alissé

European Space Agency

STS-128 Space Shuttle mission to the International Space Station

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ESA astronaut undertakes two spacewalks

ESA astronaut Christer Fuglesang from Sweden will undertake two spacewalks during his 13-day alissé STS-128 mission after arriving at the International Space Station (ISS) onboard the Space Shuttle Discovery.

STS-128 is the 30th construction flight for the Space Station and Discovery's cargo includes a European-built Multi-Purpose Logistics Module (MPLM) and ESA's Materials Science Laboratory and MELFI (Minus Eighty Laboratory Freezer). Fuglesang will be on his second spaceflight after being a Mission Specialist on the STS-116 Celsius mission to the ISS in December 2006 in which he undertook three spacewalks for ISS assembly and additional duties as part of the European Celsius mission.

As well as riding on the same Space Shuttle as before, the STS-128 mission holds other similarities for Fuglesang. For instance, when he arrives at the ISS he will again be meeting up with an ESA astronaut.

On Celsius it was Thomas Reiter from Germany – the first ESA astronaut to be a member of an ISS Expedition Crew. He returned with Fuglesang on the return leg of the STS-116 flight.

ESA astronauts Thomas Reiter (left), Expedition 14 Flight Engineer, and Christer Fuglesang, STS-116 Mission Specialist, exchange greetings in the International Space Station during Fuglesang's previous flight.

This time it is ESA's Frank De Winne from Belgium, a member of the now six-strong ISS Expedition 20 Crew since his launch on a Russian Soyuz rocket in May 2009. De Winne is scheduled to take over as Commander of the Space Station in October.

Fuglesang's main task will be to carry out two of the STS-128 mission's three scheduled spacewalks, and be responsible for the Italian-developed MPLM cargo module that is used to carry science equipment racks, food, clothes and water to the Station.

The cargo is transferred from the MPLM after it has been moved by robotic arm from the Shuttle's cargo bay and attached to a docking port on the ISS.

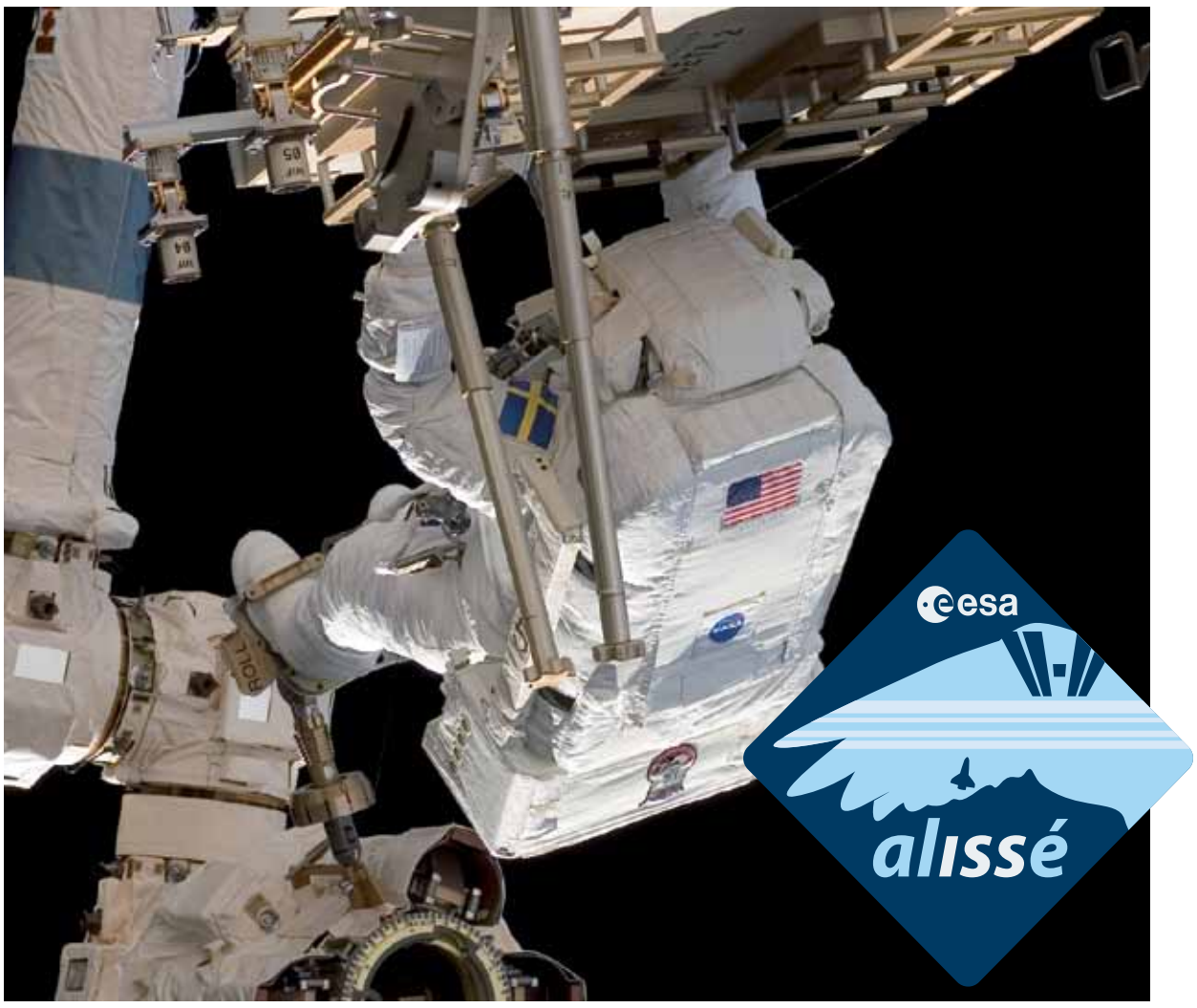
The STS-128 mission also includes the rotation of an ISS Expedition Crew member – NASA astronaut Nicole Stott replacing NASA astronaut Timothy Kopra, who returns to Earth with the Shuttle crew.

"This is yet another mission that highlights the high profile that Europe has in human spaceflight," commented Simonetta Di Pippo, ESA's Director of Human Spaceflight.

"It is a mission that Europe can be proud of, with a Swedish ESA astronaut helping to transport an Italian cargo module to the Station where a Belgian ESA astronaut is serving as a member of an Expedition Crew."

Commander Rick Sturckow will lead the STS-128 flight, with Kevin Ford serving as Pilot. Also aboard Discovery with Christer Fuglesang are mission specialists Patrick Forrester, José Hernández, John Olivas and Nicole Stott.

Simonetta Di Pippo, ESA Director of Human Spaceflight.



Christer Fuglesang works in space with his feet secured on the Canadarm2 robot arm during his mission in December 2006. The logo for the alissé mission (inset) features the wing of a bird enclosing images of the ISS and Shuttle, whilst the name is based on the alize (alizé) trade wind that blows from central Africa to the shores of America, paying homage to the great 15th century explorers who followed Christopher Columbus to the New World.

ISS is a true example of international cooperation

When ESA astronaut Frank De Winne from Belgium arrived at the International Space Station (ISS) with two other new crewmembers at the end of May 2009 the orbiting complex became a truly international endeavour.

De Winne's arrival not only marked the transition to a permanent crew of six people but also heralded, for the first time, the presence of a crewmember from each of the international partners.

"I am glad to see that the ISS crew has now developed a truly international feel with astronauts from the different partner countries – Europe, the United States, Russia, Japan and Canada," said Simonetta Di Pippo, ESA Director of Human Spaceflight.

"I think this is a shining example of the great cooperation that ESA has with its international partners and shows the way forward for the exploration of the Moon and beyond."

The STS-128 mission will see two European astronauts living in space and working together after crewmember De Winne greets his European colleague Christer Fuglesang.

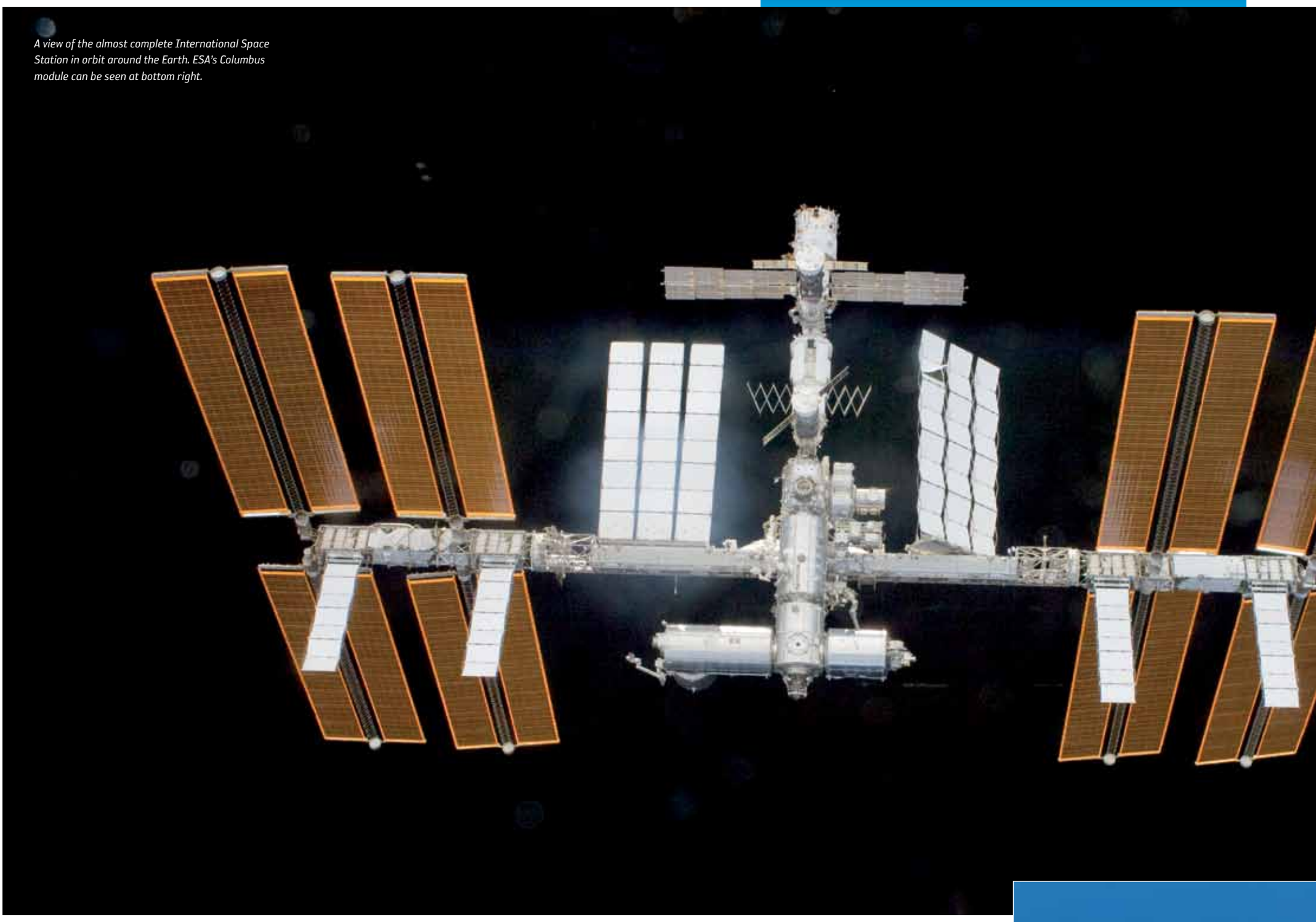
After De Winne's six-month flight, known as OasISS, the next European long-duration mission will be that of Italian ESA astronaut Paolo Nespoli who will assume the role of flight engineer on Expeditions 26 and 27. His launch is scheduled for November 2010 and he will return to Earth half a year later in May 2011.

It will be the second mission to space for Nespoli. In October 2007 he flew on Space Shuttle flight STS-120 to deliver and install the European-built Node-2 to the ISS.

Node-2, now called 'Harmony', is an interconnecting module to which the European Columbus space laboratory was attached in February 2008. Nespoli was instrumental in orchestrating four spacewalks from inside the Space Shuttle and the ISS to support construction of the Station.

Fuglesang and his STS-128 colleagues will launch to the ISS and return to Earth in the Space Shuttle Discovery, seen here during night-time preparations for an earlier flight.

Christer Fuglesang



A view of the almost complete International Space Station in orbit around the Earth. ESA's Columbus module can be seen at bottom right.

STS-128 info

Launch	August 2009
Orbiter	Discovery
Launch pad	39A, Kennedy Space Center, Florida
Landing site	Kennedy Space Center, Florida
Inclination/Altitude	51.6° / 226 km
Duration	13 days
Crew	Rick Sturckow (Commander), Kevin Ford (Pilot), José Hernández, John 'Danny' Olivas, Nicole Stott, Christer Fuglesang and Patrick 'Pat' Forrester (Mission Specialists)
Primary payload	Leonardo Multi-Purpose Logistics Module, Lightweight Multi-Purpose Experiment Support Structure Carrier

The STS-128 crew. Seated are: Pilot Kevin Ford (left), and Commander Rick Sturckow. Standing (from left): Jose Hernandez, John 'Danny' Olivas, Nicole Stott, Christer Fuglesang and Patrick Forrester, all Mission Specialists.

Unloading Leonardo

The first day after docking with the International Space Station (ISS) will see the transfer of Leonardo, the Italian-built MPLM (Multi-Purpose Logistics Module), from the Shuttle's payload bay to its temporary docking location on the nadir port of the ISS Harmony node.

Inside the node, astronauts Christer Fuglesang and Tim Kopra will have already checked that its docking mechanism is ready and waiting.

Shuttle robot arm operator Kevin Ford will gently ease Leonardo closer to the port. Its final movements are finetuned via computer commands and special hooks before it is secured firmly by 16 bolts. The whole MPLM transfer and docking process will have taken nearly four hours from start to finish.

Fuglesang will then begin the work of opening Leonardo's hatch, connecting cables and configuring its systems before being free to glide into the Station's new, if temporary, module.

During the next day – when the mission's first spacewalk is being carried out by John Olivas and Nicole Stott – Fuglesang will assume responsibility for removing items stowed in Leonardo and ensuring they all reach their allocated positions on the ISS.

"As well as this I'll see to it that all the things we bring back are packed properly," he explained.

"There are many big items and not a lot of space, so the MPLM team has worked out a logistical scheme with 25 steps of how we will go about the task. The scheme covers six days, but most of it, the first ten steps, will be done at the beginning.

"Apart from small items such as food, clothing, spares and smaller experiments packed in different cases, we have six big racks and the Zero-G Stowage Rack that

will be transferred and installed on the ISS," he said.

These large items are a new treadmill for installation in Harmony, crew quarters for the Japanese Kibo module, and an air purification system that will eventually be installed in the still-to-be-delivered Node-3.

The MPLM carries also the first ISS Research Rack fully dedicated to Material Science: ESA's Material Science Laboratory (MSL), which forms NASA's Materials Science Research Rack (MSRR-1) in the US Destiny laboratory.

The MPLM also contains the IVIDIL experiment on the Selectable Optical Diagnostics Instrument (SODI) and a number of consumables for various physiology experiments.

Christer Fuglesang and NASA astronaut Robert Curbeam during an ISS construction spacewalk in December 2006.

Fuglesang's eight-minute ride into orbit

As the Space Shuttle Discovery blasts into orbit from Cape Canaveral, Florida, Commander Rick Sturckow will be sitting at the controls at the left of the flight deck with Pilot Kevin Ford beside him.

Behind them Patrick Forrester and Jose Hernandez will carefully monitor onboard systems while on the middle deck Christer Fuglesang sits between John Olivas and Nicole Stott.

During the launch itself there is little for the crew to do other than check instrument readings during the ascent. Fuglesang and his two colleagues in the middle deck, however, do have a specific task.

Seconds after liftoff – and also at specific times during the ascent when the vibrations are at their maximum – they will evaluate how well they are able to read sign-boards that have text and figures of different sizes. This is a test to help in the design process leading up to NASA's next manned spacecraft, Orion.

Seven and a half minutes after launch the g forces reach their maximum of 3g, which lasts for about one minute, before the engines are abruptly shut down and the crew are thrown forwards in their seats as they suddenly become weightless.

"I won't have the time to enjoy the awesome feeling at that point since I have to rapidly remove gloves and helmet, parachute, the chair harness, oxygen and cooling water tubing and the radio cable," says Fuglesang.

"Then I'll glide out of my seat and backwards to a cabinet where I take out a camera and a video camera. I'll send the latter up to Pat Forrester and then I'll float with the camera and it's long 400 mm lens to the flight deck.

Fuglesang and Forrester will photograph the External Tank as it slowly recedes from the Shuttle, the images and video later downloaded to ground control where engineers will check for abnormalities during the ascent.

At this point the crew have about six hours to transform Discovery from a launch vehicle into an orbiting spacecraft where they will live and sleep for almost two weeks.

After assisting with the opening of the Shuttle's payload bay doors, Fuglesang will work with José Hernández to unpack and set up the onboard network of six laptops and a printer.

At the end of their first working day sleeping bags are taken out and the crew all find places to tether their bag for the night.

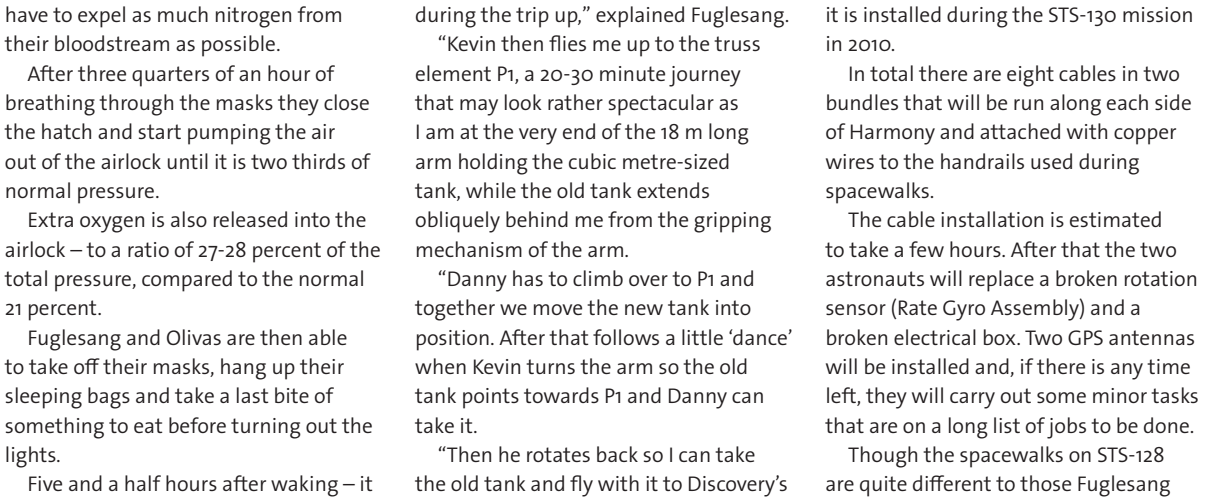
Fuglesang will also strap on his 'activity watch' which will measure his quality of sleep by monitoring how much he moves his arm during the night. He will be wearing it the entire mission – except for the spacewalks – and each morning will write a log of how he slept. The information will be used in an experiment on how well people sleep in space.

Docking with the Space Station comes on the third flight day as the two spacecraft hurtle around Earth at a height of 350 kilometres above ground level.

"My tasks are photographing what I can of the Space Station during our approach, operating the docking mechanism and focusing the airlock camera during the final ten metres," says Fuglesang.

"The hatch opening about 90 minutes after docking is a ceremonious occasion and is usually broadcast live on TV. We will be met by a big international crew aboard the ISS, twice as many as when I was there in 2006," he added.

Not only has the resident crew doubled in size, but several new modules have been added, including ESA's Columbus and Japan's Kibo.



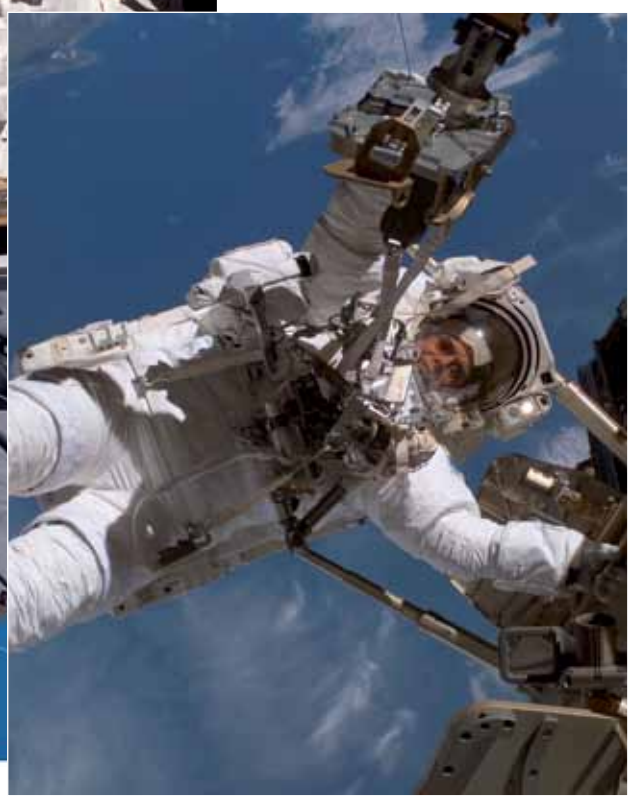
Christer Fuglesang uses a digital still camera to record details of his third spacewalk in 2006.

Walking around the edge of the world

Standard sleeping time for Space Shuttle astronauts is around eight hours, whilst International Space Station (ISS) crew are normally allocated half-an-hour more.

But for those about to step outside of the ISS, the pre-sleep routine is always very different – as in the case for Christer Fuglesang who will be undertaking the STS-128 mission's second and third spacewalk along with Danny Olivas.

Ninety minutes before bedtime on flight day six the two men will go into an airlock and don oxygen masks to start a long and tedious procedure to prepare their bodies for the low pressure in the spacesuit during the spacewalk itself.



Christer Fuglesang pictured on his first ever spacewalk during the STS-116 Space Shuttle mission in December 2006.

Suit pressure is only a third of that at sea level or that normally maintained in the ISS. So, to minimise the risk of decompression sickness, the astronauts have to expel as much nitrogen from their bloodstream as possible.

After three quarters of an hour of breathing through the masks they close the hatch and start pumping the air out of the airlock until it is two thirds of normal pressure.

Extra oxygen is also released into the airlock – to a ratio of 27-28 percent of the total pressure, compared to the normal 21 percent.

Fuglesang and Olivas are then able to take off their masks, hang up their sleeping bags and take a last bite of something to eat before turning out the lights.

Five and a half hours after waking – it takes this long for all the final spacewalk preparations and suiting up – the hatch is opened and Olivas glides out into space with Fuglesang right behind him. For ESA's Swedish astronaut it will be his fourth venture outside the ISS.

First they go to the rear of Discovery's cargo bay where the replacement ammonia tank is stowed. On the ISS Kevin Ford has manoeuvred the Canadarm2 robot arm ready for Fuglesang to jump on the foot rest that extends at the front.

During the mission's first spacewalk Olivas and Nicole Stott will have removed the existing Ammonia Tank Assembly (ATA) from the P1 truss element to await the switchover.

The ammonia is used as a cooling fluid for all the electronics on the outside of the Space Station and the idea is to replace the depleted tank with a full one in preparation for the years ahead when their will be no Space Shuttles.

"While I firmly grab the new 800 kg tank, Danny unscrews the last of four bolts that have kept the tank in position during the trip up," explained Fuglesang.

"Kevin then flies me up to the truss element P1, a 20-30 minute journey that may look rather spectacular as I am at the very end of the 18 m long arm holding the cubic metre-sized tank, while the old tank extends obliquely behind me from the gripping mechanism of the arm.

"Danny has to climb over to P1 and together we move the new tank into position. After that follows a little 'dance' when Kevin turns the arm so the old tank points towards P1 and Danny can take it.

"Then he rotates back so I can take the old tank and fly with it to Discovery's cargo hold where we fasten it on the same platform as we brought the new one up on," added Fuglesang.

The entire spacewalk lasts for about six or seven hours, depending on how smoothly it goes and if the astronauts run into specific difficulties or not.

After a day back on the orbiting Space Station/Shuttle complex, flight day nine will see Olivas wake up locked into the airlock for the third time and Fuglesang for the second ready for the mission's third spacewalk.

The first task once they are outside the ISS this time will be to run cables from the S0 truss section, located above Destiny, to the portside docking port of the Harmony node.

This second EVA for Fuglesang is more a collection of 'minor' tasks, the first of these being the most complicated when they will have to string out eight 18 m cables contained in two bundles in preparation for use by Node-3 from 2010.

The cables will eventually provide Node 3 (which has been named Tranquility) with power and data when it is installed during the STS-130 mission in 2010.

In total there are eight cables in two bundles that will be run along each side of Harmony and attached with copper wires to the handrails used during spacewalks.

The cable installation is estimated to take a few hours. After that the two astronauts will replace a broken rotation sensor (Rate Gyro Assembly) and a broken electrical box. Two GPS antennas will be installed and, if there is any time left, they will carry out some minor tasks that are on a long list of jobs to be done.

Though the spacewalks on STS-128 are quite different to those Fuglesang carried out during his Celsius mission, the general experience of being outside in space will be just as spectacular.

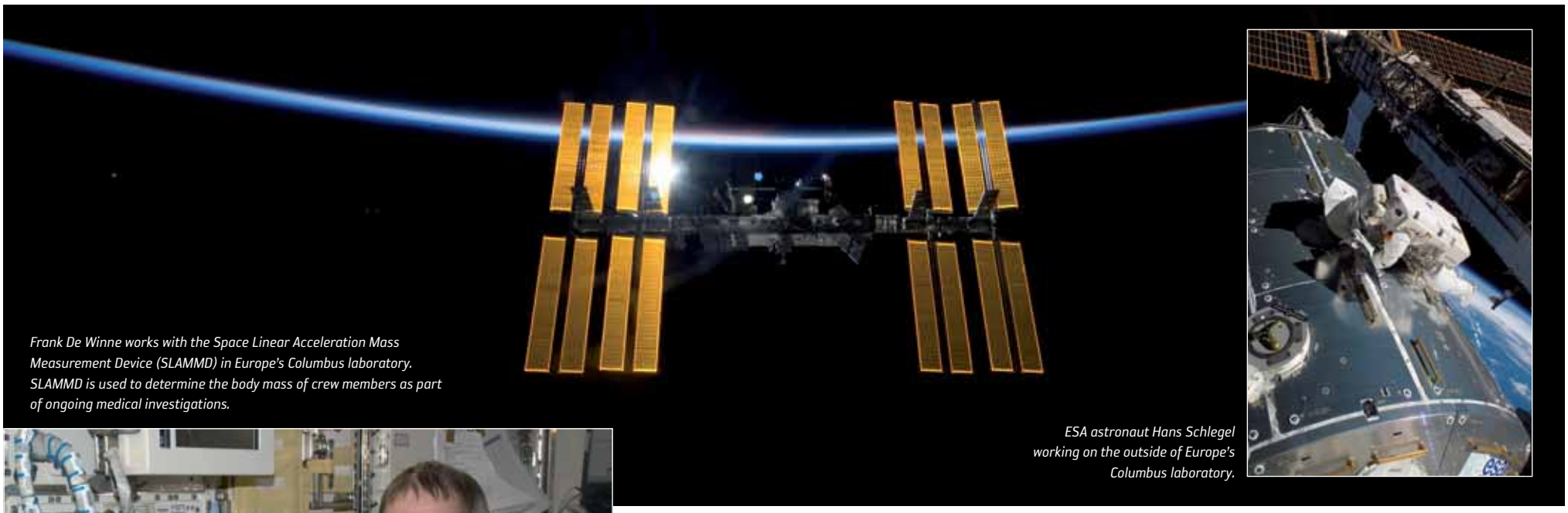
"The excitement of going out of the Space Station is fuelled by your own imagination," he says.

"In a way you have your own mini space station. It feels very liberated and the vista is, of course, better than inside where you always have to look through a rather small window.

"It is very exciting, and you have to make sure you get a few moments to enjoy the view. We always carry a camera with us to use when the opportunity arises to take photos.

"I should get some excellent views of Earth in my first EVA of the mission whilst 'spinning' around on the robotic arm. At that point I will have time just to enjoy the stunning view."

Stepping stone to the future of space exploration



Frank De Winne works with the Space Linear Acceleration Mass Measurement Device (SLAMMD) in Europe's Columbus laboratory. SLAMMD is used to determine the body mass of crew members as part of ongoing medical investigations.

ESA astronaut Hans Schlegel working on the outside of Europe's Columbus laboratory.

"The International Space Station (ISS) is a very important step for humans going further in space," according to ESA's high-flying astronaut from Sweden, Christer Fuglesang.

As both a scientist and experienced astronaut he is well-qualified to have such an opinion – by the conclusion of the alissé STS-128 Space Shuttle mission he will have completed five spacewalks, the most for any European.

"We've been to the Moon and back but I think we have probably learnt much more from all the work which has gone into building the Space Station," he said.

"People actually live there now and we are able to do a lot of research work. We are learning how to live and work in space.

"Many of the experiments are medical and so we're discovering a lot about the human body – and much of this knowledge can be applied to clinical and medical practices on Earth.

"Though the ISS has many aspects, to me the most important thing is that it is a stepping stone to go further into space in the future.

"It has also been great for international cooperation, with the United States, Russia, Japan, Europe and Canada all working together towards a common goal. It has not always been easy to get such diverse cultures together but generally speaking it has worked very well."

Fuglesang added that it was "extremely important" for Europe to be a major partner in this venture. "I hope and look forward to Europe to being part of the next exploration programme when we go back to the Moon to establish a permanent lunar research station," he said.

"Personally, I very much enjoy the experience of spaceflight. The two really big things are the weightlessness – that's a fantastic experience and it's fun.

"And the second thing is, of course, the spectacular views over the Earth. You really understand how small the world is when it takes only 90 minutes to circle around it."

alissé mission experiments

An extensive ESA science programme, which is supported by International Space Station crewmembers of all nationalities, is now ongoing, featuring material science using ESA's new Material Science Laboratory (MSL) and various applied research projects, e.g. SODI experiments.

The spacewalking tasks of Christer Fuglesang, along with his responsibility for the MPLM cargo module operations, limit his time available to undertake experiments to the following:

Exposure to outer space

The first spacewalk of the STS-128 mission involves both the removal of the Ammonia Tank Assembly (ATA) and the transfer of ESA's **EuTEF (European Technology Exposure Facility)** experiment platform from the outside of Columbus to Discovery's cargo hold.

EuTEF has housed 13 different experiments since Europe's Columbus became opperational a little over 18 months ago.

Once back on Earth, scientists will be able to examine the results of their experiments which have been exposed to outer space for more than a year.

The Flux

Fuglesang will use a simple particle flux detector, called **'The Flux'**, built by the Royal Institute of Technology (KTH) in Sweden with support from the Swedish National Space Board.

It was sent up with Columbus in 2008 and was first used by ESA French astronaut Leopold Eyharts.

The Flux shows with blinking diodes and sound how the stream of cosmic particles varies when the ISS orbits Earth and how certain modules are more protective than others.

"The most exciting part is when we pass the South Atlantic anomaly, where the flows of cosmic particles increase a hundred-fold for a few minutes," says Fuglesang.

Spinal elongation

In this NASA-sponsored investigation, spinal measurements and photographs will be taken of Fuglesang at pre-defined intervals during the flight to provide data about the amount of change that occurs in the seated height of astronauts due to spinal elongation in space. Among its uses will be in the design of future spacecraft.

Visual performance

Much like in a standard eye-test back on Earth, this NASA experiment will test ability to read letters of different sizes on placards during the high vibrations of launch. The data from Fuglesang and two colleagues will help set vibration limits for visual performance during launch.

Perception of motion

An ESA investigation – known as **ZAG (Z-axis Aligned Gravitoinertial force)** will look into the effect that weightlessness has on an astronaut's perception of motion and tilt as well as his level of performance before and immediately after spaceflight. Fuglesang will undergo a series of tests, which will take place pre- and post-flight, including an analysis of the astronaut's motion perception and eye movements whilst using a track-and-tilt chair.

Balance system

The working of our balance system and our eyes are strongly interconnected and understanding their adaptation to weightlessness is important for maintaining an astronaut's capacity for carrying out tasks in space.

The otolith organs in the inner ear play an important role in our balance system as detectors of vertical and horizontal acceleration, and this ESA experiment will assess any differences in their function before and after Fuglesang's spaceflight.

Europe's key role in Space Station

ESA united the best of Europe's skills, scientific and technical knowledge to contribute some of the Space Station's most important elements for the American, Japanese and Russian laboratories as well as ESA's own laboratory, Columbus.

Columbus – a laboratory giving Europe the opportunity to work at the cutting edge of scientific and technological research from 2008. The 75 cubic metres of inside space contains a suite of science laboratories.

Automated Transfer Vehicle (ATV) – a transport vehicle launched by Europe's Ariane-5 to carry propellant, food and other supplies. The successful flight of the first ATV, named Jules Verne, took place in 2008. Thereafter ATVs will be launched by an Ariane-5 at about 18 month intervals.

European Robotic Arm (ERA) – for the maintenance and assembly of Russian ISS elements. Operated from either inside or outside the Space Station, the 11.3 m long arm can manoeuvre equipment weighing up to 8000kg.

Nodes-2 and -3 – cylindrical elements similar in design and size to Columbus, they provide resources for connecting and operating other Space Station elements, as well as water processing and oxygen generation for the US segment and stowage for equipment racks.

Data Management System – the 'brain' of Russia's Zvezda module, performing overall control of the Russian elements, as well as guidance and navigation for the Space Station.

Cupola – an observation and control tower for the ISS is awaiting launch in 2010. It will provide astronauts with a panoramic viewpoint for guiding operations outside the ISS.

A typical view from the dome-shaped Cupola, which is planned for launch along with Node 3 in early 2010.

How to view the ISS and Space Shuttle yourself

The Space Station has now been orbiting the Earth over 15 times a day for almost 11 years – and the ESA website 'See the ISS' gives all the information needed to find the biggest spacecraft ever built as it passes overhead.

Spotting the ISS and its temporary Space Shuttle partner with the naked eye is not difficult providing you know in which direction to look. Thanks to its large solar wings, the complex is one of the brightest 'stars' making it easy to distinguish as it moves across the night sky.

The ISS passes over most points on Earth every day but cannot always be seen. The best time for ISS-gazing is just before dawn or just after sunset, when the observer is in the dark but the ISS is in the Sun.

To find out the days and exact times the ISS is visible from your location visit: www.esa.int/seeiss

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