



2019 | FRENCH
AMERICAN
INNOVATION
DAY
BOSTON

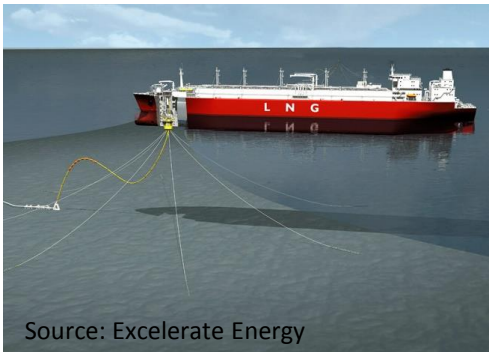
Mooring and anchoring systems

Thomas Langford

Director Offshore Energy, NGL



Where we were – traditional offshore



Source: Excelsior Energy

Where we were – traditional offshore



Source: Excelebrate Energy



CONSTRUCTION & INSTALLATION

World's largest suction anchors installed offshore Boston

System set in 30 days

To meet the growing demand for gas in the northeast US, Excelebrate Energy is building the Northeast Gateway Energy Bridge some 18 mi (29 km) offshore Boston.

The project foresees LNG shuttles shipping back and forth to source, and regasifying the LNG into the local Boston grid. LNG carriers will back on one of the two APL submerged turret offloading (STL) buoys, which will connect via flexible risers to a subsea pipeline system.

The STL buoys will be permanently anchored offshore areas when not in use, they will float 30 m (98 ft) below the surface. On arrival on site for offloading, the LNG carrier will pull one of the STL buoys into a conical-shaped opening in its keel. A secure connection will then be made after which the regasification process will begin and the LNG (returned to its gaseous state) is fed into the local gas distribution grid.

System description

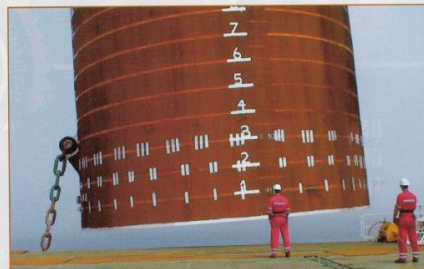
Each 150-metric ton (172-ton) STL buoy is held in place by eight mooring lines consisting of a chain segment (attached to the suction anchor) and 170-m (558-ft) length of spiral strand wire (SSW).

Due to the prevailing easterly weather and the shelter afforded by the coastline, the length of the 5 1/4 in. (134 mm) chain segments vary between 335 m (1,099 ft) and 710 m (2,329 ft) with the longer lengths on the east side of the mooring system.

With different soil conditions and different design loads at each anchor location, the suction anchor design varies per location. The largest suction anchor in the system measures 14 m (46 ft) wide, 11.5 m (37.7 ft) high, and weighs 142 metric tons (156 tons). The tallest suction anchor is 20 m (66 ft) high and 6.5 m (21 ft) wide.

Work scope

In January 2007, Jumbo Offshore signed an agreement with APL under which Jumbo Offshore and APL would jointly execute the installation of the two APL STL buoys and associated moorings using the DP2 heavy-lift vessel *Jumbo Javelin*.

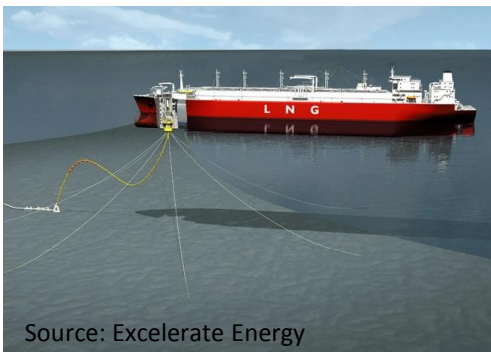


(Above) The largest suction pile measures 14 m (46 ft) in diameter, 11.5 m (37.7 ft) high, and weighs 142 metric tons (156 tons). The tallest suction pile is 20 m (66 ft) high and 6.5 m (21 ft) wide and weighs 65 metric tons (71 tons).

(Below) The ten smallest suction anchors were loaded onto the *Jumbo Javelin*'s main deck and fastened in the vertical for transportation to site.



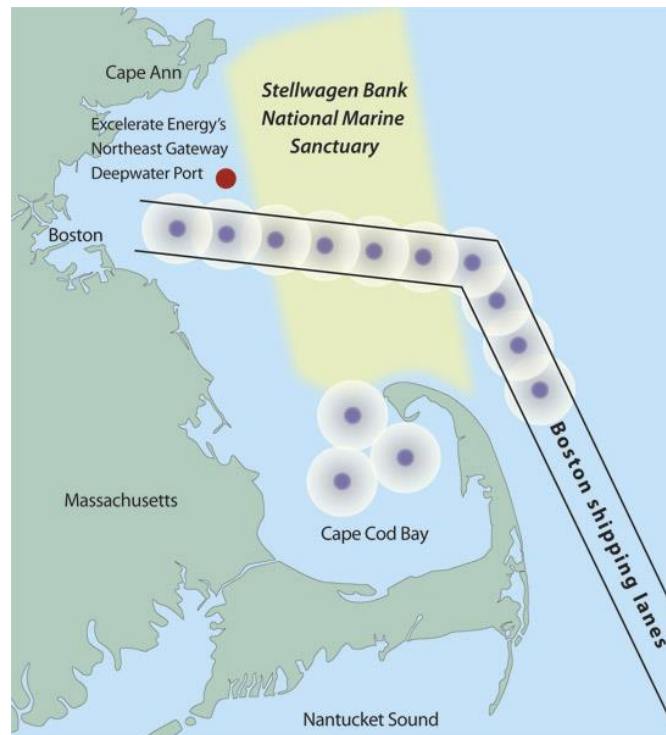
Where we were – traditional offshore



Source: Exceleerate Energy



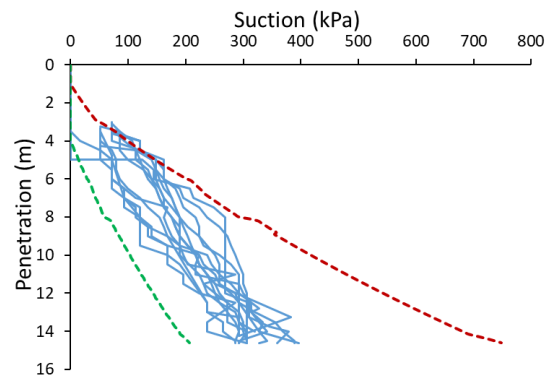
Importance of marine wildlife



Source: Woods Hole Oceanographic Institute

Where we are – Hywind Scotland

- World's first floating windfarm
- SPAR system, 25 km East of Aberdeen
- 100 to 130 m WD with suction anchors
- Direct technology application from traditional offshore
- 5 No. 6 MW turbines, can provide power to 20 000 households
- Installation in 2017
- Now combined with BATWIND energy storage concept
- Excellent operational results

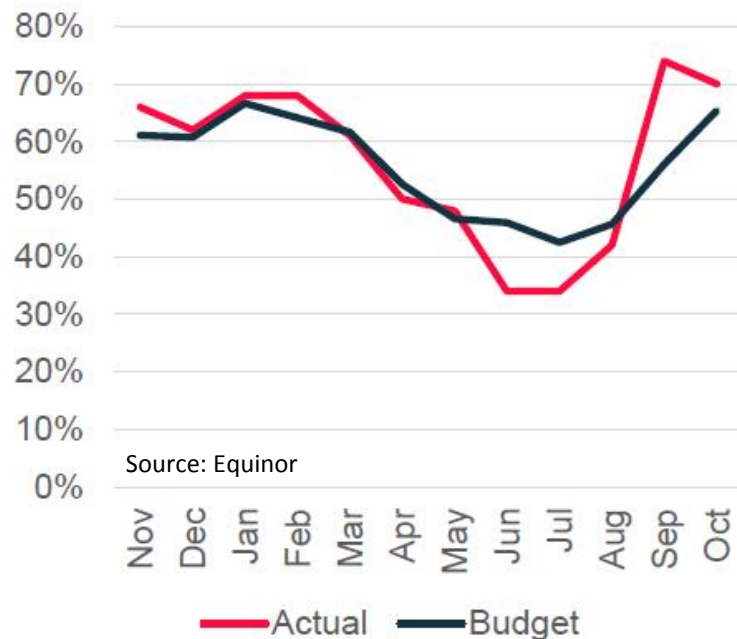


Successful use of suction anchors

Where we are – Hywind Scotland

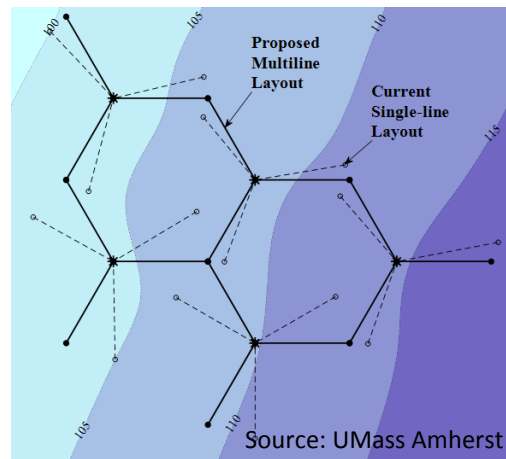
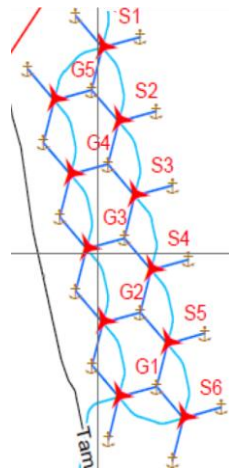
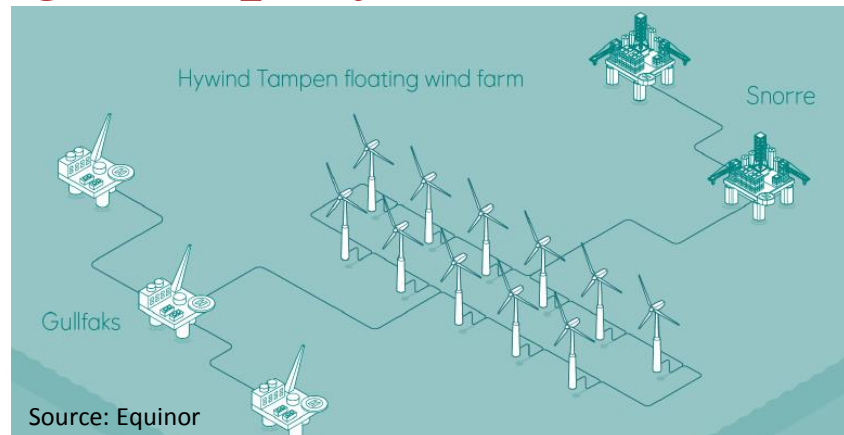
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Load factor Hywind Scotland - first year of operation



Where we are going – larger deployments

- Hywind Tampen project
- 11 installations to power O&G platforms
- Step changes in technology
 - Concrete SPARs
 - Multiline anchoring
- Multiline anchoring especially exciting for geotechnical engineers
- New loading conditions, and new safety considerations



Plenty of choice with concepts....



Source: Equinor



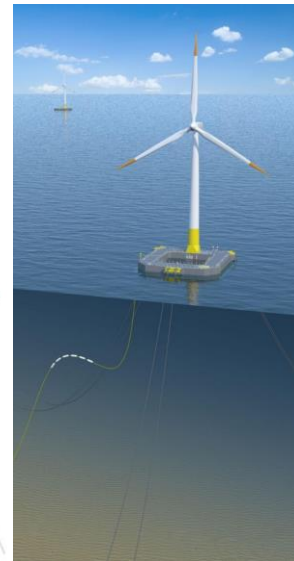
Source: Principle Power



Source: Glosten



Source: Stiesdal



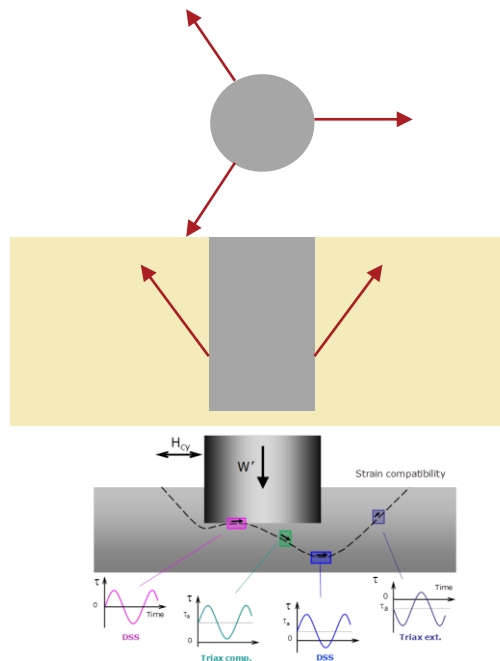
Source: Ideol



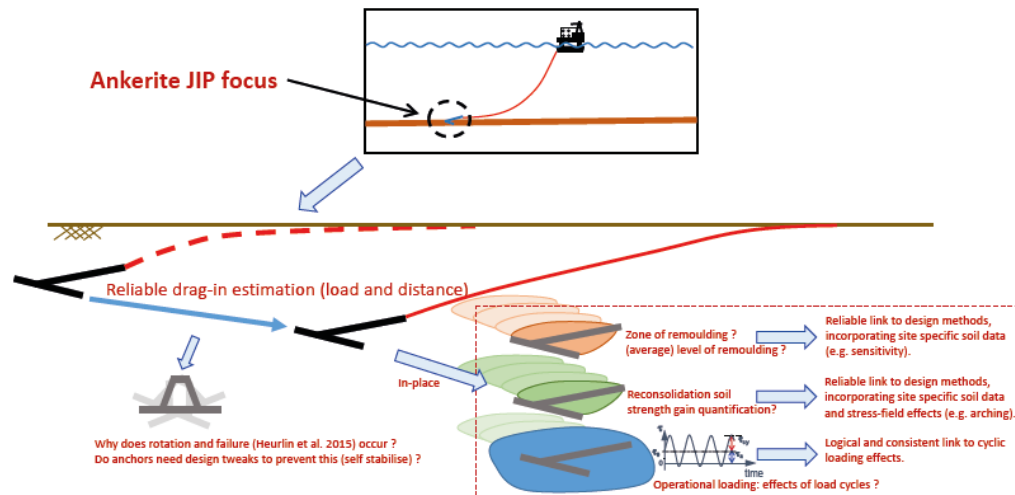
Source: SBM

Plenty of choice with concepts.....

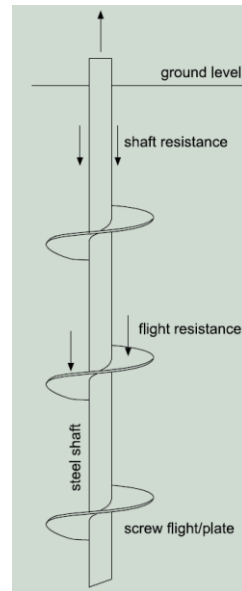
Multi-directional cyclic loading on suction anchors



Ankerite JIP to reduce risk for drag anchors



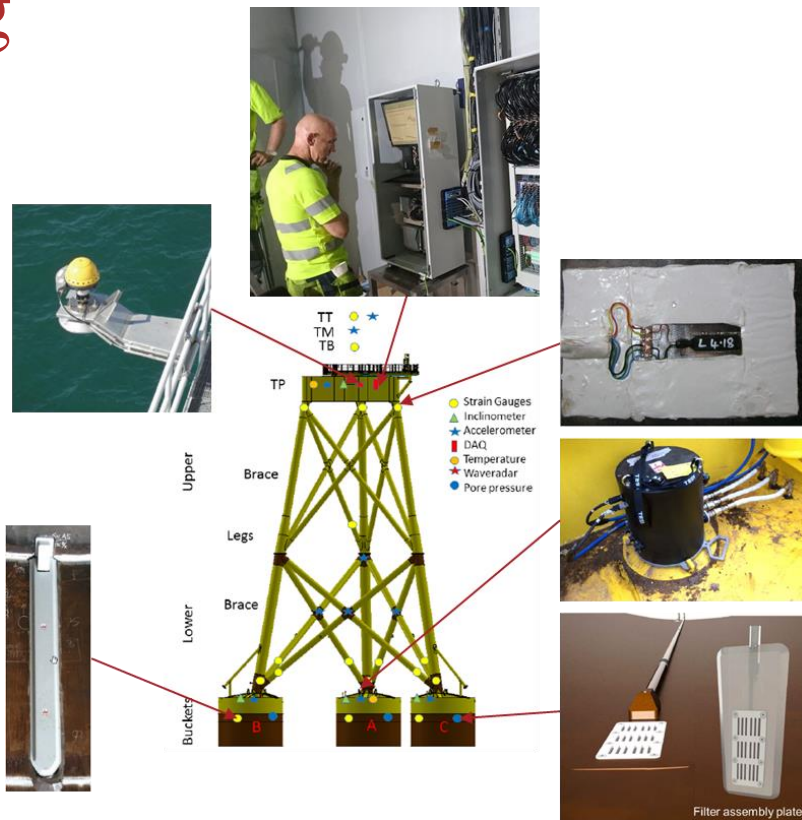
Alternative solutions



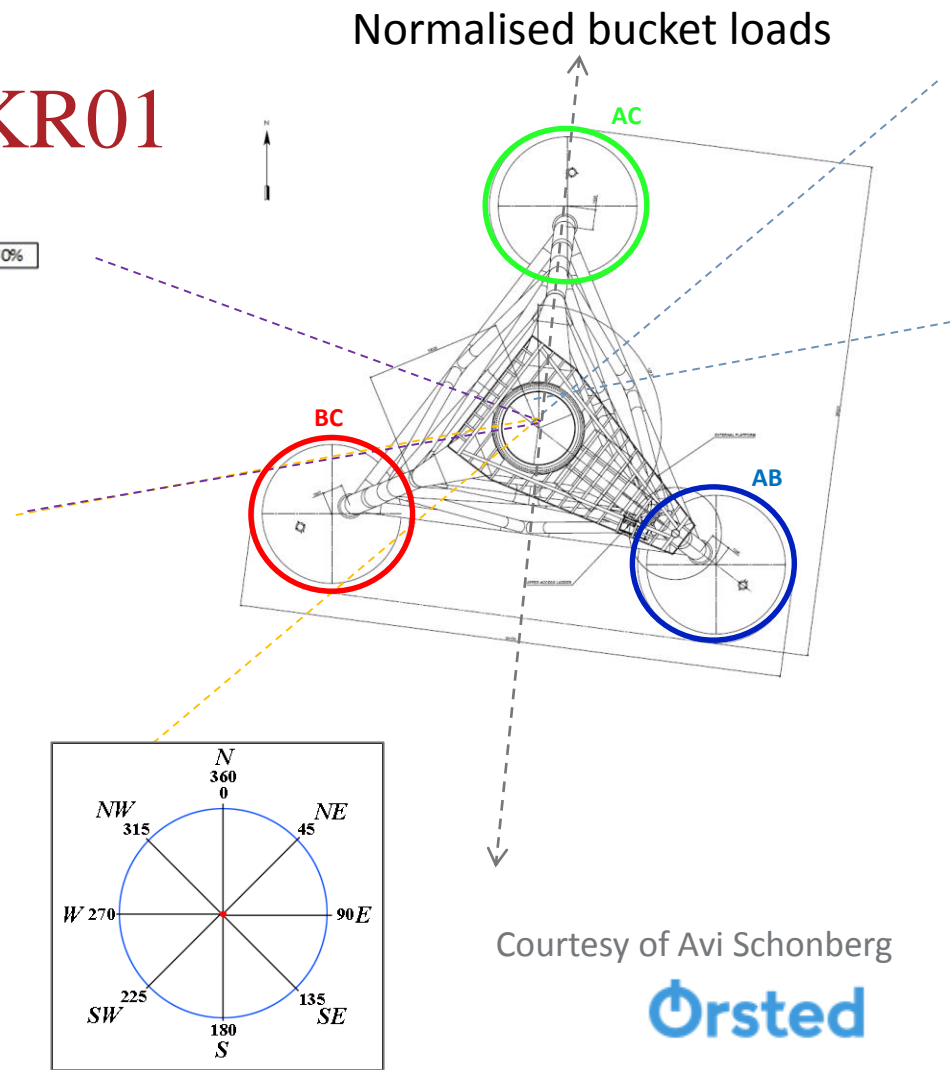
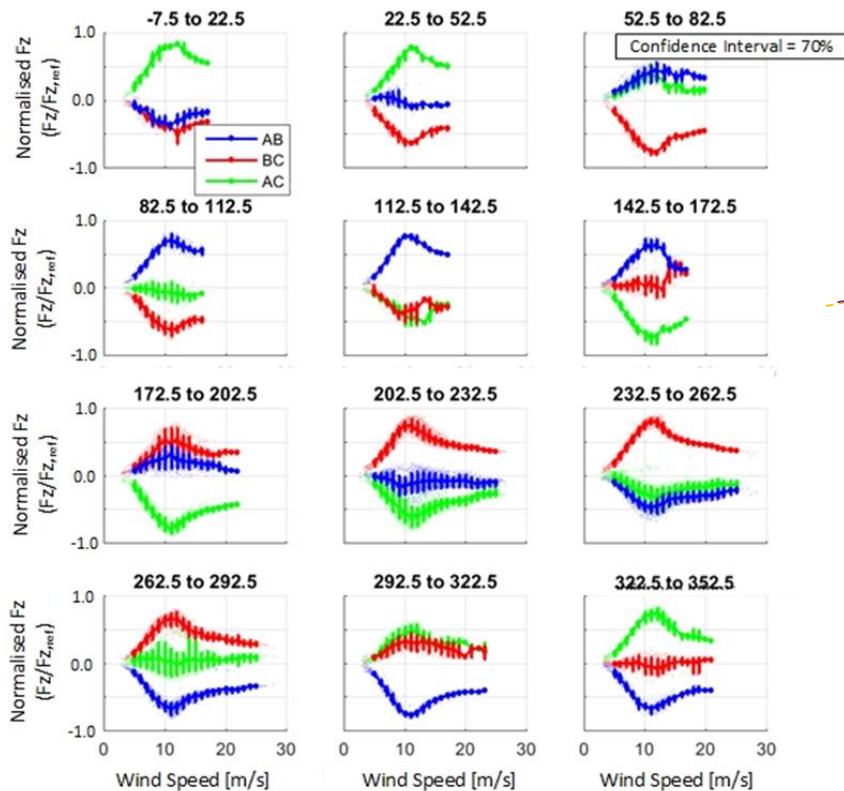
State-of-the-art monitoring

- High-quality measurements of Suction Bucket Jacket to evaluate performance and verify structural and geotechnical design:
 - Pore pressures
 - Strain and deformations
 - Inclination
 - Accelerations and dynamic movement
 - Wave radar (air gap)
- Real time monitoring both during installation and operation

Structural health monitoring

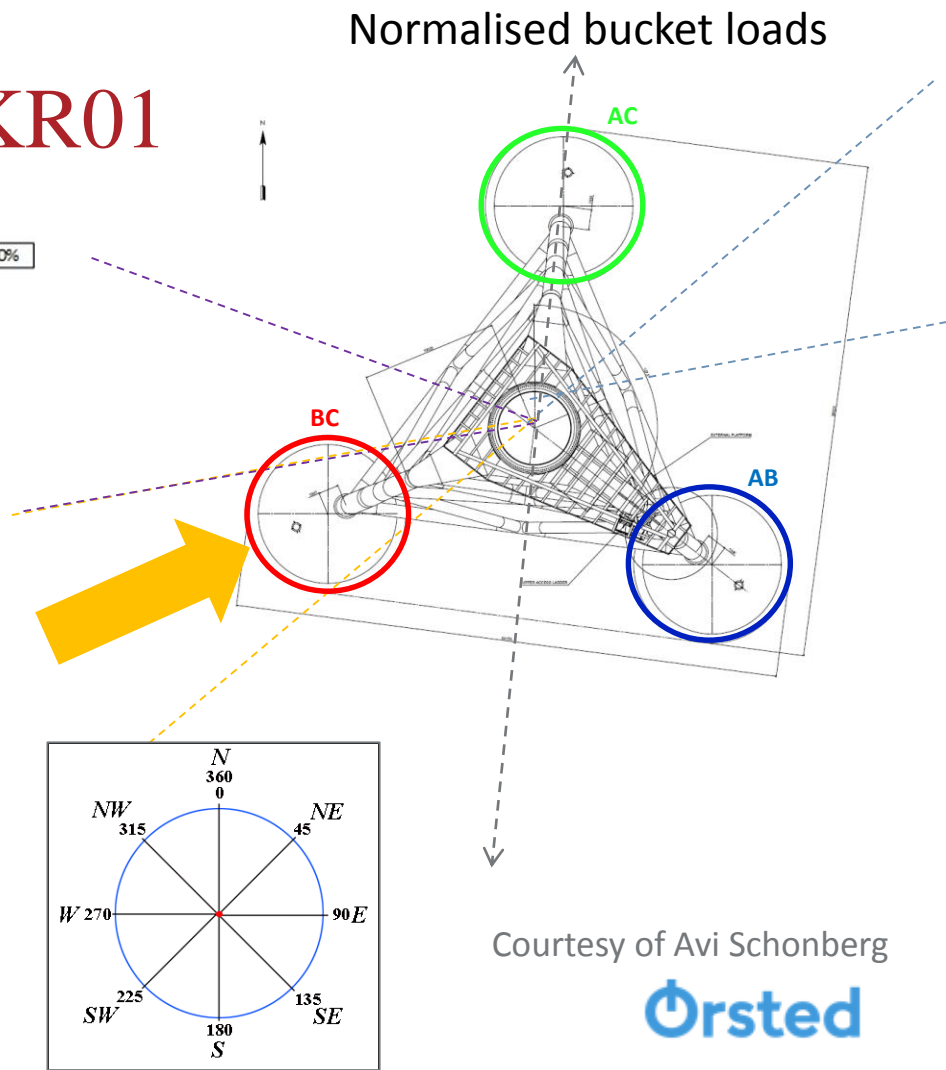
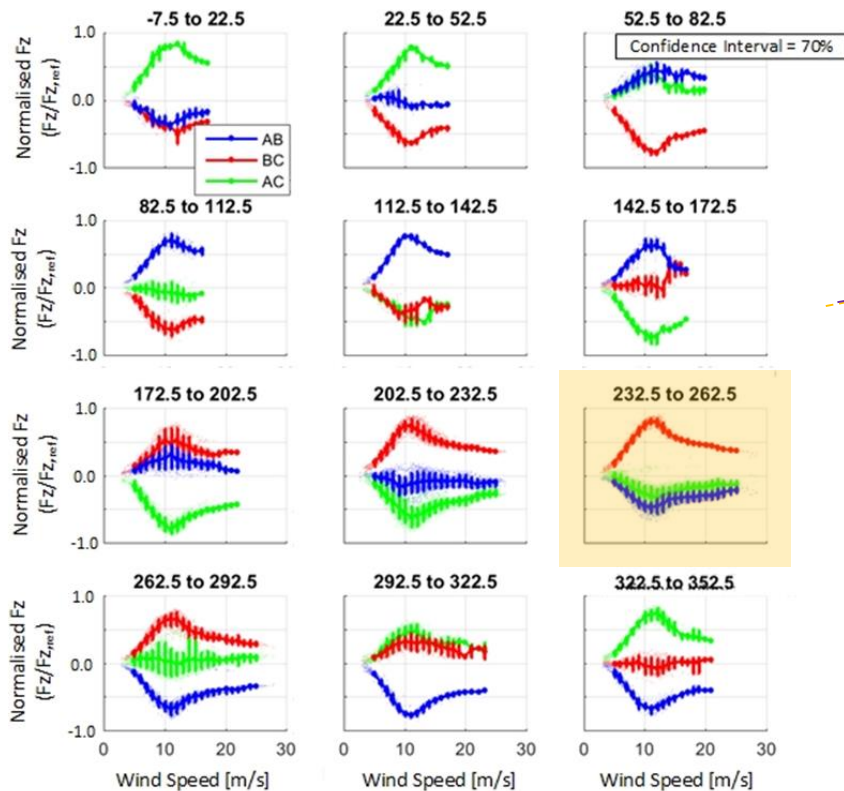


Measurements from BKR01



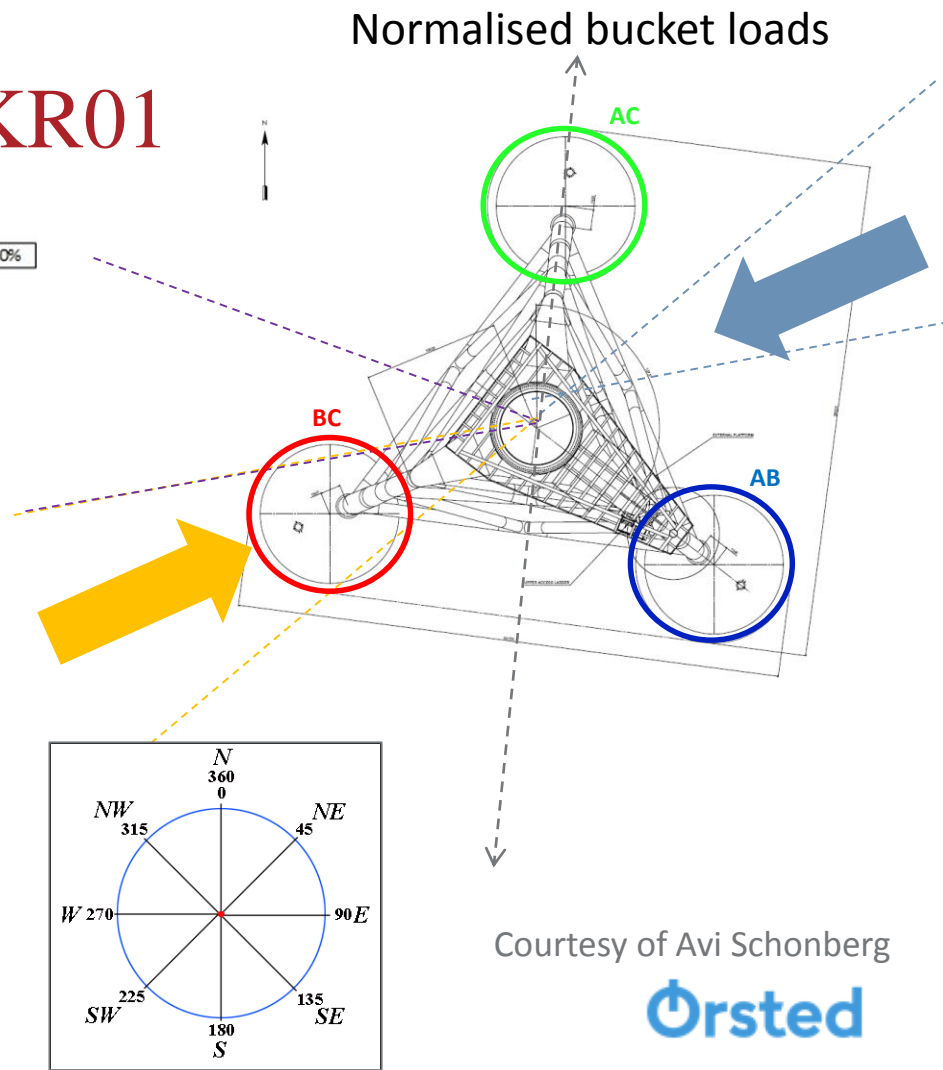
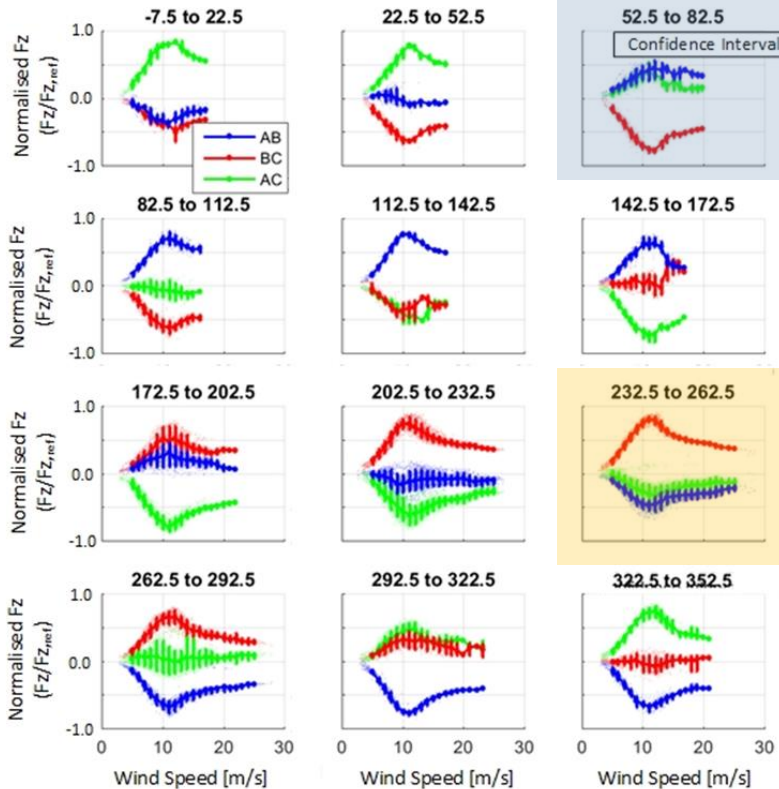
Courtesy of Avi Schonberg

Measurements from BKR01



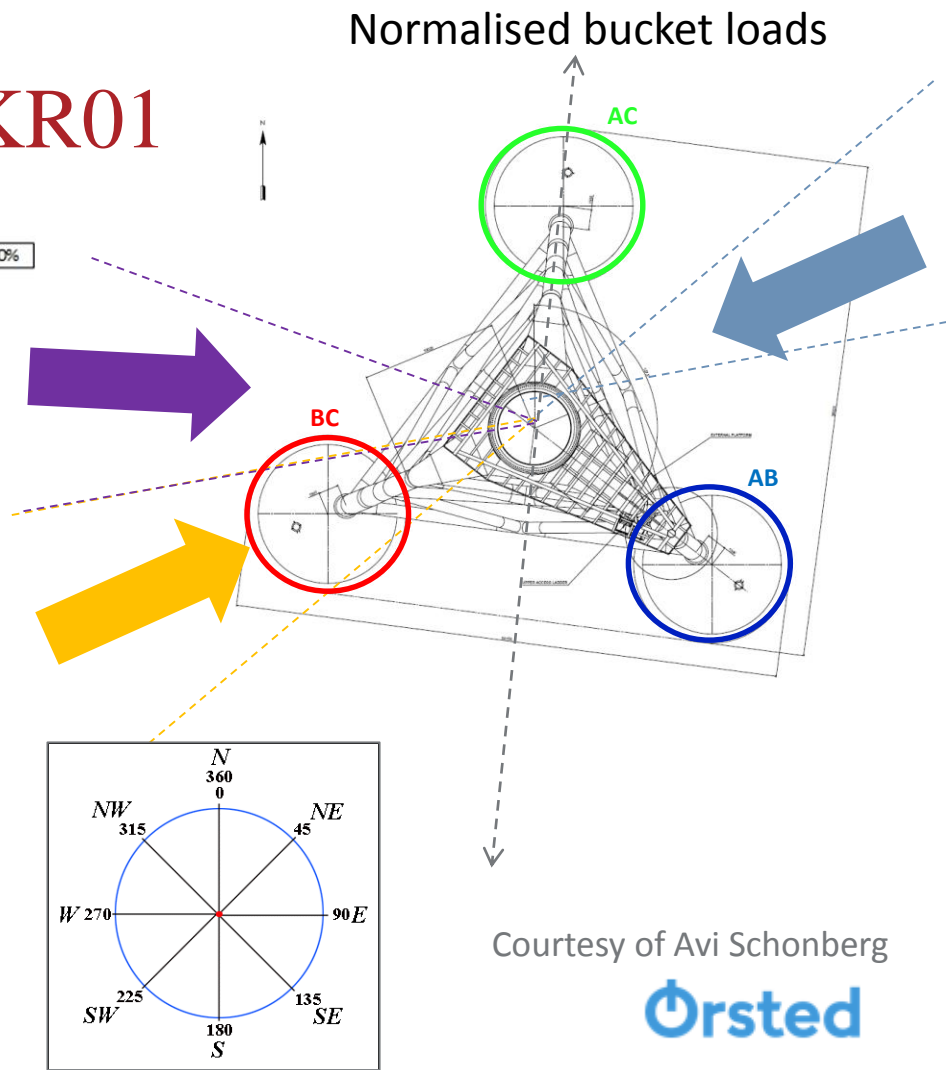
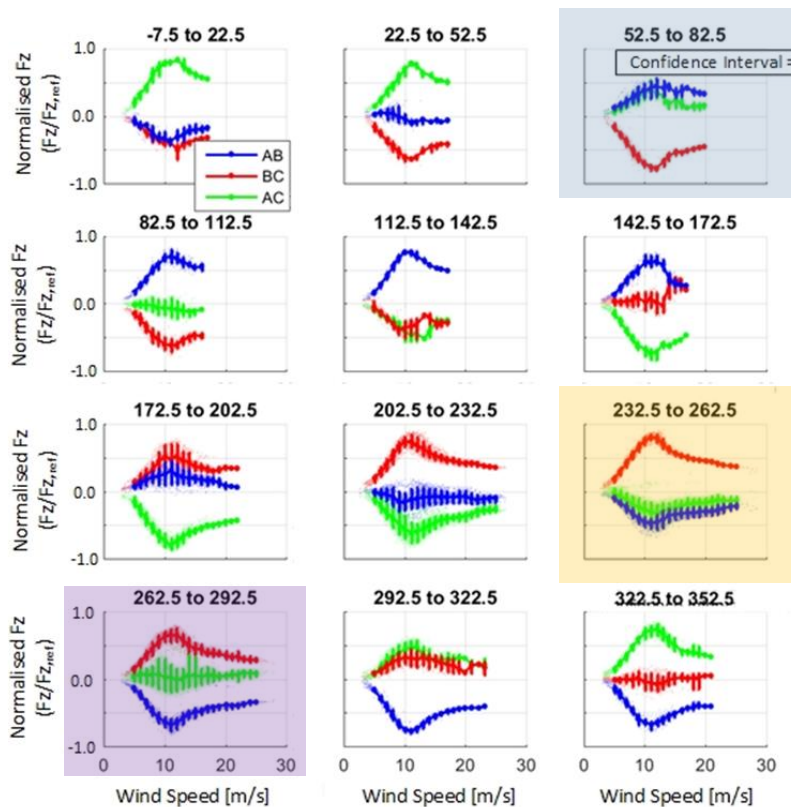
Courtesy of Avi Schonberg

Measurements from BKR01



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