

# ***IAA. Commission III***

## **DAEJEON MEETING MINUTE**

meeting date: October 11 <sup>th</sup> , 2009 <i>date de la réunion</i>		ref./réf.		page/page 1 / 4	
meeting place <i>lieu de la réunion</i>		Daejeon, Republic of Korea		chairman <i>président</i>	John C. Mankins
minute's date <i>dates de compte rendu de réunion</i>		20/10/2009		participants <i>participants</i> V. Adimurthy P. Bainum C. Bonnal C. Bruno M. Calabro I. Chang H. Djojodihardjo A. Ignatiev K. Ijichi P. Jukola S. Kibe O. Koudelka D.Kusnierkiewicz J. Liu W. Mendell A. Michel S. Mihara M. Moldabekov J. Onoda G. Reibaldi A. Rittweger C. Sallaberger K. Uesugi A. Yakovets X. Zhou	

# IAA Commission III

## DAEJEON MEETING MINUTE

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subject/objet      Progress meeting, according to the  
proposed agenda.

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### Agenda:

- I - Review of actions from previous minutes of meeting
- II - Composition of Commission III
- III - Study Groups Status
- IV - New study Group about Exploration
- V - Follow-up of SG reports and position papers
- VI - Co-Editor for Acta Astronautica Journal
- VII - Symposia Status
  - IAC 2009
  - IAC 2010
- VIII - Proposals for next IAA Conference
- IX- Actions
- X- AOB

description/description	actionee/ chargé de l'action	due date /date butoir
<p>Introduction:</p> <ul style="list-style-type: none"><li>- The Chairman briefed the Commission about the new guidelines for the next two years provided by the new IAA President, Dr Nair.</li><li>- The Chairman recalled the importance of the synergies between IAC sessions and Study Group contents.</li></ul> <p><u>I - Review of actions from previous minutes of meeting</u></p> <ul style="list-style-type: none"><li>- John C Mankins shall no longer send the synthesis paper of SG 3.6 to Acta Astronautica; action closed.</li><li>- Space elevator SG: <b>Action Closed Post-meeting: Dr Swan proposed a new Study Group on the Subject. Proposal was received (see Annex 0). Following editing within the Commission III, it will be sent to SAC for approval</b></li><li>- Letters of appointment for the participants in the Study Group 3.9 have been sent by I.A.A., though only recently. Action closed.</li></ul> <p><u>II - Composition of Commission III</u></p> <ul style="list-style-type: none"><li>- A new Secretary, Mr Ramakrishnan, has been appointed by the IAA Board. His availability for the Commission shall be checked with him</li><li>- R. Lenard has not yet confirmed his participation in Commission III. <b>IAA General Secretary to send reminder</b> If no feedback is received, after one month (e.g. by end November), a vacancy will be created in the Commission</li><li>- Commission recommends C. Sallaberger as a new member. <b>Action closed Post-meeting: Commission recommended the appointment to SAC for approval</b></li><li>- T. Yasaka, as requested by the IAA President Guidelines, will still be part of the Commission for 1 year, this brings the number of Commission Members to 11</li><li>- Consolidated Composition is shown in Annex 1</li></ul>	<p>IAA G.S.</p> <p>SAC</p>	<p>End October 2009</p>

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description/description	actionnee/ chargé de l'action	due date /date butoir
<p><u>III - Study Groups Status</u></p> <p>SG 3.2, 3.5, 3.6, 3.8 can be removed from the list of the Commission. The SG 3.5 report was published and distributed at the Congress.</p> <ul style="list-style-type: none"> <li>- SG 3.1 Advanced Propulsion: <ul style="list-style-type: none"> <li>- Max Calabro presented the SG Status</li> <li>- Non-chemical propulsion part shall be dropped</li> <li>- Chemical propulsion part is nearly completed</li> <li>- <b>Action: G Reibaldi to distribute ASAP what is available to the Commission, to assess the maturity of the study</b></li> <li>- <b>In March 2010 M. Calabro shall present the status report and detailed planning for completion.</b></li> </ul> </li> <li>- SG 3.9: Private Access to Space <ul style="list-style-type: none"> <li>- Status presented by C. Bonnal (See Annex 2)</li> <li>- 15 papers from the 2008 Congress on Private Access to Space shall be published in Acta Astronautica by Spring 2010</li> <li>- The SG Report should include about 60 pages</li> <li>- The Draft report will be made available to the Commission at the IAC 2010</li> <li>- <b>Action: J. Mankins is to examine policy development in the US regarding COTS LEO access (See US Budget in Feb. 2010, report on it at March 2010 meeting) and provide the information to C. Bonnal for consideration in the Study Group.</b></li> </ul> </li> <li>- SG 3.10: Technologies to enable near-term interstellar precursor mission <ul style="list-style-type: none"> <li>- Status presented by C. Bruno (see Annex 3)</li> <li>- Produce Draft by March 2010 for Commission review</li> <li>- The report should be synthetic, with a set of recommendations</li> </ul> </li> <li>- SG 3.11: Solar energy from Space <ul style="list-style-type: none"> <li>- J. Mankins presented the Status (see Annex 4)</li> <li>- Draft report shall be available by March 2010</li> </ul> </li> </ul> <p><u>IV - New study Group on Exploration</u></p> <ul style="list-style-type: none"> <li>- W. Mendell agrees to chair this Study Group together with M-A Perino.</li> <li>- A Study Group proposal shall be distributed to JM Contant by the end of the week. <b>Action closed post-meeting (See Annex 5)</b></li> </ul> <p><u>V – Follow-up of SG reports and position papers</u></p> <p>A discussion took place on the subject. The main points were:</p> <ul style="list-style-type: none"> <li>- Spreading of information following the completion; who gets the report is to be defined.</li> </ul> <p>&gt;&gt; The recommendation of the Commission is to request IAA to evaluate the impact factors of SG to see the effectiveness</p> <p><u>VI – Co-Editor for Acta Astronautica Journal</u></p> <p>In view of the heavy workload faced by C. Bonnal, the Commission was requested to identify a Co-editor for the Commission III for Acta Astronautica. Prof. Filippo Graziani was identified as a suitable Co-Editor.</p>	<p>G Reibaldi</p> <p>M Calabro</p> <p>J. Mankins</p>	<p>ASAP</p> <p>March 2010</p> <p>March 2010</p>

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<p><u>VII – Symposia Status, IAC 2009 and IAC 2010:</u> See Annexes 6a and 6b</p> <p><u>VIII - Proposals for next IAA Conference</u> No new proposal was made</p> <p><u>IX - Actions</u> See <i>within minutes, in bold italic</i></p> <p><u>X - AOB</u></p> <ul style="list-style-type: none"><li>- The Co-Chair informed the Assembly of Mr Morgenthaler's health status. The Commission expressed deep appreciation for the hard work he carried out in the last years, and wished the best for the future to him and his family.</li><li>- Ideas were invited for the 50<sup>th</sup> anniversary of the IAA celebration</li><li>- Next meeting: March 23<sup>rd</sup>, 2010, in Paris. A longer meeting than usual shall be requested in view of the numerous Draft Reports to be presented and discussed on that occasion</li><li>- <b>Action closed post-meeting: Commission III Briefing to SAC, on October 12<sup>th</sup>, in Daejeon (See Annex 7)</b></li></ul>		

IAA, Paris, Feb 2009

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Instructions and application form: see: "Scientific Activity" section at <http://iaaweb.org/content/view/256/393/>

## Proposal for Forming an IAA Study Group

**Title of Study:** Space Elevator - A Cultural Revolution: Breaking the Constraints of Rockets; When? How? Key Technologies

**Proposer(s):** Peter Swan, Ph.D. & David Raitt, Ph.D.

**Primary IAA Commission Preference:** Commission III  
(From Commission 1 to Commission 6)

**Secondary IAA Commission Interests:** Commission VI  
(From Commission 1 to Commission 6)

### Members of Study Team

**Chairs:** Peter Swan & David Raitt

**Secretary:** Cathy Swan

**Other Members:** (tentative – to be approached) Robert Penny (accepted Oct 13, 2009), Wiley Larson, Bryan Laubscher, Lubos Perek, Tetsuo Yasaka, Radu Rugescu, Michael Laine

### Short Description of Scope of Study (including a brief background for the study effort)

**Overall Goal:**

- (1) Identification of Key Technologies
- (2) Roadmap for Key Technologies Refinement
- (3) Description of Space Elevator Implementation – Dynamics and Control of Long Ribbon, Build-up of 1-meter wide Ribbon, Power Approach, Payload Carrying Capacity, Anchor Design
- (4) Identification of Alternative Approaches
- (5) Identify the impact on Industry and Society of the Space Elevator

**Intermediate Goals:**

- (1) Conduct sessions at IAC's (Prague, South Africa, Naples) with purpose of presenting the international aspects of the Space Elevator.
- (2) Produce a recommendation for the Academy for future studies and activities to support the development of a Space Elevator.

**Methodology:** The initial step is to sponsor sessions inside the IAA D.4.2 Symposium (Symposium on the Far Future: Renewed Visions). A parallel step is to create a study group, establish goals, objectives and timelines for a Space Elevator cosmic study. The last step would be to produce a report for the Academy that discussed the feasibility of a Space Elevator and identify the potential benefits to humanity.

**Time Line:** 1<sup>st</sup> Meeting Oct 09 in Daejeon – to establish study group (achieved )  
2<sup>nd</sup> Meeting: March 10 in Paris – to discuss progress, identify action items  
3<sup>rd</sup> Meeting: Oct 10 in Prague – to discuss report outline and timeline  
4<sup>th</sup> Meeting: Mar 11 in Paris – summarize conclusions and recommendations in the report and draft final aspects of Academy product.  
5<sup>th</sup> Meeting: Oct 11 in South Africa – produce the Academy report- signature

**Final Product (Report, Publication, etc.):**

Academy Publication entitled: International Academy of Astronautics Report on Space Elevators - A Cultural Revolution: Breaking the Constraints of Rockets; When? How? Key Technologies

**Target Community and Expected Effects:** Those organizations wishing to have inexpensive access to space: Mars/Moon program, Life in space believers, geosynchronous satellite owners (communications, solar power satellites, etc.), planetary defense organizations, commercial satellite builders, space tourism companies, and governments.

**Support Needed:** Minimal at the present time: Title a session in Prague and South Africa: Vision of the Far Future – Space Elevators and Space Tethers

**Potential Sponsors:** space agencies, Mars/Moon programs, planetary defense organizations, commercial space organizations, future human habitats and world governments.

To be returned to the IAA Secretary General Paris by fax: 33 1 47 23 82 16 or by email: [sgeneral@iaamail.org](mailto:sgeneral@iaamail.org)

Date: 13 October 09

Signature: signed Peter Swan

No Signature required if document authenticated.

**Initial Phase**

**Application received:**

**Commission Approved:**

**SAC Approved:**

**Web Site Section opened:**

**Members Appointed:**

**Final Phase**

**Peer Review by Commission Completed:**

**Recommended by the Commission:**

**Final Report Received:**

**SAC Approved:**

**BOT Accepted:**

**Publisher Selected:**

**Study Published:**

## **IAA Commission III Members, 2009-2011**

- **John C. Mankins (USA), Chairman**
- **Giuseppe Reibaldi (IT), Deputy Chairman**
- **S. Ramakrishnan, Secretary**
- **Tetsuo Yasaka, (J), Past Chair**
- **Christophe Bonnal (F), Member**
- **Claudio Bruno (IT), Member**
- **Hans E. W. Hoffmann (D), Member**
- **Wendell Mendell (USA), Member**
- **Junjiro Onoda (J), Member**
- **Roger Lenard (USA), Member** *Confirmation awaited*
- **C. Sallaberger (CA), Member** *Recommendation TBC by SAC*





## **Progress report on IAA Study Group 3.9 “Private Human Access to Space”**

**Proposer(s):** H. Rauck – G. Brachet      **Chair:** Ch. Bonnal

**Primary IAA Commission Preference:** Commission 3

**Secondary IAA Commission Interests:** Commission 5

### **Overall Goal:**

Identify and quantify the key topics associated to Manned Private Access to Space for both Orbital and Sub-orbital missions.

### **Key words:**

- Technical aspects
- Legal and regulatory aspects, safety aspects
- Financial aspects, market analyses, associated business plans
- Motivations of potential customers
- Physiological and Psychological requirements, ergonomic constraints

### **Expected outcome of the study:**

IAA Position Paper giving the keys to the topic and potentially including recommendations. Subdivision of the study into key chapters, with one “book captain” per chapter ; 7 or 8 members per chapter covering a wide range of origins (countries, agencies, industrials, searchers, operators...)

**Time line:**

Initially: 3 years following the initial proposal (March 2007)

Revised timeline:

1<sup>st</sup> IAA symposium on Private Human Access to Space (Arcachon)

⇒ 28-30 May 2008

Publication of the full CD with all the papers, most of the presentations, pictures, ... Distribution to all participants

⇒ End of September 2008

Report during IAC Glasgow

⇒ October 2008

Publication in Acta Astronautica of the 15-20 best papers out of the 68 presented in Arcachon

Process undergoing: 15 papers pre-selected

- 1 rejected
- 7 under initial review
- 4 reviewed once and under 1<sup>st</sup> revision
- 1 reviewed twice and under 2<sup>nd</sup> revision
- 2 finally accepted under Rev 1

Very long process !

Could be finished by end 2009

Tentative date was March 2009, ⇒ Revised to December 2009

Formal invitation of members of the SG, Table of contents

Additional members are welcome, but may lead to problems of coherence and homogeneity (lack of efficiency; depends on the definition of a Working Group !)

⇒ Daejeon, October 2009

First Draft, internal

⇒ IPC, Paris March 2010

Draft release for Peer Review within IAA

⇒ Praha, September 2010

Final publication

⇒ IPC, March 2011.

**IAA Position Paper on Private Human Access to Space**  
**Tentative table of contents, sub-chapters, length and chapter responsables:**

1. Introduction:
  - a. context, history,
  - b. general overview,
  - c. IAA action description

(4 pages – Bonnal)
2. Societal motivations :
  - a. New transportation culture, Space age
  - b. Effects on society
  - c. Outreach

(6 pages – Peeters, Eymar)
3. Market analysis
  - a. Current analyses and forecast
  - b. Phased approach to public access to space

(6 pages – Salt, Webber)
4. Medical, Physiological and Ergonomics
  - a. Risk factors for the crew and passengers
  - b. Medical selection, dedicated ground infrastructures
  - c. Habitability requirements, flight suits
  - d. Applicable and similar experiences

(7 pages – Gerzer, Antuñano, Winisdoerffer)
5. Legal, Insurance and Regulatory aspects
  - a. General legal frame
  - b. Risks and Insurances
  - c. Regime and Users status
  - d. Specific national regimes

(11 pages – Couston, Crowther, Masson-Zwaan (TBC), Clerc (TBC))
6. Technical aspects:
  - a. Potential solutions, variants at system level, shape, number of passengers, single or dual stages
  - b. Main sub-systems, aerodynamics, propulsion, thermal protections, TRL
  - c. Growth potential: P2P, hypersonic passenger travels

(12 pages – Calabro, Bultel, Bernard-Lépine (TBC))
7. Ground Infrastructures
  - a. Space tourism and Grand public
  - b. Spaceports : criteria, proposals

(8 pages – Droneau, Webber)
8. Reliability, Safety, Risk
  - a. Reliability requirements
  - Safety requirements

(4 pages – Romero (TBC))
9. Conclusions:
  - a. Key hurdles to overcome
  - b. Recommendations, role of Agencies

(4 pages – Bonnal)

Grand total : 62 pages (for comparison : Space Debris = 64 pages)

## Next symposia:

Current activity on the subject at world level is very low:

- Numerous flights of White Knight 2, but no flight yet of Space Ship 2
- Astrium SpacePlane TBN is frozen
- No news at all from Goddard – New Shepard – Blue Origin (Jeff Bezos)
- No significant progress on Rocketplane XP development
- Progress in propulsion at X-Cor, but nothing obvious on Lynx vehicle
- VSH is frozen
- Space Dev Dreamchaser Benson heritage ?
- Progress on ISAS side ?
- Orbispace Infinity re-scoped for sub-systems
- Numerous concepts apparently stuck nowhere: Armadillo, Da Vinci, Masten, Starchaser, Interorbital Systems Neptune,
- ...

⇒ Considering the general lack of activity at world level on this subject, and despite the strong support of Avantage Aquitaine (thanks!), the 2<sup>nd</sup> IAA Symposium on Private Human Access to Space is postponed to May – July 2011, earliest ! Decision to be taken during the next IAA Commission III meeting

→ Location and local organizer to be discussed, but same as 2008 seems a good idea.

## **Technologies to Enable Near-Term Interstellar Precursor Missions**

### **IAA Commission 3, Study 3.10**

#### **Study Outline and Status, as of Oct. 9, 2009**

#### **1. Why Interstellar Precursor Missions**

##### **Contributions by Vulpetti, Matloff in many areas**

- i. What is a precursor mission. Scientific objectives: The solar wind bow shock and heliopause. The Oort Cloud. Gravitational waves. Interstellar plasma. The “Pioneer anomaly”. The Sun gravitational lens effect, and others. Some cosmological implications of these objectives and their impact on understanding of how the universe was formed and evolved. Impact of conceptual planning of such missions on youngsters’ scientific education and career choice.
- ii. Missions planning. Why they need to be near-term (e.g., within 20 or 30 years, the working lifetime of young scientists starting their careers now). Context: first step out of the Solar System.
- iii. Emphasis of Study: primarily enabling technologies. Missions classified according to feasibility. TRL challenges and required development.

#### **2. Typical Missions**

##### **Contributions by Les Johnson, Maccone, Bruno, Simone and Bruno, Matloff, Vulpetti**

##### **2.1 Mission Constraints and Assumptions**

- i. Discuss ‘game rules’: general constraints and assumptions bounding the study.
- ii. Primary constraint: maximum payload mass. In-orbit assembly or not (cost, practicality). Launcher choice (Ariane 5 ECA, others).
- iii. Constraint: mission timescale. Data mass vs. nominal mission time. Mission extension criteria and their tradeoffs. **Contributed by Les Johnson**
- iv. Constraint: target minimum distance from Earth. Choice/selection of flight timescale. Challenges and technologies.
- v. Assumption: justify exclusion of chemical propulsion ( $SI < 470$  s). Analyze nuclear thermal propulsion ( $SI < 1000$  s) options.
- vi. Assumption: scientific instruments suite provided by space agencies and universities. Estimate masses and power consumption from existing designs. **Contribution just sent by Salvatore Santoli**
- vii. Examples. Mission to the Sun Focal point. **Maccone, Simone and Bruno**

## 2.2 Conceptual Analysis of Trajectory

Outline theoretical treatment to compare missions (see also below).

Optimize the SI of each propulsion system proposed to accomplish mission. Effect of specific mass (kg/kW) of the complete power generator and conditioning system. Criteria to compare on an equal basis different propulsion systems (e.g., solar arrays, nuclear propulsion and solar sails. Effect of propulsion system mass. **Bruno**

## 2.3 Mission Scenarios

Analyze scenarios, e.g.:

- i. Direct launch into an Earth-escape heliocentric trajectory with  $C_3 > 0$ , followed by appropriate thrusting from an electric propulsion system (EPS).
- ii. Spiral orbit-raising manoeuvre around the Earth. This will very considerably enhance the payload available, at the cost of increased mission duration (tradeoffs).
- iii. Solar sails: trajectories. Analyze options based on mass, and time limitations (e.g., this class of trajectory may start with an initially inward trajectory, to exploit solar radiation pressure to achieve significantly 'large' acceleration). **Matloff, Vulpetti**
- iv. Power. Nuclear power source vs. solar arrays. Dependence on trajectory.
- v. Hybrid mission trajectories (e.g., EPS + solar array to reach close to the sun, followed by large solar sail.

## 3. Enabling Technologies

**Contributed by Matloff, Bruno, Seboldt, Dachwald**

A major issue of study. Analyze developments required within the defined 'near-term' to enable missions identified, e.g.:

- i. Solar sails. Reducing mass/unit area. Increasing tolerance to high temperatures and space environment. to permit operation close to the Sun. Forming thin film surfaces in space. **Matloff**
- ii. Solar arrays. Mass, power, per unit area and specific mass (kg/kW). Increasing tolerance to high temperatures and space environment. **Seboldt, Dachwald**
- iii. Nuclear power. Conversion technologies, radiation shields, and radiators. Reducing specific mass. Increasing power conversion efficiency. Matching reactor to EPS ("direct drive" concepts). **Bruno**
- iv. Hi SI, high efficiency advanced propulsion systems. Variable SI vs. thrust concepts and impact on mission. Thrusters, power conditioning, control, thrust vectoring, propellant feed and storage options.

- v. Thermal control.
- vi. Deep space communications systems. Effect of data rates.
- vii. Spacecraft automated health monitoring and control.
- viii. Reliability, redundancy and lifetime considerations. Critical issues (e.g., qualification). Conventional life-testing of components and technologies no longer an option.

#### 4. The Longer Term View

##### Contributed by Long, Vulpetti

Reading the crystal ball: indications of what enhancements might be possible in the longer term, on the basis of current progress (but: ignore unpredictable “breakthroughs”).

#### 5. Conclusions

##### All.

Review of findings and predict roadmap in terms of technologies covered. Selection of mission most likely to achieve a significant scientific return.

**Pages, total to-date: 120**

#### Tentative Timetable

##### Unchanged:

First draft by the Korea 2009 IAC  
Issuing by IAA by 2010

#### Team

In alphabetical order:

Claudio Bruno	☺	Greg Matloff	☺
Mike Gruntman		Ralph McNutt	
Anders Hansson		Tibor Pacher	
Les Johnson	☺	Giovanni Vulpetti	☺
Roger Lenard			
Kevin Long	☺		
Claudio Maccone	☺		

# Solar Energy from Space: the First International Assessment of Opportunities, Issues and Potential Pathways Forward

International Academy of Astronautics - IAA Commission 3

## **Study Group Status and Preliminary Integration Results**

John C. Mankins, Chair  
Nobuyuki Kaya, Co-Chair

12 October 2009







# CONTENTS

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- Introduction
- Overview Of The IAA Solar Energy From Space SG
- Status Review For The SG
- Guidelines
  - Scenarios
  - SPS Systems Cases to be Examined:
    - ✓ RF Using A Reference System Type Architecture
    - ✓ RF Using A Sandwich System Type Architecture
    - ✓ Laser Using A Constellation Type Architecture
- SPS Functional Systems Architecture
- Technical Integration
- The Plan Forward for the IAA Study



# INTRODUCTION

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- A new study group addressing solar energy from space has been started
- Title of Study:
  - Solar Energy from Space: the First International Assessment of Opportunities, Issues and Potential Pathways Forward
- Chairs of the Study:
  - [J. Mankins](#)
  - [N. Kaya](#)
- Members:
  - See later page



# GOALS

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- **Primary Goals...**

- Determine what role solar energy from space might play in meeting the rapidly growing need for abundant and sustainable energy during the coming decades,
- Assess the technological readiness and risks associated with the SSPS concept, and (if appropriate)
- Frame a notional international roadmap that might lead the realization of this visionary concept.

- *In addition...*

- Identify and evaluate opportunities for synergies (if any) between the prospective benefits of SSP technology and systems for space missions and SSPS for terrestrial markets.
- Identify the opportunities to introduced extraterrestrial materials into an SSPS industry and assess potential connections between international lunar exploration programs now being undertaken and SSPS.



## DETAILED OBJECTIVES (1)

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- Identification of relevant markets and applications for new energy sources—including both ultimate applications in terrestrial markets, as well as interim applications in space programs.
- Identification and evaluation of the technical options that may exist for solar energy from space to contribute to meeting global energy needs.
- Identification and evaluation of the technical options that may exist for space solar power to contribute to ambitious government and commercial space mission concepts and markets
- Identification and evaluation of options for the utilization of extraterrestrial resources, in particular lunar resources in future space solar power systems
- Preliminary determination of appropriate SSPS architecture level figures-of-merit, and values of these that must be achieved in order for solar energy from space is to become economically viable for a range of terrestrial market opportunities and space applications.



## DETAILED OBJECTIVES (2)

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- Preliminary identification of other issues and policy questions that would require resolution for SSPS to become a reality (e.g., spectrum allocation).
- Assessment of the technical feasibility, technological maturity and degree of difficulty in the above space solar power options.
- Formulation of a strategic approach to realizing the potential of energy from space—and one or more technical / programmatic roadmaps implementing this strategy.
- Development of a summary report, documenting the results of the study and articulating the prospects for Energy from Space to make a substantial contribution to satisfying future global needs.
- These initial intermediate goals will be updated during the course of the study.



# STATUS

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- The new IAA Solar Energy from Space Study Group has been formed
  - Various additional members have agreed to participate since the the study was initiated by the IAA in March 2008
- A web-based group has been formed and many of the study group members have been registered
- Three working meetings were implemented in 2008
  - Japan - at or near the ISTS Conference at Hamamatsu in June 2008 (not a formal IAA workshop...)
  - US - at or near the AIAA / IECEC Conference in Cleveland, Ohio USA in July 2008 (not a formal IAA workshop)
  - A meeting of the overall study group at the Glasgow Congress in September 2008
- Four working meetings are being held during 2009
  - March at IAC IPC in Paris
  - July at ISTS in Tsukuba
  - September at the SPS 2009
  - October at the IAC in Daejeon, Korea (this meeting)



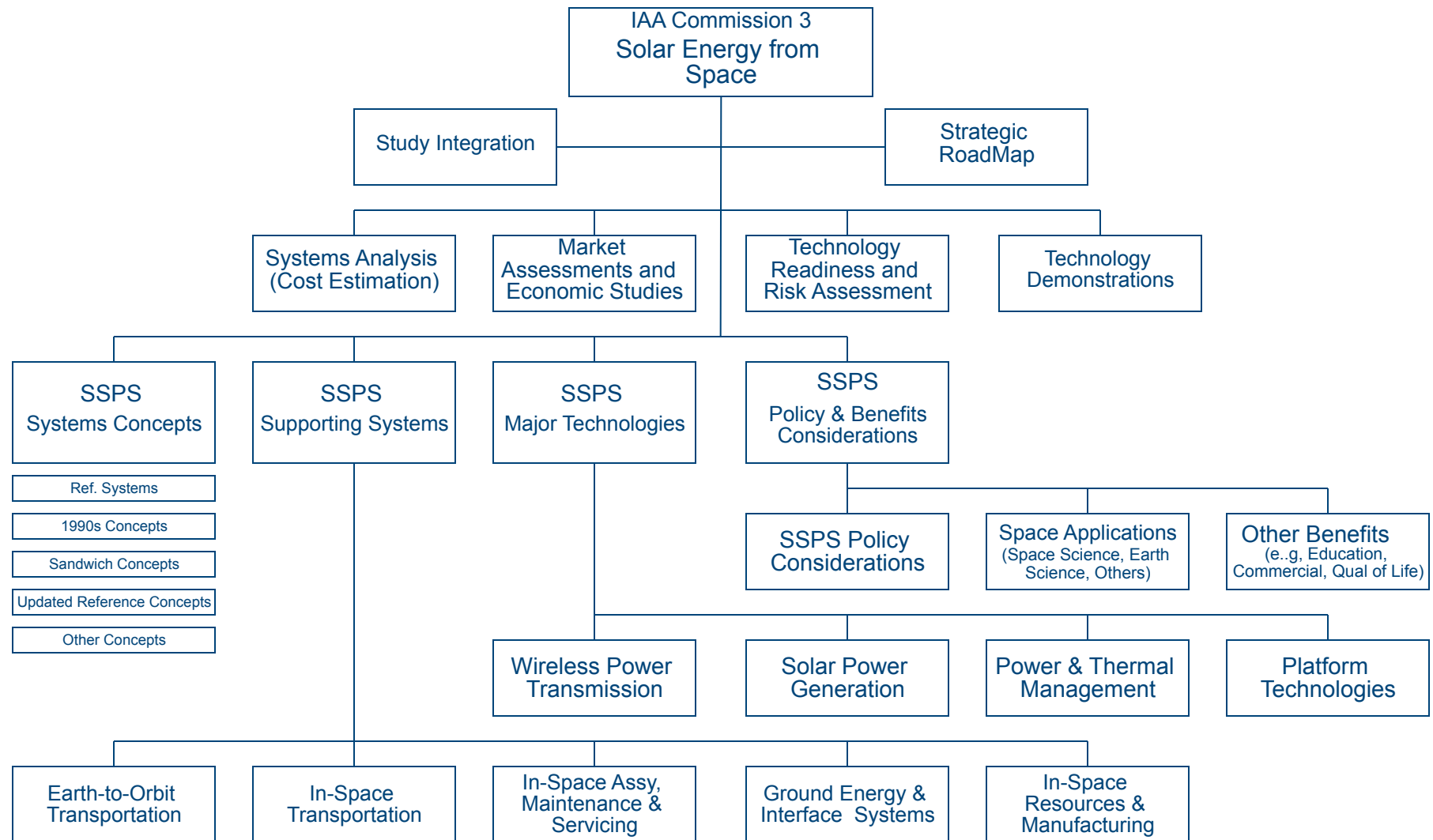
## STATUS (2)

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- Participated in a Meeting held at the 2008 URSI (International Union of Radio Science) Conference in Chicago, IL USA (August 07-16 2008)
  - “Robust” technical discussion on this subject
  - Invited identification of Study Group Members
- Work Breakdown Structure for the study group has been composed, and draft final report outline developed...
- Joint Session with the IAF organized for the 2008 IAC Congress in Glasgow
  - Discussion of the organization of report and working groups was started at the Glasgow meeting
- Joint Session with the IAF organized for the 2009 IAC Congress in Daejeon, ROK



# IAA Study: Solar Energy from Space WBS







## IAA Study Group Membership as of 09 September 2009

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- James Armor (US)
- Ivan Bekey (US)
- Henry Brandhorst, Ph.D.
- A.C. Charania (SEI)
- Paul Eckert (Boeing)
- Peter Glaser (US; ex officio)
- Jerry Grey (AIAA)
- Raghavan Gopalaswami (India)
- Joe T. Howell (US)
- Koichi Ijichi (USEF)
- Frank Little (TAMU)
- Gregg Maryniak (US)
- Shoichiro Mihara (USEF)
- Guy Pignolet (Science Sainte Rose)
- Joseph Rouge (NSSO)
- Susumu Sasaki, Ph.D. (JAXA)
- Col. Michael Smith (USAF)
- Leopold Summerer (ESA)
- Didier Vasseaux (CNES)
- Robert Wegeng (US/PNNL)
- Prof. Dr. Kai-Uwe Schrogl  
(representing IAA Commission V)
- Peter Swan (IAA Commission VI)
- Janet Verro (Space Power Assoc.)
- *Additional members, to be identified*

PLUS ... "EX OFFICIO" EVERYONE AT SPS 2009



## Schedule of Major Milestones (September 2009)

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- SG Initially Proposed – March 2007
- SG started – March 2008
- Working Meetings – 2008-2009
- Sessions at IAC
  - 2008 (Glasgow)
  - 2009 (Korea)
  - 2010 (Prague)
- Relevant Sessions @ AIAA IECEC 2009 → 2010
- Focused Conference “SPS 2009” – September 2009
- Project Final Report for Peer Review – March 2010

**IAA, Paris, Feb 2009**

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Instructions and application form: see: "Scientific Activity" section at <http://iaaweb.org/content/view/256/393/>

## Proposal for Forming an IAA Study Group

**Title of Study: Global Human Exploration – The Next Steps**

**Proposer(s): Wendell Mendell, Maria Antonietta Perino, Christian Sallaberger**

**Primary IAA Commission Preference: Commission 3**

*(From Commission 1 to Commission 6)*

**Secondary IAA Commission Interests: Commissions 5, 1, and 2**

*(From Commission 1 to Commission 6)*

### Members of Study Team

**Chairs:**

Wendell Mendell (co-chair)

Maria Antoinette-Perino (co-chair)

**Secretary:**

To be identified

**Other Members:**

Christian Sallaberger

Scott Hovland

John Logsdon

S. Ramakrishnan

Alain Dupas

Giuseppe Reibaldi

John C. Mankins

Others to be identified\*

\* Note: the study group will make a particular effort to involve younger professionals in the effort.

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*Instructions and application form: see: "Scientific Activity" section at <http://iaaweb.org/content/view/256/393/>*

### **Short Description of Scope (including a brief background for the study effort)**

A general consensus exists that human exploration of the solar system is the next great challenge to the international community of space agencies. One important school of thought holds that a program of lunar exploration and development can be the first stage of expansion of human activities into the solar system. The principal objectives of the study will be to outline and define issues with planning for human exploration beyond low Earth orbit, comprising (a) technical issues, (b) human health and capability related issues, and (c) law and policy related issues.

The report will begin with a discussion of the rationales and drivers associated with the justification of extended human exploration. The history of plans and projects will be reviewed. Programmatic objectives will be categorized and discussed, including such characteristics as serving national political goals.

Possible system architectures will be identified and the attributes of each assessed. The advantages and disadvantages of each will be expressed in the context of potential programmatic objectives. The architectures will include space transportation systems, lunar surface elements, and philosophies of operations. Attributes will include mass flow, operational cost, difficulty of establishing the initial configurations, and the effect of advances in certain key technologies. The utilization of the International Space Station for human research and potential in-space operations will be included.

Also important are discussion of the agents of exploration, i.e., governmental entities or commercial entities. Should the effort succeed in producing an ongoing and steady flow of activities, coordination and/or regulatory regimes will be necessary. With a stable (albeit small) population of humans and machines on the surface of the Moon or in cislunar space, commercial and economic issues can arise such as the exploitation of material resources. With international involvement legal issues come to fore, and examples of these will be discussed. Lessons learned from the ISS program will be incorporated.

### **Overall Goal:**

(clearly state the expected scientific or practical benefit of the study group's efforts)

The principal goal of this effort will be production of a documented baseline reference on the characteristics of a program of human exploration and the consequences of various technical choices, with an emphasis on the next steps – near term actions necessary to realize and ambitious future of human exploration beyond LEO. Conversations between nations on mutual cooperation and interaction can be made more efficient if all parties work from an understood set of assumptions.

### **Intermediate Goals:**

The organization of the study will be modular, initially separating various elements for analysis. Each of the major elements (e.g., transportation, lunar surface operations, legal regimes) will form the subject of conference sessions, thereby inviting broad participation from various communities of specialization. Once the modules are mature in their concepts and content, they will be integrated into a narrative that will provide a top-level

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*Instructions and application form: see: "Scientific Activity" section at <http://iaaweb.org/content/view/256/393/>*

presentation of the overall problem with references to more detailed discussions in the conference literature or the historical literature.

**Methodology:**

An outline of the final report will be prepared, and the major topical elements will be identified. Each element will be assigned to lead editor, who will be responsible for coordinating inputs, including membership of other IAA Commissions. At a time to be determined in the process, each element will be the topic either for a session at a major professional conference or for a small topical workshop. Based on the inputs of the conferences or workshops, the module will be updated, using proceedings as a reference source for detailed future research. A final workshop will be organized to prepare the final draft of the complete report over two and a half days of dedicated time. The report draft will be delivered to the IAA for review.

**Time Line:**

First Draft – October 2010  
Study Group Workshop No. 1 – Spring 2010  
Study Group Workshop No. 2 – Spring 2011  
Final Report – October 2011

**Final Product (Report, Publication, etc.):**

The final product will be an IAA publication.

**Target Community and Expected Effects:**

The target community consists of international space agencies, government space policy specialists, and private sector entrepreneurs.

**Support Needed:**

Some modest support will be required; details will be provided subsequently.

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*Instructions and application form: see: "Scientific Activity" section at <http://iaaweb.org/content/view/256/393/>*

**Potential Sponsors:**

Potential sponsors will include NASA, ESA, JAXA, ISRO, other space agencies and various space companies.

***To be returned to the IAA Secretary General Paris by fax: 33 1 47 23 82 16 or by email: sgeneral@iaamail.org***

**Date:**

***No Signature required if document authenticated.***

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Instructions and application form: see: "Scientific Activity" section at <http://iaaweb.org/content/view/256/393/>

**Follow-up Section for IAA use only**

**Initial Phase**

**Application received:**

**Commission Approved:**

**SAC Approved:**

**Web Site Section opened:**

**Members Appointed:**

**Final Phase**

**Peer Review by Commission Completed:**

**Recommended by the Commission:**

**Final Report Received:**

**SAC Approved:**

**BOT Accepted:**

**Publisher Selected:**

**Study Published:**

<b>IAC 2009 IAA Symposia</b> - last update 22/10/2009			
<b>ref</b>	<b>Symposium Title / Session Title</b>	<b>Coordinator (Symp.) /Chairman (session)</b>	<b>Status</b>
<b>A.5.</b>	<b>Human Exploration of the Moon and Mars Symposium</b>	<b>W. Mendell, C. Sallaberger</b>	
	A.5.1 Strategies to establish Lunar and Mars Colonies	S. Hovland, <i>W. Mendell (R)</i>	9 abstracts accepted - 3 papers uploaded
	A.5.2 Joint Session on Human and Robotic partnerships for Future Exploration Endeavours	A.R. Gross, W. Mendell, <i>R Willnecker (R)</i> ,	8 abstracts accepted - 5 papers uploaded
	A.5.3 Joint Session on the next Steps for Human Space Exploration: What are the Alternatives?	T.Nakamura, E.Messerschmid, <i>D. Sabath, G.Schwehm (R)</i>	8 abstracts accepted, 5 papers uploaded
<b>C.3.1</b>	<b>Space Power Symposium</b>	<b>J. C. Mankins</b>	
	C.3.1 Joint Session with IAA Commission 3 (Space Technology & System Development) on "Solar Energy From Space"	N. Kaya, J. Mankins, <i>J.T. Howell (R), L. Summerer (R)</i>	8 abstracts accepted - 6 papers uploaded
<b>D.3</b>	<b>Symposium on Stepping Stones for the Future: Strategies, Architectures, Concepts and Technologies</b>	<b>J. C. Mankins, A.Pradier</b>	
	D.3.1 Strategies, Architectures to Establish a "Stepping Stone" Approach to our Future in Space	J.C.Mankins, A.Pradier <i>W. H. Siegfried(R)</i>	4 abstracts accepted - 4 papers uploaded
	D.3.2 Novel Concepts and Technologies for the Exploration and Utilization of Space	J T. Howell, L. Suchet, <i>M.A. Perino (R) N.Suzuki, (R)</i>	9 abstracts accepted - 4 papers uploaded
	D.3.3 Infrastructures and Systems to Enable Ambitious Future Exploration and Utilization of Space	W. H. Siegfried, S. Hovland, <i>S Hovland (R), G. Woodcock (R)</i>	8 abstracts accepted - 5 papers uploaded
	D.3.4 / E.5.4 Joint session on Space Technology and System Management Practices and tools	P Jukola, P.A. Swan, <i>C. Moore (R)</i> , ,	11 abstracts accepted - 8 papers uploaded
<b>D.4</b>	<b>Symposium on Far Futures</b>	<b>Hans E.W. Hoffmann, G.Reibaldi</b>	
	D.4.1 Human exploration beyond Mars	H. Rauck, P. Jukola, <i>O. de Weck(R)</i>	9 abstracts accepted - 4 papers uploaded
	D.4.2 Space Elevator and Tethers	D. Raitt, P. A. Swan, <i>R. E Penny (R)</i>	10 abstracts accepted - 7 papers uploaded



<b>IAC 2010 IAA Symposia</b> - last update 28/10/2009			
<b>ref</b>	<b>Symposium Title / Session Title</b>	<b>Coordinator (Symp.) /Chairman (session)</b>	<b>Status</b>
<b>A.5.</b>	<b>Human Exploration of the Moon and Mars Symposium</b>	<b>W. Mendell, C. Sallaberger</b>	
	A.5.1 Near -term strategies for Lunar Surface infrastructure	M-A Perino, W. Mendell, <i>B Foing(R)</i>	
	A.5.2 Long term scenario for Human Presence	U.Apel, W.H. Siegfried, N.Ghafoor	
	A.5.3 Joint session on Human and Robotic partnerships to realize space exploration goals (with B3.6)	C Sallaberger, A.R. Gross, <i>R Willnecker (R)</i> , <i>M. Bottacini (R)</i>	
	A.5.4 The next steps for Human Space Exploration: What are the alternatives ?	E. Messerschmid, G. Gargir, <i>G.Schwehm (R)</i>	
<b>C.3.1</b>	<b>Space Power Symposium</b>	<b>J. C. Mankins</b>	
	C.3.1 Joint Session with IAA Commission 3 (Space Technology & System Development) on "Solar Energy From Space"	N. Kaya, J. Mankins, <i>J.T. Howell (R)</i> , <i>L. Summerer (R)</i>	
<b>D.3</b>	<b>Symposium on Stepping Stones to the Future: Strategies, Architectures, Concepts and Technologies</b>	<b>J. C. Mankins, A.Pradier</b>	
	D.3.1 Strategies, Architectures to Establish a "Stepping Stone" Approach to our Future in Space	J.C.Mankins, V. Prisniakov, <i>W. H. Siegfried(R)</i>	
	D.3.2 Novel Concepts and Technologies for the Exploration and Utilization of Space	J T. Howell, H.Yamasaka, <i>M.A. Perino (R)</i> <i>N.Suzuki, (R)</i>	
	D.3.3 Infrastructures and Systems to Enable Ambitious Future Exploration and Utilization of Space	W. H. Siegfried, S. Hovland, <i>S Hovland (R)</i> , <i>G. Woodcock (R)</i>	
	D.3.4 / E.5.4 Joint session on Space Technology and System Management Practices and tools part 1	P. Jukola ( R ) , P.A. Swan, <i>C. Moore (R)</i>	
	D3.5/ E5.5 Joint session on Space Technology and System Management Practices and tools part 2	J.C.Mankins, P.A. Swan, <i>C. Moore (R)</i> , <i>P. Jukola (R)</i>	
<b>D.4</b>	<b>Symposium on Visions and Strategies for Far Futures</b>	<b>Hans E.W. Hoffmann, G.Reibaldi</b>	
	D.4.1 Human exploration beyond Mars	A. Dupas, P. Jukola, <i>O. de Weck(R)</i>	
	D.4.2 Interstellar Precursor Missions	R. X. Lenard, C. Bruno, <i>D. Andrews (R)</i>	
	D4.3 Access to space in the Far Future	H. Rauck, <i>A Pradier, P. Jukola(R)</i> ,	
	D4.4 Space Elevators and Tethers	P. A. Swan, R. E Penny, <i>D. Raitt (R)</i>	

# IAA Commission III Status Report to SAC

Daejeon, 12/10/2009

# Composition of Commission III

For 2009-2011

- **John C. Mankins (US), Chairman**
- **Giuseppe Reibaldi (IT), Deputy Chairman**
- **S. Ramakrishnan, Secretary (new Member)**
- **Tetsuo Yasaka (J) Past Chairman**
- **Christophe Bonnal (F), Member**
- **Hans E. W. Hoffmann (D), Member**
- **Wendell Mendell (US), Member**
- **Claudio Bruno (Italy), Member (new)**
- **Junjiro Onoda (Japan), Member**
- ***Christian Sallaberger (Canada), proposed new Member***
- ***Roger Lenard ( USA), Member -- unconfirmed***

# C-III Study Group Status\*

- SG 3.1**                      **Status: Poor; repeatedly delayed**  
Draft report and plan to complete due by March C-III meeting (must show significant progress, or the SG will be cancelled)
- SG 3.5**                      **Status: Completed**  
Report published and distributed
- SG 3.9**                      **Status: Good; completion delayed 1 year**  
Draft report in 2010; completion by 2011
- SG 3.10**                    **Status: Good**  
Draft report in March 2010; completion by end of 2010
- SG 3.11**                    **Status Good**  
Draft report in March 2010; completed by IAC 2010

*\*Other Past Study Groups (3.6, 3.8) are dropped as of IAC 2009*

# Commission III IAC Symposia Status

- 2009
  - Generally, all sessions and symposia will be satisfactory / good
  - There are some issues resulting from scheduling conflicts with arrangement of sessions
  - There have been a number of last-minute paper withdrawals, and decisions by individuals not to attend the Congress
- 2010
  - Generally, planned sessions and symposia in Call for Papers are satisfactory
  - Some near term adjustments in the details of the sessions are needed (including identified some changes Chairs, Co-chairs and Reporteurs)
- 2011+
  - Plans for restructuring, based on planned new / reformulated Study Groups

# Future C-III Study Groups: General

- Commission III is planning to identify several new study groups during the coming year – addressing topics of importance for the future space global space activities
  - Also, Commission III plans to more closely align Study Groups and IAC Sessions
- A general restructuring of the approach to Symposia and Sessions will follow (planning to target the IAC following Prague); three types of Symposia / Sessions are envisioned...
  - Sessions addressing topics of interest that will likely result in study groups in the near term
  - Sessions that support new / ongoing Study Groups
  - Sessions that report on results of recently concluded Studies, and recent relevant developments
- Commission III plans to work closely with other IAA Commissions, and with relevant IAF Technical Committees in re-structuring its current IAC Sessions
- In addition, all new Study Groups will be invited to organize events external to the annual IAC
- Commission III is seeking assistance in how best to involve younger professionals in IAA activities

# Future C-III Study Groups: Exploration Technology & Systems

- Commission III is planning for a new Study Group to address future technology & systems for human/robotic space exploration
  - There is a new context for international exploration planning
  - Human and Robotic space exploration needs to be re-examined
  - Effort will build on past studies
- Current Status: Commission III is...
  - Developing a Terms of Reference / Formal Proposal
  - Identifying SG leadership
  - And, seeking participants
- The new SG will build on the results of the planned November 2011 Summit
- Commission III invites each Commission to suggest participants in the new SG

# Special Topics

- There is a need for more definition of “what happens next” after the completion of an IAA Study Group: How can we increase the Impact of IAA Studies?
  - Publication of Report(s) is only the start...
    - Distribution to Whom?
  - Protocol for Communication of Results (e.g., Dedicated Session at Next IAC? Other?)
  - Assessment / Follow-up on Results following Completion & Distribution
- Commission III is seeking assistance in how best to involve younger professionals in IAA activities