NPS survey requirements

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The NPS calorimeter detector is composed of an array of 30 columns and 36 rows of lead tungsten crystals (see Fig. 1).

Fig 1: View of the detector front face. The left picture shows the bare crystals and the right picture shows them covered by reflective material glued to plastic covers. Each crystal can be uncovered individually by removing its corresponding cover (see Fig.4).

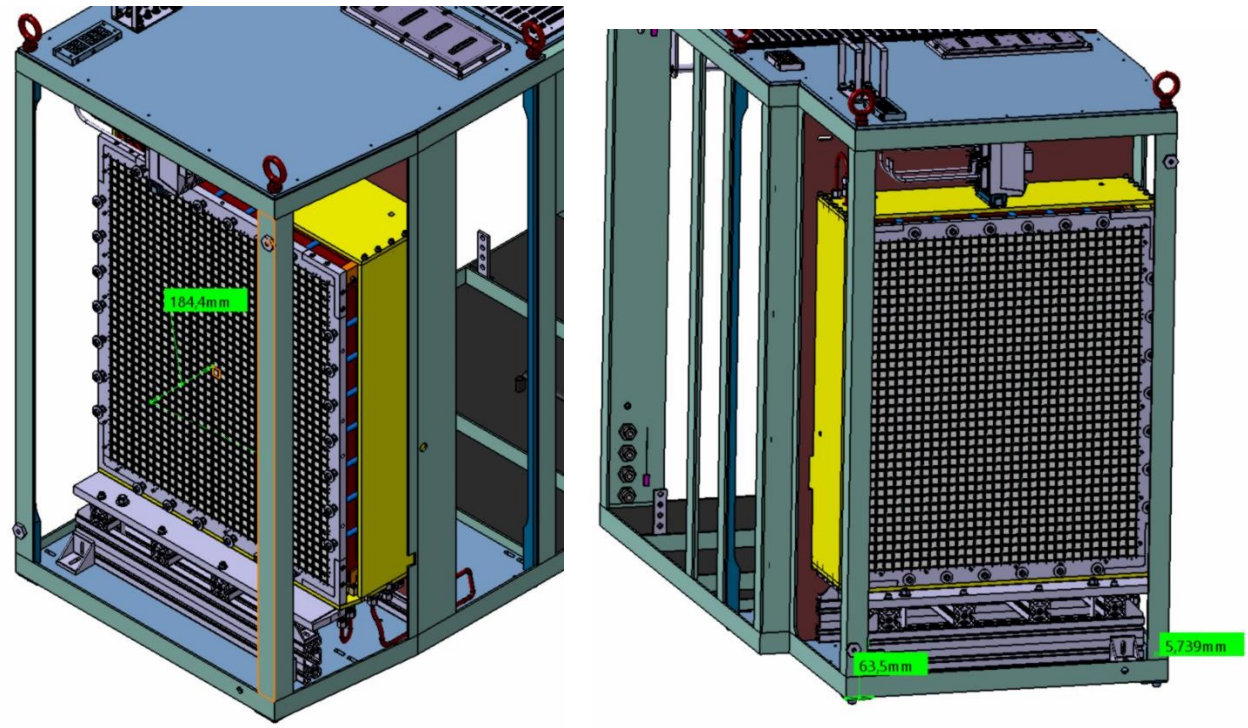

Fig. 2: Relative position of crystals with respect to the frame.

The position of the detector is defined by the coordinates of its center with respect to the Hall center and the 3 angles (pitch, roll and yaw). The orientation of its axis will define pitch and yaw. The detector roll can be determined by surveying some additional points of the detector front face (in blue in Fig. 3). The detector center and axis are defined as follows.

- The front face of the detector is the plane defined by surveying the front face of a large number of crystal faces (>20) evenly distributed across the detector. In order to survey the crystal faces, the correponding crystal must be uncovered (see Fig. 4 for details).
- The detector axis is defined as the perpendicular line to the front face of the detector that goes between the 15^{th} and 16^{th} columns and between the 18^{th} and 19^{th} rows of crystals.
- To survey the detector center, remove the cover of each of the 4 crystals around the detector center (Fig. 3) and use the carbon fiber plates supporting the crystals (shown in magenta in Fig. 4) to define two planes. Project the intercept of these two planes onto the detector face to define the detector center.

  After removing the crystal covers, there will be 2.4 mm of carbon fiber plate accessible for surveying (Fig. 4). For increased rigidity of the carbon fibers plates, it would be preferable to uncover only one crystal at a time.

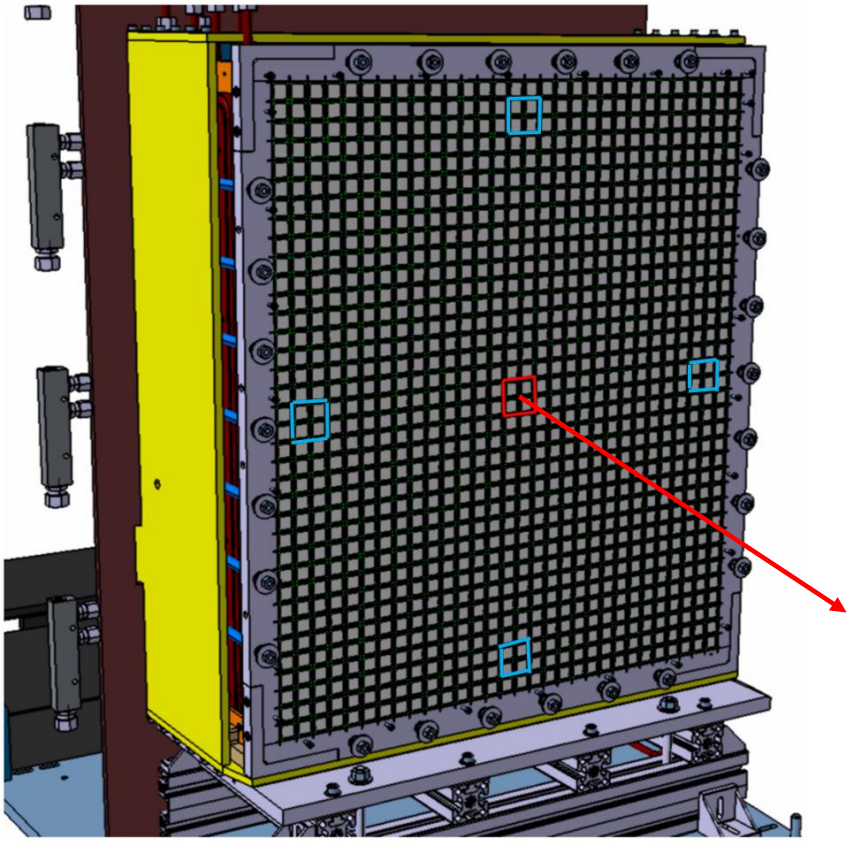

Fig. 3: Front face of the detector showing the 4 crystals (marked in red) that can be used to survey its center. Some additional points on the surface (shown in blue) can be used to determine the detector roll.

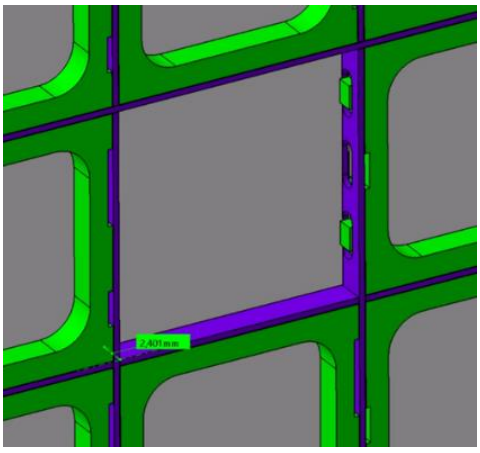

Fig. 4: Detail of the detector front face when one crystal is uncovered. The bare crystal face is accessible for surveying the crystal face and define the detector front face. The carbon fiber plates (magenta) holding the crystals extend 2.4 mm beyond the crystal face and can be used to define a horizontal and vertical planes whose intercept projected onto the detector front face will define the detector center.

Notes:

- Due to possible small motion during transportation out of the EEL building, its survey and fiducialization should be performed after the detector is in Hall C.

- Alignment of the detector should minimize mispointing of the detector axis to the Hall center (tolerance: ~2-3 mm), and position its center at the same vertical position (Y=0) as the Hall center (tolerance: 1 mm).

- The detector should be surveyed at different reference distances to the target center:
    - 3.00 m
    - 4.00 m
    - 6.00 m
    - 8.00 m (calibration setting)

  Distance is measured from the detector front face to the Hall center. Repeatability of placing the detector at each of these reference distances should be measured (3 or more times at each position).

- The angle of the detector axis with respect to the SHMS optical axis should be reported.

Kinematics settings

The following table shows the updated kinematic settings for the 2023-2024 NPS run, based on the anticipated injector (0.118 GeV) and single pass (2.094 GeV) energies for that period. Notice that NPS and HMS angles slightly change with respect to the initial values included in the experimental proposal. Notice that 2 settings (indicated in red) require the magnet at 4 deg and should run consecutively. Most of them require the magnet at 5.5 deg while 4 of them (indicated in green) can run with the magnet in either setting.

	x_B	0.2				0.36						0.5			0.6			
	Q^2 (GeV)^2	2.0			3.0	3.0			4.0		5.5	3.4		4.8	5.1			6.0
	E_b (GeV)	6.4	8.5	10.6		6.4	8.5	10.6	8.5	10.6		8.5	10.6		6.4	8.5	10.6	
	k' (GeV)	1.07	3.16	5.26	2.60	1.96	4.05	6.15	2.57	4.67	2.45	4.87	6.96	5.47	1.87	3.96	6.06	5.26
HMS angle	θ_e (deg)	31.3	15.7	10.9	19.0	28.3	17.0	12.3	24.7	16.4	26.6	16.5	12.3	16.5	38.1	22.4	16.2	18.9
NPS angle	θ_{Calo} (deg)	5.80	8.92	10.37	5.94	11.24	14.38	16.0	9.91	12.1	7.44	19.9	21.4	16.3	13.2	17.4	19.5	16.9
NPS distance	D_{Calo} (m)	6	4		6	3			4	3	4	3						
	I_b (μA)	11	5	50	11	28			50	28	50	28						
	$\frac{-t_{min}}{(\text{GeV}^2)}$	0.04				0.16				0.17		0.37		0.39	0.65			0.67
	$\frac{-t_{min}}{2\sigma_{M_X^2}}$	0.1				0.6			0.55		0.4	2		1.7	3.6			3.7
	H_2 Days	1	1	1	1	1	2	1	1	3	5	3	2	5	5	1	5	10
	D_2 Days					1	2	1	1	3	5	3	2	5	5	1	5	10

Magnet angle: 4 deg

Magnet angle: 4 or 5.5 deg

Magnet angle: 5.5 deg

Questions after 3/22 meeting with Chris Gould and Paulo Medeiros

- Define tolerance for detector alignment (mispointing) at different distances and angles.
- Does the detector need to be surveyed at each of the angles (to measure mispointing)?
- Do we need a survey after the experiment (as found)?
- Is is ok to fiducialize the detector in the floor of Hall C and then placed it into the SHMS platform?