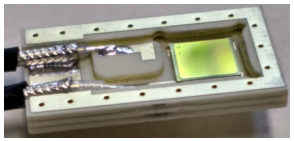
UNIVERSITÀ DEGLI STUDI DI TRIESTE
Dipartimento di Fisica
Department of Physics

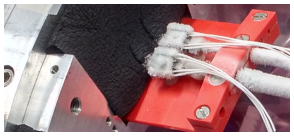
Monitors & Interlocks Update

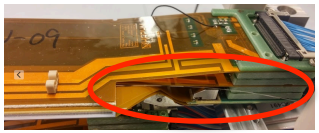
L.Lanceri for the Trieste group

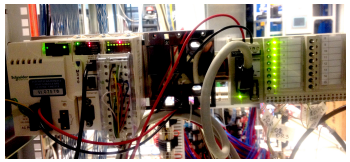
VXD Workshop, Santander, 14/09/2016

1. Radiation & Beam Abort
2. NTC & FOS Temperature
3. Dew Point Sniffers & Interlocks









Outline

This is a short summary of recent progress and to do lists,
highlighting issues related to "slow control integration and interlocks"
(see next slides, added after the discussion)
about 2 months after the following reports at the June 2016 24th B2GM:

- L. Vitale, VXD Monitor Status

(BEAST2 Phase 2 session, 20/06/2016)

- C. LaLicata, BEAST-II: Diamond Sensors, Results of Dedicated BEAST Runs

(BEAST2 Phase 1 session)

- L. Lanceri, VXD Monitors Commissioning Plans

(Installation & Commissioning session)

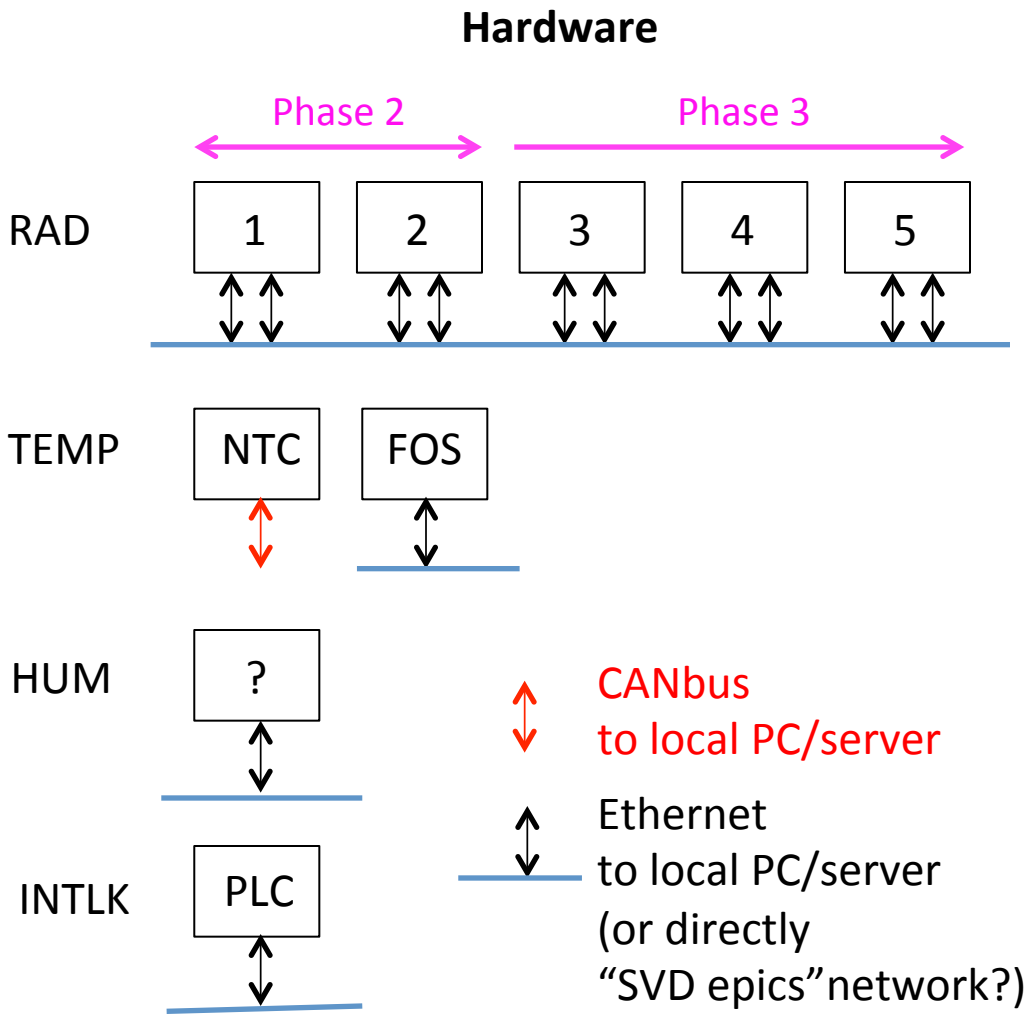
- L. Lanceri, VXD Local Hardwired Interlocks

(Slow Control and Interlocks session, 22/06/2016)

At the end, a summary of scheduling/required presence at KEK is discussed

SLOW CONTROL INTEGRATION OF MONITOR & INTERLOCKS

Mon./Intlk. Integration in Slow Control



	Software IOC	Manpower	Schedule
RAD	not yet	S.B. + …	1st sem. 2017
TEMP	Yes prototypes	S.B. + …	"now"
HUM	not yet	S.B. + …	1st sem. 2017
INTLK	Yes test	S.B. + …	"now"

SC Integration – comments - 1

- MON

  hardware:

  - Prototype box (HV, ADC, abort for 4 sensors) exists, fully tested in BEAST2 Phase 1
  - 2 Ethernet connections per box: one for continuous monitoring (4 currents digitized and sampled at 10 Hz), the other for initialization commands and full memory dump for post mortem studies after beam aborts (not frequent…!)
  - EPICs IOC must be outside (only FPGA inside the box)

  software:

  - LabView program at present. The communication protocol with the FPGA will be translated into an EPICS IOC dealing with 5 x 4 = 20 diamond sensors
  - The IOC has to take care of:
    - initialisations (uploading abort thresholds, SuperKEKB running conditions flags),
    - pedestal measurements and archive,
    - continuous monitoring at 10 Hz and full buffer memories readout after beam aborts,
    - in both cases, with pedestal subtraction and conversion from measured currents to dose rates, applying calibration constants

SC Integration – comments - 2

- TEMP

  hardware:

  - Final NTC readout box existing; read-out via CANbus
  - Final FOS interrogator existing with Ethernet interface

  software:

  - NTC: prototype IOC existing and tested at DESY beam test
  - FOS: IOC existing and used at DESY beam test for a similar interrogator by the same manufacturer; adaptations probably needed to take care of more fibers and multiplexing

- HUM

  hardware:

  - Development (Dew Point digitization and gas flow control) just started. In principle the readout could be based on a linux board including the IOC

  software:

  - The IOC should provide the 4 Dew Point measurements, some additional measurements for each sniffer (gas flow, pressure)

SC Integration – comments - 3

- INTLK

  hardware:

  - Schneider PLC, available, with digital I/O module and analog input modules
  - Interlock inputs and outputs: preliminary specifications are under discussion
  - Programmed via USB interface, development system from Schneider
  - A memory section can be accessed from outside and used for monitoring
  - Ethernet connection available

  software:

  - Communication via Ethernet using Modbus protocol in EPICS: tested and working
  - Can be used for an EPICS IOC, monitoring the status of PLC (to be developed)

- Manpower and schedule (general)
  - Main contributions up to now by Szymon Bacher
  - Szymon visited Trieste lab in August (substantial progress!); more visits and work planned in 2016 and 1st semester 2017
  - We started building up local expertise (…) on EPICS and PLC programming

RECENT PROGRESS
AND TO DO LIST UPDATES

Radiation Monitor & Beam Abort

- Recent progress (after 24th B2GM)

  BEAST2 Phase 1:

  - BEAST2 Phase 1 CVD sensors (4) re-calibrated with β source (current vs distance), with a new automated procedure
  - More data-analysis and documents-writing work is ongoing (see Hawaii mini-workshop)
  - The overall performance (4 sensors + prototype electronics) and stability in several months of uninterrupted running is very good, noise under control for aborts

  For the next Phases:

  - 12 new sCVD sensors from CIVIDEC packaged and I-V tested in the dark
  - The streamlined procedures (α source-TCT and β source-current vs distance) are ready for systematic production tests
  - The final electronics design optimization has started, on track for the pre-production of 2 readout final readout boxes for Phase 2 (8 sCVD sensors)
  - paperwork for the purchase of electronics components by Elettra: finally OK

Radiation Monitor & Beam Abort

- To do

  BEAST2 Phase 1:

  - BEAST2 Phase 1 data analysis: comparisons with simulations and PiN-diodes, for the instantaneous and integrated dosimetry
  - Calibration procedure systematics: more FLUKA simulations, comparisons with measurements of the currents in a Si sensor with the same packaging

  For the next Phases:

  - Continuation of the new CIVIDEC sCVD sensors packaging and tests/calibrations
  - Systematic database recording of test/calibration results
  - Activation of a KEK C-type account, purchase of Phase 2 long (docks to E-hut) coaxial cables
  - Phase 2 coaxial cables installation (schedule update?)
  - Specification of the required power in the E-hut racks (to Itoh-san)
  - (PC) server purchase, SVD network connections (2017 budget, see Christian)
  - Development of EPICS IOC control software (Szymon + new local manpower)

NTC & FOS Temperature Monitors

- Recent progress (after 24th B2GM)

NTC:

- (the readout system is operational with EPICS IOC since the last DESY beam test, and other LabView debugging software is also available)
- CentOS 7 linux PC now installed in our lab, with EPICS software and NTC IOC by Szymon.

FOS:

- Optimization of the calibration procedure in the climate chamber (timing, temperature cycles, fibres positioning) using a reference fibre temperature sensor

NTC & FOS Temperature Monitors

- To do

NTC:

- The CO_2 cooling system requested 12 readout channels for NTCs to be located at the Docks; we have these spare channels in the present readout system, but: need to reconsider the grouping of NTC sensors and their patch panels; additional long cable
- Prepare and test/calibrate in the lab the about 60 NTCs for the SVD ladder mount
- Participation in the ladder mount (tests of the installed NTC sensors)
- Prepare and install the long cables for Phase 2

FOS:

- Calibration of the 50 available fibers in time for the ladder mount
- Systematic database recording of test/calibration results
- Participation in the ladder mount (tests of the installed FOS sensors)
- Purchase and test the additional fibers for the outer cover
- Phase 2: install the fibers (SVD cartridge) and “patch cord” from Dock to E-hut

Both:

- Required power in E-hut, EPICS IOC (server shared with Radiation monitor?)

Dew Point Monitor and Interlocks

- Recent progress (after 24th B2GM)

  Dew Point "Sniffer":

  - Digitization of the data from the Vaisala Dew Point Transmitter using the Schneider PLC with an Analog Input interface module
  - PLC interfaced with EPICS (Modbus protocol over Ethernet) by Szymon
  - New manpower! a colleague with expertise in sensors and data acquisition programming recently started to work on this item
  - Calibration system (DewGen, DewMaster) riconfigured with dedicated N_2 bottle and copper pipes for better humidity

  Interlocks:

  - I received some feedback on interlocks specifications (Michael Ritzert, Hans-Günther Moser)
  - New manpower! A new postdoc is willing to spend a fraction of his time on PLC programming (he started already)
  - PLC – EPICS communication activated (see above)

Dew Point Monitor & Interlocks

- To do

Dew Point "Sniffer":

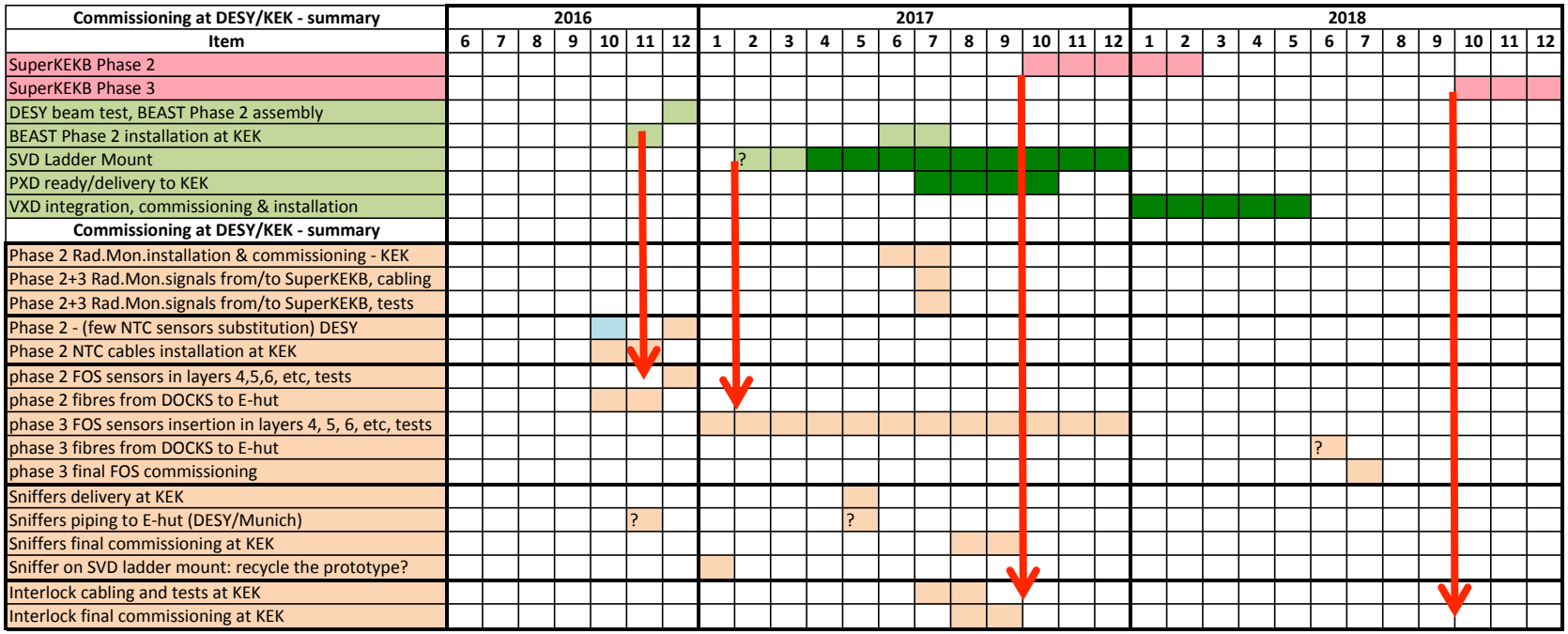
- More tests on the calibration system, with improved Cu piping and data recording from DewMaster and Vaisala Dew Point Transmitter
- Improve the prototype with computer (PLC) – controlled flowmeters and valves, completely automated for Phase 1
- Purchase additional components, in particular 3 more Vaisala sensors
- Build final system with 4 sniffers for Phase 2

Interlocks:

- Finalize the specifications, with the list of connections and signal types
- Organize the corresponding cabling connections
- First PLC program implementation, with simple interlock conditions, for initial tests with interlock sources, using the Schneider program development system on a Windows PC
- EPICS IOC on the linux PC, monitoring PLC variables

Both: installations at KEK for Phase 1 and Phase 2

Summary of commissioning at KEK



Lab activities at INFN Trieste
Installation and commissioning at DESY or KEK

Driving deadlines:

2016, November, DESY Beam Test & Phase 2 VXD Assembly

2017, February, beginning of SVD Ladder Mount

2017, October, beginning of Phase 2

2018, October, beginning of Phase 3

Ideal presence at KEK in 2017

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22	VXD workshop			?																																?												
23	Physics, computing workshops																						?															?											

First rough exercise on the ideally required presence from Trieste at KEK in 2017
(see list of activities and their ID numbers in the next slide)

Our INFN travel budget (under discussion) will probably cover about 50% of this
We will have to identify the most critical periods and contributions
(Sensor testing periods during installation, for instance)

Activities IDs

ID	Attività
1	Phase 2 Rad.Mon.installation & commissioning - KEK
2	Phase 2+3 Rad.Mon.signals from/to SuperKEKB, cabling
3	Phase 2+3 Rad.Mon.signals from/to SuperKEKB, tests
4	Phase 2 - (few NTC sensors substitution) DESY
5	Phase 2 NTC cables installation at KEK (+ other cables)
6	phase 2 FOS sensors in layers 4,5,6, etc, tests
7	phase 2 fibres from DOCKS to E-hut
8	phase 3 FOS sensors insertion in layers 4, 5, 6, etc, tests
9	phase 3 fibres from DOCKS to E-hut
10	phase 3 final FOS commissioning
11	Sniffers delivery at KEK
12	Sniffers piping to E-hut (DESY/Munich)
13	Sniffers final commissioning at KEK
14	Sniffer on SVD ladder mount: recycle the prototype?
15	Interlock cabling and tests at KEK
16	Interlock final commissioning at KEK
17	Phase 2 running shifts
18	Phase 2 commissioning

BACK-UP SLIDES
FROM THE 24TH B2GM

Numbers of Sensors

Subsystem	Phase 1/Beam Test Sensors	Phase 2 Sensors	Phase 3 Sensors (Spares)
Diamonds	4	8 new	20 new (1+4 phase1)
NTC	26	26*	56 (~60)
FOS	1 spare fiber	4+2 new fibers	38+2 (12+1)
Dew Point	1	1+3	1+3
PLC	1	1+R/O modules	1+R/O modules

* Some are different because the mechanical supports will change

Cables from Sensors to DOCKs

Subsystem	Phase 1/Beam Test	Phase 2	Phase 3 (Spares)
Diamonds 2.5 m	8	16	40
NTC 2.5 m	4 x 32	Same as BT Small modifications	4 x 32 new
FOS 2.6/2.7/2.8 m	1 Fiber	4+2	38+2 (12+1)
Dew Point	1	1+3	1+3
PLC	NA	NA	NA

Cables from DOCKs to E-hut

Subsystem	Phase 1/Beam Test	Phase 2	Phase 3 (Spares)
Diamonds 30 m	8 (2)	10+6 (4)	10+30 (4)
NTC 30 m	2 x 68	Same as BT	3 x 68 new (Vienna)
FOS 35 m	1 patch cord	4+2	38+2 (10)
Dew Point Copper tube (MPI)	1	4	4
PLC	NA	NA	NA

Readout Modules

Subsystem	Phase 1/Beam Test	Phase 2	Phase 3 (Spares)
Diamonds Elettra	1x4ch prototype Validated	2 final	5 (1)
NTC Trieste	3 modules x32ch Validated	3x32ch	3x32ch (3^{rd} unit)(+1)
FOS Interrogator	Santander	1 interrogator 16chx4splitters	Same interrogator (1)
Dew Point PLC module	1 Validated	1 +3	1+3 same as ph2 (2)
PLC Schneider	1	1+extra modules	1+extra modules

Moreover “some” readout must be available during assembly for tests

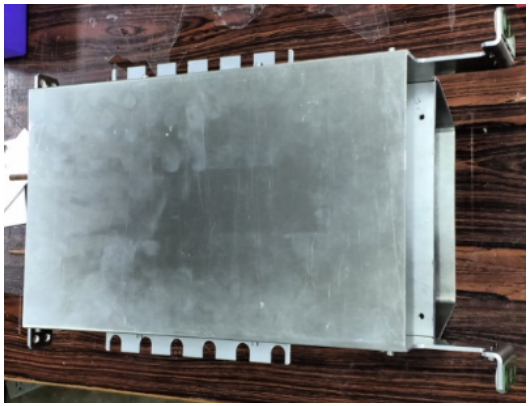
Radiation & Beam Abort - 1

Sensors: (INFN Trieste)

8 diamond sensors (4 FW, 4 BW, on beam pipe)

16 thin coaxial cable (2.5 m) with SMA connectors from sensors to DOCKs

These sensors have already been mounted on the package with final cables and are under test now



DOCKs: (Florian/Tschalie)

SMA-BNC connectors (INFN Trieste): available

Patch panels and Integration in SVD FW and BWD DOCKs:

Checked with Florian on June 19

Cables from DOCKs to E-hut (INFN Trieste)

coaxial cables (Huber Suhner S_04162-B60 5.5 mm ⌀) with BNC connectors 8 FW, 8 BW; slot assignment: see back-up slides Livio's presentation

- From DOCKs to E-hut F2, rack#F-4 (see back-up slides): ~30m length
- Plan to re-use 10 phase1 cables, other cables to be purchased asap via KEK.

Cable path: slots in outer detector octants already assigned.

Installation test in July (Shuji) after dismounting phase 1 cables.

Install phase 2 cables (October-December 2016); re-use and re-install phase 3

Radiation & Beam Abort - 2

Racks:

Rack #F-4 in F2 (assignment confirmed Feb.2016, S.Uehara and R.Itoh)

- Phase 2: 2 "readout and abort boxes" + 1 for ladder mount tests (INFN Trieste)
- 1 dedicated Ethernet switch, at least 11 connectors (INFN Trieste)

Rack #F-3 in F2 (assignment confirmed Feb.2016, S.Uehara and R.Itoh)

- 1 rack-mounted PC (INFN Trieste)
- keyboard and monitor (INFN Trieste)
- 1 NIM crate for test/debugging/signal conversion etc (to be requested to Itoh-san)

Power:

Rack #F-4 in F2

- 6 + 2 (spare) power connections low power (to be quantified), request to Itoh-san

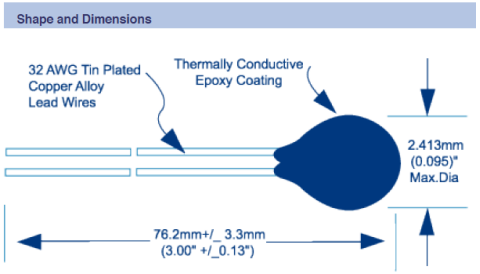
Rack #F-3 in F2

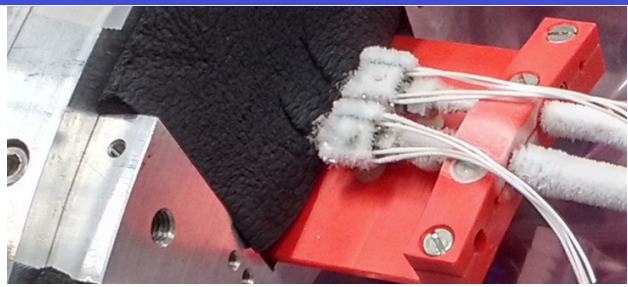
- 4 + 2 (spare) power connections low power (to be quantified), request to Itoh-san

EPICS Network:

Rack #F-3 in F2 (SVD network)

NTC Temperature - 1





Sensors (INFN Trieste)

Phase 2: 26 NTC sensors, with twisted pairs, already installed (VXD cartridge) with the final readout system (for up to 96 sensors). All available

DOCKs

Patch panels (INFN Trieste) in FW/BW DOCKs (Vienna)

DOCKs: checked with Florian on June 19

Cables from DOCKS to E-hut (INFN Trieste)

2 Flat Twisted-pair multi-conductor ribbon cables; 32.0x1.0 mm^2 - same as SVD signal cables - with KELL connectors:

from DOCKs to E-hut F2, Rack#F-2 All available

Install the two phase-2 cables (Oct. – Dec. 2016)

Cable path: slots in outer detector octants

NTC Temperature - 2

Racks:

Rack#F-2 in F2

- Phase 2 and 3: 1 readout box with 3 ELMB boards (INFN Trieste), with CANbus connection to EPICS IOC (Slow Control configuration: similar to DESY BT)
- PC (INFN Trieste) for NTC, FOS, Humidity and interlock tests/readout) (connected with EPICS via network), with screen/keyboard
- PLC (INFN Trieste) for interlocks

Power:

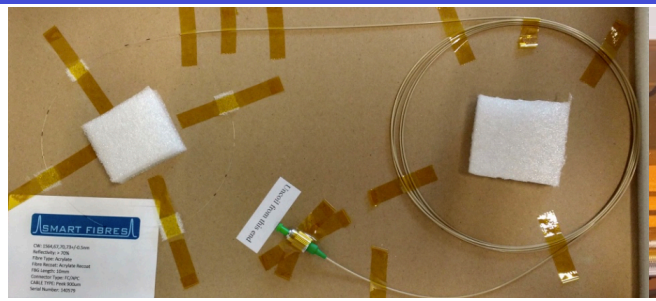
Rack #F-2 in F2

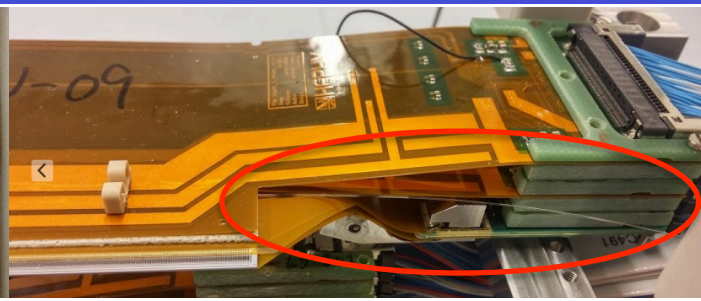
- 5 + 2 spare power connections low power (to be quantified), request to Itoh-san

Network:

- CANbus to EPICS IOC (see above)
- Ethernet for PC and PLC (SVD network)

FOS Temperature - 1





Sensors (INFN Trieste)

Phase 2: Now only 1 prototype fiber in the cartridge, layer 6;
install 3 in L6, L5, L4, + 2 on the SVD outer cover (new request agreed on June 19)
All layers fibers available, now under calibration/test, outer cover fibers to be purchased

DOCKs:

Patch panels FC/APC-FC/APC (INFN Trieste) in BW DOCK
In ph.2 only few connections: temporary solution agreed with Florian on June 19

Cables:

Optical fibers from BW DOCKs to splitters in F2, Rack#F-2.
Optical fibers patch cords 1.4 mm ⌀. Already available
Request to install all fibers from DOCKs to F2 before phase 2 (Oct.-Dec. 2016)

FOS Temperature - 2

Racks:

Rack#F-2 in F2

- Crate for splitters (INFN Trieste) Crate and splitters already available
- Interrogator unit (INFN Trieste) Already available 1 unit (spare to be purchased)

Power:

Rack #F-2 in F2

- 1 + 2 spare power connection low power (to be quantified), request to Itoh-san

EPICS Network:

1 Ethernet connection for the interrogator (SVD network).

Dew Point Sniffers

Sensors: 4 Vaisala DMT242B Dew Point Transmitters (INFN Trieste)
1 available and tested, 3 to be purchased

Cables/pipes: (DESY/Munich)
4 Cu pipes (4 or 6 mm ⌀) from the VXD dry volumes to E-hut Rack #F-1 in F2

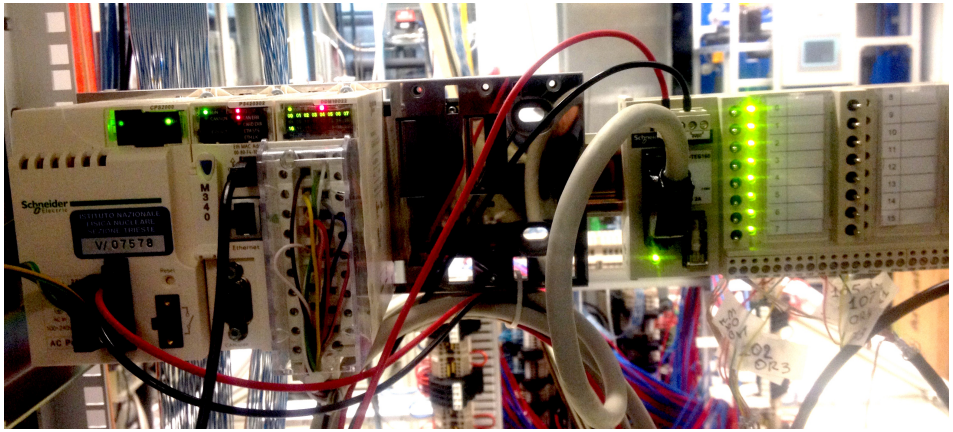
Racks:
Rack#F-1 in F2
- panel with sensors, flow meters, pump, etc (INFN Trieste)

Rack#F-2 in F2
- Same PC as NTC (connected with EPICS via network); PLC (INFN Trieste)

Power:
Rack#F-1 in F2
- 3 + 3 spares for Vaisala sensors, Flow Meters, Pump, Edgetech Dewmaster Chilled Mirror Hygrometer (for calibrations) low power (to be quantified), request to Itoh-san

Network: see interlocks, PLC

Interlocks



Electronics: Schneider Electric Modicon M340 PLC (INFN Trieste) already available

Cables:

Connections to Central Interlock, SVD Power Supply, PXD Power Supply, etc.

To be specified (draft document distributed for comments)

Racks:

Rack#F-2 in F2

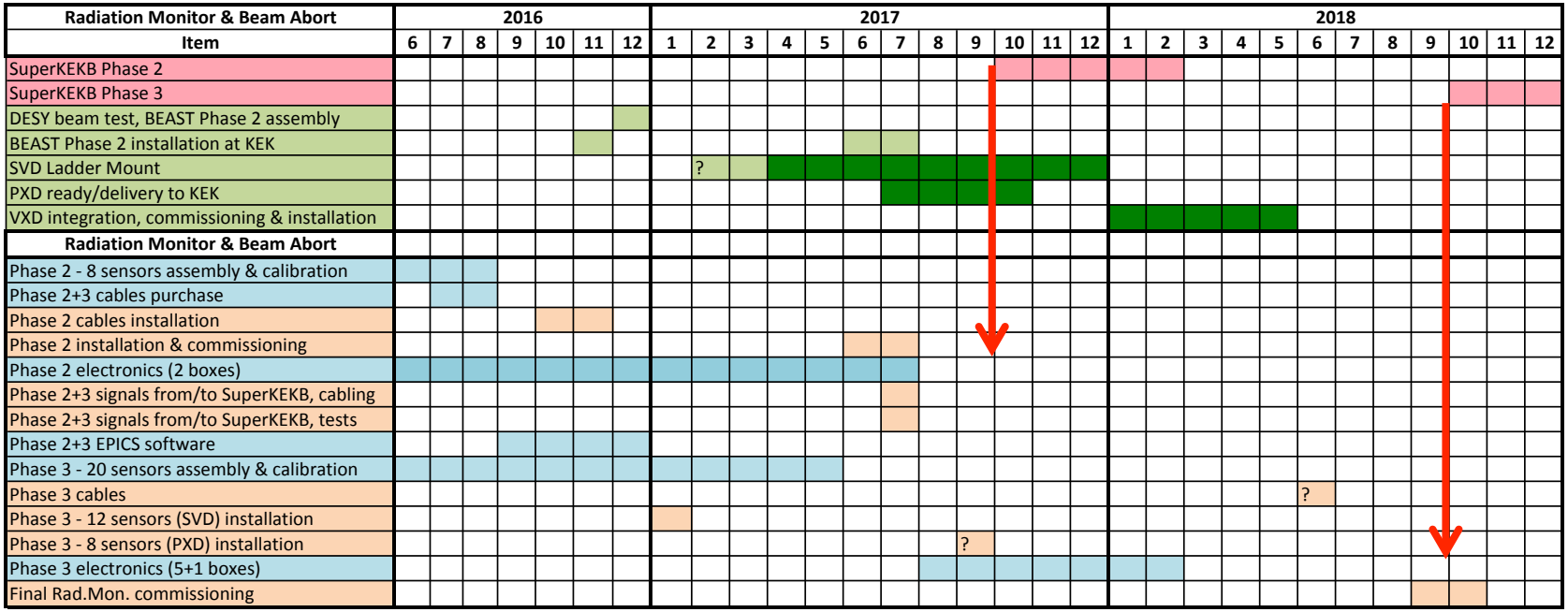
Power:

low power (to be quantified), request to Itoh-san

EPICS Network:

(SVD network)

Rad. Mon. & Beam Abort: Schedule

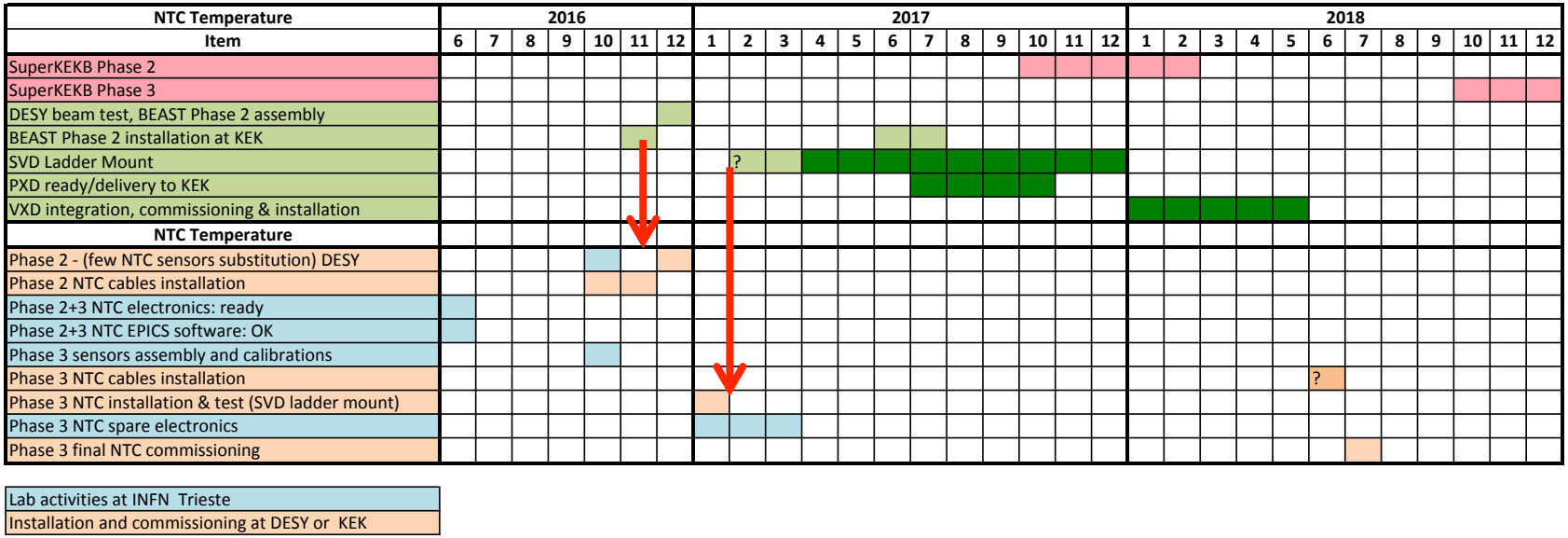


Driving deadlines:

2017, October, beginning of Phase 2

2018, October, beginning of Phase 3

NTC Temperature: Schedule



Driving deadlines:

2016, November, DESY Beam Test & Phase 2 VXD Assembly

2017, February, beginning of SVD Ladder Mount

FOS Temperature: Schedule

FOS Temperature	2016							2017											2018										
Item	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
SuperKEKB Phase 2																															
SuperKEKB Phase 3																															
DESY beam test, BEAST Phase 2 assembly																															
BEAST Phase 2 installation at KEK																															
SVD Ladder Mount									?																						
PXD ready/delivery to KEK																															
VXD integration, commissioning & installation																															
FOS Temperature																															
phase 2+3 additional fibres purchase																															
phase 2+3 fibres tests and calibrations																															
phase 2 FOS sensors in layers 4,5,6, etc, tests																															
phase 2 fibres from DOCKS to E-hut																															
phase 2+3 interrogator: available																															
phase 2+3 FOS EPICS software																															
phase 3 FOS sensors in layers 4, 5, 6, etc, insertion & tests																															
phase 3 fibres from DOCKS to E-hut																									?						
phase 3 final FOS commissioning																															

Lab activities at INFN Trieste
Installation and commissioning at DESY or KEK

Driving deadlines:

2016, November, DESY Beam Test & Phase 2 VXD Assembly

2017, February, beginning of SVD Ladder Mount

2018, October, beginning of Phase 3

Dew Point Sniffers: Schedule

Dew Point Sniffers	2016							2017											2018											
Item	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
SuperKEKB Phase 2																															
SuperKEKB Phase 3																															
DESY beam test, BEAST Phase 2 assembly																															
BEAST Phase 2 installation at KEK																															
SVD Ladder Mount									?																						
PXD ready/delivery to KEK																															
VXD integration, commissioning & installation																															
Dew Point Sniffers																															
prototype calibrations: completion																															
final design, including controls																															
purchase 3 sensors, flowmeters, gauges, pump																															
mechanical assembly																															
PLC control & interlock software (+EPICS)																															
system tests and sensor calibrations																															
Sniffers delivery at KEK																															
Sniffers piping to E-hut (DESY/Munich)						?						?																			
Sniffers final commissioning at KEK																															
Ssniffer: on SVD ladder mount: prototype?																															

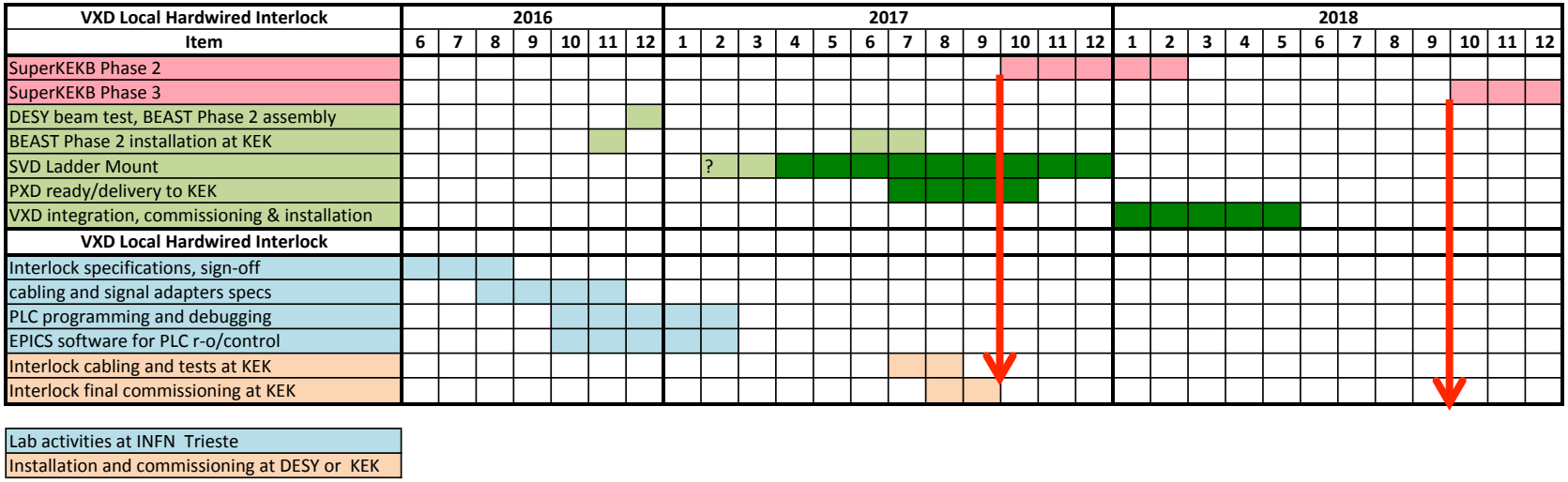
Lab activities at INFN Trieste
Installation and commissioning at DESY or KEK

Driving deadlines:

2017, February, beginning of SVD Ladder Mount

2017, October, beginning of Phase 2

Interlocks Schedule



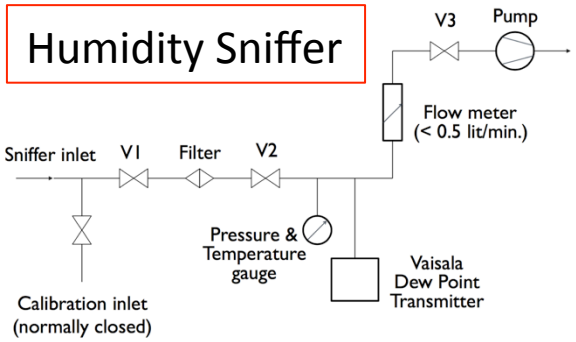
Driving deadlines:

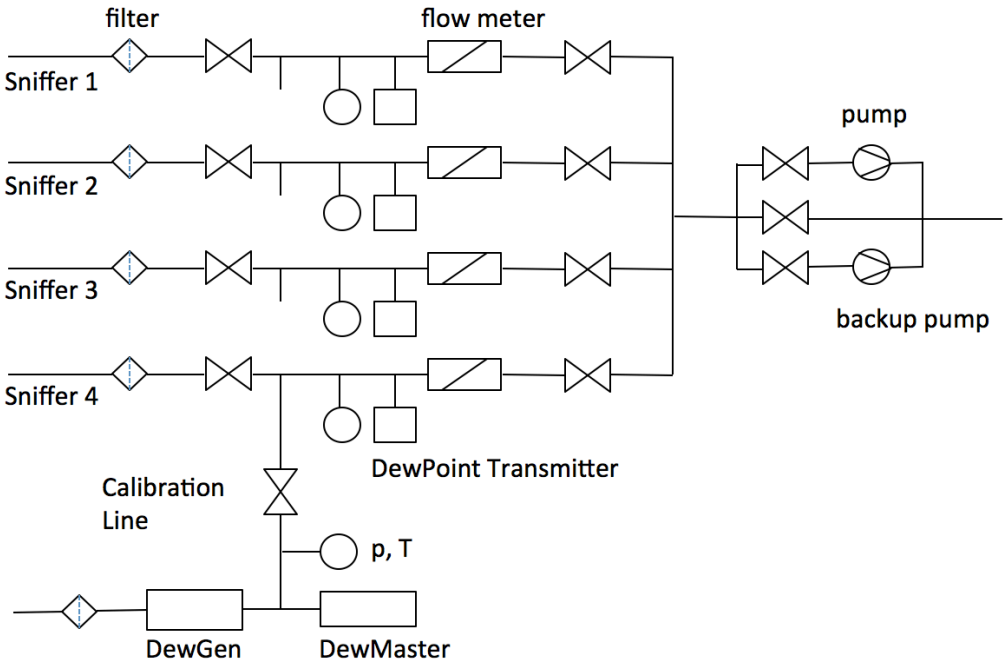
2017, October, beginning of Phase 2

2018, October, beginning of Phase 3

Dew Point Sniffers: Plans

- Prototype tested at DESY
  - OK
- Trieste (2016-2017)
  - Final design
  - Vaisala Transmitters and pumps: to be purchased with 2016 budget
  - Other components: in 2017
  - Flowmeters and valves:
  - PLC controls, programming
  - Assembly, calibrations
- KEK (2017)
  - Installation, tests, integration with interlocks and EPICS Slow Control





Interlocks: Draft Specifications

BELLE2-NOTE-0023

Hardware Protection Systems in the PXD Det

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Abstract

The PXD detector provides the two innermost tracking layer of the *Belle II* d
silicon sensors and readout ASICs are placed near the interaction point. From t
cannot easily be replaced and must reliably be protected from all possible dama

In this note, the concept of the interlock systems dealing with these situations t
to the PXD detectors is introduced.

BELLE2-NOTE-TE-2016-xxx
Draft 2.0, June 21, 2016

The VXD Local Hardwired Interlock System

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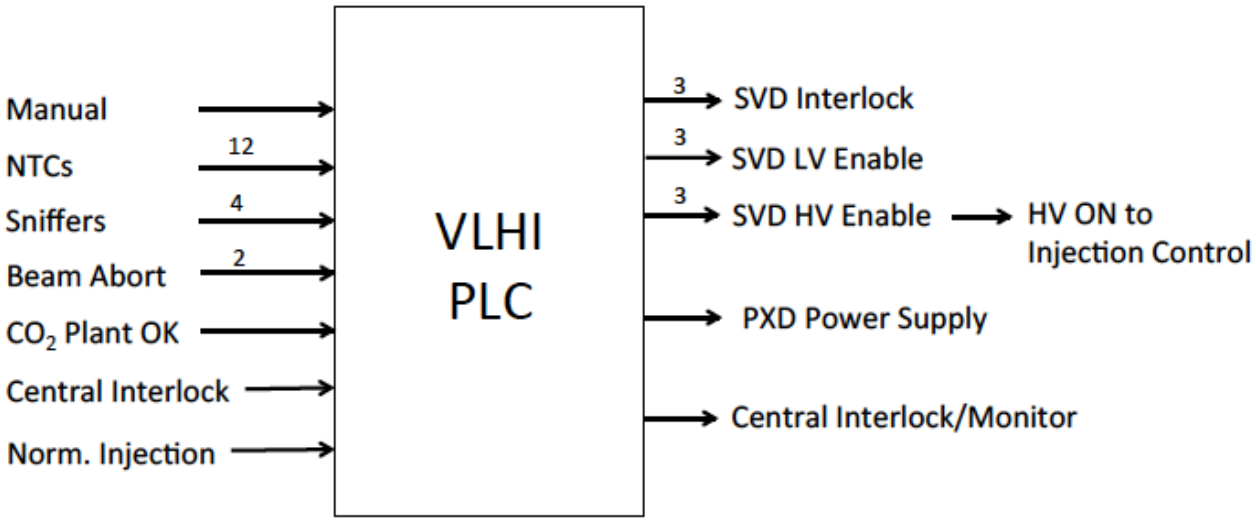
Abstract

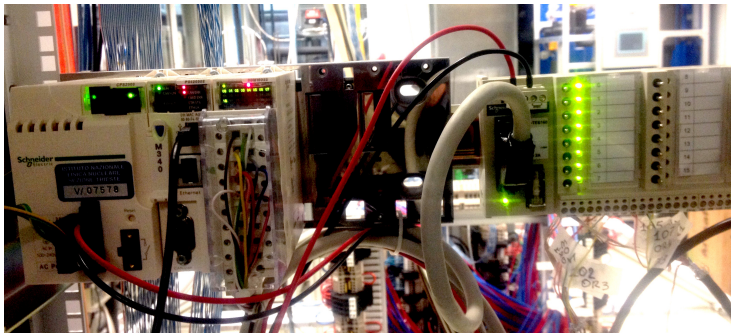
This is a summary of the hardwired interlock requirements of the *Belle II* Vertex Detector (VXD), extending the PXD requirements described in BELLE2-NOTE-0023. The inputs of the VXD Local Hardwired Interlock (VLHI) include signals from temperature, humidity, and radiation sensors, from the VXD cooling system, from the *Belle II* Central Interlock and from the SuperKEKB Injection Control system. The outputs are used to interlock the SVD and PXD power supplies, and to communicate with the Central Interlock/Monitor. An "HV on" status of the SVD power supplies will inhibit the Normal Injection Enable signal to SuperKEKB. A preliminary description of the implementation is also given.

Tentative Block Diagram, PLC

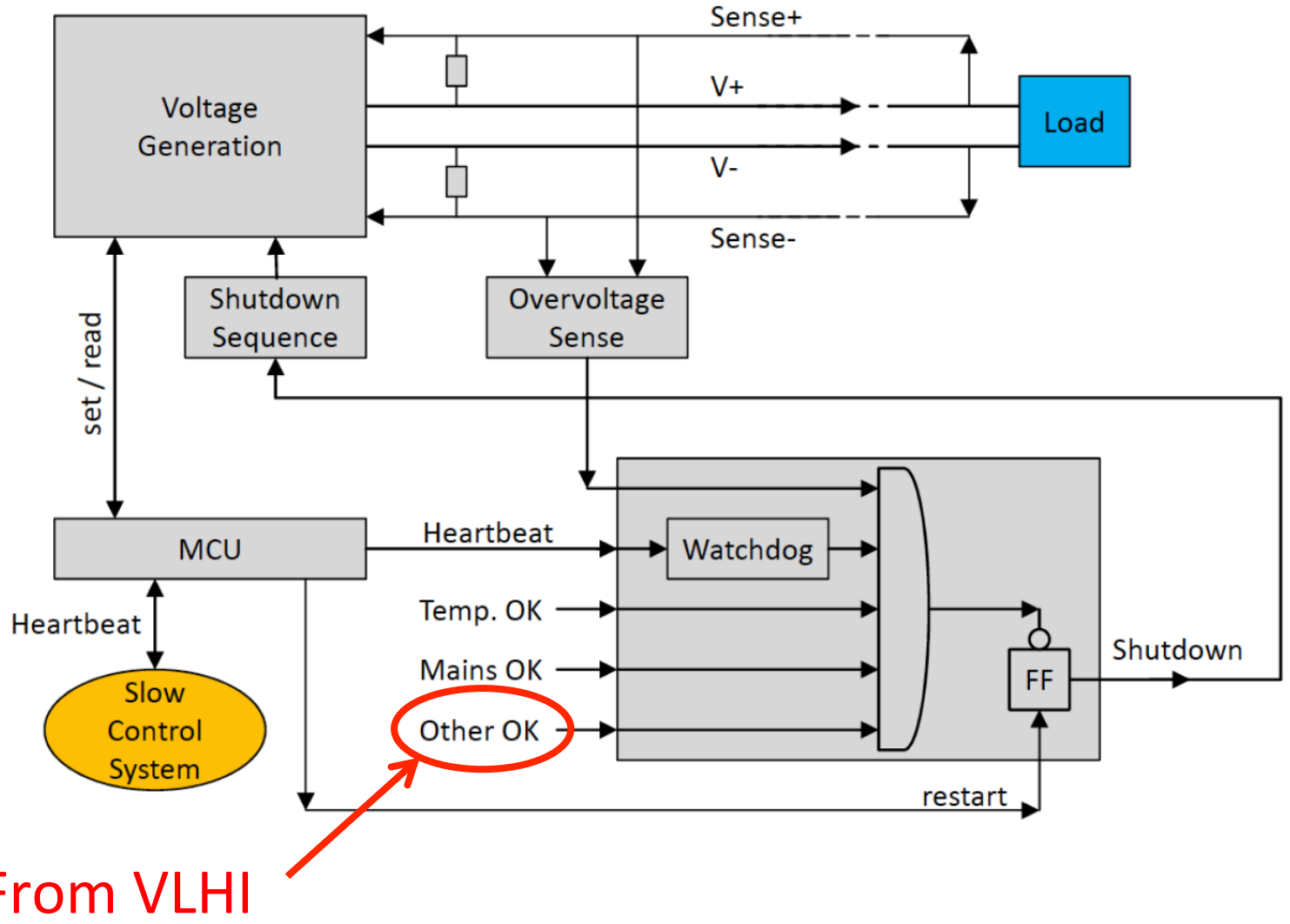
VXD Local Hardwired Interlock = VLHI



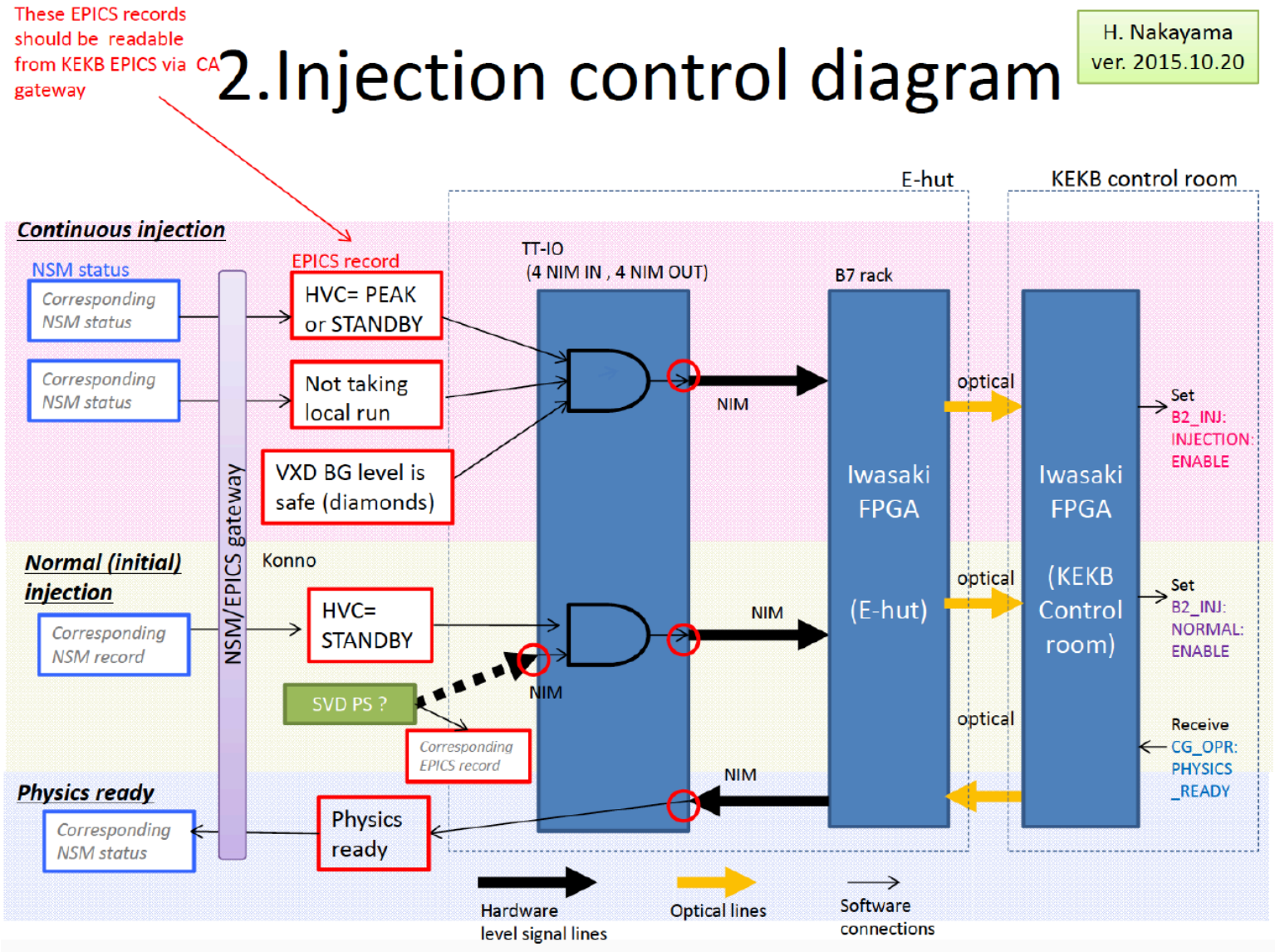
Schneider Electric Modicon M340
+ BMX DDM 16022 Discrete I/O
+ BMX AMI 0410 Analog Input



PXD Power Supplies Interlocks



SVD "HV On" in Injection Control



PLC Inputs and Outputs

Input	Label	from C.R.	Rack
Manual Interlock	Button	B3 ?	??
NTC Thermistors	Interlocks $1 \div 12$	E-Hut F2	F-2
Humidity Sniffers	Dew Point Transmitters $1 \div 4$	E-Hut F2	F-1
Humidity Sniffers	Flow Meters $1 \div 4$	E-Hut F2	F-1
Humidity Sniffers	"Pump OK" Status	E-Hut F2	F-1
CO_2 Cooling Plant	"CO_2 Plant OK" Status	??	??
Diamonds Rad. Mon.	LER, HER Beam Abort	E-Hut F2	F-3
SuperKEKB	Beam Abort, Mask injection	E-Hut F1	B-7
Power Supplies	"SVD HV On" Status	Detector Top Floor	??
Power Supplies	"PXD On" Status ?	Detector Top Floor	??
SuperKEKB	Mask (Normal) Injection	E-Hut F1	B-7

Output	Label	to C.R.	Rack
Power Supplies	SVD Interlock $1 \div 3$	Detector Balcony	$1 \div 3$
Power Supplies	SVD HV Enable $1 \div 3$	Detector Balcony	$1 \div 3$
Power Supplies	SVD LV Enable $1 \div 3$	Detector Balcony	$1 \div 3$
Power Supplies	PXD Interlock	Detector Top Floor	??
Belle II	Central Interlock/Monitor	E-Hut F1	A-10
SuperKEKB	Normal Injection Enable	E-Hut F1	B-7

Tentative list:
Inputs,
Outputs,
Counting Rooms,
Racks

SVD CAEN Power Supplies

- Exchange of signals via Patch Panels

  (under design, Pisa)

- Requested signals, from VLHI

  Interlock (x3)

  LV Enable (x3)

  HV Enable (x3)

- Status signal (inhibit to Injection Control)

  HV on