

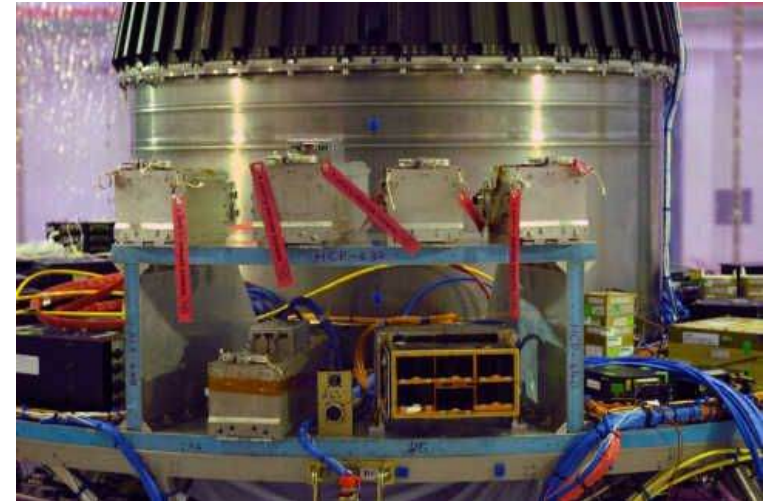
AAUSATLAB - student satellites @ Aalborg University, Denmark



AAUSATLAB

Dep of Electronic Systems
Aalborg University(AAU)

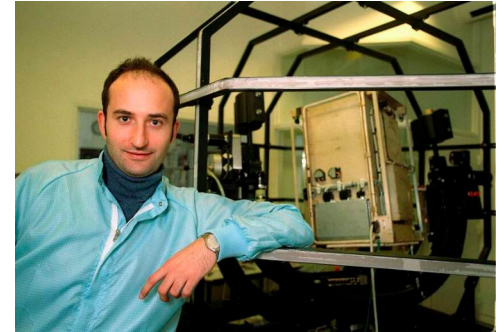
2025



Education & Space & Cubesats @ AAU

The starting history

- 1992-1999 was the first danish research satellite – Ørsted- was developed, constructed and launched
- A substantial part of Ørsted was developed at ES(Dep of Electronic Engineering)
- The starting initiative came from Mogens Blanke (prof AAU) and Jens Langeland-Knudsen (CRI)
- Launch 23 Feb 1999 in attempt nr 11
 - mission: map earth magnet field
- Ørsted was and is still considered as a huge success
- Est life time 14 months – but more than 10 times was achieved
 - 61 kg
 - No propulsion – “only” magnetorquer attitude control(pointing)
- ES students had with huge interest followed the Ørsted during the years so
- In 2000/2001 ES students proposed ES should start a space education based on ideas from the Ørsted.
- And Dep of Electronic Systems welcomed the idea.
- **A student space adventure took its beginning**



Ørsted novel attitude control system mockup in a gimbal at ES, AAU. by AAU PhD student Rafal Wisniewski which today is professor at ES, AAU



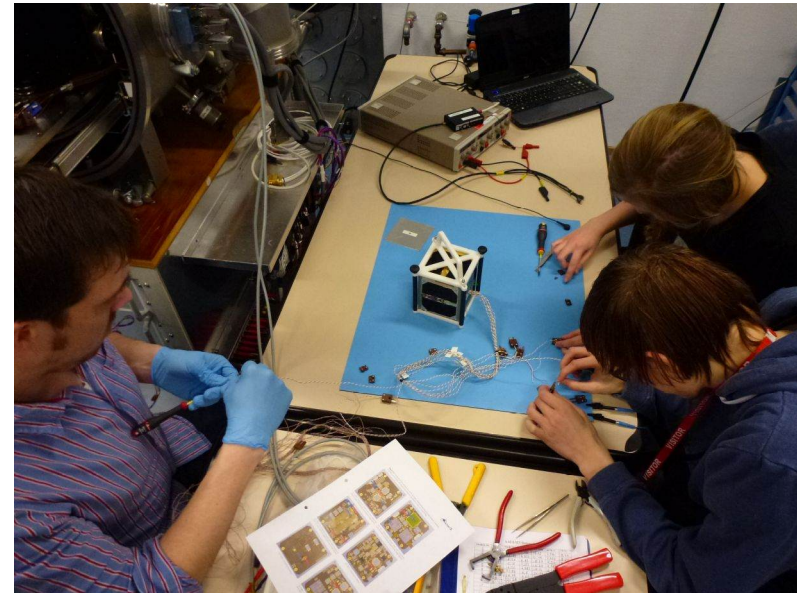
Cubesats as an educational paradigm

Credit: Bob Twiggs

- A global pioneer: prof Bob Twiggs @ Space Science at Morehead State University, KY USA
- Teaching students in space he came up with a mantra
 - Learning by doing a real space mission – a cubesat – his invention
 - Students should work as engineers and learn by doing ...
 - analyse, design and construct, launch and operate a real satellite
- The ultimate test 1 – get the cubesat launched in LEO (LowEarthOrbit) (4-600 km)
- The ultimate test 2 – conduct the mission and operate the satellite
- Its Easy but at same time difficult
- ES designed a space education
- Behind was ES staff(old Ørsted scientists and interested staff)
- +60 students the first years
- First mission was named AAU CUBESAT
- **Easy but at same time difficult :-)**



AAU students at ESA-ESTEC for final testing of AAUSAT3



A typical AAU cubesat megaproject takes 2-5 year its all about engagement and additional voluntary work

STEP 1 – Row call project startup/prolog - time to define next mission !!

- Payload camera, space junk detector, AIS ship tracker, you name it
- Initial breakdown of design
 - OBC: OnBoard Computer
 - EPS: Electronic Power System
 - PL: PayLoad
 - ADCS: Attitude Determination & Control System – maneuvering of satellite
 - Tentative budgets: power, communication, weight, volume, ...

STEP 2 – Teaching, AAU project based learning

- Starting point: “step 1”
- Choose a project which fits step 1 and the thematic for the semester and your interests
- Result 1: A functional prototype maybe with not 100% functionality
- Result 2: Result 1 integrated in a functional satellite prototype
- A semester ($\frac{1}{2}$ year) is 50% courses and exercises and 50% project work

STEP 3 – From step 2 to Flight – voluntary work

- Flight is about construct the satellite which shall to to spaced
- Not part of educational CV – its purely voluntary work
- At least same amount of work as step 1 + step 2 !!
- Students set requirement for them self high
- Not all from step 1 + step 2 continue to step 3 and step 4.

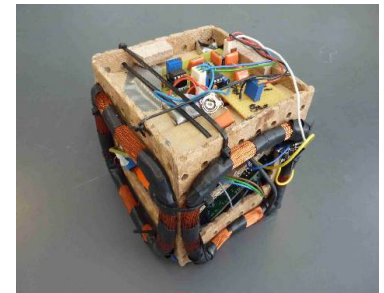
STEP 4 – Final qualification test for launch, and operations – voluntary work

- Handover to launch provider (vibration, temperature, vacuum, functionality,...)
- Launch – you may wait for days, weeks, month
- 1-2-3-4-5-6-7-8-... months/years “ of operations” from your local ground command center



At upper right: AAUSAT II before leaving AAU for launch.

At lowerright: simple 1 semester non magnetic mockup for testing mag coil attitude actuator



We(students) just Do It All

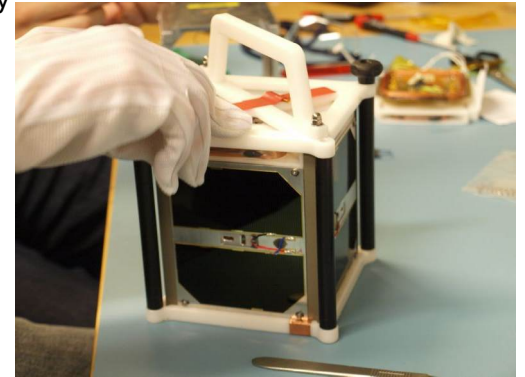
- No subsystems, frame etc from outside
- ALL is inhouse design by students
- The best and most complete way to learn is by doing(build a cubesat) and at same time get mathemackial, modelling,communication, electronic,... skills from lectures
 - analysis & design
 - Construction incl soldering, assembly, coating and much more in our clean room facilities
 - Integration of the satellite
 - Process managment – the students are responsible and have a steering committee
 - Training at ESA-ESTEC (
 - test etc
 - Travel to hand over and integrate satellite at launchsite (US, France, India,...)
 - Teachers an scientists is not participating on travels – only two students !
- We think this is quite unique.
- Students gets responsibility – they learn by the hard way
- This might be one of the major reasons for our success.



Participants

interested student

- We do not distinguish between master and bachelor students.
- A satellite has parts which are suitable for bachelor students and other for master students
- Lot of study/education work for all
- **Continuity**
- Important the knowledge and skills is passing from one generation to the next
- “Apprenticeship” from old/alumni students to new students is part of continuity
- Older students conduct voluntary courses and instruction seances
 - 2023+ Rust as new programming paradigm in our cubesats
- **This might be the most important thing which keep continuity at AAUSATLAB After more than 20 years**



AAUSAT3 in clean room



Vertical project management

- 1) The three most important things
 - 1) It must be fun for the students
 - 2) It must be fun for the students
 - 3) It must be fun for the students
- 2) Its the students project og mission
 - 1) Ownership → responsibility and engagement
- 3) Students are in control of project at all levels
 - 1) Steering group
 - 2) Project/subsystem/... groups
- 4) Responsibility, operational capabilities etc is an integral part of all management levels
- 5) You have to be ready to be “evaluated” by the rest of the whole crew/team
- 6) Some tough decisions like not flying deployable solar panels due to high risk often involves staff
- 7) Staff are here to help – also learning handling not-easy situations and decisions
- 8) Life is not always easy – like in real life



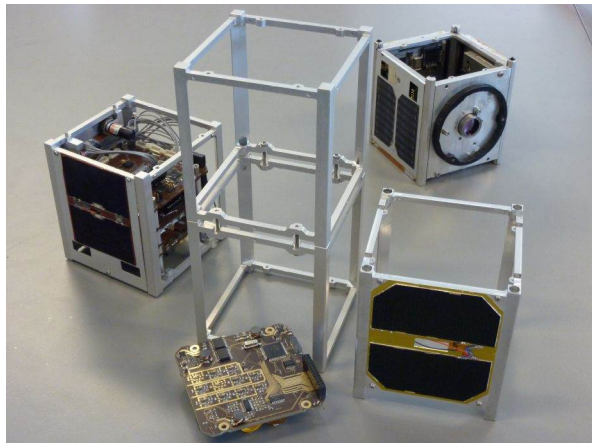
Our CV gives a conclusion: Our way works We did it our own way :-)

- 2001-2003 **AAU CUBESAT** 30 jun 2003 (our first)
- 2003-2005 ESA SSETI EXPRESS 27 oct 2005 (AAU dlv 60% of satellite incl ground segm)
- 2004-2006 Baumanetz OBC 26 jul 2006 (Uni of Moscow did buy an AAU OBC)
- 2003-2009 **AAUSAT-II** 28 apr 2008 (gamma quant detector)
- 2006-2011 GENSO (global edu ground (ESA,NASA,JAXA)
- 2008-2009 AAUSAT3/BEXUS 11 oct 2009 (ESA financed HAT ballon flight - Kiruna)
- 2007-2014 **AAUSAT3** 25 feb 2013 (AIS ship tracking 18 month operations)
- 2010-2012 AAUSAT3.5/DLR-AISAT 30 jun 2014 (invited AIS payload on DLRs AISAT)
- 2012-2015 **AAUSAT5** 05 oct 2015 (by ESA invited - Andreas first ISS mission)
- 2012-2016 **AAUSAT4** 25 apr 2016 (ESA FYS - free launch - aausat3-ng)
- (-> 2023 DISCO) vi forlod DISCO sommeren 2023
- **2024 - AAUSAT6 - first milestone - a prototype ready for Space 2025 @ AAU**

- Five ESA parabolic flight for test of some payloads (ADCS)

Upcomming research projects where we at AAU has students involved

- 2023 -> STEP - danish research astrophysics satellite mission: exopl
- 2023 -> Máni - danish research satellite mission to the moon



Først cubesat launch ever – onboard with AAU CUBESAT

Name	COSPAR ID (NORAD ID)	Type	Organisation	Mission	Mission status	Launch date (UTC)	Launch vehicle	Reentry date	Remarks
AAU CubeSat ^[45]	2003-031G (27846)	1U	Aalborg University	Technology ^[46]	Completed	30 Jun 2003 ^[47]	Rokot / Briz-KM		Battery problems, deactivated on 22 September 2003 ^[48]
CanX-1	2003-031H (27847)	1U	UTIAS	Technology demonstration ^[49]	Failed	30 Jun 2003 ^[47]	Rokot / Briz-KM		No signal from spacecraft ^[50]
Cubesat Xi-IV (Oscar 57)	2003-031J (27848)	1U	University of Tokyo	Amateur radio	Active ^[51]	30 Jun 2003 ^[47]	Rokot / Briz-KM		Still sending housekeeping information as of Sep 2023
CUTE-I (Oscar 55)	2003-031E (27844)	1U	Tokyo Institute of Technology	Amateur radio	Active ^{[52][53]}	30 Jun 2003 ^[47]	Rokot / Briz-KM		
DTUusat	2003-031C (27842)	1U	Technical University of Denmark	Tether research ^[54]	Failed	30 Jun 2003 ^[47]	Rokot / Briz-KM		No signal from spacecraft ^[54]
QuakeSat	2003-031F (27845)	3U	Stanford University	Earthquake detection ^[55]	Active	30 Jun 2003 ^[47]	Rokot / Briz-KM		
TUSat1		1U	Taylor University	Space Communication Research ^[56]		30 Jun 2003 ^[57]	Rokot/Briz-KM		First satellite from Indiana ^[57]



Economy

- Dependent of sponsor support
- No sponsor money goes to staff salary
- All money for the mission
- AAU 1,2,3,4,5 (all 1U) stipulated cost : €600k
- Maybe it sounds much but we think its a low/ok price for our product “highly qualified engineer”
- Morale: Can you do space you can do many many things



Spinn Off companies

- Old space students startet Gomspace, Satlab and Space Inventor
- Old students has or do also work at Esa, DLR and other foreign companies
- Maybe 300 or more has passed through AAUSATLAB
- In the vicinity of Aalborg University we are close to 20 companies “doing space” fully or partly
- Populated with old AAU space students(now engineers), space from around Europe and so on
- We are happy to see the growth in space industry



Space Connect North – Our new gateway to space

<https://spaceconnectnorth.com/>

- AAU - Prof Petar Popovski - is one of the founding members



Space Connect North: Your Gateway to Space Success

Space Connect North is the fastest way to launch your project into space. The growing space cluster will connect you with internationally acclaimed satcom and space companies and a world-class university, propelling your space venture to the forefront of innovation.

Aalborg University

Gatehouse Satcom, Sternula, Necas, Rohde & Schwarz Technology Center, Satlab, Spacecom, GOMspace, Danphone, Invest in Aalborg, Keysight Technologies, Trusted, Hytek PRI-DANA Elektronik, Cobham Satcom and Quadsat and more on way



ALL I ALL

WE THINK ITS A HUGE SUCCESS

FOR

ES & AAU & Denmark

&

and our educational model @ AAU



**AALBORG
UNIVERSITY**

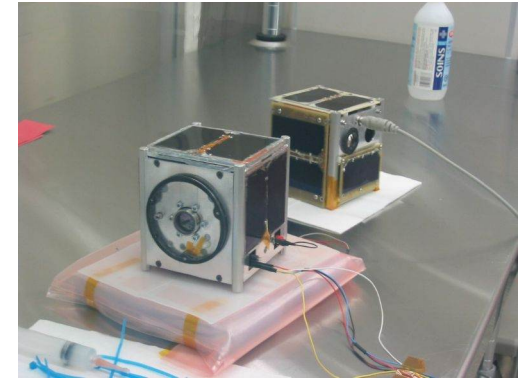
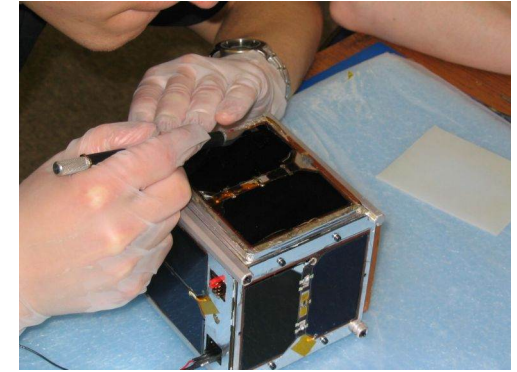


Extra: no 1 - AAU CUBESAT & nr 3 AAUSAT3

- AAU CUBESAT - launch 30 june 2003
- kcamera payload
- AAU CUBESAT did work but very weak radio link
- Camera was never tested

- AAUSAT3 - launch 25 february 2013
- 2 AAU constructed AIS receivers for tracking ships
- After first pass conclusion was "mission completed" !!!
- One SDR technology based receiver was upgraded during operation

AAUSAT3 before departure 2012/2013 and a ship tracking map from AAUSAT3



AAU CUBESAT @ Canada prep for launch - June 2003



thanks for listening



AAUSATs no 1 2 3
4 5 (6 on way)

