

TonopahSolar

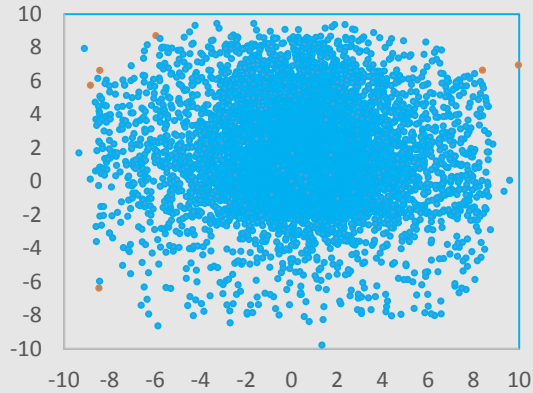
Field Deployment/ Plant Operation

Tonopah Solar Field Deployment

➤ Assessment after Construction and Initial Installation.

Heliostat Pointing Assessment 30-DEC-2016 14:35:48 PST

Azimuthal Error Mean	-0.4293	(mrad)
Azimuthal Error Stdv	2.5862	(mrad)
Elevation Error Mean	-1.0089	(mrad)
Elevation Error Stdv	2.3630	(mrad)
Tracking Error Mean	-1.3188	(mrad)
Tracking Error Stdv	3.4256	(mrad)
Heliostats Evaluated	6730	(number)



Heliostat Slope Error Assessment 31-OCT-2015

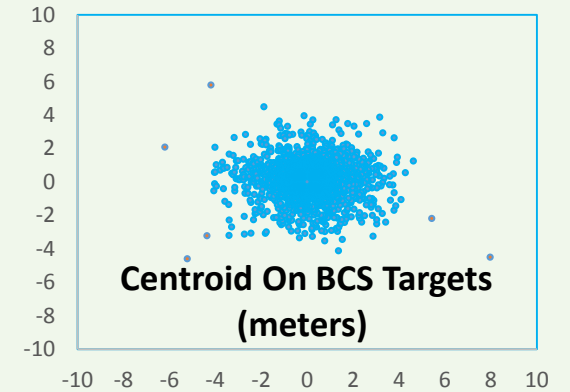
Surface X-axis Slope Error	1.5000	(mrad)
Surface Y-axis Slope Error	2.2000	(mrad)

➤ We decided to concentrate on improving tracking and made many improvements to our Automated Beam Characterization System

➤ Present Assessment

Heliostat Pointing Assessment 13-SEP-2020 15:29:20 PDT

Azimuthal Error Mean	-0.0136	(mrad)
Azimuthal Error Stdv	0.4901	(mrad)
Elevation Error Mean	-0.0570	(mrad)
Elevation Error Stdv	0.5092	(mrad)
Tracking Error Mean	-0.0812	(mrad)
Tracking Error Stdv	0.7045	(mrad)
Heliostats Evaluated	10214	(number)



Tracking Error (milliradians)



Tonopah Solar Plant Operation

- An Integrated Heliostat Field / Receiver Thermo-fluid Model, **FLUXCALC**, is run every 30 seconds in **Real-Time Mode** to integrate a Heliostat Field Ray Trace Flux calculation with the Receiver IR, Backwall Thermocouple and Flow Measurements.
- **FLUXCALC** also runs in a **Dispatch Mode** every 2 minutes to determine Heliostat Aimpoints that maximize MW_t output while respecting Receiver Tube Strain, Tube Innerwall Temperature and Heat-Shield Flux Limits
- **FLUXCALC** uses a Conjugate Gradient algorithm to find the Heliostat Aimpoint Dispatch. The following chart shows the convergence of the Heliostat Aimpoint Solution with the constraints

Iteration	TimeDate	Output (MW)	Strain (%)	Tiw (°F)	HeatShield (kW)
1	16-OCT-2020 13:09:00.000 PDT	534.3	217.4	1226.3	198
2	16-OCT-2020 13:09:00.000 PDT	533.7	157.1	1219.8	194.2
3	16-OCT-2020 13:09:00.000 PDT	533	149.1	1221.8	205.9
4	16-OCT-2020 13:09:00.000 PDT	533.1	126.1	1200	201.4
5	16-OCT-2020 13:09:00.000 PDT	531.8	122.4	1195.6	213.1
6	16-OCT-2020 13:09:00.000 PDT	531.2	119.1	1203.9	229.3
7	16-OCT-2020 13:09:00.000 PDT	530.7	112.8	1197.2	251.4
8	16-OCT-2020 13:09:00.000 PDT	529.1	109.5	1189.3	274.5
9	16-OCT-2020 13:09:00.000 PDT	530.2	103	1180.6	263.1
10	16-OCT-2020 13:09:00.000 PDT	529.1	107	1182.5	275.1
11	16-OCT-2020 13:09:00.000 PDT	528.7	104.5	1180.7	279.1
12	16-OCT-2020 13:09:00.000 PDT	528	102.9	1179.3	302.9
13	16-OCT-2020 13:09:00.000 PDT	527.8	101.2	1179	289.7
14	16-OCT-2020 13:09:00.000 PDT	527.6	99.4	1175.4	297
15	16-OCT-2020 13:09:00.000 PDT	527.7	100.4	1173.2	307.1
16	16-OCT-2020 13:09:00.000 PDT	527.4	100.4	1171.7	304.8
17	16-OCT-2020 13:09:00.000 PDT	527.4	99.5	1171.5	308.2
18	16-OCT-2020 13:09:00.000 PDT	527.2	100.4	1171	314.8
19	16-OCT-2020 13:09:00.000 PDT	526.9	99.9	1168.9	315.5
20	16-OCT-2020 13:09:00.000 PDT	527.3	98.7	1169.3	297.8