

Harvard PCM (Plate Cleaning Machine)

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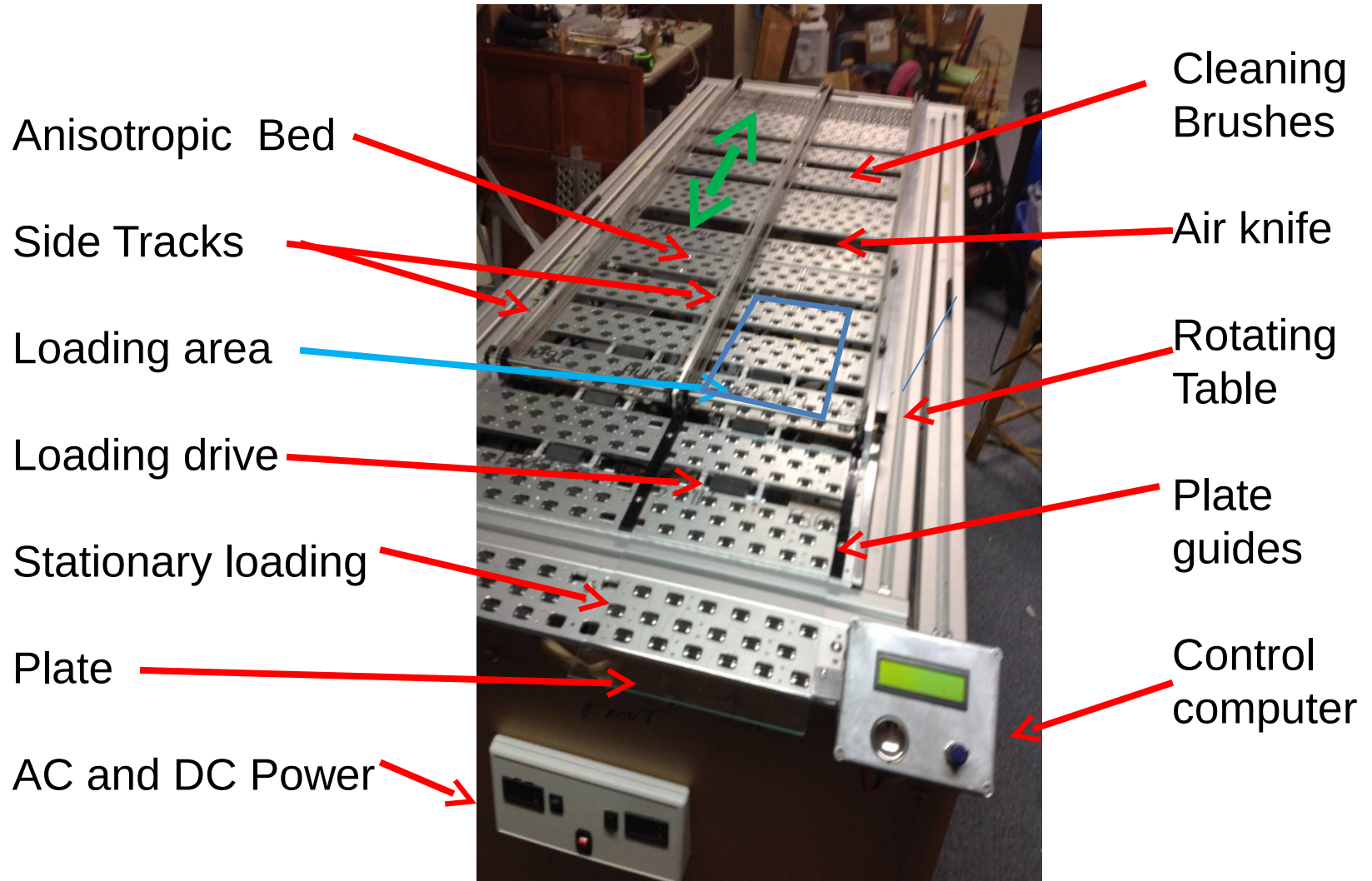
Motivation

- 500,000 plates
- [Http://dasch.rc.fas.harvard.edu/project.php](http://dasch.rc.fas.harvard.edu/project.php)
- ~60,000+ plates scanned during development phase
- Plate cleaning 4-5 x longer than digitizing
- Want to match digitizer rate.
- Hand cleaning too much labor cost to support

PCM overview

- Elements of the design
 - Transport bed
 - Fixture to capture, protect, and move the plate
 - 3 brushes to clean the plate
 - Air knife to blow dry the plate
 - Means to load/unload, the plate into the fixture.
 - Means to move the fixture with the plate

Overview of PCM components



Transport bed

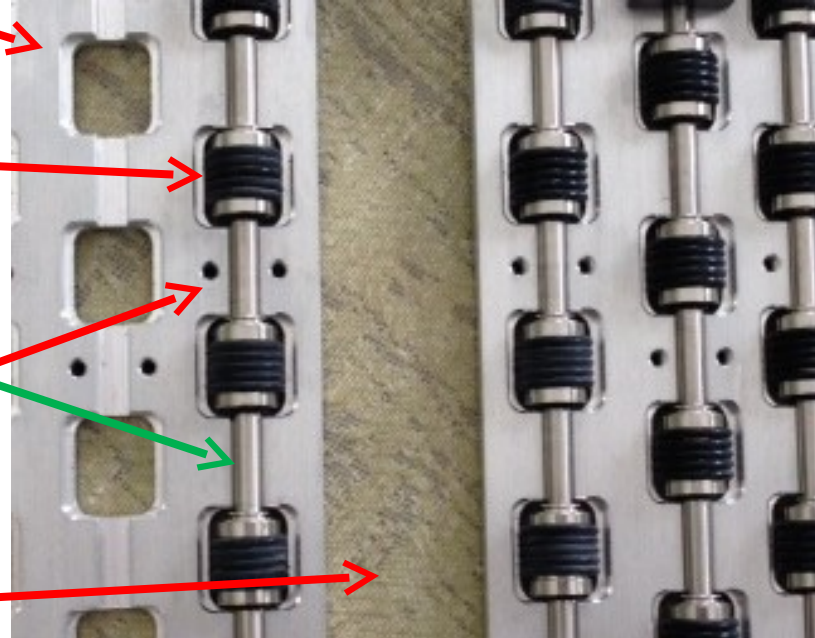
Aluminum base plate

Roller bearing with
O-rings (EDPM rubber)

Stainless steel rod

Screw holes for Delrin
piece to clamp rod

Opening for various
stations



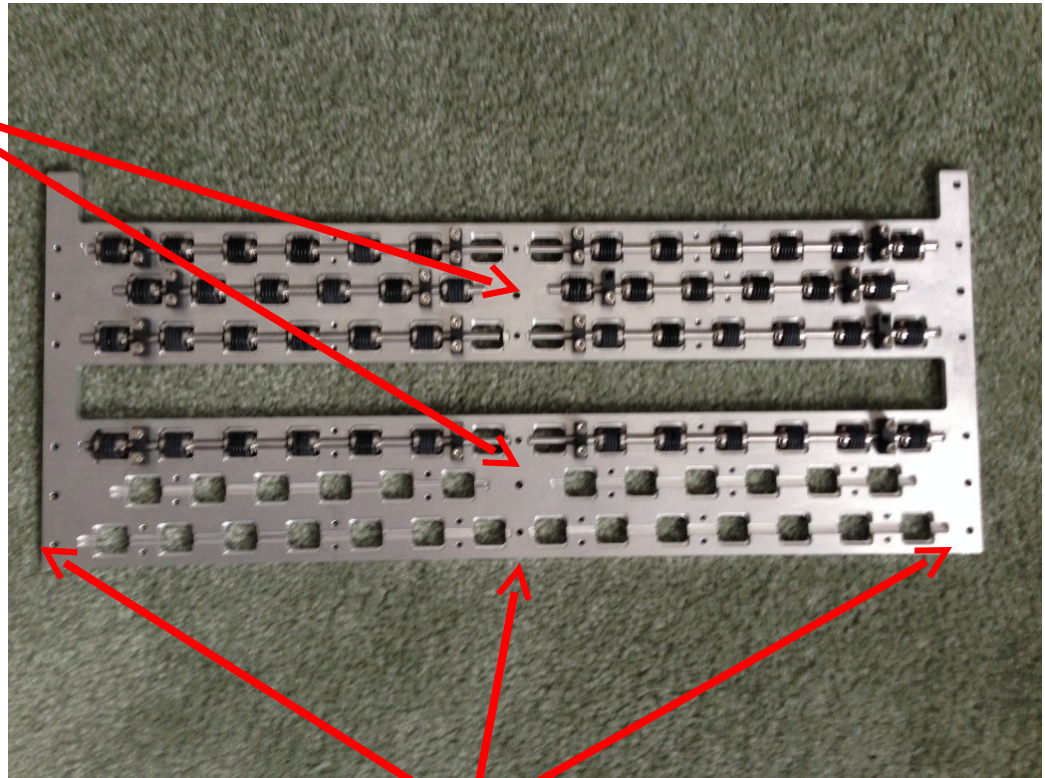
Modular plate for bed

Plate CNC machined in modular sections that could butt together (2 bed sections)

Bed section and work station
Openings flexible

Total bed is 15 ½ bed sections and 12 open areas

Full bed is 564 roller bearings with 2820 EDPM rubber O-rings



Tied together here with long outer rails
and the center rail

Plate fixture without rubber

Plenum with
air holes

Delrin angles

Supports for
air cylinders
to lift fixture

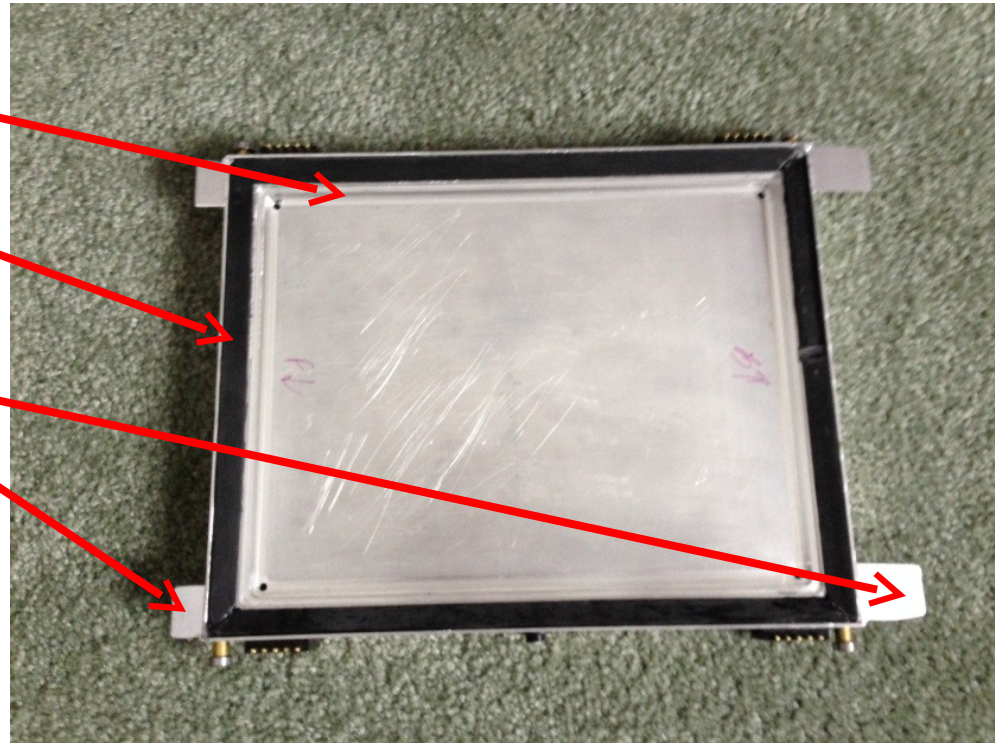
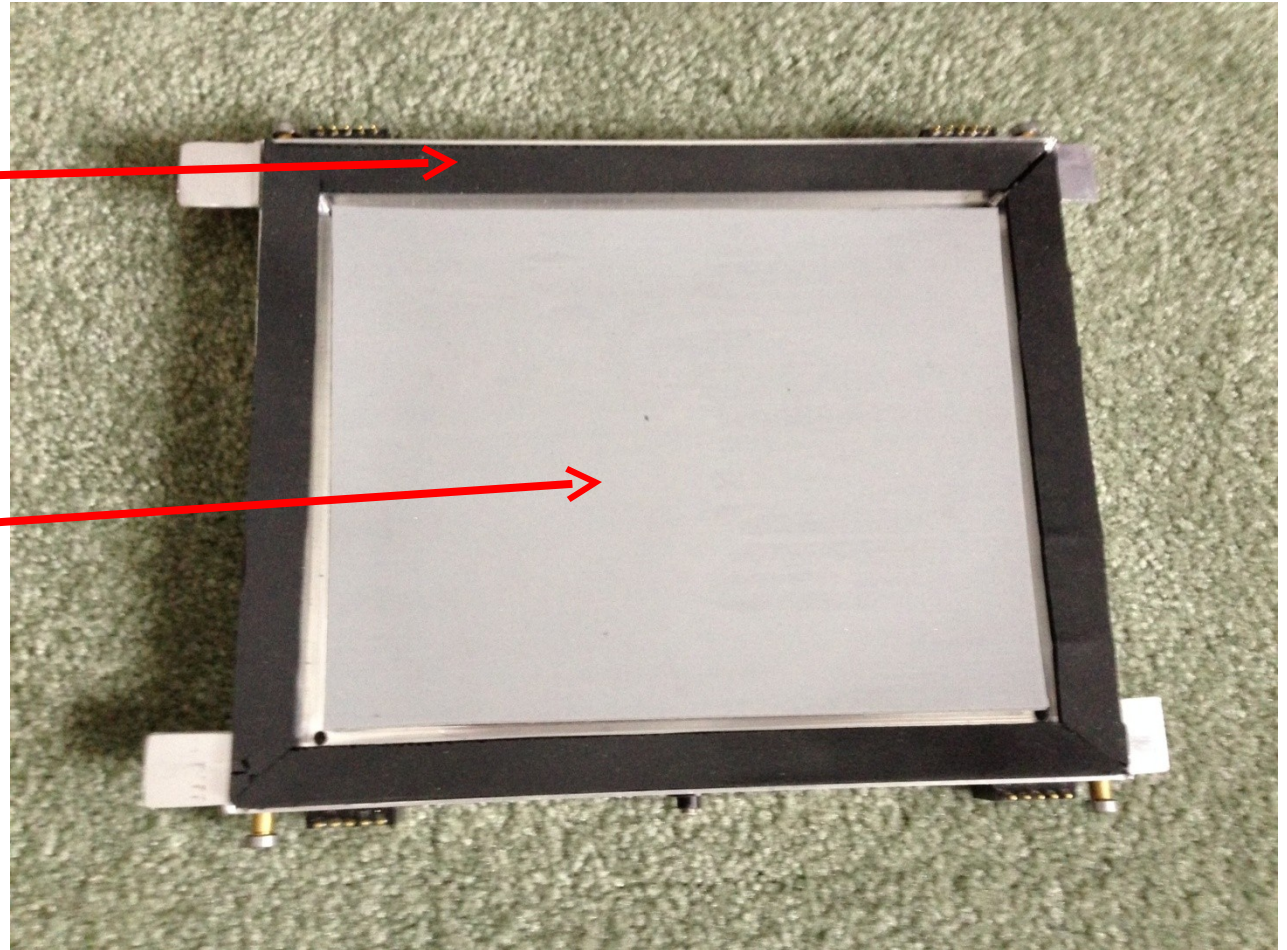


Plate fixture with silicone rubber

Black silicone rubber that is very soft to grab and seal the plate edge

Grey silicone rubber that is harder and protects emulsion



Top side of fixture

Roller bearings
to support plate
on top of side
rails and prevent
lifting by brushes

Drive chain
engagers

Magnetic to trip
sensors along
the track to
verify position.

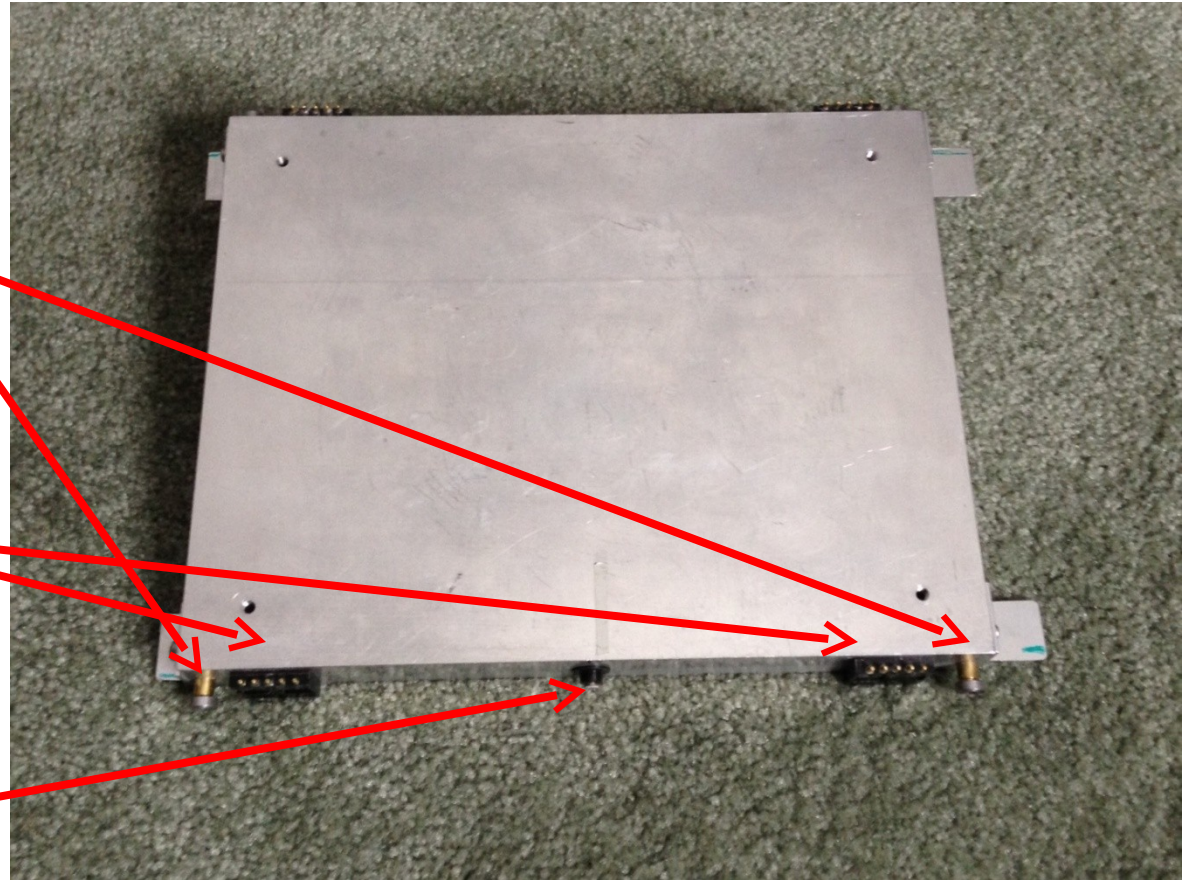
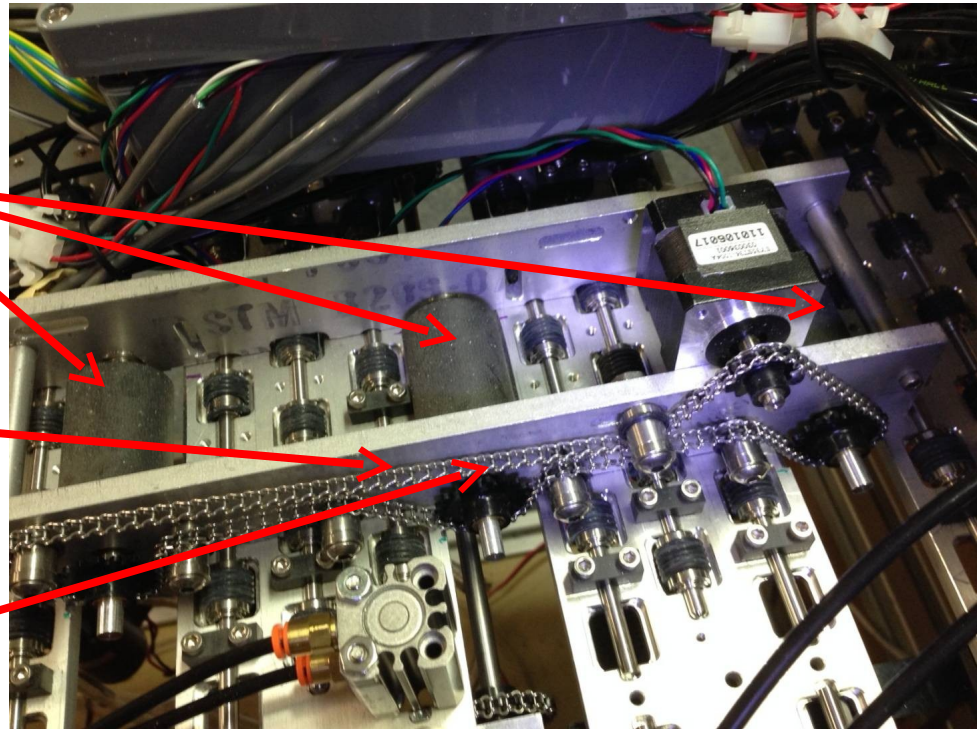


Plate loader

Synchronized rubber rollers move the plate by friction on the no emulsion side,

Stepper motor to load and unload the plates

Chain drive runs all three rollers



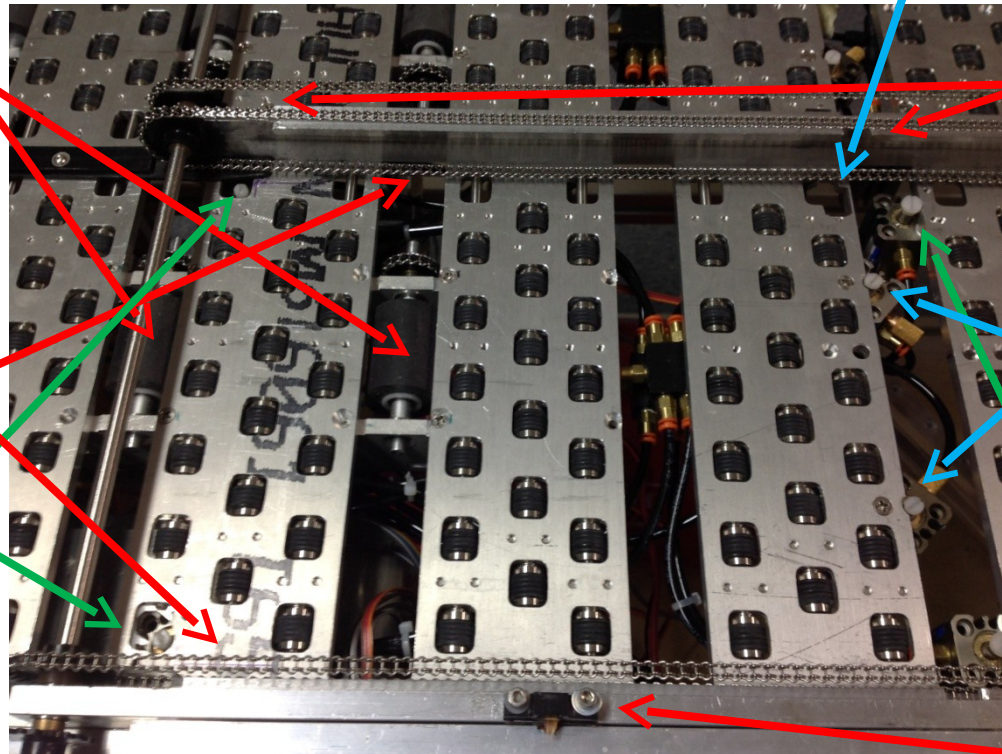
Capture station

Reflective sensor below

Synchronized
Plate drive
rollers

Fixture drive
ladder chain

Air cylinder
lifters



Slots in side
rails where
fixture rollers
can go thru

Plate stops

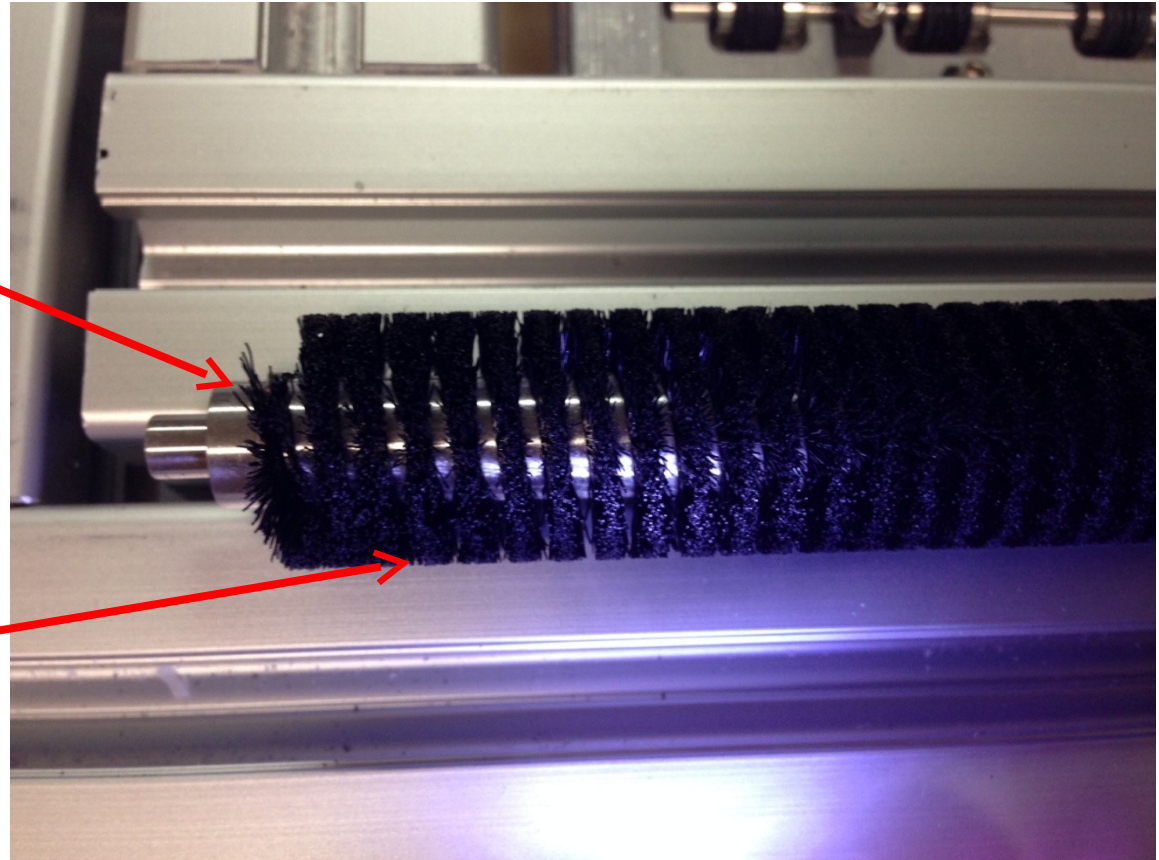
Air cylinder
lifters

Hall sensor to
identify home
position

Custom rotary brush

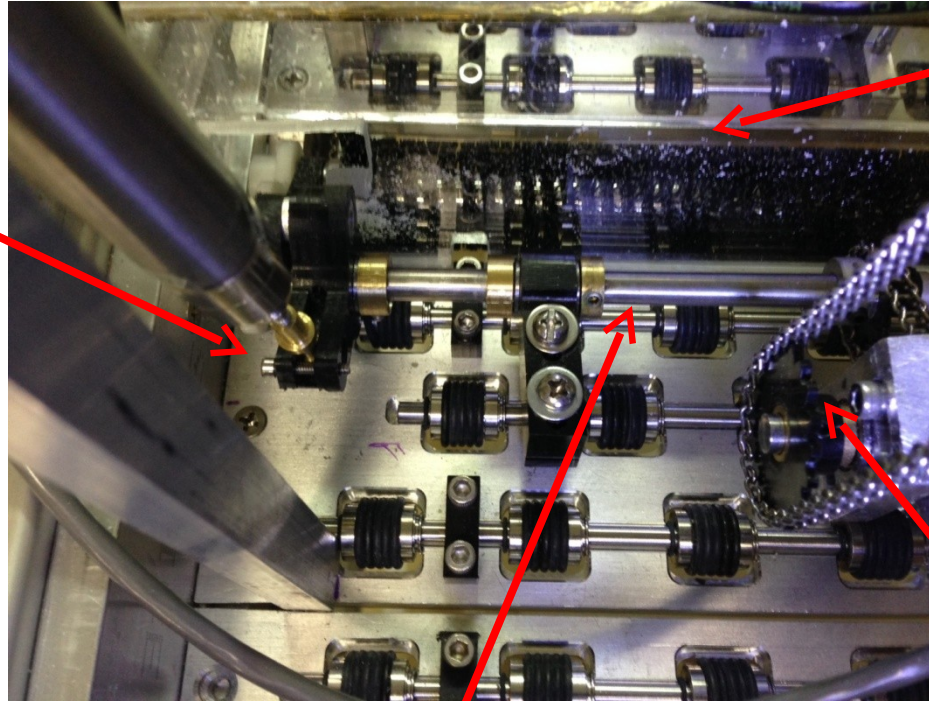
The brush is made from a stainless steel rod that has a spiral groove that holds the bristle with a steel wire

The length, ends, and bristle type and diameter are all custom specified



Controlling the brushes

The brushes are mounted to a Delrin arm at attached to an air-pot “frictionless” air cylinder



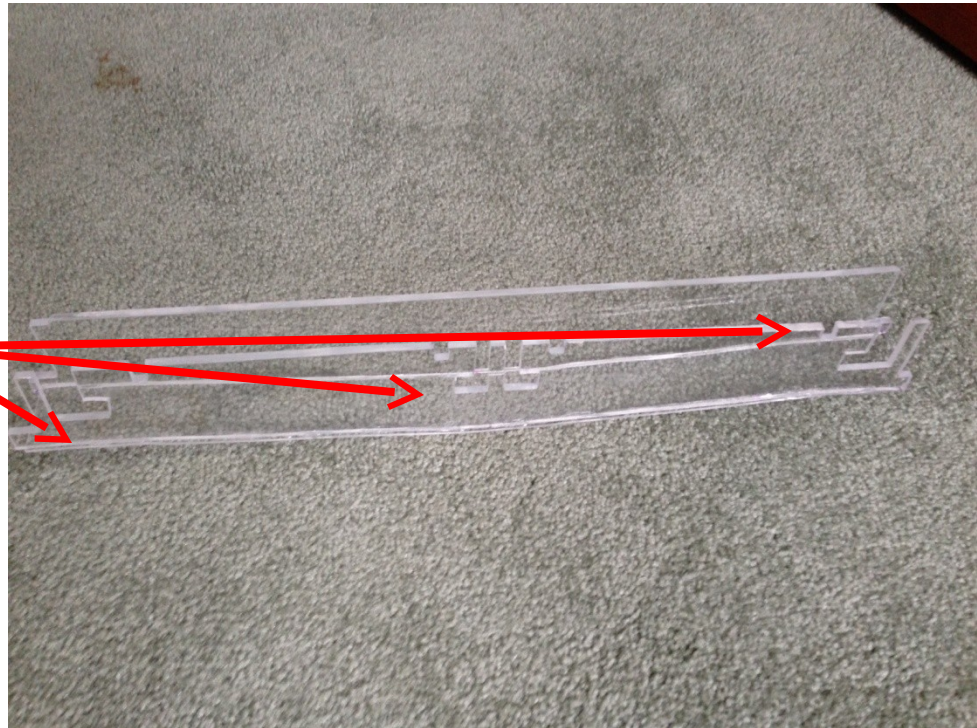
The brush is inside a clear acrylic case to catch excess cleaning fluid as the brush is sprayed with cleaning fluid

The brush is rotated by a stepper motor thru a chain and gear drive system

A rod that is rotated by the stepper motor also acts as the pivot point for the brush to raise and lower the brush

The acrylic catch tank

Each set of brushes at the same position on the two tracks has a custom made cleaning fluid catch tank. The sides of the tank allow the brush mechanisms to lift and lower the brushes

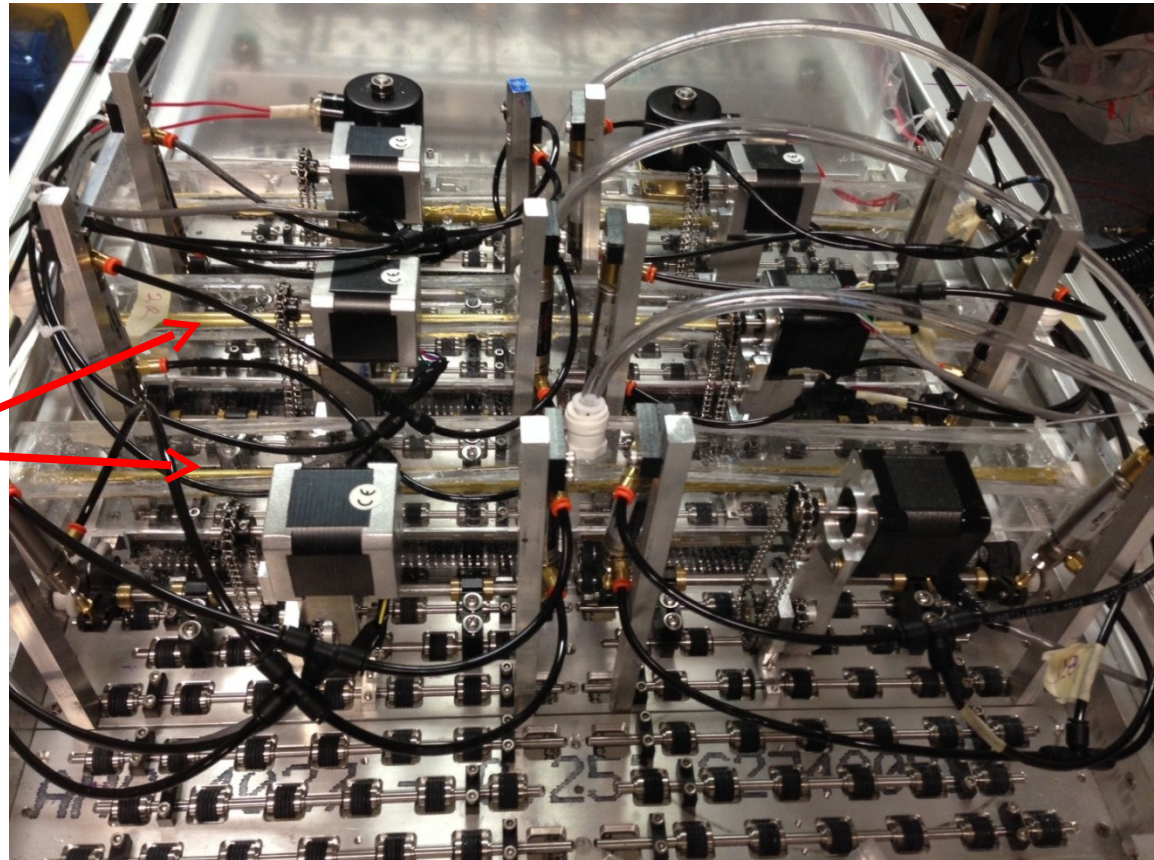


The six brushes

(three for each side)

The acrylic catch
tubs are shared
across two tracks

The brushes are
wet by brass tubes
with a series of .
015 holes that
spray up against a
lowered brush



The three Brush cleaning stations

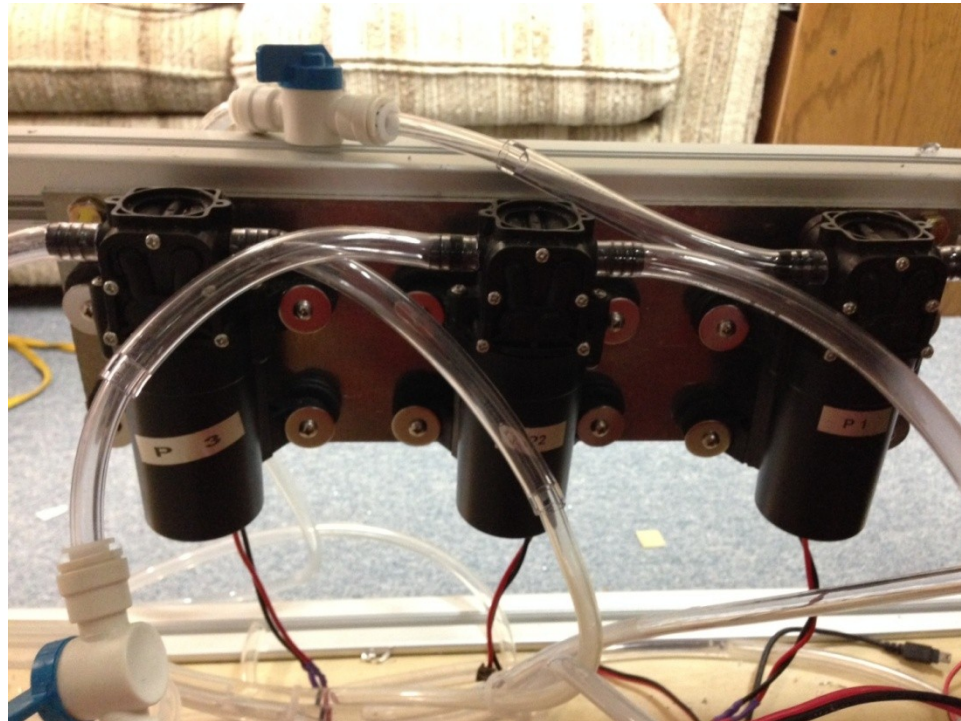
The three brushes for each track are raised against the plates and rotated to scrub the plates clean.



Cleaning fluid pumps

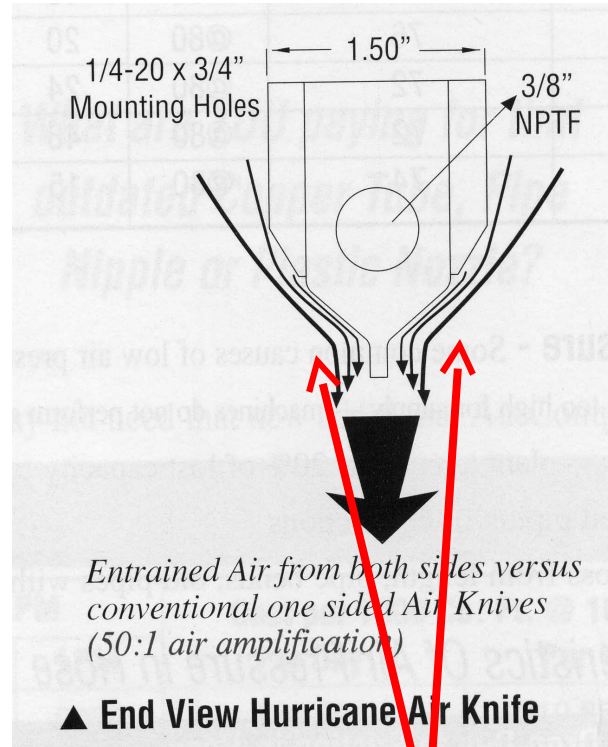
The cleaning fluid pumps are individually controlled one for each brush

Fluid moves in a series of tanks from the brush closest to the air knife to the one furthest back



The air knife dryer

Drying is done by a curtain of air created by an air knife designed to use compressed air to move 40-50 x the volume of compressed air consumed. (the Coanda effect)



Compressed air comes out two .001 in(.02mm) slots

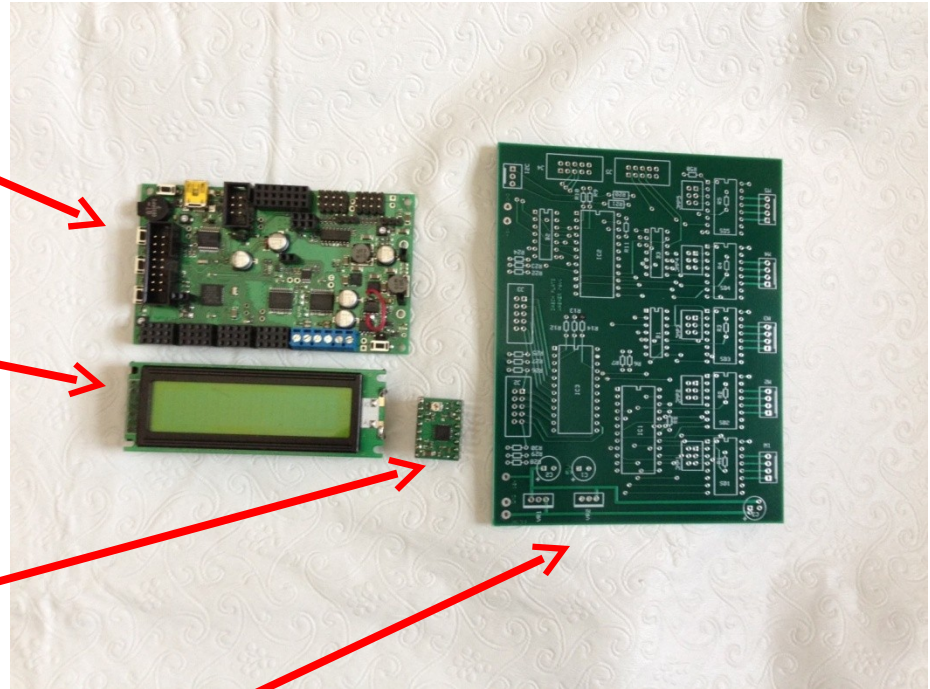
Electronic control boards

The pololu computer board

The pololu LCD display

The pololu stepper motor driver

The custom designed I/O expander board



The custom I/O expander board

5 motor drivers

Output connectors

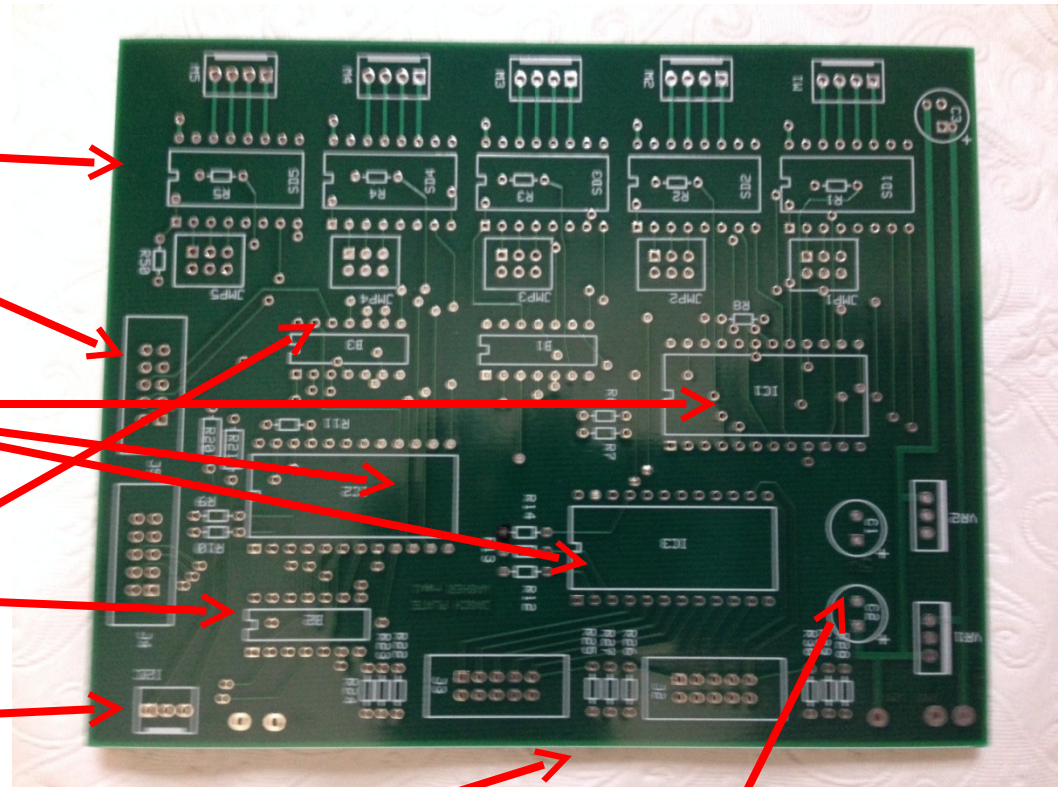
Three I2C I/O
expander chips

3 open collector
(12v) driver chips

I2C input pins

Input connectors

12V and 5 volt supplies



Cleaning cycle

