Integrating Plotly charts into Firefly visualization system

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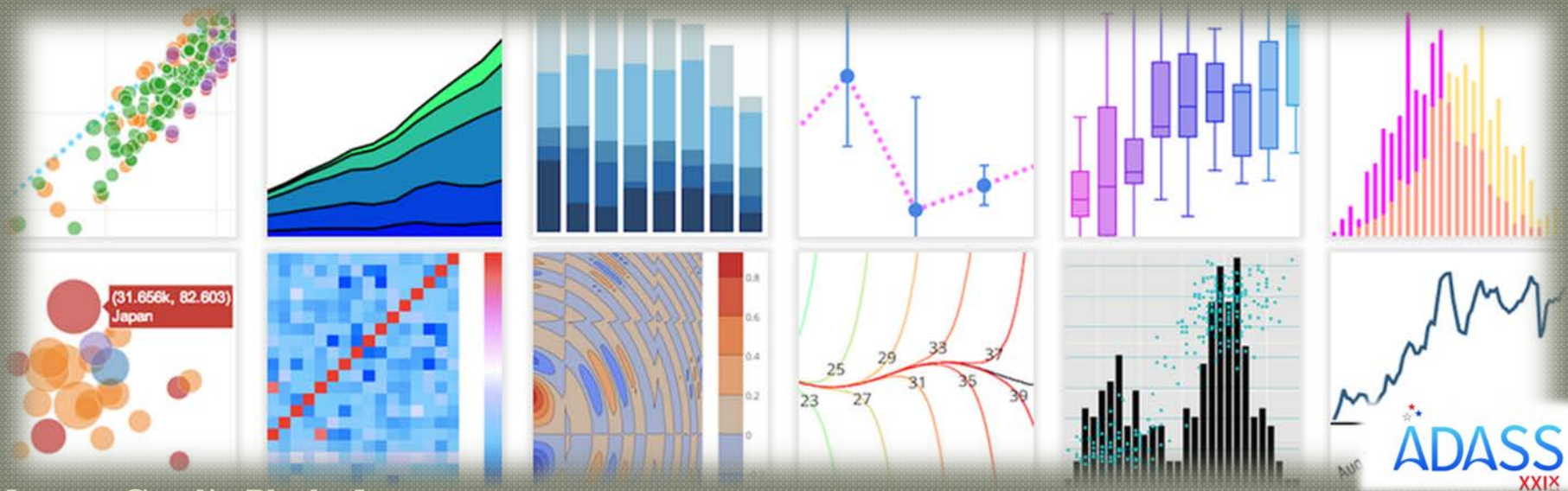
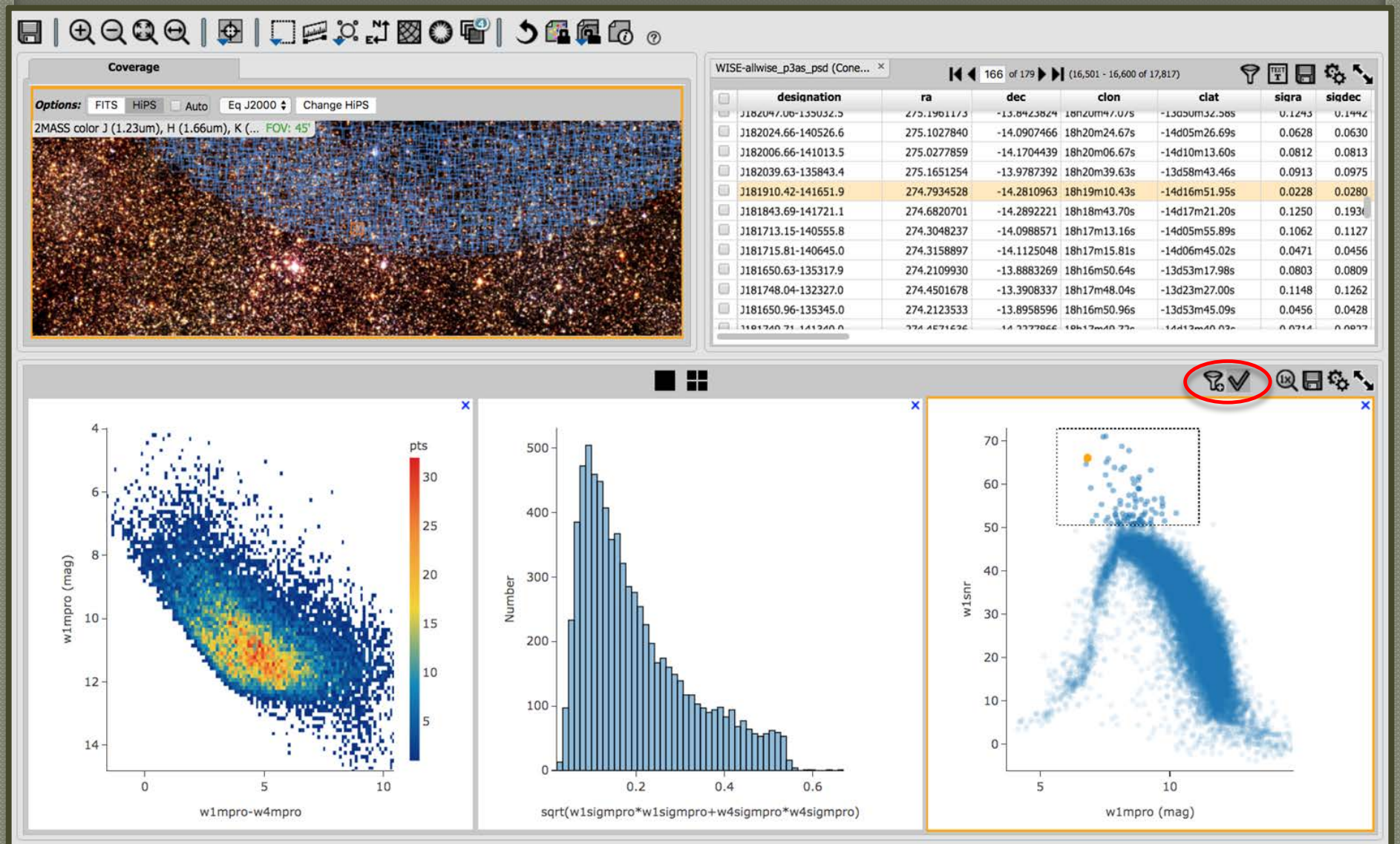
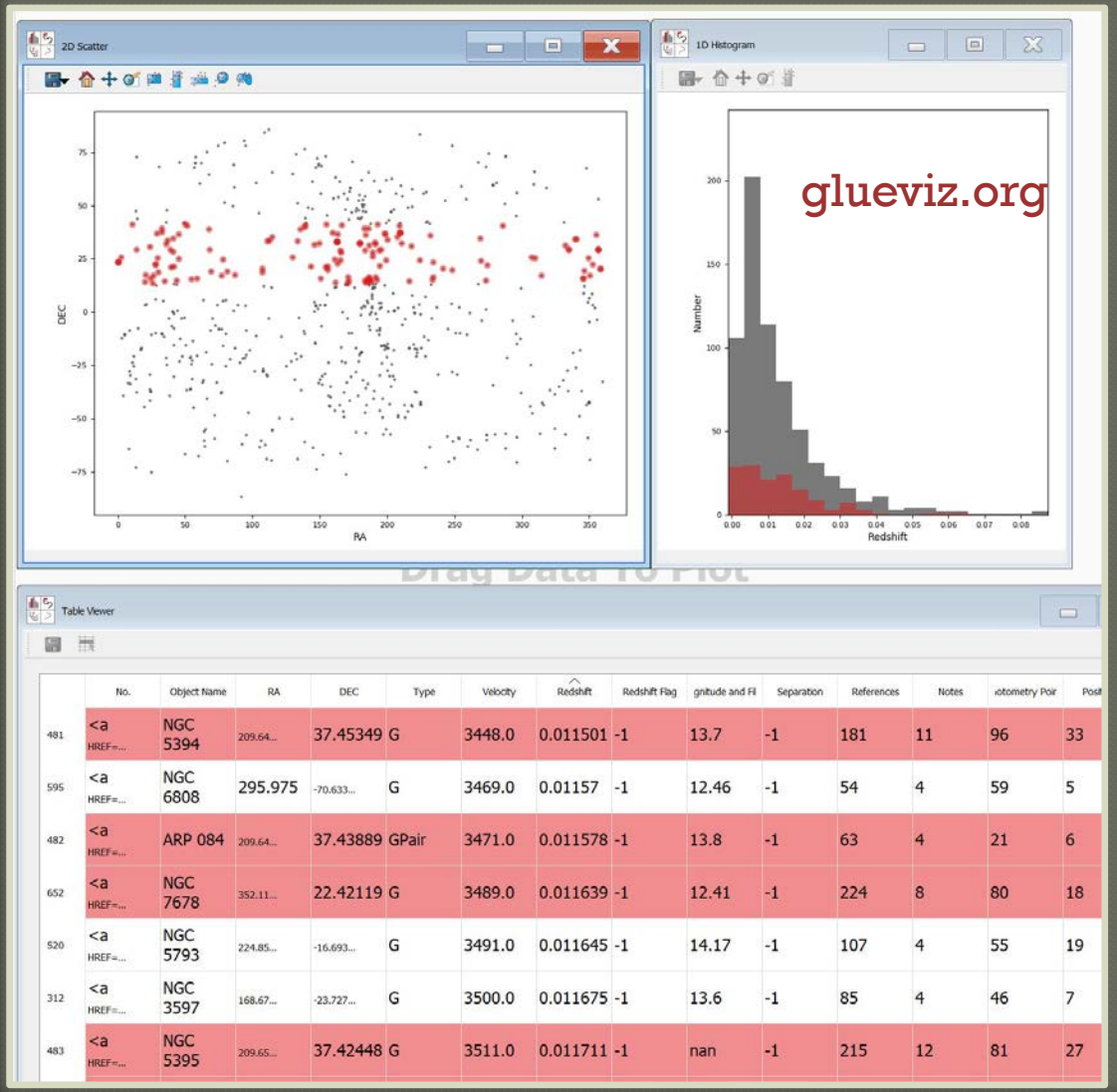


Image Credit: Plotly, Inc.

Charts in Firefly



Other tools with connected views



	No.	Object Name	RA	DEC	Type	Velocity	Redshift	Redshift Flag	gnitude and Fl	Separation	References	Notes	otometry Poir	Posi
481	<a HREF=...	NGC 5394	209.64...	37.45349	G	3448.0	0.011501	-1	13.7	-1	181	11	96	33
595	<a HREF=...	NGC 6808	295.975	-70.633...	G	3469.0	0.01157	-1	12.46	-1	54	4	59	5
482	<a HREF=...	ARP 084	209.64...	37.43889	GPair	3471.0	0.011578	-1	13.8	-1	63	4	21	6
652	<a HREF=...	NGC 7678	352.11...	22.42119	G	3489.0	0.011639	-1	12.41	-1	224	8	80	18
520	<a HREF=...	NGC 5793	224.85...	-16.693...	G	3491.0	0.011645	-1	14.17	-1	107	4	55	19
312	<a HREF=...	NGC 3597	168.67...	-23.727...	G	3500.0	0.011675	-1	13.6	-1	85	4	46	7
483	<a HREF=...	NGC 5395	209.65...	37.42448	G	3511.0	0.011711	-1	nan	-1	215	12	81	27

Brushing & Linking

propagating selections in any graph to all others

Supporting tools

glueviz.org
uwdata/falcon
Bokeh
Plotly Dash
…

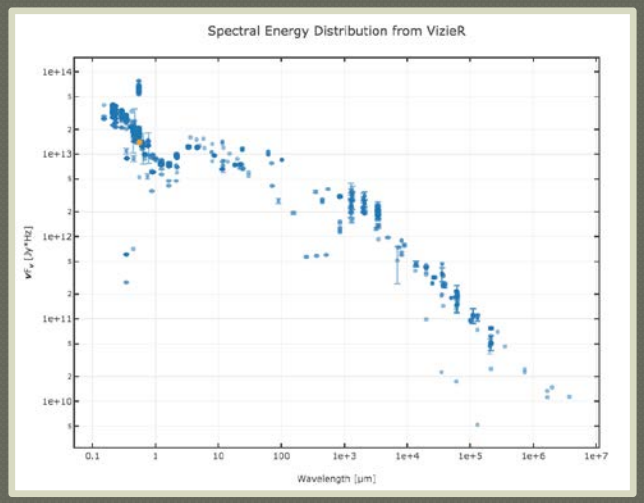
Image Credit: gluviz.org

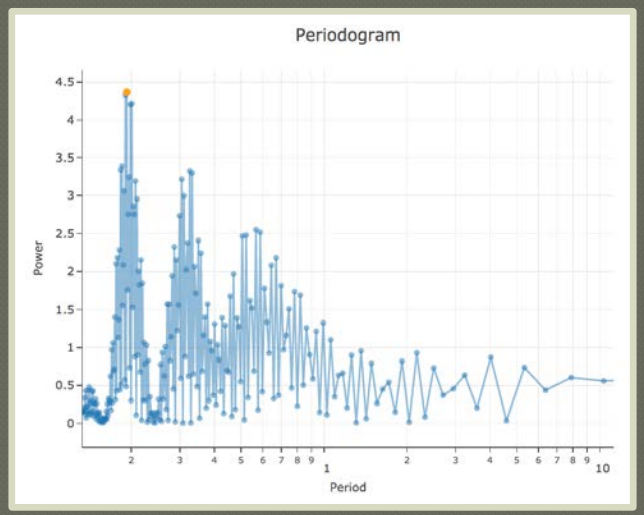
Added Value of Integration

Tools that tightly integrate data access, versioning, and management are preferred over those that put all of the data management steps purely outside of the Information Visualization system.

Dan Russell
Google research scientist

Common charts





Must support

- Scatter charts; error/limits
- Line plots
- Histograms
- Density plots

Bonus: other charts

Ideal chart tech requirements

- Visually attractive
- Interactive (dynamic tooltips, selections)
- Customizable (custom actions and looks)
- Responsive (no lag, no flicker)

- Executed in a browser (SVG, <CANVAS>, WebGL)
- Events monitoring and custom code hooks
- Easy mapping of our data to chart data
- Optimizations for iterative updates

Firefly Chart API

Do not limit API users
to common charts

Allow any chart or attribute supported
by the charting library

How do we maintain and document
these charts?

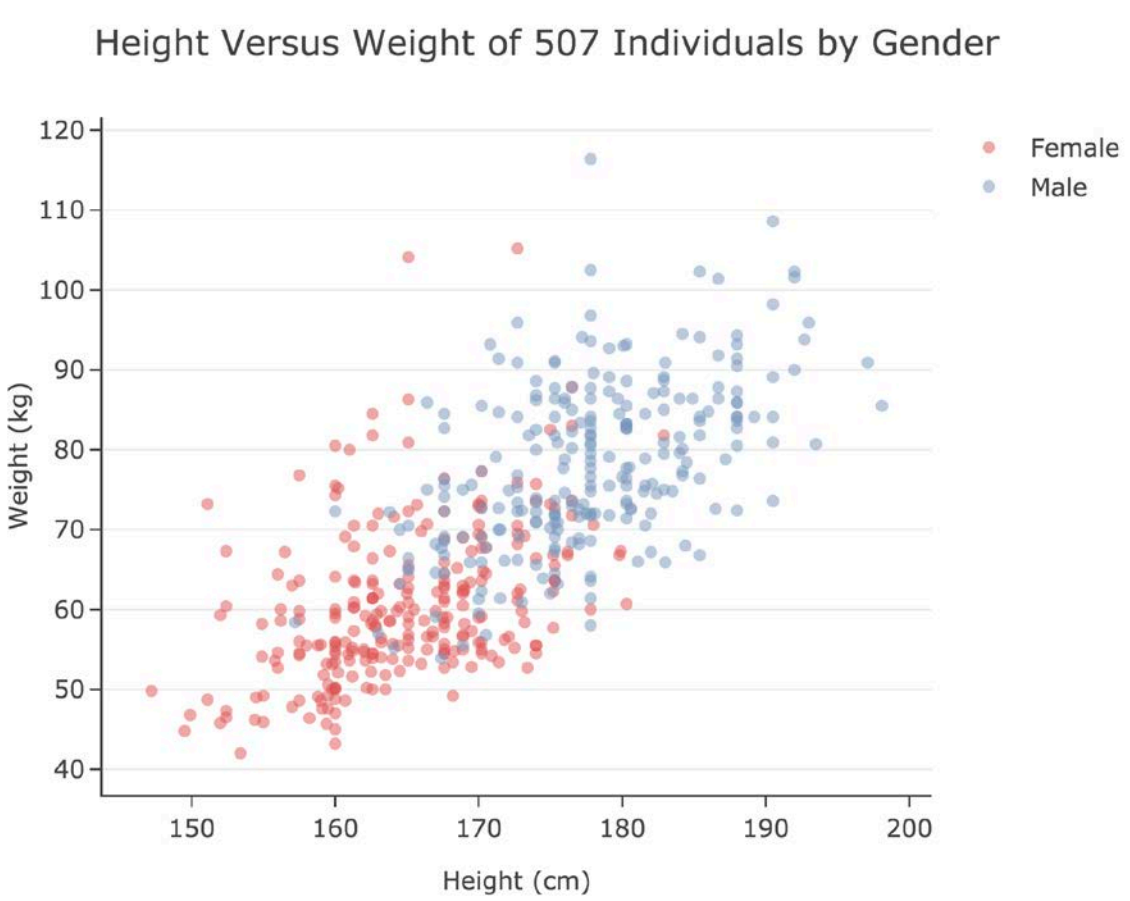
Why Plotly?

- First scientific JS charting library on the web
- Open sourced 2015
- Declarative charts in JSON
- Language and platform independent
- Supported schema translations into

  - JavaScript
  - Python
  - R
  - MATLAB

Declarative Chart Example

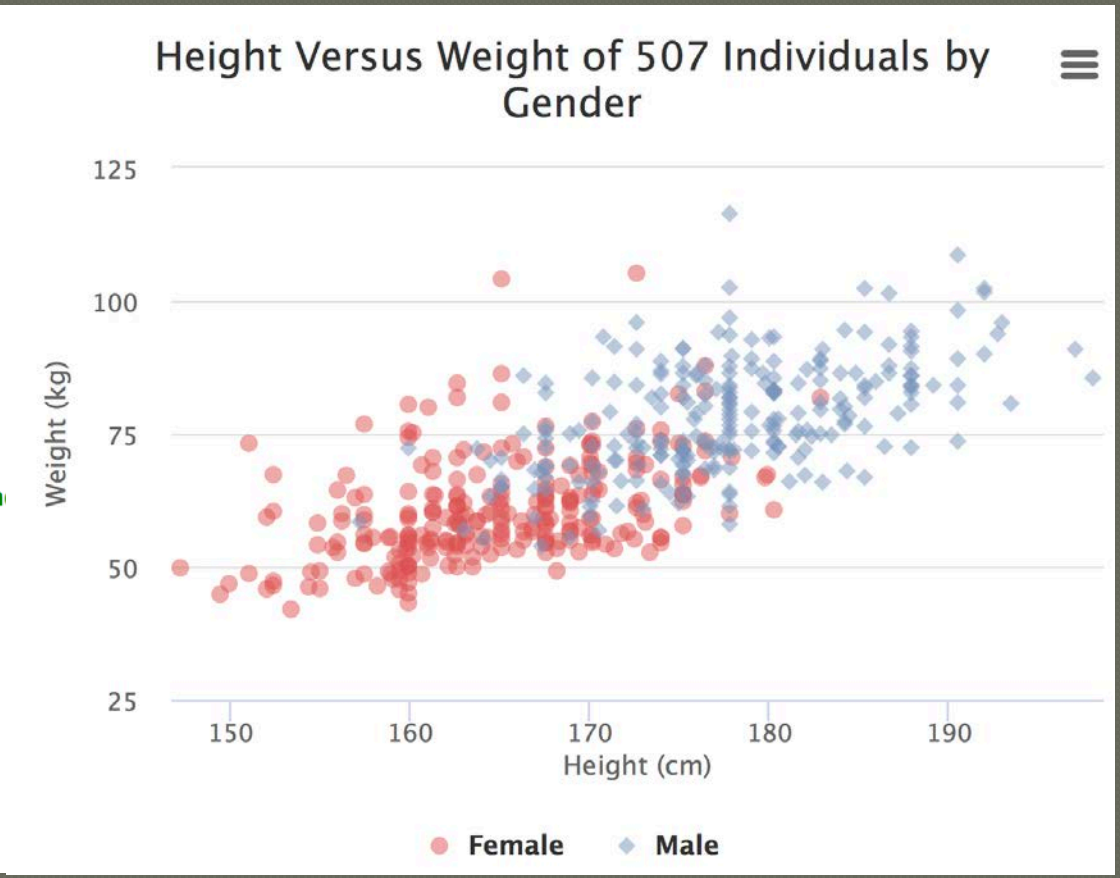
```
chart = {
    data: [
        {
            name: 'Female',
            mode: 'markers',
            marker: {
                color: 'rgba(223, 83, 8
            },
            x: [161.2, 167.5, 159.5, 15
            y: [51.6, 59.0, 49.2, 63.0,
        },
        {
            name: 'Male',
            mode: 'markers',
            marker: {
                color: 'rgba(119, 152,
            },
            x: [174.0, 175.3, 193.5, 18
            y: [65.6, 71.8, 80.7, 72.6,
        }
    ],
    layout: {
        title: 'Height Versus Weight of
        xaxis: {title: 'Height (cm)'},
        yaxis: {title: 'Weight (kg)'}
    }
};
```



Plotly.js

Declarative Chart Example

```
{
    series: [{
        name: 'Female',
        color: 'rgba(223, 83, 83, .5)',
        data: [[161.2, 51.6], [167.5, 59.0],

    }, {
        name: 'Male',
        color: 'rgba(119, 152, 191, .5)',
        data: [[174.0, 65.6], [175.3, 71.8],
    }],
    chart: {
        type: 'scatter',
        zoomType: 'xy'
    },
    title: {
        text: 'Height Versus Weight of 507 In
    },
    xAxis: {
        title: {
            text: 'Height (cm)'
        },
    },
    yAxis: {
        title: {
            text: 'Weight (kg)'
        }
    },
}
```



Highcharts

Declarative Chart Definitions

```
{
    series: [{
        name: 'Female',
        color: 'rgba(223, 83, 83, .5)',
        data: [[161.2, 51.6], [167.5, 59.0],

    }, {
        name: 'Male',
        color: 'rgba(119, 152, 191, .5)',
        data: [[174.0, 65.6], [175.3, 71.8],
    }],
    chart: {
        type: 'scatter',
        zoomType: 'xy'
    },
    title: {
        text: 'Height Versus Weight of 507 In
    },
    xAxis: {
        title: {
            text: 'Height (cm)'
        },
    },
    yAxis: {
        title: {
            text: 'Weight (kg)'
        }
    },
}
```

Highcharts

```
{
    data: [
        {
            name: 'Female',
            mode: 'markers',
            marker: {
                color: 'rgba(223, 83, 83, .5)'
            },
            x: [161.2, 167.5, 159.5, 157.0, 15
            y: [51.6, 59.0, 49.2, 63.0, 53.6,
        },
        {
            name: 'Male',
            mode: 'markers',
            marker: {
                color: 'rgba(119, 152, 191, .5
            },
            x: [174.0, 175.3, 193.5, 186.5, 18
            y: [65.6, 71.8, 80.7, 72.6, 78.8,
        }
    ],
    layout: {
        title: 'Height Versus Weight of 507 In
        xaxis: {title: 'Height (cm)'},
        yaxis: {title: 'Weight (kg)'}
    }
};
```

Plotly.js

Declarative Charts Approach

Used by popular chart libraries:
Plotly, Highcharts, Vega-lite, many more

More than 1000 properties in each

Incompatible data models / vocabularies:

- Series in Highcharts
- Traces in Plotly
- Layers in Vega-Lite

Forces teams to choose one charting library and build on top of it

Plotly Figure Hierarchy

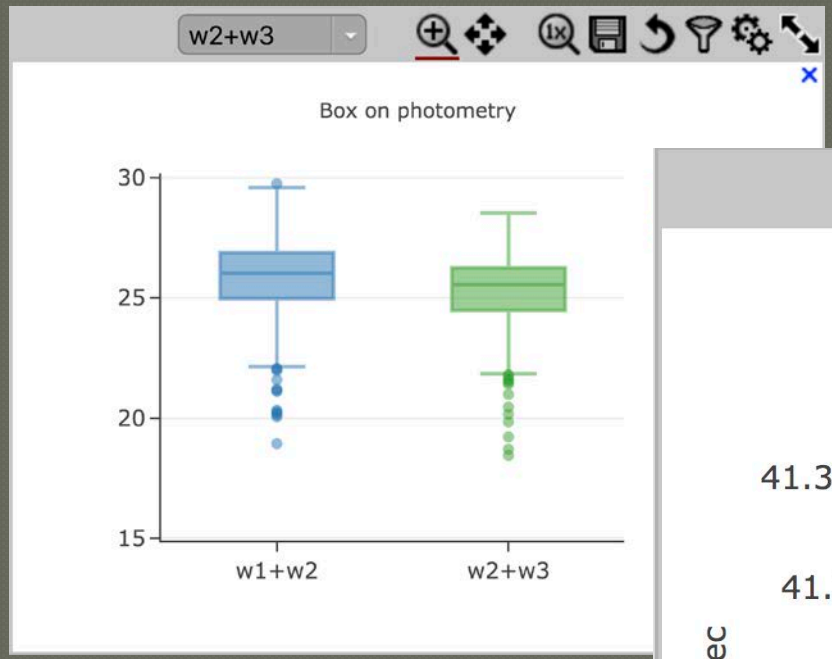
DATA [ ]
- TRACE { }
  - x, y, z [ ]
  - text [ ]
  - ERROR_X, ERROR_Y { }
    - array, arrayminus [ ]
  - MARKER { }
    - color ABC or [ ]
    - size 123 or [ ]
    - colorscale ABC or [ ]
    - symbol ABC

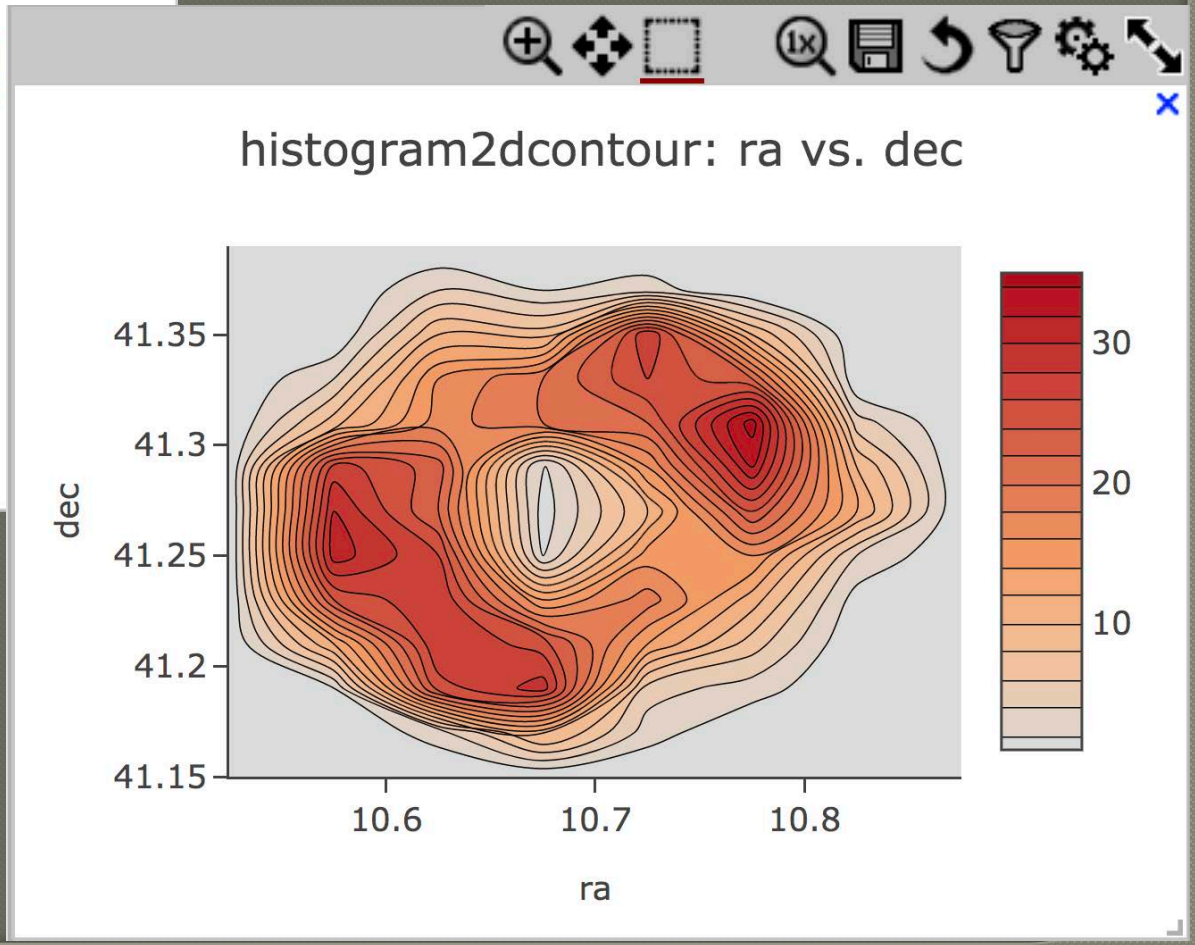
LAYOUT { }
- showlegend True/False
- autosize True/False
- XAXIS, YAXIS { }
- SCENE { }
  - XAXIS, YAXIS, ZAXIS { }
- TITLE { }
- LEGEND { }
- ANNOTATIONS { }

{ } = dictionary
[ ] = list
ABC = string
123 = number

Credit: plotly_js_cheat_sheet.pdf

Sample charts





Example – creating box chart

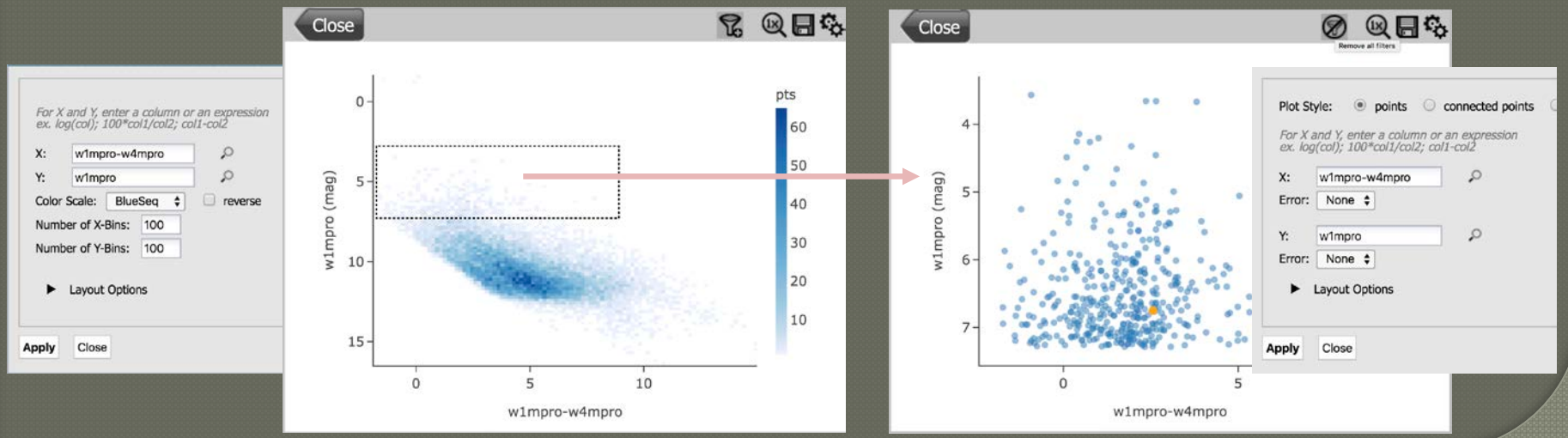
```
data = [
    {
        type: 'box',
        name: 'w1+w2',
        tbl_id: "wiseCatTbl",
        y: "tables::w1mpro+w2mpro"
    },
    {
        type: 'box',
        name: 'w2+w3',
        tbl_id: "wiseCatTbl",
        y: "tables::w2mpro+w3mpro"
    }
];

layout = {
    title: 'Box on photometry',
};

firefly.getViewer().showChart({layout, data}, 'boxContainer');
```

Table and column references

Plotly chart definition

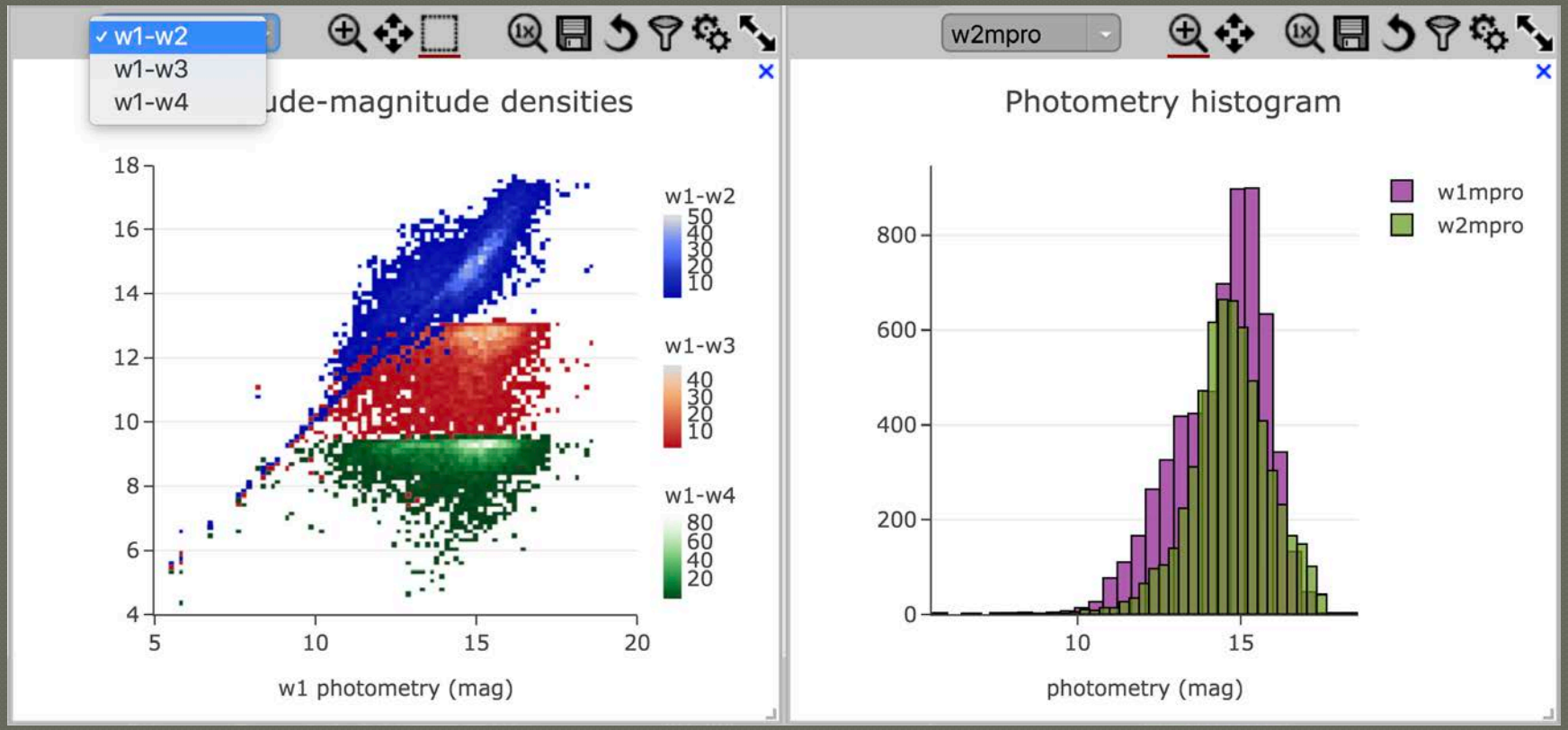
Firefly Enhancements

- Aggregating data on the server
- Upper/lower limits display
- Default chart: switching between heatmap and scatter based on the number of points
- UI for basic actions and chart modifications



Firefly Enhancements

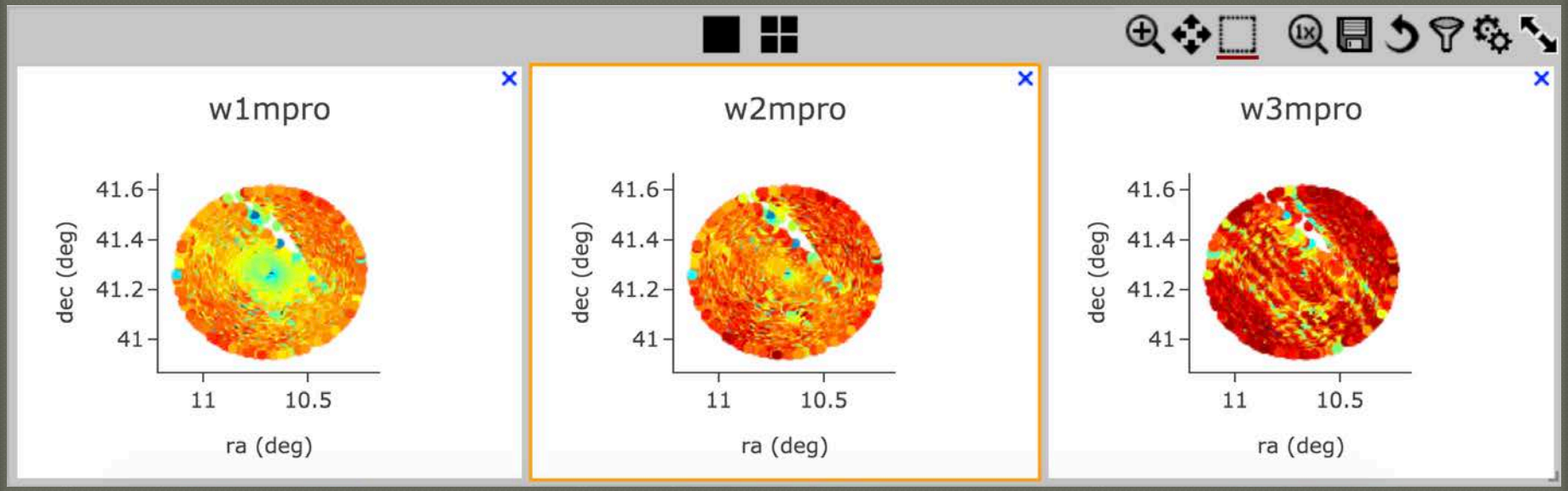
Multi-trace UI: add, remove, rearrange traces



Summary

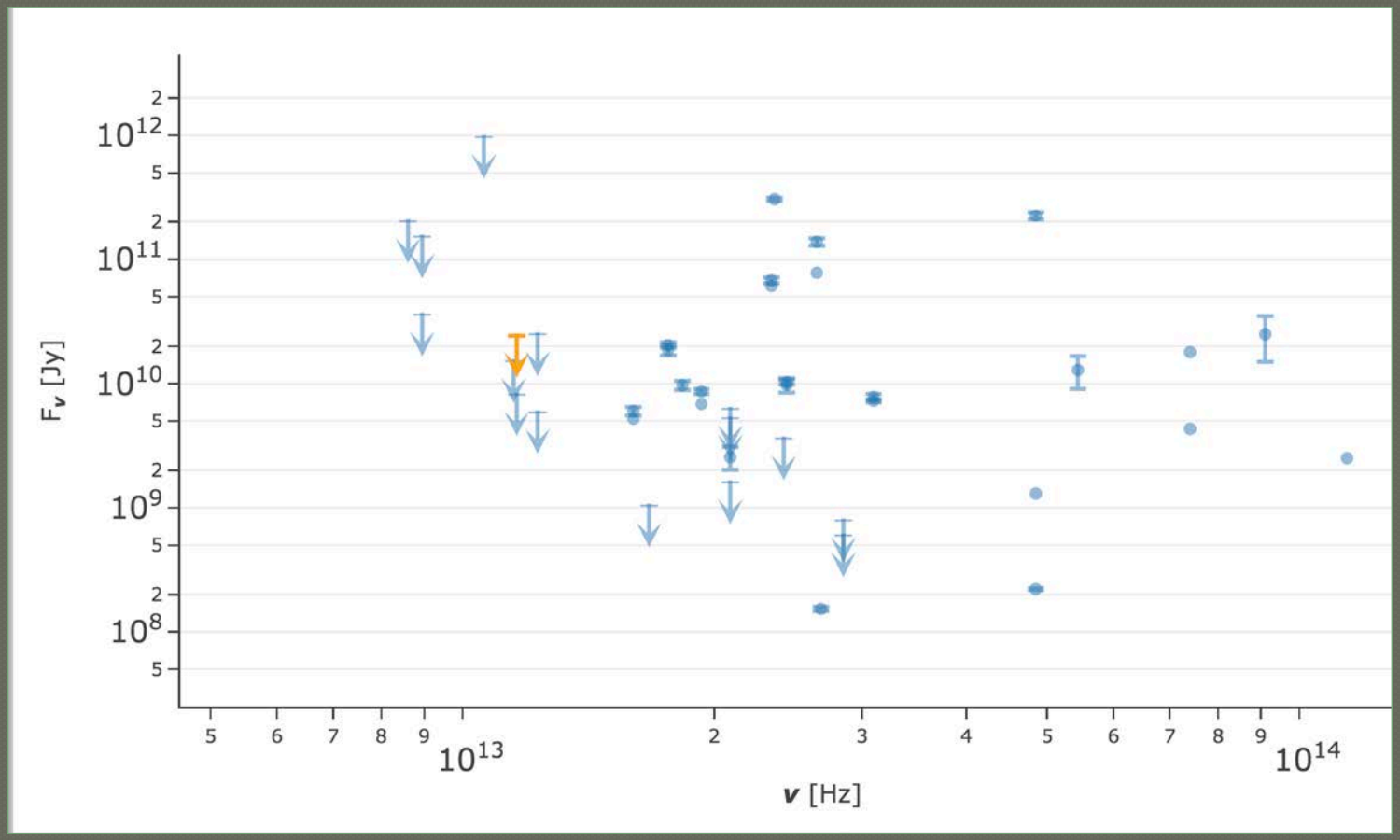
- Plotly proved to be a good choice to support our chart display and brushing and linking capabilities.
- Its declarative chart schema made our charting framework lightweight, flexible, and easy to extend.
- Any chart that Plotly supports can be used to visualize table data in Firefly API.
- Use https://plot.ly/javascript/ for chart examples and attribute reference.

Thank you!



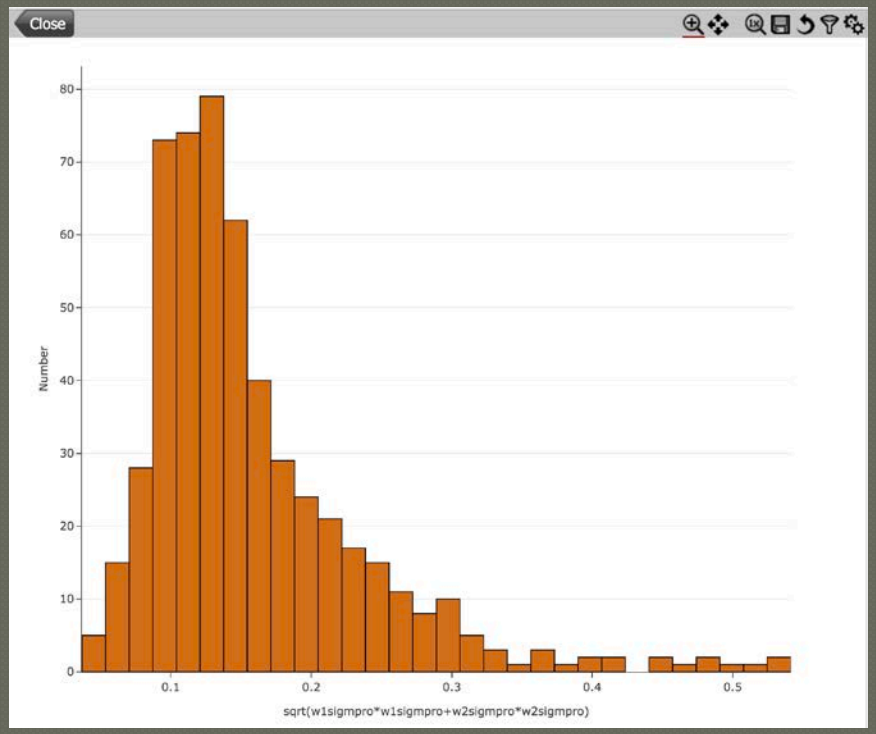
Firefly Enhancements

Displaying Upper and Lower limits

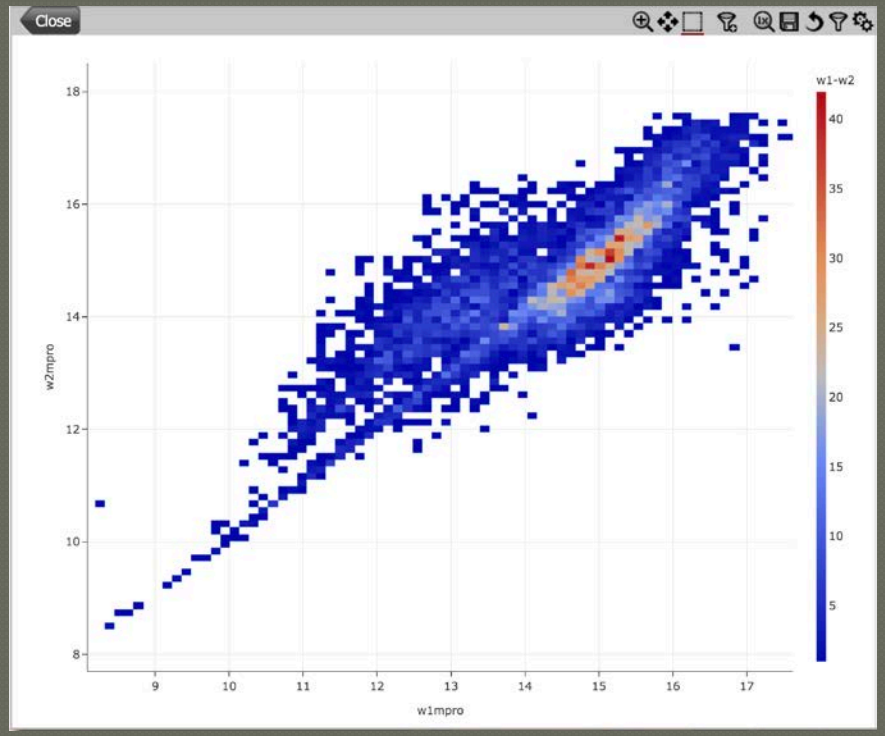


Firefly Enhancements

Aggregating data on the server



Firefly Histogram



Firefly Heatmap