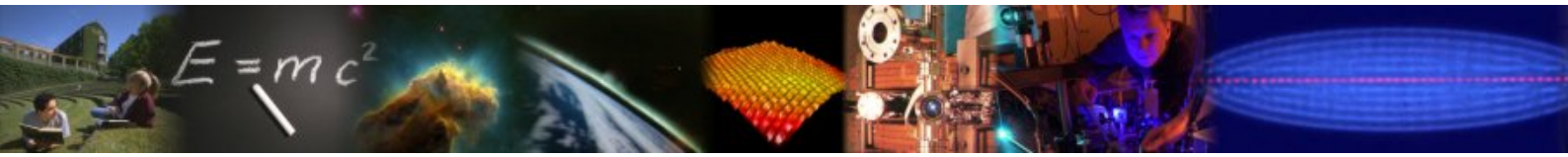
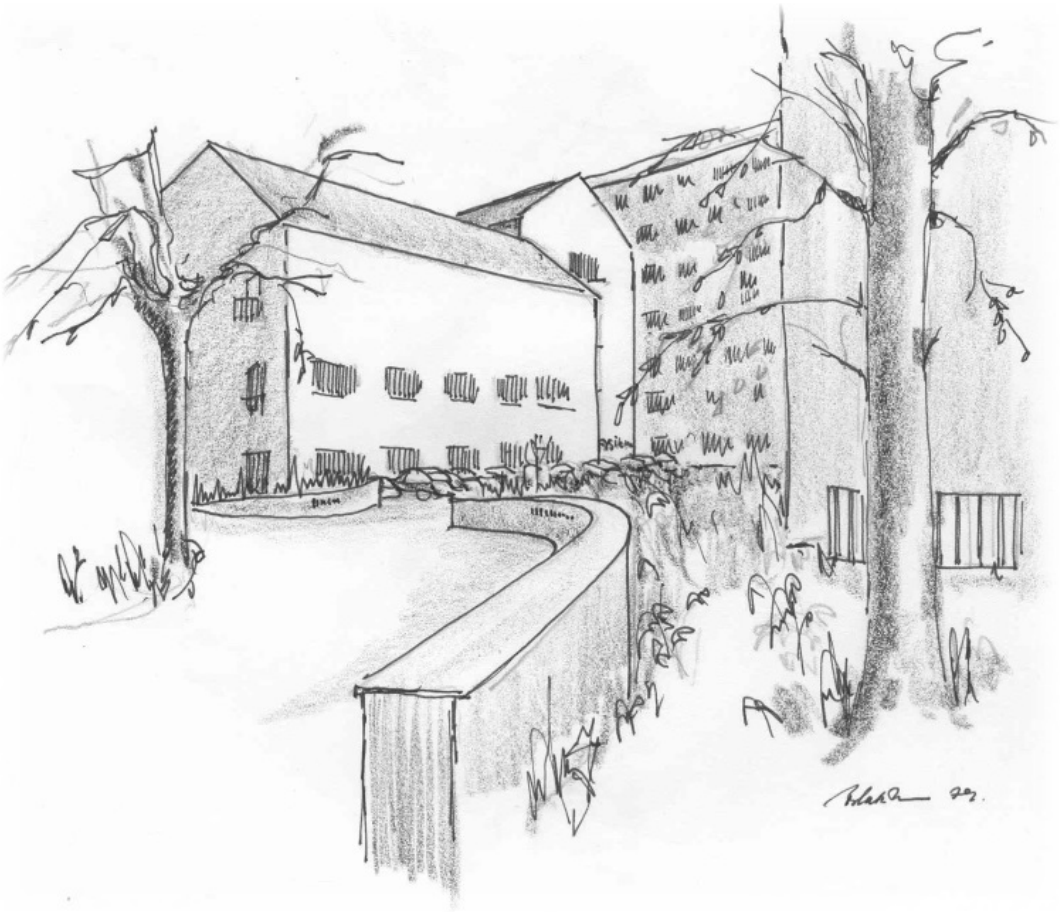
AARHUS
UNIVERSITY
DEPARTMENT OF PHYSICS AND ASTRONOMY



STRATEGY
2016-2020

Department of Physics and Astronomy



1. Introduction

The Department of Physics and Astronomy (IFA) at Aarhus University (AU) offers excellent education and research, good infrastructure and broad cohesiveness. It has a good admission of new student – the third highest at the Faculty of Science and Technology (ST). We have successfully implemented a special track (IFA-challenge programme) for talented students, who seek additional challenges within their field of research.

Physics is fundamental for our basic understanding of nature and forms the foundation for a wide range of technologies. The research performed at the Department reaches from the smallest of scales to the largest in the universe. We cover a wide range of areas such as cosmology, exoplanets, quantum phenomena, light absorption in proteins and solar cell research, and the gap between basic research and technology is continuously decreasing. Sprung from the institute are different research initiatives and interdisciplinary centres, i.e. 'The Institute for Storage Ring Facilities in Aarhus' (ISA) with the synchrotron light source ASTRID2, iNANO, the 'Atomic Mass Spectrometry' (AMS) centre, and the Stellar Observation Network Group (SONG). These initiatives have their foundation in the ability of the Department to develop experimental equipment of a very high standard.

Our university is part of an international community in constant movement. The Department continuously has to adjust for and encounter the new challenges and opportunities that lie ahead. This strategy report outlines how we view our tasks in the coming 5 years, and how we address the most significant challenges that relate to our field of research. All the activities build on a desire to understand the basic physical laws both in a fundamental sense and in the complexity as revealed through measurements.

It is of utmost importance for the development of the Department to recruit the right/best candidates and to add the right academic profiles to the Department. This strategy report therefore also contains a recruitment strategy and plan.

The strategy report has been drawn up with broad participation from the Department. The subjects have been discussed at residential meetings and at several joined meetings for the scientific employees of the Department. During the process there have been co-editors responsible for summarizing the conclusions within the subjects: research, education, talent development, technical infrastructure and knowledge exchange/ industrial collaborations. These contributions form the basis for this strategy report, which is adopted by the departmental management team.

The purpose of the strategy is to point to the future. What do we want to achieve and how to achieve it.

Please enjoy .....

2. Vision, Mission and Executive Summary

The primary mission of the Department is to:

- Perform research at the highest international level with the purpose of gaining fundamental insight in the areas of physics and astronomy.
- Offer and further develop research-based education within physics and astronomy at the highest international level.
- Collaborate with external national and international partners within knowledge exchange and development.

These goals will be ensured through focus on excellence in all aspects (research, education, recruitment, administrative and technical support).

Our vision is to be in the lead, nationally, within several sub disciplines of physics and astronomy. We want our research to be internationally recognized and respected, broadly utilized and published in the highest impact journals.

The quality of the research performed at the Department should stand comparison to the strongest international research communities.
IFA has a strong international profile and a substantial network of collaborations. The researchers of the Department publish their results in the most prestigious journals and exhibit international ambitions, for instance by attracting ERC Starting, Consolidator and Advanced grants in strong competition. Great emphasis is given to professional qualifications.

In addition to a high academic level, excellent research requires a sound economy, which we ensure through professional administrative support at grant applications. In addition, we encourage our researchers to enter into relevant scientific communities that may increase chances for funding.
We experience that the competition for funding both within basic and applied research has increased. We will target three aspects: **i)** optimize the success rate at the application stage (pre-award) though administrative support, **ii)** exploit more strategic research constellations, **iii)** increase the relative number of the research grants related to technology and industrial collaborations.

An important competitive parameter for the different scientific disciplines at the Department is the ability to develop research equipment of very high quality. This requires dedicated Technical and Administrative Personnel (referred to as TAP staff) with the strongest possible qualifications.
IFA has unique facilities and a good technical infrastructure. There is a broad diversity in the research areas, theoretical as well as experimental, and several examples of fruitful interdisciplinary collaborations. The heads of the technical divisions ensure that their staffs continuously improve their qualifications to meet the current demands of the scientific researchers (referred to as VIP staff).

The Department strives to appear as a dynamical unit with great cohesiveness that jointly solves the core tasks. The key values of the Department build on trust and respect across professional boundaries.
We will insure cohesiveness through good communication, conducting joint meetings with open discussions. Furthermore, we encourage the researchers at the Department to collaborate and hereby strengthen both the specific research as well as the possibility to attract external funding. We aim at integrating administrative employees at ST in the Department's environments to secure an efficient handling of the administrative tasks, and we encourage that all employees display flexibility in executing their tasks. The success of the Department builds on professional expertise, trust, openness and commitment.

- We wish to support the investment at ST within Material Science where the Department holds particularly strong competences and infrastructure. In extend we will work with central themes such as "Space Science and Technology" and "Quantum Technologies".

- The Department wishes to exploit the unused potential for business relations through increased collaboration with the Department of Engineering and other departments. The semiconductor group already does this in exemplary manner, however, there is potential in several groups.

- In the first instance the Department wishes to strengthen the experimental and theoretical activities within Material Science through two new positions. Furthermore, we will build a new theoretical activity around 'Quantum devices/phenomena' with both fundamental scientific and technological potential, for example in interaction with investments within nano-science and engineering.

3. Organization and Physical Surroundings

The daily management is undertaken by

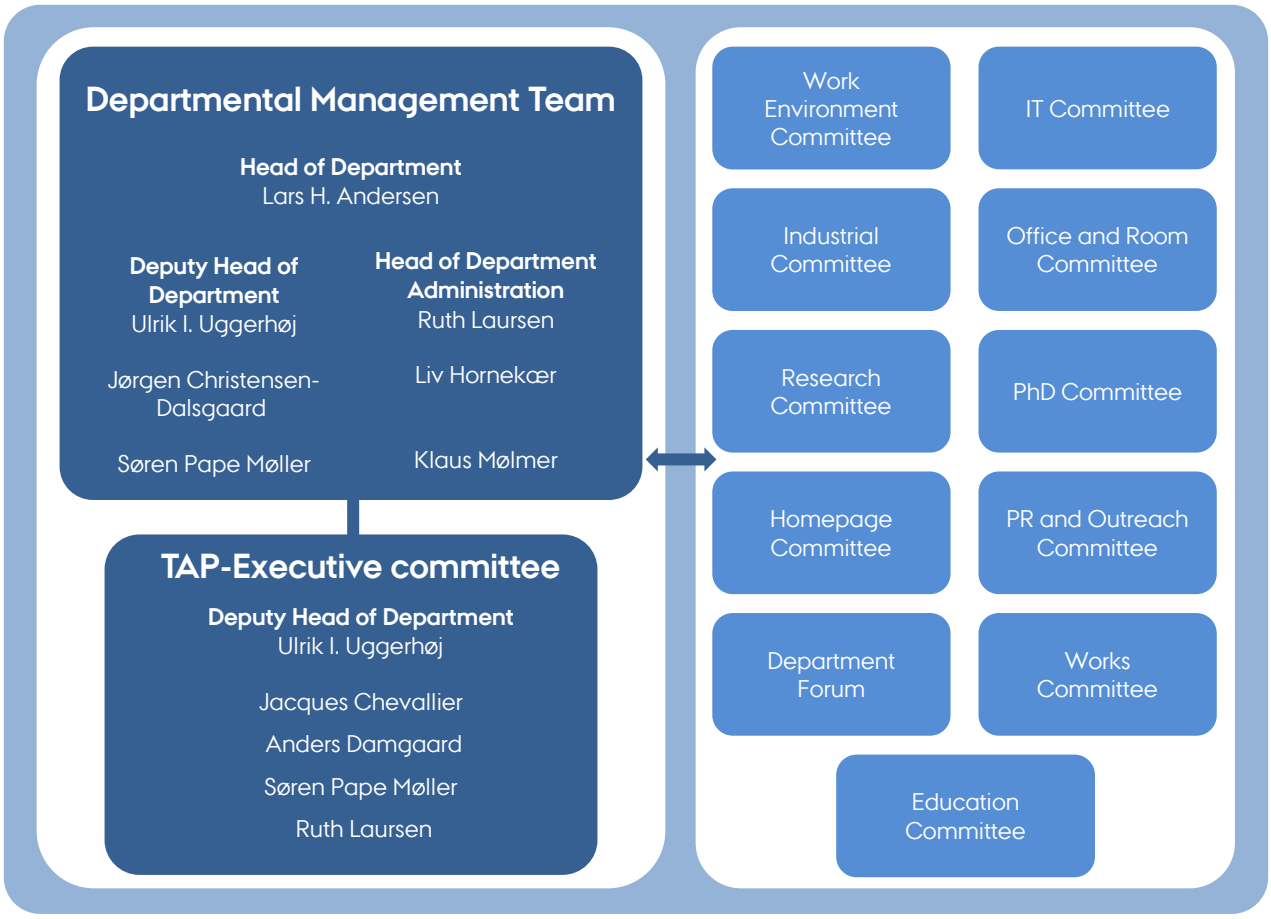
Head of Department:	Lars H. Andersen
Deputy Head of Department:	Ulrik I. Uggerhøj
Head of Department Administration:	Ruth Laursen

The Department Management Team is appointed by the head of the Department and consists of a range of key staff members representing the employees of the Department.

Technical-administrative tasks are further treated in a **TAP Executive Committee.** The committee is appointed by the head of the department. The TAP Executive Committee is currently led by the deputy head of the department. In addition the committee consists of the head of the department administration and the heads of the technical divisions: Support Team/ISA, Mechanical Team and Chemistry/Cleanroom.

The Strategic Research Management is taken care of by the head of the department in collaboration with the Research Committee, primarily consisting of the professors from the Department.

Strategies in relation to recruitment of scientific employees are executed in accordance with the recruitment procedures approved by the Department. Main tasks such as education, PR, homepage etc. are handled by a range of committees, appointed by the head of the department. Each committee has clearly defined terms of references. In addition, the Department also has a well-functioning Works Committee and Department Forum.



The experimental research at IFA is strongly dependent on a highly educated TAP-staff and modern workshop facilities. The major renovations in recent years have left IFA with exceptionally good facilities that we view as future-proof for years to come.

IFA has a strong technical and administrative infrastructure. This structure has enabled the construction of large and important research instruments at the Department and simultaneously underlies the technical knowhow for all of ST in connection to interdisciplinary initiatives (Scientific Computing Center, ASTRID2, AMS, clean room, Wind Tunnel, etc.). Accelerator technology continually plays a prominent role at the Department and has contributed to the fact

that Aarhus is now building one of the largest particle therapy centres at the Aarhus University Hospital in Skejby.

4. Employees and Culture

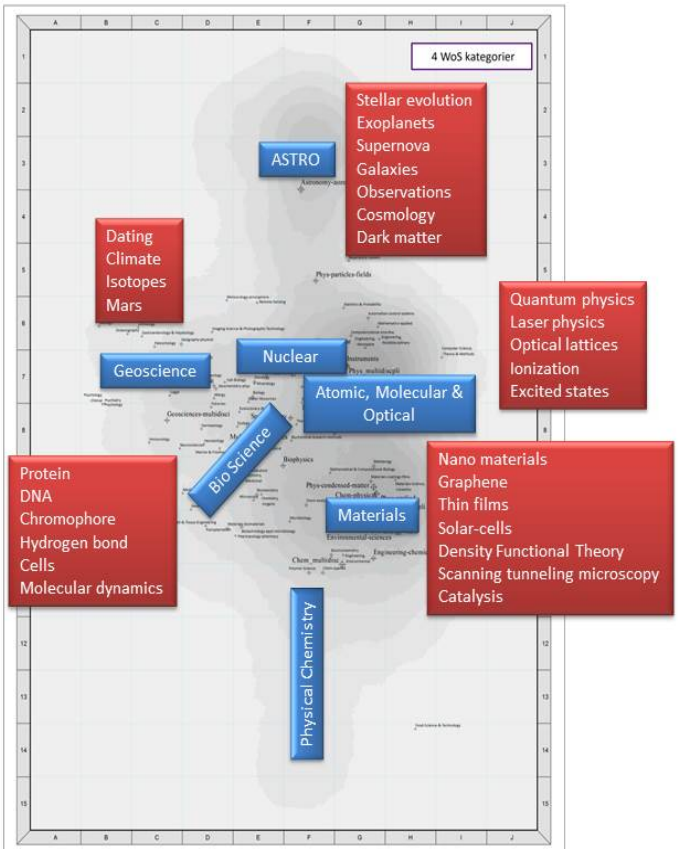
IFA is a Department with 32 tenured scientific employees, 46 TAP (including ISAs technical staff), 54 postdocs and guest researchers and 75 PhD students. It is the intention of the department management to create the best work-related and social boundary conditions for the employees. We wish to create a team spirit where cooperation takes place in confidence and trust, and where the employees become responsible players in decision-making and planning. The department management prioritizes skill development of the employees. Through the specific divisions we take care of the development and further education of all the employees in their specific field and in relation to the changing requirements of a workplace in constant development.

An analysis of the Department's employee demographics is found in appendix a.

5. Overall Objective, International Position and Positions of Strengths

The main areas of research at IFA can be divided into Atomic, Molecular and Optical (AMO) Physics, Biomolecular Physics, Few-body and Subatomic Physics, Material-, Condensed Phase- and Surface Physics, Astrophysics and Astronomy, in addition to interdisciplinary groups such as Accelerator Mass Spectroscopy (AMS) and ISA, maintaining the synchrotron facility ASTRID2. Several of these areas are divided into smaller groups, all with significant international visibility. At the time of writing the permanent staffs consists of 21 experimental physicists (added to this 6 TAP and 1 VIP at ISA) and 11 theoretical physicists.

A graphical representation of a Web of Science (WoS) bibliometric analysis of the publications from the Department gives a good overview of the activities. The metric is determined by the academic key words. It shows Astrophysics as partly separated, great activity centred on AMO and Material Science and a large fraction of research with outreach to other disciplines such as Geoscience, Bioscience and Chemistry.



Graphical representation of the publications from IFA. The academic landscape is based on articles and key words that appear together. The density (e.g. the areas of the landscape with the highest number of publications) is given by the grey scale. The analysis is based on approximately 1700 articles from the Department. The red boxes indicate specific keywords located at specific positions of the landscape.

Several smaller research groups consist of a single VIP and his or her postdocs and PhD students. However, resources, academic discussions and collaborations are shared across the groups. We strive at a common understanding and mutual respect between the research groups, among others through residential meetings, debates and broad representation and participation in the committees and councils at the Department.

The Department engages in activities at international research facilities, among others in Hamburg and at CERN. Especially the long relation to CERN has influenced the research and technological development of the Department. The use of ASTRID as a synchrotron radiation facility originally started through transfer of accelerator and vacuum knowhow from CERN and this has since lead to the involvement of the Department in the particle therapy centre at the Aarhus University Hospital. Extended use of earth based astronomical observatories (NOT, ESO) have led to the development and commissioning of the first SONG-telescope in Tenerife. New research activities, for example at the European Spallation Source (ESS), with neighbouring institutes are supported technically by our workshops. The Cleanroom at iNANO is being used by several research groups from the Department and its operation is secured through our TAP-staff in collaboration with iNANO

The overall objectives are formulated through our three mission statements. Above all, it is our primary mission to gain a deeper fundamental insight into natural sciences. Everything,

however, is neither equally interesting nor important. The challenge lies in deciding which of the many possible research areas (there is a large diversity in the topics of physics) we should invest in, while preventing the size of the specific areas to reach subcritical levels. Our vision is to be in the lead, nationally, with regards to research, education and knowledge exchange. More details will be given in section 7.

6. Analysis of the Strengths and Weaknesses of the Department

IFA has unique facilities and a good technical infrastructure. There is a broad diversity in the research areas, theoretical as well as experimental, and several examples of fruitful interdisciplinary collaborations. IFA continues to have a strong national profile and a large international network, dedicated employees and in general high satisfaction with the work conditions. Several laboratories and teaching rooms are newly renovated and no larger premises remain unused. The decrease in staff together with the increase in the number of students throughout the last 10-15 years, has resulted in a relatively high teaching load of the VIP (on average approximately 50% according to own standards). A fierce competition for research funding has resulted in wasted efforts on unfunded applications. The contradictory requirement, in connection to successful applications, to cover existing research related expenses together with co-financing from the Department imposes a great challenge.

A limited number of retirements are expected with only 3 VIPs turning 70 towards 2020 (and the following not until 2025). A renewal among the VIP staff through new recruitment is desirable and needed to encounter the increased teaching load (partly due to the new IFA challenge programme) and to be able to operate with new focus areas.

Parts of the employees at IFA have their day to day activities at iNANO, especially related to the centre activities within materials (primarily semiconductors and surfaces – both theoretical and experimental). The Department views these as core physics activities.

SWOT Analysis of the Department of Physics and Astronomy

Strengths	Weaknesses
• Strong research environment (theory and experiment) • Education of high scientific standard • Good study environment • New IFA 'Challenge track' line • Committed employees (TAP & VIP) • Several centres (SAC, ISA, NICE) • Internationally competitive students • Good research equipment • Good infrastructure (e.g. construction) • Strong national profile • Large international network • Good external funding statistics • Relatively open research environment	• Uneven gender profile • Tendency towards group sizes reaching a critically low level • Small share of applied research
Opportunities	**Threats**
• Expansion of interdisciplinary collaborations • New opportunities with ASTRID2 • Cleanroom facilities, Wind tunnel, AMS • Unused potential in funding possibilities in connection to innovation • More EU funding • Recruitment of new research leaders • Extended collaborations between theory and experiment	• Limited economical latitude • Large time consumption at funding applications • Insufficient funds within the Danish National Research Foundation • 'Migration' of women after PhD • Large teaching load / VIP

7. Strategy 2016-2020

The following account of the Department's strategy has been drawn up from incoming contributions together with the considerations of the departmental management team.

a. Flagships

It is unquestioned and consistently pointed out by almost all of the employees at the Department, that the Astronomy Group at IFA represents a research-related flagship. The group has gained high international visibility by bringing together the qualifications of several talented scientists. Several students and strong young researchers are recruited, and the group is in the lead in several projects of high international attraction. The group also has strong collaborations to other departments at the Faculty of Science and Technology such as the Departments of Engineering, Geoscience and Bioscience.

The Department has been through a long academic development, and lately established a MSO professorship in close collaboration with iNANO and the Department of Engineering. This development has made it possible for the Material Physics Group to consolidate and obtain larger grants within material and energy research. There is great potential that collaboration across more departments could evolve into a flagship.

IFA is the only department in Denmark with accelerators of significant importance and the complex of accelerators gives IFA a unique national and international position. We expect that the new beamlines at ASTRID2 for nano- and atomic scale physics will attract external scientists and will form the basis of a flagship together with the relevant research groups of the Department.

We point to areas with the potential for collaborations across of ST (to be elaborated later):

- Properties of Materials
- Space Science and Technologies
- Quantum Technologies
- Bioscience
- Climate

IFA has a range of smaller groups with high research output and substantial academic and economic resources. It is both a challenge and a dilemma, on the one hand to ensure diversity and renewal of the efforts of individual researchers, and on the other hand to coordinate research and create "flagships" with the prospect of applying for funding related to larger centres. Hence, it is important that the focus on flagships is not demotivating for the innovative research that is best performed in smaller, adaptable units. IFA, therefore, has a recruitment strategy that favours to complement, rather than to duplicate existing competencies. At the same time, great emphasis is put on recruiting within fields where the candidate becomes an integrated part of an academic community and avoiding hiring in fields of research that are better covered by other national players. The permanent staff at the Department engage

actively in both the debate of new subjects and focus areas, such as in the outreach "search committee" work by drawing attention to the job adverts of the Department.

a. Talent and Recruitment

IFA has to be equipped to fertilise the aspiring talents and invest in the most promising. The Department wishes to take advantage of tenure track with a combination of targeted "head hunting" and open advertisements. On the other hand we do not want these initiatives to be at the cost of regular advertisements.

During the past decades IFA's staff has been significantly reduced by almost 40%, primarily due to natural retirements. In the same period, the number of admitted students has gone up by approximately a factor of 3. Furthermore, IFA has established a talent programme that requires approx. 2 full time positions. Guidance and education of PhD students plays an important role and should be supervised by scientifically qualified VIPs. It is necessary to critically assess the complete teaching load at the Department, since the same researchers' resources also have to be used for new projects, applications and international networks. There should be focus on activities that can attract talents, recognition and (thereby) research funding. A strengthening of the VIP staff seems necessary, and IFA wishes more or less to recruit in the same pace in the coming decade as in the previous one, although the number of VIPs that will retire towards 2020 is limited.

b. Research

The research performed at the Department is coordinated and financed primarily by the individual researchers. The strategic work of the departmental management is therefore on the one hand to regulate and ensure an open discussion of the scientific focus of the Department and on the other hand to ensure optimum conditions for the very diverse scientific research profiles of the Department.

Part element of the steering function is to:

- Ensure a fair and adequate distribution of the administrative and educational obligations among the employees.
- Ensure a TAP-infrastructure especially for supporting the experimental groups (and at a reasonable cost)
- Continue inclusion of the employees in formulating recruitment plans, job advertisements and in promoting the Department and its scientific activities.

In addition, the departmental management team ensures the involvement of the Department in relevant joint strategic investments at ST and decides upon the size of the infrastructure at the Department.

c. Education

The admission numbers for the latest 4 years ('12,'13,'14,'15) were 115, 116, 103 and 116, respectively. The largest youth cohorts in several years were observed in 2012-2013. However, no clear trend is reflected in the admission numbers.

The number of students that obtained their bachelor's degree in physics from IFA in the years '12, '13 and '14 were 35, 48 and 61, respectively. With a yearly admission of approximately 110 students and an overall completion rate of 55%, the future status quo should aim at 60 %. 28, 26 and 40 obtained a master's degree in physics and 8, 5 and 4 obtained a master's degree in astronomy (all the numbers are from the report: "Uddannelsesevaluering af fysik, ST-AU 16.06.15").

IFA recommends that admission to the Bachelor of Science (BSc) programme requires a minimum grade point average of 7 with the exception that applicants with a lower grade point average can be admitted through a credential evaluation based on a motivated application, interview or entrance examination.

In general all classes should have a midterm evaluation, such that it is possible to react on criticisms, etc., from the students. Such evaluations are important, especially in connection with full semester courses and will be effectuated shortly. The Educational Committee proposes an oral evaluation. Subsequently, the lecturer in charge of the course gives feedback to the students, possibly via the instructors.

In future, we will focus on the completion time of the student, such that we do not suffer economical losses due to prolonged studies. At AU, the target number for extension of the prescribed period is 9.5 months towards 2020, corresponding to a reduction of 4.7 months compared to 2014.

In connection with the transformation to semester structure, we will have a close look at the number of courses offered and ensure a more efficient use of the teaching resources at the Department.

IFA wishes to educate more high-school teachers in physics. The Department brings forward a recommendation for ST to establish a committee at the faculty level for drafting proposals to improve boundary conditions and visibility of the combination of two subjects, such as physics - mathematics and physics – chemistry with teaching qualifications in both subjects.

d. Industrial Collaboration

The employees at IFA are involved in a range of collaborations with the private industry, with the participation of approximately 20 companies. The initiative to enter these collaborations was traditionally in the hands of the researchers or groups and the corresponding company. However, IFA has recently established an industrial committee to offer guidance in connection with such collaborations.

The Department has a longstanding tradition of developing and utilizing large and extensive research apparatus. The unique feature here is that, by and large, all have been developed at the Department, thus creating a high level of competences among the engineers and technicians at the Department. Despite the relatively modest size (compared to similar departments nationally as well as internationally), these conditions, in addition to great strengths

within the theoretical disciplines, have enabled the Department to be in the lead worldwide in several areas of experimental physics. A prerequisite for this to continue and to be reinforced is that we constantly evolve the scientific qualifications of our TAP staff and TAP division heads through for instance short postings at other research institutions.

It should be pointed out that an extended part of the research takes place at larger international premises, such as in Hamburg or at CERN – not unimportant relative to our connection to the international research community. In this context, IFA also takes part in the design/development of the European Spallation Source (ESS) in Lund, a neutron facility that is expected to play a significant role in connection with material science after 2020. At ESS there is furthermore a close collaboration with the Department of Chemistry established in connection with the experiment Heimdal, among others.

We wish to strengthen IFA's industrial collaborations. We envision that joint researcher education projects and utilization of infrastructures in collaboration with other departments, possibly in particular the Department of Engineering, could stimulate this development. This requires, among others, increased awareness among IFA's tenured VIP staff of the gain and possibilities that come with such collaborations.

All possible funding opportunities should be looked at; from large international networks, over greater centre-like strategic research projects, to the possibility of funding individual industrial PhDs or postdocs in relation to a specific project.

Great potential lies in building a network of former students that currently are employed in the industry. The Industrial Committee at IFA therefore plans to take the initiative of hosting an annual meeting for industrial collaborators, inspired by the successful high school teachers' day.

The possibility of promoting selected strategic business-related areas through recruitment of new scientific staff should be taken under consideration.

One last, however important objective for the industrial collaboration is to raise awareness of different business-related career paths among IFA's students. We believe that this knowledge could be an important contribution to the business counselling among the students. This will probably motivate many students, and it will give the companies the possibility to raise their profile in preparation for future recruitment.

e. *Public Outreach:*

The scientific staff at IFA has traditionally contributed significantly to public outreach. The successful public lectures in natural science are a result of the collaboration between IFA and Jens Holbech. A large number of IFA's employees give popular science lectures - both at the AU and around the country, at high-schools for instance. The exact number has not been accounted for. In addition, IFA offers a range of activities for high schools through our visitors' service.

Public outreach is highly prioritized by the departmental management. We find that this is an important part of the university as a whole. Naturally, IFA should take on a key role, since many of our scientific areas are of great interest to the public, and we have a large range of excellent speakers at our disposal.

We are, however, aware that public outreach potentially is a time consuming activity. From the university's part we have to limit the activities and prioritize the ones that we consider have the highest impact. IFA's departmental management team continuously follow the public activities (visitor's service) and have a high focus on potential impact versus work effort. An analysis of the extend of these activities together with "private" activities such as at the Public University, which also contribute, to the good reputation of IFA, are planned to be initiated in the nearest future.

f. *Collaborations across ST:*

The core competences and positions of strengths of the Department are spread out on several scientific disciplines and our employees together with the technical infrastructure are to a large extend able to enter into **interdisciplinary focus areas of the Faculty of Science and Technology (ST).** Particularly in the following research areas:

Properties of Materials. Dominated by characterization techniques such as STM and synchrotron radiation. Other examples are the properties of semiconductors in connection with solar cell applications and quantum structures doped in graphene in relation to the development of quantum computers. The properties of surfaces and new two-dimensional materials also remain a central theme. These activities already exist in collaboration with iNANO and the Department of Engineering. The Departments of Chemistry, Engineering, Physics and Astronomy and the iNANO Centre combined, possess great strength in this area that also include synthesis. Theoretically, the area is covered by one professor at IFA, and strengthening the theoretical side with focus on the treatment of atoms of larger atomic mass than Carbon would be desirable.

Space Science and Technologies. The astrophysics research at the Department is internationally recognized. The group has obtained an extremely important coordinating position in relation to utilizing a wide range of research infrastructure. The group participate, actively in research and instrument projects nationally as well as internationally. The largest group working with astrophysics is centred around the Stellar Astrophysics Centre (SAC) – a Centre of Excellence supported by the Danish National Research Foundation that study sun, stars and exoplanets. During the past few years the astrophysics group has established close collaborations with several groups at AU, including Bioscience and Geoscience, and has a long range of collaborations with research groups at NBI/KU and DTU Space.

Space science and technology is a major area of interest with large unexploited potential for building a strong research environment in a strategic and coordinated frame. The idea is to establish an interdisciplinary space science initiative involving a long range of players from ST which among others could include SAC, the Supernova- and Cosmology groups, ISA (establishing radiation conditions corresponding to the ones found in space), the Planetary Environment Facilities, the Astrobiology group and arctic research at Bioscience, Earth – sun –

and climate research and planetary research at Geoscience, research in materials under extreme conditions at the Department of Chemistry and space technology, robot technology, electronics, detector- and instrument- development at the Department of Engineering. An initiative of this kind will, among others, ensure that we embed the research infrastructure, nationally and internationally, directly in a joined unit and in addition create a stable collaboration partner to the private industry, specifically companies that build satellites and space technology, in general.

Quantum Technologies. Here we refer to new technologies that take advantage of the special quantum mechanical relations applying to microscopic systems: the wave properties of particles, superposition, Heisenberg's uncertainty principle and entanglement. As the ability to design materials and capture single atoms, for example, that we can control on a quantum mechanical level, increases, we gain access to a range of revolutionary technologies: fast quantum computers, safe encryption, ultra-sensitive sensors, etc. An AU initiative could spring from IFA's unique competencies in theory and experimental AMO physics, surface and nano science and combine these with strong contributions from research groups from Chemistry, Mathematics, Computer science and Engineering. This is a relatively young field of research that attracts many young researchers. Its applications receive great attention and are explicitly mentioned in for instance Horizon 2020.

Bioscience. The Department has strong activities in molecular biophysics with the focus on the electronic properties of biomolecules (chromophores, peptides, DNA) both theoretically and (primarily) experimentally. We are pioneers in the area of photophysical properties of isolated biomolecules, and we can compete with the best groups in the world. Physics enters as a natural part of a new area, where biological, chemical and physical disciplines including engineering meet. A joint initiative across ST would strengthen ST's position significantly.

Climate, where our AMS Dating Center engage in close collaboration with Geoscience. We will especially be able to enter collaborations on the linkage between the changes in the activity of the Sun, revealed by the ^{14}C activity in tree rings, and the variation in the climate over thousands of years. Furthermore, we will use cosmogenic isotopes ^{10}Be and ^{26}Al to determine the distribution of ice sheets and glaciers far back in time and hereby gain insight into the dynamical mechanisms that control the prevalence of for instance the inland ice on Greenland.

8. Action Plan

Initiatives that support the desired goals of this strategy report can be found in appendix d) in form of strategy cards grouped into Excellent Research, Talent Development, Education, Public Sector Advice and Industrial Collaboration.

Academic Positions

The further development of the Department in relation to the technical staff will be executed under consideration of the actual requirements, and employment of new staff will primarily take

place in connection with retirements in the TAP divisions. On the academic side we will make use of advertising at all levels: Tenure-track, Associate Professor and Professor. It is the Department's wish to exploit the tenure-track opportunity to hire talented researchers early in their careers. This type of advertisements will be important benchmarks for prosperous talents in planning their research career. Professorships will equivalently be important benchmarks for the associate professors at the Department. An equal distribution of associate and full professors seems appropriate, however, depending on the current age distribution among the VIP.

Generally, we have no problem in attracting international applicants to the advertised positions and we experience an increasing tendency towards hiring more foreigners. The balance between the genders is still very uneven. It is our clear approach to recruit the best candidate to our positions regardless of nationality and gender. A more equal gender balance shall be ensured through a culture at the Department that ensures good conditions for both male and female students as well as for the employees.

Positions from the previous strategy rapport include:

- Two positions in the Astronomy group in connection with SAC (budgeted for 2016 and 2017, respectively)
- Associate professorship in experimental Quantum Optics (budgeted for 2017)

Plan for new employments:

- **2017** Associate professor or tenure track position in **experimental Material Science.** In subjects such as thin films and with the possibility of a strong connection to the industry.

- **2018** Associate professor or tenure track theory position in **New Quantum Phenomena**. Here we especially think of the physics behind new solid state quantum devices and quantum thermodynamics relevant to nano-scale physics.

- **2020** Associate professorship in **theoretical Material Science** covering electronic properties of materials, potentially also including photovoltaics and photo catalysis. Reaches out to collaborations between physics, chemistry and iNANO.

Members of the Research Committee have also expressed wishes in other directions (such as Nuclear / Astrophysics and Experimental attosecond science). Realization hereof depends on the economy of the Department and will require further analysis.

9. Appendices

a. Employee Demographics

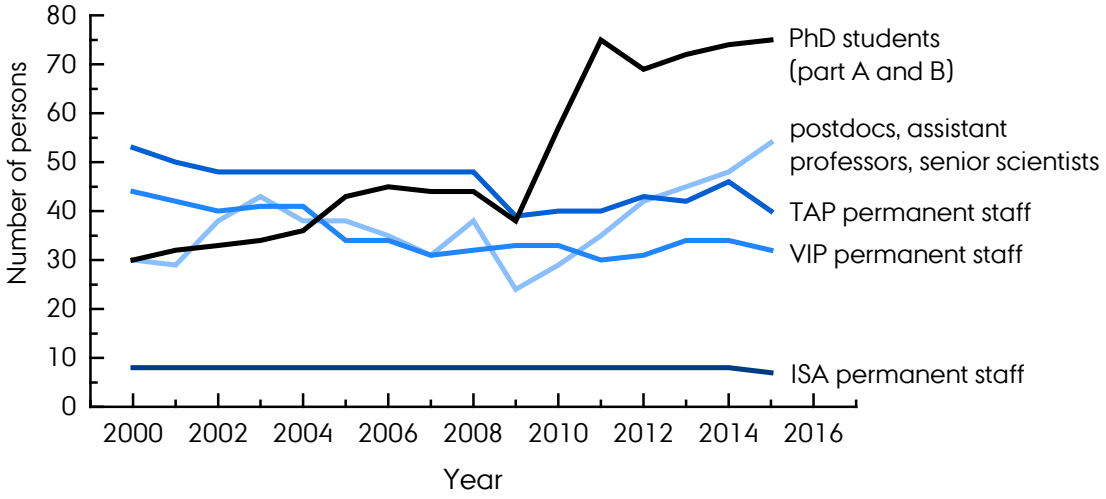


Figure 1 The figure shows the evolution of the employee demographics from the years 2000 to 2015

b. Large infrastructure / research platforms

- **AMS** dating facility, operated as an income-generating activity.

- **ASTRID2** synchrotron radiation facility where we seek to build **NANOLINE** for high resolution photoemission spectroscopy using national infrastructure funding schemes. NANOLINE will furthermore enable a long range of absorption techniques in the soft x-ray regime. NANOLINE will offer full integration of modern scanning tunnel microscopes (STM) developed at IFA. With the low photo energy range NANOLINE will in the most optimum way complement the upcoming MAX IV synchrotron light-source facility in Lund. NANOLINE will be fully integrated in the portfolio of the current beamlines at ASTRID2 that already has a well-established user programme based on scientific excellence.

- **Ion accelerators and storage rings** primarily targeting (bio) molecular purposes (ELISA, SAPHIRA...).

- **Chemistry laboratory** and facilities for material synthesis and material analysis.

- **Cleanroom.** The cleanroom is a well-equipped state-of –the-art facility for the preparation of thin films and nanostructures. At the moment the semiconductor group is the largest user of the clean room. The group has three Innovation Fund Denmark projects and one project financed by the VILLUM Foundation that are more or less depending on the cleanroom, and where the presence of the cleanroom has been a contributing factor in attracting projects. Within the last half year the cleanroom has been used for the fabrication of nanometre large crystal structures Si_3N_4 membranes, and new quantum technological materials will be prepared in the cleanroom.

- Several high technological **laser laboratories**, including laserlab.dk - an interdisciplinary national research infrastructure, to strengthen the development of advanced light sources with the purpose of applications in industry and research.

- **Wind Tunnel** operated as an income-generating activity and primarily used for the studies of planetary environments.

- **Scanning Probe Microscopes** (SPM), can be found in several laboratories both at the Department of Physics and Astronomy and at iNANO.

- **SONG** (Stellar Observations Network Group) with telescopes at Tenerife and further telescopes to be constructed.

- **KASOC** (Kepler Asteroseismic Science Operations Centre), internationally used data archive for Kepler Asteroseismic data. A corresponding archive (TASOC) is under preparation for the TESS-mission.

- **Centre for Scientific Computing Aarhus.** Center for Scientific Computing Aarhus (CSCAA) is a centre under ST. CSCAA purchases, maintain and supports high-performance computers for a long range of groups from Physics, Chemistry, Medicine and Economy. CSCAA defines, implements and enforces the policies for the use of the computer resources in collaboration with the users. CSCAA's organization consists of a User Forum, a Steering Committee, a Center leader and the staff. In 2015 alone there were 127 users, of which 48 were from IFA.

c. Funding Statistics and Bibliometric Analysis

- Funding

Table 1and Figure 2 shows the distribution of external funding for the period 2008 to 2015. The granted amounts in relation to specific years have been assigned on the basis of the starting date of the project. This approach is chosen to ensure a rigorous comparison of the grants across the years.

Table 1 External funding at IFA 2008-2015 divided into Danish public, Danish private and EU funding (in DKK)

	2008	2009	2010	2011	2012	2013	2014	2015
Danish public	29,415,470	59,096,357	40,295,789	55,758,189	63,239,332	32,841,294	20,700,507	36,679,540
Danish private	8,880,399	22,049,128	34,869,509	20,533,221	10,139,495	26,511,889	30,090,093	26,876,984
EU	15,128,465	4,114,738	8,025,365	38,471,879	14,802,624	28,007,249	2,013,582	29,196,703
Other international	20,000	1,299,146	5,852,395	1,688,227	0	126,750	550,1621	20,083,466
Total	53,444,334	86,559,369	89,043,058	116,451,516	88,181,451	87,487,182	58,305,803	112,836,692

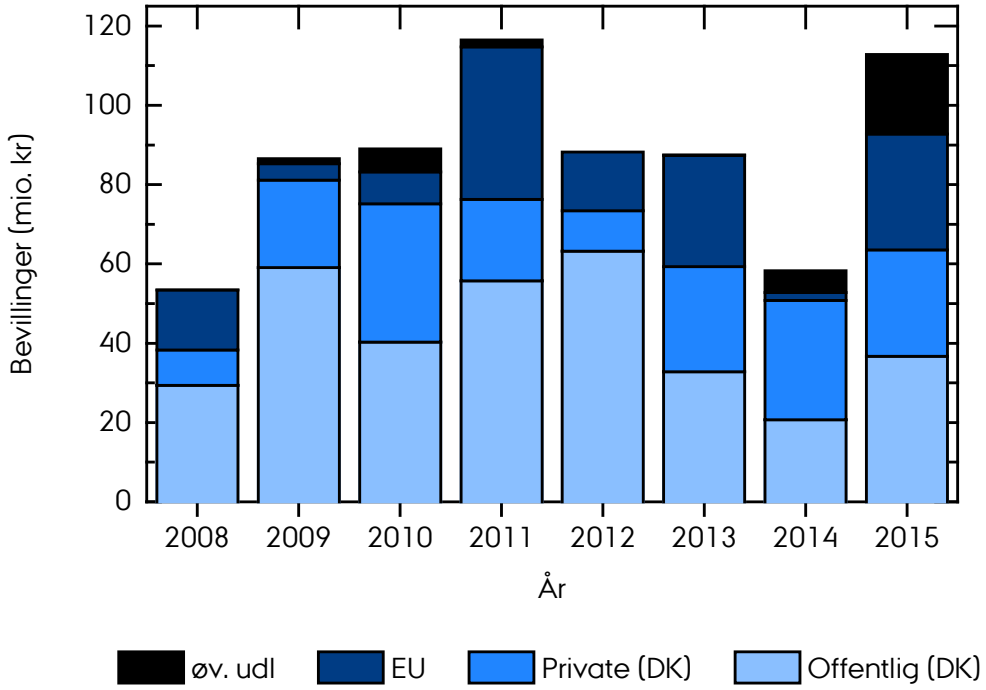


Figure 2 Distribution of external funding 2008-2015

- Publications Statistics

Table 2 shows an analysis of the publications and citations from IFA from 2005 to 2015, where a 3 year "sliding time window" is used. A clear increase in the total number of publications as well as in the number of publications / VIP is observed. Towards 2010-2012 a significant increase in the number of citations / publication, is furthermore observed. However, this trend seems to stagnate towards 2015.

Table 2 Peer-reviewed publications registered in Web of Science (WoS)*

Period	Number of publications	Number of citations*	Number of citation / publication**	Number of VIP (average)	Number of publications / VIP
2005-2007	756	2950	3,9	33	23
2006-2008	778	3537	4,5	32	24
2007-2009	799	3521	4,4	32	25
2008-2010	864	4390	5,1	33	26
2009-2011	897	5336	5,9	32	28
2010-2012	951	6868	7,2	31	30
2011-2013	996	6569	6,6	32	31
2012-2014	1081	6988	6,5	33	33
2013-2015	1107	7589	6,9	33	33

* From Web of Science (Address = Aarhus SAME astro* or Aarhus SAME dept physics or Aarhus SAME inst physics or Aarhus SAME storage ring)

** The citations are accumulated from the years where the articles have been published.

A more detailed analysis of the years 2010-2015 shown in Table 3 reveals a similar tendency. A clear increase in the number of publications is observed up until 2014, whereas the number of citations / publication is slightly falling. The number of publications drops again in 2015.

Table 3 Peer-reviewed publications and citations for the years 2010-2015

Year	Number of publications in Pure	Number of publications in WoS	Number of citations in WoS						Number of citations / publication in the first 3 years
			2010	2011	2012	2013	2014	2015	
2010	321	309	522	1770	1923	1844	1725	1520	13.6
2011	338	308		525	1668	1645	1514	1230	12.5
2012	375	334			460	1668	1709	1536	11.5
2013	395	354				603	1817	1713	11.7
2014	393	393					731	2161	(7.4)
2015	368	360						564	(1.6)

Error! Not a valid bookmark self-reference. shows the distribution of rank 1 and rank 2 for peer-reviewed publications registered in pure from 2010 to 2015. It should be noted that the records prior to 2012 are subject to some uncertainty. A general increase of the rank 2 publications is observed. The high number of rank 2 publications in 2015 may indicate that high impact journals have been prioritized over the total number of publications.

Table 4 Danish Bibliometric Research Indicators (BFI) for peer-reviewed publications as registered in Pure 2010-2015

Year	Rank 1*	Rank 2*	No classification	Total
2010	138	131	52	321
2011	116	166	56	338
2012	153	167	55	375
2013	172	171	52	395
2014	171	170	52	393
2015	144	183	41	368

* The analysis contains all peer-reviewed publications registered in Pure. Rank 1 and 2 (highest) have been assigned on the basis of the BFI for the corresponding year. Books or contributions to books have been ranked according to the BFI of the publisher.

d. Strategy Cards

Strategy card: Department of Physics and Astronomy (IFA)

Vision	**To be in the lead, nationally, within several sub disciplines of physics and astronomy. We want our research to be internationally known and respected, broadly utilized and published in the highest impact journals.**				
Mission	To perform research at the highest international level with the purpose of gaining fundamental insight into the areas of physics and astronomy. To offer and further develop research-based education within physics and astronomy at the highest international level. To collaborate with external national and international partners within knowledge exchange and development				
Stakeholders	Employers, companies, organizations, alumni, students, the general public, academic colleagues and grant makers				
Outcome areas	**Excellent research**	**Talent development**	**Education**	**Public sector advice**	**Industrial collaboration**
Strategic focus areas	• Strengthen the quality of research at IFA • Strengthen the interdisciplinary research • Stimulate research break-throughs • Strengthen internationally recognized research • Ensure job satisfaction among the scientific staff (VIP) and the technical and administrative staff (TAP)	• Strengthen the quality of the PhD programme • Recruitment of the brightest talents from Denmark and abroad • Establish clear and coherent career paths for researchers	• Offer education at its highest level • Ensure that our education contains all central academic disciplines as well as interdisciplinary initiatives • Increase the extent, relevance and quality of further and continued education offers • Attract the best foreign student • Ensure the well-being of our students	• Strengthen independent research-based consultancy and research dissemination • Strengthen the knowledge society through independent and inspiring knowledge transfer	• Strengthen innovation, collaboration and knowledge exchange with industry

Strategic requirements	**Focus on excellence in all aspects (research, education, recruitment, administrative and technical support)**		
	Strong economy	Dedicated TAP and VIP staff	High quality facilities and infrastructure
Values	The Department strives to appear as a dynamical unit with great cohesiveness that jointly solves the core tasks. The key values of the Department build on trust and respect across professional boundaries.		

Focus areas	Strategic goals	Critical success factor	Measurable goals	Initiative 2016-2020
Excellent Research				
Strengthen the quality of research at IFA	To provide the best research environment and to employ the brightest researchers. To promote research of high international scientific quality with high visibility through journals, conferences and the media.	Increase external funding to the research groups	KPI goal for publications Increase the relative ratio of rank 2 publications with 20% from 2015 to 2020	Continue the current recruitment policy where strong candidates are attracted and the brightest talents are hired Ensure high quality of administrative and technical support to the researchers Active use of the research committee Focus on the issues related to few female researchers
Strengthen the interdisciplinary research	To enter into new research relations and centres. To strengthen interdisciplinary initiatives	To engage in the relevant interdisciplinary flagships at Science and Technology		Presentations of interdisciplinary research at the Residential meetings. Presentations from the head of the departments and/or researchers from other departments at the faculty
Stimulate research break-throughs	To have the courage to focus on research of	More publications in high impact	A minimum of 20 publications yearly in high impact journals(Nature, Science, PRL, …) with an	A priority of the individual researcher

Focus areas	Strategic goals	Critical success factor	Measurable goals	Initiative 2016-2020
Excellent Research				
	potentially ground-breaking nature To create new solutions and mind-sets	journals	impact factor > 5	
Strengthen internationally recognized research	To identify niche strategic priority areas where IFA has the potential of taking the lead internationally To provide optimum conditions for forming strong research groups	Strengthen the relations to foreign research institutions. Exploit IFAs technical infrastructure (e.g. accelerator facilities, ASTRID 2)		Make active use of the AUFF Guest Researcher Grants
Ensure job satisfaction among the researchers	To have satisfied and committed researchers	Continues focus on job satisfaction and career development	Job satisfaction is ensured through analysis of the staff development dialogue (SDD) forms for VIP	Analysis and discussion of the complete SDD results
Ensure job satisfaction and professional development of	To have satisfied and committed	Continues focus on job satisfaction and	Job satisfaction will be ensured through analysis of the SDD forms for the TAP	Follow-up on the SDD results of the TAP staff

Focus areas	Strategic goals	Critical success factor	Measurable goals	Initiative 2016-2020
Excellent Research				
the TAP staff	members of the TAP staff	professional competence development of the TAP staff		Frequent assessment of the presence of the right professional competences and securing of continuing education and training Information about current and forthcoming research initiatives to the TAP staff

Focus areas	Strategic goals	Critical success factor	Measurable goals	Initiative 2016-2020
Talent development				
Strengthen the quality of the PhD programme	To offer an excellent PhD programme	Create a new generation of top researchers	That 25% of the PhD students continue as postdocs after graduation That a minimum of 90% of the graduate students complete their PhD within the standard time limit	The PhD programme will be followed closely through meetings with the supervisor Assessment of the course catalogue to ensure academic breadth and depth
Recruitment of the brightest talents from Denmark and abroad	To secure a greater talent mass	To attract more top researchers through international networks and attractive employment opportunities	Foreign PhD students graduating within the standard time limit The prospect of a career in Denmark for the most talented PhDs	Participation in ITN networks, etc. Engage in relevant international collaborations, targeting summer schools
Establish clear and coherent career paths for researchers	To ensure recruitment of the brightest researchers	Transparency in relation to the recruitment strategy of the Department	Use of tenure-track positions	Focus on the issues related to gender balance in the step between PhD and postdoc

Focus areas	Strategic goals	Critical success factor	Measurable goals	Initiative 2016-2020
Education				
Offer education of the highest quality	To deliver the highest possible level of research-based teaching	Comparison of the level to other institutions that are used for benchmarking. That the most talented students enrol in the PhD programme at IFA	Number and share of students graduating within the standard time limit. Result of evaluations from the students	We will ensure that even the most active researchers also engage in teaching Continue to secure that the teachers have participated in pedagogical courses and use recognized textbooks and teaching methods.
	To continuously renew and develop the education both in form and content	The quality will be ensured through surveys carried out among the students (form) and employers of our graduates (content)	Follow up on the quality through surveys among the students. Analysis of the employment situation of graduates from IFA (where, how fast, which job function)	The education will be evaluated continuously at residential meetings Midterm evaluation of the semester courses Reduction in the number of courses offered, such that, as a rule, courses have a minimum of 8 students attending.
Ensure that our education contains all central academic disciplines as well as	To educate more high school teachers in physics		Increase of the number of graduates from Master's degree programmes with teaching qualifications in two subjects	Recommendation for Science and Technology to establish a committee for drafting proposals to draw attention to and provide better framework for the combination of two subjects.

Focus areas	Strategic goals	Critical success factor	Measurable goals	Initiative 2016-2020
Education				
interdisciplinary initiatives				
Increase the extent, relevance and quality of further and continued education offers	To supply the Danish educational system with natural science know-how	Offer further education to high school teachers	Proliferation of knowledge about IFAs activities among high school teachers	Offering two continuing educational days yearly to high school teachers
Attract the best foreign student	To increase (long term) the number of research relations to researchers worldwide.	To increase the number of the brightest Master's and PhD students.	Towards 2020: Increase the number of Master's and PhD students from the EU, China, India, Brazil and Russia	Attract foreign applicants through open PhD position advertisements
Ensure the well-being of our student	To have satisfied and committed students	Continues focus on the well-being of our students	Satisfaction is ensured through surveys among the students, in addition to the AU Study Environment Survey (of which the response rate should be enhanced significantly)	Follow up on IFA's SDD analysis for PhD students Support of student activities of social character Aim at ensuring reading/studying areas for the students

Focus areas	Strategic goals	Critical success factor	Measurable goals	Initiative 2016-2020
Public sector advice				
Strengthen independent research based consultancy and research dissemination	To convey the latest research to society. To gain influence through societal debate and public sector advice	That our resources within public sector advice and knowledge transfer are clearly visible		Public sector advice, knowledge exchange and other outreach activities should be clearly visible on the IFA homepage
Strengthen the knowledge society through independent and inspiring knowledge transfer	To improve the quality and increase awareness of our role and responsibility in dissemination of knowledge	To offer research lectures to the general public in Denmark Encourage and reward VIP for "high yield" outreach efforts	A minimum of 50 research lectures per year Transfer knowledge in ways that target broad audiences	Public sector advice is given upon contact of the individual researchers. Their area of expertise should be apparent from the IFA homepage.

Focus areas	Strategic goals	Critical success factor	Measurable goals	Initiative 2016-2020
Industrial collaboration				
Strengthen innovation, collaboration and knowledge exchange with industry	To establish contact between researchers and industry to promote innovation, collaboration and knowledge exchange	That part of our researcher inspire/contribute to new research based initiatives in industry	Increased number of industrial PhD students and postdocs towards 2020	Periodic meetings in the industrial committee, that informs the rest of the Department of ongoing opportunities Hosting an annual meeting for industrial collaborators