

# MSU FRIB

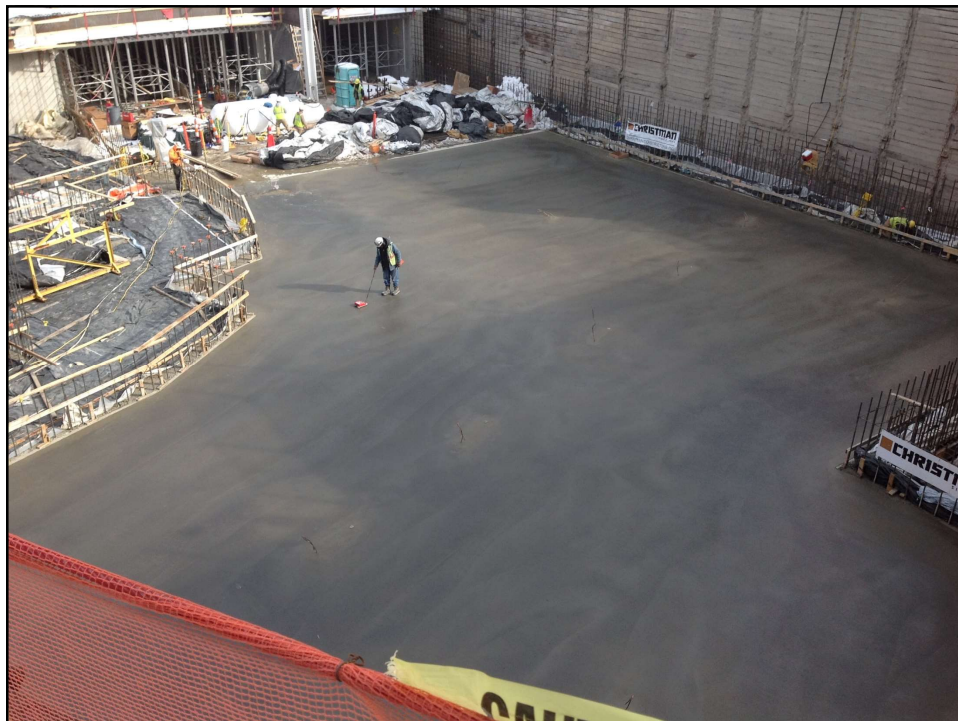
Facility for Rare Isotope Beams

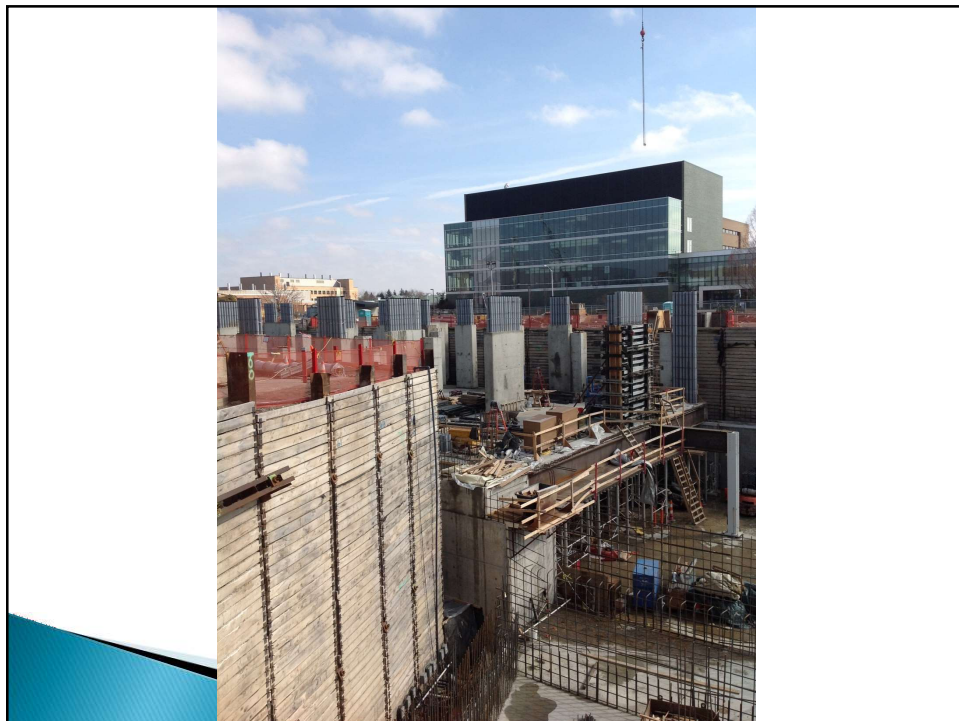
## Facility For Rare Isotope Beams

- ▶ \$730 million (base)
  - DOE / SOM / MSU
- ▶ A scientific accelerator facility for nuclear science:
  - Provides intense beams of rare isotopes (short lived nuclei not normally found on earth)
- ▶ Will advance knowledge in:
  - Nuclear physics & nuclear astrophysics
  - Fundamental interactions of nuclei
  - Applications of rare isotopes for society

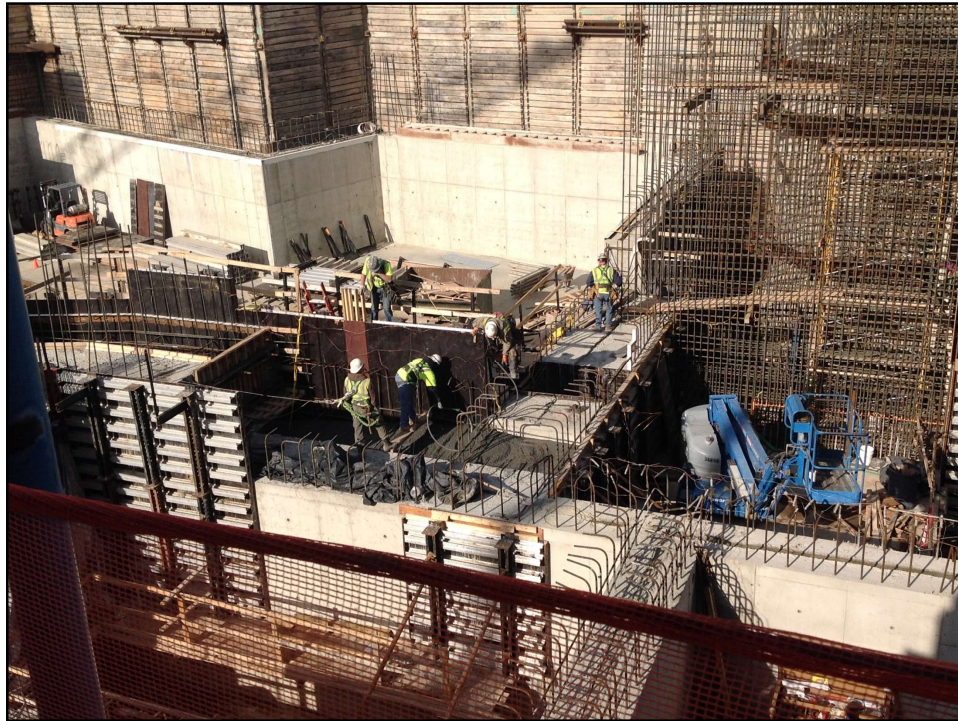
## FRIB CONCRETE SUMMARY

- ▶ Bid in March 2012:
- ▶ ~ 45,000 yards
  - Mass concrete (23k yds)
  - Structural concrete (19k yds)
  - Self consolidating concrete (1k yds)
  - Lightweight concrete (1k yds)
  - Heavy weight concrete (300 yds)









## CONCRETE MATERIALS CHALLENGES

- ▶ 35 F minimum; **70 F maximum** plastic concrete temperature specification for mass placements.
  - ICE:
    - ~ 800,000 lbs (7,600 yards (5/1 – 10/1); 75 lb/yd dosage).
    - @ 82 F mix temp., not enough replaceable mix water (ice) to meet 70 F. No ship / schedule impact.
    - Difficult to meet production rates of 150 – 250 yph.
  - LIQUID N<sub>2</sub>:
    - ~ \$360,000.00 (2 plts; 7,600 yards (5/1 – 10/1); 15 F cooling).



## CONCRETE MATERIALS CHALLENGES

- ▶ Maximum allowable concrete temperature during the period of heat dissipation shall not exceed 160 F.
  - Thermal modeling of test blocks of proposed mass mix showed a 62 F adiabatic temperature rise.
  - 90 F initial + 62 F adiabatic = 152 F maximum.

## CONCRETE MATERIALS CHALLENGES

SPREAD AND CONTINUOUS FOOTINGS	4000 PSI
PITS, TRENCHES, WALLS, GRADE BEAMS	4000 PSI
SLAB-ON-GRADE	4000 PSI
SUPPORTED SLABS, BEAMS, COLUMNS	4000 PSI
ALL OTHER CONCRETE, UNLESS OTHERWISE NOTED	4000 PSI
LEAN CONCRETE	2000 PSI
CONCRETE EXPOSED TO FREEZING AND THAWING	4500 PSI
MUD MATS	2000 PSI
HIGH DENSITY	4000 PSI
RF CONDUIT ENCASEMENTS	2000 PSI

CONCRETE EXPOSED TO WEATHER OR FREEZING SHALL BE AIR-ENTRAINED. EXTERIOR BEAMS, COLUMNS, WALLS, GIRDERS, SLABS, OR ANY OTHER CONCRETE CAST DURING COLD WEATHER SHALL BE CONSIDERED AS CONCRETE EXPOSED TO WEATHER AND FREEZING.

## CONCRETE MATERIALS CHALLENGES

- ▶ 8 degree F heat gain difference between a 4,000 psi non-air mix versus a 4,500 psi air entrained mix.
- ▶  $160\text{ F max}_{\text{spec}} - 70\text{ F adiabatic}_{4500\text{ AE}} = 90\text{ F max}_{\text{int}}$
- ▶ 85 F initial temp (safety).

## CONCRETE MATERIALS CHALLENGES

- ▶ Proposed 4,000 Non-air Entrained Mixture:
  - Thermal ramifications.
  - 56 day  $f'_c$  for all mass concrete.
  - Air content: Do not allow air content of trowel-finished slabs to exceed 3 percent.

## CONCRETE MATERIALS CHALLENGES

- ▶ High Density Concrete:
  - 250 pcf nominal expected density
  - 247 pcf minimum expected density
  - 4,000 psi 28-day compressive strength
  - Elemental weight percent composition meeting MSU radiation transport department's design requirements

## HIGH DENSITY PRODUCTION

- ▶ Safety SOP created:
  - Keep all personnel outside of a gravel train's rollover radius (box up).
  - Conveyor belts & scale discharges run at ½ capacity.
  - Bins filled to ½ capacity maximum.
  - Delivery Mixers 3 yard maximum load size.
  - Plant moisture probes turned off. Hot plate only.



## HIGH DENSITY PRODUCTION

### ► Batching & delivery SOP created:

- Stockpiles covered with 10 mil plastic.
- All bins, hoppers, scales and mixers washed before charging HD aggregates or concrete.
- No other concrete batched after wash procedure started.
- Re-temper water not allowed (HRWR used if needed).
- No side tank water allowed on mixers. Wash water on site.

**5/14/2015 DELIVERY  
MSU FRIB  
88.5 YARDS**

<u>YARDS</u>	<u>TIME TESTED</u>	<u>TEMP</u>	<u>DENSITY</u>
3	5:57 AM	60 F	253.1
6	6:16 AM	60 F	252.4
9	6:41 AM	60 F	253.9
12	6:49 AM	60 F	253.7
15	6:56 AM	60 F	258.4
18	7:04 AM	60 F	252.1
21	7:12 AM	60 F	255.3
24	7:22 AM	60 F	252.5
27	7:29 AM	60 F	254.1
30	7:42 AM	60 F	255.3
33	7:49 AM	60 F	256.1
36	7:56 AM	60 F	254.5
39	8:07 AM	60 F	253.7
42	8:15 AM	60 F	251.7
45	8:24 AM	60 F	254.5
48	8:33 AM	60 F	255.3
51	8:37 AM	60 F	258.1
54	8:45 AM	60 F	251.7
57	8:51 AM	60 F	254.9
60	8:58 AM	60 F	252.9
63	9:04 AM	60 F	252.9
66	9:13 AM	60 F	255.7
69	9:24 AM	60 F	256.5
72	9:37 AM	60 F	254.5
75	9:51 AM	60 F	256.9
78	10:02 AM	60 F	254.5
81	10:17 AM	60 F	252.9
84	10:29 AM	60 F	254.5
87	11:42 AM	60 F	253.4

<http://wlns.com/2015/03/03/frib-project-ahead-of-schedule/>

**MEDIAN 60 254.5**  
**AVERAGE 60 254.3**  
**RANGE 0 251.7 - 258.4**

