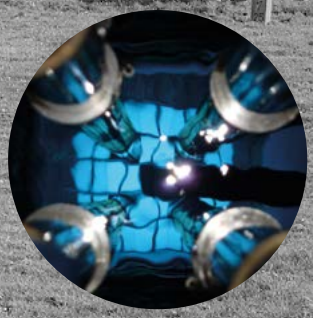
60 years reactor of the TU Delft



Introduction
by Theun Baller and Jan Leen Kloosterman

A timeline
in image and text

Interviews
with Ad Verkooijen, Tim van der Hagen and Bert Wolterbeek

TU Delft | Reactor Institute

Contents

This is a publication of
TU Delft Reactor Institute in
honour of the 60th anniversary
of the reactor.
April 2023

Text interviews
Abel Streefland,
TU Delft Library

Text and images timeline
Femke Werkman,
TU Delft Reactor Institute

Editorial support
DBAR text & editing

Illustration
Henk Molenaar

Photography*
Roy Borghouts,
Sam Rentmeester,
Guus Schoonewille,
TU Delft Reactor Institute
(Menno Blaauw,
Femke Werkman,
Ico Zonneveld)

Design, layout and graphics
Bianca Wesseling,
Haagsblauw

Printing
Grafia Multimedia

*TU Delft Reactor Institute has made every effort to identify all sources and copyright holders of the visual material used.

4 Introduction

6 Directors of the institute 1988-2022

7 Timeline 1956-1998

12 Interview Ad Verkooijen

14 Timeline 1999-2012

18 Interview
Tim van der Hagen

20 Timeline 2013-2023

26 Interview
Bert Wolterbeek

60 years of research and education with the TU Delft reactor

Sixty years ago, on Wednesday 24 April 1963, the Higher Education Reactor (HOR) became operational for the first time. In the book “Enthralled by radiation and strategy: history of the Interfaculty Reactor Institute in Delft” by Hugo van Dam and Frida de Jong, the description of the first time that the HOR ‘became critical’ reads like an exciting book. After years of preparations, the moment was finally there: the reactor could be put into operation.

At that time, the Delft research reactor was not the only one in the Netherlands. Both RCN in Petten and ITAL in Wageningen already had their own research reactors. Later, the ATHENE reactor in Eindhoven was added, too. TU Delft’s HOR is now the only reactor for academic research and education in the Netherlands. A fact we are proud of!

The TU Delft Reactor Institute, as we now call it, is often still known as RID. The institute has gone through a number of name changes over the past 60 years. Not much has changed at the core, except that the fuel enrichment has been lowered and the reactor power has been increased. We still use the reactor for research and education. But a lot has happened around that. Over time, the buildings have been expanded, the control room has been relocated and a separate experimental hall and cooling facility have been built. The number of staff and research has grown steadily.

We have moved along with important changes in society. You can see this in the type of research that is being done: the subjects reflect the societal priorities of the moment. In the early 1980s, there was an emphasis on environmental pollution research using lichens, aging of plastics, scintillation crystals and electronics, gas nuclear reactors and fluidised bed nuclear reactors. In the 1990s, gel dosimetry, lithium batteries and ion deposition techniques. The current focus is on solar cells, batteries and materials for the hydrogen economy. There is also a lot of attention for medical isotopes for the diagnosis and treatment of cancer and for the structure of food (such as meat substitutes and plant-based milk). Self-healing materials for aerospace and magnetic cooling are other current examples.

In this glossy, we interviewed the last three directors who look back on their time at the institute. But we also look forward. We are only too happy to do so: once the major OYSTER project, the installation of a cold neutron source and the development of instruments, has been completed, we will make a huge step forward for many more years of research and education with our reactor through a significant improvement in beam quality.

As we’re writing this, the installation of the cold neutron source is close to completion. Soon, the reactor with all instruments will be fully operational again. Thanks to this innovation, the instruments will be able to perform up to fifty times better. We look forward to the scientific breakthroughs that this will yield!

Jan Leen Kloosterman, chair of the Department of Radiation Science and Technology

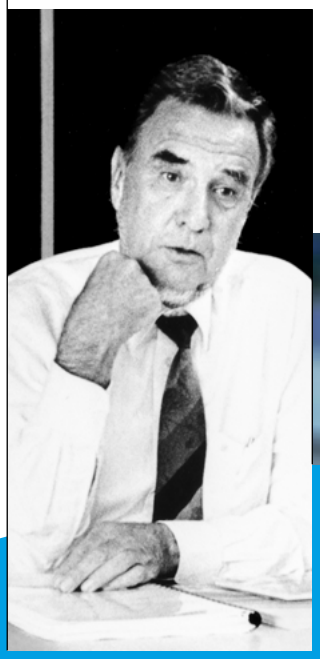
Theun Baller, ad interim director of the TU Delft Reactor Institute

Jan Leen Kloosterman

Theun Baller

Directors of the reactor 1988-2022

1988-1996



Marcel de Bruin

1996-2004

Ad Verkooijen

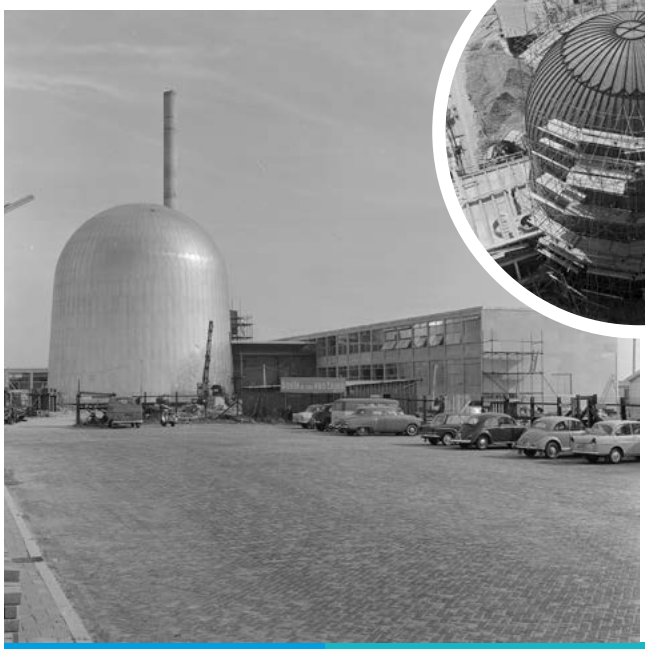
2005-2012

Tim van der Hagen

2012-2022

Bert Wolterbeek

Development and construction



1956

Decision is taken by the Ministry of OK&W (nowadays OC&W): the Delft Institute of Technology gets its own reactor.

1957

June 25
Establishment of the Reactor Institute Delft.

1958

Start of construction and installation of the Radiation Protection Service

Construction of the reactor.

1962

June
Laboratory building ready.

Start of the reactor

1963

24 April
The reactor becomes operational for the first time at 4 am.

End of 1963
Reactor at 100 kW power.

1966

Electron accelerator (Van de Graaff).

September
Reactor at 500 kW power.

1967

Construction of the cooling towers commences.

1968

1 June
Reactor at 2 MW power.

1969

13 May
RID becomes Interuniversity Reactor Instituut (IRI).

Reactor permit for 3 MW power.

1971

Stainless steel cladding of the basins completed.

1977

Research department of Radiation Chemistry founded.

1987
IRI becomes Interfaculty Reactor Institute.

1981

29 May
Construction of new control room finished.

1987

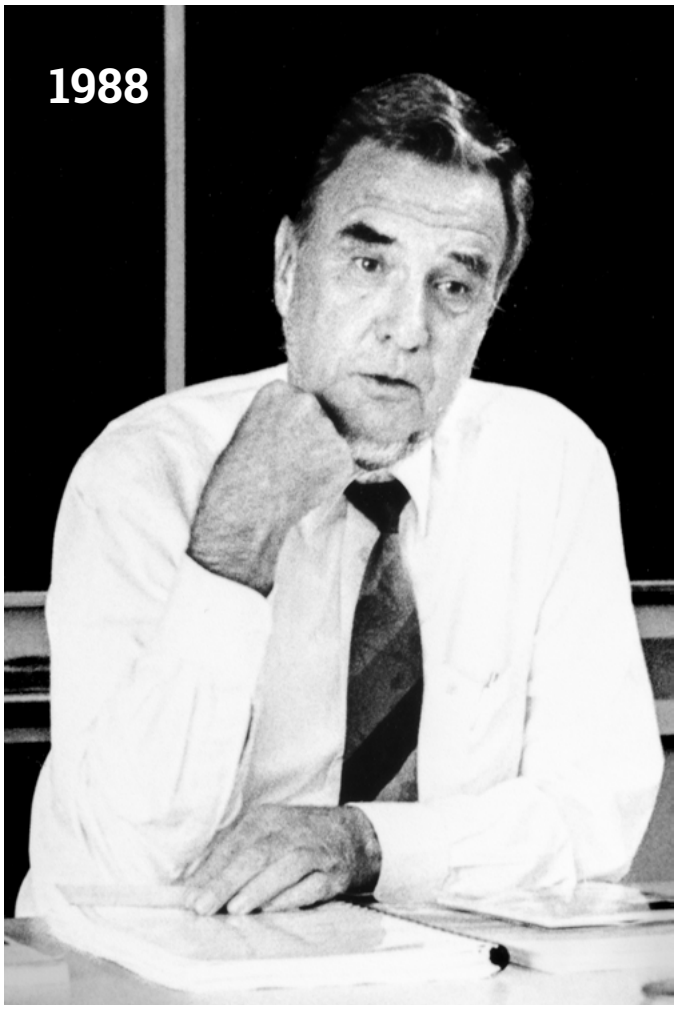
1 September
IRI changes from Interuniversity to Interfaculty Reactor Institute.

1988

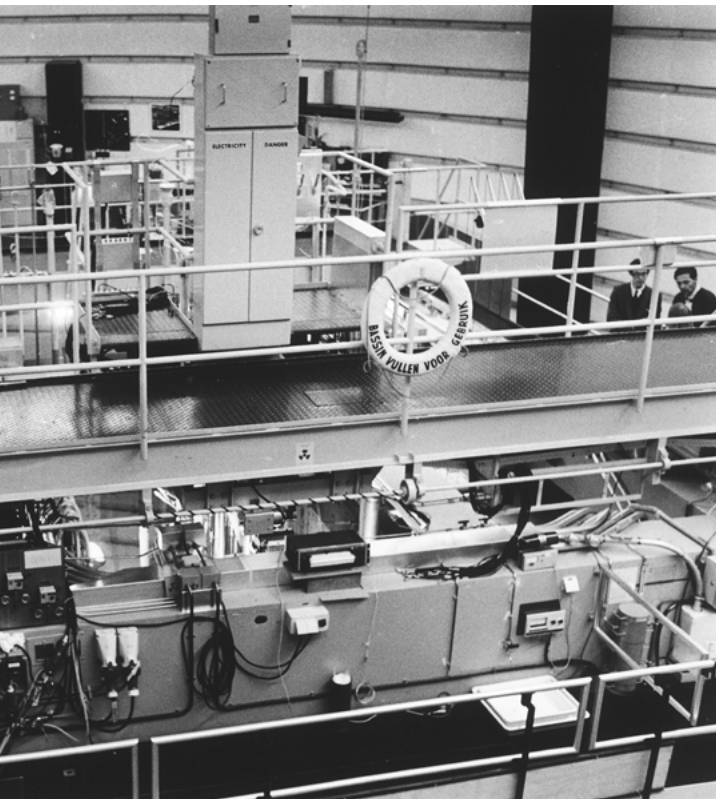
September
Prof. Marcel de Bruin appointed director of IRI.

1989

Laser TRMC facility operational.



Prof. Marcel de Bruin



1993

First university laboratory with accreditation for instrumental neutron activation analysis.

Reflectometer for research into interfaces (ROG) operational.

1995

Positron Emission Particle Tracking (PEPT).

1996

1 May
Prof. Ad Verkooijen appointed director.

1998

TNO group on medical applications of radiation moves to IRI.

June
Opening of the new experiment hall.

Before coming to TU Delft, **Ad Verkooijen** worked at the research department of the research, consultancy and testing institute KEMA in Arnhem. In May 1996 he succeeded Marcel de Bruin as director of RID, which was then still called IRI. He remained director until 2004.

How did you end up at TU Delft?

A chair was created by the energy companies, but it could not be called nuclear energy. It was called 'Large-Scale Energy Conversion'. It was a chair in mechanical engineering and the dean at the time was staunchly against the name nuclear energy. It was 1995 and nuclear power was not popular. Marcel de Bruin was then director of the IRI.

At that time, TU Delft was working on a major project, the modernisation of the support services. Marcel had been approached to lead it. He would step down as director of the IRI. I had only just been appointed in June and in November I was asked to become director of the IRI. So, I reserved one day a week for my professorship and for four days a week I was director of the IRI. In the context of changes at TU Delft, there was a movement from scientific directors to integral management, with both scientific and business affairs falling under one director. That was the case with me from the start.

I was director for eight and a half years. Above all, it was a period of big changes. When I arrived, the attitude of the TU community towards the reactor was not very positive. Contact with the Executive Board was not very warm either. The scientific importance of the reactor was not really shared. The institute was located somewhat far away, contacts were not very intensive, it was a bit of an island.

One of the first things I did then was to try to show that we really deliver good scientific quality. And at a university there is only one

way to show that, and that is through a research assessment. The VSNU had drawn up a protocol for this. IRI had not been involved in that, so we took the initiative ourselves, in 1997. We were put against the yardstick and that yielded good and bad results. Look, in this type of institute there is a scientific pecking order. And from that assessment emerged a different pecking order. That was very interesting to see.

In this way, we prepared the institute for the 21st century

How many departments did the IRI have at that time?
We had Radiochemistry, Radiation Chemistry, Neutron Physics, Radiation Research Instrumentation (ISO) and Reactor Physics. ISO was part of the IRI, but also part of Applied Physics, which was a separate faculty at the time. 'Defects in Materials' was part of Reactor Physics, which has become independent, partly due to the good score in that research assessment. And we also took over Medical Radiation Physics from TNO in my time.

Throughout the whole period I tried to make more connections, create collaborations, because I think the interesting areas are at the interface of the disciplines. I adjusted the entire budget distribution and allocation, skimming part of it in advance, which the scientists got that back in the form of collaborative projects. Sure, there were colloquia and a science day, but that was often preaching to one's own parish. There was virtually no cross-pollination. And that was a broader problem at TU Delft.

Was there bureaucratisation?
I tried to bring a sense of quality to the organisation. You do that for several reasons. First of all, you want to learn from the research, so make a plan in advance, and look back afterwards and learn from it. Second, you need to know how much money you spend, and how much time you use. Timekeeping, I introduced that. There is always a hint of bureaucratisation around that, and that it is at the expense of the actual science. At the same time, we wanted to keep the creativity flowing.

In the first years of the new century, the survival of the IRI was in jeopardy, wasn't it?
Around 2000, the Veltman Committee scrutinised the IRI, looking at whether the institute still had a right to exist and whether it should be discontinued. So, I set up three working groups to investigate where we should go with the reactor: no reactor at all, replacing the reactor with accelerators, or improving the reactor. It turned out that the reactor could not bring us into the top league, but that we could make it a pretty good instrument with a number of upgrades. We were good at developing high-quality instruments. In my last period between 2002 and 2004, we already initiated the rejuvenation of the institute, which was further boosted by my successor Tim van der Hagen.

I think the institute was ready. People had become aware of the scientific quality. We'd been working on that and achieved really good progress there. At the same time, TU Delft had also made a number of strides forward. There was also always pressure on finances. I believe that in one of my last years, the institute had to cut 1 million, for which a major reorganisation programme was set up at the time. More than 50 people left, of the approximately 230 employees, all on a voluntary basis.

As far as I'm concerned, it was a period of building. We built cooperation, quality, a new experimental hall and a new office wing. When I came, the IRI consisted of the old building from 1966 and all kinds of barracks that had been added and that were not actually not habitable. In this way, we prepared the institute for the 21st century.

2003 Lustrum day

1999

First reactor based positron source in the world (POSH) operational.

2001

2 October
Ground-breaking ceremony of the new office building by Prof. Tim van der Hagen.

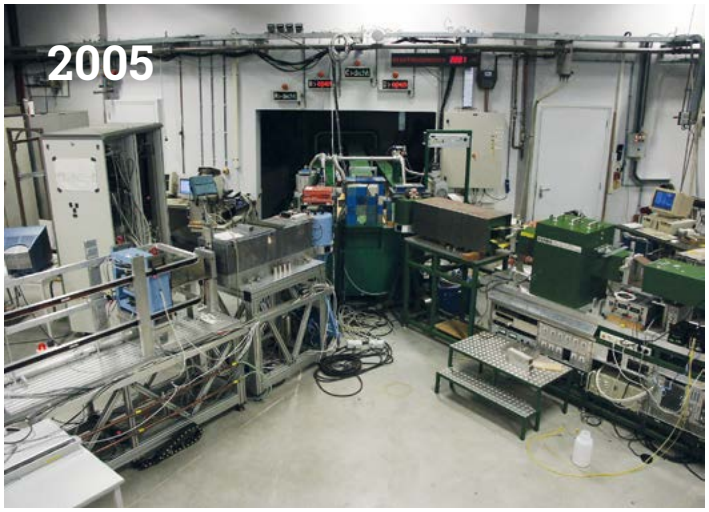
2004

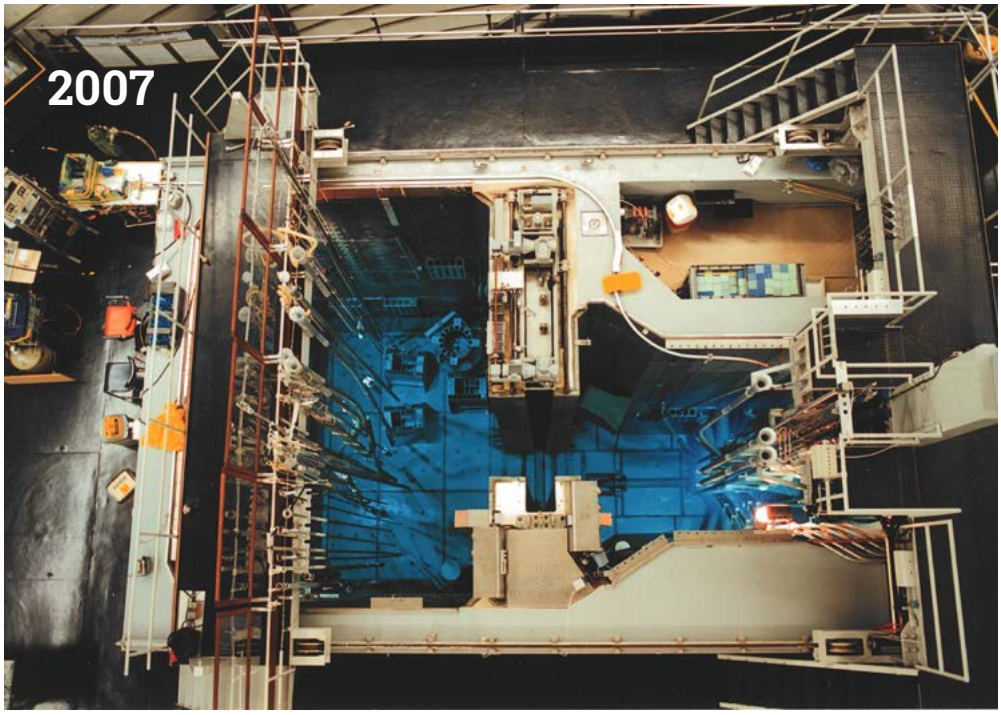
23 November
Executive Board approves business plan IRI, including OYSTER.

2005

1 January
Prof. Tim van der Hagen appointed director RID.

IRI split into RID and RRR (Faculty Applied Sciences).



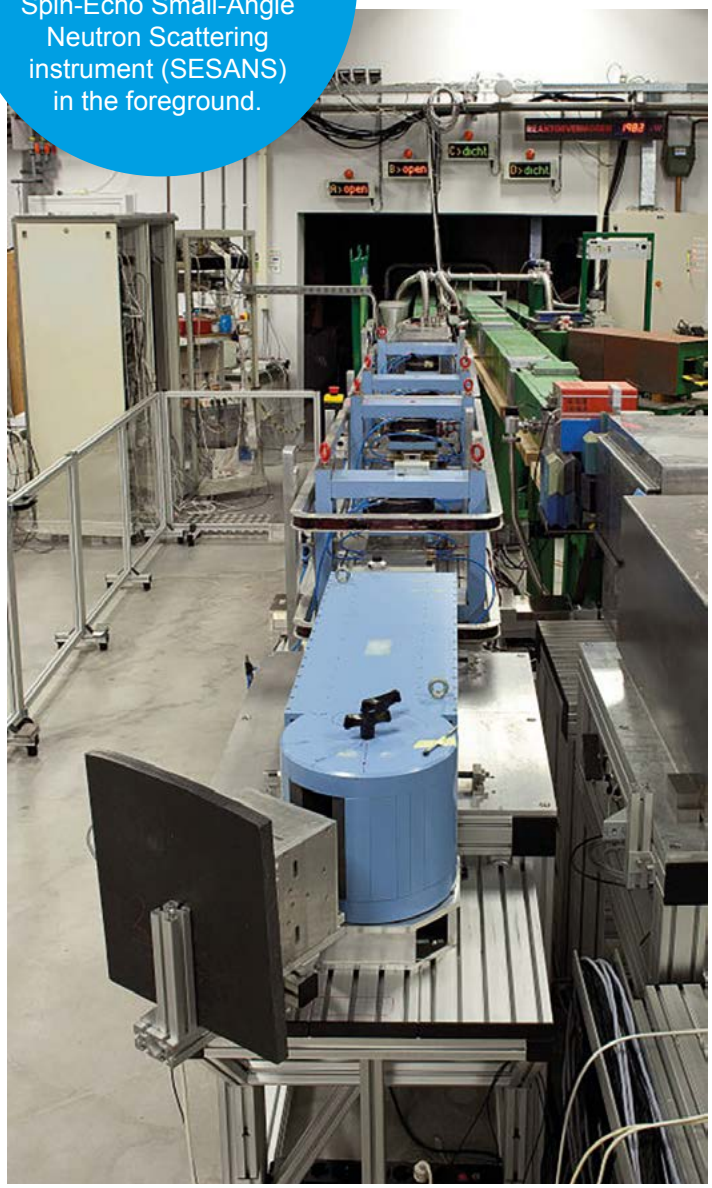


2009

11 May
RID becomes IAEA Collaborating Centre.

2010
SESANS

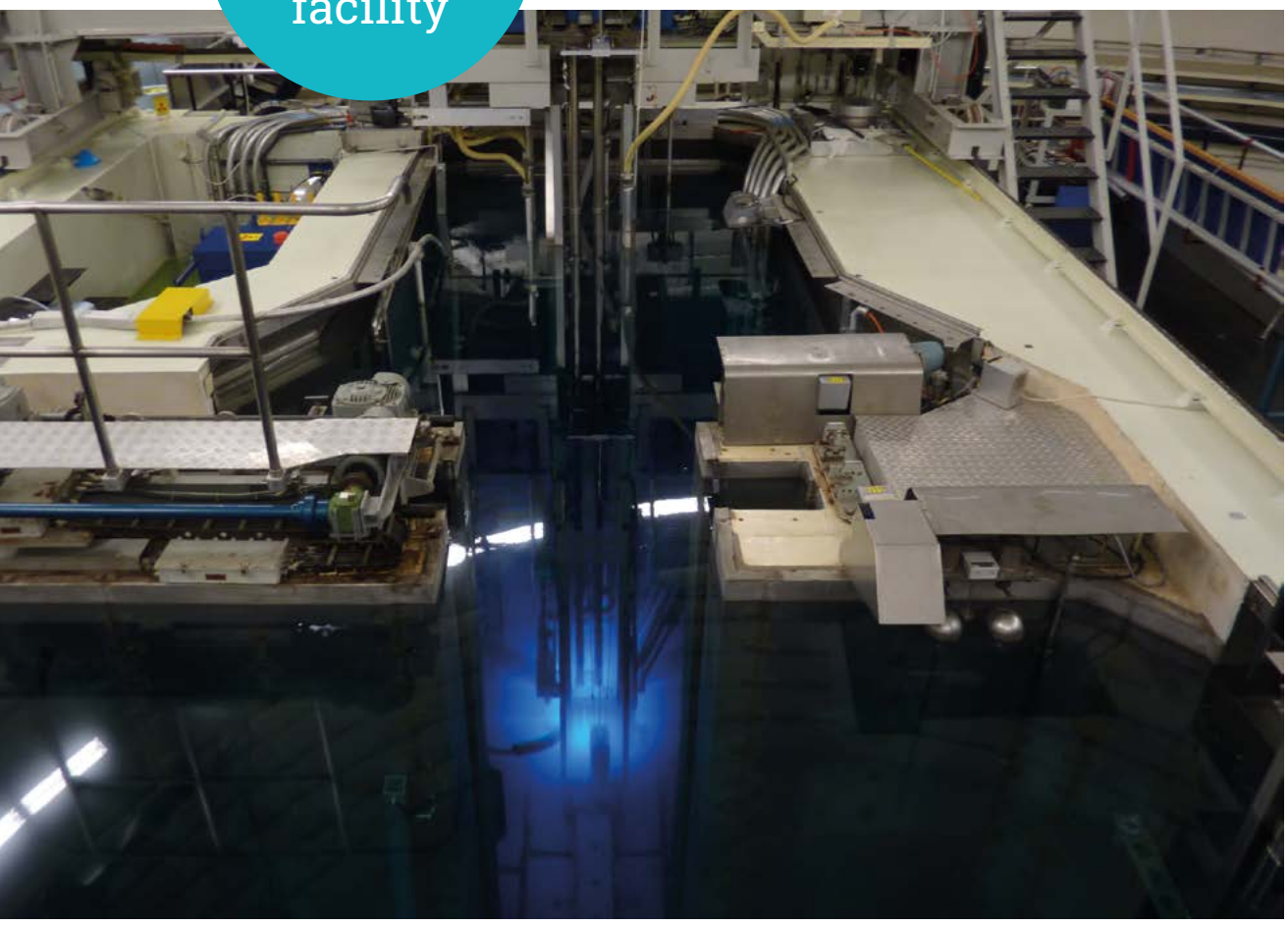
Experiment hall with the Spin-Echo Small-Angle Neutron Scattering instrument (SESANS) in the foreground.



2011

Installation of the lead facility.

2011
Installation of the lead facility



2012

20 January

OYSTER (Optimized Yield - for Science, Technology & Education - of Radiation), starts. The programme is financed by the Dutch government, TU Delft and a number of commercial parties. The aim is to promote new research and education in the field of production of radioisotopes in reactors, neutron activation analysis, positron annihilation spectroscopy, neutron scattering and (medical) imaging.

The innovative facilities and instruments developed within the framework of OYSTER will become available to researchers at Dutch universities and companies. Thus, they will become important tools for the development of better and more sustainable materials and techniques.
The potential for radiation-related scientific research and innovation in health, renewable energy and materials will be significantly enhanced and expanded.

The applications spectrum ranges from medical isotopes for the diagnosis and treatment of cancer, batteries and solar cells to better types of steel.

1 July

Prof. Bert Wolterbeek appointed director RID.

Tim van der Hagen studied applied physics in Eindhoven. He obtained his PhD in Delft in 1989 and remained affiliated with RID. In 1999 he was appointed Professor of Reactor Physics. From 2005 to 2012 he was director of the Reactor Institute Delft (RID). Since May 2016 he has been President of the Executive Board of TU Delft.

What has been the biggest change when you were director?

When I became director, I noticed that we were very internally focused, while interaction with the outside world is crucial for developing further. We hardly did any teaching either, so there was little contact with students. I think both are very important. That has all changed dramatically.

renewal. On 1 January 2005, everyone left IRI and joined TU Delft. I had been a kind of quartermaster until then, but it made sense that I would also finish this job. So, I became director on 1 January 2005. That was the start of a nice and challenging period of 7 years as director.

In terms of content, we focused on two major themes: health and energy. Bert Wolterbeek became a professor and he became my right-hand man. Together we have further developed the institute in its new form. We were always on the same page: the institute had to become more scientific, everything via second and third money stream funding, and we had to provide much more education.

> I am proud of the institute that it is today and that I was able to play my modest role in it.

You started as a director at a tense time.

That's right, it was a period of much-needed innovation for the continued development of the institute. The RID was then still called Interfaculty Reactor Institute (IRI). The year 2004 was quite crucial. I dare say that the institute was hanging by a thread and its survival was at stake.

An external committee that advised the Executive Board was very critical of the continued existence of the IRI. Karel Luyben, as dean of the faculty, was then instructed to get to work on this. Karel saw this as a crucial momentum.

Together with Marcel de Bruin I then wrote a plan in the summer of 2004. 'Lean and Energetically on Course', that's what it was called. Overhauling everything, creating other departments, transferring everything to TU Delft. It became a period of repositioning, restructuring and substantive

What characterised the next period?

We turned more and more towards the outside world. Many ministers came over at that time. That was also when we decided to bring proton therapy to Delft. This is how we brought in the topic of health as an anchor.

The next step was to move the Faculty of Applied Sciences to the south side of the campus, which eventually led to the new Applied Sciences building opposite the reactor institute. And finally, of course, we needed money. We soon came up with the idea of the cold source. In the beginning I thought it would go quickly, the government was enthusiastic, but it took until 2012 before we got it done. It was really a high-level game to get that money. Lobbying day and night. And this immediately meant the end of my scientific work. Ultimately, it was a cabinet decision. On Friday afternoon, three ministers had to say 'yes' to 38 million euros for the reactor institute. Then I thought: now I can stop as a director. We just need to buy a cold source. It turned out that it is not that simple either, because here we are… another ten years later…

And then there was the disaster in Fukushima.

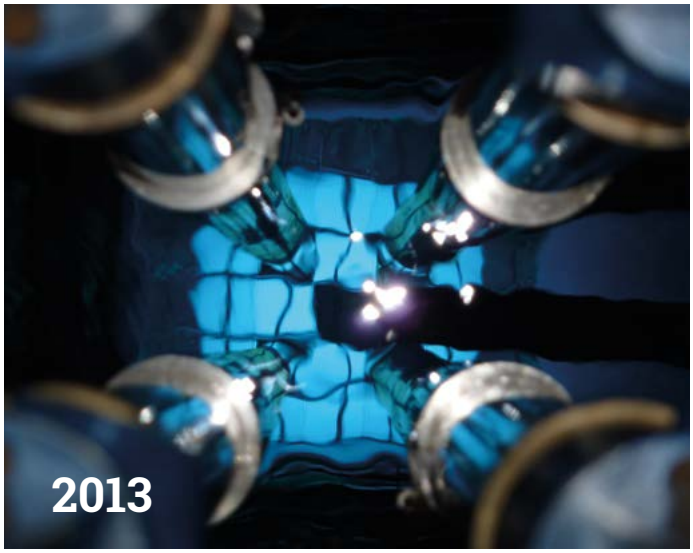
Yes, that was 2011 and intense. It was a topic that was in the news extensively and for a long time. That too was intense. That attention was mainly due to my field, nuclear energy, and so I was often called upon to interpret the latest developments.

After Fukushima, supervision was tightened considerably. A fairly costly stress test is now performed every ten years. The Executive Board helped in this by separating the budgets of OYSTER and those of the stress tests.

What are you most proud of?

I am proud of the institute that it is today and that I was able to play my modest role in it. Each phase has been crucial to get to where we are today.

I am also proud of where the institute stands now, in full interaction with the outside world. Finally, I am pleased of where the institute is physically located, next to Applied Sciences and HollandPTC. I think I am most proud of the fact that all these changes have been successful. Things sometimes take a little longer, but it all worked out.



2013

50 years
Construction starts of the first new neutron diffraction instrument (PEARL) in the reactor hall.

2014

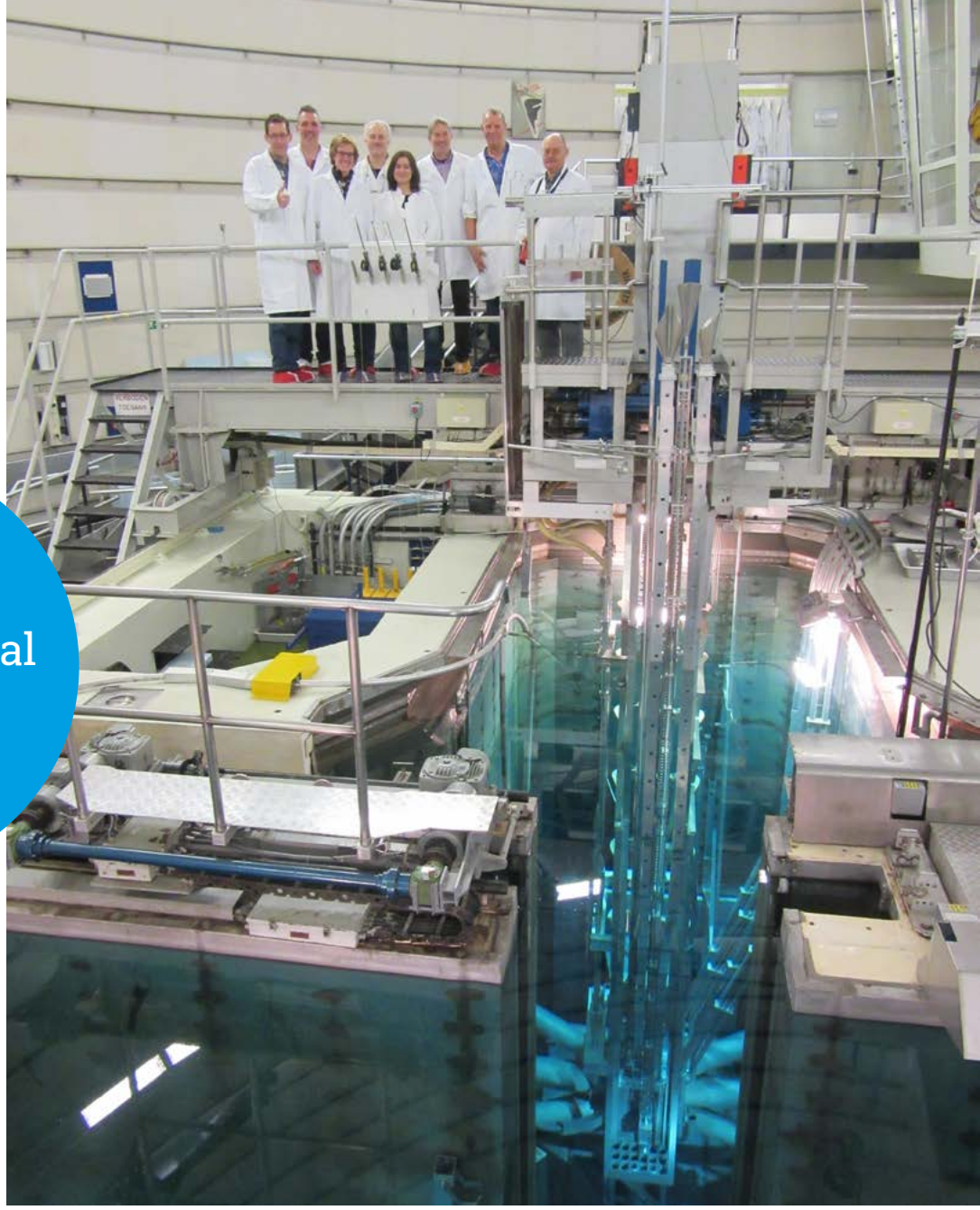
PEARL is delivered. This instrument unravels the crystal structure of (energy) materials, for example for hydrogen storage, lithium batteries and magnetocaloric installations.

2015

Construction of the prototype flexible radiation facility (FlexBeFa).

Construction of the prototype neutron imaging instrument (POSH-PALS).

2014
Small Angle Neutron Scattering (SANS)



2016
FlexBeFa fully operational to produce medical isotopes

2016

Construction of FlexBeFa to develop new production methods for medical radionuclides.

Start Phase 1 of the OYSTER project, which consists of an engineering phase for the construction of CNS utilities and the “mock up” phase.

2017

Start construction of CNS cooling building. This building, including equipment, ensures the cooling of the cold source that is installed at the reactor core. At an extremely low temperature of -250°C, the neutrons produced are much slower and interact much more with samples, enabling the scientists to achieve even better research results.

Full commissioning of the neutron imaging instrument FISH.

Opening of the battery lab.

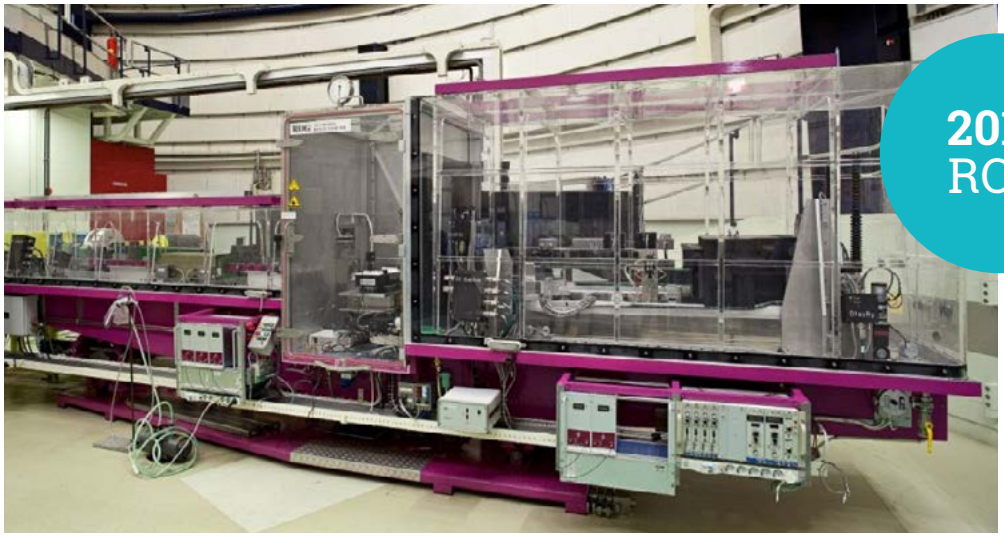
2018

Completion construction phase CNS utilities.

OYSTER permit applied for, including environmental impact assessment (MER).

Delivery cryogenic installation.

2017
Opening of the battery lab



2017
ROG

2019

Delivery of installations required for tests using the mock-up cold source.

Tests completed successfully, start of Phase 2. Definitive permit for CNS issued by the ANVS.

Reactor stopped to allow for modifications towards installing the CNS.

Reactor protection systems expanded for the CNS.

Relocation of neutron reflectometer (ROG) from the reactor hall and completely new construction in the experiment hall.

2020
Re-plating the dome

2021
Dome plating renewed

2020

Start Phase 2, production of the In-Pool Assembly (IPA) and partial delivery of installations for CNS utilities.

2021

CNS cooling building and installations ready. Modified SESANS moves from experiment hall to reactor hall.

Modifications of the radiological shielding and new neutron conductor for the neutron depth profiling setup (NDP).

Reactor re-started after various modifications towards OYSTER.

2022

Neutron Reflectometer (ROG) first instrument to be ready and operational.

Test beam, SESANS and neutron depth profiling back in use and installation of new detector for SANS

2023

60 years

Pneumatic FlexBeFa operational.

24 April
Reactor 60 years operational.

2022
Visit of the Executive Board

2023
New name, new lettering

Originally a biologist, **Bert Wolterbeek** obtained his PhD in Utrecht and Delft, where he was supervised by Marcel de Bruin. He joined RID as a student in 1978 and as an employee in 1982. He became Head of the Department of Radiochemistry, Professor in 2006 and Chair of the Department of Radiation Science & Technology (RST) in 2010 (until 2018). In 2012 he succeeded Tim van der Hagen as director of the RID. He retired at the beginning of this year.

Tim van der Hagen's period is sometimes characterised as the institute's 'second youth'. How would you characterise your period as director of the RID?
In 2012, the OYSTER subsidy was awarded. OYSTER concerns the engineering and installation of the cold neutron source, in combination with updated and the development of completely new neutron instruments. What tools should we deploy, and in what order should they be developed? Who do we involve externally? We've discussed these issues with many international scientists. Around 2014, 2015, after all kinds of tenders with large engineering parties, we started looking at how we could realise the instruments and the cold source. The disaster in Fukushima meant stricter regulations, stricter requirements, both for the existing RID and for the plans we had. That has also caused delays, in the period from 2014 to now.

So, when the cold source is installed in 2023, when the new instruments are lined up, and we can actually work with those cold neutrons, then that rejuvenation will have really been implemented. And that rejuvenation will have meant that we can function in a better way in the scientific environment. In that sense, my period as director was an interim period. From 'the idea' to 'it's finally here'.

What is the biggest change the institute has experienced in the last 10-20 years?
The biggest change is how research is financed, not only for the RID but for everyone. Nowadays, contributions from the second and third money streams are indispensable. This is in contrast to about 20 years ago, when basically everything was still paid for from the first money stream. As we did 20 years ago, we still employ some 50 or 60 PhD students, but now they are all externally funded. This also means that everyone is now much more aware of the type of research they want to do, what they want to achieve with it, and who is interested in it. Because without external financing it will no longer happen. Of course, the OYSTER programming has everything to do with that. That is a huge turnaround. I think that went very well.

> I am proud of the organisation we have set up for the OYSTER project and that we are ready for what is to come.

What were you least proud of?
I've always been a talker. What you have to learn in a role as a director is not to talk, but to listen. You have to be well-attuned to the emotions that are involved. And that has been a process, to be honest. I know what I want myself, but that isn't always enough. What do you change if something doesn't go as it should or as intended? Your goal? The timelines? The resources? The resources in our case are, to put it very disrespectfully, especially the people. Connecting those three things –resources, goals and time– without getting frustrated yourself; I found that difficult. I am impatient by nature. And the aspect of time is something that has sometimes stressed me out. And then you also have to make sure that you don't show your own frustration, or at least don't let it become a problem. Because otherwise you will frustrate people around you while you have to keep motivating them. It's just about things that everyone experiences as frustrating, not just me.

What do you see as the biggest challenge for the future?
As far as I am concerned, the greatest challenge is to find connections with scientists in the Netherlands and abroad. Ensuring that they want to use your institute. While you are still aligning the equipment, you already have to think about this, otherwise you will be too late. Make sure you reach everyone. So don't just look at the institute itself, but also at the outside world. You really have something to offer with the institute and having completed OYSTER, which has made you intrinsically more attractive. But that won't help you as long as it's not recognised and as long as you don't make connections.

What are you most proud of?
I am proud of the organisation we have set up for the OYSTER project and that we are ready for what is to come. We've done a lot of work on that organisation. Long before we completed the OYSTER project, we already had to shape that. I'm glad that worked out.