Australian light sources: XFEL and Compact Compton Source

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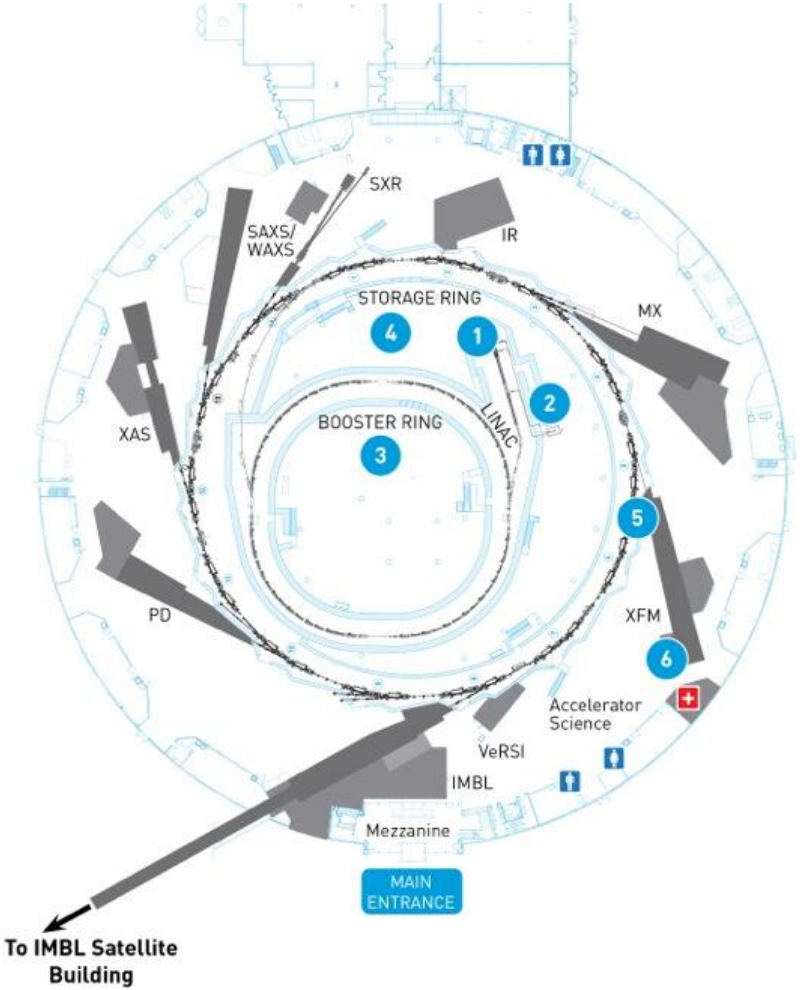
On behalf of the Australian collaborators on CLIC

CLIC Workshop 9 March 2017

Australian Synchrotron Light Source

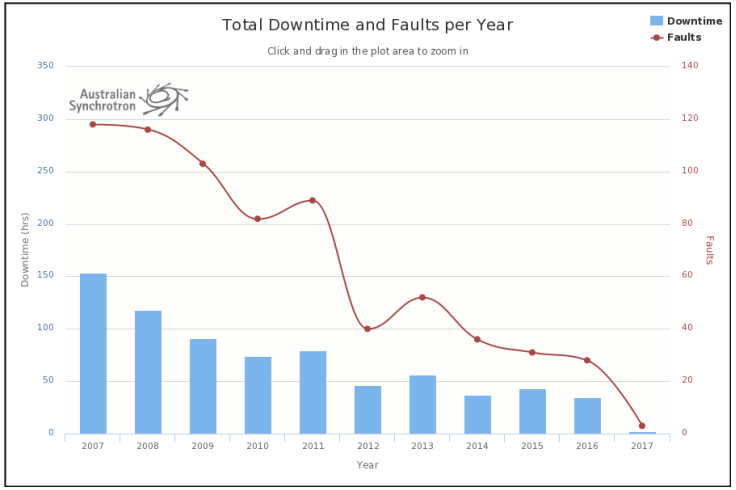
Photon Beamlines

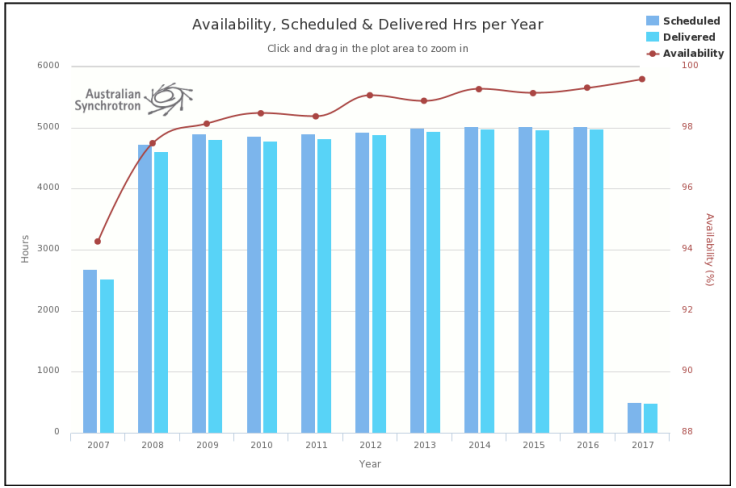
- 10 existing beamlines
- Space for 20+ total
- $10M-$20M per beamline

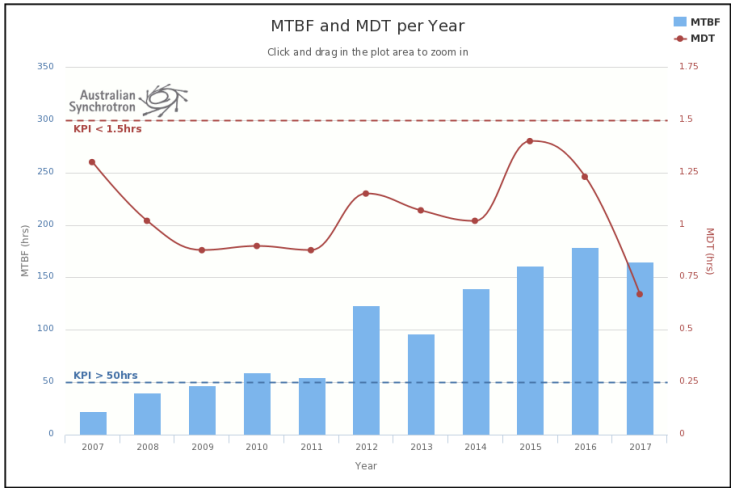


Operational Statistics

- 98% beam availability
- MTBF > 150 hr
- MDT < 1 hr
- Faults and downtime minimised







New Developments

- Light source taken over by Australian Nuclear Science and Technology organisation (ANSTO) in Sydney
- $520M ten year funding through 2027
- Funding is for refurbishment and operations only
- Capex funding being sought for new beamlines
- XFEL development pushed out to after the storage ring is fully occupied with beamlines
- New priority for compact sources located at universities driven by User Community demand

Activities with the CLIC Collaboration

- Structure manufacture and assembly (Ashley French, 2009-2010)
- Thermal Shock and cooling modelling in PETS (Tessa Charles, 2010)
- Damping ring vertical emittance tuning modelling and measurements for CDR (Kent Wootton 2011-2014)

Dowd, R., Boland, M., et al. Achievement of ultralow emittance coupling in the Australian Synchrotron storage ring. Phys. Rev. ST Accel. Beams, 14(1):012804 (2011).

Wootton, K. P., Boland, M. J., et al. Observation of picometer vertical emittance with a vertical undulator. Physical Review Letters, 109(19):194801 (2012).

Wootton, K. P., Boland, M. J., Corbett, W. J. et al. Storage ring lattice calibration using resonant spin depolarization. Physical Review Special Topics: Accelerators and Beams, 16(7):074001 (2013).

Wootton, K. P., Boland, M. J. and Rassool, R. P. Measurement of ultralow vertical emittance using a calibrated vertical undulator. Physical Review Special Topics: Accelerators and Beams, 17(11):112802 (2014).

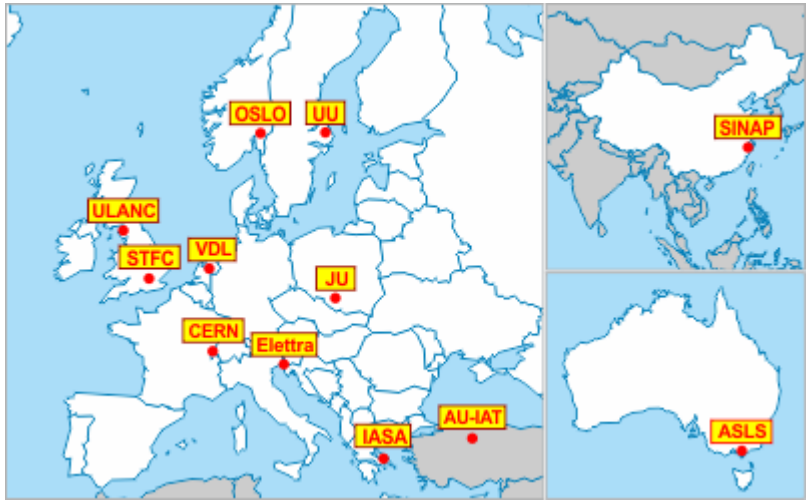
- XbFEL modelling (Tessa Charles, 2014-2016)

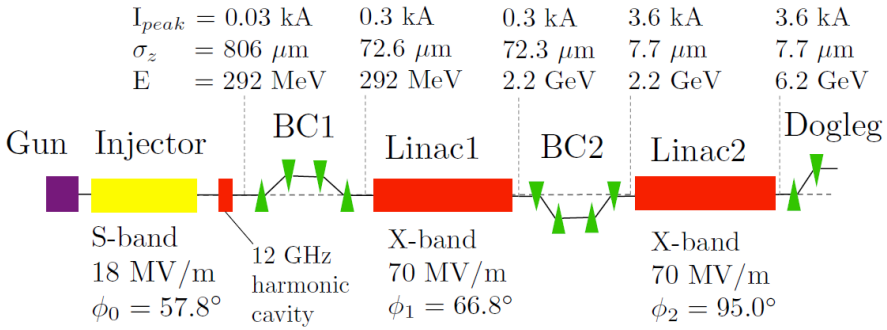
T. K. Charles, D. M. Paganin, A. Latina, M. J. Boland and R. T. Dowd, accepted Physical Review Accelerators and Beams (2017)

- XBOX3 commissioning (Matteo Volpi, Thomas Lucas and Paul Giansiracusa 2016-2017)

Baseline CLIC X-band FEL design

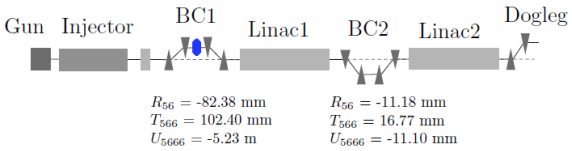
X-band FEL
Research & Development



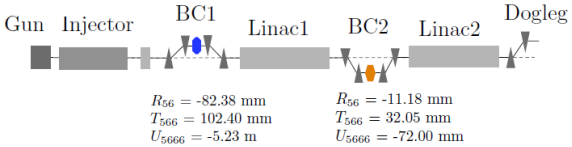


A. Aksoy

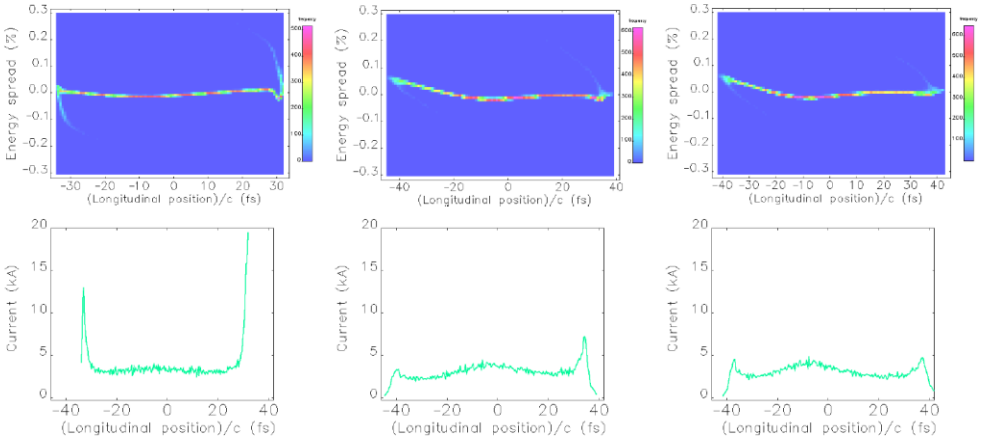
Current-horn suppression for reduced CSR-induced emittance growth



(a) Layout 2: linac design including the addition of an octupole magnet to BC1 to avoid current horn formation.



(b) Layout 3: linac design including an octupole magnet in BC1, and a sextupole in BC2 for further optimization of CSR suppression.



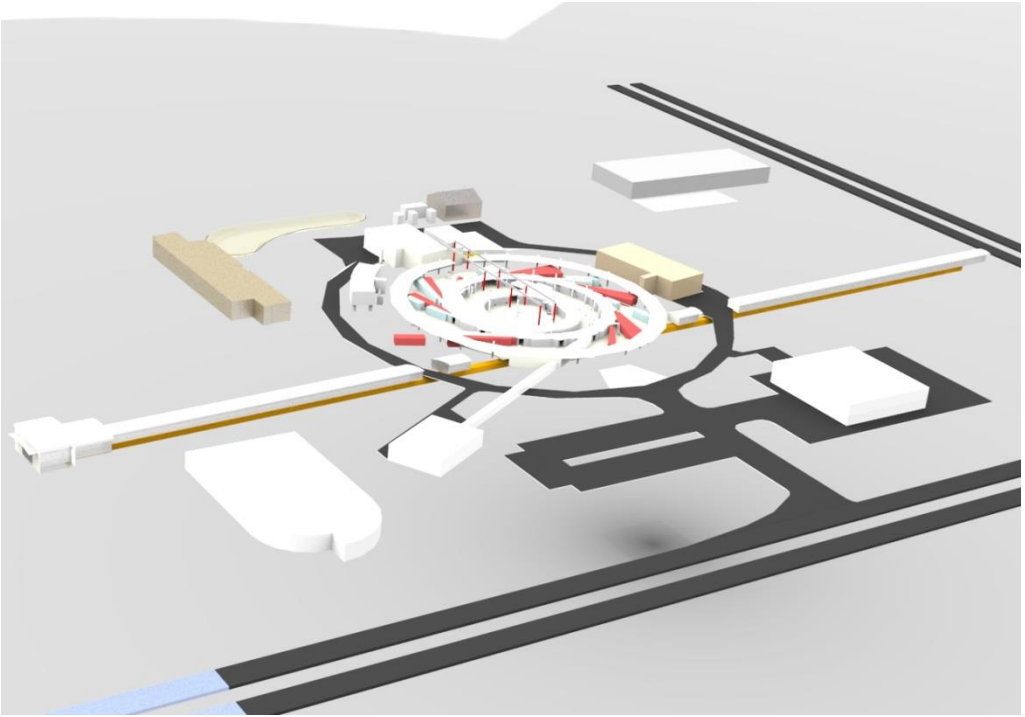
T. Charles

AXXS

AXXS – Australian X-band X-ray Source
AXXS n. /ˈæksɪs/ *fig.* A central prop, which sustains any system.

Development plan for the Australian Light Source community:

1. develop the remaining beamlines (space for an additional 6 IDs)
2. upgrade the storage ring lattice to MBA (compact MAX IV magnets?)
3. upgrade the injector to a full energy x-band linac (3 GeV)
4. upgrade to additional linac for XFEL (6 GeV)

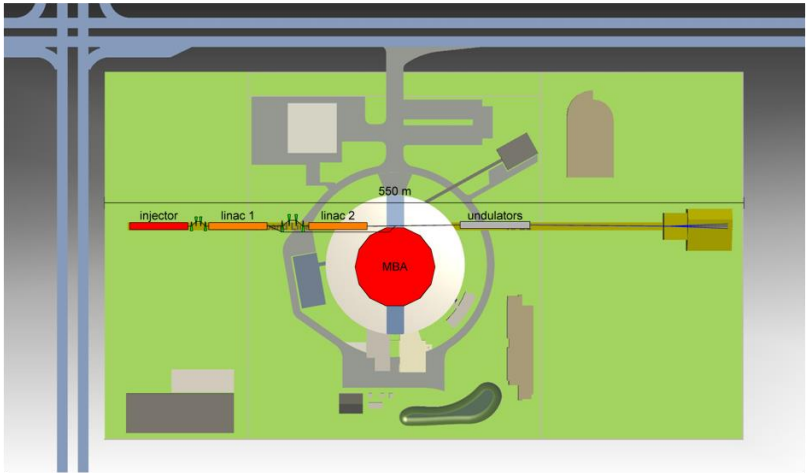


XFEL User Community in Australia

- Strong XFEL user base with regular beamtime on LCLS and members of review committees for European XFEL
- Strong government funding, especially in life sciences

CENTRE FOR ADVANCED MOLECULAR IMAGING
AN ARC CENTRE OF EXCELLENCE

- Site constraint 550 m:
- Same tunnel, energy and source points for storage ring upgrade.
- Time constraints: need to finish building out the remaining beamlines before justifying a new ring or FEL.



Users requesting compact light sources

- User want to compliment the storage ring light source x-ray beamlines with their own compact light sources
  - Reduce time between beamtime
  - Enable proof-of-principle experiments before synchrotron beamtime
  - Better prepared users for higher quality beam at synchrotron facility
  - Broaden the light source user community (some potential users never apply for beam time due to the low proposal acceptance rate)
- Example facility at Technical University Munich MuCLS

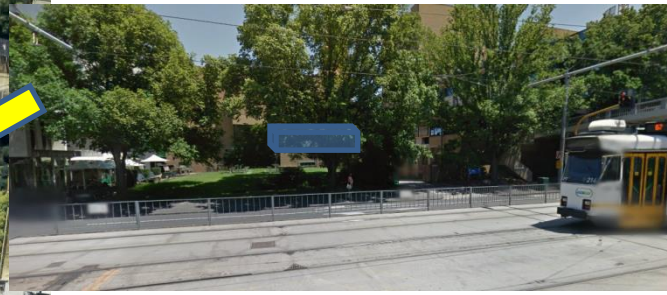
E. Eggl *et al.*, "The Munich Compact Light Source: initial performance measures," *J. Synchrotron Radiat.*, vol. 23, no. 5, pp. 1137–1142, Sep. 2016.

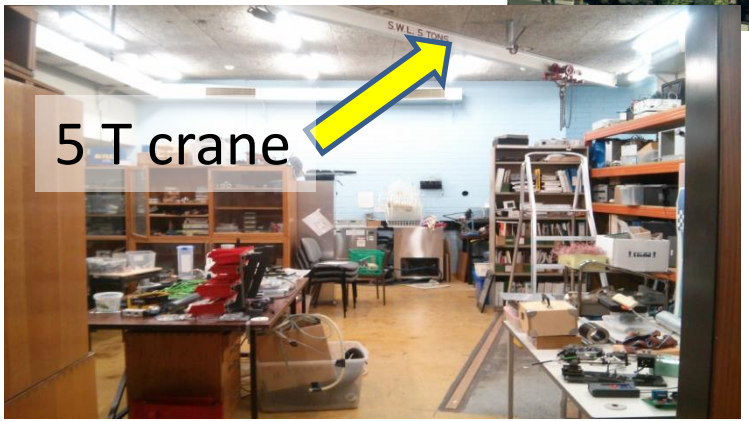
4.6 m circ.
Storage ring

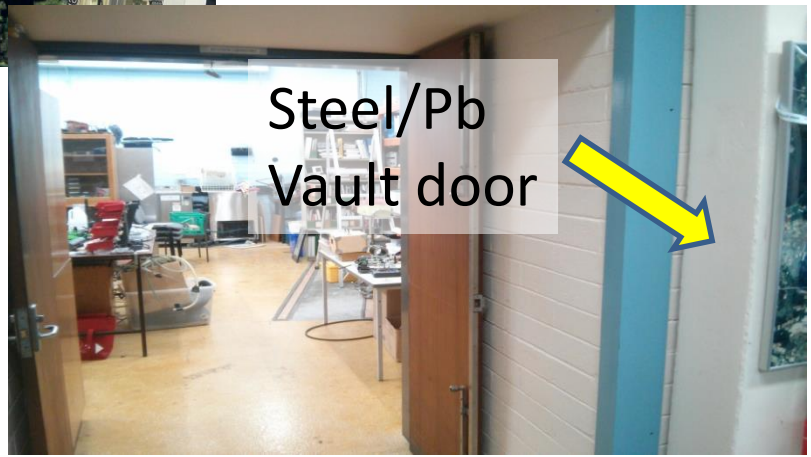
S-band linac

Accelerator R&D at Melbourne University

- Build expertise through light source, CERN and CLIC collaborators
- Driven primarily by x-ray user community needs
- Starting to engage industry partners, e.g. RFS Word in Melbourne
- Applying for Australian Research Council grants and partnering in H2020 proposals

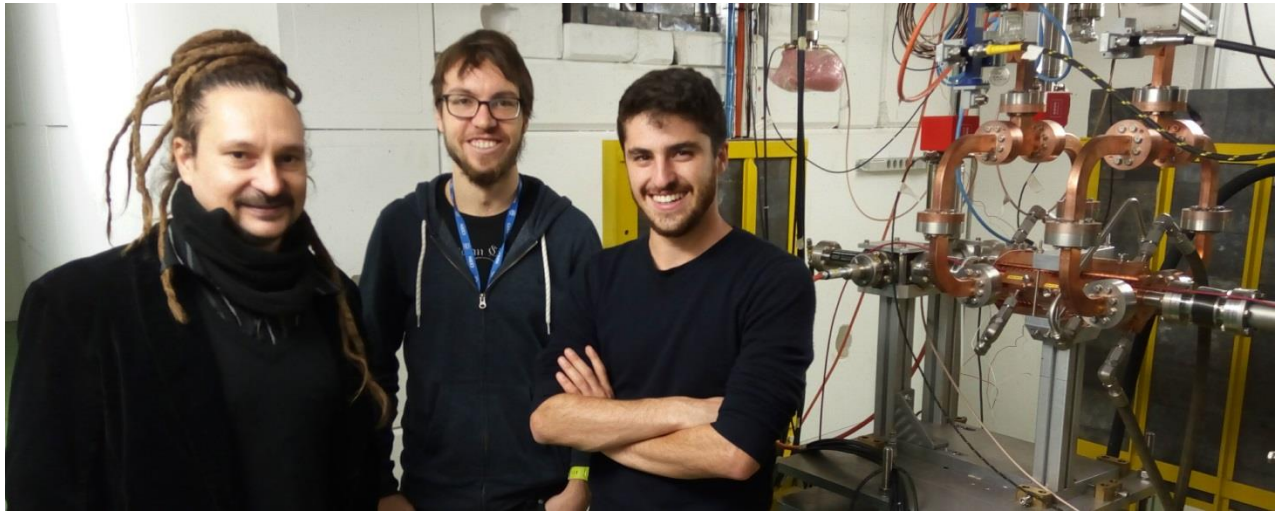






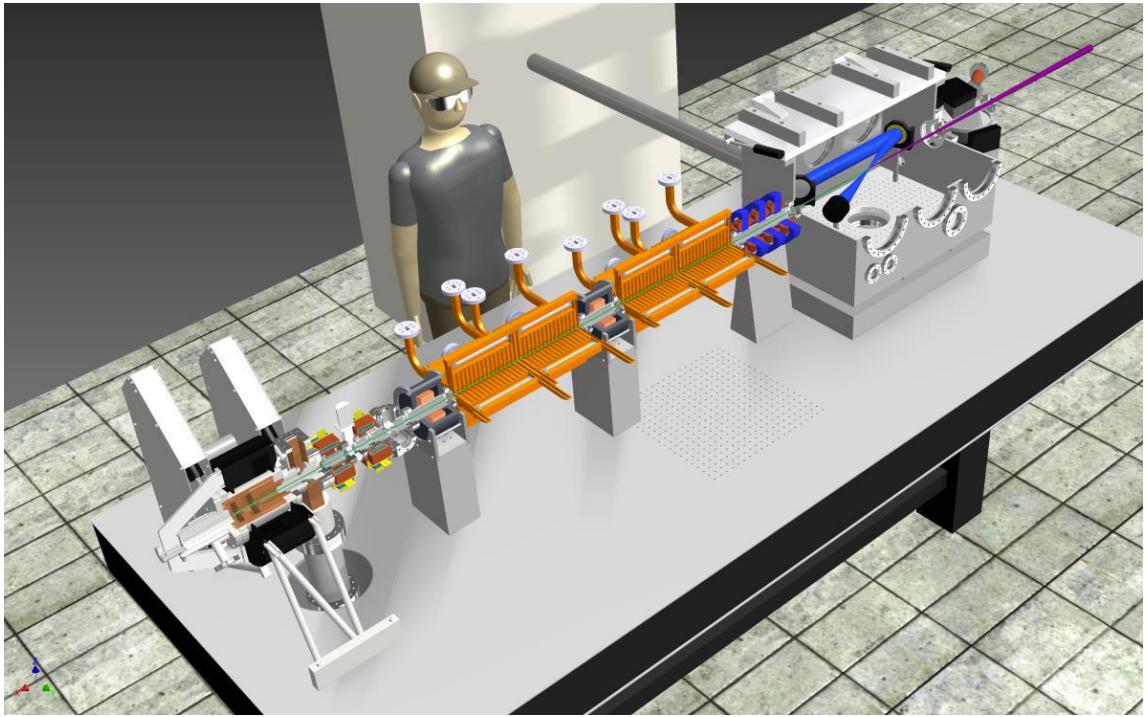
Introducing the team

- Mark Boland (Australian ACAS Team Leader)
- Geoff Taylor (Australian ATLAS Team Leader)
- Roger Rassool (Particle and X-ray Detectors)
- Matteo Volpi, Tom Lucas and Paul Giansiracusa, XBOX3 commissioning and XBOX1 and XBOX2 operations
- Tessa Charles, submitted PhD on magnetic chicane for electron bunch compression



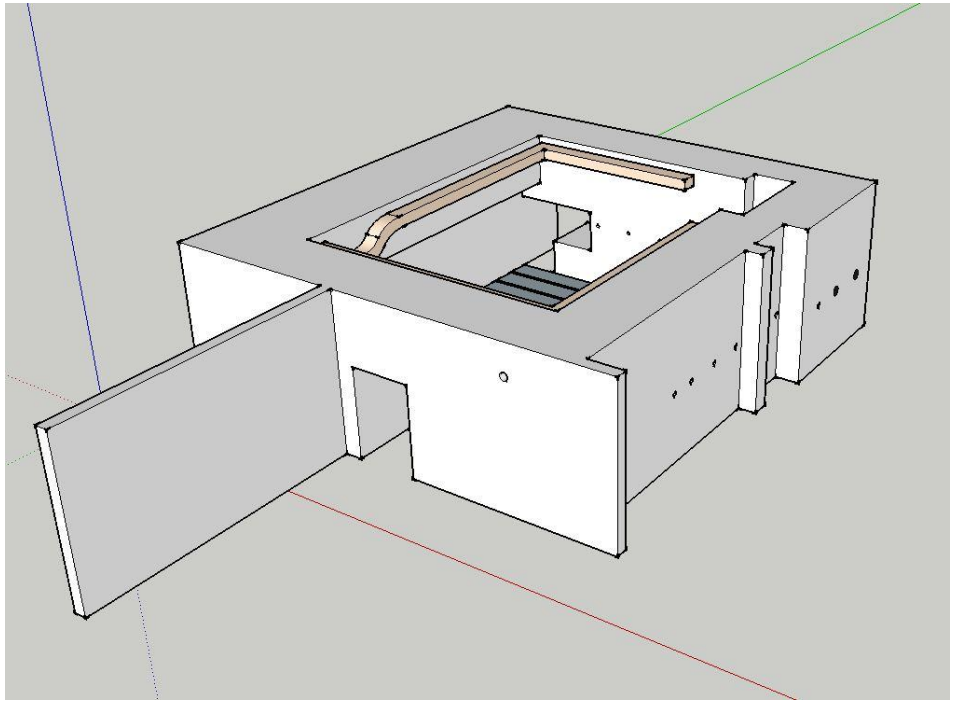
Collaboration with TU/e on Smart*Light

- Inverse Compton Scattering source of quasi monochromatic x-rays (see details in Jom Luiten talk from TU/e this session)
- Xavier Stagier to spend 2 month in Melbourne first half of 2017
- Share RF source and s-gun resources
- Develop similar proof of concept machines in Eindhoven and Melbourne 2017-2019



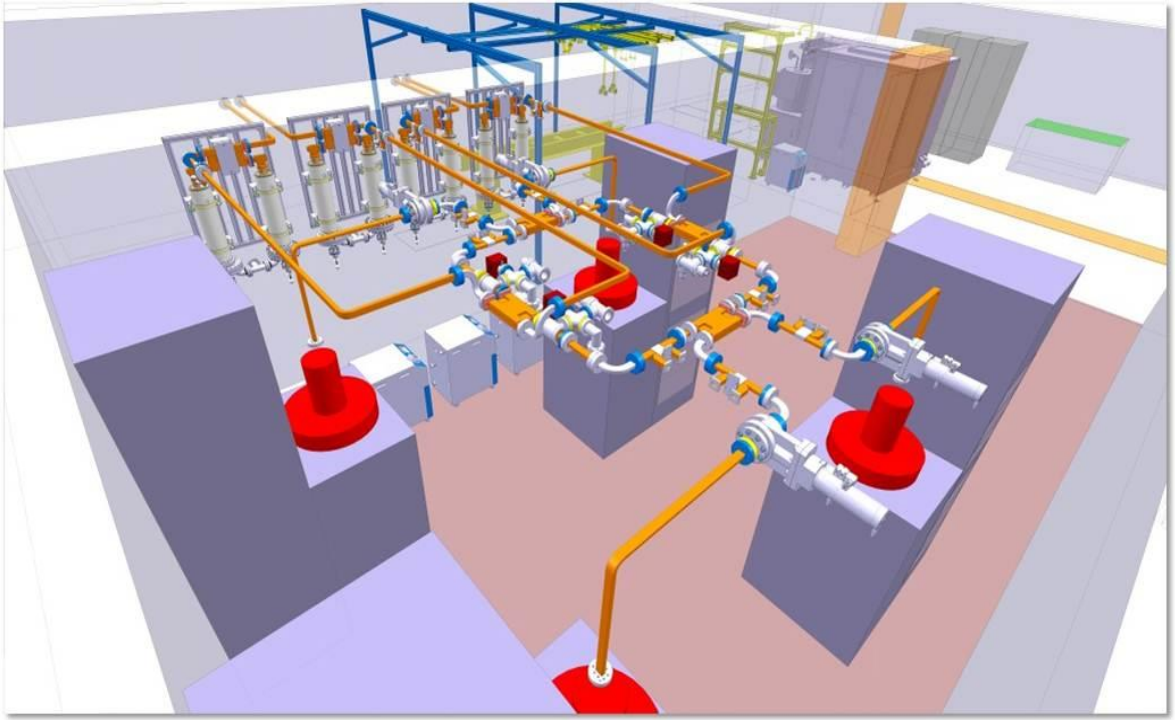
Accelerator Bunker at University of Melbourne

- Previously used for 35 MeV betatron
- Space for x-band linac and laser for Compton source



XBOX3 partly to Melbourne ~18/19

- Bring part of XBOX3 to Melbourne for high gradient test stand and future linac based x-ray source



Future

- Enthused by CLEAR and ARIEL access programme and another 4 years+ of electron accelerator activities at CERN
- Started collaborating with TU/e on compact x-ray source
- Participating in H2020 application CompactLight
- Strong user request for distributed compact x-ray sources to compliment large storage ring beamlines