# SwissCube Project

## 3rd Annual Cubesat Workshop

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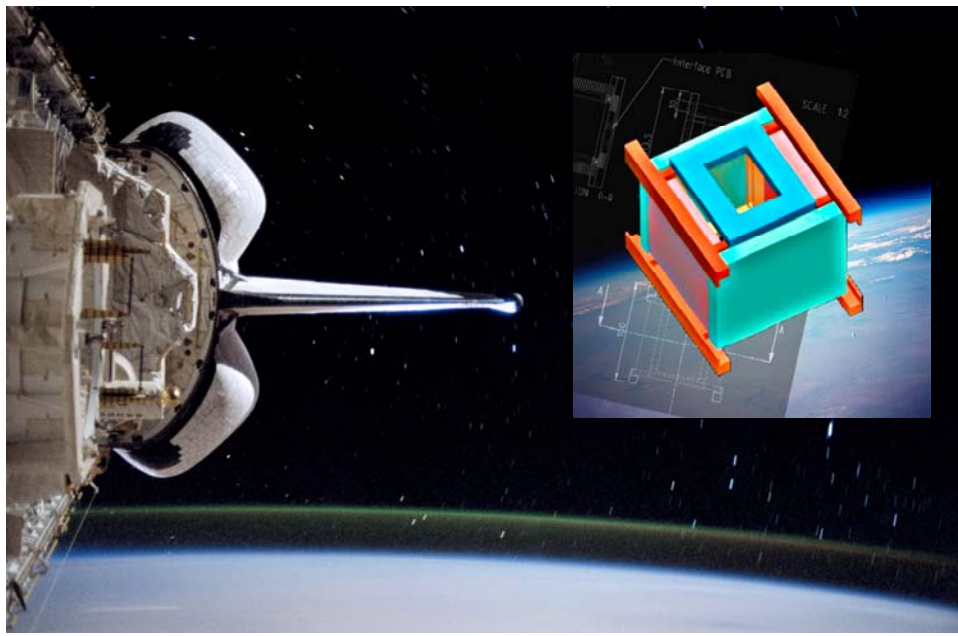
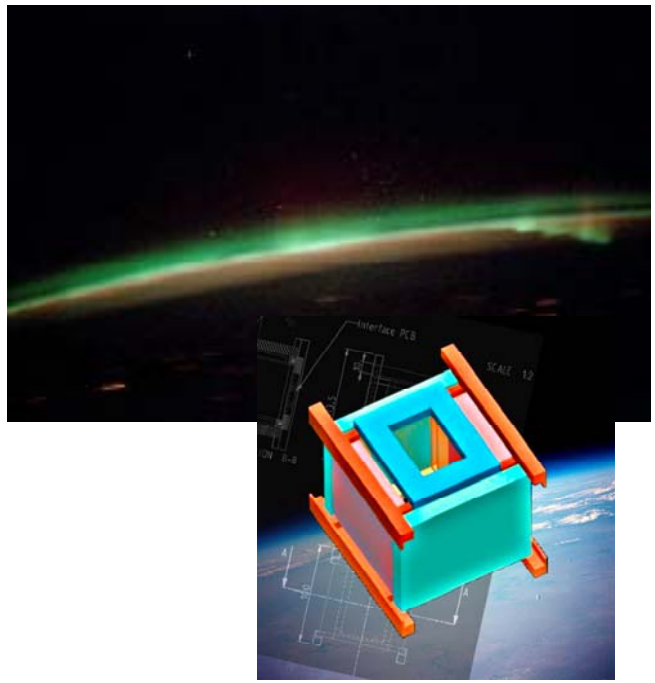


# Outline

- Project and science objectives
- Preliminary mission assumptions
- Project organization (participants + schedule)
- Test and model philosophy
- Conclusion

# Project Objectives



- **Goal is to have a Swiss Cubesat in orbit by 2008**
  - Satellite and ground segment defined, designed, built, tested and operated by students
    - Multi-disciplinary, multi-lab, multi-university collaboration
    - Strong educational aspect: student/industry ties, ESA/NASA development phases and standards
  - Budget:
    - ~ $ 200 k (including launch) over 2.5 years
    - already gathered 2/3 of budget
  - High visibility project for Swiss universities and industry partners since it would be the first Swiss satellite launched
- **Two mission objectives:**
  - Science: characterize variability of Nightglow phenomena in intensity and altitude
  - Technology: test and qualify a new Single Photon Avalanche Detector
- **Primary success criteria:** Deliver a fully tested cubesat to launch site
- **Secondary success criteria:**
  1. Launch, close RF link and download telemetry
  2. Receive Science data and characterize operations

# Science Objectives

- Science Objectives:

  Take comprehensive measurements of the NightGlow Phenomena over all latitudes and longitudes and over a period of 3 months (primary mission) to 12 months (extended mission)

- Measurements in the 75-110 km altitude with [5] km spatial resolution

- Measure two to three bands of emissions in the spectral range of [550 – 880] nm with spectral resolution less than [1] nm
  - Preliminary bands: 558, 762 and 840 nm

- Detector
  - A. Rochas, M. Gani, B. Furrer, P. A. Besse, and R. S. Popovic, "Single photon detector fabricated in a complementary metal–oxide–semiconductor high-voltage technology", *REVIEW OF SCIENTIFIC INSTRUMENTS,* vol. 74(7), July 2003

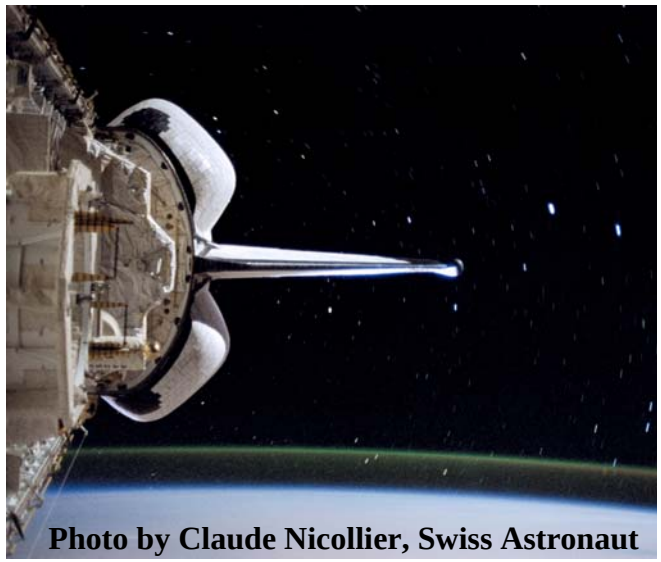


Photo by Claude Nicollier, Swiss Astronaut

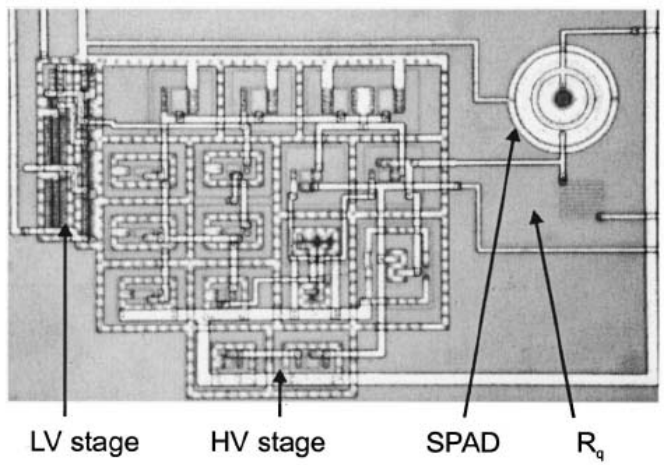
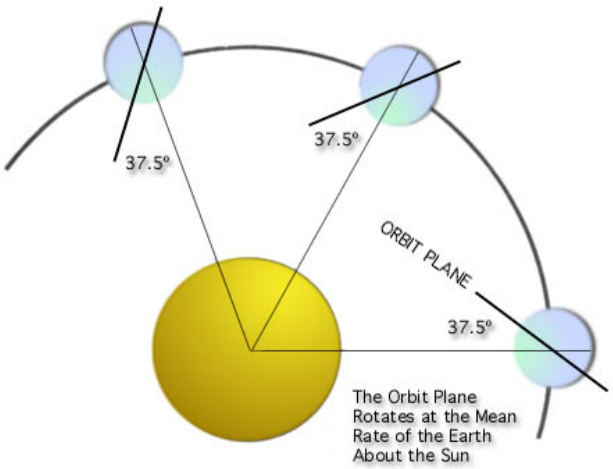
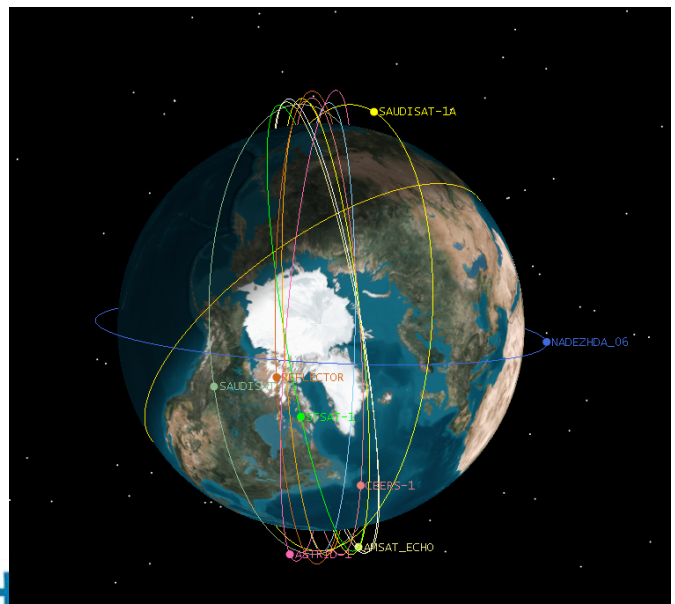


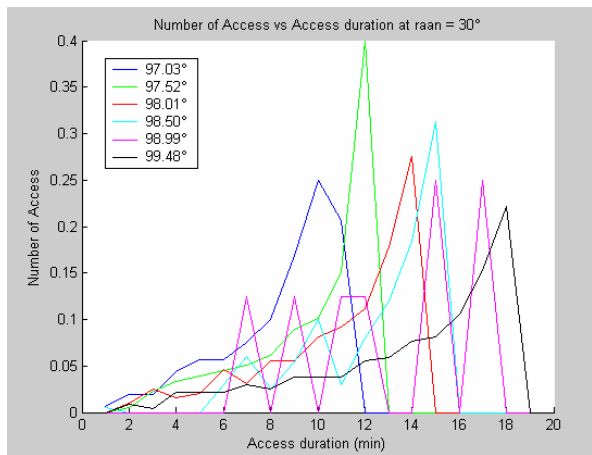

FIG. 3. Picture of the CMOS-high-voltage SPAD. The circular SPAD and the quenching resistor can be seen on the right-hand side. The low-voltage and the high-voltage parts of the comparator can be seen as well.

# Preliminary Mission Assumptions

| | |
|---|---|
| • Launch | DNEPR or VEGA launch vehicles |
| • Orbit | Most likely Sun-synchronous |
| • Inclination | ~ 97 - 99° |
| • Orbital Altitude | ~ 400 - 1000 km |
| • Orbital period | ~ 90 - 105 min |
| • Eclipses | ~ 30 % of orbital period |
| • Avg. power | ~ 1.5 W |
| • Mean pass duration | ~ 10 min |
| • Data downlink rate | ~ 1 kbps |

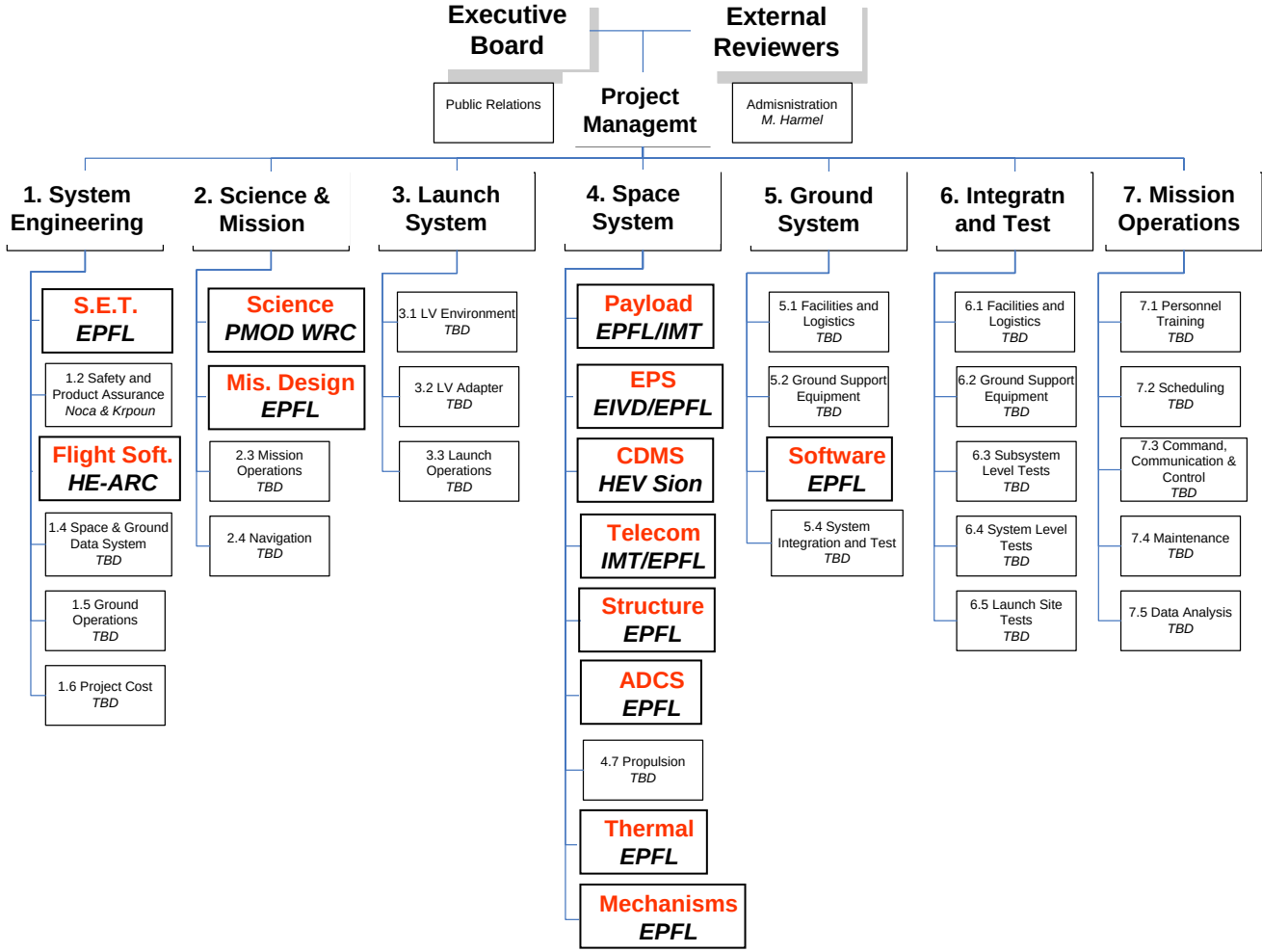


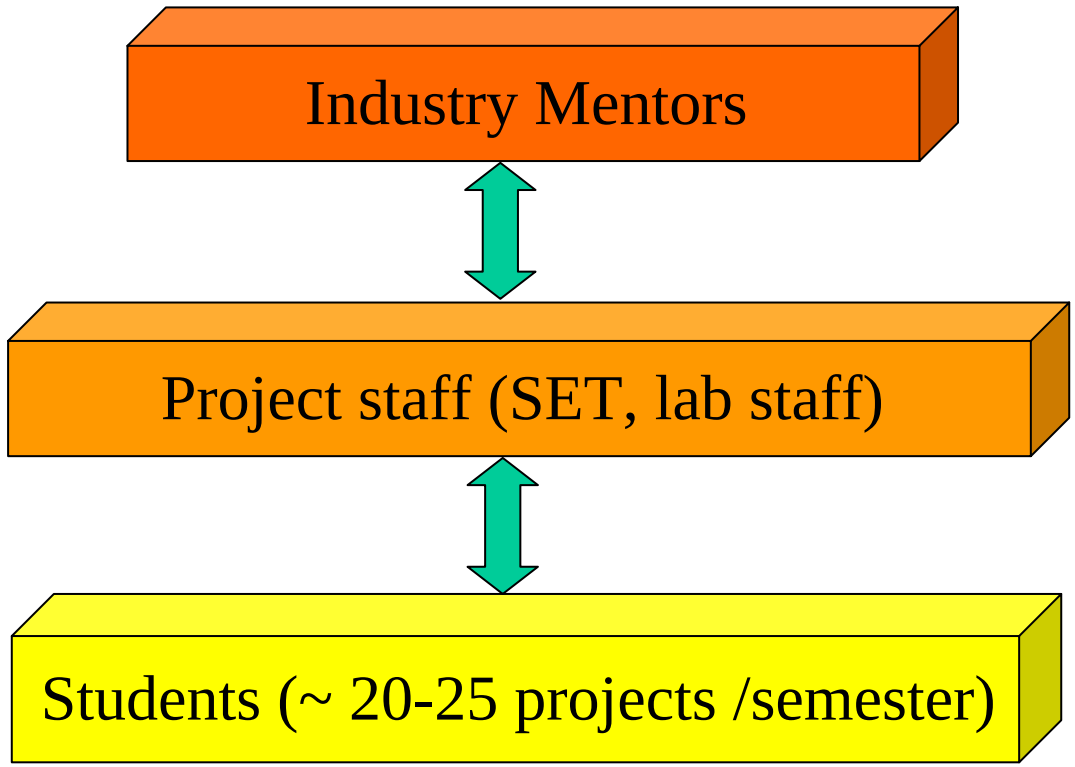
# Project Organization (1/2)

- Key SwissCube subsystem responsibility is spread across several labs and universities. Current partners:
  - EPFL: 10 labs
  - Université de Neuchatel: 3 labs
  - HES Sion: 1 lab
  - HES Yverdon: 2 labs
  - HE-ARC: 1 lab
- Executive Board includes industry sponsors and university representatives
- External reviewers include Swiss industry representative and ESA partners

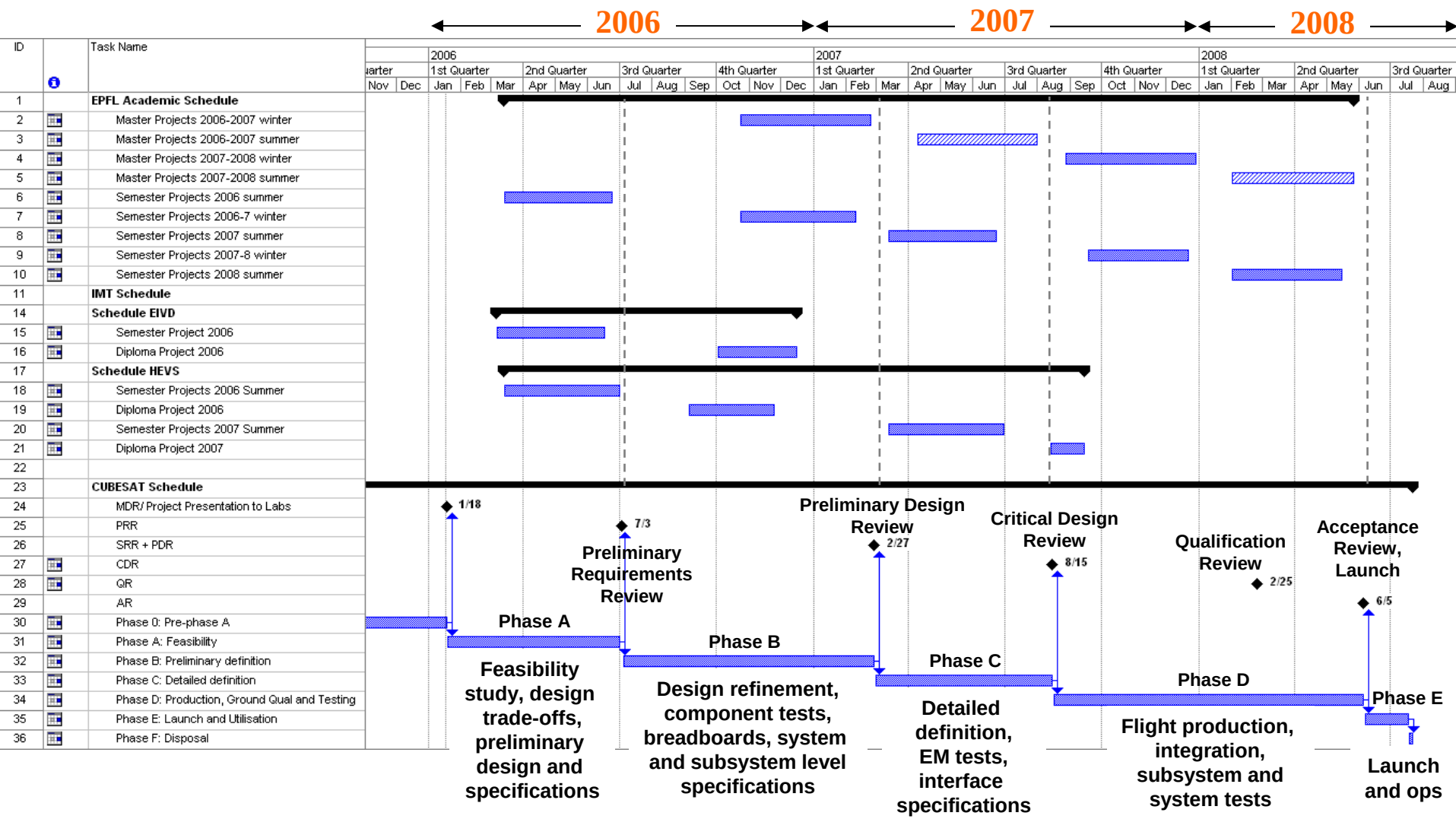


# Project Organization (2/2)

- Most of the work will be done by the students
  - Concurrent engineering environment
  - Multi-center communication via video conferences
- In each lab one scientific staff is leader of a given subsystem, supervises the student projects on that topic, coordinates with engineering team and provides continuity over time.
- System Engineering Team (SET) provides oversight and coordination.
- Each subsystem will have an expert mentor in industry.

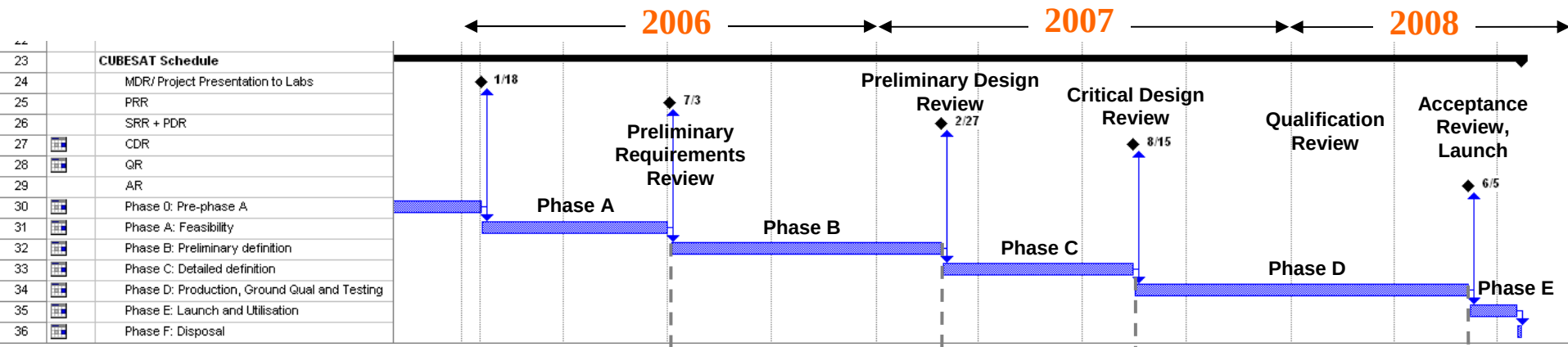


# Project Schedule

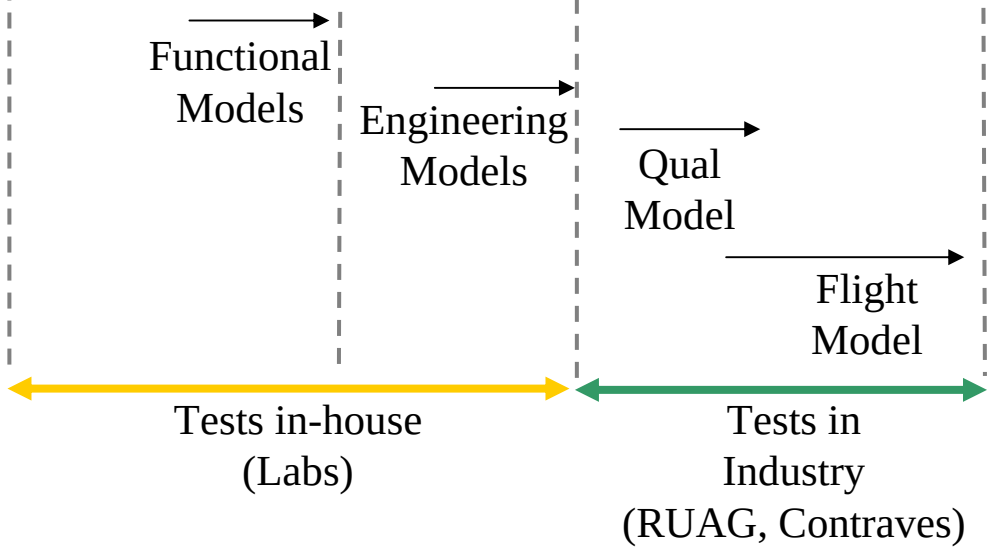



| ID | | Task Name |
|---|---|---|
| 1 | | **EPFL Academic Schedule** |
| 2 | | Master Projects 2006-2007 winter |
| 3 | | Master Projects 2006-2007 summer |
| 4 | | Master Projects 2007-2008 winter |
| 5 | | Master Projects 2007-2008 summer |
| 6 | | Semester Projects 2006 summer |
| 7 | | Semester Projects 2006-7 winter |
| 8 | | Semester Projects 2007 summer |
| 9 | | Semester Projects 2007-8 winter |
| 10 | | Semester Projects 2008 summer |
| 11 | | **IMT Schedule** |
| 14 | | **Schedule EIVD** |
| 15 | | Semester Project 2006 |
| 16 | | Diploma Project 2006 |
| 17 | | **Schedule HEVS** |
| 18 | | Semester Projects 2006 Summer |
| 19 | | Diploma Project 2006 |
| 20 | | Semester Projects 2007 Summer |
| 21 | | Diploma Project 2007 |
| 22 | | |
| 23 | | **CUBESAT Schedule** |
| 24 | | MDR/ Project Presentation to Labs |
| 25 | | PRR |
| 26 | | SRR + PDR |
| 27 | | CDR |
| 28 | | QR |
| 29 | | AR |
| 30 | | Phase 0: Pre-phase A |
| 31 | | Phase A: Feasibility |
| 32 | | Phase B: Preliminary definition |
| 33 | | Phase C: Detailed definition |
| 34 | | Phase D: Production, Ground Qual and Testing |
| 35 | | Phase E: Launch and Utilisation |
| 36 | | Phase F: Disposal |

# Preliminary Test Schedule and Philosophy




- The SwissCube is a relatively high-risk low-cost development, but testing will parallel as much as possible a high-reliability mission to ensure success
- Model Philosophy:
  - Set of breadboards/mockups in Phase B (Functional Models)
  - Engineering Models in Phase C
  - Qual Model and Flight Model in Phase D (prototype approach)
- Compliant with ECSS as much as possible



# Conclusions

- Today's programmatic challenge
  - Efficient transfer of information between students over the different phases of development
- Today's technical challenge
  - Current payload asks for relatively tight pointing and stabilization requirements, and volume requirements
  - System studies and trades are on-going to find solution
- Need for communication with YOU
  - Assume that a great deal of information already exists
    - Parts list, what worked, what didn't?
  - Experience of Cubesat developments within a university environment
    - What worked, what didn't?
- Conclusion
  - Starting project in a multi-university environment
  - All advices, sharing of experience are welcome!