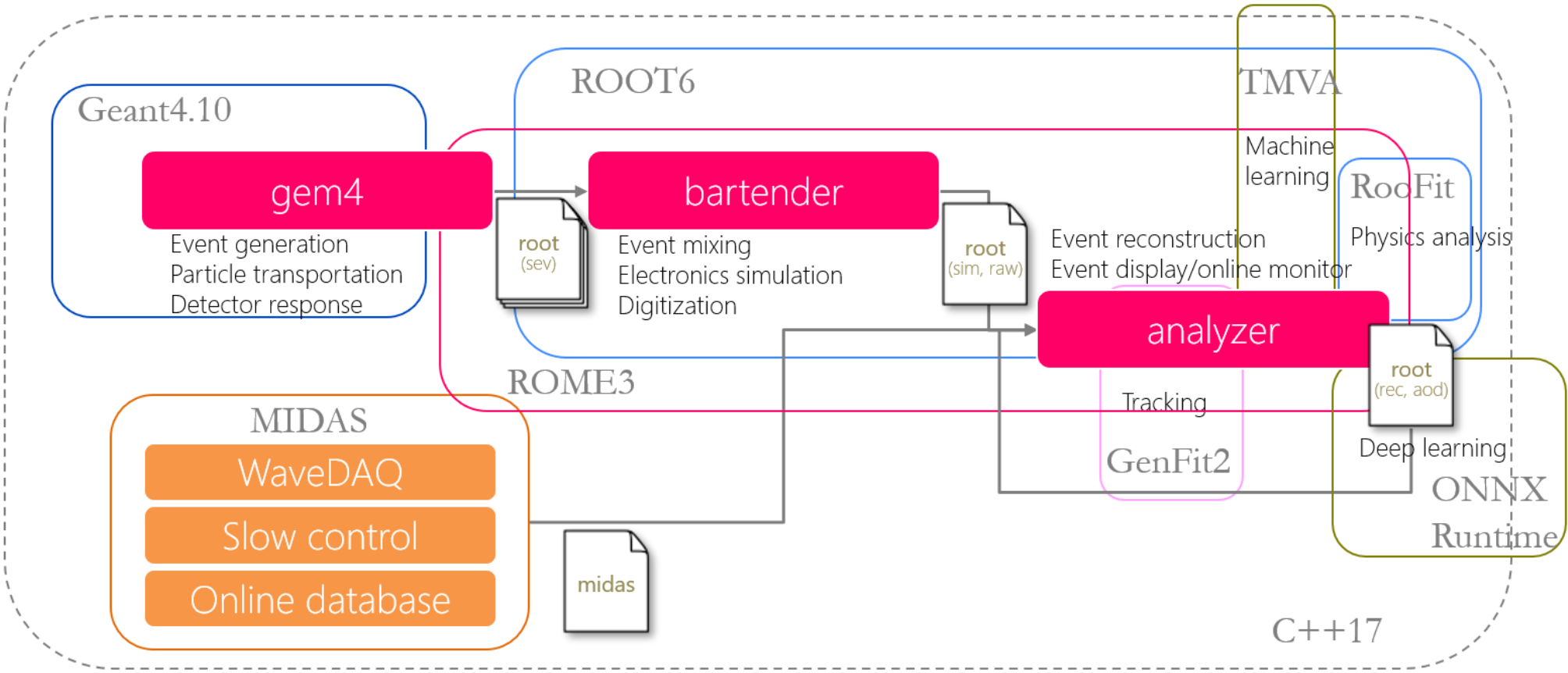
MEG II Database

UCHIYAMA, Yusuke

Mu3e meeting, 14nd Dec. 2021

MEG II software



database

Run info.
Geometry
Calibration

MySQL

SQLite

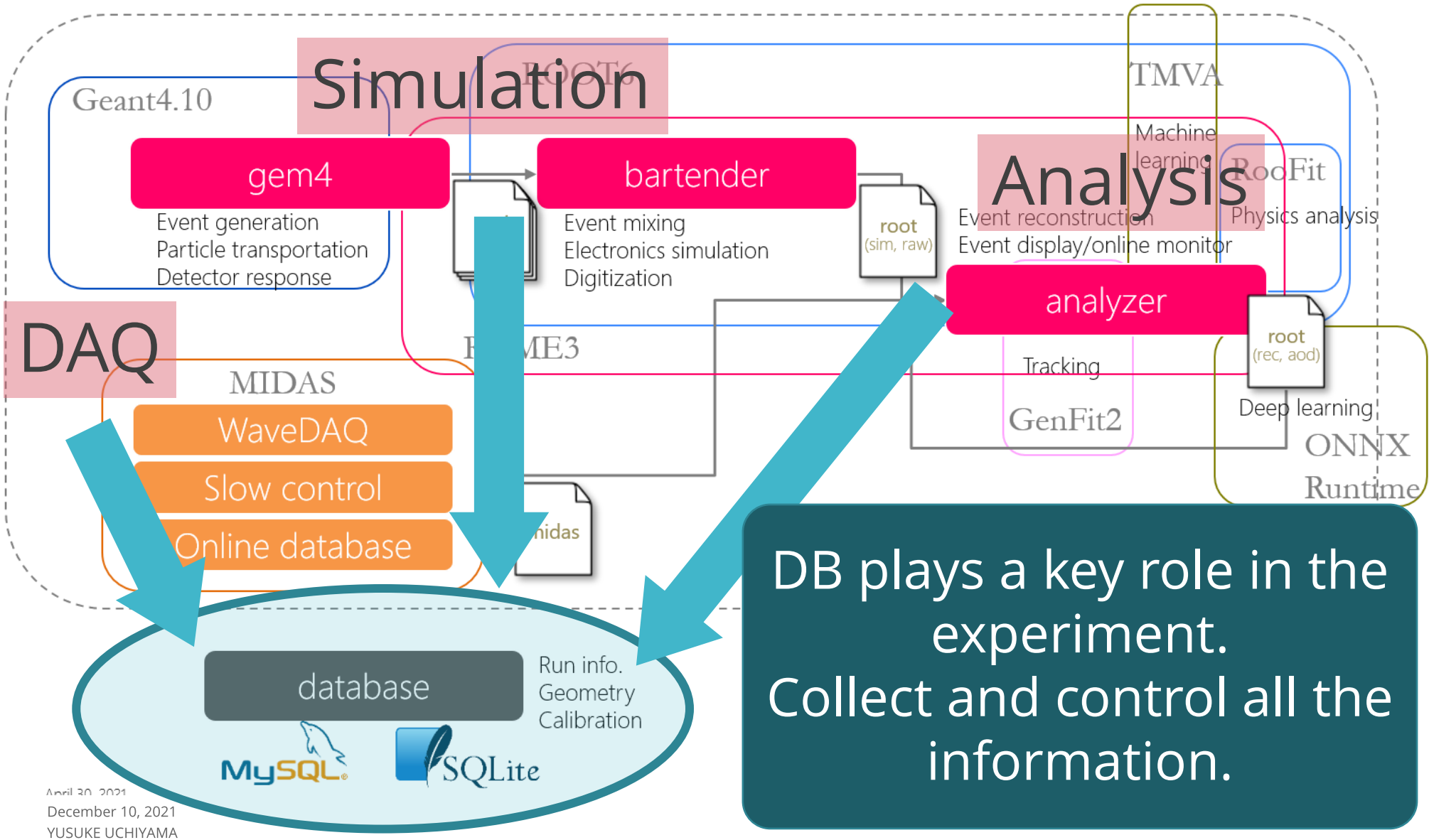
Code management

Repository
Version control
Merge developments

Atlassian Bitbucket

git

MEG II software



DB plays a key role in the experiment.
Collect and control all the information.

1

Run information

- Catalog for runs
- Link to detector & analysis configurations

2

Detector information

- Geometry, configuration
- Cabling, channel mapping

3

Analysis information

- Analysis parameters
- Calibration constants

SQL DB

SQL type DBs are used: MySQL & sqlite3

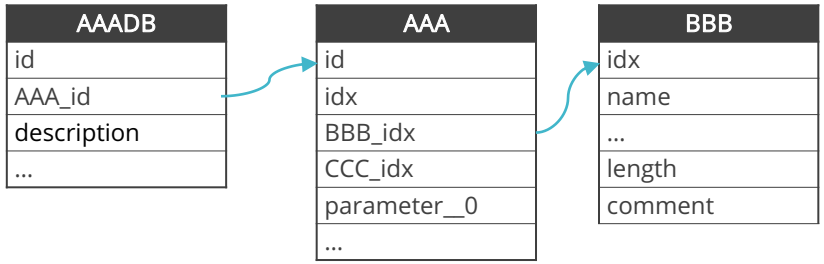
- MySQL is a server type DB, sqlite3 is a file type DB.
- Explain later.

Our software (MIDAS & ROME) supports SQL DB

- Provide basic & common functions to access DB.
- Users don't have to write API or complicated SQL queries.
- Set some rules & conventions for DB structure.

DB is composed of tables

- Make a table for a set of information.
- Individual tables can have different structures.
- Each table has primary keys of 'id' and/or 'idx'.
- Connect tables with 'inner join'



RunCatalog

The RunCatalog is the most basic table in DB

- id of RunCatalog = run number
- All other information is linked to RunCatalog

When a run is taken, MIDAS logger inserts a new entry

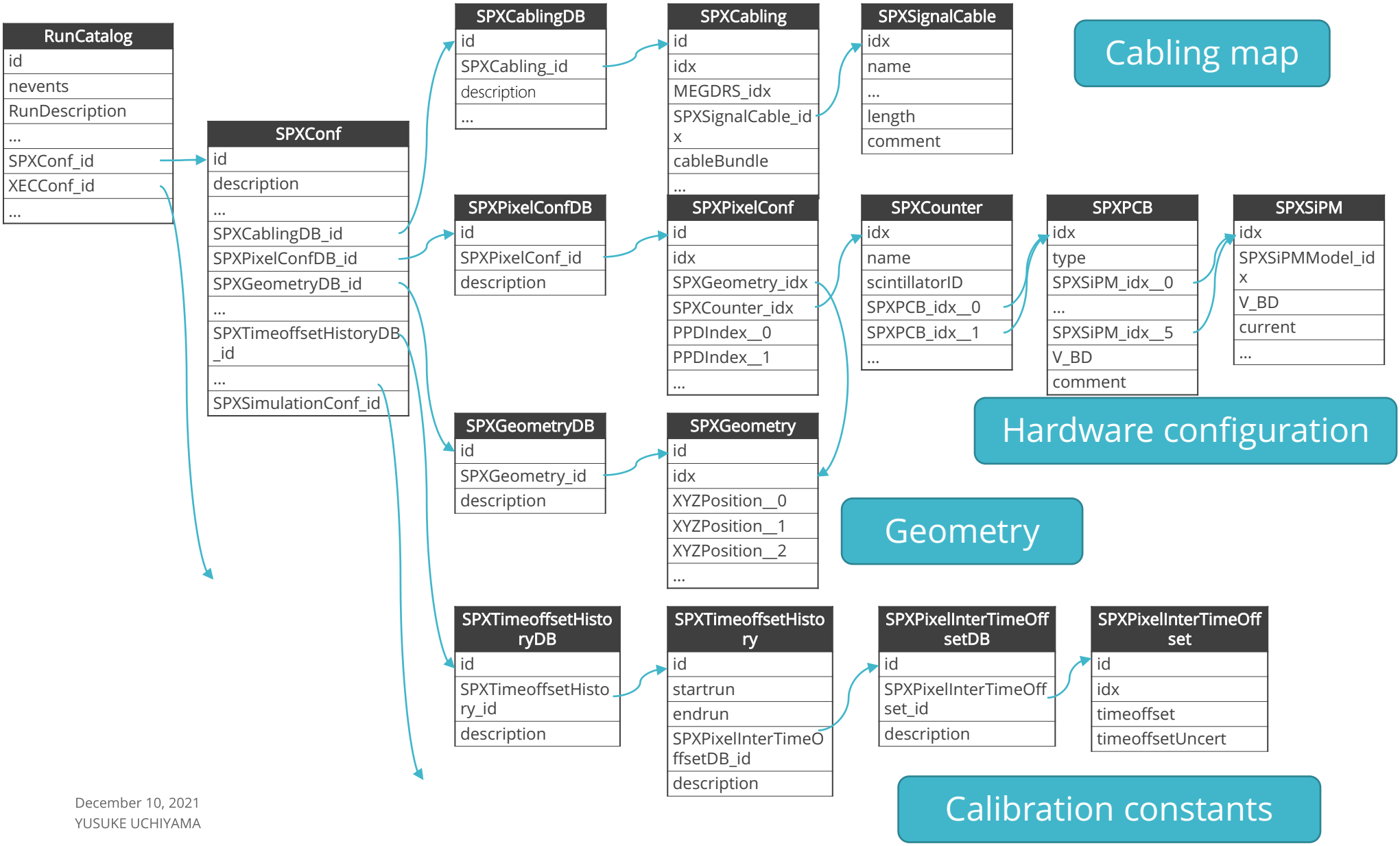
- Fields are linked with ODB fields
- Filled in BOR or EOR
- Some are filled later (after offline analysis)

Column	Type	
id	int	Primary key
Junk	tinyint	
Physics	tinyint	
StartTime	datetime	
StopTime	datetime	
RunOperator	varchar	
nevents	int	
RunDescription	text	
BeamOn	tinyint	
BeamMode	varchar	
COBRAon	tinyint	
TotalTime	int	
LiveTime	int	
DeliveredCurrent	double	
MEGConf_id	int	
SPXConf_id	int	
CYLDCHConf_id	int	
XECConf_id	int	
XECGainDB_id	int	
XECPMTHVDB_id	int	
MD5Sum	varchar	
SciCat_id	varchar	

Links to detailed info.

Example

SPX: Scintillator PiXel detector



Use case:

Since all the hardware information is stored in DB, it is used not only in software but also during hardware work.

A single query used during detector commissioning

```
SELECT floor(SPXCabling.idx/16) as ‘slot’, SPXCabling.idx%16 as ‘ch’,
SPXCabling.idx, SPXCabling.cableBundle as ‘bundle’, SPXSignalCable.name
as ‘cable’, backplaneLocation as ‘BP’, backplaneChannel,SPXGeometry_idx
as ‘position’, SPXCounter_idx as ‘counter’,
SPXCounter.operationVoltage__0 as ‘V_op CH1’,
SPXCounter.operationVoltage__1 as ‘V_op CH2’
FROM SPXConf, SPXPixelConf, SPXCabling, SPXSignalCable, SPXCounter
WHERE SPXCabling.SPXSignalCable_idx=SPXSignalCable.idx AND
(SPXCabling.idx=SPXPixelConf.PPDIndex__0 OR
SPXCabling.idx=SPXPixelConf.PPDIndex__1) AND
SPXPixelConf.SPXCounter_idx=SPXCounter.idx AND
SPXPixelConf.id=SPXConf.SPXPixelConfDB_id AND
SPXCabling.id=SPXConf.SPXCabling_id and SPXConf.id=80 ORDER BY
`SPXCabling`.`idx`;
```

User only needs specify the basic configuration ID.

Use case:

You'll get all the mapping of the detector

- Very useful for detector assembly, cabling, and bad-channel investigation.

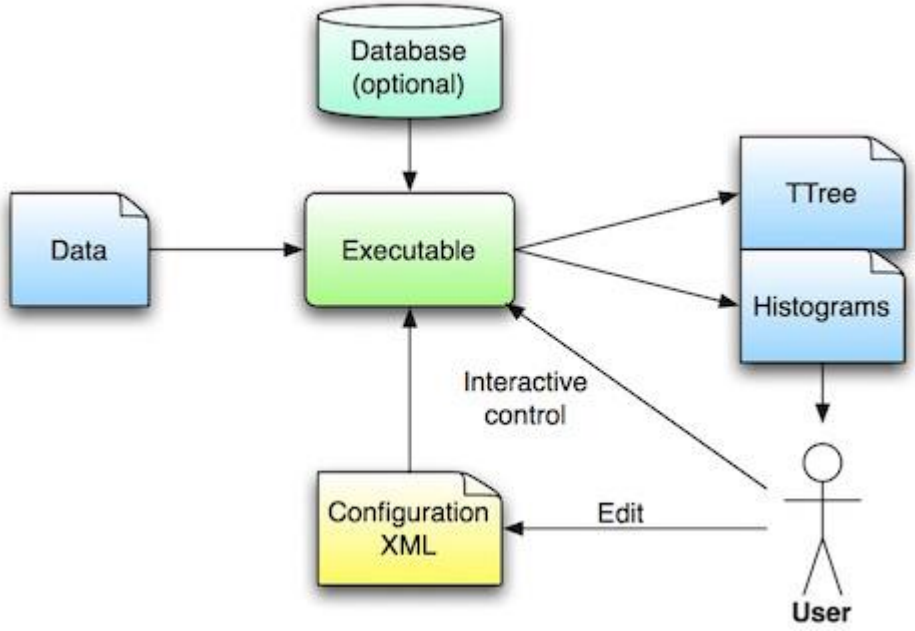
slot	ch	idx	bundle	cable	BP	backplaneChannel	position	counter	V_op CH1	V_op CH2
0	0	0	36	dc14Ac6uh	2	16	0	431	163.75	163.94
0	1	1	11	dc08Ac5uh	0	16	0	431	163.75	163.94
0	2	2	36	dc13Bc4dc	4	16	1	432	163.88	163.59
0	3	3	11	dc08Ac6uh	1	16	1	432	163.88	163.59
0	4	4	36	dc13Bc3dc	6	16	2	422	164.63	163.54
0	5	5	11	dc11Aa6u	3	16	2	422	164.63	163.54
0	6	6	36	dc13Bc2dc	8	16	3	426	164.44	164.3
0	7	7	11	dc11Bc1uh	5	16	3	426	164.44	164.3
0	8	8	36	dc13Bc1dc	10	16	4	430	164.02	164.02
0	9	9	11	dc11Ba7u	7	16	4	430	164.02	164.02
0	10	10	36	dc14Ac7uh	12	16	5	206	163.38	163.34
0	11	11	11	dc11Aa5u	9	16	5	206	163.38	163.34
0	12	12	36	dc05Ac6dh	14	16	6	202	163.52	163.31
0	13	13	11	dc11Aa8u	11	16	6	202	163.52	163.31
0	14	14	36	dc05Ba7d	16	16	7	423	164.61	164.65
0	15	15	11	dc11Ba6u	13	16	7	423	164.61	164.65

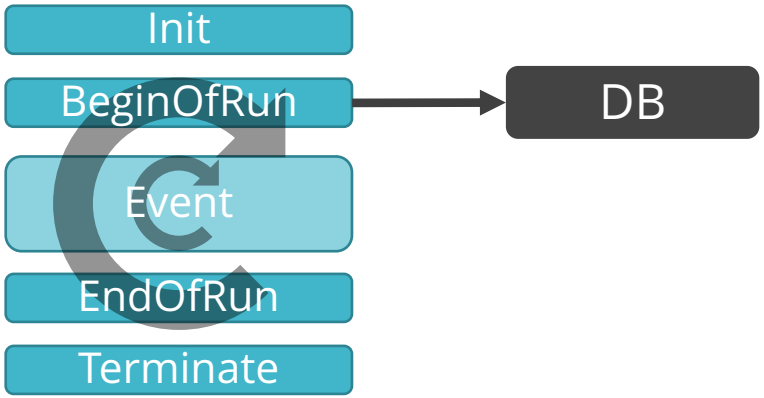
slot	ch	idx	bundle	cable	BP	backplaneChannel	position	counter	V_op CH1	V_op CH2
1	0	16	36	dc05Ba6d	18	16	8	204	163.41	163.13
1	1	17	11	dc11Aa7u	15	16	8	204	163.41	163.13
1	2	18	36	dc05Aa7d	20	16	9	203	163.25	163.29
1	3	19	11	dc11Bc2uh	17	16	9	203	163.25	163.29
1	4	20	36	dc05Ac0dc	22	16	10	205	163.34	163.23
1	5	21	11	dc11Bc7uh	19	16	10	205	163.34	163.23
1	6	22	36	dc05Ba5d	24	16	11	427	164.1	164.24
1	7	23	11	dc11Bc4uh	21	16	11	427	164.1	164.24
1	8	24	36	dc05Aa6d	26	16	12	424	164.42	164.49
1	9	25	11	dc11Bc3uh	23	16	12	424	164.42	164.49
1	10	26	36	dc05Ac7dh	28	16	13	428	164.17	164.05
1	11	27	11	dc11Bc5uh	25	16	13	428	164.17	164.05
1	12	28	36	dc05Ac4dh	30	16	14	425	164.48	164.43
1	13	29	11	dc11Ba5u	27	16	14	425	164.48	164.43
1	14	30	36	dc05Aa8d	31	16	15	429	164.15	163.82
1	15	31	11	dc11Ba8u	29	16	15	429	164.15	163.82
2	0	32	70	dc09Bc0uh	2	15	16	412	164.37	163.26
2	1	33	3	dc06Ba2d	0	15	16	412	164.37	163.26
2	2	34	70	dc09Bc6uc	4	15	17	421	164.63	163.03
2	3	35	3	dc06Ac3dh	1	15	17	421	164.63	163.03
2	4	36	70	dc09Bc6uh	6	15	18	396	165.02	164.17
2	5	37	3	dc06Ba3d	3	15	18	396	165.02	164.17
2	6	38	70	dc09Bc3uc	8	15	19	398	164.73	164.16
2	7	39	3	dc06Aa3d	5	15	19	398	164.73	164.16
2	8	40	70	dc09Bc3uh	10	15	20	392	164.2	164.32
2	9	41	3	dc06Ac6dh	7	15	20	392	164.2	164.32
2	10	42	70	dc09Bc7uh	12	15	21	413	164.3	163.34
2	11	43	3	dc06Aa0d	9	15	21	413	164.3	163.34
2	12	44	70	dc09Bc5uh	14	15	22	393	164.67	164.22
2	13	45	3	dc06Ac5dh	11	15	22	393	164.67	164.22
2	14	46	70	dc09Bc0dh	16	15	23	404	164.51	163.85
2	15	47	3	dc06Ba1d	13	15	23	404	164.51	163.85
3	0	48	70	dc09Bc2uc	18	15	24	389	164.39	164.35

In MEG software

MEG offline software is based on ROME
(Root based Object oriented Midas Extension)

- Provide API for SQL databases.
- Read database at BOR
- and store the values in Folders





User specify connection b/w parameter in folder and DB path in an XML file

```
      <Field>
            <FieldName>StartTime</FieldName>
            <FieldType>TString</FieldType>
            <FieldComment>Start of the run (online).</FieldComment>
            <DataBaseName>meg</DataBaseName>
            <DataBasePath>&quot;/RunCatalog[id=%d]/startTime&quot;,gAnalyzer->GetGSP()-
>GetCustomizedDatabaseConfiguration()->GetCustomRunNumber()==-1?(Int_t)gAnalyzer->GetCurrentRunNumber():gAnalyzer-
>GetGSP()->GetCustomizedDatabaseConfiguration()->GetCustomRunNumber()</DataBasePath>
      </Field>
      <Field>
            <FieldName>StopTime</FieldName>
…
      <Field>
            <FieldName>MEGConfId</FieldName>
            <FieldType>Int_t</FieldType>
            <FieldComment>MEGConf.id in database to be used</FieldComment>
            <FieldInitialization>0</FieldInitialization>
            <DataBaseName>meg</DataBaseName>
            <DataBasePath>&quot;/RunCatalog[id=%d]/MEGConf_id&quot;,gAnalyzer->GetGSP()-
>GetCustomizedDatabaseConfiguration()->GetCustomRunNumber()==-1?(Int_t)gAnalyzer->GetCurrentRunNumber():gAnalyzer-
>GetGSP()->GetCustomizedDatabaseConfiguration()->GetCustomRunNumber()</DataBasePath>
            <DataBaseIfStatement>gAnalyzer->GetGSP()->GetCustomizedDatabaseConfiguration()->GetMEGCustomDBConf()-
>GetMEGConfId()==-1</DataBaseIfStatement>
      </Field>
```

User specify connection b/w parameter in folder and DB path in an XML file

Another example: array field

```
      <Field>
            <FieldName>PositionID</FieldName>
            <FieldType>Short_t</FieldType>
            <FieldComment>Position ID = SPXGeometry.idx</FieldComment>
            <DataBaseName>meg</DataBaseName>
            <DataBasePath>&amp;quot;/SPXConf[id=%d]/SPXPixelConfDB/SPXPixelConf(0,%d)/SPXGeometry_idx&amp;quot;,gAnalyzer-
>GetGSP()->GetCustomizedDatabaseConfiguration()->GetSPXCustomDBConf()->GetSPXConfId()==-1 ? gAnalyzer-
>GetSPXRunHeader()->GetSPXConfId() : gAnalyzer->GetGSP()->GetCustomizedDatabaseConfiguration()->GetSPXCustomDBConf()-
>GetSPXConfId(),gAnalyzer->GetSPXRunHeader()->GetNPixels()-1</DataBasePath>
            <DataBaseIfStatement>(gAnalyzer->GetSPXRunHeader()->GetNPixels())</DataBaseIfStatement>
```

id given from RunCatalog or steering parameter

```
/SPXConf[id=%d]/SPXPixelConfDB/SPXPixelConf(0,%d)/SPXGeometry_idx
```

inner join

inner join

idx runs through # of counters

The field = 'PositionID'

User doesn't have to write complicated SQL queries.

In software: geometry

SPXGeometryDB table

id	SPXGeometry_id	description
0	0	MC development, from PixelPosition4
1	1	US with Alignment 2019, from 3D survey
2	2	Excluded insufficient data from id 1
3	3	For MC - 5mm Random seed deviation
4	4	2019 US (id2) + 2018 DS
5	5	CAD values for pixel centers, angles are same as id=0.

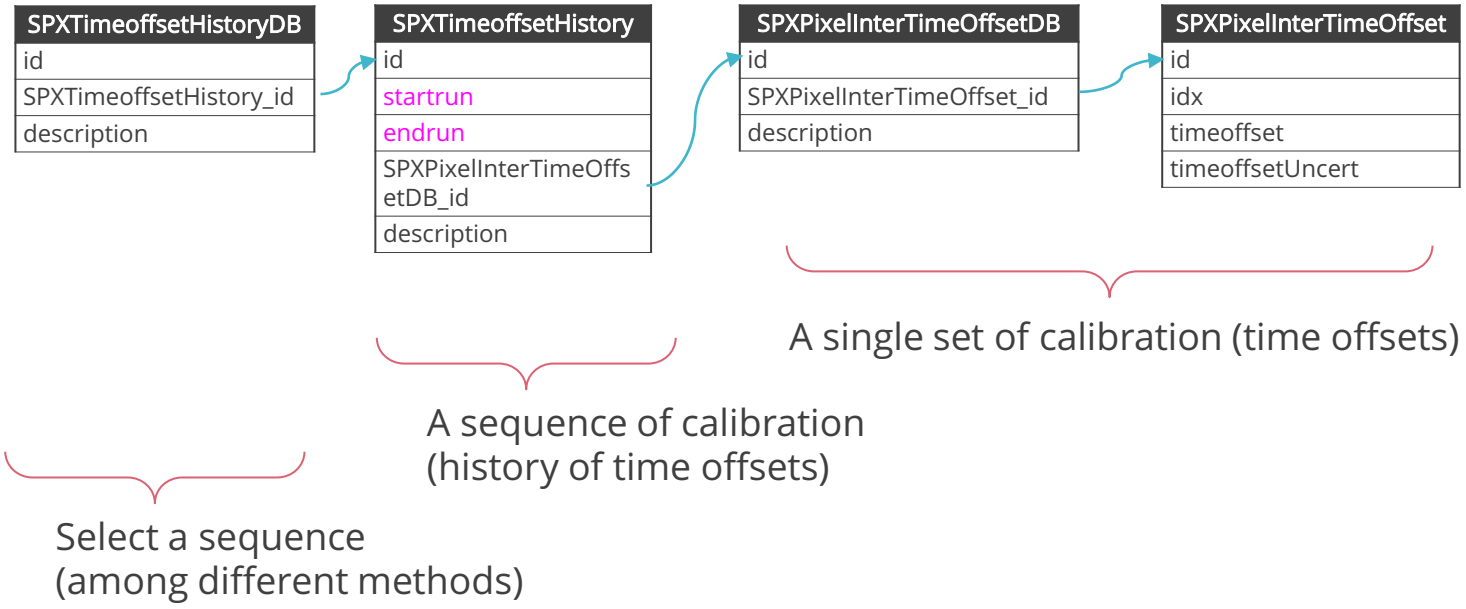
SPXGeometry table

		Coordinates			Euler angles			
id	idx	XYZPosition__0	XYZPosition__1	XYZPosition__2	XPhi	XTheta	XPsi	GeometricalHitOrder
0	0	31.6826	-1.64003	30	3.14159	0.785398	3.08987	0
0	1	30.8771	-7.28566	27.25	3.14159	0.785398	2.90987	1
0	2	29.0739	-12.6958	30	3.14159	0.785398	2.72987	4
0	3	26.3312	-17.6958	27.25	3.14159	0.785398	2.54987	5
0	4	22.7377	-22.124	30	3.14159	0.785398	2.36987	8
0	5	18.4095	-25.8373	27.25	3.14159	0.785398	2.18988	9
0	6	13.4865	-28.7157	30	3.14159	0.785398	2.00987	12
0	7	8.12762	-30.6662	27.25	3.14159	0.785398	1.82987	13
0	8	2.50612	-31.6259	30	3.14159	0.785398	1.64987	16
0	9	-3.19632	-31.5636	27.25	3.14159	0.785398	1.46987	17
0	10	-8.79568	-30.4813	30	3.14159	0.785398	1.28987	20
0	11	-14.1105	-28.4142	27.25	3.14159	0.785398	1.10987	21
0	12	-18.9694	-25.4291	30	3.14159	0.785398	0.929877	24
0	13	-23.2154	-21.6222	27.25	3.14159	0.785398	0.749881	25
0	14	-26.7116	-17.1163	30	3.14159	0.785398	0.569867	28
0	15	-29.3443	-12.0577	27.25	3.14159	0.785398	0.389872	29
0	16	31.6826	-1.64003	35.5	3.14159	0.785398	3.08987	2
0	17	30.8771	-7.28566	32.75	3.14159	0.785398	2.90987	3
0	18	29.0739	-12.6958	35.5	3.14159	0.785398	2.72987	6
0	19	26.3312	-17.6958	32.75	3.14159	0.785398	2.54987	7

Geometry for each scintillator counter

- for different setup (design, MC, different years)
- Geometry is fetched from DB and constructed in software: Geant4 and analyzer (e.g., GenFit)

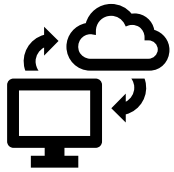
In software: calibration

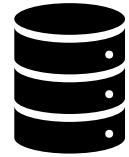


Able to have different streams of calibrations

- Time dependent calibration constants
- Store different streams of calibration in parallel: e.g., results from different methods or different groups.
- Select one with a single ID; easy to switch different calibrations.

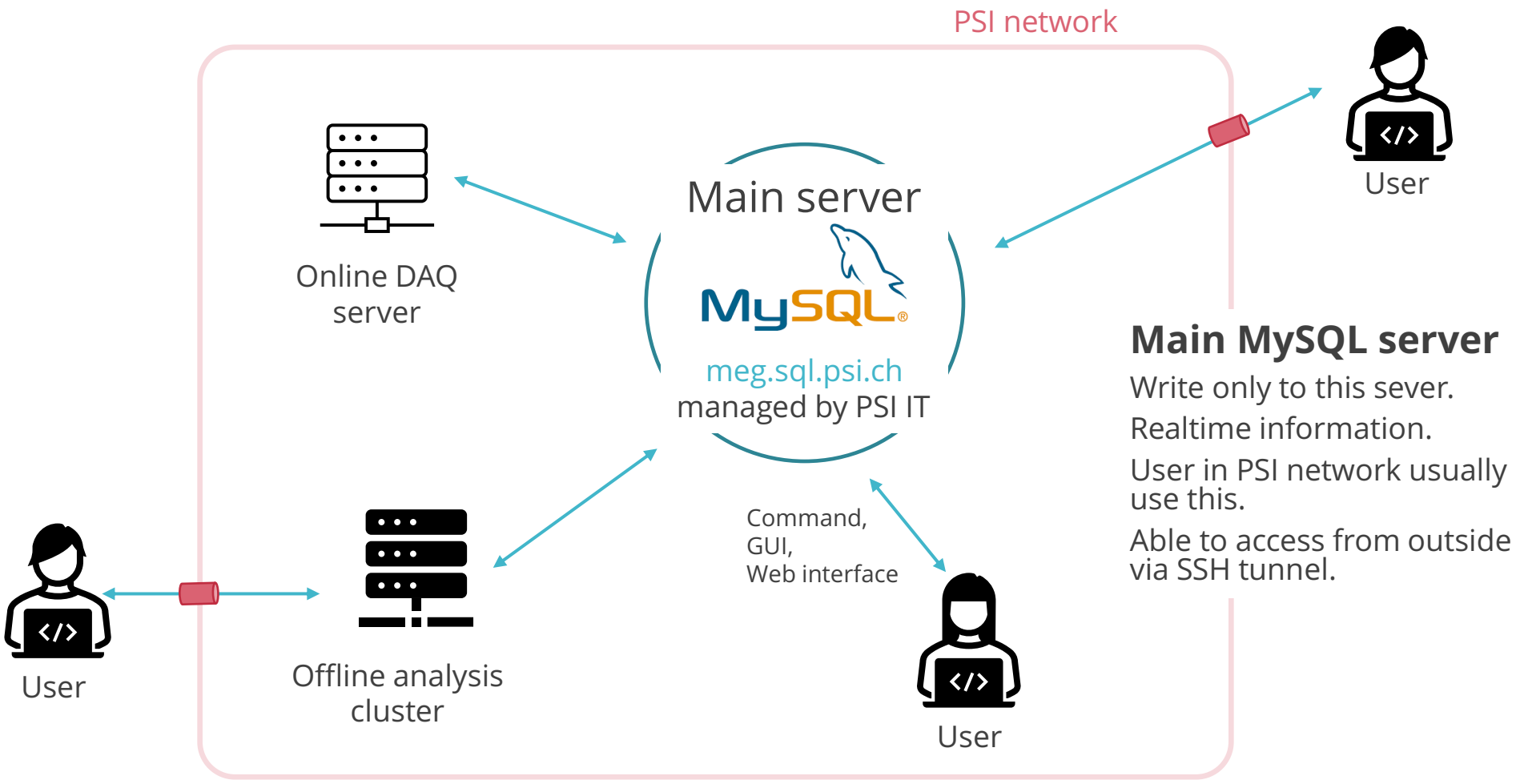
System





Closed as a file.
Available locally (even offline).
Snapshots
    Official process with a frozen DB

System



Main MySQL server

Write only to this sever.

Realtime information.

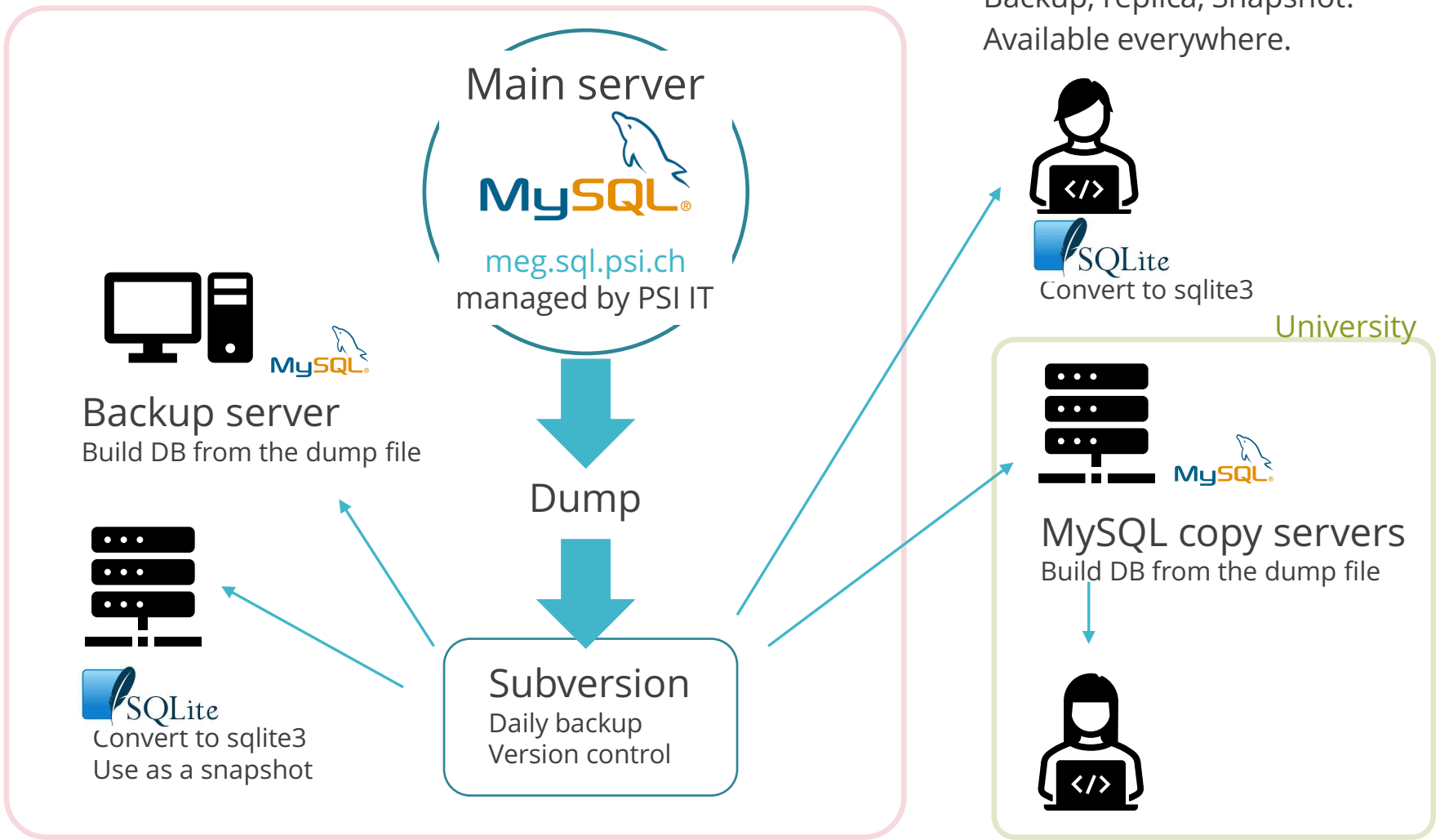
User in PSI network usually use this.

Able to access from outside via SSH tunnel.

System

Dump file & sqlite3 file

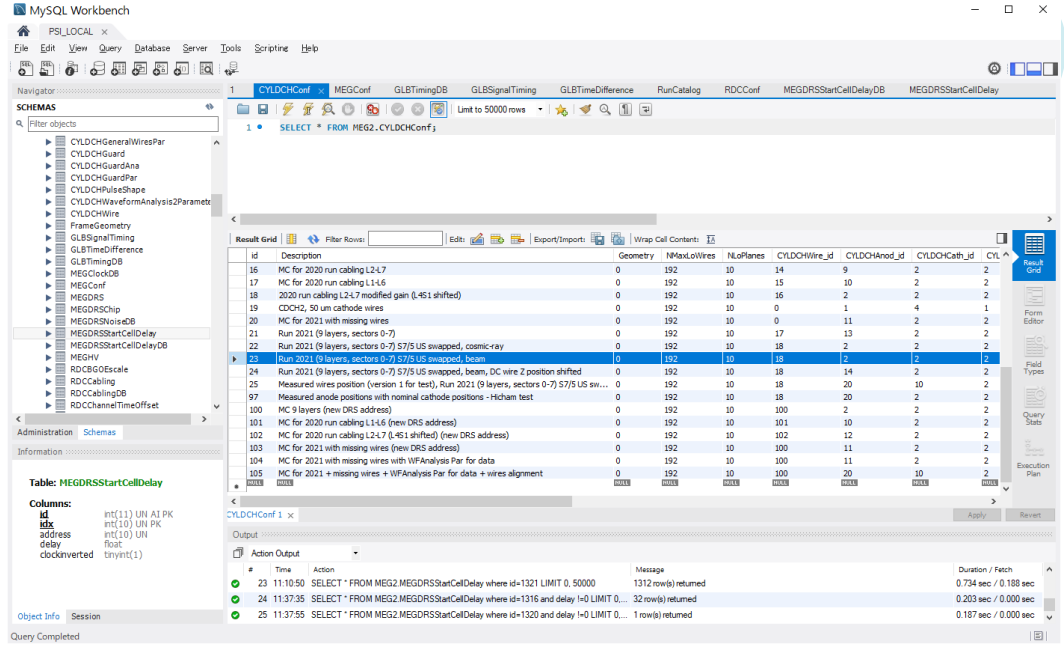
One way (read-only).
Daily update.
Backup, replica, Snapshot.
Available everywhere.

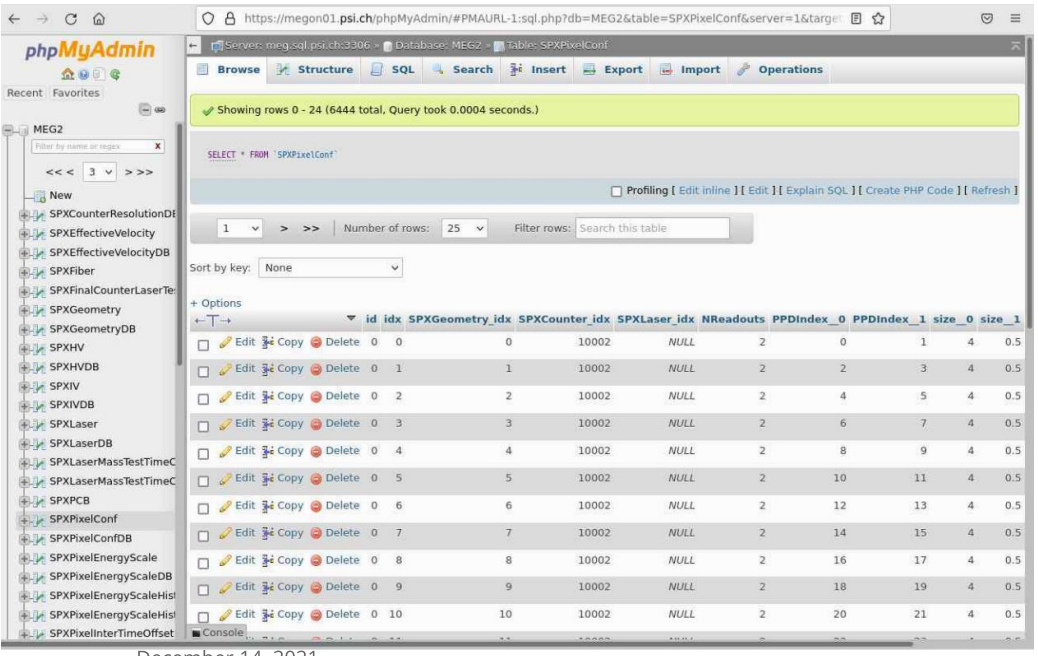


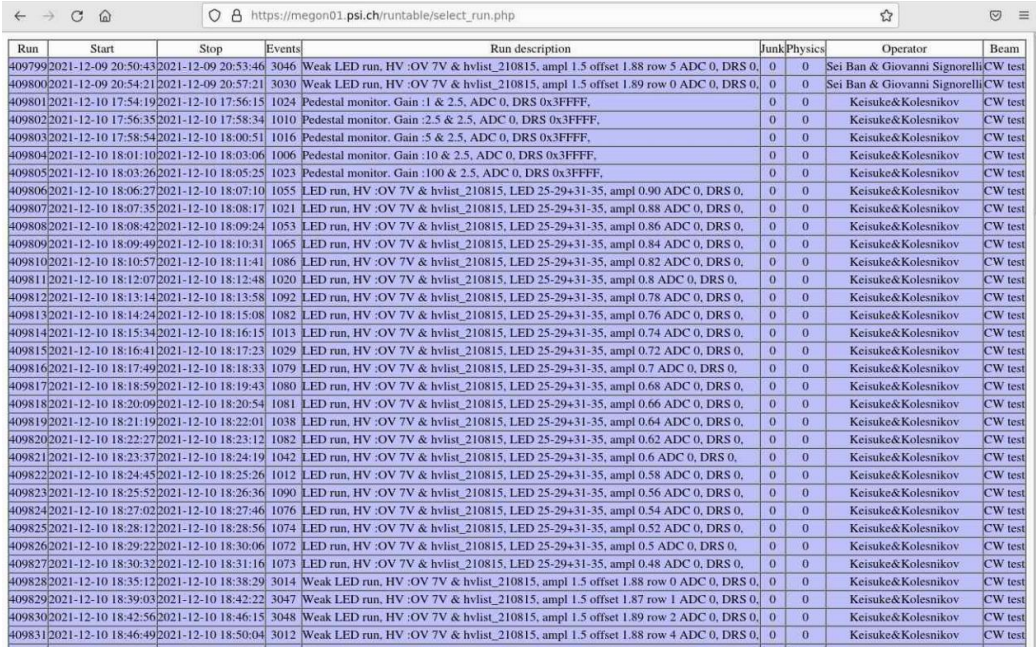
We have one master server and no slave (replication) servers

- We haven't used MySQL replication functionality because it didn't work well 15 years ago. It may work well now.
- The backup and copy is one way and asynchronous; only once per day.
  This will help avoid propagating errors to all copies, but user using the copies must wait at max one day to get the new entries.
- Access concentrates on the master server. It can be an issue with many cores in the offline cluster. In MEG II, there are 320 cores in PSI cluster, and max connections is set to 400, without problem so far.
- User can sometimes do wrong operation, which may screw up the content or cause a crash of server. In such a case, recover the master from the backup. We may loose update for at max one day.
- MIDAS DAQ doesn't work when the server is down. When the master is down, we switch to the backup server; later the new run entries are copied to the master.

Interfaces







Run	Start	Stop	Events	Run description	Junk	Physics	Operator	Beam
409799	2021-12-09 20:50:43	2021-12-09 20:53:46	3046	Weak LED run, HV :OV 7V & hvlist_210815, ampl 1.5 offset 1.88 row 5 ADC 0, DRS 0,	0	0	Sei Ban & Giovanni Signorelli	CW test
409800	2021-12-09 20:54:21	2021-12-09 20:57:21	3030	Weak LED run, HV :OV 7V & hvlist_210815, ampl 1.5 offset 1.89 row 0 ADC 0, DRS 0,	0	0	Sei Ban & Giovanni Signorelli	CW test
409801	2021-12-10 17:54:19	2021-12-10 17:56:15	1024	Pedestal monitor. Gain :1 & 2.5, ADC 0, DRS 0x3FFFF,	0	0	Keisuke&Kolesnikov	CW test
409802	2021-12-10 17:56:35	2021-12-10 17:58:34	1010	Pedestal monitor. Gain :2.5 & 2.5, ADC 0, DRS 0x3FFFF,	0	0	Keisuke&Kolesnikov	CW test
409803	2021-12-10 17:58:54	2021-12-10 18:00:51	1016	Pedestal monitor. Gain :5 & 2.5, ADC 0, DRS 0x3FFFF,	0	0	Keisuke&Kolesnikov	CW test
409804	2021-12-10 18:01:10	2021-12-10 18:03:06	1006	Pedestal monitor. Gain :10 & 2.5, ADC 0, DRS 0x3FFFF,	0	0	Keisuke&Kolesnikov	CW test
409805	2021-12-10 18:03:26	2021-12-10 18:05:25	1023	Pedestal monitor. Gain :100 & 2.5, ADC 0, DRS 0x3FFFF,	0	0	Keisuke&Kolesnikov	CW test
409806	2021-12-10 18:06:27	2021-12-10 18:07:10	1055	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.90 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409807	2021-12-10 18:07:35	2021-12-10 18:08:17	1021	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.88 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409808	2021-12-10 18:08:42	2021-12-10 18:09:24	1053	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.86 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409809	2021-12-10 18:09:49	2021-12-10 18:10:31	1065	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.84 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409810	2021-12-10 18:10:57	2021-12-10 18:11:41	1086	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.82 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409811	2021-12-10 18:12:07	2021-12-10 18:12:48	1020	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.8 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409812	2021-12-10 18:13:14	2021-12-10 18:13:58	1092	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.78 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409813	2021-12-10 18:14:24	2021-12-10 18:15:08	1082	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.76 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409814	2021-12-10 18:15:34	2021-12-10 18:16:15	1013	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.74 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409815	2021-12-10 18:16:41	2021-12-10 18:17:23	1029	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.72 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409816	2021-12-10 18:17:49	2021-12-10 18:18:33	1079	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.7 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409817	2021-12-10 18:18:59	2021-12-10 18:19:43	1080	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.68 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409818	2021-12-10 18:20:09	2021-12-10 18:20:54	1081	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.66 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409819	2021-12-10 18:21:19	2021-12-10 18:22:01	1038	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.64 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409820	2021-12-10 18:22:27	2021-12-10 18:23:12	1082	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.62 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409821	2021-12-10 18:23:37	2021-12-10 18:24:19	1042	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.6 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409822	2021-12-10 18:24:45	2021-12-10 18:25:26	1012	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.58 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409823	2021-12-10 18:25:52	2021-12-10 18:26:36	1090	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.56 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409824	2021-12-10 18:27:02	2021-12-10 18:27:46	1076	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.54 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409825	2021-12-10 18:28:12	2021-12-10 18:28:56	1074	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.52 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409826	2021-12-10 18:29:22	2021-12-10 18:30:06	1072	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.5 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409827	2021-12-10 18:30:32	2021-12-10 18:31:16	1073	LED run, HV :OV 7V & hvlist_210815, LED 25-29+31-35, ampl 0.48 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409828	2021-12-10 18:35:12	2021-12-10 18:38:29	3014	Weak LED run, HV :OV 7V & hvlist_210815, ampl 1.5 offset 1.88 row 0 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409829	2021-12-10 18:39:03	2021-12-10 18:42:22	3047	Weak LED run, HV :OV 7V & hvlist_210815, ampl 1.5 offset 1.87 row 1 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409830	2021-12-10 18:42:56	2021-12-10 18:46:15	3048	Weak LED run, HV :OV 7V & hvlist_210815, ampl 1.5 offset 1.89 row 2 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test
409831	2021-12-10 18:46:49	2021-12-10 18:50:04	3012	Weak LED run, HV :OV 7V & hvlist_210815, ampl 1.5 offset 1.88 row 4 ADC 0, DRS 0,	0	0	Keisuke&Kolesnikov	CW test

Tips: Re:dash

Re:dash can visualize the database content easily.

- You can create ‘dash-boards’ for real-time monitoring.
- It is NOT used by MEG officially but used by some sub-groups.
- You need a redash server.

Summary

Reviewed MEG II SQL database usage

- DB plays an essential role in the experiment
- both in hardware and software activities.
- All the information of the experiment should be collected in and controlled with the DB.
- Software fully supports DB
- both online & offline, data & simulation, seamlessly.
- This scheme was established and has been working well for >15 years.

- Some part may be old in modern system. If you start from scratch now, you may build in better way.