KLM Status

R. de Sangro
per il gruppo KLM - Frascati & Roma Tre

Belle II Referee Meeting
8 Settembre, 2021

Outline

- KLM Operations in runs 2021a,b
- Neutron backgrounds
- Summer work
  - DAQ upgrade
  - Digitization Look-back window study
  - New SCROD firmware for EC/Barrel Scintillators
- Attività italiane in corso
- KLM Upgrade

KLM 2020c-2021ab DAQ Operations

- KLM DAQ notably more robust
- KLM errors were significantly reduced

Full summary of KLM DAQ errors in run 2021a and 2021b

February 15	ttdown	DC 26
February 22	ttlost	DC 17
March 11	ttlost	FTSW 170
April 8	ttlost	DC 15
April 18	ttlost	DC 27
May 19	ttlost	.org not available
May 22	ttlost	DC 38
May 23	ttlost × 4	FTSW 170
May 24	ttlost × 3	FTSW 170
May 26	ttlost × 3	FTSW 170
May 27	ttlost	FTSW 170
June 4	ttlost × 7	FTSW 170
June 13	ttlost	FTSW 170
June 15	ttlost	FTSW 170

February 11	COPPER 7001	• New SLC script had a glitch • Used older one ~/bin/bootslc_ropc_cpr_klm.sh
March 11	COPPER 7001	• CPU daughter card replaced
March 14	COPPER 8004	• cprcontrold process crashed due to an out-of-memory error • Due to memory leak during NSM data allocation • Fixed on maintenance day
April 15	COPPER 7001	Data corruption
April 15	COPPER 7002	Data corruption
April 18	COPPER 7002	Data corruption
May 10	COPPER 7002	Data corruption
May 23	COPPER 7004	Data corruption
May 25	COPPER 7002	Data corruption
June 2	COPPER 7004	Data corruption
June 4	COPPER 7002	Data corruption

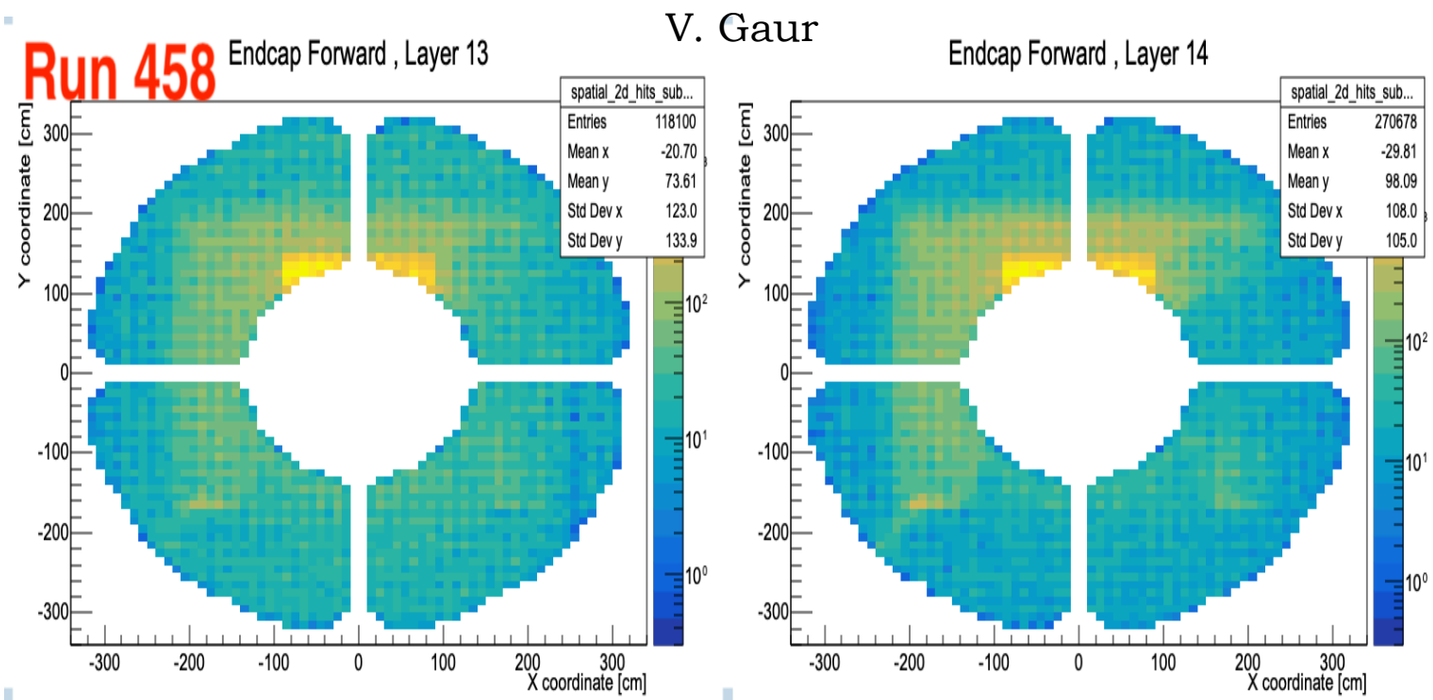
- Need to fix FTSW 170 during summer
- Copper 7002 may need daughterboard replacement

Neutron Backgrounds

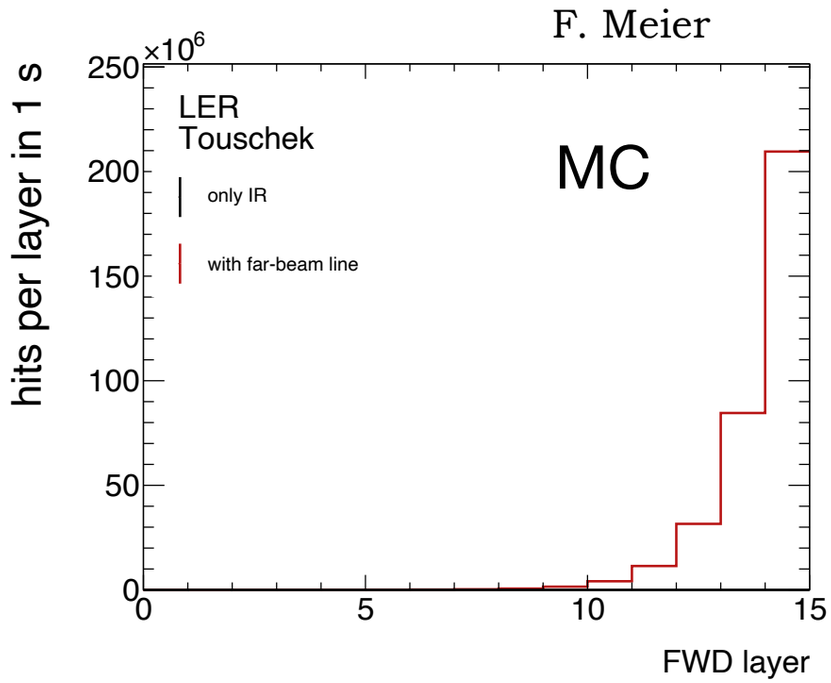
- Observed high rate in the last two layers of scintillators in the FWD EndCaps

- According to MC this is due to neutrons related to (mostly) Touschek background in the LER

V. Gaur



F. Meier



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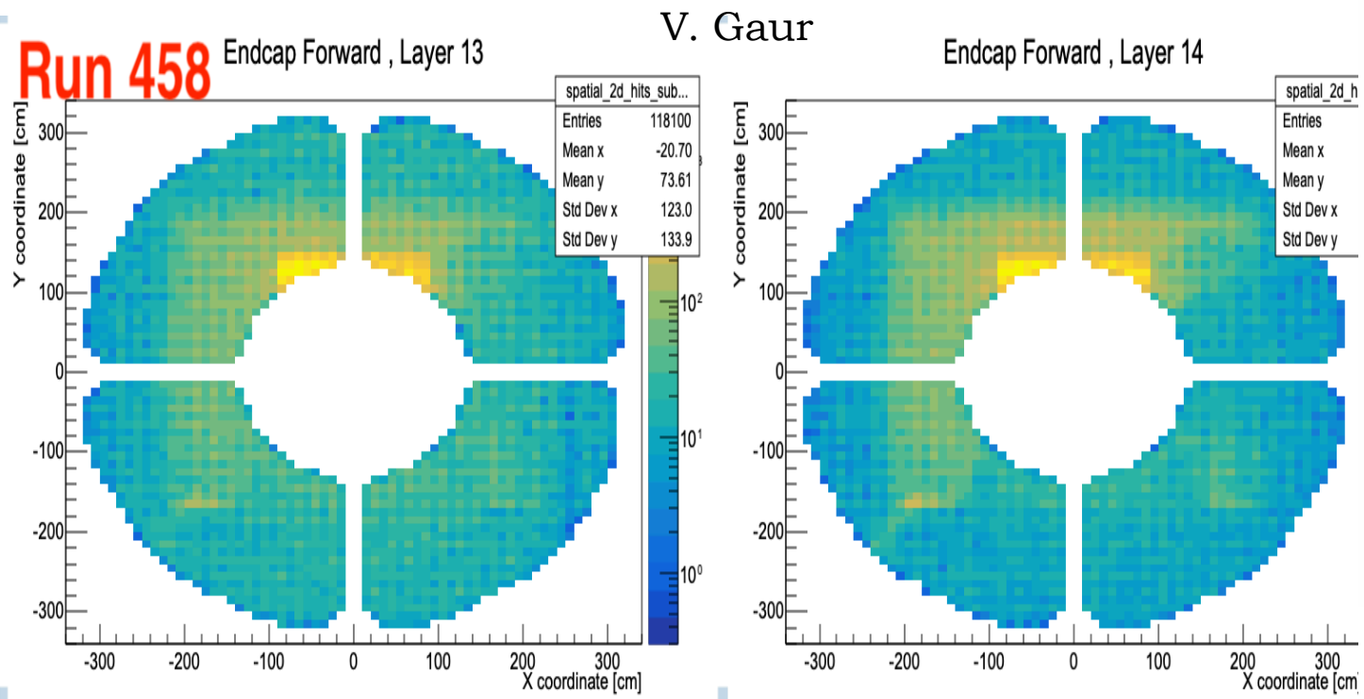

PE wall in KEKB tunnel

Figure 10.11: Polyethylene shield.

Figure 10.12: Tapered shield.

PE at QCS

- Study possible shielding to be installed during LS1 (2022)

KLM Summer 2021 Work

KLM: 2021 summer-shutdown work plan

- ✓ PCIe40 testing (TOP+KLM) by DAQ group during most of summer shutdown
  indico.belle2.org/event/4490/contributions/23352/
- ✓ Slow-control GUI finalization to prepare for PCIe40 DAQ in 2021c
  indico.belle2.org/event/4490/contributions/23353/
- ✓ Measure signal quality on the TTD line for recently problematic FTSW 170 replace the cable or the unit
  indico.belle2.org/event/4490/contributions/23351/
- ✓ Opportunistic testing *(coordinated with DAQ group)* of scint-readout firmware updates for feature extraction (better time resolution + pulse-height measurement) and of KLM-trigger firmware updates (cross-sector, back-to-back definition, …)
  indico.belle2.org/event/4490/contributions/23349/

KLM TTD tree:

```
FTSW191(master-KLM)
 ↳ FTSW229(BKLM-ehut) → FTSW162-165
 ↳ FTSW230(BKLM-ehut) → FTSW166-169
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 ↳ FTSW170(copper) ← problematic
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- ✓ Slow-control GUI finalization to prepare for PCIe40 DAQ in 2021c
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- ✓ **FTSW170 was fine**
  ⇒ replace TTRX cards on Copper and CAT cables
- ✓ Opportunistic testing *(coordinated with DAQ group)* of scint-readout firmware updates for feature extraction (better time resolution + pulse-height measurement) and of KLM-trigger firmware updates (cross-sector, back-to-back definition, …)
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Ongoing

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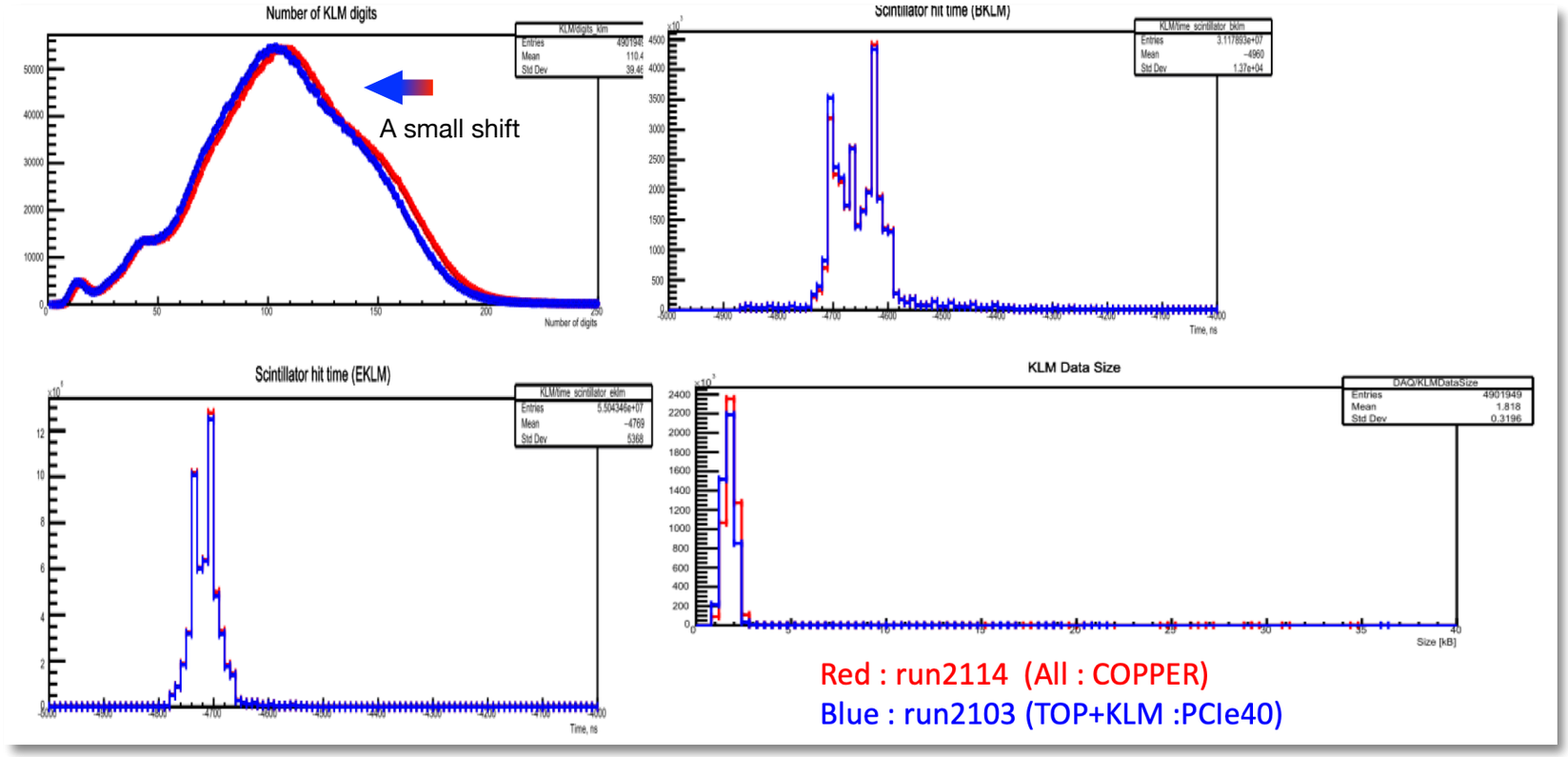
KLM DAQ Upgrade to PCIe40

- Preliminary tests were performed during run 2021ab
- Will migrate to the new DAQ for run 2021c, if all tests OK



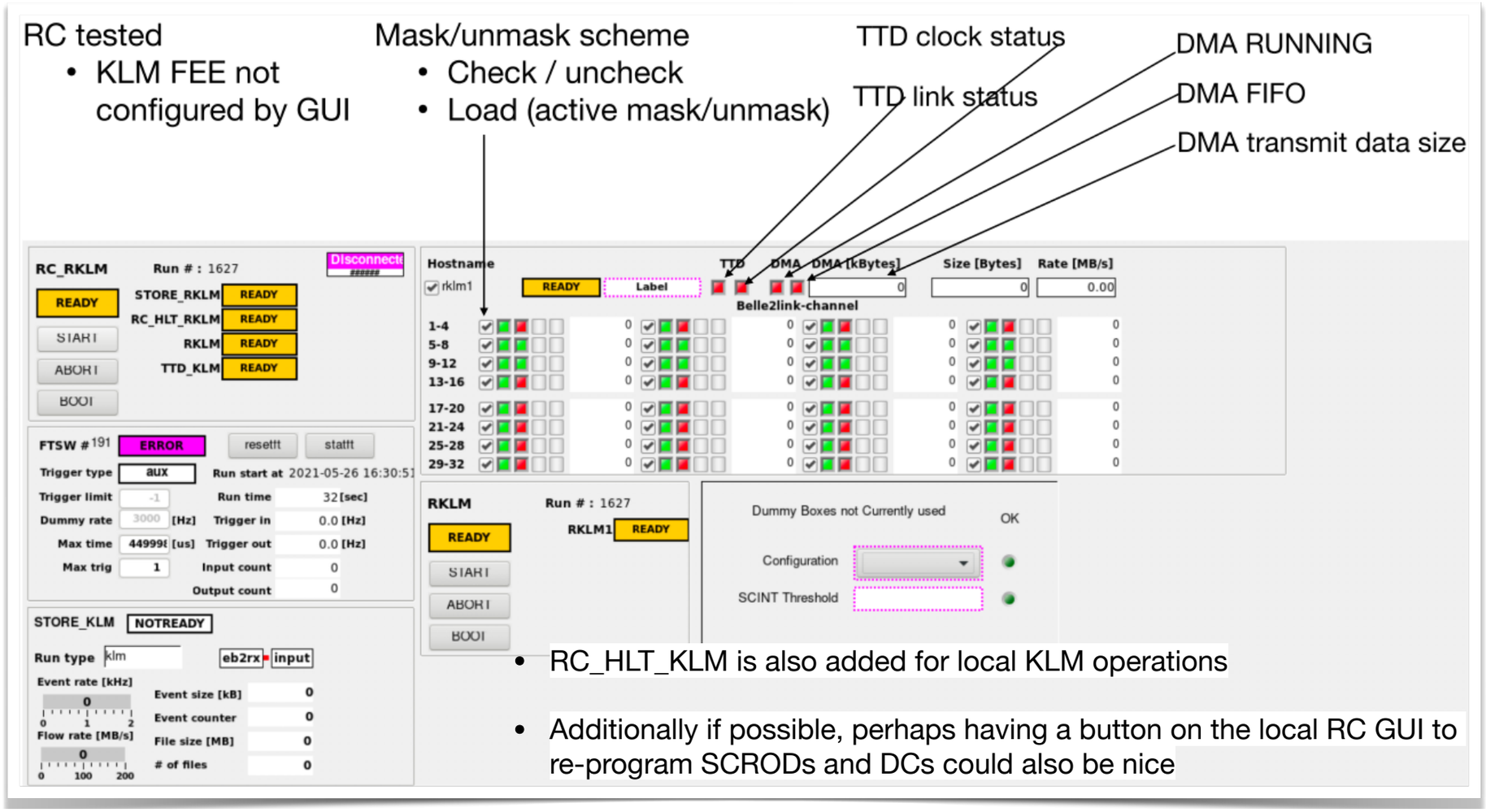
Present status:

- Commissioning of full KLM+TOP in August is ongoing
  - Long (~19hrs) run times achieved at 30 kHz DAQ rate
  - Still some (quite rare) problems (persistent BUSY) to be understood

- BKLM fully operational while connected to PCIe40

KLM DAQ Upgrade to PCIe40

New PCIe40 based KLM GUI basically finished, under extensive test



- RC_HLT_KLM is also added for local KLM operations
- Additionally if possible, perhaps having a button on the local RC GUI to re-program SCRODs and DCs could also be nice

Present status:

- KLM local run GUI was tested with 50% of KLM FEEs.
  - 18 hours run at 10kHz, with no troubles.
- Global run GUI also tested with KLM only
  - 9 hours at 30kHz input rate and it was also fine.

KLM Summer 2021 Work

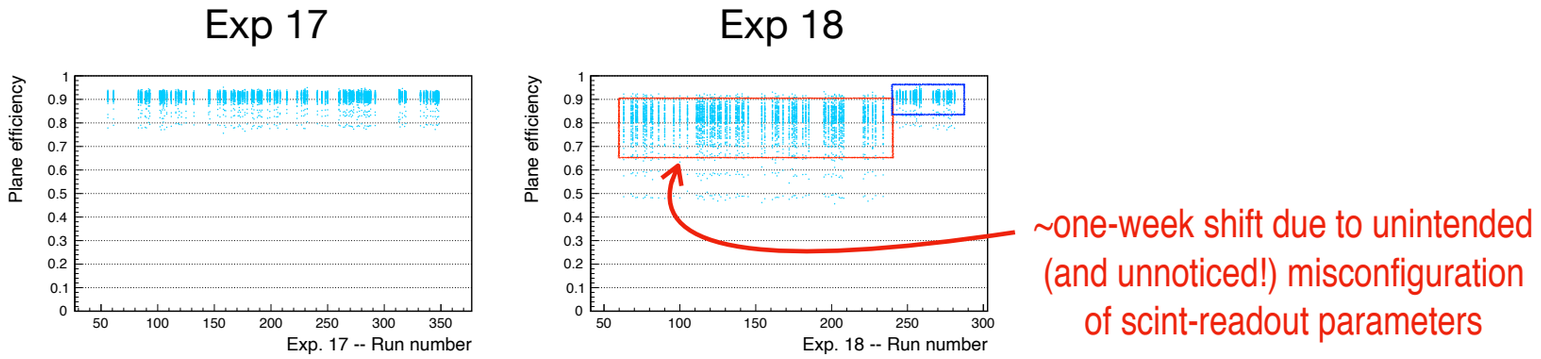
KLM: 2021 summer-shutdown work plan, cont'd

✓ Updates of DQM to

- provide real-time efficiency measurements
  indico.belle2.org/event/4490/contributions/23352/ slide 13

Ongoing

Barrel Scints

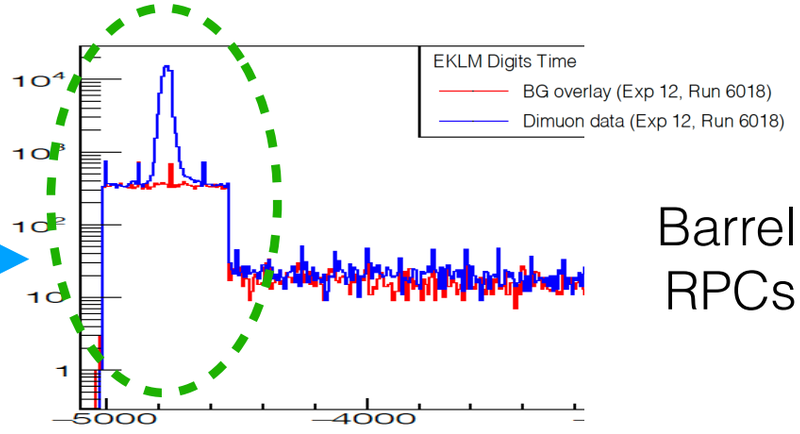


~one-week shift due to unintended (and unnoticed!) misconfiguration of scint-readout parameters

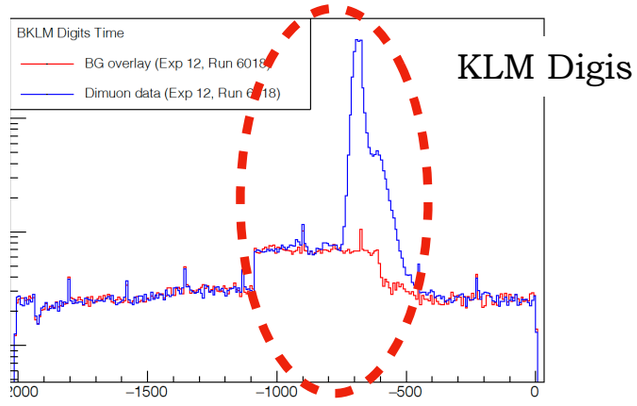
- monitor location of in-time peak relative to digitization window
  indico.belle2.org/event/4490/contributions/23356/ slides 11, 14

Done!

Endcap Scints



Barrel RPCs



- implement best practices of other groups (especially ECL) for more user-friendly presentation and programmatic alerts
  indico.belle2.org/event/4490/contributions/21569/

KLM Summer 2021 Work

KLM: 2021 summer-shutdown work plan, cont'd

✓ Updates of DQM to

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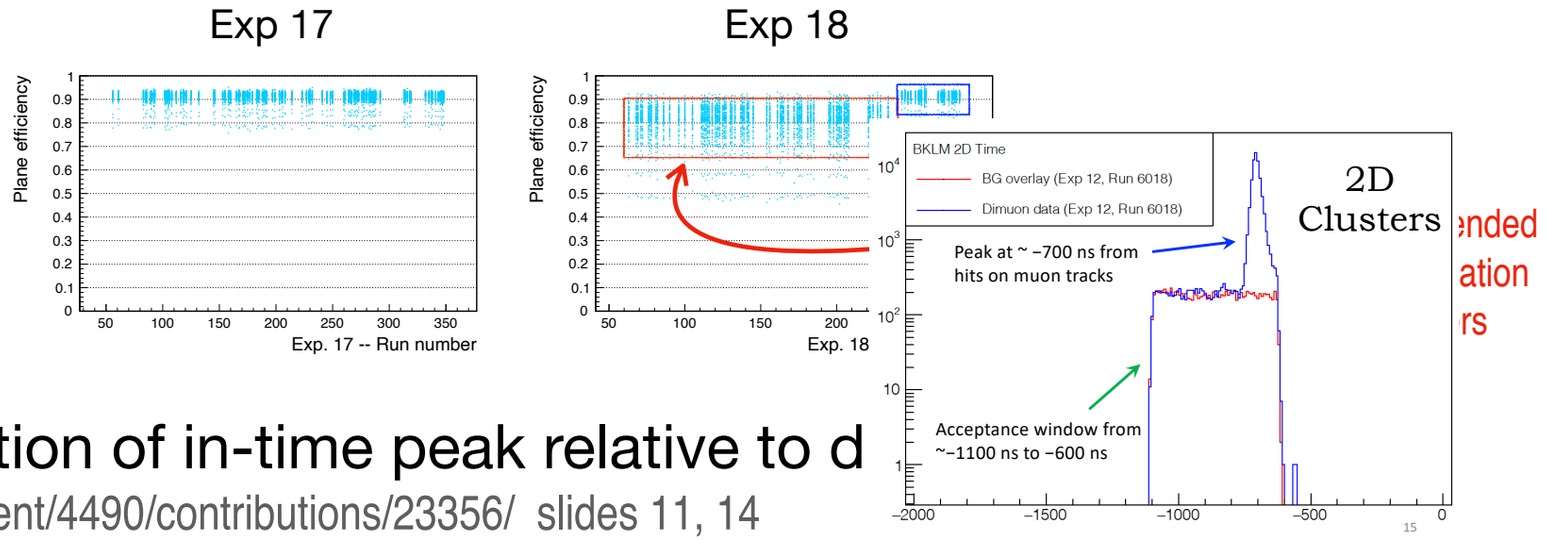
Ongoing

Barrel Scints



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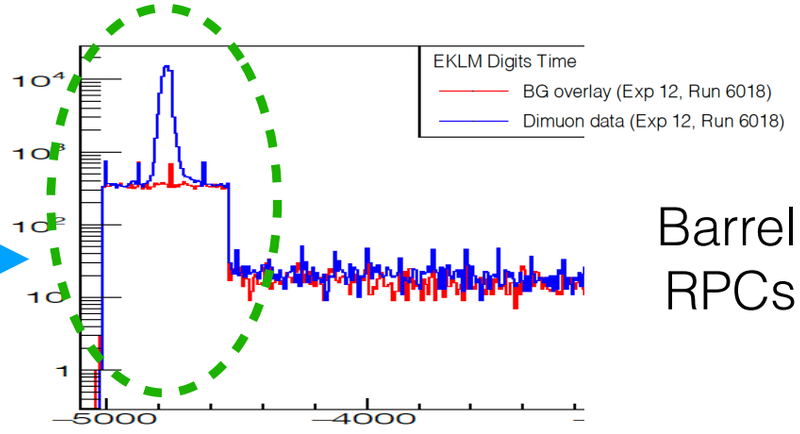

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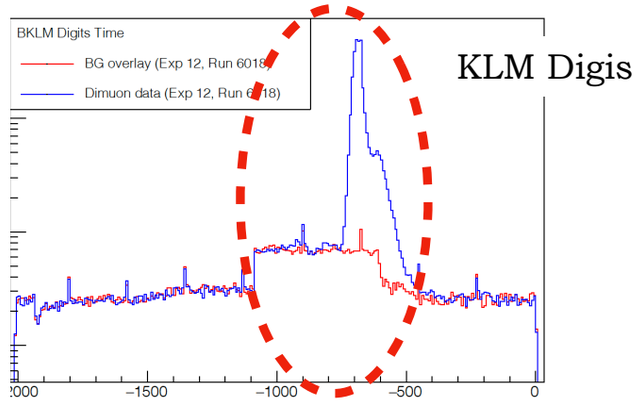

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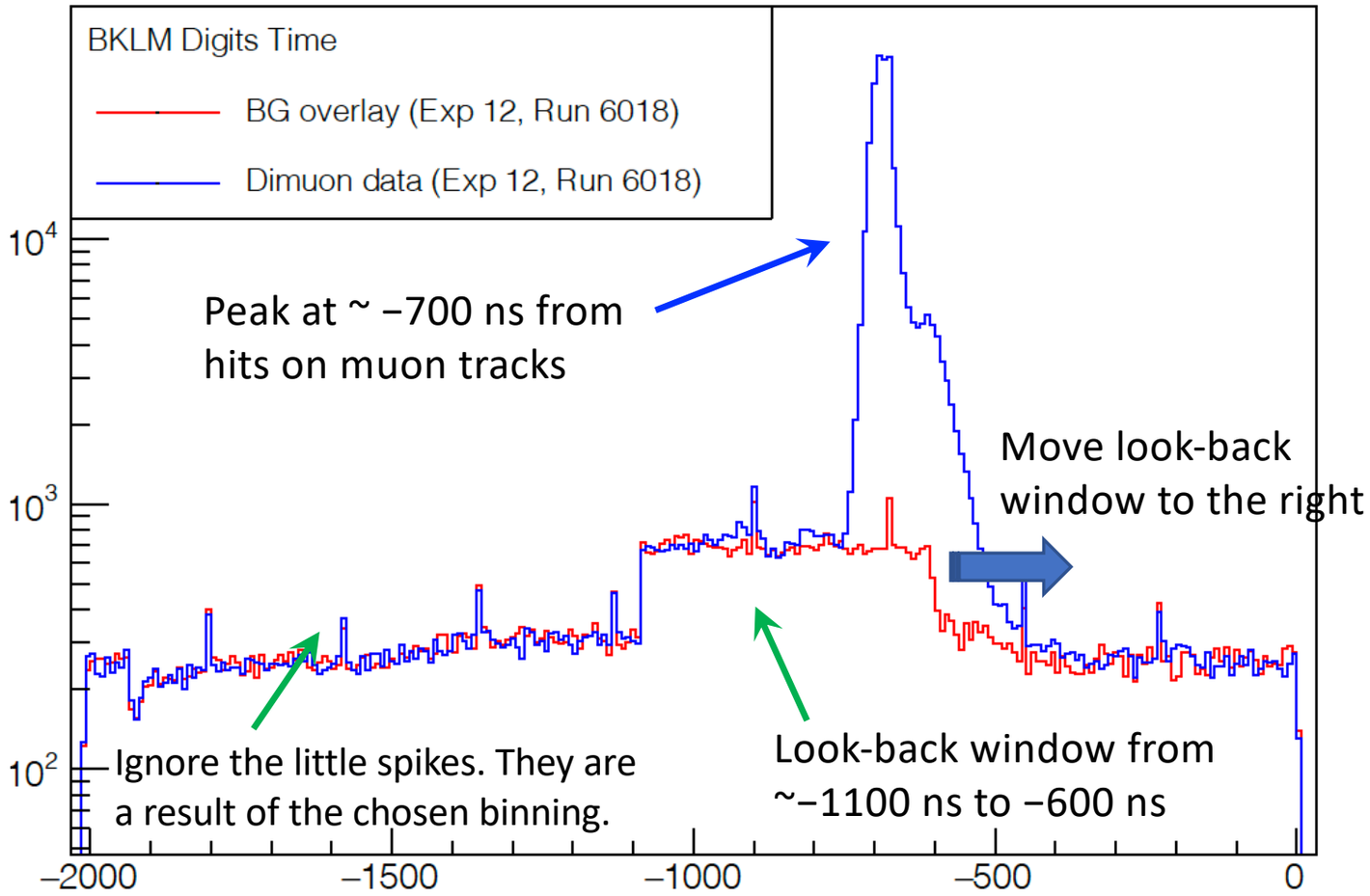
Digitization Look-Back Window

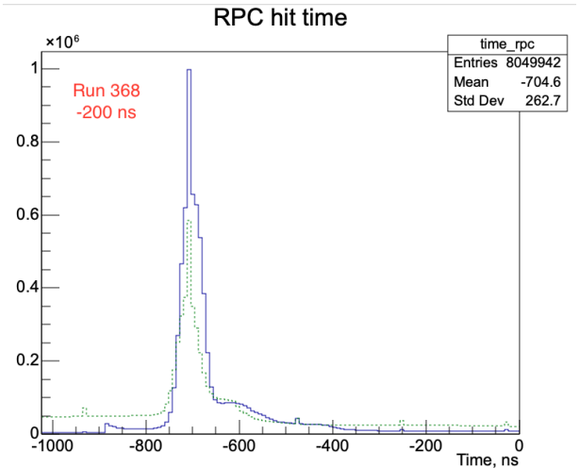
Reason for moving RPC look-back window: digit times

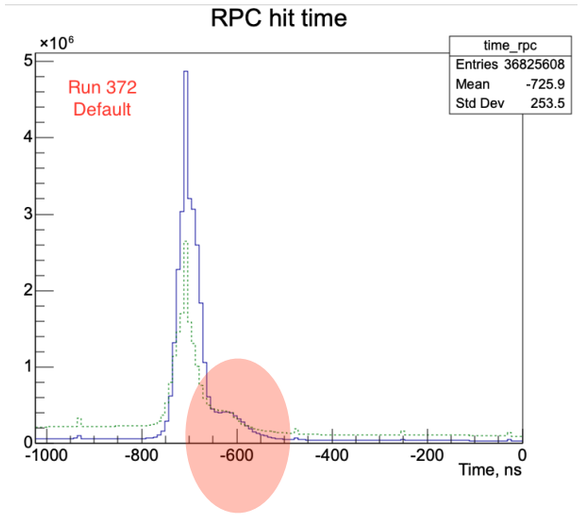
- Signal hits (muons) peak at −700 ns across the upper edge of look-back window from −1100 ns to −600 ns
- Background hits have a flat distribution in the window
- Separate issue: background hits also occur out side the window at a reduced rate
- Goal: move look-back window by about +200 ns

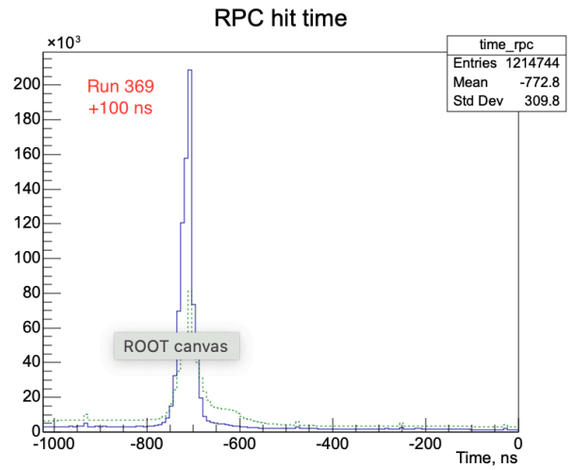


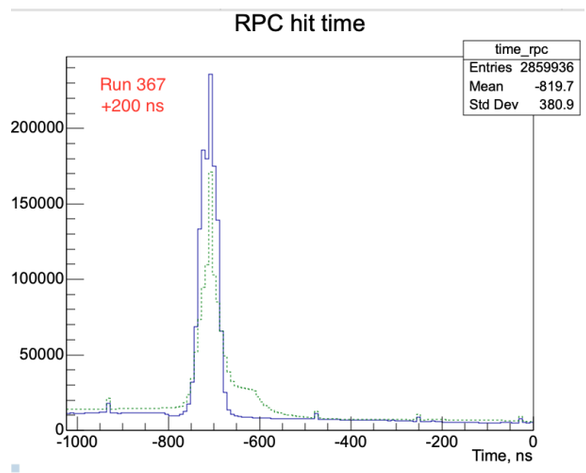
Digitization Look-back Window Scan

- Test scan of different digitization windows performed w/cosmic rays









⟵ Worst Default Better ⟶ “Optimal”

- Adjust setting and study 2D digit efficiency to confirm choice of new value

New Scintillator FW

- Initial KEK testing of SCROD waveform readout firmware was carried out on August 7.
  - Version tested @ ttd11: /bdaq/group/b2klm/lastfw/klm_scint_vFE03.bit
  - Identified a few more things that need tuning

- More testing ongoing

Attività Italiane

- KLM Performances
  - Muon ID (A. Martini) ← Responsabilità vacante da quando Alberto ha lasciato Roma Tre
  - RPC/Scint. Efficiency (G. De Pietro)
  - KL ID
    - Responsabile Belle II KL-ID (G. Finocchiaro) ★
    - Sviluppo BDT (C. Martellini, A. Di Cicco, R.d.S.)
    - Analisi Eventi Φγ (A. Di Cicco, G. Finocchiaro, A.Passeri, M. Piccolo)
    - Trigger efficiency (E. Graziani, M. Campajola)
- KLM Software (G. De Pietro)
  - Belle II Deputy Software Coordinator ★
  - Belle II Minor Release Manager
  - Deputy KLM software coordinator e KLM/Tracking Liaison & Calibration Expert
- KLM Documentation (M. Laurenza)

KLM Group Organization

Belle II KLM Organization

(June 2021)

§ Management
Coordinator: Leo Piilonen
Deputy: Pasha Pakhlov

¶ KLM PI Group
Chair: Riccardo de Sangro

 # Detector Operations
Coordinator:
Vipin Gaur
Deputy:
Diptaparna Biswas

§ Detector Hardware
Coordinator:
Vipin Gaur
Deputy:
Vitaliy Popov

¶ DAQ Firmware
Coordinator:
Kurtis Nishimura
Scint FW Lead:
Chris Ketter
RPC FW Lead:
Brandon Kunkler
DC FW Lead:
Brandon Kunkler
Trigger FW Lead:
Vasily Shebalin

 # Online Software
Coordinator:
Swagato Banerjee
Deputy:
Zach Stottler

§ Offline Software
Coordinator:
Kirill Chilikin
Deputy:
Giacomo De Pietro

¶ Data Quality
Coordinator:
Taylor Kimmel
Deputy:
Tommy Lam

 # Calibration
Coordinator:
Chunhui Chen
Efficiency:
Giacomo De Pietro
Timing:
Xiaolong Wang
Alignment:
Pavel Oskin
MuID Systematics:
(vacant - Roma3?)
KLID Systematics:
Giuseppe Finocchiaro

Da trovare un responsabile

§ Documentation
Coordinator:
Martina Laurenza
Deputy:
Jim Cochran

Liaisons to other Belle II groups:

Technical Board
¶ KLM Liaisons:
KEK: Kazutaka Sumisawa
SW: Kirill Chilikin
Perf: Soeren Prell

DAQ Group
 # KLM Liaison:
Diptaparna Biswas

TRG Group
§ KLM Liaison:
Kurtis Nishimura

Physics (PID) Performance
¶ KLM Liaison:
(vacant - Roma3?)

Tracking Group
 # KLM Liaison:
Giacomo De Pietro

Neutrals Group
§ KLM Liaison:
Giuseppe Finocchiaro

DQM Group
¶ KLM Liaison:
Swagato Banerjee

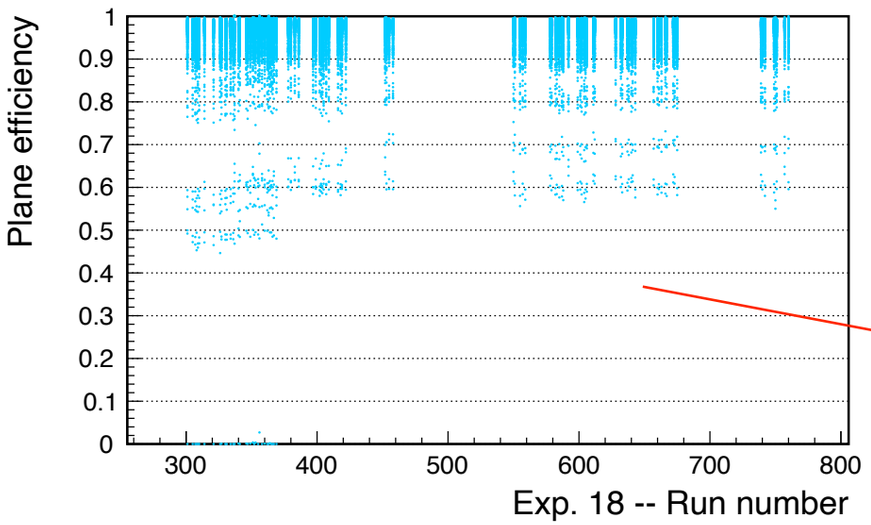
Background Group
 # KLM Liaison:
Frank Meier

All positions are term-limited (two years) and renewable
§ Term boundary is at February B2GM
¶ Term boundary is at June B2GM
# Term boundary is at October B2GM

KLM RPC Efficiency

G. De Pietro

Exp 18



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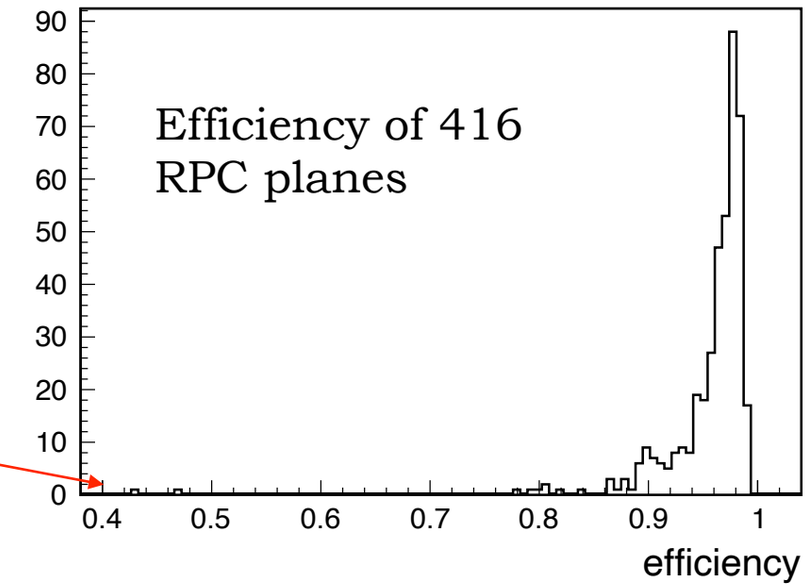
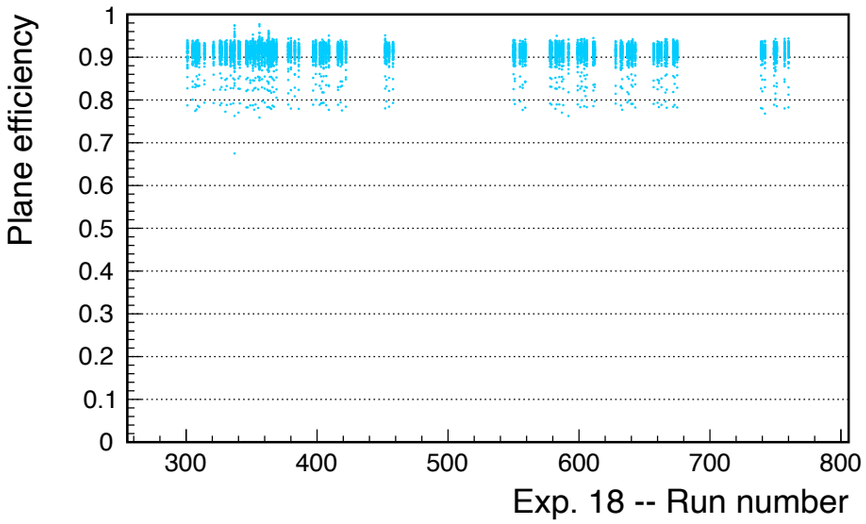
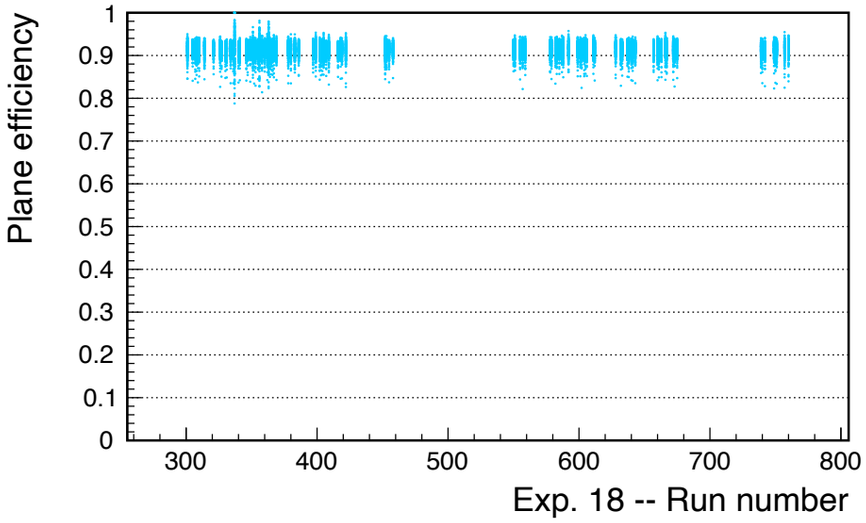




Barrel Scintillators

- Calibration validation (Efficiency plots) is now performed automatically

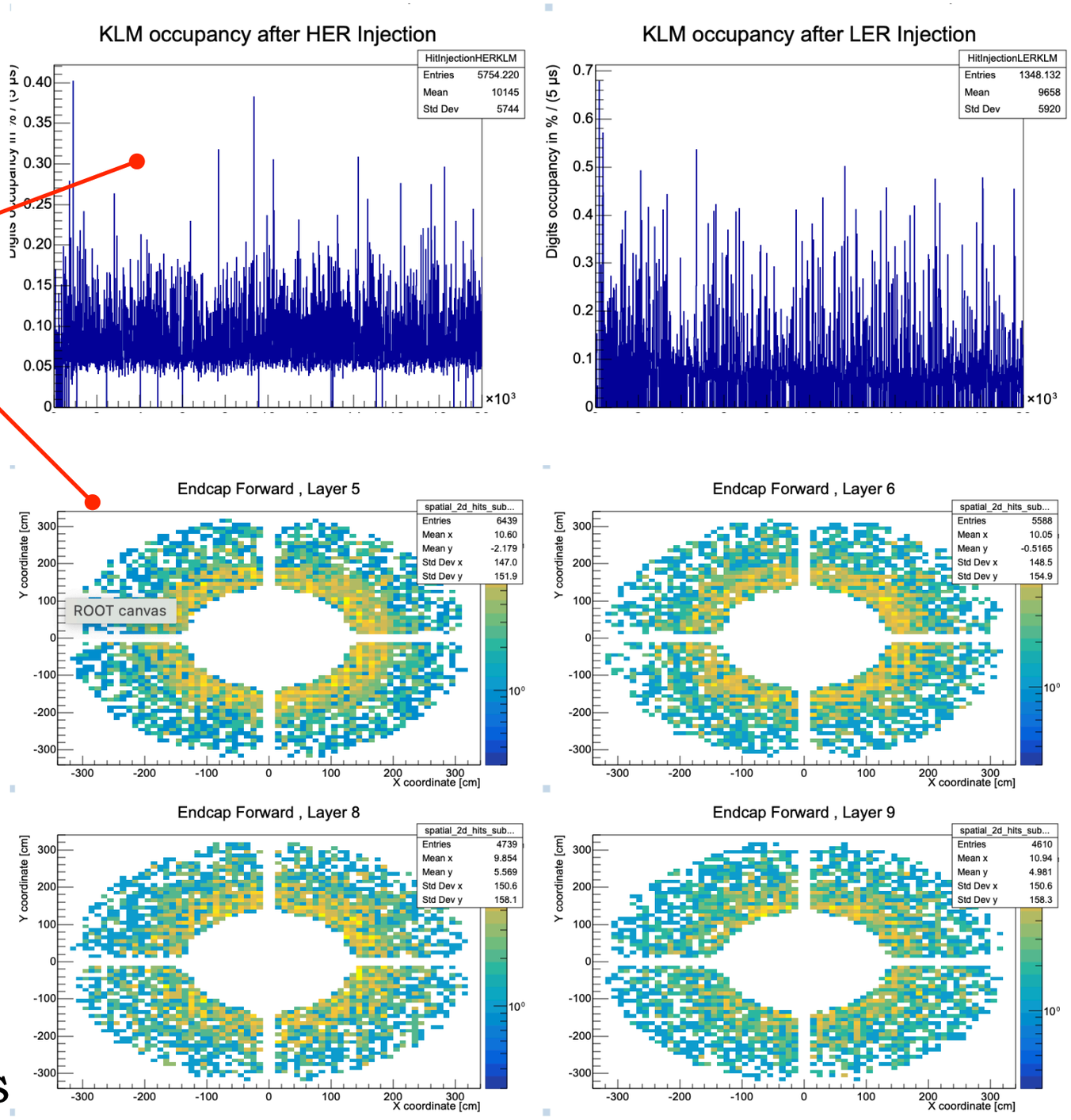


EC Scintillators

KLM Software

G. De Pietro

- Improved DQM Plots
  - More KLM Digi plots
  - Injection Background
  - EKLM 2D Hits plots
- New in release 6
  - Timing Calibration
  - Full re-write (U.Hawaii) of TSIM KLM trigger simulation
- To Do:
  - Check Event T_0
  - Background overlay files



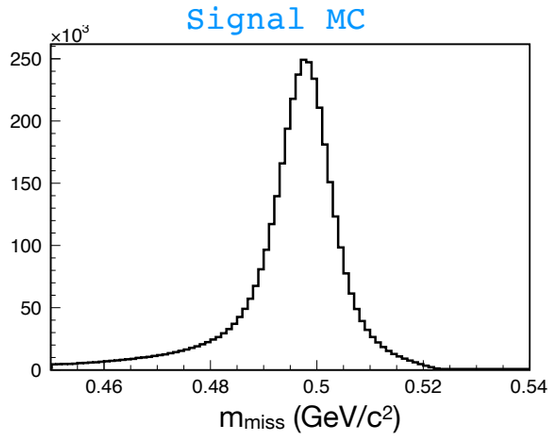
KLM – Attività 2021 in corso

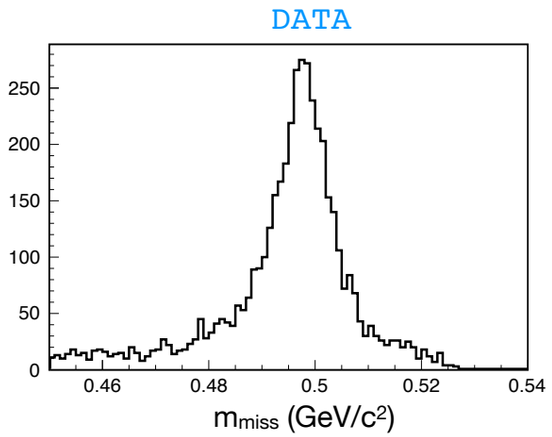
KL ID performance with $\Phi(K_S K_L)\,\gamma$

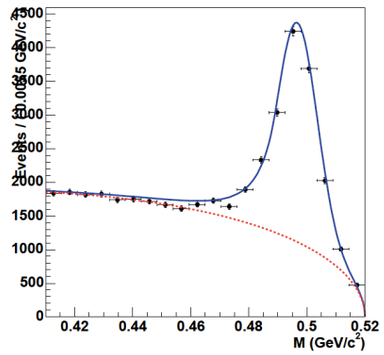
G. Finocchiaro
A. Passeri, M. Piccolo

- Very simple topology, with strong signature: 1 hard photon + 2 pion tracks (K_S)
  - Constrain the γ energy using 2-body decay hypothesis of the initial (e^+e^-) and intermediate (ϕ) states, via:

$$s - m_\phi^2 = 2E_\gamma\left(E_{ee} - \vec{p}_{ee}\cdot\frac{\vec{p}_\gamma}{E_\gamma}\right)$$

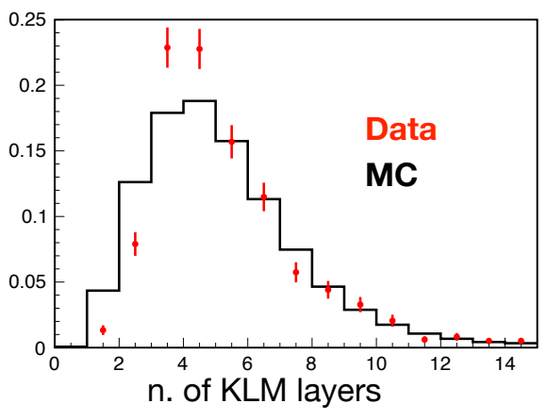


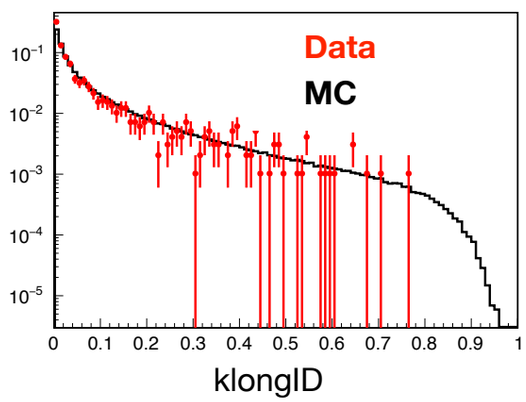


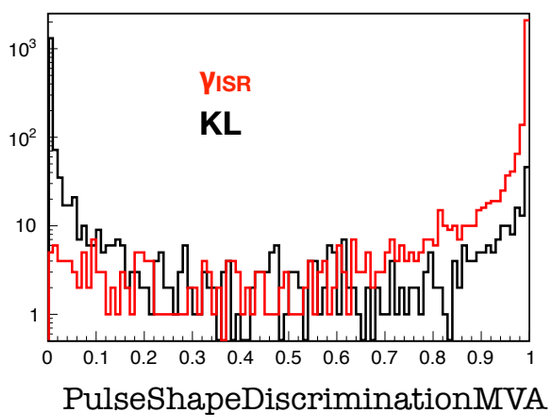


Better purity than in the *BABAR* study

  - No information from KLM and ECL (modulo γ_{ISR}) is used. σ(p)~10 MeV/c (MC); σ(ϕ,θ)~3 deg (MC, DATA)
  - Constitute a clean, unbiassed sample to study properties of K_L signals in the detector. Examples:







➡ Provide valuable information to tune and characterise improved algorithms for K_L identification

cdcklm1 Trigger

E. Graziani
M. Campaiola

- New trigger line for single muon trigger based on CDC and KLM information, available from Exp12, run1235 in Run 2020c

- Useful for many Dark Sector and tau analyses with muon final states

- Recent hardware improvements:
  - Threshold for KLM lowered to 4 hit layers
  - Trigger includes now End Cap KLM
  - New KLM trigger lines added to CDCKLM and KLMB2B:
    - Coincidence short CDC track-EKLM
    - Coincidence ECL-EKLM
- Study these new trigger bits efficiencies in the coming months

BELLE2-NOTE-TE-2020-028

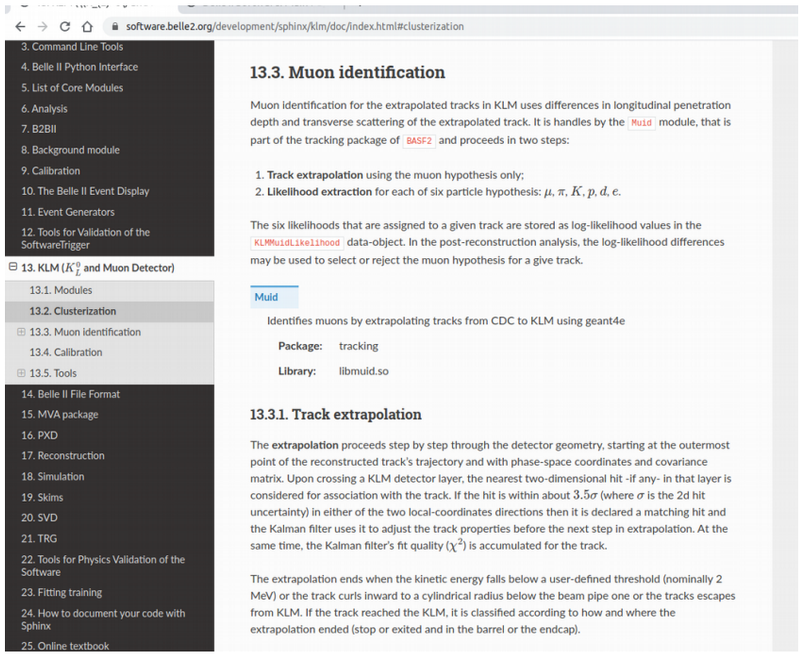
KLM Documentation Project

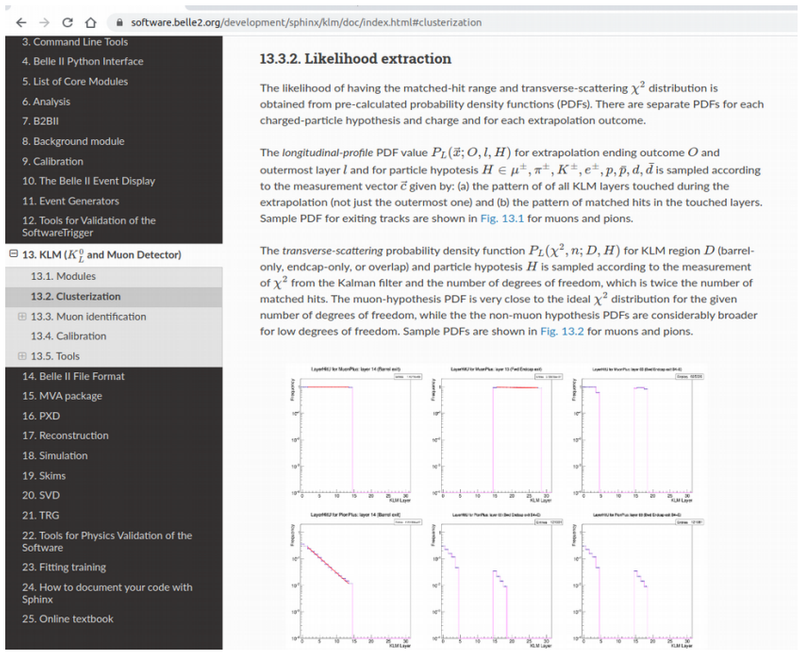
M. Laurenza

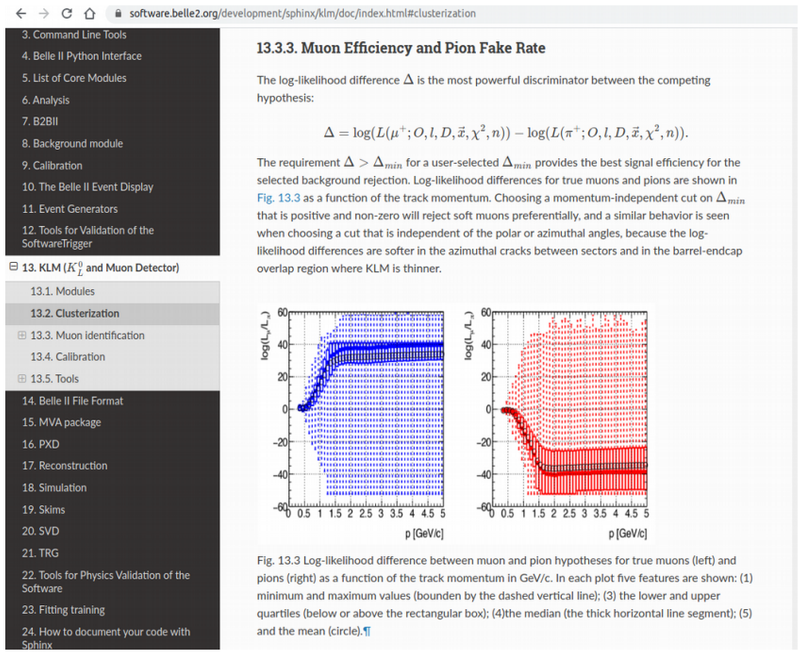
Documentation

Muon-ID entirely in Sphynx

Sphynx:







MuonID: Track extrapolation, likelihood extraction, Muon Efficiency and pion fake rate.

Clusterization, Calibration (https://agira.desy.de/browse/BIIKLM-188)

\+ KLM validation plots, klm confluence page update...

KLM Upgrade

- Prodotte a Rome Tre 1 FE board (12 canali) e 1 MPPC FE controller

MPPC Front End board →

KLM Upgrade

Detector R&D

- Qualify and check scintillators and MPCC
  - Raw material scintillation process study (Roma3), Cosmic ray stand LNF
- KLM Software upgrade (simulation and reconstruction)
- Rad had studies at ENEA (neutrons anf photons)
  - ENEA Casaccia (neutrons and photons)
  - ENEA Frascati (neutrons FNG) Frascati Neutron Generator

Software

- Define new geometry and simulation to study
  - Optimal detector configuration
  - Realistic performances of new detector
  - Improvement of performances vs beam background

KLM Upgrade

Detector R&D

NB: Chiediamo un gettone per mantenere questa attività in attesa di possibili sviluppi futuri

- Qualify and check scintillators and MPCC
  - Raw material scintillation process study (Roma3), Cosmic ray stand LNF

- KLM Software upgrade (simulation and reconstruction)

- Rad had studies at ENEA (neutrons anf photons)
  - ENEA Casaccia (neutrons and photons)
  - ENEA Frascati (neutrons FNG) Frascati Neutron Generator

Software

- Define new geometry and simulation to study
  - Optimal detector configuration
  - Realistic performances of new detector
  - Improvement of performances vs beam background

Anagrafica 2022

LNF (4.6 FTE)

M. Beretta (T)(0.1)
A. Calcaterra (0.7)
R. de Sangro (*) (0.9)
A. Di Cicco (AR) (1.0)
G. Finocchiaro (0.9)
C. Martellini (1.0)
I. Peruzzi
M. Piccolo

+2.4 FTE!

Roma Tre (5.4 FTE #)

E. Bernieri (0.5)
P. Branchini RN (0.7)
A. Budano (T) (0.5)
S. Bussino (0.5)
G. De Pietro AR (1.0)
E. Graziani (*) (0.7)
M. Laurenza Dott (1.0)
A. Passeri (0.5)

(#) strictly KLM
(*) Resp. Locale

Richieste Finanziarie KLM

KLM	Missioni (k€)		Consumo (k€)		Commenti
	LNF	Roma Tre	LNF	Roma Tre	
Mantenimento Elettronica KLM	6 SJ	12 SJ			
Turni Sottorivelatore	6				4.5 mesi di run 1*pers./giorno=4.5 MU*0.20 (12/60) frazione IT
Setup Cosmici per misure pre/post irraggiamento			3		Lavorazioni meccaniche e materiali di consumo
Costo-macchina irraggiamenti				3	Enea Casaccia

Totale: 6k€ +18k€ SJ Missioni, 6k€ Consumo