ERA-Instruments
An ERA-Net initiative for promoting infrastructure funding in the life sciences

ERA-Instruments WP 2
Measures for existing Research Infrastructures

Task 2.3
Establishing a directory

Deliverable D2.5
Comprehensive instrumentation survey
on Next Generation Sequencing (NGS)

Task leader
Czech Science Foundation (GACR)

January 2011

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Comprehensive instrumentation survey

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1 Executive summary

ERA-Net consortia play an important role in facilitating cutting edge scientific activities within the European area. One of the important tasks is to map the distribution of top scientific instruments and possibly also to coordinate related research efforts. The main purpose of this survey was to collect data about midsize cutting edge instruments, the Next Generation Sequencing (NGS) equipment, in biomedical research institutions in Europe. This study was designed using the experience the team obtained during a previous study that was focused on the development of a NMR/MRI equipment database.

Data were collected by means of an online questionnaire survey. The form of questionnaire was created by the partner CNRS in cooperation with ERA-Instruments partners and 3 other European consortia. It consisted of 7 parts and about 45 questions that were filled in by respondents from October 2009 to February 2010. CNRS was also responsible for the data collection.

The obtained data were transferred and imported into a web accessible database that enables online searching based on given parameters. The database was built for web access using different internet browsers in order to allow access to users with different computer operating systems. A great effort was made to create a user friendly environment for the application and to enable search options based on criteria such as functional characteristics of the instruments, geographical location or experimental methods used.

After analysis of the collected data, the survey has a total of 76 responses from 13 countries, representing information of about 153 pieces of NGS equipment. The collected data provide a representative sample of important detailed information about the location and use of the NGS equipment. Based on the results of this study, a full scale survey should be performed that would evaluate and give more representative results within the entire European Union.

There are three major criteria for searching the on-line database: by country, by the type of research application, and by operational NGS technology. The comprehensive analysis provides further information about other details such as the number and type of NGS equipment by country, type of research institution and methodological approaches used etc. One of the interesting areas covered by the survey was also to determine the present possible bottlenecks associated with the use of the NGS equipment in research. The main bottlenecks for setting up and implementing new applications were identified as the inadequate number of personnel available for data analysis (bioinformatics and technical personnel) and the low level of funding.

The scientific area of NGS equipment is a very rapidly developing biomedical field, where new technologies are being applied constantly. Therefore, the main concern for future surveys should be to ensure that the existing database is updated regularly and in a timely fashion. This would help meet the needs of the scientific community and all organisations participating in the ERA-Instruments project. The database may provide valuable information to the interested parties.

The database is easily accessible at: www.gacr.cz/era/era-instruments-database.html.

2 Introduction

It has become increasingly obvious that concepts and strategies for Research Infrastructure (RI) funding should be harmonised and coordinated within the European Union (EU). The European Strategy Forum on Research Infrastructures (ESFRI) has determined requirements for European RI funding and has presented a roadmap for large-scale equipments. Growing attention is being paid to life sciences relying on RIs that are less centralised and more networked. There is a clear need for action in the interdisciplinary area between physics, chemistry, biology and the medical sciences as cutting edge instrumentation becomes increasingly expensive and, yet, indispensable for world-class research.

However, promotion of research policies, apart from the ESFRI projects, has been restricted so far to national efforts without managing these actions with a European perspective. Funding and research organisations cannot afford to remain only at the national stage with worldwide competition for the best scientists and the most promising projects. Frontier research is international since long and funding organisations have to follow scientists to the European level.
ERA-Instruments aims at initiating coordination and the development of a sustainable network of 16 partners including ministries, research councils, funding agencies and charities active in funding life science RI. This European platform of relevant stakeholders will set up comprehensive tools for the adequate treatment of instrumentation related topics enabling conclusions for research policies on both national and European levels. The ERA-Net will focus on bio-analytical instrumentation (incl. post-genomic high-throughput techniques) such as NMR, mass spectrometry, microscopy, micro-array platforms etc. Midsize equipment has become a strategic essential strength for European countries. Promotion of RI funding in FP7 and support for new member states will also strengthen the position of European research.

3 About work package 2

3.1 Objective

The intention of work package (WP) 2 is to map the present situation of existing research infrastructures for life science research in Europe through the creation of inventories of cutting edge instrumentation. The first phase of the project, which served to establish procedures, resulted in the detailed analysis of the European state of the art in the matter of NMR and MRI equipment. Our second inventory is dedicated to Next Generation Sequencing (NGS) equipment.

3.2 Approach

On a European level, the European Union (EU) and the European Science Foundation (ESF) have conducted more general investigations on research infrastructures with rather limited use when specific techniques are concerned. The first questionnaire within ERA-Instruments aimed at the area of magnetic resonance (NMR, MRI) and brought data which have been extremely useful and sustainable by the scientific community and all concerned. Based on the evaluation of the current situation in European research, and due to the fact that three other European consortia have similar interests, it was decided that the second survey would be focused on NGS equipment. The core objective of this second survey was to get data about some of the European NGS centres at the largest possible scale, rather than to obtain an overview of all centres as was done in our first study.

When measuring NGS equipment, we followed the procedure that was successfully used in the first survey and adapted it to NGS specifics. NGS equipment and its users were identified through an online questionnaire created by partners within ERA-Instruments and with the assistance of three other consortia – e.g. E-RARE (providing the list of units and questions); gEUVADIS (providing the list of contacts) and RDPlatform (providing scientific advice). The data were gathered into the database and analysed.

Cooperation with the three above-mentioned consortia was an important aspect in work coordination. The collaboration allowed the use of a unified questionnaire with appropriate sections that were regarded as the main aim of each partner, instead of having four similar ones.

The WP 2 consists of four parts:
Task 2.1 Establishing the procedure
Task 2.2 Collecting data for the survey
Task 2.3 Establishing a directory
Task 2.4 Access to infrastructure

4 About task 2.3 Establishing the directory

Task 2.3 covers analysing and processing data collected within the online questionnaire organised by the partner CNRS (in terms of task 2.1 – Establishing the survey procedure and task 2.2 – Collecting data for the survey) and the publication of the gathered data in the form of a web database.

4.1 Establishing the directory database

4.1.1 Preparatory stage

The first step for the database creation was to gain respective information. This was done within task 2.2 – Collecting data for the survey. Data were identified through an online questionnaire built by our partner within ERA-Instruments –CNRS and with the assistance of three other consortia - E-RARE, gEUVADIS and RDPlatform. Close collaboration with the mentioned groups was established to synchronise work based on common interests. This allowed the use of a unified questionnaire. Particular tasks of the consortia members regarding the preparation the questionnaire and data collection were as follows:

- ERA-Instruments: provided the online questionnaire;
- E-RARE: provided the list of units and questions;
- gEUVADIS: provided the list of contacts;
- RDPlatform: provided scientific advice.

The close cooperation between GACR and CNRS played a key role in establishing the database, as it had been necessary to follow a joint strategy for the collection, transfer and processing of the data gathered from the first phase and modify it to NGS specifications. To accomplish those tasks, the partners collaborated mainly through email except for one face-to-face consultation that took place during the ERA-Instruments workshop in Vienna at the end of March 2010.

Several stages of consultation between ERA-Instruments partners and the three other consortia were carried out in order to optimise the actual questionnaire, which was finally launched on 20th October 2009. The questionnaire was available online

on the CNRS website, which was already used for the previous NMR/MRI survey. Access to the unified questionnaire was sent on behalf of the four consortia to the respective European centres working with the NGS. In mid-November reminders were sent and other countries were contacted so as to get comprehensive feedback. Then, at the beginning of February 2010, it was decided that it would be desirable to gain more data on NGS equipments. The consortia individually contacted the main national NGS centres that had not answered the questionnaire so far and asked them to complete the survey. The consortia also checked for incomplete responses and invited such centres to complete the survey. The questionnaire was closed on 24 February 2010. More information regarding how the survey procedure was established and on the data collection for the survey is available in ERA-Instruments reports D2.1 and D2.3 composed by CNRS.

At the beginning of February, GACR and CNRS agreed on a data exchange procedure. GACR received the definitive dataset from CNRS in mid-March. After that, GACR began to prepare the draft of the dynamic web presentation.

From the lessons learned on the first database on NMR/MRI equipment, GACR optimised some technical aspects to the current situation (e.g. the file format, the software used and the layout, algorithms for transforming the obtained data to the format best suited to the database).

The first pilot version of the dynamic web presentation was disseminated among WP 2 partners for comment at the end of June 2010. GACR received some useful comments, remarks and new ideas that were incorporated into the database within the work on its final version. Cooperation between IT departments of both partners was on very professional basis for the whole duration of the task. The task was successfully finished on time in December 2010.

The database on NGS, NMR and MRI equipments is easily accessible at: www.gacr.cz/era/era-instruments-database.html.

4.1.2 Structure of the database

The structure of the database was tested on the previous pilot study of the NMR and MRI equipments. The pilot version of the structure of the database was tested, analysed and modified in order to become as simple as possible as well as “user friendly” to satisfy the needs of the research community and also funding institutions. The newly designed structure was fully accepted and acknowledged by the research community as simple, well-arranged and “user-friendly.”
It therefore served as a starting point for the creation of the NGS database where specifics of NGS had to be implemented.

Sets of detailed information about both types of equipment were gathered by means of the questionnaire. The aim of the questionnaire for this second study was to collect information about selected NGS European centres at the largest possible scale. This aim was, however, not fully reached as some of the approached centres did not provide all required information, and a larger community could have been included into the survey in order to get the fullest picture. Future surveys should therefore focus on enlarging the approached respondent community.

The main page provides basic information about the ERA-Instruments project as well as a short description of the survey itself, including the method used for data collection and the analysis of the collected data in form of the most significant figures.

The most important information about the particular equipment, its owner and technical parameters are designed to fit on one screen. A detailed description of the research connected with each equipment as well as useful contact details of responsible personnel are given in separate blank windows.

4.1.3 Search criteria

Finally, the search criteria used in the database were identified and agreed after broad discussion. In the consultation phase several groups were involved, such as researchers from different areas and countries, ERA-Instruments partners and experts from the given field. The three most important criteria for searching in the database were determined to be country, type of application, and type of NGS operational technology. The criteria used in this database were previously tested on the NMR and MRI equipment study, were proved to be suitable and were consequently used in this database.

Even broader search options for users were enabled by incorporating Java script to the application. This tool allows the maximum use of information currently made available on the web due to the simple but complex filtration of the presented data according to several parameters simultaneously.

The number of records which meet the requested parameters are conveniently specified. All the responses are continuously listed on the page and can be viewed on screen by scrolling.

4.1.4 Technical aspects

The final version of the database was developed to be run on MS Windows OS platforms (i.e.: W2K, WinXP, Vista) in the 3 most commonly used web browsers: MS Internet Explorer, Mozilla Firefox and Opera. Based on previous experience with the pilot NMR and MRI database, a few incompatibilities that were identified when running the Safari web browser on Apple's Mac OS platform were eliminated. The data format was adjusted; the newest network access and technologies from this field were applied. All used platforms are now compatible, match the given requirements and are functioning well to allow the exploitation of a broad research community in a "user friendly" way.

4.1.5 Update

The aim of this first data collection survey was to verify the possibility of data collection in the NGS field and the possibilities of cooperation between different consortia. This survey provides data as of the date of collection and up-to-date information on NGS centres. The NGS is a very rapidly developing field where new technologies are being applied constantly. Therefore, the main concern for future surveys will be to ensure that the existing database is updated in a regular and timely manner, in addition to basic technical maintenance and other updates. The existing data should be also continually updated as new data become available.

4.2 Data analysis

4.2.1 Data reliability

The data used for analysis in this report were collected only within the framework of the ERA–Instruments project. The European Next Generation Sequencing (NGS) equipments and users were identified by a methodology based on an online questionnaire established within the ERA-Instruments as well as with three other consortia.
The quality of the responses has been approved by a core group of the European consortia as a representative sample of the existing NGS. Only information available from the responses given in the questionnaire was processed. Participation in the survey was on a voluntary basis. The results are strongly dependent on the willingness of the respondents to provide the requested information and the current situation in the number of equipments may be different from results presented within the database. It is important to stress out that this is not an exhaustive and fully representative list of all the NGS equipments available within EU countries. It serves as a representative sample and provides important detailed information, especially about the use of the equipment. Based on the results of this study, a full scale survey should be performed that would evaluate and give more representative results within the entire EU. The present results should provide only a representative picture of the NGS equipments for the interested parties. It is most likely that the current data is biased due to the selective nature of the respondents.

4.2.2 General summary of results

Altogether participants in 21 countries were contacted and asked to provide input for this survey. Participants from only 13 countries have provided information, representing 76 respondents and 153 pieces of equipment in total that have been identified and analysed with this survey.

The data analysis focused on the three major criteria for the database search. These corresponded to the most important search criteria identified for possible use of this database.

1. Identification of NGS equipment based on location (country).
2. The specific type of NGS equipment.
3. The types of applications the NGS equipment is used for.

SHORT RESULTS REVIEW IN GRAPHIC FORM:

1) Respondents of the NGS questionnaire in individual countries

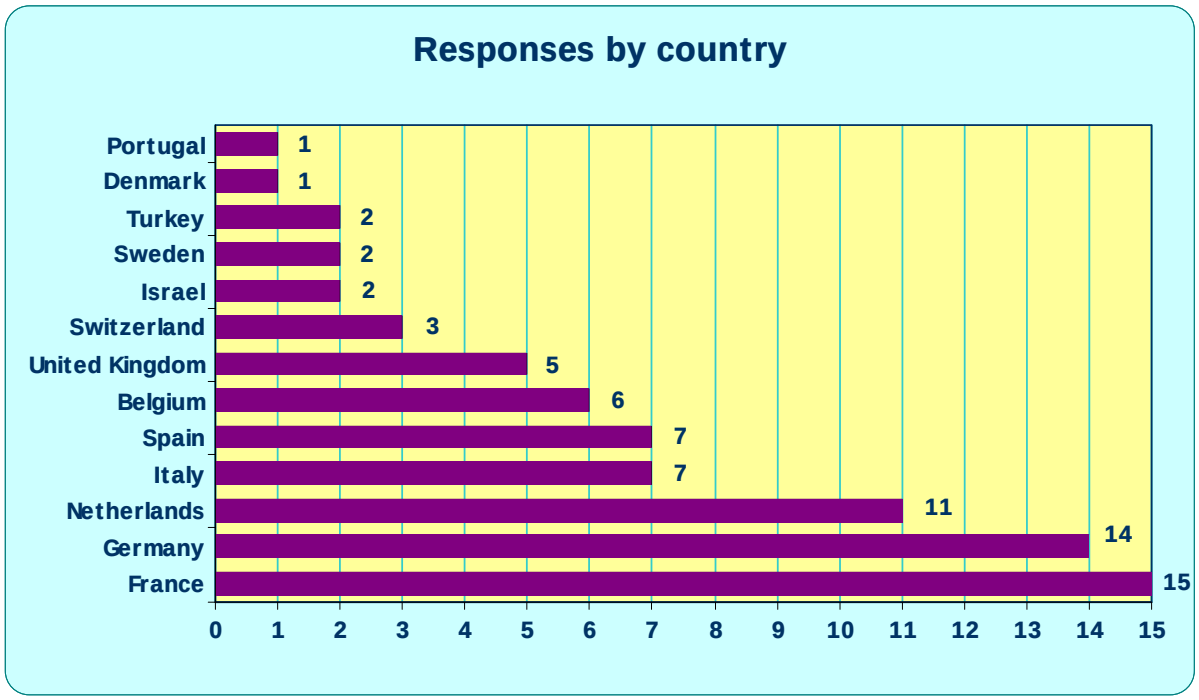


Figure 4.1 – Responses by country

In total 76 respondents from 13 countries completed the online questionnaire. It has to be stressed that almost 53% of the replies represent feedback from only three EU countries – France (15 replies), Germany (14 replies) and the Netherlands (11 replies). The second group of countries in respect to the number of responses (5-7 replies per country) consists of Belgium, Italy, Spain and the United Kingdom. Low feedback (3 and fewer replies per country) was registered from Denmark, Israel, Portugal, Sweden, Switzerland and Turkey. It is essential to underscore that this figure does not represent the number of NGS equipment per country, but represents only the number of completed questionnaires. We might assume that countries like Germany and France provided the most replies due to the large size of those countries and thus due to the expectedly higher number of institutions using NGS equipment.

2) Analysis based on the types of NGS equipment used and the distribution of the most frequent types by location

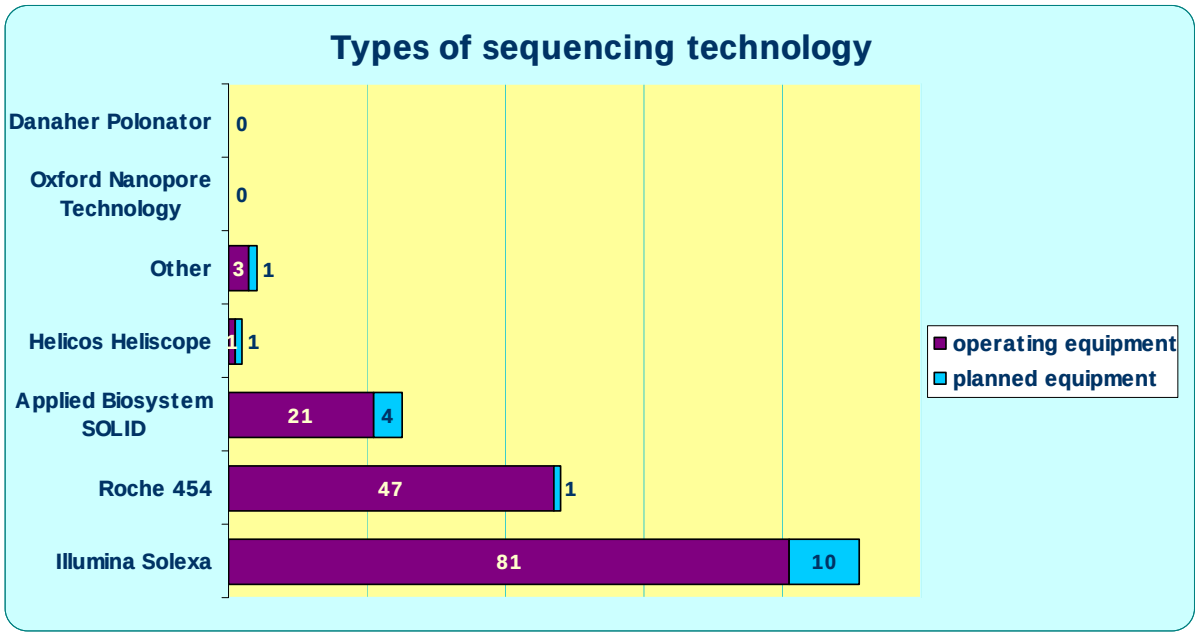


Figure 4.2 – Types of sequencing technology

In total, data on 153 pieces of sequencing technology apparatuses were obtained and analysed. The most frequent technology used is the Illumina Solexa (81 pieces of equipment; i.e. 53% of the total) followed by the Roche 454 (47 pieces; i.e. 31%) and the Applied Biosystem SOLID (21 pieces; i.e. 14%). The next three technologies suggested in the questionnaire (Helicos Heliscope, Oxford Nanopore Technology and Danaher Polonator) are not used at all or just rarely. In the laboratory of the Royal Institute of Technology in Sweden, three other types of equipment - Illumina HiSeq2000 were identified. The figure also shows that the Illumina Solexa technology is the most requested piece of equipment to be purchased within the next year (at the time of data gathering).

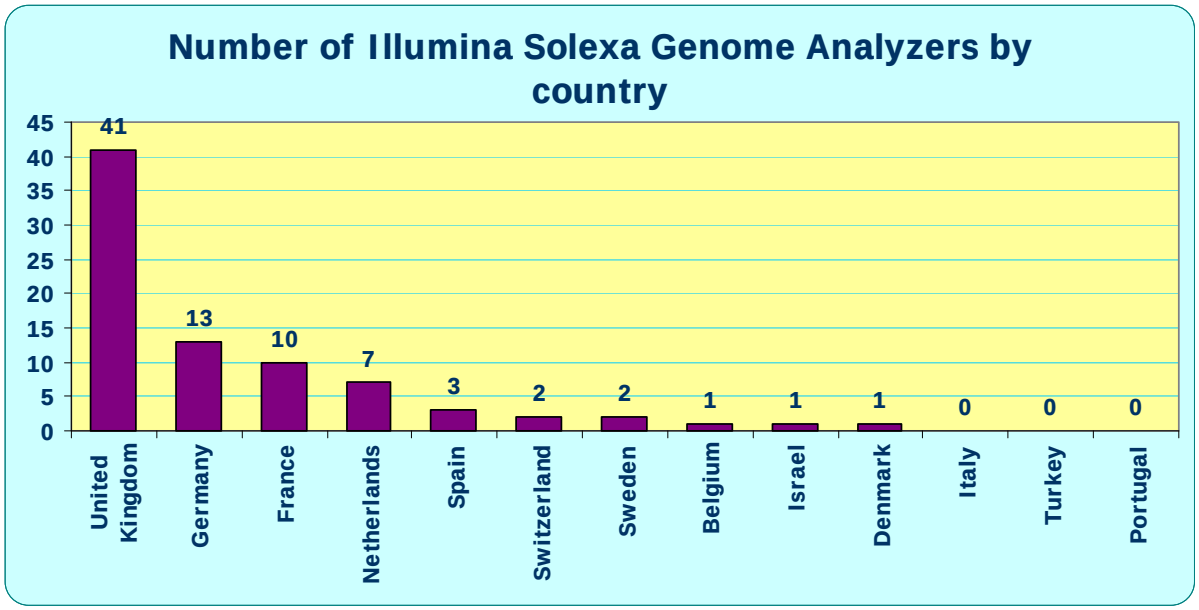


Figure 4.3 – Number of Illumina Solexa Genome Analyzers by country

Over 50% (41 out of 81 pieces) of the identified Illumina Solexa instruments were located in the United Kingdom, and of those, 37 pieces were located in Wellcome Trust Sanger Institute.

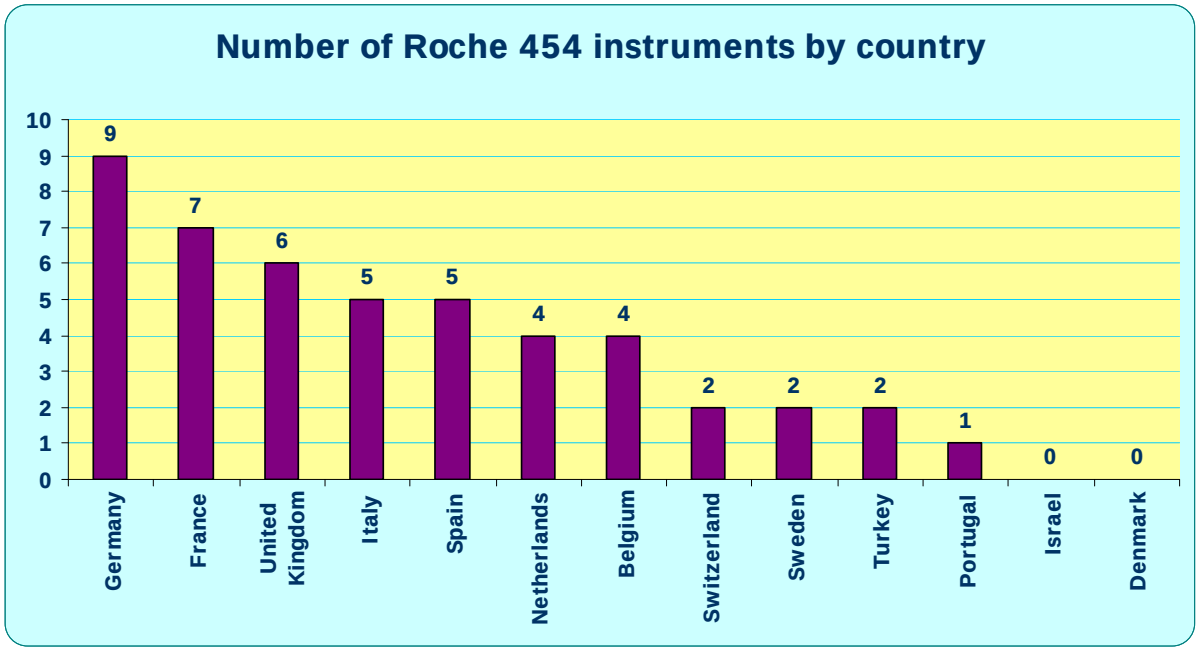


Figure 4.4 – Number of Roche 454 instruments by country

Germany, France and the United Kingdom represent almost 50% (22 out of 46 pieces of equipment) of all the identified Roche 454 instruments.

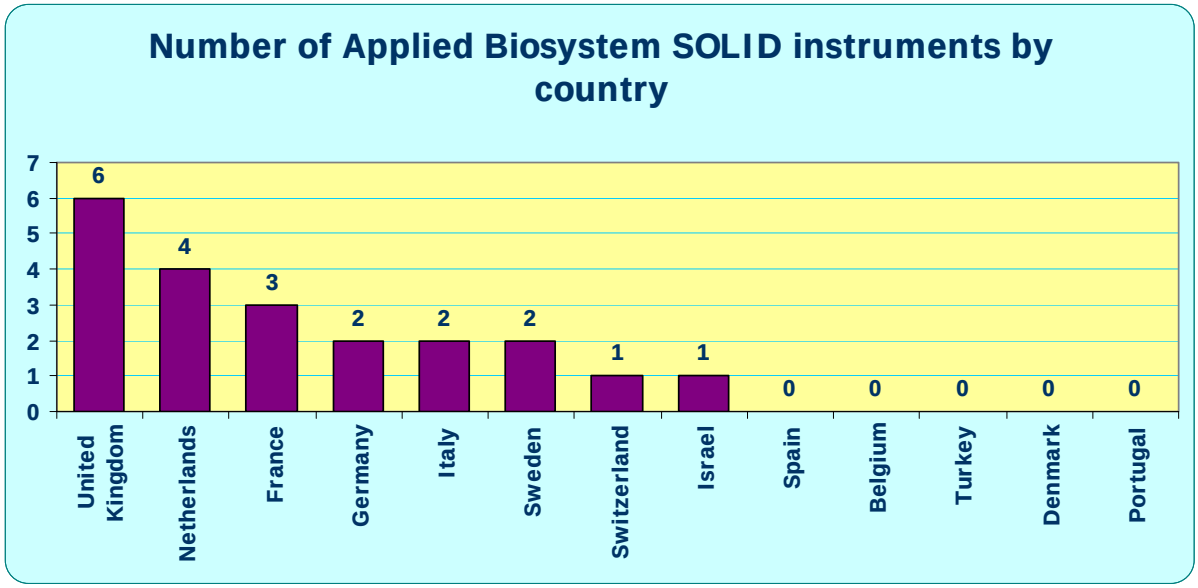


Figure 4.5 – Number of Applied Biosystem SOLID instruments by country

The United Kingdom, the Netherlands and France are countries with the majority of the Applied Biosystem SOLID instruments. These countries represent 62% (13 out of 21 pieces) of all the identified Applied Biosystem SOLID instruments. It should be said here that it could also be a generation phenomenon. If the units used to have Roche 454 and now more to Illumina Solexa, therefore it is logical to have for the time being, more of the first ones and less of Illumina.

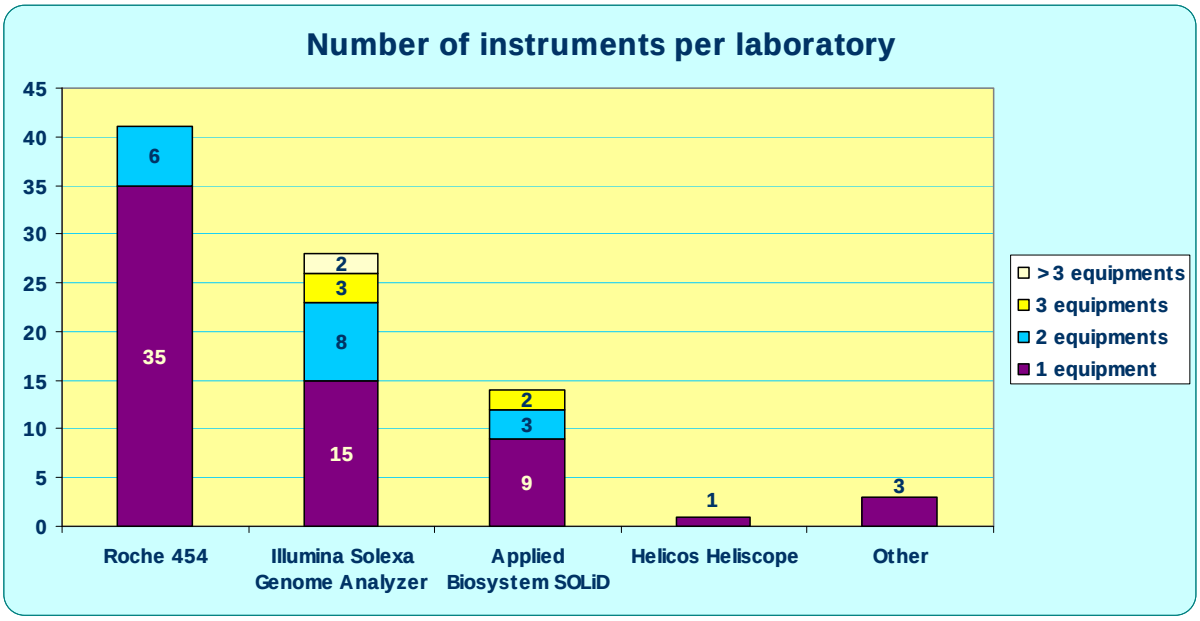


Figure 4.6 – Number of instruments per laboratory

Out of the 153 equipments identified, most of the laboratories use only one piece of NGS equipment. The Illumina Solexa technology is frequently used as two or more instruments per lab, as well as Applied Biosystem.

3) Analysis based on the type of the institution using the NGS technology.

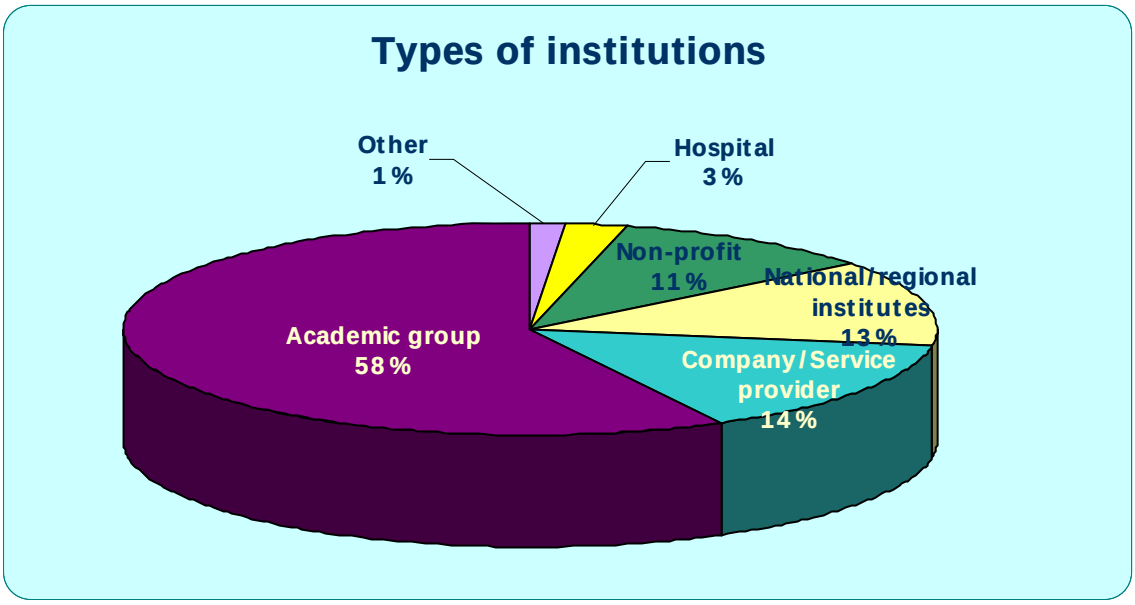


Figure 4.7 – Distribution according to the type of the institution using NGS technology

This figure shows that the NGS equipment is largely available among academic institutions (44 replies out of 76), significantly less among private companies (11 replies), in regional or national sequencing institutes (10 replies) and in non-profit research organisations (8 replies). Three laboratories fall within hospitals and other institutions.

4) Analysis based on the type of research performed on the equipment

For database users, i.e. both the scientific community and funding agencies, it is important to not only identify the hardware but also the type of research the equipment is used for, as well as the methodology that is available.

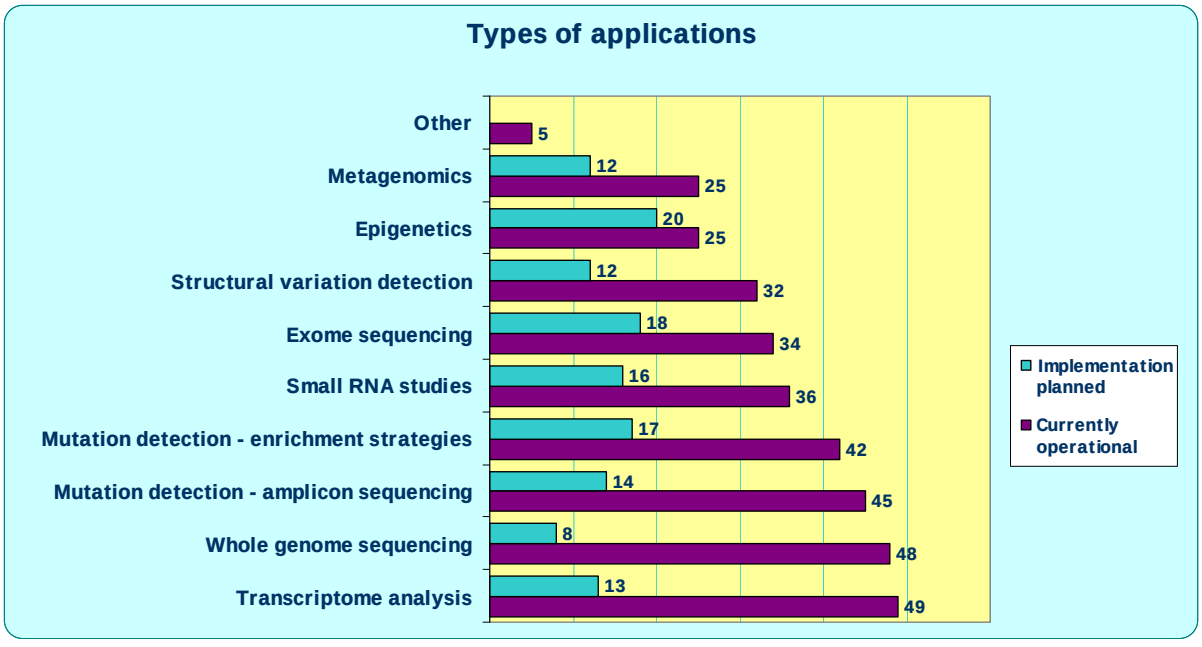


Figure 4.8 – Overview of types of applications performed and planned on the equipment

Transcriptome analysis and whole genome sequencing are the types of applications carried out in approximately 70% of the laboratories which replied (49 and 48, respectively, out of 68). Every other laboratory conducts mutation detection - amplicon sequencing, mutation detection - enrichment strategies, small RNA studies and exome sequencing. Almost 30% of the respondents plan to implement epigenetics applications in their laboratories and 25% of the respondents plan to implement exome sequencing and mutation detection - enrichment strategies.

The questionnaire also tried to identify possible bottlenecks associated with the use of the NGS equipment. Three possible areas were studied:

- bottlenecks for setting up and implementing new applications
- bottlenecks associated with NGS data analysis
- main areas of problems with conducting external NGS projects

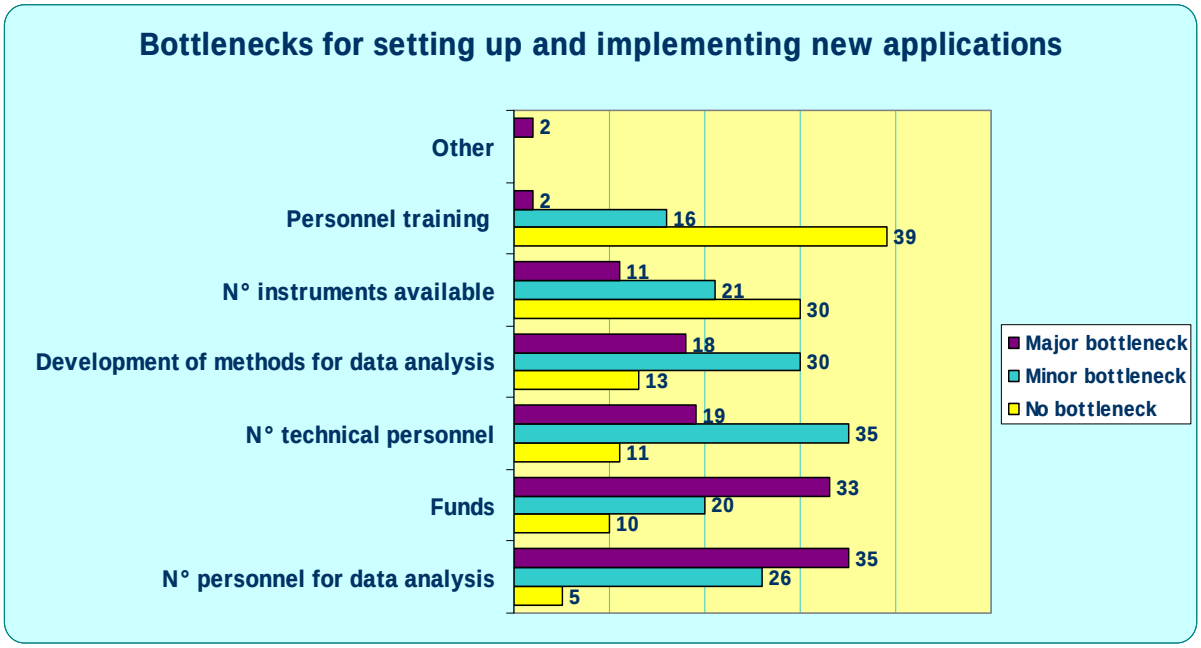


Figure 4.9 – Bottlenecks for setting up and implementing new applications

About 50% of the laboratories mentioned that the main bottlenecks for setting up and implementing new applications were in the number of personnel for the data analysis and in the funds available. By contrast, personnel training represented only a minor or no bottleneck for most of the laboratories, similarly as the number of instruments available.

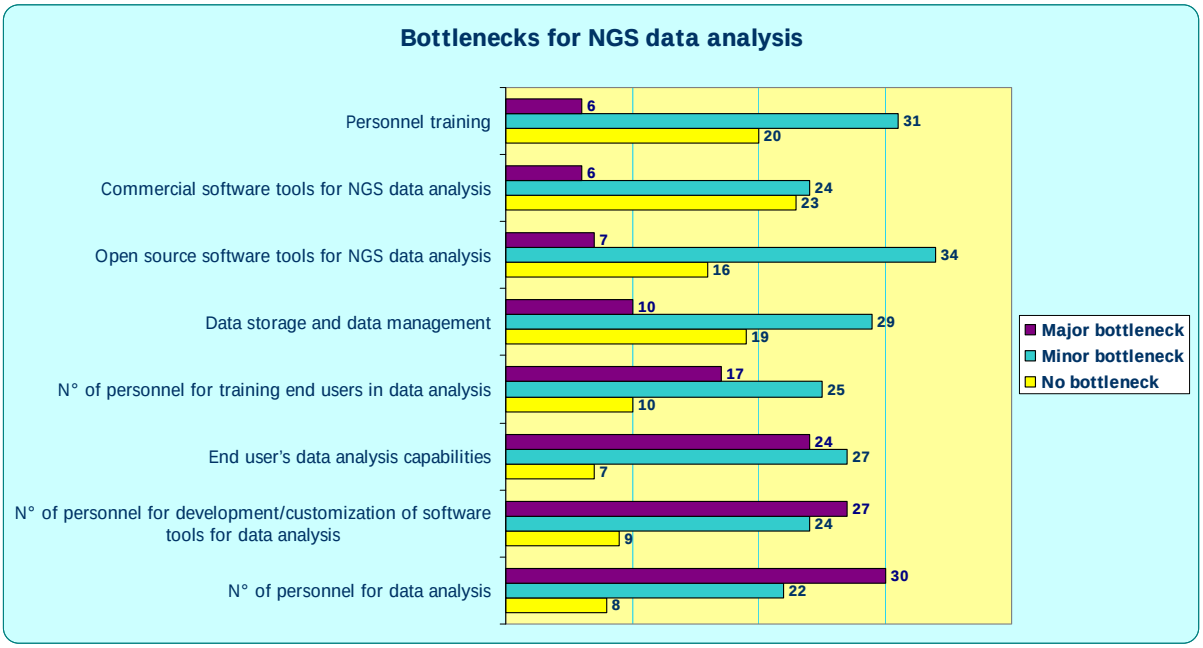


Figure 4.10 – Bottlenecks for NGS data analysis

The main bottleneck for NGS data analysis was in the number of personnel available for the data analysis. This is indicated by 60% of respondents. About 50% of the laboratories see major bottlenecks in the number of personnel for development/customization of the software tools for data analysis and in the end user´s data analysis capabilities. Minor or no bottlenecks are mentioned for personnel training, commercial and open source software tools for NGS data analysis.

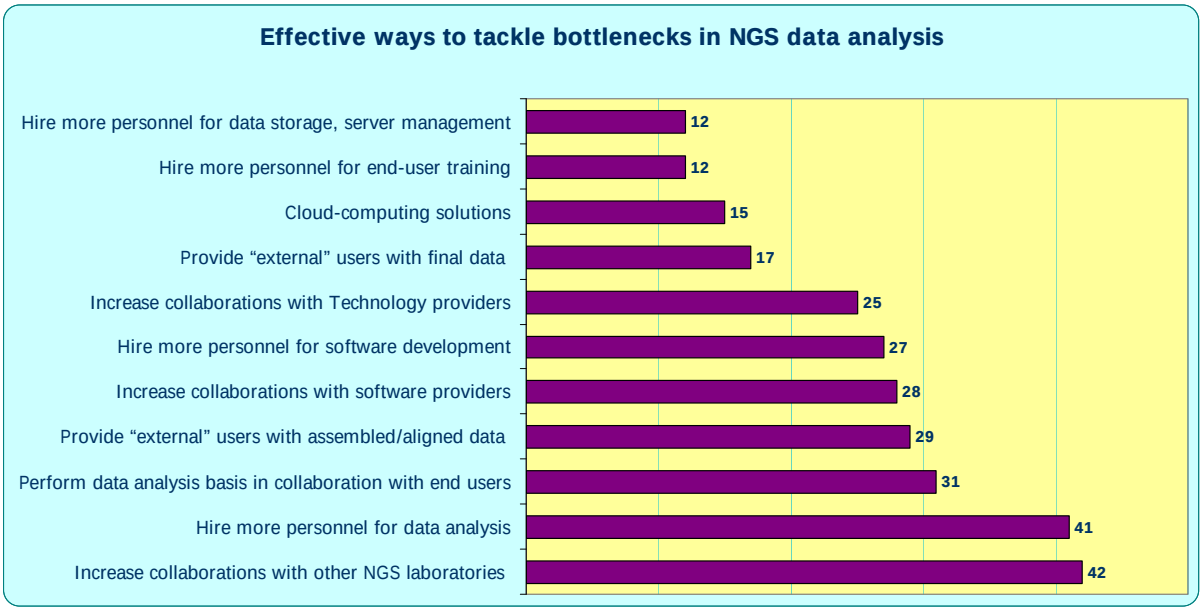


Figure 4.11 – Ways to tackle bottlenecks in NGS data analysis

Increased collaboration with other NGS laboratories and hiring more personnel for data analysis were considered effective ways to tackle bottlenecks for NGS data analysis for almost 70% of the respondents (42 and 41, respectively, of 61 responses). This corresponds well with the obtained data describing the main bottlenecks (see above).

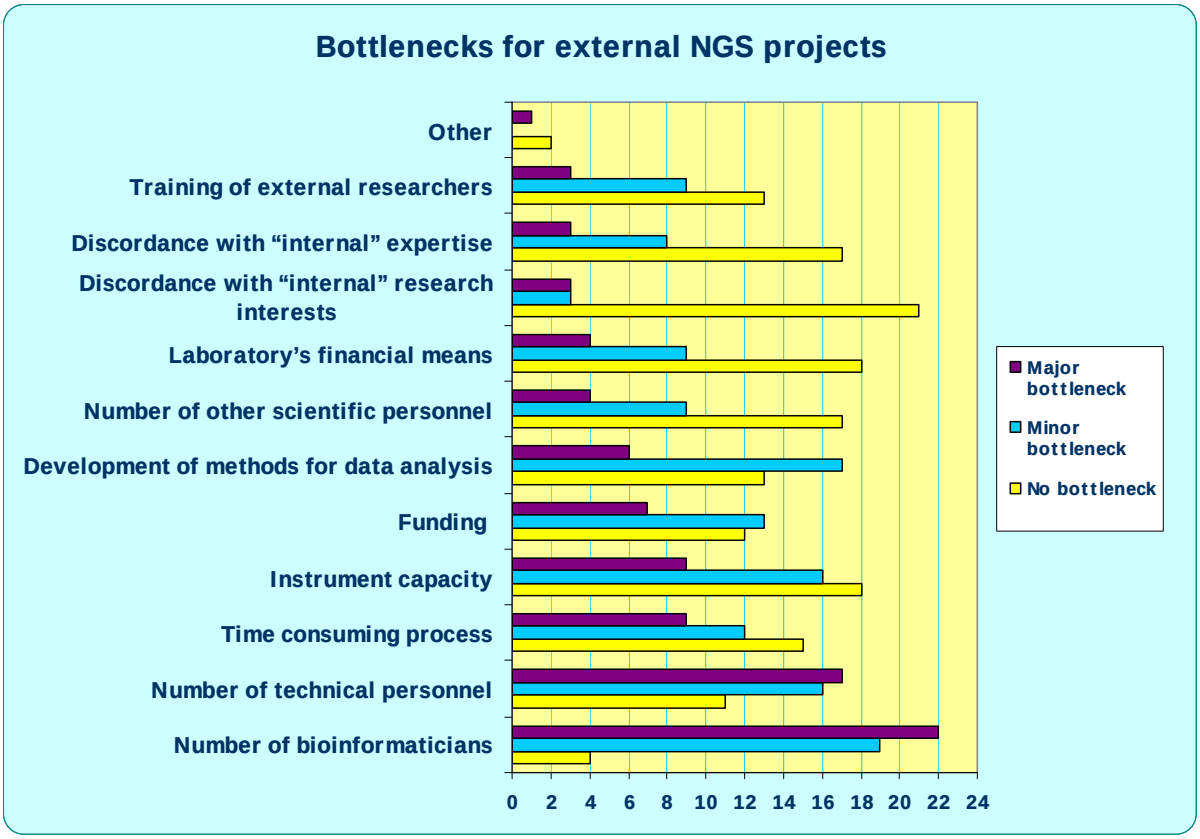


Figure 4.12 –Bottlenecks for conducting external NGS projects

The main problems associated with conducting external NGS projects were seen in the number of bioinformatics and technical personnel. On the contrary, the discordance between external projects with internal research interests and financial means are not seen as bottlenecks in almost 50% of the laboratories.

5) Analysis based on access to NGS technology, scientific personnel working with the NGS technology, financing resources for research and cooperation with the external NGS facilities

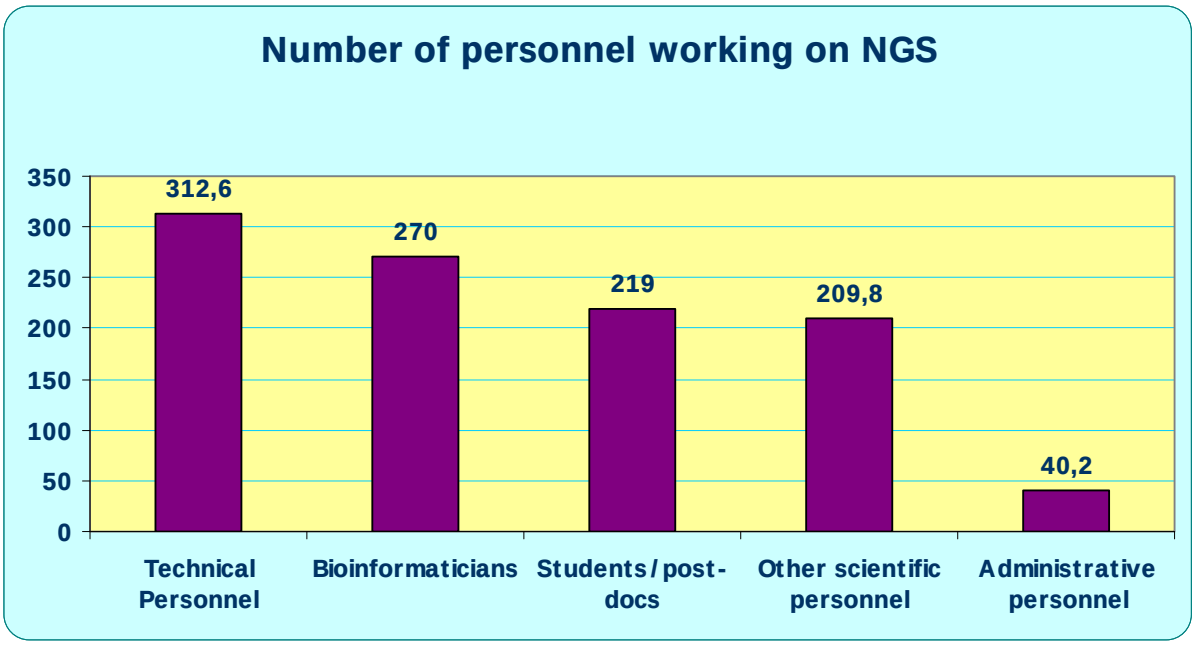


Figure 4.13 – Number of personnel working on NGS

As could be expected, the highest number of staff working in NGS laboratories were technical personnel, followed by bioinformaticians. The lowest number represented administrative personnel.

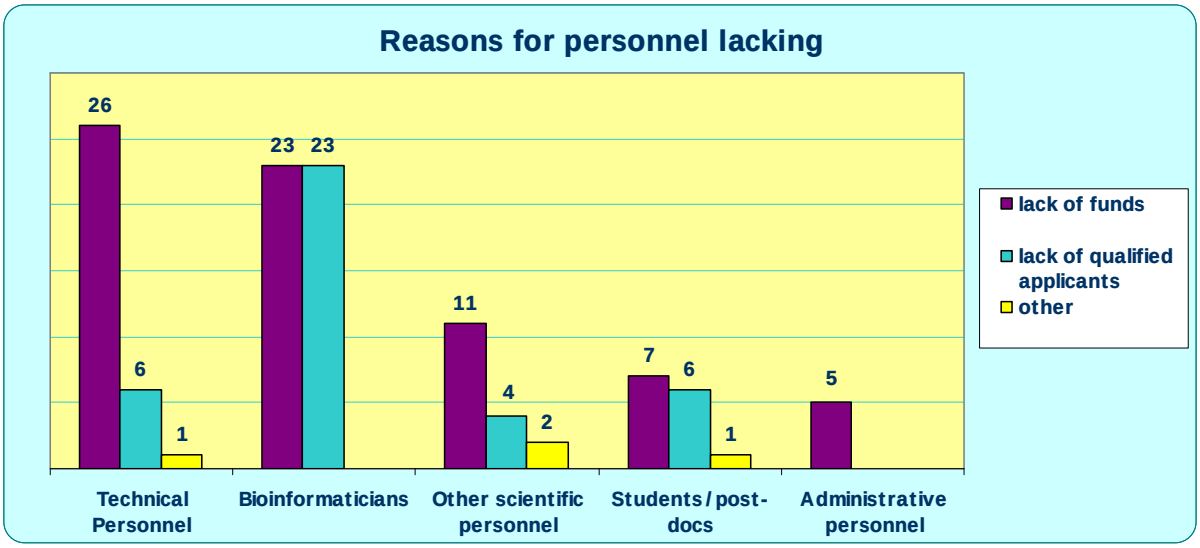


Figure 4.14 – Reasons for the lack of personnel

Two thirds of the respondents perceived the number of personnel as a bottleneck for carrying out NGS activities in their laboratories. The main reasons for the lack of personnel were the low level of funds and also not enough qualified applicants.

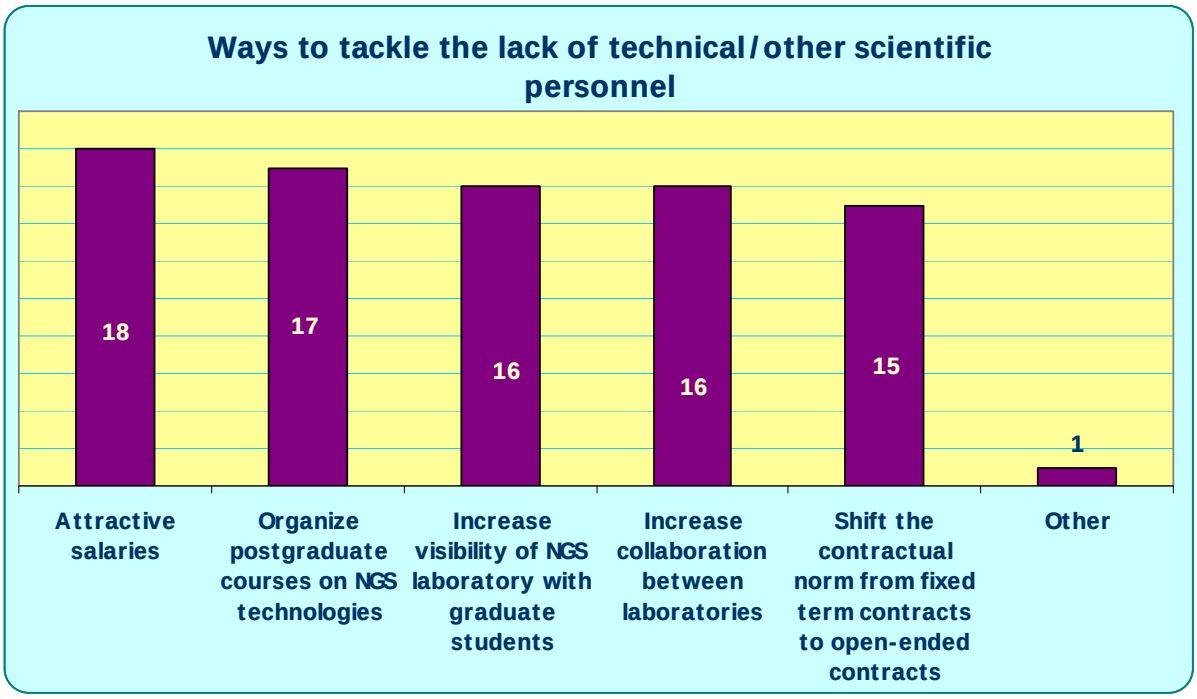


Figure 4.15 – Ways to improve the lack of technical/other scientific personnel

The different proposed ways to deal with the lack of technical and other scientific personnel were represented equally.

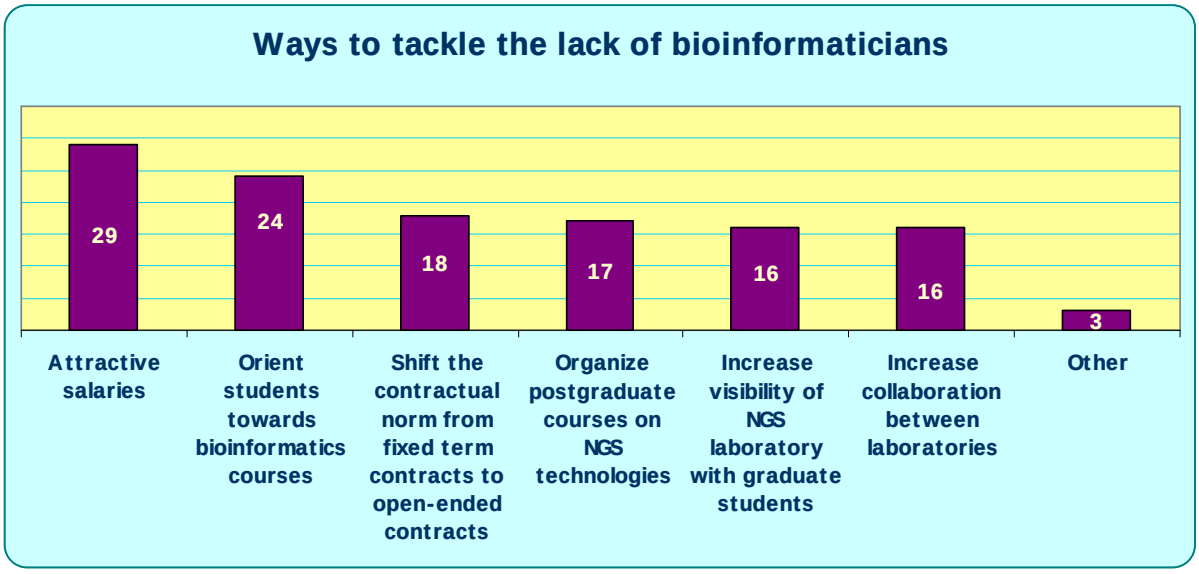


Figure 4.16 – Ways to improve the lack of bioinformaticians

Attractive salaries and increases in number of students were seen as most effective ways to tackle the lack of bioinformaticians.

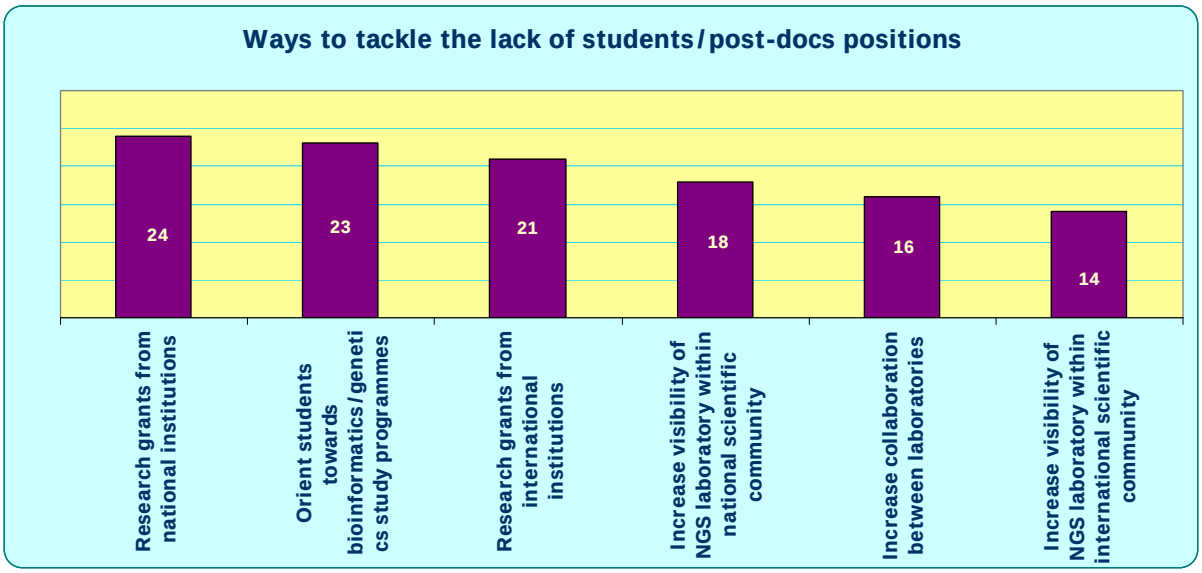


Figure 4.17 – Ways to improve the lack of students/post-docs positions

Research grants from national and international institutions and orientation towards bioinformatics/genetics study programmes were suggested as the best approaches to deal with the lack of students/post-docs positions for 40% of respondents.

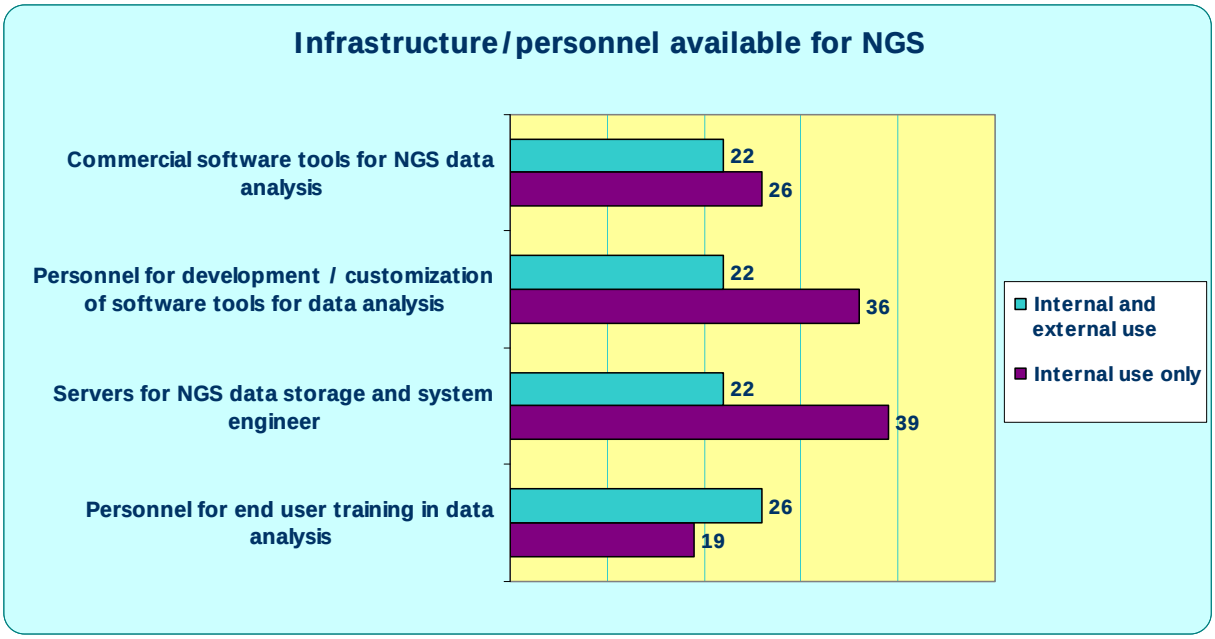


Figure 4.18 – Infrastructure/personnel available for NGS

Personnel for end user training in data analysis are available for internal and external use in 40% of laboratories (26 out of 65 responses). Internal use only predominates at other infrastructure/personnel available for NGS in laboratories.

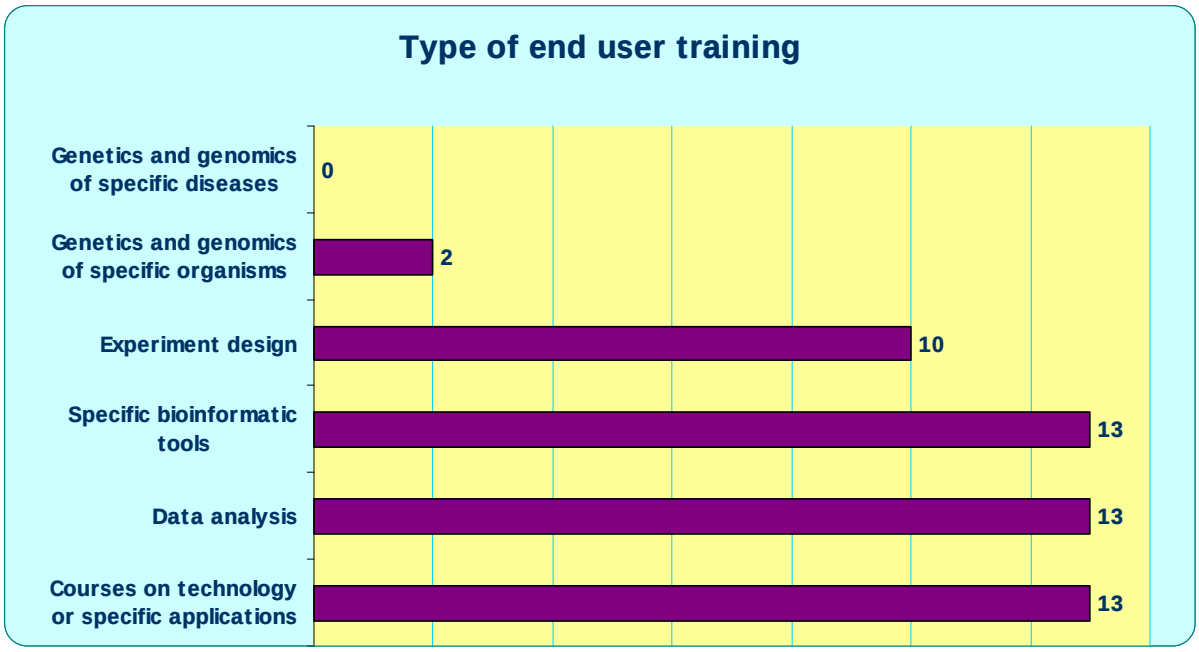


Figure 4.19 – Type of end user training

Over half the laboratories (13 out of 23) arrange courses on technology or specific applications, on data analysis and on specific bioinformatics tools. Courses on genetics and the genomics of specific organisms and of specific diseases are organised rarely or not at all based on the survey findings.

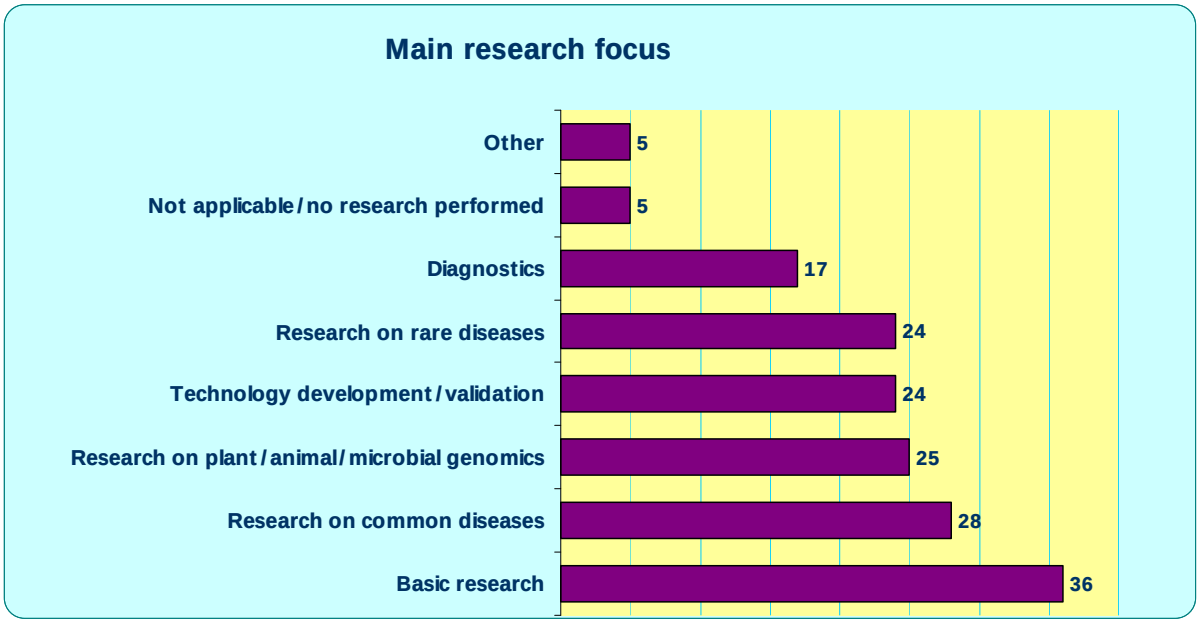


Figure 4.20 – Research focus of respondents

The research focus of the respondents was spread evenly across the research areas, with the main focus concentrated on the basic research and research on common diseases.

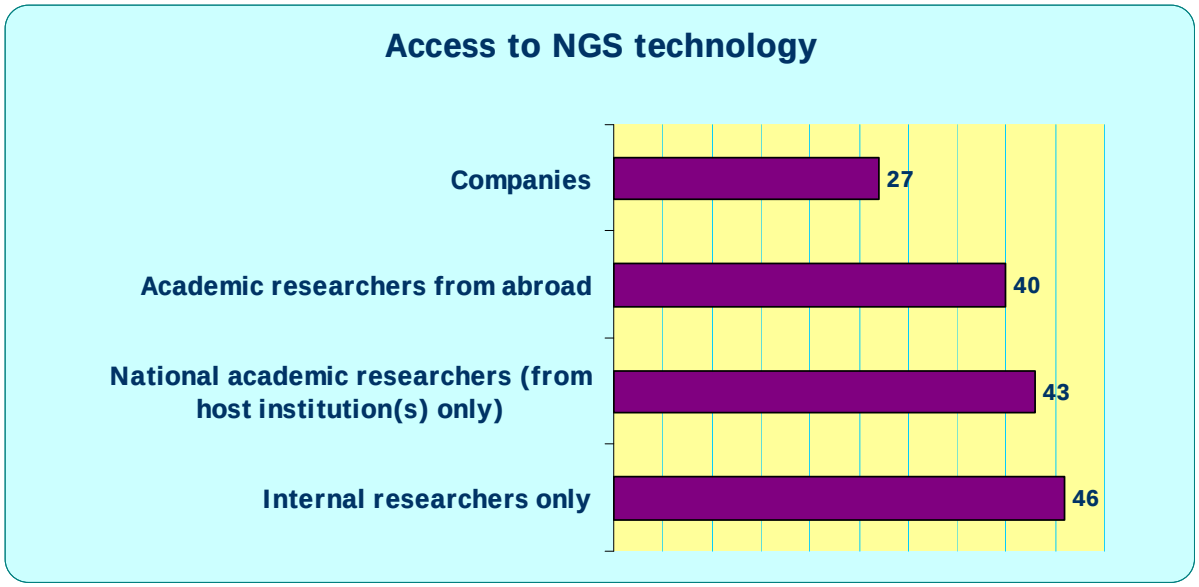


Figure 4.21 – Access to NGS technology

85% of the laboratories which answered the online questionnaire enable access to the NGS technology for internal researchers only. 80% of laboratories enable access to academic researchers from the host institution(s). The access to these equipments is not open to external users.

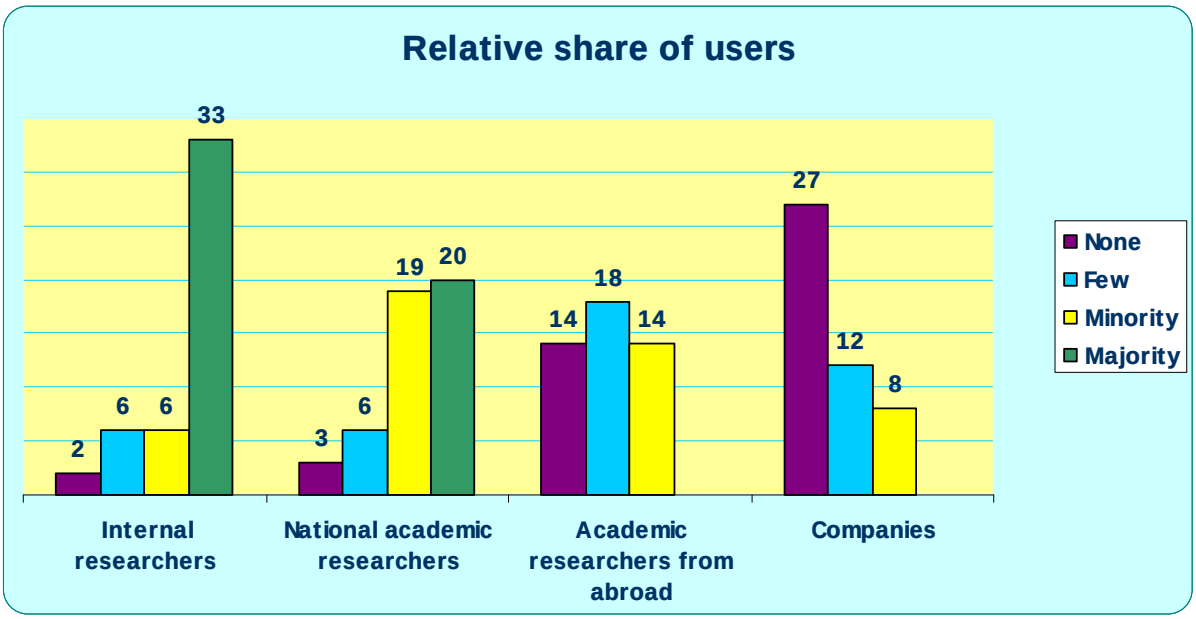


Figure 4.22 – Relative share of users

The use of the NGS technology by users from companies was low in the respondent laboratories, as underlined also by the previous points.

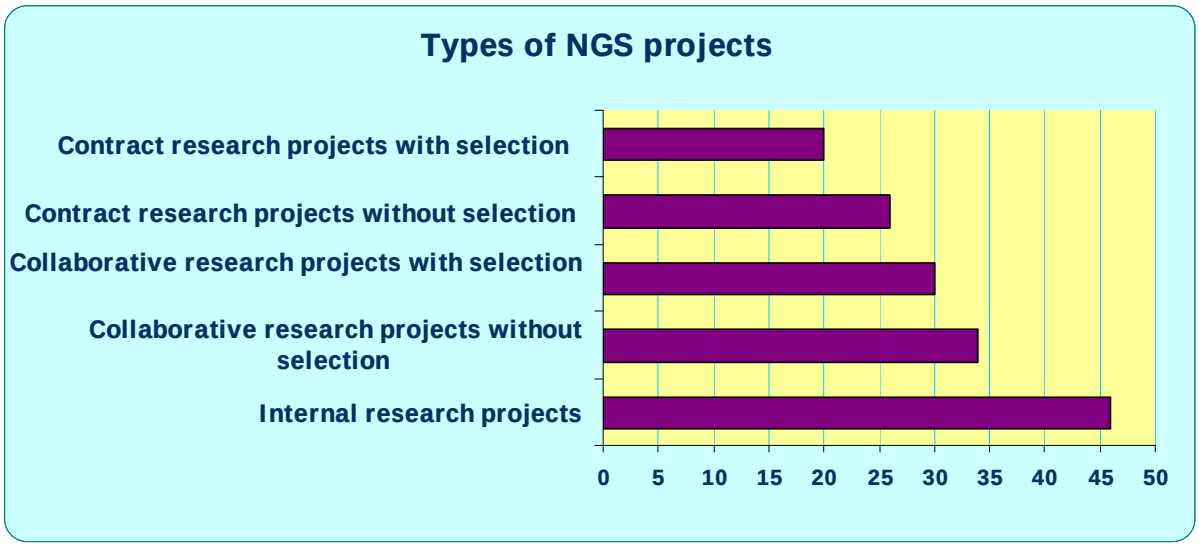


Figure 4.23a – Types of NGS projects

Once again, most of the projects done on the NGS equipments are made for internal users. This is why few contract projects are done, as well as few collaborative projects with selection.

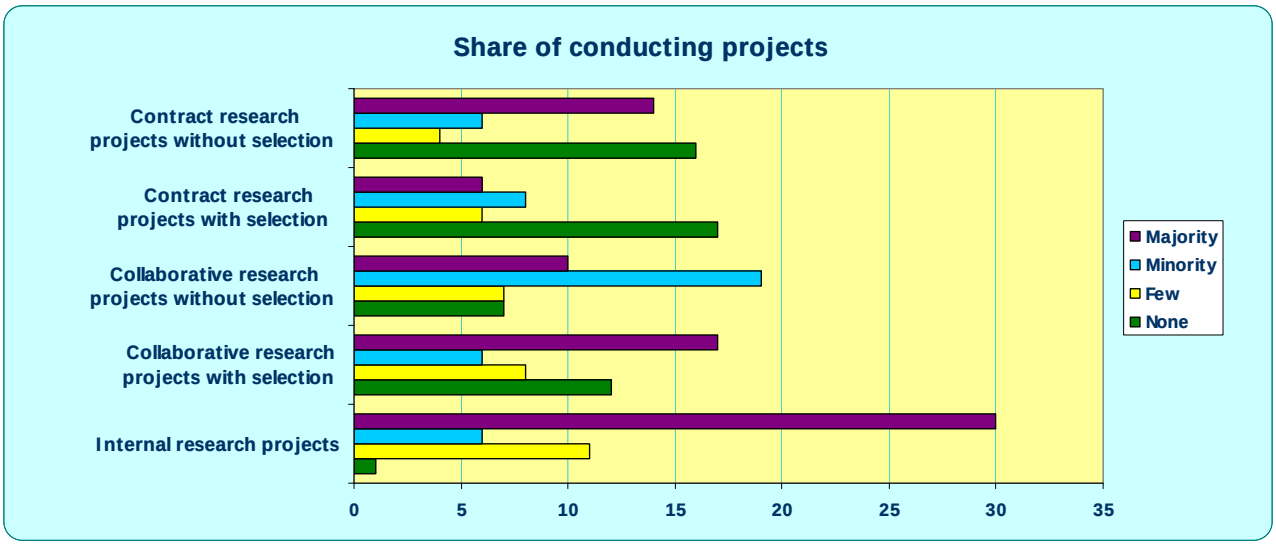


Figure 4.23b – Share of conducting projects

Internal NGS research projects (e.g. projects initiated by the laboratories) can be conducted in 85% of institutions. Collaborative NGS research projects with specific selection procedures can be managed in 56% of laboratories (63% of laboratories also enable conducting projects without such procedures). On average only 43% of laboratories enable conducting contracted NGS research projects (e.g. fee-for-service).

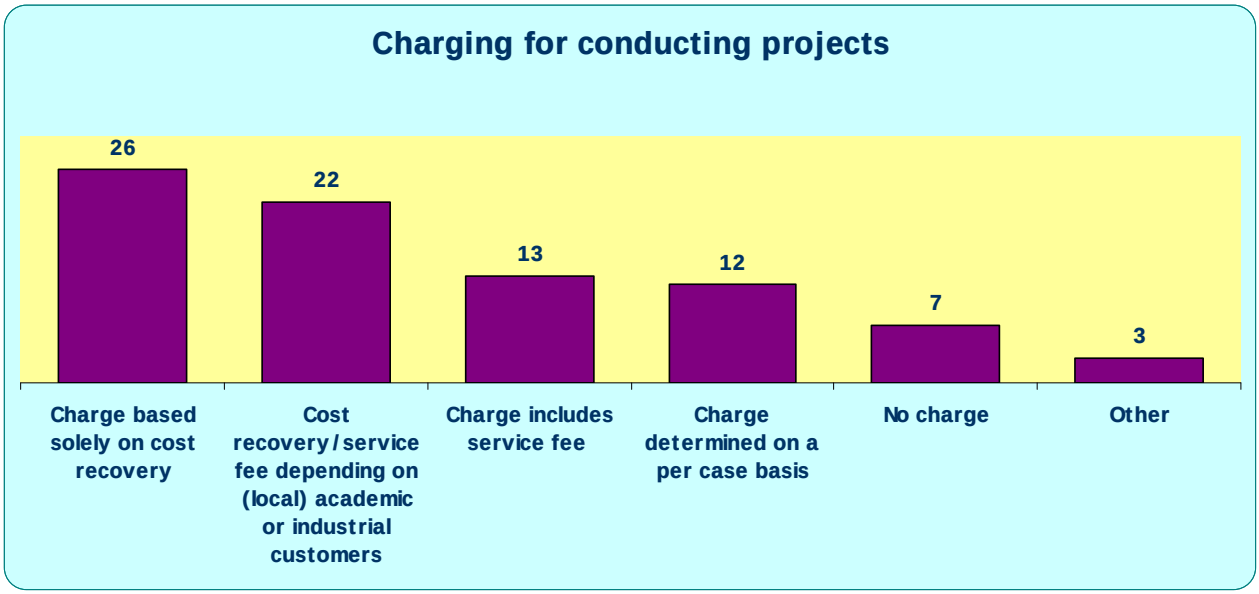


Figure 4.24 – Charging for conducting projects

Customers/collaborating institutions are charged based entirely on cost recovery (consumables, personnel cost) in 48% of laboratories. The second most frequent type of charging for conducting projects is cost recovery/service fee depending on (local) academic or industrial customers.

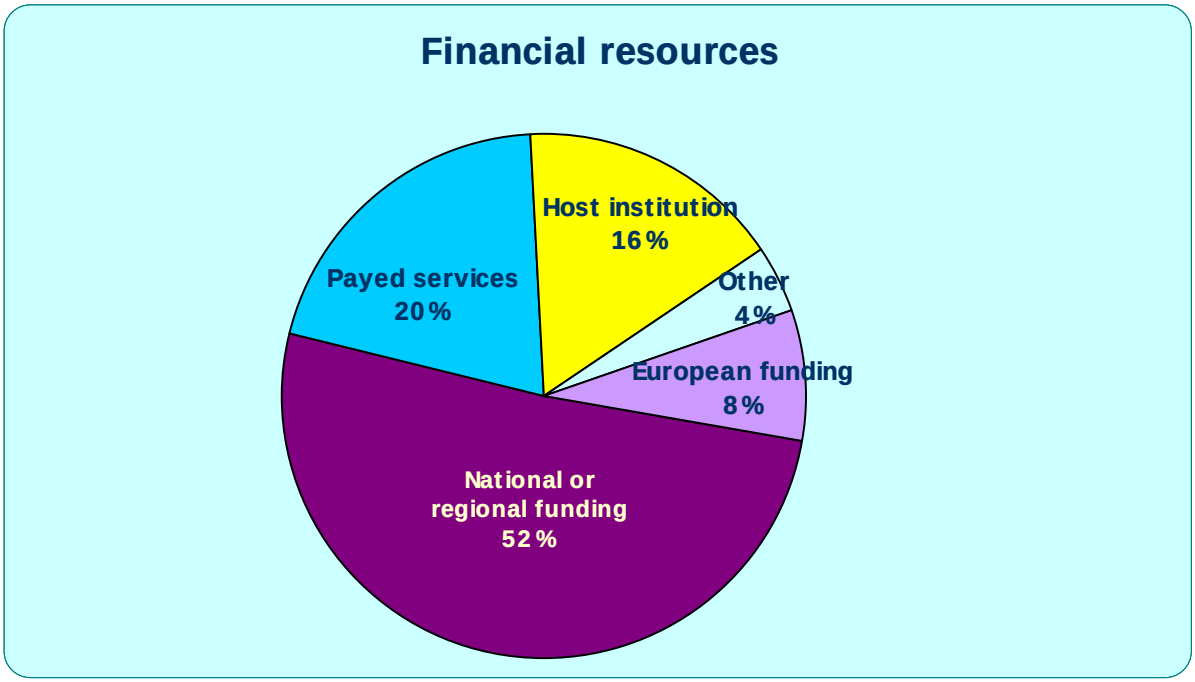


Figure 4.25 – Financial resources

Most financial resources for the laboratories come from the national or regional resources. European funding on NGS does not appear to be so relevant, being less important than the paid services.

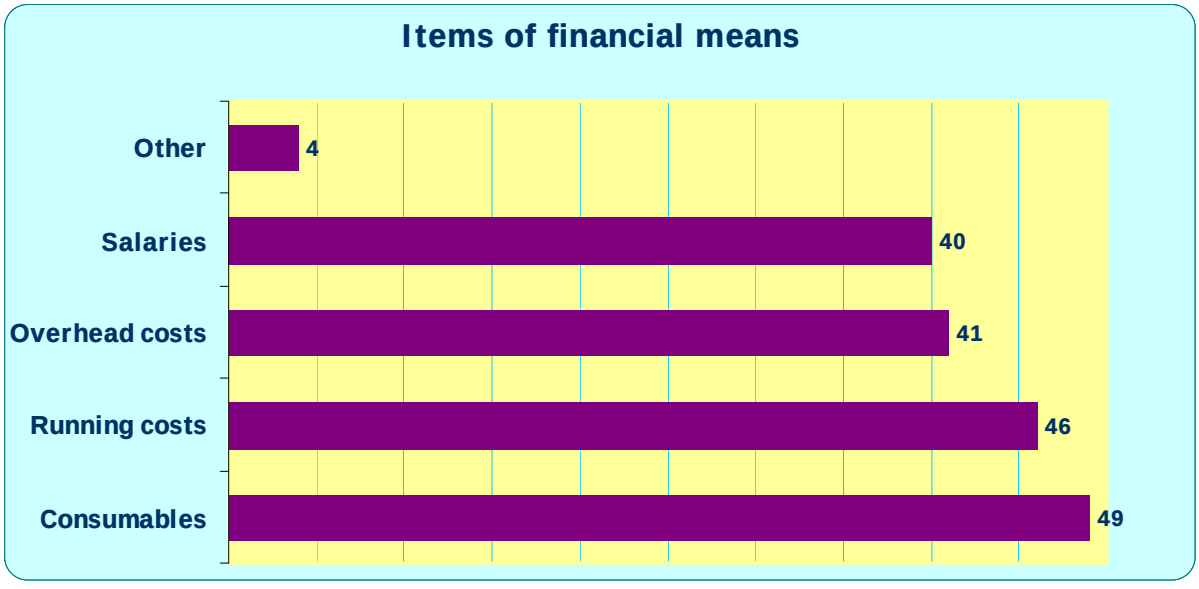


Figure 4.26 – Items of financial means

Funds of most laboratories are used to cover consumable costs, running costs, overheads and salaries.

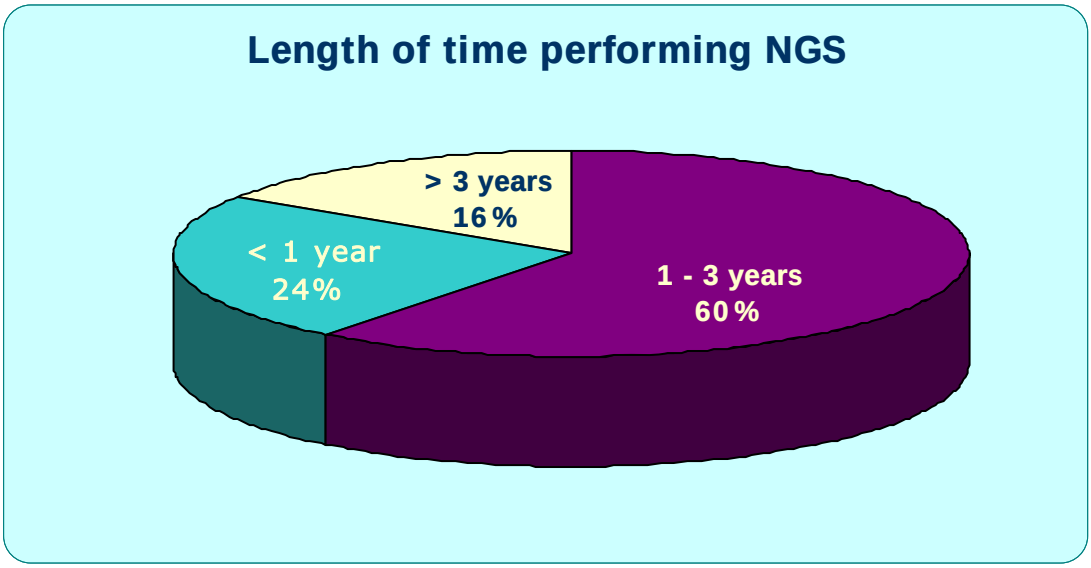


Figure 4.27 – Length of time performing NGS

The majority of institutions are performing NGS within the time frame of 1-3 years (46 replies out of 76). Only a small portion of laboratories have over 3 years of experience with NGS technology (12 replies out of 76).

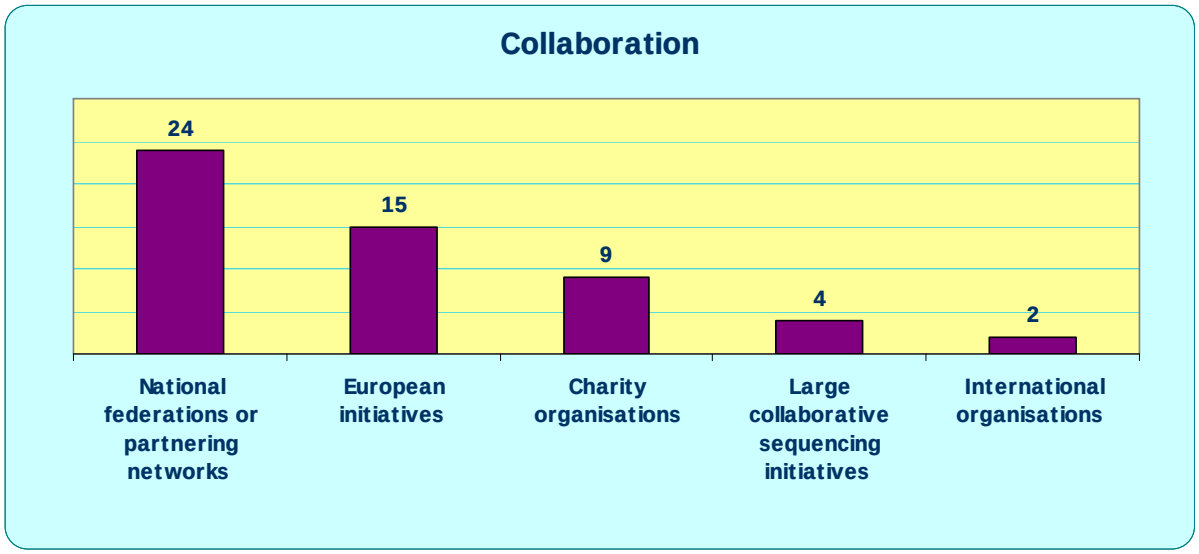


Figure 4.28 – Collaboration

46% of the laboratories were involved in the national federations or in partnering networks, 29% in European initiatives, 17% in charity organisations and significantly lower number in large collaborative sequencing initiatives and international organisations. Once again, it underlines the fact that most NGS equipments are used by internal researchers for internal projects.

5 Conclusion

One of the aims of ERA-Instruments is establishing an overview of the midsize cutting edge instrumentation for life science research in Europe. After the first successful pilot survey dedicated to NMR and MRI equipment, which is very much appreciated by scientific communities and the other actors working in this field, it was decided to follow that survey with a study of other instrumentation being sufficiently used and relevant for an EU inventory. Thus, the second inventory was focused on NGS equipment with the aim of mapping the present situation of these equipments in Europe and was performed with optimized procedures learned in the NMR and MRI survey. An important aspect within the task 2.3 has been

cooperation with the three other consortia, which proved that joint activities of the ERA-Nets would be necessary for an effective strategy in developing the European Research Area.

The outcomes of the task 2.3 can be summarized in the following points:

- The whole task is based on data gained by the online questionnaire available for respondents on the CNRS website from 20 October 2009 till 24 February 2010. The questionnaire consisted of 7 parts and about 45 questions. CNRS was also responsible for the data collection. (More details are available at http://www.gacr.cz/era/era-instruments-database.html).

- The first run of survey resulted in feedback of 76 responses from 13 countries, representing 153 pieces of NGS equipment.

- Only information available from the responses given in the questionnaire were processed. The results are strongly dependent on the willingness of respondents to provide information, and thus the current situation in the number of equipment may be different. Therefore, this analysis does not represent a full mapping of European NGS instruments. However the obtained data cover a representative sample and provide important detailed information, especially about the use of NGS equipment. Based on the results of this study, a full scale survey should be performed to evaluate and to get more representative results within the entire EU. The existing results should provide only a representative picture of the European NGS equipment for the involved parties.

- Three significant criteria for searching in the database were determined: country, type of application and type of operational NGS technology.

- The detailed analysis provides information about number of responses per country and the number of NGS equipment by country.

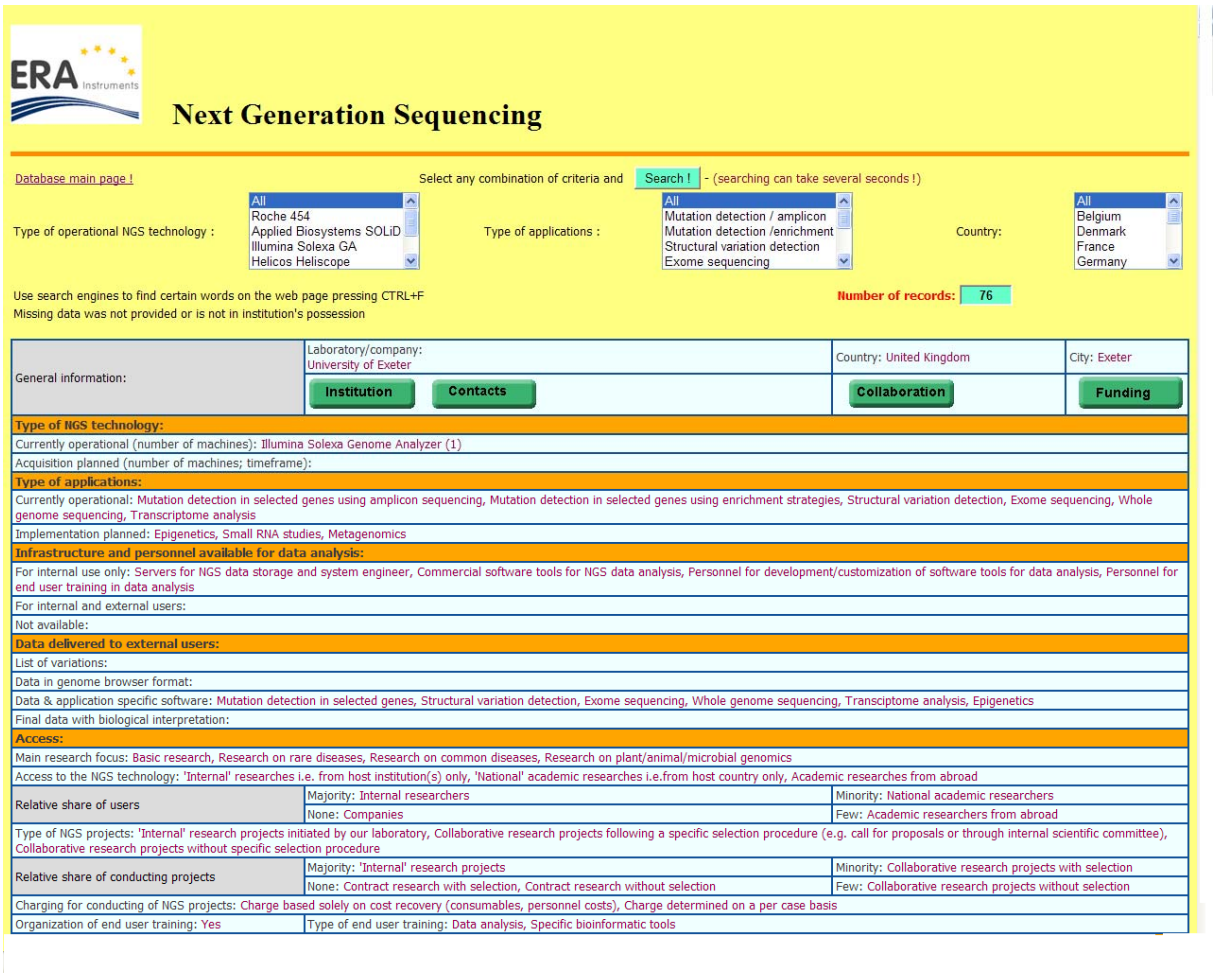
- The main bottlenecks for setting up and implementing new applications were identified as the number of personnel for data analysis and the funds available. Increased collaboration with other NGS laboratories and hiring more personnel for data analysis were considered effective ways to solve these problems.

- The main problems associated with conducting external NGS projects were seen in the number of bioinformaticians and technical personnel.

- Other interesting facts identified came from the analysis of the scientific personnel working with the NGS technology, financing resources for research and external NGS facilities cooperation.

- The area of NGS is a very rapidly developing domain where new technologies are being applied constantly. Therefore, the main concern for future surveys should be to ensure that the existing database is updated regularly and in a timely manner, in addition to basic technical maintenance, in order to meet the needs of the scientific community and all organisations participating in the ERA-Instruments project.

6 Snapshot from the database web-site



Next Generation Sequencing

Database main page !

Select any combination of criteria and Search ! - (searching can take several seconds !)

Type of operational NGS technology : All; Roche 454; Applied Biosystems SOLiD; Illumina Solexa GA; Helicos Heliscope

Type of applications : All; Mutation detection / amplicon; Mutation detection /enrichment; Structural variation detection; Exome sequencing

Country: All; Belgium; Denmark; France; Germany

Use search engines to find certain words on the web page pressing CTRL+F
Missing data was not provided or is not in institution's possession

Number of records: 76

General information:	Laboratory/company: University of Exeter	Country: United Kingdom	City: Exeter
	Institution Contacts	Collaboration	Funding
Type of NGS technology:			
Currently operational (number of machines): Illumina Solexa Genome Analyzer (1)			
Acquisition planned (number of machines; timeframe):			
Type of applications:			
Currently operational: Mutation detection in selected genes using amplicon sequencing, Mutation detection in selected genes using enrichment strategies, Structural variation detection, Exome sequencing, Whole genome sequencing, Transcriptome analysis			
Implementation planned: Epigenetics, Small RNA studies, Metagenomics			
Infrastructure and personnel available for data analysis:			
For internal use only: Servers for NGS data storage and system engineer, Commercial software tools for NGS data analysis, Personnel for development/customization of software tools for data analysis, Personnel for end user training in data analysis			
For internal and external users:			
Not available:			
Data delivered to external users:			
List of variations:			
Data in genome browser format:			
Data & application specific software: Mutation detection in selected genes, Structural variation detection, Exome sequencing, Whole genome sequencing, Transciptome analysis, Epigenetics			
Final data with biological interpretation:			
Access:			
Main research focus: Basic research, Research on rare diseases, Research on common diseases, Research on plant/animal/microbial genomics			
Access to the NGS technology: 'Internal' researches i.e. from host institution(s) only, 'National' academic researches i.e.from host country only, Academic researches from abroad			
Relative share of users	Majority: Internal researchers	Minority: National academic researchers	
	None: Companies	Few: Academic researchers from abroad	
Type of NGS projects: 'Internal' research projects initiated by our laboratory, Collaborative research projects following a specific selection procedure (e.g. call for proposals or through internal scientific committee), Collaborative research projects without specific selection procedure			
Relative share of conducting projects	Majority: 'Internal' research projects	Minority: Collaborative research projects with selection	
	None: Contract research with selection, Contract research without selection	Few: Collaborative research projects without selection	
Charging for conducting of NGS projects: Charge based solely on cost recovery (consumables, personnel costs), Charge determined on a per case basis			
Organization of end user training: Yes	Type of end user training: Data analysis, Specific bioinformatic tools		

7 Annex

NGS by localities

Roche 454	
	city (number of equipment)
BELGIUM	Leuven (1) Liege (1) Antwerp (1) Brussels (1)
FRANCE	Lille (2) Clermont-Ferrand (1) Rennes (1) Toulouse (1) Evry (2)
GERMANY	Berlin (3) Tübingen (1) Gatersleben (1) Greifswald-Insel Riems (1) Neuherberg (1) Plön (1) Düsseldorf (1)
ITALY	Padova (1) Napoli (2) Rome (1)

	Segrate (1)
NETHERLANDS	Nijmegen (1) Amsterdam (1) Leiden (1) Utrecht (1)
PORTUGAL	Cantanhede (1)
SPAIN	Barcelona (3) Valencia (1) Badalona (1)
SWEDEN	Stockholm (2)
SWITZERLAND	Zürich (1) Balgach (1)
TURKEY	Ankara (1) Istanbul (1)
UNITED KINGDOM	Edinburgh (1) Cambridge (1) Liverpool (2) Hinxton (2)

Illumina Solexa Genome Analyzer	
	city (number of equipment)
BELGIUM	Liege (1)
DENMARK	Copenhagen (1)
FRANCE	Lille (1) Paris (3) Montpellier (3) Illkirch (Strasbourg) (1) Evry (2)
GERMANY	Berlin (7) Braunschweig (2) Neuherberg (3) Düsseldorf (1)
ISRAEL	Rehovot (1)
NETHERLANDS	Nijmegen (1) Rotterdam (1) Leiden (4) Groningen (1)
SPAIN	Barcelona (2) Madrid(1)
SWEDEN	Uppsala (2)
SWITZERLAND	Plan-les-Ouates (2)
UNITED KINGDOM	Edinburgh (2) Cambridge (1) Exeter (1) Hinxton (37)

Applied Biosystem SOLID	
	city (number of equipment)
FRANCE	Evry (1) Marseille (1) Sophia Antipolis (1)
GERMANY	Berlin (2)
ISRAEL	Jerusalem (1)
ITALY	Naples (1) Lainate - Milan (1)

NETHERLANDS	Nijmegen (1) Amsterdam (1) Utrecht (2)
SWEDEN	Stockholm (2)
SWITZERLAND	Zürich (1)
UNITED KINGDOM	Liverpool (3) Cambridge (3)

Helicos Heliscope	
	city (number of equipment)
NETHERLANDS	Leiden (1)