



## CIRiS- Centre for Interdisciplinary Research in Space

- CIRiS is a department of NTNU Samfunnsforskning AS (NTNU Social Research)

**CIRiS research areas;**

- 1) **Recycling life support systems** for plant cultivation (on ground)
- 2) **Plant research on The International Space Station (ISS)**
- 3) **Human Factors** in Integration & Operation

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## N-USOC - The Norwegian User Support & Operation Centre

**In 2005 we became one of ESAs User Support and Operation Centres for ISS**

N-USOCs activities;  
Integration and operation of the payloads **EMCS** and **AIS**





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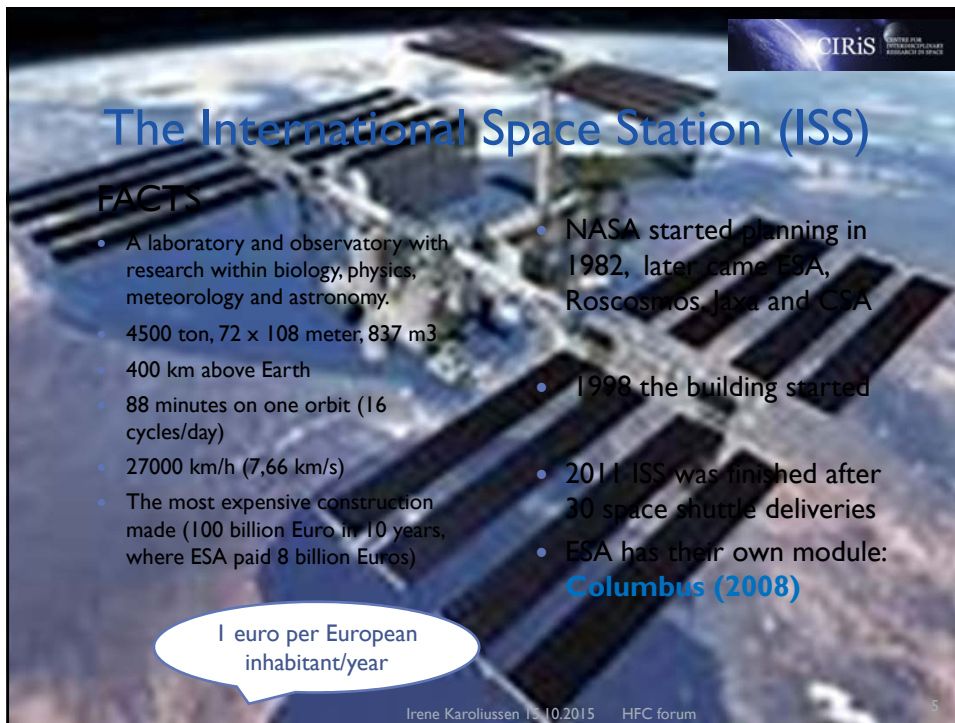
## Control Centres operating for ISS: NASA, ESA, Roscosmos, JAXA and CSA




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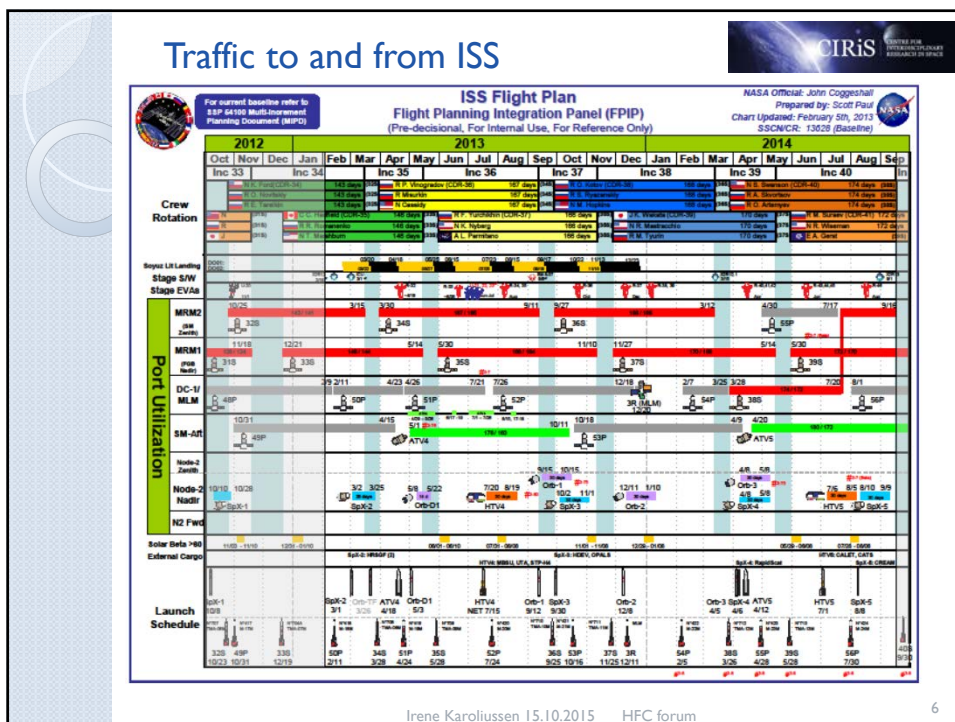
## The International Space Station (ISS)


### FACTS

- A laboratory and observatory with research within biology, physics, meteorology and astronomy.
- 4500 ton, 72 x 108 meter, 837 m<sup>3</sup>
- 400 km above Earth
- 88 minutes on one orbit (16 cycles/day)
- 27000 km/h (7,66 km/s)
- The most expensive construction made (100 billion Euro in 10 years, where ESA paid 8 billion Euros)
- NASA started planning in 1982, later came ESA, Roscosmos, Jaxa and CSA
- 1998 the building started
- 2011 ISS was finished after 30 space shuttle deliveries
- ESA has their own module: **Columbus (2008)**

1 euro per European inhabitant/year

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## Traffic to and from ISS

ISS Flight Plan  
Flight Planning Integration Panel (FPIP)  
(Pre-decisional, For Internal Use, For Reference Only)

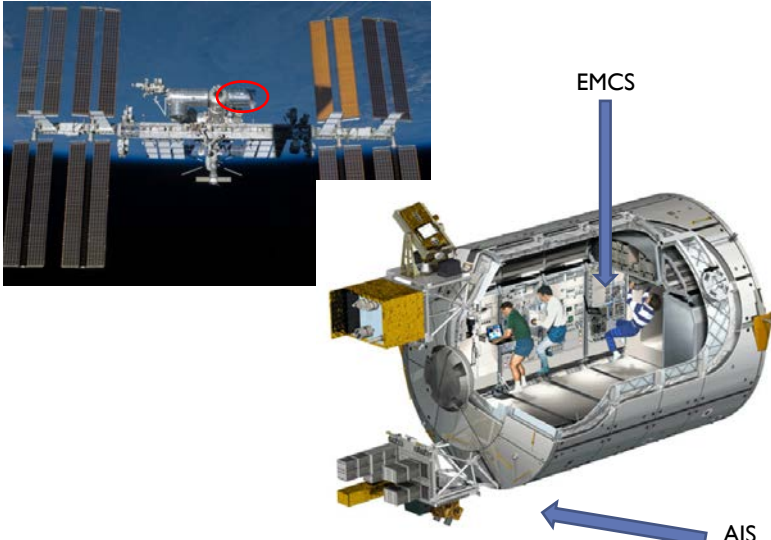
NASA Official: John Coggeshall  
Prepared by: Scott Paul  
Chart Updated: February 5th, 2013  
SSOW/CR: 13628 (Baseline)

	2012				2013				2014															
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
<b>Crew Rotation</b>	Inc 33			Inc 34	Inc 35			Inc 36	Inc 37			Inc 38	Inc 39			Inc 40								
<b>Port Utilization</b>	[Detailed Gantt chart showing MRM2, MRM1, DC-1/1, MLM, SM-A1T, Node-2, Node-1, N2 Fwd, Solar Beta, External Cargo, and Launch Schedule with various mission names and dates]																							

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### Columbus module – launched on Atlantis (STS-22) February 2008

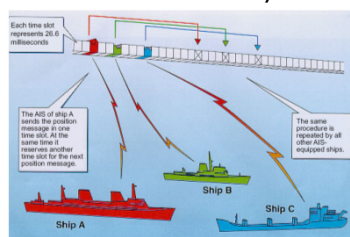


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### Colombus based AIS (COLAIS)

#### Automated Identification System




- In 2006 ESA , FFI (Forsvarets Forsknings Institutt) and Kongsberg Seatex decided to develop and test AIS on ISS
- COLAIS (NORAISI) was launched in May 2010 and has been collecting data since
- N-USOC monitor and control AIS from our control room during week days (Mon-Fri)

- Every ship identified with type of cargo, position, course etc.
- Signals are sent on 2 frequencies in the maritime VHF band
- Signals detected by ships nearby and radar stations along the coast

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## European Modular Cultivation System (EMCS)



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## What is EMCS?

EMCS is a small cultivation system (“greenhouse”) with exchangeable experiment containers (ECs)

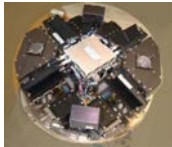
**In EMCS you can;**

- Study gravitational signals in plants or small animals
- Study tropisms in plants


**EMCS characteristics;**

- Automated system for water, temperature, humidity and gas mixtures
- Gravitational level from 0-2 g (two centrifuges for 600 mm in diameter)

During experiments N-USOC monitor and control EMCS from our control room **24/7**



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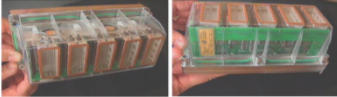


### History N-USOC Real Time Operations:

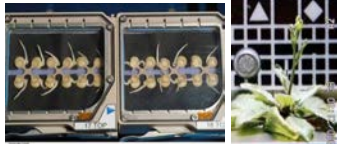
- 2006:** EMCS Commissioning in the US Laboratory "Destiny"
- 2006:** Tropi in EMCS – 3x6 days long US experiment
- 2007:** Gravi in EMCS – 2x30 hours long ESA experiment
- 2008:** Multigen-1 in EMCS – a 75 days long ESA experiment
- 2008:** EMCS Relocation to the European Lab Module "Columbus"
- 2008:** Cell Wall/Resist Wall (CW/RW) in EMCS–50 days long Japanese experiment
- 2010:** Tropi2 – 2X6 days long US experiment, replicating Tropi
- 2010:** Vessel ID System Install and Commissioning (NORAIS 1)
- 2010:** Genara A – 12 days long ESA experiment
- 2011:** Plant Signaling
- 2013:** Seedling growth 1
- 2014:** Gravi2
- 2014:** Seedling growth 2
- 2015:** NORAIS 2 installed

**Planned for 2016:**

- Plant RNA Regulation
- Seedling Growth 3



Tropi and Tropi2



Gravi and Multigen

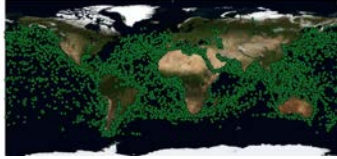
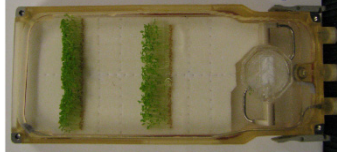



Image developed from 90.000 AIS messages. Courtesy of FFI





Genara A

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## Flight Experiments

- Seed setup in the EC
- The EC is sealed
- The EC is transported to launch-site (Kennedy Space Center in Florida, or Bajkonur in Kazakhstan)

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## Launch


**Launched in Space-X,  
Progress or Soyuz**



**A robotarm grabs and  
dock the capsule**




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## On the Space Station

**1) After docking the astronauts  
unpack the ECs (8) and install  
them in EMCS**



**2) Experiment start and  
execution; N-USOC are monitoring  
24/7 from our control room**

**3) Experiment stop; samples are  
fixed/frozen and brought back to  
Earth**



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## Life on ISS

Videos;

Life on ISS (Suni, 25 min)  
<https://www.youtube.com/watch?v=hynlWe0wOT8>

Life on ISS, only music (ca. 4 min)

- <https://www.youtube.com/watch?v=tgRMAVoHRbk>
- Hadfield; water(3 min)  
<https://www.youtube.com/watch?v=IMtXfwk7PXg>
- Williams tour of ISS(bedroom, kitchen, bathroom) 8,41 min  
[https://www.youtube.com/watch?v=XkM\\_04Ch76E](https://www.youtube.com/watch?v=XkM_04Ch76E)
- **Hadfield brush teeth**  
<https://www.youtube.com/watch?v=3bCoGC532p8>
- How to wash your hair  
<https://www.youtube.com/watch?v=kOll7AgonHM>
- Hadfield sleep  
<https://www.youtube.com/watch?v=T1hWJfsoikw>
- Fuglesang godis (0,48 min)  
<https://www.youtube.com/watch?v=aVdfXkHJ8zk>

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## Backup-slides

### Kitchen



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## Life on ISS

**Work out;** astronauts work out minimum 2 hours a day. Still they experience loss of muscles and bonemass



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## Life on ISS

**Food and drink;** there is no fridge and seldom re-supplies. The diet is mainly freeze-dried food. Magnets and straps «holds» the food in place so it doesnt float away. Urine and sweat is recycled to drinking water!



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## Life on ISS

**Toilet and personal hygiene;** astronauts strap themselves to the toilet which is a kind of «vacuum-cleaner». Instead of showering they use wet wipes and dry-shampoo.



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## Hear cut



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# Mounting AIS outside Columbus



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