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**The policy on space launchers:
significant challenges to overcome**

PRESENTATION

For Europe and for France, mastery of space technologies and the ability to access space in an autonomous manner are interests, the importance of which has never been greater. In a context of unprecedented dissemination of space applications to new fields of activity, to growing economic and strategic stakes, it is more than ever necessary to retain sovereign access to space. However, the family of Ariane launchers, providing a means for such access and a symbol of the success of Europe in space, is now faced with significant challenges, perhaps even more significant than those that it had to overcome after the failure of the Ariane 5 flight in December 2002.

This situation arises from the escalation of American competition from SpaceX, who replaced Arianespace as the global leader on the commercial market in 2017. However, it appears that the new Ariane 6 launcher, whose development was decided by the European Space Agency in 2014 to tackle such competition, will only be a transient response to this challenge.

These difficulties coincided with the crisis suffered by the Kourou launch base, “Europe’s Spaceport”, in the context of social disturbances having appeared in French Guiana during spring 2017. The space centre has since faced contradictory requirements between the need to improve its competitiveness with regard to American competition and the expectations of the territory, which considers that it does not benefit enough from the effects of space activities.

The Cour had warned public authorities of Ariane's potential difficulties in the insert to the 2014 annual public report entitled "space transport: a strategic ambition, priority to cost reduction"¹. At the time, it had insisted on the challenges relating to the insufficient competitiveness of European launchers and to too-limited European funding for the Kourou launch base.

Faced with a situation that has deteriorated since 2014, it once again warns of the challenges that the space launcher policy must address and which call for urgent decisions to be made at national and European level. From the audits that it has carried out on the Centre national d'études spatiales (National Centre for Space Research, CNES) and on the Space centre of French Guiana, it has drawn four lessons relating to the space launch policy: sovereign access to space is of more strategic importance than ever to Europe and France (I); the Ariane 6 launcher must evolve quickly to remain competitive and ensure sovereign access to space (II); the significant budget risks inherent to the space policy must be better anticipated (III); further participation from France's European partners must be sought (IV).

I - Sovereign access to space is of more strategic importance than ever to Europe and France

Sovereign access to space, i.e. the ability to send satellites into orbit without relying on foreign powers: is a strategic interest that France has promoted with respect to its European partners since the 1970s (A); is of more strategic importance than ever to France and to Europe in the context of the "New Space" revolution (B); is the subject of heightened strategic competition between the main powers (C).

¹ *Cour des comptes, 2014 annual public report, Le transport spatial : une ambition stratégique, une priorité à la baisse des coûts (Space transport: a strategic ambition, priority to cost reduction), p. 145-173. La Documentation française, February 2014, 480 p., available at www.ccomptes.fr.*

A - For several decades, France has promoted the strategic importance of launchers

1 - Sovereign access to space is at the heart of national strategic interest

Since the 1970s, space has witnessed significant applications, both civil and military, in the fields of Earth observation and communications. In this context, having one's own launcher prevents dependency on another third power to access space and to freely send corresponding satellites into orbit. It is also a means of directing public investment towards high-technology sectors, which represent future economic benefits.

Very early on, France considered such sovereign access to space as a strategic issue. It mobilised its space agency, the CNES, as well as its industry, which is now brought together under the Ariane Group², to develop what would later become the Ariane launcher family, enabling in particular the sending of satellites into geostationary³ orbit.

This strategic interest is historically-speaking all the more important to France as there are strong synergies between civil space activities and nuclear deterrence, given that it is the same consultancy firms and the same factories that produce both Ariane launchers and ballistic missiles.

2 - France has promoted this strategic interest to its European partners

Very early on, France sought to involve its European partners, some of which (mainly Germany and Italy) also considered that there should be no reliance on third powers to send satellites into orbit and that their industries should fully participate in the space adventure.

The conditions set out in 1974 by NASA⁴ to launch French and German communication satellites, and which intended to prohibit any commercial exploitation, convinced Europeans of the need to possess their own launcher. For this purpose, they set up the European Space Agency, an interstate international organisation, enabling volunteer States to participate in the Ariane launcher programmes, by benefitting from the

² Ariane Group is 50% owned by the Airbus group and 50% by the Safran group.

³ This orbit enables a satellite to circulate at the same speed as the earth's rotation, and thereby to remain permanently above the desired geographical area.

⁴ *National aeronautic and space agency* : American space agency.

effects on their industry in proportion to their investment, based on the geographical ‘juste retour’ rule. This also allowed the involvement of European industrialists in the space adventure by getting them to participate in Arianespace’s capital⁵, the company that markets the launchers.

Consciousness of the strategic need for sovereign access to space has gradually solidified in Europe. Thus, the Kourou agreements, signed under the aegis of the European Space Agency in 2008, make the launch base in French Guiana Europe’s spaceport and provide for a share of the costs between European partners. In addition, sovereign access to space was recognised as a strategic interest by the European Union.

B - The emergence of “New Space” renders sovereign access to space more necessary than ever

1 - Space applications will concern an ever-growing number of activities.

Historically centred around defence, communication and observation, and a prerogative for major powers, space applications are now starting to undergo a revolution, often referred to as “New Space”.

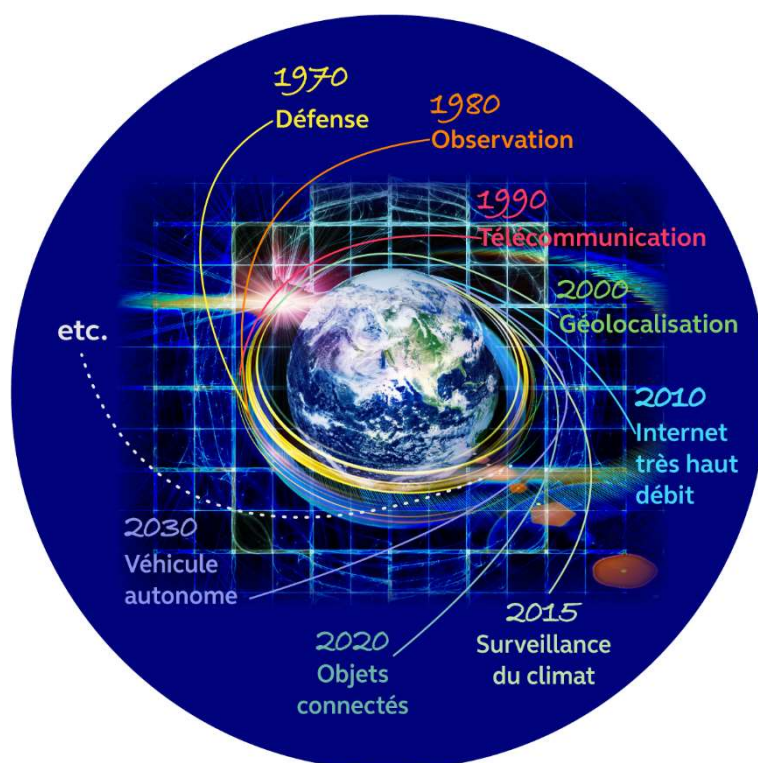
Firstly, it translates into a considerable extension of space applications, which in the long term may come to concern all human activities. As an example, applications enabling to collect and exchange data necessary for the monitoring of climate change, for positioning assistance for maritime navigation and future autonomous vehicles, for the monitoring of main railway networks for maintenance purposes, for the use of connected devices, already depend on space technologies.

Like geolocation, which is now commonly used in daily life, these new applications are spreading at a quick rate. In upcoming years, digital revolution, and the ever-growing data exchanges that it involves, will offer addition prospects for space-based applications.

⁵ Today, Ariane Group is Arianespace’s majority shareholder with close to 74% of shares.

In such a context, autonomous access to space is more important than ever; it addresses many issues: security and defence, industrial and economic issues, societal issues, and issues relating to outreach and influence policies. However, access to space no longer only concerns historical state actors, but also new arrivals, drawn by the new potential offered by space, both public (developing countries) and private, whether the GAFA⁶ or independent operators.

New space applications



Source: Cour des comptes

⁶ Internet giants: initially Google, Apple, Facebook and Amazon (GAFA).

2 - A sovereign launcher is vital to stay in the running

It is essential for France and Europe to seize these opportunities to fully benefit from the potential for economic growth related to new space applications.

In this context, sovereign access to space is now more than ever a major strategic issue for France, but also for Europe. It is a matter of having the reassurance of being able to launch satellites at competitive prices and without usage restrictions.

It is also a matter of ensuring that satellites are placed in orbit safely, as the technological sophistication of satellites makes them vulnerable to cybersecurity threats and to undesirable manipulations prior to their launch.

C - Space is the subject of heightened competition between major powers

1 - The United States have once more become world leaders with the success of SpaceX

After two decades of absence, due to the priority afforded to manned flights and the space shuttle, which had allowed Arianespace to take the first place in the global market of commercial satellite launches, the United States returned to the global competition in the field of launchers. A massive budget effort, combined with private initiatives, led to the emergence of SpaceX, which dethroned Arianespace as world leader in 2017. During the first semester of 2018 alone, Space X successfully completed 12 launches with its Falcon 9 launcher, i.e. more than Arianespace had achieved in one year.

This competition does not stop at SpaceX. For a long time, the other major space powers have understood the strategic interest of sovereign access to space and have developed their own launchers. This includes Russia, Japan, China and India. Furthermore, SpaceX's success has inspired other private stakeholders: the American company Blue Origin therefore announced that it would be developing a new launcher for the beginning of the 2020 decade.

Table 1: launchers at global level

	Europe	United States			Russia	Japan	India	China
Geostationary orbit 36,000 km	Ariane 5 10.5 t Dual launch	Atlas V 6.8 t	Delta IV 11.2 t	Falcon 9 5.5 t	Proton 6.3 t	H-II 5.6 t	GSLV 2.2 t	Long March-3 2.2 t
Median orbit 22,000 km	Soyuz	Antares		Delta II	Soyuz			Long March-4 and 7
Low orbit 300 to 1,500 km	Vega	Pegasus		Minotaur	Rokot Dnepr Soyuz 2.1.V	Epsilon	PSLV	Long march-2, 6 and 11
Number of launches from 2006 to 2016	93	196			304	29	33	143
Failure Rate	1%	4.5%			7%	0%	12%	2%

Source: Report of Ms. Geneviève Fioraso to the Prime minister of July 2016, “Open space : l’ouverture comme réponse aux défis de la filière spatiale” (Open space: openness to address the challenges of the space field).

2 - Europe is becoming more conscious of the importance of this issue

Historically, the European space policy in general, and its launcher aspects in particular, were exclusive to the European Space Agency and the most-involved States in this field: France, as a pioneer in the field and the first funder, Germany, who deployed significant industry and who is the second largest contributor to the Ariane family, and lastly, Italy, who developed its own launcher, Vega, for launches into low orbits.

For several years, the “New Space” revolution has led to the gradually rise in consciousness among European stakeholders. Thus, the European Union, building on its experience acquired from satellite programmes such as Galileo, aiming to compete with the American GPS, intends to take its rightful place in space policy. The European Commission is considering devoting an increasing portion of the European budget to space, to an amount that should reach €16b over the 2021-2027 period, and suggesting the adoption of a regulation on space to better coordinate the work of all stakeholders involved: the European Union, the European Space Agency, State members and industrialists.

Faced with the rise in stakes and competition from multiple sources, Europe in space is at a crossroad: bringing its assets together and devoting further financial means to meet challenges, in order to take on its full role in the development of “New Space”, or lose a major strategic ability acquired after fifty years of effort.

If European States wish to remain in the global competition for autonomous access to space and new applications, they will have no other choice than to use resources that match this ambition, and to unite their efforts in a field in which States alone no longer have sufficient budget resources to compete in this global strategic competition.

II - The Ariane 6 launcher must evolve to remain competitive

The new European launcher Ariane 6, whose development was decided by the European Space Agency in 2014, runs the risk of not being sustainably competitive with American company SpaceX (A). It will need to evolve, which will require decisions to be made at European level (B).

A - Ariane 6’s current economic model poses risks

1 - American competition is currently favoured on the launcher market

The launch of satellites concerns both institutional satellites and commercial satellites. The former are not generally open to competition, for two series of reasons. On the one hand, technical interfaces between launchers and satellites are such that possessing a sovereign launcher provides protection against the risk of seeing a third power, to whom launches would be entrusted, capable of limiting the use of a satellite or collecting its data. On the other hand, entrusting a national operator with one’s institutional launches⁷, at advantageous prices for said operator, could be a way for a State to bolster its economic situation and to enable it to approach the very competitive market of commercial launchers in a more favourable way.

⁷ Launches carried out to the benefit of States or other European or international public institutions.

In this field, the United States have a major competitive advantage. They possess the largest civil space-activity budget in the world (NASA's budget in 2018 was of \$19.5b, compared with €5.6b for the European Space Agency) and offer their launchers a captive market supported by public procurement. The European institutional launcher market is much more modest, open to non-European providers, and shared amongst several ordering parties: the European Space Agency, the European Union, Eumetsat⁸ and the main States.

The commercial satellite market has the characteristic of its prices being negotiated in US dollars, which exposes and competitors, save for American ones, to an exchange risk. Despite this handicap, Arianespace had succeeded in holding the leading position worldwide on the commercial market for over two decades, backed by the reliability of its launchers and a competitive offer. This situation changed with the emergence of SpaceX, who asserted itself at a time when the commercial market for geostationary orbit launchers was the subject of a certain wait-and-see approach (less than 10 orders placed per year worldwide over the last three years, compared with over 20 the previous years). At the same time, another segment of the commercial market, that of Low Earth orbit satellite constellations⁹, could emerge and offer relays for growth in the coming years.

2 - SpaceX relies on industrial renovation, technological breakthrough and support from public procurement

SpaceX's success was born from the combination of massive public financial support from America, through public procurement, and the success of two gambles, relating to industry and technology.

As regards industry, the gamble consisted of manufacturing a launcher, Falcon 9, on a large scale and on the same site, with a single motor based on proven propulsion technologies. This industrial approach to mass production allowed it to optimise costs and therefore to take an aggressive marketing approach to reduce prices, whilst the overall equilibrium of its economic model is ensured through American orders placed at prices far above market price.

⁸ European Organisation for the Exploitation of Meteorological Satellites.

⁹ Many small satellites working via a network in Low Earth orbit.

This is widely different to the European approach to launchers, which implies a complex industrial distribution involving several production sites in Europe, due to the rules of geographical return, according to which each State is entitled to industrial return on its territory that is equivalent to its investment in development. Furthermore, Arianespace currently exploits three launchers on the commercial market: Ariane 5, Vega and Soyuz, which must cross the Atlantic before being launched from French Guiana.

In technological terms, SpaceX succeeded in reusing one of its launcher's stages, thereby opening the way for new cost reductions, and enabling it to offer even lower prices on the commercial market. With the introduction of the Falcon 9 Block 5 version announced in 2018, SpaceX intends to go even further in this field, with the goal of being able to use the same launcher up to 10 times. On the contrary, at this stage, Europeans have only developed technological building blocks enabling, over time to acquire reusable technology, such as the new Prometheus motor, currently being studied, and the Callisto reusable prototype, two projects launched at France's initiative by the CNES.

3 - Ariane 6, the first response to this challenge, is born of a compromise between European partners and industrialists

Sensing the challenge presented by the progress made by American company SpaceX, in December 2014, French public authorities supported the project for the new Ariane 6 launcher proposed by industrialists from the Airbus and Safran groups. This project is the result of a compromise between the State members of the European Space Agency – and particularly those who are most involved in the European launcher policy (Germany, France and Italy) –, industrialists and space agencies. They aim to reconcile three main objectives:

- gain sovereign access to space for institutional launches, a goal that is recognised to be of strategic relevance, both for the European Space Agency and for the European Union;
- ensure the competitiveness of the European launcher on the commercial market and thereby put an end to public financial support mechanisms for exploitation (balancing subsidy for the exploitation of Ariane 5 provided to Arianespace and funded by the European Space Agency; recapitalisation of Arianespace in 2004 and 2010 subscribed by the CNES);
- entrench the success of the European space policy as regards launchers, by providing for an industrial distribution that enables each contributing State to benefit from industrial 'juste retour' within their territory.

Ariane 6's economic model is based on economies made during the production process, thanks to the launcher's modularity¹⁰ which enables it to better adapt to the evolutions of an uncertain market, an increase in speed with the same powder propellant used for the Ariane 6-2, Ariane 6-4 and Vega C launchers, and industrial integration based on increased responsibilities entrusted to industrialists as regards governance of the Ariane family.

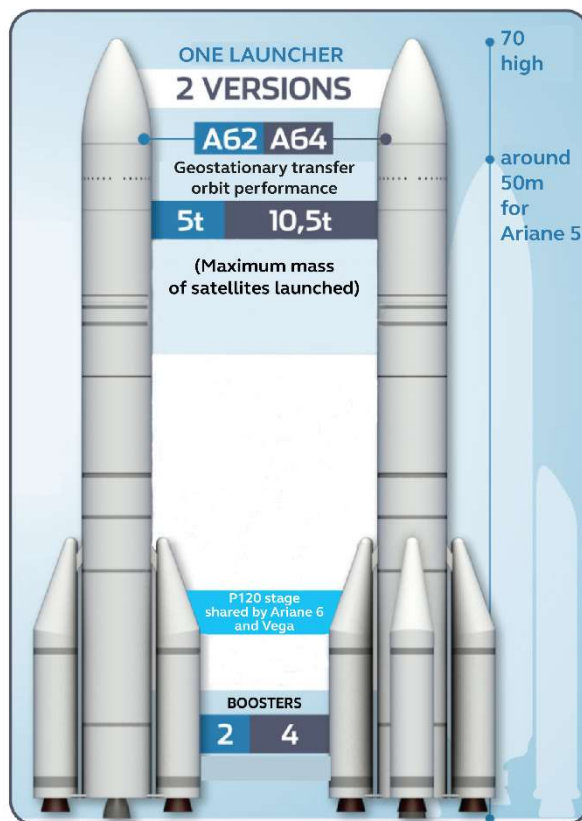
This the Airbus and Safran groups have combined their assets in the field of launchers to create Ariane Group in 2016, which became project manager for the development of the new Ariane 6 launcher. Furthermore, since the repurchasing of the shares held by the CNES, Ariane Group has become the majority shareholder of Arianespace, which markets the launchers.

The goal of this economic model was to quickly achieve the first Ariane 6 launch planned for the summer of 2020, in order to be able to compete with SpaceX's economic model, as it was in 2014. To attempt this, Europeans made the cautious choice of resorting to mastered technologies rather than to the technological breakthrough of reusable solutions, which European stakeholders did not believe in in 2014.

Although the ambitious development schedule for Ariane 6 has been observed, there is a large risk that the launcher will not be sustainable competitive when faced with SpaceX, who continues to progress. This risk is all the greater as the wait-and-see approach taken by the commercial market of geostationary orbit launches and the evolution of exchange rates placed Arianespace in a sensitive position on this market, without being able to benefit from public procurement at a similar level to SpaceX.

¹⁰ Ariane 6 must be able to ensure the both the launch of institutional and commercial satellites in geostationary orbit and the launch of Low Earth orbit satellite constellations. It exists in two versions, Ariane 6-2, with two powder propellants, intended for institutional launches, and Ariane 6-4, with four powder propellants, intended for dual launches into geostationary orbit, i.e. the sending of two satellites into orbit on each launch.

The two Ariane 6 versions



Source: CNES

B - French and European public authorities will need to quickly make decisions to develop Ariane 6

1 - New funding will be necessary to develop Ariane 6 towards renewable technologies

During its ministerial-level meeting planned in Madrid during the second half of 2019, the European Space Agency's Executive Board will need to decide on the evolution of European policy as regards launchers. In particular, due to the progress made by American competition, new development budgets will be necessary to enable European launchers to access this technology.

As regards Ariane 6, the new Prometheus motor, whose initial funding was decided in Lucerne, as well as the Callisto prototype, developed jointly by the CNES and the German and Japanese space agencies, are the first technological building blocks on which European must capitalise to develop a new reusable stage to ensure Ariane 6's necessary development.

2 - The Ariane 6 launcher must be supported by other means than balancing subsidies

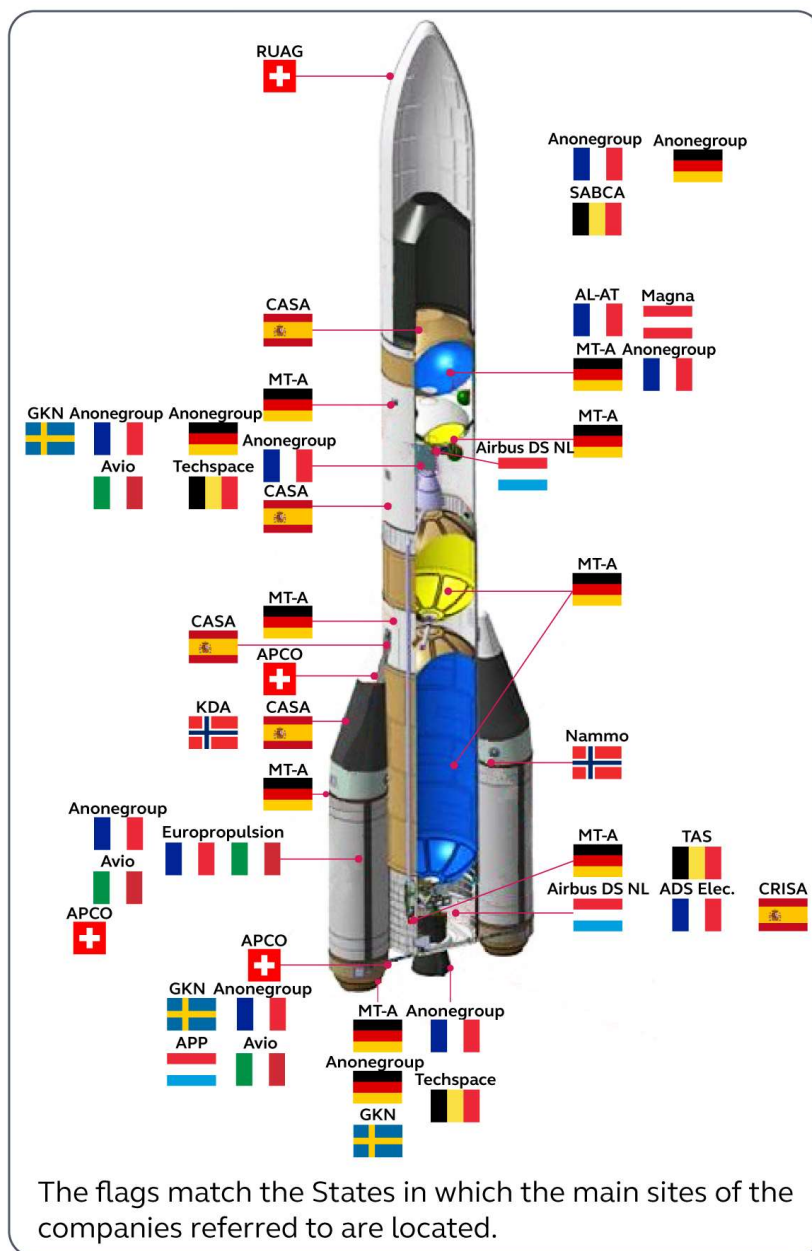
The meetings held by the European Space Agency's Executive Board are also an opportunity to assess industrialists' demands as regards operational support. In this field, the decisions made since 2014 have been limited to assisting with the transition from Ariane 5 to Ariane 6, with Ariane 6's expected competitiveness being meant to put an end to balancing subsidies for Arianespace. In order to encourage all stakeholders in the sector to make necessary competitiveness efforts, government support should indeed take other forms than said balancing subsidies.

Thus, European public procurement for institutional launchers should be solidified: if the main public stakeholders involved - the European Space Agency, the European Union, Eumetsat and the main States - accepted to place multiannual orders for their institutional launchers, industrialists would benefit from further visibility over their planned workload and from the securing of their funding. Furthermore, whilst it is justified that States contributing towards the development of launchers benefit from a geographical 'juste retour' from their investment, these rules for return should at the very least be relaxed. They should in particular be managed in a multiannual and general way across all European space programmes.

Lastly, in the current and future context of strong competition at international level, intra-European competition between the lower spectrum of Ariane 6 and the higher spectrum of Vega C should be limited as much as possible¹¹.

¹¹ The power of a launcher is measured based on the ton-weight of satellites that it can launch and the distance from earth at which it can place them in orbit. From this point of view, Ariane 6 is positioned in the higher spectrum (sending into geostationary orbit of two satellites with a maximum combined mass of 10.5 tons), whilst Vega is positioned at the lower end of the spectrum (sending into Low Earth orbit). The evolutions leading to an increase in Vega's power could result in this launcher competing with Ariane 6 in certain sectors of the commercial market.

Geographical return for Ariane 6



Source: Arianespace

III - Significant budget risks inherent to the space policy should be better anticipated

The funding of France's policy as regards launchers poses significant budget risks, which must be better managed: the risk of a crowding-out effect, related to the need to fund Ariane 6, its future development and new space application simultaneously (A); the risk of political credibility, related to the practice of arrears in payments to the European Space Agency which must end (B).

A - Budget efforts for launchers runs the risk of being made at the expense of other aspects of the space policy

1 - The 2017 trade-offs generated additional appropriations to fund to European Space Agency

Budget programme 193 - *Space Research* for the mission - *Research and Higher Education* of the Ministry of Higher Education, Research and Innovation is the main source of funding for the CNES and, by extension for France's space policy. This programme feeds, on the one hand, the programmes carried out by the European Space Agency, and, on the other, the other space programmes that are often carried out in cooperation with other States and with industrialists. The policy relating to launchers is carried out, for the most part, as part of the European Space Agency's non-compulsory programmes¹².

During the second semester of 2017, French public authorities decided to sharply increase budgetary appropriation to programme 193 on the budget line destined to finance French contributions towards the European Space Agency. This line will gradually rise from €833m in 2017 to €1,376m in 2020, i.e. an increase of €895m during the 2018-2020 period in comparison with the previous trajectory?

¹²The European Space Agency's programmes are divided into compulsory programmes, financed in proportion to the national wealth of each Member State, and non-compulsory programmes, financed only by volunteer States.

Such a significant effort attests to France's constant commitment to the European space policy as regards launchers. First, it aims to clear the debt to the Agency that France had abnormally allowed to build up to €308m at the end of 2017, at the risk of weakening its credibility.

2 - This effort is made at the expense of other space activities

However, France's significant budget efforts for launchers are not only made through new appropriations. Thus, the sharp increase in the budget trajectory, decided in 2017 for the budget line for France's contribution towards the European Space Agency was carried out, in part, by redeploying resources within the CNES. It was thus that €229m were removed from other space activities over the 2018-2022 period, in comparison with the previous trajectory.

The efforts made for launchers therefore risk resulting in a crowding-out effect as regards the resources dedicated to other fields, and particularly orbit systems and new space applications, which are nonetheless an essential part of developing "New Space".

3 - Potential additional public funds, devoted to launchers, should finance innovation as a priority

French and European public authorities will need to simultaneously finance: Ariane 6's development; subsequent technological evolutions to access reusable technology solution, which will be vital to maintain the launcher's competitiveness when faced with American competition and to ensure sovereign access to space; the development of orbit systems and downstream technologies, which will enable Europe to take its rightful place in the "New Space" revolution.

Such funding will need to be provided under restrictions, by taking into consideration the overall situation of public finance. This situation advocated for the potential future public funds for launchers to be devoted as a priority to innovation and not to supporting industrialists' operation.

B - The practice of arrears in payments to the European Space Agency must be definitively put to an end

1 - France must now regularly fund its contributions to the European Space Agency

The resulting budget effort decided by France during the second semester of 2017, to fund its contribution to the European Space Agency, enables it to both consider, as early as 2020, the clearing of its arrears in payment and to improve the situation of the Agency's treasury. The accelerated clearing of arrears in payment had become inevitable, whilst the increase in appropriations decided clears the past and solidifies France's commitment to the Agency at the same time.

Furthermore, the fact of no longer resorting to the facilities of arrears in payment to finance national commitments is vital, both to ensure proper budget management and for the credibility of the commitments undertaken under the European Space Agency.

2 - The multiannual budget planning of the space policy must be improved

Unlike practices for other public policies for investment in long-term projects (such as in the field of armaments for example), budget planning for the space policy is carried out based on an annual rationale consisting of planning commitment appropriations to equal payment appropriations. This practice does not allow for sufficient anticipation of the effects of commitments undertaken by France; on the contrary, it leads to impasses, which have in the past translated into mass recourse to arrears in payment. Indeed, the CNES does not have sufficient budget appropriations to pay the entirety of France's contribution called for by the European Space Agency.

In order to improve this situation, it is necessary for commitment appropriations for budget programme 193 to now be planned in a multiannual manner¹³. These must take into account the amounts that France subscribed to during the meetings of the European Space Agency's Executive Board, even if these amounts relate to development projects that will be staged across several years.

¹³ The Cour had already passed on this message in its special report of December 2012 on the CNES' accounts and management for the financial periods from 2004 to 2011.

IV - Increased participation must be sought from European partners

While France is making the most significant financial efforts, increased participation towards financing the space policy must be sought from European partners (A). This European participation must concern both the development of launchers and the financing of the European Spaceport in Kourou (B).

A - France, who is making the most significant financial effort, must convince its European partners to invest more

In recent years, France's financial investment has resulted in it subscribing to half of the €4b decided to develop Ariane 6, during the European Space Agency's Executive Board ministerial meeting in Luxembourg in December 2014. France then committed to financing 58% of the €431m decided during the ministerial meeting in Lucerne in 2016 and 69% of the €376m decided by the Agency's Executive Board in June 2018.

This financial effort is a long-term one as France is the leading contributor to Ariane launchers since the 1970s. Despite the Kourou agreements signed in 2008 on the funding of Europe's Spaceport, France continues to provide 84% of the launch base's expenses.

The significant financial effort made at national level to promote sovereign access to space, the strategic relevance of which is increasingly European, makes it justified and credible to take an approach consisting of convincing France's European partners to invest more, given that the clearing of its debt towards the European Space Agency enables it to retrieve the influence that it is owed.

B - This investment must concern launchers and Europe's spaceport

1 - The financial effort required to develop Ariane 6 should mobilise all European resources

Currently, the European space policy on launchers is funded by the European Space Agency's non-compulsory programmes. This means that it relies on the voluntary subscription of States, and mainly France, Germany and Italy. Given that sovereign access to space is a deciding factor in the "New Space" revolution and that its strategic importance is now recognised, both by the European Space Agency and the European Union, increased participation from European funding is necessary.

On the one hand, funding from the European Space Agency could be increased by changing the status of launcher development, so that they become compulsory programmes within the meaning of the Agency's Financial Regulations. This would enable contributions from all Member States, in proportion to their national wealth, and no longer only from a few voluntary States, who until now have subscribed to the non-compulsory launcher development programmes.

On the other hand, the European Commission's suggestion to award the space section of the European Union's multiannual budget with €16b for the 2021-2027 period must be supported and directed towards the European Union's participation towards funding launchers, which is not currently the case. This implies that the terms for cooperation between the European Union and the European Space Agency are clarified, which could be done in the European Regulation on Space which is currently being prepared, in a context in which both of these organisations already have experience on working together for major programmes, such as the Callisto geolocation system.

Finally, the European space policy is also a matter for States themselves, who could make further efforts as regards precursory projects under restricted cooperation. Thus, Germany and France financed the development, with contribution from Japan, of the Callisto module which was a precursor to what could be a reusable stage and serve as a basis for future developments intended to help Ariane 6 evolve towards reusable technology.

2 - The Kourou agreements on funding Europe's spaceport should be revised to include the European Union

The Kourou agreements signed in 2008 make the launch base in French Guiana Europe's spaceport. This implies, on the one hand, France providing the base for launches by other European stakeholders and, on the other hand, a shared funding of investments and fixed expenses: a third is covered by States financing the launcher programmes, a third is covered by the European Space Agency in proportion to the gross domestic product of Member States and a third is covered by France.

However, the implementation of these agreements has led France to finance 84% of the costs of Europe's spaceport alone if one takes account of, firstly, the fact that the basis for calculation of the Kourou agreements does not include all operating costs and, secondly, the observation that France is the main contributor towards financing the European Space Agency's launcher programmes.

Further European funding to Europe's spaceport, whether from the European Space Agency or from the European Union, would also be desirable, particularly during a time in which a programme to modernise infrastructures should be put in place to ensure Ariane 6 launches as from 2020. This would imply reviewing the Kourou agreements within a much larger framework to also include the European Union.

3 - The French Guiana space centre must concentrate on launches, the reception of Ariane 6 and the search for competitiveness

The French Guiana Space Centre (GSC) and all Europe spaceport stakeholders must face several challenges. The first is to successfully complete the launch operations for Ariane 5, Vega and Soyuz, in a context marked by an increased launch rhythm: 11 launches were thus carried out in 2017.

Europe's spaceport must prepare for the arrival of Ariane 6 in 2020, which goes beyond the construction of the new ELA4 launch complex. Indeed, this implies reviewing the site's organisation, particularly in terms of security, and carrying out investments to modernise infrastructures. It is highly desirable that this modernisation programme is carried by European stakeholders.

French Guiana can contribute towards this effort, so long as the actions to assist the territory improve its ability to locally train space technicians and executives and therefore aid in reducing the volume of staff sent from metropolitan France.

These challenges are significant enough that they will take all of the energy of Europe spaceport's stakeholders, which advocates for the GSC to be discharged from the daily management of funds that it dedicated to assisting the territory.

Indeed, the presence of high-tech space activities in French Guiana generates legitimate expectations from the territory as regards economic and social impacts, and the GSC has long carried out actions to assist the territory: thus, it devoted around €50m to such actions between 2007 and 2013; a similar amount is planned for the 2014-2020 period, €12.5m of which in 2017. Nonetheless, the management of this fund follows a window logic leading to appropriations being spread too thinly.

The State is the best-placed and most legitimate actor to coordinate this action under the State/French Guiana territorial authority planning contract, which should include the Phèdre II plan¹⁴. The CNES' contribution should be subject to a fixed inscription in the planning contract, even if this means that the GSC directs funds towards actions that are particularly useful to it, such as higher education in the Space field for example. The State would therefore be able to ensure coherency across all actions taken under the planning contract to better benefit the territory¹⁵.

CONCLUSION AND RECOMMENDATIONS

The Cour warns of the challenges that the space launcher policy faces today, a policy which, now more than ever, is of a major strategic interest as regards sovereign access to space for Europe and for France, in the context of the "New Space" revolution. Public finances will indeed need to simultaneously support: Ariane 6's development; the technological innovations necessary for this launcher to evolve towards reusable technology in order to maintain its competitiveness; orbit system projects, which offer promising perspectives in the field of new applications allowed by the space field.

¹⁴ Action plan for the economical and social development of French (Phèdre II) signed by the Minister of Overseas Territories and the Minister of Higher Education and Research.

¹⁵ Good coordination must be ensured for the interventions allowed by European funding, under the cohesion policy in outermost regions. The Cour highlights that for this French Guiana territory, insufficient performance in the selection of projects and in the implementation of subsidies to European Structural and Investment Funds (See. Volume I, Chapter IV, 2 *The management of European Structural and Investment Funds (ESIF) overseas: mixed results, a performance approach that should be consolidated*).

Given that this is a European policy, important decisions will need to be taken involving all partners: the European Space Agency, whose Executive Board will meet at ministerial level in 2019; the European Union, in a context in which new legislation could produce the adoption of a regulation on space and the increase in the budget portion awarded to space; States and industrialists.

It is a matter of Europe remaining a space power in the foreground, in a context marked by significant progress currently made by American competition, with powerful support from public procurement.

In such a context, the Cour issues six recommendations to public authorities:

- 1. where new public funds are to be allocated in support of the launcher family, give priority to technological innovation rather than support to operation;*
 - 1. seek further involvement from European partners and the European Union itself;*
 - 2. put a definite end to the practice of arrears in payments to the European Space Agency;*
 - 3. improve the space policy's budget programming by programming commitment appropriations to budget programme 193 - Space Research - of the Higher education and research mission on a multiannual basis;*
 - 4. during the 2019 European Space Agency ministerial meeting, suggest an ambitious plan to modernise Europe's spaceport and guide the Kourou agreements towards further European participation towards funding the space centre;*
 - 5. refocus the spaceport around its core activity, by leaving the responsibility of steering and managing French Guiana's development projects to the State, with financial support from the CNES.*
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Recipient having no observations

Chair of the Centre National d'Études Spatiales (CNES)
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Recipient having not responded

Ministry of Public Action and Accounts
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RESPONSE FROM THE MINISTER OF ARMED FORCES

First allow me to highlight the quality of the Cour's work on this topic; its report places emphasis on challenges that I fully support. This is the case in particular of the strategic importance, now more than ever, of sovereign access to space for Europe and for France in a context of democratisation of access to space and heightened competition between powers.

Regarding the recommendations issued by the Cour which I fully support, three analyses and observations developed by the Cour in particular call for observations on my part.

Firstly, the Cour argues for a relaxing of geographical return, and suggests that it be taken into account in a multiannual and multi-programme framework. It is no doubt necessary to go beyond such a relaxation, and to call into question the very principle of geographical return, given that it is the cause of a significant lack of industrial optimisation, arising from the addition of contract management layers, on the one hand, and the duplication of skills in Europe, on the other.

In particular, when a country such as France has already reached its quota, its skills can no longer be benefitted from and the ESA's funding is therefore affected to redeveloping skills in another country, as part of a rationale that may subsequently seem as sub-optimal, a fortiori in a highly competitive sector. However, I note that Ariane 6 will not, at this time, be able to benefit from a relaxing of industrial rules of return due to the programme's progress.

Secondly, on the longer term, the Cour takes it for granted that "reusable technology solutions, will be vital to maintain the launcher's competitiveness when faced with American competition and to ensure sovereign access to space". However, this implies building a viable economic model in a European market that is smaller than that of the United States, and in a context in which maintaining industrial know-how and skills requires minimal production. This also implies analysing in detail the consequences on the strategic ballistic missile sector which would arise from abandoning powder boosters for civil launchers.

An equal balance will therefore need to be sought and studying a launch with reusable components remains relevant.

In any case, the sovereignty of access to space has a cost, which must be better divided between Europeans, as described by the Cour in its report.

In this respect, the Cour recommends multiannual orders for the institutional launches carried out by the main public stakeholders involved, including the main States. We could add that beyond multiannual commitments, the commitment to launching institutional satellites using European launchers would already constitute a large step forward.

Indeed, France, no doubt accompanied by Italy due to Vega, is the only major State stakeholders that systematically applies this European preference, in coherence with the policy on sovereign access to space.

In this respect, all European stakeholders should further contribute towards the launcher sector via institutional orders.

Lastly, although I share the Cour's analysis on the French Guiana spaceport, one must also take into account the attractiveness of this market for our European partners. Technically speaking,

Kourou is well-suited to the launch of geostationary satellites. However, this market segment is getting smaller. Thus, strong financial backing could encourage our partners to opt to use alternative launch bases such as in Portugal (Azores), or Norway, which are better adapted to low-Earth polar orbits.

RESPONSE FROM THE MINISTER OF HIGHER EDUCATION, RESEARCH AND INNOVATION

I would like to add the following in response to the six recommendations issued by the Cour to public authorities in the conclusion to its insert.

I agree with recommendation no. 1 which invites us, "where new public funds are to be allocated in support of the launcher family, [to] give priority to technological innovation rather than support to operation".

New public funds in support to the launcher family must not be provided at the expense of innovation for satellite technologies.

However, it is vital to complete the development of the Ariane 6 launcher as this will generate a reduction in the cost of launches compared with the existing Ariane 5 launcher.

At the same time, the Ministry of Higher Education, Research and Innovation (MESRI) will suggest accelerating the development of new technologies to prepare for after Ariane 6, using the low-cost reusable Prometheus motor and the retrievable stage demonstrators Callisto and Themis.

I also support recommendation no. 2, which recommends that we “seek further involvement from European partners and the European Union itself”.

We must build a European institutional market and these efforts have come to fruition with the Vega launcher, however this remains to be done for Ariane 6.

The European Commission and the European Space Agency (ESA) have committed to using European launchers for their space programmes.

Furthermore, five European states (France, Germany, Italy, Spain and Switzerland) committed, during the ESA’s ministerial committee of 25 October 2018, to using European launchers for their institutional satellites as a priority.

The possible transition of the launcher sector into the ESA’s compulsory programme would result, with the current rules of geographical ‘juste retour’ on investment, in a more complex industrial organisation with consequences on the cost price. In addition, in order to improve the future launchers competitiveness with respect to American competition in particular, discussions are in progress with the ESA to set out terms favouring an optimisation of the cost price.

As regards recommendation no. 3 to “put a definite end to the practice of arrears in payments to the European Space Agency”, I recall that France has made significant efforts to reduce its arrears in payments to the ESA, with the goal of clearing this debt by the end of 2020.

Thus, France’s participation as set out in the ESA’s Medium-term plan (MTP) is as follows: €965m in 2018, €1,175m in 2019, €1,376 in 2020, and €1,033.4 in 2021 and 2022. As a reminder, the amount of France’s participation in 2017 totalled €833.4m.

Furthermore, the Cour invites us to “improve the space policy’s budget programming by programming commitment appropriations (CA) to budget programme 193 “Space Research” of the “Higher education and research” mission on a multiannual basis” (recommendation no. 4)

The MESRI’s General Directorate for Research and Innovation (DGRI), as well as the Directorate for Budget (DB), have always considered that the handling of France’s contribution to the ESA via CA, different to PAs (programme appropriations), is not compliant with the nature of this annual contribution which is only legally binding after the Agency’s annual budget has been voted.

Furthermore, it is the same logic that governs the budgeting of all French contributions to international scientific organisations, except when these contributions are made in kind and involve investments that can be managed as CAs different to PAs.

The commitments made by France when it decided to subscribe to an ESA programme are monitored on a multiannual basis under the MTP (Medium Term Plan) and treated for accounting purposes as the State's off balance sheet commitments, in accordance with the Cour's recommendation in 2008.

The MESRI supports recommendation no. 5 to, "during the 2019 European Space Agency ministerial meeting, suggest an ambitious plan to modernise Europe's spaceport and guide the Kourou agreements towards a larger European participation towards funding the spatial centre".

Modernising the French Guiana Space Centre (GSC) is fundamental. Europe must be encouraged to fund the spaceport, which must be considered one of the "main European infrastructures".

This idea is gaining momentum, particularly for the European Union's draft Space regulation, but is still faced with strong resistance from some states.

Finally, as regards recommendation no. 6, by which the Cour invites us to "Refocus the spaceport around its core activity, by leaving the responsibility of steering and managing French Guiana's development projects to the State, with financial support from the CNES", the MESRI would like for the CNES to continue to be involved, in collaboration with the State's authorities (prefecture) and the territorial community of French Guiana, in the development of French Guiana.

The CNES' participation towards these projects is important for the Guianese population.

In the Government's report to the Parliament of 11 December 2017 on the economic impacts of space activities in Guyana, it reminds that the Space sector is the leading private employer within the territory and the leading contributor in terms of wealth, with 17% of the GDP.

RESPONSE FROM THE MINISTER OF OVERSEAS TERRITORIES

This report highlights the Kourou base's strategic interest for Europe, for France and for the Guianese territory.

I fully support the analyses and recommendations made by the Cour, and particularly the rationalisation of relations between the French Guiana space centre and the Guianese territory, for which the State's departments have been mobilised.

More specifically, in point IV.B.3. you highlight that the French Guiana space centre must concentrate on launches, the reception of Ariane 6 and the search for competitiveness, an analysis that I fully agree with, with support from by departments and the French Guiana prefect.

In its conclusion, the Cour recommends that the CNES's contribution towards the Guianese territory "be subject to a fixed inscription in the planning contract" between the State and the Guianese territorial community. It highlights that "the State would therefore be able to ensure coherency across all actions taken under the planning contract to better benefit the territory".

I must state that, in collaboration with Frédérique Vidal, Minister of Higher Education and Research, I launched, on 11 December 2017 the action plan for French Guiana's economic and social development (Phèdre II). Its objectives are threefold:

- increase the space sector's contribution to the Guianese economy;*
- render the space sector's contribution, which today is quite fragmented, more legible and more effective;*
- better involve the Guianese population and their representatives in the space sector's actions for French Guiana.*

This translates into an additional €10m from the CNES for the Guianese territory, via an agreement between the CNES and the University of French Guiana, as well as via an agreement between the CNES, the public interest group FCIP of the French Guiana Education authority Academy.

As hoped for within the government, the "Phèdre II" plan is therefore more than a mere planning contract as it involves all territorial authorities within the territory and in particular, besides the Guianese territorial community, the 22 municipalities and the 4 inter-municipalities within the territory. I also hoped for the Guianese prefect to be further involved in the governance of this mechanism, by performing the necessary coordination role that the Cour recommends, between the State's departments on the one hand, and between the State and local authorities on the other.

More generally, I attach importance to the “Phèdre II” plan becoming the basis for the collaboration that the Cour would like to renew. Indeed, I consider that a simple inscription in the planning contract would break the necessary link between the French Guiana space centre and the multifaceted stakeholders in French Guiana and would risk further corroborating the Guianese population’s feeling of neglect.

JOINT RESPONSE FROM THE CHAIR OF ARIANEGROUP AND THE CHAIR OF ARIANESPACE

Arianespace and ArianeGroup would like to thank the Cour des Comptes for its work, which provides an update to the challenges relating to space launchers that were already analysed in a previous report during the decision to develop Ariane 6 in 2014 and underlines the critical decisions that need to be made in 2019 to solidify Europe’s access to space.

The media coverage of the 100th Ariane 5 launch from the French Guiana Space Centre (GSC) last September was a reminder that Europe possessed the most reliable commercial launcher in the world. This reliability and quality of service are appreciated by Arianespace’s clients and envied by its competitors. With the flexibility and competitiveness gains that Ariane 6 will provide in 2020, Europe will be even better equipped to face global competition and prepare to take over the commercial market, which will not fail to take on more diverse shaped than in the past.

We share the Cour’s opinion by which it underlined the importance of collective awareness in Europe: launchers develop on an uncertain market, faced with competition that is massively supported by its own national public authorities. The decisions made in 2014, which set up a new governance based on an ambitious industrial and institutional organisation, have allowed to quickly start developing a new launcher under a limited budget; these are based on the consideration of three imperatives:

- firstly, to improve the global competitiveness of the European launcher sector. In this respect, industrial consolidation, having resulted in the creation of ArianeGroup and combined with massive efforts from the industrial sector in terms of competitiveness and financing (€400m in equity investments into the development of Ariane 6, i.e. 10% of the programme’s envelope), will allow to reduce the launcher’s costs;*

- secondly, the multiplication of mission profiles (electric propellant, constellations, etc.) called for a modular, flexible launcher with relighting capabilities in order to meet market expectations and maintain leadership of the commercial market;
- lastly, it was key for Europe to possess a launcher capable of sending European institutional missions into orbit, which was only marginally the case for Ariane 5.

Ariane 6 was therefore Europe's best response to the industrial, technological, institutional and commercial challenges. Its architecture is not set in stone and ArianeGroup is already discussing the next cycle of innovations applicable to Ariane 6 with the CNES' teams in order to take into account the quick developments occurring as regards the market, competition and technology. This is the point of the low-cost Prometheus motor, but also of a light upper stage.

Less than two years from Ariane 6's first launch, it is now vital to secure and develop the partnership between the agencies and the industry that was set out in 2014. This consolidation relies firstly on a Europe that commits to a "Buy Europe Act", which will enable European business to fight their competitors on an even playing ground. Without confirmation of Europe's institutional commitment, through long-term group orders for the launch of European institutional missions, the sector's economic equilibrium is at stake. This commitment will also solidify the European industry business plan, formalise the production of a first batch of Ariane 6 launchers and ensure optimal transition from Ariane 5 to Ariane 6.

Secondly, this securitisation cannot occur without an evolution in the overall governance of the sector, similar to the reform carried out by NASA during the 2000s, to return American rockets to flight at a competitive price following the end of the Shuttle programme. Firstly, this requires a clearer distribution of the roles and responsibilities taken on by the European Space Agency and the European Commission. In parallel, national space agencies cannot forego discussions on the necessary economies that must accompany the competitiveness gains initiated by industrialists, in particular ArianeGroup and Arianespace who announced a reduction in workforce representing 2,300 posts over the next four years. The entire European space community must recover some room for manoeuvre and relax, as much as possible, the restrictions of geographical return which cause excess production costs, and which compound exposure to exchange risks (Ariane 6's production costs are billed in euros and commercial revenue on the global market are in dollars).

Unlike other space powers which can rely on high interior demand, the sustainability of the European model relies on its ability to meet the commercial challenge: from €20,000 per kilo placed in orbit by Ariane 5 previously, the goal is to reduce this cost by 40% with Ariane 6 as early as 2020, and then to reach a new stage with Ariane 6 Evolution as from 2025, whilst preparing for reuse, if adapted to the model of missions effectively accessible to Ariane 6. This requires us to prepare for the future through ambitious R&T programmes to continue to gain in competitiveness compared with the costs targeted by Ariane 6 through the introduction of more disruptive developments such as an ultra-light carbon upper stage and a future low-cost motor, Prometheus, which will propel the first European reusable demonstrator, Themis. The ESA's 2019 interministerial conference should allow to launch such funding whilst renewing the sector's governance through relaxed geographical return.

In sum, ArianeGroup and Arianespace share the Cour's recommendations aiming to ensure more effective governance, clearer budget planning, further participation from European partners and further priority to technological innovation programmes to prepare future Ariane 6 developments. Far from weighing on the European space budget (in 2018, the launcher family only used around 20% of all European, ESA and European Union budgets included), the Ariane programme is the basis for an ambitious Europe in space capable of bringing together all Europeans around an adventure that they are proud of and a future project that is vital to their sovereignty.