



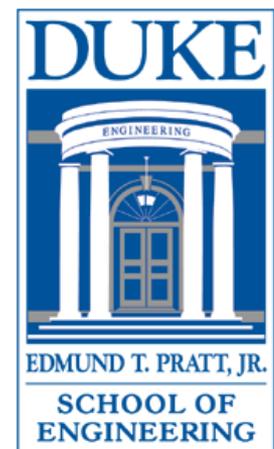
Managed by Fermi Research Alliance, LLC for the U.S. Department of Energy Office of Science

ADC Transmission

Mauricio Villa

GEM Fellow, Duke University

16 August, 2016

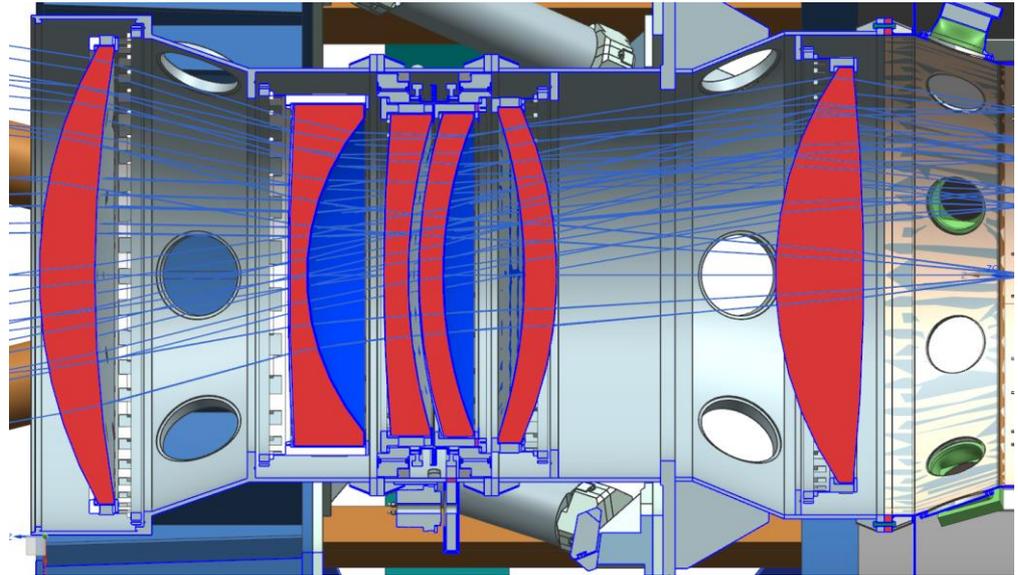


Outline

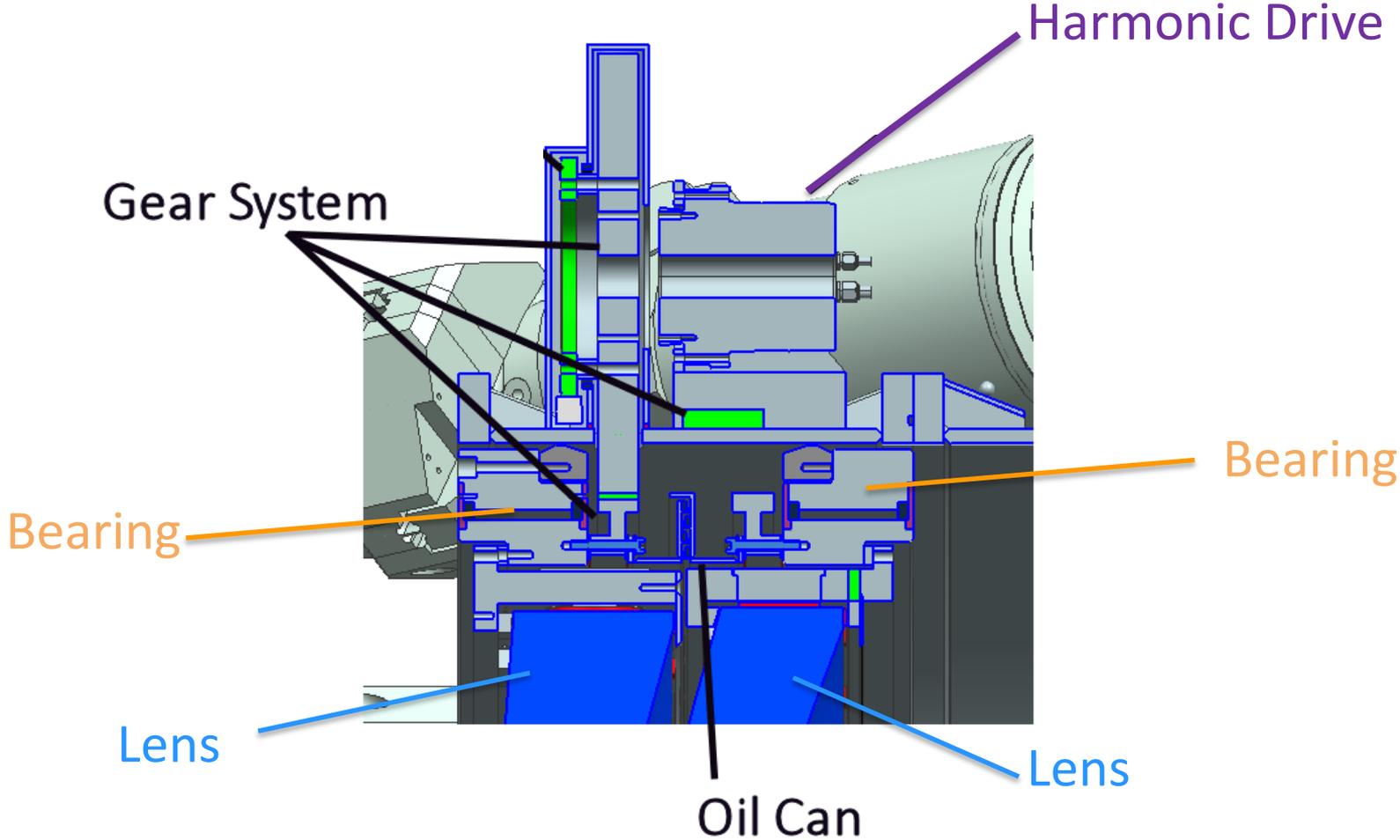
- **ADC Introduction**
- ADC Transmission Options
 - BRECOFlex Belts
 - NEXEN Roller Pinion Gear
- Conceptual Design of Motor Platform
- Questions

ADC Introduction

- DESI -- Dark Energy Spectrographic Instrument
 - Mayall Telescope at Kitt Peak, AZ
- ADC -- Atmospheric Dispersion Corrector lens
 - There are 2 lenses used to correct for light dispersion caused by the atmosphere



ADC Introduction: Specifications



ADC Introduction: Specifications

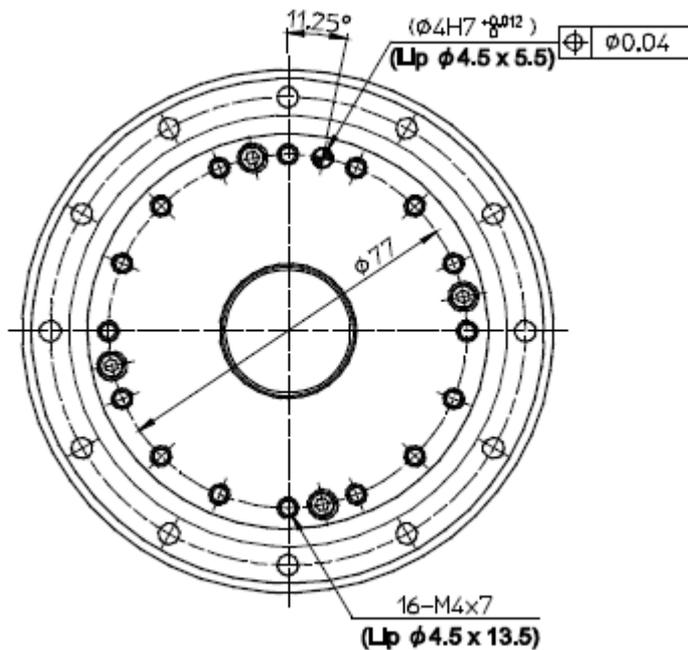
Description	Value
Rotational Load (ADC lens, cell, bearing and fasteners)	Weights = 214 kg (472LBS) wr ² = 40.8 kg-m ² (968 Lb-ft ²)
Starting Torque	100 Nm (885 LB-in)
Running Torque	80 Nm (708 LB-in)
Driven Gear Rotation Speed range	0 to 10 degrees/sec (0 to 1.7 rpm)
Rump-up/down	Max 3 seconds
Lifetime	155,000 duty cycles over a 5 year period
Idle time	months
Accuracy on the rotation	+/- 0.1 degree
Tangential Backlash	NONE if possible
Gear centers distance	584mm +3mm/0 or (23.000" +0.125"/0)
Driven gear addendum diameter	951mm 0/-3mm or (37.450" +/-0.125")
Material	Steel/Plastic
Protection from corrosion	Required
Minimum safety factor against Yield, fracture or buckling	4.0
Optimization of weights	required
Maintenance/cleaning of gears from outside of barrel	No lubrication is HIGLY preferable

Outline

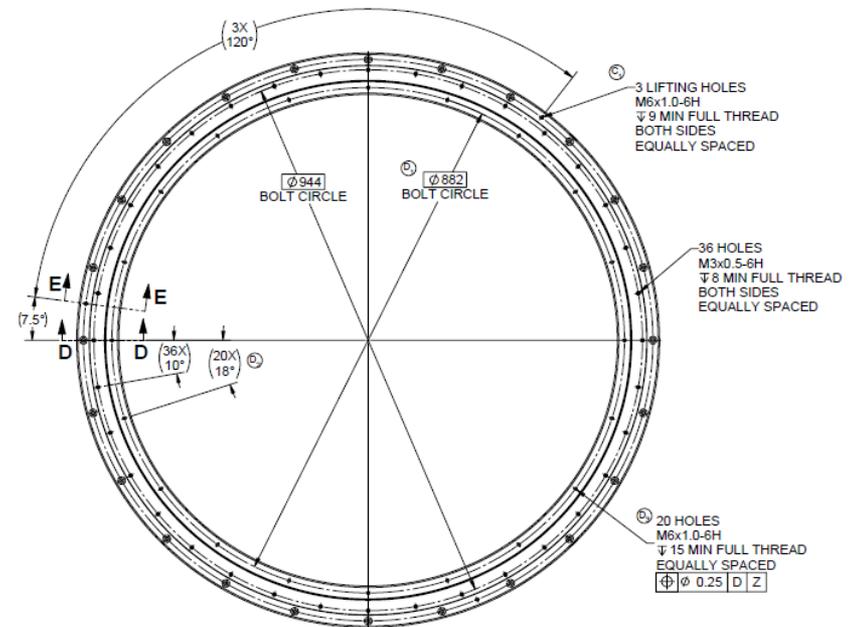
- ADC Introduction
- **ADC Transmission Options**
 - **BRECOFlex Belts**
 - **NEXEN Roller Pinion Gear**
- Conceptual Design of Motor Platform
- Questions

Mating specifications for Pinion and Gear

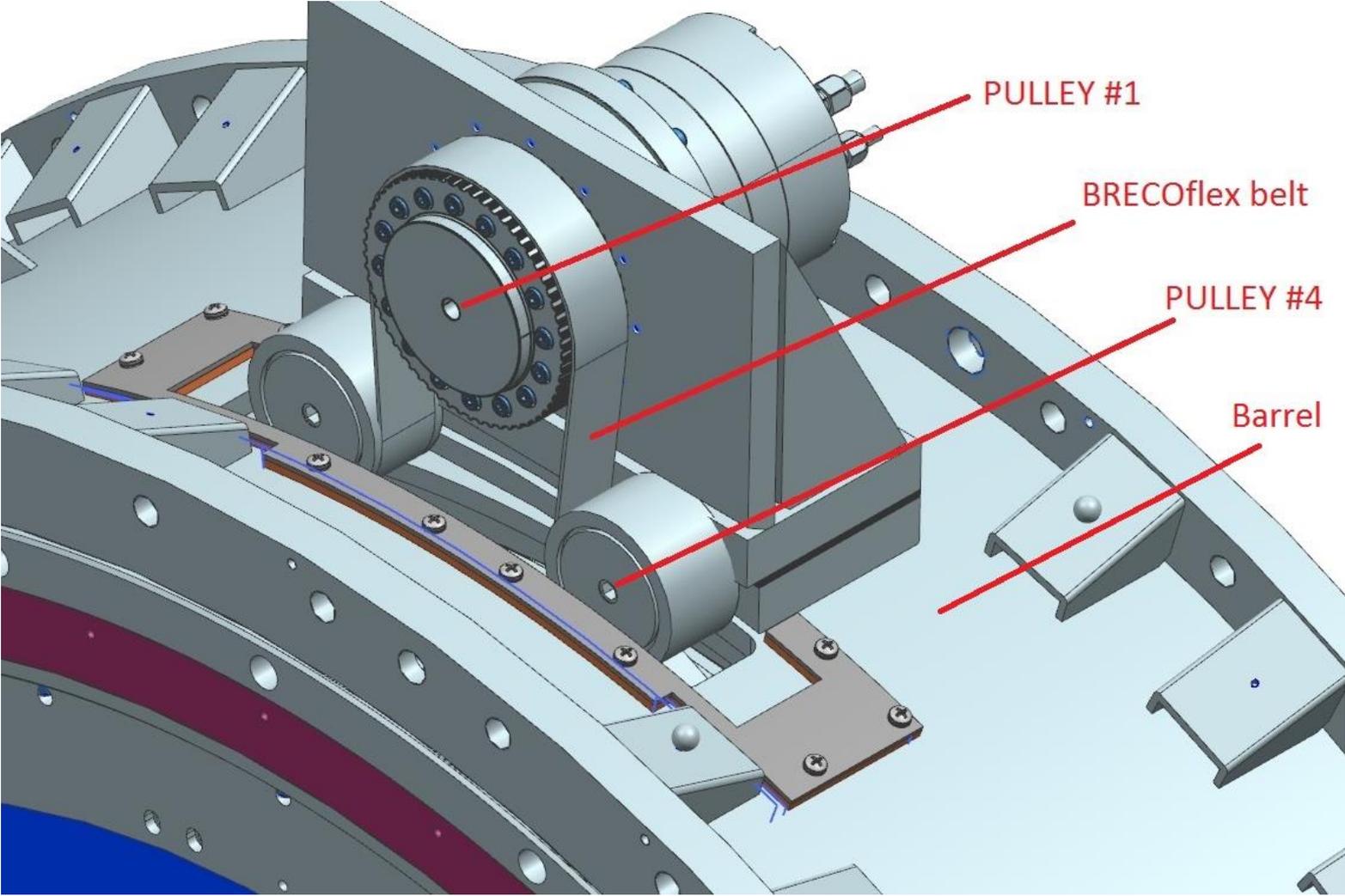
- From HarmonicDrive SHA series manual
 - SHA25A-SG : bolt circle, bolt sizing and tolerances



- From KAYDON Spec Drawing
 - DWG 19691A01: bolt circle, bolt sizing and tolerances



BRECOFlex Transmission System Components



BRECOFlex Considerations

- Allowable Tensile Strength
- Tooth Shear Strength
- Belt stiffness
 - Backlash, Slipping teeth
 - Pretension
- Space constraints
 - Size of idlers
 - Width of belt

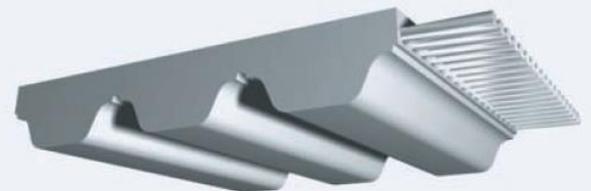


AT-Series



page 30 - 37

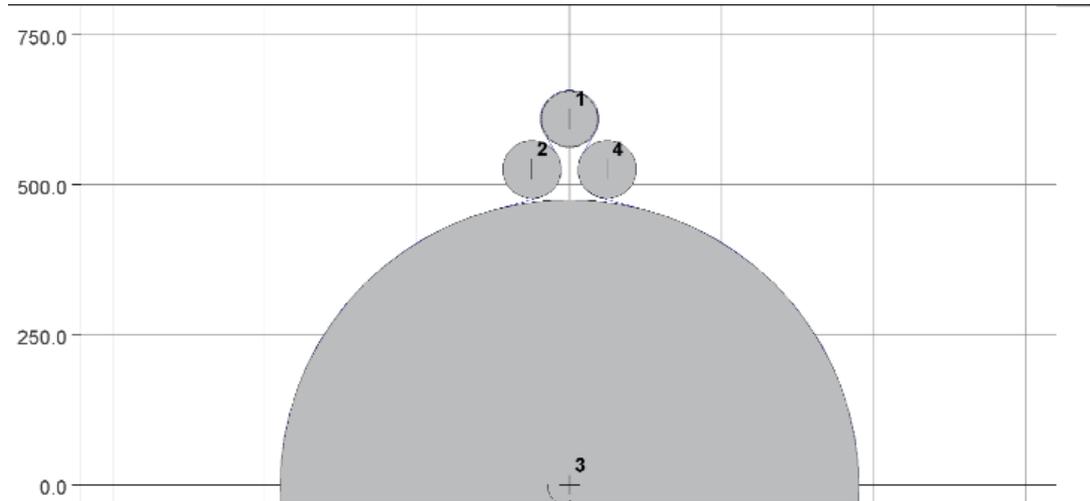
REDFLEX GEN III-Series



page 38 - 41

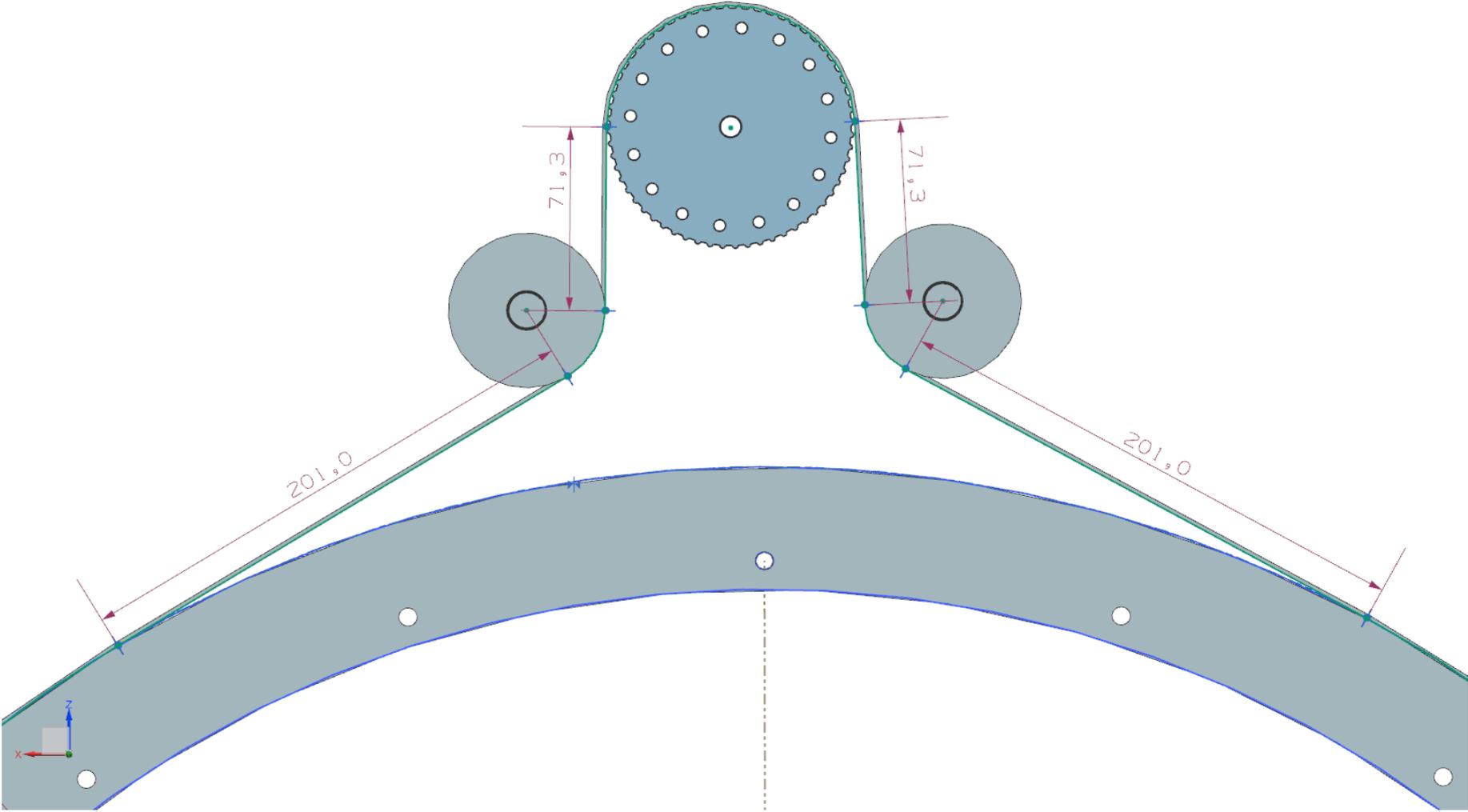
BRECO Flex Drive: ADC layout Configuration based on the std sizes.

- allow for a belt length of 3350mm

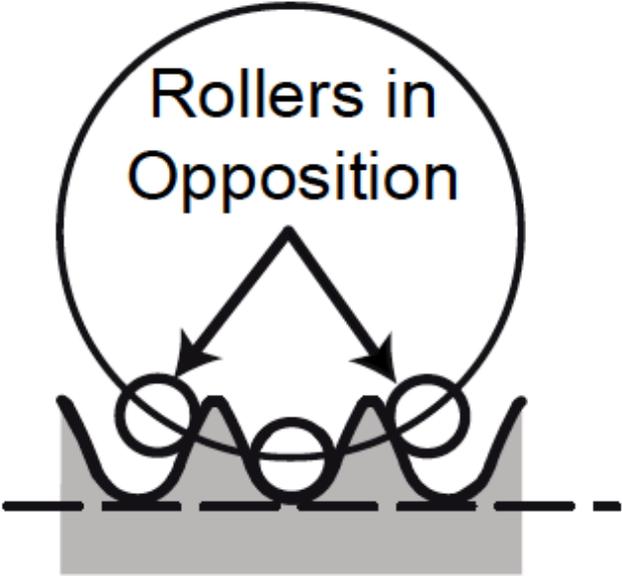


pulley	rot. direc.	No. of teeth	X [mm]	Y [mm]	pitchØ [mm]	outsideØ [mm]	span length [mm]	angle of mesh [°]	arc Length [mm]	centre dist. [mm]
1	ccw	60	0.00	610.00	95.67	94.27	40.90	241.18	201.36	104.23
2	cw	0	-61.71	526.00	96.07	94.27	82.21	104.97	88.00	529.61
3	ccw	597	0.00	0.00	950.31	948.91	82.21	328.76	2726.38	529.61
4	cw	0	61.71	526.00	96.07	94.27	40.90	104.97	88.00	104.23

BRECO Flex Drive: ADC layout Configuration

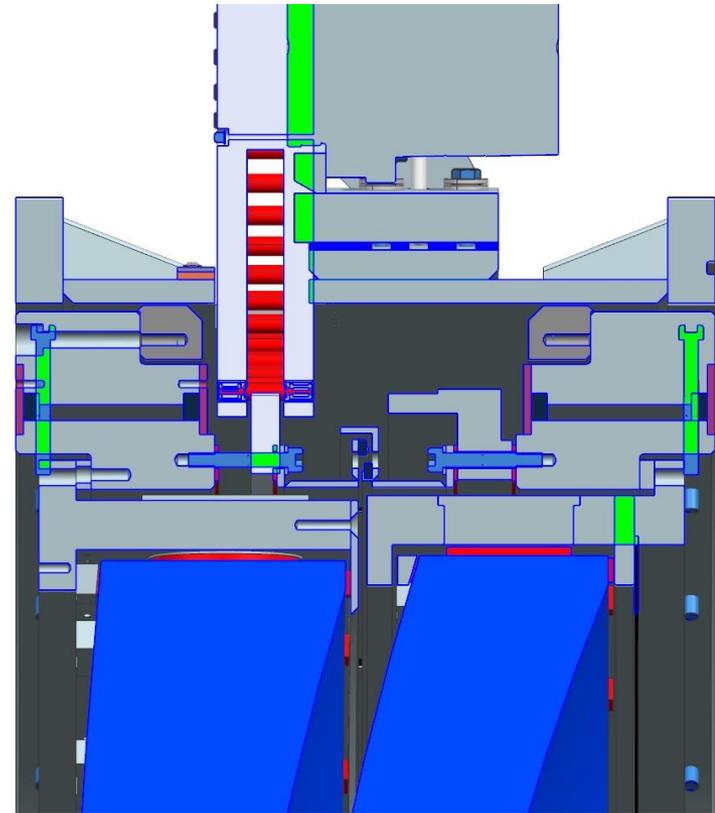
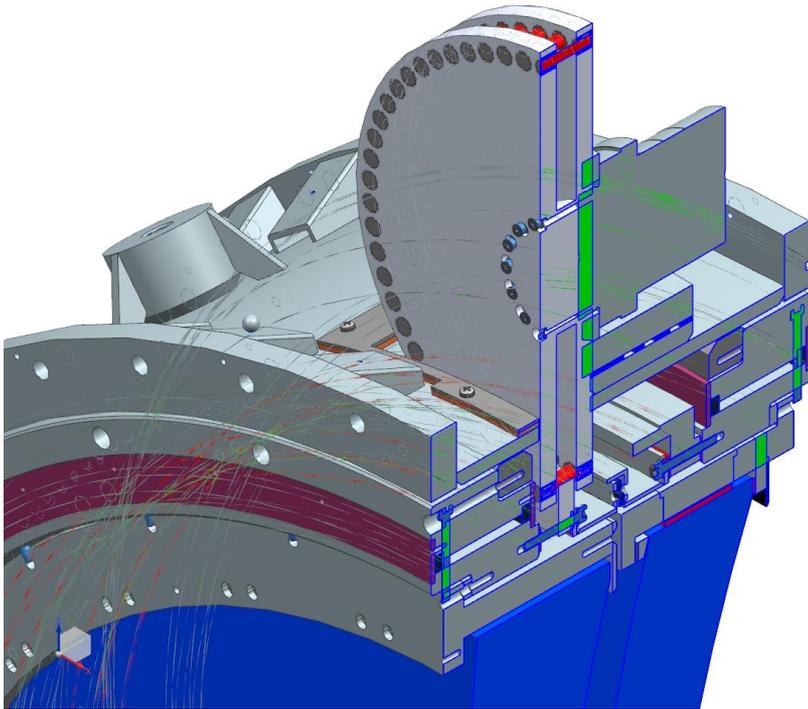


NEXEN Transmission System



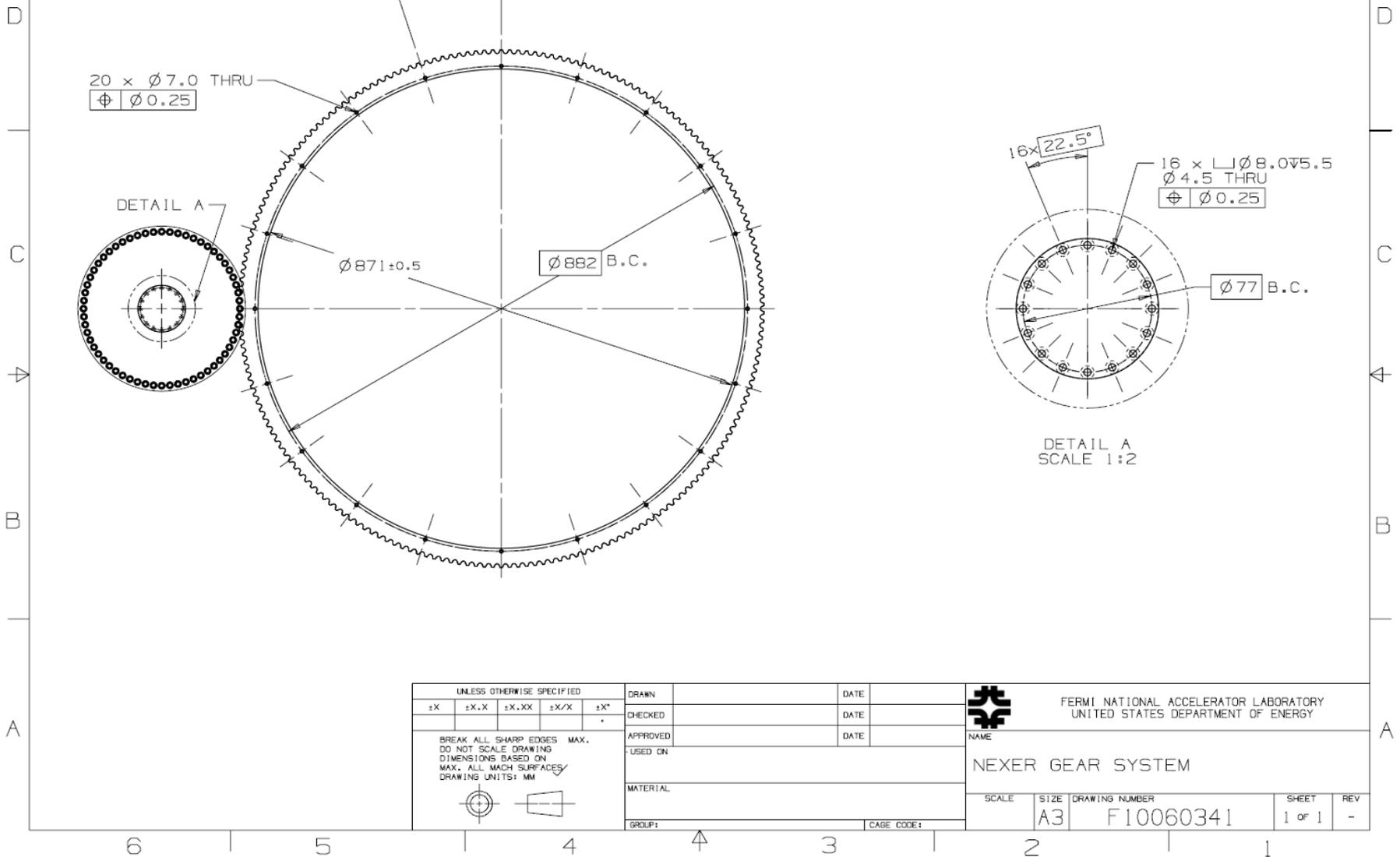
NEXEN Transmission System

- NEXEN catalog options do not satisfy our size requirements.
- Worked with NEXEN to develop a custom design



DESCRIPTION: ASSEMBLY MODEL OF NEXER GEAR SYSTM FOR DES1
 CATEGORY: PROJECT: DES1

REV	REVISION CONTROL DOCUMENT	DATES	SIGNATURES	
-	F10060341---RCD		DRAWN	
			APPROVED	



20 x Ø 7.0 THRU
 ± 0.25

20 x 18°

Ø 871 ± 0.5

Ø 882 B.C.

16 x 22.5°

16 x L Ø 8.0 ± 5.5
 Ø 4.5 THRU
 ± 0.25

Ø 77 B.C.

DETAIL A
 SCALE 1:2

UNLESS OTHERWISE SPECIFIED					DRAWN	DATE
±X	±X.X	±X.XX	±X/X	±X*	CHECKED	DATE
BREAK ALL SHARP EDGES MAX. DO NOT SCALE DRAWING DIMENSIONS BASED ON MAX. ALL MACH SURFACES DRAWING UNITS: MM					APPROVED	DATE
					USED ON	
MATERIAL						
GROUP:					CAGE CODE:	

Fermilab
 FERMI NATIONAL ACCELERATOR LABORATORY
 UNITED STATES DEPARTMENT OF ENERGY

NAME
 NEXER GEAR SYSTEM

SCALE	SIZE	DRAWING NUMBER	SHEET	REV
	A3	F10060341	1 of 1	-

NEXEN and BRECOflex General Comparisons

- NEXEN

- Advantages

- No middle section changes
 - High positional accuracy (up to 30 μm)
 - “Near zero backlash”
 - Easy to assembly and to do maintenance
 - Pinions can be replaced easily
 - **Lifetime of 200 years of operation**

- Disadvantages

- Gear will be done in segments
 - Addressed by reconfiguring oil can.
 - Rely on a specific company

- BRECOflex

- Advantages

- No middle section changes
 - Multiple manufacturers

- Disadvantages

- Belt replacement poses challenges
 - No solid information on
 - Re-tensioning frequency
 - Belt lifetime
 - More components
 - Installation more difficult

NEXEN				
Number of Sets	Price Per set	Total Price wo extra pinion	Price Extra Pinion per Unit	Total for this item (\$k)
2				
3				
10-12 week delivery				
Fermilab Designer – ~2 weeks (1 FTE)				
Two motor and two controllers				
Total				

BRECO flex				
Number of Sets	Price Per set	Total Price wo extra pinion	Price Extra Belt	Total for this item (\$k)
3				
8 week delivery				
Fermilab Designer – ~6 weeks (1 FTE)				
Three motor and two controllers				
Total				

Prices are confidential!

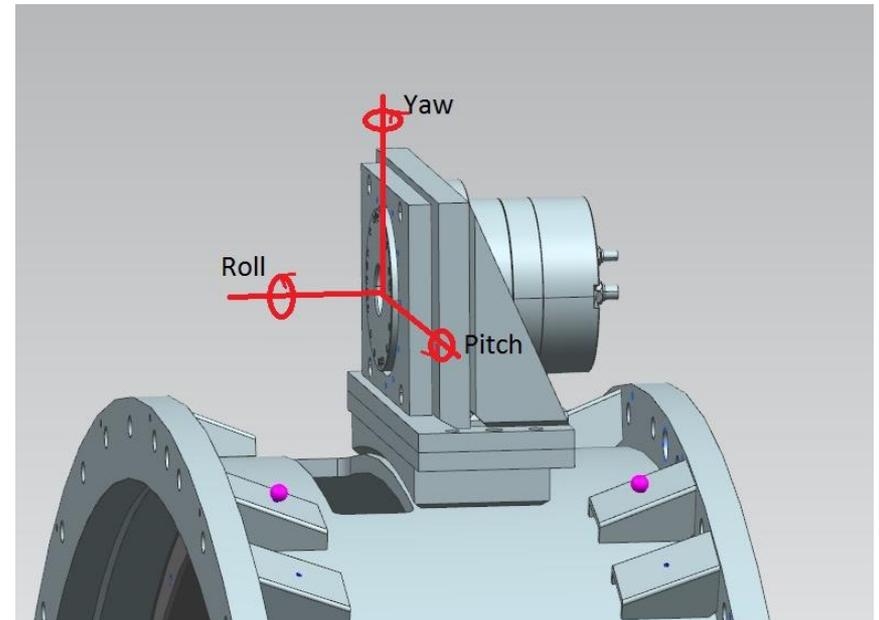
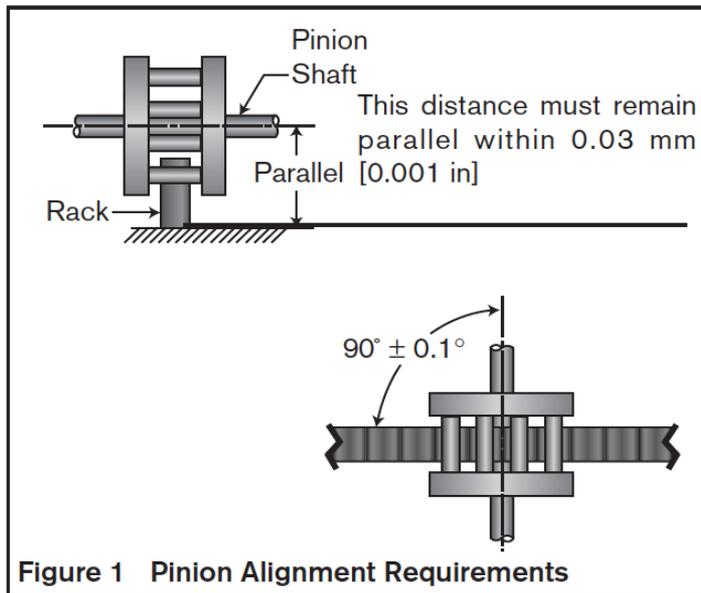
Costs for these system are about that for a luxury car, with a difference of about \$15-20k

Outline

- ADC Introduction
- ADC Transmission Options
 - BRECOFlex Belts
 - NEXEN Roller Pinion Gear
- **Conceptual Design of Motor Platform**
- Questions

Definitions

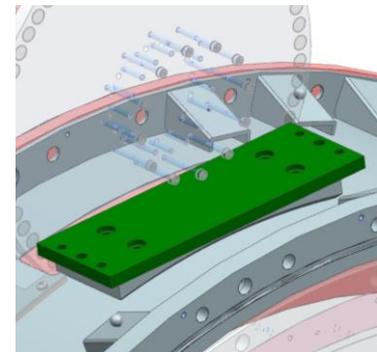
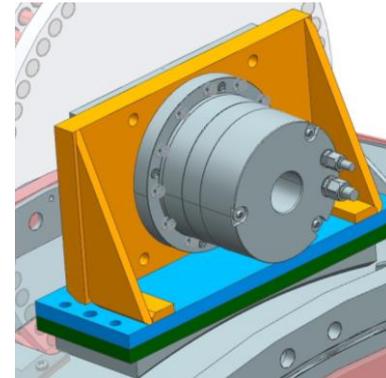
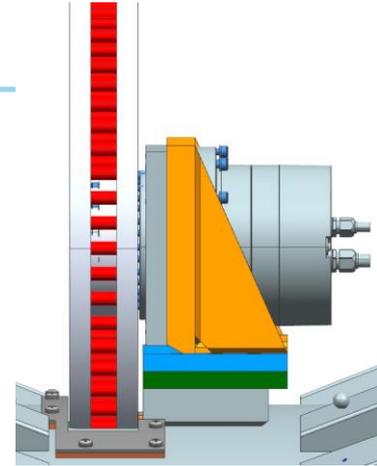
- Need to align Motor/Pinion within parallelism specifications required by Nexen
(see “How to align Nexen gear and pinion system” from Aug 1,2016)



Within this presentation, the “Fixed plate” refers to the block already welded to the Middle Section

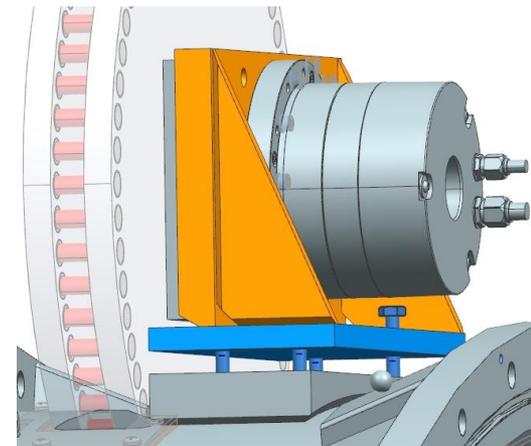
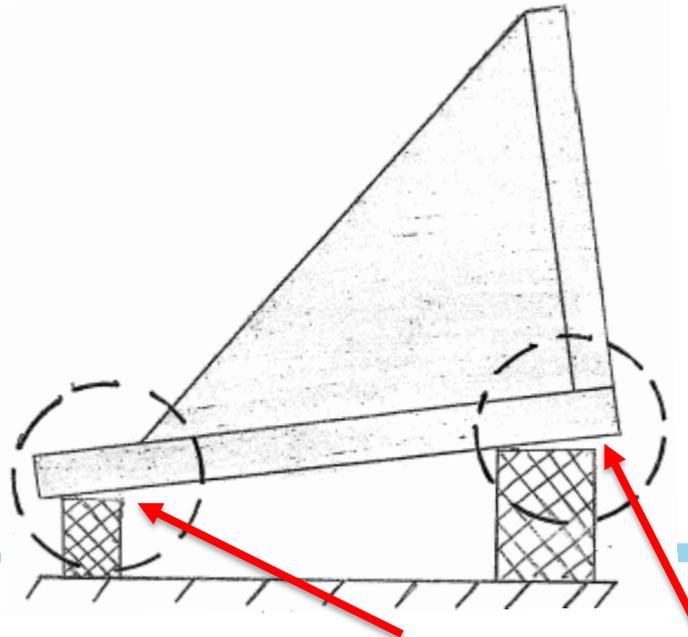
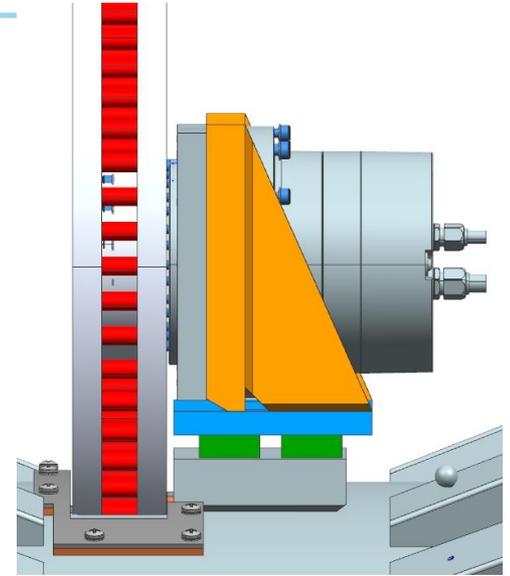
Conceptual Idea #1: Pros and Cons

- Pros:
 - Mating with Fixed plate is straightforward
 - Plenty of space for connector bolts and precision pins
- Cons:
 - Structural strength/rigidity a concern if tack welding shims/Blue plate/Yellow bracket
 - Aligning Pitch and Roll simultaneously by distributing shims may prove time consuming/difficult



Conceptual Idea #2: Pros and Cons

- Pros:
 - Improved structural rigidity between Yellow bracket and Blue Plate
 - Adjusting Pitch and Roll simple with bolt method
- Cons:
 - Need to reduce length and width of blue plate (and Yellow bracket) to facilitate tack welding the blocks*
 - Determining height of blocks will require a potentially iterative process



QUESTIONS?

Special Thanks to...

- Giuseppe Gallo and Gaston Gutierrez
- Sandra Charles and Judy Nunez
- The National GEM Consortium
- Joe Howell and Dave Pushka

Skills Learned this summer

- CAD modeling proficiency improved
- Understanding of mechanical design of precision parts improved
- Professional skills required in working with engineers improved
- Learned how to make not-soggy (instant) oatmeal

- The National GEM Fellowship...
 - For underrepresented US citizens in STEM
 - **PAYS FOR GRADUATE SCHOOL**
 - Apply during your senior year of undergrad
 - Valuable internships with Employer Sponsors
 - **PAYS FOR GRADUATE SCHOOL**
 - Fellowships for both Masters and PhD students
 - Living stipend during the school year



Your Fermilab network has plenty of GEM people you can talk to!
(Sandra Charles, Maurice Ball, Charlie Orozco, Chris Cameron, Miguel Marchan,
Me and **many** other alums/employees)

mauricio.villa@duke.edu