Athena: Status

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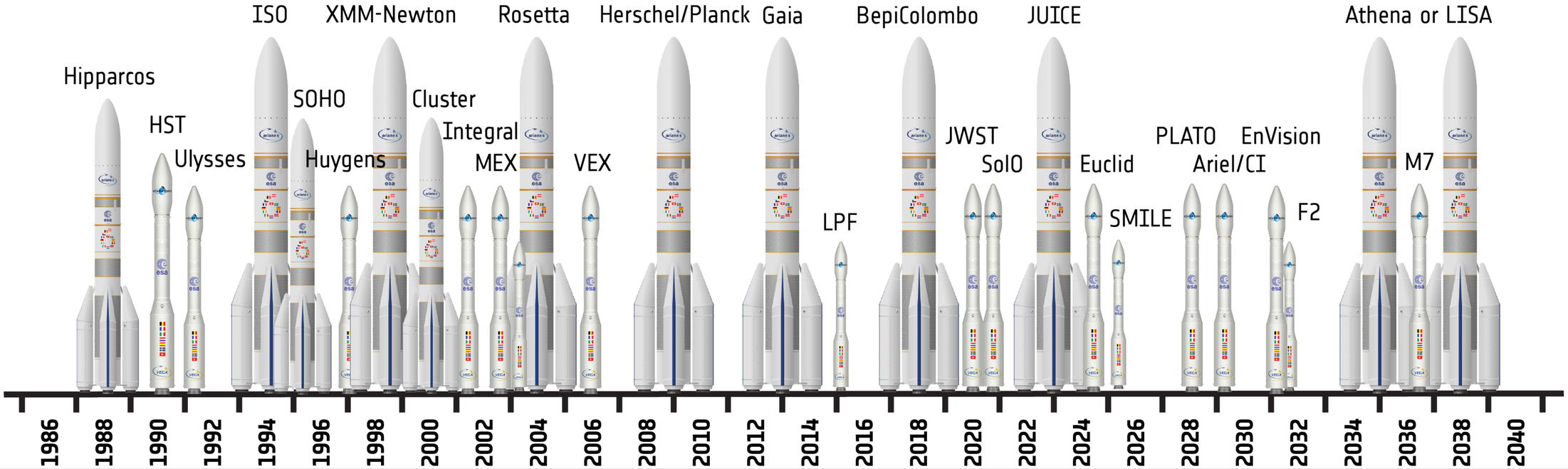
Introduction

- The Science Programme is a cornerstone of ESA
  - Diversity, both in terms of the science theme and mission size, is at the heart of the programme
- ESA Science missions fall in to four categories:
  - Large (Flagship missions, ~Billion Euro)
  - Medium (~0.5 Billion Euro)
  - Small/Fast (~150 Million Euro)
  - Mission of Opportunity (<50Million Euro)



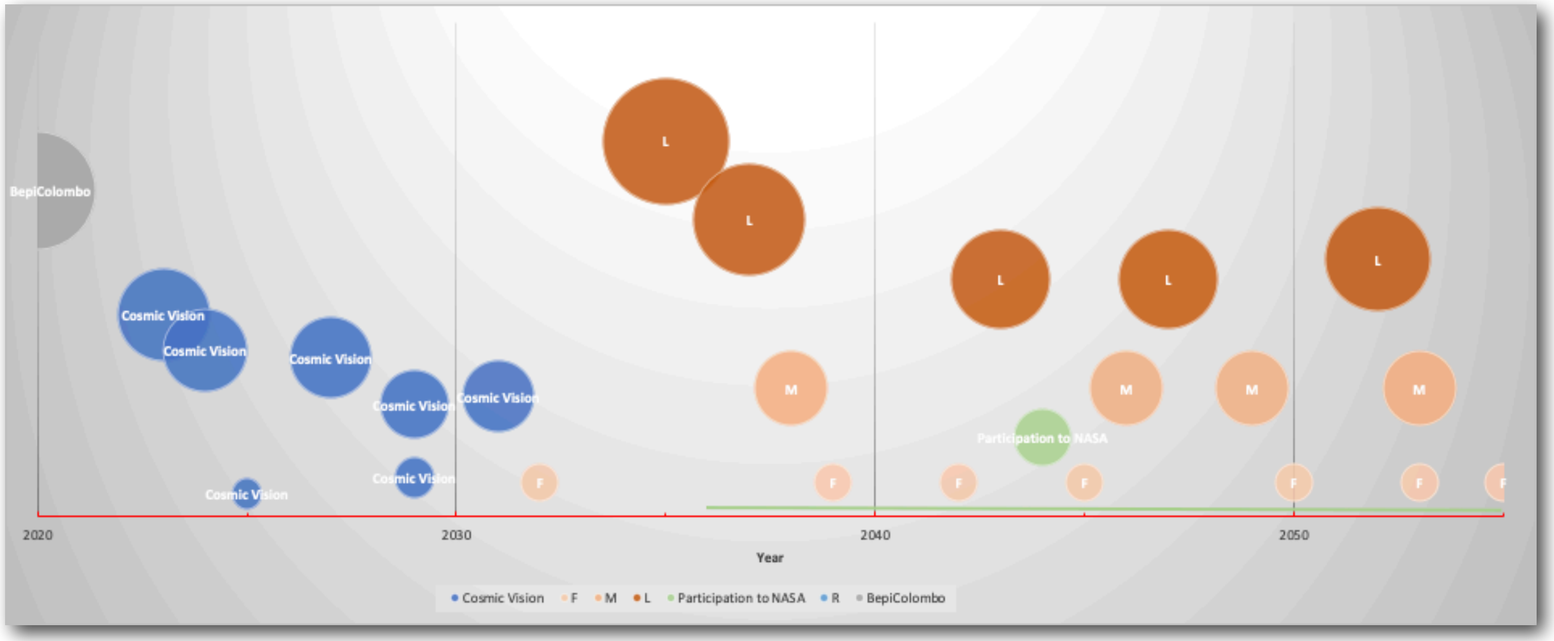
Current Status

- Within the Science Programme we continuously maintain a Long Term Implementation Plan (LTIP)
  - The LTIP covers the current content of the science programme, as well as the future content (out to the 2050s)
  - This plan is updated every three years following the Ministerial Council (CMIN) when we receive our new Level of Resources (LoR) for the following period

- LISA and Athena were selected with a Cost-at-Completion (CaC) of €1.05Bn (~€1.17Bn in e.c. 2022)
  - This CaC was already exceeded at the CMIN19, when the combined cost of the missions was **€2.5Bn**
- Over the last three years, the technical progress of both missions has improved significantly, but at the same time, so has the cost.
  - Athena: ~€1.9Bn (e.c. 2022)
  - LISA: ~€1.5Bn (e.c. 2022)
  - Total L-mission envelope **~€3.4Bn**
- These costs are not sustainable in the ESA Science programme, if we hope to maintain the diverse content of LTIP

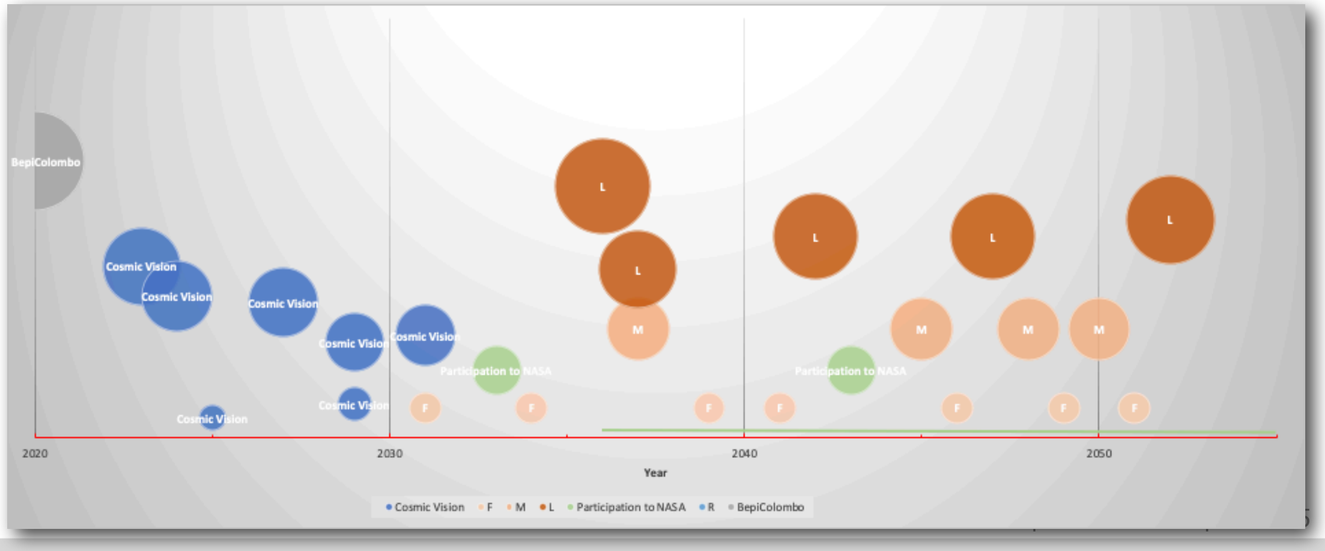
Current Status [2]

- The ESA Executive have considered many options to maintain both Large missions in their current implementations, however, no credible solution has been found
  - Only option would be to stop all new programme content for the next decade, and to revisit currently existing costs (i.e. mission extensions)
- This would lead to a programme dominated by the Large Missions, removing the programme diversity which sits at the heart of the Science Programme
- Therefore, the Executive has made a proposal to the Science Programme Committee (SPC) to maintain both programme diversity as well as maintaining less ambitious Large Missions



ESA Proposal to SPC

- The SSAC and SPC were asked to consider 7 questions related to the content of the Science Programme, including:
  - Dominance of the Athena and LISA missions
    - *"The Executive would like to have confirmation that the SPC does not see a Programme where all other elements have been removed/postponed to allow the implementation of the Athena and LISA package at 3.4 B€ as viable"*
- Proposal:
  - Stop the Athena adoption process, currently planned for June 2023
    - While maintaining technology development activities which may be required for a re-scoped mission
  - Rescope the Athena mission to significantly reduce the cost
  - Maintain tight financial constraints on LISA to avoid any further cost increase (and at the same time look for cost decreases)
  - Advance the LISA adoption target date to November 2023



Current proposal approved by SPC

- An SPC Workshop was held to discuss the proposal and agree on the way forward:
  - L-mission envelope set at €2.6Bn
    - Split between the two mission is not decided
  - Athena science objectives shall be modified to provide parameter space to allow cost reductions to be made
    - *NewAthena* will follow a strict design-to-cost approach
    - Target cost ≤ €1.3Bn
  - LISA cost to be reduced to ≤ €1.3Bn
    - LISA will also follow a strict design-to-cost approach
  - One mission should be adopted in 2023
    - Whichever mission is technically ready to enter implementation
  - Independent science review teams will be asked to review the science and science feasibility of both missions. e.g.
    - Athena: rescoped science objectives and Definition Study Report (aka the Red Book)
    - LISA: Definition Study Report
  - The mission which is not adopted in 2023, will be adopted when technically ready to do so

What's next?

- The common view of the SPC is that *NewAthena* should, to the maximum extent possible, capitalise on the significant investment made by all stakeholders in the preparation of Athena

- The goal of the *NewAthena* activity is the definition of a new X-ray observatory mission that:
  1. Can be implemented with a target ESA Cost-at-Completion (CaC) of ≤€1.3Bn
  2. Is considered by the Advisory Structure and by the SPC to be a "flagship-class" mission
  3. Makes use of, insofar as possible, the technologies already developed for Athena

#1: spells out the affordability within a diverse Science programme, in view of the current and expected programme income

#2: is rather ill-defined. However, in spite of the likely unavoidable reduced mission performance of *NewAthena*, a recent independent science review highlighted areas in which the science case can be "enriched" by taking stock of the recent developments in the fields of astrophysics addressed by Athena (e.g. multi-messenger astronomy)

#3: recognises the significant investment already made in Athena. However, this has to be applied with some flexibility to avoid over-constraining the exercise, making it impossible to achieve a mission configuration that will satisfy Point 1.

Definition of NewAathena

- The definition of *NewAthena* will, by necessity be an iterative process, with some steps taking place in parallel.
- The currently foreseen steps are:
  - Analysis of possible reduced instrument configurations
    - Lead by Athena Instrument PIs, with support from the ESA engineering team
    - Goal: Is there a way to significantly reduce the ESA CaC, by reducing the instrument performance?
    - ESA will, insofar as possible, assess the system level cost impact from any instrument design change
    - Depending on number of iterations, it is expected this step may take between 3-5 months of work
  - Assembly of the science re-definition team
    - SSAC recommended to bring in fresh views when defining the science objectives of *NewAthena*
    - An open Announcement of Opportunity (AO) will be released asap for membership of the Science Re-definition Team
    - Athena and independent scientists are encouraged to apply without prejudice
  - Consultation with international partners
    - International Partners have already been notified of the process and will be engaged in the re-definition activities
  - Consultation with National funding agencies
    - National Funding Agencies will be consulted to ascertain their continued commitment to the mission and what changes to their nationally provided elements they would be willing to entertain

Definition of NewAthena [2]

- The currently foreseen steps are (Contd):
  - Definition of the minimum disrupted mission
    - Given the outcome of the previous steps, and in consultation with all stakeholders, ESA will take the responsibility to define a viable Minimum Disrupted Mission (MDM)
      - However, there is no guarantee that such a mission exists within the programmatic and technical constraints
    - The MDM definition will be under a Design-to-Cost approach, and therefore will remain under ESA responsibility, but with regular reporting to all stakeholders
  - Consultation of the ESA Advisory Structure and of the SPC
    - Once the MDM is defined the Advisory Structure will be requested to review the science case and science feasibility to ascertain whether the MDM is still a “Flagship” mission
    - Assuming yes, the ESA Executive will present the outcome of the activity to the SPC, with a proposal for the way forward (e.g. possible route to adoption)

Conclusion

- Athena has *not* been cancelled, but is being re-formulated to fit with the programme and technical constraints of the ESA Science Programme
- The Athena Independent Science Review team have identified science objectives to enhance the science case
  - We believe a less ambitious Athena will still produce flagship science
- Activities towards the re-definition of the mission has already started
  - Both instrument consortia are investigating possible reductions in performance
  - ESA Study Team are investigating system level reductions
  - Both instrument and ESA teams must work together to define an MDM
- The Science Re-definition Team AO will be issued asap
  - Aim is to have team in place shortly after the summer break
  - *NewAthena* science team will include Early Career Scientists to bring new ideas to the table

- We, ESA, are still committed to launch a large-class X-ray observatory, producing Flagship Science.