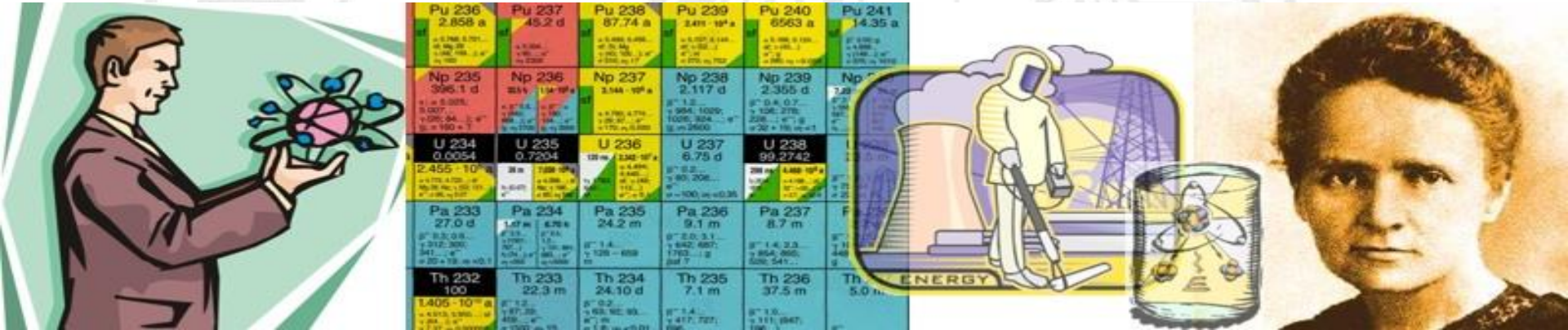
Kjerne- og radiokjemi i Norge – hvor går veien videre?

Jon Petter Omtvedt

Kjemisk institutt, UiO

NKS foredrag 30. november 2016



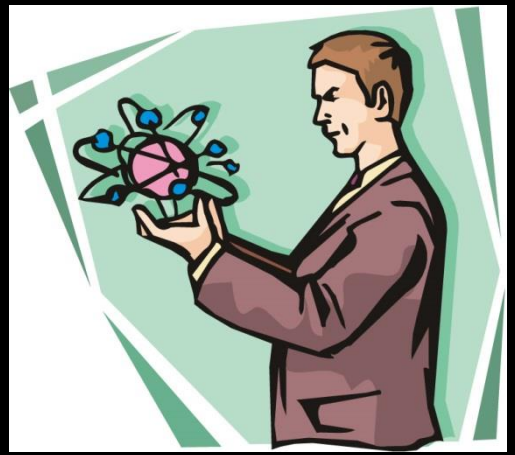
Outline

- What is ***Nuclear and Radiochemistry*** *(NRC)*?
- Short (?) **history** of NRC at UiO
- The **future**
  - exciting **research** opportunities
  - difficult **funding** situation
  - need for NRC **competence and knowledge**

What *is* Nuclear and Radiochemistry?

My definitions:

- **Nuclear chemistry** is *basic (nuclear) research about properties of nuclei* (borderline between Chemistry and Physics)
- **Radiochemistry** is *application* of nuclear chemistry



Nuclear and Radio*chemistry* Research?

- **Nuclear Energy**, in particular fabrication of fuel and treatment of spent nuclear fuel
- Synthetization of **radiolabeled compounds for medical** diagnostics and therapy
- Migration of radionuclei in nature (**radioecology**)
- **Radiation protection** & **nuclear forensics**
- **Fundamental properties** of nuclei
- **Radiotracers** used as tools in industry & research

Ellen Gleditsch – Norway's Marie Curie

- The young pharmacist Ellen Gleditsch was employed as assistant to prof. E. Bødtker in 1903.
- She soon showed her scientific qualities and was able to take her "PhD" in 1906, after much hard work.
- She then worked as associate professor until 1907.

Ellen Gleditsch, Student 1902

Ellen Gleditsch – Norway's Marie Curie

- The exciting developments in the Curies laboratory draw her to Paris.
- The French laboratories was crowded, but Bødker was able to convince M. Curie that his assistant was worthy and that she "was so small she would hardly occupy any laboratory space". Beside this, Curie needed a chemist.

Elen Gleditsch – further reading

https://www.muv.uio.no/uios-historie/mennesker/forskeren/realister/gleditsch-lykknes-250907.html

Ellen Gleditsch: Professor, r...

Forsiden UiO › Museum for universitets- og vitenskapshistorie

For ansatte | English website | Søk

UiO : Museum for universitets- og vitenskapshistorie

Forsiden MUV | UiOs historie | Tall og fakta | Samlinger | Publikumstjenester | Om MUV

- UiOs historie
- Mennesker
- Forskeren
  - Humanister
  - Jurister
  - Pedagoger

Ellen Gleditsch: Professor, radiokjemiker og mentor

Ellen Gleditsch (1879-1968) studerte radioaktivitet hos Marie Curie i Paris og ble Norges første autoritet innen dette feltet.

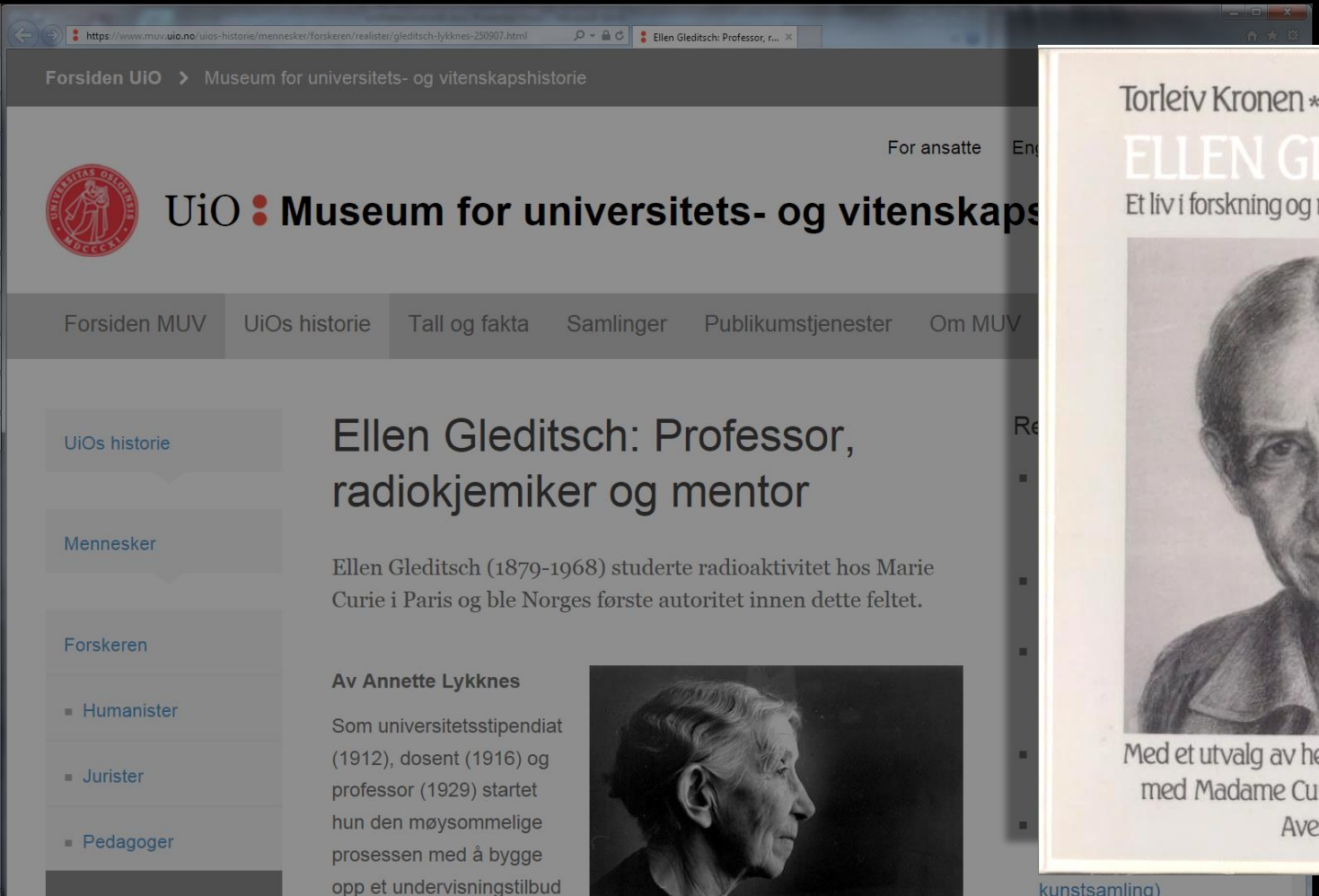
Av Annette Lykknes

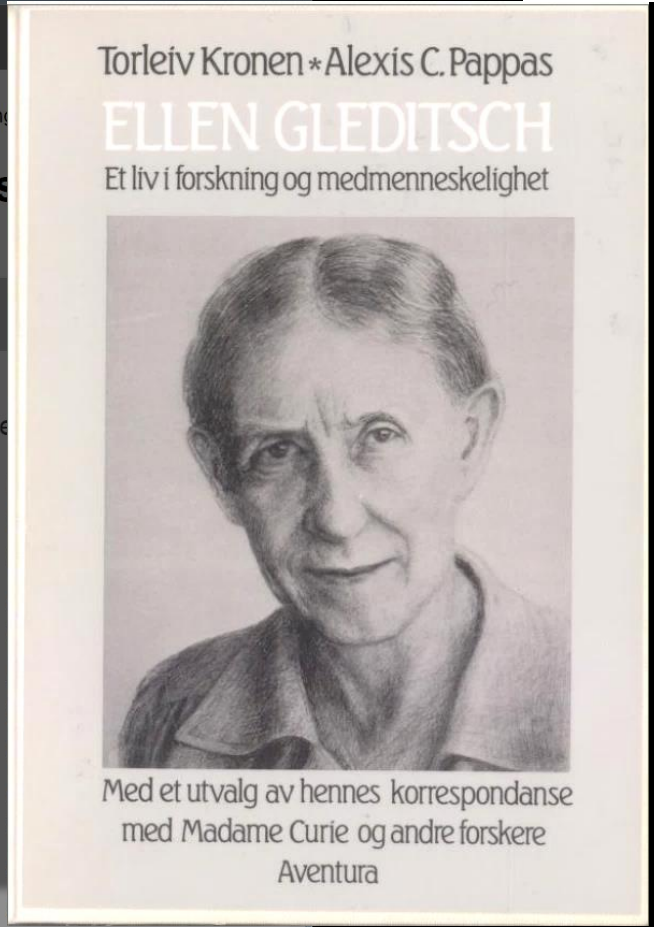
Som universitetsstipendiat (1912), dosent (1916) og professor (1929) startet hun den møysommelige prosessen med å bygge opp et undervisningstilbud

Relatert stoff

- Lydoptak (NRK): Ellen Gleditsch forteller om UiO under krigen
- Artikkel: Odd Hassel - Nobelprisvinner i kjemi
- Artikkel: Ingen "Mildare" behandling - Kjemikeren Milda Prytz
- Artikkel: Tre kjemikere i Professorboligen
- Reidar Aulies portrett av Gleditsch (UiOs kunstsamling)

Elen Gleditsch – further reading





Elen Gleditsch – further reading

NTNU

Ansatte

Annette Lykknes

Førsteamanuensis

Program for lærerutdanning
annette.lykknes@ntnu.no
73590496 48031517

Jonsvannsveien 82, PLU * B373

Forskningsområder: Kjemididaktikk og kjemi/vitenskapshistorie

Interesseområder: Kjemiundervisning, lærebøker, skriving i naturfag/kjemi, kvinner i naturvitenskap og ingeniørfag, forskerpar, vitenskapelige instrumenter, ingeniørutdanning, kjemihistorie 20 årh.

Emner: Kjemi fagdidaktikk (PPU 4224/4727) - Episoder i naturvitenskapenes historie (RFEL 3093) - Selvvalgt teori (LPY3006 - Master i naturfagdidaktikk)

Vitenskapelig, faglig og kunstnerisk arbeid

Viser et utvalg av aktivitet. Se alle publikasjoner i databasen

Tidsskriftspublikasjoner

NRC in Norway - Timeline

1914

1945

UiO Professors

Ellen Gleditsch
(1879-1968)

NRC in Norway - Timeline

1914

1945

1947 IFA

1957

1951 JEEP I

1985

UiO Professors

Ellen Gleditsch
(1879-1968)

Alexis A. Pappas
(1915-2010)

NRC in Norway - Timeline

1947 IFA

1951 JEEP I

1914 1945 1957 1964 1985 1995 2014

UiO Professors

Ellen Gleditsch
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Alexis A. Pappas
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NRC in Norway - Timeline

1914

1945 1947 IFA

1957 1951 JEEP I

1964 1969 - EKOFISK Oil is discovered

1985

1995

2014

NRC in Norway - Timeline

1914
1945
1947 IFA
1957
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1964
1969 EKOFISK
1985
1980 IFE
1995
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Per Hoff
(1951-)

NRC in Norway - Timeline

IFA

EEP I

69 FISK

1980 IFE

1985

1995

2014

Britt Salbu builds up Radioecology at Ås

Lindis Skipperud & Britt Salbu

Centre for Environmental Radioactivity (CERAD)

Norges miljø- og biovitenskapelige universitet

Norwegian Centre of Excellence

The Research Council of Norway

rolf Alstad
1927-2014)

Per Hoff
(1951-)

After 1995

1947 IFA

1951 JEEP I

1969 EKOFISK

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?

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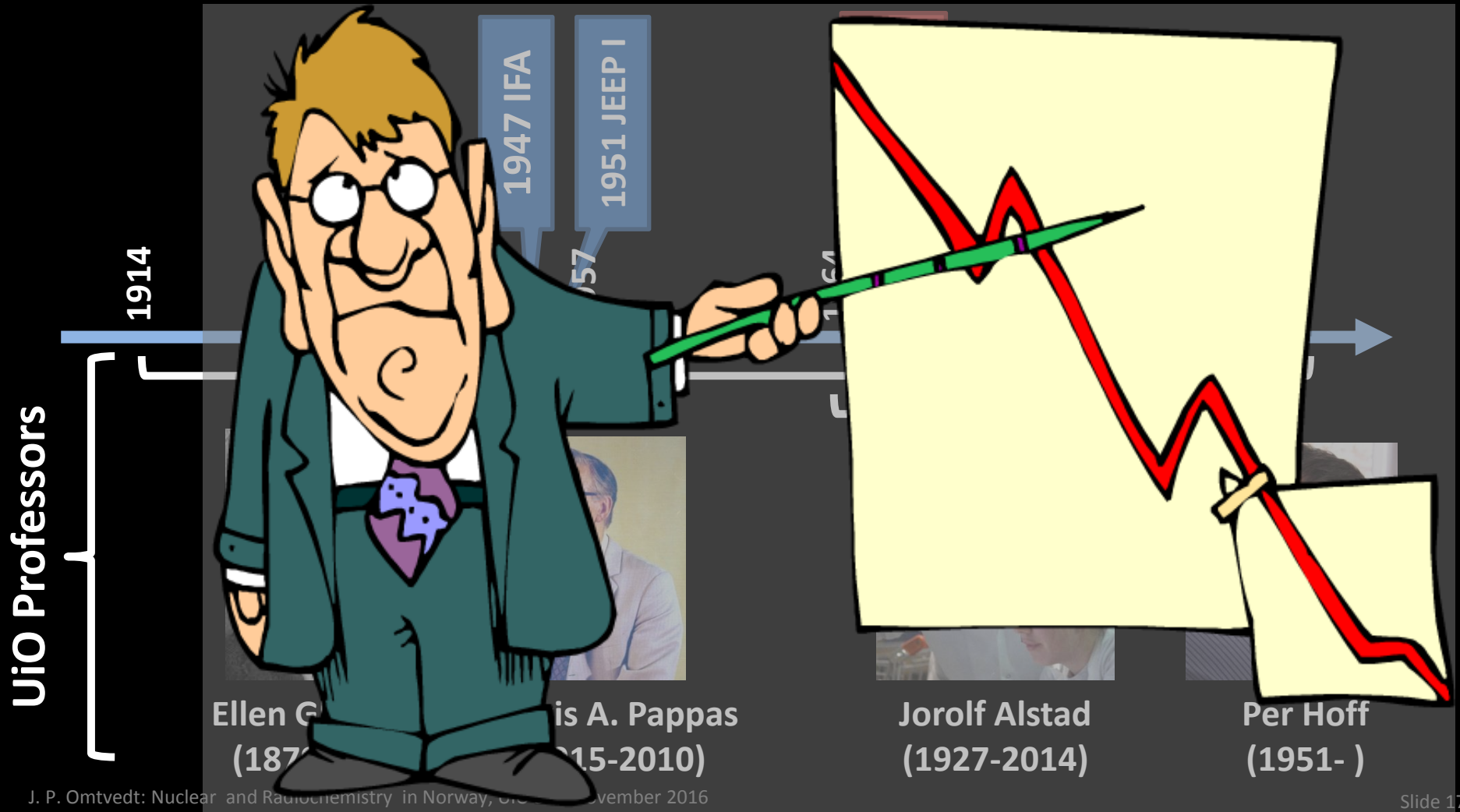
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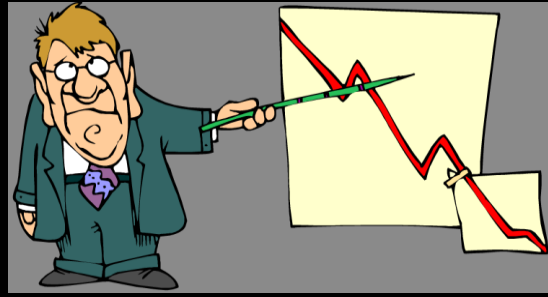
1995 - 2010



Successes:

- Foundation for Algeta developed by Roy Larsen under supervision of Per Hoff and Jorolf Alstad in the 1990's

Xofigo®
radium Ra 223 dichloride
INJECTION

http://www.bayer.no/nn/bayer-norge/bayer-og-algeta/om-algeta

Om Algeta

Bayer: Science For A Better Life
Bayer Nordic – Norge

Menu | Søg | Kontakt

Hjem › Bayer Norge › Om Bayer i Norge › Om Algeta

Algetas historikk

Algeta - En norsk suksesshistorie

Begynnelsen
Algeta ble stiftet under navnet Anticancer Theraupeutic Inventions AS (ATI) i 1997 av Roy Larsen, en nukleærkjemiker fra Universitetet i Oslo, og Øyvind Bruland, professor i onkologi ved Radiumhospitalet, basert på deres forskning på alfa-emitterende substanser brukt til kreftbehandling.

I 2001 ble Thomas Ramdahl ansatt som administrerende direktør – han kom da fra Pronova Biocare AS hvor han jobbet som Senior Vice President, Operations. I 2001 ble også den første dosen av et nytt legemiddel ferdigstilt, og kliniske forsøk startet. Institutt for Energiteknikk på Kjeller, og IFE har siden vært en god og viktig samarbeidspartner for Algeta.

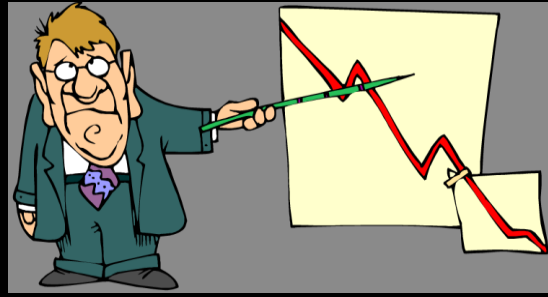
I 2003 skiftet ATI navn til Algeta og 27. mars 2007 ble Algeta notert på Oslo børs. Ved børsnotering hentet selskapet inn 250 millioner kroner og kunne dermed øke staben ytterligere.

1995 - 2010

Successes:

- Foundation for Algeta developed by Roy Larsen under supervision of Per Hoff and Jorolf Alstad in the 1990's
- Research group for chemical and physical studies of Super-heavy Elements (SHEs) built up from 1995

1995 - 2010



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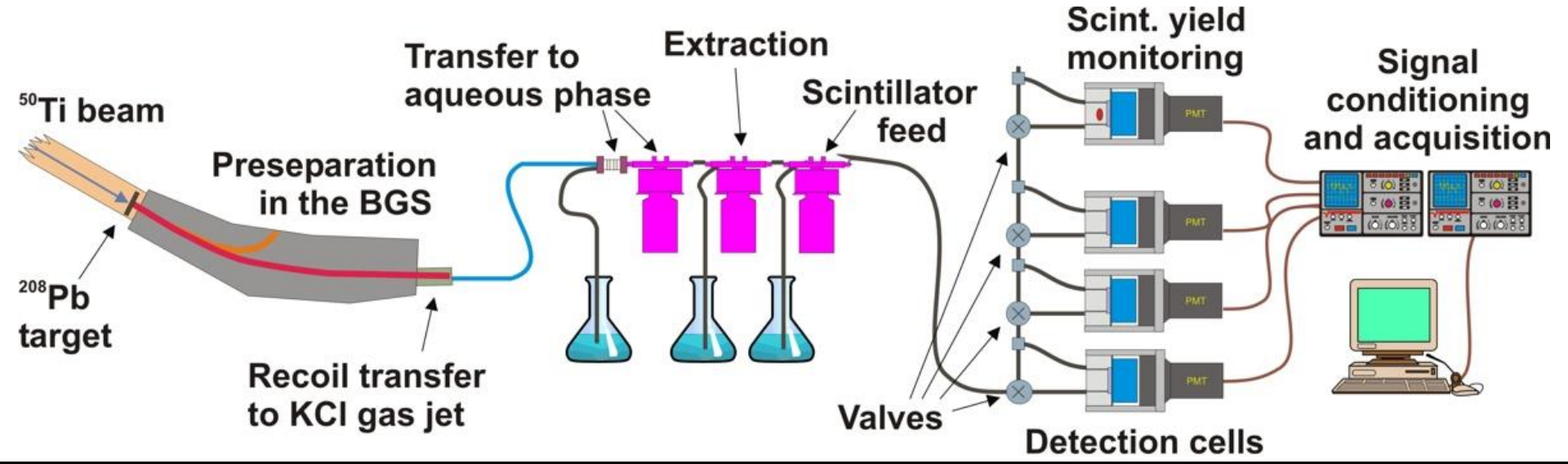
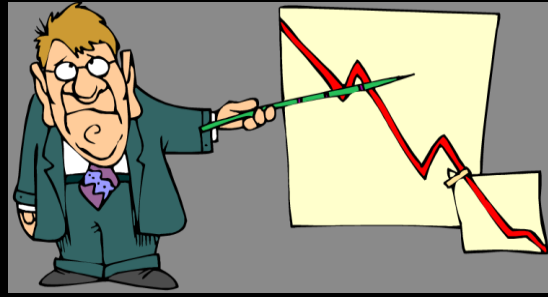
J. P. Omtvedt *et al.*, J. Nucl. Radiochem. Sci. **3**, 121 (2002).



1995 - 2010



BGS + SISAK + Scintillation counting

$^{208}Pb(^{50}Ti, n)^{257}Rf$ ($T_{1/2}$ = 4 s)

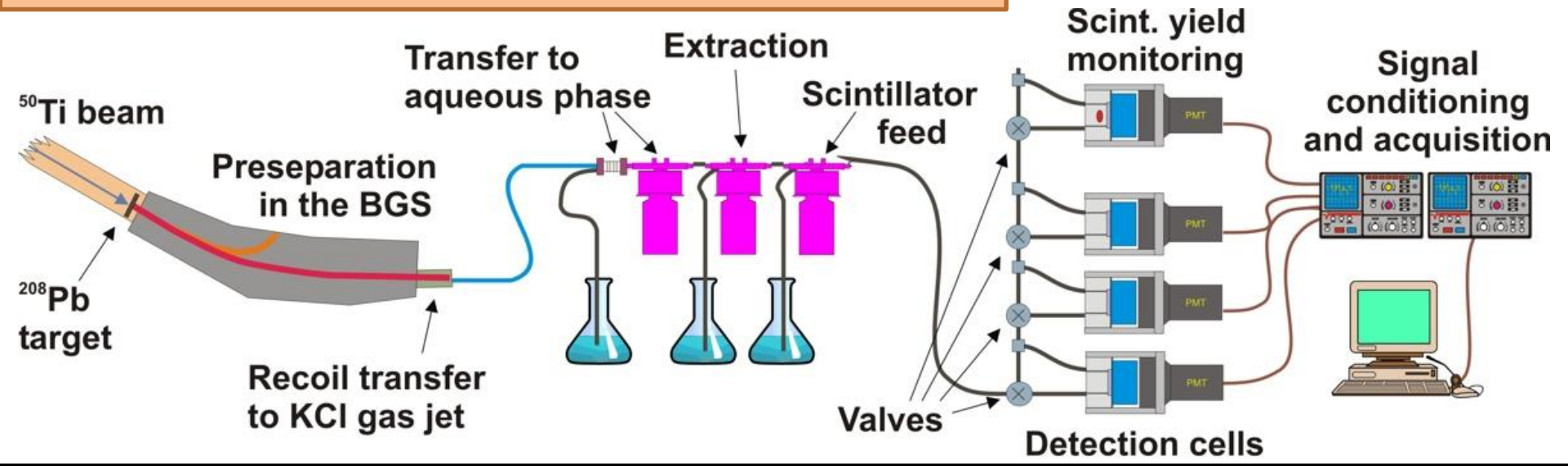
– ***fastest liquid phase chemistry ever performed for SHE-research***.

J. P. Omtvedt *et al.*, J. Nucl. Radiochem. Sci. 3, 121 (2002).

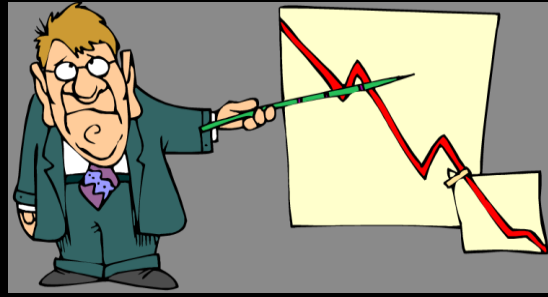
rsen under

the 1990's

udies of Super-



1995 - 2010



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- SAFE center created in 2005
  - Joint use of the Oslo Cyclotron Laboratory (OCL)
  - Major upgrade of OCL and radiochemistry laboratories
  - PET research started at Ki and is a major "satsningsområde" at UiO

SAFE
Centre for Accelerator Based Research and Energy Physics

2005 - 2015

Problem buildup:

- Economic setback at Ki around 2004-2008 hits NuC hard
- Large fraction of staff ineffective due to illness or maternity leave in period from 2005-2015
- UiO radiation protection organization a total failure
- PET-chemistry PI quits in 2010
- Very few students

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- OCL unsuitable for PET and SHE model experiments
  - SAFE discontinued in 2015
  - Foundation for PET vanishes

What went wrong with SAFE?

- Original ideas:
  - Should become strong enough to attract external funding
  - The Nuclear Physics Group and the Nuclear Chemistry Group should each be built up to 4 – four – PIs

- Reality:
  - All applications (>10) were turned down
  - Nuclear Chemistry Group downsized, not expanded
  - No administrative support, too little technical support
  - OCL not suitable for PET

2015 - 2016

New Life-Science Building

- No space or money for NRC facilities
- Whap will happen to NuC?

Summary as per 2016

- **Nuclear Chemistry Group** (NuC) is formally part of **Center for Environmental Science** (SMV)
- Two PIs at NuC
  - **Patrick Riss** returns to full position in Oslo from 1. Dec
- **Bent Schoultz** is involved in building up ^{211}At research at OCL
- **Radiation Protection** "an open question"
- Good **laboratory facilities**
- No in-house **source for radionuclei**
- Old and run-down **detectors**

Very Fragmented Community

MedFak

NMS
Norsk Medisinsk Syklotronsenter

Hospitals

P. Riss

J.P. Omtvedt

BioGeo-Chemistry Centre

SHE Research

B. Scoultz

SMV

Life-Science Building

Chemistry Department

Rad P.

OCL

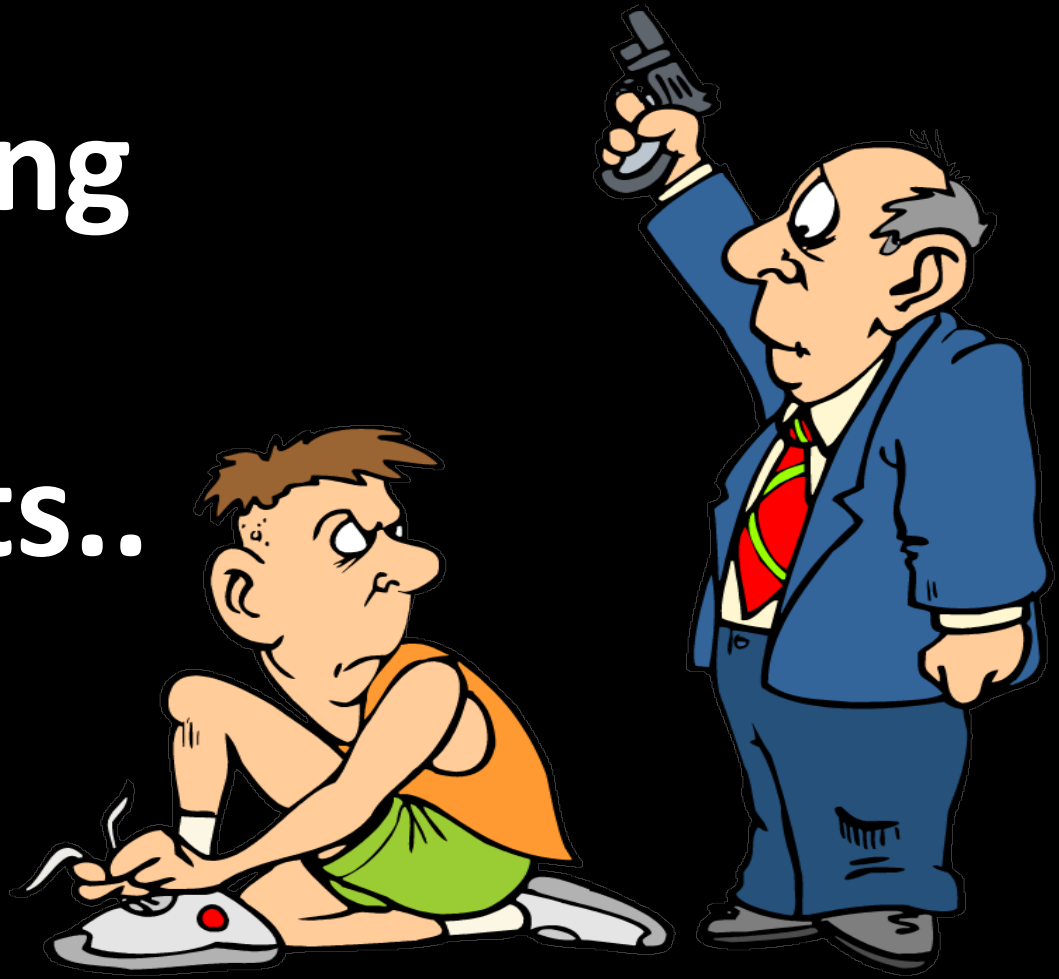
IFE

Industrial use of radiotracers?

JEEP?

2017-2025

A good starting point for improvements..



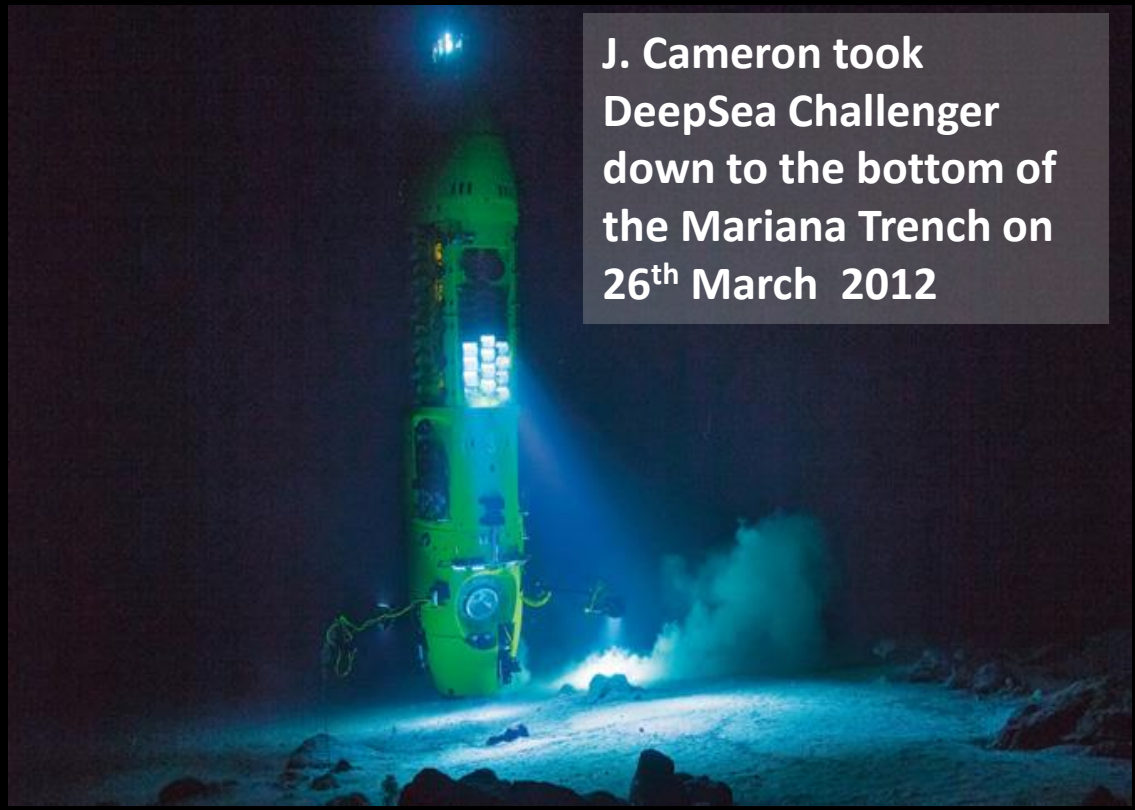
Do Society *Need* NRC?

- Estimates in the US and EU indicate that future need for radiochemists is 5x larger than "production"
- Needed for
  - **Nuclear power industry**:
    - for buildup or,
    - if shut down (for decommissioning)
  - **Nuclear medicine** (diagnostic and therapy)
  - **Tracers** for industry and research
  - **Radiation protection** (industry, hospitals and government)
  - **Radioecology** and **nuclear forensics**

Do NRC belong in Academia?

Basic science is about pushing the limits and go where nobody has been before

J. Irwin and D. Scott's Apollo 15 mission to the moon in 1971 (NASA)



J. Cameron took DeepSea Challenger down to the bottom of the Mariana Trench on 26th March 2012

Basic science is about pushing the limits and go where nobody has been before

Discover and study New Elements

J. Irwin
mission
(NASA)

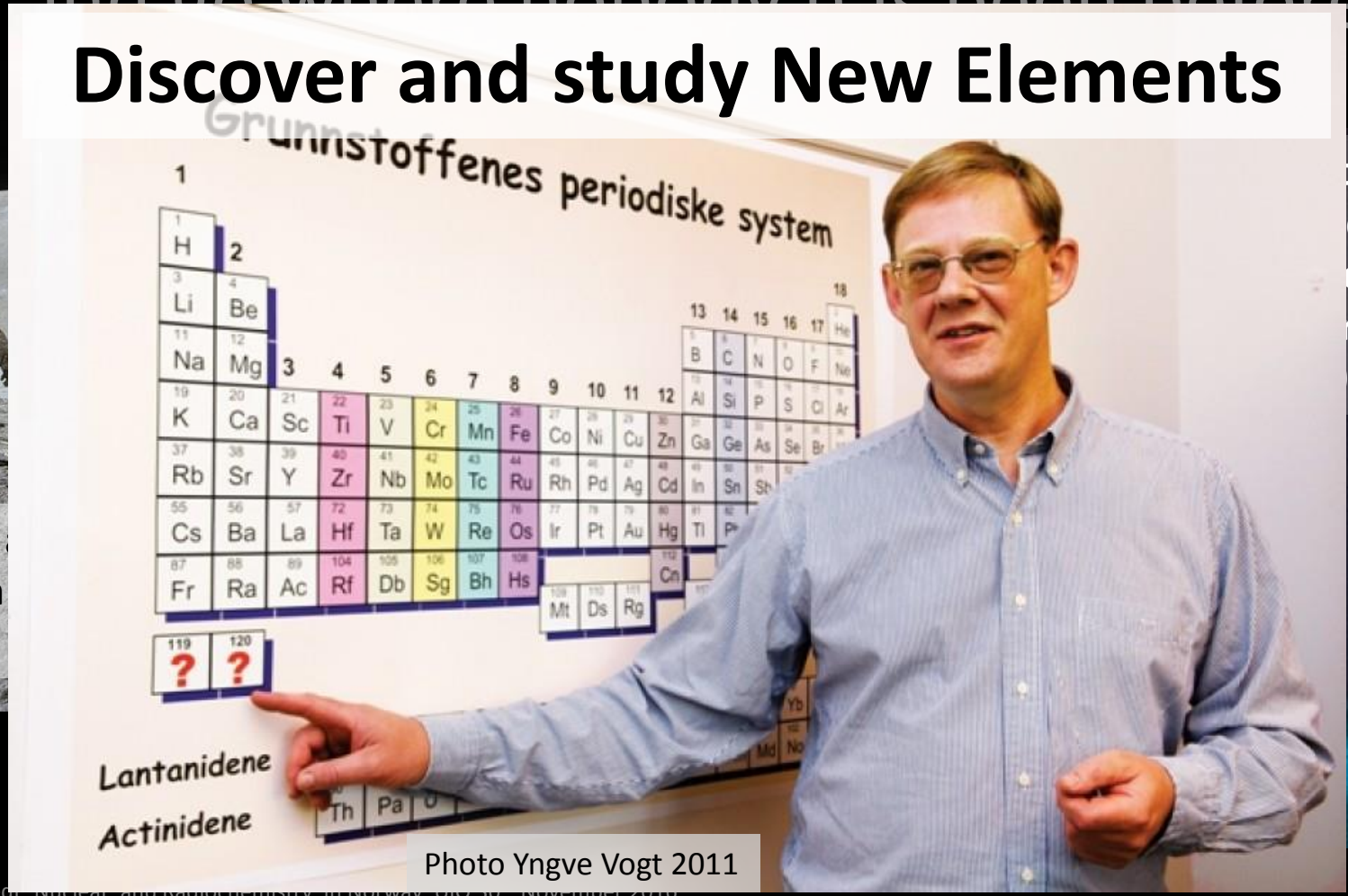
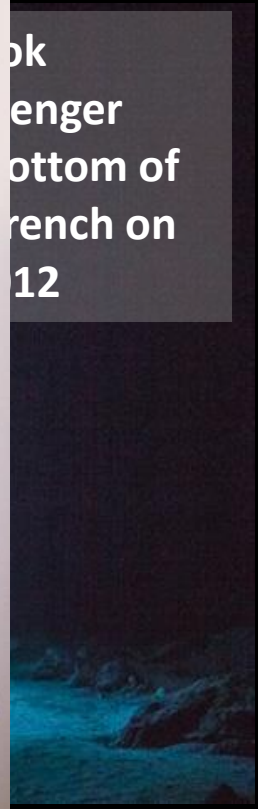


Photo Yngve Vogt 2011



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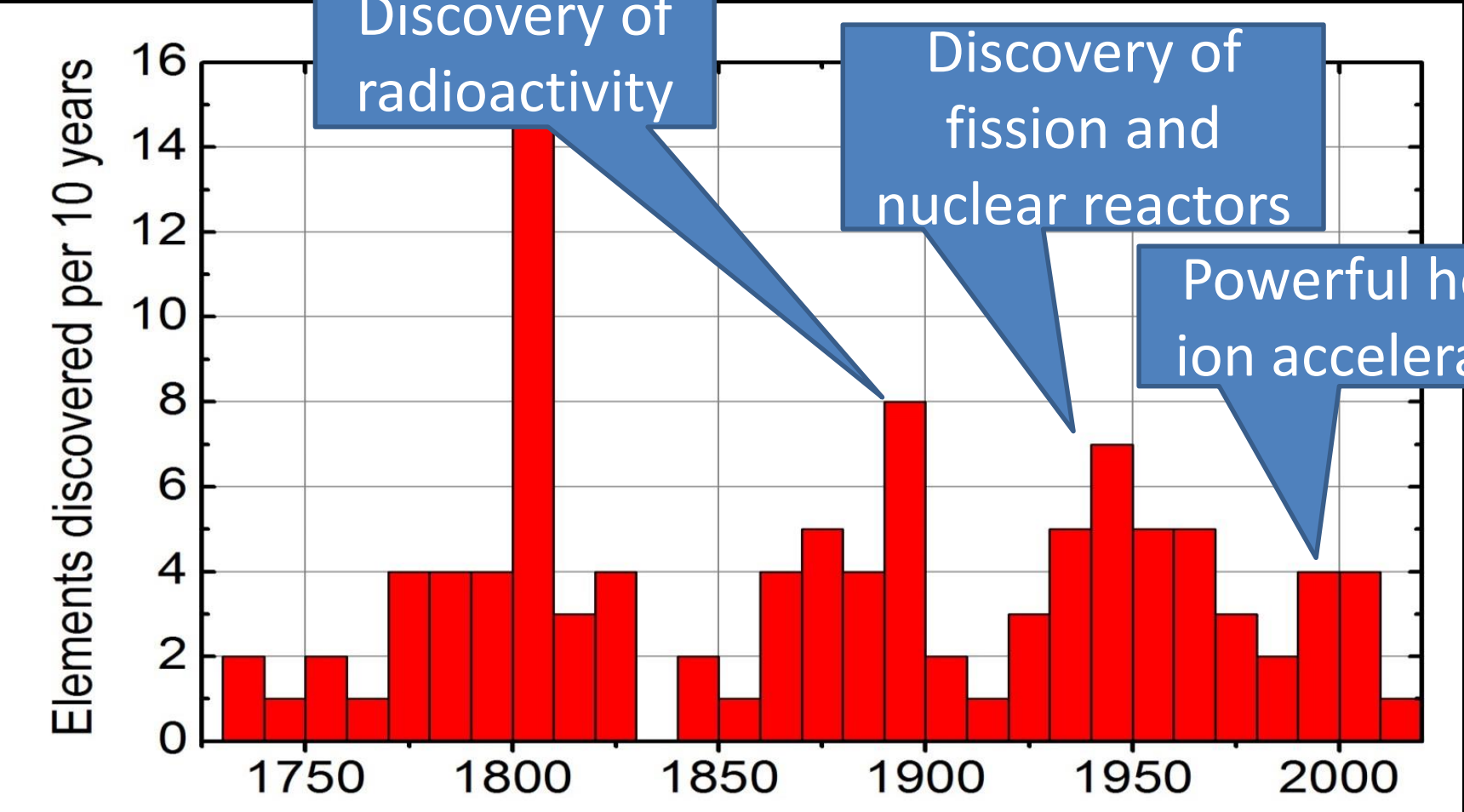
Element Discovery - Trend



Do NRC belong in Academia?

- Crafting new radiolabeled compounds for Nuclear Medicine is neither easy nor obvious – many challenging research opportunities.

Do NRC belong in Academia?

- Crafting new radiolabeled compounds for Nuclear Medicine is neither easy nor obvious – many challenging research opportunities.
- Using radiotracers to understand and solve problems in applied research is important and challenging

Hydromet

http://hydromet.no/homepage/index.html — Homepage (English)

Hydromet

A UiO-NTNU-Sintef-IFE Norwegian Research Council hydrometallurgy comptense-building project in collaboration with Norwegian companies Yara, Boliden Odda og Glencore Nikkelverk

- Startside
- Kurs og utdannelse
- Møter og seminarer
- Partnere
- Pekere
- Internsider
- Homepage (English)
  - Protected pages
  - Hydrometallurgy Course

Homepage (English)

The four-year Hydromet project aims at strengthening and developin hydrometallurgical research and education in Norway.

The project is a close collaboration between Norwegian process indu forefront Norwegian research institutions: The University of Oslo (UiO University of Trondheim (NTNU), and the research institutes SINTEF Participants from the process industry are Yara International in Porsgrunn, Glencore Nikkelverk in Kristiansand, and Boliden in Odda.

The Hydromet project has two main goals:

- To educate candidates highly skilled in hydrometallurgy and therefore

Kontaktpersoner

Jon Petter Omtvedt
(prosjektleder)

Dag Ø. Eriksen
(daglig prosjektleder)
post@hydromet.no

Få informasjon!

Ønsker du informasjon om seminarer, arrangement og andre ting vedrørende

Do NRC belong in Academia?

- Crafting new radiolabeled compounds for Nuclear Medicine is neither easy nor obvious – many challenging research opportunities.
- Using radiotracers to understand and solve problems in applied research is important and challenging
- Countering treats from criminal and terrorist smuggling and using nuclear material is extremely challenging

Do NRC belong in Academia?

- Crafting new radiolabeled compounds for Nuclear Medicine is neither easy nor obvious – many challenging research opportunities.
- Using radiotracers to understand and solve problems in applied research is important and challenging
- Countering treats from criminal and terrorist smuggling and using nuclear material is extremely challenging
- Understanding how radionuclei behave environmentally is challenging and important.

Nuclear and Radiochemistry Research?

- **Nuclear Energy**, in particular fabrication of f
  treatment of spent nuclear fuel
- Synthetization of **radiolabeled compounds f**
  medical diagnostics and therapy
- Migration of radionuclei in nature (**radioeco**
- **Radiation protection** & **nuclear forensics**
- **Fundamental properties** of nuclei
- **Radiotracers** used as a tools in industry & re

Politically impossible

UiO priority

CeRAD and NMBU (Ås)

UiO opportunity

Sustainability

	PET	Hydro-metallurgy	SHE
Good Science	✓	✓	✓
Students	✓	✓	✓
Funding	✓	✓	

NuC@UiO should:

- Maintain NUC knowledge and competence
- Contribute to education in Radiation Protection

- Key areas:
  - Nuclear Medicine (i.e. radiopharmaceutical chemistry)
  - Super-heavy Elements research
  - Application of radiotracers in industry

Education

- We have participated in the CINCH EU-projects to promote and enhance NRC teaching in Europe
  - NRC EuroMaster label based on minimum requirements for NRC competence and knowledge
  - Developed e-learning tools (headed by UiO)
  - Free NRC Textbook written by Jukka Lehto (UH)
  - Access to courses across Europe for UiO students
- CINCH-III (application submitted)
  - UiO will head creation of a NRC MOOC

CINCH E-learning tools

NucWik — Nuclear and Radiochemistry Teaching Material Wiki

CINCH Moodle Platform

RoboLab — Remote Operated RadLab for Teaching Radiochemistry

CSE exercises

Details?
Talk at NRC9:

CINCH

Cooperation in Education and Training in Nuclear- and Radiochemistry in Europe

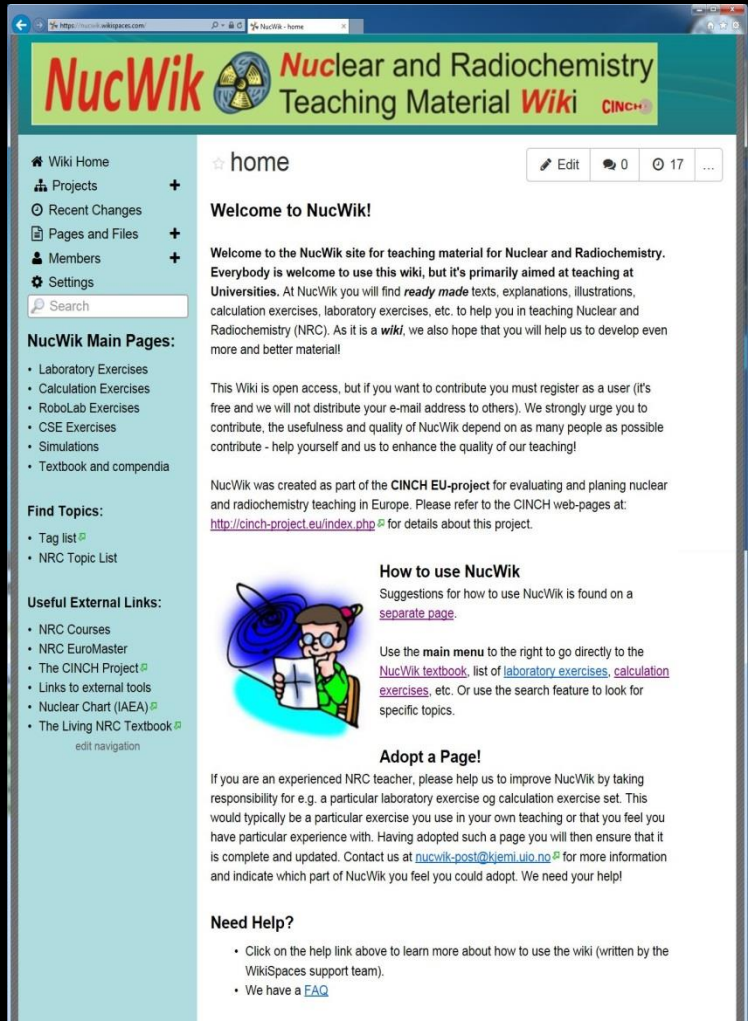
Site for Sharing *Teaching Material*

NucWik:

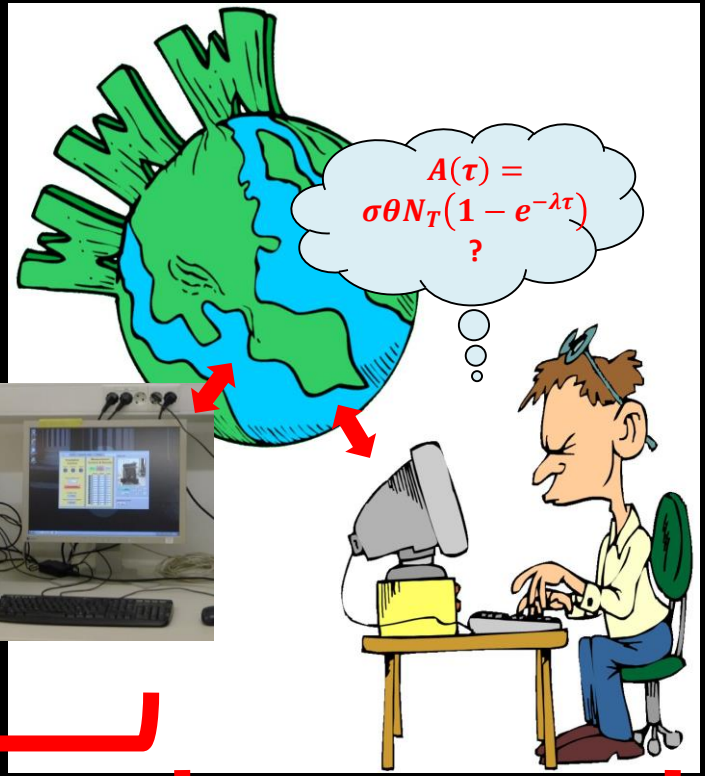
- No reading or downloading restrictions.
- Must register to upload material or edit content.
- It's free!

http://nucwik.wikispaces.com/

.. or just Google "NucWik"



RoboLab Principle



A real nuclear laboratory using radioactive material

Student using the lab through his computer

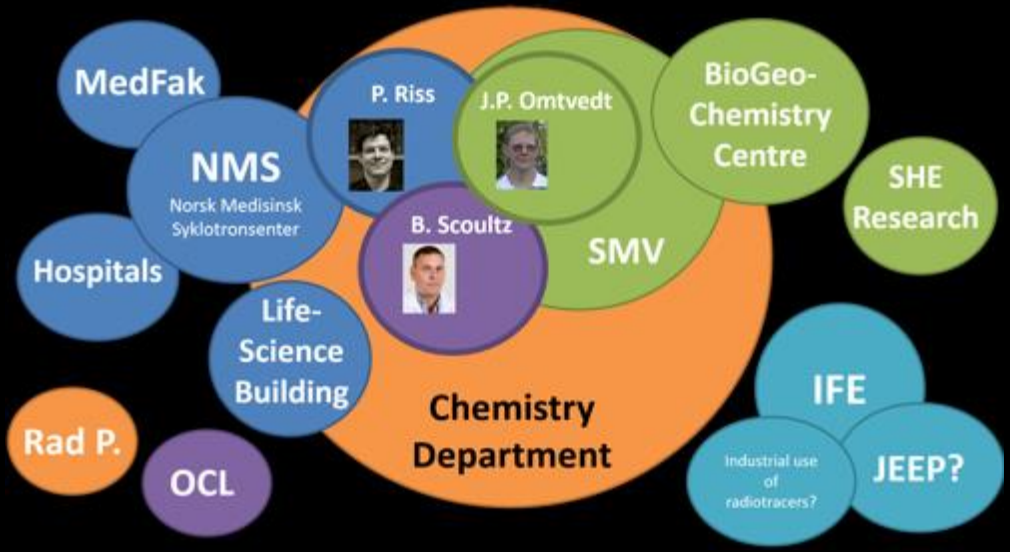
RoboLab Remote Operated RadLab for Teaching Radiochemistry CINCH

Challenges & Opportunities

- Will Kjeller reactor be shut down? Where should we make our radionuclides? Can we get our own n-generator (~5 MNOK)?
- PET-research
  - Can we get a used PET cyclotron?
  - New center for Nuclear Medicine at IFE?
- SHE and hydrometallurgy research
  - Hydrometallurgy and "urban mining" related research is fundable, wanted (by industry) and attract students
  - SHE must be based on travel (particle accelerators in Rez and RIKEN)

Conclussions

- Fragmentation of resources is a big problem



Conclussions

- Physical location must be decided
  - Where should NuC stay when Department moves to new building?
  - What relation should NuC have to possible new cyclotron center at IFE?
  - How should NuC relate to new BioGeoChemistry center?
  - What relation should NuC have to NMS?

Conclussions - For My Own Part

- Hydrometallargy is fundable and have large overlap with SHE chemistry (LLX etc.)
  - SHE is first priority, this is what I do best
  - Hydrometallurgy (including environmental concerns, recycling of metals and urban mining) is second priority

Talk dedicated to memory of

Jorolf Alstad

(1927 – 2014)

Thanks for your Attention!