

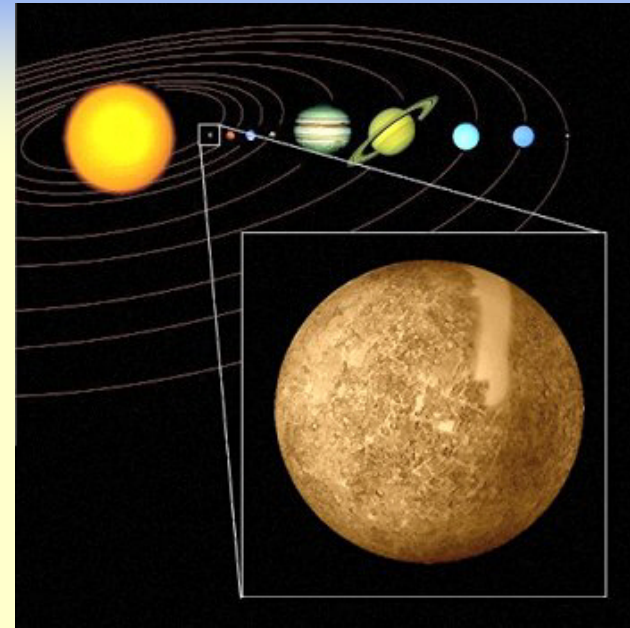
BepiColombo

ESA's 5th Cornerstone Mission

ベピ・コロombo



Professor Giuseppe Colombo



BepiColombo Mission Scenario Presentation to SSWG

J. van Casteren

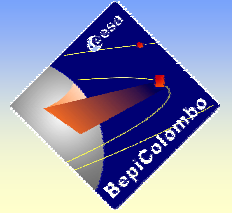
8 September 2005, ESA HQ

BepiColombo Project



8 September 2005

BC-EST-HO-2626



Content

Presentation of ESA/SPC(2005)22

1. Project Status and Re-Definition
2. Payload Status
3. Way forward
4. Decision Required by SPC

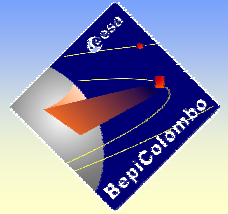


8 September 2005

BC-EST-HO-2626

BepiColombo Project

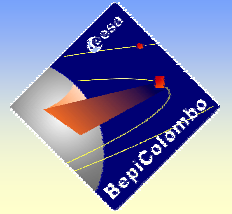
Project status



- Final study review milestone reached in April 2005
- The new mission target cost is significantly above the level assigned by SPC in 2003
- The development risk is too high due to eroded system mass margin (10%).
- The Executive decided not to proceed with the spacecraft ITT
- Re-definition phase was started:
 - Systematic review of programmatic assumptions, design drivers and mission scenarios
 - Bring the project back to an affordable target cost
 - recover 20% system mass margin
 - If possible, preserve the 2012 launch window
- Delay imposed in April has eroded the risk margin for a 2012 launch



BepiColombo Project

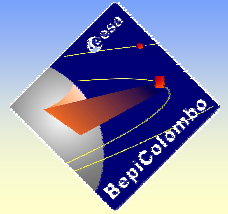


Why Electric Propulsion?

- Compatibility with Soyuz/Fregat launch mass
 - If chemical propulsion is taken, the mass penalty is of the order of 1100 kg
- Reduction of cruise duration
 - 5 years electric propulsion
 - 6.3 years with chemical
- However, electric propulsion induces a high cost penalty and development risks for the engines



BepiColombo Project

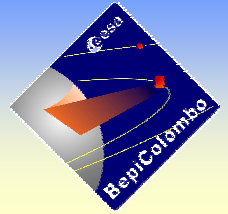


Approach of the re-definition

- Investigate alternative mission scenarios, based on chemical propulsion and gravity assists
- These are the only options for launch in 2012
- Identify cost savings for spacecraft design, including electrical propulsion systems
- A more powerful launch vehicle is required
- Launchers considered are European or from Japan, however, the latter are for illustrative purposes as there is no indication at all that such launcher could be provided



BepiColombo Project



Chemical Propulsion Considerations

- A chemical propulsion has lower development risk than electrical propulsion mission
- The spacecraft implementation cost are significantly lower than that for an electrical mission
- Mass to escape required is of >3000 kg, eliminating Soyuz/Fregat as launcher
- Ariane 5 is suitable as for a dedicated launch
- A launch on Ariane 5 to GTO with co-passenger is not feasible as <1000 kg is available for the co-passenger



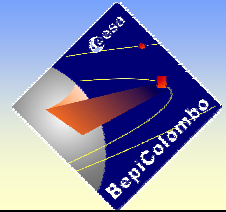
BepiColombo Project

8 September 2005

BC-EST-HO-2626

6

Chemical Propulsion Options



Case	Launch Date	Cruise Duration	Arrival Date	Launcher	Launch Strategy	System Margin
Chem 1	March 2012	6.3 years	July 2018	A5 ECA	Direct Escape	Sufficient
Chem 2	March 2012	6.3 years	July 2018	A5 ECA	Highly Elliptic Orbit	More than sufficient
Chem 3	March 2012	6.3 years	July 2018	H-IIA304	Direct Escape	Sufficient
Chem 4	August 2012	8.5 years	February 2021	A5 ECA	Direct Escape	Sufficient
Chem 5	August 2013	8.5 years	February 2022	A5 ECA	Direct Escape	Insufficient
Chem 6	August 2013	8.5 years	February 2022	A5 ECA	Highly Elliptic Orbit	More than sufficient
Chem 7	October 2013	8.5 years	April 2022	A5 ECA	Direct Escape	Sufficient

Full A5 ECA price

Option 1 is selected for the final trade-off



- 1) A5 GTO option is discarded because < 1000 kg would be available to a co-passenger
- 2) A5 ESV and ECB versions are discarded due to unavailability

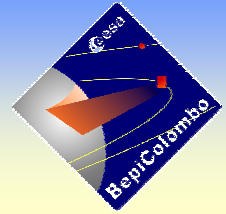


BepiColombo Project

8 September 2005

BC-EST-HO-2626

7



Electrical Propulsion Options for 2013

Mission using Soyuz is not compatible with requirements

Case	Launch Date	Cruise Duration	Arrival Date	Launcher	Launch Strategy	System Margin
SEP 1	September 2013	9.3 years	December 2022	Soyuz/ Fregat	Highly Elliptic Orbit + Lunar Fly By	Sufficient
SEP 2	February 2013	7 years	March 2020	Soyuz/ Fregat	Highly Elliptic Orbit + Lunar Fly By	Sufficient
SEP 3	September 2013	5.8 years	June 2019	H-IIA202	Highly Elliptic Orbit + Lunar Fly By	More than sufficient
SEP 4	September 2013	4.9 years	August 2018	H-IIA2024	Direct Escape	More than sufficient

Option 3 is selected for the final trade-off



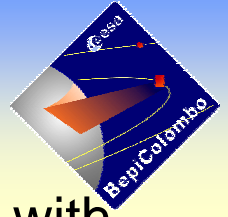
BepiColombo Project

8 September 2005

BC-EST-HO-2626

8

Programme Level Consideration

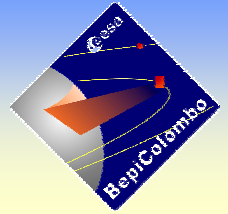


- A mission using Soyuz/Fregat as launcher is not compatible with the requirements
- The only option to use Soyuz/Fregat would be to combine the MPO and MMO payload into a single spacecraft
 - Significant reduction of scientific capabilities
 - Total cost of the same order as the baseline
 - In case of new payload selection, delay is inevitable
- The Chem 1 option (M€ 650) is attractive and low risk, However, its expenditure profile is incompatible with the science programme, unless other approved elements, worth M€ 150, are removed.
- The SEP 3 option (M€ 620, excluding launcher) is the most promising nominal mission at acceptable implementation risk and its expenditure profile is compatible with the present science programme



BepiColombo Project

MPO Payload Status



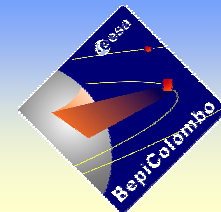
- The PI teams started the payload definition work highly motivated; momentum must be kept to ensure success
 - The scientific performance is compatible with objectives
 - The draft experiment interface documentation is completed
 - Mass / power resources are tight
- Payload final definition and accommodation depends on the S/C design. Prerequisite for detailed definition is to select the Prime Contractor
- Feasibility of BELA, MGNS and MANGA to be demonstrated by the November 2005 SPC. Feasibility studies are progressing well
- ESA provided common items are defined.
- The funding status is generally OK, however, funding of the UK instruments is a problem



BepiColombo Project

Programmatic Status:

Status of Payload Funding per Country



Exp. \ Country	A	B	FIN	F	D	I	IR	E	CH	UK	RUS	S	J	US	Others	OPEN
BELA					X			X	X							
ISA						X										
MANGA		X		X									X			
MERMAG	X				X					X						
MERTIS					X											
MGNS		X									X					
MIXS			X							X						X
MORE						X										
PHEBUS				X							X		X			
SERENA	X	X		X	X	X	X		X		X	X		X	X	
SIMBIO-SYS				X		X			X							
SIXS			X							X						
STATUS																ESA

Remarks: 1) CH contribution to SIMBIO-SYS TBC but flagged green by ASI
 3) MERTIS shift to other international partner under discussion

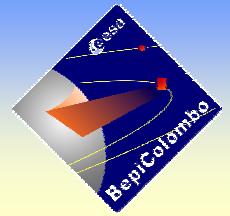


BepiColombo Project

8 September 2005

BC-EST-HO-2626

11



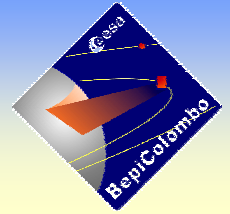
UK Funding Status

- PPARC has difficulty to fund the 2 proposed UK instruments MERMAG and MIXS
- MERMAG funding refused, however, recovery has been found:
 - Dr. Glassmeier (TU Braunschweig) is new PI
 - Design capitalises on magnetometer for MMO
 - Contributions from Germany, Austria and UK
- MIXS funding from UK covers approx. 40%
 - Part not funded estimated at 8 to 11 M€
 - No alternative partner has been identified
 - No viable back-up has been identified
 - Cancellation results in severe loss of unique chemical composition information



BepiColombo Project

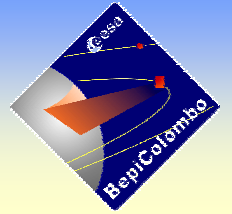
MIXS Options



- PPARC has requested ESA (SPC) to provide the missing elements, however:
 - Diffusion of authority, as experienced with Beagle 2
 - This approach is not recommended
- Transfer UK role to institutions in other European member states
 - Scientific and financial interest elsewhere in Europe could not be found
- Implement MIXS as a European facility instrument
 - Confirm that MIXS is scientifically fundamental to the mission
 - Entirely funded by SPC
 - No UK leadership for MIXS
 - Scientific leadership and team selection through an open AO
 - Modify the Science Management Plan
 - Cost and feasibility to be investigated
- The SPC will be asked to decide on acceptance of such approach



BepiColombo Project

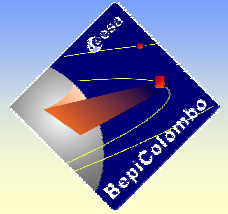


Way Forward (1)

- The Executive cannot recommend a 2012 launch
 - The nominal electric propulsion is too risky
 - The chemical propulsion is a good low risk alternative
 - Both these missions have an expenditure profile incompatible with the present science programme
- The electrical propulsion mission with launch in September 2013 is the only realistic option
 - Adequate system margin and schedule reserve
 - While far above the 2003 target cost, it is affordable in the science programme financial envelope



BepiColombo Project



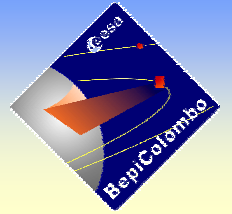
Way Forward (2)

- The Executive proposes to initiate implementation of the BepiColombo mission for launch in September 2013
 - The definition of the mission, spacecraft and propulsion modules is sufficiently mature to permit committing Industrial offers
 - Issue the spacecraft ITT in December 2005 to
 - Enable detailed payload definition and keep its momentum
 - Consolidate the system design and specifications
 - Maintain a realistic schedule for the issue of subcontract ITTs
 - Spacecraft procurement will be phased such that the contract could be stopped at PDR in case the launcher funding is not resolved by this time
 - Clarify how the launch might be procured. The most economical solution requires agreement with Japan, consistent with European launcher procurement policy



BepiColombo Project

Way Forward (3)



- A status report will be given at the November 2005 SPC meeting
 - On the launch procurement
 - On the payload funding (Letters of Commitment)
- Formal approval of the CaC prior to kick-off of the development contract

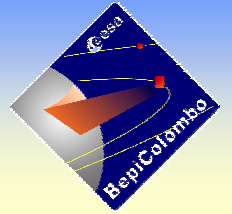


8 September 2005

BC-EST-HO-2626

BepiColombo Project

16



Decisions Required

- The Executive requests the SPC to decide:
 1. Whether to replace the 2012 launch date with a nominal launch in 2013
 2. The course of action to be taken to put in place a full nominal payload
- Otherwise, the SPC is asked to give general guidance on approaches to be followed



BepiColombo Project

8 September 2005

BC-EST-HO-2626

17