Abort System Upgrades

Christoph Montag

S. Nayak, P. Thieberger, H. Hahn, M. Blaskiewicz, J. Tuozzolo,
J. Sandberg, A. Zhang, J. Mi, C. Pai, ...

Upgrade areas

- Dump upgrades
- Kicker modifications
- Preventing pre-fires, or damage from them

Dump window replacement

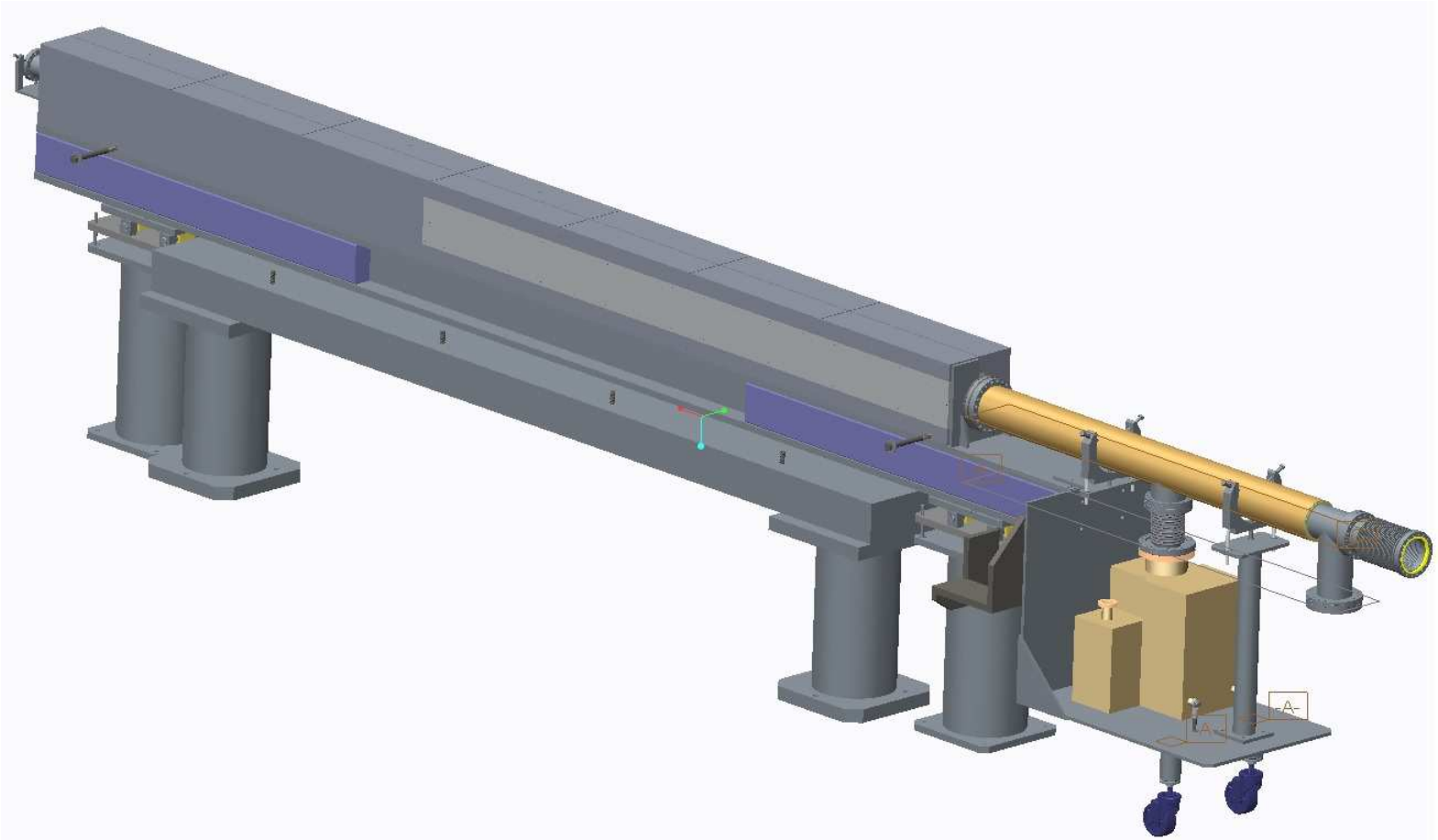
- Ever increasing gold intensities and decreasing emittances may cause mechanical failure of the existing stainless steel window

- ANSYS shows a safety factor of 2.8 at 0.7e9, and 1.4 at 1.6e9 for cooled beams with 4 and 8 πmm mrad, resp.

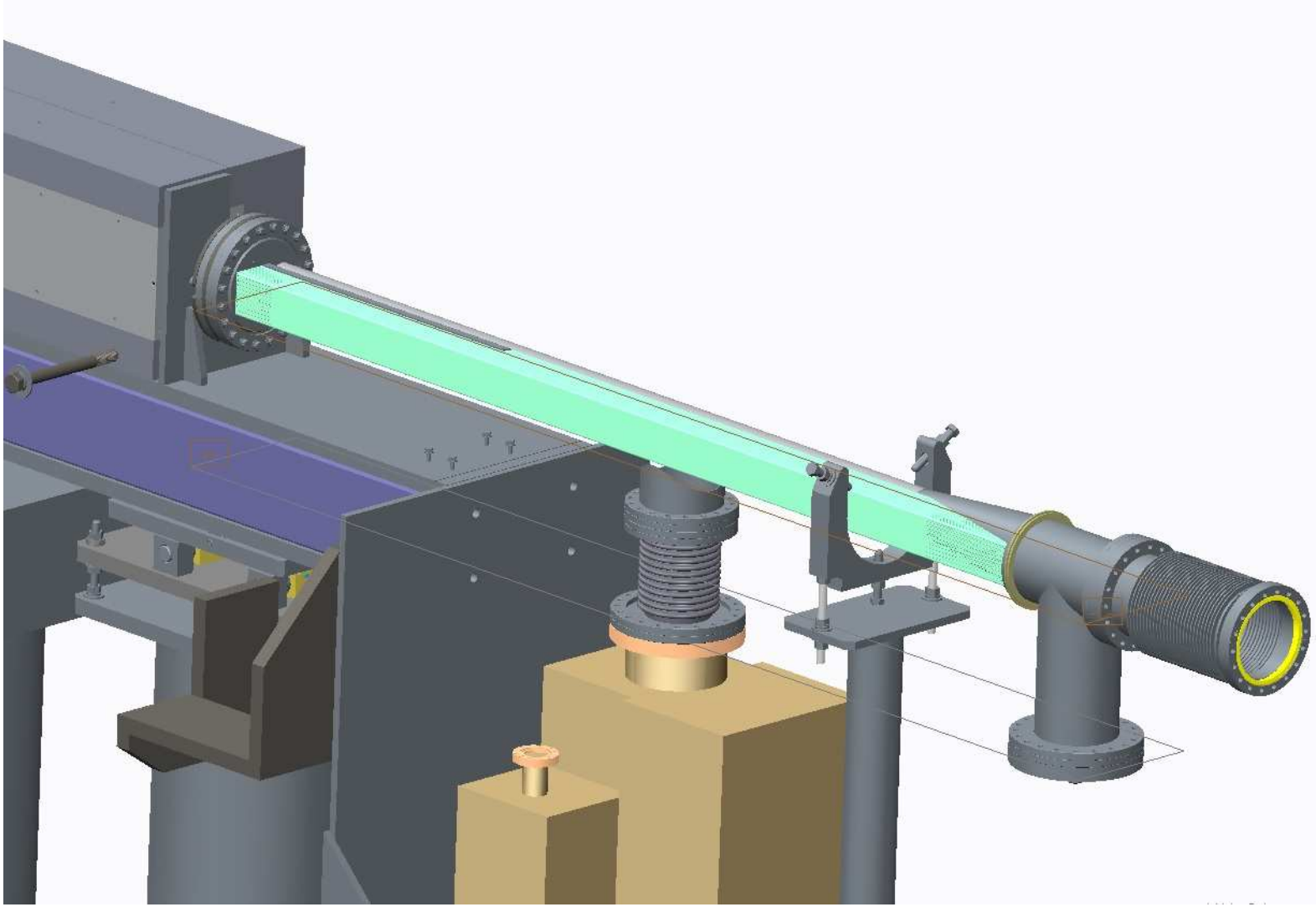
- Safety factor should not drop below 2

- After replacing the window with titanium, 2.1e9 with 10 πmm mrad will yield a safety factor of 2

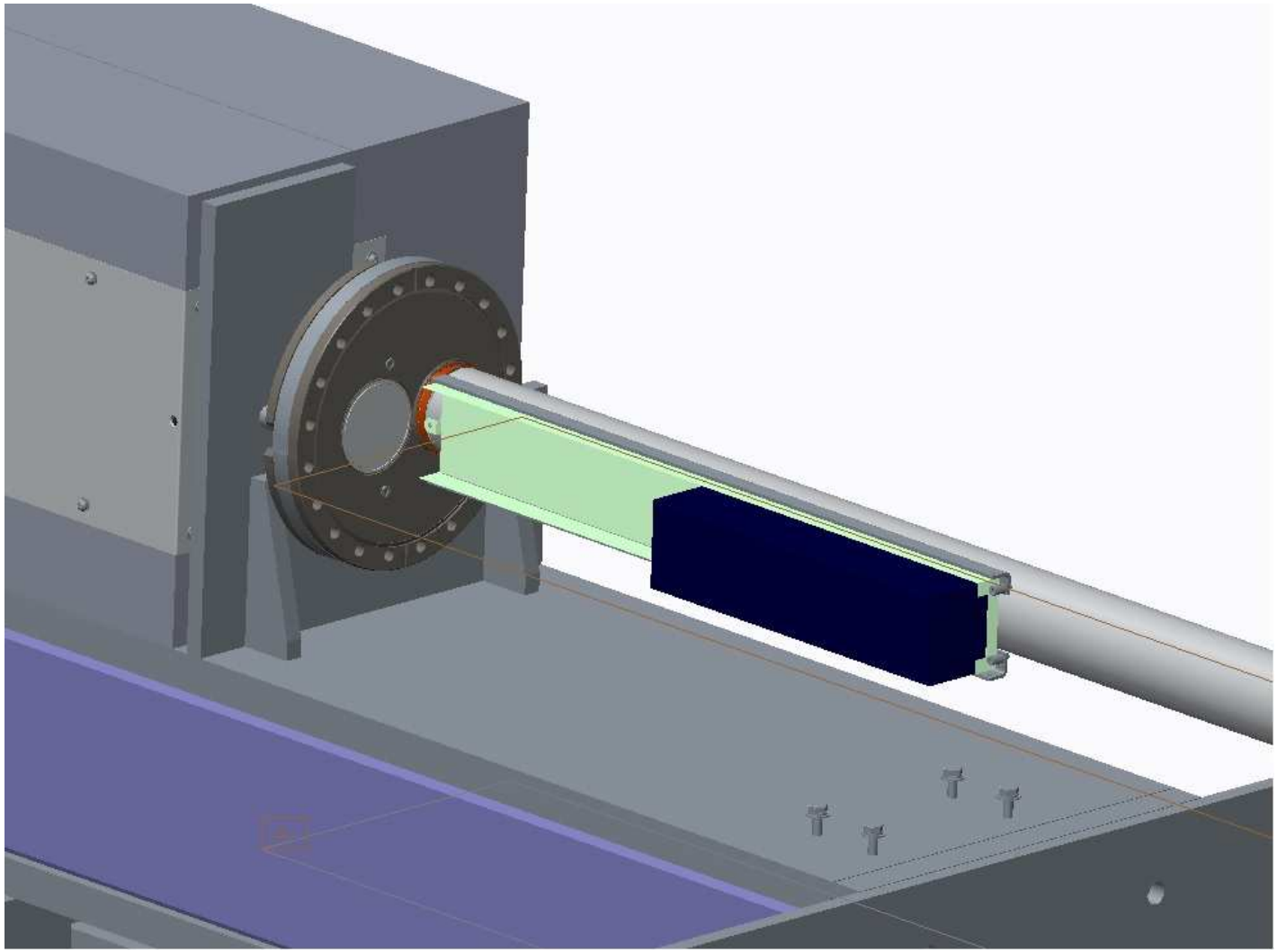
Beam dump assembly



C-C Carbon block upstream of window



Window



Kicker modifications

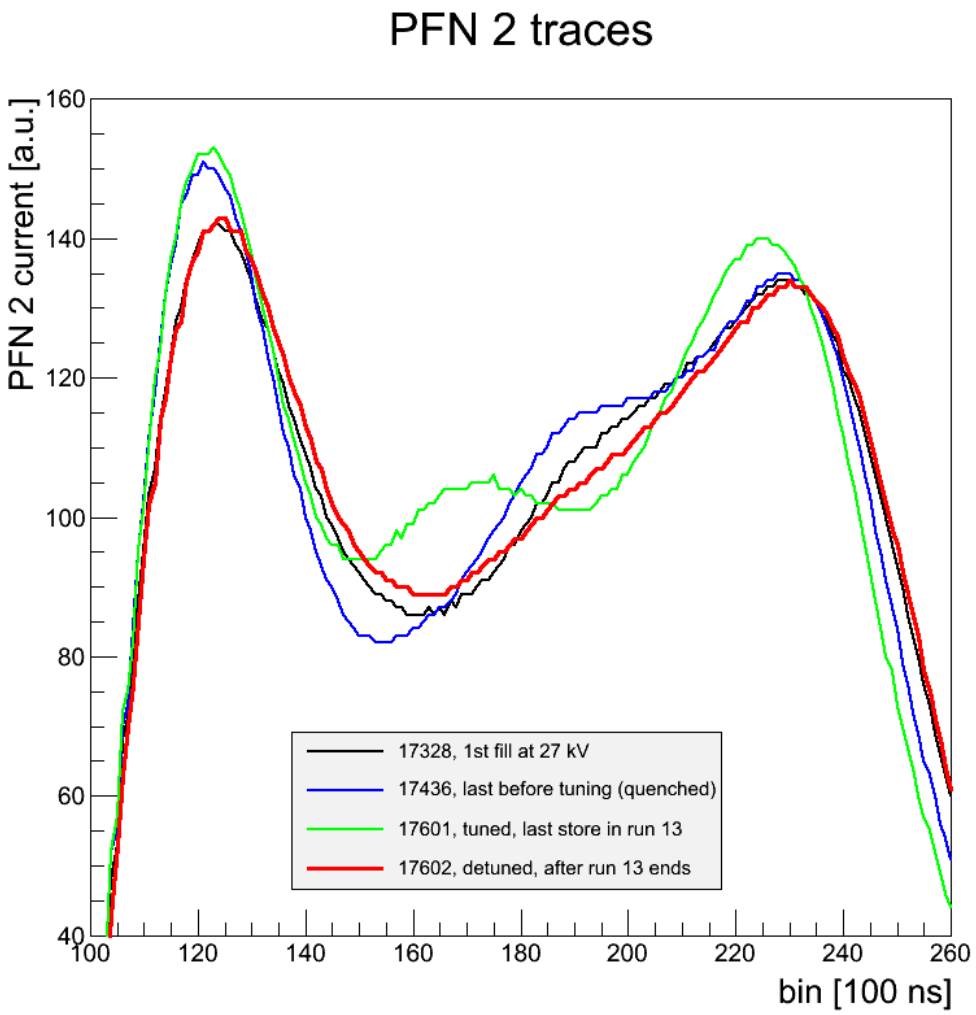
- Deterioration of the kicker pulse shape was observed during Run-13, resulting in frequent quenches of the downstream Q4 magnets

- Beam induced heating of the kicker ferrites was identified as the root cause

- With increased proton bunch intensities and reduced bunch length, this problem is expected to get worse

- Kickers need to be modified

Evolution of Yellow module 2 during Run-13



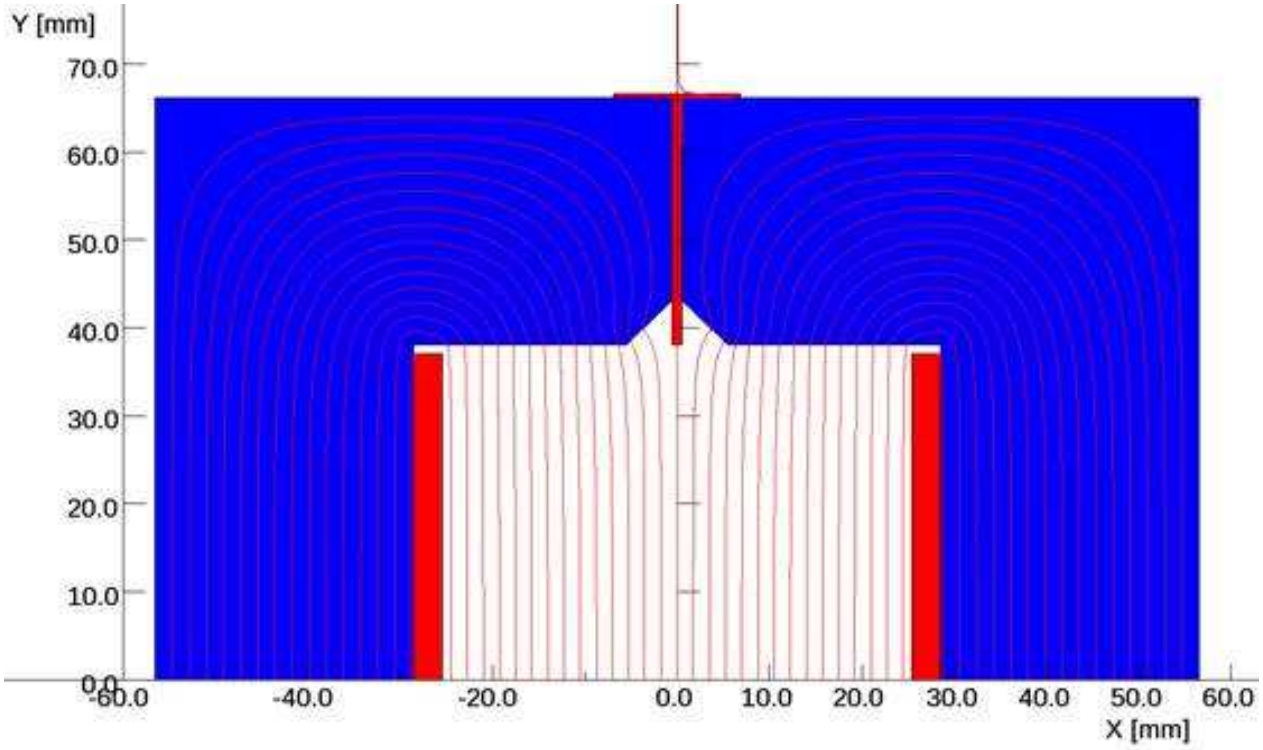
Countermeasures

1. Modified eddy current strip geometry to reduce impedance and therefore heating

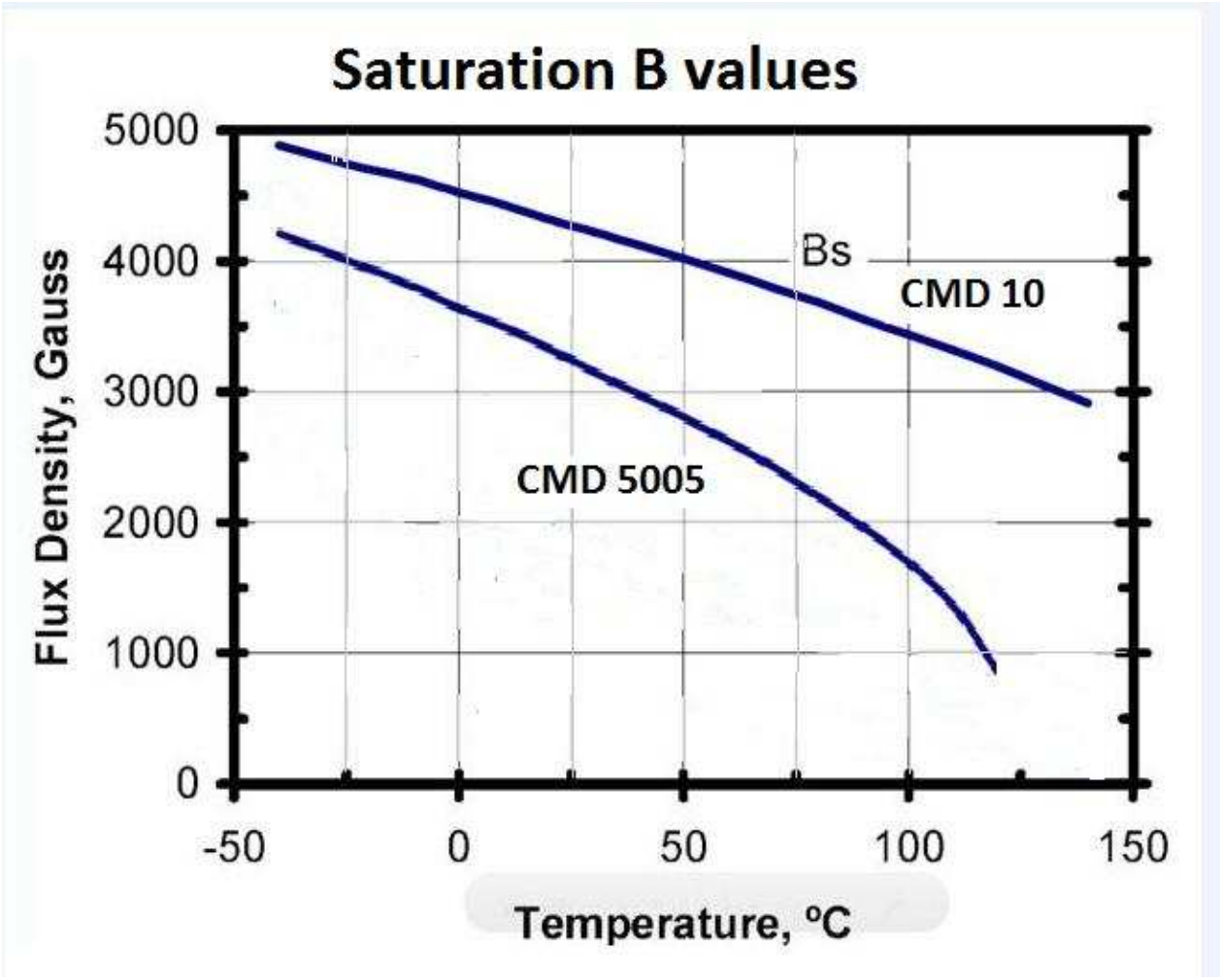
2. Replace CMD-5005 kicker ferrite material with CMD-10, which is less susceptible to temperature increases

3. Add water cooling to reduce ferrite temperature

Chamfered ferrites with modified eddy current strip

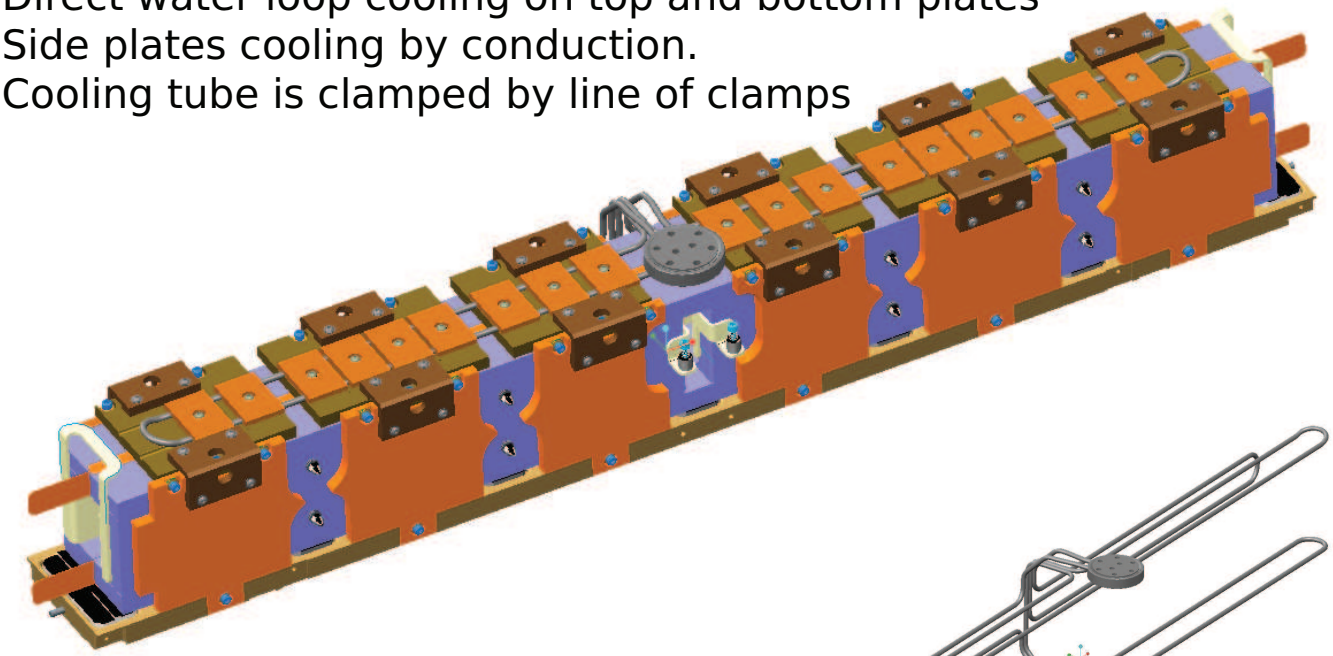


Saturation curves for two different ferrite materials



New Magnet with liquid cooling (Fluorinert)

Ferrite clamped by spring loaded copper plates in all surfaces.
Direct water loop cooling on top and bottom plates
Side plates cooling by conduction.
Cooling tube is clamped by line of clamps

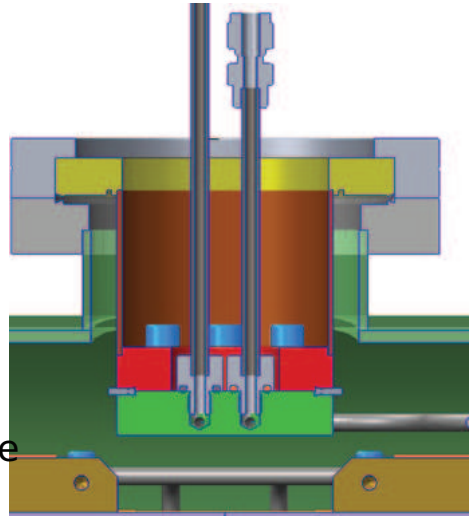


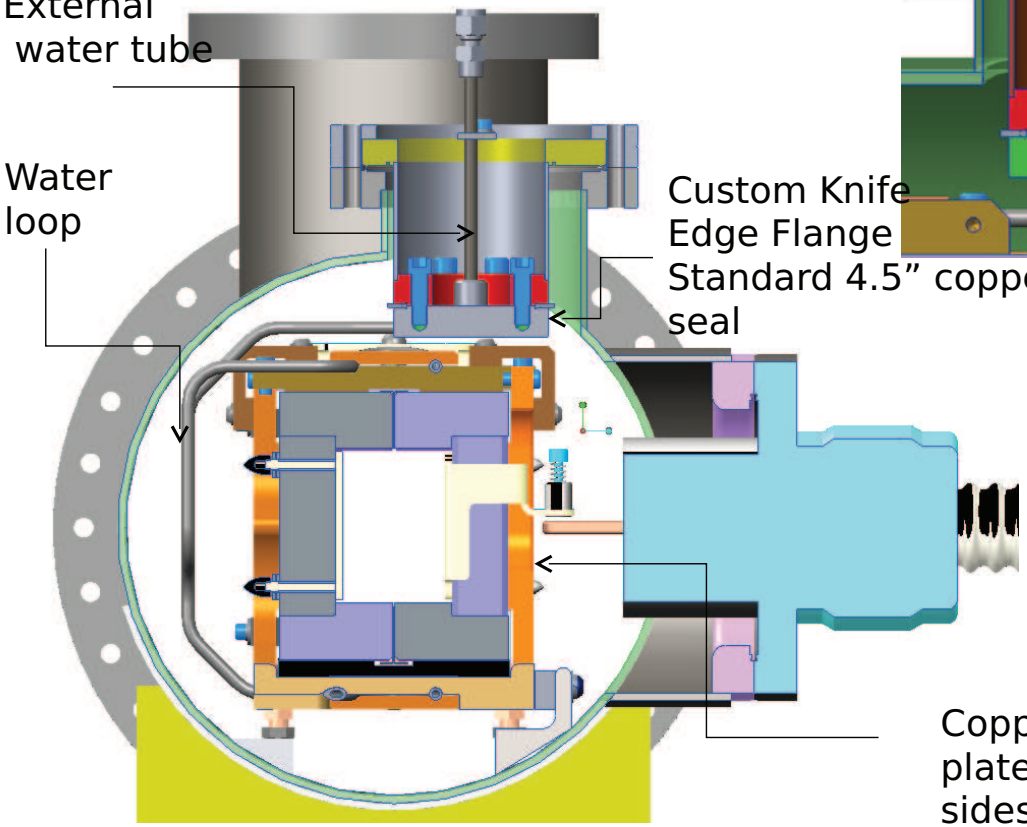
Magnet
Wt. 320 lb

.

Liquid Cooling (Fluorinert FC40):

Continuous liquid loop with knife edge flange for external connection





.

Are pre-fires preventable?

1. Lowering the kicker voltage

   - There is a notion that at lower voltage pre-fires can be prevented
   - Lowering the voltage would require additional kicker modules to provide the same total kick
   - A pre-fire on the ramp at 13 kV showed that pre-fires can happen even at low voltages

   Lowering the kicker voltage may help to reduce the probability of pre-fires, but won't prevent them altogether

2. Conditioning

   - Conditioning to a voltage higher than operationally required should prevent pre-fires
   - Made two series of attempts at conditioning on down-ramps
   - First attempt resulted in a series of pre-fires on subsequent stores
   - Second attempt started after a pre-fire; had several pre-fires after conditioning

   There is indication that conditioning somehow triggers pre-fires on subsequent stores, but statistics is (and always will be) poor

3. Lowering the thyratron reservoir voltage

   - Lowering the thyratron reservoir voltage makes these harder to trigger, therefore reducing the porbability of pre-fires

   - In the past, reservoir voltage was lowered when a particular module pre-fires multiple times

   - If reservoir voltage is set too low, thyratron may not fire

   - At the beginning of each run, all reservoir voltages were re-set to the design value of 5 volts

   Thyratron voltages should be kept at the values found during the run, not re-set to 5 volts every year

Experience at other hadron colliders

- LHC: 8 pre-fires per year, at half the design energy

- HERA: One pre-fire per year

No direct comparison possible due to different modulator technologies
Pre-fires seem unpreventable

Protecting experiments from pre-fires

- Learned just before the run that each and every Blue pre-fire causes detector damage at STAR
- Optics analysis shows that 5 o'clock triplet is first aperture to get hit in case of a pre-fire
- Implemented pre-fire protection bumps in both rings to intentionally lose beam in mid-arc in case of a pre-fire
- Dedicated emergency absorbers will be installed of Run-15 (A. Drees)

No reported detector damage at STAR in RUN-14

Summary

- Higher heavy ion intensities require replacement of the dump window with titanium instead of stainless steel

- Kicker modifications to prevent pulse shape deterioration due to shorter, higher-intensity proton bunches

- Emergency absorbers will protect experiments in case of pre-fires, which seem unpreventable

Upgrades are currently underway for Run-15