Development & Integration of a 7th Axis Rail system for a Fusion Tokamak Robot

SAN DIEGO STATE UNIVERSITY
College of Engineering

GENERAL ATOMICS

DIII-D NATIONAL FUSION FACILITY

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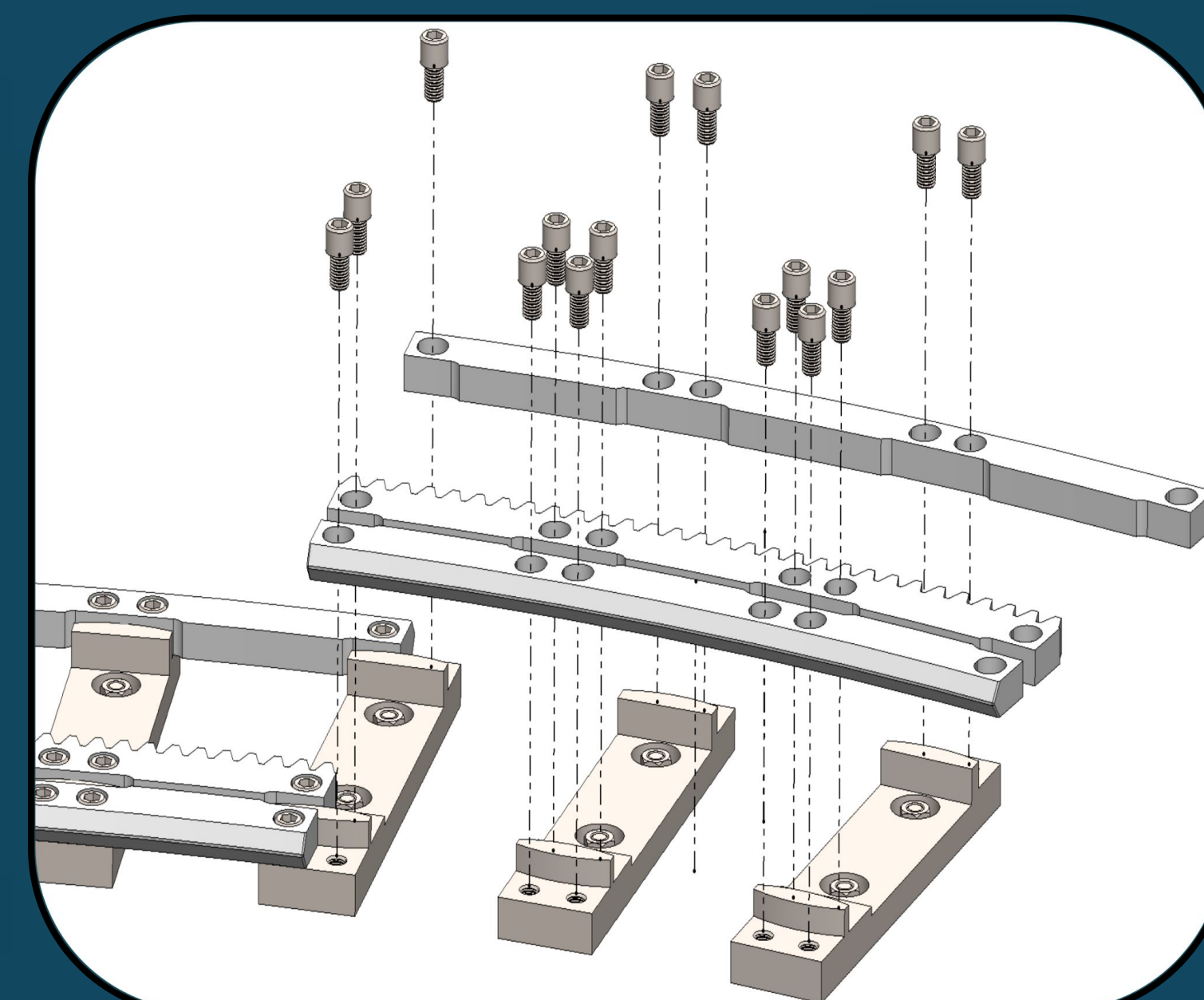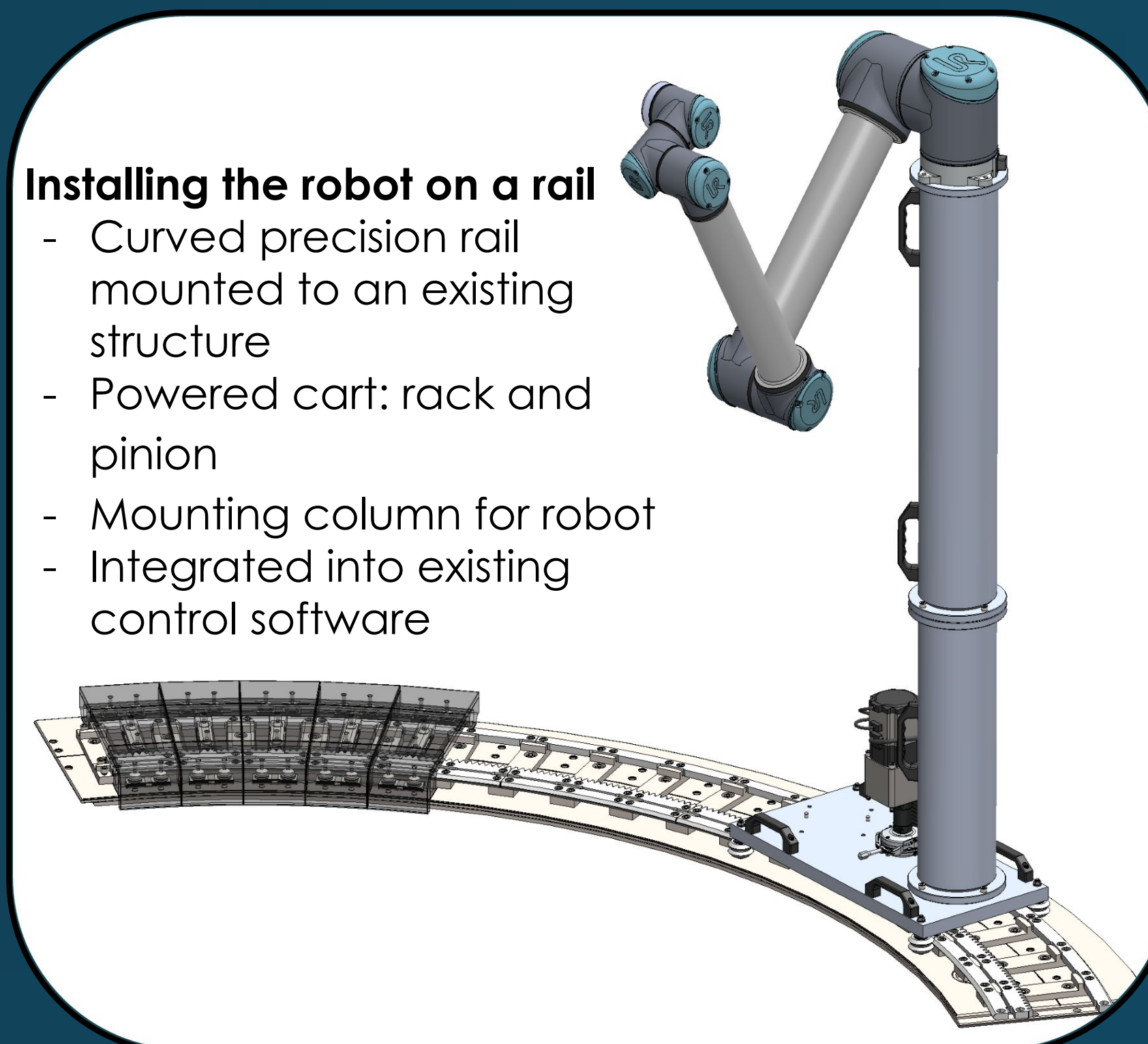Systems Engineer

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Control Integration

Project Overview

DIII-D employs a 6-axis robotic arm for tasks inside a fusion reactor for welding and calibrations, but its range of access is limited. This project aims to integrate a curved rail into the system, increasing the range and capabilities of the robot arm.
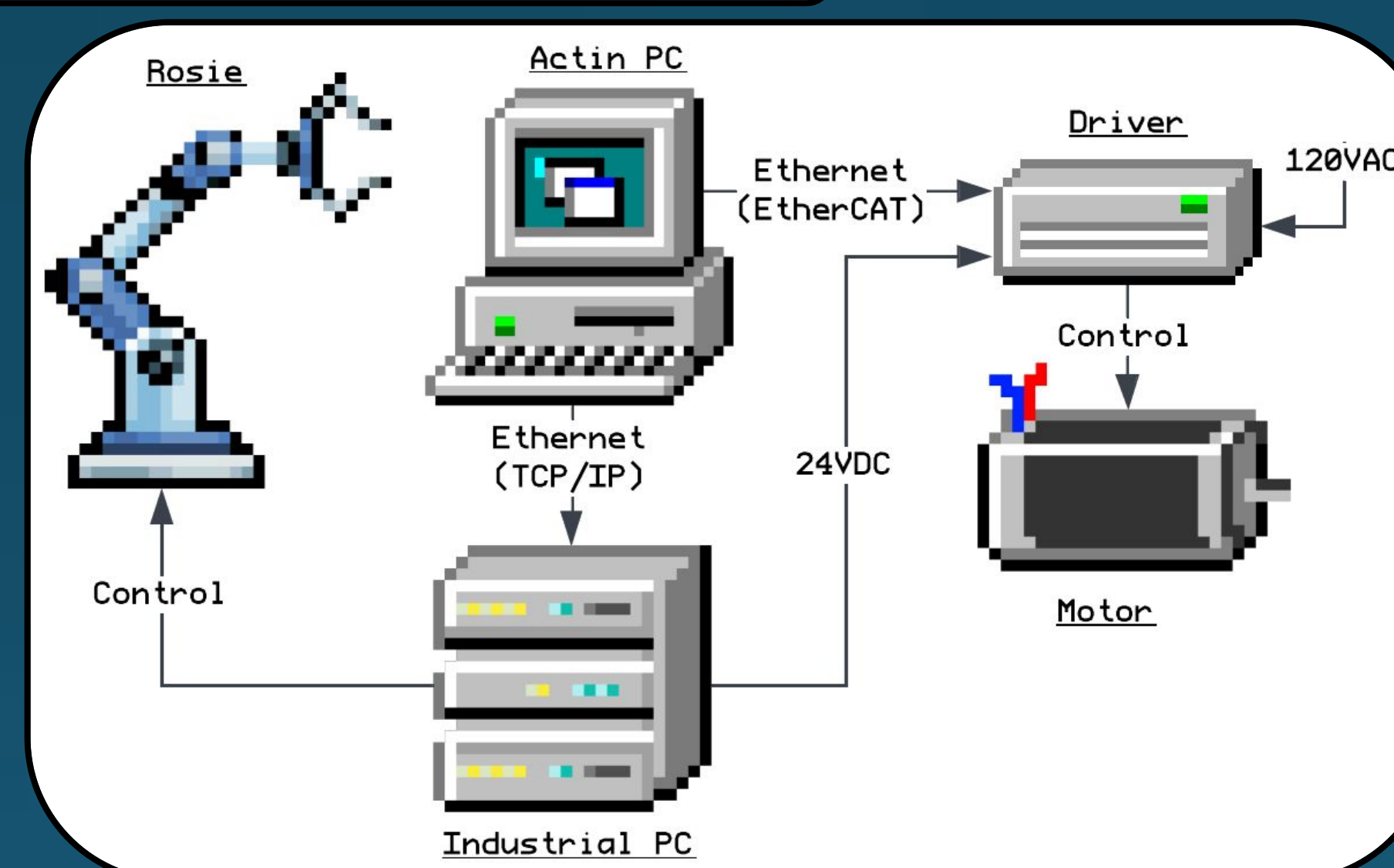
General Atomics DIII-D

The DIII-D National Fusion Facility is operated by General Atomics for the U.S. Department of Energy. It is pioneering the science and innovative technology that will enable the development of nuclear fusion as an energy source for the next generation.

Proposed Solution

Installing the robot on a rail
- Curved precision rail mounted to an existing structure
- Powered cart: rack and pinion
- Mounting column for robot
- Integrated into existing control software
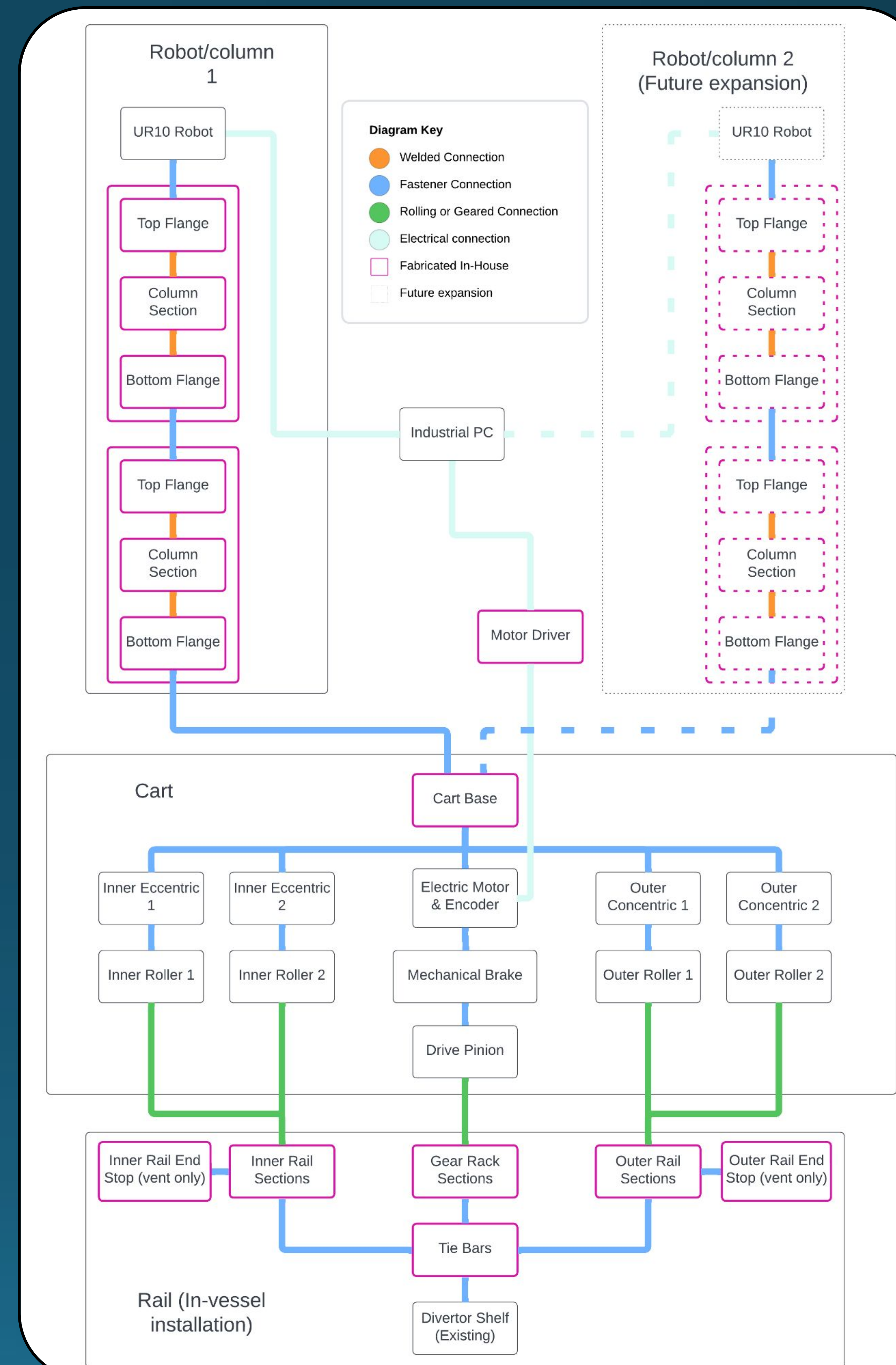
Motor Control System

- The cart stepper motor driver acts as the EtherCAT slave.
- An EtherCAT master is integrated inside the Python GUI using PySOEM.
- Universal Robotics: Actin is used for robot arm control.

Rosie
Actin PC
Driver
120VAC
Ethernet (EtherCAT)
Control
Ethernet (TCP/IP)
24VDC
Motor
Control
Industrial PC

Assembly & Manufacturing

System Level Diagram

Robot/column 1
Robot/column 2 (Future expansion)

UR10 Robot
UR10 Robot

Diagram Key
- Welded Connection
- Fastener Connection
- Rolling or Geared Connection
- Electrical connection
- Fabricated In-House
- Future expansion

Top Flange
Column Section
Bottom Flange
Top Flange
Column Section
Bottom Flange

Industrial PC

Top Flange
Column Section
Bottom Flange
Top Flange
Column Section
Bottom Flange

Motor Driver

Cart
Cart Base

Inner Eccentric 1
Inner Eccentric 2
Electric Motor & Encoder
Outer Concentric 1
Outer Concentric 2

Inner Roller 1
Inner Roller 2
Mechanical Brake
Outer Roller 1
Outer Roller 2

Drive Pinion

Inner Rail End Stop (vent only)
Inner Rail Sections
Gear Rack Sections
Outer Rail Sections
Outer Rail End Stop (vent only)

Tie Bars

Rail (In-vessel installation)
Divertor Shelf (Existing)

Acknowledgements

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