János Nagy: Report about visit to IRF Institutet för Rymdfysik, Swedish Institute of Space Physics Kiruna, Sweden

In KFKI (Central Research Institute for Physics) Campus their are two entities: Wigner Research Centre for Physics and Centre for Energy Research are interested in space research activities, i.e. space physics and space instrument development. The goal of my visit was to learn of experiences of IRF in instrument development and engineering activity. IRF has taken in 39 space missions over the past decades. IRF and Wigner had earlier cooperation in space research physics and space instrument development in the projects Venus Express and BepiColombo and now the presently ongoing Juice-PEP project. In Juice-PEP we faced more strict requirements of ESA as ever before in previous projects. All phases of development were checked by experts of ESA. To insure fulfillment of these requirements we need to improve our technology, labs, workshops and quality insurance.

The main focus of IRF is experimental physics research in space. The base of their development is the cooperation of researchers, electrical, mechanical, software engineers and technicians. The science/ engineering ratio is about 50%. IRF involves PhD students in the ongoing tasks, who will get to know the institute well, and from students IRF can insure refreshments of team members. A part of PhD students continues their career in IRF after finishing their studies. In KFKI we should follow this practice by improving cooperation between scientists and engineers and involving students by university diploma topic announcements.

IRF advantages in space projects over other players are the following:

- they unite excellent scientific and engineering performance,
- high reliability,
- low mass / small volume and
- ability to meet all mission requirements: functional, mechanical, electrical, EMI, thermal and radiation.

The engineering background covers wide spectra of activities:

- **mechanical design, FE modelling, analysis and manufacturing**
- **electronics design, simulation and manufacturing**
- **PCB design,**
- **soldering components, assembly PCBs,**
- **on-board software and FPGA code development**
- **thermal modelling and design**
- radiation modelling and design
- **reliability analysis and fail-safe design**
- vacuum system design
- **selection of materials and processes for space**
- some kinds of surface treatment,
- **harness manufacturing**
- **test system manufacturing**
- protective gas system manufacturing

- **environmental testing (thermal, TVAC, limited EMI and mechanical)**
- calibrations with particles
- **product and quality assurance**
- **project management**

In bold the areas are where the competence should be strengthened or purchasing the suitable device refreshment belong to baseline in KFKI campus.

I held a presentation about our activity in DCC development for Juice. During my stay, the thermo vacuum test of DPU and DCC designed by us was in operation. During the tests, card1 temperature increased by 4-5 ^{o}C after switching the JNA sensor. The reason for the temperature increase of the sensor of DCC-card1 has to be clarified, the HK data with the measured temperature values and the function fitted the data which were promised to be sent.

IRF is very well supplied with modern equipment, for instance, there are a few Thermal Vacuum Chambers (TVAC) at disposal. In IRF I saw the Nanovac TVC025 Thermal Vacuum Chamber, the volume of which is sufficient for the whole assembled Juice-PEP instrument tests with all sensors, DPUs and Power Supply Unit with mechanical cases and elements. We try to apply for financial support to be able to purchase a Nanovac TVC025 Thermal Vacuum Chamber, similar to the one used by IRF in Juice project.

IRF: Mechanical test equipment include LDV S780 and a newly ordered one, which is under delivery, a TenTek M4040A with LST600M vibration stand. Our possibilities for mechanical tests are sufficient, the detailed description of equipment is here https://remred.space/vibration-shock-testing/vibration-testing. The operation of our mechanical test equipment was outsourced in RemRed Ltd. because they can insure business applications for financial support of operation.

As for CAD/CAM software products, we try to follow the cost-effective way of IRF, to contact producers directly excluding dealers hoping to reach educational advantages. An example for this method is that Wigner purchased ORCAD software for 7 million HUF (approx. 17 k€) to use it in Juice-DCC project, IRF could rent it for 100 €/sample/year.

As to quality insurance, an engineer is assigned for it in IRF. He knows applicable ESA standards and checks their application and prepares reports. Assigning an engineer seems to be a useful practice. A young colleague started his career in our team, and we would like to employ him on quality insurance area.

As to soldering, we have a clean room in KFKI campus for assembling electronic circuits with all required equipment. Its operation was outsourced to Remred Ltd. too. A technician with ESA certificates for soldering is missing. We are planning to apply to our ministerial commissioner for space exploration for financial support to receive the ESA certificates for soldering for at least one technician or to find a person who has the required certificates. There are two persons in Hungary who gained ESA certificates. By achieving our self-assembly we would save a great amount of money. DCC soldering price was almost in the same price range as components and repairs, and component changes require extra days causing delays by having to send cards to England for soldering.

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