ZDC-RPD INTEGRATION DURING RUN 3 HI RUNS

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For the ZDC group

TREX Meeting

5/13/22

INTRODUCTION

- *Extensive presentation on detector design given at the **TREX meeting hosted on April 6th***
- *Discussion w/ transport group via e-mail about detector clearance and craning constraints*
- *A few updates on support structure - will be presented at the end of this talk*

Full list of up-to-date Technical Drawings

- ***RPD detector** (FINAL - unchanged since the last meeting - detector constructed and @ CERN)*
- ***RPD support structure & integration w/ the TAN** (being finalized - last couple of points for discussion today)*

OUTLINE

- *Storage of the detectors after the Run (not enough space in the existing ZDC sarcophagi)*
- *Installation w/ slight shift (4-5cm) of the BRAN on Arm 1-2*
- *Eventual safety check – clearance of the HV connections on the detector*
- *Updates on support structure since the last presentation*
- *AoB*

STORAGE AFTER RUN

Existing Sarcophagi

- *The two ZDC sarcophagi have some spare space - different for the two arms (different space occupied by EM modules)*
  - *Arm 8-1 Sarcophagus has enough space (~14 cm) to host also RPD 8-1 after the run.*
  - *Conversely, Arm 1-2 Sarcophagus has only ~5.5 cm left - and therefore would not be possible to use it to store RPD*

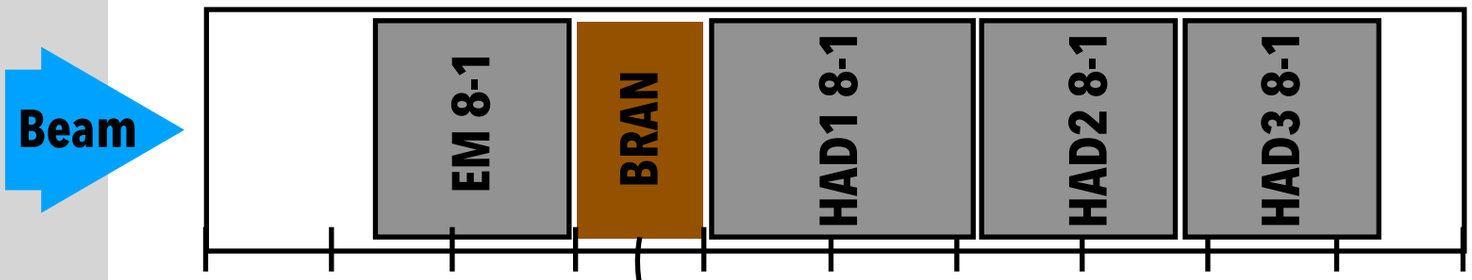
Sarco ZDC 8-1

Sarco ZDC 1-2

- *It appears a new storage will have to be established - for at least one of the two detectors*
- *We would like to request **input from RP** on how to proceed on this item, to start working on it ASAP*

RPD INSTALLATION - ARM 8-1

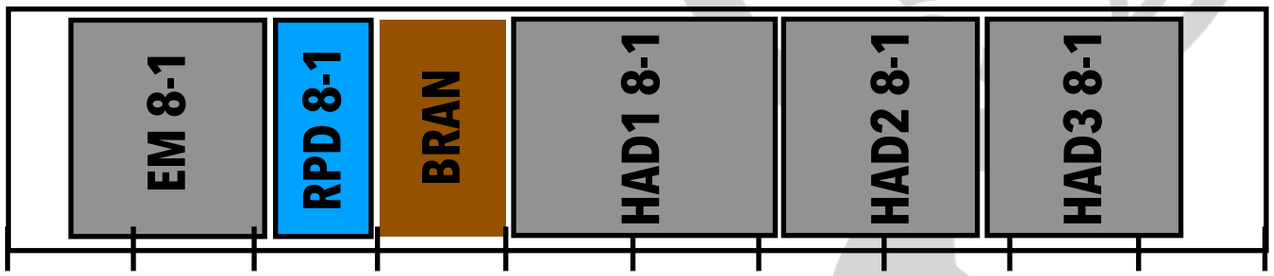
Arm 8-1 w/o the RPD (e.g. a la Run 2)



- *No issues are expected in terms of space*
- *The RPD can be craned in before EM 8-1, which will then be inserted right upstream of it*
- *No changes in the craning for the HADs, no need to touch the BRAN*

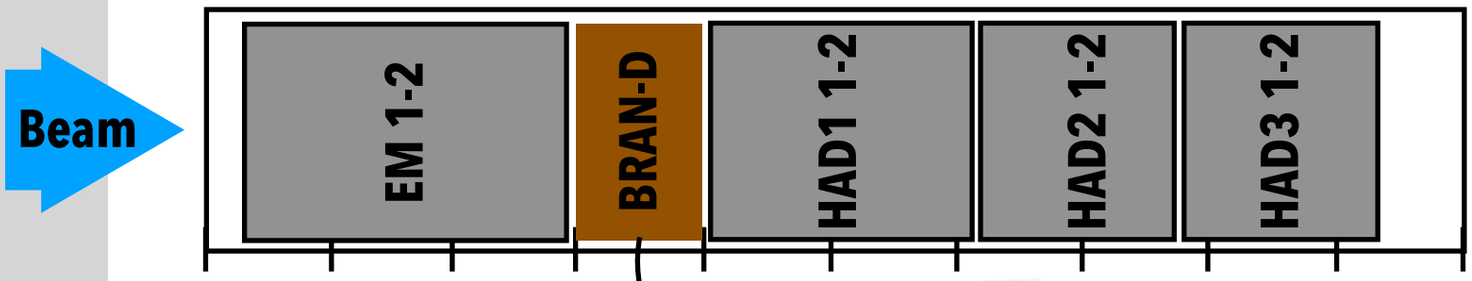
- *"Short" ZDC EM (no pixels) ~155 mm*
- *"Old" BRAN design for 2022*
- *More than 100 mm to accommodate the RPD between EM 8-1 and the BRAN* ✓

Arm 8-1 w/ the RPD



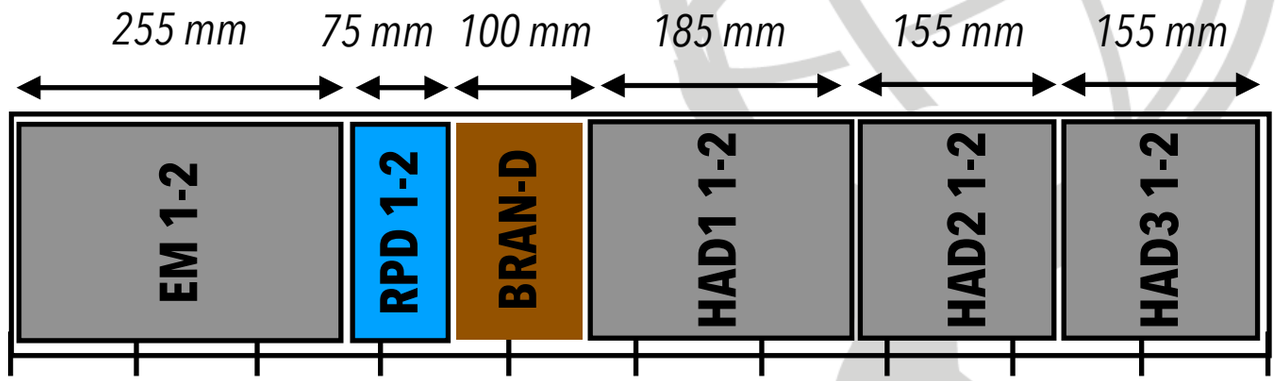
RPD INSTALLATION - ARM 1-2

Arm 1-2 w/o the RPD (e.g. a la Run 2)

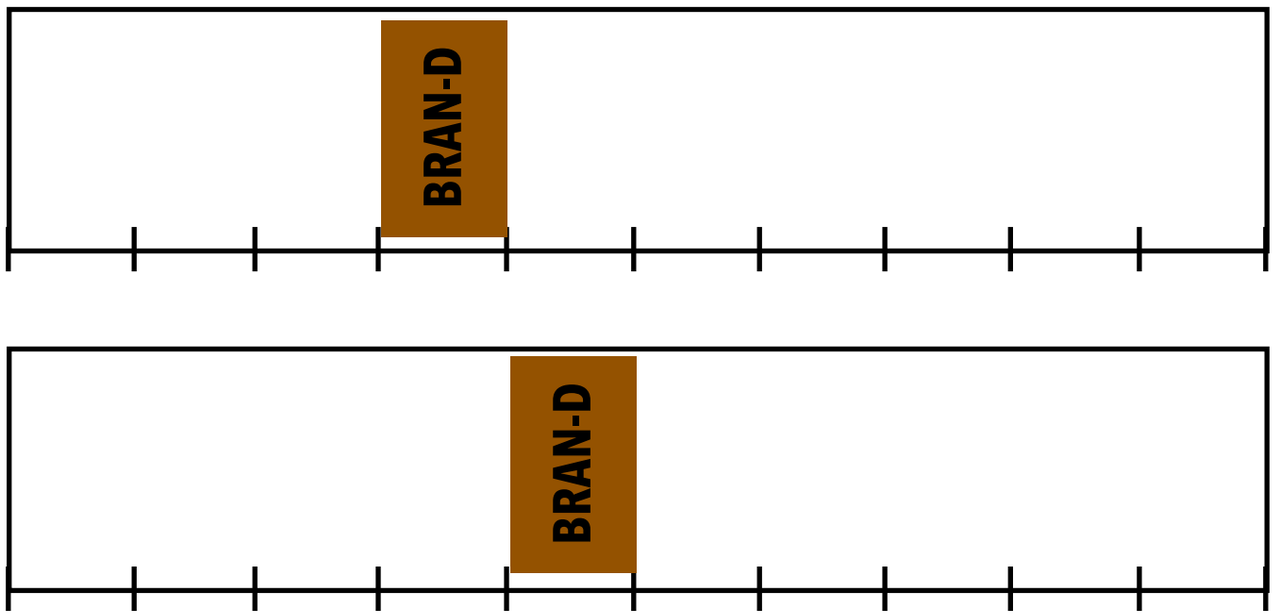


- *"Long" ZDC EM (backend for old pixels - unluckily not removable) ~255 mm*
- *"New" BRAN-D design installed in January*
- *Only ~45 mm to accommodate the RPD between EM 1-2 and the BRAN* ❌
- *A small shift of the BRAN downstream (~50 mm) is necessary to install the RPD*

- *Total length occupied by devices ~ 925 mm*
  - *Should be possible to accommodate everything without issues*
- *Enough room to accommodate the RPD*
- *If BRAN colleagues agree, eventual craning procedure to be determined*

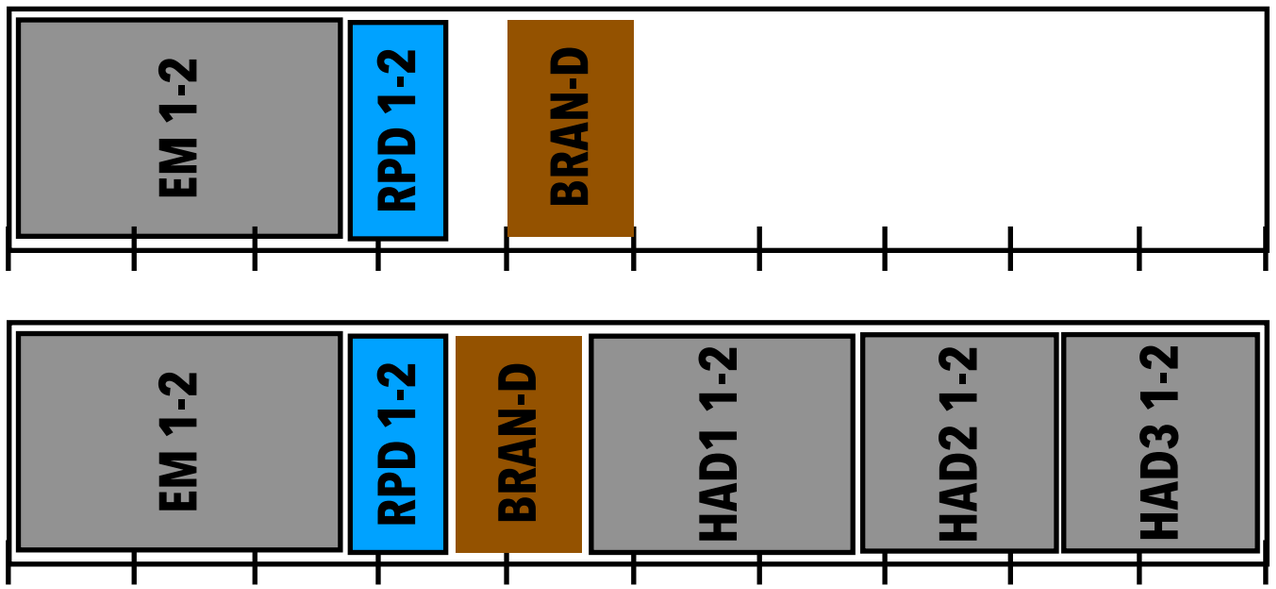


RPD 1-2: CRANING PROPOSAL



1 *Remove copper bars after p+p running*

2 *Crane back the BRAN-D of ~10 cm*

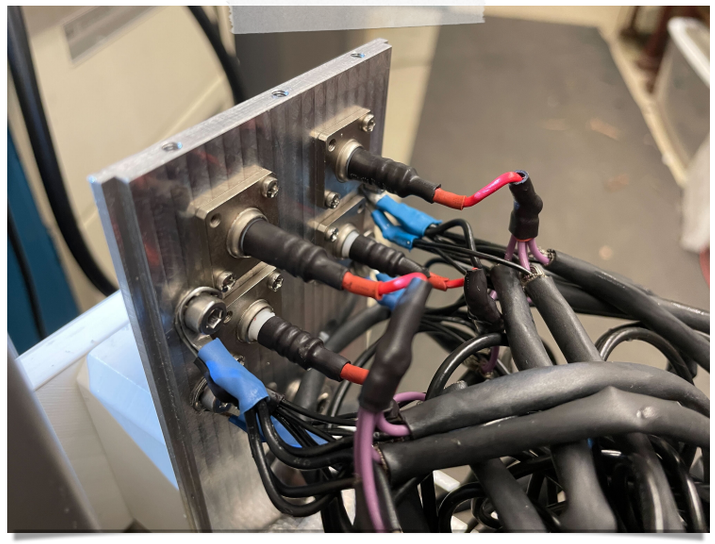


3 *Crane in EM1-2 and RPD 1-2*

4 *Crane forward the BRAN - near RPD1-2*

Crane in HAD1 1-2, HAD2 1-2, HAD3 1-2

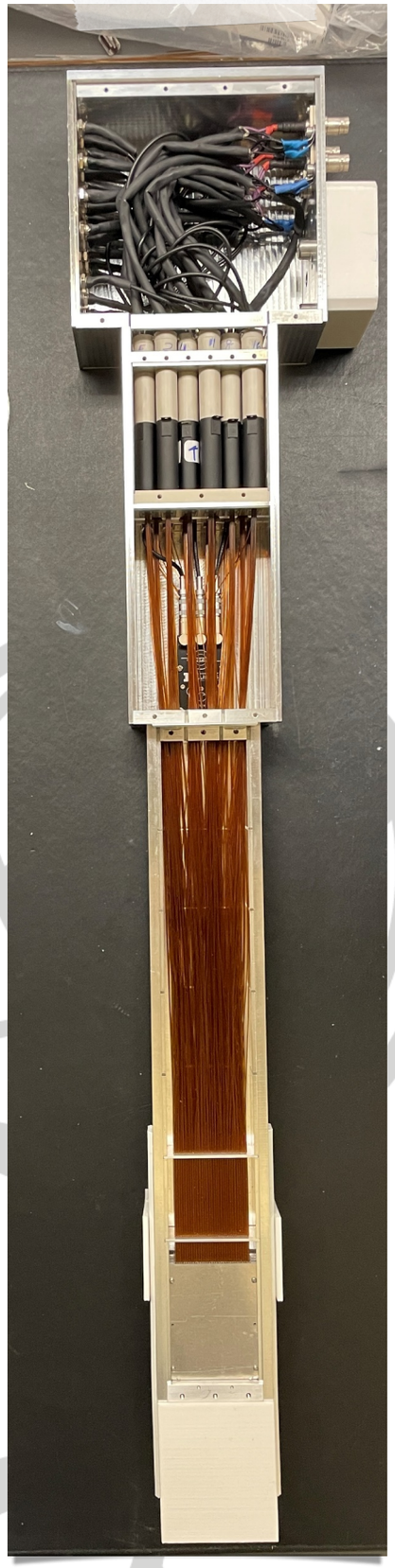
RPD INTERNAL CABLING



High Voltage

- *Interface w/ outside provided w/ SHV panel-mount connectors*
- *Hamamatsu basis have 2x individual, unshielded wires for HV+GND*
- *Custom implementation to avoid lone wires acting as antennae because of lack in coaxial shiedling*
- *wire-mesh heat-shrink connected to GND envelopes line from wall to PMT HV divider*
- *stripped braided wires bolted to wall run down mesh heat-shrink, tying to GND*
- *small but unavoidable gap to split off HV & GND lines (~5 cm) at the bulkhead*
- *Doubly-overlapping standard heat-shrink insulates soldered connection to SHV pin*

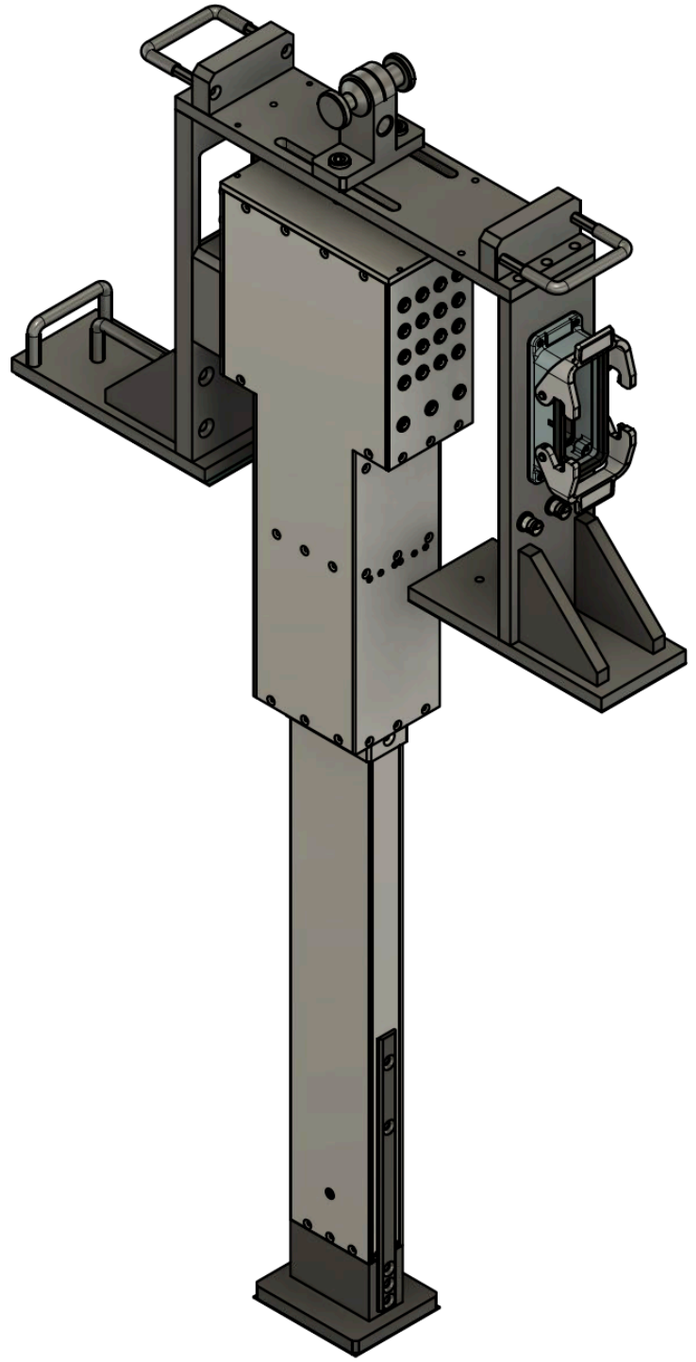
- *So far - no issues were found with tests run for ~hours in lab at UIUC & CERN*
- *Running for ~days/weeks planned @ test beam and during test w/ LUCROD electronics at 251*



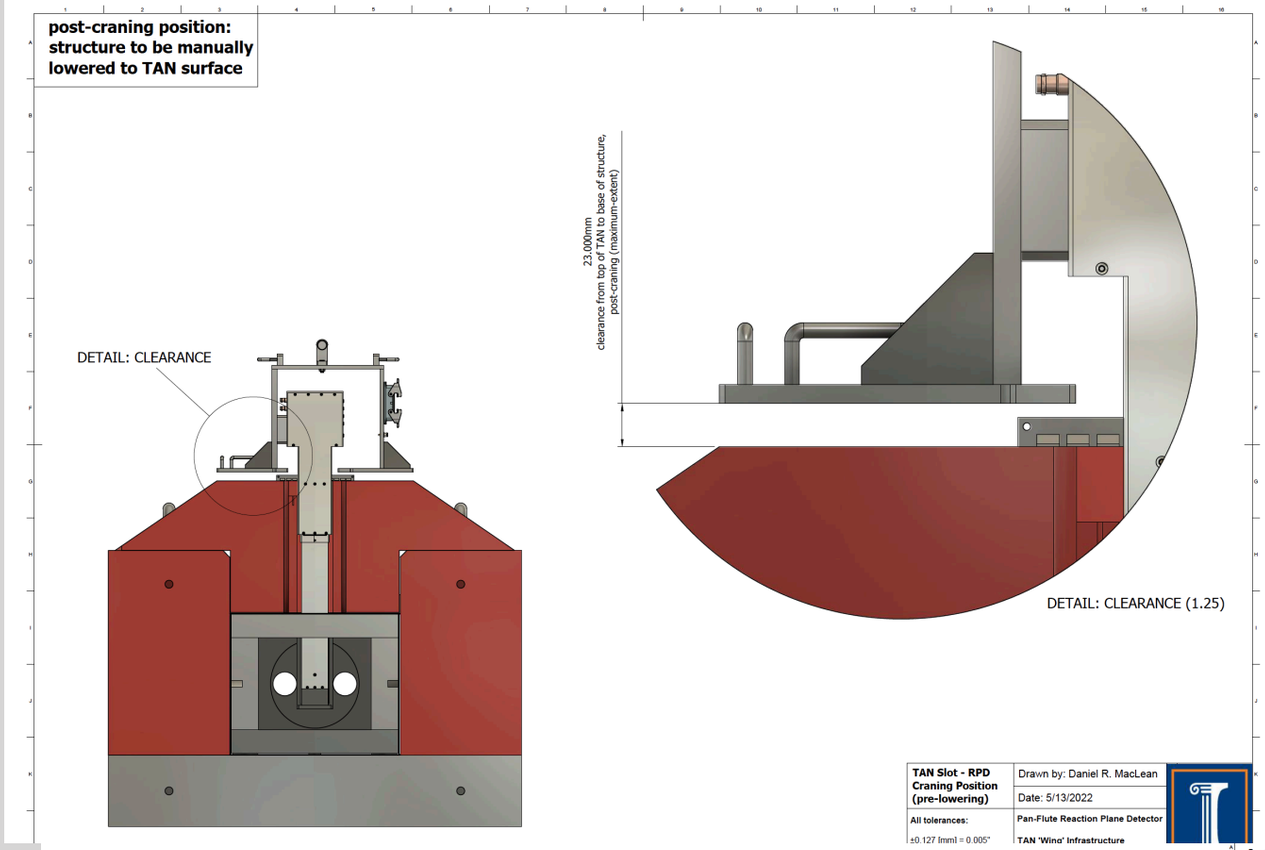
Since the internal cabling is custom made, do we need to pass specific inspections before installing the detector?

SUPPORT STRUCTURE: (SEMI)FINAL DESIGN

- *A few improvements compared to last TREX meeting - following up discussion w/ transport group and mock-up tests of parts in the lab*
  - *RPD foot height sized to match shower centre accounting for +170 urad half-crossing angle expected in 2022 Heavy Ion run*
    - *Support structure updated accordingly to open the possibility of moving the detector between 0 and 250 urad half-crossing angle, in case of variations in 2023-2025 Runs.*
    - *Only hardware modification needed: production of a new foot*
- *Change logic in the detector installation procedure*
  - *Detector craned in "fully extended" mode - foot touches the bottom of the slot before the wings*
  - *Wings lowered in a second moment*
  - *A few handles were introduced to help in this procedure*



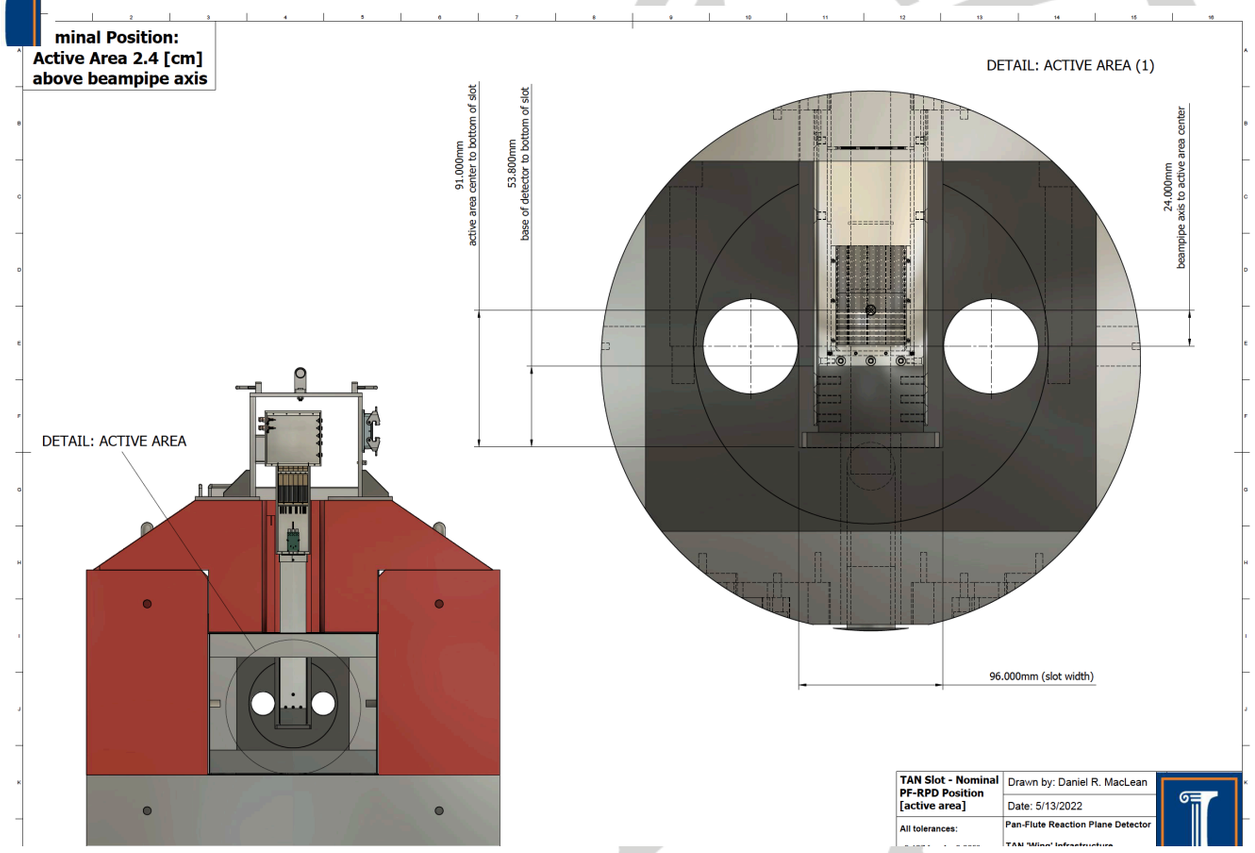
NEW INSTALLATION PROCEDURE PROPOSED



RPD configuration at the moment of of craning

RPD configuration once the wings are lowered down in position - after craning

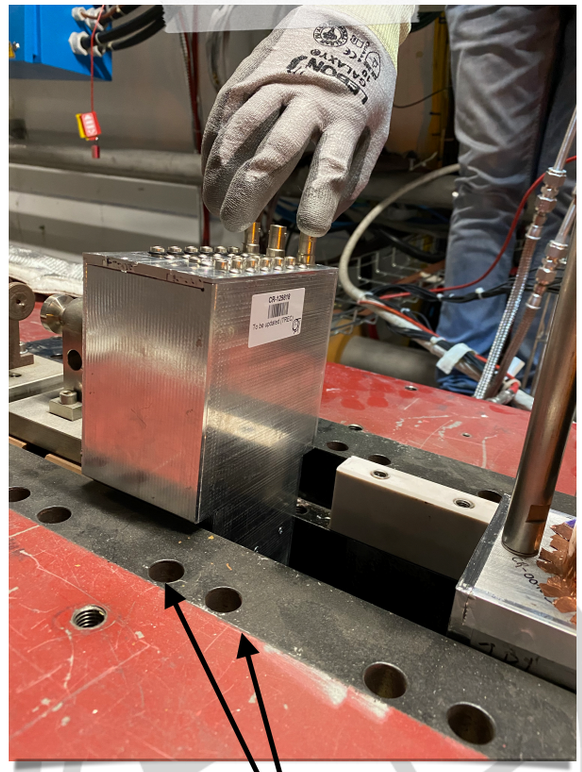
- *2x operators - one on passerelle side - one on corridor*
- *Handles are used to manually lower the detector after loosing the bolts mating the RPD to the support structure*
  - *Mechanically much easier*
  - *Avoid issues related to potential malfunctioning of RPD lowering system*



LAST TWO OPEN ITEMS

How to secure the detector in position

- *Relatively light mass (< 20 kg) of the RPD + support structure system, may favor inadvertent movement of the device once craned in the slot*
  - *The re-adjusting of the position would take time (and exposure for personnel)*
  - *Implementing a fastening system would avoid this issue*
  - *A couple of different possibilities are currently evaluated, all are involving the usage of the dowel holes on the TAN*
    - *Is it possible to make use of these holes?*
- *Measurement of the holes and comparison w/* ***TAN technical drawings*** *would be crucial. Would be possible to have access to the tunnel before Tuesday? Measurement would not take more than 1h.*



Alignment

- *Is it possible to request a survey once the detector will be craned in the slot? If yes - we can consider attaching a few optical targets in strategic positions of the structure/detector (if it can be fastened to the TAN)*
  - *Measurement can be taken in the YETS*

SCHEDULE & SUMMARY

Schedule

- *Detectors are now both at CERN - undergoing tests w/ electronics @ Lab 251*
- *One week of ATLAS ZDC/RPD test beam on July 6-13th @ H4*
- *The support structure is basically ready for production if cleared by this group, only open points to be still fixed related to the dowel holes. Can be shipped with test-beam material (@ CERN by end June).*

RPD test @ 251

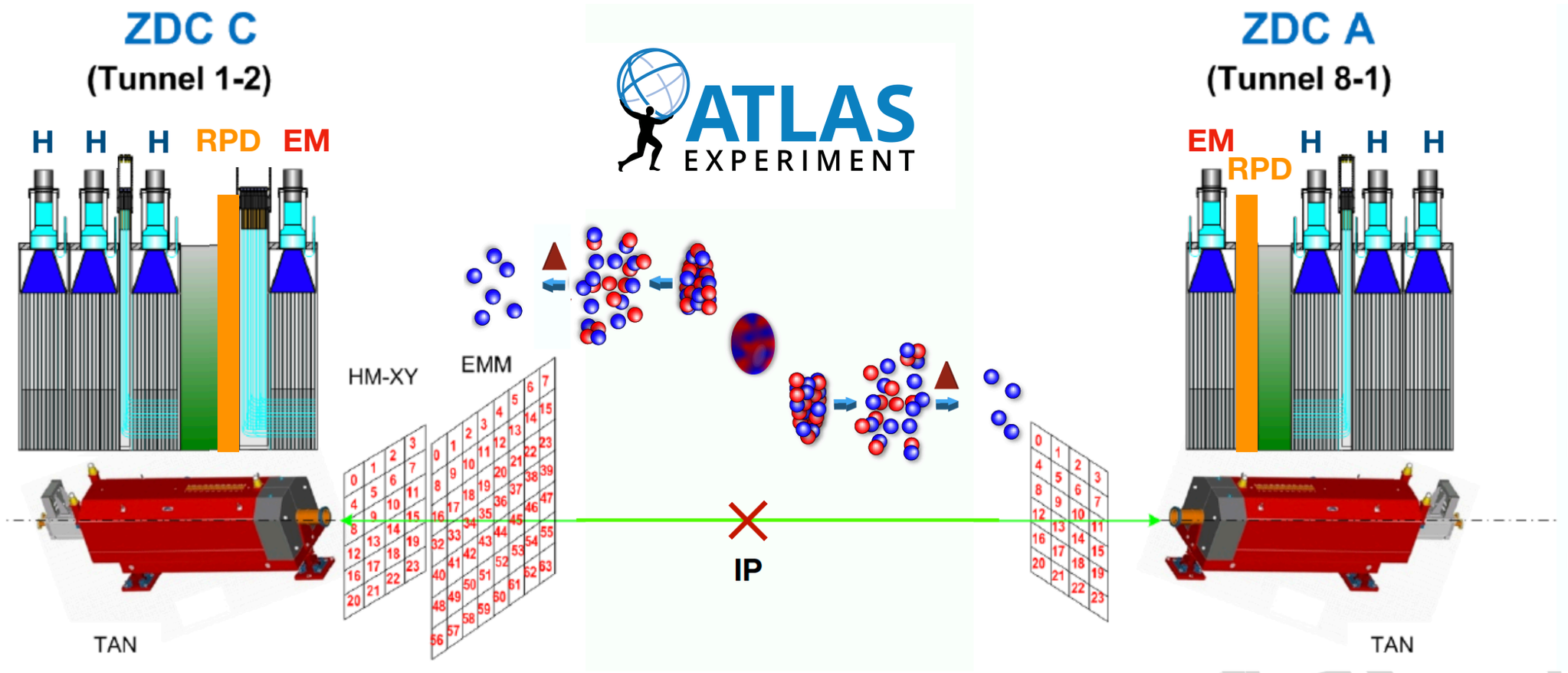
Full list of up-to-date Technical Drawings

- ***RPD detector*** *(FINAL - unchanged since the last meeting - detector constructed and @ CERN)*
- ***RPD support structure & integration w/ the TAN*** *(being finalized - only detector eventual fastening to the TAN needs to be implemented)*
- *Further material can be provided upon request*

BACKUP

RPD IN TAN HI-LAYOUT

- *The ATLAS ZDC was originally (Run 1) equipped with transverse segmentation (pixels) - unfortunately largely compromised with the deployment of the detector during Run 1 p+p run.*



Arm 1-2

- 64 EM pixels
- 24 HAD pixels

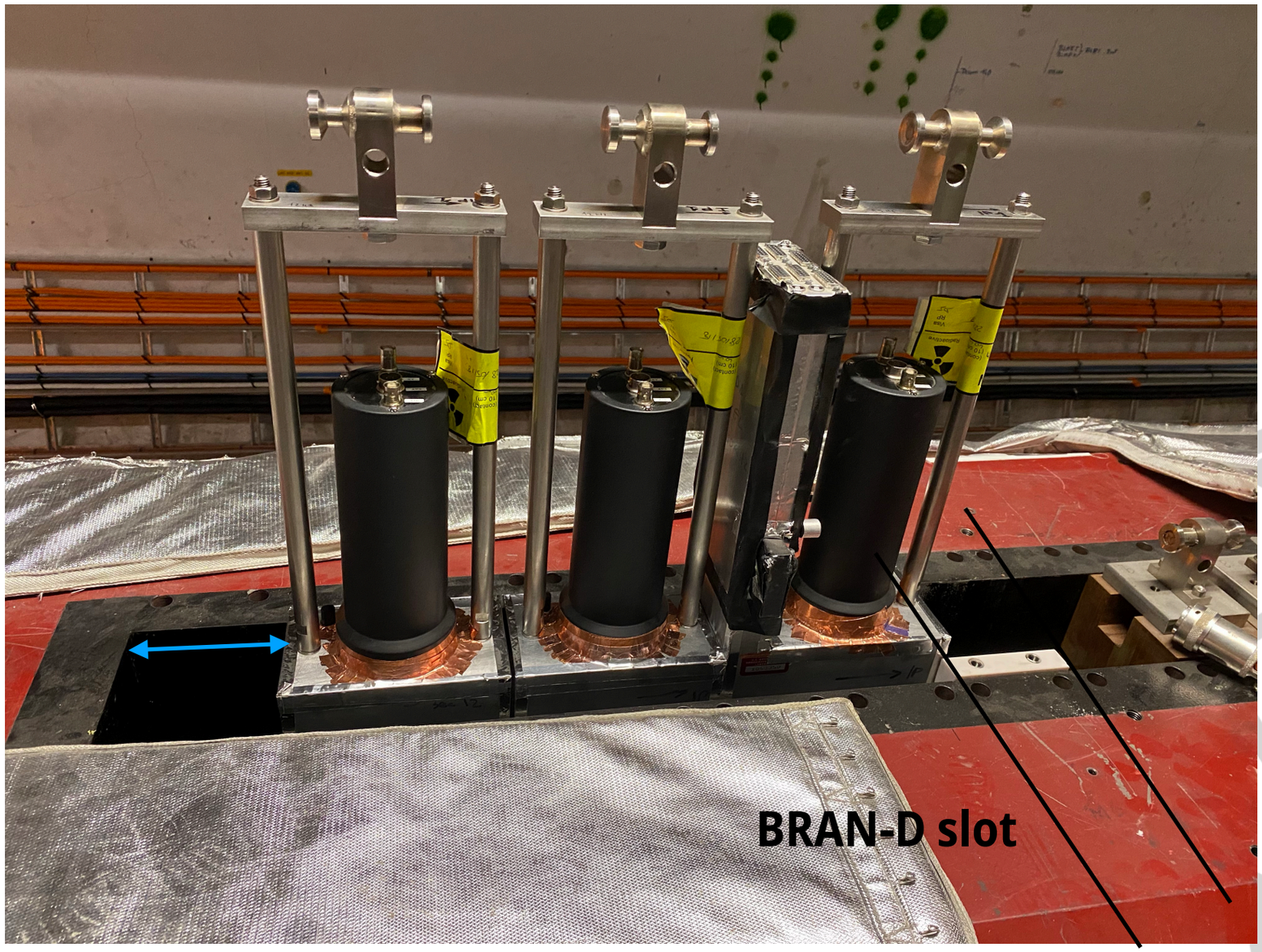
Arm 8-1

- 24 HAD pixels

- *Transverse mapping of the forward neutron shower allows for the measurements of the reaction plane characterizing HI collisions, enabling new measurements (e.g. directed flow)*
- *The new **Reaction Plane Detector (RPD)** will restore this capability for the ATLAS ZDC*

AVAILABLE SPACE IN TAN

Picture from 2021 pilot-run

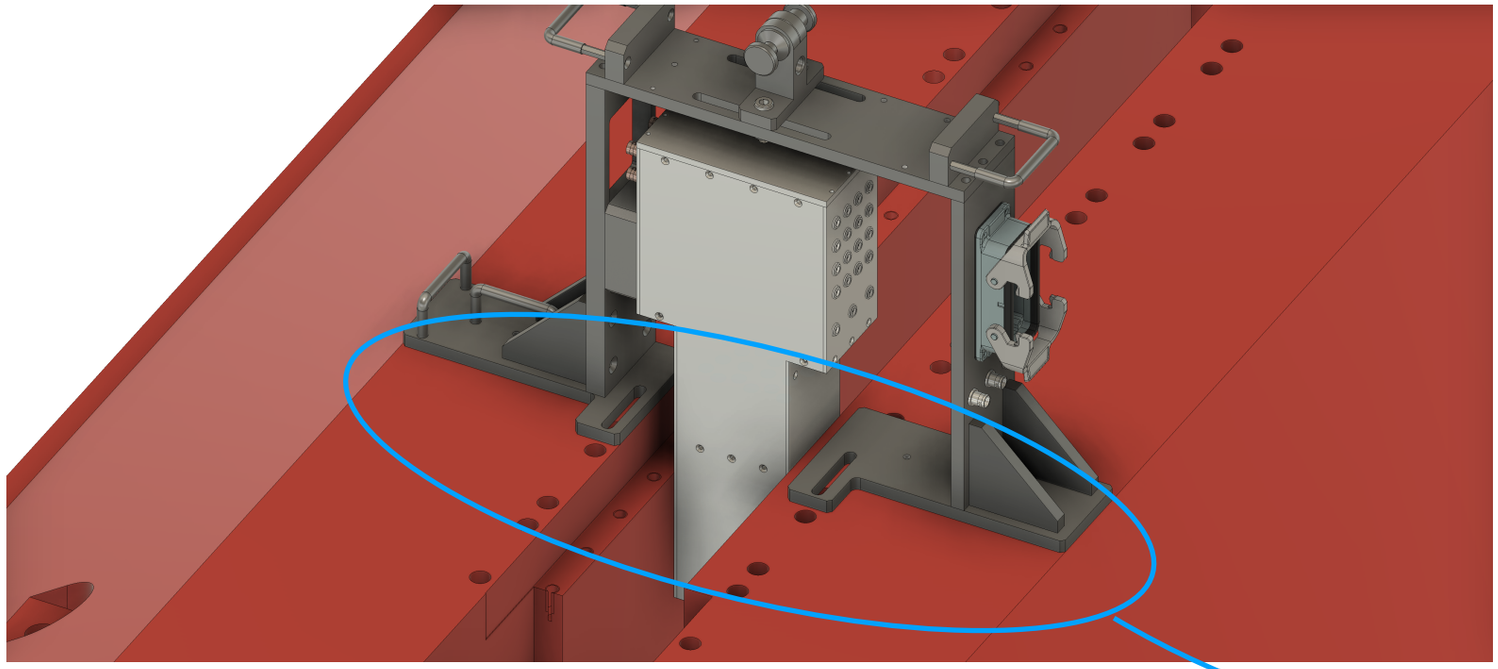


ZDC HAD modules in nominal position (e.g. right downstream of the BRAN slot)

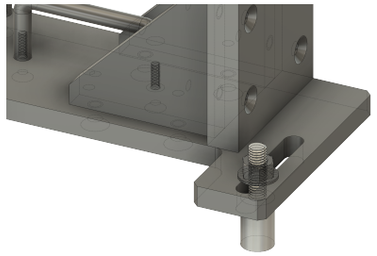
Overall shift needed in this configuration: ~ 4.5 cm

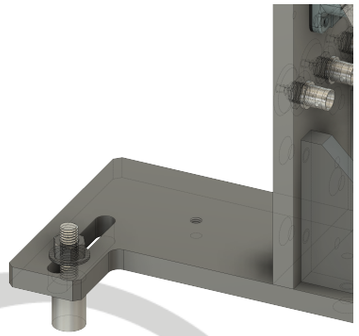
Available longitudinal space for shift of the setup displayed in the picture by ⟷

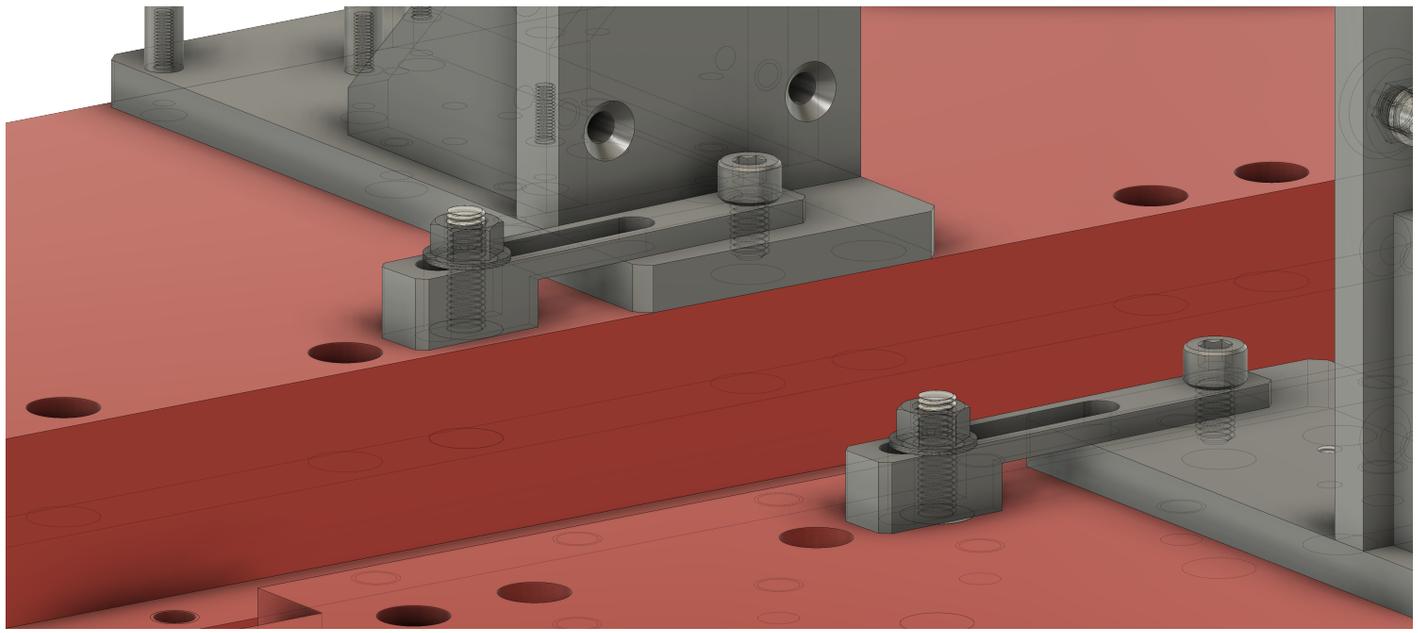
POSSIBLE FASTENING SOLUTIONS



Proposed solution A

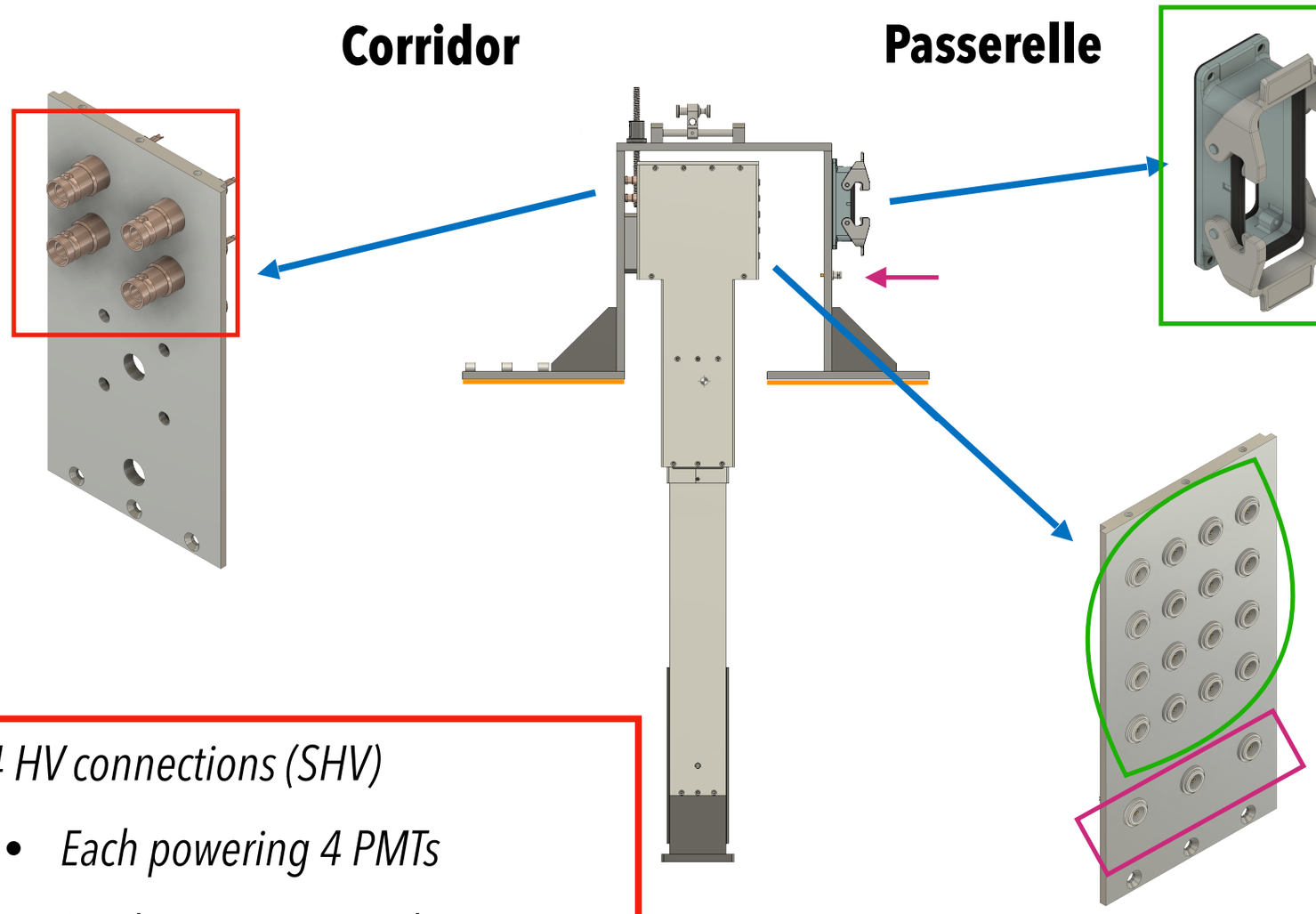






Proposed solution B

RPD EXTERNAL CONNECTIONS



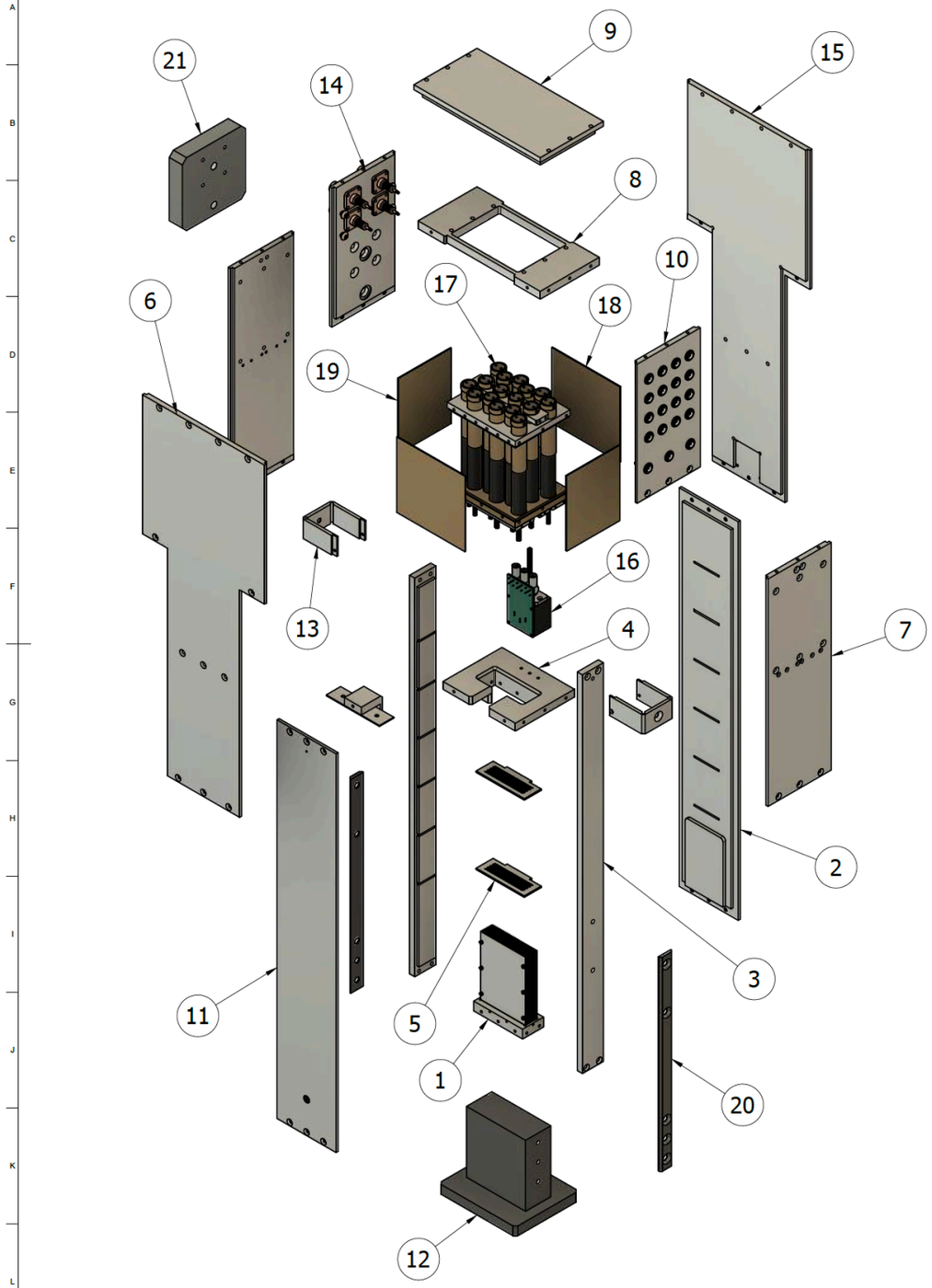
- *16 signal channels (LEMO+Harting)*
  - *Readout via LHCf channels*
  - *Interface to the RPD via specific Harting connector*
  - *Bridging cables in USA15 between LHCf and ZDC rack installed in last October by M.Ciapetti's team*

- *4 HV connections (SHV)*
  - *Each powering 4 PMTs*
  - *Implementation exploiting multi-core HV cables already available per each arm*

- *3 LED calibraition channels (LEMO+BNC)*
  - *Driven from USA15 using the old ZDC CC50 cables (already in place)*
  - *CC50 connects on RPD support structure (BNC) for fast connection after craning*

- *Wings isolated from the TAN w/ kapton/vetronite foil to avoid ground loops*

RPD - EXPLODED VIEW



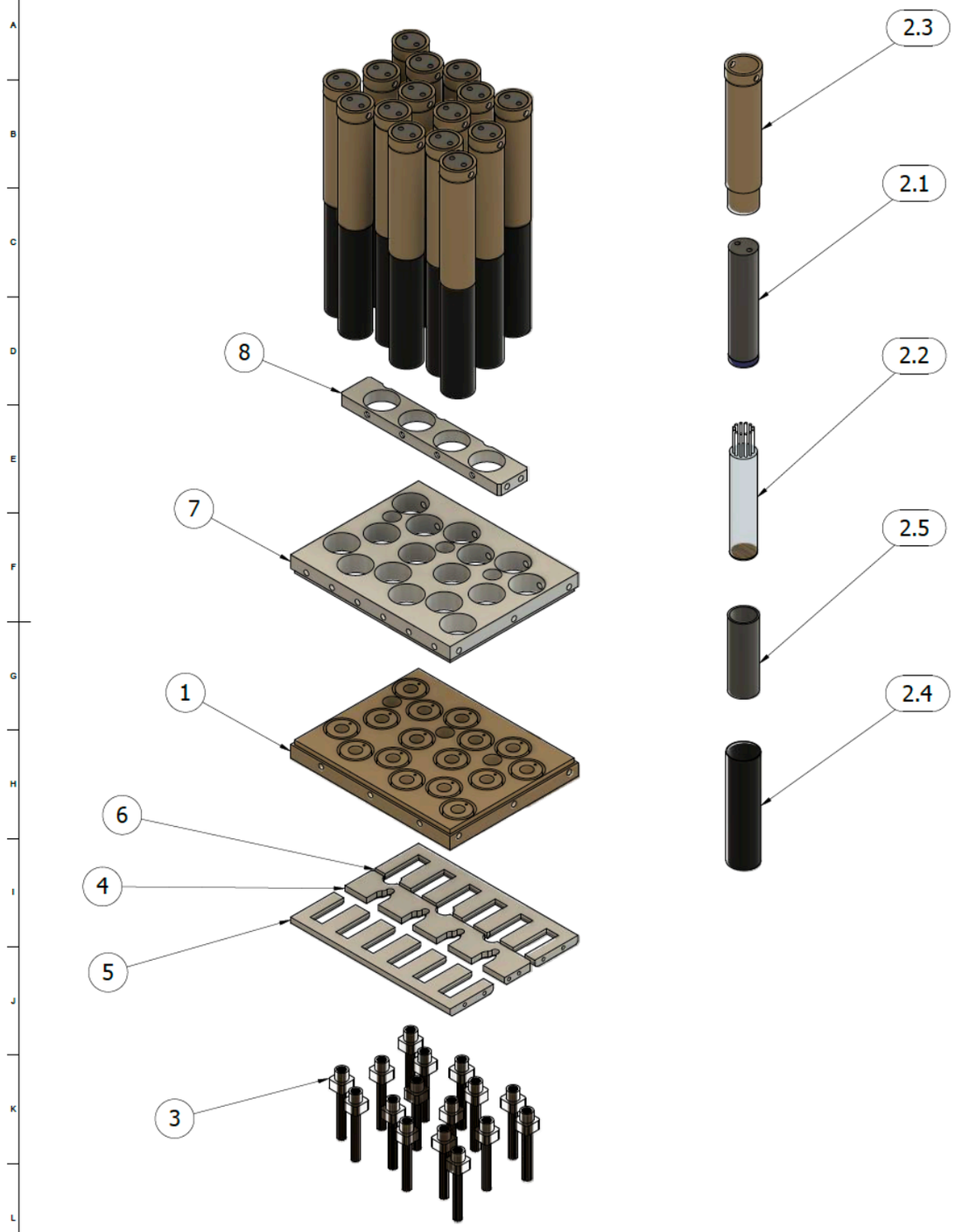
Parts List				
Item	Qty	Part Name	Material	Mass
1	1	Active-area-assembly v38		156.467 g
2	1	Lower-rear-wall v32	Aluminum 6061	369.182 g
3	2	Lower-side-wall v37	Aluminum 6061	216.081 g
4	1	Lower-adaptor_fiber-channel-assembly v17	Aluminum 6061	119.695 g
5	2	Fiber_routing_plate v16	Aluminum 6061	4.437 g
6	1	Upper-front-wall v35	Aluminum 6061	529.610 g
7	2	Mid-side-wall v43	Aluminum 6061	223.007 g
8	1	Upper-adapter v34	Aluminum 6061	107.929 g
9	1	Top-plate v37	Aluminum 6061	334.547 g
10	1	Upper-side-wall_connectors v40		184.886 g
11	1	Lower-front-wall v32	Aluminum 6061	371.216 g
12	1	Y-positioning-and-sample-irradiation_sub-assembly v10	Aluminum 6061	595.418 g
13	2	Optical-isolation-buffer v15	Aluminum 6061	16.049 g
14	1	Upper-side-wall_mounting-and-HV v38		202.141 g
15	1	Upper-rear-wall v65	Aluminum 6061	523.086 g
16	1	LED-GMS_MPC-style_mk5 v31		48.145 g
17	1	PMT-array_mk3 v57		502.240 g
18	2	PEEK-HV-insulation_front-and-rear-walls4 v12	PEEK	8.286 g
19	2	PEEK-HV-insulation_mid-side-walls v10	PEEK	6.445 g
20	2	Y-positioning-brace v14	Aluminum 6061	22.484 g
21	1	Generic-mounting-block-placeholder v34	Aluminum 6061	223.997 g

Full Assembly mass (estimate): ~6.5 kg

(includes an estimated ~1 kg of additional cabling
and optical fibers not present in CAD model)

Exploded View & BOM	Drawn by: Daniel R. MacLean	
	Date: 2/15/2022	
All tolerances: ±0.127 [mm] = 0.005" (unless otherwise specified)	**Pan-Flute Reaction Plane Detector**	
	LHC Run 3 Model	
	ATLAS ZDC Group - UIUC	

PMT ASSEMBLY - EXPLODED VIEW



Parts List				
Item	Qty	Part Name	Material	Mass
1	1	Fiber-PMT-interface-plate v41	PEEK	43.112 g
2	16	R1635-subassembly_mk3 v24		22.060 g
2.1	1	E1761-04_PMT-base v7	Plastic	5.851 g
2.2	1	R1635-PMT v11	Glass	7.896 g
2.3	1	R1635-insulation-cylinder_mk3 v12	PEEK	2.753 g
2.4	1	E989-28_Hamamatsu-mu-metal-shield v3	Iron, Gray	3.302 g
2.5	1	R1635-conductive-bushing v13	Aluminum 6061	2.257 g
3	16	Square-fiber-plug v5	Glass	0.835 g
4	1	Center-fiber-plug-brace v5	Aluminum 6061	8.031 g
5	1	Front-fiber-plug-brace v7	Aluminum 6061	10.197 g
6	1	Rear-fiber-plug-brace v8	Aluminum 6061	10.149 g
7	1	Staggered_upper-PMT-support-frame v25	Aluminum 6061	60.417 g
8	1	4-ch-PMT-brace v15	Aluminum 6061	8.499 g

Total sub-assembly mass (estimate): 528.8 g

PMT Array Exploded View & BOM	Drawn by: Daniel R. MacLean	
	Date: 2/15/2022	
All tolerances: ±0.127 [mm] = 0.005" (unless otherwise specified)	**Pan-Flute Reaction Plane Detector**	
	LHC Run 3 Model	
	ATLAS ZDC Group - UIUC	