

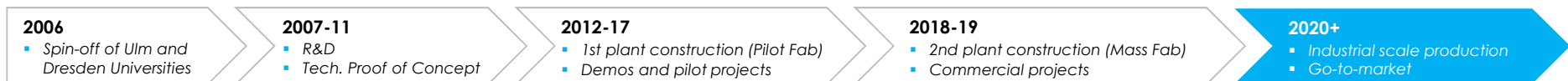
Simple Process Monitoring of Multiple Parameters Using JMP®

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Heliatek at a Glance

Pioneer in organic solutions for solar energy



- Founded in 2006 out of TU Dresden & University of Ulm, Germany
- Technology leader in OPV with innovative product & unique Roll-to-Roll production process
- 1 Mio m² capacity Fab in ramp up for 2020 series production
- ~170 employees, >60 Mio € Factory in Dresden 
- Leading investors: BASF, ENGIE, Innogy, AQTON, BNP-Paribas & EIB financing



Ultra-Light

Low weight of less than 2 kg/m² for low static requirements



Truly Green

Low carbon footprint with less than 10 g CO₂e/kWh, non-toxic & no rare materials, low material input, easy & ecofriendly disposal



Flexible

Bendable to a minimum radius, adjustable to non-straight surfaces and shapes



Customizable

Variable dimensions up to 14 m lengths & 1.3 m width; transparent & different colors to customize



Ultra-Thin

Less than 1 mm thick solar film perfectly suited for integration



Easy-to-Install

Easy-to-install solution for solar upgrade, non-invasive to surface underground, easy to handle in transport and installation



JMP at Heliatek

- Data crunching
 - Join data from several sources (.txt, .xlsx, .jpg, ...) and simplify via AddIns for e.g. reporting (Yield/efficiency/...)
- Descriptive and explorative data analysis (EDA)
- Design of experiments (DOE)
- Quick and dirty data visualization
- ... frequent DB queries for process control

 Alarm-Board

Alarm-Board: Requirements

Shutter Open																												
OV1-003	OV1-004	OV2-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Alarm Deposition Rate																												
OV1-003	OV1-004	OV2-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004
0	3	0	3	0	0	0	0	5	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0

Alarm Sensor Life																												
OV1-003	OV1-004	OV2-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

- **Keep track** of multiple process parameters in a running production
- Share an easy-to-read visualization
- Send automatical alarm emails (*focus today will be the alarm deposition rate*)



Script

```
1  Names Default To Here( 1 );
2  /// Define constants
3  n = 1;
4  q = 2;
5
6  /// Define component list
7  lDetails = {"OV1-003", "OV1-004", "OV2-001", "OV2-002", "OV2-003",
8  "OV4-001", "OV4-002", "OV4-003", "OV4-004", "OV4-005", "OV5-001",
9  "OV6-004", "OV6-005", "OV7-001", "OV7-003"};
10
11  /// Build tables which will be updated iteratively via loop
12  BuildDataTables = Function( {},
77
78  BuildDataTables();
79
80  /// Build UI and Graphs
81  WAlarm = New Window( "AlarmBoard",
202
203  pb1 << Save Picture( "C:\Users\TWE\Desktop\50_JMP_Paper_Talk\2020_
204
205  /// Load specification table
206  OpenSpecTable = Function( {},
239
240  /// Loop and data manipulation
241  startwork = Function( {},
390
391  /// Check Limit exceedings ...
392  Alarm_Check = Function ({}),
428
429  /// Send Alarm-Mail
430  AlarmMail_Rate = Function( {},
445
446  /// Close all|
447  CloseScript = Function( {},
461
```

- User Input
- Looping over DB query („schedule()“ function)
- Check for limits exceedings
- Visualization (.html)
- Automatical alarm mail (.cmd)

show



Alarm-Board: Requirements

Shutter Open																												
OV1-003	OV1-004	OV1-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Alarm Deposition Rate																												
OV1-003	OV1-004	OV1-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004
0	3	0	3	0	0	0	0	5	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	

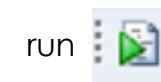
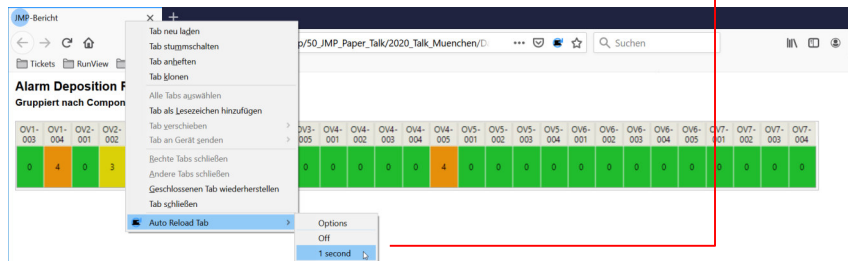
Alarm Sensor Life																												
OV1-003	OV1-004	OV1-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

- Keep track of multiple process parameters in a running production
- **Share** an easy-to-read visualization
- Send automatical alarm emails (*focus today will be the alarm deposition rate*)

Alarm-Board: Share the results - Case 1

```
vbc31 = cb31 << get;
If( vbc31 == 1,
rAlarm = gb1 << report;
rAlarm << Save HTML("C:\Users\TWE\Desktop\50_JMP_Paper_Talk\2020_Talk_Muenchen\Daten\HTML\case1.html");
.);
////////////////////////////////////
```

- Publishing via „save HTML“ function
- Need „Auto-Reload“ via additional browser AddIn
- Shows irregular hangovers



Alarm-Board: Share the results - Case 2 (via custom .html)

```
//////////////////////////////// Case2: save static .jpg and refresh via HTML code //////////////////////////////////  
vbc32 = cb32 << get;  
  
If( vbc32 == 1,  
gb1 << Save Picture( "C:\Users\TWE\Desktop\50_JMP_Paper_Talk\2020_T  
////////////////////////////////
```

```
<!DOCTYPE html>  
<html>  
<head>  
<title>AlarmBoard</title>  
<meta charset="UTF-8" />  
</head>  
<style>  
img {  
  max-width: 100%;  
  height: 100%;  
}  
</style>  
<script>  
setInterval(function() {  
  var myImageElement = document.getElementById('myImage');  
  myImageElement.src = 'file:///C:/Users/TWE/Desktop/50_JMP_'  
}, 1000);  
</script>  
</head>  
<body>  
<p>  
<img src="file:///C:/Users/TWE/Desktop/50_JMP_Paper_Talk/2020_'  
</p>  
</body>  
</html>
```

index.html

- Save graphs as .jpg and overwrite each iteration
- Publish via custom .html including „setInterval“ function



Alarm-Board: Requirements

Shutter Open																												
OV1-003	OV1-004	OV2-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004
Alarm Deposition Rate																												
OV1-003	OV1-004	OV2-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004
0	3	0	3	0	0	0	0	5	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Alarm Sensor Life																												
OV1-003	OV1-004	OV2-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004

- Keep track of multiple process parameters in a running production
- Share an easy-to-read visualization
- **Send** automatical alarm emails (*focus today will be the alarm deposition rate*)

Alarm-Board: Alarm conditions

Shutter Open																													
OV1-003	OV1-004	OV1-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004	
Green	Green	Green	Green	Red	Red	Green	Green	Green	Green	Red	Red	Red	Red	Red	Green	Red	Red	Green	Green	Red	Red	Green	Green	Red	Red	Green	Green	Green	Green

Alarm Deposition Rate																												
OV1-003	OV1-004	OV1-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004
0	3	0	3	0	0	0	0	5	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0

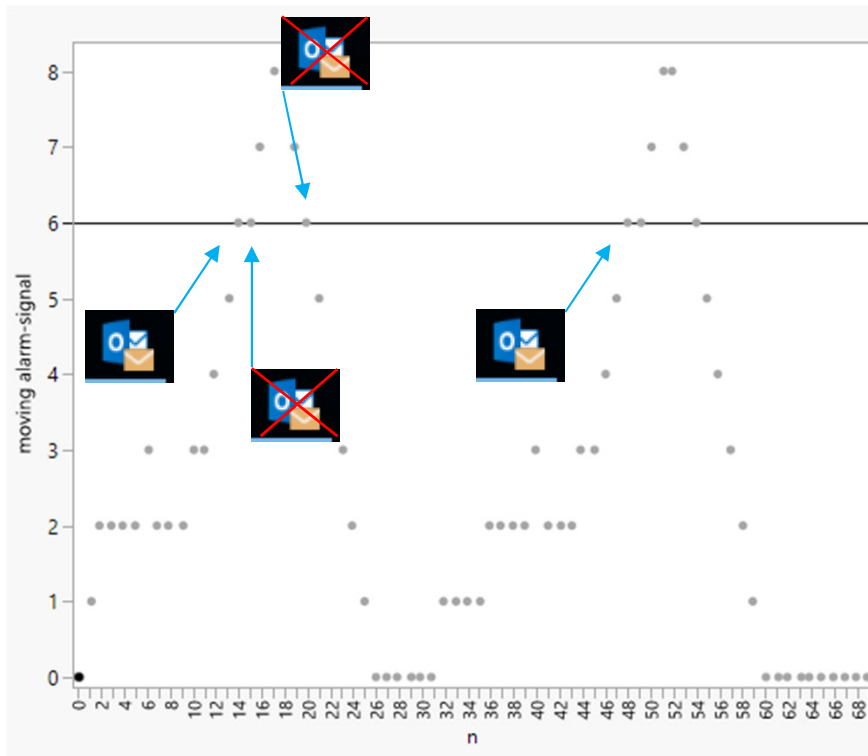
Alarm Sensor Life																													
OV1-003	OV1-004	OV1-001	OV2-002	OV2-003	OV2-004	OV3-001	OV3-002	OV3-003	OV3-004	OV3-005	OV4-001	OV4-002	OV4-003	OV4-004	OV4-005	OV5-001	OV5-002	OV5-003	OV5-004	OV6-001	OV6-002	OV6-003	OV6-004	OV6-005	OV7-001	OV7-002	OV7-003	OV7-004	
Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green



- Deposition rate exceeds specification x-times (here x6) within a specific period e.g. time segment (here last 10 queries)
- Send a single email upon limit exceeding automatically



Alarm-Board: Automatical Alarm-email - Exceptions



- Send Alarm-email only for increasing alarm-signal
- Suppressing Alarm-email for
 - the same alarm-signal multiple times
 - decreasing alarm-signal

Alarm-Board: Automatical Alarm-email - Exceptions

```

360  /// Copy Component , n, Alarm_max
361  Component_alt = dt0_3:Component << get values;
362  n_max_alt = dt0_3:n << get values;
363  Alarm_max_alt = dt0_3:Alarm_max << get values;
364
365  dt0_3 << select all rows() << delete rows;
366  dt0_3 << Concatenate( Data Table( dt0_2_2 ), "Append to First Table" );
367  Close( dt0_2_1, nosave );
368  Close( dt0_2_2, nosave );
369
370  /// Paste old Component , n, Alarm_max
371  dt0_3:Component_alt << set values(Component_alt);
372  dt0_3:n_max_alt << set values(n_max_alt);
373  dt0_3:Alarm_max_alt << set values(Alarm_max_alt);
374

```

```

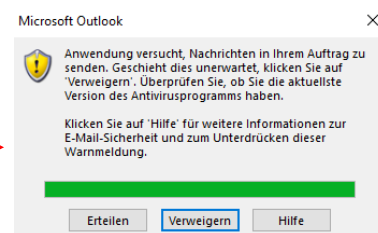
391  /// Check Limit exceedings ...
392  Alarm_Check = Function ({}),
393
394  dtAlarm1 = dt0_3 << Summary(
395  Group( :Component ),
396  Max( :n_max ),
397  Max( :Alarm_max ),
398  Freq( "Keine" ),
399  Weight( "Keine" )
400  );
401
402  dtAlarm2 = dt0_3 << Summary(
403  Group( :Component_alt ),
404  Max( :n_max_alt ),
405  Max( :Alarm_max_alt ),
406  Freq( "Keine" ),
407  Weight( "Keine" )
408  );
409
410  dtAlarm3 = dtAlarm1 << Join( With( dtAlarm2 ),
411  By Matching Columns( :Component = :Component_alt ),
412  Drop multiples( 0, 0 ),
413  Include Nonmatches( 0, 0 ),
414  Preserve main table order( 1 )
415  );
416
417  AlarmList_Rate = dtAlarm3:Component[dtAlarm3 << get rows where( :Name("Max.(Alarm_max)") == 6 &
418  (:Name("Max.(Alarm_max)") > :Name("Max.(Alarm_max_alt)"))];
419  AlarmList_RateNo = (N Items( AlarmList_Rate ));
420  If( AlarmList_RateNo > 0,
421  AlarmMail_Rate();
422  );
423
424  Close(dtAlarm1, no save);
425  Close(dtAlarm2, no save);
426  Close(dtAlarm3, no save);
427
428  );

```

- Add columns with previous data (*iteration n-1*)
- Fill List with affected components - only if
 - alarm-signal_n = 6 and
 - alarm-signal_{n-1} < alarm-signal_n
- Send Alarm-email via custom function (AlarmMail_Rate())

Alarm-Board: Automatical Alarm-email - Case1

```
Names Default To Here( 1 );  
Mail(  
    "torsten.weber@heliatek.com",  
    "Alarm", "Test"  
);
```



- Using Outlook the user has to confirm the output of the „Mail()“ function
- Confirmation request can be blocked in Outlook settings, but some companies may not allow this due to network security issues

Alarm-Board: Automatical Alarm-email - Case 2

```
//AlarmMail
AlarmMail_Rate = Function( {},

    AlarmList_Rate2 = Concat Items( AlarmList_Rate, ", " );
    alertRate = ("C:\Program Files (x86)\blat3219_32.full\blat3219\full\full\alertRate.cmd");
    lf = Load Text File( alertRate );
    lf = Munger( lf, 1, "Limit", "Limit " || AlarmList_Rate2 );
    Save Text File(
        "C:\Program Files (x86)\blat3219_32.full\blat3219\full\full\alertRate2.cmd",
        lf, Mode( "replace" )
    );
    Run Program(
        Executable( "C:\Program Files (x86)\blat3219_32.full\blat3219\full\full\alertRate2.cmd" ),
        read function( "text" )
    );
);
```

Please ask your administrator if you are allowed to do that!

- Execute open source software Blat [1] in JMP for Mail transfer via internal SMTP-Server:
 - Write .cmd
 - Mailing list, ...
 - Load .cmd as text file
 - Replace e.g. subject according to limits
 - Run .cmd



[1] <https://www.blat.net/>

Summary

- The Alarm-Board
 - shows multiple process parameters in an easy readable way
 - updates the data continuously in a loop with the „schedule“ function
 - shares the graphs via customized .html script to overcome loading-hangovers and AutoReload AddIns
 - sends automatical emails via executing SMTP software



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Thank you for your listening