Introduction

My name is Ana Rakonjac and I am a physicist at the Measurement Standards Laboratory (MSL). I am European and moved to New Zealand in high school, then completed my university studies with a PhD from Otago University. I worked overseas for a number of years (in the UK as a post-doc, then in Singapore at a deep tech start-up company), then returned to New Zealand in September 2021 and took up a position at MSL.

I am very much invested in New Zealand's success in the sciences. Not only on a personal level with regards to my career, but because of the benefits that a science powerhouse brings to a country, such as employment opportunities, economic investment and output, and direct benefits to residents. There are also ongoing unsolved social problems in RSI that are common to many countries around the world, such as career uncertainty, under-representation of women and minorities, and lack of funding. The Future Pathways green paper is asking all the right questions, and I hope that we can collectively trigger positive changes for New Zealand's RSI environment.

I am making this submission on an individual basis. Though I am sure that many of my opinions are shared by my peers and colleagues, the views in this submission are wholly my own.

Section 1 - Research Priorities

We should consider Priorities that have the biggest potential to help us grow as a nation and improve the lives of all residents. This means funding areas of potential high economic growth, rather than supporting industries that are already self-sufficient. When considering impact to New Zealanders on a personal level, this means identifying what needs to change to help the most vulnerable people thrive. We must take care to make smart, appropriate Priorities and identify what is suitable for public sector research and what is best left to industry.

Given the precarious state of the planet, we also need to focus on risk mitigation, resilience, and self-preservation. This means preparing for climate change, reducing pollution (especially by the dairy industry), preserving our natural habitat, pandemic preparation, etc. We have seen through the covid pandemic that we are vulnerable to supply chain problems and are reliant on outside assistance for vital medication (e.g. covid vaccines). For example, growing a local pharmaceutical industry would be of immense national importance. What if New Zealand could produce its own vaccines and reagents? What if we could create enough that we could export such things to other countries? Our future would be more firmly in our own hands. As the climate crisis gets worse, international relations may also get worse, so we need to be more self-sufficient.

Priorities design: What principles could be used to determine the scope and focus of research Priorities?

A national research Priority should have strategic relevance to New Zealand's aspirations and general benefit to the population, though the benefits may be indirect. There should be room for short, medium, and long term Priorities.

Below, I propose some examples for the sort of scope and focus a Priority might have:

- Benefit to New Zealanders
    - Job and wealth creation (examples: new industries, 10x development of existing industries)
    - Improvements in health and wellbeing (examples: cancer research, vaccine development, mental health)
    - Resilience for future challenges (examples: climate change, natural disasters, pandemics, supply chain disruptions)
    - Addressing known shortfalls (example: Māori representation in STEM)
- International standing
    - World-class research
    - Collaboration with international partners to strengthen our research
    - Impact beyond New Zealand
- Timescales
    - Short term (5 years)
    - Medium term (10-20 years)
    - Long term (30+ years)
    - Ability to quickly address emerging challenges (example: pandemic)

Priority-setting process: What principles should guide a national research Priority-setting process, and how can the process best give effect to Te Tiriti?

Principles:

- "Big picture" thinking
    - Panel of experts with a broad view beyond their subject areas of expertise
    - Multi-faceted viewpoints (science + economic + social contexts)
    - People making decisions should not have a conflict of interest (example: boosting funding to your own institution or your particular industry)
- Diverse input
    - Researchers + industry + end users
    - Explicit Māori representation
    - People from different career stages, including early career
    - Representation for demographics often left out (example: disabled people)
    - Demographic diversity (gender, ethnic, age)
- Evidence-based

    - Case studies from overseas and analysis of their applicability to New Zealand (example: how do other countries do this and will it work here?)
    - Latest research
    - Consultation with communities
- Transparency
    - Those setting priorities should not be direct appointments by a particular government organisation
    - Proposed priorities should go through a consultation process where practical (may not be appropriate for short-term priorities due to time-sensitivities)
- Agility
    - Advisory committee on rapidly emerging challenges
    - Evaluation and monitoring of long-term priorities

I am personally a proponent in involving Māori at every stage of the priority-setting process, such as including Māori experts on every panel and committee and consulting with Māori community leaders. It's better to over-represent Māori than under-represent.

Operationalising Priorities: How should the strategy for each national research Priority be set and how do we operationalise them?

I do not have well-informed feedback for this question, but perhaps something like a "National Research Priority Council" could lead the governing.

Section 2 - Te Tiriti, mātauranga Māori, and Māori aspirations

I am not Māori, so I will leave it to Māori to contribute to this section in detail. However, I have a few comments.

I work in physics, and there is a startling lack of Māori representation in this field. I would like to see an increase in outreach and dedicated scholarships to encourage Māori students to enter STEM fields and pursue careers in physical sciences. We should aim to remove barriers as much as possible and provide financial incentives, and work with Māori groups to increase engagement with students and to improve career aspirations for young Māori people. The best research environment is a diverse one. Even if there is no historical Māori knowledge in a particular field (like quantum physics), people from diverse backgrounds bring their own culture and ways of working to the lab, and we can all learn from each other.

Section 3 - Funding

Core Functions: How should we decide what constitutes a core function, and how do we fund them?

We should consider core functions in terms of what is lost if the function is not funded. Some functions may be very obviously needed, but others may require a more in-depth examination.

There should be a core function decision flowchart that quantitatively considers impact to New Zealand's residents, impact to the economy, and knock-on effects. The mindset should not be "how much does it cost to fund this function", but rather "what do we lose if we don't fund it?" If those losses are unacceptable, then the function is vital.

Existing organisations that provide core functions should be thoroughly consulted on their needs. There is a tendency to underfund organisation in New Zealand, which internally puts a lot of pressure on staff and infrastructure, which in turn wastes time. For example, having the budget to hire a specialist is more efficient than non-specialists trying to do the same job because the specialist will get everything done faster and therefore save money. Productivity is also not linear with funding. An extra 20% to an organisation's budget could boost its productivity by 50%.

We should also be weary about the push to be financially self-sufficient. This may be appropriate for some core functions and inappropriate for others. If there is too much emphasis on financial self-sufficiency, this could be a drain on resources as more staff need to be hired to cover associated costs (product development, customer engagement, administration, finance, legal). A cost/benefit analysis must be done to see if it's actually worthwhile. Also, organisations that serve the public should not be obligated to make a profit. If there is a need to bring in external funds via commercialisation, it could make more sense to have a partner organisation focused on business development that remains financially self-sufficient.

Establishing a base grant and base grant design: Do you think a base grant funding model will improve stability and resilience for research organisations?

Yes. I think it will also help with issues outlined in the Workforce section, particular in regards to the job security of early career researchers.

Establishing a base grant and base grant design: How should we go about designing and implementing such a funding model?

I like the suggestion that base grants could be used to cover salaries, especially if this removes the need for overhead costs in grants. If base grants covered long term post-doc level staff as well, it would significantly help progress research across the country. Base grants could additionally fund technical support (fully or partially), such as mechanical and electronic technicians, glassblowers, IT, and administrative support. I am concerned, however, that base grants covering salaries could lead to inflexibility when it comes to creating new positions in an institution and career progression, so there must be a mechanism to allow for this.

Section 4 - Institutions

Rather than answer the specific key questions posed, I would like to provide some feedback that is particular to my experience in New Zealand and overseas. The green paper points out that there are numerous inefficiencies in the current CRI system. As I see it, a major issue with CRIs and Callaghan Innovation is that public good research and commercialisation are often tangled up in a way that seems to stifle both. I believe we can do better.

I will discuss the role of MSL within the RSI ecosystem, as well as suggest alternative models for CRI-type institutions.

Measurement Standards Laboratory

MSL is contained within Callaghan Innovation. Most, if not all, national metrology institutes (NMIs) around the world are not housed within an innovation agency. Some are dedicated institutions (National Physical Laboratory in the UK) and some are part of bigger national institutions with wider research scopes (example: National Institute for Standards and Technology in the US). Their organisational structure varies - some have a corporate model with a CEO and a board, while others have a director and a relatively flat structure. Nearly all of the highest leadership roles (CEOs and directors included) are held by scientists with expertise in the field, whereas MSL and Callaghan are led by people with expertise primarily in business. Indeed, this is common across scientific institutions in New Zealand, such as CRIs. This creates a major clash because incentives for business and commercialisation are often at odds with incentives for research, especially long-term projects.

MSL has a major role in supporting New Zealand industry. It does this by maintaining standards as a service, which is a time-consuming endeavour that requires scientific and technical expertise. Maintaining standards itself is not profitable (in the same way that seismic and environmental monitoring are not commercial ventures, though they are vital), but we do commercial calibration work for clients, help clients solve particular problems, and support second and third tier calibration labs in the country, which brings in external money. Other NMIs do this as well, because traceable calibrations are critical for supporting a wide variety of industries. The other role of MSL is to advance the field of metrology. As science and technology develops, we develop the ability to make more precise measurements, and so international metrological standards also change and we must remain a part of that change. These goals are somewhat antithetical to commercialisation, though there is certainly scope for partnering with an innovation agency for some projects.

I propose that MSL is separated out of Callaghan Innovation and instead placed within a physical sciences CRI-like institute or run as an independent institute. This would bring us in line with our international peers. Many of our overseas counterparts are stable organisations that have been around for decades, and this stability helps them thrive. Leadership should be by scientists, though the leadership structure could benefit by including a business expert. Business development support could come through a partner organisation such as Callaghan Innovation as the need arises, but the relationship should be one of genuine partnership. MSL scientists should also be able to have their own external grants to support research in our field and help us become leaders rather than followers. As we are part of Callaghan Innovation, we cannot do this, and it’s stifling.

Alternative models for research institutions

There are many different models for structuring non-university research institutes. One very successful example is the Max Planck Society in Germany, which covers many independently-run Max Planck Institutes that collectively form a major research powerhouse. These are non-profit and non-government organisations whose funding primarily comes from

the German government, supplemented by external funding (mostly from European Union initiatives). Institute leadership is by scientists. This sort of model could be applicable for some areas of research in New Zealand that fall under core functions, particularly for those areas where a commercial approach is inappropriate.

Another potential model is A*STAR (Agency for Science, Technology, and Research) in Singapore. A*STAR has a corporate chair and a board, and the executive leadership is advised by scientists. They oversee a number of "National Research Initiatives" which could be equivalent to New Zealand's national Priorities. They also oversee many research entities and institutes, have their own enterprise organisations, and administer and award grants. Note that most of the research institutes and entities are directed by scientists, not by individual corporate boards, which I am sure decreases costs and administrative burdens. As Singapore has a similar population size to New Zealand, such a structure could be appropriate here. Singapore is also a great success story - they revolutionised their research environment in a short period of time and they have a thriving tech start-up community.

On the role of Callaghan Innovation

Innovation agencies have an important role to play in the RSI ecosystem. I would like to draw attention to an organisation in Singapore called SG Innovate, which helps researchers pivot into entrepreneurship. They mentor start-up companies and help get them funded through private investment. Singapore has a lot of private investors and venture capital companies compared to New Zealand, so the same financing model may not work here. However, the concept of supporting young, passionate scientists and engineers in founding start-ups to commercialise their research is exactly in line with Sir Paul Callaghan's assertion that "100 inspired entrepreneurs could turn this country around". This is a role that Callaghan Innovation could fulfil.

Final comments

Scientists working at CRIs, universities, and other research institutions are heavily invested in the success of their work, have an excellent grasp of requirements for success, and would like to have agency over the organisations in which they work. Top-down leadership from business specialists in non-university RSIs is often unwelcome because: (1) leaders are less invested in the work and the institution than the scientists and tend to move on after a few years, (2) a lot of time is wasted in educating the new leaders that come along every few years, and (3) there is a mismatch in work culture that causes friction. We all want to be successful in what we do, and we would like leadership that's on the same page as us.

Section 5 - Research Workforce

The problems outlined in the green paper are common to many countries and need to be addressed.

On the topic of equity and diversity, we must address womens' career progression with consideration to childcare. I propose that there is mandatory equal paid parental leave for parents of any gender. The mandatory aspect is important, because trends show that male researchers tend to avoid taking their allocated parental leave because they don't want to

negatively impact their career, whereas female researchers rarely have that choice. This further perpetuates gender stereotypes and negatively impacts gender balance in research.

Workforce and research Priorities: How should we include workforce considerations in the design of national research Priorities?

Scientific institutions are by and large international, and science itself thrives on international collaboration. However, we also need a local workforce. To support the national research Priorities, we should support local talent through PhD scholarships, post-doctoral fellowships, and permanent staff scientist positions. In particular, we should incentivise and support Māori in taking up these roles. Opportunities must also be given to overseas applicants, or it will likely not be possible to fill all available roles.

Base grant and workforce: What impact would a base grant have on the research workforce?

Base grants would be an excellent positive step. They would be especially beneficial to early career researchers and provide new, flexible pathways. They could also help university research groups retain post-docs for long term projects, then give them a path to progress in their research careers outside of the traditional academic structure.

It is reasonable to have base grants be conditional on performance criteria. However, we must be cautious to evaluate people relative to the norms in their field. For example, publication record is tricky; in some fields, publishing 5 papers a year is normal, while in others, one paper every two years is normal. Also, publication record is biassed against caregivers, so it disproportionately impacts women. Care must be taken not to introduce new inequities.

Better designed funding mechanisms: How do we design new funding mechanisms that strongly focus on workforce outcomes?

We could give dedicated grants to minorities in early/mid career, or even give them to everyone. In the US, it's common to get start-up funding from your university if you are starting a tenure track position. In New Zealand and many other countries, there is no such start-up funding, so researchers have to spend a considerable amount of time applying for grants instead of doing research, and their research could be dead in the water if they fail to secure a grant. Perhaps start-up funds could be included in the base grant scheme.

Section 6 - Research Infrastructure

I do not have specific feedback. Whatever action we take, we should aim to have RSI infrastructure on par with similar sized economies.