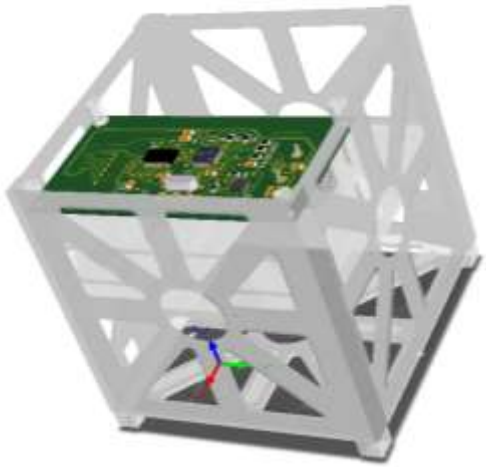
Lessius

LeSTAR

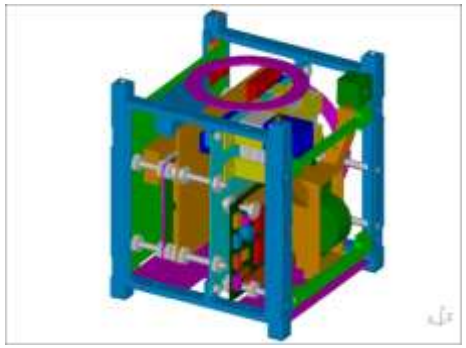
Lessius Satellite
for Teaching and
Autonomous Research

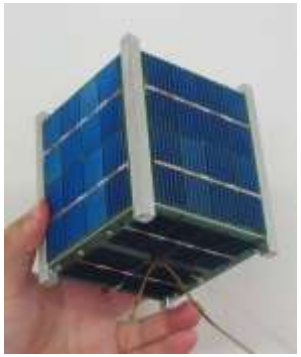


Ing. Dirk Van Merode
Ing. Peter Arras

LeSTAR

- CubeSats are HOT!
  - Initiatives for affordable educational satellites
  - Initiatives for multi-orbiting of CubeSats to augment opportunities and reduce pricing
  - Development of accessible, off-the-shelf hardware





LeSTAR

- Manned biochemical research is difficult
  - Expensive
  - Difficult access
  - Long waiting lines

LeSTAR: Lessius Satellite for Teaching and Autonomous Research

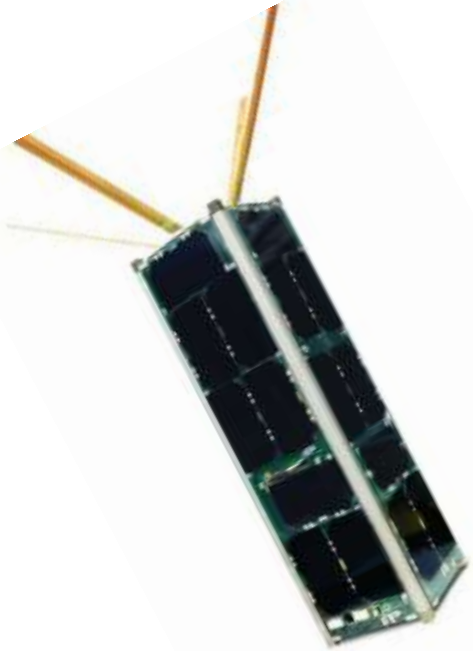
Lessius

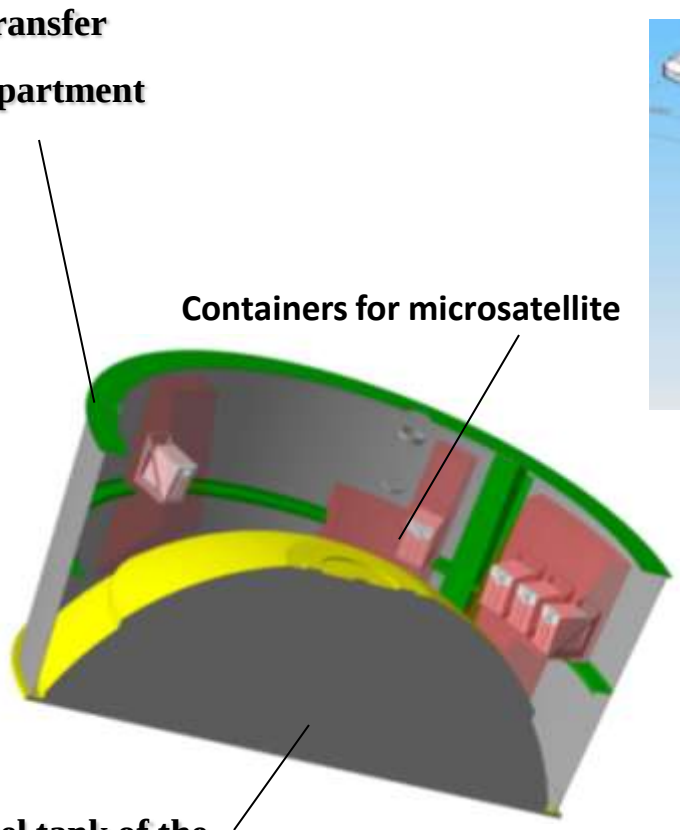
Many CubeSat missions and launch opportunities

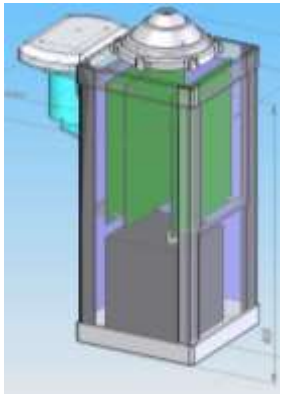
Difficult accessible manned missions

Autonomous Biochemical Research on board CubeSats

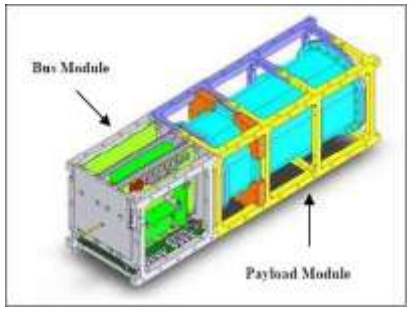
LeSTAR: Lessius Satellite for Teaching and Autonomous Research



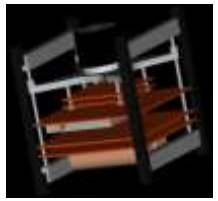




LeSTAR: Lessius Satellite for Autonomous Research



- Proof-of-Technology
- Uniform basic functionality in 1 unit for reuse in future missions
- Expandable from 2 to 6 units
- Development of biochemical payload
- Integration of biochemical payload
- Benchmark biological space research and set-up different requirements for future missions
- System integration



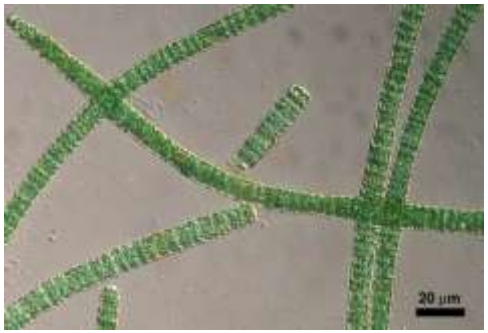
LeSTAR: Lessius Satellite for Autonomous Research

- Software development: flight / GS
- Launch preparation
- Flight simulations
- Data aquistion and handling
- Processing and interpreting the data
- IP dissemination

LeSTAR: Payload: BiOxE

- "The cyanobacterium *Arthrospira* sp. strain PCC8005 is a candidate for use in spacecraft biological life support systems, for CO_2 and nitrate removal, and oxygen and biomass production. However, to ensure the reliability of such a biological life support system it is necessary to characterize the response of *Arthrospira* sp. PCC8005 to *in situ* spaceflight conditions. "

Dr. Natalie Leys – SCK-CEN



LeSTAR: Payload: BiOxE

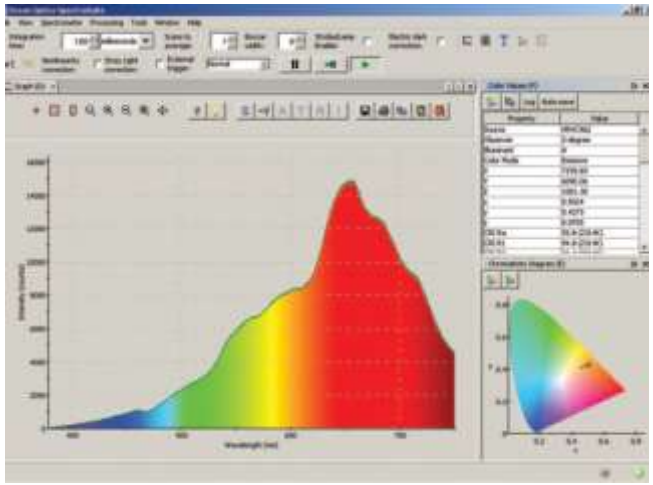
- Growing of photosynthetic, edible micro-algae under microgravity conditions
  - Biomass and Oxygen Efficiency
  - production of a miniature bioreactor
  - environment control (light, temperature, pressure)
  - microfluidic network for reagent distribution
  - automation, digitalisation and communication of the measured results
  - biocompatibility of the biochemical load and the materials used for the bioreactor
  - interface with the satellite command and data handling system

LeSTAR: Payload: BiOxE

- Process reagents
  - Arthrospira spirulina PCC 8005
    - High on proteins, essential fatty acids, minerals, vitamins and nutrional pigments
    - Antioxidant
    - Usage in biohydrogen production
    - Resiliance to ionizing radiation up to 3200Gy
  - Zarouck-UBP
    - Zarrouk is an alkaline culture medium for bluegreen photosynthetic cyanobacteria

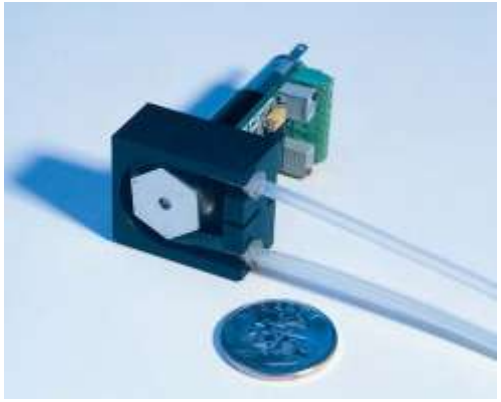
LeSTAR: Payload: BiOxE

- Process parameters
  - turbidity - optical density OD - increase (cell concentration)
  - pressure increase (oxygen production)
  - fluorescence (photosynthesis)
  - alkalinite pH (carbonate consumption)
  - temperature
  - housekeeping data: Illumination (light on/off status) & pump activity (on/off status)



LeSTAR: Payload: BiOxE

- Process controlls
  - LED-illumination: 5 W/m²
  - Heating : 30°C
  - Peristaltic pump



e.g. Experimental conditions : V_{liq} = 50 mL, T° = 35°C, Illumination = 5 $W.m^{-2}$

Biomass concentration reached at the steady state g/L	γ (lighted fraction)	Dilution rate h^{-1}	r_x $g.L^{-1}.h^{-1}$	Flow rate $mL.h^{-1}$
0.3	1.00	0.01800	$5.3*10^{-3}$	0.900
0.5	1.00	0.01240	$6.2*10^{-3}$	0.620
0.8	0.85	0.00765	$6.1*10^{-3}$	0.383
1.0	0.64	0.00600	$6.0*10^{-3}$	0.300

LeSTAR: Payload

- Secondary payload (if applicable)
  - Goal is to gain wide sympathy for the project
  - Enable access for secondary schools to space for popularisation of space education
  - Internet accessible and controllable groundstation

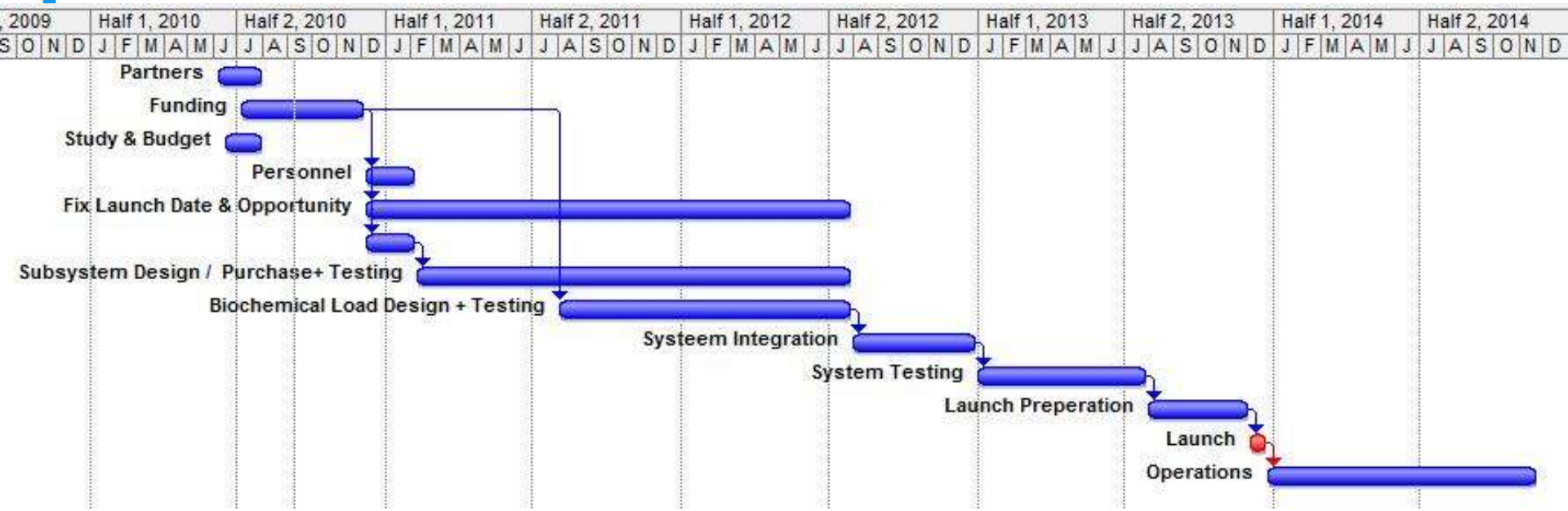
LeSTAR: Lessius Satellite for Teaching

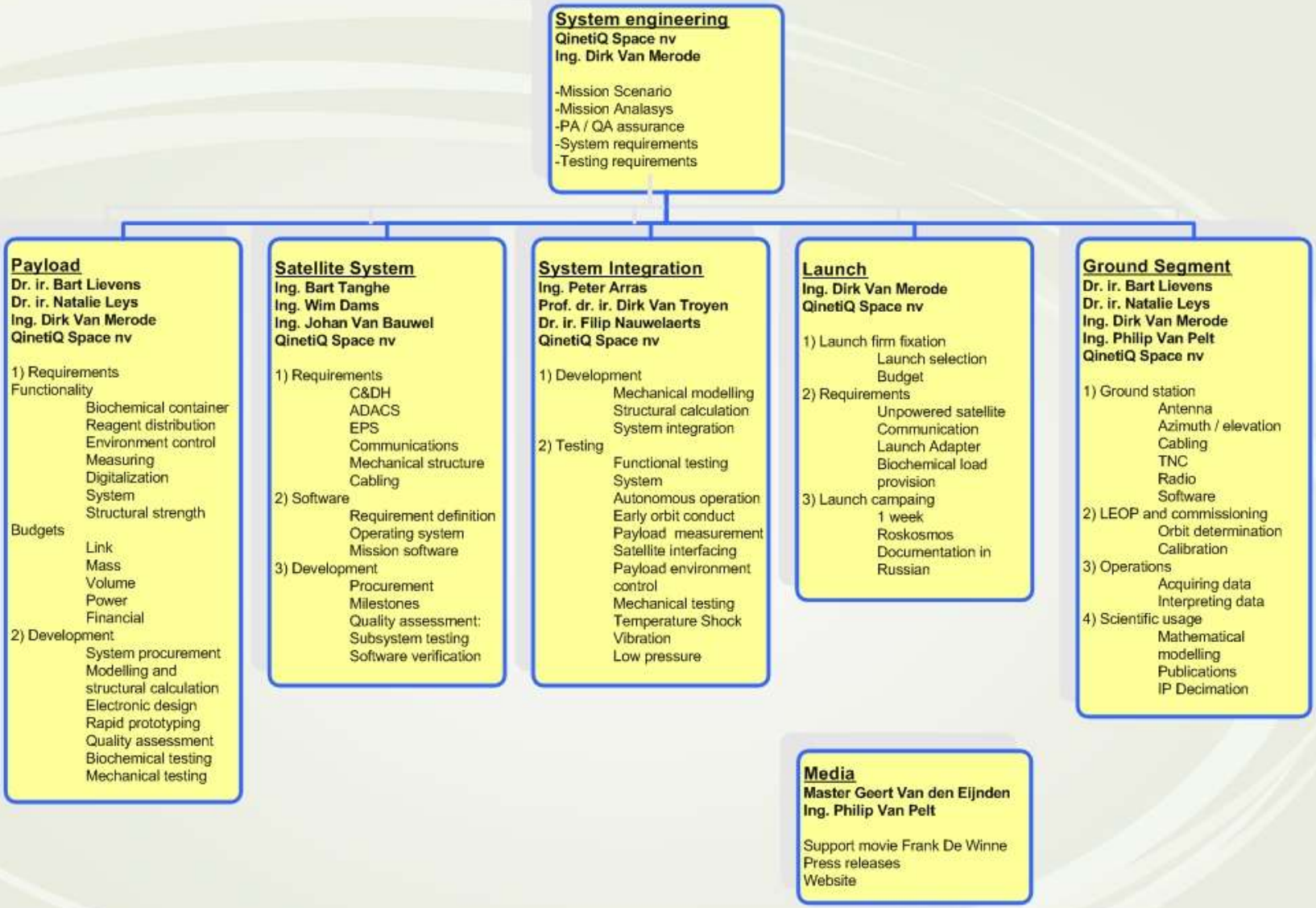
- Attract students to high-innovative studies
- Media plan for placing Belgian space education and research in the picture and to appeal to the general public by increasing visibility of the technological sector
- Fix space elements in the curriculum
  - Design Methodology
  - Space Requirements
  - Project Management

LeSTAR: Budgets

- Budgets for Payload (preliminary)
  - Power: 2400mW
  - Mass: 2091g
  - Volume: 130x96x90 mm

LeSTAR: Timing




System engineering
QinetiQ Space nv
Ing. Dirk Van Merode
-Mission Scenario
-Mission Analasys
-PA / QA assurance
-System requirements
-Testing requirements
Payload
Dr. ir. Bart Lievens
Dr. ir. Natalie Leys
Ing. Dirk Van Merode
QinetiQ Space nv
1) Requirements
Functionality
Biochemical container
Reagent distribution
Environment control
Measuring
Digitalization
System
Structural strength
Budgets
Link
Mass
Volume
Power
Financial
2) Development
System procurement
Modelling and structural calculation
Electronic design
Rapid prototyping
Quality assessment
Biochemical testing
Mechanical testing
Satellite System
Ing. Bart Tanghe
Ing. Wim Dams
Ing. Johan Van Bauwel
QinetiQ Space nv
1) Requirements
C&DH
ADACS
EPS
Communications
Mechanical structure
Cabling
2) Software
Requirement definition
Operating system
Mission software
3) Development
Procurement
Milestones
Quality assessment:
Subsystem testing
Software verification
System Integration
Ing. Peter Arras
Prof. dr. ir. Dirk Van Troyen
Dr. ir. Filip Nauwelaerts
QinetiQ Space nv
1) Development
Mechanical modelling
Structural calculation
System integration
2) Testing
Functional testing
System
Autonomous operation
Early orbit conduct
Payload measurement
Satellite interfacing
Payload environment control
Mechanical testing
Temperature Shock
Vibration
Low pressure
Launch
Ing. Dirk Van Merode
QinetiQ Space nv
1) Launch firm fixation
Launch selection
Budget
2) Requirements
Unpowered satellite
Communication
Launch Adapter
Biochemical load provision
3) Launch campaing
1 week
Roskosmos
Documentation in Russian
Ground Segment
Dr. ir. Bart Lievens
Dr. ir. Natalie Leys
Ing. Dirk Van Merode
Ing. Philip Van Pelt
QinetiQ Space nv
1) Ground station
Antenna
Azimuth / elevation
Cabling
TNC
Radio
Software
2) LEOP and commissioning
Orbit determination
Calibration
3) Operations
Acquiring data
Interpreting data
4) Scientific usage
Mathematical modelling
Publications
IP Decimation
Media
Master Geert Van den Eijnden
Ing. Philip Van Pelt
Support movie Frank De Winne
Press releases
Website

LeSTAR: Partners

- SCK-CEN
  - Provision of know-how in preparation and execution of biochemical microgravity experiments
  - Set up of biochemical requirements
  - Coaching of master students in the development phase
  - Provide biological material
  - Review of biochemical payload
  - Set up testing schemes before, during and after flight
  - Mathematical modelling of biomass growth and oxygen production efficiency
  - Review of testing results

LeSTAR: Partners

- QinetiQ Space nv
  - Review of mission scenario
  - Support in setting up the system requirements and system specifications
  - Support in setting up the development and verification plan
  - Setting up the PA/QA plan and further support (review) of the PA documents written by Lessius
  - Support (design reviews) of payload and satellite design and engineering
  - Support during systems assembly, integration and test
  - Support in launch selection and ICD
  - Support In LEOP and commissioning activities

LeSTAR: Partners

- Brigadier-General Frank viscount De Winne
  - Internationally Renowned Esa Astronaut with Belgian Nationality
  - Godfathership of the LeSTAR project
  - Providing moral support
  - Promoting space education in a general way

LeSTAR: Partners

- KULeuven, Institute for Astronomy
  - Associated University
  - LASA: Leuven Centre for Aeronautics and Space Science and Applications
  - Independent reflection team
  - Requirements definition
  - Reliability analysis
  - Support on system engineering

LeSTAR: Partners

Lessius

- Technical University Berlin
  - design of on-board computer
  - delivery of and support on satellite subsystem hardware
  - development of flight software
  - interfacing with satellite subsystems
  - consultancy on technical and orbital requirements
  - setting up procedures
  - technical design reviews
  - review of mission scenario
  - support on software development
  - support on quality assurance

Technische Universität Berlin

LeSTAR: Partners

- Université de Liège
  - Know-how satellite projects
  - Cooperation in space technology in a Belgian context
  - Independent reflection team
  - Requirements definition
  - Reliability analysis
  - Support on system engineering
  - Sharing of know-how and documents
  - Student and staff exchange

LeSTAR: CRIST

- Partner in TEMPUS – CRIST (KZ,RU,UA)
  - Design of micro- and picosatellites
  - Radio communication for space
  - MCAD/ECAD for satellite development and astronautics
  - Network of groundstations Mechelen – Siberia
  - International Network of Expertise

LeSTAR: CRIST

Lessius

European Commission

TEMPUS

„Curricula Reform in Space Technology in Kazakhstan, Russia, Ukraine“

JOINT PROJECT CURRICULUM DEVELOPMENT

financed by Tempus

CRIST

www.crist-kru.eu






Ground Station Network

Each participating university has its own grounds tation

Each participating university has its own limited satellite communication window

A combined network will improve data retrieval from student satellites

Contact

Dirk Van Merode

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Departement Technology
Lessius Mechelen University College
Campus De Nayer

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