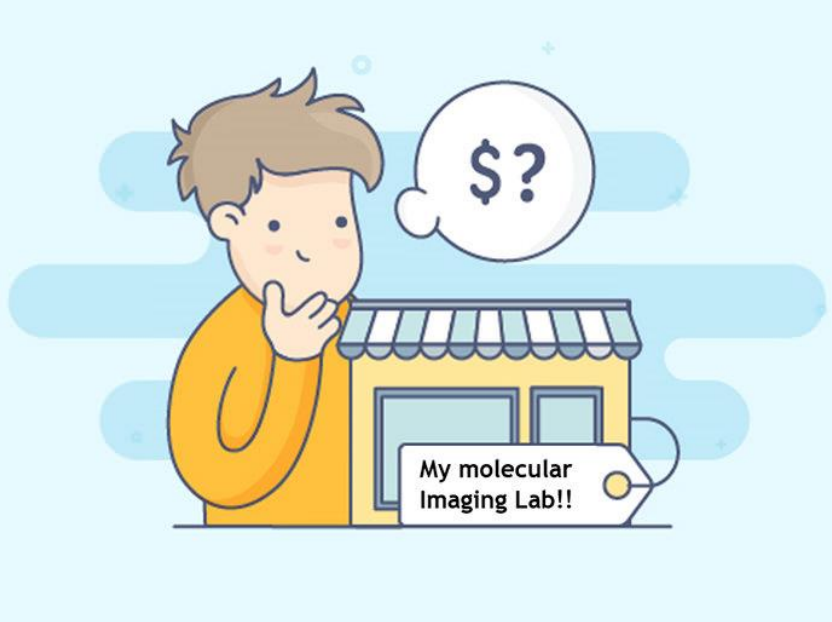

WHITE PAPER

How much does it cost to build a molecular imaging facility? Sharing our experience from BIOEMTECH new labs!

BIOEMTECH

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Sharing our experience from BIOEMTECH new labs!

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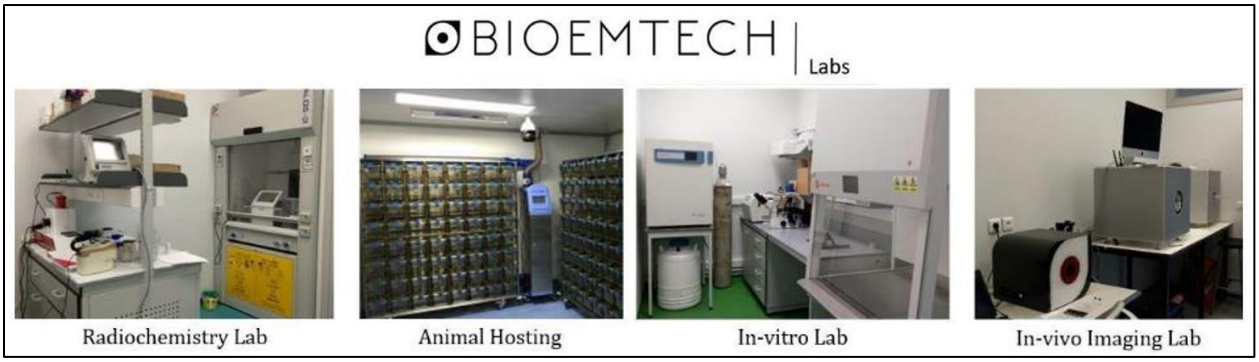


I. Introduction

Many researchers believe that the cost of building a molecular imaging facility is driven by the cost of imaging equipment. And this cost is usually high and hard to afford for a single research team or CRO company. Universities and Research Centers decide to build a core imaging facility and share it among all research groups. Small companies think that they will not afford the costs and even large companies consider it as an important investment. But, is this really the case?

I.1. BIOEMTECH needs

Three years ago, in BIOEMTECH (www.bioemtech.com) we decided to build our own molecular imaging facility. For the first years of company's life, we had collaborated with wonderful people and shared resources with different groups inside "Demokritos" Research Center. However, it was time to move a step ahead, so that we could run the increasing number of our projects, have the flexibility to test different things for our imaging products, and mainly respond to the multiple requests for offering imaging services. Obviously, you need your own lab to have the flexibility to test new ideas and become a real CRO. But also, in academia you need imaging in your daily work, so that you can use it to take decisions and gain time and resources. It is not enough to image few selected mice, usually at the end of a study, having done all the work ex-vivo, just to add some nice images in a publication.

I.2. What information was available

We tried to find what was a typical cost for such an investment, but it was really hard. Most people that we knew gave us controversial estimations. Usually, they had the experience from a large public core facility, which included different laboratories and instruments and the total cost was several millions. Such facilities were usually built, using resources from large infrastructure projects and in this case one can make generous choices, not always applicable to someone who wants to enter the field. Not applicable to us! "OK, let's Google it", I thought, but the only thing that came up was estimations on the cost of different imaging systems. So, we decide to do it by ourselves. We did it and I feel that we should share this experience with others! For any questions, do not hesitate to contact me at george@bioemtech.com.

I.3. What are the minimum requirements?

Let's rephrase the question and think: "What do I need to be able and run a typical, full molecular imaging study?". Adding more and more to an existing laboratory never ends. But what is the minimum required, so that you can do it in house? Obviously, you need:

- Animal house, with mice and perhaps rats

- In vitro lab, to grow cells and perform basic assays
- Radiochemistry lab, to label compounds with isotopes and fluorophores
- Imaging lab, which can support at least a couple of imaging modalities

I.4. Some assumptions

Let's focus on these four labs and leave out office space, meeting room, kitchen, bathroom etc. Let's also assume that the space in a building exists and you have been given an open space of ~100-150 square meters. It is enough to start! Our costs had to do with prices that we were given in Greece, but for scientific equipment, prices usually do not range a lot. Imaging systems have a cost that can vary among manufacturers and depending on specific agreements. I do not intend to give specific prices, but I think that it is fair (or even generous) to say that the simplest modality i.e. optical is 100K€, two modalities i.e. SPECT/CT 400K€ and when adding PET you go up to 1M€. Finally, I add as an alternative the price of our desktop imaging products, the "eyes". Some of you may have heard or you can have a look here (http://bioemtech.com/products/). OK, it may sound like a bit advertising, but today they are an existing option in the market and I have no reason to hide their end-user price, which is comparable to other lab equipment.

II. Costs per category

It is likely that you may find differences in some of these costs, based on your country, type of organization or existing facilities. But I think that the big picture remains the same.

II.1. Procedures, licenses, building adjustments (~60k€)

This includes costs for licenses and surveys (~7k€), internal transformation like walls etc (~8k€), air-conditioning and ventilation (~17k€), benches and other furniture (~16k€) and fire protection (~5k€)

II.2. Radiation Protection (~30k€)

This includes shielded viewing barriers and bin waste container, lead blocks (line, corner), survey meter and dosimeters for 10 persons.

II.3. Animal house (~45k€)

This includes costs for one medium IVC for mice, one IVC for rats, cage sterilizer and few smaller items.

II.4. In vitro cell lab (~60k€)

This includes basic equipment such as CO2 incubator, plate reader, microscope, sterilizer, centrifuge machine, safety cabinet and other smaller equipment.

II.5. Radiochemistry lab (290k€-345k€)

This includes the basic equipment such as gamma counter, fume hood with shielding and without (for synthesis), HPLC, TLC, Dose calibrator, centrifuge, water purification, ultrasonic probe and other smaller equipment. There smaller costs are for medium energy isotopes, while the higher if a second shielded fume hood is required for higher energy isotopes.

II.6. In vivo imaging systems (340k€-1,200k€)

This part is tricky! There are four basic modalities: optical, CT, PET and SPECT (intentionally I leave MRI out). Few groups can obtain all modalities in a single step. Prices range, so I make a rough assumption as I said, where optical is 100k€, CT is 150k€, microSPECT is 300k€ and microPET is 400k€. You can do the adjustments depending on the offers that you may have. I also add the prices of BIOEMTECH 2D systems: γ-eye (2D-SPECT) for 80k€, β-eye (2D-SPECT) for 100k€., I also include the two new products that we have on the queue ϕ-eye (2D-optical) for 75k€ and χ-eye (2D-X-ray) for 75k€.

II.7. Monthly running expenses (22k€)

These can vary depending on the activities. So, it is based on our current workflow and includes expenses for PET/SPECT isotopes, mice, cells and chemical consumables and percentage of annual service of equipment.

III. What are the possible options?

There are various possible paths to start your molecular imaging lab. It always depends on your budget, needs and vision. Of course, there are always some minimum requirements and dependencies, so that you do not end up with systems that you never use, because something else is missing. But the worst thing that can happen is to make a large investment, which will not bring you the expected return in terms of projects and research outcomes.

III.1. No imaging at all (~510k€-565k€)

This includes the costs of all procedures and licenses, having the animal facility, cell lab and radiochemistry lab. Here, you can be independent and do all studies up to biodistribution level. It is around half a million. Still, you cannot get images, which means that you are not a molecular imaging lab yet! And it looks like adding a microSPECT/CT or microPET/CT will require to double your budget. This is true and this is why you may decide not to make this investment. Or you may decide to stick to optical imaging. At least this shows that you are happy to work with 2D imaging. But don't rush. Before you do so, you may have to read the other options.

III.2. Add optical and only one radioisotope system (~1,125k€)

This includes all facilities described above, plus an optical imaging and a microSPECT/CT (just because it is cheaper than PET/CT). You may do not have everything, but now you are a real molecular imaging lab! Still, you need to secure an additional 1.1 million. Not easy to do it by yourself. So, I guess that you will need to push your Institution to go for a core facility, where you will have some access. And if there are not many like you, it is likely that your institute will never do it!

III.3. Add all imaging systems (~1,525k€)

This includes all facilities described before, plus an optical imaging and a microSPECT/PET/CT. Now you have everything! Some people say that if you can find 1.1 million, you can also find 1.5 million. It is true, but don't forget that this is to share with others!

III.4. What about live imaging with BIOEMTECH "eyes"? (620k€-880k€)

I do not cheat with the numbers. With "γ-eye" it is possible to have images of SPECT isotopes with only an 80k€ investment. Adding 100k€ more, you can also have "β_eye" and images of PET isotopes. So, with a total investment of ~700k€ it is possible to have a real molecular imaging facility, including in vivo imaging of SPECT and PET isotopes. Yes, there is no reason to postpone your plans! Build your facility, start with low energy isotopes and "γ-eye" and then upgrade to high energy and '"β-eye". Sounds like a plan? Some may say that it sounds like an advertisement, but this is how we started our preclinical Laboratories in BIOEMTECH!

III.5. And what about having it all? (1,700k€)

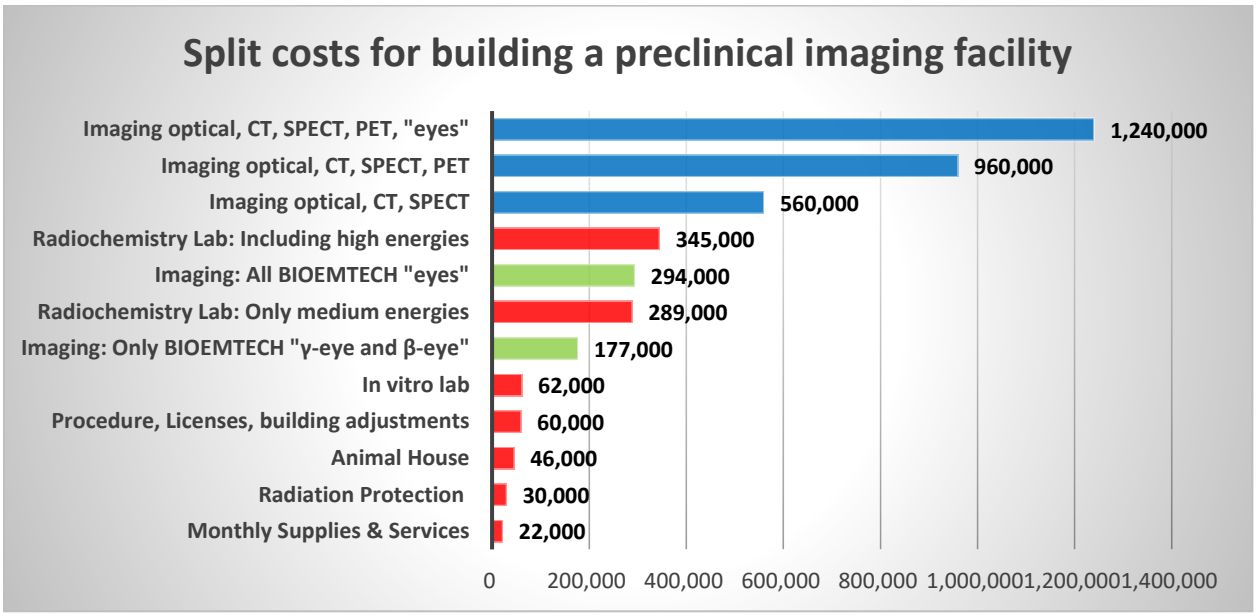
Finally, there is the "I want it all" scenario. Here, you have secured funding and you decide to have nice high end optical, microSPECT/PET/CT. But you also want to add the 2D "eyes", to improve throughput and gain time, as well as add the real time imaging capability. It looks like going from 1,5 million to 1,7 million does not make a great difference. And I am sure that if you go for such an investment, you will get the best possible prices from all manufacturers, including us! If you are one of those lucky persons, do not miss the opportunity to add something small, simple, which gives real time, dynamic, images.

Believe me! You will do so many things in parallel with the “eye” and your high-end systems will never stop being busy.

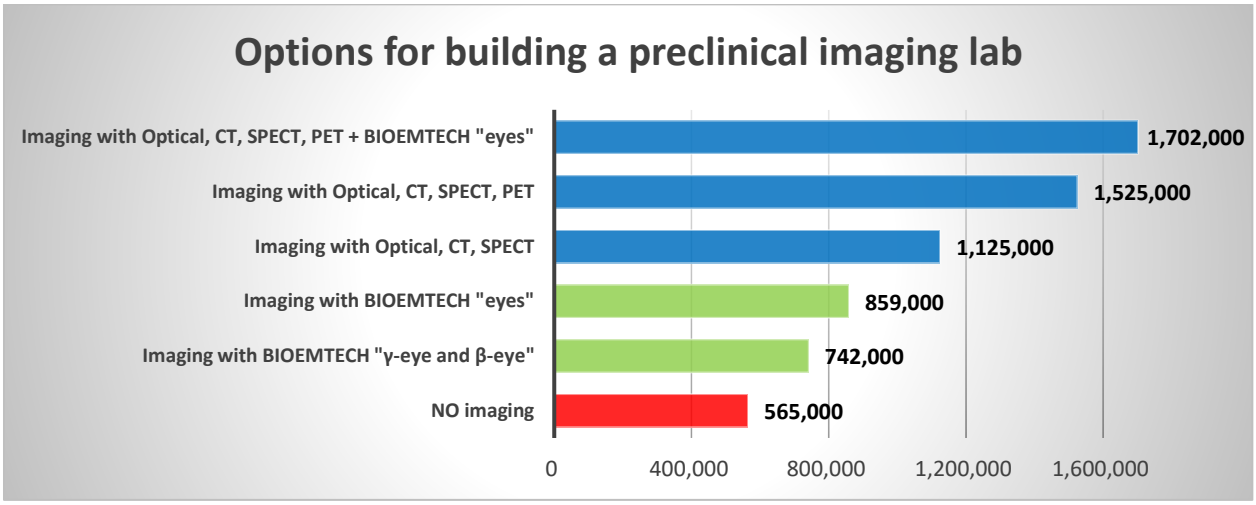
IV. And some analysis

IV.1. Total costs

If you are still reading this article, chances are that you want to see some more numbers. First, I provide the overview of all possible SPLIT coasts, to see the different options. With “red” those that you cannot avoid if you want to have mice, cells and radiochemistry (medium or low energies). With “blue” the different options for having imaging systems. Finally, with “green” I give the option for having two BIOEMTECH products, “γ-eye” and “β-eye”, which cover imaging of SPECT and PET isotopes or to have our upcoming “ϕ-eye” and “χ-eye” as well.



From our experience the most expensive part of the initial investment was the radiochemistry lab and all equipment associated with it. So, the TOTAL budget that you need for different options is shown in the next figure.

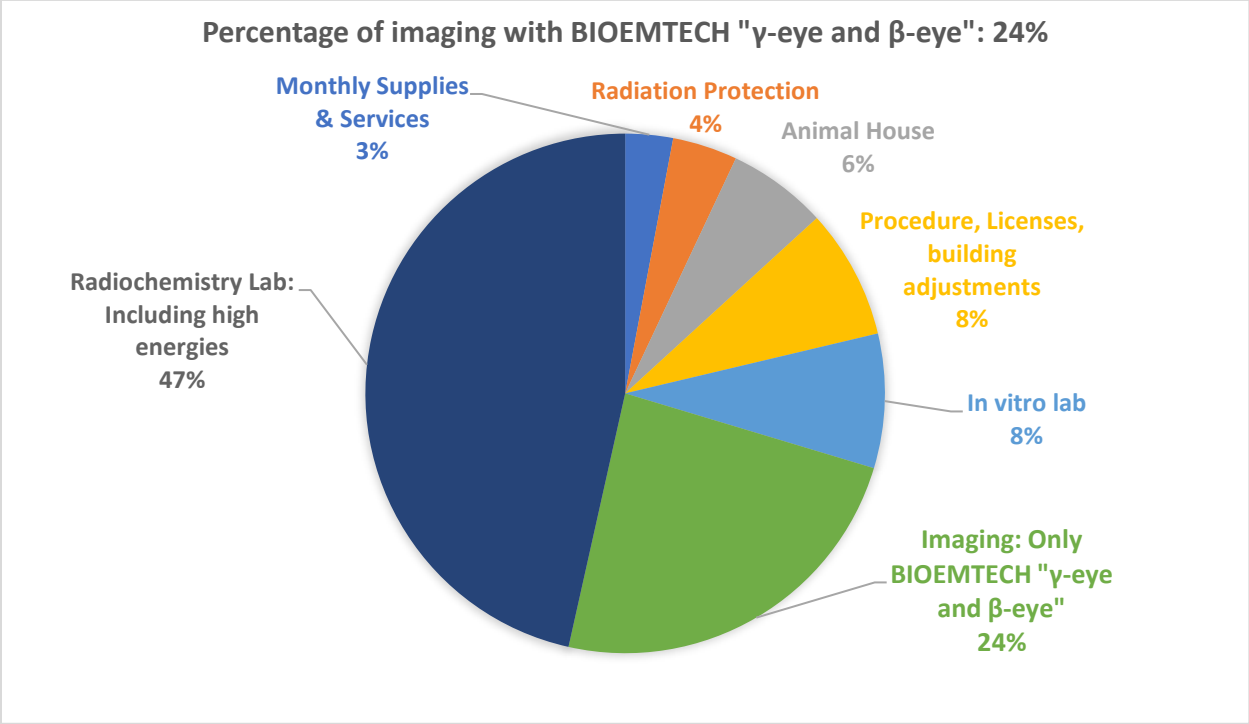


You will need approximately 565k€ to have a nice facility with mice, cells, radiochemistry but …no imaging. Imaging with existing high-end solutions quickly doubles your required budget. However, the option to start with just BIOEMTECH “γ-eye” and “β-eye” requires a small additional investment and you

can have in vivo images. I will come back to it in a while. Let's now see how costs are split in three typical options:

IV.2. Selecting only BIOEMTECH γ-eye and β-eye as your imaging solution

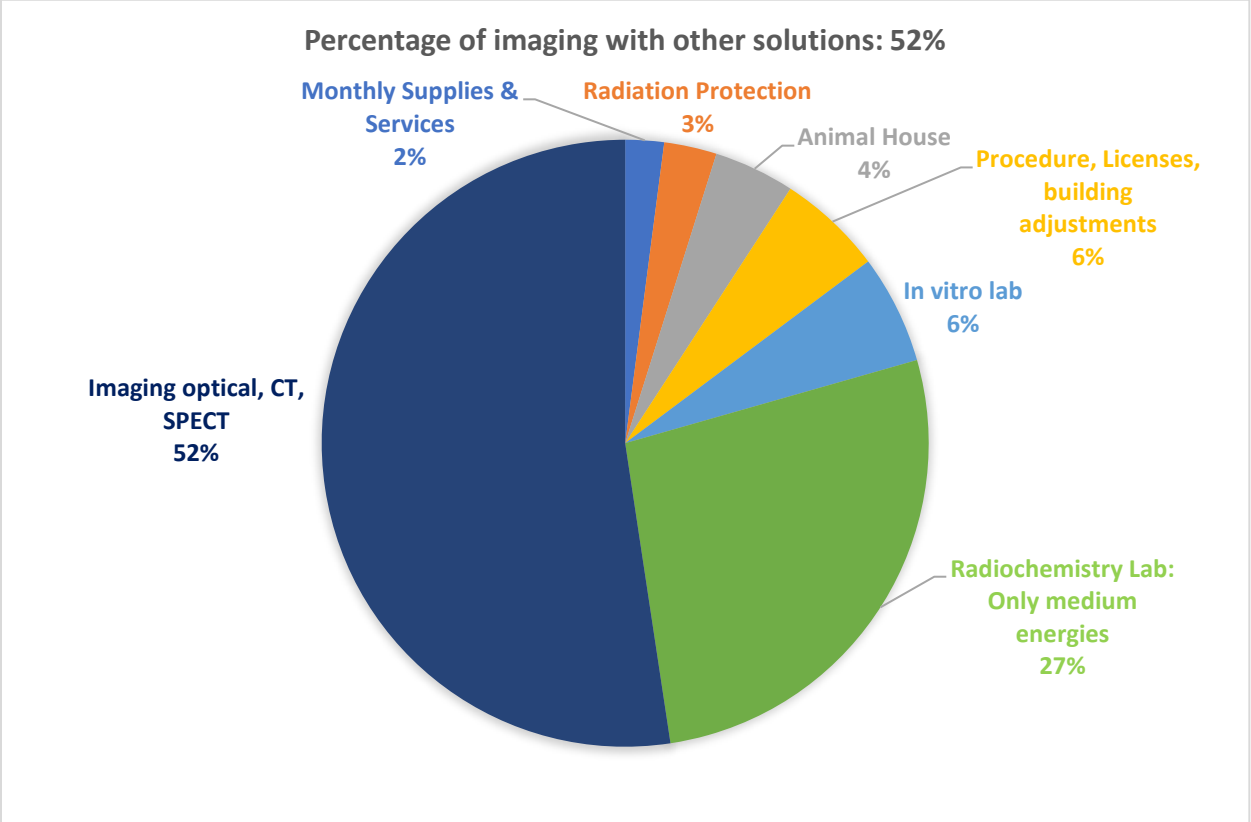
I assume that your budget is limited and there is a dilemma if some imaging devices can be added; the most feasible option (apart from optical) would be to go for "γ-eye" and "β-eye".



As you can see, this will add 24% to your initial investment, but now you are able to get images! It is important to think that you can now save time by avoiding costs for subcontracting imaging studies, reduce biodistributions, minimize the number of animals required for each study and increase the accuracy of your results. It looks like their cost can be covered by just avoiding a few subcontracts. An important advantage is that the "eyes" are considered "lab equipment" and their cost can be covered by a small project, with no needs to follow the procedures that are required for shared equipment! So, there are different ways to get them.

IV.3. Selecting only optical, CT and SPECT from high-end solutions

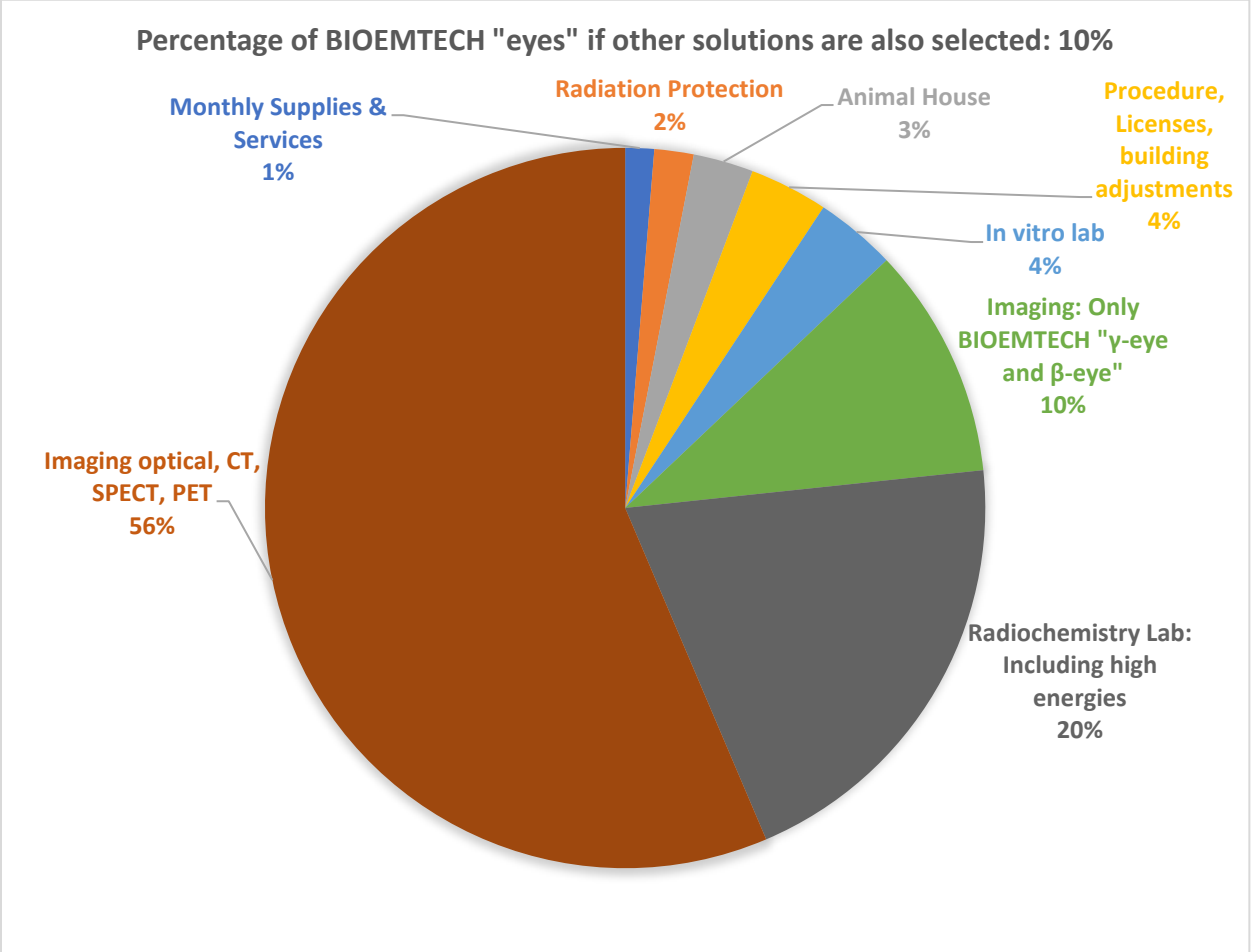
Here I assume that someone decides to go for only one high-end solution, i.e. that there is budget for optical and microSPECT/CT.



Now the radiochemistry lab supports only medium energies (so a bit cheaper), but still the cost of the imaging systems is 52% of the total investment! And it looks like you will have to go through all procedure required for large equipment, wait for a big project or institutional decision and in the end …share the system! There are different ways to use this budget. For example you can go for a nice optical imaging system, add also PET in your radiochemistry lab, add both "β-eye" and "γ-eye" to work with all isotopes and keep some budget to subcontract imaging for your best mice. Or, since you want to go for a SPECT/CT, add only "β-eye", so that you can do PET isotopes as well! It is likely that others will subcontract you for imaging; you didn't expect this, did you?

IV.4. Building a fully equipped lab and adding γ-eye and β-eye to increase throughput

Here I assume that someone has the budget to go for all: optical, and microSPECT/CT/PET. What about also adding "γ-eye" and "β-eye"?



Still, 56% of the budget will go to obtain all high-end imaging systems (optical, SPECT/PET/CT). If you decide to add “β-eye” and “γ-eye”, the total investment will increase only by 10%! But now, you can increase throughput and benefit from having the ability to get real time images, as well as have a fast screening tool for daily work. As I said before, with such a budget, you will get really good prices. But, it is likely that these systems will end up to the core facility. What about if you could keep “β-eye” and “γ-eye” in your lab? Just to check things daily and avoid the long queue in the high end system?

V. Conclusions

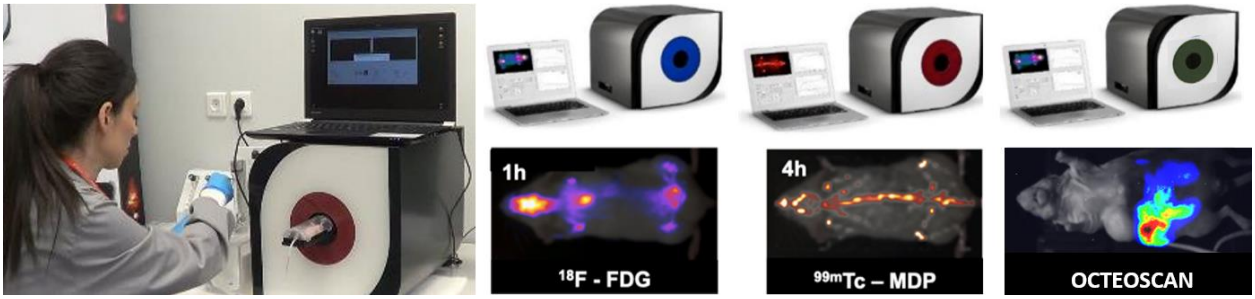
These numbers are real. Our lab also became a reality. This search took more than 3 years and we always try to think what the next step or the next system for purchase will be. I hope that this will be useful for those who dream of having a molecular imaging lab, for those who write grants so that they can build their own, for those who have an initial budget and try to take the best decisions, for those who want to replace old equipment and for those who have already a facility running and want to extend it. Honestly, I believe that BIOEMTECH “eyes” have some unique features that make them rather attractive and obviously a cost-effective investment. However, the motivation of this article was -and remains- to share our experience and help our colleagues gain time and avoid mistakes when planning how to spend their valuable, and usually public, budget. And last but not least, I really hope that it will help more and more groups, all over the world to understand that a molecular imaging facility is not something impossible. It is an investment that can be done step by step. Each step will provide the resources to go to the next one and all these steps will lead to wonderful results, answer to important scientific questions and hopefully provide new diagnostic and therapeutic tools for the society.

VI. About BIOEMTECH

BIOEMTECH is located in the Technological Park of Demokritos Research Center, in Athens Greece. Having a strong academic background, the company provides unique, high quality products and services in the field of drug research and biotechnology.

VI.1 BIOEMTECH products: eyes

BIOEMTECH specializes in the design and construction of desktop, small animal imaging systems for pre-clinical, pharma, biotechnology, and medical research; Our trademark 'eye' refers to compact and desktop devices, which transform lab desks into in-vivo imaging labs, allowing easy and real time in-vivo dynamic screening of radiolabeled compounds, providing unique information for imaging PET and SPECT isotopes, as well as fluorophores.



(Left) The γ-eye™ system in use, (Right) Top to bottom: β-eye™, γ-eye™,φ-eye™ systems, indicative images from the eyes with ^{18}F-FDG, ^{99m}Tc and Octeoscan respectively.

VI.2. BIOEMTECH CRO services

BIOEMTECH Laboratories offer a full preclinical platform, from in vitro studies to in vivo imaging. We provide small animal imaging services, for advanced experiments on multi-scale level for both diagnostic and therapeutic protocols, in our unique, fully equipped and licensed laboratories that include:

- In vitro lab for cell studies
- Animal facility (mice & rats)
- Radiochemistry lab
- Imaging facility (microCT/SPECT/PET)

BIOEMTECH Laboratories: in vitro, radiochemistry, animal hosting and imaging labs, door-to-door.

All studies are in full accordance with the 3Rs principle (animal reduction, replacement and refinement) and all international standards, while our personnel is specially trained on the undertaken activities (FELASA & radioactivity accreditation).

VI.3. Fillable mouse phantom

BIOEMTECH introduced the first generation of fillable mouse and rat phantoms, designed for nuclear medicine (PET/SPECT) applications, but already successfully tested for X-ray (CT), Magnetic Resonance Imaging (MRI), Optical Imaging (OI) and Magnetic Particle Imaging (MPI).

Fillable mouse phantom kit and indicative images from PET SPECT, CT, MRI, Optical and MPI imaging tests

VII. Contact Us

For more info do not hesitate to contact us.

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