Beam instrumentation triggers and data

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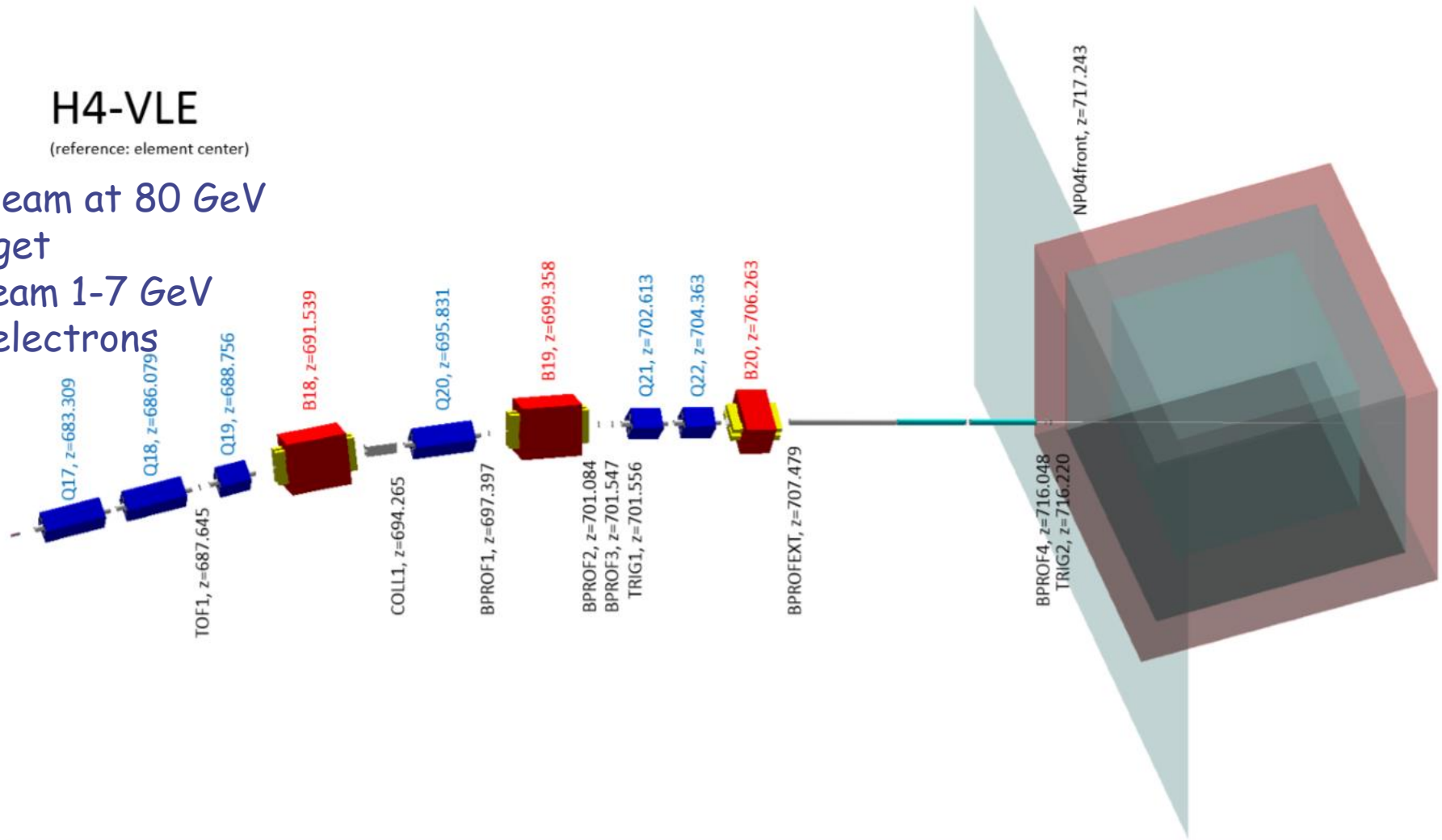
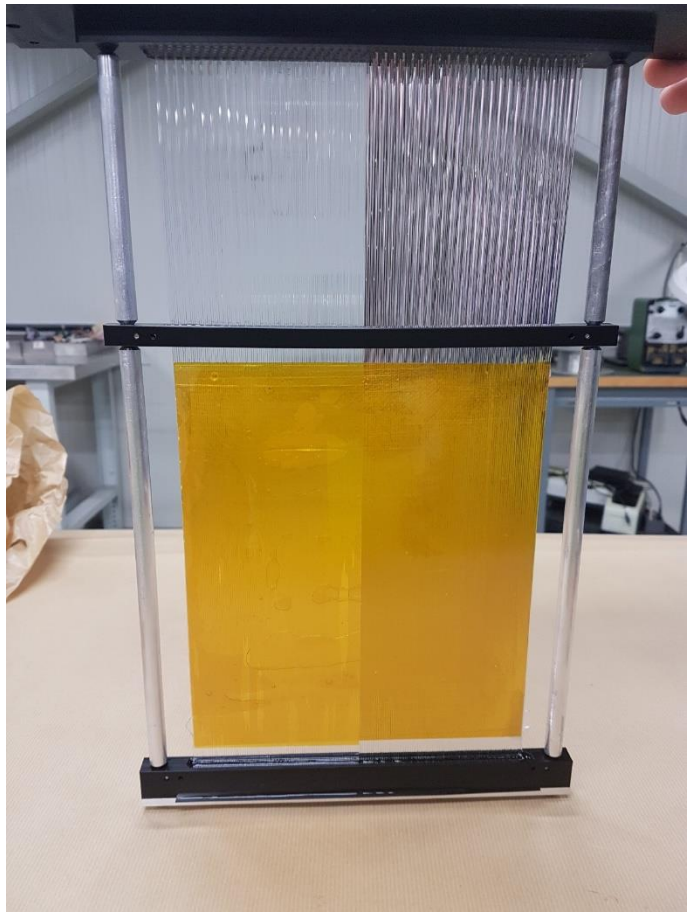
Schematic overview H4-VLE

Secondary beam at 80 GeV
Cu or W target
->tertiary beam 1-7 GeV
Hadrons or electrons

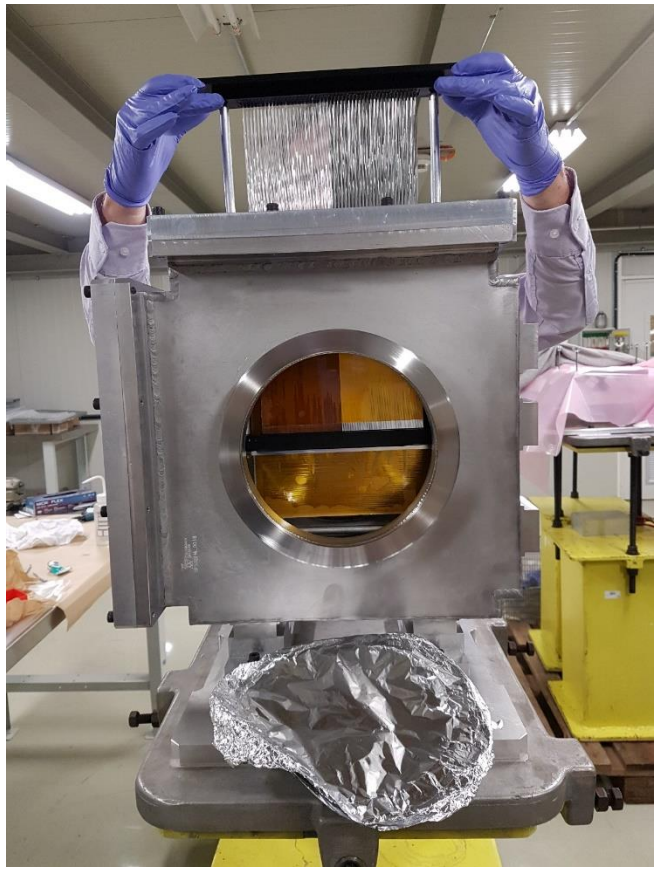


Beam Monitor (XBPF)

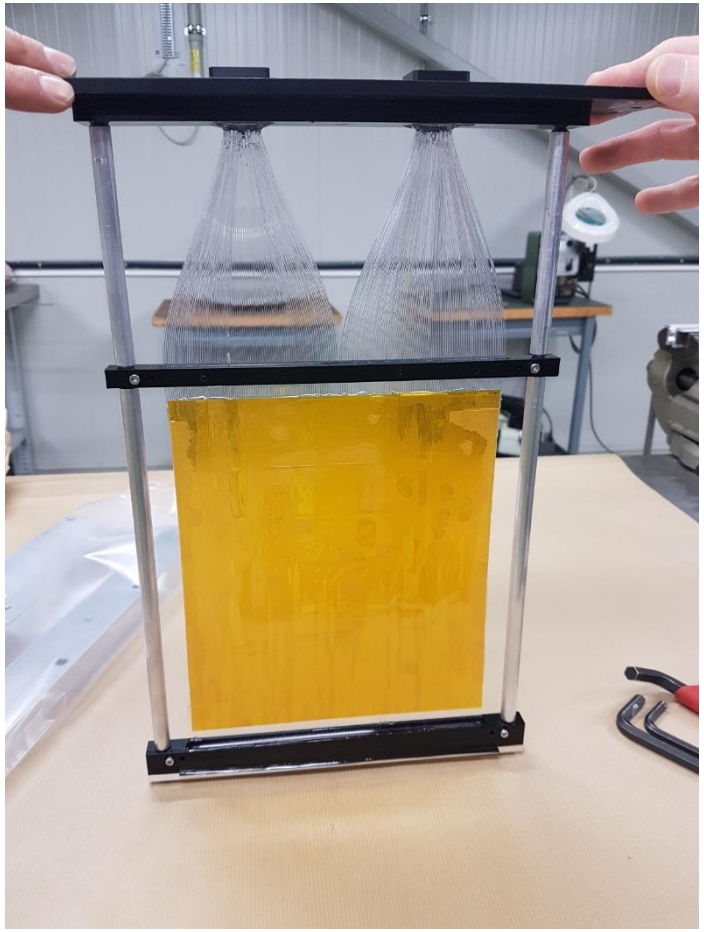


- Scintillating square fibres,
- 1mm^2 section
- Readout by SiPm, one per fiber
- 192 fibres for one plane

- Hosted in vacuum-tight tanks
- Two planes can be hosted in one tank
- Can be aligned/oriented
- Gauges for surveyors included



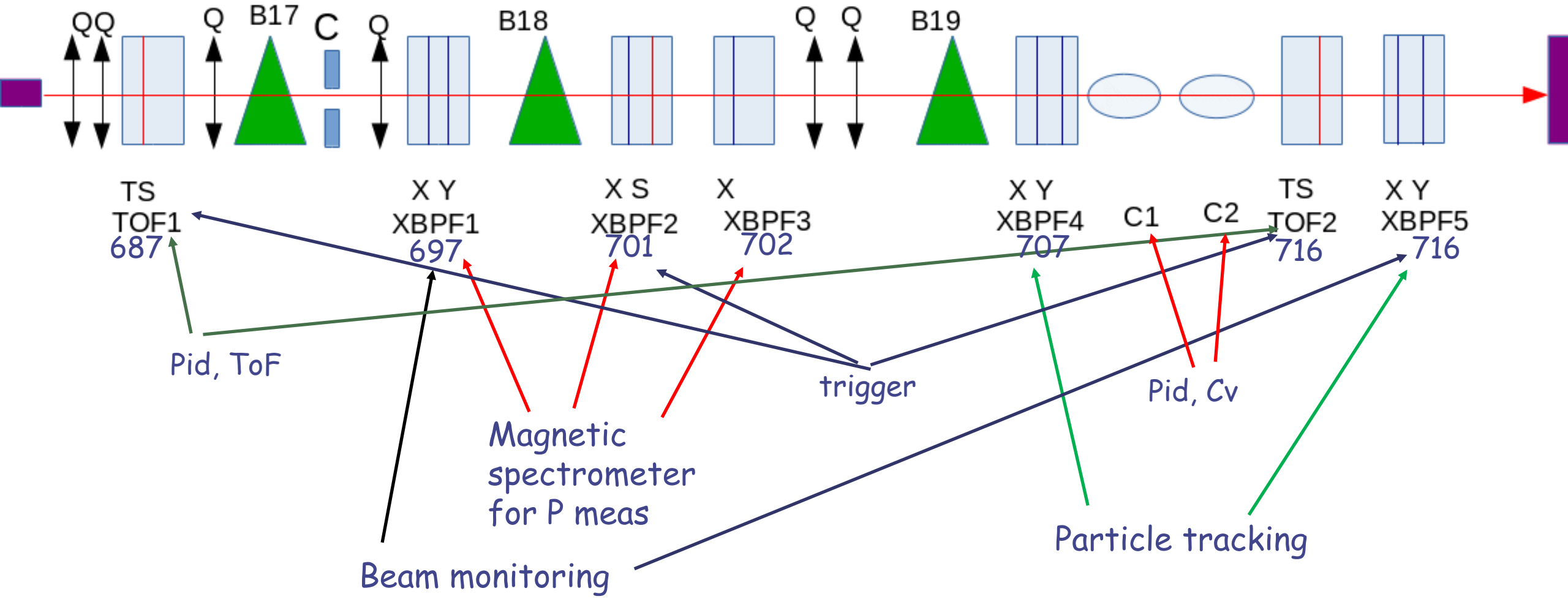
Trigger (+ToF) detectors (XSCINT)



- Same fibres as monitors
- Readout by 2 PMTs

H4- VLE monitor schematics

- Black: quadrupoles. Green: bending magnets Boxes: detector supports. X,Y : scint. fibre layer. S=scint. for trigger ST=trigger+time-of-flight detector
- Each box can host 2 detectors



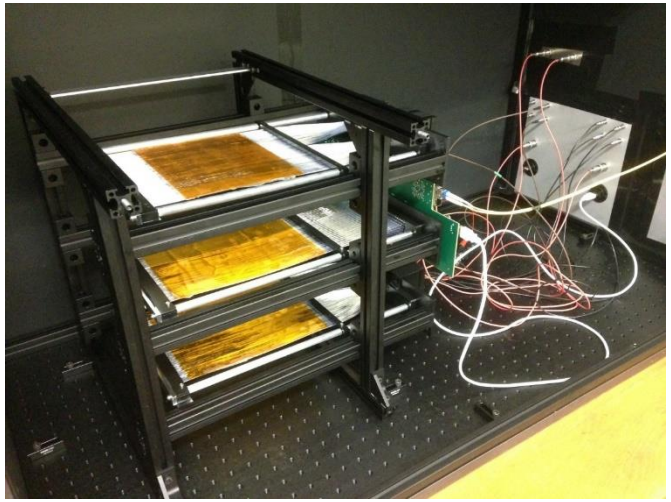
Totals

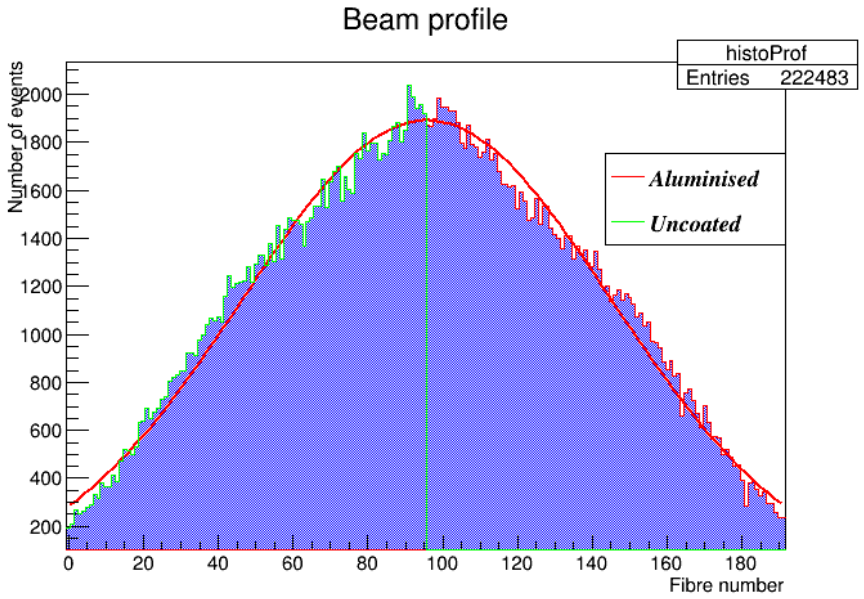
- 8 planes of XBPF , 192 fibres each . Signal from each fibre (DATA) + OR of 192 for Trigger
- 3 planes of XSCINT, two PMTs each. Logical signal sent to DATA and Trigger
- 2 Cerenkovs, with CO_2 or possibly a Freon like gas (R&D ongoing) up to 15 bars. Logical signal sent to DATA and Trigger

- The coincidence among the three scintillator planes will build a BI GLOBAL TRIGGER
- Data from BI will be recorded only in presence of a valid BI Trigger
- Synchronization with NP02 ensured by White Rabbit TimeStamps (see http://www.ohwr.org/projects/white-rabbit)

Schedule/tests

- Two XSCINT and one XBPF ready (2 planes)
- Test in PS beam successful (<1ns for ToF)
- Readout ready
- Currently running as cosmic telescope in lab
- Production of the other modules ongoing , for a total of 10 XBPF planes and 5 XSCINT
- Scheduled to be ready for commissioning





TRIGGERs

- Sent to NP04 as NIM
  - Beam extraction
  - BI global Trigger
  - 2 Cerenkovs
  - 4 XBPF ORs (one signal each two planes)
  - 3 XSCINT (not really needed, we already get the global trigger as AND of these three)
- BI DAQ located near to beamline and NP04 DAQ to minimize signal transfer time
- NP04 trigger experts visited test setup to check signal compliance

DATA -I

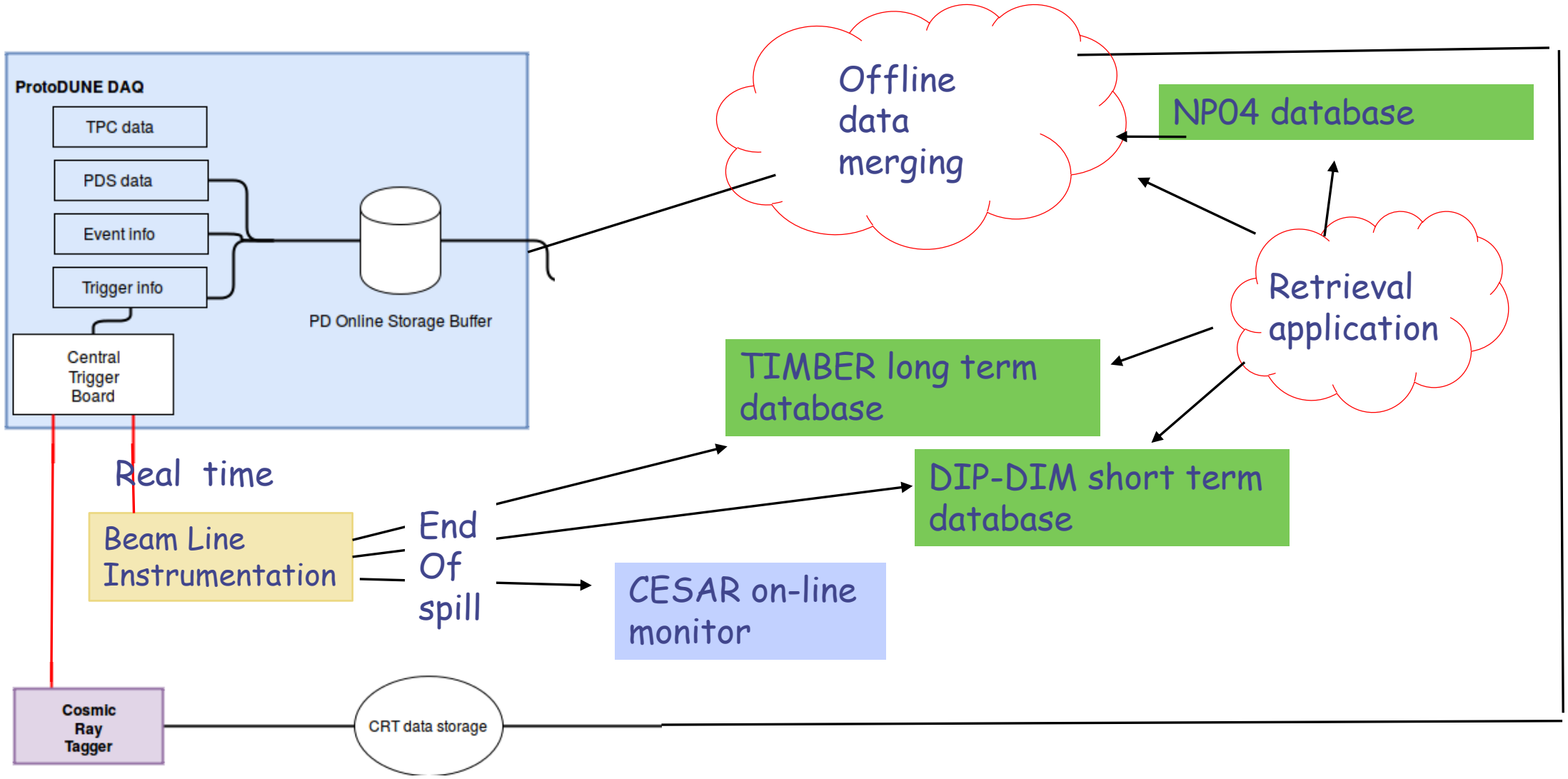
- XBPF data read by Front-end software (FESA class)
- ToF signal sent to FMC-TDC, to obtain a White Rabbit timestamp on digital signals with a precision of 81ps. Readout by FESA class
- Cerenkov logical signal sent to FMC-TDC as above
- Cerenkov low control status (gas pressure, pmt Hv …) FESA class
- All FESA sent to DIP and TIMBER databases at the end of each extraction (4.8 s)

https://wikis.web.cern.ch/wikis/display/EN/DIP+and+DIM

https://wikis.cern.ch/display/CALS/CERN+Accelerator+Logging+Service

- Minimum time between two extractions 10s, reasonable average 30s
- Same FESA classes sent to the CESAR system → provide online scalers/plots to BI and in NP04 control room http://sba.web.cern.ch/sba/cesar/Cesar_manual.htm

Data flow


ProtoDUNE DAQ
TPC data
PDS data
Event info
Trigger info
Central Trigger Board
PD Online Storage Buffer
Offline data merging
NP04 database
Retrieval application
TIMBER long term database
DIP-DIM short term database
Real time
Beam Line Instrumentation
End Of spill
CESAR on-line monitor
Cosmic Ray Tagger
CRT data storage

XBPF FESA class

Once per extraction

Data for each trigger

Once per extraction

variable name	var. type and size	description
acqMode	string	Acquisition mode of the XBPF. Options: STOP, ACQUIRE, Command, Timer, Timing. Value should be ACQUIRE for normal operation.
acqStamp	int 64bit	UNIX timestamp of the acquisition. (Note: an acquisition corresponds to a beam extraction)
cycleName	string	Name of the present accelerator's super-cycle.
cycleStamp	int 64bit	UNIX timestamp of the present accelerator's super-cycle.
equipmentName	string	Name of the XBPF beam monitor according to its distance to the primary target.
countsRecords	int 64bit	Number of recorded events in the present acquisition.
eventsData	array of 10 int 64bit × [countsRecords]	Event structure of the records. Format: 10 words containing the trigger timestamp, event timestamp and the 192 fibres information. More information in table 1.2. Note: the 6 data words follow little-endian order.
countsTrigs	int 64bit	Number of trigger signals received during the present acquisition. Note: in the absence of erros, should match [countsRecords]
countsRecordsWithZeroEvents	int 64bit	Number of recorded events in the present acquisition with zero counts. Can be used to calculate the inefficiency of the detector.
counts	int 64bit	Total number of hits accumulated in the 192 fibres during present acquisition. Can be used to estimate the multiplicity of the detector.
profile	array of 192 int 64bit	Beam profile of the present acquisition.
mean	double	Mean of the current profile.
timeFirstEvent	int 64bit	WR timestamp of the first recorded event.
timeFirstTrigger	int 64bit	WR timestamp of the first received trigger.
timeLastEvent	int 64bit	WR timestamp of the last recorded event.
timeLastTrigger	int 64bit	WR timestamp of the last received trigger.
message	string	User-customised message.
acqType	string	Expert variable: value should be Timing.
acqTypeAllowed	string	Expert variable: value should be Timing.
profileMm	array of 192 double	Used for debugging.

XBPF data structure and size

- For each trigger, 10 words, 64 bits each
- Time stamps and 192 fibres

- ➔ even assuming max 100 Hz X 5s X 640 b =

  320 kb / beam spill

  40 kB /beam spill

Max repetition rate 1 spill / 10 seconds

64 Table 1.2: Event structure

32-bit word	meaning
0	trigger time stamp 32 LSB
1	trigger time stamp 32 MSB
2	event time stamp 32 LSB
3	event time stamp 32 MSB
4	DATA 0 LSB
5	DATA 1
6	DATA 2
7	DATA 3
8	DATA 4
9	DATA 5 MSB

TDC data structure

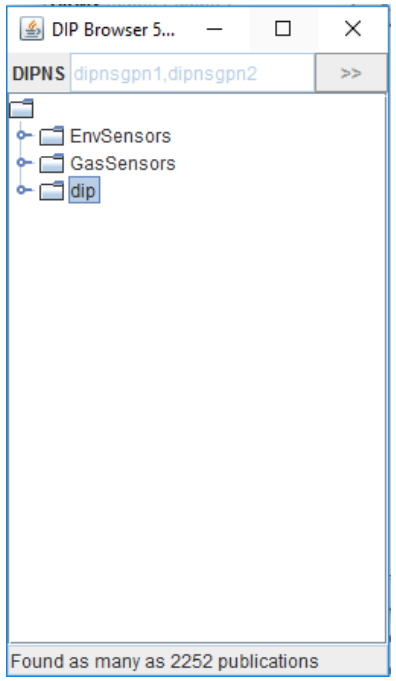
TDC used to stamp Xscint, Cerenkov etc

variable name	var. type and size	description
acqStamp	int 64bit	UNIX timestamp of the acquisition. (Note: an acquisition corresponds to a beam extraction)
cycleName	string	Name of the present accelerator's super-cycle.
cycleStamp	int 64bit	UNIX timestamp of the present accelerator's super-cycle.
timestampCount	int 64bit	Number of pulses received during the acquisition.
seconds	int 64bit × [timestampCount]	TAI seconds. Note this is *not* an UTC time; the counter does not support leap seconds. The internal counter is also limited to 32 bits (2038-error-prone).
coarse	int 64bit × [timestampCount]	Number of ticks of 8ns since the beginning of the last second.
frac	int 64bit × [timestampCount]	Fractional part of a 8ns tick, rescaled to (0...4095) range - i.e. 0 = 0ns and 4095 = 7.999ns.
seq_id	int 64bit × [timestampCount]	Channel sequence number.
gseq_id	int 64bit × [timestampCount]	Board sequence number.
ref_gseq_id	int 64bit × [timestampCount]	Board sequence number of the reference channel timestamp. Note: the reference channel feature is not used.

DIP can also be accessed via web:

- Enter in your web browser the following link : http://cern.ch/dipbrowser/gpn.jnlpx

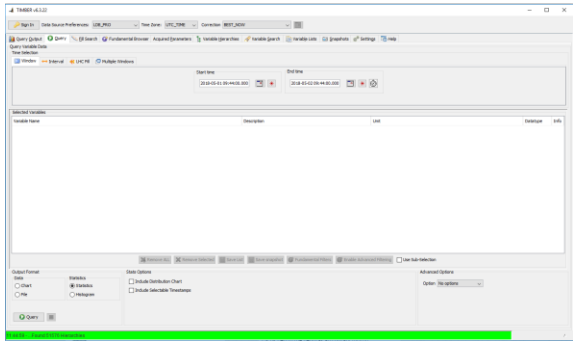
- The Download of *gpn.jnlpx* will start automatically
- Open the gpn.jnlpx
- DIP should start

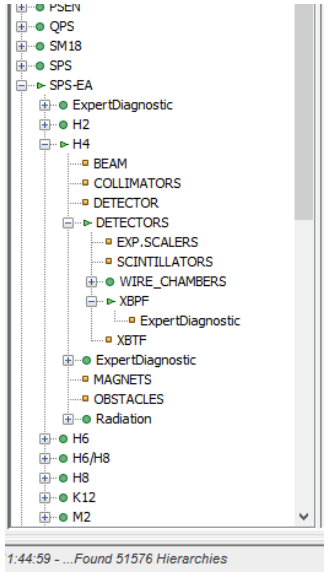


Same for TIMBER

- Enter in your web browser the following link :
- http://lhc-logging.web.cern.ch/lhc-logging/timber/

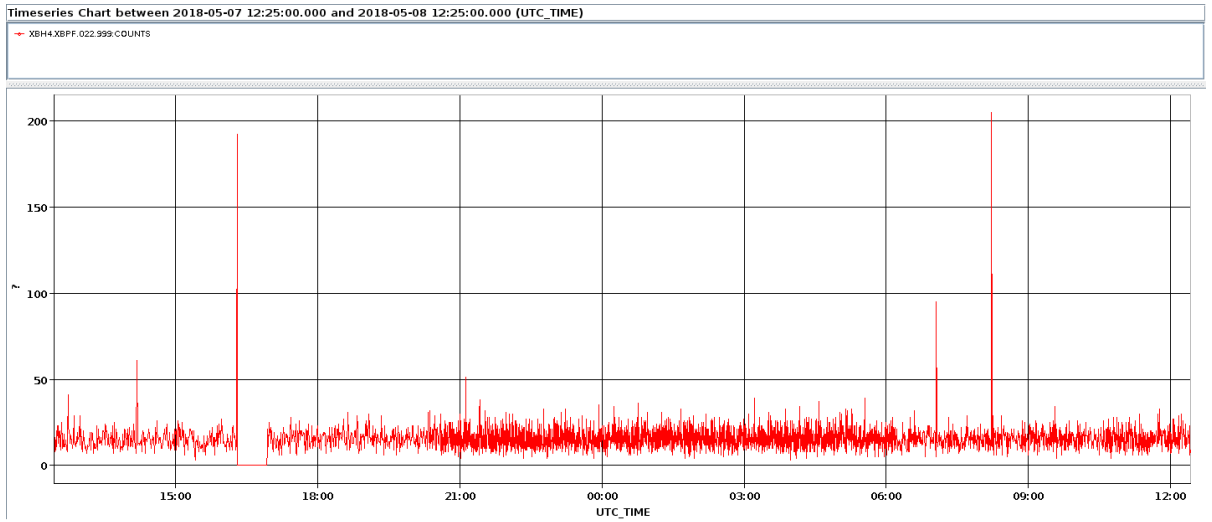
- The Download of *timber.jnlpx* will start automatically
- Open the *timber.jnlpx*
- Timber should start

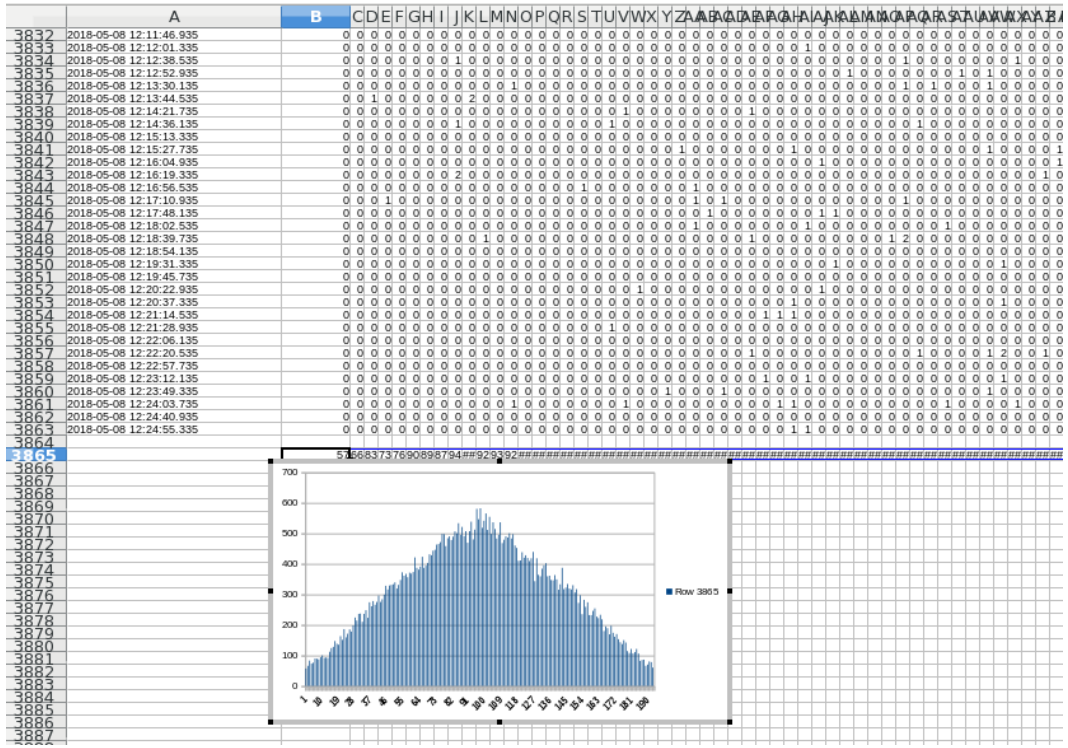




Can limit time span and query selected variables, get histos or lists

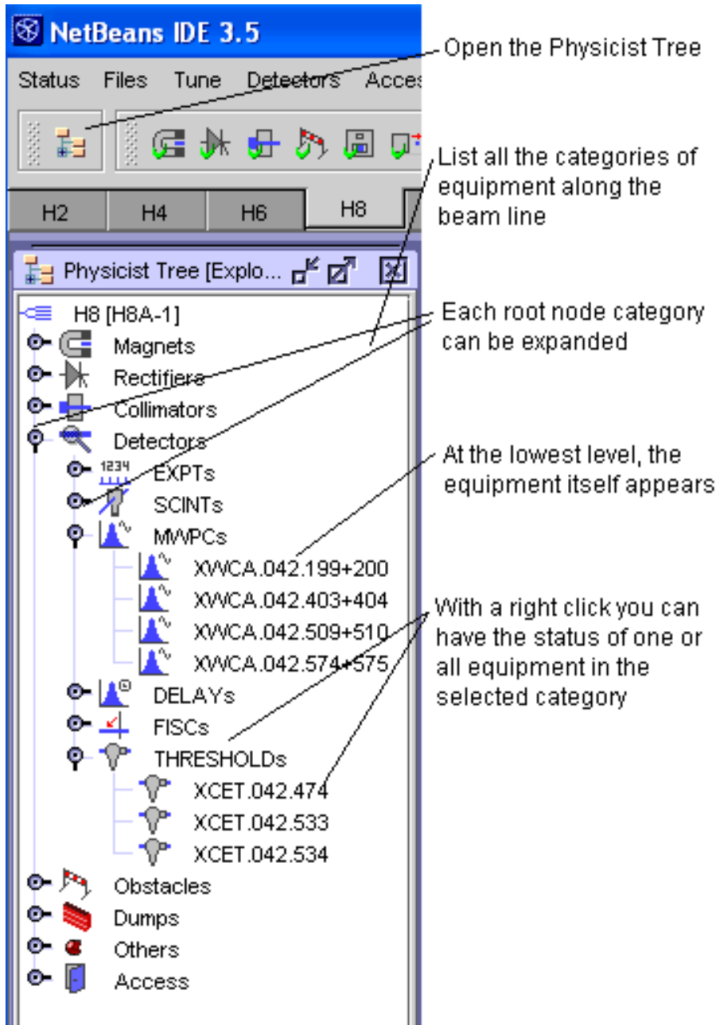
Examples from Timber





CESAR

- http://sba.web.cern.ch/sba/cesar/Cesar_manual.htm



Beam status and settings, equipment status, basic counters, histograms of beam profiles…

Conclusions

- Trigger signals from BI to NP04 will include a master trigger and partial triggers from all the BI elements.
- Synchronization through White Rabbit time stamping
- First checks on trigger signals done
- Data transfer from BI to CERN databases will occur after each beam extraction
- Small amount of data: max 40 kB /beam spill , max repetition rate 1spill/10 s
- Data transfer through FESA classes ready, test data now available
- Data extraction from CERN Database to NP04 database under development at FNAL
- Data extraction can be already tested with lab data from cosmic telescope.

backup

Beamline construction schedule

	Task Name	Start	Finish	Durat
19	Installation grillage	Mon 26/02/18	Fri 09/03/18	2 wks
20	Installation echelles a cables	Mon 12/03/18	Fri 23/03/18	2 wks
21	Tracage faisceau	Mon 26/03/18	Fri 30/03/18	1 wk
22	Cablage quai	Mon 02/04/18	Fri 20/07/18	16 wk
23	Installation escalier, passerelle	Mon 07/05/18	Fri 11/05/18	1 wk
24	Preparation support aimants	Mon 30/04/18	Fri 04/05/18	1 wk
25	Installation aimants H4	Mon 07/05/18	Fri 18/05/18	2 wks
26	Installation instrumentation XBPF H4	Mon 21/05/18	Fri 25/05/18	1 wk
28	Installation dump + toit +blindage	Mon 16/07/18	Fri 20/07/18	1 wk
29	Alignement 1	Mon 28/05/18	Fri 15/06/18	3 wks
27	Installation collimateur H4	Mon 04/06/18	Mon 04/06/18	1 day
30	Raccordement ED aimants	Mon 18/06/18	Fri 29/06/18	2 wks
31	Installation Vacuum H4 quay	Mon 18/06/18	Fri 22/06/18	1 wk
32	Installation Vacuum H4 164	Mon 25/06/18	Fri 29/06/18	1 wk
33	Installation plateforme NP04	Mon 02/07/18	Fri 06/07/18	1 wk
34	Installation Cerenkov XCET	Mon 09/07/18	Fri 13/07/18	1 wk
35	Alignement	Mon 02/07/18	Fri 13/07/18	2 wks
36	Installation dump + toit +blindage	Mon 16/07/18	Fri 20/07/18	1 wk
37	Installation ceinturage	Mon 23/07/18	Fri 27/07/18	1 wk
38	Hardware commisionning	Mon 23/07/18	Fri 27/07/18	1 wk
39	Beamcommisionning	Mon 30/07/18	Fri 03/08/18	1 wk
68	**Detectors Installation**	**Mon 30/05/16**	**Fri 25/05/18**	**500 da**
06	**Infrastructure installation**	**Mon 13/06/16**	**Mon 10/07/17**	**271 da**
16	**Gas Ar extraction system installation**	**Thu 13/10/16**	**Wed 20/12/17**	**300 da**
14	YETS 2017/2018	Mon 18/12/17	Mon 02/04/18	13.2 w