5th Slow Extraction Workshop at MedAustron in Wiener Neustadt

11-15 February 2024
TFZ Wiener Neustadt
Europe/Berlin timezone

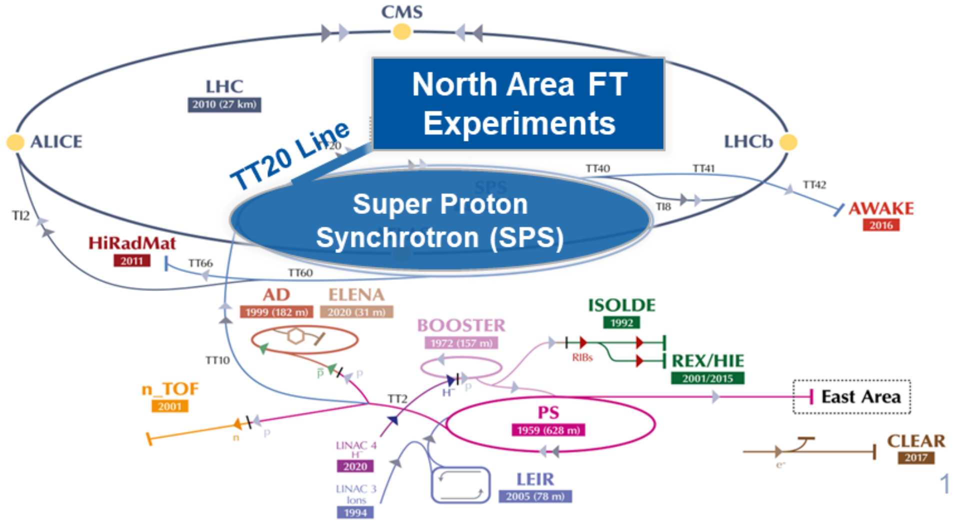
Fast Spill Monitoring at the CERN SPS

Status
&
Plans

F.Roncarolo, CERN SY-BI

S. Benitez, S.Mazzoni, D.Belohrad , S. Burger,
M.Martin, A.Goldblatt
E.Calvo, E.Effinger, C.Zamantzas

V.Kain, M.Fraser, F.M.Velotti, P.A. Arrutia Sota
F.Addesa, L.Esposito



North Area FT Experiments

TT20 Line

Super Proton Synchrotron (SPS)

CERN SPS for Fixed Target Experiments

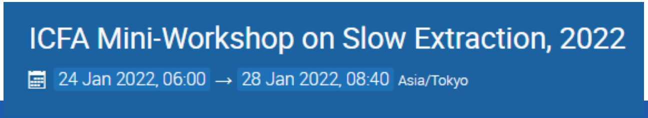
Protons @ 400 GeV sent towards NA experiments via **Slow Extraction** process

- RF disabled at flat top, ideally **fully de-bunched** beam is sent to transfer line

Spill ‘**quality**’ affected at macro and micro-structure level by:

- **hysteresis**, non-reproducibility of **momentum distribution**, regulation and **ripples** of power supplies, **spikes** at RF switch-off

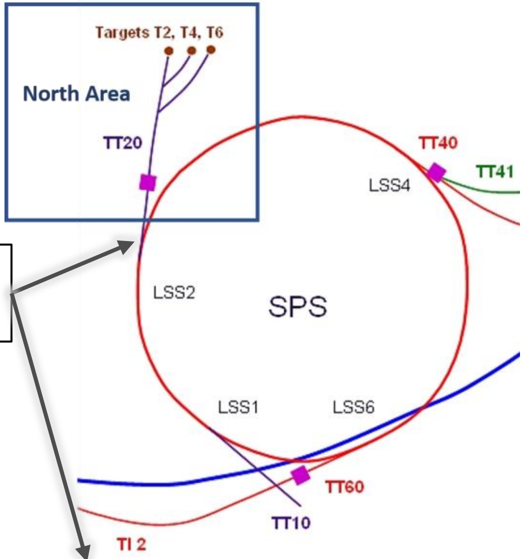
V.Kein @ :



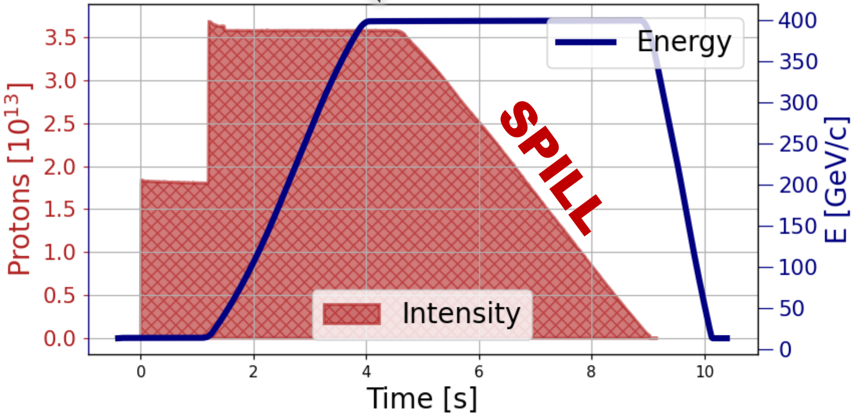
ICFA Mini-Workshop on Slow Extraction, 2022

24 Jan 2022, 06:00 → 28 Jan 2022, 08:40 Asia/Tokyo

SPS_SX_status_plans_Jan2022 (kek.jp)



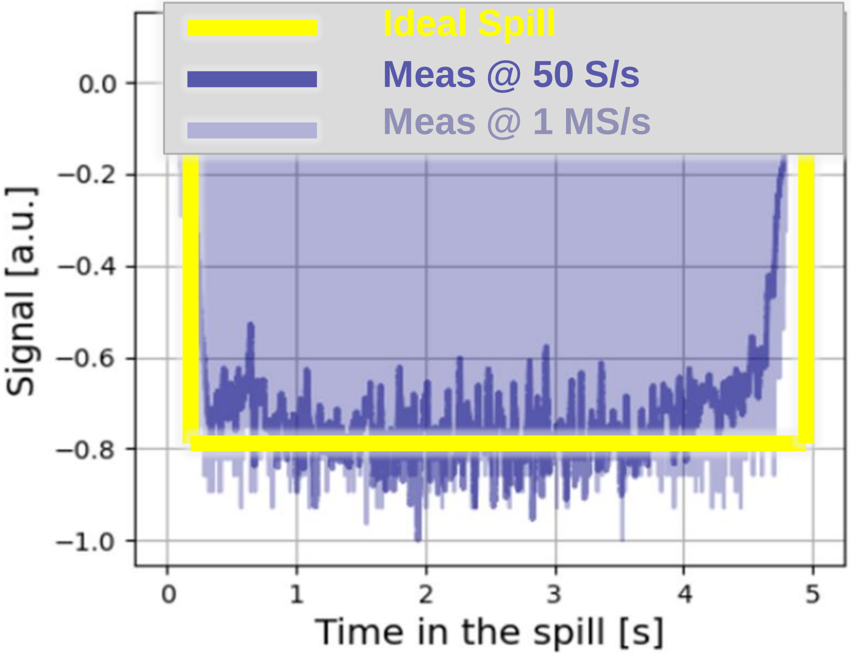
Slow extraction



Spill Structure and quality

Monitoring the ‘spill quality’

- **Essential** for spill control and successful physics in fixed target experiments
- **Challenging**, at first because single pass de-bunched beams can’t be measured by standard synchrotron diagnostics as Beam Current Transformers



Spill Quality – Duty Factor

$$0 \le \mathscr{F} = \frac{\overline{I(t)}^2}{\overline{I^2}} = \frac{P_{DC}}{P_{Tot}} \le 1 \tag{2.1}$$

For each interval Δt, the ideal case corresponds to a Poisson distribution for which

$$\overline{I} = \langle I \rangle = I_0 \cdot \frac{\Delta t}{T} \quad \text{with } I_0 = \int_0^T I(t)dt \tag{2.2}$$

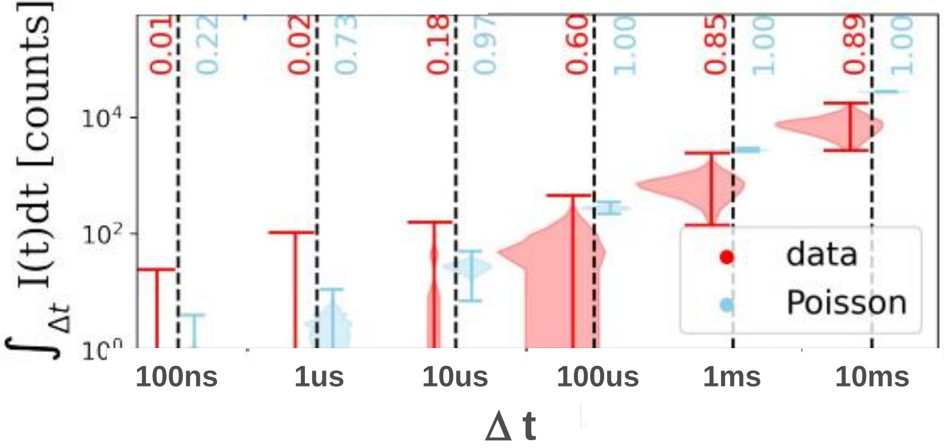
and the duty factor can be expressed as

$$\mathscr{F}_{Poisson}(\Delta t) = \left[1 + \frac{T}{I_0 \cdot \Delta t}\right]^{-1} \tag{2.3}$$

This is, again for each interval Δt, the upper limit of the real duty factor that can be written as

$$\mathscr{F}_{real}(\Delta t) = \left[1 + \frac{\langle I(t) \rangle}{\overline{I(t)}^2}\right]^{-1}. \tag{2.4}$$

P.A. Arrutia Sota



Data in the plot was taken with the NA62 GTK detector. Both when comparing the particle-rate histograms and the duty factors, it is evident that the real spill performs significantly below the **Poisson limit**.

An upgrade of the spill monitors would allow to develop and optimise techniques to mitigate this difference.

Spill Monitoring Requirements - General

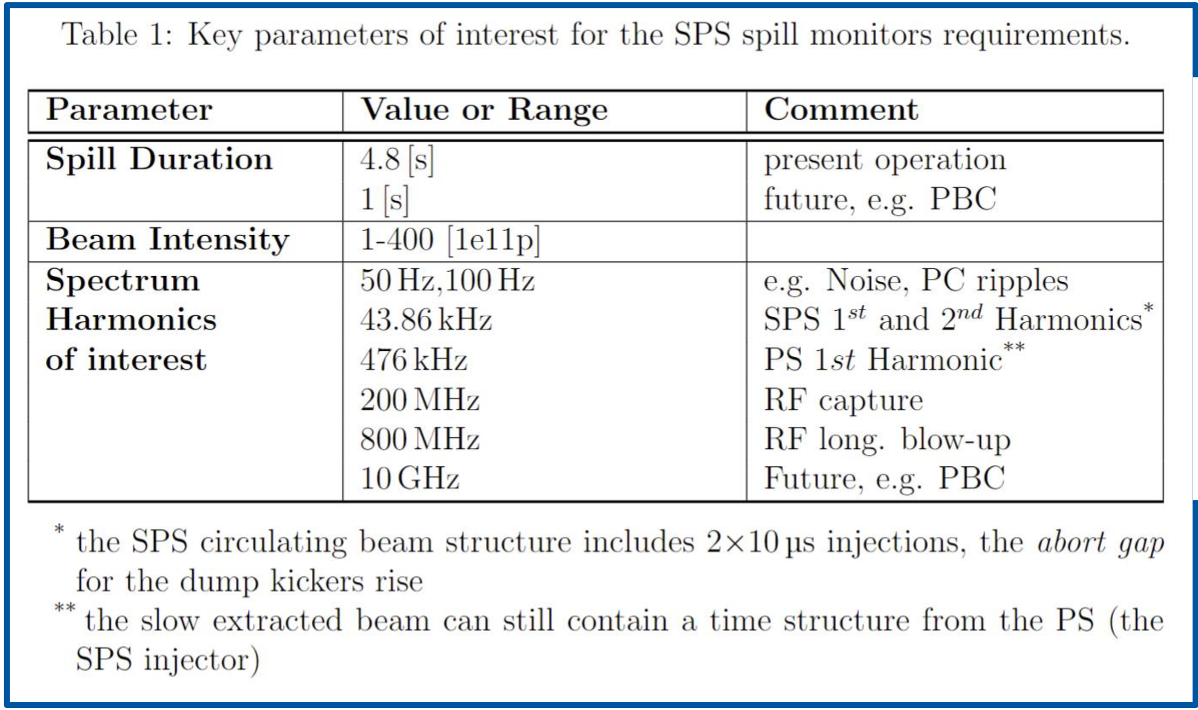


Table 1: Key parameters of interest for the SPS spill monitors requirements.

Parameter	**Value or Range**	**Comment**
Spill Duration	4.8 [s]	present operation
	1 [s]	future, e.g. PBC
Beam Intensity	1-400 [1e11p]	
Spectrum Harmonics of interest	50 Hz,100 Hz	e.g. Noise, PC ripples
	43.86 kHz	SPS 1st and 2nd Harmonics*
	476 kHz	PS 1st Harmonic**
	200 MHz	RF capture
	800 MHz	RF long. blow-up
	10 GHz	Future, e.g. PBC

[*] the SPS circulating beam structure includes 2×10 µs injections, the *abort gap* for the dump kickers rise

[**] the slow extracted beam can still contain a time structure from the PS (the SPS injector)

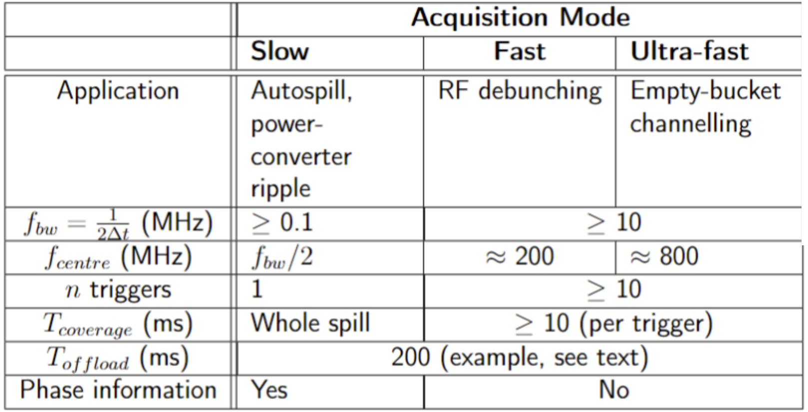
From **few nA** to **few uA**

From **few Hz** to

- **800 MHz** (SPS NA CONS, short term)
- **several GHz** (PBC, long term)

Spill Monitoring Requirements – DAQ

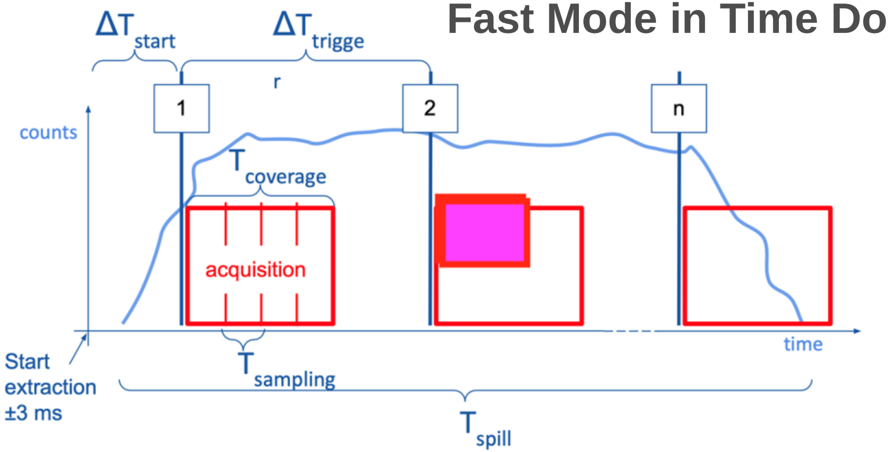
For NA CONS monitors == current developments



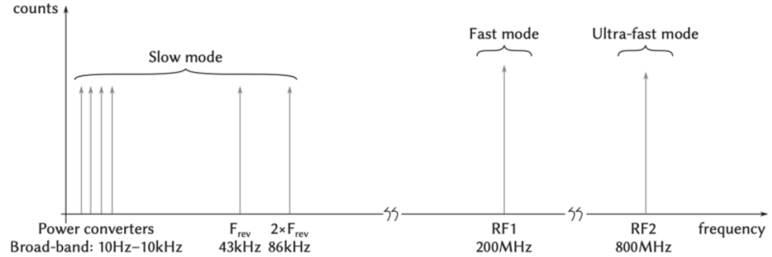
	Acquisition Mode		
	Slow	**Fast**	**Ultra-fast**
Application	Autospill, power-converter ripple	RF debunching	Empty-bucket channelling
$f_{bw} = \frac{1}{2\Delta t}$ (MHz)	≥ 0.1	≥ 10	
f_{centre} (MHz)	$f_{bw}/2$	≈ 200	≈ 800
n triggers	1	≥ 10	
$T_{coverage}$ (ms)	Whole spill	≥ 10 (per trigger)	
$T_{offload}$ (ms)	200 (example, see text)		
Phase information	Yes	No	

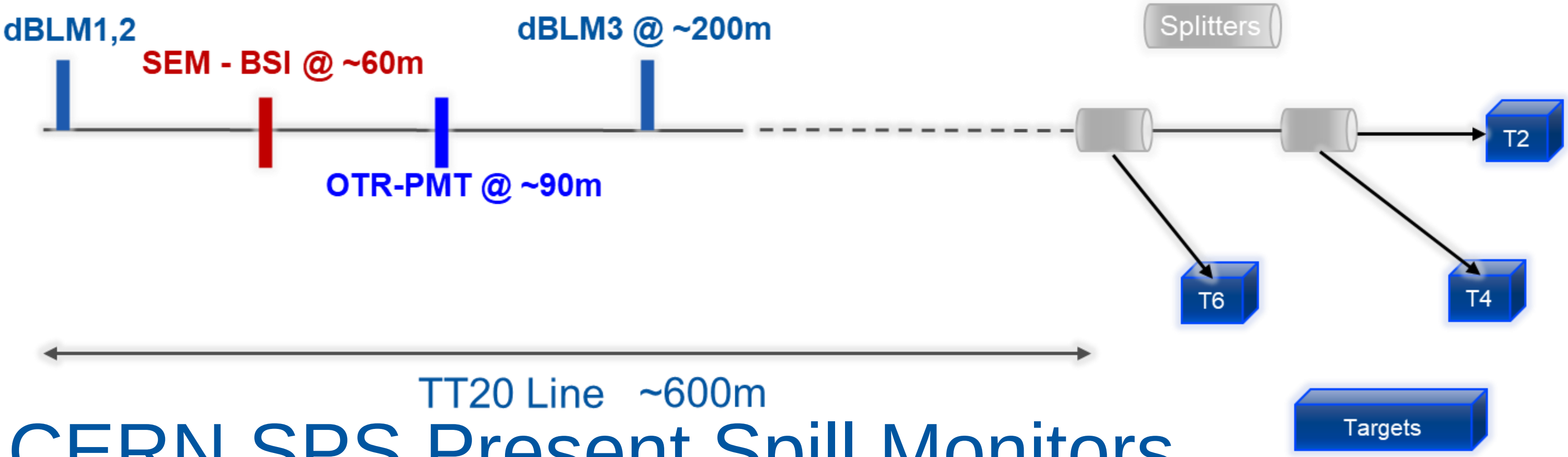
Table 3.1: List of requirements for North-Area spill monitors data processing.

Fast Mode in Time Domain



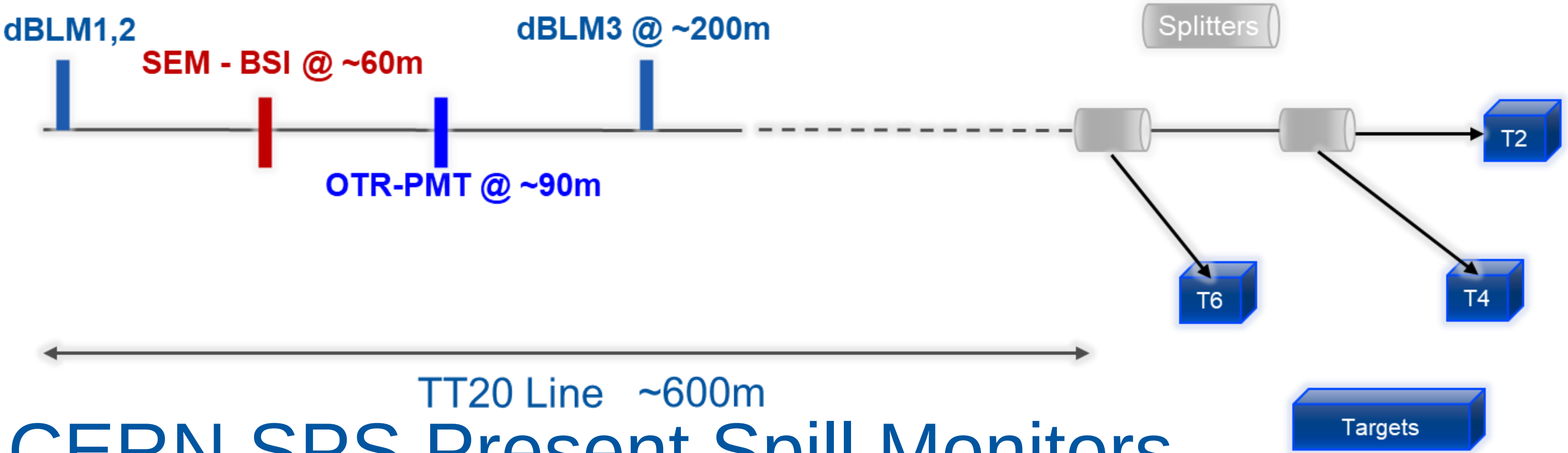
Slow and Fast Modes in Time Freq. Domain





CERN SPS Present Spill Monitors

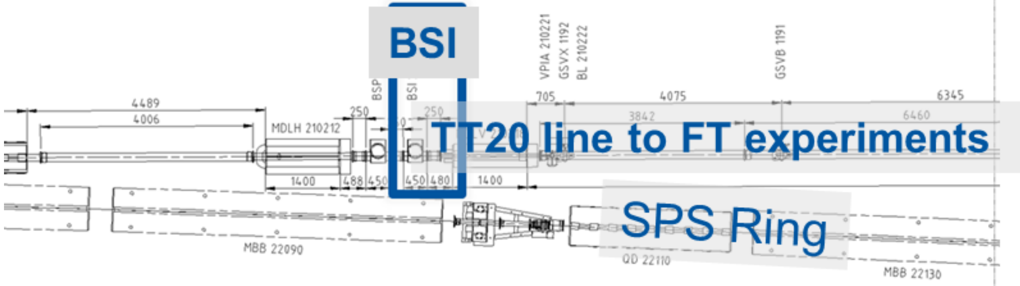
Secondary Emission Monitor (SEM)	DC → 1-2 MHz
3 x Diamond Beam Loss Monitors (dBLM)	25 kHZ → 1-2 GHz
Optical Transition Radiation – Photomultiplier Monitor (OTR-PMT	DC → 200 MHz 800 MHz +- xx MHz



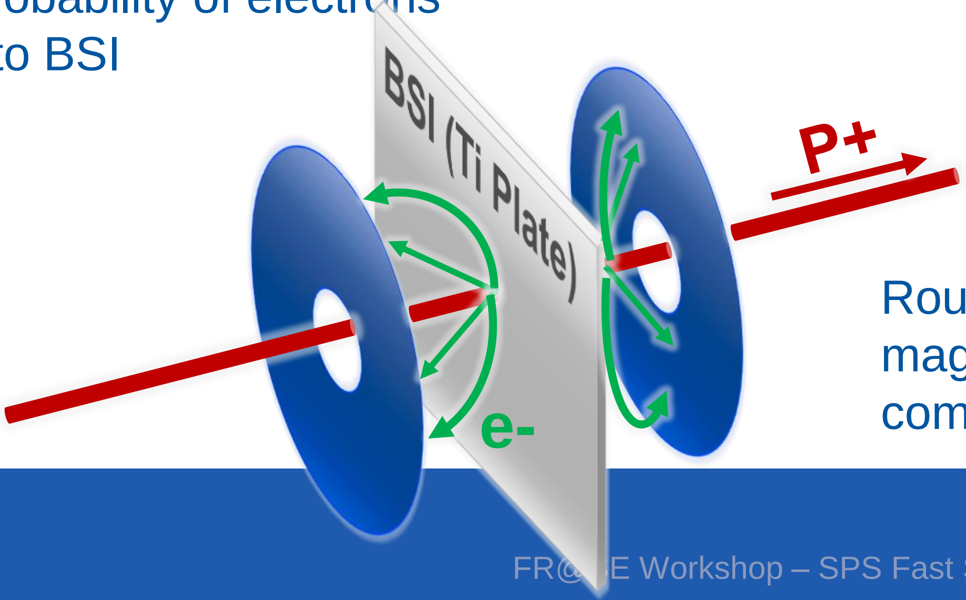
CERN SPS Present Spill Monitors

1. **Secondary Emission Monitor (SEM)**
2. 2 x Diamond Beam Loss Monitors (dBLM)
3. Optical Transition Radiation – Photomultiplier Monitor (OTR-PMT)

Secondary Emission Monitor (SEM - BSI)



SEM BSI = Aluminum foil
Proton beam generates
Secondary Electrons , pulled
by **bias (+200V) plates** to
minimize probability of electrons
going back to BSI



Routinely used to **feedforward** magnet power converters and compensate **50-100Hz** ripples

Secondary Emission Monitor (SEM)

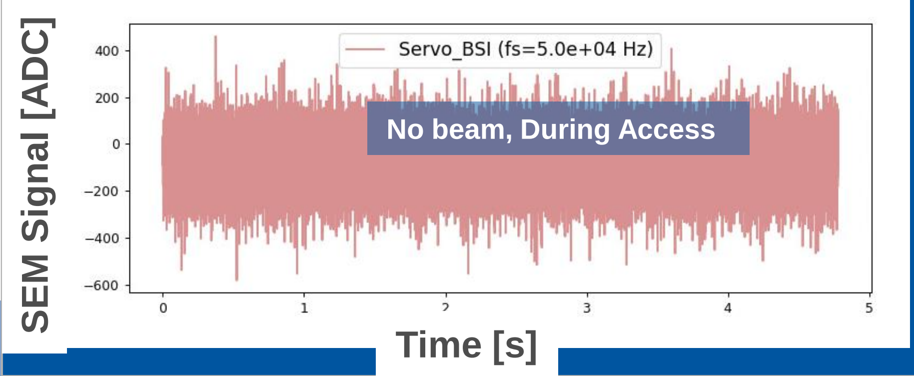
DAQ

- Amplifier in the tunnel (10MHz BW)
- CK50 cables (>200m)
- Low pass filter (1kHz) to suppress high freq noise
- VME ADC (100kHz BW, 200kS/s, 16bit)

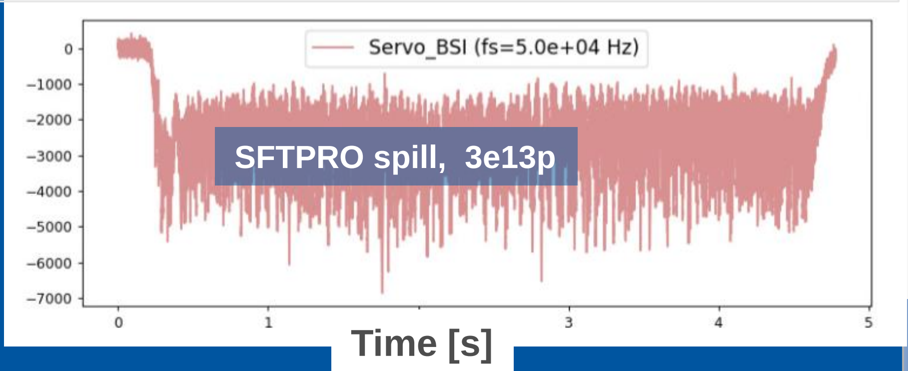
Signal / Noise Ratio (before 2022)

- Low signal (SEY=~4%) and pickup noise
- **SNR** = ~ 4000 / 800 (p2p) [ADC counts] **~= 5** in this example, after **low pass @ 1kHz**

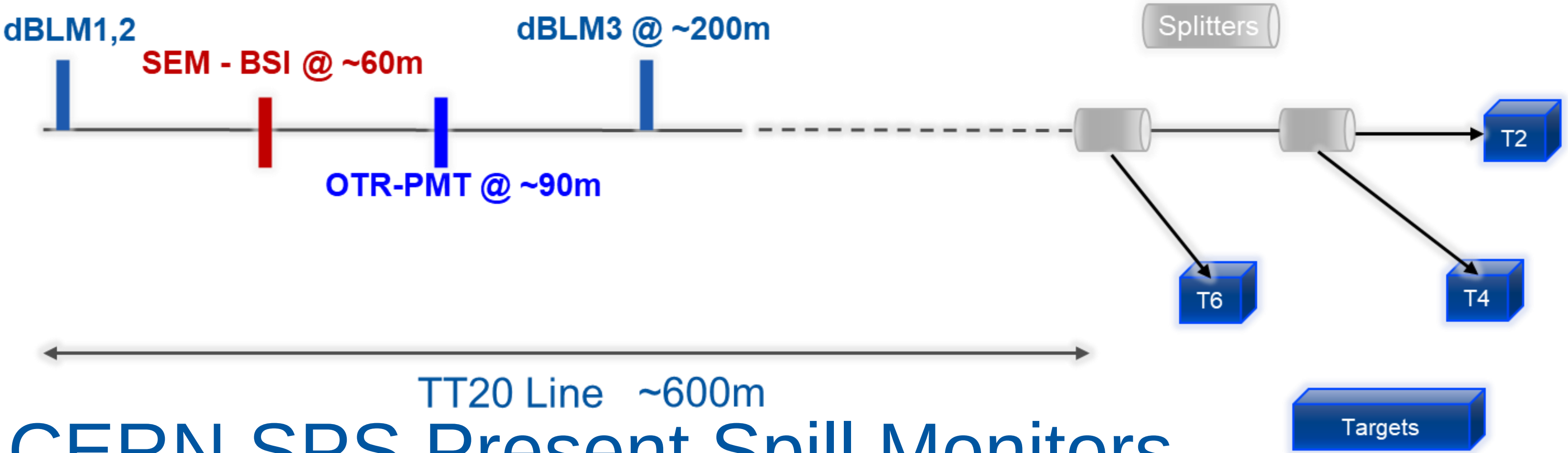
Refurbishment of in vacuum detector + cabling done beginning of 2023. No dramatic improvement. EMI pick-up noise (in vacuum) still suspect.



No beam, During Access



SFTPRO spill, 3e13p

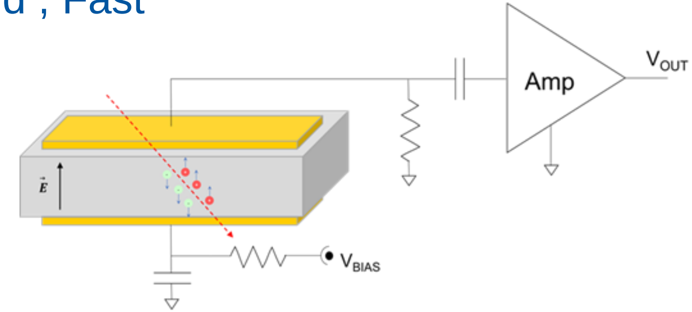


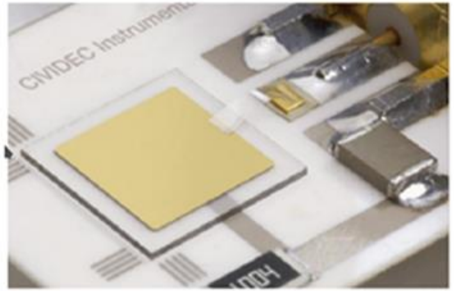
CERN SPS Present Spill Monitors

1. Secondary Emission Monitor (SEM)
2. **3 x Diamond Beam Loss Monitors (dBLM)**
3. Optical Transition Radiation – Photomultiplier Monitor (OTR-PMT)

Diamond Beam Loss Monitors (dBLM)

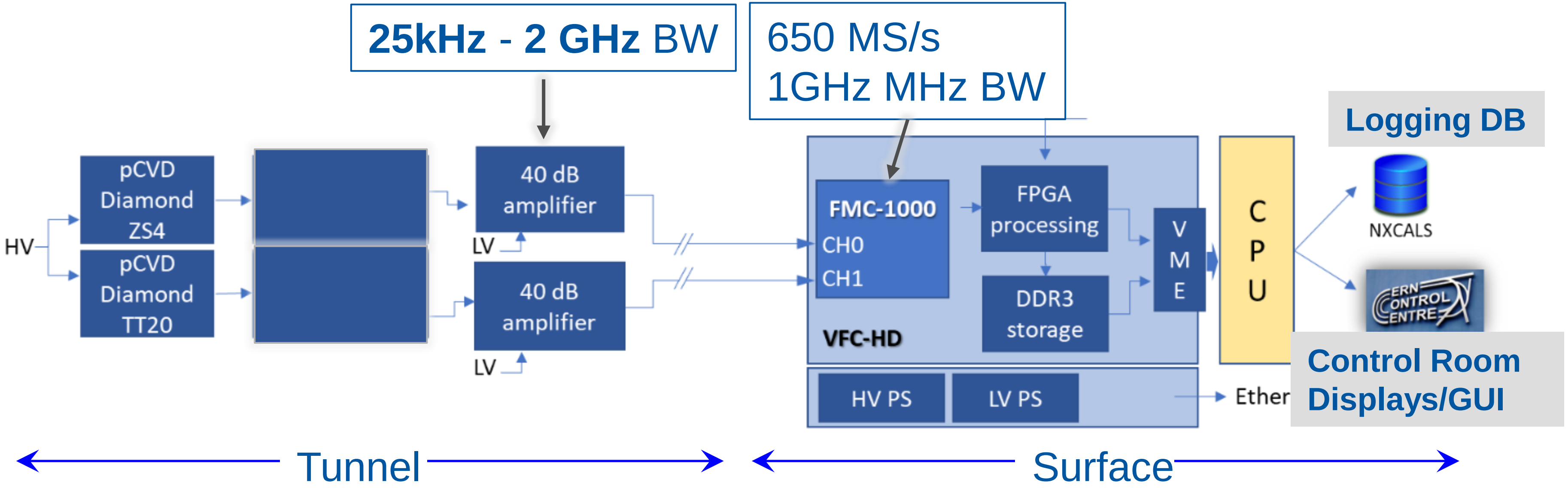
- Chemical Vapor Deposition (CVD) , 1cm x 1cm , 500um thick, Gold Coated
- Electron-Hole pairs from ionizing radiation traversing the substrate
- Used for many years in CERN synchrotrons (LHC, SPS, PS, PSB) and inj/extr beamlines
- Rad hard , Fast





- **E. Calvo Giraldo et al., “The Diamond Beam Loss Monitoring System at CERN LHC and SPS”, IBIC Proceedings, 2022. TU2C2**
- H. Frais-Kolbl, E. Griesmayer, H. Kagan, and H. Pernegger, “A fast low-noise charged-particle CVD diamond detector,” IEEE Transactions on Nuclear Science, vol. 51, no. 6,pp. 3833–3837, 2004, doi:10.1109/TNS.2004.839366
- B. Dehning, E. Effinger, H. Pernegger, D. Dobos, H. Frais-Kolbl, and E. Griesmayer, “Test of a Diamond Detector Using Unbunched Beam Halo Particles,” CERN, Tech. Rep., 2010, https://cds.cern.ch/record/1258407

dBLM DAQ



25kHz - 2 GHz BW

650 MS/s
1GHz MHz BW

Logging DB

**Control Room
Displays/GUI**

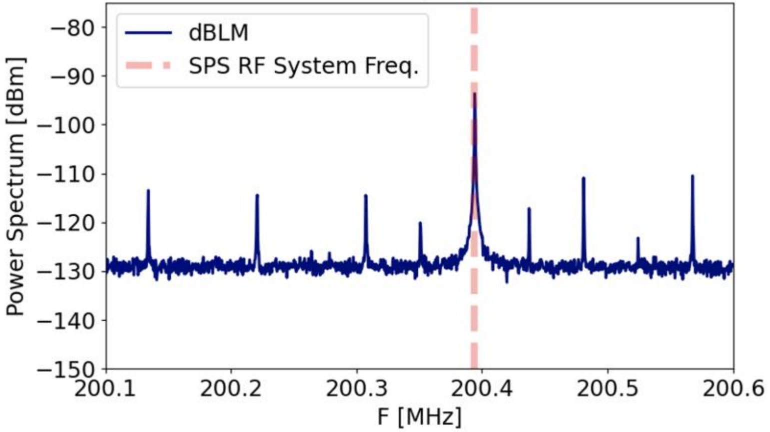
Tunnel

Surface

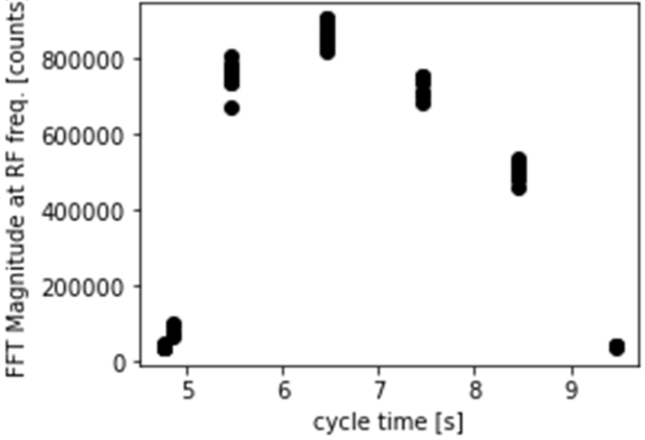
System fully integrated into CERN control system, data logged

dBLM – Measurement Example

200 MHz Harmonic in a 2ms ‘chunk’ of the spill

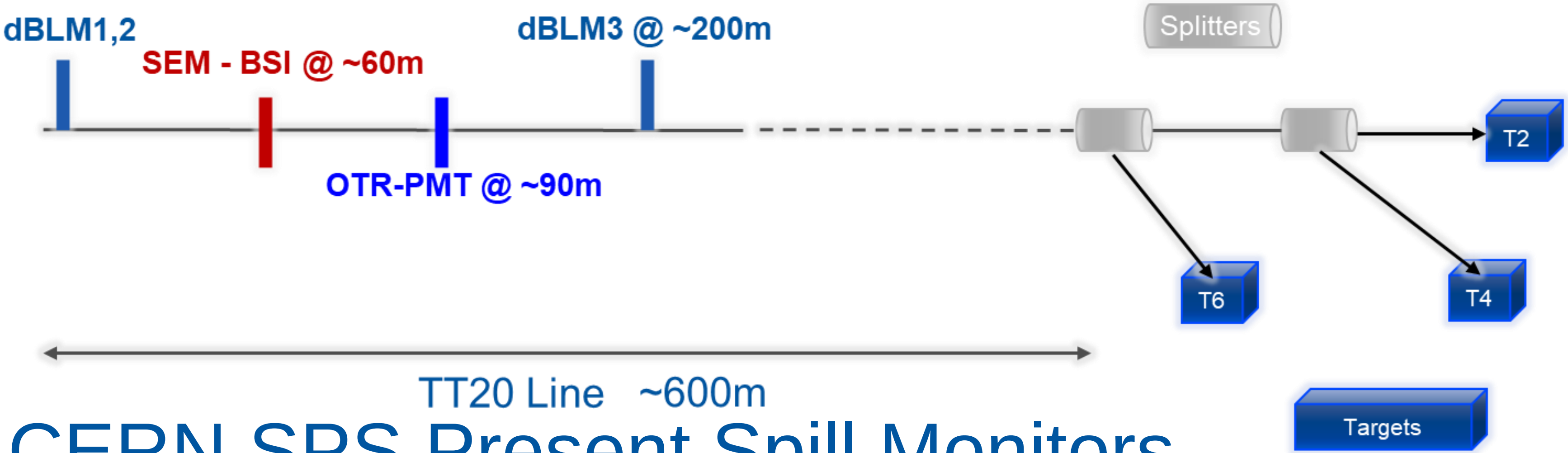


200 MHz Evolution along the spill



Measurements achieved after subtracting average signal spectrum without beam

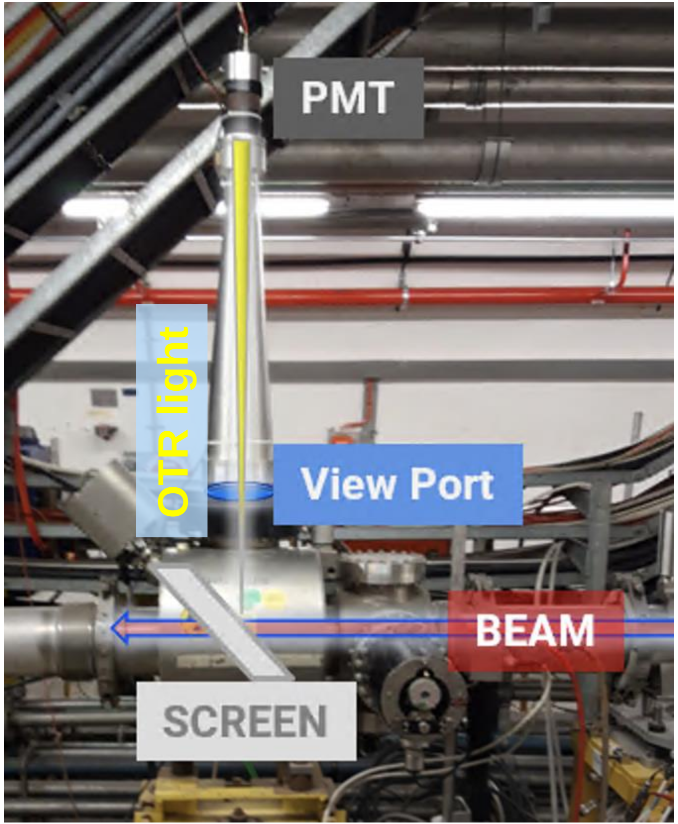
P. A. Arrutia Sota et al. “dBlms first results and md planning, presentation at CERN SLAG” (2022), `https://indico.cern.ch/event/1155679`



CERN SPS Present Spill Monitors

1. Secondary Emission Monitor (SEM)
2. 2 x Diamond Beam Loss Monitors (dBLM)
3. **Optical Transition Radiation – Photomultiplier Monitor (OTR-PMT)**

Optical Transition Radiation (OTR) – Photomultiplier (PMT)



Concept: count (instead of ‘standard’ imaging) photons from OTR

2021-2022:
Old system refurbished with new Ti screen, PMT and amplifier

2022-2023

- Test measurements via non-operational DAQ (next slide)
- From the start we could measure spill structure and power spectrum from DC to 300 MHz
- High signal even with OTR screen OUT → System sensitive to beam losses
- Small signal increase with screen IN → captured OTR radiation < than expected

PMT – OTR DAQ 2022-2023

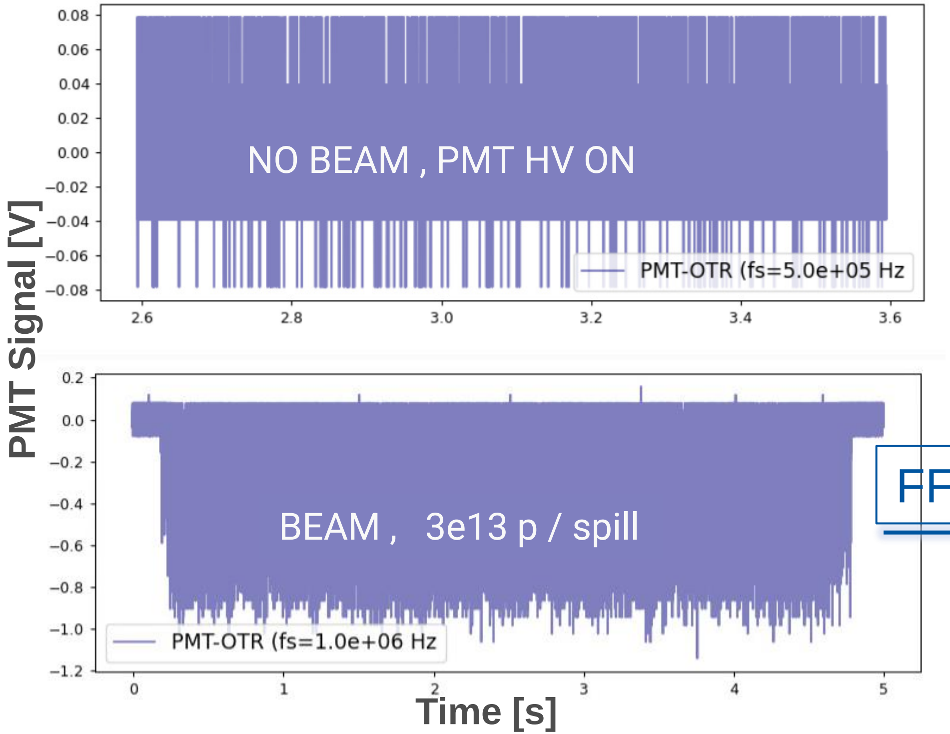
- **Fast PMT** ~ 0.8 ns anode pulse rise time
- **Wide band (DC-300MHz) amplifier** @ PMT output
- CK50 cables to surface (>200m)
- Signal duplicated to 2 separate PicoScope® **digitizers (500MHz BW, 5GS/s, 2GS Memory)**
  1. Set at ~low rate (e.g**. 1MHz**) to cover all spill (**5sec**)
  2. Set at high rate (e.g. **625MHz**) to cover ‘chunks’ of **1-10 ms** along the spill
- PicoScope® USB connection to Linux **PC integrated into CERN control system (FESA)**

OTR – PMT (example with fs=1MHz)

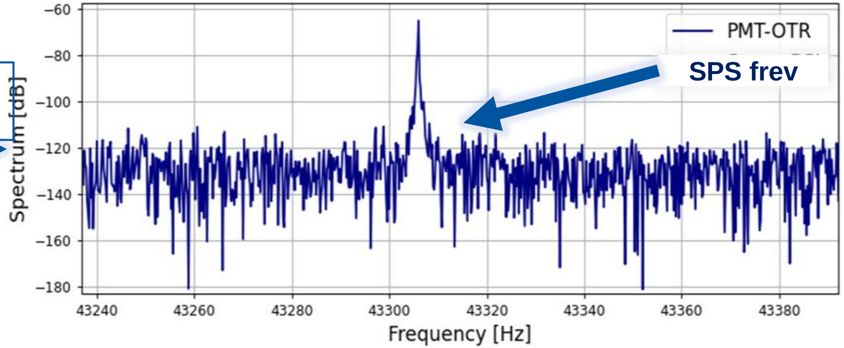
Low noise.

Here, with no beam and PMT HV ON

- **SNR**~=0.9/0.160=**5.6** in this example
- Similar to SEM, but here there is no low pass filter



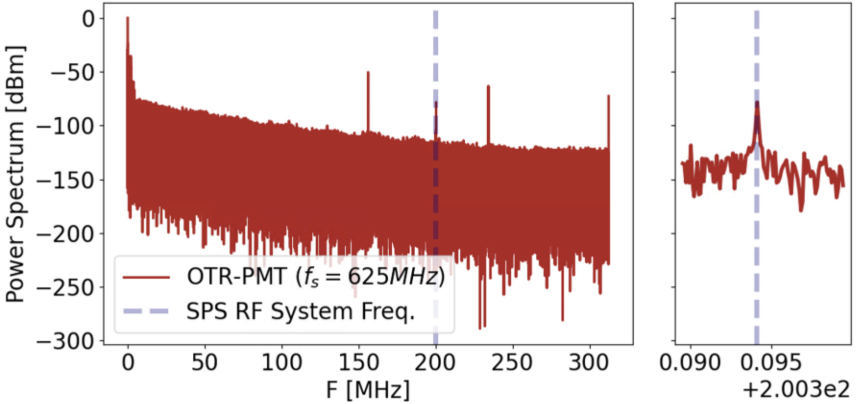
FFT

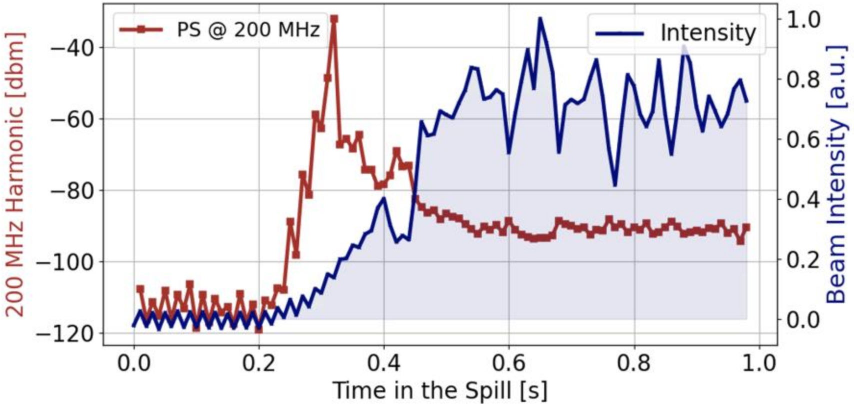


OTR – PMT (example with fs=625 MHz)

High frequency acquisition on a ‘chunk’ to study presence SPS RF (nominal=200.3941 MHz) in spill intensity

Scanned trigger delay to measure 200 MHz harmonic along the spill (here only first part of the spill)



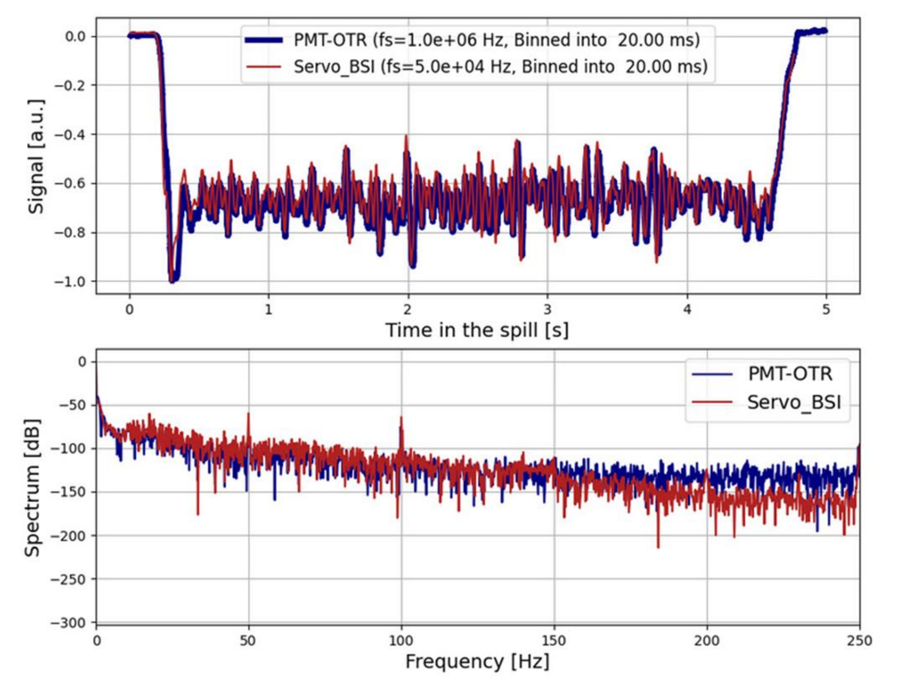


Comparison between SEM and OTR-PMT systems

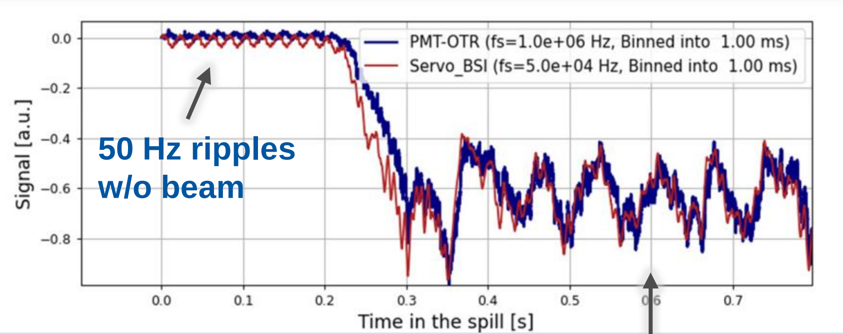
OTR-PMT vs SEM

Binning both monitors in equal time intervals

@ 20 ms



@ 1 ms (Zoom on Start of the Spill)



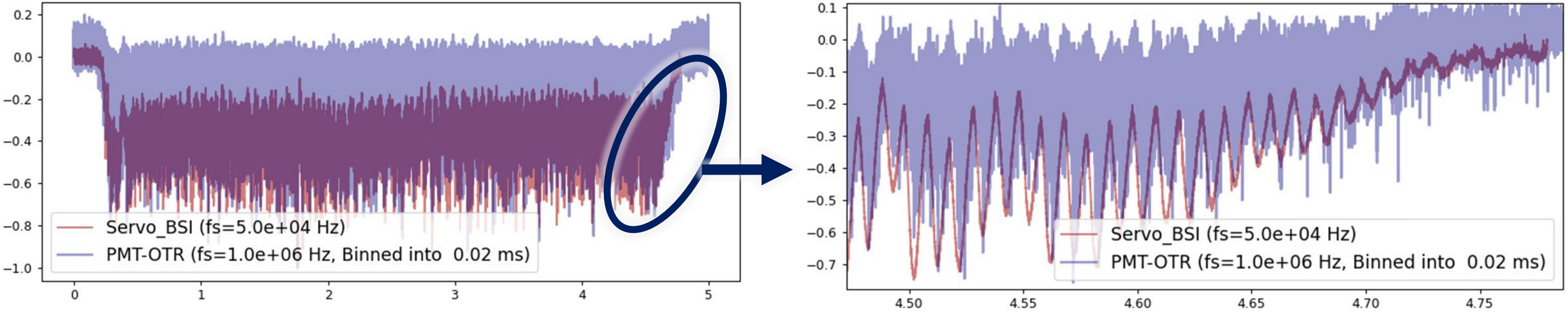
50 Hz ripples w/o beam

10 Hz beam intensity modulation

Impressive agreement between two systems based on different detector, DAQ and 30m apart

OTR-PMT vs SEM

SEM @ 50 kHz (20us), no binning
OTR-PMT @ 1MHz binned @ 50 kHz (20us)



As expected from **SEM** setup**: low pass filter (1kHz) reduces overall BW**, even when sampling at higher rate (50 kHz in this example)

OTR-PMT gives same envelope (100Hz beam intensity fluctuations) **but also measures higher frequency** beam intensity fluctuations

OTR-PMT system limitations

Location with ‘high’ losses

Limited diagnostics to check OTR screen and optics alignment

Test DAQ based on ‘PicoScopes’

- → PMT ageing
- → difficult to quantify and optimize OTR radiation detection efficiency
- → No possibility for signal conditioning / processing before and after digitization (like with FPGA based DAQs)

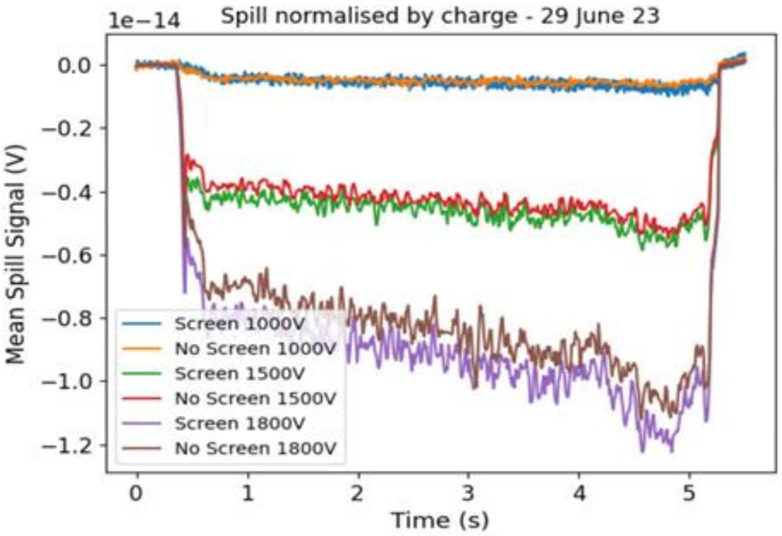
OTR-PMT – screen IN vs screen OUT

After many tests to compare the signal integrated with the screen IN w.r.t. screen OUT, including

- PMT voltage scans
- Proton beam steering on the screen
- Diffusing or focusing radiation on PMT

→ Kept on seeing small changes with screen IN or OUT

→ Either very large losses or very low OTR collection efficiency (or large error on simulations of expected number of OTR photons production)



OTR-PMT – screen IN vs screen OUT

December 2023: inspection of screen installation revealed quite a large **misalignment (3 to 5 degrees)** w.r.t. nominal 45 degrees w.r.t. beam trajectory

→ Simulations indicate that radiation collection efficiency only few %

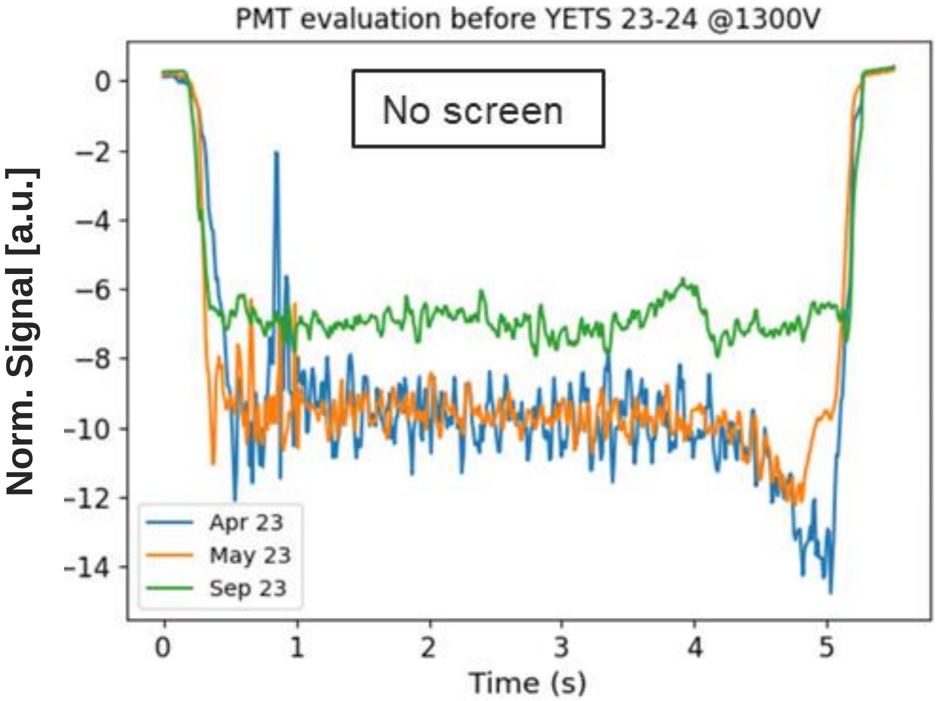
→ **This quite ‘big’ issue could mean ‘very good’ news**

→ **Alignment for 2024 carefully checked** during shutdown + will have diagnostics to check on-line (See later slides)

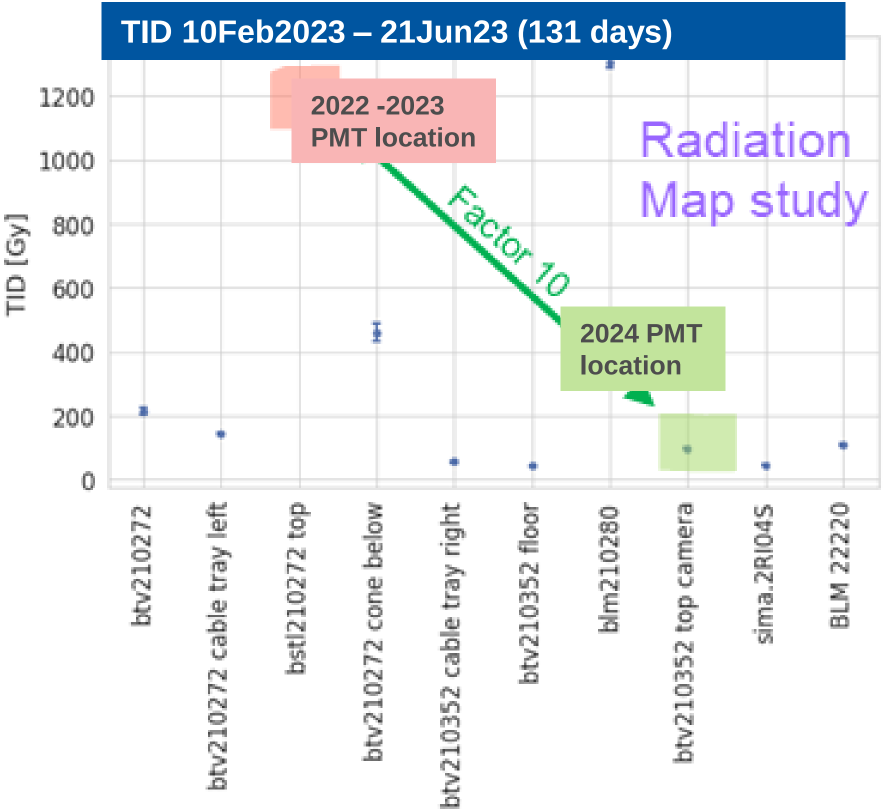
OTR-PMT – PMT ageing

2023 operation / tests with increased HV and high proton losses evidenced the PMT ageing

→ **30-40% signal** (normalized to extracted intensity) **degradation** in Sep w.r.t. Apr/May



OTR-PMT – Radiation Maps



We looked at available radiation surveys and indeed the present detector location is not favorable.

OTR-PMT system refurbishment for 2024 run

Move detector at location with less expected losses

New detector layout including camera for imaging OTR light

New VME DAQ

OTR-PMT – New Location, New Layout

- The fast spill monitor system was moved to another existing screen station, where 2023 losses where much less
- More robust optical design
- Added translation stage hosting PMT and Imaging camera, will be possible to check OTR photons are focused on sensor.

New VME DAQ

- After formalizing the function specifications for the short term (see initial slides):
  - **Developed, produced and installed (2023-24 winter shutdown) new VME ADC** expected to fulfill requirements **up to 800 MHz**
  - Few words on how we managed to arrive here in the next two slides

DAQ – from Functional to Engineering Specs

Acquisition Mode	Sampling Rate	Storage Needed	Ccomments / Remarks
Slow	> 200kHz	32 Mbits	• Suitable for ADCs with a sampling frequency > 200kHz. • Can increase sampling rate and memory for better frequency or temporal resolution.
Fast (up to 200MHz)	≥ 400 MHz	64 Gbits	• Requires ADC with minimum 400 MHz sampling rate and sequential triggering mechanism to reduce data storage needs.
Ultra-fast (800MHz)	≤ 1.6 GHz	Depends	• Can be under-sampled if the ADC and signal path support it. • Alternatively, a fast ADC at > 1.6 GHz can be used, or the 800 MHz frequency can be down-mixed to a compatible band for Fast mode.

DAQ – Implementation

4.1.2 Implementation

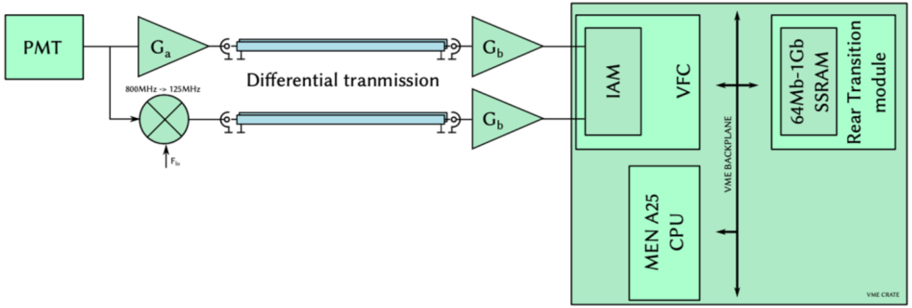
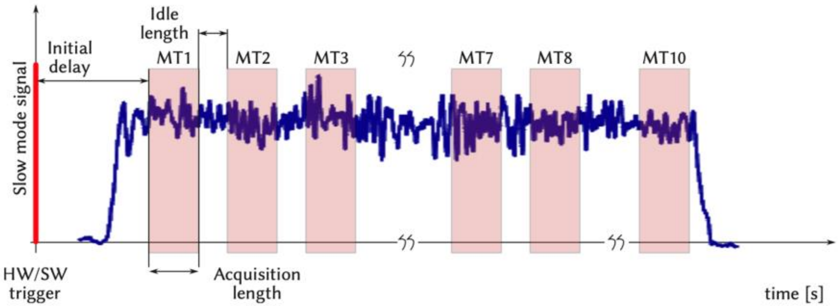


Figure 4.1: System-level schematic of the implemented COTS DAQ

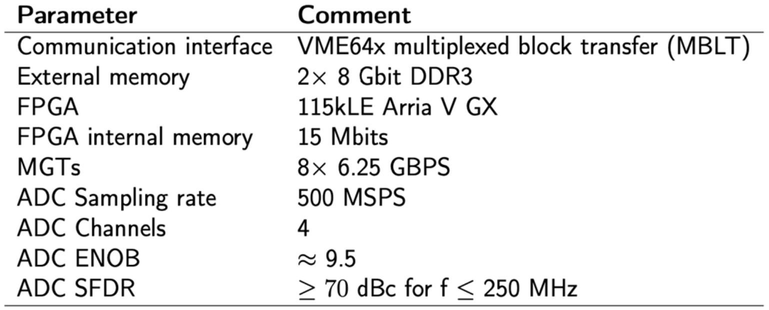
New VME DAQ based on CERN BI carrier board (VFC) with 500MS/s FMC ADC

- Designed for DC-200MHz + 800MHz (down conversion to 125MHz) +-100MHz
- installed, to be commissioned with beam

Fast mode trigger and timing logic



DAQ – VFC + FMC ADC specs



Parameter	Comment
Communication interface	VME64x multiplexed block transfer (MBLT)
External memory	2× 8 Gbit DDR3
FPGA	115kLE Arria V GX
FPGA internal memory	15 Mbits
MGTs	8× 6.25 GBPS
ADC Sampling rate	500 MSPS
ADC Channels	4
ADC ENOB	$\approx$ 9.5
ADC SFDR	$\geq$ 70 dBc for f $\leq$ 250 MHz

Table 4.1: Properties of the DAQ composed of VFC and FMC-500 ADC module.

PLANS (to go to xx GHz)

Plans towards xx GHz range (DAQ side)

On-going studies (conceptual + few lab tests for the moment

Option	Pros	Cons
ATCA	High-speed communication channels, used in CERN experiments	Expensive, requires minimum configuration, not cost-effective for isolated system
SoC (RFSoC)	Flexibility in choosing ADCs, local communication between ARM CPU and FPGA	Existing modules have low memory, limited availability of larger memory options
PCIe	Widely used standard, high-speed data transfer, supports DMA	Requires PCIe form-factor FPGA carrier with sufficient memory, limited module options with large memory

Towards xx GHz (Detector Side)

Cherenkov detector for proton Flux Measurement (CpFM)

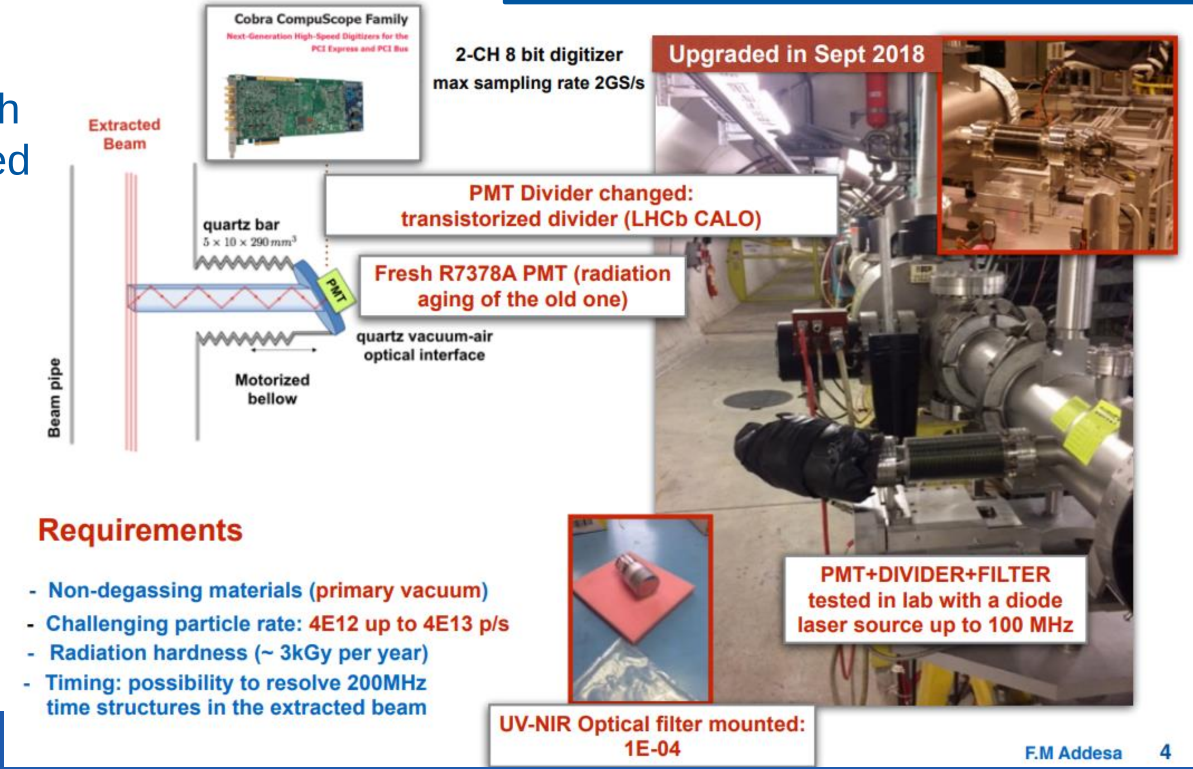
Plans towards xx GHz range (Detector side)

Cherenkov detector for proton Flux Measurement(CpFM)

F. M. Addesa et al. “In-vacuum Cherenkov light detectors for crystal-assisted beam manipulations,” https://cds.cern.ch/record/2661725

In vacuum quartz bar producing Cherenkov light

- System evolution of one used with low particle flux for crystal assisted extraction
- **Can go to few GHz at least (as OTR-PMT, but with better SNR)**
- Validated in 2018 with custom made DAQ



Cobra CompuScope Family

Next-Generation High-Speed Digitizers for the PCI Express and PCI Bus

2-CH 8 bit digitizer
max sampling rate 2GS/s

Upgraded in Sept 2018

Extracted Beam

quartz bar $5 \times 10 \times 290\, mm^3$

PMT

Beam pipe

Motorized bellow

quartz vacuum-air optical interface

PMT Divider changed:
transistorized divider (LHCb CALO)

Fresh R7378A PMT (radiation aging of the old one)

Requirements

- Non-degassing materials (primary vacuum)
- Challenging particle rate: 4E12 up to 4E13 p/s
- Radiation hardness (~ 3kGy per year)
- Timing: possibility to resolve 200MHz time structures in the extracted beam

PMT+DIVIDER+FILTER
tested in lab with a diode laser source up to 100 MHz

UV-NIR Optical filter mounted:
1E-04

F.M Addesa 4

Plan

- Resurrect system
- Study ultimate bandwidth
- Propose ~standard DAQs

Cherenkov detector (CpFM) – Status

New phase of tests could **start end of 2023**

- The status of the **PMT** has been checked with photon source in tunnel → **ok**
  - Being connected to **‘Picoscope’**
- The stepper motor, connections of HV functional and integrated in control system.
- Installed a new cover, to ensure light tightness.
  - The dark counts have been measured. **The setup is ready and waiting for the beam to measure.**

2024 tests will lead to next phase towards fulfilling multi-GHz requirements, with possible options

- **Consolidate / upgrade** present system
- **Start new design** based on same technology , e.g. less invasive radiator, different radiator
- **Look at other techniques**

All this within Physics Beyond Colliders (PBC) project

Outlook / General Remarks

- **SEM detector is robust** in measuring 50-100 Hz, SNR limited
- **dBLMs surely suitable for high freq**. measurements. Poor SNR to be understood
- **OTR-PMT:**
  - proved to work (as BLM …) up to 200MHz
  - 2024: explore 800MHz, with new VME DAQ. If all ok, port it to ‘operational’ state
- For **all monitors**: maximizing SNR, identifying and mitigating different sources of **noise, EMI and background**
  - If some of them are confirmed to be ‘local’, consider new locations (as already done for ORT-PMT)
- Going to **> 1GHz** range implies DAQ upgrades (e.g. optical signal transmission) and/or new techniques (e.g. optical systems like CpFM)
  - **efforts on fast DAQs will be applicable to different techniques**.
- Depending on existing monitors progress, **alternative/complementary methods** (gas scintillation, gas ionization) can be considered, not discussed today

BACKUP / SUPPORT / REFERNECE SLIDES

Limitations and plans

System	Limitation(s) that can be improved	Plan
SEM	SNR, Analog BW and Sampling rate	Refurbish in vacuum detector ,consider new amplifier and ADC, aim a removing 1kHz filter
dBLM	SNR	More beam based studies in TT20 Consider option of mono-crystalline detector + amplifier decoupling low and high frequencies ?
OTR-PMT	High signal with screen OUT	Dedicated beam based studies (signal vs beam position) Move or Duplicate PMT (away from losses)
Gas Scintillation	-	Study expected signal levels at SPS
Cherenkov Detector	-	Resurrect system Study fast DAQ that can be integrated into CERN control system

Summary (with present implementations)

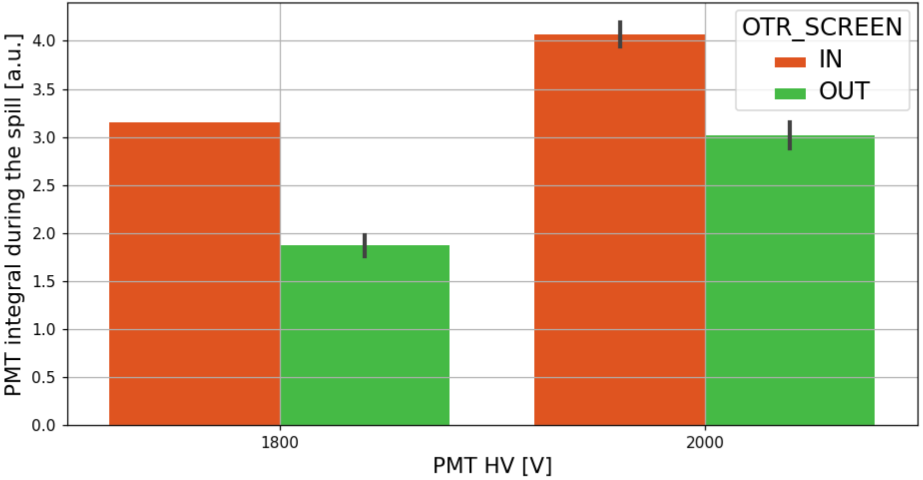
System	Analog BW	Sampling	Max Acq Period
SEM	10 MHz (amplifier) 1 kHz (LP filter)	Up to 200 kS/s	Full Spill
dBLM	2 GHz Amplifier 500 MHz Digitizer Low Cutoff @ ~25kHz	650 MS/s (fixed)	Xxx ms
OTR-PMT	300 MHz Amplifier 500 MHz Digitizer	Up to 5 GS/s	Full spill @ few MHz ~ 3ms @ 5GS/s

The 3 systems have long Cu cables also limiting BW to < 500MHz

- **Digitization in the tunnel and optical signal transmission** is under study (see backup slide)

OTR - PMT

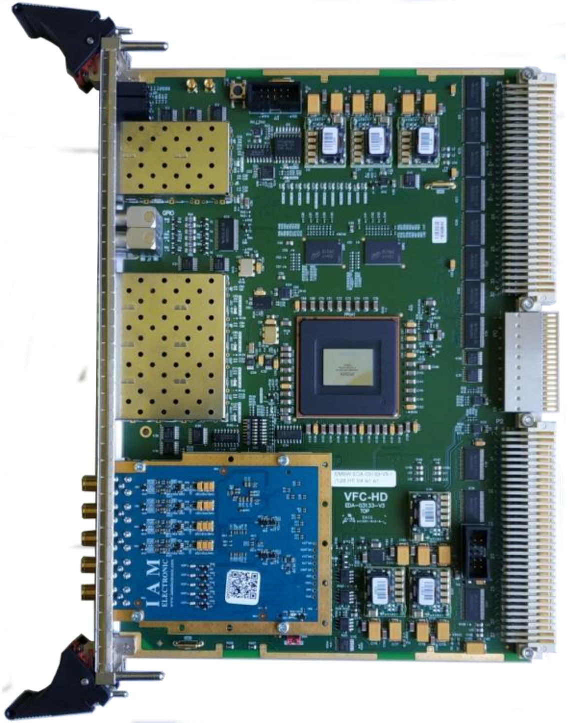
- Resulted to be very sensitive to beam losses during physics (>1e13 p/spill) even if PMT is 1m away. Plan: move or duplicate PMT and to be dominated by OTR w.r.t. losses

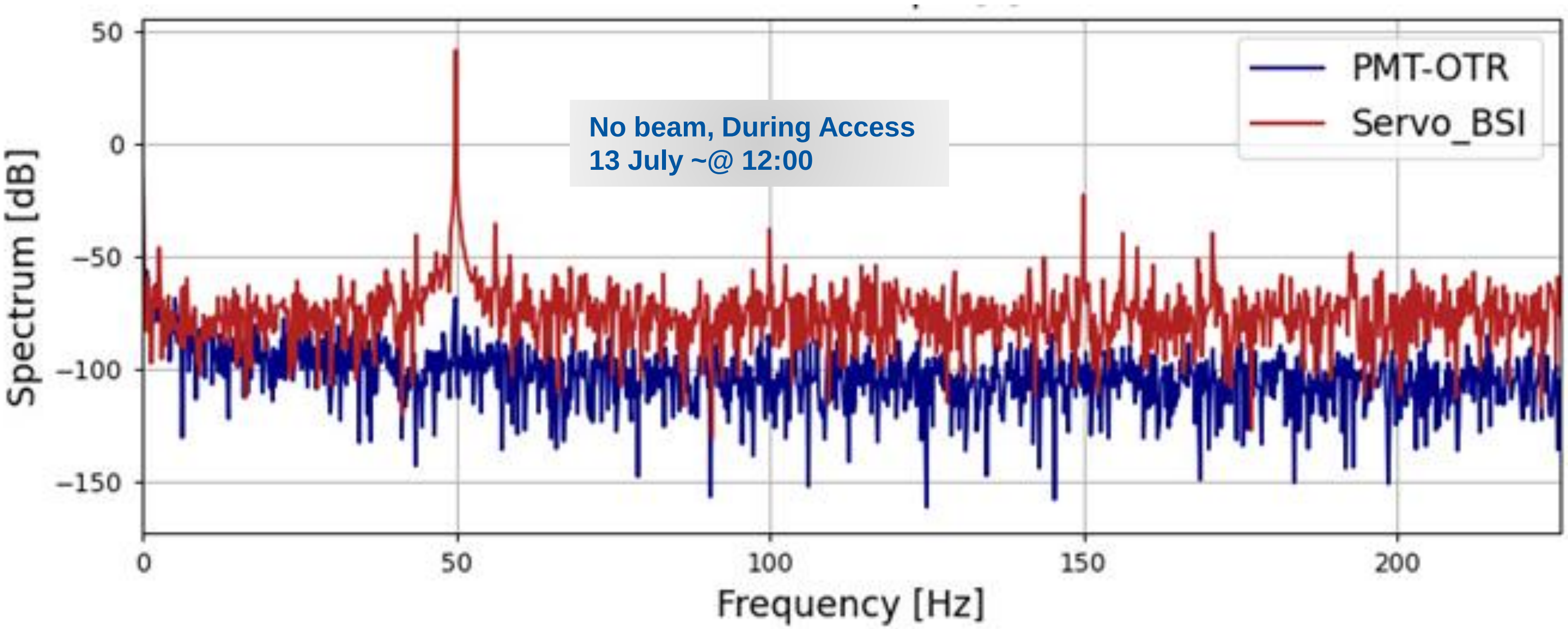


OTR – PMT – Fast DAQ studies

- New acquisition system based on VFC+ FMC ADC
- single channel acquisition
- fast sampling mode with selectable down sampling:
  - 500MS/s @ ~2 seconds of data storage
  - 250MS/s @ ~4 seconds of data storage

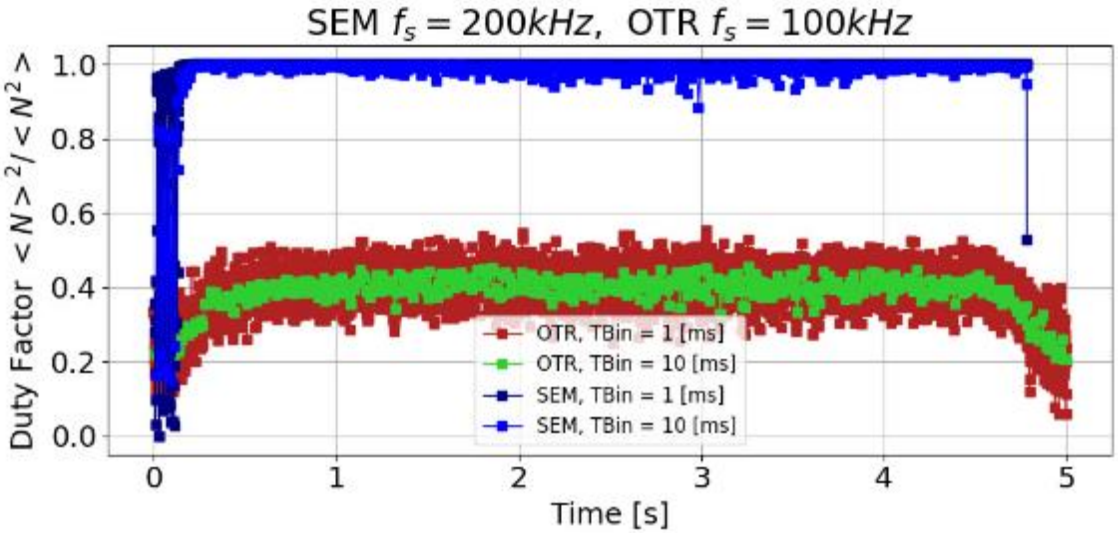
- slow sampling mode, e.g. 200kHz up to 2 MHz: still to be defined how long acquisition can be stored:
  - DDR memories store fast sampling data
  - FPGA internal memory is 64MBits → 1MSample → 5.2seconds





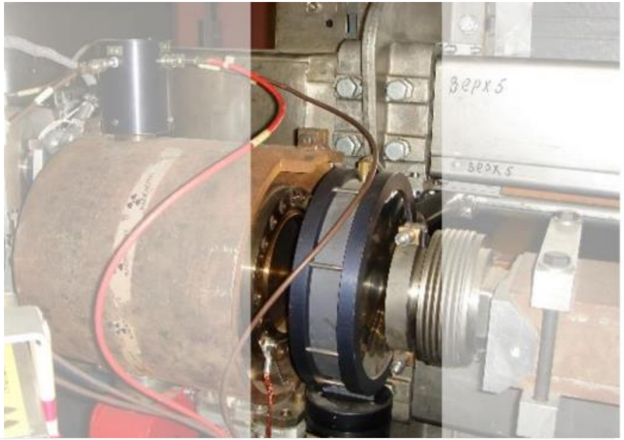
No beam, During Access
13 July ~@ 12:00

Duty Factor


SEM $f_s = 200kHz$, OTR $f_s = 100kHz$
Duty Factor $<N>^2/<N^2>$
1.0
0.8
0.6
0.4
0.2
0.0
0
1
2
3
4
5
Time [s]
OTR, TBin = 1 [ms]
OTR, TBin = 10 [ms]
SEM, TBin = 1 [ms]
SEM, TBin = 10 [ms]

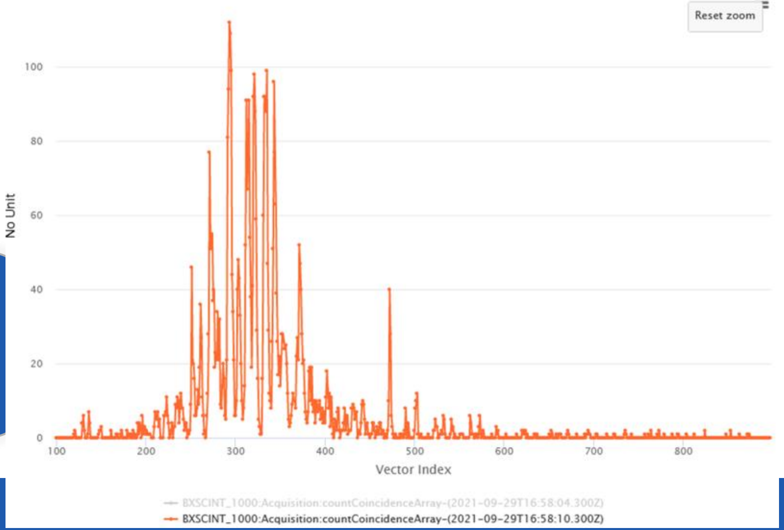
Gas Spill Detector @ CERN PS

24 GeV protons



- Based on detecting light emitted by beam-gas interaction
- Tank filled with Nitrogen, ~22m from extraction point
- Decay time ~ 10ns
- Two PMTs in coincidence (to suppress noise)
- Analog pulses converted to NIM-standard (30 ns, −1 V) and sampled at 2 kHz
- DAQ: 10 kHz possible, now set to 2.5kHz
  - Ultimate BW now anyhow limited by present cables and VME bus
- TDC based DAQ under study, could reach 1 MHz

Plan (depending on resources and priorities):
Study signal levels and feasibility @ SPS 400 GeV



dBLM

		Comments/Remarks
Detector / Method	pCVD crystals	
Max Sampling Freq	**650 MHz**	BI standard carrier board (VFC) + 2 Ch-650 MS/s FMC ADC
Analog BW	**Better than ~200 MHz (detector response)**	Well suited @ LHC for ghost and satellite bunch measurements
Maximum acquisition window	Few ms (limited by memory buffers and logging DB restrictions)	
S/N	To be fully assessed	**Noise in TT20 higher than ~all other CERN dBLM locations**

OTR - PMT

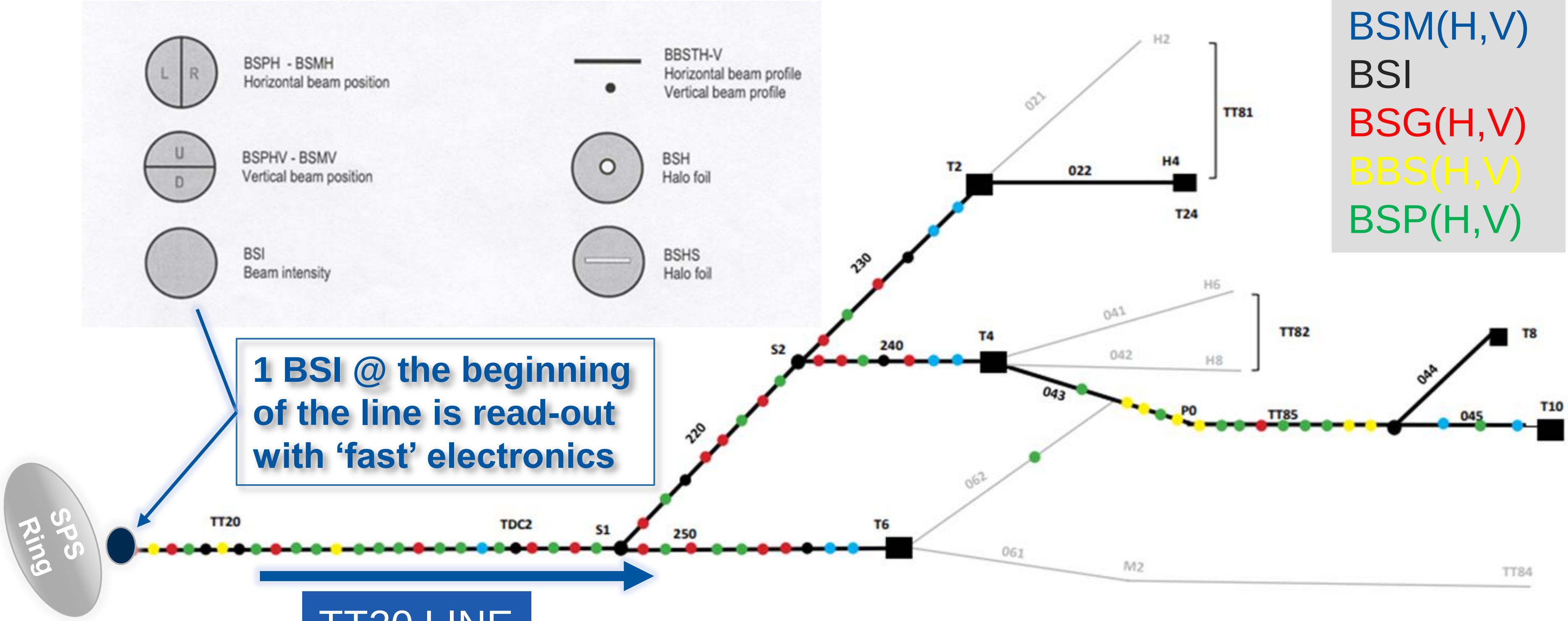
		Comments/Remarks	**Plans**
Detector / Method	OTR from Ti screen	With FT physics beams: see signal without screen == losses on PMT	Bring existing **PMT** (or add second PMT) **away from beam pipe** to be less sensitive to direct losses
Analog BW	**500 MHz** (Picoscope) **200 MHz** amplifier	Can look at faster amplifier (or remove it)	**Longer term studies**: ▪ VME digitizer (next slide) ▪ digitize in the tunnel and optical signal transmission
Max Sampling Freq	**5 GS/s** (Picoscope)	Signal split to two scopes in parallel to have: -chunk at high rate -full spill at low rate	
Maximum acquisition window	Full spill (at ~low rate e.g. 1MHz) 10mS @ 625 MHz		
S/N	160e-3 [p2p] /1 [V] = **1./ 0.160**	**Low noise**	

Secondary Emission Monitor (SEM - BSI)

		Comments/Remarks	**Plans**
Detector / Method	Electrons Secondary Emission from Al Foil	**SEY (few 1e-2)** changes with radiation and vacuum history	Refurbishments with new detectors assembly in YETS 2022-23
Max Sampling Freq	**200 kHz**	Can upgrade to faster ADC	
Analog BW	**~10 MHz (Ampli)** **~kHz (analog filter)**	Both can be made faster if S/N allows	Amplifier tests in the lab, BW studies
Maximum acquisition window	Full Spill		
S/N	**~ 4000 / 800 (p2p) [ADC counts] ~= 5**	50 Hz also with no beam	Noise studies in the lab

Secondary Emission Monitors (SEM)

~80 monitors + ~50 in target boxes – DAQ sampling @ 50Hz



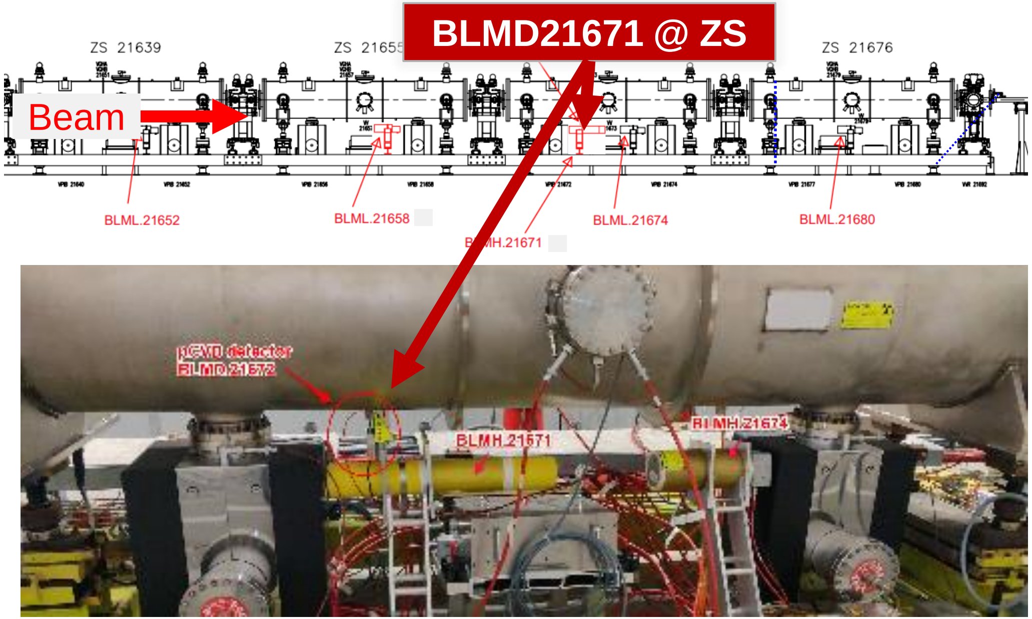
1 BSI @ the beginning of the line is read-out with 'fast' electronics

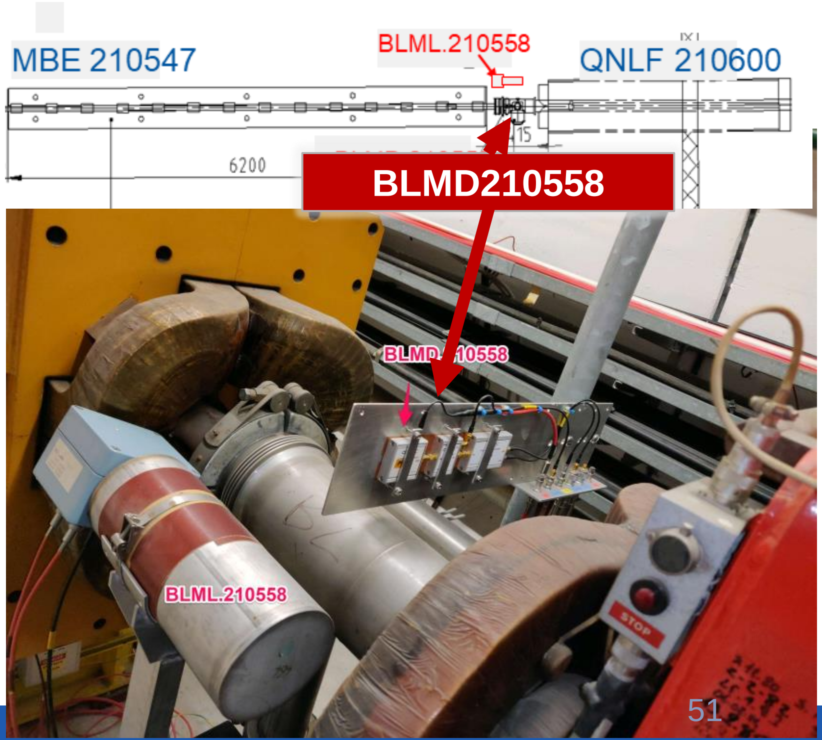
BSM(H,V)
BSI
BSG(H,V)
BBS(H,V)
BSP(H,V)

TT20 LINE

Diamond Beam Loss Monitors (dBLM)

2 dBLM installed in SPS (@electrostatic septum and @transf. line quad)

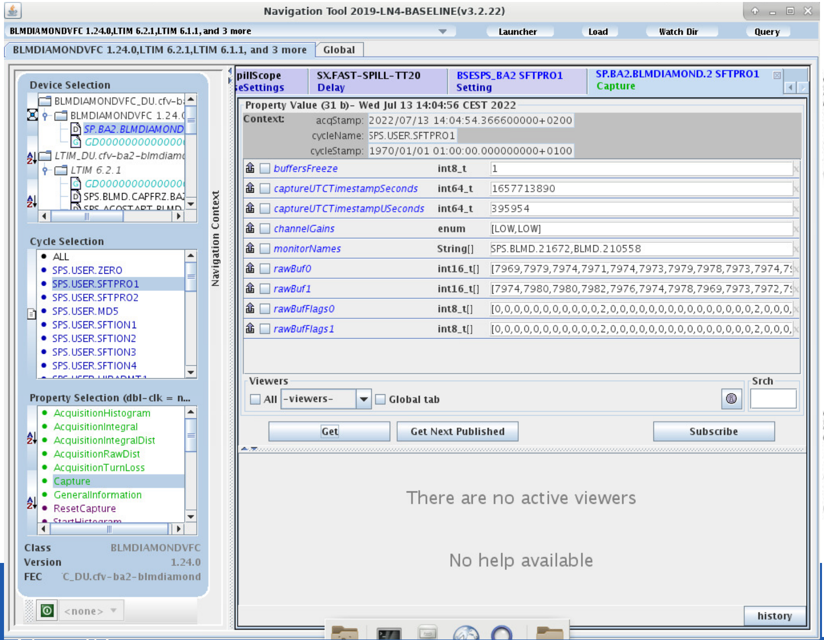




E. Calvo, E.Effinger , C.Zamantzas et al.

Diamond BLMs

No beam, during Access 13 July



Class BLMDIAMONDVFC
Version 1.24.0
FEC C_DU.cfv-ba2-blmdiamond

Property Value (31 b)- Wed Jul 13 14:04:56 CEST 2022

Context:
acqStamp: 2022/07/13 14:04:54.366600000+0200
cycleName: SPS.USER.SFTPRO1
cycleStamp: 1970/01/01 01:00:00.000000000+0100

buffersFreeze	int8_t	1
captureUTCTimestampSeconds	int64_t	1657713890
captureUTCTimestampUSeconds	int64_t	395954
channelGains	enum	[LOW,LOW]
monitorNames	String[]	SPS.BLMD.21672,BLMD.210558
rawBuf0	int16_t[]	[7969,7979,7974,7971,7974,7973,7979,7978,7973,7974,7
rawBuf1	int16_t[]	[7974,7980,7980,7982,7976,7974,7978,7969,7973,7972,7
rawBufFlags0	int8_t[]	[0,0,0,0,0,0,0,0,0,0,0,2,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,2,0,0,0,
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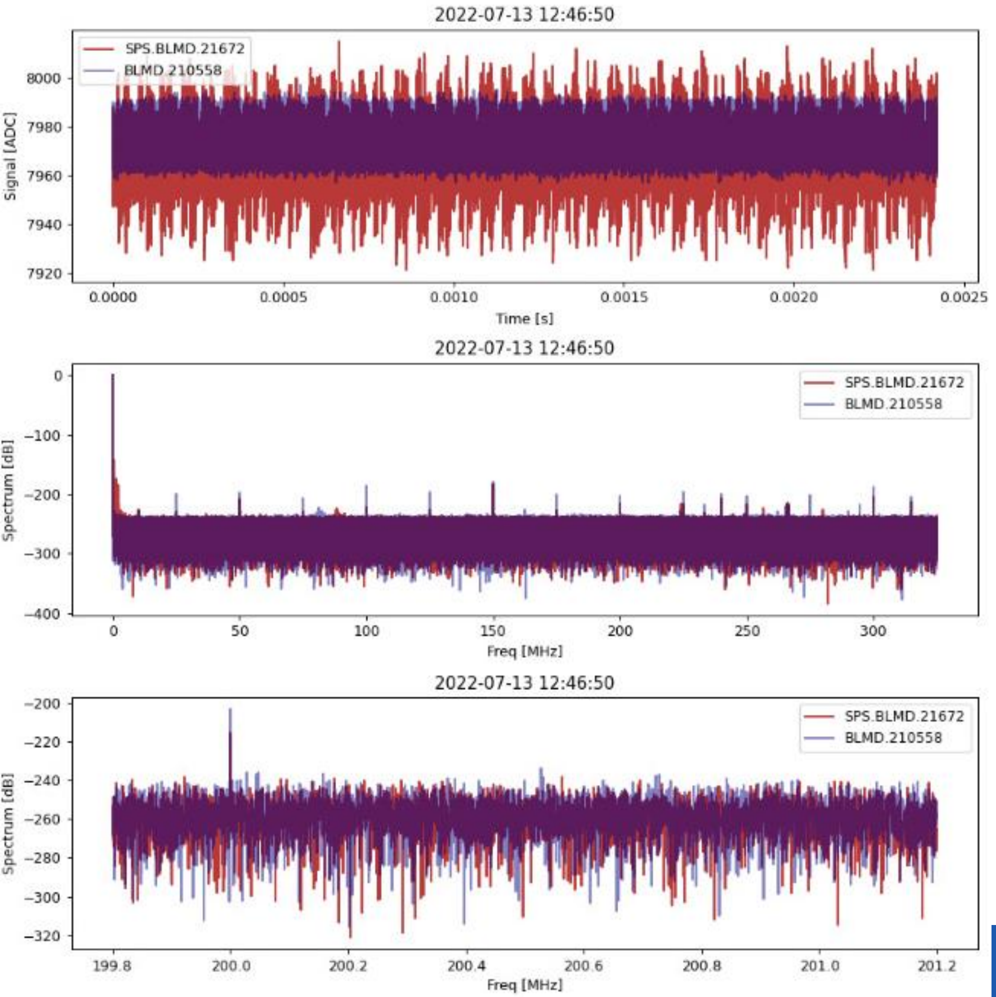
There are no active viewers

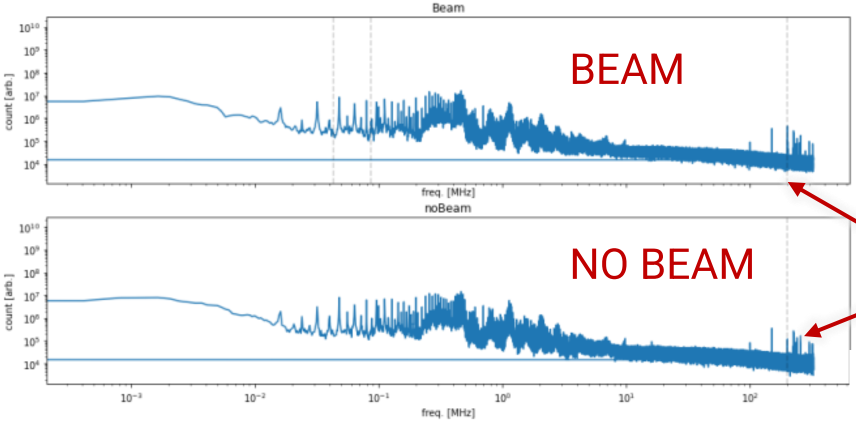
No help available



P.A. Arrutia Sota, E. Calvo, E.Effinger , C.Zamantzas et al.

Diamond BLMs

During normal operation, the signal is rather noisy But it is possible to exploit it via processing in the frequency domain (Pablo A., 11 May)

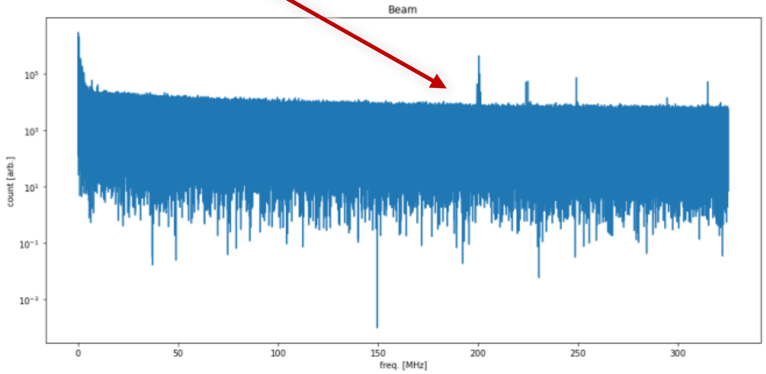


BEAM

NO BEAM

200 MHz

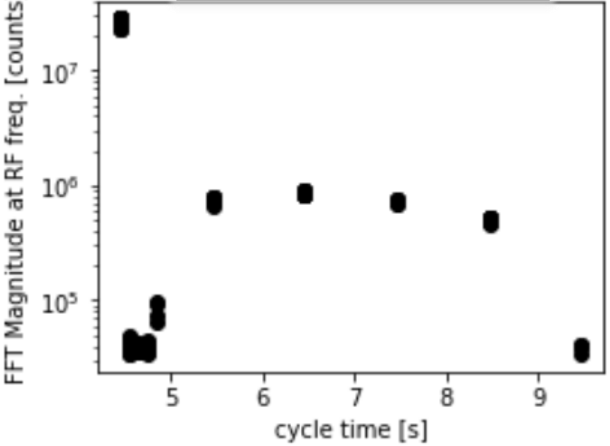
(BEAM) − (NO BEAM) =



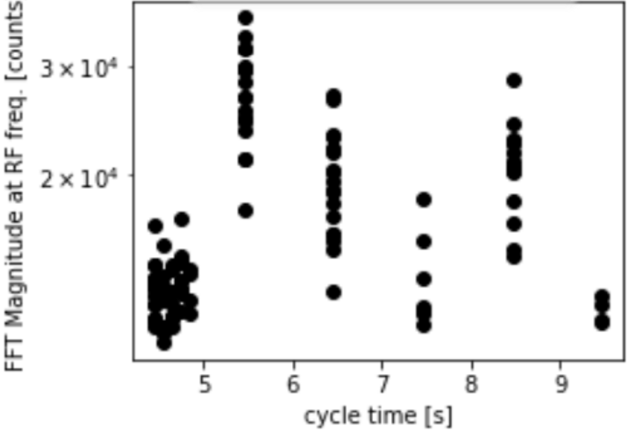
Diamond BLMs

- Evolution of the 200 MHz Harmonic during the spill (Pablo A., 11 May)

BLMD21671 @ ZS



BLMD210558



Spill Shape Reconstruction in the EAST Area

- Spill Shape Reconstruction in the EAST Area through the mixed-secondary radiation field produced by beam-target collisions at CHARM

- **pCVD dBLM** placed inside CHARM irradiation room
- Data acquisition with an oscilloscope in the control room

- AC signal dBLM noise discrimination, data partitioning in 20 ms, distribution of number of events throughout the 450ms proton bunch → spill shape reconstruction

- Analysis of the spill shape consistency over hundreds of multiple consecutive acquisitions in each CHARM positions

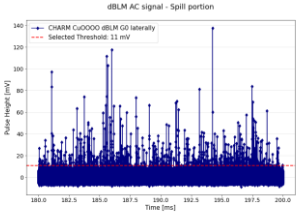
- Comparison of the spill shape reconstructed by the dBLM with a IC BLM placed on a standing pole

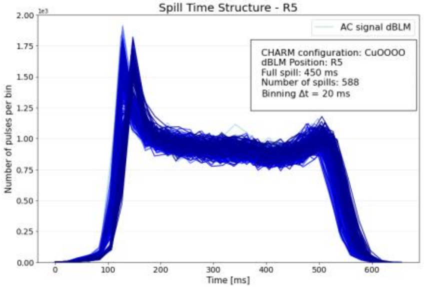
- Cross-validation of the analysis with XSEC Data:
  - F61.XSEC.023
  - T08.XSEC.070
  - T08.XSEC.094

Most of the spills' shape reconstructed by the dBLM are in **good agreement** with the SEC!

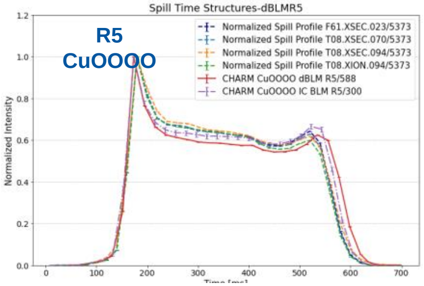
- This method to reconstruct the spill shape with the dBLM has been validated in all CHARM positions!

- Tests in R13 are still ongoing to further investigate the feasibility of the analysis in harsh positions





dBLM R5 CuOOOO Spill Shape reconstruction

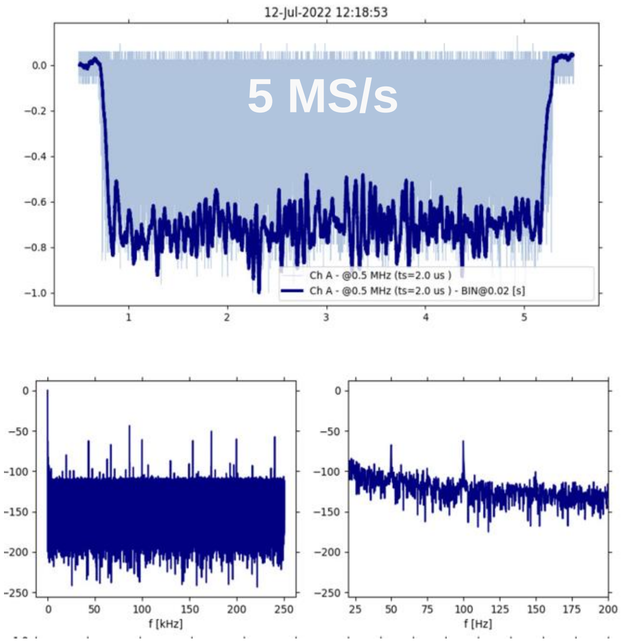


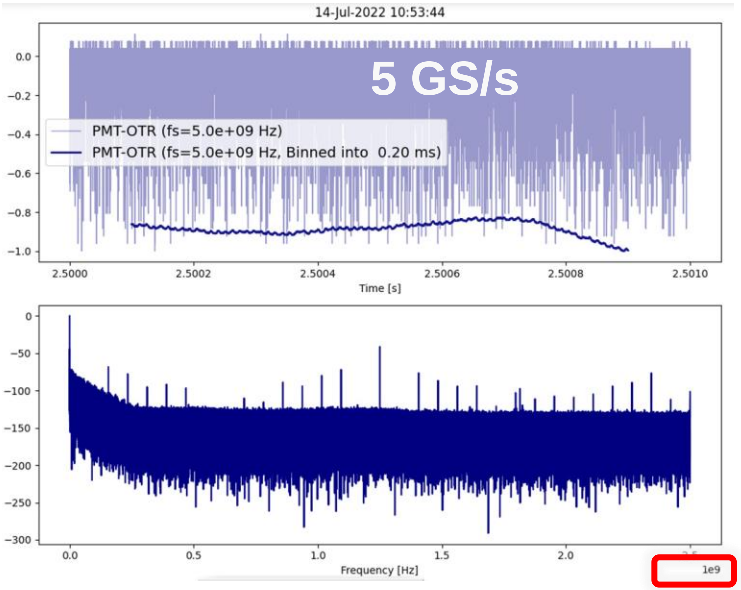
dBLM - IC BLM - XSEC - XION comparison

OTR - PMT

With present setup

- full spill at low rate (few MHz, ideal to see 50-100Hz in one shot)
- chunks
  - ✓ up to few ms at high rate (e.g. 500-600MHz) to properly sample the 200MHz harmonic
  - ✓ Fractions of ms up to 5 GHz sampling rate





Spill Detectors Locations