Opportunities for beam loss reduction at modest cost

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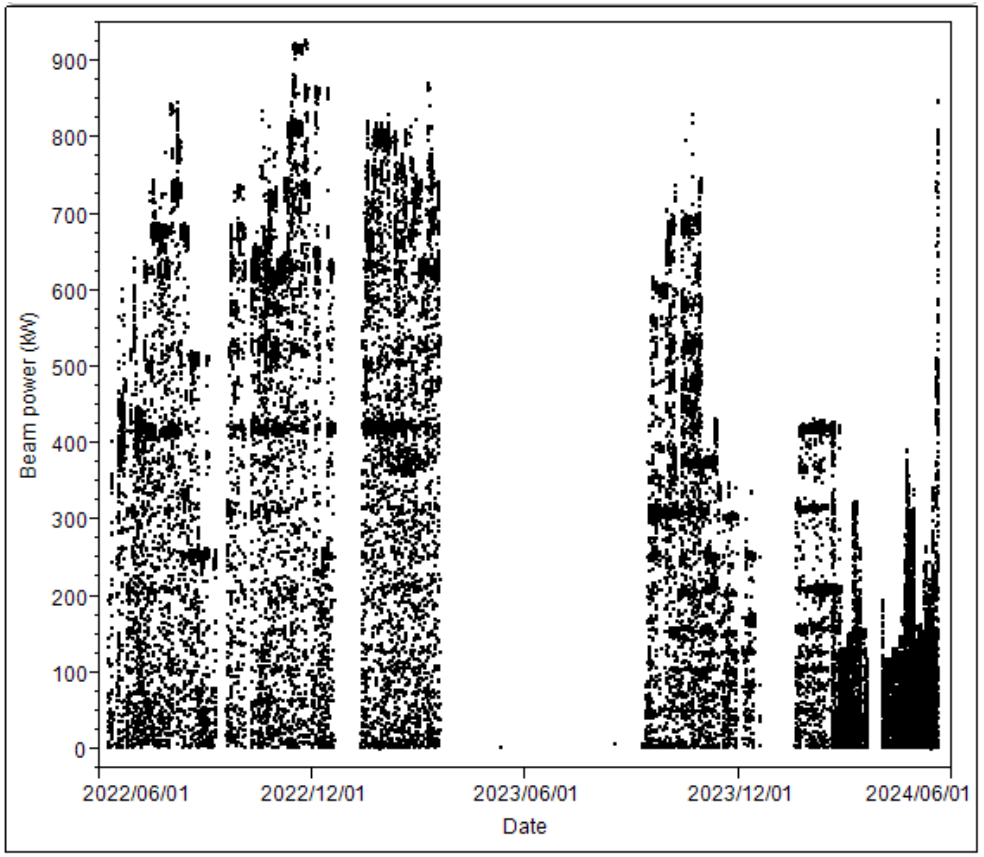
IDXs (xenon ion chambers)

- Each electrometer can support four ion chambers in proximity.
- IDXs at 2E02 through AE02 reduced BLM trips in extraction a factor of four to five from 2023 to 2024 as Ops could distinguish on which pass steering required attention.
- During 2024 SAM, four IDXs were added to NE spreader near 7S00, 3S00, 7S01 and 9S00 BLMs for same purpose. These helped Ops distinguish between 7S and 9S cause of BLM trips in early April. They also show orbit drift in low-current running when locks aren't effective.

https://logbooks.jlab.org/entry/4354930 https://logbooks.jlab.org/entry/4354782

- One IDX was installed on beam pipe before CM 1L02 via donation by RadCon. The hope is this will aid NW recombiner steering. ~100 m cable. Reads 30 R/hr field emission now.

E02 IDX: beam power during runs without/with



BLM rates: without and with E02 IDXs

22-23 run: **without** 4/6/8/A E02 IDX
39458 total BLM FSDs over 278 days

BLM	# of trips
ILM7S01	2885
ILM4E02	1140
ILM8E02	12305

23-24 run: **with** 4/6/8/A E02 IDX
8789 total BLM FSDs over 243 days

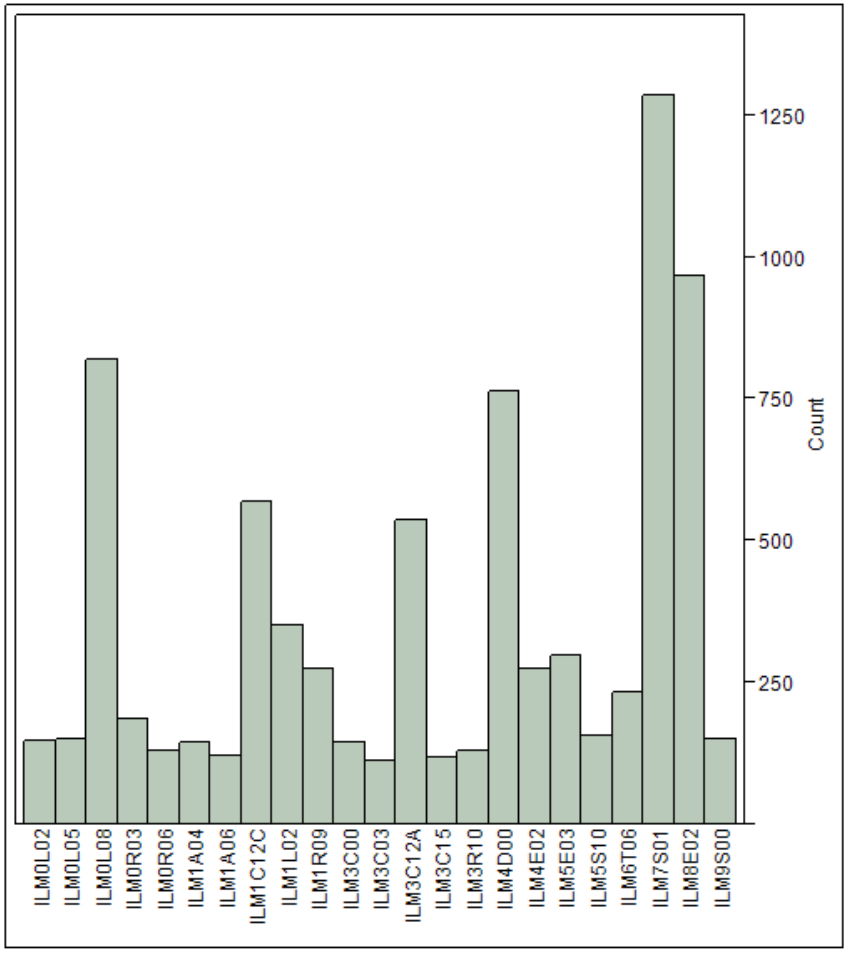
BLM	# of trips
ILM7S01	1283
ILM4E02	270
ILM8E02	963

Normalize 23-24 run, with lower beam power than 22-23, by 7S01 trips, multiplying by 2.25 (2885/1283)

BLM	# of trips, normalized	% of 22-23 run
ILM4E02	608	53
ILM8E02	2167	18
4E02 + 8E02	2774	21

A factor of four improvement might be a better estimate given beam power change, even with the normalization. Still great.

BLM trips during 2023-2024 run



Frequencies

Level	Count	Prob
ILM0L02	145	0.01815
ILM0L05	148	0.01853
ILM0L08	815	0.10202
ILM0R03	182	0.02278
ILM0R06	126	0.01577
ILM1A04	142	0.01777
ILM1A06	119	0.01490
ILM1C12C	567	0.07097
ILM1L02	349	0.04369
ILM1R09	272	0.03405
ILM3C00	141	0.01765
ILM3C03	108	0.01352
ILM3C12A	533	0.06672
ILM3C15	115	0.01439
ILM3R10	127	0.01590
ILM4D00	761	0.09526
ILM4E02	270	0.03380
ILM5E03	294	0.03680
ILM5S10	152	0.01903
ILM6T06	231	0.02891
ILM7S01	1283	0.16060
ILM8E02	963	0.12054
ILM9S00	146	0.01828
Total	7989	1.00000

N Missing 804

23 Levels

BLMs with over 100 trips shown. 7S01 and 9S00 now have IDX.

4D00 is now inside the poly on the spectrometer dump and must be recalibrated. It and 0L08 likely trip on recirculated beam.

Additional IDXs in priority order

- Next set of four in BSY at $25K including labor: after Lambertson transverse to all beam pipes, 1C12, 2C07 and 3C12 (high dispersion points). 2C07 will also aid Hall B steering during nA CW delivery.
- Four by the Hall A Compton, to provide localization that the litre-volume ion chamber there cannot. Many trips likely there during MOLLER. $25K
- SW spreader, NE recombiner, NW recombiner and transport recombiner. $100K
- Consider another BSY set to monitor beam lines near empty penetrations which led to changed work rules.

BPMs

- CASA proposed adding BPMs to arc quad girders lacking them during 12 GeV upgrade: denied. BPMs were moved instead. 13 missing in each of arcs 1 and 2; 6 in each of the higher arcs. 74 total (big $$)
- Activation sites in Radiation Survey compendium lacking BPMs: 1A17, 1A20 and 2A20. Add?
- Alternative: lower peak dispersion in arcs 1 and 2 to ~5 m. Keeps beam in more accurate BPM volume and halo away from wall.
- Add IDX stack in middle of each arc? Passes 1-4.
- *Convert 1A16/19/22/24 diagnostic BLMs to MPS per activation on Radiation Survey compendium. Perhaps 2A19 as well, if cost low.*

Other technology BLMs

- LCLS II uses energy-deposition calibrated diamond sensor point BLMs and optical fiber for full coverage BLMs. Fibers have PMTs on both ends for localization – easier with 1 MHz pulse rate than 1497 MHz.
- Electronics designs can be obtained from SLAC
- Expensive, $5M (2024$) for replacement of all existing point BLMs and full fiber coverage.
- Prototype fiber ~$50K by borrowing tooling from SLAC.
- PRAB paper provided has details.

Simulation

- CASA is adding apertures to the elegant deck in a simplified manner to support degrader and positron studies.
- Simulations with two Gaussians, core and halo, would be expensive. Start with just 1 mm sigma halo?
- Detailed simulation in one region including magnet steel and actual beam pipe might be considered based on results above.

Revisit existing BLMs

- Spreadsheet previously discussed has recommended voltages.
- https://logbooks.jlab.org/entry/4359263 shows that the spreader BLMs see field emission from the C100s, especially those at the same height. Xenon ion chambers do not. Can BLM background be suppressed?

Backup

https://opswiki.acc.jlab.org/wiki/Machine_Information

has location information for BLMs, NDXs, IDXs, and burn spots.

https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-54842

BLM over-sensitivity checks via harp swipes TN-22-042

https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-263524/23-002.pdf

Quick check of MPS BLM sensitivity to energy offsets

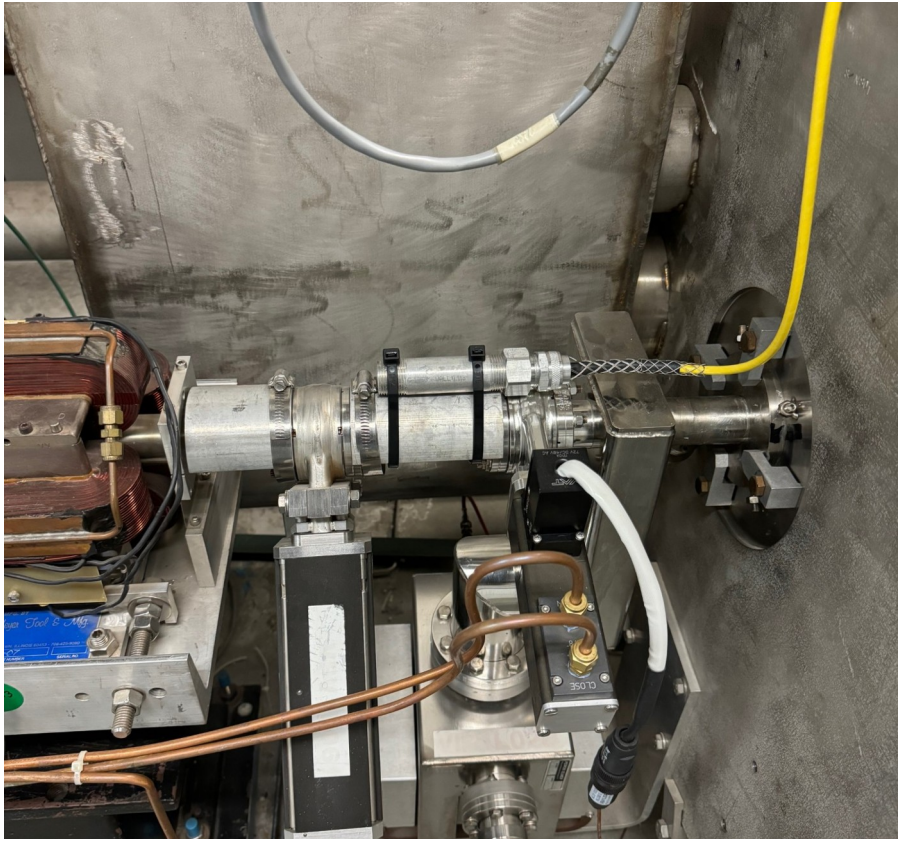
https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-278043/23-070.pdf

BSList 109361:YA steering conducted 05 October 2023

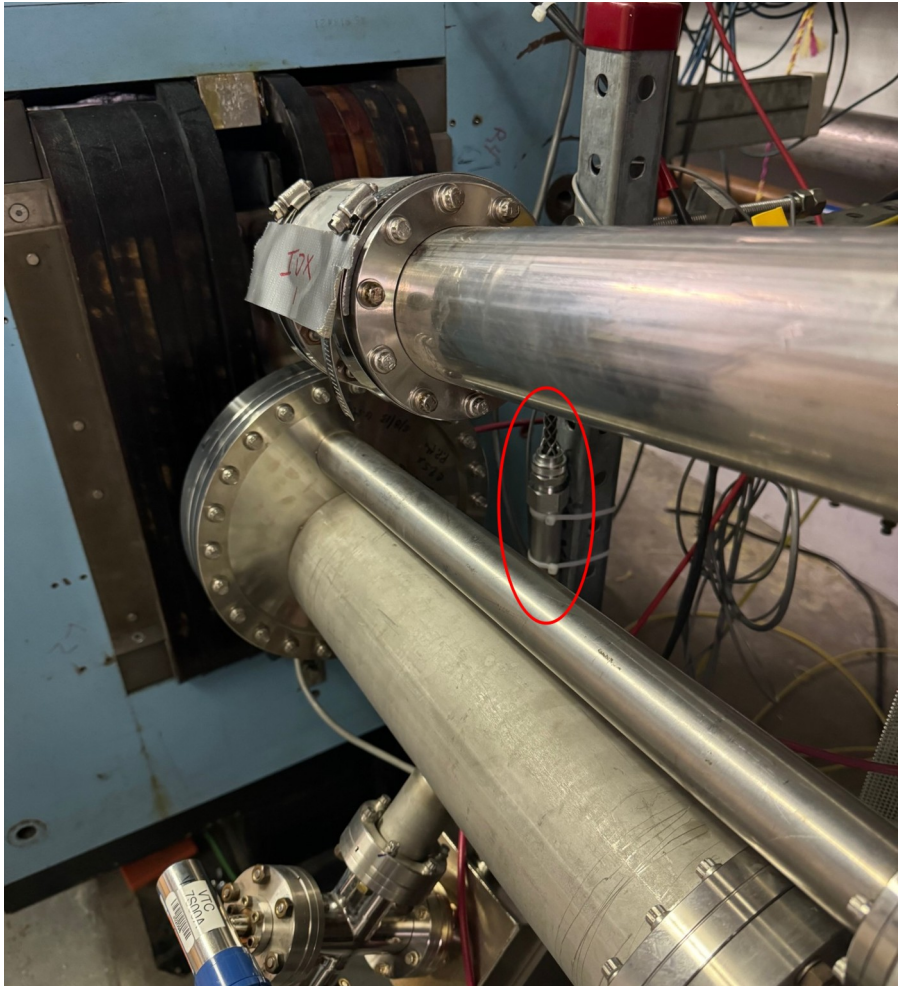
https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-295778/25-012.pdf

CEBAF radiation surveys 2023-2020 (arcs), 2024-2017 (BSY)

1L02



IDX7S00



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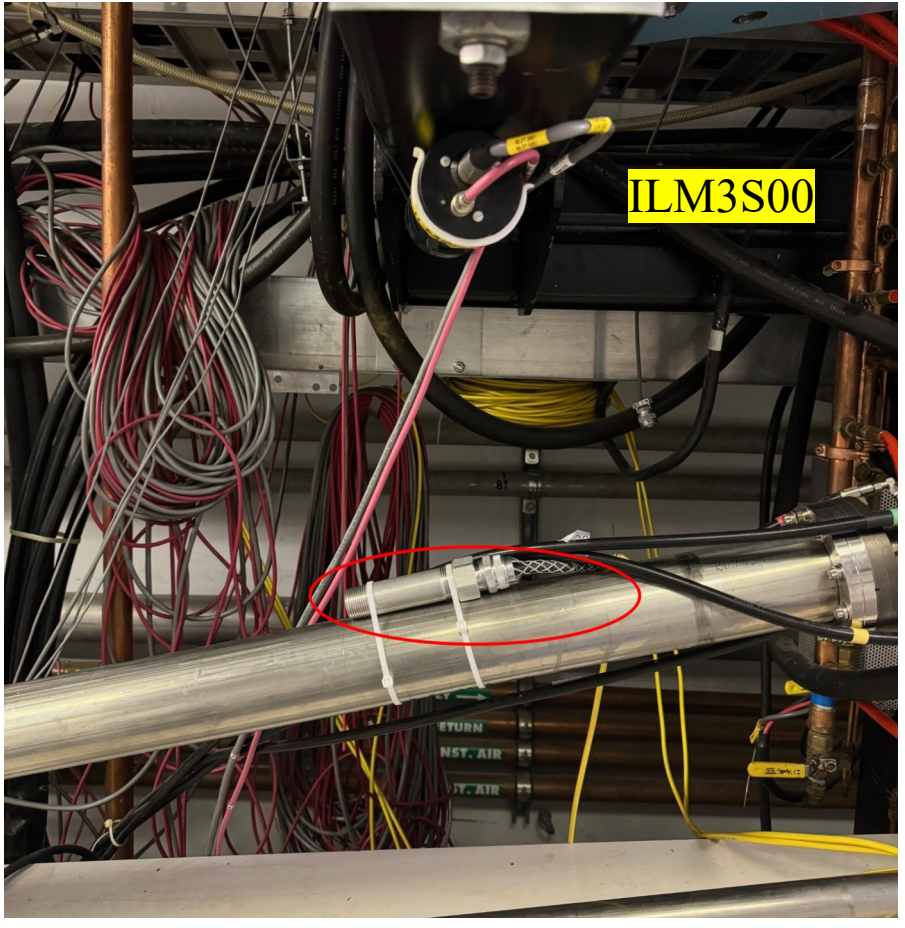
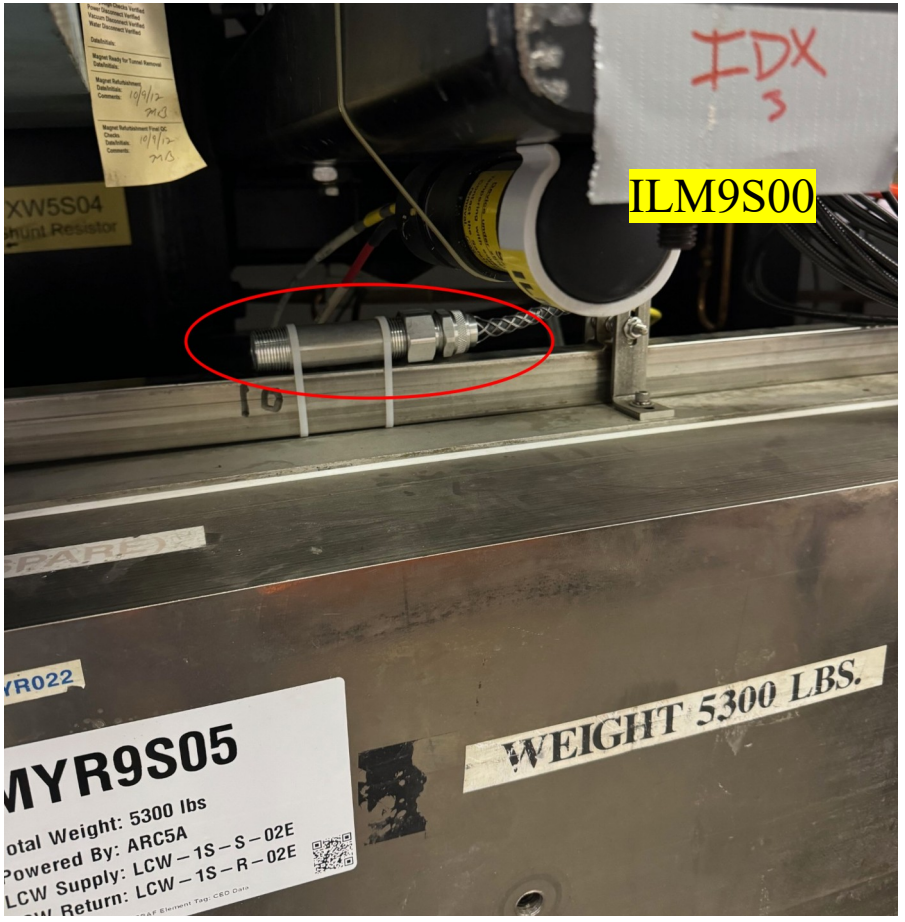
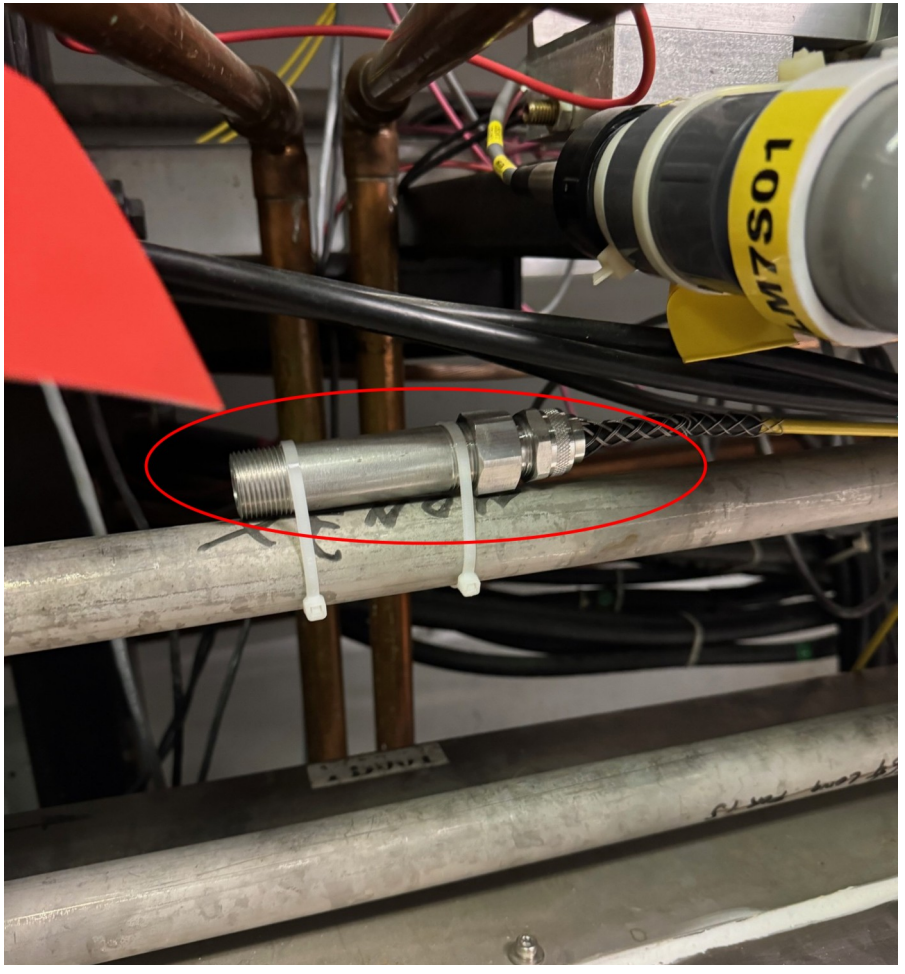


IDX9S00


IDX
3
ILM9S00
XW5S04
WEIGHT 5300 LBS.
MYR9S05
otal Weight: 5300 lbs
Powered By: ARC5A
LCW Supply: LCW-1S-S-02E
LCW Return: LCW-1S-R-02E

IDX7S01



4/6/8/A E02 IDX