Contextualizing plant performance
with Oracle OEE data

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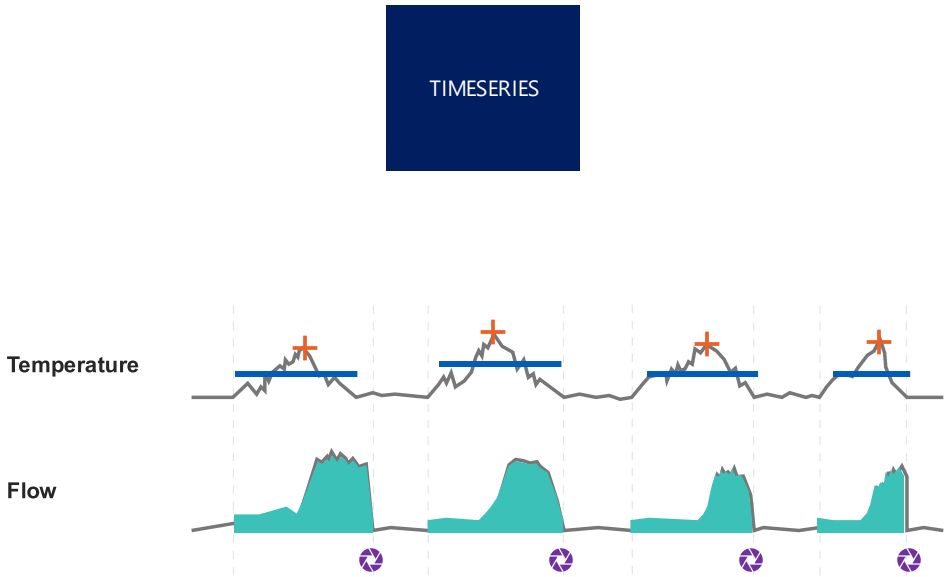
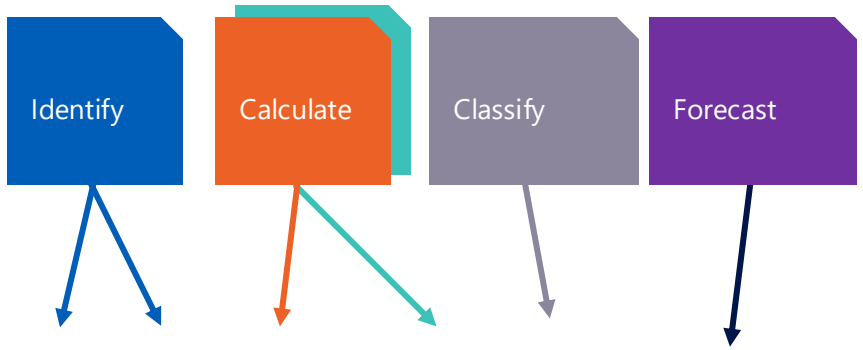
OUR JOURNEY TOGETHER

- The **vision –** why context data matters
- The **technology** – opening up connectivity
- The **implementation** – deep dive and lessons learned
- The **results** – what we've achieved so far
- **Next steps** – scale up value

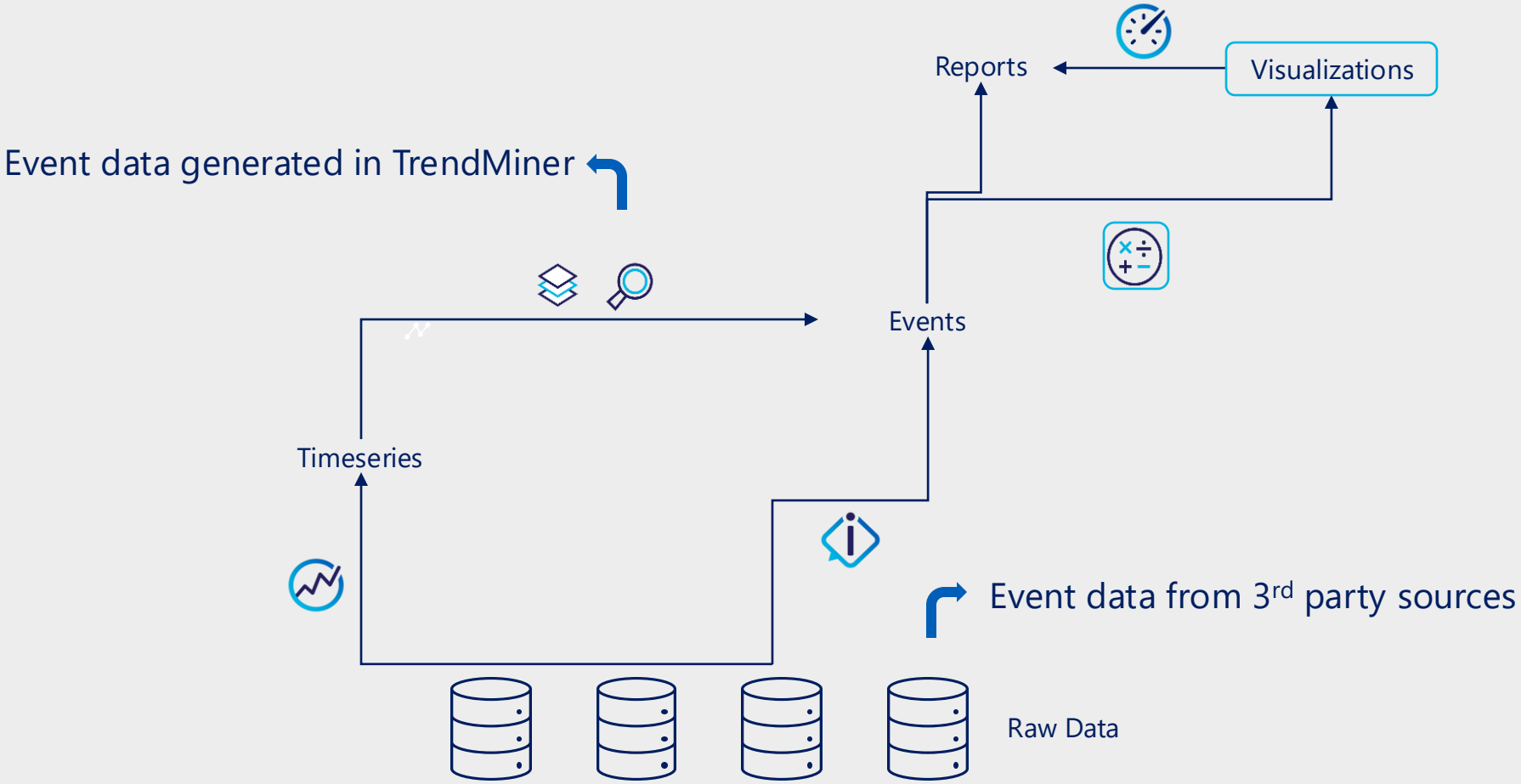
WHY CONTEXT DATA MATTERS





Batch ID	Duration	Max. temperature	Output	Grade	Quality
O36601	40min	63 °C	342m³	Pharma	PASS
O36602	39min	68 °C	312m³	Commercial	PASS
O36603	34min	62 °C	282m³	Pharma	FAIL
O36604	25min	67 °C	379m³	Pharma	PASS

ENHANCED DATA LAYER



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Benefits & Business impact

// Increase process understanding

// Support data driven decision making

// Focus on Self Service Data analytics

// Created tangible process improvements like:

COGS ↓ Yield ↑ Quality ↑ Cycle time ↓

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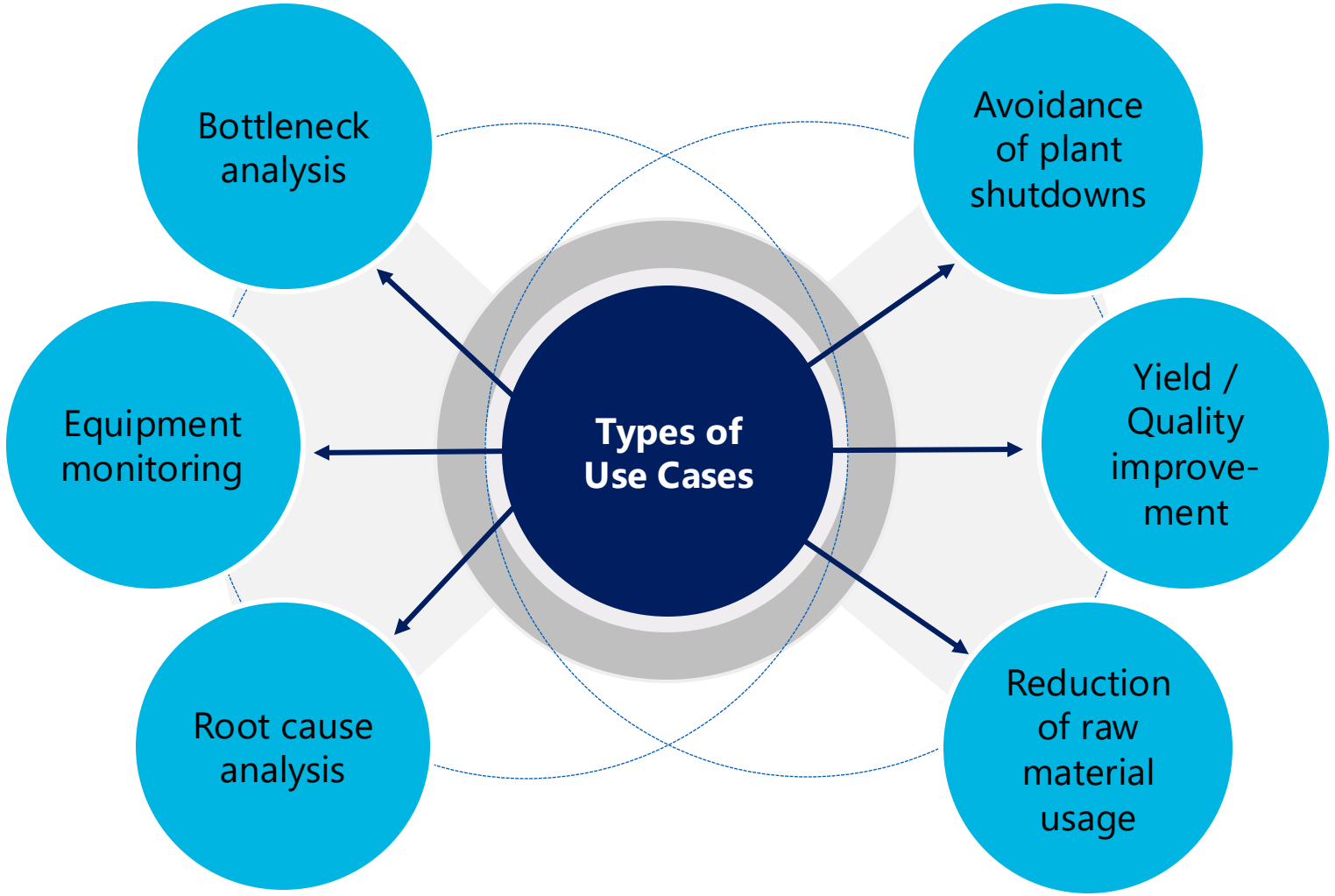
Use Cases



OEE DATA IN LULING

Typical use cases

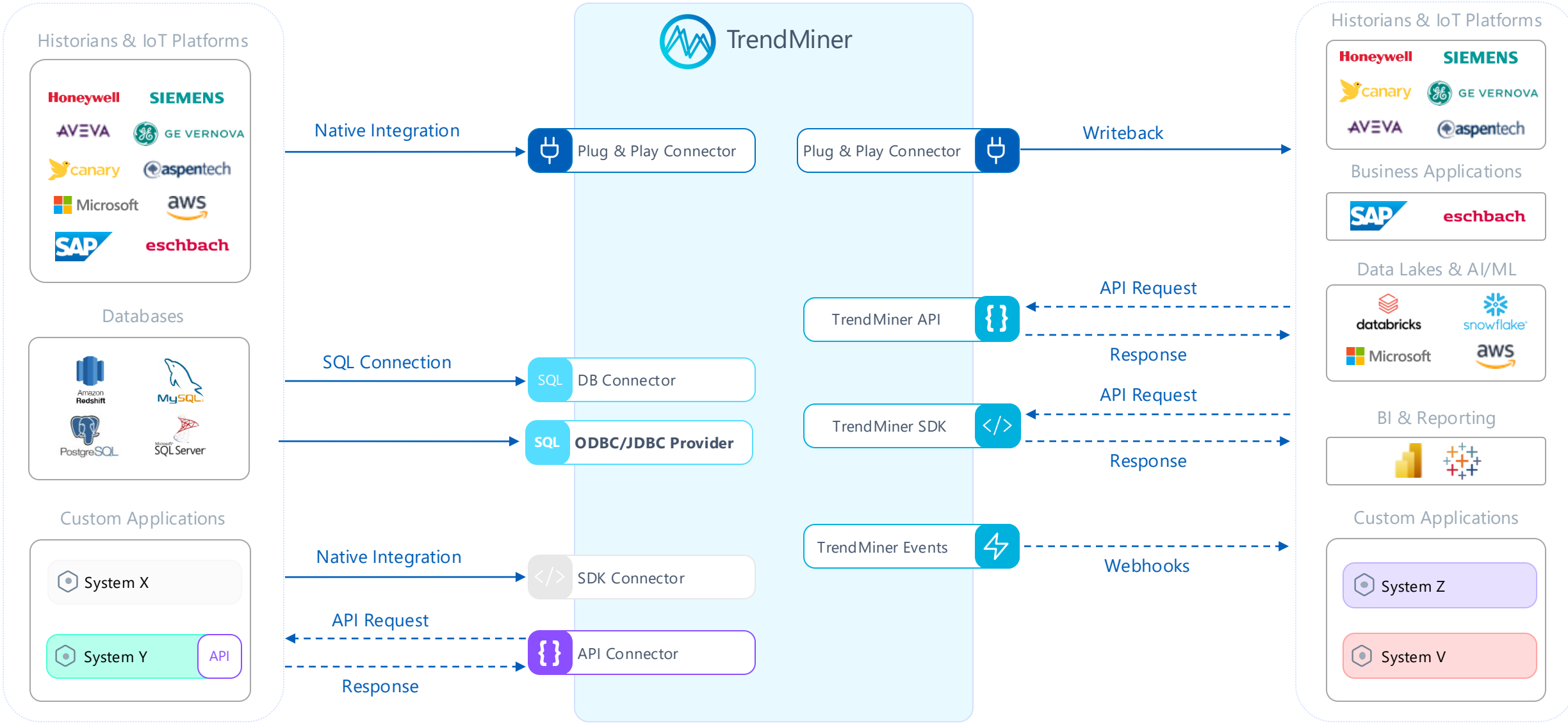
Luling

- IP21 historian connected
- TrendHub and DashHub

Bring in OEE Data

- Delta V database

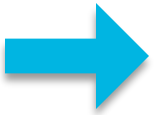
FLEXIBLE INTEGRATION ARCHITECTURE

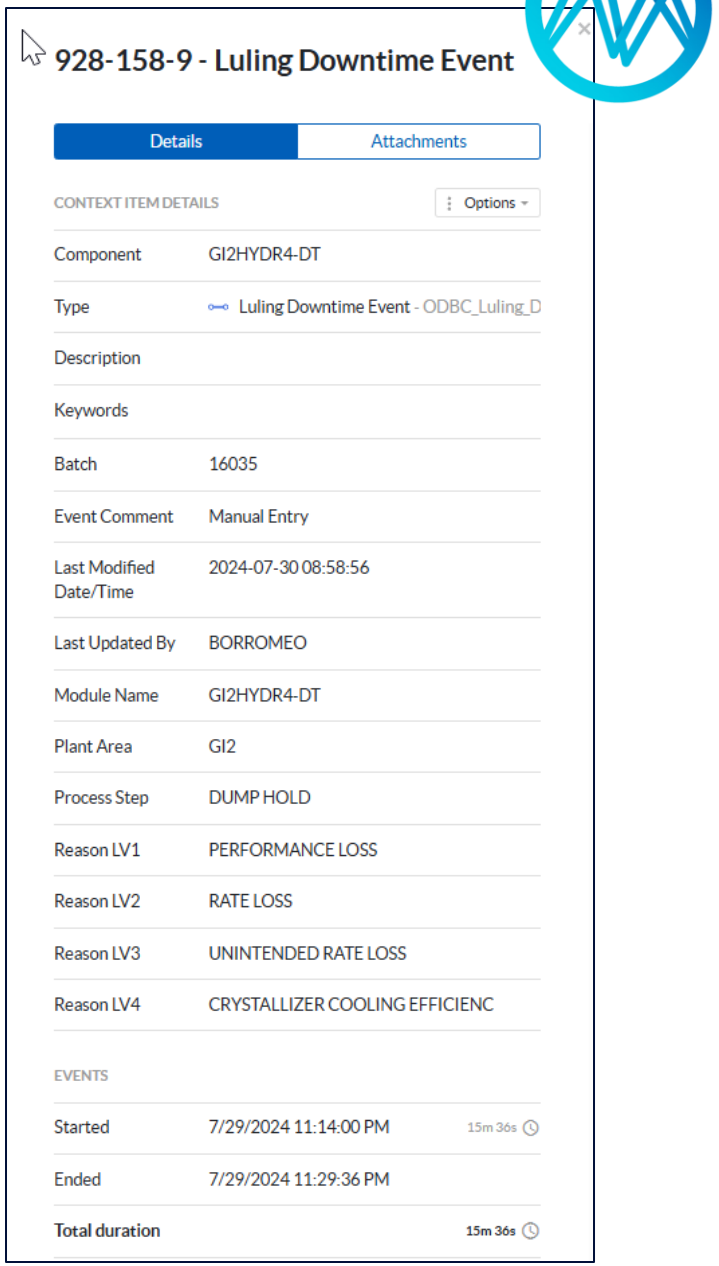


IMPLEMENTATION

PROCESS_STEP	BATCH	DOWNTIME_HOURS	REASON_LV1	REASON_LV2	REASON_LV3	REASON_LV4	EVENT_COMMENT	LAST_UPDATED_BY	CREATED_DT_UTC	MODIFIED_DT_UTC	TM_ASSET
DUMP HOLD	11028	0.28	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	DRY END	Manual Entry	BORROMEO	2024-02-21 20:16:42	2024-02-21 20:16:42	LUL-GI5HYDR9-DT
DUMP HOLD	11035	0.33	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	DRY END	Manual Entry	BORROMEO	2024-02-21 20:16:42	2024-02-21 20:16:42	LUL-GI5HYDR9-DT
STOP PCL3	11036	0.32	UNPLANNED DOWNTIME	OPERATIONAL	GI5HYD9	HM ACTIVATED	GI5FC103-05 < MV12	BORROMEO	2024-02-21 20:16:42	2024-02-21 20:16:42	LUL-GI5HYDR9-DT
DUMP HOLD	11038	0.53	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	CRYSTALLIZER	Manual Entry	BORROMEO	2024-02-21 20:16:42	2024-02-21 20:16:42	LUL-GI5HYDR9-DT
DUMP HOLD	11058	0.89	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	DRY END	Manual Entry	BORROMEO	2024-02-21 20:16:42	2024-02-21 20:16:42	LUL-GI5HYDR9-DT
DUMP HOLD	11061	0.47	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	DRY END	Manual Entry	BORROMEO	2024-02-21 20:16:42	2024-02-21 20:16:42	LUL-GI5HYDR9-DT
DUMP HOLD	11076	0.93	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	DRY END	Manual Entry	BORROMEO	2024-02-21 20:16:42	2024-02-21 20:16:42	LUL-GI5HYDR9-DT
DUMP HOLD	11654	0.27	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	PLANNED - INTERLOCK/USF CHECKS	Manual Entry	BORROMEO	2025-03-13 16:33:25	2025-03-13 16:33:25	LUL-GI5HYDR9-DT
DUMP END	11757	0.63	UNPLANNED DOWNTIME	OPERATIONAL	GI5HYD9	HM ACTIVATED	HOLD button Active	BORROMEO	2025-03-17 13:38:21	2025-03-17 13:38:21	LUL-GI5HYDR9-DT
DUMPING	11612	0.27	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	INSTRUMENT - LEVEL	Manual Entry	BORROMEO	2025-03-12 02:59:01	2025-03-12 02:59:01	LUL-GI5HYDR9-DT
DUMPING	11758	0.43	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	INSTRUMENT - LEVEL	Manual Entry	BORROMEO	2025-03-17 15:06:30	2025-03-17 15:06:30	LUL-GI5HYDR9-DT
PCL3 CHARGE	11717	0.26	UNPLANNED DOWNTIME	OPERATIONAL	GI5HYD9	RAW MATERIAL - PCL3 NOZZLE PLU	Manual Entry	BORROMEO	2025-03-16 00:07:27	2025-03-16 00:07:27	LUL-GI5HYDR9-DT
DUMP HOLD	11759	0.38	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	INSTRUMENT - LEVEL	Manual Entry	BORROMEO	2025-03-17 16:36:56	2025-03-17 16:36:56	LUL-GI5HYDR9-DT
PCL3 CHARGE	15797	0.25	PERFORMANCE LOSS	PLANNED RATE REDUCTION	INTENDED RATE LOSS	DSIDA LIMITED		BORROMEO	2024-10-23 21:06:12	2024-10-23 21:06:12	LUL-GI5HYDR9-DT
PCL3 CHARGE	15846	0.25	PERFORMANCE LOSS	PLANNED RATE REDUCTION	INTENDED RATE LOSS	DSIDA LIMITED		BORROMEO	2024-10-26 20:25:40	2024-10-26 20:25:40	LUL-GI5HYDR9-DT
STOP PCL3	15775	0.88	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	EQUIPMENT - VESSEL	Manual Entry	BORROMEO	2024-10-22 19:11:05	2024-10-22 19:11:05	LUL-GI5HYDR9-DT
PCL3 CHARGE	15847	0.25	PERFORMANCE LOSS	PLANNED RATE REDUCTION	INTENDED RATE LOSS	DSIDA LIMITED		BORROMEO	2024-10-26 21:33:26	2024-10-26 21:33:26	LUL-GI5HYDR9-DT
PCL3 CHARGE	15798	0.26	PERFORMANCE LOSS	PLANNED RATE REDUCTION	INTENDED RATE LOSS	DSIDA LIMITED		BORROMEO	2024-10-23 22:33:30	2024-10-23 22:33:30	LUL-GI5HYDR9-DT
PCL3 CHARGE	15848	0.25	PERFORMANCE LOSS	PLANNED RATE REDUCTION	INTENDED RATE LOSS	DSIDA LIMITED		BORROMEO	2024-10-26 22:42:03	2024-10-26 22:42:03	LUL-GI5HYDR9-DT
PCL3 CHARGE	15806	0.25	PERFORMANCE LOSS	PLANNED RATE REDUCTION	INTENDED RATE LOSS	DSIDA LIMITED		BORROMEO	2024-10-24 07:31:09	2024-10-24 07:31:09	LUL-GI5HYDR9-DT
DUMP END	15807	15.3	UNPLANNED DOWNTIME	OPERATIONAL	GI5HYD9	HM ACTIVATED	HOLD button Active	BORROMEO	2024-10-25 01:02:40	2024-10-25 01:02:40	LUL-GI5HYDR9-DT
PCL3 CHARGE	15849	0.25	PERFORMANCE LOSS	PLANNED RATE REDUCTION	INTENDED RATE LOSS	DSIDA LIMITED		BORROMEO	2024-10-26 23:49:15	2024-10-26 23:49:15	LUL-GI5HYDR9-DT
STOP PCL3	15779	0.59	UNPLANNED DOWNTIME	OPERATIONAL	GI5HYD9	EQUIPMENT - PIPING	Manual Entry	BORROMEO	2024-10-23 00:09:11	2024-10-23 00:09:11	LUL-GI5HYDR9-DT
DUMP HOLD	15779	0.46	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	EQUIPMENT - PIPING	Manual Entry	BORROMEO	2024-10-23 00:37:59	2024-10-23 00:37:59	LUL-GI5HYDR9-DT
STOP PCL3	15807	0.66	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LOSS	EQUIPMENT - AGITATOR	Manual Entry	BORROMEO	2024-10-24 21:01:44	2024-10-24 21:01:44	LUL-GI5HYDR9-DT

Row 1 of 500 fetched so far (more rows exist)

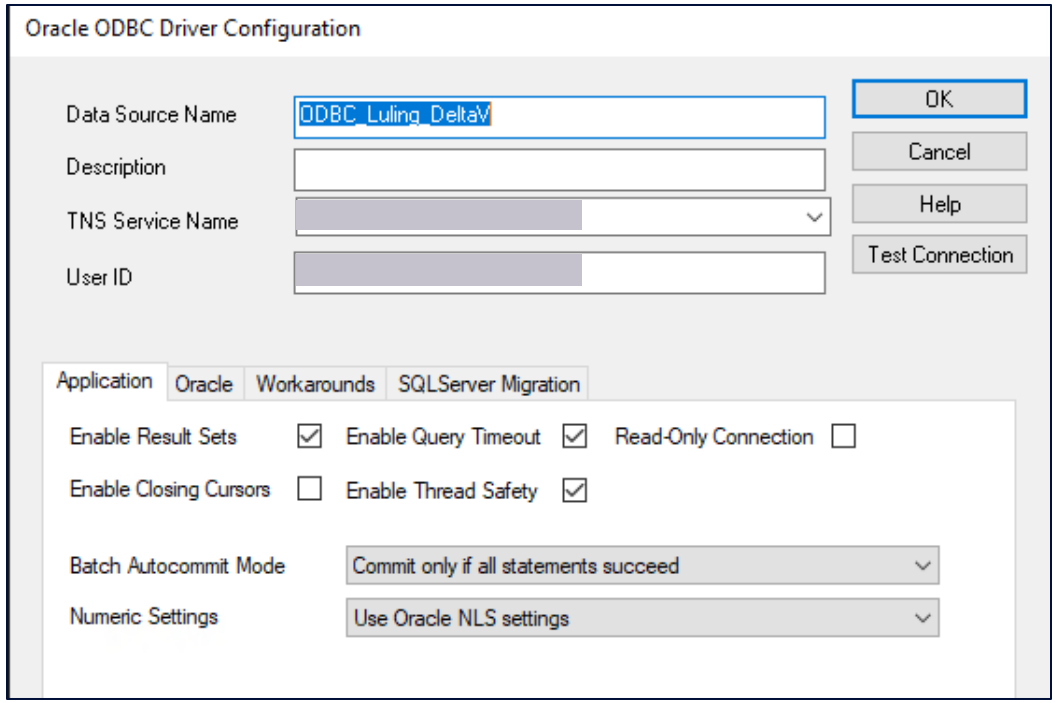


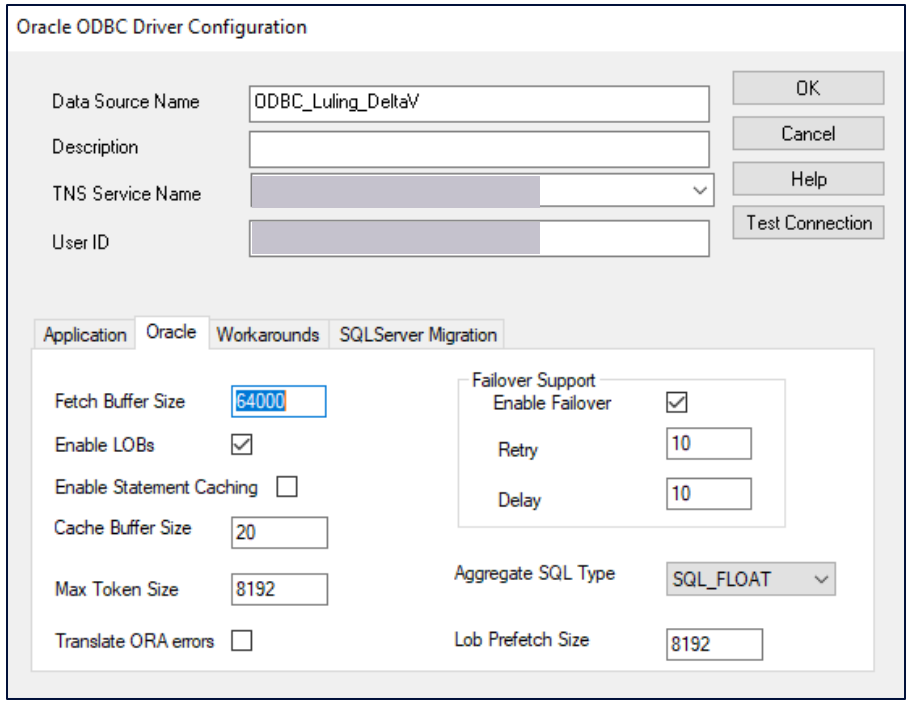


THE BUILDING BLOCKS

- TrendMiner's ODBC provider to set up and configure connectivity
- OracleDB ODBC driver to talk to the database (+ configure behaviour)
- Data model
- Queries to retrieve data and map to data model

ODBC DRIVER



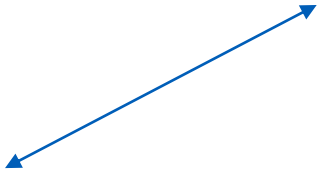


- Check available ODBC driver(s) for your datasource
- Tip: configure DSN to simplify connection string
- Check on customization options offered by driver

DATA MODEL

Event definition

id	batch	component	state	REASON_LV1	REASON_LV2	Comment	...
11000_1	11000	GI5HYDR9	Started	PERFORMANCE LOSS	DRY END	Manual Entry	...
11000_2	11000	GI5HYDR9	Ended	PERFORMANCE LOSS	DRY END	Manual Entry	...



id	type	name	parentId	dataType	dataValue
LULING	ASSET	LULING	NULL	NULL	NULL
GI1HYDR1	ATTRIBUTE	GI1HYDR1	LULING	DATA_REFERENCE	GI1-HYDR1
GI1HYDR2	ATTRIBUTE	GI1HYDR2	LULING	DATA_REFERENCE	GI1-HYDR2
GI2HYDR3	ATTRIBUTE	GI2HYDR3	LULING	DATA_REFERENCE	GI3-HYDR3
...					

Asset tree definition

Mapping IP21 tags with phase info to asset tree

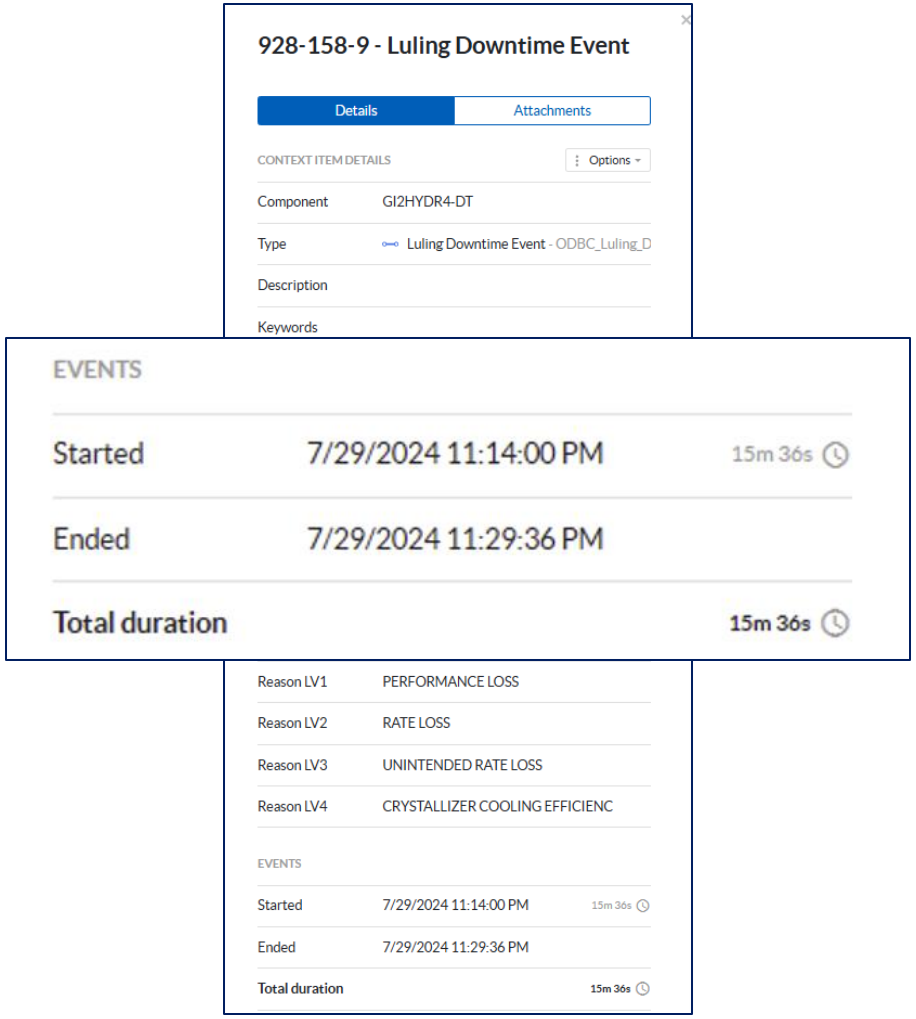
QUERIES

```
### Events Query   ###
-----------------------

WITH  DT_StartedEvents AS
(
  SELECT
    TO_CHAR(DOWNTIME_EVENT_ID) || '_0' as id,
    DOWNTIME_EVENT_ID as name,
    '01Test_Luling_DeltaV' as type,
    EVENT_START_UTC as occurred_at,
    MODIFIED_DT_UTC as modified_at,
    '0e09ba57-cafc-4da6-b426-4a0025d99f32' as components,
    'Started' as state,
    null as description,
    null as keywords,
    DOWNTIME_EVENT_ID as grouping_key
  FROM
    OEE.TRENDMINER_CONTEXT_VIEW
  WHERE
    TO_DATE(EVENT_START_UTC,'YYYY-MM-DD HH24:MI:SS') > TO_DATE({AFTER},'YYYY-MM-DD HH24:MI:SS')
    AND
    TO_DATE(EVENT_START_UTC,'YYYY-MM-DD HH24:MI:SS') < TO_DATE({BEFORE},'YYYY-MM-DD HH24:MI:SS')
),

DT_EndedEvents AS
(
  SELECT
    TO_CHAR(DOWNTIME_EVENT_ID) || '_1' as id,
    DOWNTIME_EVENT_ID as name,
    '01Test_Luling_DeltaV' as type,
    EVENT_END_UTC as occurred_at,
    MODIFIED_DT_UTC as modified_at,
    '0e09ba57-cafc-4da6-b426-4a0025d99f32' as components,
    'Ended' as state,
    null as description,
    null as keywords,
    DOWNTIME_EVENT_ID as grouping_key
  FROM
    OEE.TRENDMINER_CONTEXT_VIEW
  WHERE
    TO_DATE(EVENT_END_UTC,'YYYY-MM-DD HH24:MI:SS') > TO_DATE({AFTER},'YYYY-MM-DD HH24:MI:SS')
    AND
    TO_DATE(EVENT_END_UTC,'YYYY-MM-DD HH24:MI:SS') < TO_DATE({BEFORE},'YYYY-MM-DD HH24:MI:SS')
),

DT_Events AS
(
  SELECT * FROM DT_StartedEvents
  UNION
  SELECT * FROM DT_EndedEvents
  ORDER BY
    id
)
SELECT
  *
FROM
  DT_Events
WHERE
  id > coalesce({CURSOR}, '0')
```

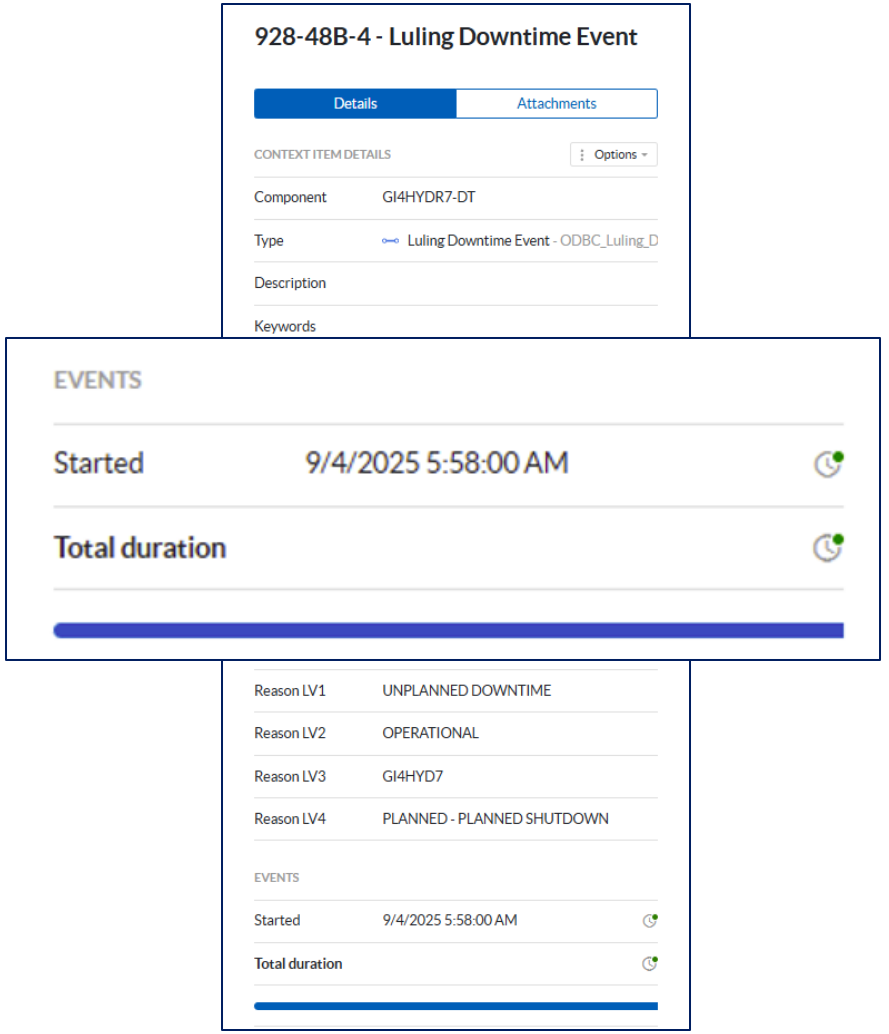
```
Types Query


WITH  EventTypes AS (
  SELECT
    '01Test_Luling_DeltaV' as id,
    'Luling Downtime Event' as name,
    'DB1F1F' as color,
    'Started' as startstate,
    'Ended' as endstate,
    'Started,Ended' as states,
    '01_LDTE_PlantArea,02_LDTE_ModuleName,03_LDTE_ProcessStep,04_LDTE_Batch,05_LDTE_ReasonLV1,06_LDTE_ReasonLV2,07_LDTE_ReasonLV3,08_LDTE_ReasonLV4,09_LDTE_EventComment,10_LDTE_LastUpdatedBy,11_LDTE_LastModifiedDateTime' as fields
FROM dual
)
SELECT * from EventTypes
WHERE
  id > coalesce(TO_CHAR({CURSOR}), '0')



  Type by id query
```

```
WITH DT_Fields AS
(
  SELECT id, name, type, placeholder, options from OEE.TRENDMINER_CONTEXT_FIELDS
)
SELECT
*
FROM
DT_Fields
where id > coalesce(TO_CHAR({CURSOR}), '0')
```

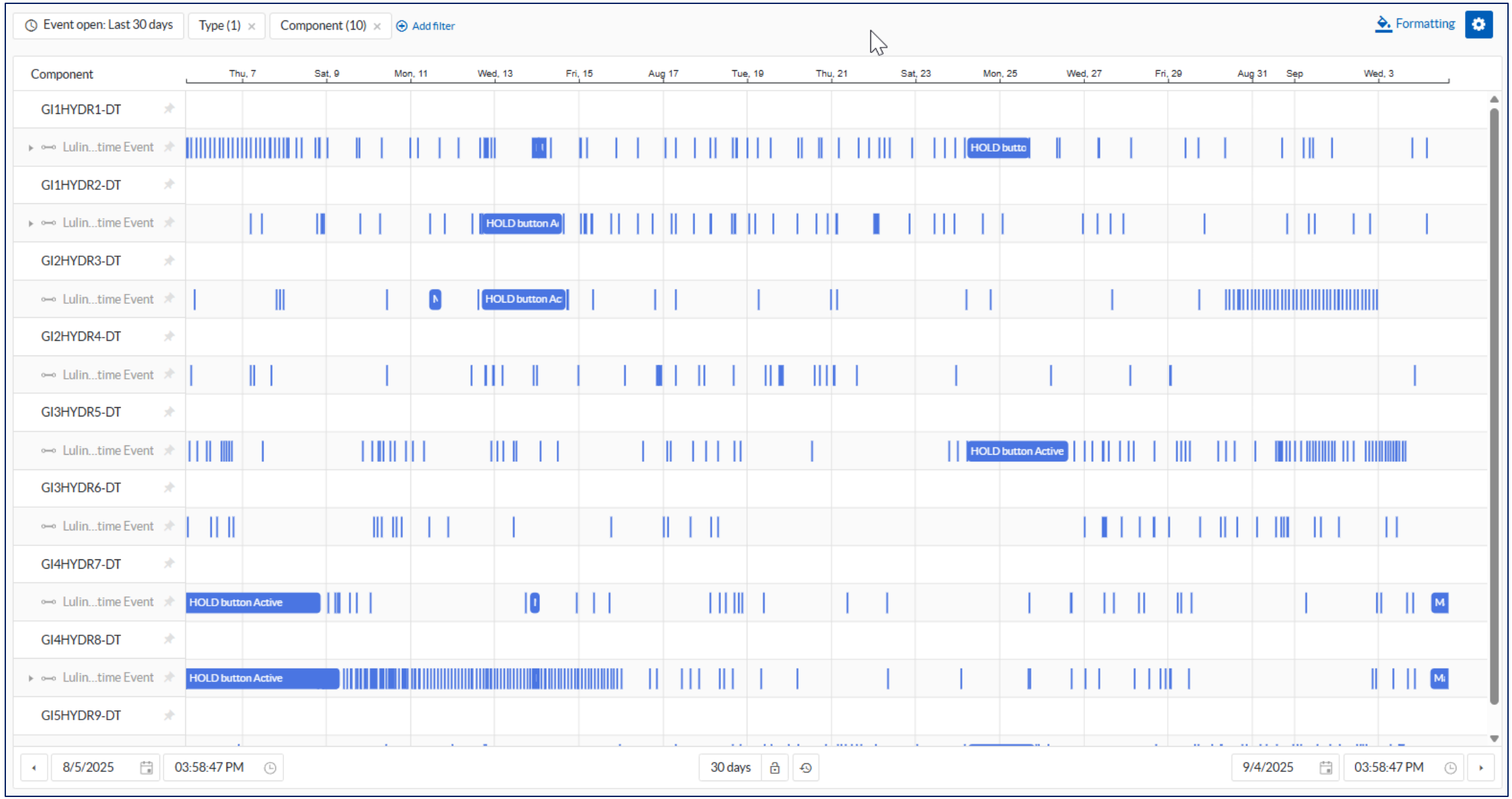
IMPLEMENTATION RESULTS

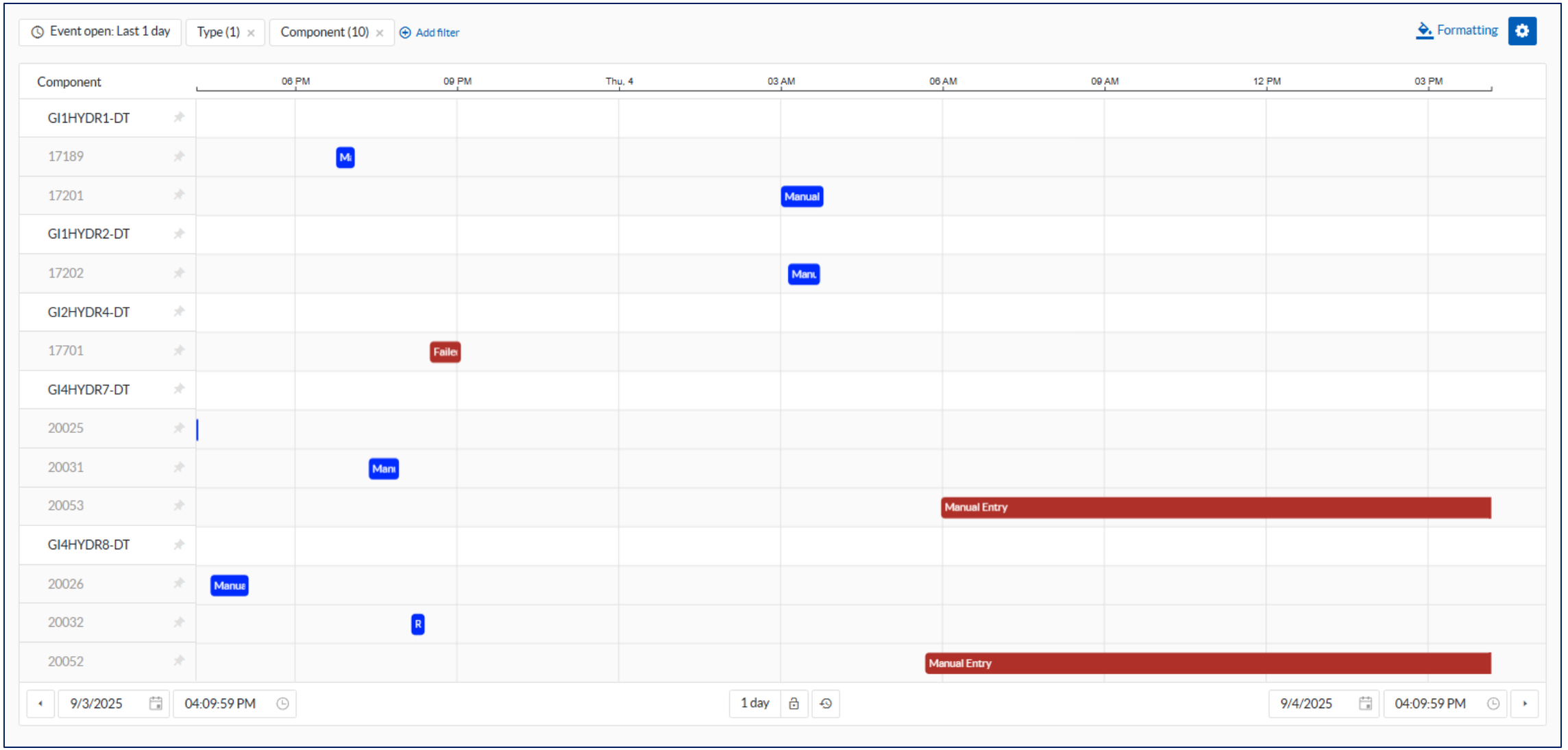


Finished event



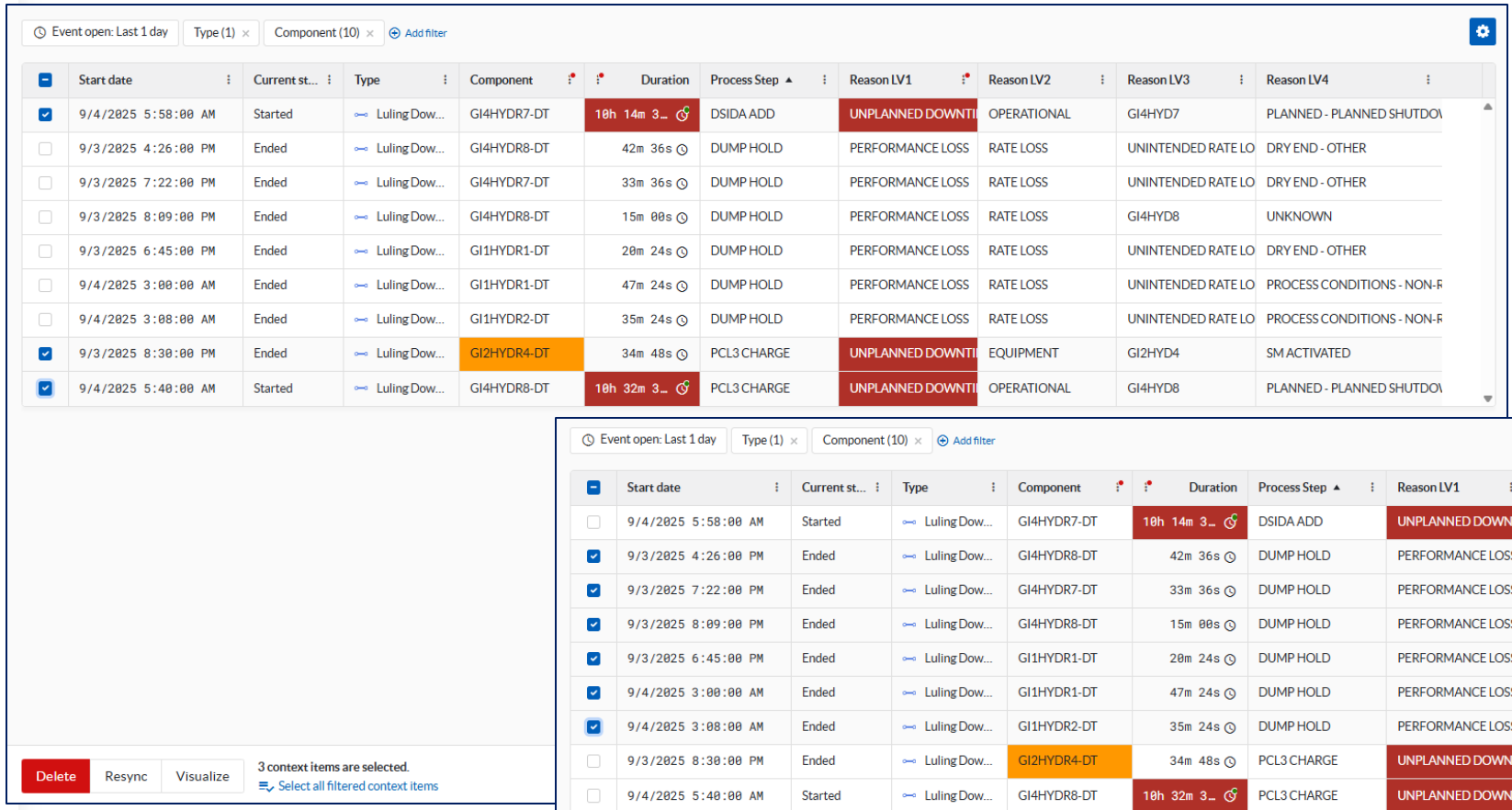
Event in progress

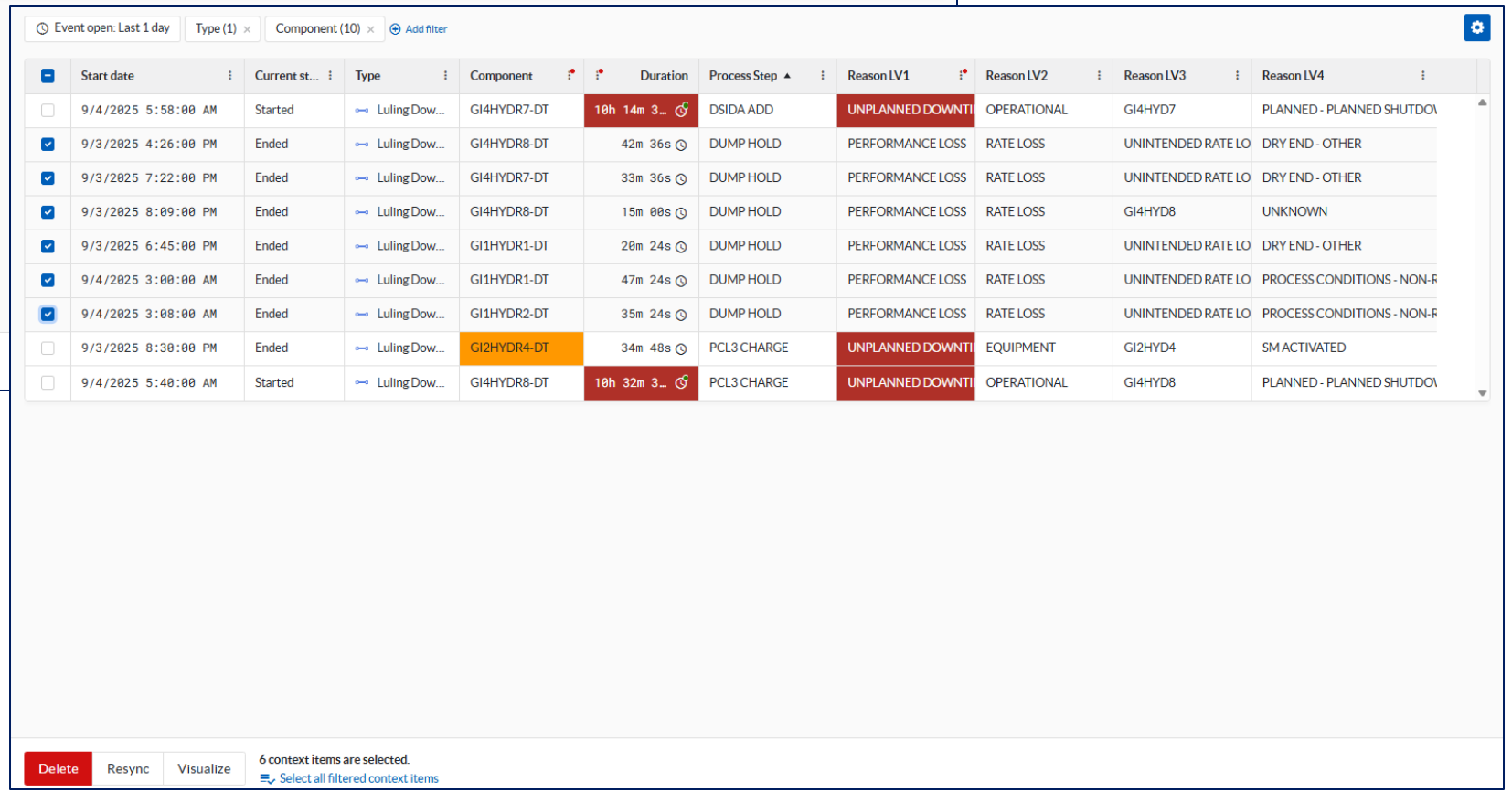


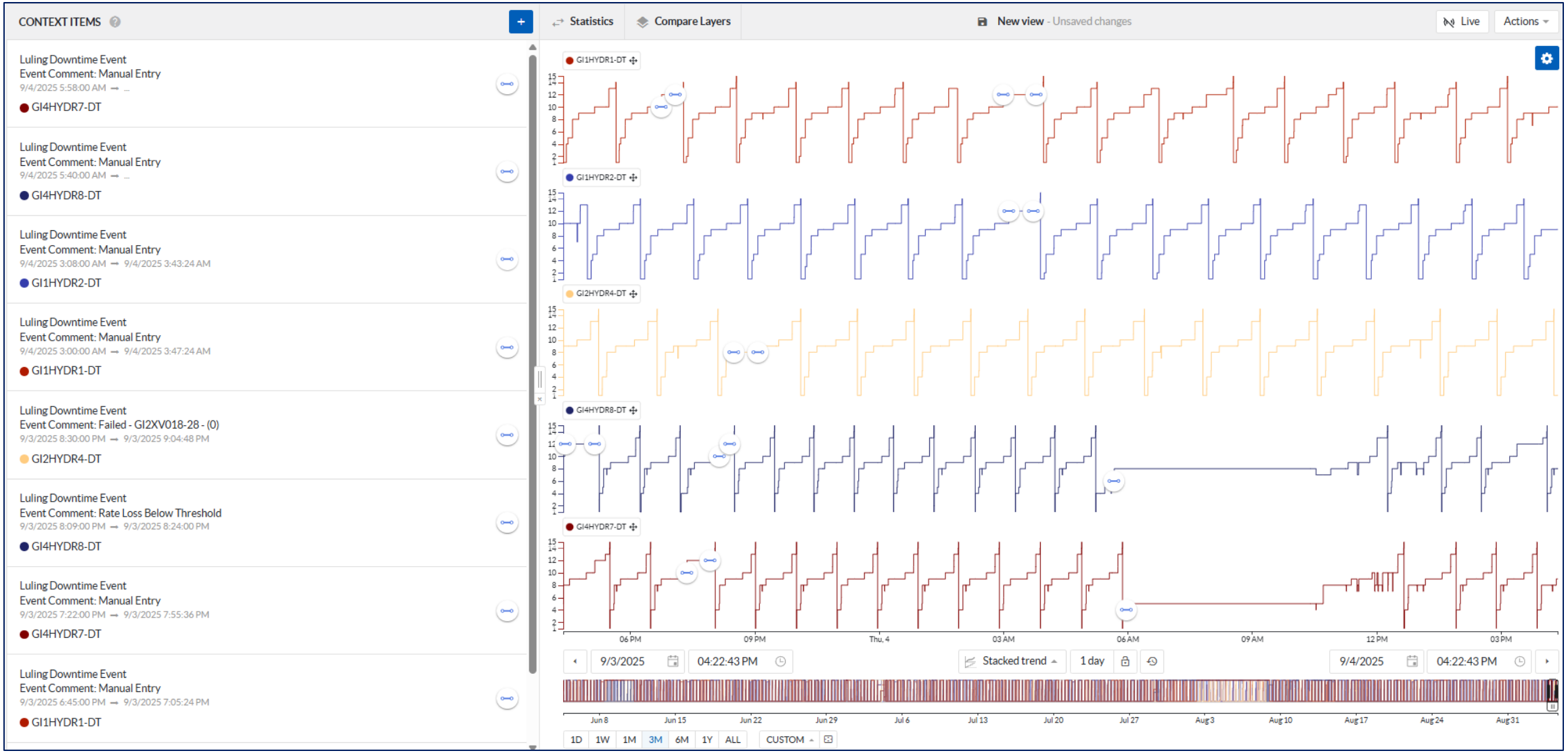


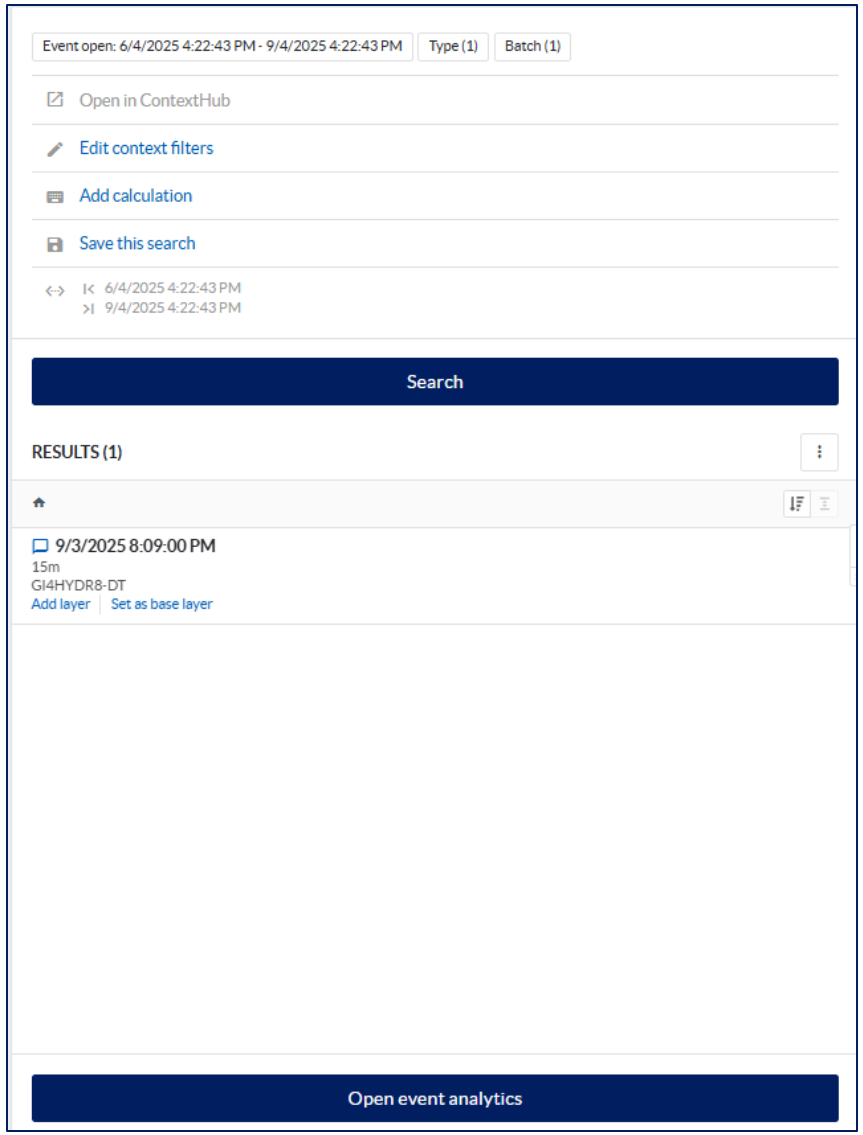
Event open: Last 1 day | Type (1) | Component (10) | Add filter

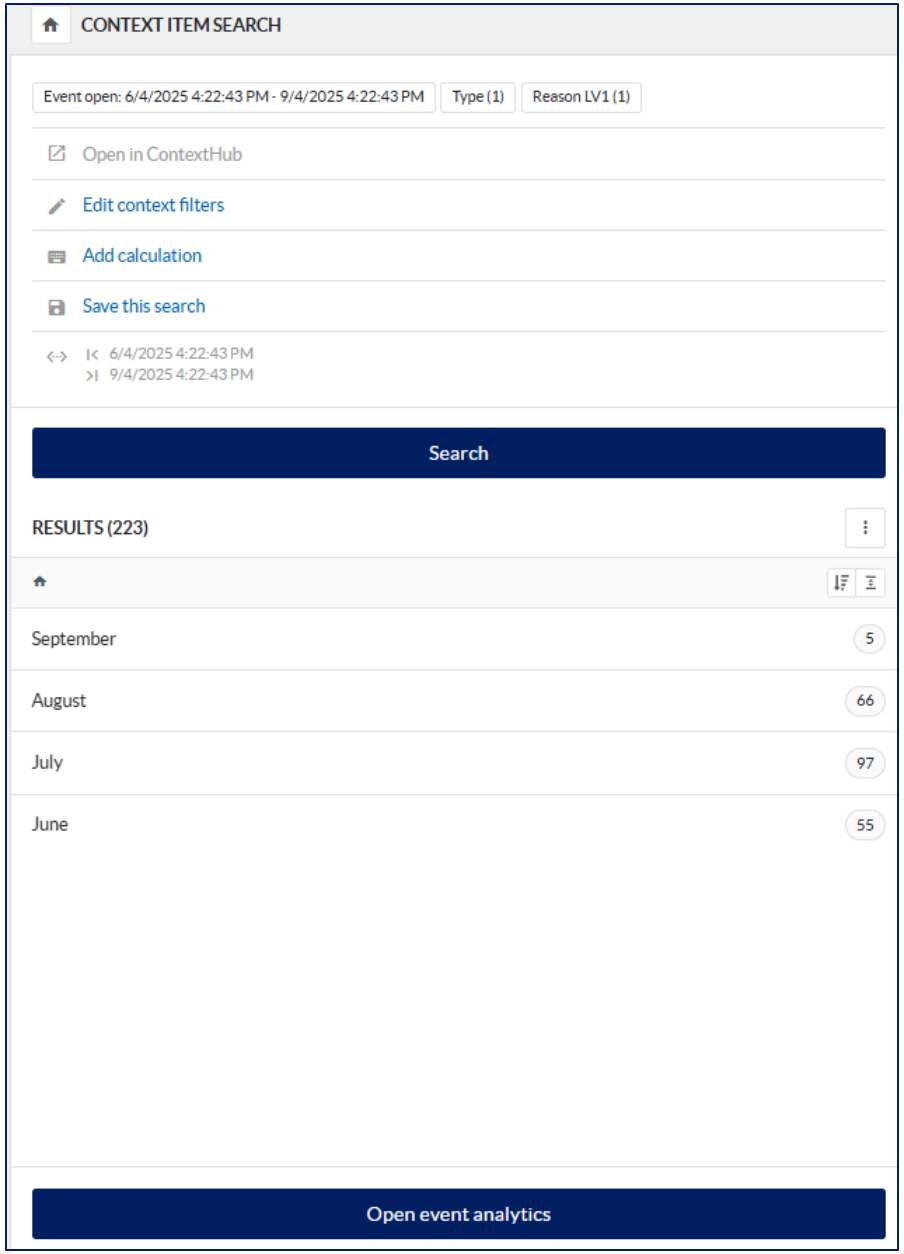
Start date	Current st...	Type	Component	Duration	Process Step	Reason LV1	Reason LV2	Reason LV3	Reason LV4
9/4/2025 5:58:00 AM	Started	Luling Dow...	GI4HYDR7-DT	10h 14m 3...	DSIDA ADD	UNPLANNED DOWNTI	OPERATIONAL	GI4HYD7	PLANNED - PLANNED SHUTDO\
9/3/2025 4:26:00 PM	Ended	Luling Dow...	GI4HYDR8-DT	42m 36s	DUMP HOLD	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LO	DRY END - OTHER
9/3/2025 7:22:00 PM	Ended	Luling Dow...	GI4HYDR7-DT	33m 36s	DUMP HOLD	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LO	DRY END - OTHER
9/3/2025 8:09:00 PM	Ended	Luling Dow...	GI4HYDR8-DT	15m 00s	DUMP HOLD	PERFORMANCE LOSS	RATE LOSS	GI4HYD8	UNKNOWN
9/3/2025 6:45:00 PM	Ended	Luling Dow...	GI1HYDR1-DT	20m 24s	DUMP HOLD	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LO	DRY END - OTHER
9/4/2025 3:00:00 AM	Ended	Luling Dow...	GI1HYDR1-DT	47m 24s	DUMP HOLD	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LO	PROCESS CONDITIONS - NON-R
9/4/2025 3:08:00 AM	Ended	Luling Dow...	GI1HYDR2-DT	35m 24s	DUMP HOLD	PERFORMANCE LOSS	RATE LOSS	UNINTENDED RATE LO	PROCESS CONDITIONS - NON-R
9/3/2025 8:30:00 PM	Ended	Luling Dow...	GI2HYDR4-DT	34m 48s	PCL3 CHARGE	UNPLANNED DOWNTI	EQUIPMENT	GI2HYD4	SM ACTIVATED
9/4/2025 5:40:00 AM	Started	Luling Dow...	GI4HYDR8-DT	10h 32m 3...	PCL3 CHARGE	UNPLANNED DOWNTI	OPERATIONAL	GI4HYD8	PLANNED - PLANNED SHUTDO\











LESSONS LEARNED

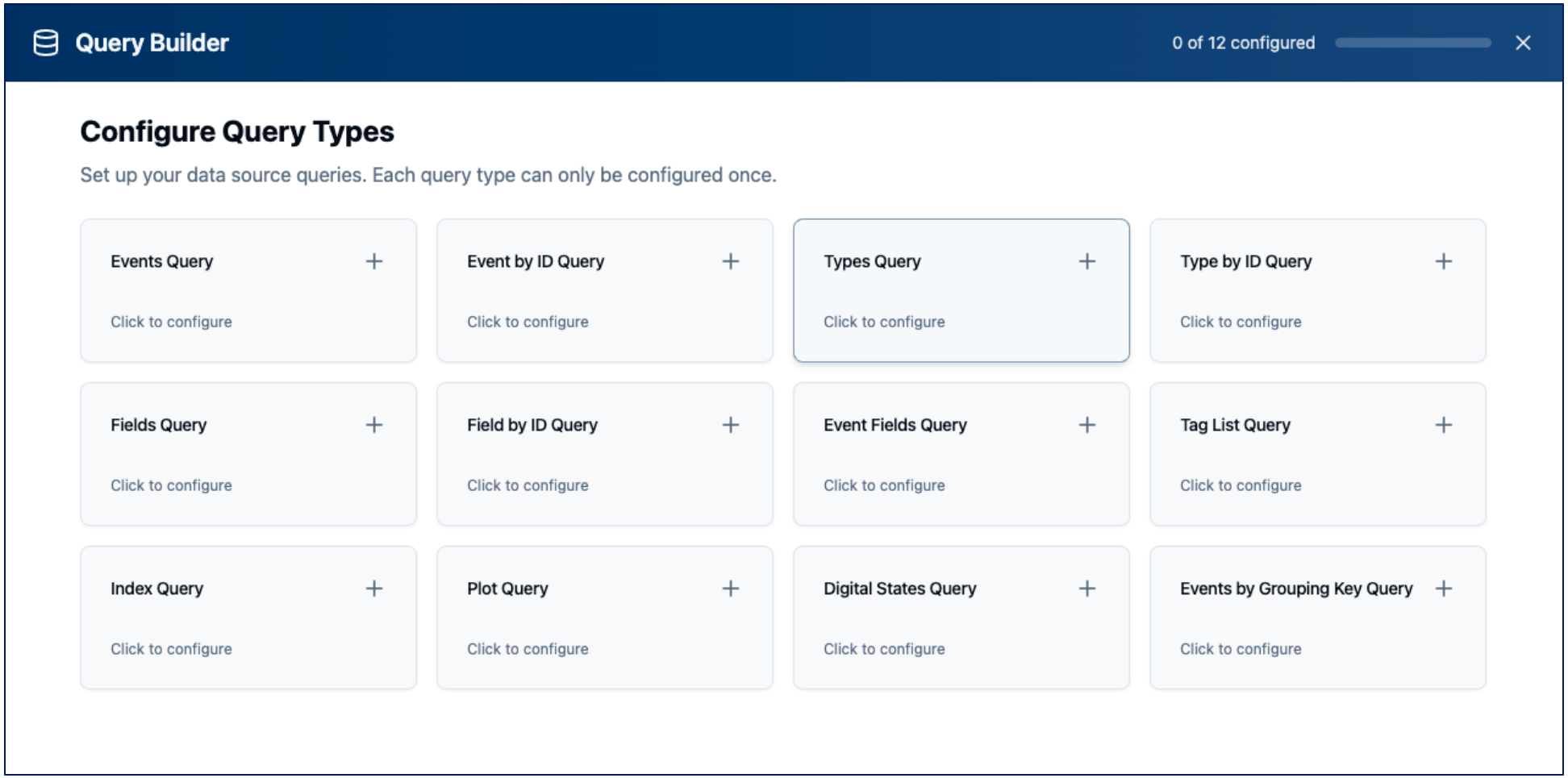
- **Start from a use case**
  - Keeping value in mind
  - Have a clear picture of the end goal to work towards
- **Availability of a DBA (database admin) is crucial**
  - Setting up the ODBC connection
  - Creating dedicated table views, also for testing
  - Troubleshooting
- **Step-by-step approach**
  - Start from a simple connection and some empty context items
  - Adding in fields and attributes gradually
- **Documentation**
  - Document what has been built, how and why
  - This helps scale activities to other data sources / plants

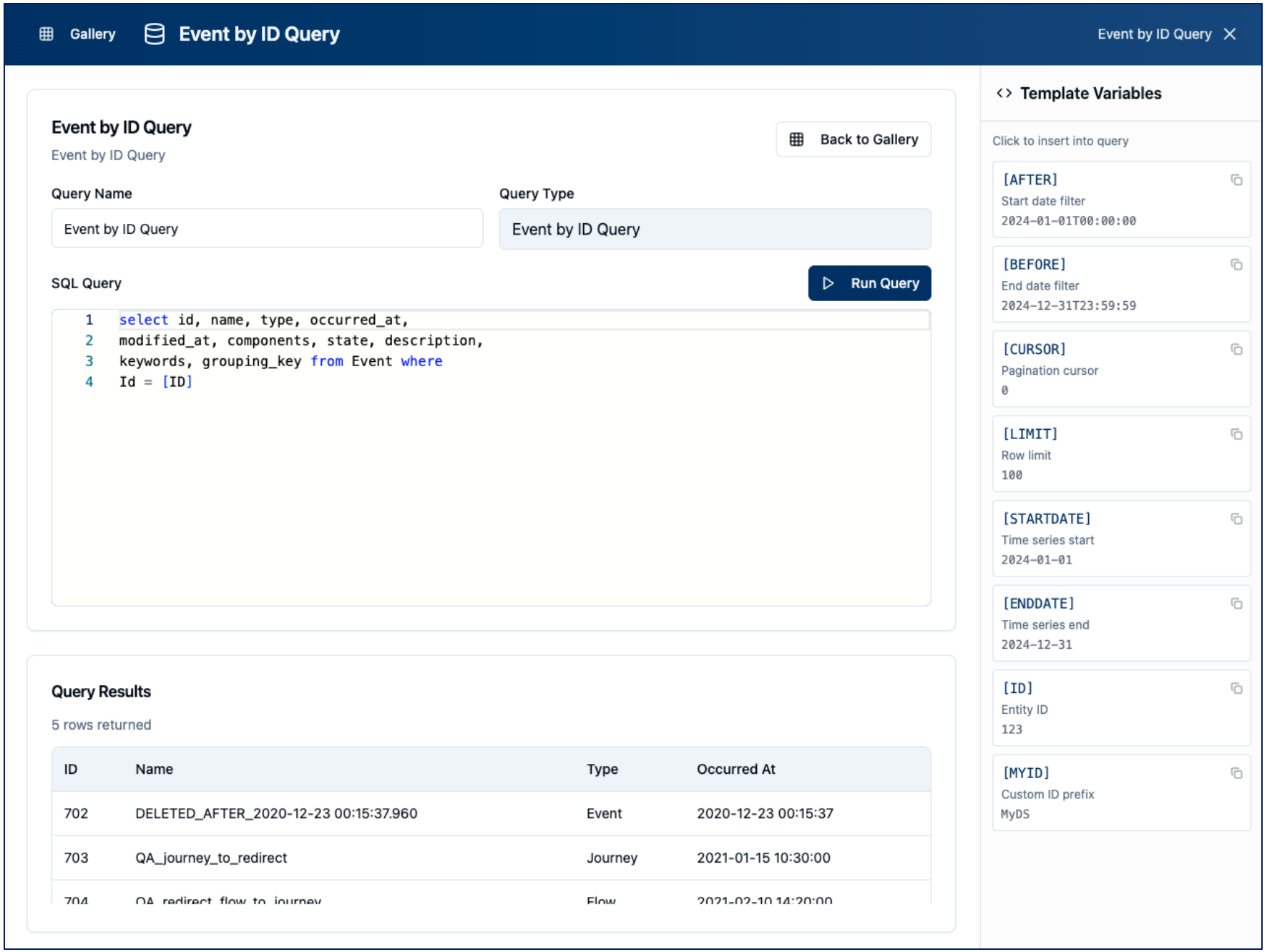
LESSONS LEARNED (2)

- Improvements to the admin experience would fast-track development of connection
  - Syntax correctness
  - Validating columns, variables etc.
  - Completeness of query set

- Learnings are being applied by product team to bring improvements to market in 2026

SNEAK PEAK





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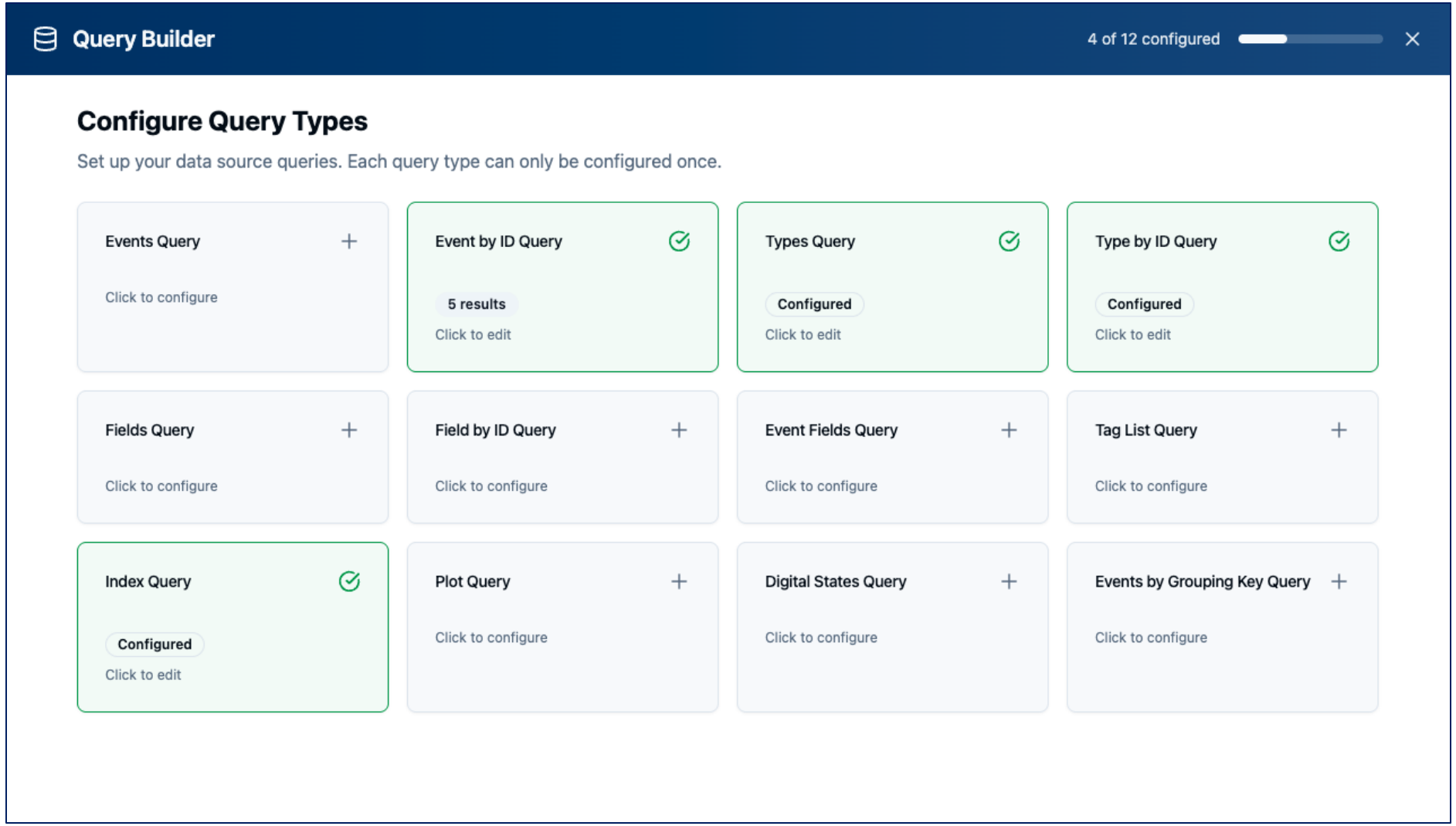

NEXT STEPS

- ✔ Initiation of the Journey
- ✔ Establishing ODBC Connection
- ○ User Training
- ○ Adoption Monitoring
- ○ Future Vision

Q&A

TrendMiner