UCL DEPARTMENT OF SPACE AND CLIMATE PHYSICS
MULLARD SPACE SCIENCE LABORATORY

The Akon Europa Penetrator

Submitted to ESA in response to the M5 call for mission proposals

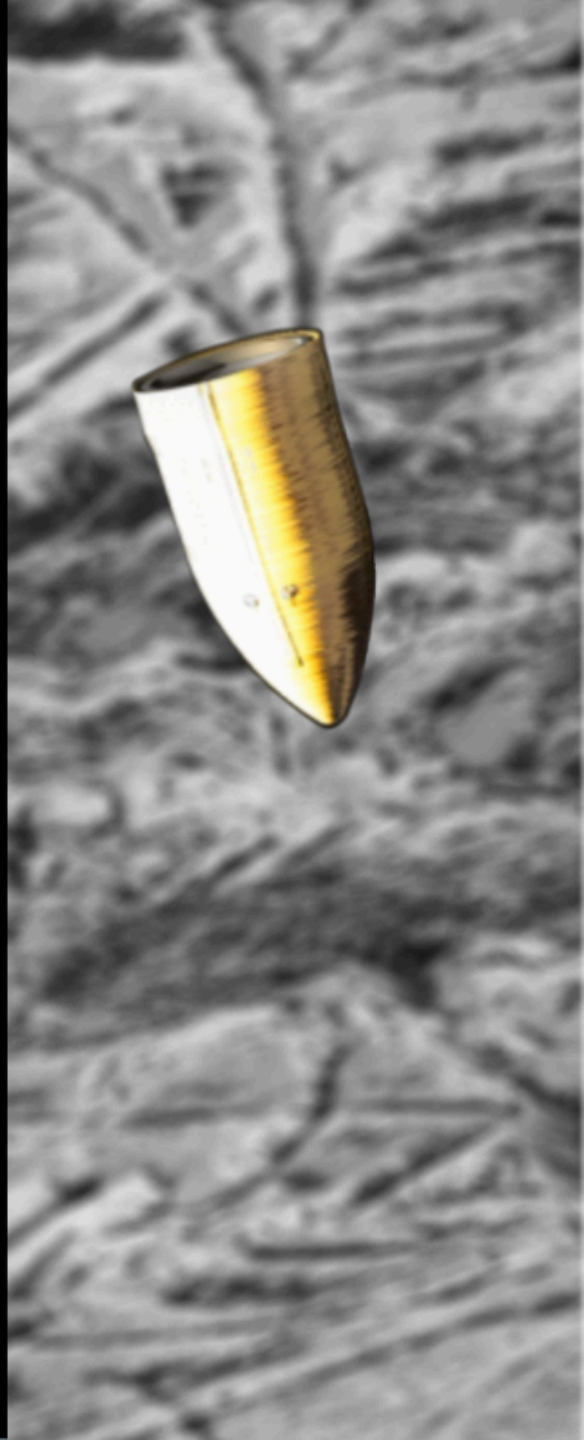
Geraint Jones
UCL Mullard Space Science Laboratory

Zita Martins
Imperial College London

on behalf of the International Akon and Europa Initiative Teams

Many thanks to Marie-Claire Perkinson (Airbus Defence & Space) for some presentation materials

g.h.jones@ucl.ac.uk
z.martins@imperial.ac.uk



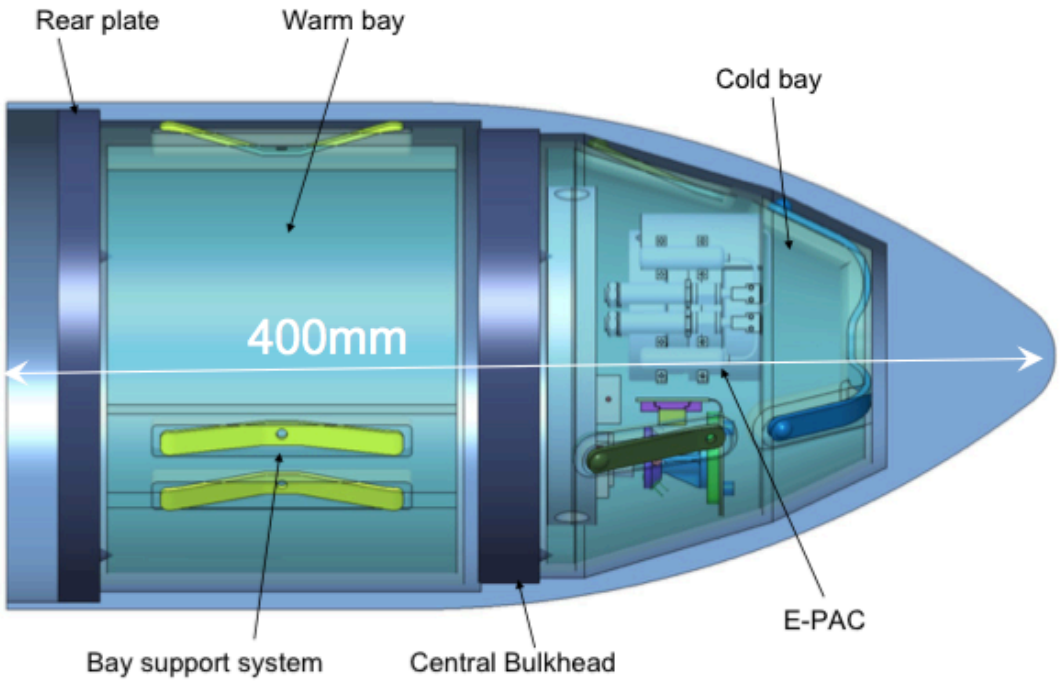
- Kinetic penetrators allow direct delivery of instruments to planetary subsurfaces
- **Akon** involves delivery an instrumented penetrator to Europa subsurface at 300 m/s. Penetration of up to a few metres

- Despite potential benefit, high speed impactors naturally regarded as high risk
- ESA has for several years funded development of a penetrator design specifically tailored for delivery to icy moons in the outer solar system
- Maturity of design resulting from development work would allow scientific consortia to propose viable missions to employ this technology
- In 2015, ESA also funded concurrent design facility study for use of 250kg slot on NASA Europa Clipper

Ἄκων – gift of a javelin from Zeus to Europa

Penetrator Configuration

- ESA-funded development work led to two-bay design
- Both bays thermally isolated from 80K subsurface ice, slowing cool-down of instruments
  - **Front** short lifetime bay houses drill and instruments for sample analysis
  - **Rear** heated bay: longer lifetime for data storage and relay
- Bays protected from impact loads
  - Torlon Leaf Springs
  - Provide thermal isolation from shell
- Communications via antenna at rear; several designs possible
- Rugged long-life batteries a key component: allow long duration operations and data downlink



Full Scale Testing – Summer 2013

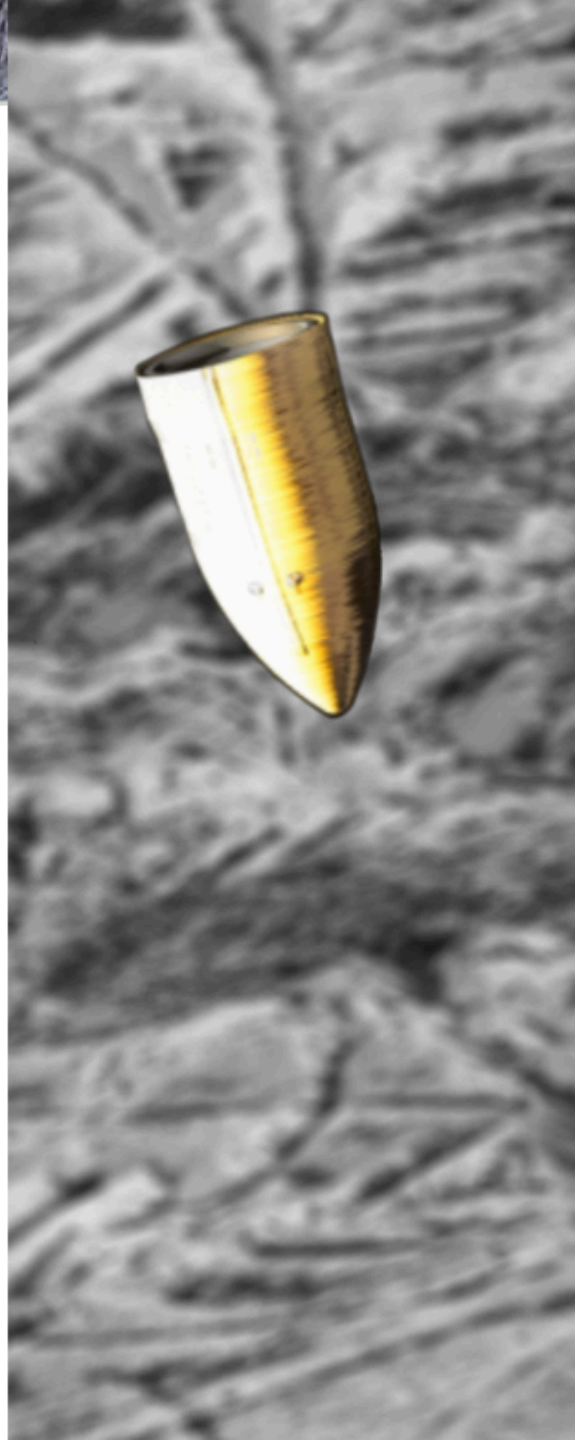
- Mechanical design worked well
- Survived 340 m/s impact, 25° pitch angle
- Environmental tests before and after impact proved thermal concept was valid

Follow-on Testing

- Impact tests for much harder target material also successfully carried out for penetrator elements
- Separate high deceleration tests of individual components, validating a wide range of essential elements of the penetrator
- Complemented by simulation work

Akon proposal to ESA

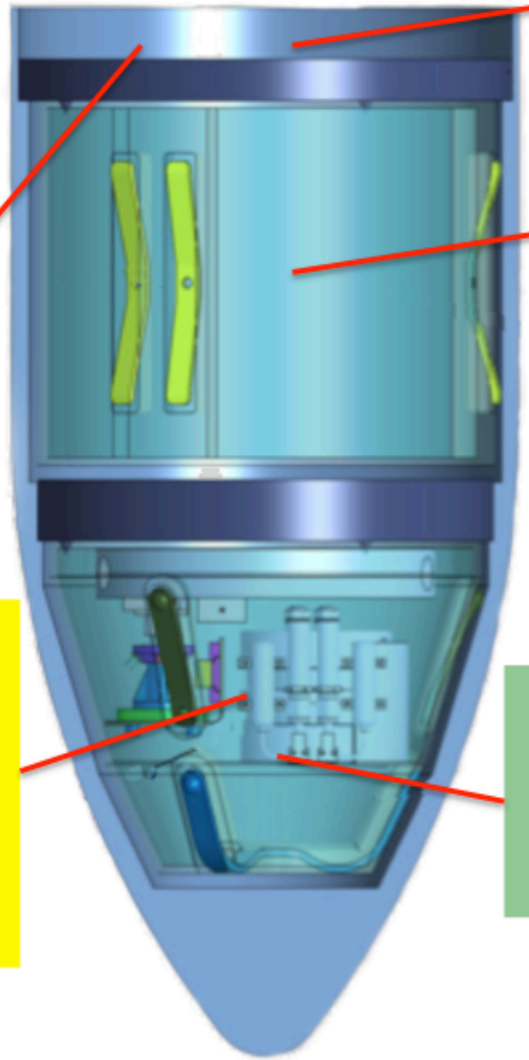
- ESA's M5 call for mission proposals perfect opportunity for proposal of Akon, making use of mature penetrator design
- April 2016: NASA indicated 250 kg slot no longer available on Europa Mission; Akon proposal is for delivery to Europa by NASA Europa Lander
- Baseline uses ESA-funded design, but is scalable (with changes to instruments)
- Baseline delivery through release from Europa Lander at ~35km altitude; landing site therefore in same region as NASA lander; option if mass allowed for delivery from orbit for alternative landing site
- Data relay via Carrier and Orbit Stage (COS)
- Akon Science complements and enhances return from Europa Mission, Europa Lander, and JUICE



Sacrificial Ring (not shown)
EDI Descent Imager
AMS Exospheric sampler head

Rear Plate
Antenna

Rear Plate
MAG Magnetometer
ESP Microseismometer
ERA Energetic Particles



Warm Bay
Power
Common DPU
Data storage
Communications

INSTRUMENTS

SUBSYSTEMS

Cold Bay
VISTA Thermogravimetry
ASPIRE Wet Chemistry
MPASS-MPAA Habitability
AMS Regolith mass spec.
ESI Sample Imager

Cold Bay
Drill and sample handling
Accelerometer
Tiltmeter

Ακων Akon

Multidisciplinary Science

Magnetosphere

- External magnetic field variability at fixed point on surface
- Monitoring of subsurface radiation environment

Exosphere

- Direct sampling of exosphere composition profile from 0-35 km

Geophysics

- Surface properties
- Possible thickness of ice crust from reflected impact signal
- Internal magnetic field variations
  - isolating saline ocean signal
  - currents in subsurface ocean
- Moonquakes (source location estimates working with Europa Lander)

Geology

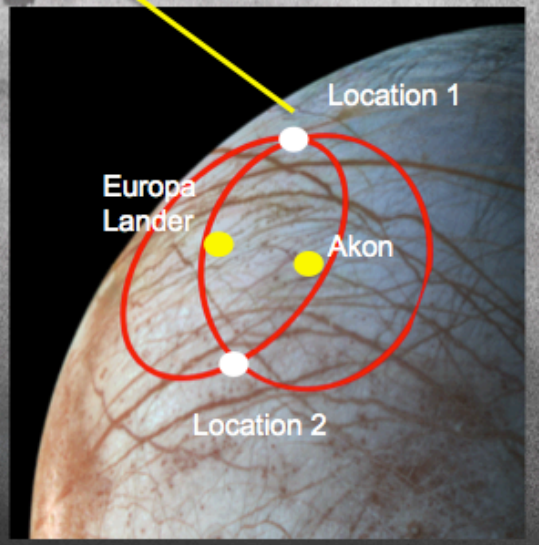
- Multispectral and polarimetric imaging of landing site surroundings

Geochemistry

- Ice composition and subsurface chemistry

Astrobiology

- Biosignature detection
- Measurement of habitability parameters
  - temperature
  - conductivity
  - pH
  - redox



Proposed Payload

Instrument Acronym	Description	Primary Nations
EDI	Descent Imager	IT/UK
VISTA	Thermogravimetry analyser	IT
ASPIRE	Wet chemistry package	UK/USA
MPASS-MPAA	Habitability conditions package	ES
AMS	Exosphere and regolith mass spectrometer	UK/DE
ESI	Sample imager	FR/CH
MAG	Magnetometer	UK
ESP	Microseismometer	UK/USA
ERA	Energetic particle detector	DE/NO

Status

- Proposal submitted in October 2016
- Baseline payload instruments and costings approved by respective national agencies
- Open to contributions from US
- Akon still under consideration by ESA
- All ESA national agencies involved formally supported proposal to ESA in February 2017