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PSI

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WICA-HTTP and WICA-JS

Two components for bringing PSI's EPICS control system data to the web

Prepared originally for EPICS Collaboration Meeting ITER June 2019.
Updated: September 2019.

Project Motivations

Primary Goal – Status Display Replacement

"Replace the displays which show the status of PSI's main facilities with something that scales better to the future."

Minimum Requirements

- Provide a tool for PSI's offsite technical staff -> should allow them to verify that the scientific facilities are working correctly.
- Provide a tool for PSI remote users -> should allow them to see how the program of work is evolving (so they can decide whether to come on-site)
- Improved User Experience -> should provide a "fancier", more responsive user interface that work equally well on desktop, tablet and mobile devices. Buzzword: "PWA's.

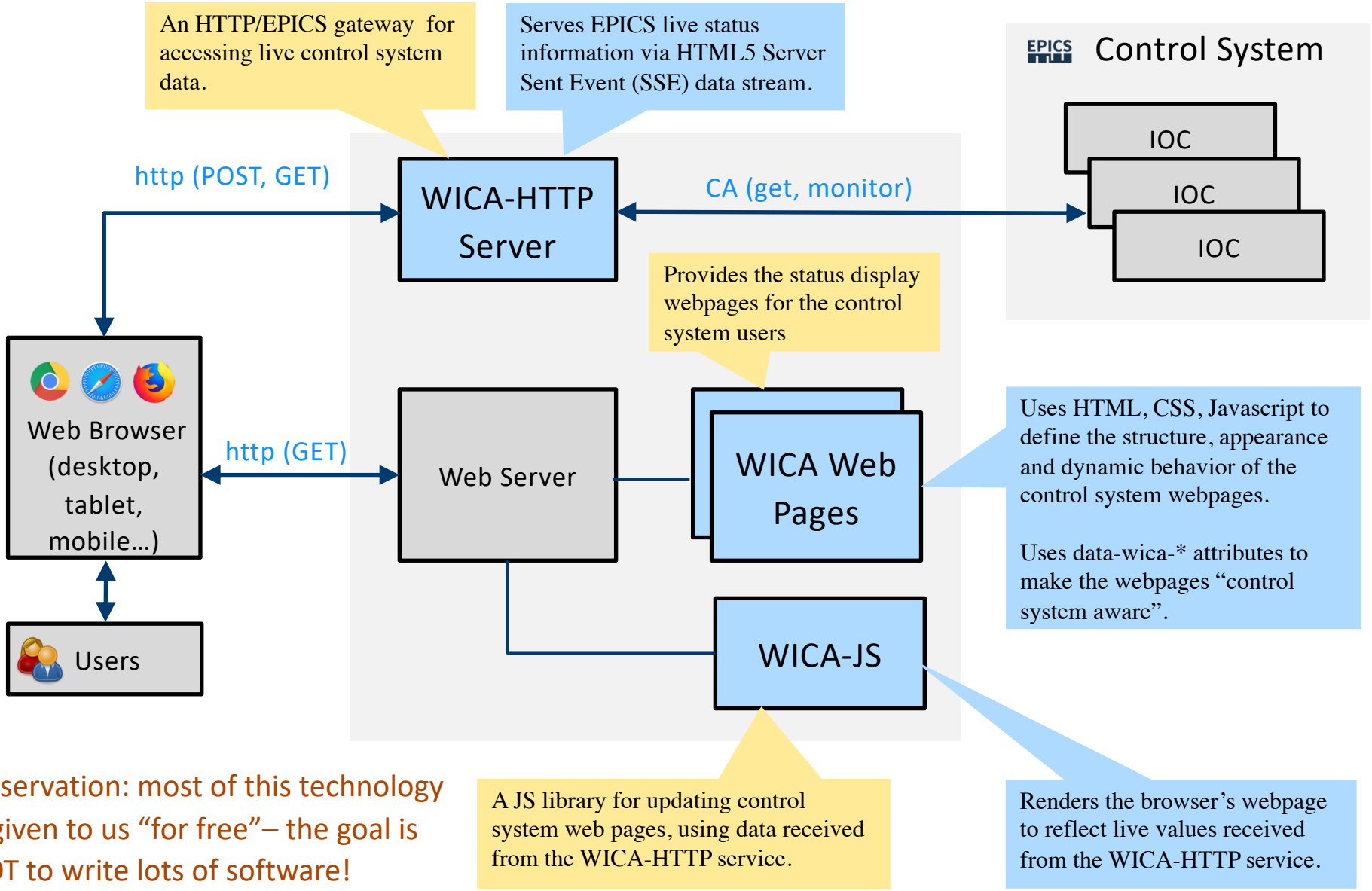
Secondary Goal – Learn Lessons

"Explore the difficulties of achieving the above by leveraging off powerful, modern, well-tested and widely-used web frameworks and libraries."

Solution Summary

- A new solution has been developed called "**WICA**".
- WICA stands for **Web Interface for Controls Applications**. (The CA previously stood for "Channel Access", but the intention is to make the library compatible with newer control system protocols when/if we actively use them).
- WICA consists of:
  - **WICA-PAGES**: these are standard HTML5 webpages that leverage off user-defined '**data-wica-***' attributes to configure the control system channels of interest and to define other properties needed to render the element.
  - **WICA-HTTP**: this is an HTTP microservice which provides a means of getting, setting and/or streaming live data from an EPICS-based control system.
  - **WICA-JS**: this is a Javascript library which scans the WICA webpages, sets up a live data stream from the WICA-REST server and which updates the visual appearance of the elements in real time.
- WICA can render the textual content of html elements directly, or can work with other JS libraries (eg plot libraries like **Plotly**, **Highcharts** or web component libraries like **LitElement**) where more sophisticated functionality is required.

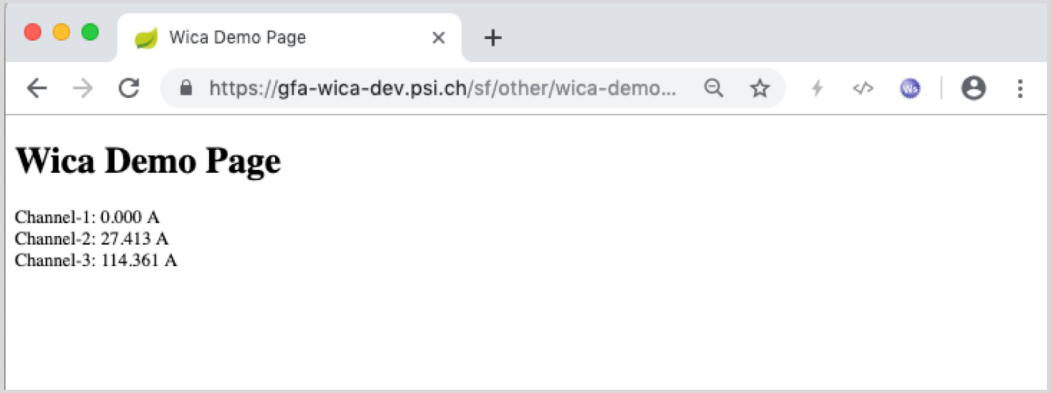
WICA Overview Picture



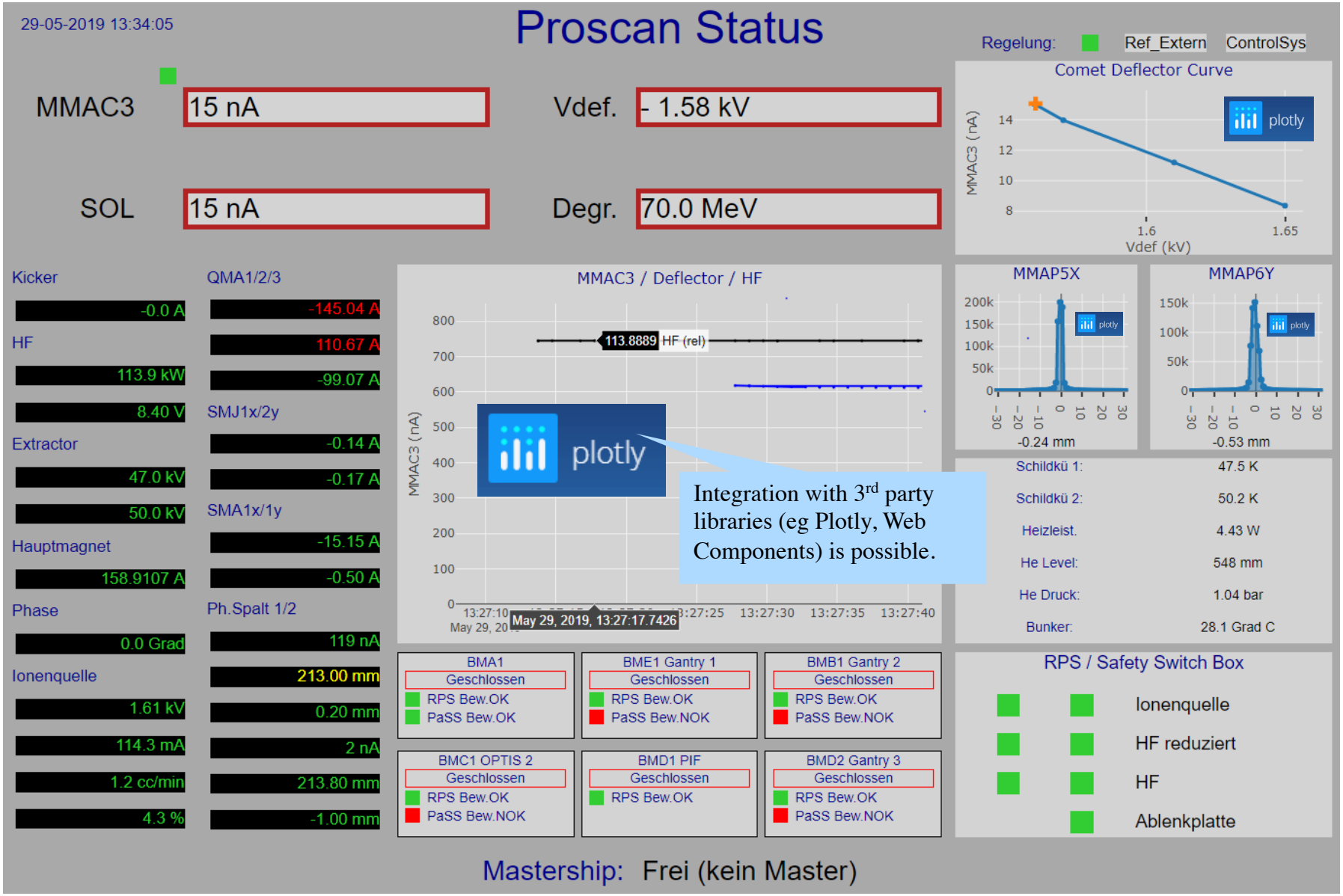
Observation: most of this technology is given to us "for free"– the goal is NOT to write lots of software!

Simple Wica Web Page Example

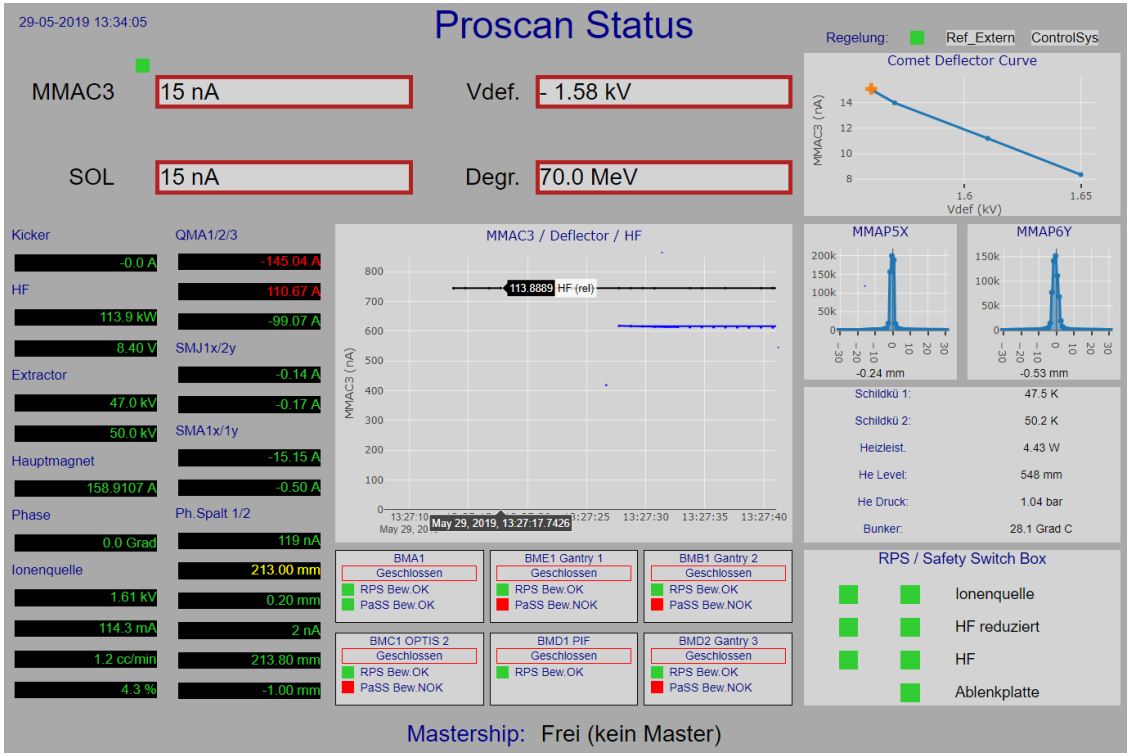
```
<!doctype html>
<html lang="en">
<head>
    <meta charset="utf-8"/>
    <title>Wica Demo Page</title>
    <script src="/wica/wica.js" type="module"></script>
</head>
<body>
    <h1>Wica Demo Page</h1>
    <label>Channel-1:</label> <span data-wica-channel-name="SINEG01-MBND300:I-READ"></span> <br>
    <label>Channel-2:</label> <span data-wica-channel-name="SINLH02-MBND100:I-READ"></span> <br>
    <label>Channel-3:</label> <span data-wica-channel-name="SINBC02-MBND100:I-READ"></span> <br>
</body>
</html>
```

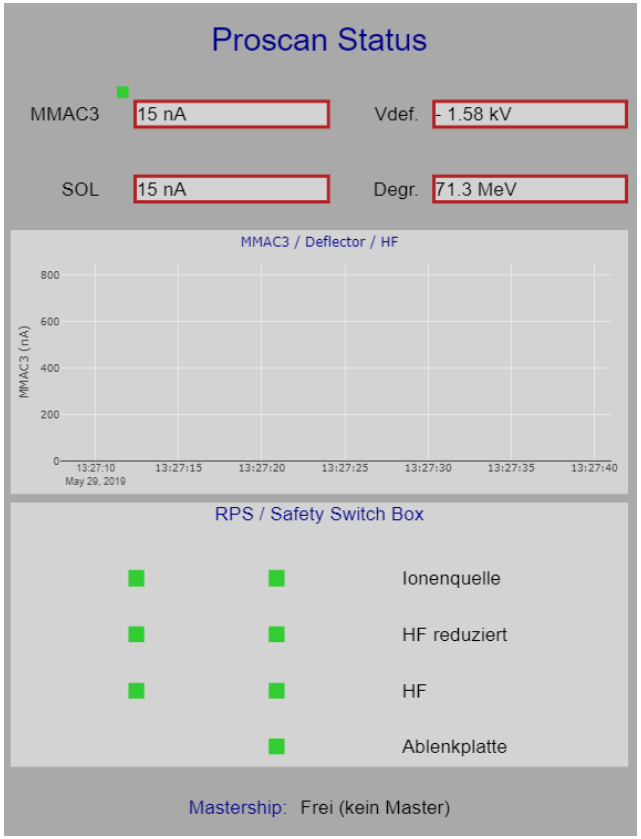


More Complicated Example: Goal was to make it as ugly as the original ! ;-)



Because the pages just use normal web technology we can use CSS media queries to change the formats according to the features of the viewing device…





WICA-HTTP Service: an HTTP/EPICS Gateway

The WICA HTTP Service supports HTTP operations (POST, PUT, GET, DELETE) on two information resources that map onto the underlying control system: '*Channel*' and '*Stream* '.

'Channel' means EPICS channel. '*Stream*' is a collection of channels which can be aggregated together and sent down the wire as a single HTML5 Server-Sent-Event (SSE) message.

The implementation is based on **Java Open JDK** (11) and **Spring Boot** (2.1). The use of Spring Boot, particularly has a big impact on reducing the amount of code that needs to be written. Communication with the EPICS Control System is achieved using the PSI-funded **Java CA** client library (written by Matej Sekoranja, CosyLab).

At PSI the server is deployed in a **Docker Container**. We hope this will provide an easier migration path for scaling the solution upwards should the load become excessive.

OpenJDK

Spring Boot

docker

WICA-HTTP Service - Create Stream

Command: 'Stream Create'

This command takes an array of channel names and returns a ***<stream_id>*** which can be used later for subscription purposes. Optional properties provide finer-grained control over the data when it is streamed.

```
POST http://localhost:8080/ca/streams
Content-Type: application/json
{ "channels" : [ { "name": "wica:test:counter01", "props": { "daqmode": "monitor"  } },
                 { "name": "wica:test:counter02", "props": { "daqmode": "poll", "pollint": "5000" }
}],
  "props" : { "prec": 2, "hbflux": "8000", "monflux": 1000, "pollflux": 2000 }
}

Returns a new <streamId>, a unique string which can be used subsequently for subscribing.
```

What the backend server does:

- creates EPICS channels to obtain data from the IOCs on the backend control system
- obtains the EPICS channel metadata (type, alarm and control limits, etc.)
- establishes an EPICS ca monitor on each channel and begins to cache the received values.

Additional Options:

- control over the ***precision*** of the streamed data.
- control over the ***rate*** at which information is sent down the stream.
- control over whether the stream contains ***polled*** or ***monitored*** data.
- control over various types of ***filtering***.

WICA-HTTP Service – Subscribe to Scream

Command: 'Stream Subscribe'

This command takes a <*stream_id*> and returns the corresponding live data stream.

```
GET /ca/streams/<streamId>
Returns the HTML5 Server-Sent-Event Stream (SSE) for the specified <streamId>.
```

What the backend server does:

Returns a continuous stream of server-sent event messages with the following message types:

- **channel-metadata:** for all channels in the stream – **sent once**.
- **channel-monitored-values:** includes information on monitored channels which have changed – **sent periodically** (at a configurable rate).
- **channel-polled-values** includes information on polled channels which have changed - **sent periodically** (at a configurable rate).
- **stream-heartbeat**: a message which the WICA-JS library uses to detect loss of the connection – sent periodically.

WICA-REST Service – Stream Messages

Example Stream Messages:

```
id:3
event:ev-wica-channel-metadata
data:{"wica:test:counter01":{"type":"REAL","egu":"","prec":0,"hopr":0.00,"lopr":0.00,"drvh":0.00,"
drvl":0.00,"hihi":NaN,"lolo":NaN,"high":NaN,"low":NaN}}
:2019-09-08 17:30:28.181 - channel metadata

id:3
event:ev-wica-channel-value
data:{"wica:test:counter01":[{"sevr":"0","val":11042.00}]}
:2019-09-08 17:30:29.085 - channel monitored values

id:3
event:ev-wica-channel-value
data:{"wica:test:counter02":[{"sevr":"0","val":61077.00}]}
:2019-09-08 17:30:34.077 - channel polled values

id:3
event:ev-wica-server-heartbeat
data:2019-09-08T17:30:36.078750
:2019-09-08 17:30:36.078 - server heartbeat
```

WICA-REST Service Commands – Channel Get / Put

Commands: 'Channel Get' and 'Channel Put'

These commands offer a very simple channel get/put capability.

```
GET /ca/channels/<channelName>[?timeout=XXX][]

Returns a JSON string representation of the value of the channel. For a channel whose underlying
data source is EPICS the returned information looks like this:

{"type":"STRING","conn":true,"val":"15.101","sevr":0,"stat":0,"ts":"2019-03-
06T09:37:22.103198","wsts":"2019-03-06T09:37:22.103211","wsts-alt":1551865042103,"dsts-
alt":1551865042103}
```

```
PUT /ca/channels/<channelName>
Content-Type: text/plain the new value

Somevalue

Returns a string "OK" when the put was successful.
```

What the backend server does:

- creates an EPICS CA channel to the process variable on the EPICS control system.
- performs a synchronous, (= "confirmed") GET/PUT operation, returning/using the obtained/supplied value.

Additional Options:

- Control over the timeouts for the getting or putting the data.

WICA-JS Library

The WICA-JS library is loaded after the rest of the webpage to scan the source document for elements that are ‘’wica-aware” (= elements whose **'data-wica-channel-name'** attribute is set).

The library then collaborates with the WICA-REST server to stream back the channel metadata (eg alarm and display limits) and changing channel values, setting the following attributes to match the received data:

Attribute	Description
data-wica-stream-state	Contains status of connection to Wica Server.
data-wica-channel-connection-state	Contains status of connection to data source.
data-wica-channel-alarm-state	Contains alarm status of data source.
data-wica-channel-metadata	Contains last received metadata from data source.
data-wica-channel-value-latest	Contains last received value from data source.
data-wica-channel-value-array	Contains array of latest received values from data source.

Lessons Learned so far…

- Creating Flexible, Modern, Responsive, Beautiful webpages for today's web that integrate with our control system data is now possible. ☺
- But… leveraging off the possibilities of the today's modern web doesn't come cheap… there is a lot of extra information to think about when trying to build responsive, scalable layouts.
- Whatever format we choose **(.medm, .ui**, **.html**) there will always be a lot of extra information to capture that before our lab did not really care about…
- Tooling would be useful, but web designers seem to prefer hacking html and Javascript than using the builder tools that have been common in the EPICS community. To make a solution with wide applicability to our users we would need them.
- Fortunately "incompatible browser syndrome" is less of a problem these days… however ***Internet Explorer*** (and their newer browser ***Edge***) are still outside the web community and likely to remain so. At our Lab we mainly ignore them. (JS Libraries such as ***Modernizr*** can assist in autodetecting incompatibilities and providing a hint to the user if the browser does not adequately support the required features).

Project Next Steps

Consolidation

- Complete **WICA-RELAY** -> access webpages from internet whilst satisfying PSI's internet security guidelines.
- Complete rollout of displays for all PSI's scientific facilities.
- Publish **WICA-HTTP** and **WICA-JS** to web (if there is interest).

Improve the User Experience

"Make further improvements that take advantage of the capabilities offered by our new enabling technologies (Spring Boot, Lit-Element, modern JS)"

- Possibility to include Epics status information in any web page.
- Create webpages that comply with the requirements of PSI's communication department
- Provide status displays usable from other devices (tablets, phones, wearables…)

Future

- Consider whether a GUI Build Tool would be viable.
- Consider whether an import tool would be viable (PSI's PEP tool at least should be straightforward)

Thanks for your attention ! ☺

Thanks go to:

- Simon Ebner
- Daniel Lauk

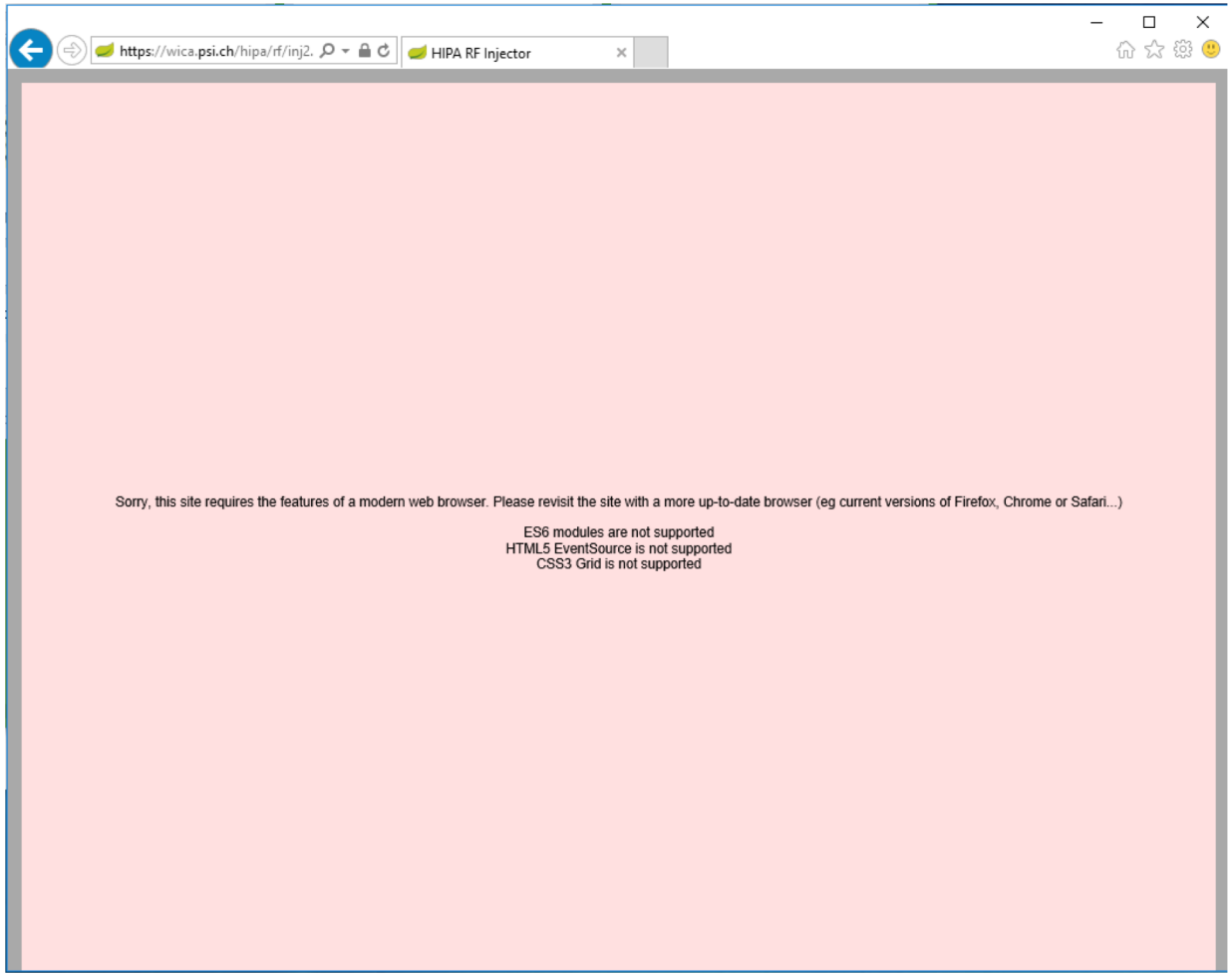
And especially:

- Dirk Zimoch (for giving this talk)

For questions on this work please contact:

- Simon Rees - simon.rees@psi.ch or
- Simon Ebner - simon.ebner@psi.ch

Use of *Modernizr* JS library to autodetect any browser compatibility issues.



Not looking at any companies anywhere in particular (Seattle)…

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Goals and Non-Goals

- Provide an HTTP REST (micro)service for accessing PSI's EPICS-based control system from the web.
- Make it easy for users to create HTML pages that show the evolving live status of the control system.
- Explore some of the issues involved in bringing the control system's user-interface to the web.
- Currently Not a Goal: provide a general-purpose replacement for PSI's caQtDM display-building technology. (two essential components are still missing: design tool, conversion tool).

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Concrete Use Case - 2

Provide EPICS Microservice for Snapshot Tool

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Implementation -1

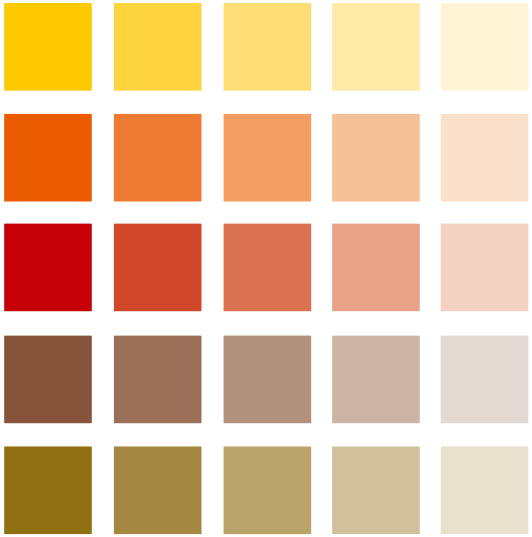
- General principle: consolidate our future solutions based on technologies that are the unquestionable standard in any serious IT companies. Everything has moved to the web… “no-one develops applications for the desktop any more”.

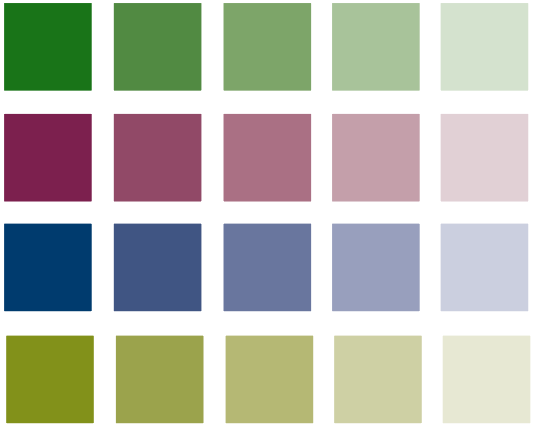
- Leverage off the general availability of powerful, highly scalable, open source frameworks to write the minimum code possible.

PSI Colour Scheme

PSI's basic colours

Colour options for graphs:
1st choice





Colour options for graphs:
2nd choice