



# **THE DUBLIN INSTITUTE FOR ADVANCED STUDIES**

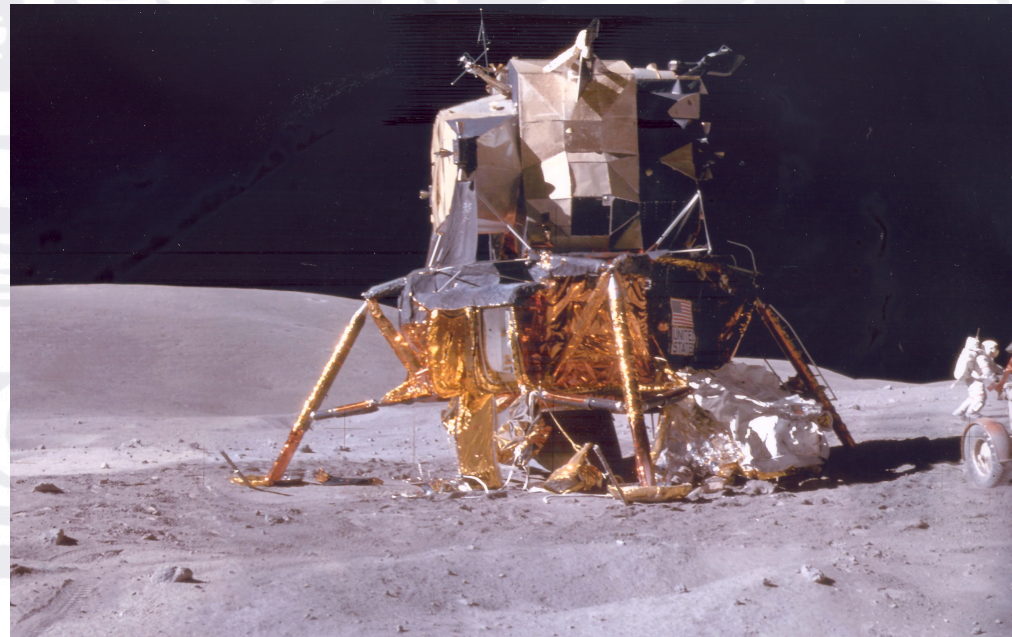
**FORTY YEARS OF RESEARCH IN  
SPACE  
1972 – 2012**

Dublin Institute for Advanced Studies

The Dublin Institute for Advanced Studies (DIAS) pioneered space physics in Ireland with experiments on the Lunar Surface during Apollo 16 and Apollo 17 missions in 1972 and 1973 respectively. These were followed by the Ultra Heavy Cosmic Ray Experiment on the Long Duration Exposure Facility (LDEF) launched into Earth orbit by the space shuttle Challenger in April 1984. DIAS also participated in the Giotto Mission to Halley's Comet (EPONA instrument) in the mid eighties, the subsequent extended mission to Comet Grigg Skjellerup and the Soviet PHOBOS (SLED instrument) mission to Mars in 1986 along with the Maynooth University group and European scientists, in 1992. In all the group has successfully completed 16 experiments in space over the last 40 years.



*The DIAS-Berkeley detectors resting against the lunar module leg on the lunar surface*



*Apollo 16 Lunar Module in April 1972*

## Space Shuttle Challenger launches the LDEF in 1984

One fifth of the LDEF craft housed the large DIAS-ESTEC experiment which remained in Earth orbit for over 5 years. The experiment collected the largest ever sample of galactic cosmic ray nuclei with charge greater than 70 in Earth orbit and the first significant sample of actinide elements and helped to increase our knowledge of the properties and origin of these nuclei.



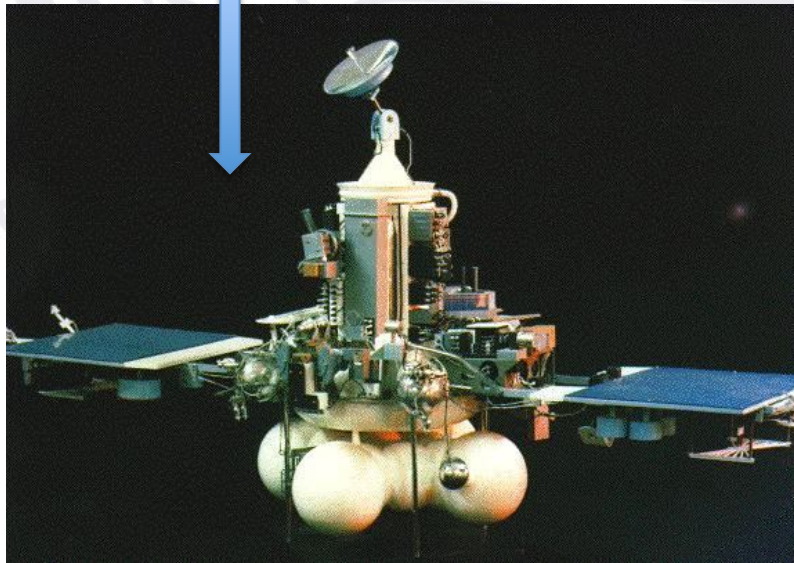
# PRESENTATION OF APOLLO 16 DETECTORS TO NATIONAL MUSEUM OF IRELAND - JANUARY 2014



## The Phobos Mission

The SLED twin telescope particle detector aboard the PHOBOS spacecraft was designed to record low energy particle intensities in the environment of Mars and performed successfully while in orbit at the planet. It also measured solar flare related particle enhancements in interplanetary space.

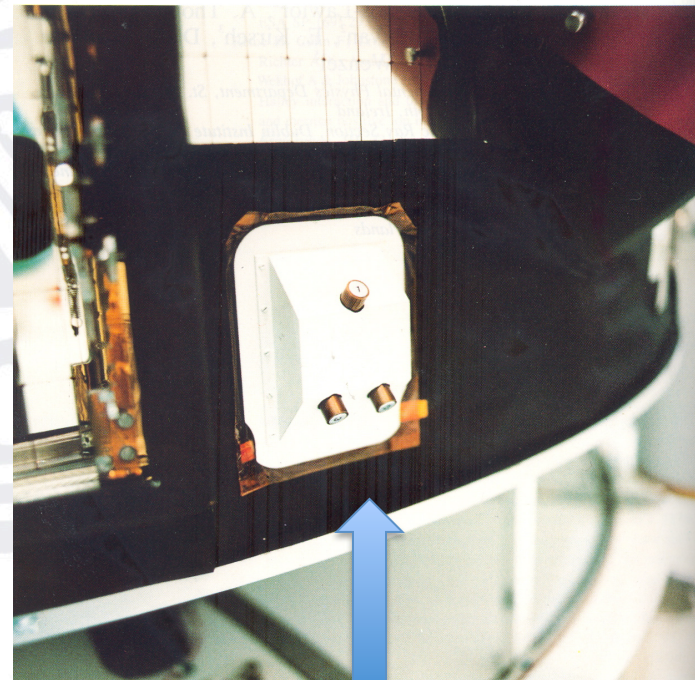
*PHOBOS Spacecraft*



## Giotto Mission to Halley's Comet

### The Energetic Particle Analyser (EPONA)

The Irish-German instrument on Giotto recorded measurements of energetic charged particles on the sunward side of Comet Halley and investigated particle acceleration processes at close approach (closest approach 600 km).



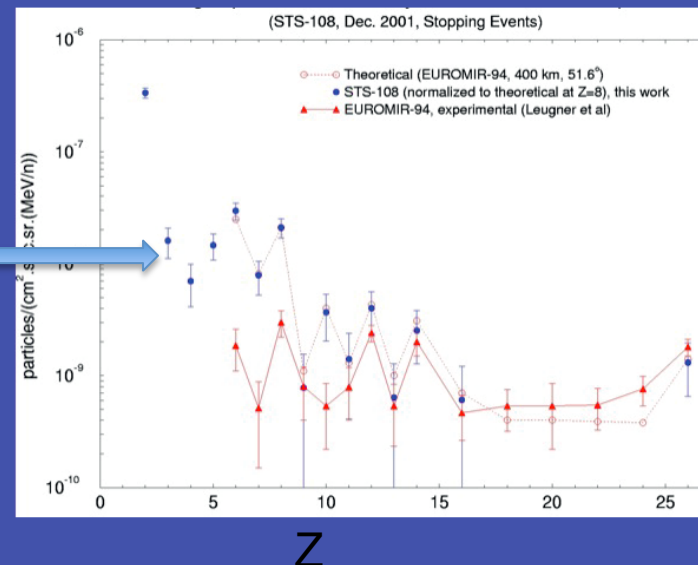
## DIAS and the International Space Station

The first Irish experiment on the International Space Station was undertaken by the DIAS group in 2001. DIAS scientists had built up an international reputation as one of the leading researchers in the investigation of cosmic radiation which is one of the most hazardous threats to human space travel. The DIAS group made the first ever measurements of the charge spectrum of cosmic ray nuclei from Helium to Iron in the space station on the STS-108 mission in 2001 and followed with further measurements on STS-112 and ISS-7S between 2002 and 2003. These high energy particles penetrate the spacecraft walls and living quarters of the astronauts and produce further nuclear interactions and can cause cancer in humans .



*Launch of  
STS-108*

*Charge  
Distribution of  
Cosmic Rays  
( $Z \geq 2$ ) in Low  
Earth Orbit  
compared with  
theory and  
data from the  
MIR spacecraft  
in 1994*



## DIAS and the MATROSHKA Experiment

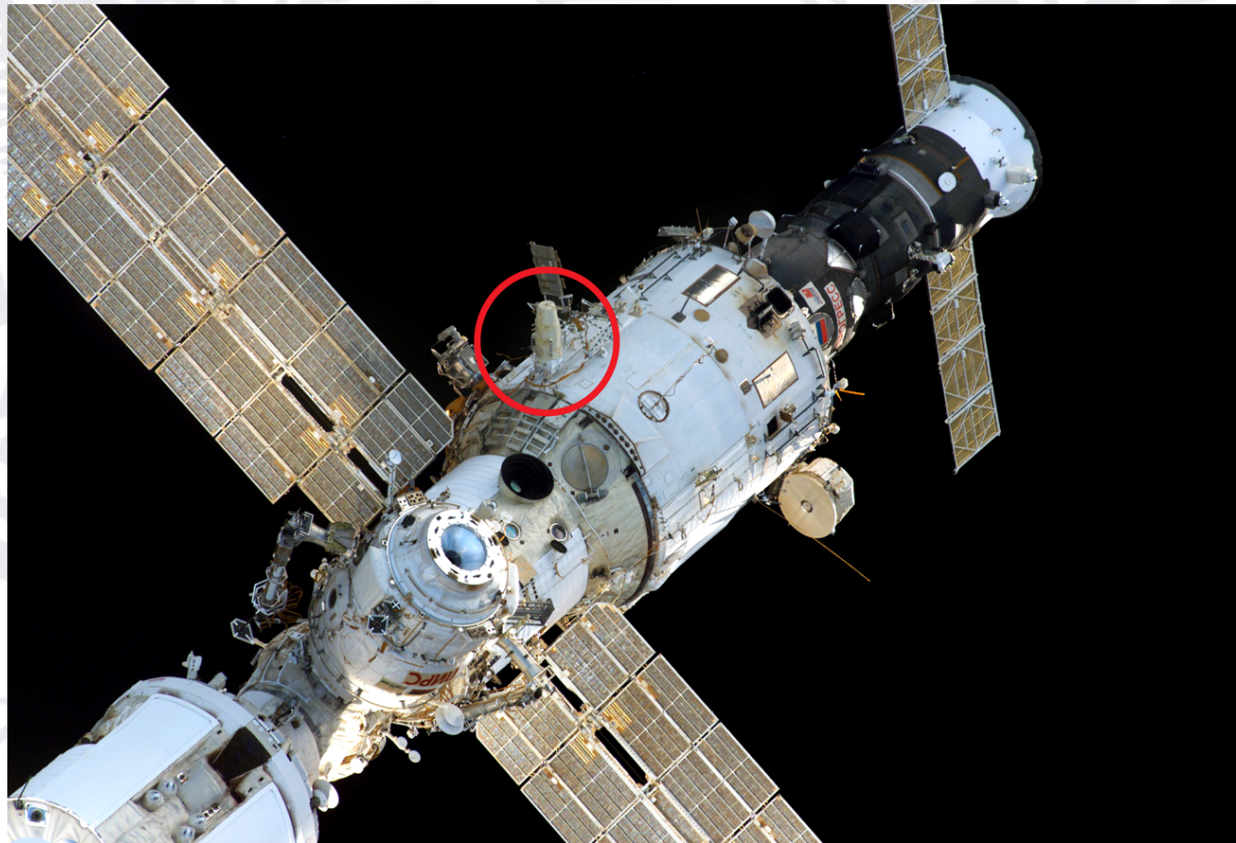
The threat to humans in deep space caused by cosmic radiation and solar energetic particles is of great concern to astronauts and space agencies in general. Despite decades of human activities in space, the impact of space radiation on sensitive organs was not investigated in detail until very recently. The European Space Agency developed an International research facility called MATROSHKA which was coordinated by the German Space Agency (DLR) in Cologne. It consisted of a torso designed to simulate a human body and is made of tissue equivalent material. Several radiation measuring devices were placed at locations corresponding to the eye, kidney, stomach, intestine, heart and other important organs. DIAS detectors were placed at the kidney, stomach and skin.

*The MATROSHKA  
Phantom*



## The MATROSHKA Phantom (circled) exposed outside the Space Station.

On extra-vehicular activities (EVA) astronauts are exposed to the full intensity of cosmic rays and solar energetic particles. MATROSHKA was also exposed inside the living quarters of the space station for an extended period. DIAS detectors were located at the kidney, eye and skin.





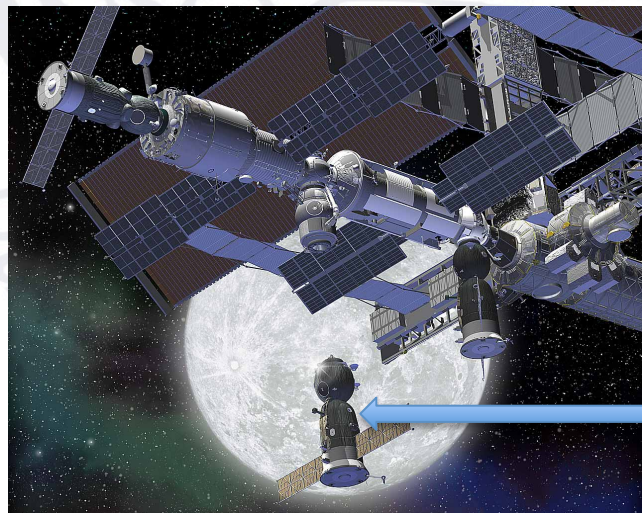
## The PROGRESS Spacecraft

PROGRESS is an unmanned Russian expendable spacecraft and is launched with the Soyuz rocket. It was used to replace detectors on the Space Station during the MATROSHKA experiments.



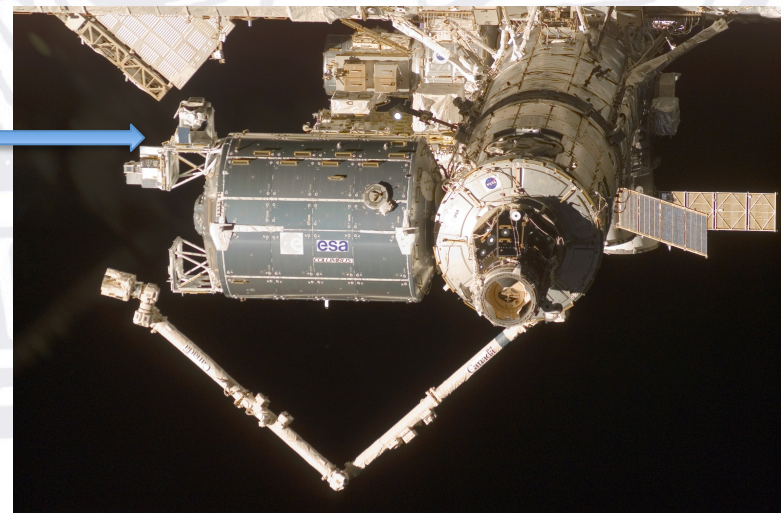
## BIOLOGICAL SAMPLES EXPOSED TO COSMIC RADIATION IN SPACE

DIAS scientists have collaborated with The Belgian Nuclear Research Centre and the Czech Academy to investigate the effect of cosmic radiation on bacteria using the International Space Station (the DOBIES project). For instance the team undertook experiments on the ISS in October 2003, April 2004, and inside the Columbus module on the Space Station in October 2008. The Russian Soyuz spacecraft was employed to deliver the detectors on two occasions. Cosmic rays can cause damage to DNA in humans and bacteria. Bacteria are important on space missions for recycling waste. They can also undergo unwelcome mutations in long term missions.



*Columbus Laboratory*

*Soyuz delivering experiments to the ISS*



# THE ESA-ESF THESEUS PROJECT --PREPARING FOR MARS VOYAGE

Cosmic radiation is considered to be the main health hazard for human exploration and colonisation of the solar system. As a consequence, a group of experts in the area of space radiation measurements was selected to investigate the various difficulties involved in future space travel with particular emphasis on a voyage to Mars. The group, shown below at one of their meetings in the Black Forest, produced a report which formed part of the the ESA road map for Mars exploration, published in 2012.

## *THESEUS Project Team*

*Michael Hajek (Austria), Vince Pisacane (USA), Pawel Bilski (Poland), Denis O'Sullivan (Ireland), Thomas Berger (Germany), Livio Narici (Italy) Guenther Reitz (Germany), Daniel Heynderickx (Belgium), David Bartlett (UK), Tsvetan Dachev (Bulgaria), and Yukio Uchihori (Japan)*

