

High precision measurement of the vacuum box of the PANDA Luminosity detector at FAIR

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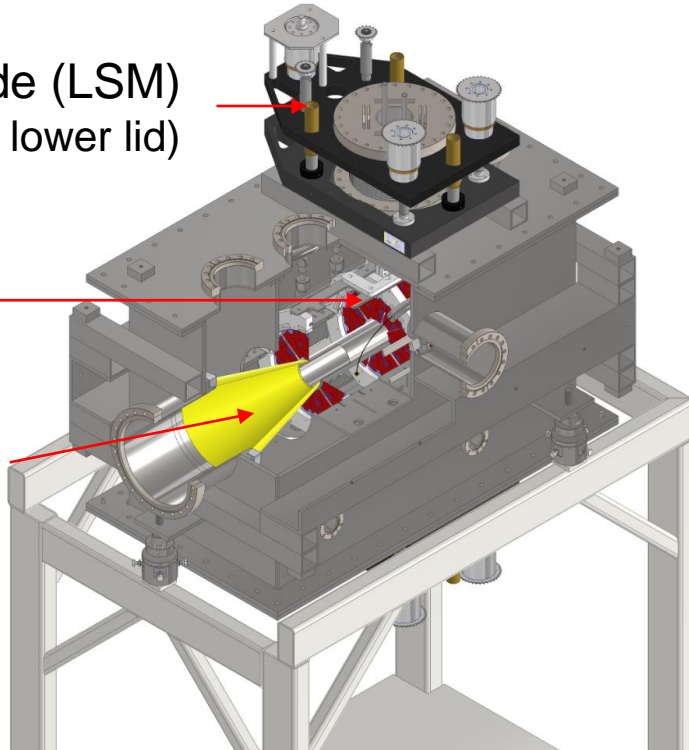


Lumi-Box

Linear Shift Mode (LSM)
(on the upper and lower lid)

Half detector

Transition cone
(thin polymer foil)



Survey Group delivers
position of SMR nests



But we need position of MuPix

➔ Need of transfer
measurement (outside to inside)

Position of half detectors in the box

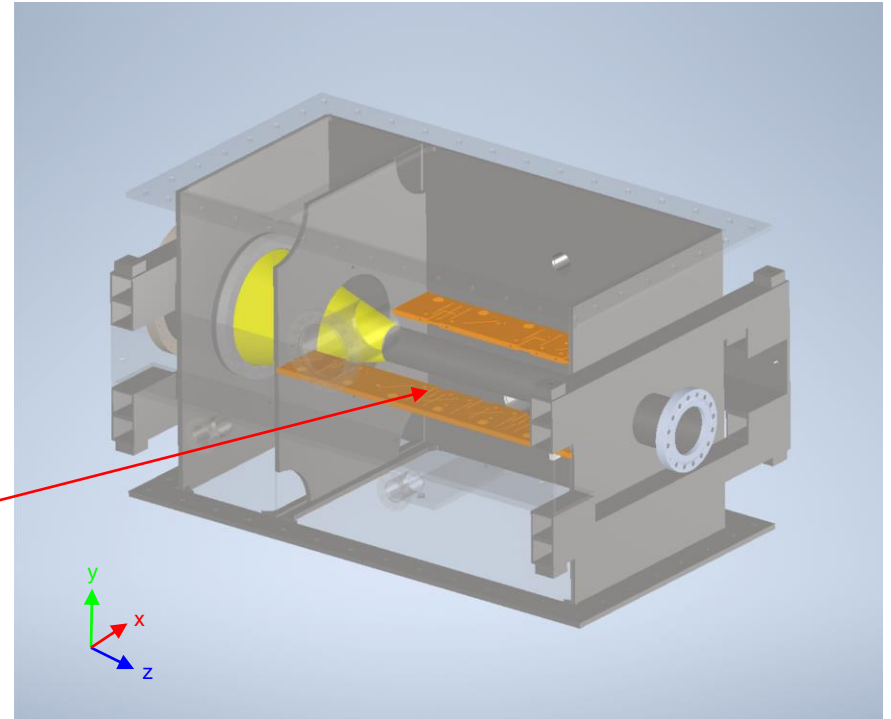
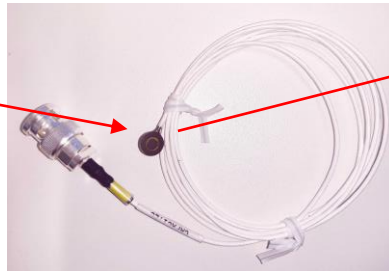
Capacitive distance sensors will measure the position of the half detectors relative to their own position

→ Position of the MuPix sensors relative to the capacitive sensors

Necessary because of the LSM

Cap. sensor with BNC-interface

Estimated Precision: $\leq 1 \mu\text{m}$



Measure box when

1. open

- Serves as a reference

2. partially closed

- Reveals in what extend box deforms when lower lid is screwed to box body

3. completely closed

- Reveals in what extend box deforms when both lids are screwed to box body
- Measure how reproducible upper lid can be attached to box body

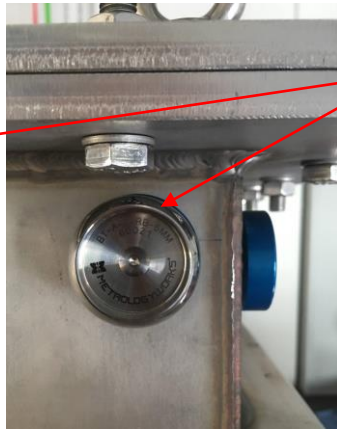
4. vacuum is applied

- Reveals how much box body and lid deform

Transfer measurement

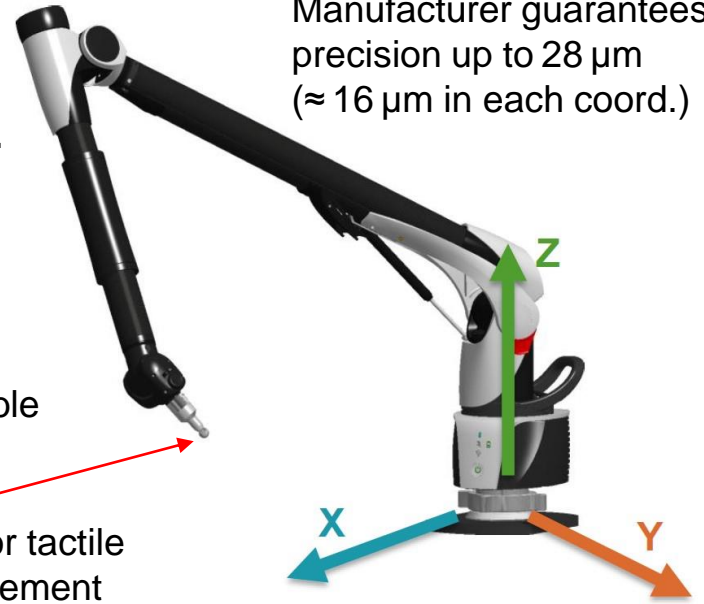
Q: Where are the capacitive sensors inside the box?

A: **Measurement arm** measures positions of cap. sensors relative to the SMR Ball probe centers



Reset ball makes SMR ball probe center measurable for the arm

Prober for tactile measurement



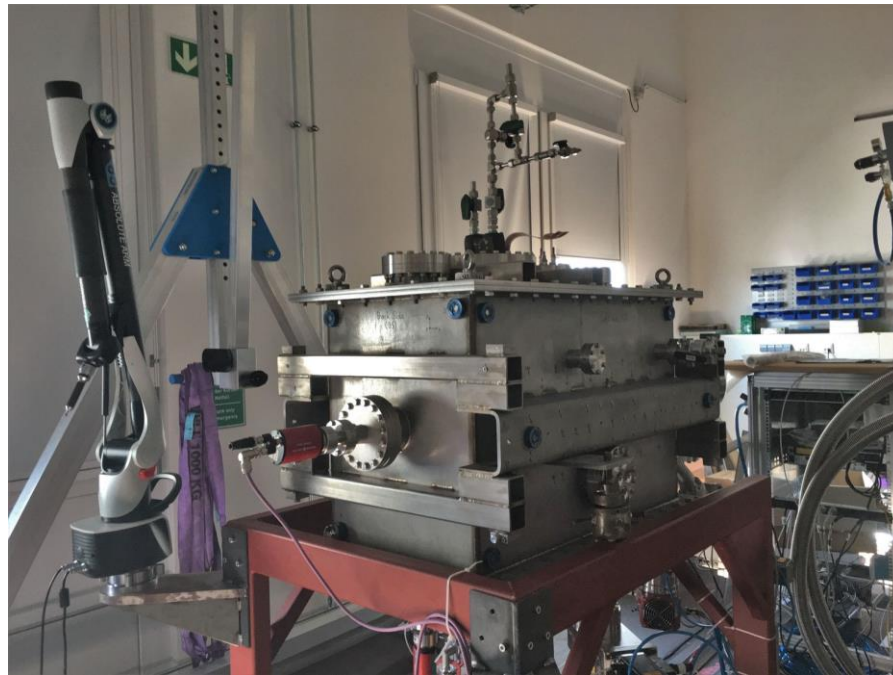
Setup

Arm screwed on cantilever that is attached to box stand

Goal: Measure position of fixed points with a reproduction precision of

$$\sigma = \sqrt{x^2 + y^2 + z^2} \leq 50\mu m$$

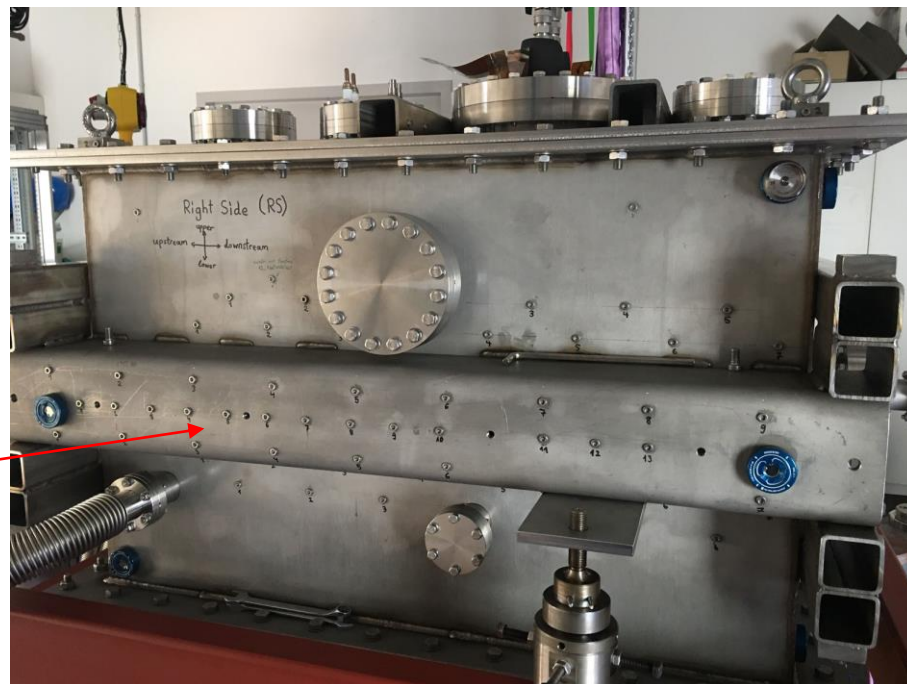
($\approx 16\mu m$ in each direction)



Method

Problem: Probe tip needs *stable hold* for every point on the box

Solution:
127 washer stacks glued on the box for probing (+27 on the lid)



Reference Measurement – Box without lids

Step 1: Creation of a measurement routine in dedicated software (PC-DMIS)

Step 2: Perform routine 20 times in order to obtain some statistics

Now we have measured each point 20 times

Step 3: Calculate the mean value of and std. dev. for every single point

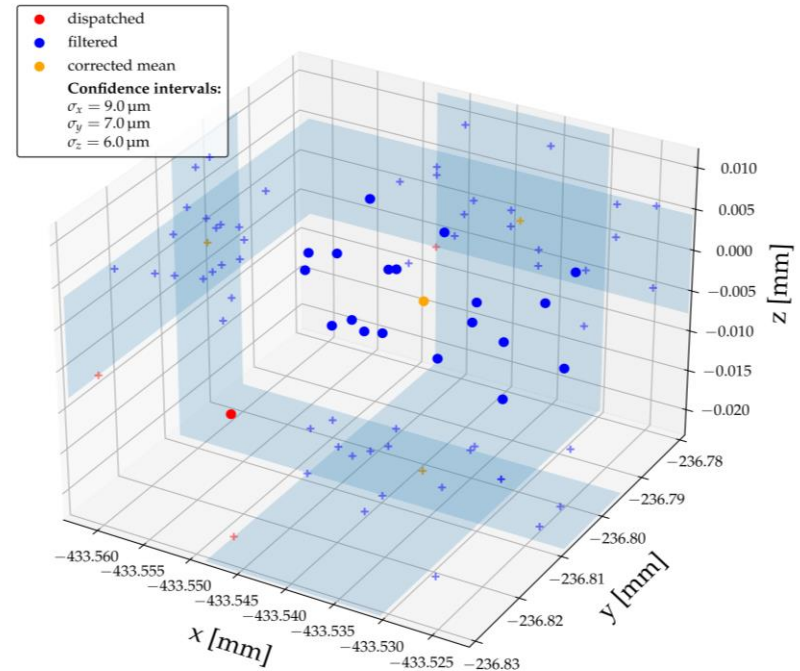


Preliminary Results 1/2

- The **measurements** cluster around the **mean value**
- Some measurements can heavily deviate from the **mean value** (measured in a different angle, etc.)
 - One needs to measure multiple times
Dispatch the one with the **highest deviation**

	Reff LS	Reff RS	Reff lid
$\bar{\sigma}_x$	6 μm	19 μm	16 μm
$\bar{\sigma}_y$	19 μm	20 μm	19 μm
$\bar{\sigma}_z$	7 μm	13 μm	16 μm

Reference Measurement LS - Reset Ball_BS_1



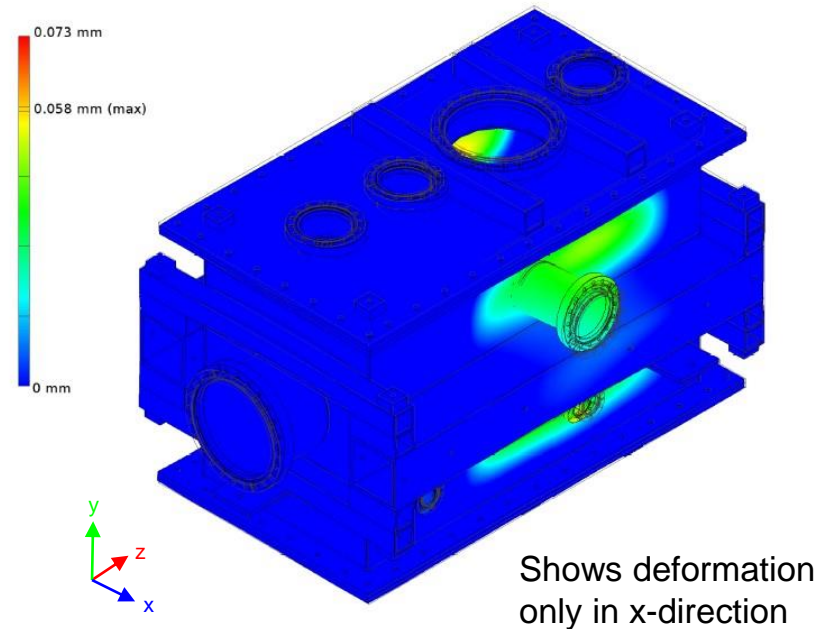
What can we expect under vacuum conditions?

Q: What about vacuum conditions?

A: Box will deform (FEM simulations)

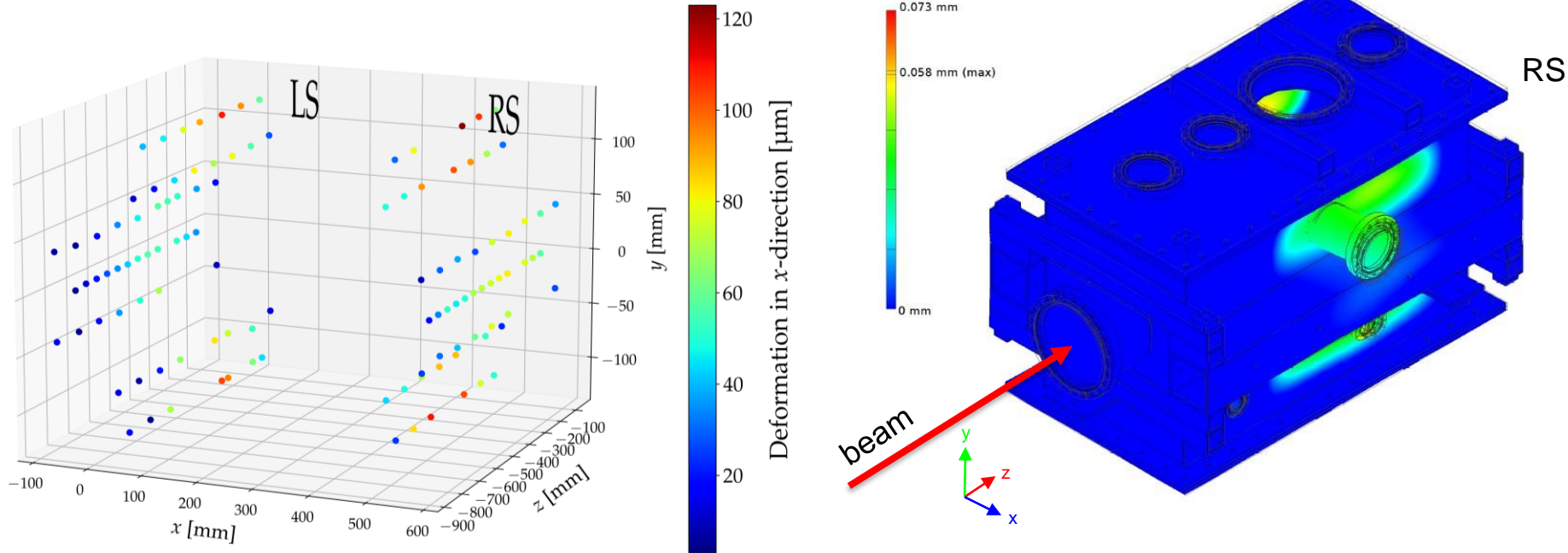
Consequence: Position of capacitive sensors is lost

Solution: Measure how box deforms under vacuum conditions



Preliminary so far 2/2

Box Deformation - Cycle 1



- ✔ • Proof of concept: Measurement arm offers the required resolution
- ✔ • Results proof that the box design fulfills requirements (rigidity)
- ⚠ • Transfer algorithm: How can the position of the cap. sensors be determined when vacuum is applied?