Study of force transmission from compression plate to rods

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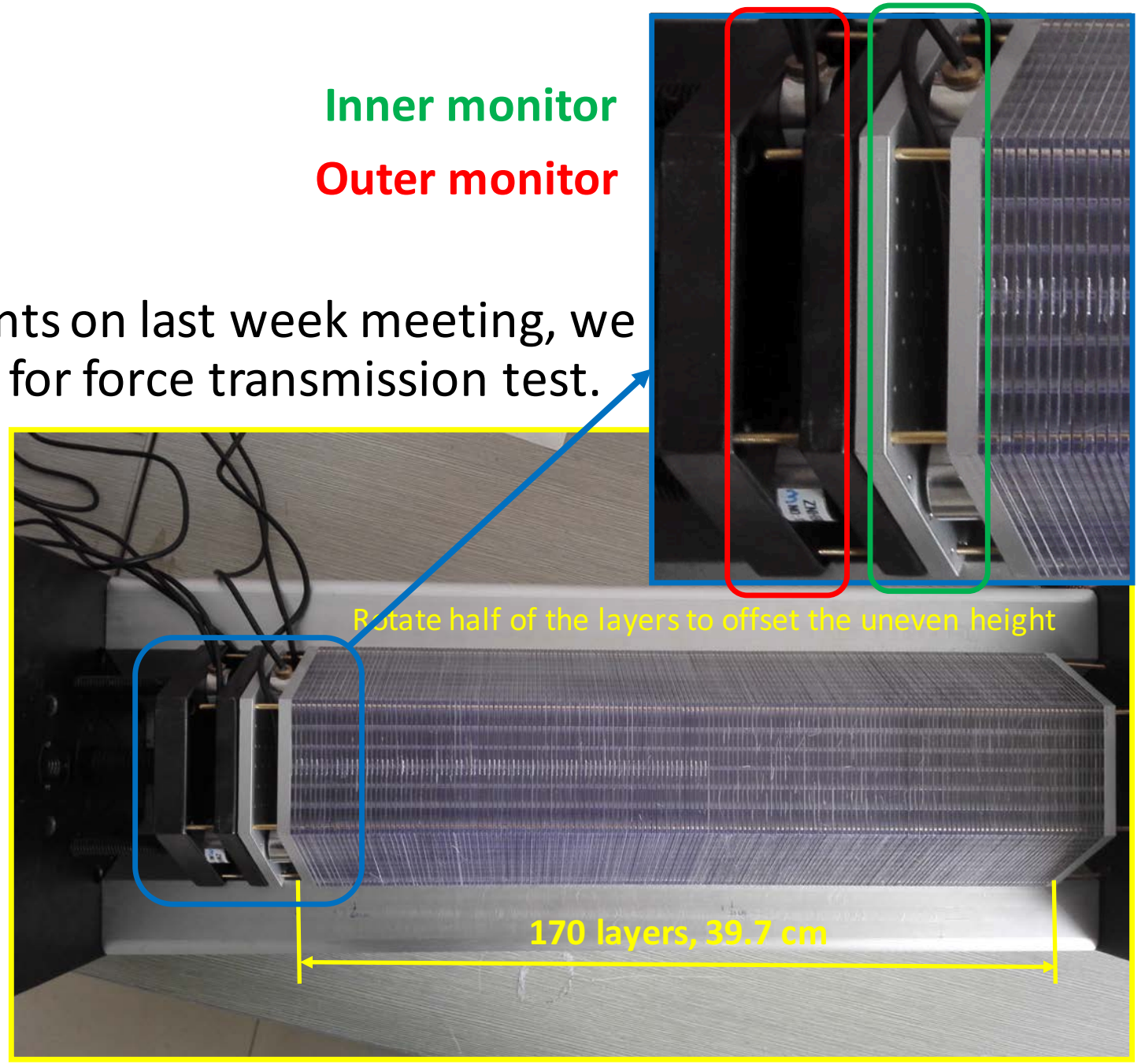
Comments on Force Transmission

- **3/24/2016 Meeting to discuss EC and DAQ:**

A. Participants: Cunfeng Feng, Yi Wang, Chendi Shen, Jianping Chen, Xiaochao Zheng, Vince Sulkosky, Ye Tian, Rakitha B., Alexandre C.
B. Chendi showed progress on THU side: 20160324/Shen-Chendi-2016_3_24.pptx
    1. compression went up to 500kg and stack height appeared stable;
    2. insert 6 rods and turn nuts to snug, stopped immediately when the force sensor reading starts to change;
    3. then released the compression plate, took module off the assemble stand.
    4. now is painting Kedi's reflective paint on the module sides.
    5. This is good progress, but XC is a little worried about adding the paint this early, since it will not allow further adjustment to the stack.
C. Most of time we discussed on how to transfer force from the compression plate to the screw/rods.
    1. the method previously used by SDU -- tighten the nuts until the sensor reads zero -- wouldn't work because this will cause higher pressure to the stack, and because the change in the force sensor reading will not reflect the actual force from the nuts (rods and force sensor have different elastic modulus).
    2. If we tighten the nuts to snug, stop immediately when the force sensor reading start to change, and then release the compression plate, the final compression force is determined by the "k" factor of the stack vs. the rod. Xiaochao's calculation is shown here: 20160324/compression_calc_20160324.pdf. We don't know the Young's modulus for the paper (or THU's reflective material), but using some online search for the printer paper, the compression force is about 1/5 of the initial preload force (500kg). However, one can see this method is not so reliable because the actual modulus may differ from the standard values.
    3. We finally agreed somewhat on the following procedure:
        a. compress the stack with 500kg until stable;
        b. reduce the compression to 144kg=24kg/rod (this is the compression needed for the static friction to balance the weight, using a static friction coeff of 0.1). -- we may reduce this to 72kg total (12kg/rod) later given that the measured static friction of 0.2. Also we don't want to stress the rods too much;
        c. insert the rods, turn nuts to snug;
        d. release the compression plate, at the mean time use a torque wrench to tighten the screws. Set the torque to be a specific value. Need testing to find out what torque force would provide the 24kg force.
        e. Stop when the compression plate is completely released and the torque wrench reaches the set value.
        f. In the long term, we need to modify our design to have two back plates similar to the ALICE module. See Yaping's graph: 20160324/DCal_forceTransfer_forXiaochao.pdf. Right now, our primary goal perhaps should be to make a working module get an idea about what the light yield is.

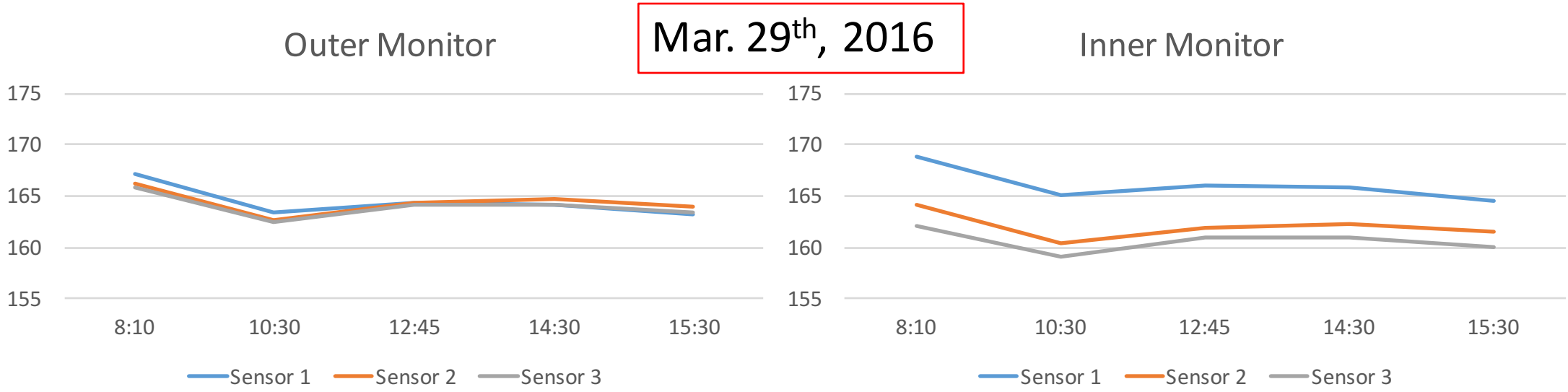
New Prototype

- According to the comments on last week meeting, we made another prototype for force transmission test.
- We use 2 monitors, each monitor has 3 sensors.
  - The outer monitor is used to monitoring the compression during assembly.
  - The inner monitor is embedded in the prototype for long-term monitoring.



Compression Test

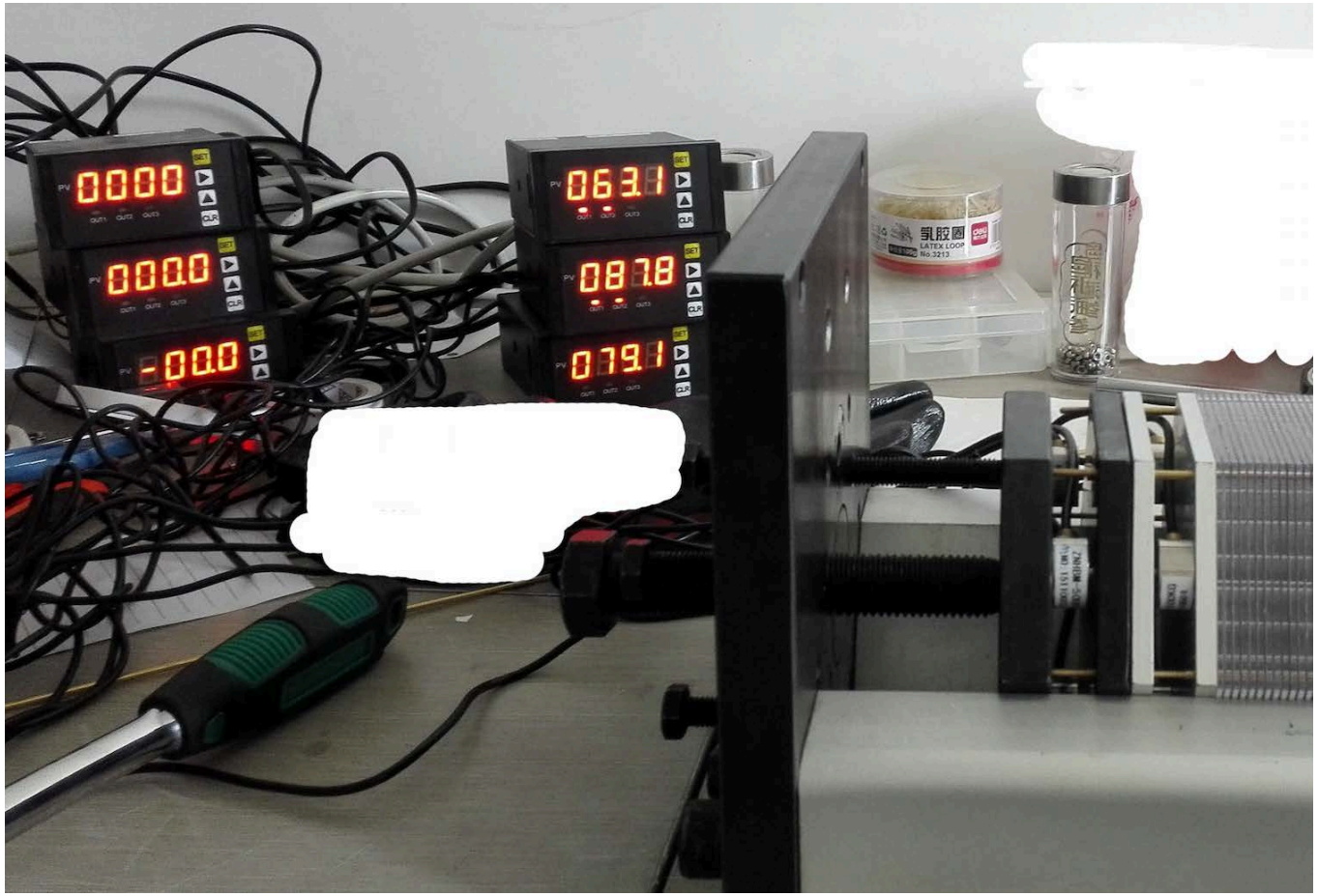
- ~ 500 KG force is applied to compress the module. When the pressure is less than 400 KG, increase the pressure to 500 KG
- It takes about 2 days to make the pressure stable



The results of monitoring in outer and inner monitors have the same trends, and agree with each other if take into account the friction

Transfer Force

- Decrease the force of compression to ~200 KG
- Tighten each nut and stop immediately when the sensor reading starts to change
- Release the compression force to 0
- Inner monitor reading shows that the force has been transferred to rods



Yes, the force in the rods of our last prototype is too big. The brass rods with nuts are good enough to hold 200 KG force.

Long-term Monitoring

- Long-term monitoring is done by inner monitor, the sensor readings are different with each other, but are all stable, the fluctuation is mainly caused temperature