

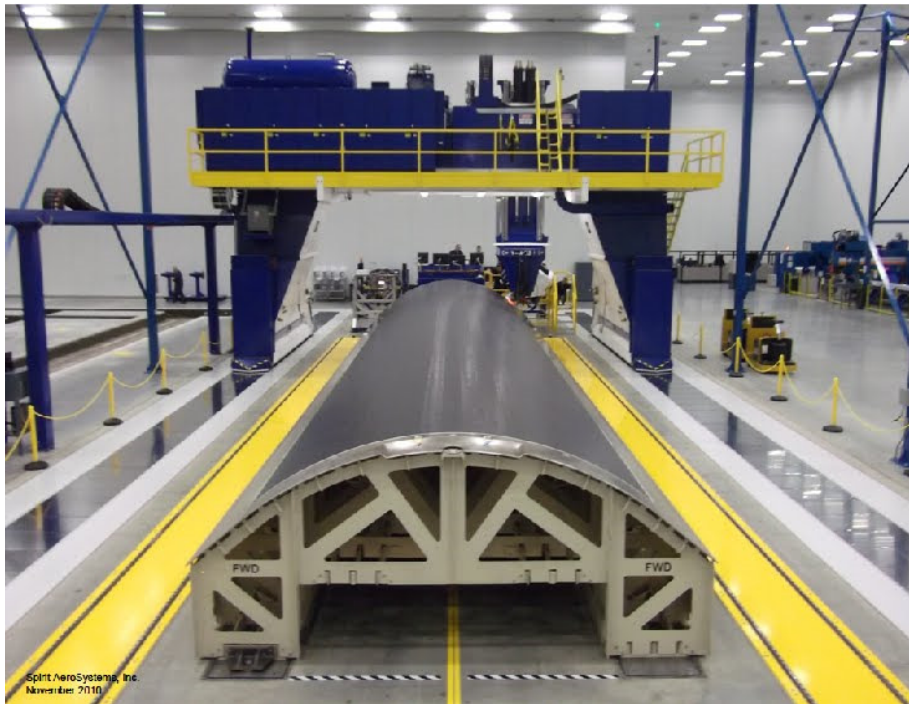
# FURTHER ENHANCEMENTS IN ACCURATE ROBOTIC AUTOMATED FIBER PLACEMENT WITH MODULAR HEADS AND HIGH-PERFORMANCE CONTINUOUS STEERING AXIS

GUY FAUBION, KYLE JEFFRIES  
ELECTROIMPACT INC.



# AFP MACHINES

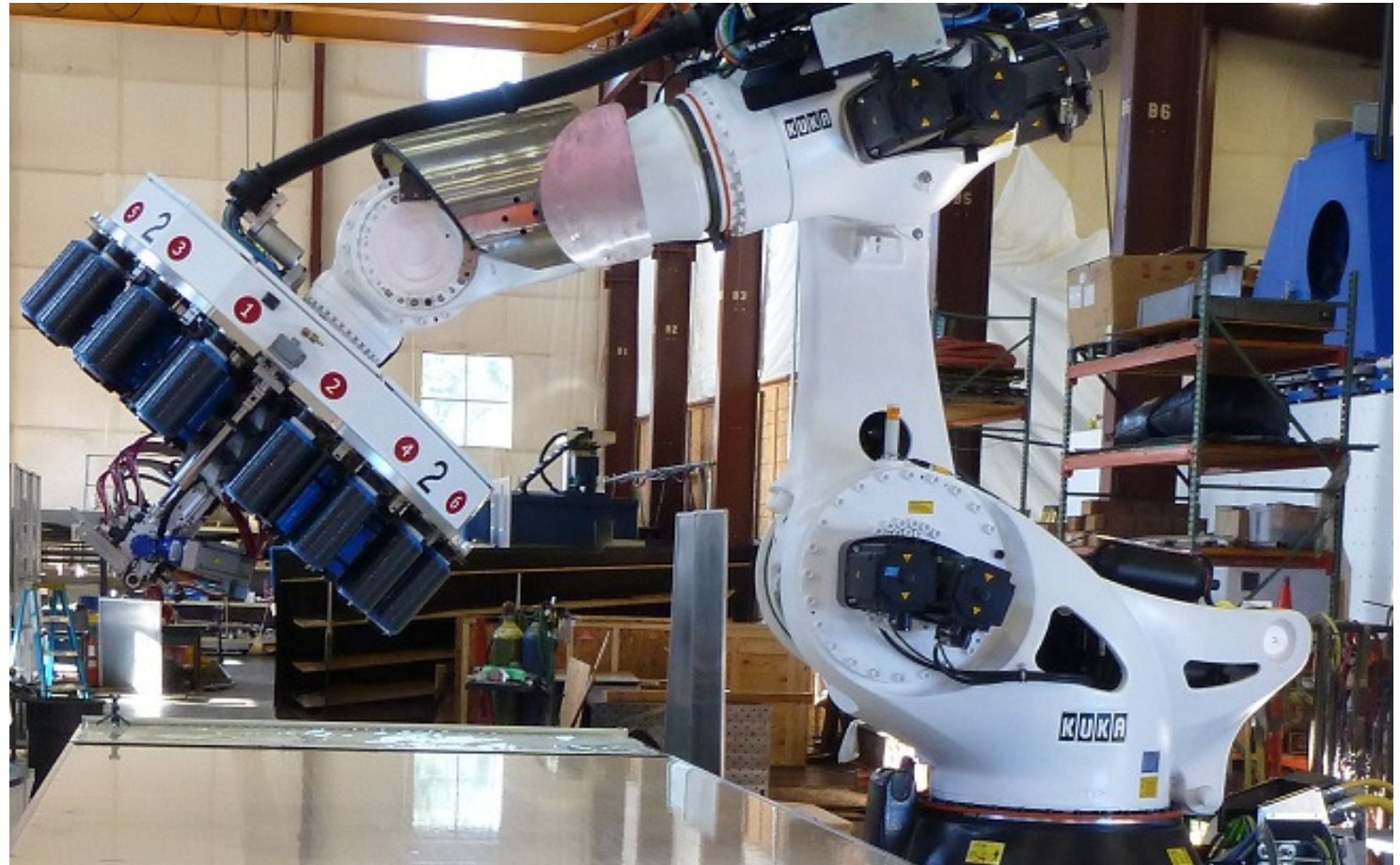
- GANTRY
- POSTMILL



# AFP MACHINES

## ROBOTS

- AFFORDABLE
- SHORT LEAD TIME
- RELIABLE
- REPEATABLE
- MODERATE FOUNDATION REQUIREMENTS
- INACCURATE FOR AEROSPACE



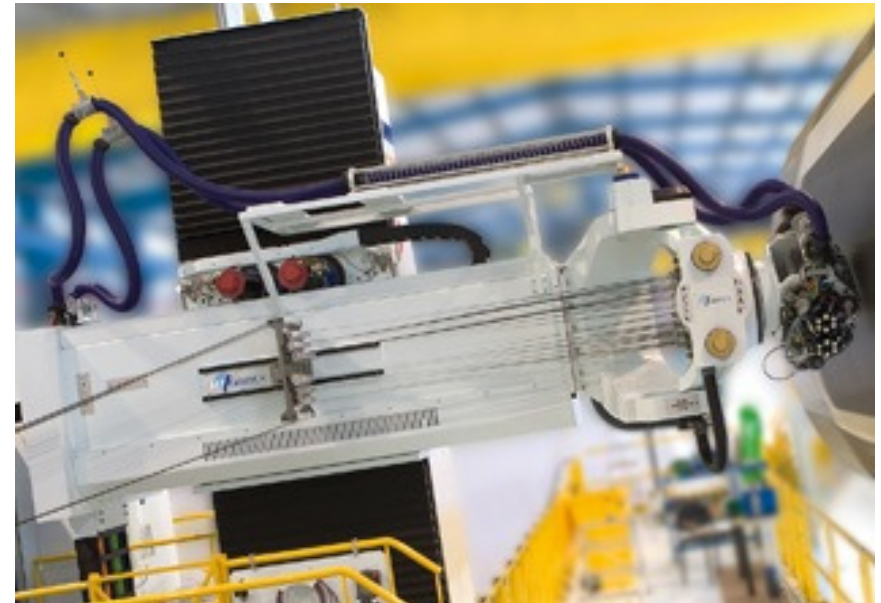
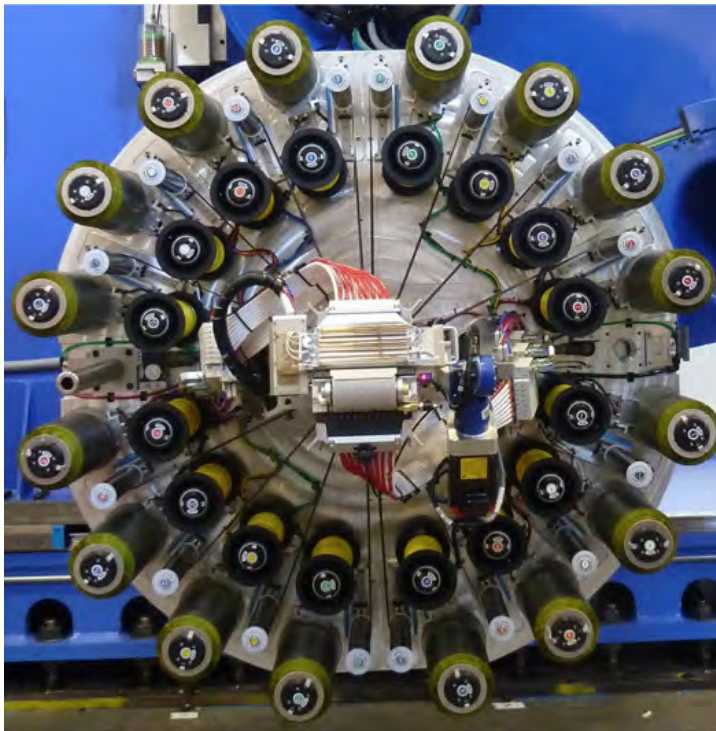
# AFP PROCESS IMPROVEMENTS

- NEW FIBER DOES NOT REQUIRE CHILLED CREEL



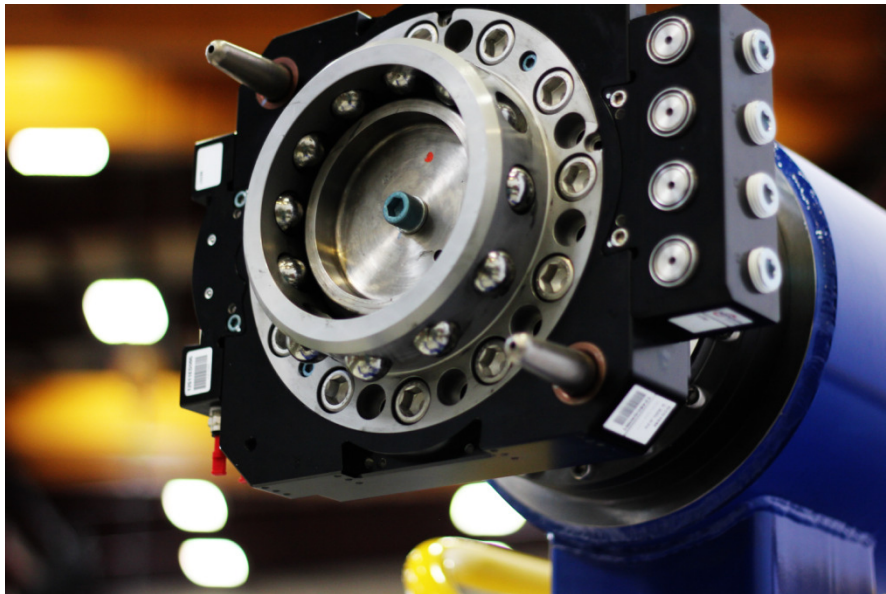
# AFP PROCESS IMPROVEMENTS

- MODULAR HEAD
- SIMPLIFIED TOW PATH



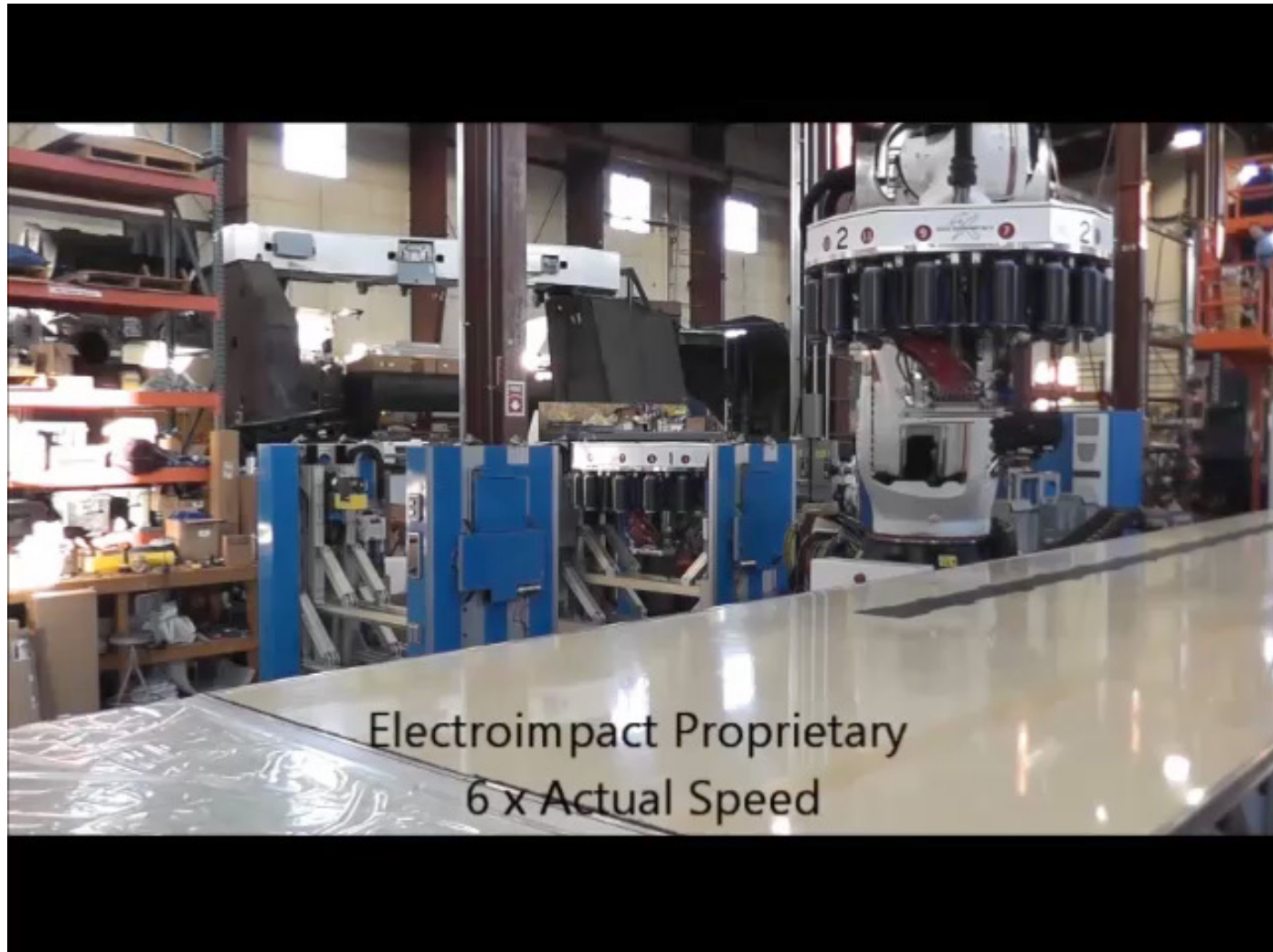
# AFP PROCESS IMPROVEMENTS

- ROBOTIC TOOL CHANGER
- QUICK CHANGE PROCESS HEADS



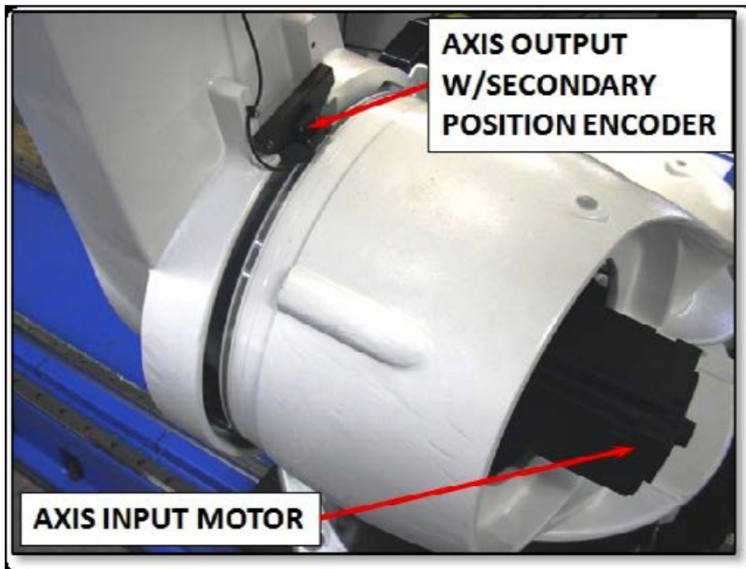
# AFP PROCESS IMPROVEMENTS

- PROCESS HEAD CHANGE VIDEO



# AFP PROCESS IMPROVEMENTS

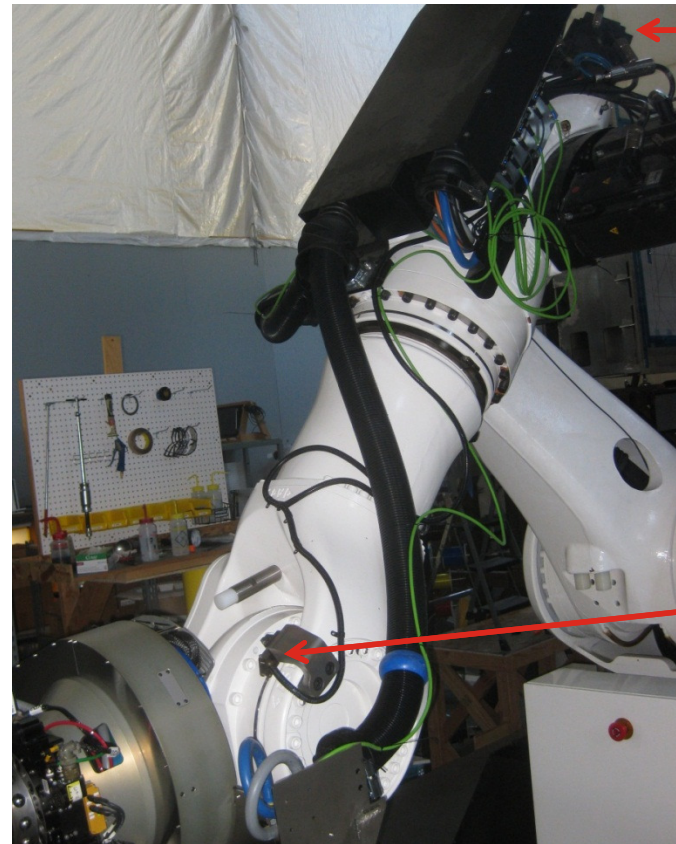
- SECONDARY FEEDBACK



ELIMINATES:

- BACKLASH
- GEAR TRAIN WINDUP
- GEARBOX WINDUP

EXACT POSITION OF EACH JOINT

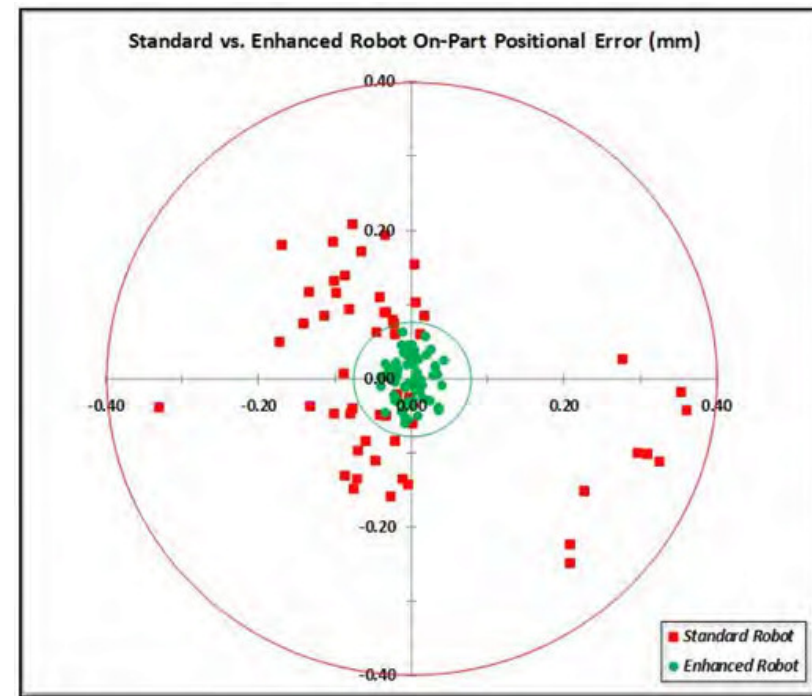
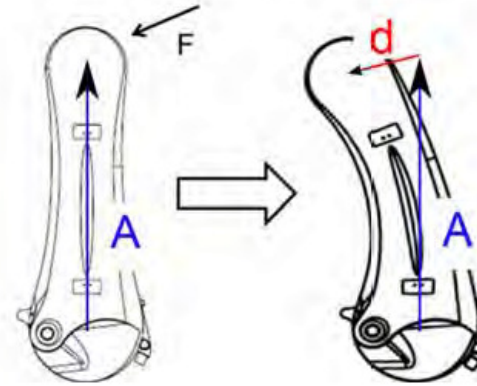


- LONG DRIVE TRAIN
- MULTIPLE BEVEL GEARS
- TORQUE TUBES
- GEARBOX



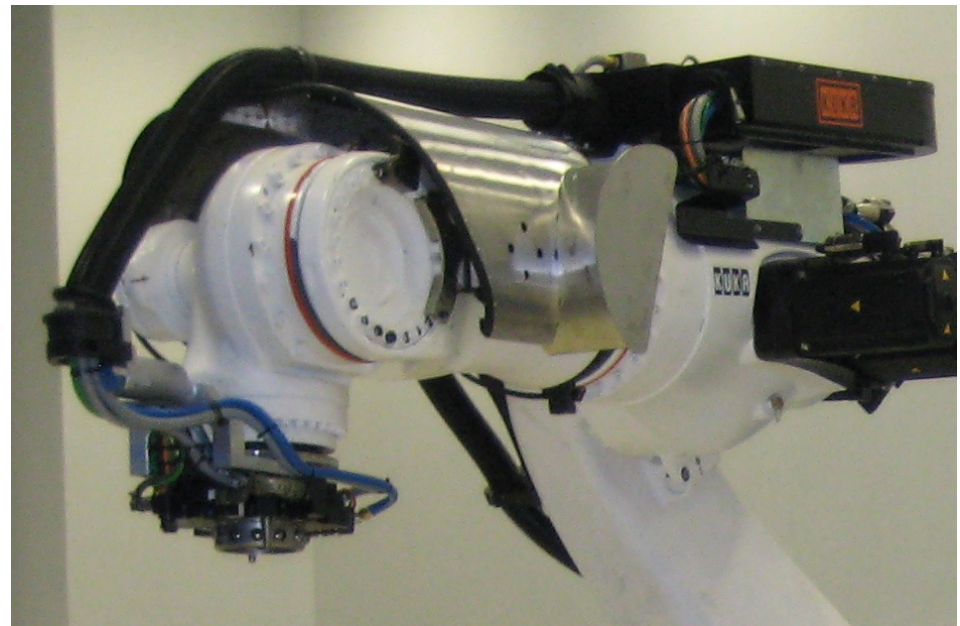
# AFP PROCESS IMPROVEMENTS

- HIGHER-ORDER KINEMATIC MODEL
- FULLY LOADED ROBOT
- HUNDREDS OF POSES THROUGHOUT WORKING ENVELOPE.
- FULLY AUTOMATED
- ACCOUNTS FOR DEFLECTIONS/ROTATIONS
- COMBINE SECONDARY FEEDBACK
- SIEMENS 840Dsl INDUSTRIAL CNC
- SIGNIFICANTLY IMPROVED ACCURACY



# STEERING AXIS DESIGN CRITERIA

- INCREASE PERFORMANCE
  - SPEED
  - ACCELERATION
  - REDUCE TIME OFF-PART
- CONTINUOUS ROTATION
  - ELIMINATE CABLE MANAGEMENT
  - ELIMINATE CABLE/HOSE WEAR AND FAILURE
  - REDUCE PROGRAMMING
  - ALLOW DIRECTION OF SHORTEST ROTATION
- MAINTAIN AXIS-5 RANGE OF MOTION
- MINIMIZE WEIGHT
- MINIMIZE TOOL POINT DISTANCE



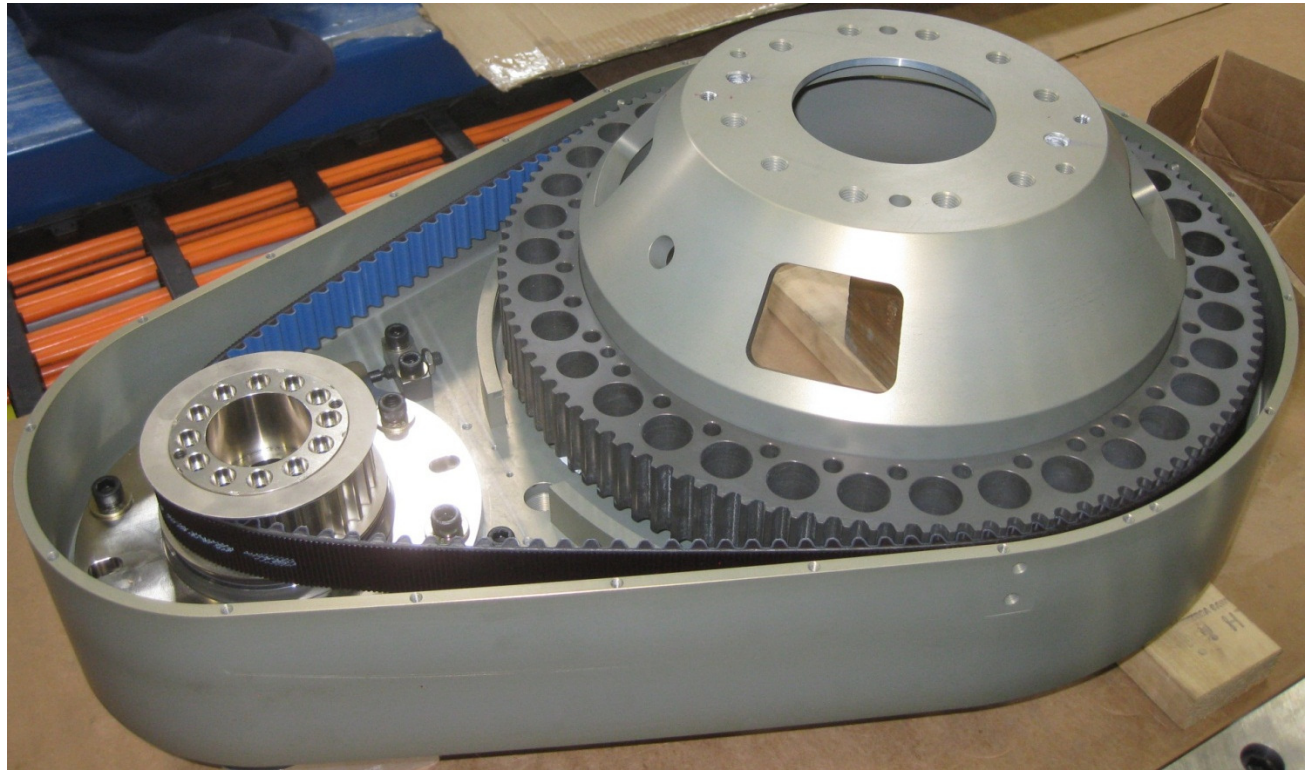
# STEERING AXIS DESIGN

- REMOVE STANDARD
- ROBOT AXIS-6



# STEERING AXIS DESIGN

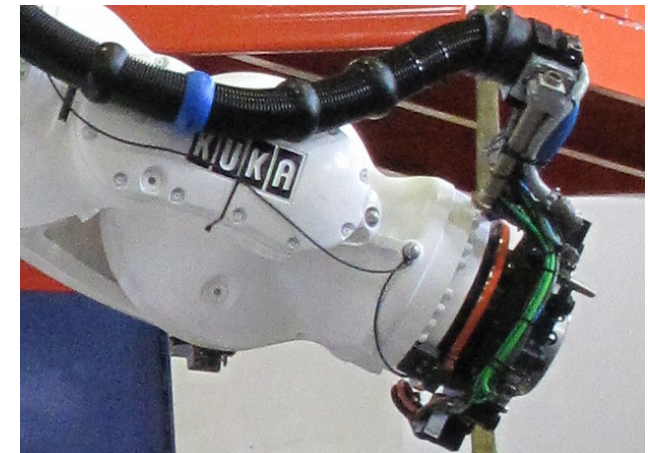
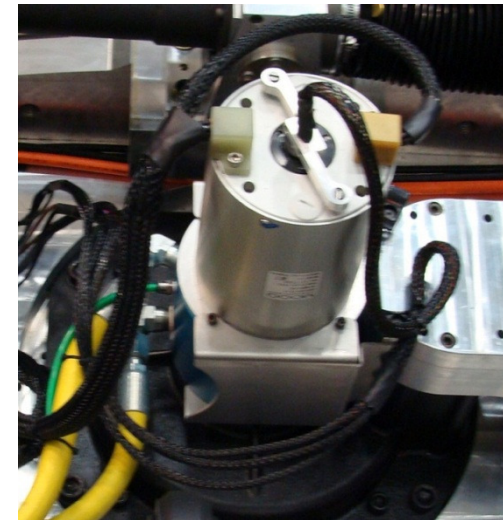
- BELT DRIVE
  - MIN. HEIGHT
  - NESTED UTILITIES
  - NESTED ENCODER
  - MIN. BACKLASH
  - MIN. LUBRICANTS



# STEERING AXIS DESIGN

- NESTED SLIP RINGS

- POWER
- SIGNAL
- PNEUMATIC
- 113mm SHORTER



# STEERING AXIS DESIGN

- ELIMINATE CABLE MANAGEMENT
- SIMPLIFY CNC PROGRAMMING



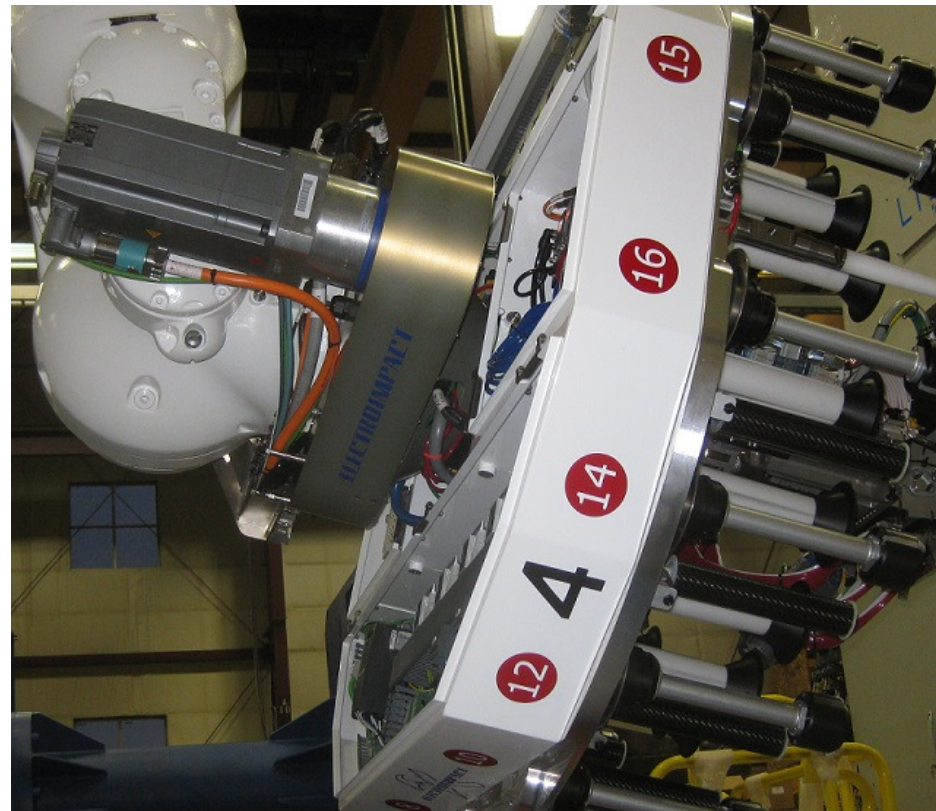
# STEERING AXIS DESIGN

- STEERING AXIS REORIENTATION PERFORMANCE



# STEERING AXIS DESIGN

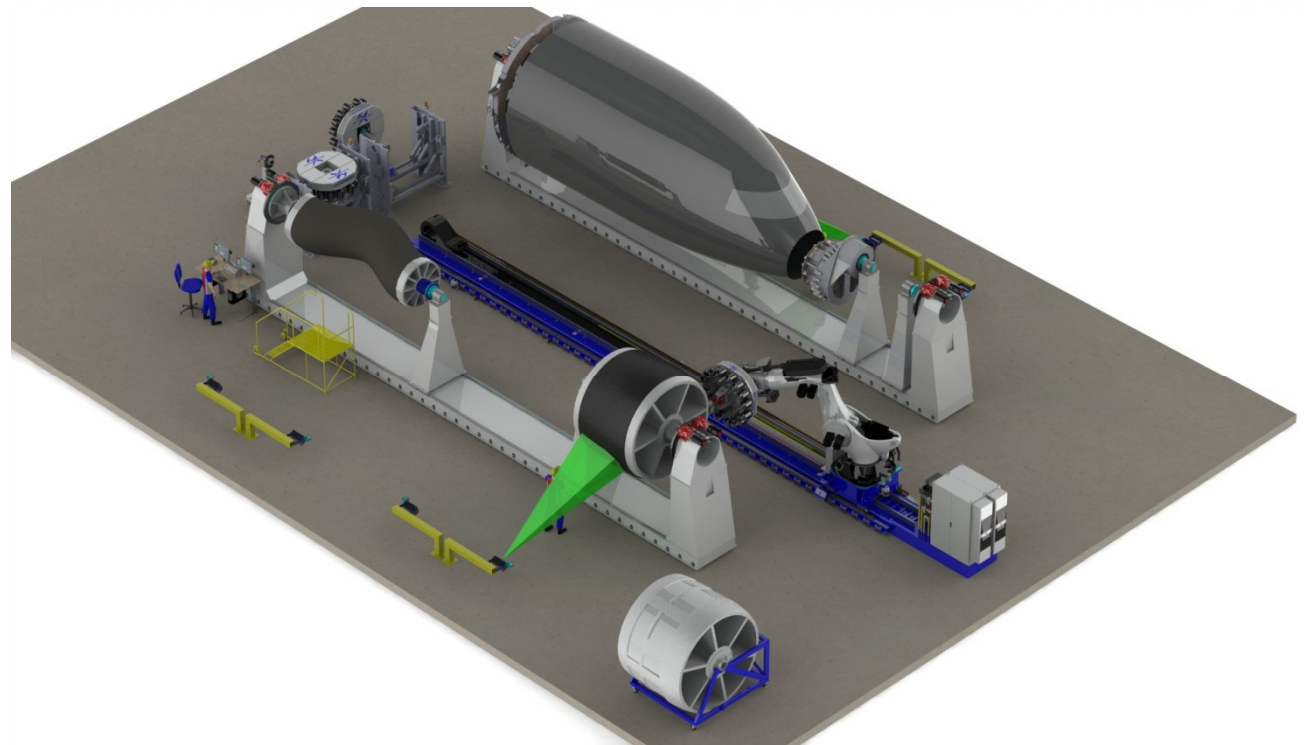
- PANCAKE DESIGN
- 150mm TP
- 90kg
- 3X ROTATIONAL PERFORMANCE
- ELIMINATES CABLE/HOSE WEAR/FAILURE
- FULL AXIS-5 MOTION
- SECONDARY FEEDBACK





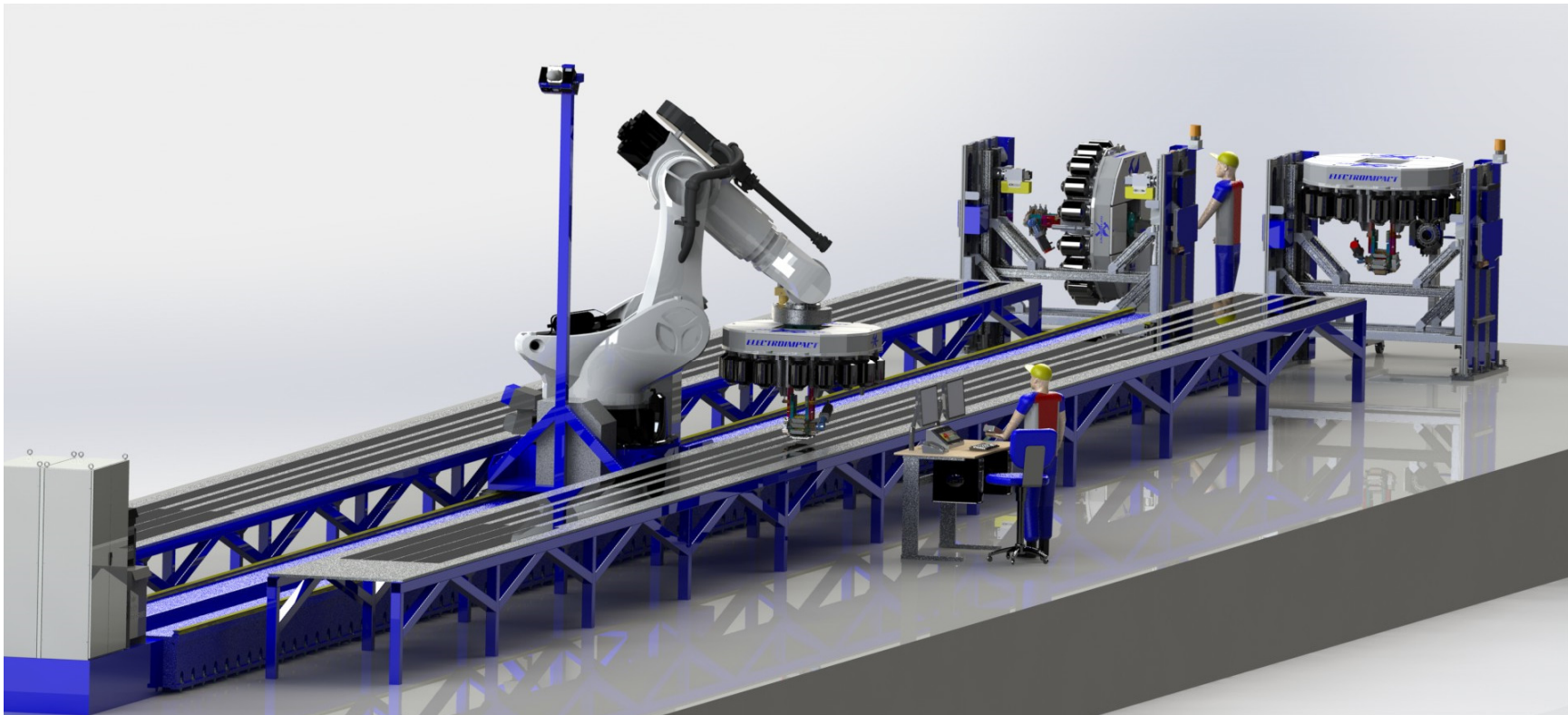
# APPLICATIONS

- ROBOT CELL WITH MULTIPLE ROTATORS
- ROBOT CAN ACCESS PARTS ON BOTH SIDES OF THE LINEAR TRACK
- LASER PROJECTION FOR PLY BOUNDARIES, IDENTIFICATION OF COURSES AND TOWS, AND PROGRAMMED LAPS AND GAPS.



# APPLICATIONS

- AFP FLAT CHARGE CELL WITH 2 VACUUM TABLES AND ULTRASONIC CUTTING HEAD
- MAINTENANCE AREA WITH 2 TRANSFER STANDS



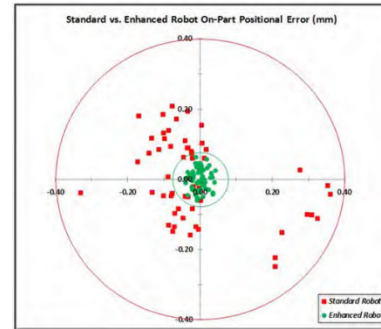
# SUMMARY



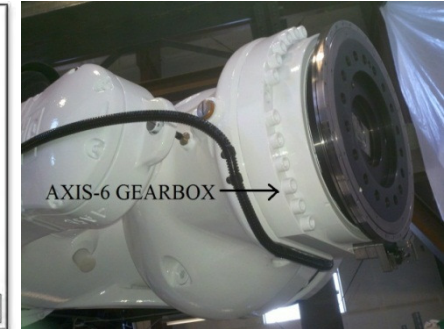
OFF-THE-SHELF  
ROBOT



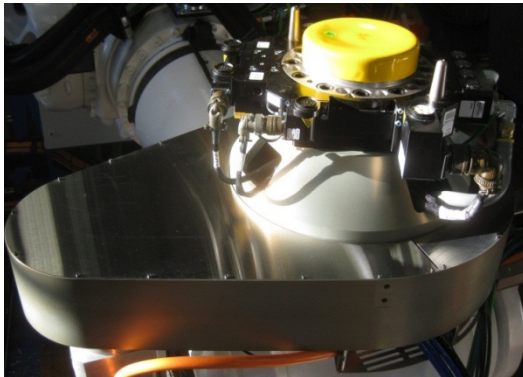
SIEMENS 840DsI  
SECONDARY FEEDBACK



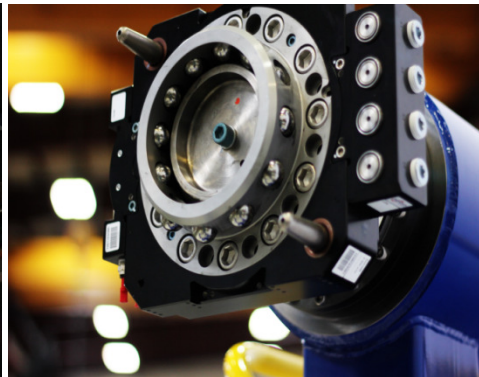
HIGH-ORDER  
KINEMATICS



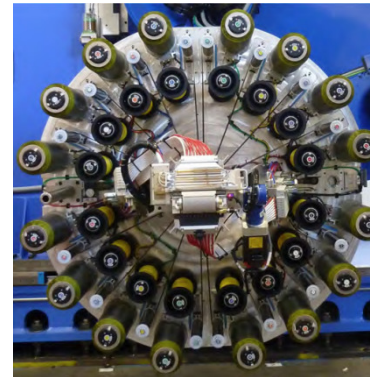
KUKA  
AXIS-6



HIGH-PERFORMANCE  
CONTINUOUS STEERING AXIS



TOOL  
CHANGER



MODULAR  
HEAD



ACCURATE  
HIGH-PERFORMANCE  
AFP ROBOT

# QUESTIONS

