

```
{  
  "$schema": "https://vega.github.io/schema/vega/v5.json",  
  "description": "Interactive Process Capability Analysis Dashboard",  
  "background": "#0f172a",  
  "padding": 25,  
  "autosize": {"type": "fit", "contains": "padding"},  
  "width": 1400,  
  "height": 900,  
  
  "signals": [  
    {  
      "name": "sigmaLevel",  
      "value": 3,  
      "bind": {  
        "input": "range",  
        "min": 1,  
        "max": 6,  
        "step": 0.5,  
        "name": "Sigma Level: "  
      }  
    },  
    {  
      "name": "showNormalCurve",  
      "value": true,  
      "bind": {"input": "checkbox", "name": "Show Normal Distribution "}  
    },  
    {  
      "name": "selectedLot",  
      "value": null,  
      "on": [  
        {"events": "@lotPoint:click", "update": "datum.lot_breaker_id"},  
        {"events": "dblclick", "update": "null"}  
      ]  
    },  
    {  
      "name": "histogramBins",  
      "value": 25,  
      "bind": {  
        "input": "range",  
        "min": 10,  
        "max": 50,  
        "step": 5,  
        "name": "Histogram Bins: "  
      }  
    },  
    {  
      "name": "usl",  
      "update": "data('specLimits')[0] ? data('specLimits')[0].usl : 11"  
    },  
    {  
      "name": "lsl",  
      "value": 11  
    }  
  ]  
}
```

```

"update": "data('specLimits')[0] ? data('specLimits')[0].lsl : 9"
},
{
  "name": "histMin",
  "update": "lsl - 0.2"
},
{
  "name": "histMax",
  "update": "usl + 0.2"
},
{
  "name": "grandMean",
  "update": "data('overallStats')[0] ? data('overallStats')[0].grandxbar : 10"
},
{
  "name": "sigma",
  "update": "data('overallStats')[0] ? data('overallStats')[0].sigma : 0.1"
},
{
  "name": "totalSamples",
  "update": "data('overallStats')[0] ? data('overallStats')[0].total_samples : 1"
}
],
"data": [
  {
    "name": "dataset",
    "values": []
  },
  {
    "name": "lotStats",
    "source": "dataset",
    "transform": [
      {
        "type": "aggregate",
        "groupby": ["lot_breaker_id"],
        "ops": ["mean", "max", "min", "max"],
        "fields": ["measuredvalue", "measuredvalue", "measuredvalue", "sampleqty"],
        "as": ["xbar", "max_val", "min_val", "n"]
      },
      {
        "type": "formula",
        "as": "range",
        "expr": "datum.max_val - datum.min_val"
      }
    ]
  },
  {
    "name": "overallStats",
    "source": "lotStats",
    "transform": [
      {
        "type": "aggregate",

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    "ops": ["mean", "mean", "count", "sum"],
    "fields": ["xbar", "range", null, "n"],
    "as": ["grandxbar", "rbar", "num_lots", "total_samples"]
},
{
  "type": "formula",
  "as": "d2",
  "expr": "datum.total_samples <= 2 ? 1.128 : datum.total_samples <= 3 ? 1.693 :
datum.total_samples <= 4 ? 2.059 : datum.total_samples <= 5 ? 2.326 : datum.total_samples <= 6
? 2.534 : datum.total_samples <= 7 ? 2.704 : datum.total_samples <= 8 ? 2.847 :
datum.total_samples <= 9 ? 2.970 : 3.078"
},
{
  "type": "formula",
  "as": "sigma",
  "expr": "datum.rbar / datum.d2"
}
],
},
{
  "name": "specLimits",
  "source": "dataset",
  "transform": [
    {
      "type": "aggregate",
      "ops": ["max", "max", "max"],
      "fields": ["upperlimit", "lowerlimit", "nominallimit"],
      "as": ["usl", "lsl", "nominal"]
    }
  ]
},
{
  "name": "capabilityMetrics",
  "source": "overallStats",
  "transform": [
    {
      "type": "lookup",
      "from": "specLimits",
      "key": null,
      "fields": [null],
      "values": ["usl", "lsl", "nominal"],
      "as": ["usl", "lsl", "nominal"],
      "default": {"usl": 11, "lsl": 9, "nominal": 10}
    },
    {
      "type": "formula",
      "as": "cp",
      "expr": "(datum.usl - datum.lsl) / (6 * datum.sigma)"
    },
    {
      "type": "formula",
      "as": "cpu",
      "expr": "(datum.usl - datum.grandxbar) / (3 * datum.sigma)"
    }
  ]
}

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},
{
  "type": "formula",
  "as": "cpl",
  "expr": "(datum.grandxbar - datum.lsl) / (3 * datum.sigma)"
},
{
  "type": "formula",
  "as": "cpk",
  "expr": "min(datum.cpu, datum.cpl)"
},
{
  "type": "formula",
  "as": "status",
  "expr": "datum.cpk >= 1.33 ? 'CAPABLE' : datum.cpk >= 1.0 ? 'MARGINAL' : 'NOT
CAPABLE'"
},
{
  "type": "formula",
  "as": "statusColor",
  "expr": "datum.cpk >= 1.33 ? '#10b981' : datum.cpk >= 1.0 ? '#f59e0b' : '#ef4444'"
},
{
  "type": "formula",
  "as": "plusSigma",
  "expr": "datum.grandxbar + (sigmaLevel * datum.sigma)"
},
{
  "type": "formula",
  "as": "minusSigma",
  "expr": "datum.grandxbar - (sigmaLevel * datum.sigma)"
}
]
},
{
  "name": "histogram",
  "source": "dataset",
  "transform": [
    {
      "type": "bin",
      "field": "measuredvalue",
      "extent": {"signal": "[histMin, histMax]"},
      "maxbins": {"signal": "histogramBins"},
      "as": ["bin0", "bin1"]
    },
    {
      "type": "aggregate",
      "groupby": ["bin0", "bin1"],
      "ops": ["count"],
      "as": ["count"]
    },
    {
      "type": "formula",
      "as": "count"
    }
  ]
}

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        "as": "binCenter",
        "expr": "(datum.bin0 + datum.bin1) / 2"
    }
]
},
{
    "name": "normalCurve",
    "values": [{}],
    "transform": [
        {
            "type": "sequence",
            "start": {"signal": "histMin - 0.3"},
            "stop": {"signal": "histMax + 0.3"},
            "step": 0.01,
            "as": "x"
        },
        {
            "type": "formula",
            "as": "density",
            "expr": "(1 / (sigma * sqrt(2 * PI))) * exp(-0.5 * pow((datum.x - grandMean) / sigma, 2))"
        },
        {
            "type": "formula",
            "as": "y",
            "expr": "datum.density * totalSamples * ((usl - lsl) / histogramBins)"
        }
    ]
},
{
    "name": "controlChart",
    "source": "lotStats",
    "transform": [
        {
            "type": "window",
            "ops": ["row_number"],
            "as": ["lotNumber"]
        },
        {
            "type": "formula",
            "as": "ucl",
            "expr": "overallStats[0].grandxbar + (2.326 * overallStats[0].rbar / overallStats[0].num_lots)"
        },
        {
            "type": "formula",
            "as": "lcl",
            "expr": "overallStats[0].grandxbar - (2.326 * overallStats[0].rbar / overallStats[0].num_lots)"
        },
        {
            "type": "formula",
            "as": "outOfControl",
            "expr": "if(datum.lotNumber > 10, datum.outOfControl, null)"
        }
    ]
}
]
```

```
        "expr": "datum.xbar > datum.ucl || datum.xbar < datum.lcl"
    },
    {
        "type": "formula",
        "as": "isSelected",
        "expr": "selectedLot === null || selectedLot === datum.lot_breaker_id"
    }
]
},
],
"scales": [
{
    "name": "histX",
    "type": "linear",
    "domain": {"signal": "[histMin, histMax]"},
    "range": [420, 1370],
    "nice": true
},
{
    "name": "histY",
    "type": "linear",
    "domain": {"data": "histogram", "field": "count"},
    "range": [420, 50],
    "nice": true,
    "zero": true
},
{
    "name": "controlX",
    "type": "linear",
    "domain": {"data": "controlChart", "field": "lotNumber"},
    "range": [420, 1370],
    "zero": false
},
{
    "name": "controlY",
    "type": "linear",
    "domain": {
        "fields": [
            {"data": "controlChart", "field": "xbar"},
            {"data": "controlChart", "field": "ucl"},
            {"data": "controlChart", "field": "lcl"}
        ]
    },
    "range": [850, 470],
    "nice": true
},
{
    "name": "colorScale",
    "type": "ordinal",
    "domain": ["in", "out"],
    "range": ["#10b981", "#ef4444"]
}
]
```

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[  
  "marks": [  
    {  
      "type": "group",  
      "name": "header",  
      "encode": {  
        "enter": {  
          "x": {"value": 0},  
          "y": {"value": 0},  
          "width": {"signal": "width"},  
          "height": {"value": 60},  
          "fill": {"value": "transparent"}  
        }  
      },  
      "marks": [  
        {  
          "type": "rect",  
          "encode": {  
            "enter": {  
              "x": {"value": 0},  
              "y": {"value": 0},  
              "width": {"signal": "width"},  
              "height": {"value": 60},  
              "fill": {"value": "#1e293b"},  
              "cornerRadius": {"value": 12}  
            }  
          }  
        },  
        {  
          "type": "text",  
          "encode": {  
            "enter": {  
              "x": {"value": 25},  
              "y": {"value": 35},  
              "text": {"value": "⌚ PROCESS CAPABILITY ANALYSIS"},  
              "fontSize": {"value": 28},  
              "fontWeight": {"value": "bold"},  
              "fill": {"value": "#ffffff"},  
              "align": {"value": "left"},  
              "baseline": {"value": "middle"}  
            }  
          }  
        },  
        {  
          "type": "text",  
          "encode": {  
            "enter": {  
              "x": {"signal": "width - 25"},  
              "y": {"value": 35},  
              "text": {"signal": "timeFormat(now(), '%B %d, %Y')"},  
              "fontSize": {"value": 14},  
              "fill": {"value": "#94a3b8"}  
            }  
          }  
        }  
      ]  
    }  
  ]
```

```
        "align": {"value": "right"},  
        "baseline": {"value": "middle"}  
    }  
}  
]  
,  
{  
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    "name": "statsPanel",  
    "encode": {  
        "enter": {  
            "x": {"value": 0},  
            "y": {"value": 80},  
            "width": {"value": 390},  
            "height": {"value": 800},  
            "fill": {"value": "transparent"}  
        }  
    },  
    "marks": [  
        {  
            "type": "rect",  
            "encode": {  
                "enter": {  
                    "x": {"value": 0},  
                    "y": {"value": 0},  
                    "width": {"value": 390},  
                    "height": {"value": 800},  
                    "fill": {"value": "#1e293b"},  
                    "cornerRadius": {"value": 16},  
                    "stroke": {"value": "#334155"},  
                    "strokeWidth": {"value": 2}  
                }  
            }  
        },  
        {  
            "type": "rect",  
            "name": "basicStatsHeader",  
            "encode": {  
                "enter": {  
                    "x": {"value": 0},  
                    "y": {"value": 0},  
                    "width": {"value": 390},  
                    "height": {"value": 50},  
                    "fill": {  
                        "gradient": "linear",  
                        "stops": [  
                            {"offset": 0, "color": "#3b82f6"},  
                            {"offset": 1, "color": "#2563eb"}  
                        ]  
                    },  
                    "cornerRadiusTopLeft": {"value": 16},  
                    "cornerRadiusTopRight": {"value": 16}  
                }  
            }  
        }  
    ]  
}
```

```
        }
    },
{
  "type": "text",
  "encode": {
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      "x": {"value": 20},
      "y": {"value": 28},
      "text": {"value": "📊 STATISTICS"},
      "fontSize": {"value": 16},
      "fontWeight": {"value": "bold"},
      "fill": {"value": "#ffffff"}
    }
  }
},
{
  "type": "group",
  "encode": {
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      "y": {"value": 70}
    }
  },
  "marks": [
    {
      "type": "text",
      "from": {"data": "overallStats"},
      "encode": {
        "enter": {
          "x": {"value": 0},
          "y": {"value": 0},
          "text": {"value": "Total Samples"},
          "fontSize": {"value": 13},
          "fill": {"value": "#94a3b8"}
        }
      }
    },
    {
      "type": "text",
      "from": {"data": "overallStats"},
      "encode": {
        "enter": {
          "x": {"value": 350},
          "y": {"value": 0},
          "text": {"signal": "format(datum.total_samples, '')"},
          "fontSize": {"value": 16},
          "fontWeight": {"value": "bold"},
          "fill": {"value": "#e2e8f0"},
          "align": {"value": "right"}
        }
      }
    }
  ]
},
```

```
{
  "type": "text",
  "from": {"data": "overallStats"},
  "encode": {
    "enter": {
      "x": {"value": 0},
      "y": {"value": 35},
      "text": {"value": "Number of Lots"},
      "fontSize": {"value": 13},
      "fill": {"value": "#94a3b8"}
    }
  }
},
{
  "type": "text",
  "from": {"data": "overallStats"},
  "encode": {
    "enter": {
      "x": {"value": 350},
      "y": {"value": 35},
      "text": {"signal": "format(datum.num_lots, '')"},  

      "fontSize": {"value": 16},
      "fontWeight": {"value": "bold"},  

      "fill": {"value": "#e2e8f0"},  

      "align": {"value": "right"}
    }
  }
},
{
  "type": "text",
  "from": {"data": "overallStats"},
  "encode": {
    "enter": {
      "x": {"value": 0},
      "y": {"value": 70},
      "text": {"value": "Mean ( $\bar{X}$ )"},  

      "fontSize": {"value": 13},
      "fill": {"value": "#94a3b8"}
    }
  }
},
{
  "type": "text",
  "from": {"data": "overallStats"},
  "encode": {
    "enter": {
      "x": {"value": 350},
      "y": {"value": 70},
      "text": {"signal": "format(datum.grandxbar, '.4f')"},  

      "fontSize": {"value": 16},
      "fontWeight": {"value": "bold"},  

      "fill": {"value": "#60a5fa"},  

      "align": {"value": "right"}
    }
  }
}
```

```
        }
    },
    {
        "type": "text",
        "from": {"data": "overallStats"},
        "encode": {
            "enter": {
                "x": {"value": 0},
                "y": {"value": 105},
                "text": {"value": "Std Dev ( $\sigma$ )"},
                "fontSize": {"value": 13},
                "fill": {"value": "#94a3b8"}
            }
        }
    },
    {
        "type": "text",
        "from": {"data": "overallStats"},
        "encode": {
            "enter": {
                "x": {"value": 350},
                "y": {"value": 105},
                "text": {"signal": "format(datum.sigma, '.5f')"},
                "fontSize": {"value": 16},
                "fontWeight": {"value": "bold"},
                "fill": {"value": "#60a5fa"},
                "align": {"value": "right"}
            }
        }
    }
]
},
{
    "type": "rect",
    "encode": {
        "enter": {
            "x": {"value": 0},
            "y": {"value": 220},
            "width": {"value": 390},
            "height": {"value": 50},
            "fill": {
                "gradient": "linear",
                "stops": [
                    {"offset": 0, "color": "#dc2626"},
                    {"offset": 1, "color": "#b91c1c"}
                ]
            }
        }
    }
},
{
    "type": "text",
```

```
"encode": {
  "enter": {
    "x": {"value": 20},
    "y": {"value": 248},
    "text": {"value": "⚠ SPEC LIMITS"},
    "fontSize": {"value": 16},
    "fontWeight": {"value": "bold"},
    "fill": {"value": "#ffffff"}
  }
},
{
  "type": "group",
  "encode": {
    "enter": {
      "x": {"value": 20},
      "y": {"value": 290}
    }
  },
  "marks": [
    {
      "type": "text",
      "from": {"data": "specLimits"},
      "encode": {
        "enter": {
          "x": {"value": 0},
          "y": {"value": 0},
          "text": {"value": "Upper Spec (USL)"},  

          "fontSize": {"value": 13},
          "fill": {"value": "#94a3b8"}
        }
      }
    },
    {
      "type": "text",
      "from": {"data": "specLimits"},
      "encode": {
        "enter": {
          "x": {"value": 350},
          "y": {"value": 0},
          "text": {"signal": "format(datum.usl, '.3f')"},  

          "fontSize": {"value": 16},
          "fontWeight": {"value": "bold"},
          "fill": {"value": "#fca5a5"},
          "align": {"value": "right"}
        }
      }
    },
    {
      "type": "text",
      "from": {"data": "specLimits"},
      "encode": {
        "enter": {
```

```
        "x": {"value": 0},
        "y": {"value": 35},
        "text": {"value": "Nominal"},
        "fontSize": {"value": 13},
        "fill": {"value": "#94a3b8"}
    }
}
},
{
    "type": "text",
    "from": {"data": "specLimits"},
    "encode": {
        "enter": {
            "x": {"value": 350},
            "y": {"value": 35},
            "text": {"signal": "format(datum.nominal, '.3f')"},
            "fontSize": {"value": 16},
            "fontWeight": {"value": "bold"},
            "fill": {"value": "#c084fc"},
            "align": {"value": "right"}
        }
    }
},
{
    "type": "text",
    "from": {"data": "specLimits"},
    "encode": {
        "enter": {
            "x": {"value": 0},
            "y": {"value": 70},
            "text": {"value": "Lower Spec (LSL)" },
            "fontSize": {"value": 13},
            "fill": {"value": "#94a3b8"}
        }
    }
},
{
    "type": "text",
    "from": {"data": "specLimits"},
    "encode": {
        "enter": {
            "x": {"value": 350},
            "y": {"value": 70},
            "text": {"signal": "format(datum.lsl, '.3f')"},
            "fontSize": {"value": 16},
            "fontWeight": {"value": "bold"},
            "fill": {"value": "#fca5a5"},
            "align": {"value": "right"}
        }
    }
}
]
},
```

```
{
  "type": "rect",
  "encode": {
    "enter": {
      "x": {"value": 0},
      "y": {"value": 410},
      "width": {"value": 390},
      "height": {"value": 50},
      "fill": {
        "gradient": "linear",
        "stops": [
          {"offset": 0, "color": "#10b981"},
          {"offset": 1, "color": "#059669"}
        ]
      }
    }
  }
},
{
  "type": "text",
  "encode": {
    "enter": {
      "x": {"value": 20},
      "y": {"value": 438},
      "text": {"value": "\u2225 CAPABILITY"},
      "fontSize": {"value": 16},
      "fontWeight": {"value": "bold"},
      "fill": {"value": "#ffffff"}
    }
  }
},
{
  "type": "group",
  "encode": {
    "enter": {
      "x": {"value": 20},
      "y": {"value": 480}
    }
  },
  "marks": [
    {
      "type": "text",
      "from": {"data": "capabilityMetrics"},
      "encode": {
        "enter": {
          "x": {"value": 0},
          "y": {"value": 0},
          "text": {"value": "Cp (Potential)"},  

          "fontSize": {"value": 13},
          "fill": {"value": "#94a3b8"}
        }
      }
    }
  ],
  "update": [
    {
      "type": "text",
      "from": {"data": "capabilityMetrics", "as": "currentCp"},  

      "encode": {
        "enter": {
          "x": {"value": 0},
          "y": {"value": 0},
          "text": {"value": "Current Cp"},  

          "fontSize": {"value": 13},
          "fill": {"value": "#94a3b8"}
        }
      }
    }
  ]
}
```



```
        "cornerRadius": {"value": 10}
    }
}
{
    "type": "text",
    "from": {"data": "capabilityMetrics"},
    "encode": {
        "enter": {
            "x": {"value": 175},
            "y": {"value": 105},
            "text": {"field": "status"},
            "fontSize": {"value": 18},
            "fontWeight": {"value": "bold"},
            "fill": {"value": "#ffffff"},
            "align": {"value": "center"}
        }
    }
}
]
},
{
    "type": "rect",
    "encode": {
        "enter": {
            "x": {"value": 0},
            "y": {"value": 630},
            "width": {"value": 390},
            "height": {"value": 50},
            "fill": {
                "gradient": "linear",
                "stops": [
                    {"offset": 0, "color": "#8b5cf6"},
                    {"offset": 1, "color": "#7c3aed"}
                ]
            }
        }
    }
},
{
    "type": "text",
    "encode": {
        "enter": {
            "x": {"value": 20},
            "y": {"value": 658},
            "text": {"value": "SIGMA LIMITS"},
            "fontSize": {"value": 16},
            "fontWeight": {"value": "bold"},
            "fill": {"value": "#ffffff"}
        }
    }
},
{

```

```
"type": "group",
"encode": {
  "enter": {
    "x": {"value": 20},
    "y": {"value": 700}
  }
},
"marks": [
  {
    "type": "text",
    "from": {"data": "capabilityMetrics"},
    "encode": {
      "enter": {
        "x": {"value": 0},
        "y": {"value": 0},
        "text": {"signal": "'+' + sigmaLevel + '\u03c3'" },
        "fontSize": {"value": 13},
        "fill": {"value": "#94a3b8"}
      }
    }
  },
  {
    "type": "text",
    "from": {"data": "capabilityMetrics"},
    "encode": {
      "enter": {
        "x": {"value": 350},
        "y": {"value": 0},
        "text": {"signal": "format(datum.plusSigma, '.4f')"}, 
        "fontSize": {"value": 16},
        "fontWeight": {"value": "bold"}, 
        "fill": {"value": "#c4b5fd"}, 
        "align": {"value": "right"}
      }
    }
  },
  {
    "type": "text",
    "from": {"data": "capabilityMetrics"},
    "encode": {
      "enter": {
        "x": {"value": 0},
        "y": {"value": 35},
        "text": {"signal": "'-' + sigmaLevel + '\u03c3'" },
        "fontSize": {"value": 13},
        "fill": {"value": "#94a3b8"}
      }
    }
  },
  {
    "type": "text",
    "from": {"data": "capabilityMetrics"},
    "encode": {
```

```
"enter": {
    "x": {"value": 350},
    "y": {"value": 35},
    "text": {"signal": "format(datum.minusSigma, '.4f')"},
    "fontSize": {"value": 16},
    "fontWeight": {"value": "bold"},
    "fill": {"value": "#c4b5fd"},
    "align": {"value": "right"}
}
}
}
]
}
],
{
  "type": "group",
  "name": "histogramPanel",
  "encode": {
    "enter": {
      "x": {"value": 410},
      "y": {"value": 80},
      "width": {"value": 970},
      "height": {"value": 380}
    }
  },
  "marks": [
    {
      "type": "rect",
      "encode": {
        "enter": {
          "x": {"value": 0},
          "y": {"value": 0},
          "width": {"value": 970},
          "height": {"value": 380},
          "fill": {"value": "#1e293b"},
          "cornerRadius": {"value": 16},
          "stroke": {"value": "#334155"},
          "strokeWidth": {"value": 2}
        }
      }
    },
    {
      "type": "text",
      "encode": {
        "enter": {
          "x": {"value": 485},
          "y": {"value": 30},
          "text": {"value": "Distribution Histogram"},
          "fontSize": {"value": 18},
          "fontWeight": {"value": "bold"},
          "fill": {"value": "#e2e8f0"}
        }
      }
    }
  ]
}
```

```
        },
    },
    {
        "type": "rect",
        "from": {"data": "histogram"},
        "encode": {
            "enter": {
                "x": {"scale": "histX", "field": "bin0"},  

                "x2": {"scale": "histX", "field": "bin1"},  

                "y": {"scale": "histY", "field": "count"},  

                "y2": {"scale": "histY", "value": 0},  

                "fill": {
                    "gradient": "linear",
                    "stops": [
                        {"offset": 0, "color": "#60a5fa"},  

                        {"offset": 1, "color": "#3b82f6"}
                    ]
                },
                "stroke": {"value": "#1e40af"},  

                "strokeWidth": {"value": 1},
                "cornerRadiusTopLeft": {"value": 4},
                "cornerRadiusTopRight": {"value": 4}
            },
            "update": {
                "fillOpacity": {"value": 0.85}
            },
            "hover": {
                "fillOpacity": {"value": 1},
                "stroke": {"value": "#fbbf24"},  

                "strokeWidth": {"value": 2}
            }
        }
    },
    {
        "type": "line",
        "from": {"data": "normalCurve"},  

        "encode": {
            "enter": {
                "x": {"scale": "histX", "field": "x"},  

                "y": {"scale": "histY", "field": "y"},  

                "stroke": {"value": "#fbbf24"},  

                "strokeWidth": {"value": 3},  

                "strokeOpacity": {"signal": "showNormalCurve ? 1 : 0"}
            }
        }
    },
    {
        "type": "rule",
        "from": {"data": "overallStats"},  

        "encode": {
            "enter": {
                "x": {"scale": "histX", "field": "grandxbar"},  

                "y": {"value": 50},  

                "y2": {"value": 55}
            }
        }
    }
]
```

```
        "y2": {"value": 420},
        "stroke": {"value": "#ffffff"},
        "strokeWidth": {"value": 3},
        "strokeDash": {"value": [8, 4]}
    }
}
},
{
    "type": "text",
    "from": {"data": "overallStats"},
    "encode": {
        "enter": {
            "x": {"scale": "histX", "field": "grandxbar"},
            "y": {"value": 40},
            "text": {"value": "MEAN"},
            "fontSize": {"value": 11},
            "fontWeight": {"value": "bold"},
            "fill": {"value": "#ffffff"},
            "align": {"value": "center"}
        }
    }
},
{
    "type": "rule",
    "from": {"data": "specLimits"},
    "encode": {
        "enter": {
            "x": {"scale": "histX", "field": "lsl"},
            "y": {"value": 50},
            "y2": {"value": 420},
            "stroke": {"value": "#ef4444"},
            "strokeWidth": {"value": 3}
        }
    }
},
{
    "type": "text",
    "from": {"data": "specLimits"},
    "encode": {
        "enter": {
            "x": {"scale": "histX", "field": "lsl"},
            "y": {"value": 65},
            "text": {"value": "LSL"},
            "fontSize": {"value": 11},
            "fontWeight": {"value": "bold"},
            "fill": {"value": "#ef4444"},
            "align": {"value": "center"}
        }
    }
},
{
    "type": "rule",
    "from": {"data": "specLimits"},
```

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"encode": {
  "enter": {
    "x": {"scale": "histX", "field": "usl"},
    "y": {"value": 50},
    "y2": {"value": 420},
    "stroke": {"value": "#ef4444"},
    "strokeWidth": {"value": 3}
  }
},
{
  "type": "text",
  "from": {"data": "specLimits"},
  "encode": {
    "enter": {
      "x": {"scale": "histX", "field": "usl"},
      "y": {"value": 65},
      "text": {"value": "USL"},
      "fontSize": {"value": 11},
      "fontWeight": {"value": "bold"},
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      "align": {"value": "center"}
    }
  }
},
{
  "type": "rule",
  "from": {"data": "capabilityMetrics"},
  "encode": {
    "enter": {
      "x": {"scale": "histX", "field": "plusSigma"},
      "y": {"value": 50},
      "y2": {"value": 420},
      "stroke": {"value": "#a78bfa"},
      "strokeWidth": {"value": 2},
      "strokeDash": {"value": [6, 3]}
    }
  }
},
{
  "type": "text",
  "from": {"data": "capabilityMetrics"},
  "encode": {
    "enter": {
      "x": {"scale": "histX", "field": "plusSigma"},
      "y": {"value": 80},
      "text": {"signal": "'+' + sigmaLevel + '\u03c3'" },
      "fontSize": {"value": 10},
      "fill": {"value": "#a78bfa"},
      "align": {"value": "center"}
    }
  }
},
}
```

```
{
  "type": "rule",
  "from": {"data": "capabilityMetrics"},
  "encode": {
    "enter": {
      "x": {"scale": "histX", "field": "minusSigma"},  

      "y": {"value": 50},  

      "y2": {"value": 420},  

      "stroke": {"value": "#a78bfa"},  

      "strokeWidth": {"value": 2},  

      "strokeDash": {"value": [6, 3]}
    }
  }
},  

{
  "type": "text",
  "from": {"data": "capabilityMetrics"},  

  "encode": {
    "enter": {
      "x": {"scale": "histX", "field": "minusSigma"},  

      "y": {"value": 80},  

      "text": {"signal": "'-' + sigmaLevel + '\u03c3'"},  

      "fontSize": {"value": 10},  

      "fill": {"value": "#a78bfa"},  

      "align": {"value": "center"}
    }
  }
}  

],  

"axes": [  

  {
    "orient": "bottom",
    "scale": "histX",
    "labelColor": "#94a3b8",
    "labelFontSize": 11,
    "titleColor": "#e2e8f0",
    "titleFontSize": 13,
    "titleFontWeight": "bold",
    "title": "Measured Value",
    "gridColor": "#334155",
    "gridOpacity": 0.3,
    "domainColor": "#475569",
    "tickColor": "#475569",
    "format": ".2f"
  },
  {
    "orient": "left",
    "scale": "histY",
    "labelColor": "#94a3b8",
    "labelFontSize": 11,
    "titleColor": "#e2e8f0",
    "titleFontSize": 13,
    "titleFontWeight": "bold",
    "title": "Standard Deviation"
  }
]
```

```
"title": "Frequency",
"gridColor": "#334155",
"gridOpacity": 0.3,
"domainColor": "#475569",
"tickColor": "#475569"
}
]
},
{
  "type": "group",
  "name": "controlChartPanel",
  "encode": {
    "enter": {
      "x": {"value": 410},
      "y": {"value": 480},
      "width": {"value": 970},
      "height": {"value": 400}
    }
  },
  "marks": [
    {
      "type": "rect",
      "encode": {
        "enter": {
          "x": {"value": 0},
          "y": {"value": 0},
          "width": {"value": 970},
          "height": {"value": 400},
          "fill": {"value": "#1e293b"},
          "cornerRadius": {"value": 16},
          "stroke": {"value": "#334155"},
          "strokeWidth": {"value": 2}
        }
      }
    },
    {
      "type": "text",
      "encode": {
        "enter": {
          "x": {"value": 485},
          "y": {"value": 30},
          "text": {"value": "X-Bar Control Chart"},
          "fontSize": {"value": 18},
          "fontWeight": {"value": "bold"},
          "fill": {"value": "#e2e8f0"}
        }
      }
    },
    {
      "type": "text",
      "encode": {
        "enter": {
          "x": {"value": 485},
```

```
        "y": {"value": 52},
        "text": {"value": "Click points to filter • Double-click to reset"},
        "fontSize": {"value": 11},
        "fill": {"value": "#64748b"},
        "fontStyle": {"value": "italic"}
    }
}
},
{
    "type": "rule",
    "from": {"data": "overallStats"},
    "encode": {
        "enter": {
            "x": {"value": 420},
            "x2": {"value": 1370},
            "y": {"scale": "controlY", "field": "grandxbar"},
            "stroke": {"value": "#60a5fa"},
            "strokeWidth": {"value": 2},
            "strokeDash": {"value": [8, 4]}
        }
    }
},
{
    "type": "text",
    "from": {"data": "overallStats"},
    "encode": {
        "enter": {
            "x": {"value": 1375},
            "y": {"scale": "controlY", "field": "grandxbar"},
            "text": {"value": "\u0304X\u0304"}, // \u0304X\u0304
            "fontSize": {"value": 11},
            "fontWeight": {"value": "bold"},
            "fill": {"value": "#60a5fa"},
            "align": {"value": "left"},
            "baseline": {"value": "middle"}
        }
    }
},
{
    "type": "rule",
    "from": {"data": "controlChart"},
    "encode": {
        "enter": {
            "x": {"value": 420},
            "x2": {"value": 1370},
            "y": {"scale": "controlY", "field": "ucl"},
            "stroke": {"value": "#f59e0b"},
            "strokeWidth": {"value": 2}
        }
    }
},
{
    "type": "text",
```

```
"from": {"data": "controlChart"},  
"encode": {  
    "enter": {  
        "x": {"value": 1375},  
        "y": {"scale": "controlY", "field": "ucl"},  
        "text": {"value": "UCL"},  
        "fontSize": {"value": 11},  
        "fontWeight": {"value": "bold"},  
        "fill": {"value": "#f59e0b"},  
        "align": {"value": "left"},  
        "baseline": {"value": "middle"}  
    }  
},  
}  
,  
{  
    "type": "rule",  
    "from": {"data": "controlChart"},  
    "encode": {  
        "enter": {  
            "x": {"value": 420},  
            "x2": {"value": 1370},  
            "y": {"scale": "controlY", "field": "lcl"},  
            "stroke": {"value": "#f59e0b"},  
            "strokeWidth": {"value": 2}  
        }  
    }  
},  
,  
{  
    "type": "text",  
    "from": {"data": "controlChart"},  
    "encode": {  
        "enter": {  
            "x": {"value": 1375},  
            "y": {"scale": "controlY", "field": "lcl"},  
            "text": {"value": "LCL"},  
            "fontSize": {"value": 11},  
            "fontWeight": {"value": "bold"},  
            "fill": {"value": "#f59e0b"},  
            "align": {"value": "left"},  
            "baseline": {"value": "middle"}  
        }  
    }  
},  
,  
{  
    "type": "line",  
    "from": {"data": "controlChart"},  
    "encode": {  
        "enter": {  
            "x": {"scale": "controlX", "field": "lotNumber"},  
            "y": {"scale": "controlY", "field": "xbar"},  
            "stroke": {"value": "#64748b"},  
            "strokeWidth": {"value": 2}  
        },  
        "exit": {  
            "x": {"scale": "controlX", "field": "lotNumber"},  
            "y": {"scale": "controlY", "field": "xbar"},  
            "stroke": {"value": "#64748b"},  
            "strokeWidth": {"value": 2}  
        }  
    }  
},  
}
```

```
"update": {
  "strokeOpacity": [
    {"test": "datum.isSelected", "value": 1},
    {"value": 0.2}
  ]
}
},
{
  "type": "symbol",
  "name": "lotPoint",
  "from": {"data": "controlChart"},
  "encode": {
    "enter": {
      "x": {"scale": "controlX", "field": "lotNumber"},
      "y": {"scale": "controlY", "field": "xbar"},
      "size": {"value": 150},
      "strokeWidth": {"value": 2}
    },
    "update": {
      "fill": [
        {"test": "datum.outOfControl", "value": "#ef4444"},
        {"value": "#10b981"}
      ],
      "stroke": [
        {"test": "datum.outOfControl", "value": "#7f1d1d"},
        {"value": "#064e3b"}
      ],
      "fillOpacity": [
        {"test": "datum.isSelected", "value": 1},
        {"value": 0.3}
      ],
      "strokeOpacity": [
        {"test": "datum.isSelected", "value": 1},
        {"value": 0.3}
      ],
      "cursor": {"value": "pointer"}
    },
    "hover": {
      "size": {"value": 250},
      "strokeWidth": {"value": 3}
    }
  }
},
{
  "type": "text",
  "from": {"data": "controlChart"},
  "encode": {
    "enter": {
      "x": {"scale": "controlX", "field": "lotNumber"},
      "y": {"scale": "controlY", "field": "xbar", "offset": -15},
      "text": {"field": "lot_breaker_id"},
      "fontSize": {"value": 9},
      "fontWeight": "bold"
    }
  }
}
```

```
        "fill": {"value": "#94a3b8"},  
        "align": {"value": "center"},  
        "baseline": {"value": "bottom"}  
    },  
    "update": {  
        "fillOpacity": [  
            {"test": "datum.isSelected", "value": 1},  
            {"value": 0.3}  
        ]  
    }  
}  
}  
],  
"axes": [  
    {  
        "orient": "bottom",  
        "scale": "controlX",  
        "labelColor": "#94a3b8",  
        "labelFontSize": 11,  
        "titleColor": "#e2e8f0",  
        "titleFontSize": 13,  
        "titleFontWeight": "bold",  
        "title": "Lot Number",  
        "gridColor": "#334155",  
        "gridOpacity": 0.3,  
        "domainColor": "#475569",  
        "tickColor": "#475569"  
    },  
    {  
        "orient": "left",  
        "scale": "controlY",  
        "labelColor": "#94a3b8",  
        "labelFontSize": 11,  
        "titleColor": "#e2e8f0",  
        "titleFontSize": 13,  
        "titleFontWeight": "bold",  
        "title": "X-Bar (Lot Mean)",  
        "gridColor": "#334155",  
        "gridOpacity": 0.3,  
        "domainColor": "#475569",  
        "tickColor": "#475569",  
        "format": ".3f"  
    }  
]  
}
```