SPORT

Scintillation Prediction Observations Research Task

The Agile Development of SPORT Spacecraft

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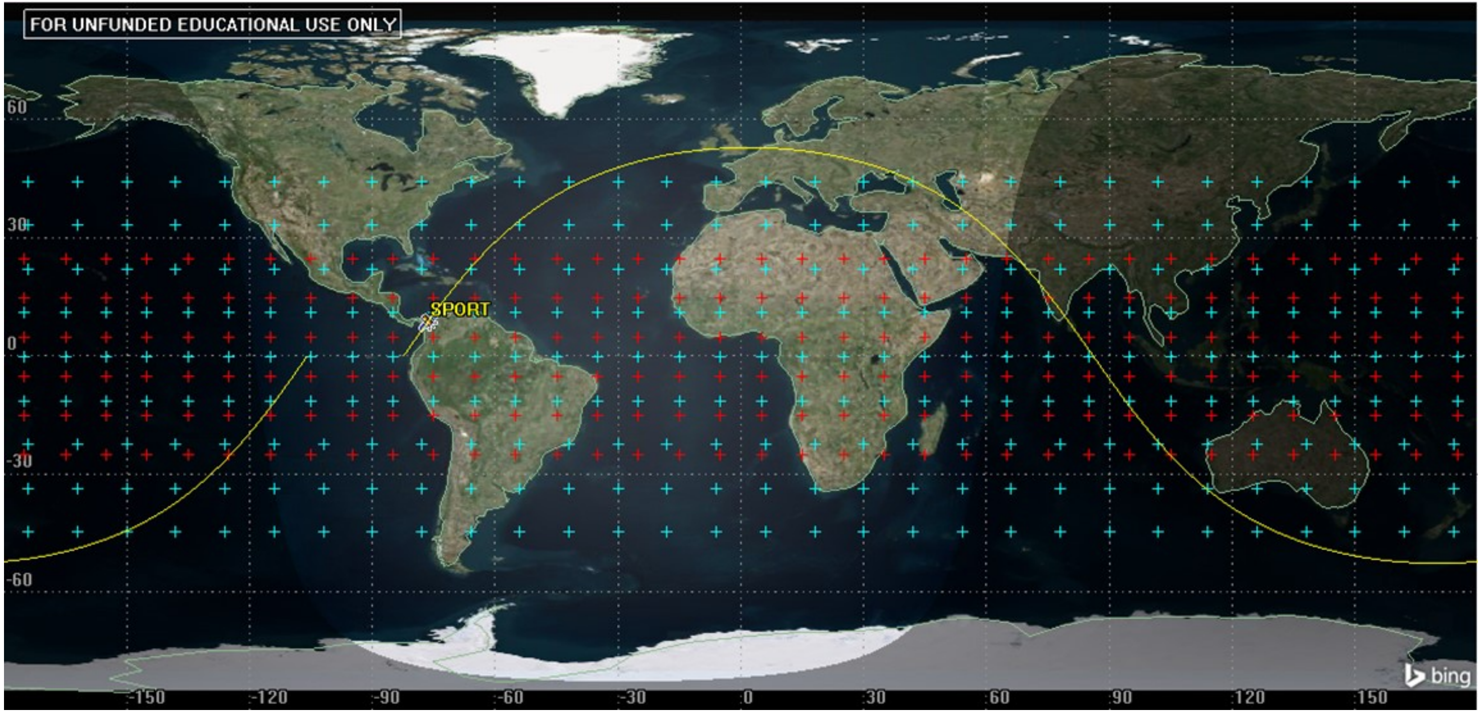
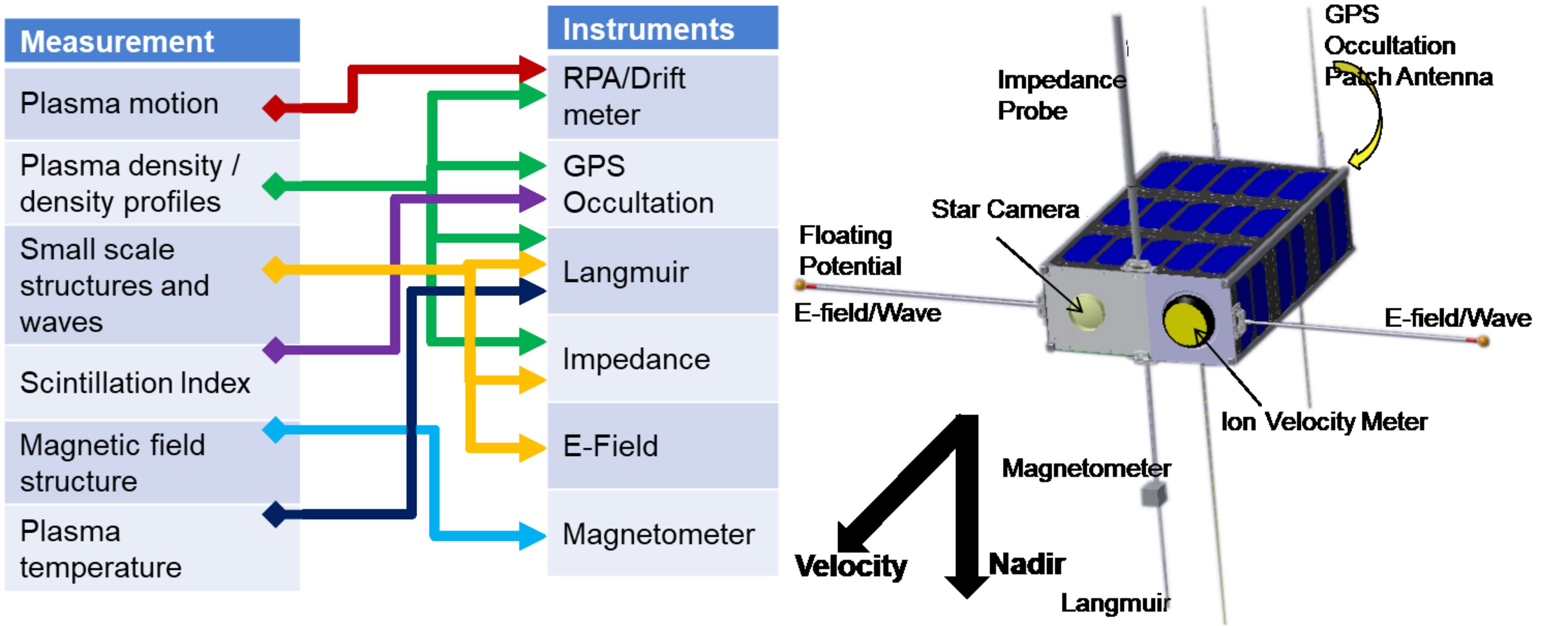
SPORT Mission



SPORT Mission Measurements



Waterfall Approach?

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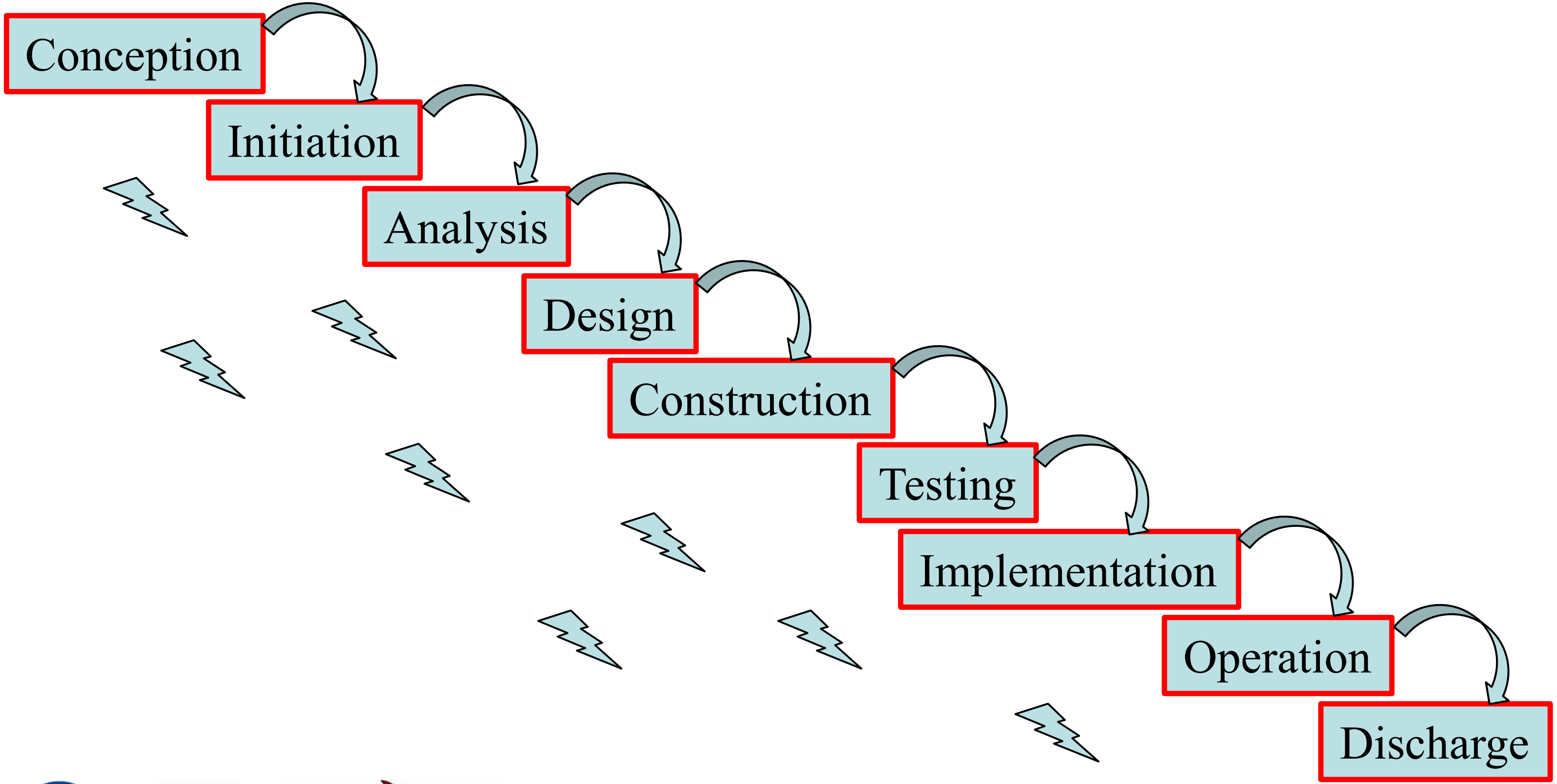

AEROSPACE UT DALLAS UAH The University of Alabama in Huntsville UtahStateUniversity

But: Development Uncertainties

- Experiments complexity
- Number of experiments and teams: many interactions needed
- Insufficient competence of the design team
- Unknown design practices from NASA
- New NASA design approaches for CubeSats
- Lack of information: NO Umbrella Agreement between Brazil and United States

Agile Manifesto

- **Individuals and interactions** over processes and tools
- **Working software (model)** over documentation
- **Customer collaboration** over contract negotiation
- **Responding to change** over following a plan

Source: www.agilemanifesto.org

Principles behind the Agile Manifesto

Source: www.agilemanifesto.org

- Our highest priority is to satisfy the customer
- Welcome changing requirements, even late in the development
- Deliver working software (model) frequently
- Business people and workers must work together daily
- Build project around motivated individuals
- Face-to-face conversation
- Working software (model) is the primary measure of progress
- The sponsors, developers, and users should be able to maintain a constant pace
- Attention to technical excellence
- Simplicity is essential
- Best architectures, requirements and designs emerge from self-organizing teams
- The team reflects on how to be more effective: tunes and adjusts its behavior accordingly

Principles behind the Agile Manifesto

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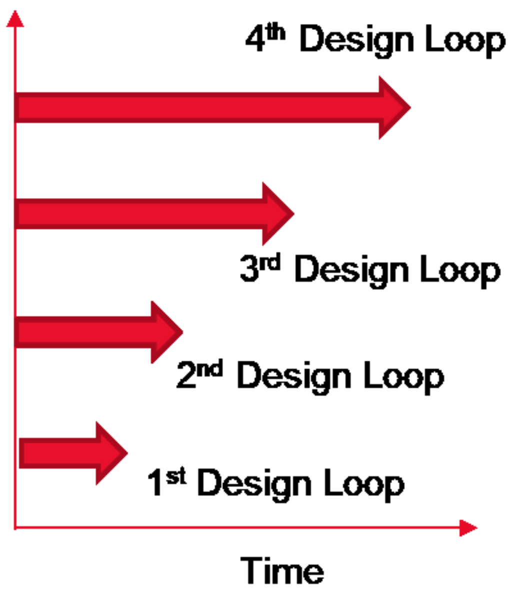
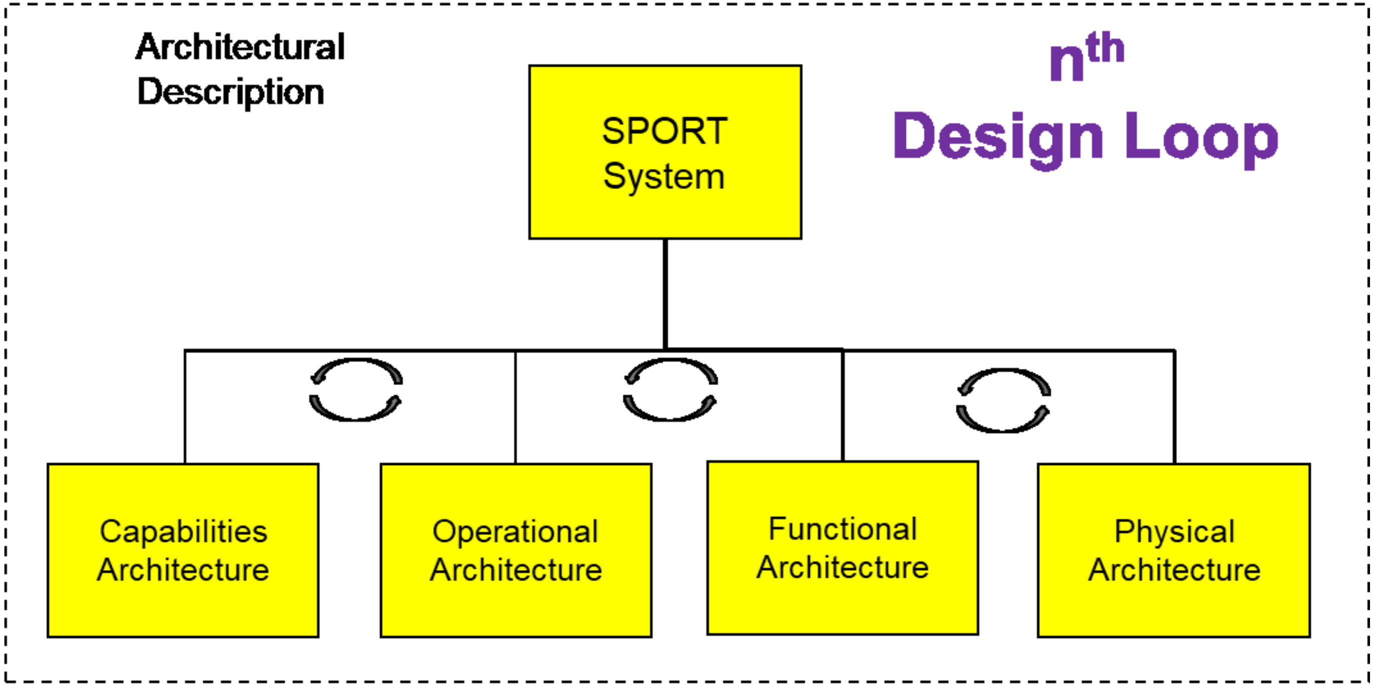
- Satisfy the customer: UTD, NASA Goddard, USU, Aerospace, NASA Marshall
- Changing requirements: happening when necessary, example: pointing accuracy
- Deliver working model frequently: CAD, Thermal, Electrical, Radiation, Orbital, Control
- Business people and workers must work together: NASA HQ, Brazilian Congress, COMAER
- Motivated individuals: team was liberated from work, but EVERYONE came to work
- Face-to-face conversation: videoconference 3x or 2x per week
- Working model as measure of progress: frequent presentations
- Group should be able to maintain a constant pace indefinitely: happening
- Attention to technical excellence: three forms of risk management
- Simplicity is essential: KISS strategy
- Best architectures, requirements and designs emerge from self-organizing teams: we have
- The team tunes and adjusts its behavior accordingly: more or less

SPORT Development Strategy





Simplified diagram from System Engineering Analysis, Design and Development

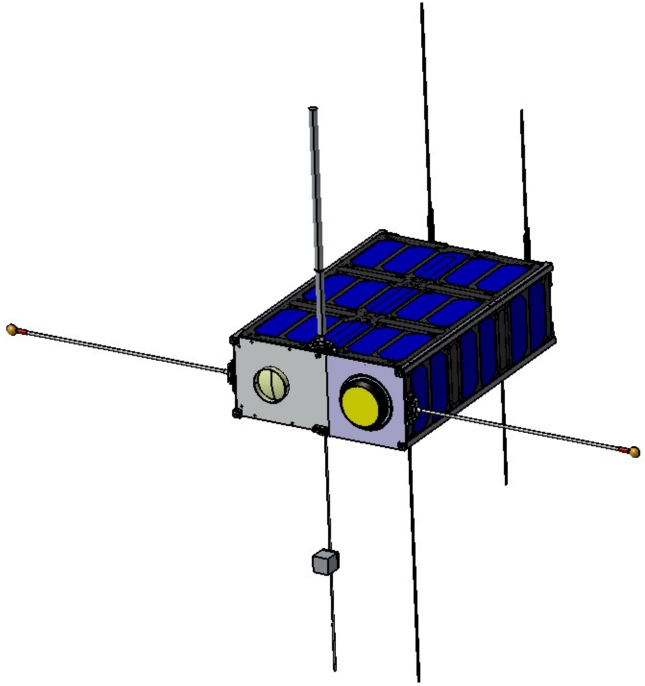
First Loop (2 months)

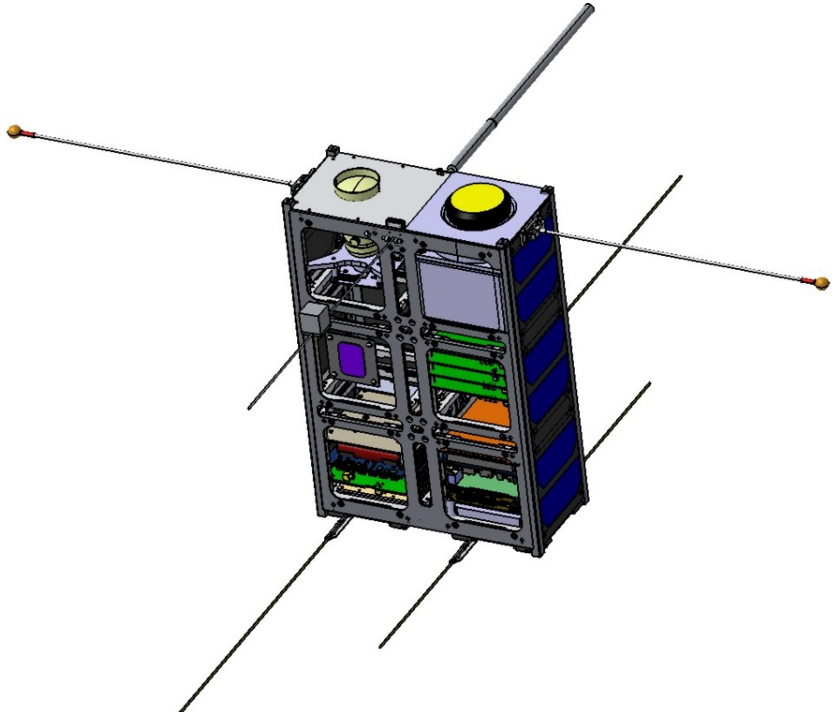
- Stakeholder analysis
- Field Data
- Mission Need, Goals and Objectives:
- Mission Concept
- Operational Modes Definition

The results of the first loop were presented on the bi-weekly meeting

LOOP 1

Concept similar to ITASAT



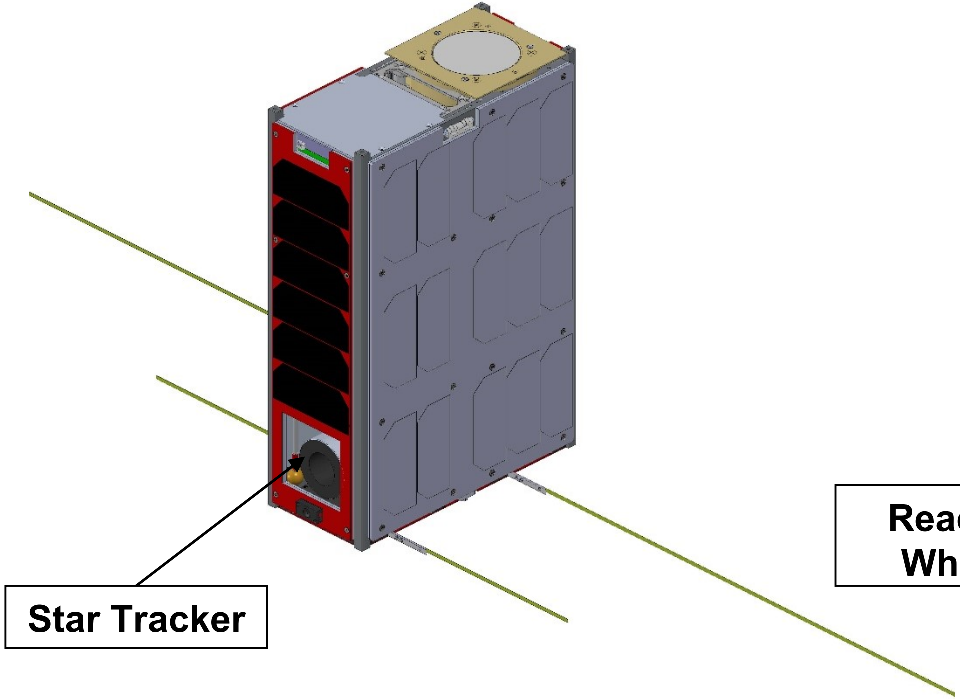


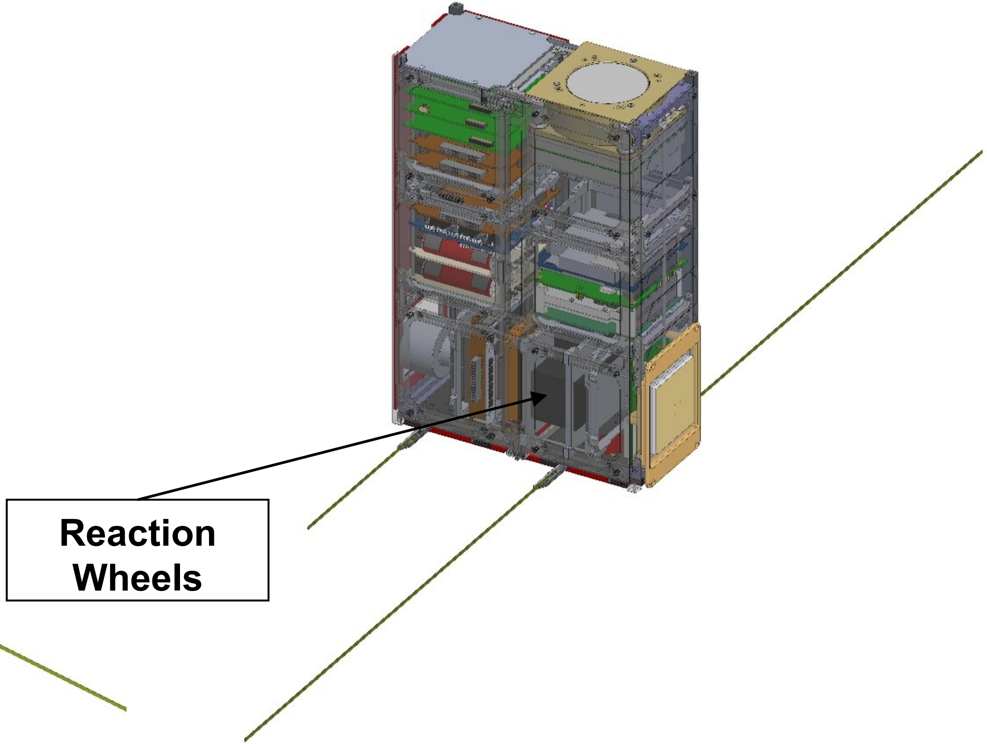
Second Loop (3 months)

- Mission requirements
- Scenarios Specification
- Concept of Operations
- Mission Event Timeline
- Risk Analysis: Mission level
- Review of Operational Modes

The results of the second loop were presented on the bi-weekly meeting

LOOP 2



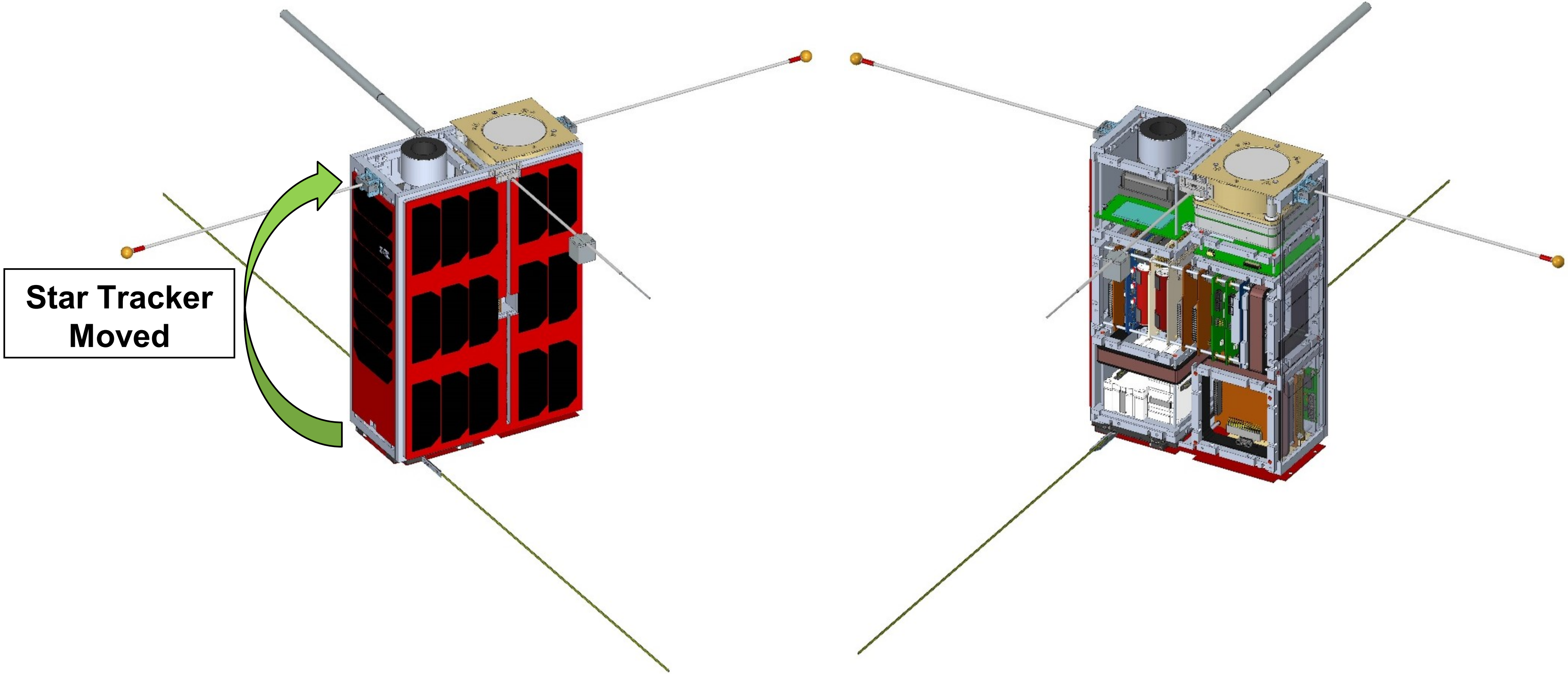


Third Loop (3 months)

- System and Subsystem Requirements
- Operational Scenarios
- Preliminary System Architecture and Budget (power, mass and data)
- Mission Event Timeline
- Risk Analysis: System level
- Preliminary Systems Interface definition
- Sport State, Modes and Use Cases
- Attitude Control Model
- Mechanical Model
- Power Generation Simulation

The results were presented on the Sport Workshop on September 2017

LOOP 3

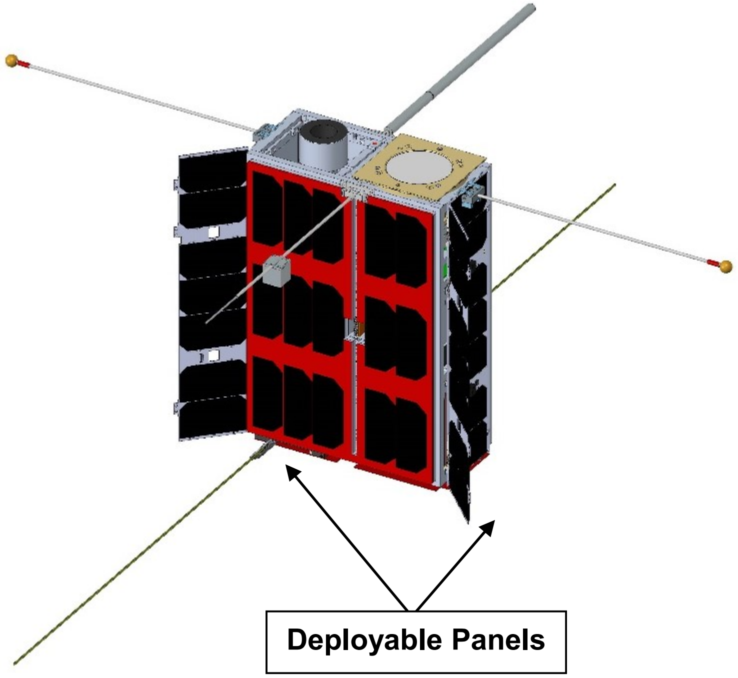


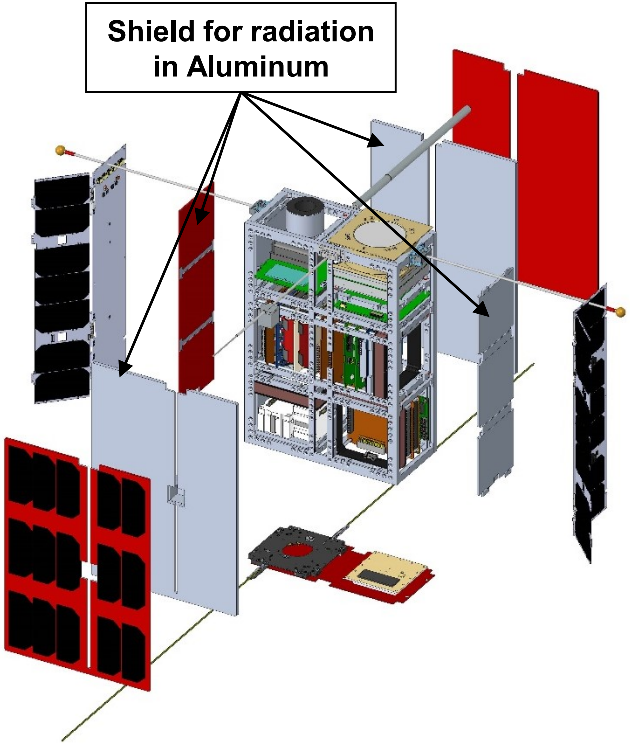
Fourth Loop (6 months)

- Updated CONOPS
- Mission and System Requirements
- Preliminary Mechanical Analysis
- Preliminary Thermal Analysis
- Functional Analysis and Description
- Preliminary Systems Architecture
- Risk Analysis: subsystem level
- Preliminary Software Architecture
- Preliminary Electrical Diagram
- Preliminary Harness Identification
- Power, Mass and data Budget
- Power Generation Analysis
- Mission Event Timeline Update
- Sport State, Modes & Use Cases update

The results were presented on the CSR/PDR of Sport Project on April 2018

LOOP 4



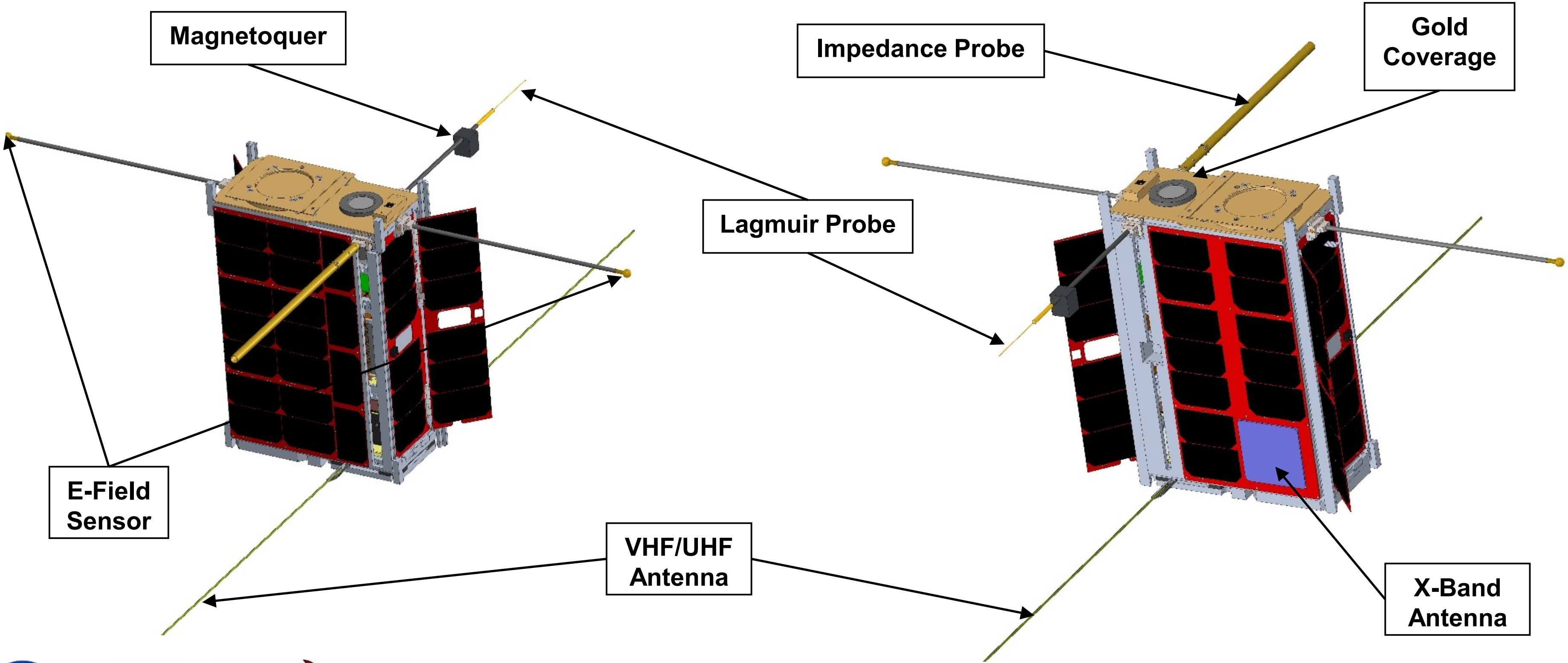


Fifth Loop (4 months)

- Mission and System Requirements Review NASA approach)
- Subsystem requirements (NASA approach)
- Detailed Thermal Analysis
- Software Analysis and Development (System Modelling)
- Detailed Software Architecture
- Risk Analysis: Subsystem update
- Detailed Electrical Diagram
- Pointing Budget
- Power, Mass and Data Budgets Review
- Spacecraft Physical Architecture Definition
- Orbit Decay Analysis
- Mission Event Timeline Update
- Sport Sates, Models and Use Cases Update
- Parts Procurement

The results were presented on the Sport Equipment's CDR on August 2018

LOOP 5


Magnetoquer
Impedance Probe
Gold Coverage
Lagmuir Probe
E-Field Sensor
VHF/UHF Antenna
X-Band Antenna

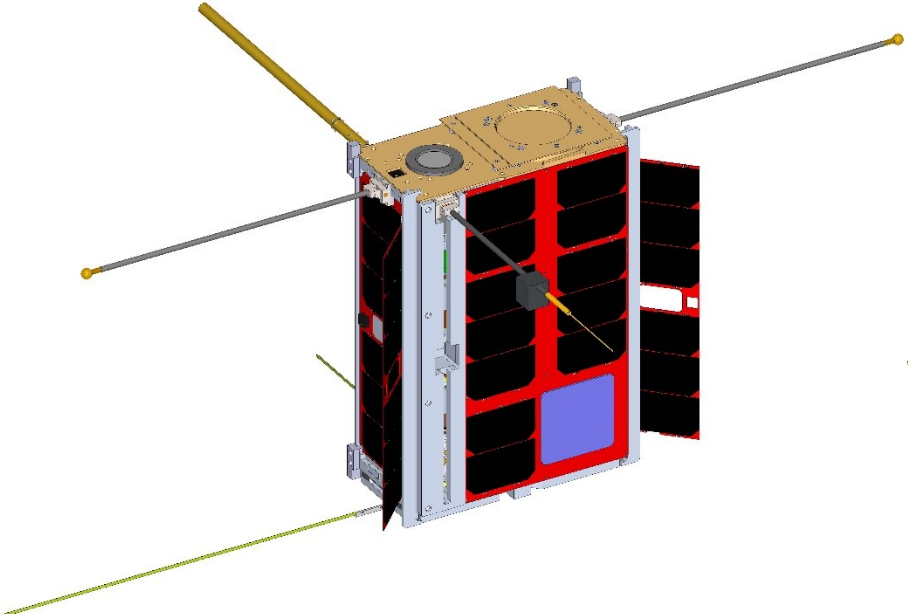
Sixth Loop (present)

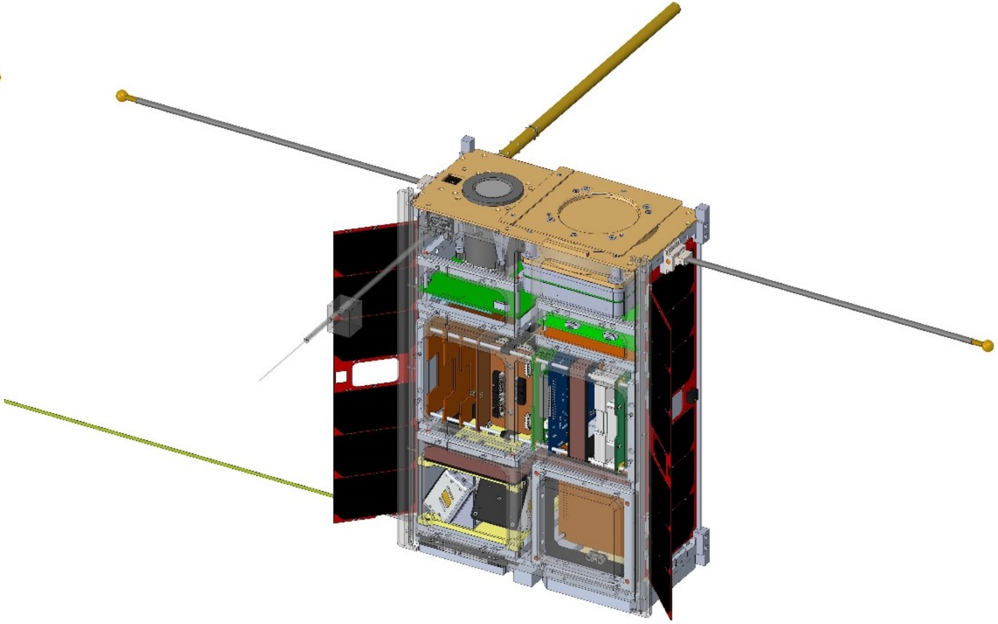
- Mission and System Requirements baselined
- Detailed Mechanical Analysis
- Detailed Thermal Analysis
- Software Analysis and Development (emulators definition and development)
- Detailed System Architecture (interfaces and functional tests with emulators and simulators)
- Risk Analysis: Subsystem follow-up
- Detailed Electrical Diagram
- Detailed Software Architecture
- Spacecraft Physical Architecture update
- Power, Mass and Data budget review
- Pointing budget update
- Mission Event Timeline Update
- Sport Sates, Models and Use Cases Update
- Parts Procurement
- Verification and Validation strategy

The results will be presented on the Spacecraft emulators test with the instruments on November 2018

LOOP 6

Detail of Structure and Deployable Panel in progress





Conclusions

- In the SPORT bus design an evolutionary approach was used: Agile
- It was necessary due to the uncertainties in the project as a whole
- It was possible because of a multi-disciplinary self-organizing team
- This allowed a highly iterative development with the Stakeholders
- Which produced a close collaboration between developers and Stkh
- Each iteration worked with four architectures at the same time
- Which allowed a cross-fertilization in the development
- Results were presented constantly to the Stakeholders
- These results were based on working models rather than documents