MANiaC DPU EM & EFM

MANiaC DPU EM & EFM Manufacturing, Assembly and Test

Programm / Ausschreibung	ASAP, ASAP, ASAP 18. Ausschreibung (2021)	**Status**	abgeschlossen
Projektstart	01.06.2022	**Projektende**	31.07.2024
Zeitraum	2022 - 2024	**Projektlaufzeit**	26 Monate
Keywords	Comet Interceptor, MANiaC, Digital processing unit, Engineering model, EEE parts procurement, Electronics assembly, Electronics tests		

Projektbeschreibung

Das Institute beteiligt sich am Messinstrument MANiaC (Mass Analyzer of Neutrals in a Coma), an Bord der Comet Interceptor Mission der ESA, mit der Entwicklung der Digital Processing Unit (DPU). Comet Interceptor, eine dreiteilige Raumsonde, wird einen Kometen welcher das erste Mal ins Sonnensystem vordringt untersuchen. MANiaC analysiert mit einem time-of-flight Massenspektrometer die Neutralteilchen in der Coma.
Im Rahmen des ASPA#17 Programms ist das Institut unter dem Projekttitel „MANiaC DPU Prototype Development“ bereits mit der Entwicklung des DPU Prototypen aktiv. Im Rahmen von ASAP#18 ist unter dem Projekttitel „MANiaC DPU EM & EFM Manufacturing“ der Bau der Nachfolgemodelle, Engineering Model und Electrical Functional Model vorgesehen. Die Motivation für den ASAP#18 Antrag liegt in erster Linie in der Finanzierung der benötigten elektronischen Komponenten für die beiden Modelle. Das Institut ist in der Lage, das Team an Ingenieuren zu finanzieren bzw. zur Verfügung zu stellen, aber die Kosten für die speziellen elektronischen Komponenten übersteigt das vorhandenen Sachbudget bei weitem. Der Bau der beiden Modelle soll unmittelbar nach der Fertigstellung des Prototypen beginnen. Ein Problem sind die zunehmend längeren Lieferzeiten für elektronische Bauteile, weshalb die Beschaffung der Bauteile mindestens ein Jahr im Voraus begonnen werden muss. Dies ist auch der Grund für die etwa ein Jahr lange Überlappung mit der Prototypentwicklung.
Die beiden Modelle, EM und EFM, sollen auf Basis des bereits vorliegenden Design des Prototypen gebaut werden. Eventuell nötige Änderungen werden in einer Redesign Phase in die Konstruktion eingearbeitet. Unmittelbar danach ist die Fertigung der Elektronikplatinen und weiter die Assemblierung und entsprechende Tests am Institut vorgesehen. Am Ende des Projekts soll die beiden Modelle der MANiaC DPU vollständig getestet vorliegen und an die Projektpartner an der Universität Bern geliefert werden.
Die DPU für MANiaC wird die neuste Prozessorgeneration der LEON Serie verwenden. Die Anzahl der diversen Schnittstellen sowie die Busbreite erfordern eine hohe Zahl an elektrischen Kontakten. Daher ist dieser Prozessor nur in einem sogenannten Column-Grid-Array Gehäuse verfügbar. Das Institut hat diesen Gehäusetyp bisher nur durch externe Firmen bestücken lassen. Im Rahmen des Projektantrags ist daher auch die Entwicklung der Prozessdefinition für Bestückung von CGA Gehäusen vorgesehen. Im ersten Schritt wird der CGA Lötprozess aber nur für Prototypen und Modelle wie Engineering Model angewendet. Eine allfällige Zertifizierung des Prozess für Flugmodelle ist im Moment nicht vorgesehen.

Abstract

The institute participates in the Comet Interceptor mission with the development of the digital processing unit (DPU) for the MANiaC (Mass Analyzer of Neutrals in a Coma) instrument. Comet Interceptor is the first F-class mission and will explore either a long period comet, a so-called dynamic new comet entering the solar system first time, or encounter an interstellar object. MANiaC analyses the neutral particles in the coma by use of a time-of-flight mass spectrometer and a neutral density gauge. A so-called read-out-electronics will digitize the data and submit the gained spectra to the DPU.
The institute is already active in the design of the first DPU prototype in the frame of the ASAP#17 program under the project title “MANiaC DPU Prototype Development”. This activity should be continued in ASAP#18 with the manufacturing of the engineering model (EM) and an electrical Functional Model (EFM). The project is titled “MANiaC DPU EM & EFM Manufacturing”. The main reason for this proposal is the EEE parts procurement for the two models. The institute provides the manpower, but there is not sufficient budget to finance the rather expensive EEE components. The manufacturing of the two models should start immediately when the prototype testing has been completed. The increasing lead time for EEE components is driving the schedule, therefore it is essential to order the components already on year in ahead to the actual need. That’s, why the two projects, “Prototype Development” and EM&EFM manufacturing” are overlapping by approximately one year. Necessary changes, based on the outcome of the prototype tests will be incorporated if necessary during the redesign phase. In case necessary a re-layout cycle will be performed and the and PCB ordered. The assembly and all tests will be performed at the institute. Due to limited manpower, space and test equipment, the two models will be built in series. After successful testing the two models will be deliver to the PI-institute. The prototype remains at the institute as reference for software development.
The use of the latest processor models, the LEON quad core GR740 has also impact on the in-house assembly processes. The high number of interfaces and the large bus width drive the pin count for the processor, thus this type is available in column-grid-array package only. Up to now IWF used external facilities to assembly CGA packages. Within the proposed MANiaC activity it is foreseen to a establish a process specification for the soldering of CGA components by use of the in-house vapour phase solder facility. A certification for soldering of flight boards is outside the scope of this proposal.

Endberichtkurzfassung

The Mass Analyzer for Neutrals in a Coma (MANiaC) instrument is a mass spectrometer onboard the ESA Comet-Interceptor space mission, and it will analyze the atomic and molecular composition of the gas forming the comet’s tail. The instrument is led by the University of Bern in Switzerland but the IWF in Graz is providing two key components: the Data Processing Unit (DPU) and the Application Software. The DPU is the brain of the instrument. It controls the sensors, records the scientific data and communicates with the host spacecraft, and is composed of a number of electrical components (e.g., processor, memory modules etc.) and the interface connectors. The project covered the development, manufacturing and testing of the DPU Engineering Model (EM) and Electrical Functional Model (EFM), a critical first step in the MANiaC development before the production of the DPU flight unit.

The first part of the project covered the finalization of the DPU design, and the procurement of the long-lead EEE components and Printed Circuit Boards (PCB). An important secondary activity consisted in validating the assembly/soldering process for the column grid array (CGA) package of the DPU processor. The MANiaC DPU uses a new generation processor (GR740), which is only available in a CGA package. This was the first time such package is used in an IWF design, and a dedicated activity was successfully conducted to demonstrate the soldering process.

The second part of the project was the manufacturing, assembly and testing of the EM DPU. Two EM DPUs were produced. The EM1 was delivered to the University of Bern (UBE) in March 2024 and integrated into the EM instrument. The EM2 was completed in the spring of 2024 and remains at the IWF where is used extensively to develop the functional tests and to support the implementation/validation of the Application Software.

The third and final part of the project was the manufacturing, assembly and testing of the EFM DPU. Unfortunately, two major delays affected the finalization of this part: the long-lead time (18 weeks) for the procurement of the PCBs, and delay in completing the FPGA configuration (unforseen long-unavailability of a key staff member). Nevertheless, the EFM DPU has been assembled (with the exception of the FPGA) before the end of the project. While delayed, the EFM activities are still on-going and will be completed by the end of 2024.

The IWF is continuing the development of the MANiaC DPU ProtoFlight Model (PFM) and Application Software with a contract from the European Space Agency (PRODEX) for the next two years.

Projektpartner

- Österreichische Akademie der Wissenschaften