Australian Government

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Overview of Very High Energy Electron Radiotherapy

Potential for Australian Growth

Dr Rebecca Auchettl

Accelerator Technology Forum

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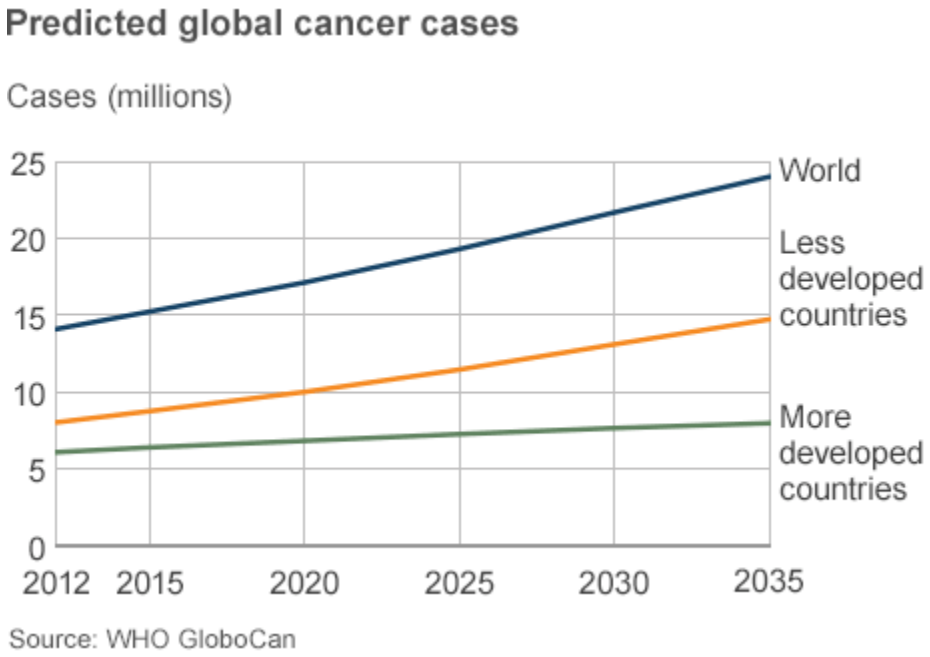
Science. Ingenuity. Sustainability.

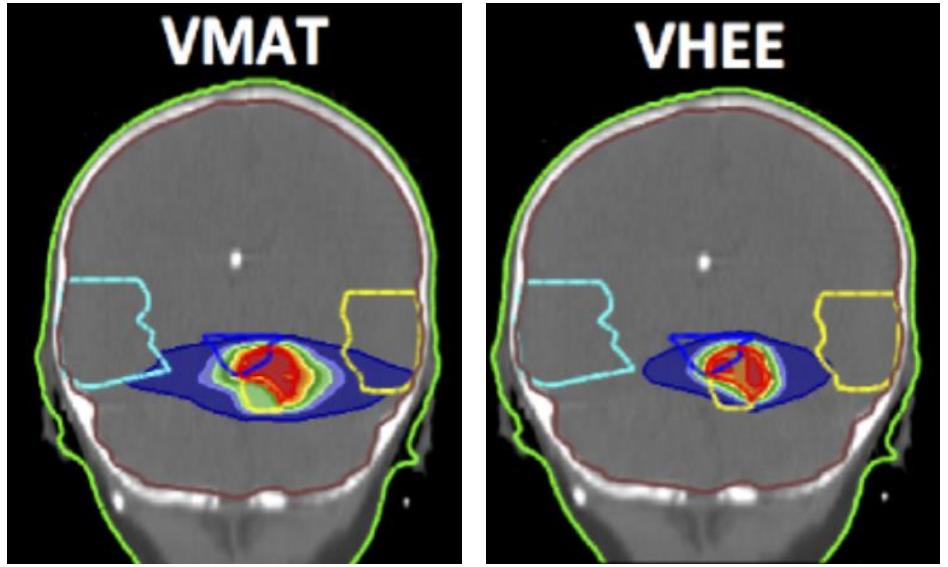
Radiotherapy

- Cancer is one of the biggest killers in Australia and globally
  - Around 3 of every 10 deaths in Australia
  - Worldwide nearly 1 in 6 deaths
  - Radiotherapy treatments expected to increase to 27 million new cancer patients per year by 2030



Clinical problems with radiotherapy

- Collateral damage to normal tissue
- Dose Depth
- Dosage fall off
- Dose conformity to the target volume
- Limited clinical applicability



Bazalova-Carter et al. (2015)

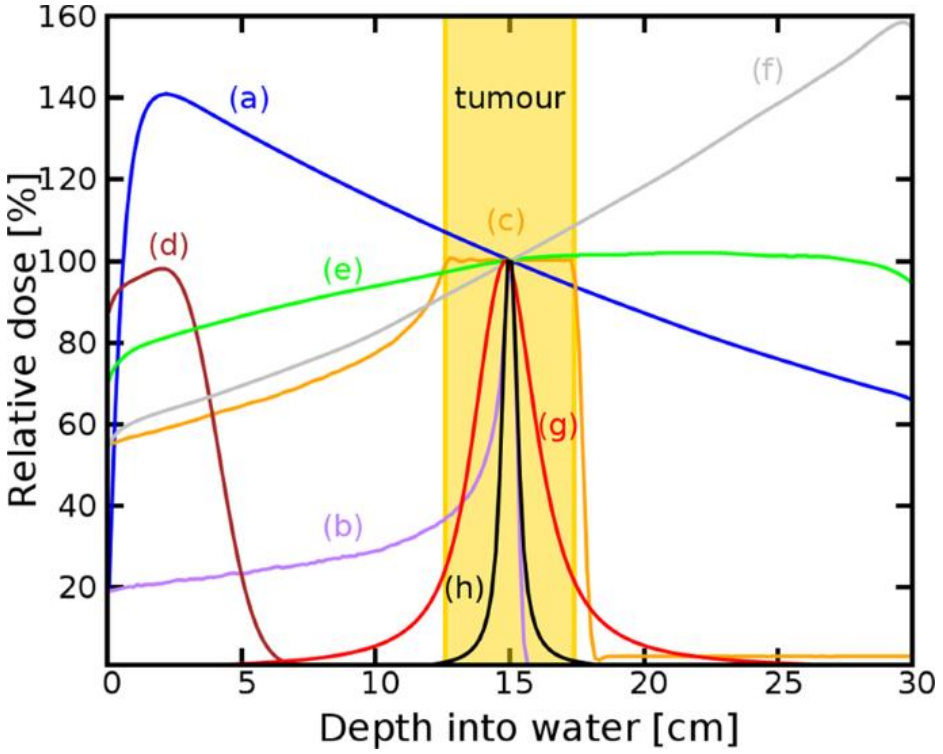
Very High Energy Electron Radiotherapy

- However, recently it was shown that high energy electron radiotherapy is a promising alternative
- Unlike traditional radiotherapy and proton therapy, VHEE (≥40 MeV):
  - Large penetration depth
  - Low radiation dose to surroundings
  - Is insensitive to minor changes in patient positioning and geometry
  - Sparing of critical structures

Advantages of VHEE

- Different beam modalities
  - Electrons give us the ability to steer and focus the beam
  - High-energy focused beams can precisely concentrate radiation dose
  - Reduce lateral scattering and concentrate the dose deposition
  - High dose so treatment time is shorter – less side-effects for patient

K. Kokurewicz et al (2019)



Requirements for realisation and limiting factors

- Compact design for hospital setting
- Must be cost effective
  - Traditional radiotherapy cost per course ~$15,000
  - Proton radiotherapy cost per course ~$75,000
  - Driver of accessibility to the public
- Reliable treatment in clinical hospital setting
  - Need precisely controlled electron beams

How do we produce a VHEE machine compact enough to fit inside a hospital?

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Use a high gradient X-Band compact linear accelerator

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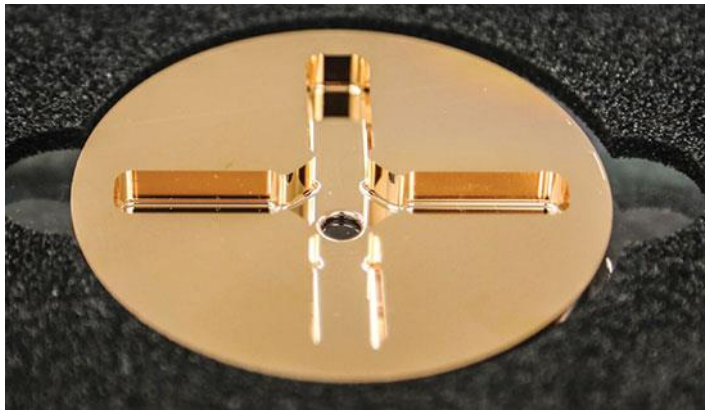
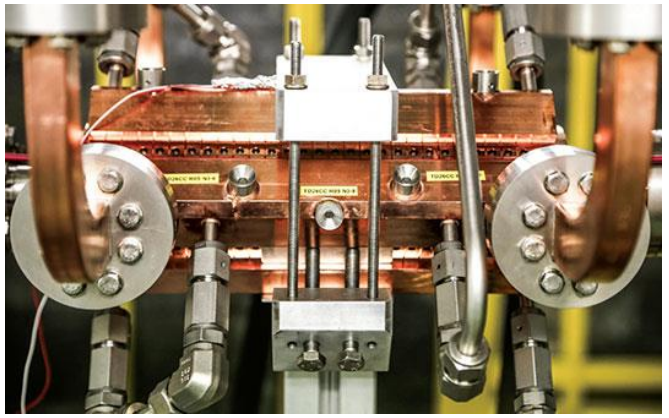
X-Band technological requirements of VHEE

- High gradient, high current Linac technologies
- RF Power Source, Accelerating Structures, XBOX test structures
  - Using a 50 MW X-band klystron as the RF power source, it is possible make a compact 1.5 m long machine to generate 100 MeV

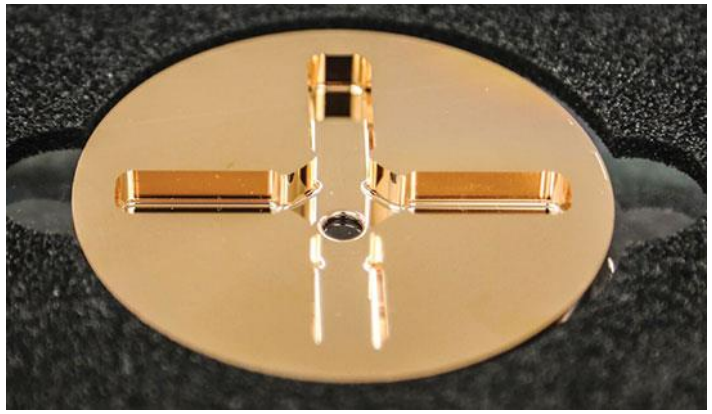


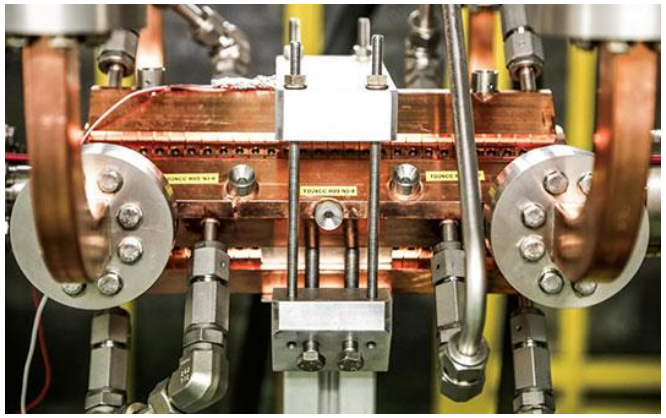


M. Volpi (2020)

Technological requirements of VHEE

- Luckily, we can leverage existing accelerator physics technologies and expertise that were developed through collaborations
- High performance Linac technologies are already developed, are in operation and well suited to the needs of a VHEE facility





M. Volpi (2020)

Harness and coalesce the accumulated experience within Australia and with our international colleagues

Potential contributions to VHEE in Australia

- Radio frequency (RF) systems for high gradient electron Linacs
- Linac key components include accelerating structures, high-power test stands facilities - important for prototyping and performance testing
  - Developed through the CLIC (Compact Linear Collider) Collaboration and CERN

W. Wuensch (2020)

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Melbourne will house 2 of the CERN Test Stands

- 2x6 MW Performance high power test stands (CERN)
- Test stands (XBOX-3) are coming to University of Melbourne / ANSTO in November!
  - See Professor Geoffrey Taylor and Dr Matteo Volpi (University of Melbourne) presentations on Tuesday
- ~ $6 Million dollar, 7 ton RF high power system

M. Volpi (2020)

Opportunities to contribute to VHEE in Australia

- University of Melbourne will host the first high-frequency high gradient accelerator lab in the Southern Hemisphere
  - X-LAB – X-Band Accelerator Laboratory (Dr Suzie Sheehy – University of Melbourne and collegues)
- Our group and other colleagues are also involved in other X-Band technology development:
  - Through the design of a compact and flexible XFEL which uses the same technologies VHEE will require (CompactLight Collaboration)
  - Inverse Compton Scattering Source (University of Melbourne, Eindhoven)

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Australia is in a excellent position to realise VHEE

- Australia can play a key role in the development of a compact and cost-effective VHEE facility
  - Unique capability (test stands) and laboratory (X-LAB)
  - Unique expertise and experience accumulated
- The high performance Linac technologies required for VHEE are already well established and can be easily adapted to a VHEE facility
- See Dr Matteo Volpi presentation on Tuesday!

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Thank you

rebeccaa@ansto.gov.au

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