FR2BCO05

Magnet Information Management System Based on Web Application for the KEK e-/e+ Injector Linac

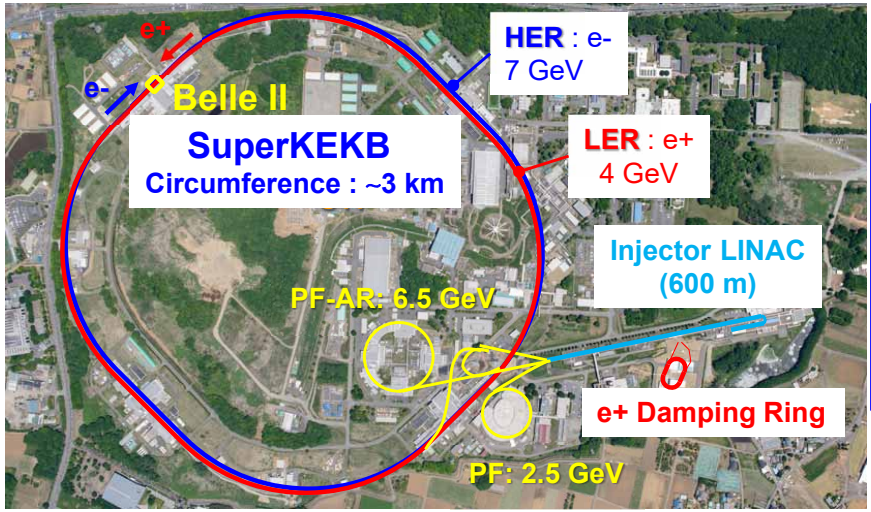
Masanori Satoh, Yoshinori Enomoto (KEK Acc. Lab., SOKENDAI)
Takuya Kudou (Mitsubishi Electric System & Service Co., Ltd)

Outline

- Lepton Accelerator Complex in KEK Tsukuba Campus
- Device information database system
- New Magnet information management system based on Web application
- Summary

Lepton Accelerator Complex in KEK Tsukuba Campus

--- e-/e+ injector, four rings and e+ DR ---
Simultaneous top-up injection since 2019



Each ring requires much different beam quality

Injector linac beam up-to 50 Hz
Bunch charge: 0.1 nC – 4 nC (10 nC for e+ production)
Beam energy: 2.5 GeV – 7 GeV
Emittance: 15 – 150 mm·mrad (normalized)

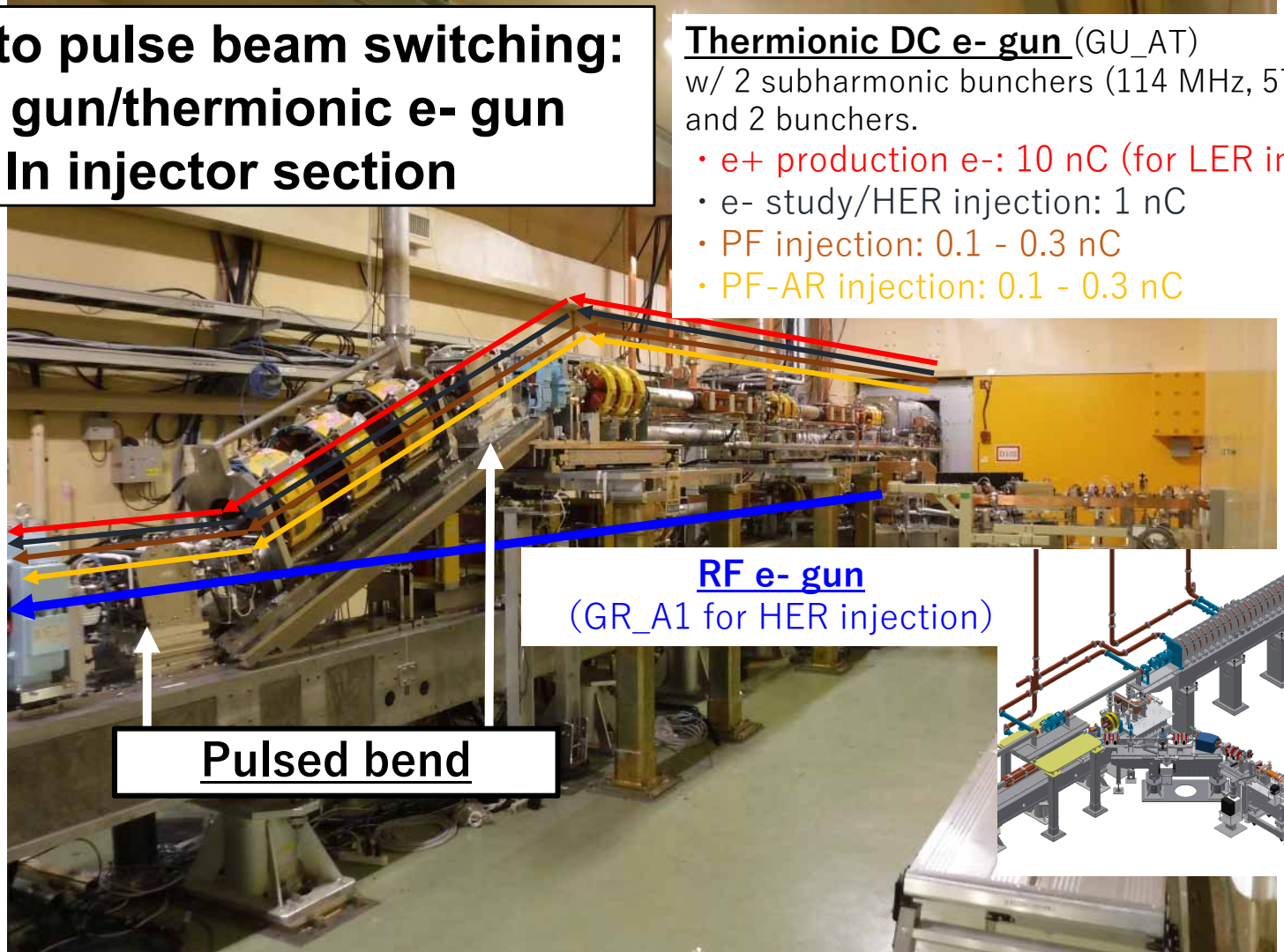
Injector Linac provides the beams to 4 (+1) different rings up to 50 Hz

- **Photon Factory** } Light Source
- **PF-AR**
- **SuperKEKB High Energy Ring (HER)**
- **SuperKEKB Low Energy Ring (LER) + Damping Ring** } Belle II experiment

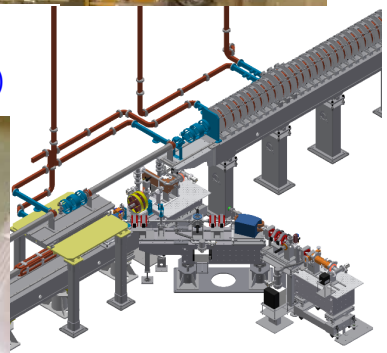
Pulse to pulse beam switching: rf e- gun/thermionic e- gun In injector section

Thermionic DC e- gun (GU_AT)
w/ 2 subharmonic bunchers (114 MHz, 571 MHz) and 2 bunchers.

- e+ production e-: 10 nC (for LER injection)
- e- study/HER injection: 1 nC
- PF injection: 0.1 - 0.3 nC
- PF-AR injection: 0.1 - 0.3 nC

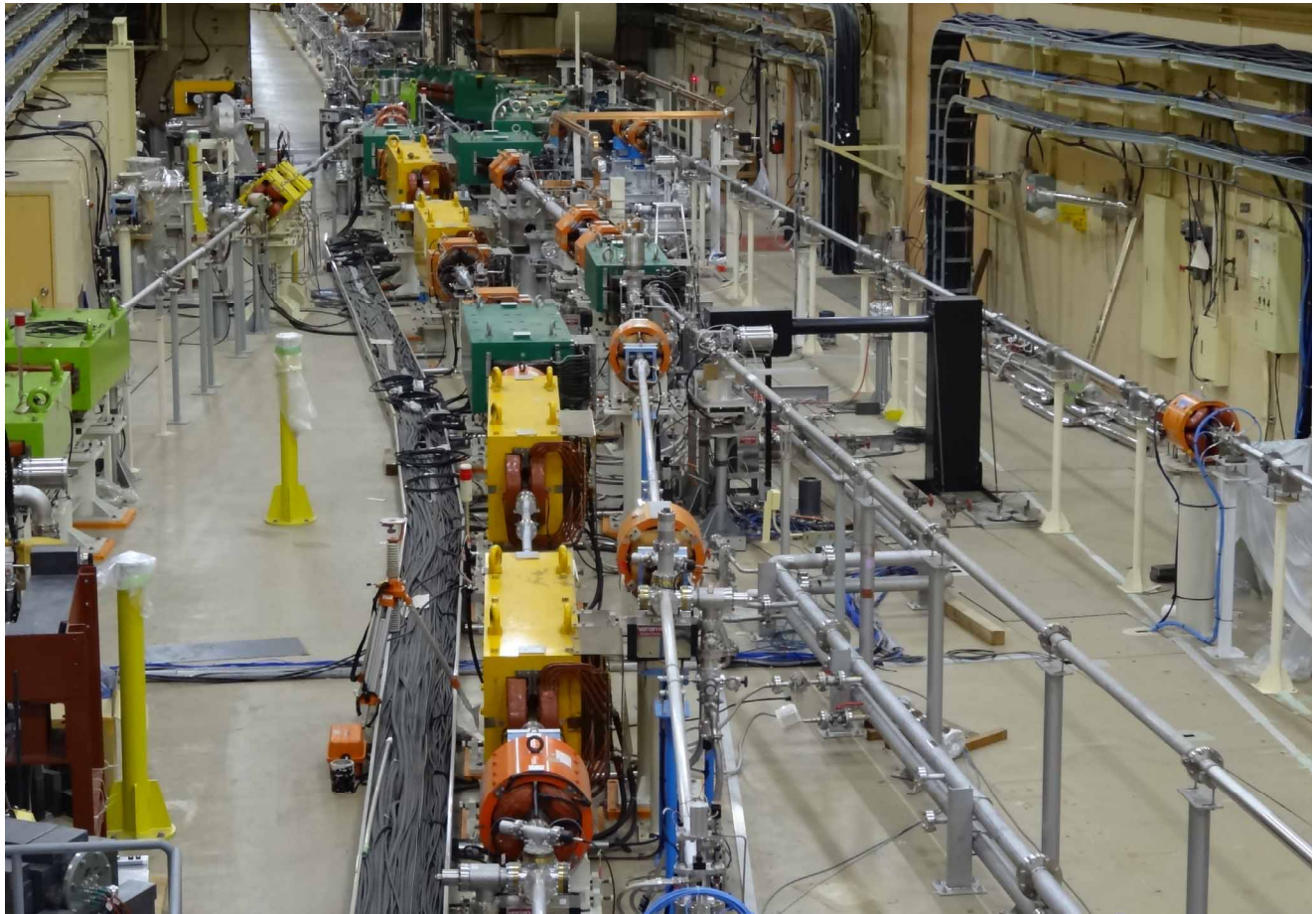


RF e- gun
(GR_A1 for HER injection)



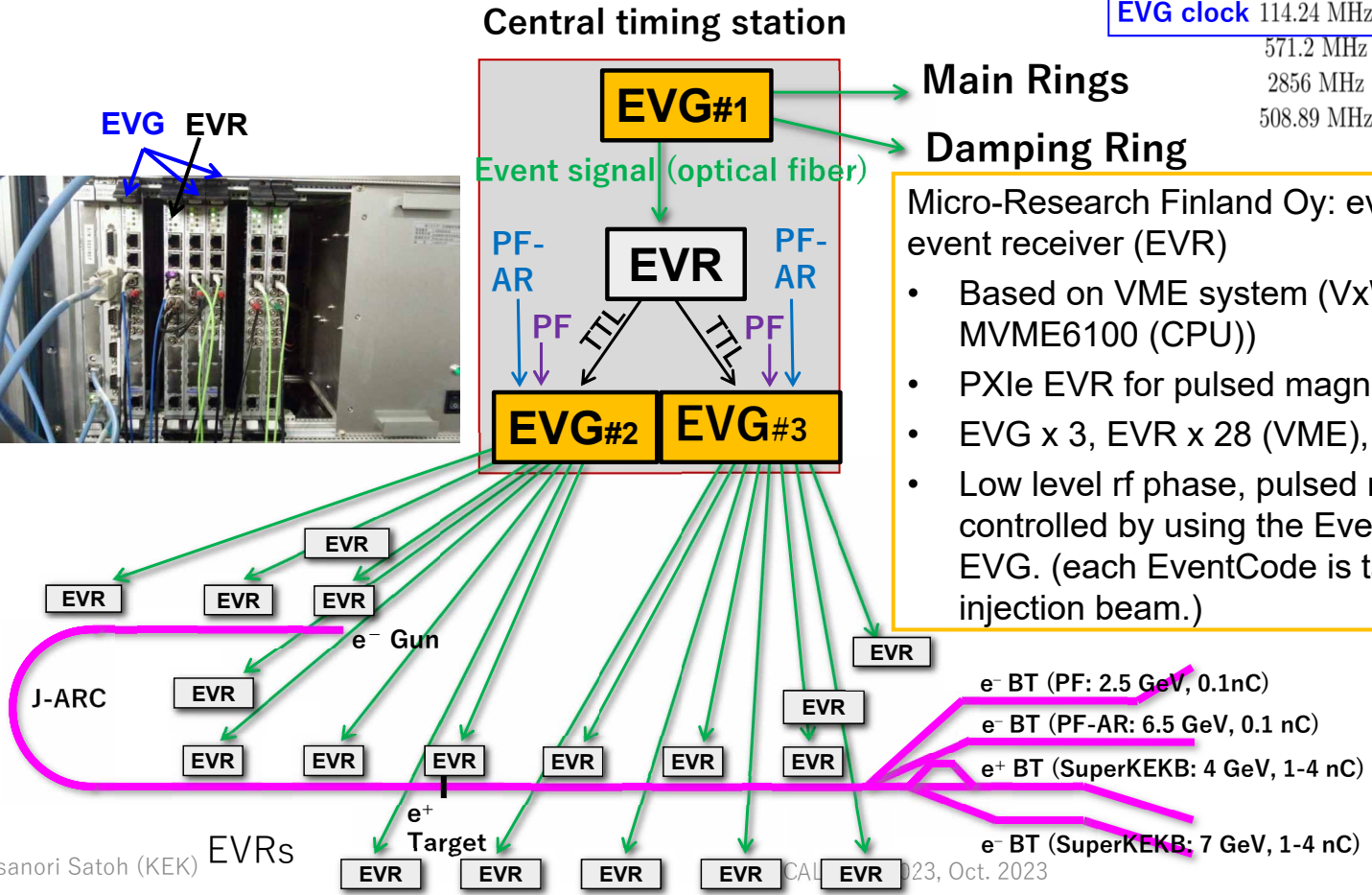
Pulsed bend

Beam switching yard
from injector to each ring beam transport line



Event Based Timing System

Frequency	Ratio	Purpose
10.385 MHz	-	RF Gun
EVG clock 114.24 MHz	x11	Linac SHB1 & RF Gun
571.2 MHz	x55	Linac SHB2
2856 MHz	x275	Linac Main RF & RF Gun
508.89 MHz	x49	DR & MR RF

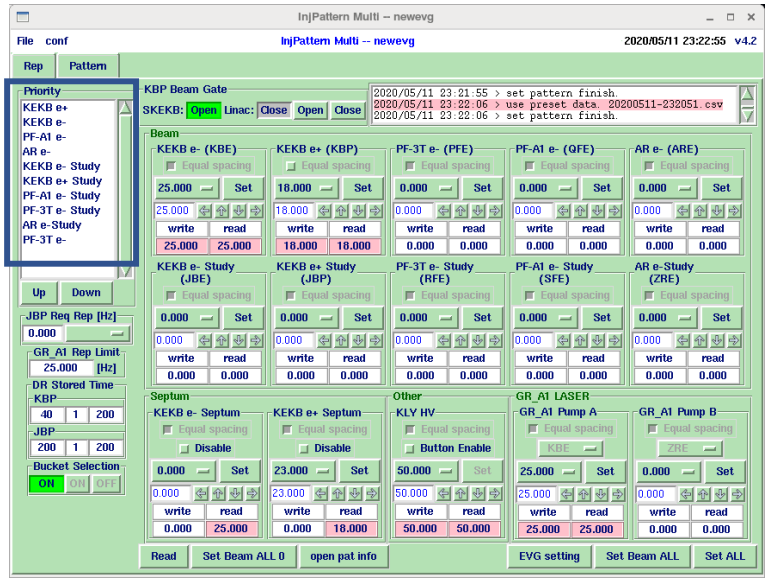


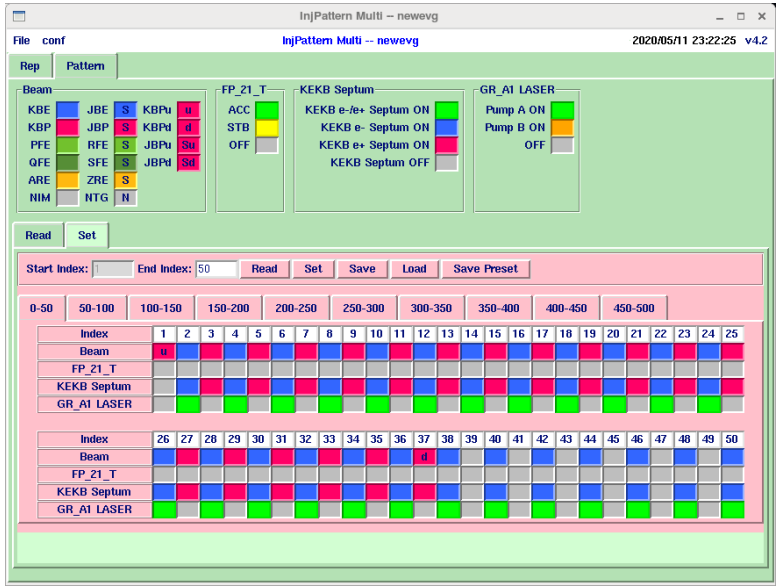
Micro-Research Finland Oy: event generator (EVG), event receiver (EVR)

- Based on VME system (VxWorks6.8 (RTOS), MVME6100 (CPU))
- PXIe EVR for pulsed magnet control
- EVG x 3, EVR x 28 (VME), x17 (PXIe)
- Low level rf phase, pulsed magnet, etc are controlled by using the EventCode distributed from EVG. (each EventCode is tagged to each ring injection beam.)

Beam Injection Pattern Generation

- **Beam repetition rate is determined by demand from each ring.**
- **Priority can be defined.**





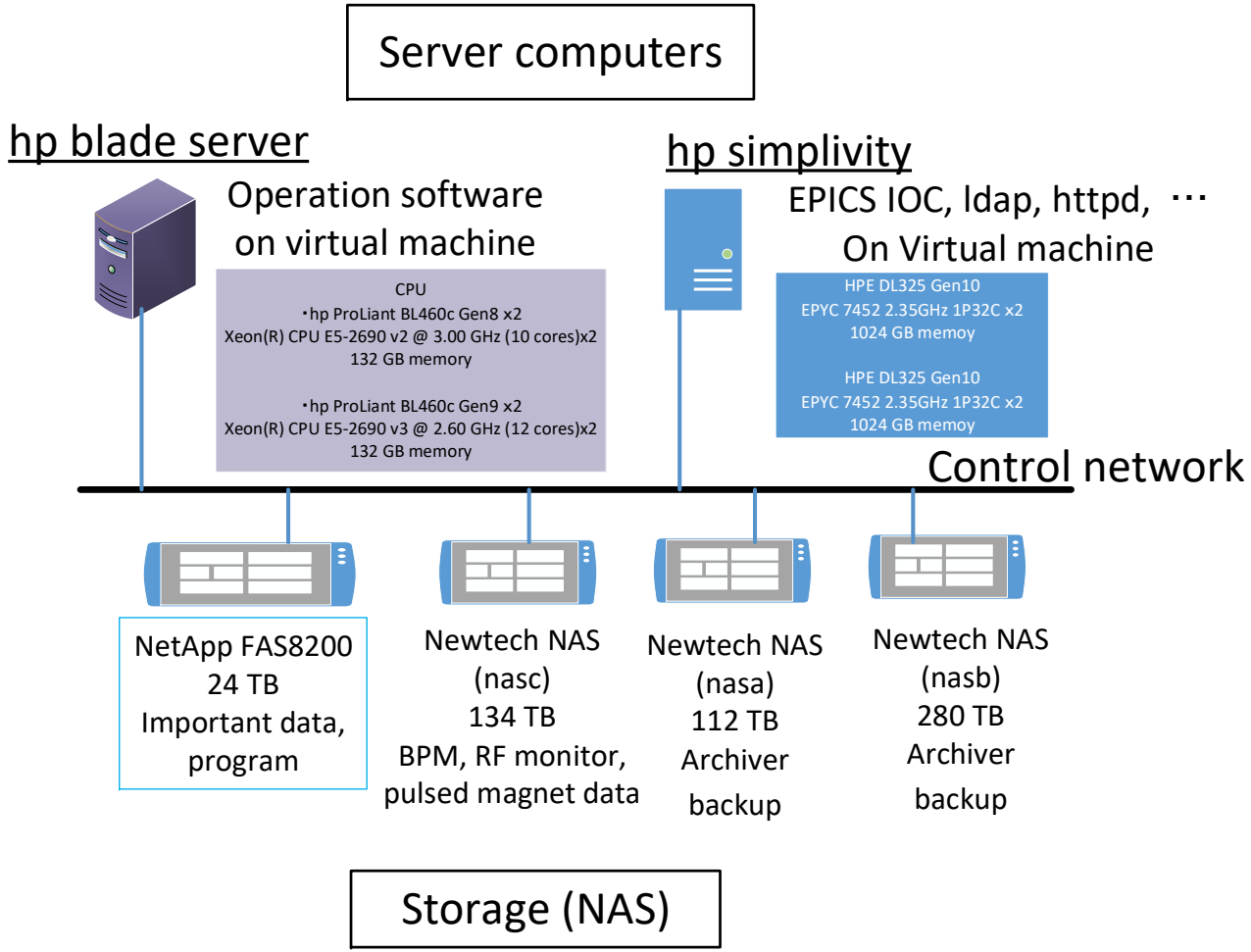
Beam repetition rate management for each beam injection mode.

Beam mode

KBE: SuperKEKB e- (HER)
KBP: SuperKEKB e+ (LER)
QFE: PF
ARE: PF-AR

Injector Linac Control System

- **EPICS based control system with HA server computers.**
- **500 IOCs are running on virtual machine.**
- **Local controller**
  - **VME**
  - **PLC**
  - **Embedded system**
  - **PXIe**



Device information system

- **The text-based database files have long been used for the device information management.**
- **They are master information for generating EPICS database files and other configuration files of LINAC control software programs.**
- **In this management scheme, it is not easy for common users except a control software expert to access and update any information.**
- **Database files: /usr/users/control/*tbl.tbl**

Screen monitor (profile monitor) related database file

file name: scrn2tbl.tbl

- Using this database file, EPICS database can be generated with shell or Python scripts.

```
! @(#) scrn2tbl.tbl dec.01.2018. version 1
!-----------------------------------------------
!
! NAME : screen name
! SECT : sector
! TYPE : deveice type
!       = 'PLC type1 (mikawa)'          1:YES, 0:NO     0000 0000 0000 0001     0001
!       = 'PLC type2 (toyotomi)'        1:YES, 0:NO     0000 0000 0000 0010     0002
!       = 'not insert/remove'           1:YES, 0:NO     0000 0000 0000 0100     0004
!       = 'TWO SCREENS'                 1:YES, 0:NO     0000 0000 0000 1000     0008
!       = 'GC Camera (GC650)'           1:YES, 0:NO     0000 0000 0001 0000     0010
!       = 'GC Camera (GC1020)'          1:YES, 0:NO     0000 0000 0010 0000     0020
! BMODE : Beam Mode
!       ='KBE'                          1:YES, 0:NO     0000 0000 0000 0001     0001
!       ='KBP'                          1:YES, 0:NO     0000 0000 0000 0010     0002
!       ='PFE'                          1:YES, 0:NO     0000 0000 0000 0100     0004
!       ='QFE'                          1:YES, 0:NO     0000 0000 0000 1000     0008
!       ='ARE'                          1:YES, 0:NO     0000 0000 0001 0000     0010
!       ='JBE'                          1:YES, 0:NO     0000 0000 0010 0000     0020
!       ='JBP'                          1:YES, 0:NO     0000 0000 0100 0000     0040
!       ='RFE'                          1:YES, 0:NO     0000 0000 1000 0000     0080
!       ='SFE'                          1:YES, 0:NO     0000 0001 0000 0000     0100
!       ='ZRE'                          1:YES, 0:NO     0000 0010 0000 0000     0200
!       ='NIM'                          1:YES, 0:NO     0000 0100 0000 0000     0400
!       ='NTG'                          1:YES, 0:NO     0000 1000 0000 0000     0800
!       ALL MODE                                                                ffff
!
!-----------------------------------------------
!separator = ' '
!keyword   = "NAME SECT TYPE BMODE"
!format    = "%s %s %x %x"
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
SC_AT_G1        A       0001    Offe
SC_AT_G5        A       0001    Offe
SC_AT_O         A       0001    Offe
SC_A1_G         A       0001    0001
SC_A1_O         A       0001    0001
SC_AS_1         A       0012    0000
SC_A1_1         A       0012    0001
SC_A1_C2_O      A       0012    0001
```

Previous database files of magnet system

Database file name	contentes
mgtbl.tbl	DC magnet controller (PLC) information
mgbasetbl.tbl	Pulsed magnet controller (PXI) information
mgpvtbl.tbl	Magnet name/EPICS PV name table
mgbtbl.tbl	DC magnet excitation curve (magnetic field)
mgktbl.tbl	DC magnet excitation curve (k value)
mgbptbl.tbl	Pulsed magnet excitation curve (magnetic field)
mgbftbl.tbl	DC magnet fudge factor
mgbfptbl.tbl	Pulsed magnet fudge factor

Contents of magnet relater database files

Excitation curve (coefficients of fitting polynomial)

```
!↓
!separator
!keyword
!format     =       "%s %lf %d %lf %lf %lf %lf %lf %lf %lf %lf %lf"↓
!↓
BM_AT_J1 0.7461977 7 2.0648E-03 5.5384E-03 4.0852E-05 -1.3193E-06 1.9443E-08 -1.4039E-10 4.7789E-13 -6
BM_AT_J5 0.7440547 7 1.46581E-03 5.47120E-03 3.63971E-05 -1.05224E-06 1.44002E-08 -9.72086E-11 3.06191
BX_AT_0 0.008407342 1 0 0.001681468 0 0 0 0 0 0 0 0↓
BY_AT_0 0.008407342 1 0 0.001681468 0 0 0 0 0 0 0 0↓
BM_16_C1 0.338602 7 1.194185E-03 5.559374E-03 1.291535E-05       -1.304585E-06 7.828253E-08 -2.346886E-
BM_16_C2 0.338113 7 1.067642E-03 5.533907E-03 2.635390E-05       -3.009850E-06 1.676876E-07 -4.626279E-
BM_16_C3 0.338711 7 1.192142E-03 5.565421E-03 1.407860E-05       -1.831112E-06 1.190518E-07 -3.622459E-
BM_16_C4 0.337909 7 1.196444E-03 5.484598E-03 3.062452E-05       -2.999390E-06 1.579246E-07 -4.299464E-
```

Pulsed magnet information

```
!----------------------------
!separator = ' '
!keyword   = "NAME NODE CASE CH OPE
!format    = "%s %s %s %d %x"
!
!NAME       NODE            CASE  CH OPE
!-------------------------------------
!
PF_13_5     ACC-PM-PC-1     1EB   0  1
PD_13_5     ACC-PM-PC-1     1EB   1  1
PX_13_5     ACC-PM-PC-1     1EB   2  1
PY_13_5     ACC-PM-PC-1     1EB   3  1
PY_12_2     ACC-PM-PC-1     1EB   4  1
PX_13_2     ACC-PM-PC-1     1EB   5  1
```

File header (Changelog)

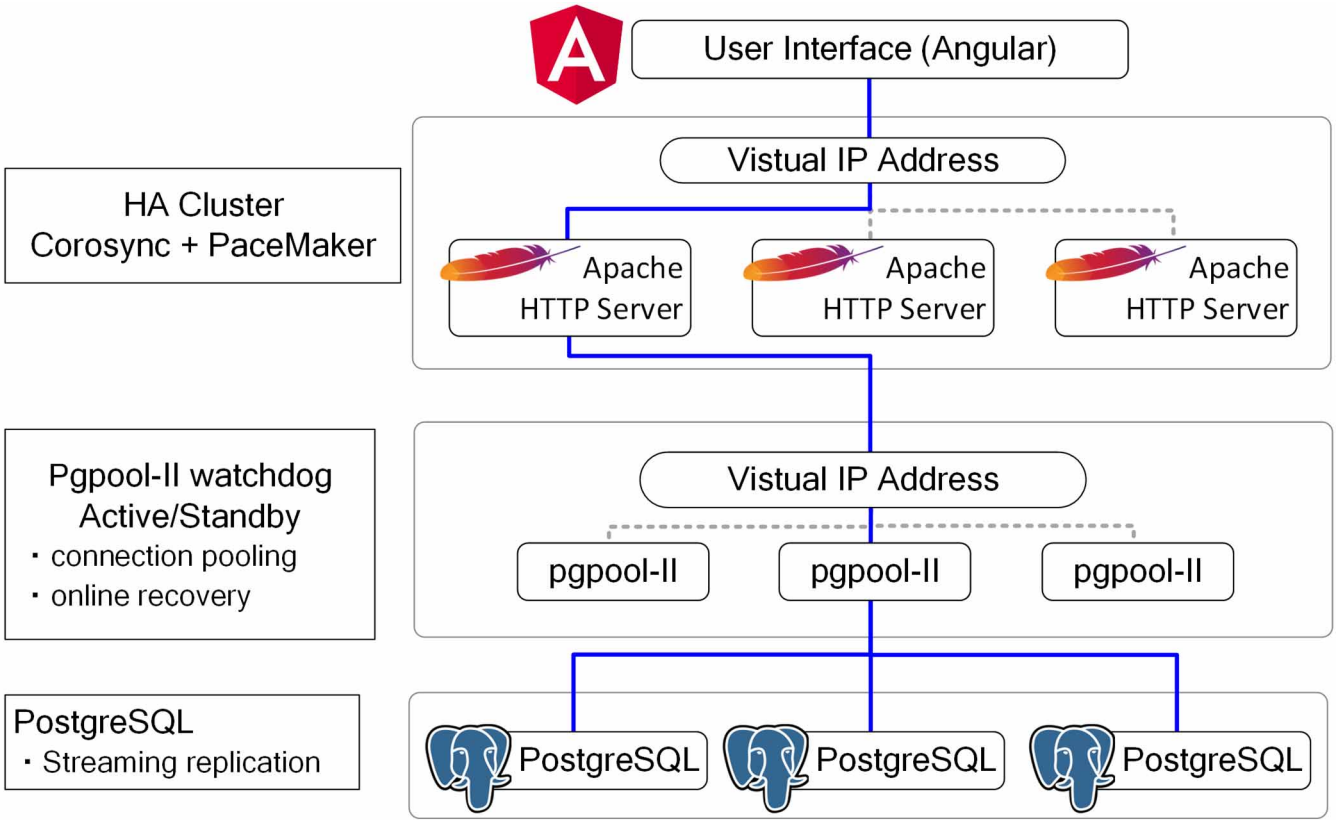
```
!                   .06.2019 modified MAX cur
!                            PX_13_5 5.5 -> 8.0, PY_13_5 1.5
!                            PX_13_2 5.5 -> 8.0, PX_17_4 1.5
!                            PX_18_4 2.0 -> 6.0, PY_18_4 2.0 -> 8.0, PX_21_4 2.0 -> 6.0,
!                            PY_21_4 1.5 -> 6.0, PY_24_4 2.0 -> 8.0, PX_24_4 2.0 -> 8.0
!    t.k, Sep.10.2019 BM_RO_1/6 MAX 265 -> 349
!    t.k, Jan.10.2020 modify pulsemagnet READ_W IWRITE -> READ_W
!    t.k, Jan.22.2020 FB 0 -> 1
!                            BM_RO_1/6, BM_RO_2/3/4/5,
!                            SL_15_T, SL_15_11, SL_16_11, SL_16_22, SL_16_33,
!                            BM_61_1/6, BM_61_2/5, BM_61_3/4, BM_61_A1, BM_61_A2/3
!    t.k, Feb.27.2020 comment out BM_61_AS, BS_61_AS
!    t.k, Jul.07.2020 QD_AT_J2,J3,J4 MAX 35 -> 100
!    t.k, Sep.02.2020 QD_AT_J2, QF_AT_J3, QD_AT_J4 OFF 00FE -> 0076
!                            remove QF_13_5, QD_13_5, QF_23_44
!                            add BY_A1_C4, PX_13_52, SX_15_15, SX_15_25, SY_16_15, SX_16_25
!    t.k, Sep.14.2020 BY_A1_C4,SX_15_15,SX_15_25,SY_16_15,SX_16_25 ON 0001 -> 00FF
```

New magnet information management system

- **To improve the usability of magnet database, a web-base application was developed.**
- **For non-software experts, it is not easy to update the database and check the present status.**
- **Multiple database files are consolidated into PostgreSQL.**
- **By using web application GUI, non experts can easily operate the database.**

System diagram

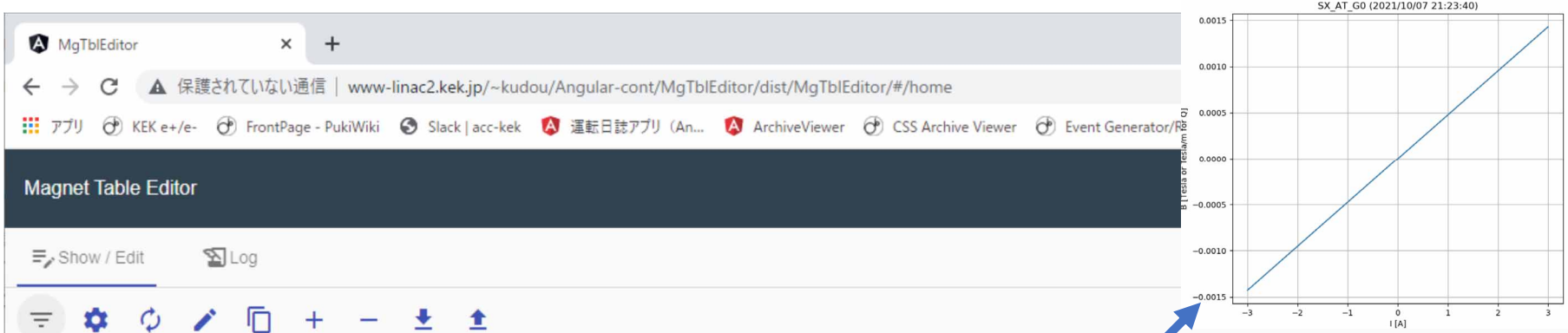
- **Angular (UI), PostgreSQL (database), HA cluster (Corosync, PaceMaker)**



Functionality

- The access control of the database can be managed using the already existing Lightweight Directory Access Proto-col (LDAP) server at LINAC. (read only or read-and-edit access)
- Data can be easily edited (modify, add, delete data) directly within the web browser by the allowed user.
- The bulk import/export data with the CSV file format. (all data or the selected data)
- 600 magnet information are registered. Each magnet information has 100 data column components. (magnet name, power supply specification, ….)

Web application main page (after authentication with ID/password)



	電磁石名称	電源名称	情報更新日	情報更新者	磁場有効長 [m]	磁場近似テー...	磁場近似テー...	磁場近似テー...	磁場近似式
1	ML_AT_G0	ML_AT_G0	2021-09-24 12...	TPさん	0.024731	2021-09-24 12...	http://www-lina...		区間[A]:0～3, 多項式係数: [0.00000000E+00,1.70884
2	SX_AT_G0	SX_AT_G0	2021-09-27 22...	TPさん	0.05796	2021-09-27 22...	http://www-lina...		区間[A]:-3～3, 多項式係数: [0.00000000E+00,2.7588 区間[A]:3～6, 多項式係数: [0.00000000E+00,2.75889
3	SY_AT_G0	SY_AT_G0	2021-09-10 00...	紙谷	0.05796	2021-09-24 11...	http://www-lina...		区間[A]:-3～3, 多項式係数: [0.00000000E+00,2.7588
4	ML_AT_G1	ML_AT_G1	2021-09-10 00...	紙谷	0.02473	2021-09-24 11...	http://www-lina...		区間[A]:0～3, 多項式係数: [0.00000000E+00,1.70884
5	SX_AT_G1	SX_AT_G1	2021-09-10 00...	紙谷	0.04196	2021-09-24 11...	http://www-lina...		区間[A]:-3～3, 多項式係数: [0.00000000E+00,4.7554
6	SY_AT_G1		2021-09-10 00...	紙谷	0.04196	2021-09-24 11...	http://www-lina...		区間[A]:-3～3, 多項式係数: [0.00000000E+00,4.7554
7	SL_AT_G1		2021-09-10 00...		290267	2021-09-24 11...	http://www-lina...		区間[A]:0～35, 多項式係数: [0.00000000E+00,7.7925
8	SL_AT_G2		2021-09-10 00...		290267	2021-09-24 11...	http://www-lina...		区間[A 925
9		SL_AT_G3/4		紙谷	0.290267	2021-09-24 11...	http://www-lina...		区間[A 925
10		SL_AT_G3/4		紙谷		021-09-24 11...	http://www-lina...		区間[A]:0～35, 多項式係数: [0.00000000E+00,7.7925
11		SX_AT_G4		紙谷		021-09-24 11...	http://www-lina...		区間[A]:-5～5, 多項式係数: [0.00000000E+00,8.6366

PS name

user name

magnet name

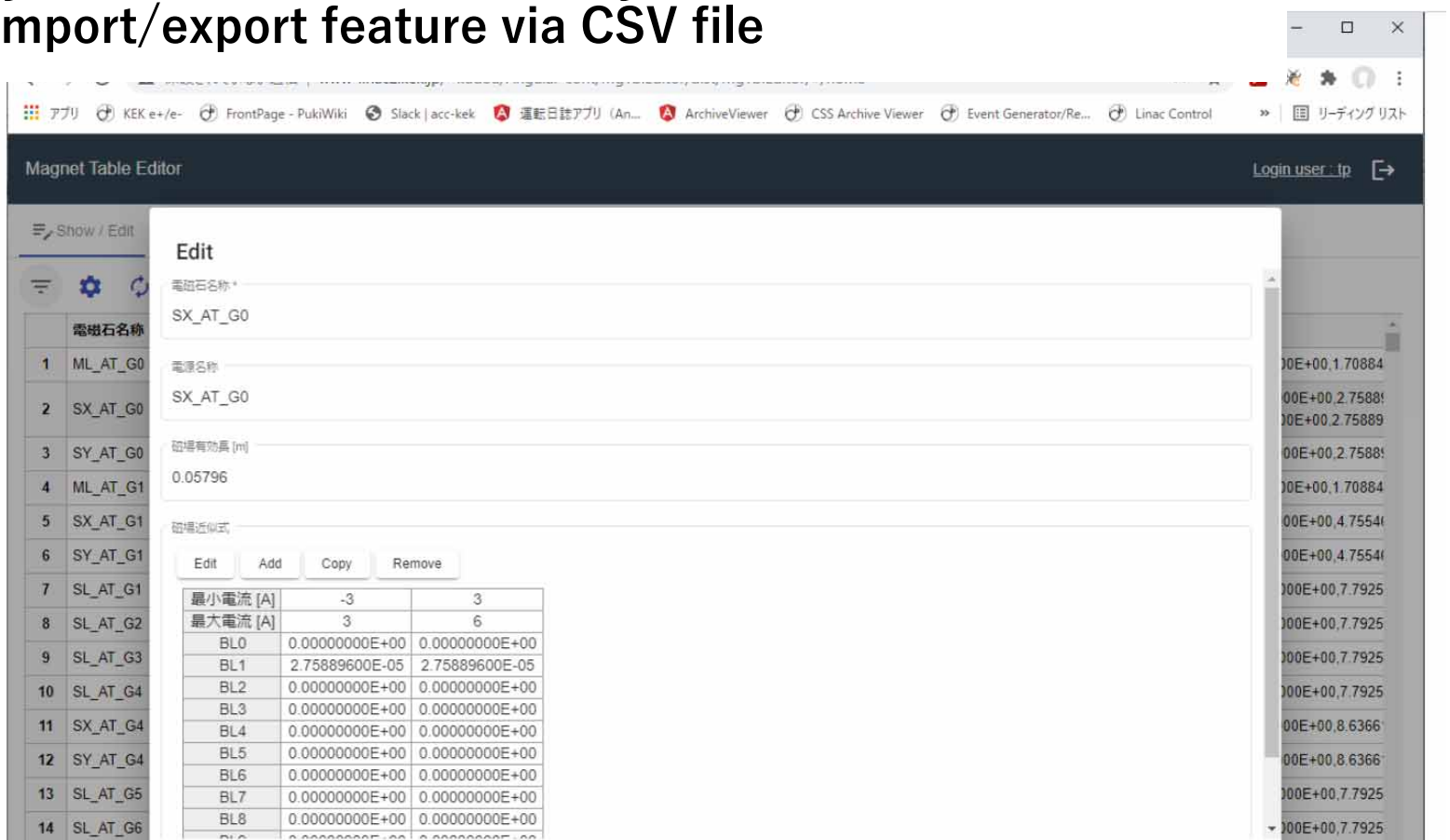
last update

manet effective length

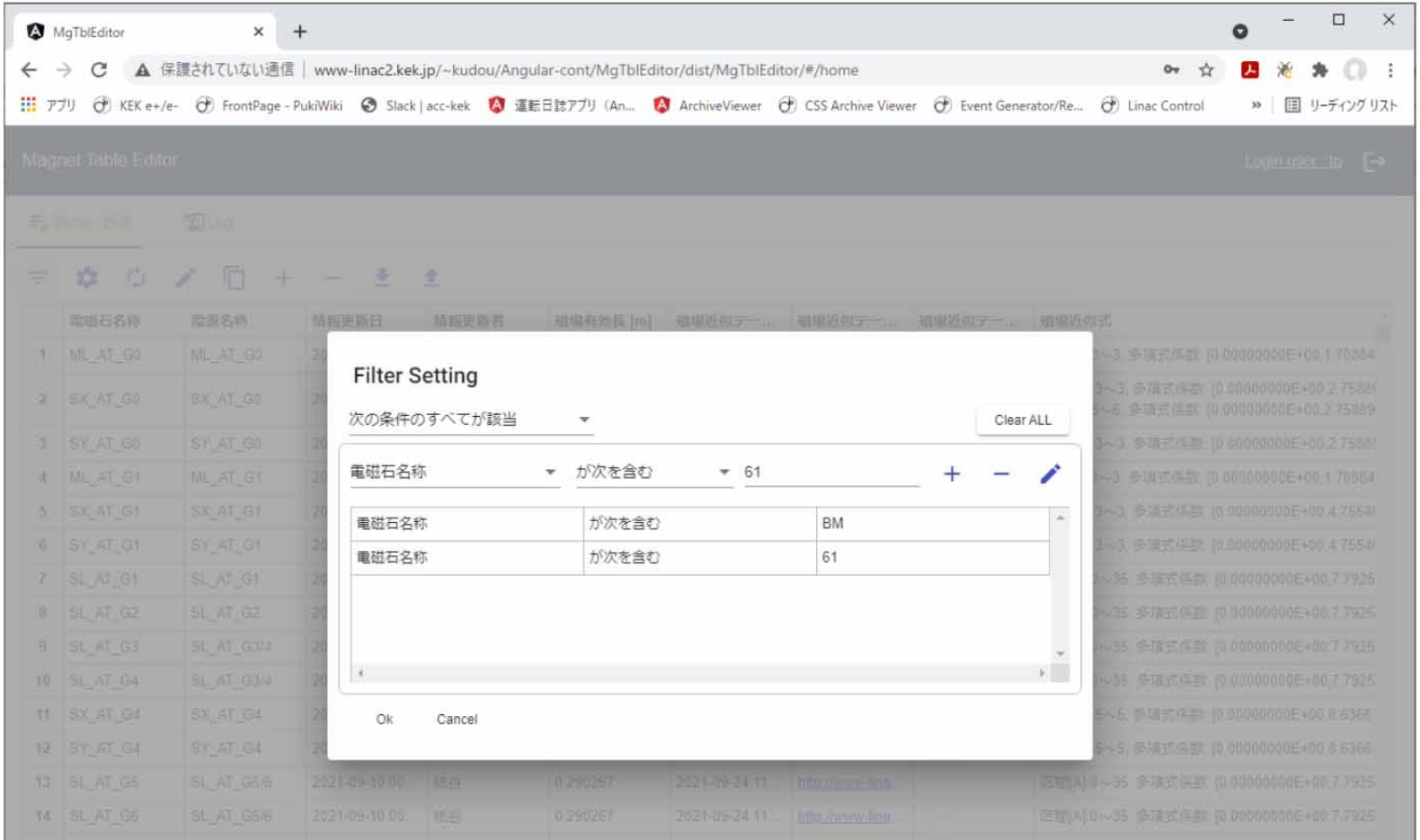
excitation curve coefficients

Edit page

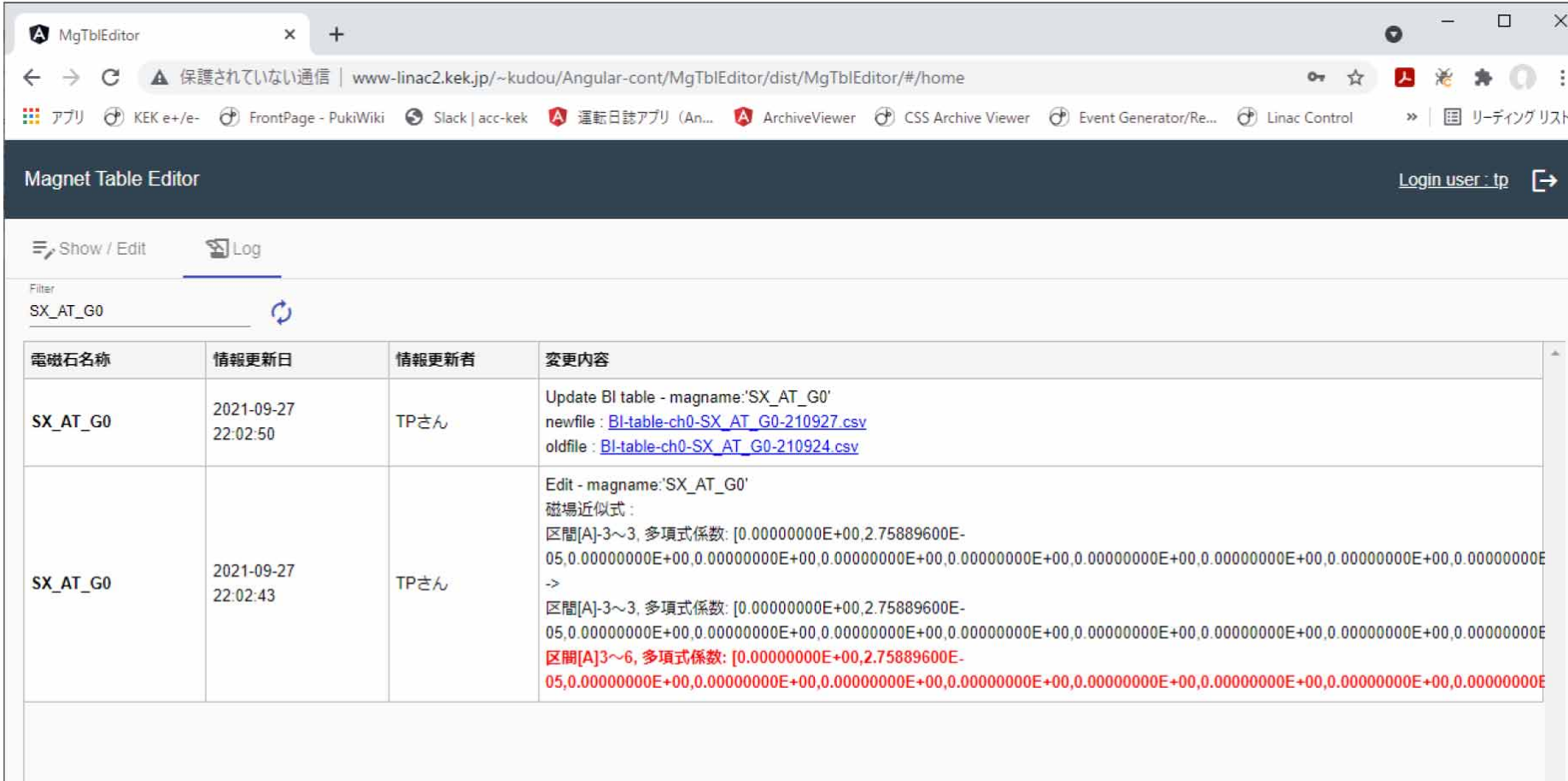
- Modify/Add/Delete items directly within the web browser
- Bulk import/export feature via CSV file



Filtering setting



Changelog



電磁石名称	情報更新日	情報更新者	変更内容
SX_AT_G0	2021-09-27 22:02:50	TPさん	Update BI table - magname:'SX_AT_G0' newfile : BI-table-ch0-SX_AT_G0-210927.csv oldfile : BI-table-ch0-SX_AT_G0-210924.csv
SX_AT_G0	2021-09-27 22:02:43	TPさん	Edit - magname:'SX_AT_G0' 磁場近似式 : 区間[A]-3～3, 多項式係数: [0.00000000E+00,2.75889600E-05,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E ->区間[A]-3～3, 多項式係数: [0.00000000E+00,2.75889600E-05,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E 区間[A]3～6, 多項式係数: [0.00000000E+00,2.75889600E-05,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E+00,0.00000000E

Summary

- **The text-based database files have long been used for the device information management. (generating EPICS database files and other files required for control software programs)**
- **In the new magnet information management system, the multiple database files are consolidated using PostgreSQL. The complexity of managing these database files is markedly reduced.**
- **Non-software experts can easily modify the data-base using the operational interface of the web application developed by Angular.**
- **We will expand this system to other device information management (accelerating structure, klystron, and a beam monitor).**

Thank you for your attention!