable via much lower cost
    - sounding rocket ... or
    - ... piggy-backed launch?

Immediate route forward

- Upcoming 2010 *Call for a Medium-size mission opportunity in ESA's Science Programme for a launch in 2022* (≤€470m cost to ESA)
- Call includes "*a mix of smaller missions approximately equivalent, in terms of overall financial envelope and profile, to one M mission could also result from the present Call*" (Soyuz based HAM•E *<<€100m)*
- Deadline 2nd December 2010
- **Proposal contents**
  - **Mission case (✓) – help!**
  - **Observation case (?) – help!!!**
  - **Science case (??) – help!!!!!**
- Also ... create an ESA Topical Team
- Also ... further mission design consideration via group design project within Cranfield's MSc in Astronautics & Space Engineering (equivalent to >48 person months design effort)