Development of the ASTRI Heliostat

Joe Coventry[1], Maziar Arjomandi[2], John Barry[3], Manuel Blanco[4], Greg Burgess[1], Jonathan Campbell[5], Phil Connor[7], Matthew Emes[2], Philip Fairman[8], David Farrant[8], Farzin Ghanadi[2], Victor Grigoriev[4], Colin Hall[6], Paul Koltun[7], David Lewis[5], Scott Martin[8], Graham Nathan[2], John Pye[1], Ang Qiu[5], Wayne Stuart[8], Youhong Tang[5], Felix Venn[1] and Jeremy Yu[2]

(1) Australian National University (2) University of Adelaide (3) Queensland University of Technology (4) CSIRO Energy Flagship (5) Flinders University (6) University of South Australia (7) CSIRO Mineral Resources Flagship (8) CSIRO Manufacturing Flagship

ASTRI
AUSTRALIAN SOLAR THERMAL RESEARCH INITIATIVE

The Australian Solar Thermal Research Initiative (ASTRI) aims to develop a high optical quality heliostat with a target cost – manufactured, installed and operational – of 90 AUD/m². The objective is to demonstrate proof-of-concept for the new heliostat and improved heliostat field designs by the end of 2016, followed by demonstration in a pilot plant during the second ASTRI period (2017-2020), as a precursor to a full-scale commercial installation.

Heliostat concept development

Three new heliostat design concepts are being investigated. These concepts will be down-selected to a single concept for testing in late 2016.

Heliostat A

- 30 m^2 sandwich panel mirror facets with minimal support structure
- Tilt-roll tracking with linear drives
- Autonomous power and control

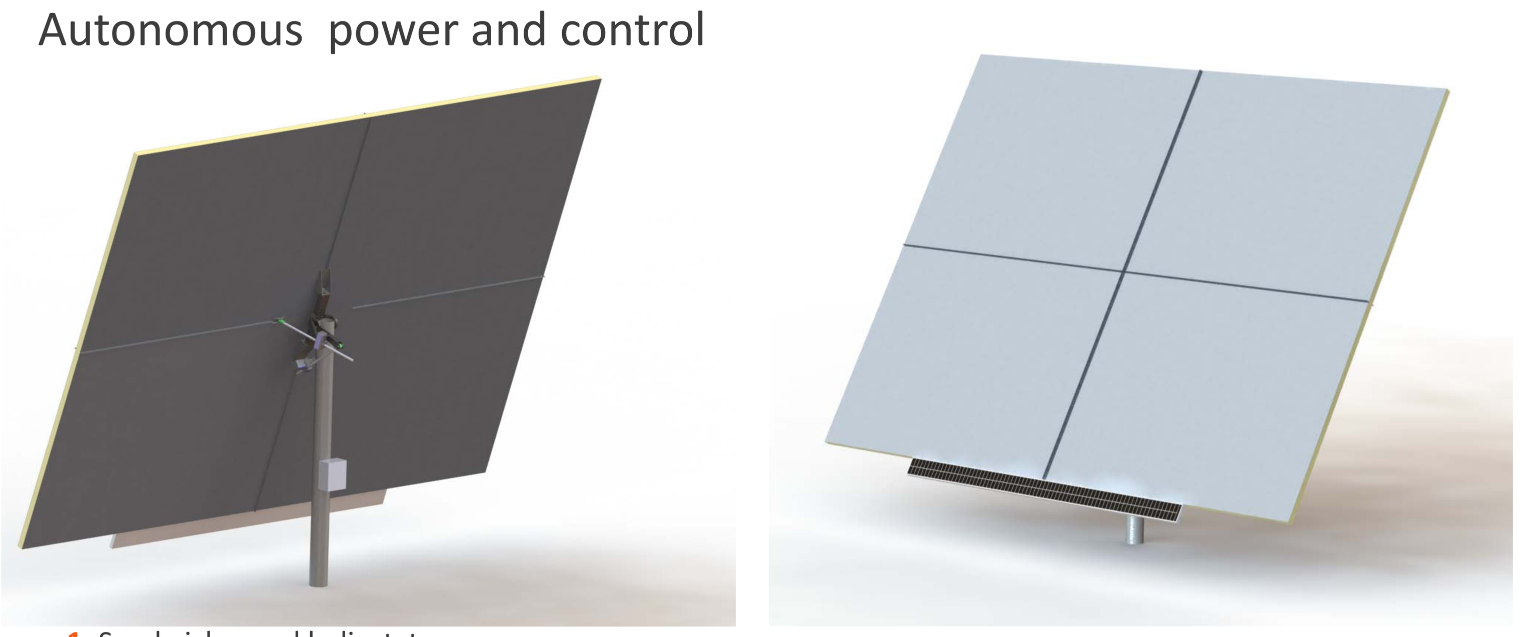

Figure 1: Sandwich panel heliostat

Heliostat B

- 20 m^2 with 81 mini-facets (50 x 50 cm sized facets).
- Active adjustment of each facet for improved optics (reduced astigmatism)
- Cost increase due to additional actuators balanced by lower cost coarse tracking of support frame

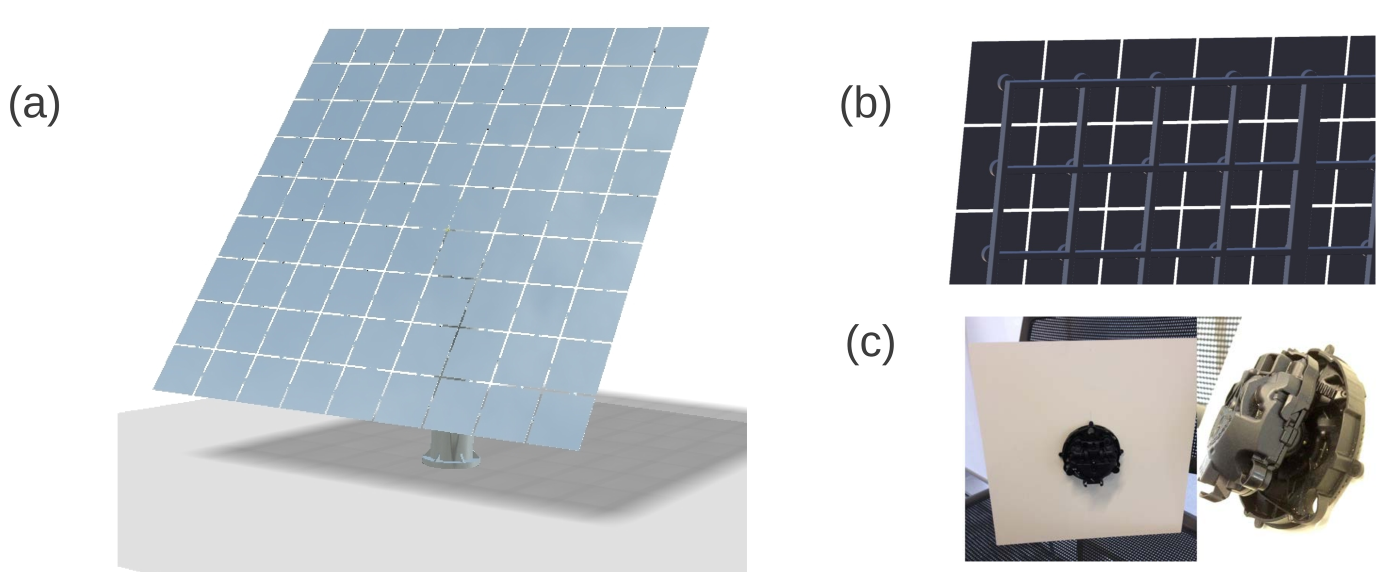

Figure 2 (a) Mini-facet concept image. (b) close up of rear. (c) proposed actuator as used in automotive industry mounted to glass mirror panel and close up of actuator.

Heliostat C

- 12-16 m2 with three-four facets with the shape to minimise blocking and deformation due to wind
- Fully pre-fabricated, drop in place with autonomous power, control and initial set-up. Installation time less than 30 minutes including alignment
- Footings: concrete free non-displacement pile system
- Optional optical closed-loop control

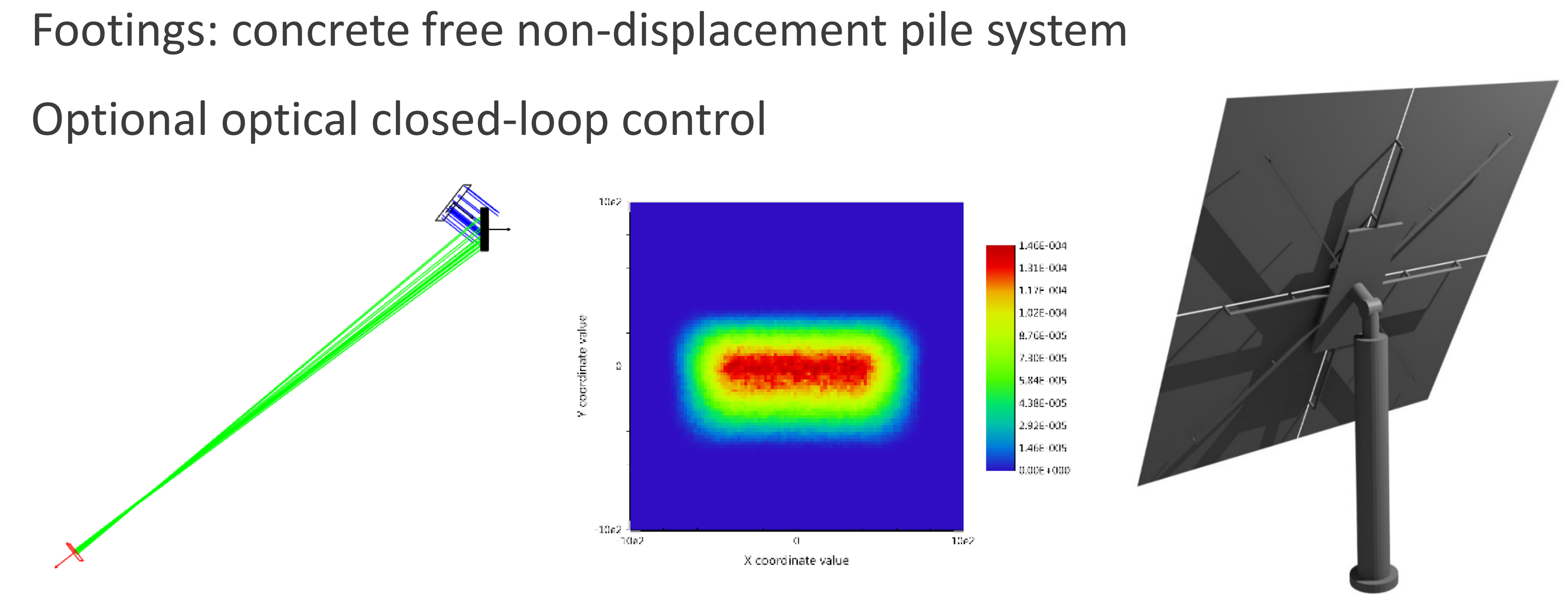

Figure 3: Ray tracing investigating asigmatic image of off-axis (38°) heliostat and rear v
The actual mirror shape and truss will be optimised to reduce deformation from wind and blocking losses.

Heliostat technology advancement

The heliostat concept design is supported by technology development streams, including the goal of knowledge transfer to the CSP community

Mirror facet development

- Glass-steel-core-steel layups, with a short-list of aluminium honeycomb, expanded polystyrene foam and polyurethane foam core materials
- FEA to optimise material usage for specified slope error and peak stress

Figure 4: Prototype aluminium honeycomb mirror (left), trials of laser cut EPS (centre), and PU-cored structural wall panels used as a basis for new mirror panel designs (source: APC Manufacturing and Logistics Pty Ltd).

Aerodynamics and wind loads

- Wind tunnel experiments and CFD are used to quantify the forces and moments on operating heliostats as a function of aspect ratio, elevation angle, facet dimensions, flow speed, and turbulence intensity in the atmospheric boundary layer (ABL)
- The length scales of vortices in the ABL are identified to optimise geometrical dimensions of heliostats
- The findings of this work will be used to develop a validated engineering method for calculation of heliostat static and dynamic wind loads

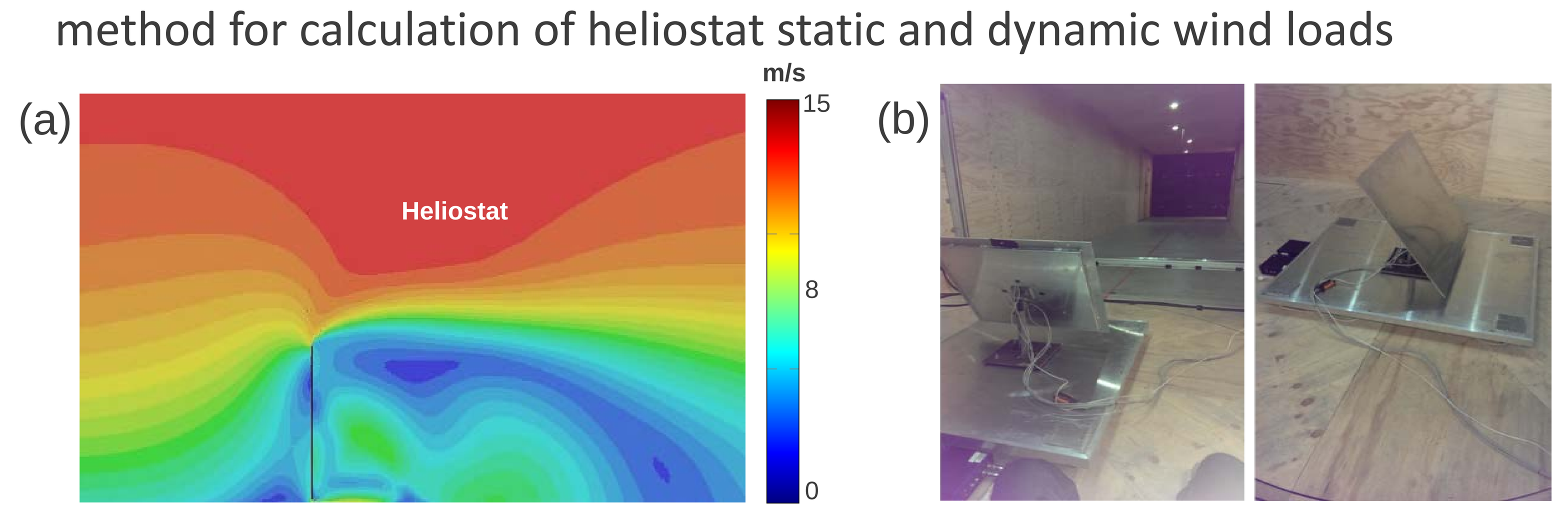

Figure 5: (a) Simulation of flow behaviour around normal heliostat, (b) Heliostat setup at operation position.

Heliostat field optimisation

- Optimal shape of heliostat field is derived from annual efficiency maps
- Field layout is based on radial stagger with smooth transitions between heliostat zones to minimise blocking losses
- Optimal spacings are determined from analysis of shading and blocking in a small group of heliostats

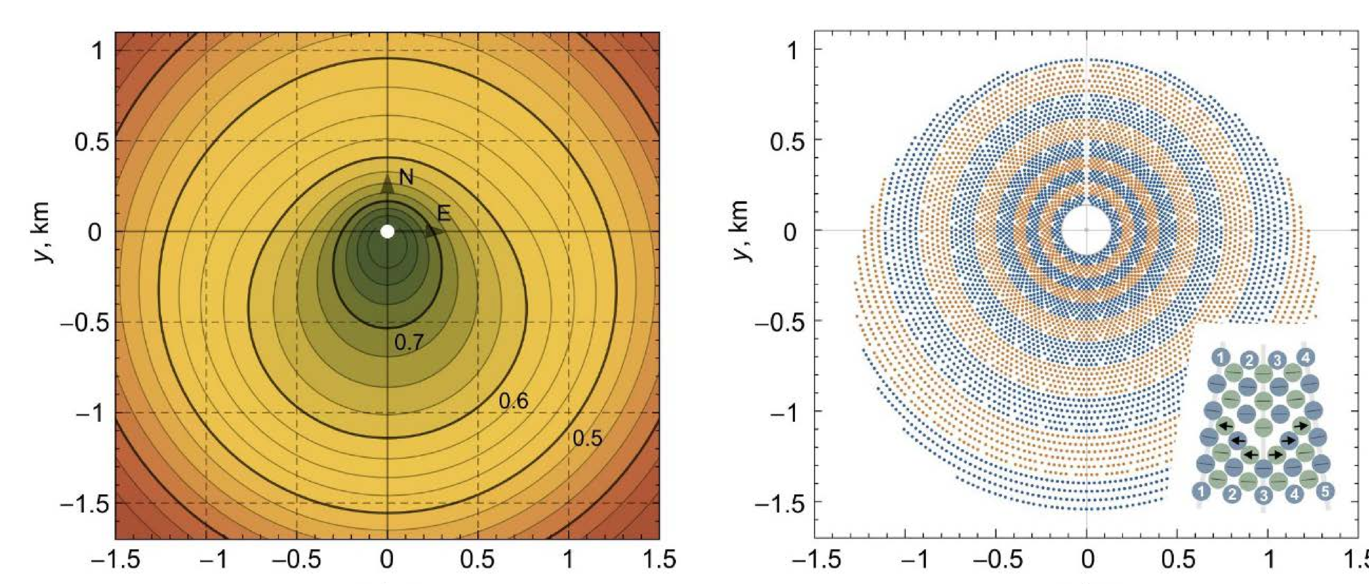

Figure 6: Annual efficiency map and layout of heliostat field for ASTRI reference plant.

AUTHOR CONTACT
Joe Coventry
e joe.coventry@anu.edu.au
w www.astri.org.au

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