

Automated Transfer Vehicle GNC Innovations and Lessons Learned



November 17 - 18, 2008

CNES, 2 place Maurice Quentin, Paris - FRANCE

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Symposium on ATV GNC Innovations and Lessons learned

Purpose

The first Automated Transfer Vehicle "Jules Verne" successfully docked to the ISS on April 3rd, after a series of in-orbit demonstrations of its phasing, collision avoidance and rendezvous capabilities. It is not only the largest European spacecraft ever built, but also the first European vehicle able to perform automated rendezvous and docking, and the largest ever to do so in the complex context of human spaceflight. A high system performance, and compliance to severe safety constraints, had to be assured for this achievement.

The purpose of this symposium is to present ATV Jules Verne flight control system going from mission definition and concept to GNC innovative solutions, validation and flight demonstration. A large part is also allocated for round table and discussion about this European program in cooperation with ISS international team. Major driver of this symposium is emphasis that will be put on lessons learned for future missions.

Among innovations in the field of GNC capabilities for safe autonomous rendezvous, accurate final approach & docking and reliable safety chains for collision avoidance, there are:

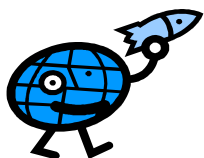
- Innovative navigation with Improved Sensor Suite,
- Optimal thrusters management,
- Autonomous rendezvous guidance,
- Robust optimal control,
- Independant safety capabilities.



and Jules Verne Flight



to design and validation



From concept

Awards

The French organisation Syntech Informatique, its German counterpart BITKOM and the Club des Grandes Entreprises de l'Embarqué awarded the prize "Critical Embedded Software Trophy" to Astrium for the Flight Applicative Software (FAS) and the Monitoring and Safing Unit (MSU) developed for the ATV

Symposium on ATV GNC - Program

17 November 2008

9h00 Welcome and introduction

9h15-11h15: **Session I - ATV mission and GNC concepts**

- I.1 - "ATV program" ,*Jean Louis Hautempenne and Siegfried Chavy ASTRIUM ST*
 - Milestones
 - Mission profile and Vehicle design
 - GNC and Safety challenges
- I.2 - "Modes definition and GNC concepts" , *Patrick. Delpy*
- I.3 - "Flight control and safety chains principle" (Including Navigation Overview, FCM, CM...) *Bruno Cavois ASTRIUM ST*
- I.4 - "ATV Jules Verne: GNC monitoring at ATV-CC/FDS (concepts and mission results)", *Mauro Augelli CNES*

Coffee break

11h30-12h00 : **Session II - GNC Innovation presentation**

- II.1 - "Innovative Relative GPS Navigation function", *Narmada ASTRIUM ST*

Lunch break (FNAC)

13h45-15h45 : **Session II' - GNC Innovation presentation**

- II.2 - "Accurate optical sensor Navigation function", *Nicolas Fau ASTRIUM ST*
- II.3 - "Autonomous rendez-vous guidance function », "Robust H_{∞} control design for final approach" *Martine Ganet Isabelle Quinquis ASTRIUM ST, Jérôme Bourdon Nuno Silva EADS group*
- II.4 - "Optimal Thrusters Management Function", *Nuno Silva EADS group*

Coffee break

16h00-17h45 : **Session III' - FCM design and safety demonstration**

- III.1 - "FCM design and trajectory safety assessment", *Bruno Cavois ASTRIUM ST*
- III.2 - "Class A Monitoring Safety Unit for Free flight including Coarse Monitoring" *David Berthelie EADS and Helene Requiston ASTRIUM ST*
- III.3 - "Collision Avoidance Manœuvre », *Nuno Silva EADS and Narmada ASTRIUM ST*

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9h00-10h15 : Session IV - Flight control validation

- IV.1 - "ATV GNC Functional validation", *David Berthelier, EADS, Helene Clerc and Mathieu Chaize ASTRION ST*
- IV.2 - "ATV GNC Qualification », *Xavier Clerc ASTRION ST*

Coffee break

10h30-12h00 : Session V - ATV control centre and Jules Verne flight

- V.1 - "On-ground orbit determination for RGPS initialisation and relative trajectory monitoring", *Isabelle Escané CNES*
- V. 2 - « TATT - Ground tool for attitude restitution", *Alex Torres and Johan Montel CNES*
- V.3 - "Jules Verne ATV Demonstration Objective Report (JADOR)", *Mathias Bonnet ESA.*

Lunch break (FNAC)

13h45-15h15 : Session VI - Jules Verne's flight and post flight analysis

- VI.1 - "Ariane 5/ATV challenges" *Stéphanie Joner and Sophie Caruel ASTRION ST*
- VI.2 - "Jules Verne's flight demo days and docking", *Grégory Personne ASTRION ST and Emilio de Pasquale ESA*
- VI.3 - "ATV GNC approach and docking analysis post flight analysis", *Grégory Personne ASTRION ST*
- VI.4 - "ATV GNC tumbling post flight analysis", *Emilio de Pasquale ESA*

Coffee break

15h30-17h30 Round table - Lessons learned and future missions

- Lessons learned
 - CNES, ESA, ASTRION ST (all presenters), NASA, RSC Energia, Astronauts ...
- Discussion about future missions

Registration

Registration is free of charge and opened on cct cnes French website:

cnes.cborg.net/cct/bipublic.html

- First fill cct inscription
- Then register for : SCA-Retour d'expérience du GNC ATV