



2013-01-21

LHC Luminosity Calibration & Measurement Working Group

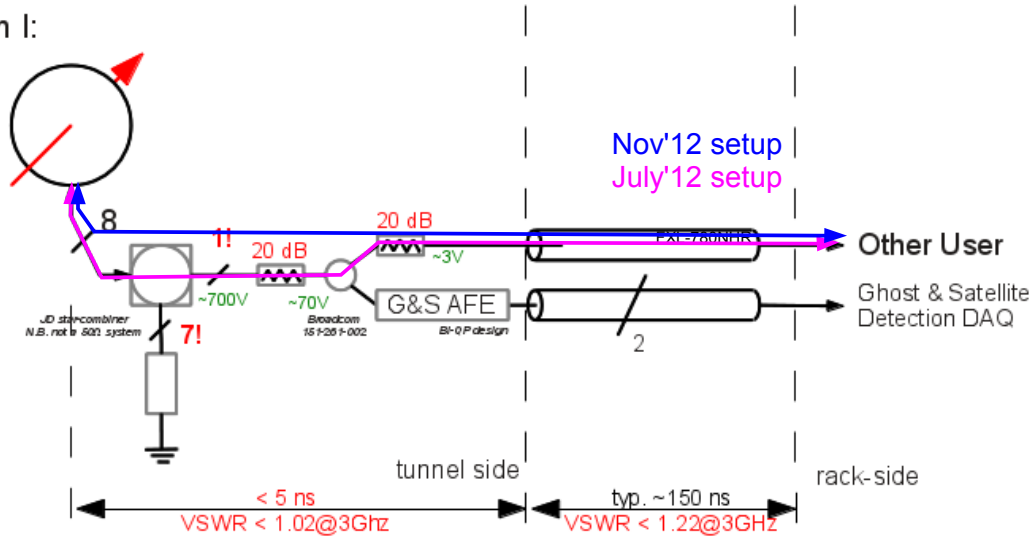
# WCM-based Satellite Measurements during the November'12 VdM scans

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Thomas Bohl, BE-RF

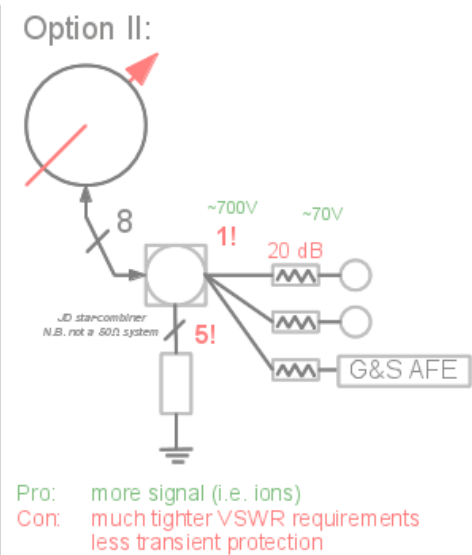


# Proposed New WCM Cabling Layout (> LS1)

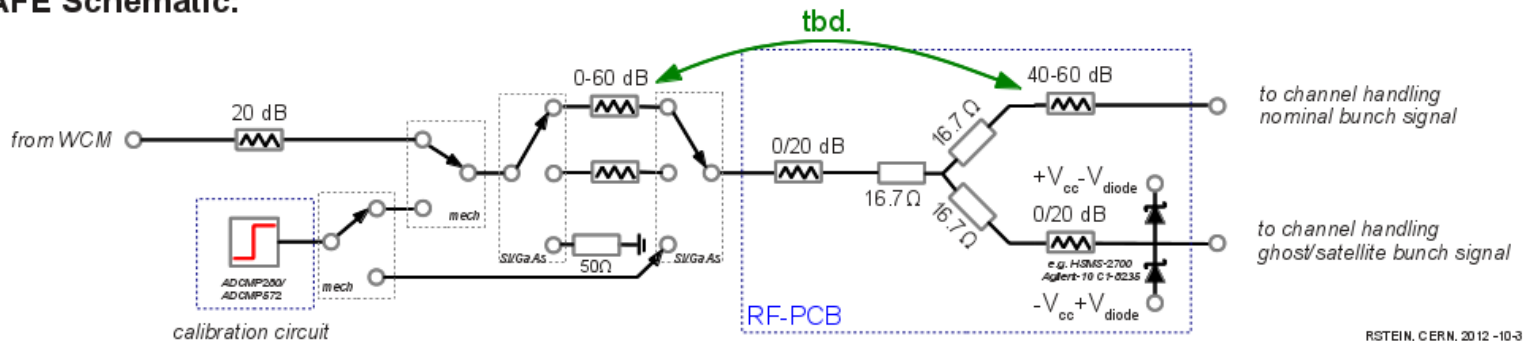
Option I:



Option II:



## G&S AFE Schematic:

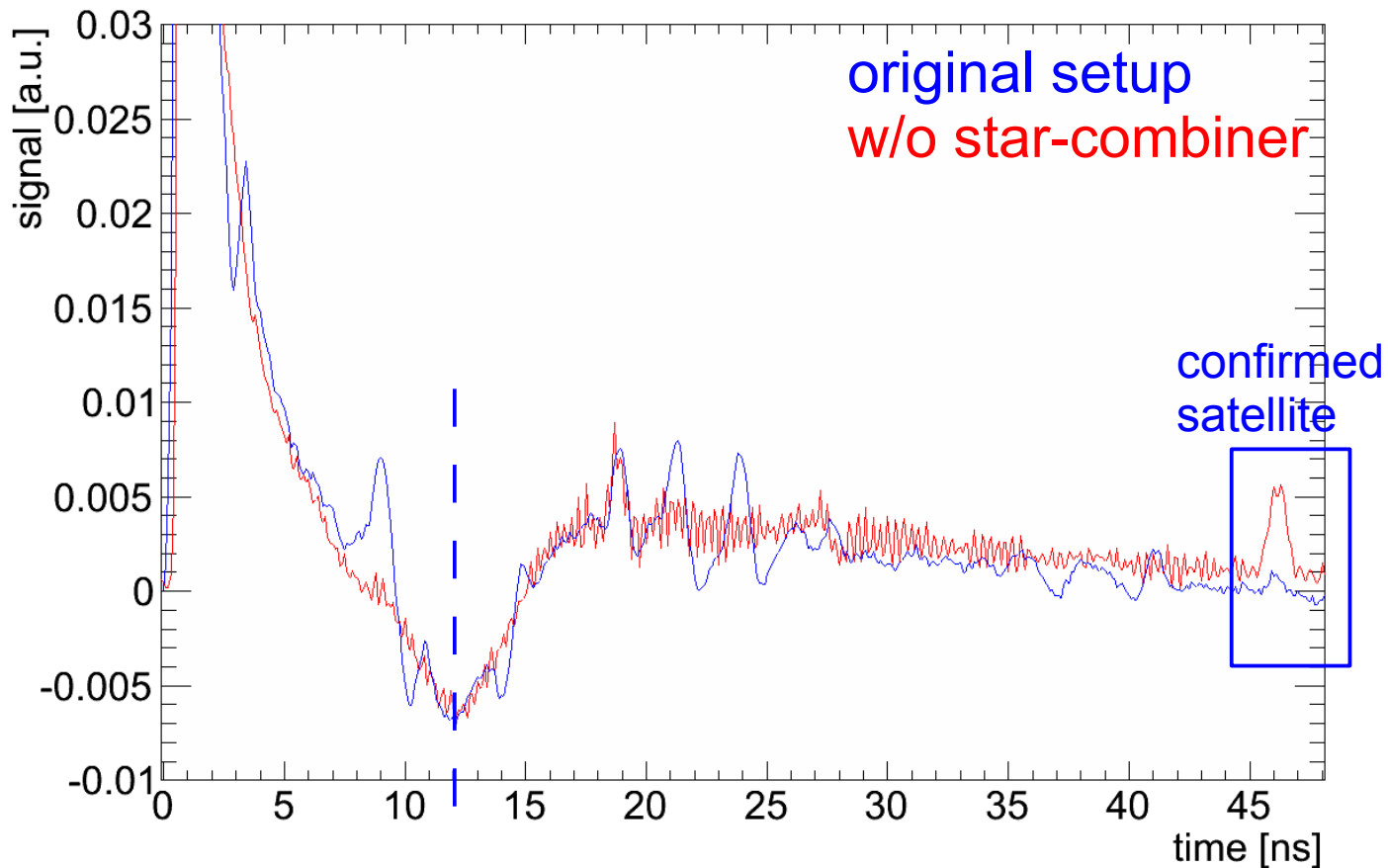


RSTEIN, CERN, 2012-10-31, V3

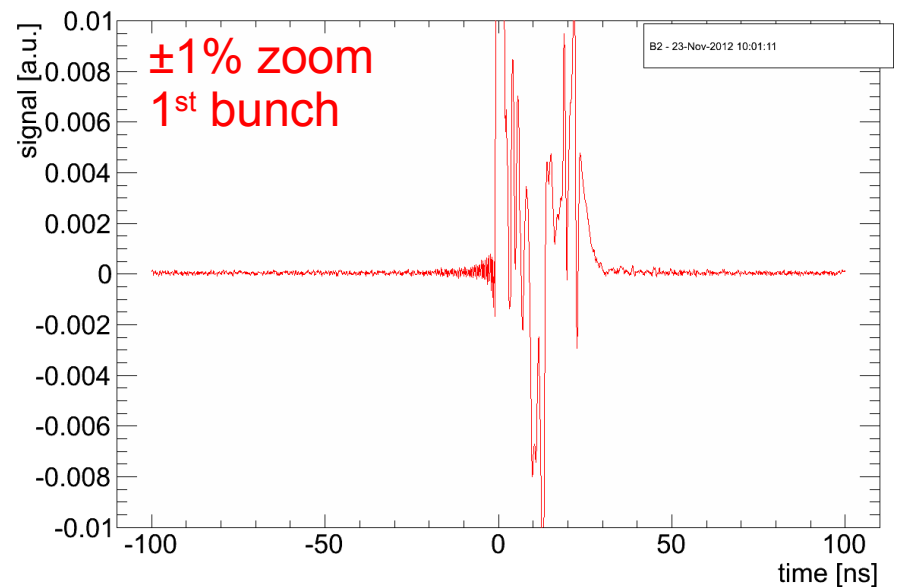
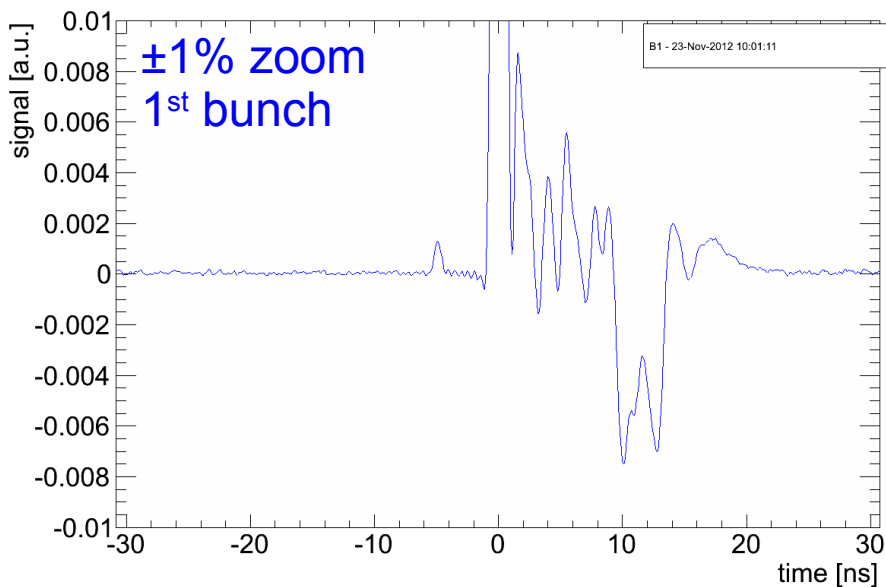
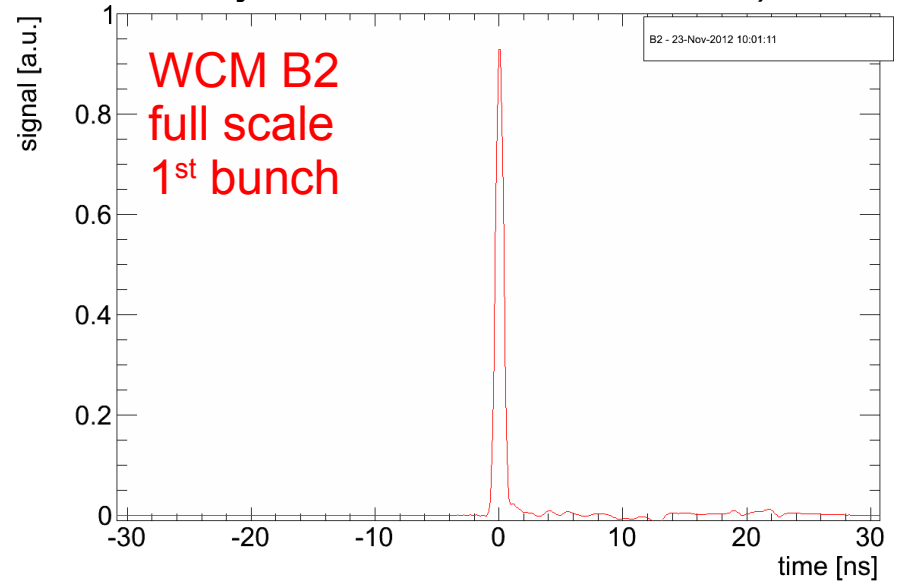
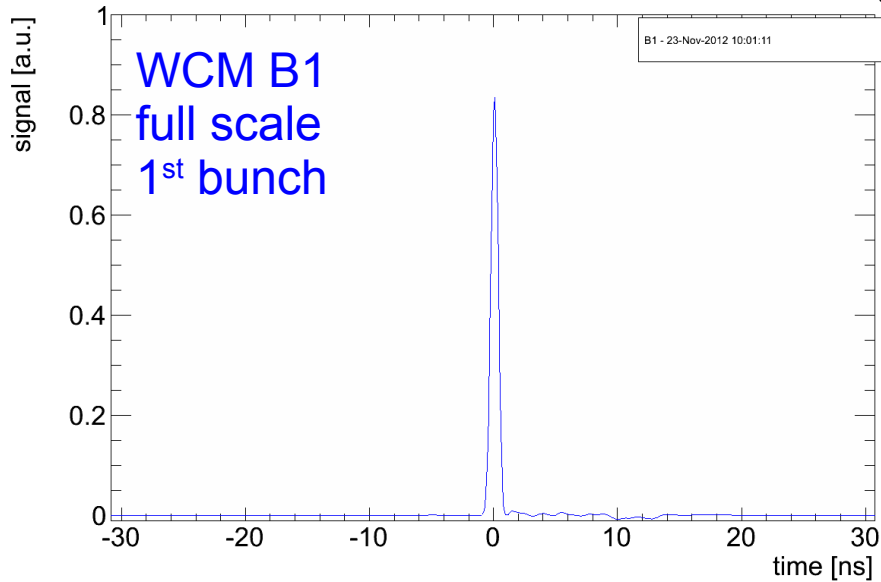
- For the LHC only one signal path implemented (upgrade as for PS?)
- All transfer function (except WCM) calibrated and under control down to  $<10^{-4}$

# 2012: First Beam Data after Modifications – July vs. November VdM Scan B1

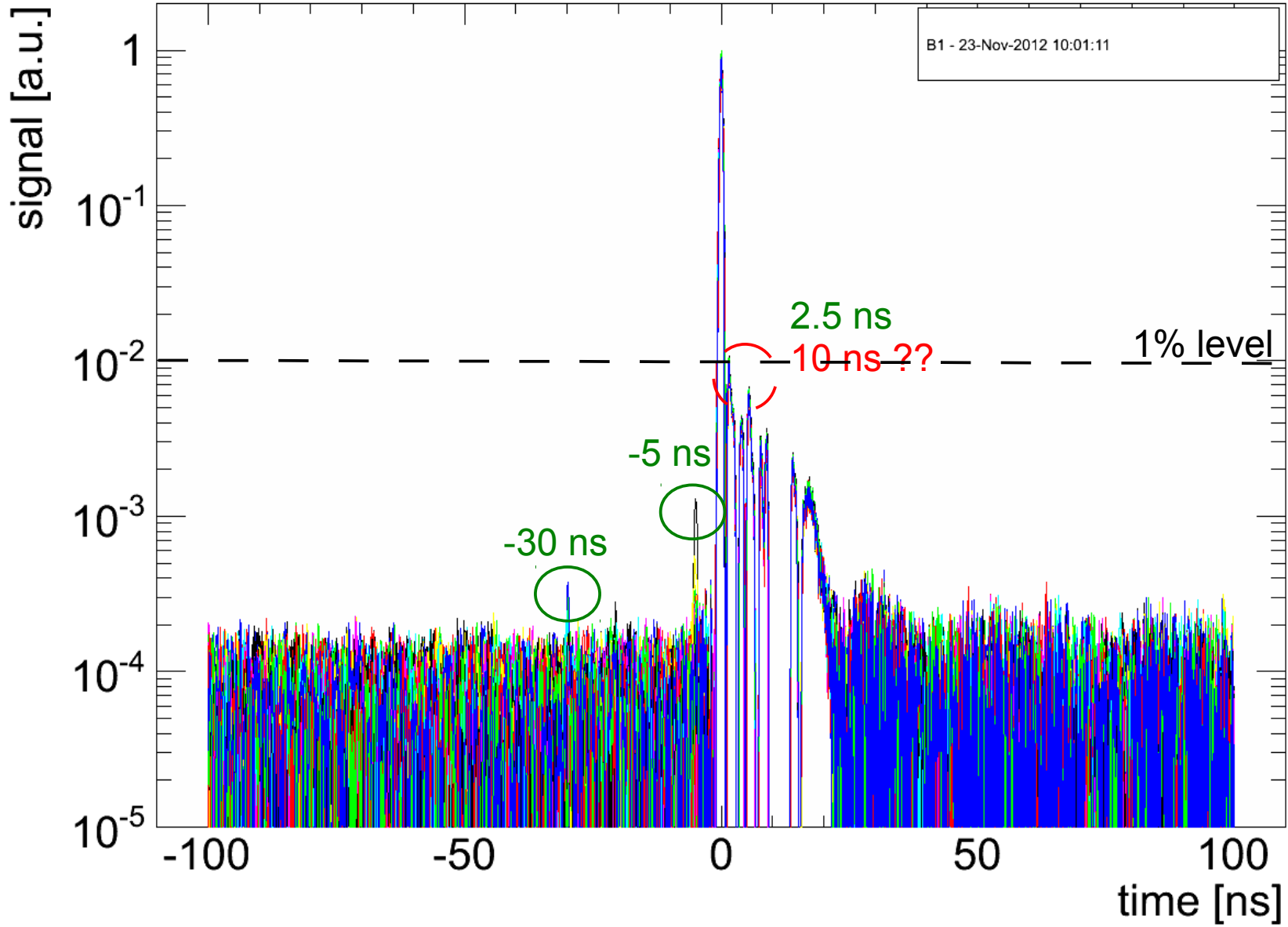
- During last TS: synchronised setup B1 & B2: simplified setup → reduced systematics by removing star-combiner
- re-measured cable/scope transfer function → eliminates all reflections except those created within the WCM itself (N.B. cannot back-propagate these changes for B2 measurements during VdM scan in November)



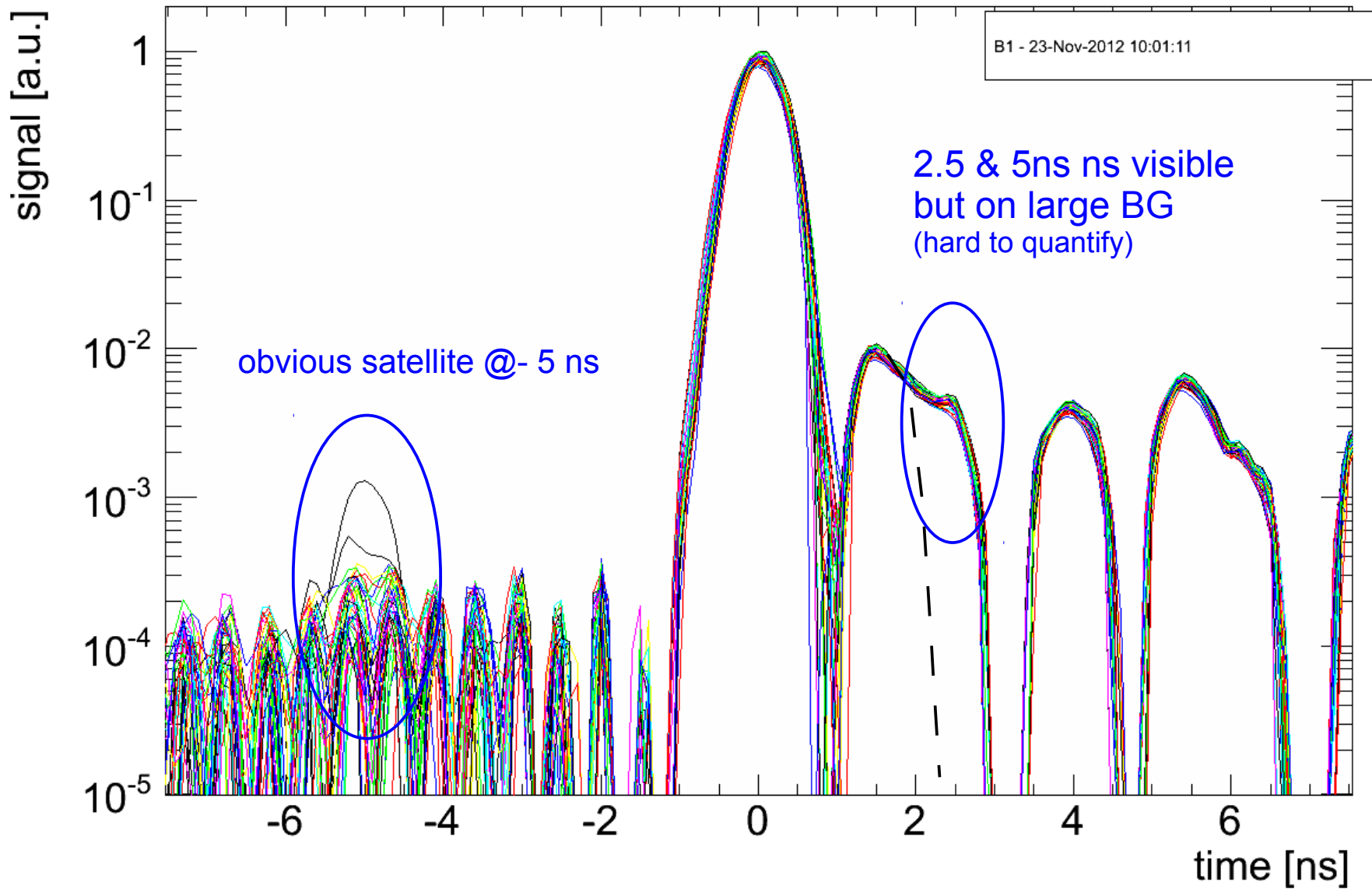
- Removed the star-combiner for B1 (source for sys. reflection after bunch)



# Typical WCM Signal Response – Log Scale

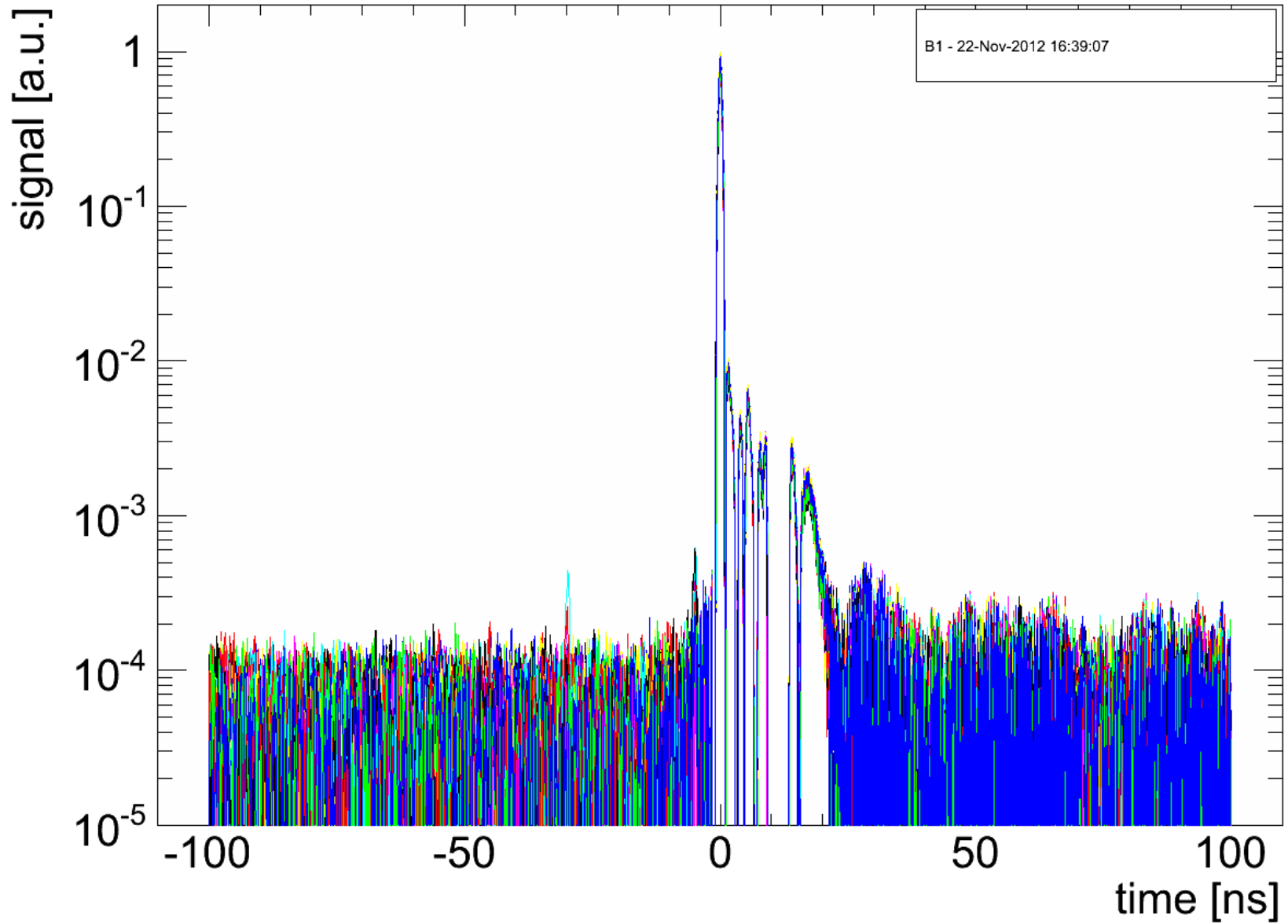


# Typical WCM Signal Response – Log Scale - Zoom



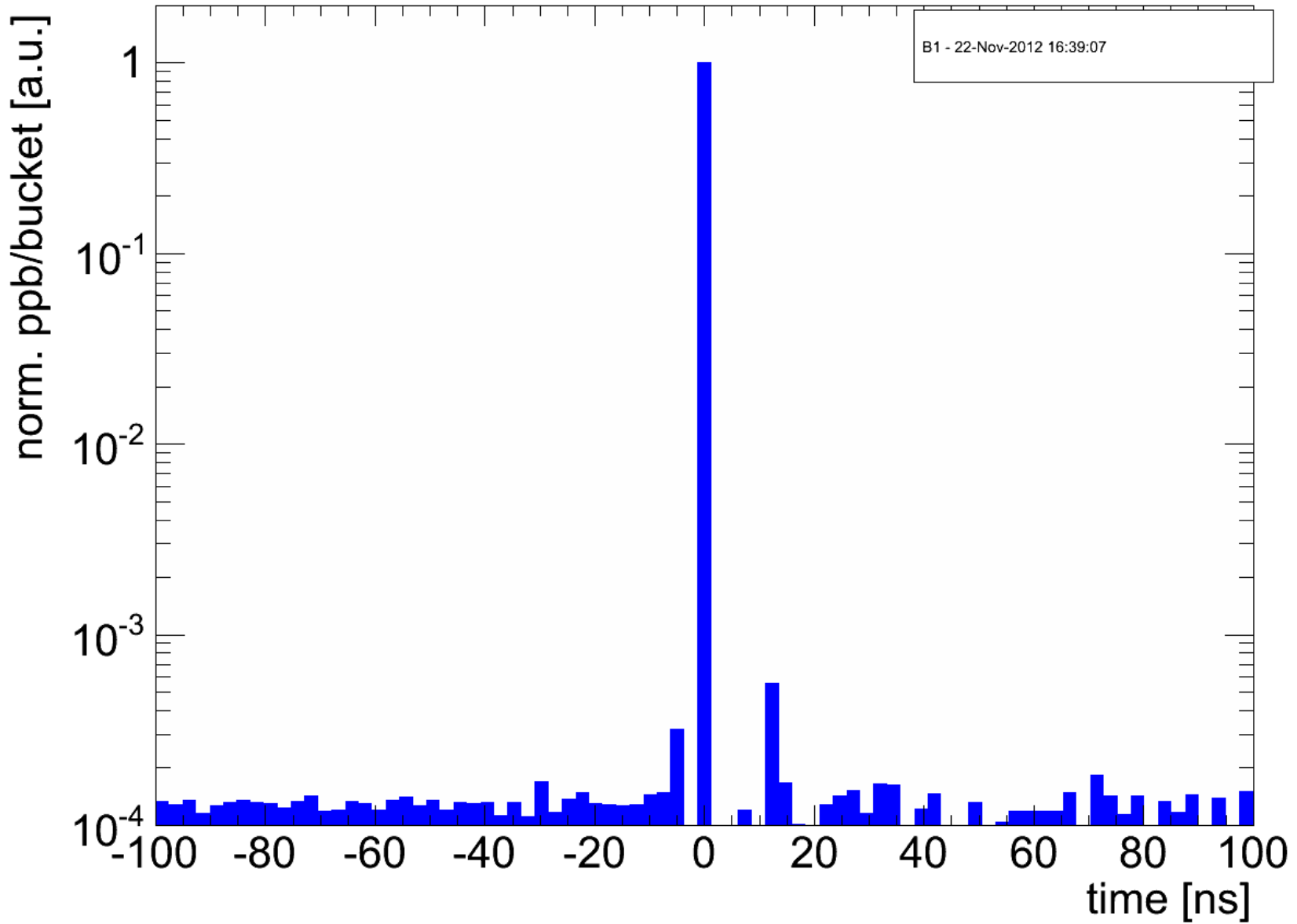


# VdM Scan 21th November – B1 I/II Superimposed Raw Traces





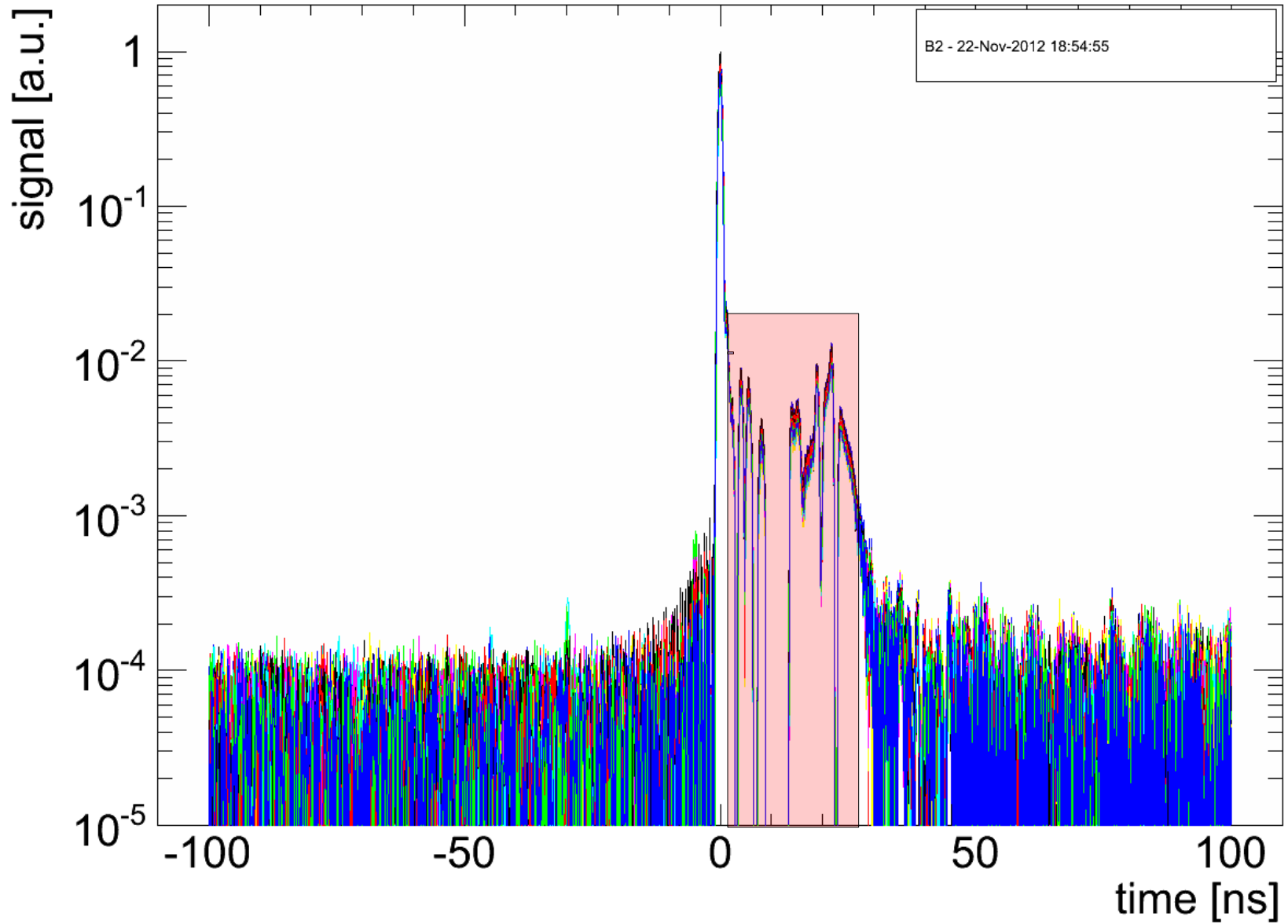
# VdM Scan 21th November – B1 II/II Integrated over RF Bucket





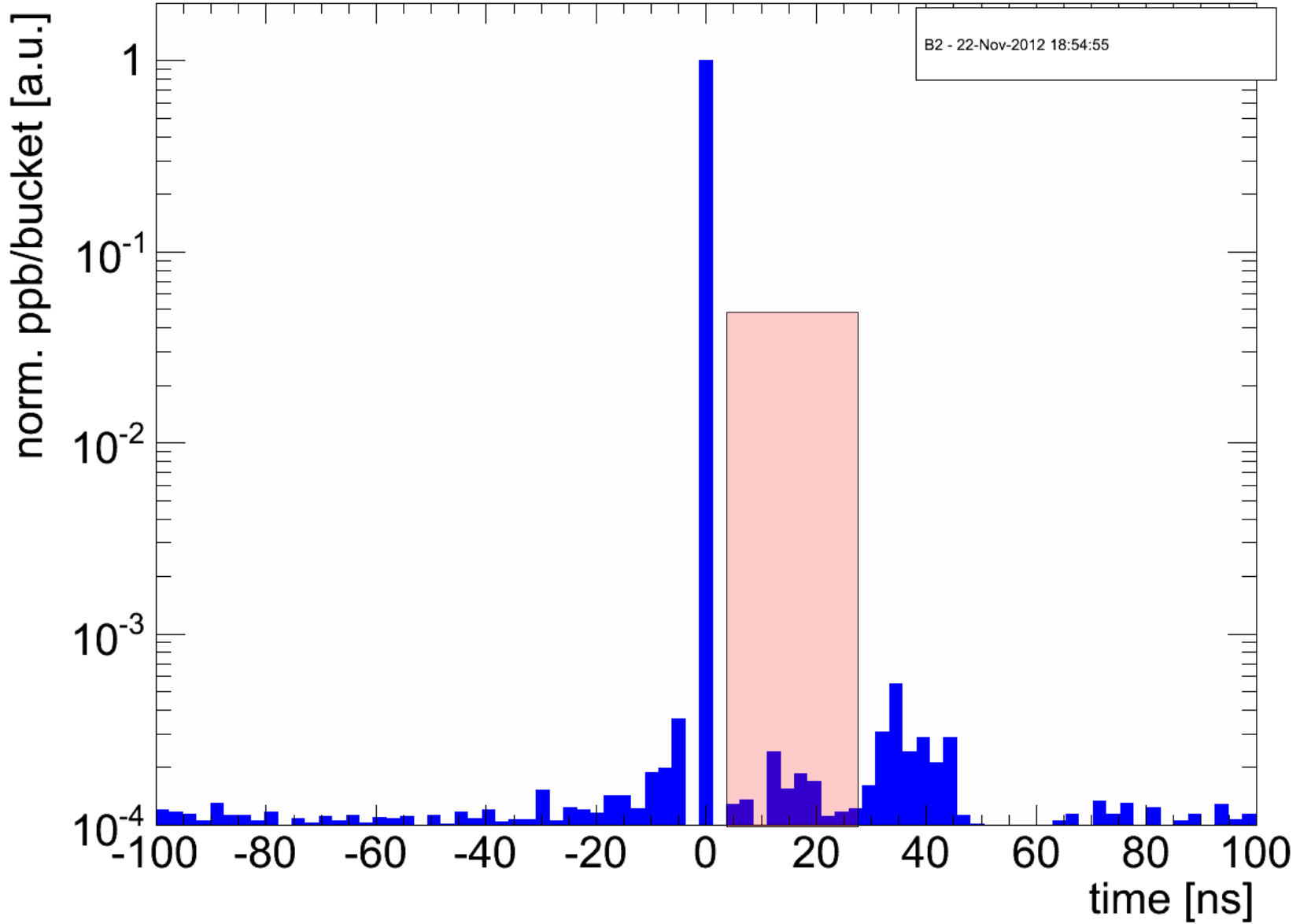


# VdM Scan 21th November – B2 I/II Superimposed Raw Traces



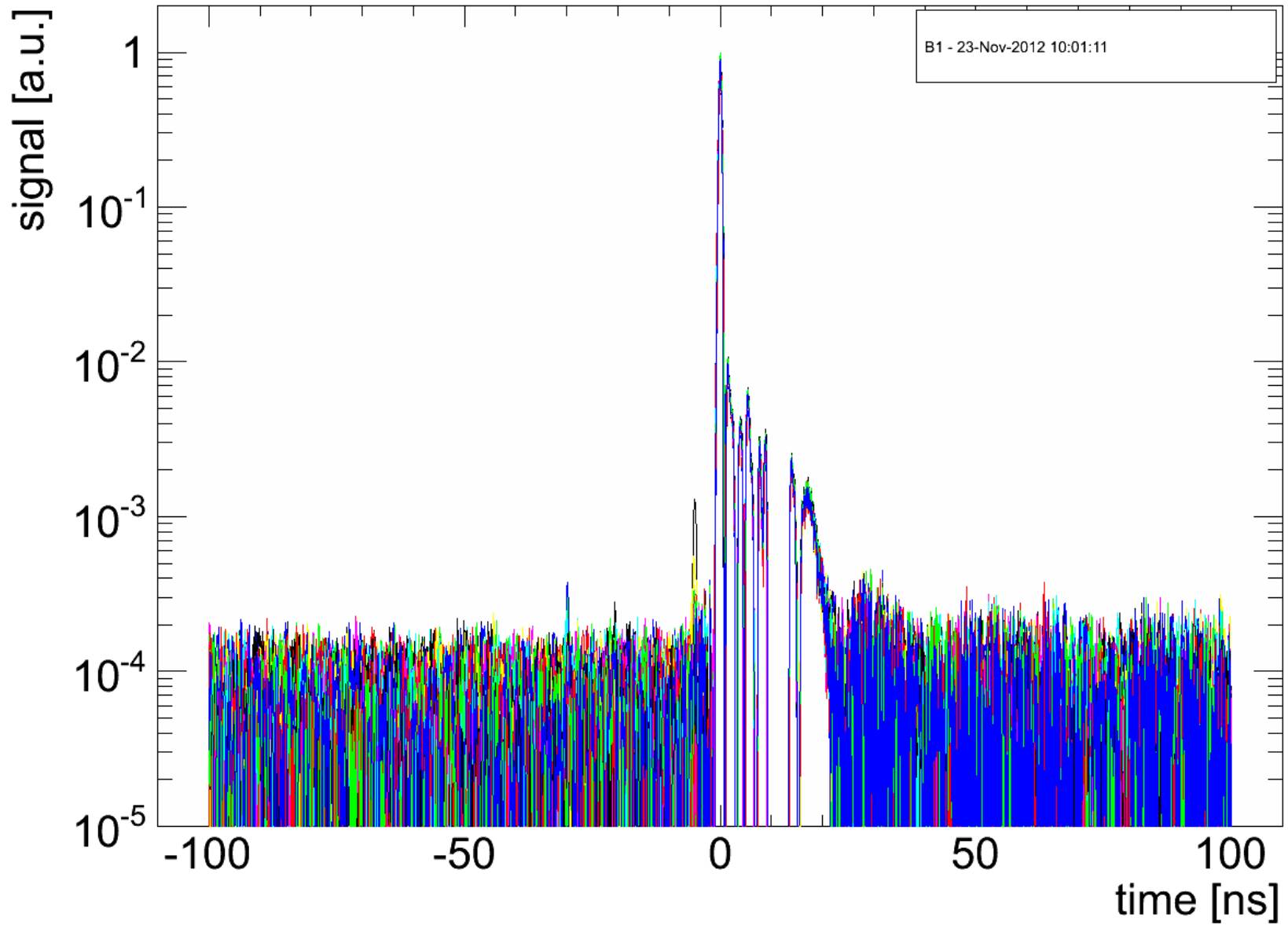


# VdM Scan 21th November – B2 II/II Integrated over RF Bucket



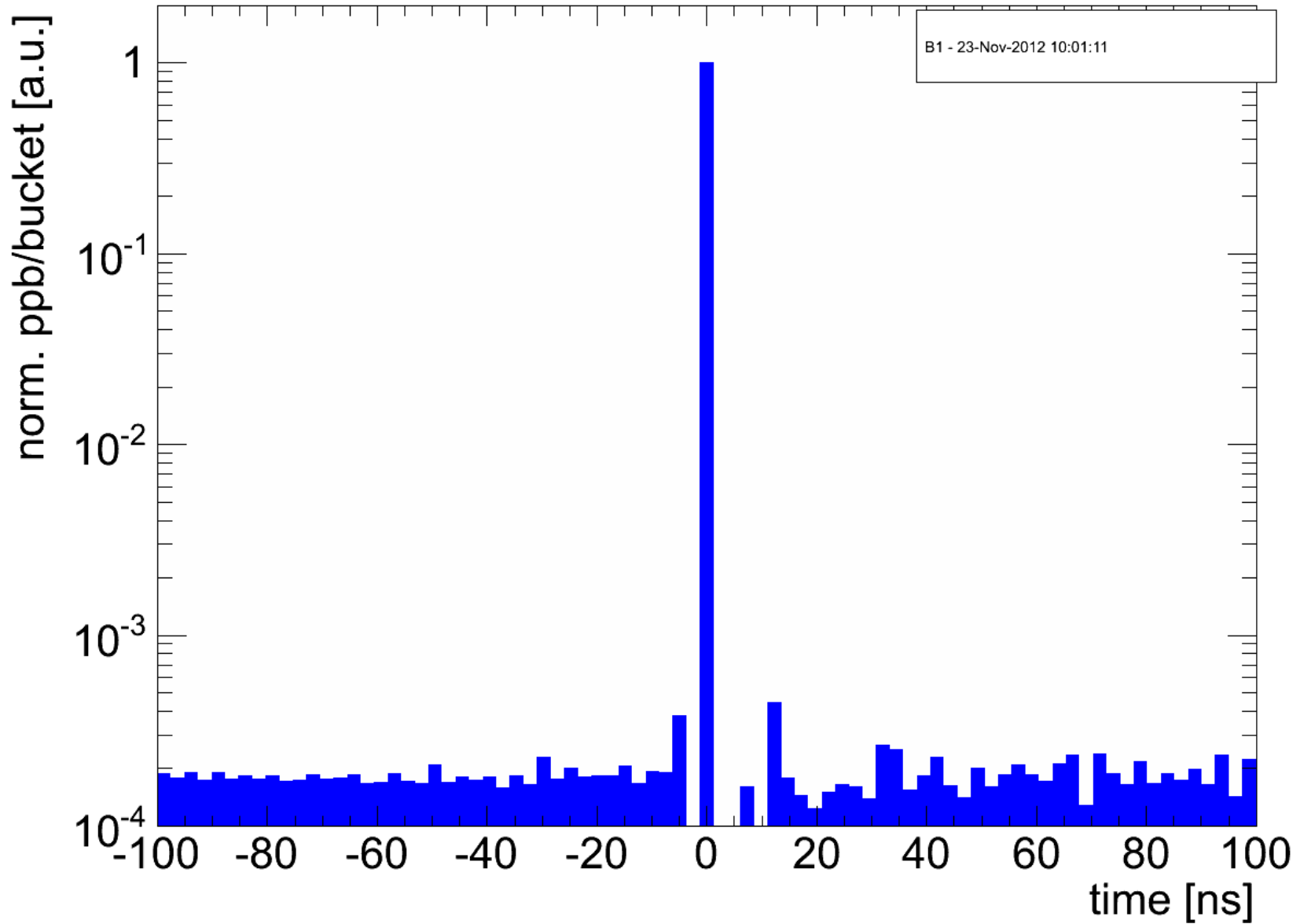


# VdM Scan 23th November – B1 I/II Superimposed Raw Traces



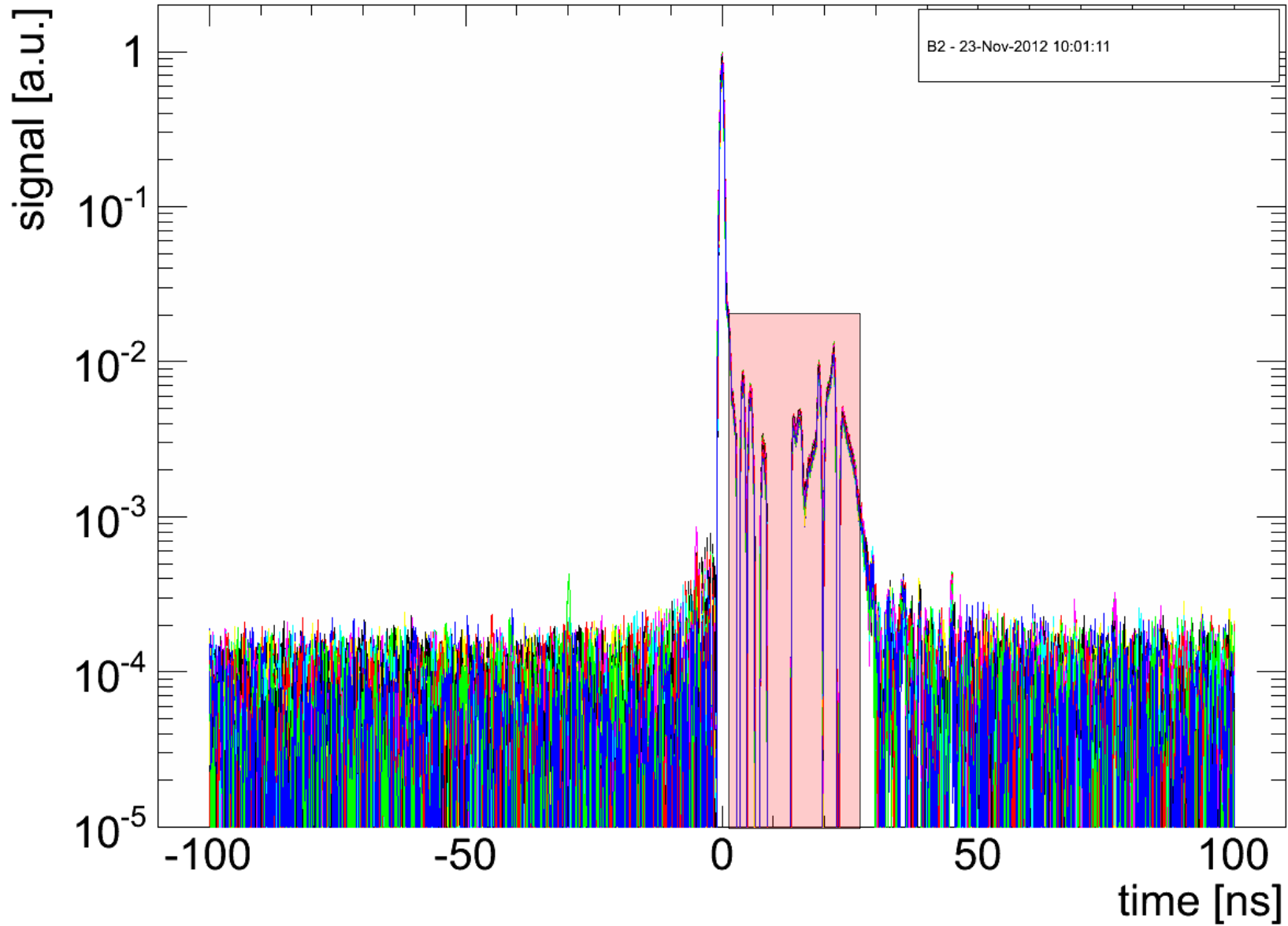


# VdM Scan 23th November – B1 I/II Superimposed Raw Traces



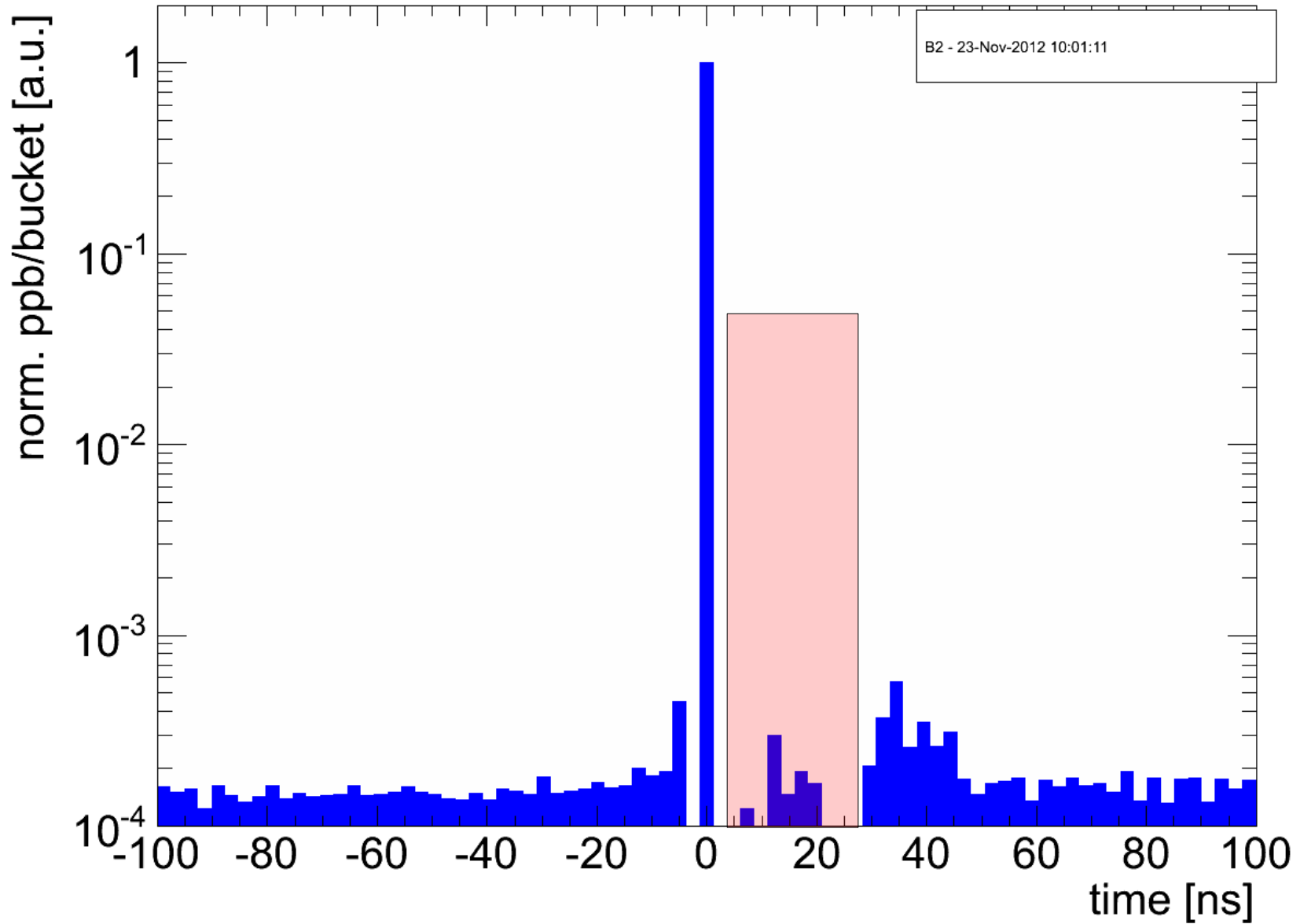


# VdM Scan 23th November – B2 I/II Superimposed Raw Traces





# VdM Scan 23th November – B2 I/II Superimposed Raw Traces



- Beam 1:

- @-30 ns:  $n_b \approx 0.1 \dots 0.44 \cdot 10^{-3} \langle I_b \rangle_{\max} \rightarrow \text{total: } 0.17 \cdot 10^{-3} I_{B1}$
- @- 5 ns:  $n_b \approx 0.3 \dots 0.6 \cdot 10^{-3} \langle I_b \rangle_{\max} \rightarrow \text{total: } 0.31 \cdot 10^{-3} I_{B1}$
- @+2.5 ns:  $n_b \approx 3.0 \dots 4.0 \cdot 10^{-3} \langle I_b \rangle_{\max} \rightarrow \text{total: } ??? I_{B1}$
- @+10 ns:  $n_b \approx 0.2 \cdot 10^{-3} \langle I_b \rangle_{\max} \rightarrow \text{total: } 0.6 \cdot 10^{-3} I_{B1} \text{ <not confirmed>}$

- Beam 2:

- @-30 ns:  $n_b \approx 0.1 \dots 0.3 \cdot 10^{-3} \langle I_b \rangle_{\max} \rightarrow \text{total: } 0.15 \cdot 10^{-3} I_{B1}$
- @- 5 ns:  $n_b \approx 0.2 \dots 0.8 \cdot 10^{-3} \langle I_b \rangle_{\max} \rightarrow \text{total: } 0.35 \cdot 10^{-3} I_{B1}$
- @+2.5 ns:  $n_b \approx ??? \text{ <likely there but dominated by systematic>}$
- @+35/45 ns:  $n_b \approx \text{small} \langle I_b \rangle_{\max} \rightarrow \text{total: } 0.6 \cdot 10^{-3} I_{B1} \text{ <not confirmed>}$

- Beam 1 & Beam 2: no sig. contributions outside [-100 ns,+100ns] w.r.t. main bunch

- Beam 1:

- ? bunches@-50 ns:  $n_b \approx ??? \cdot 10^{-3} \langle I_b \rangle_{\max}$  → total:  $0.21 \cdot 10^{-3} I_{B1}$
- 4 bunches@-30 ns:  $n_b \approx 0.2 \dots 0.44 \cdot 10^{-3} \langle I_b \rangle_{\max}$  → total:  $0.232 \cdot 10^{-3} I_{B1}$
- 7 bunches@-5 ns:  $n_b \approx 0.2 \dots 1.3 \cdot 10^{-3} \langle I_b \rangle_{\max}$  → total:  $0.382 \cdot 10^{-3} I_{B1}$
- ? bunches@+2.5 ns:  $n_b \approx 3.0 \dots 4.0 \cdot 10^{-3} \langle I_b \rangle_{\max}$  → total:  $??? I_{B1}$
- 7 bunches@+10 ns:  $n_b \approx 0.2 \dots 1.3 \cdot 10^{-3} \langle I_b \rangle_{\max}$  → total:  $1 \cdot 10^{-3} I_{B1}$

- Beam 2:

- 3 bunches@-30 ns:  $n_b \approx 0.3 \dots 0.4 \cdot 10^{-3} \langle I_b \rangle_{\max}$  → total:  $0.18 \cdot 10^{-3} I_{B1}$
- 5 bunches@- 5 ns:  $n_b \approx 0.2 \dots 1.0 \cdot 10^{-3} \langle I_b \rangle_{\max}$  → total:  $0.45 \cdot 10^{-3} I_{B1}$
- @+2.5 ns:  $n_b \approx ???$  <likely there but dominated by systematic>
- @+35/40/45 ns:  $n_b \approx \text{small} \langle I_b \rangle_{\max}$  → total:  $\sim 10^{-2} I_{B1}$  <not confirmed>

- Beam 1 & Beam 2: no sig. contributions outside [-100 ns,+100ns] w.r.t. main bunch



- Improved WCM systematics for B1 and B2 (after Nov'12)
- WCM resolution  $\pm \sim 5 \cdot 10^{-5}$  (r.m.s.)  $\pm \sim 6 \cdot 10^{-5}$  (sys.) for an integration period of  $\sim 20$  s
- Satellite detections systematic:
  - $t = 0-15$  ns:  $I_{\text{sat(sys)}} < 5 \cdot 10^{-3} < I_{\text{bunch}} >_{\text{max}}$ , otherwise:  $I_{\text{sat(sys)}} < 10^{-5} < I_{\text{bunch}} >_{\text{max}}$
- N.B. presented satellite numbers based on following cut threshold
  - I. before main bunch:
    - raw signal  $> 2 \cdot 10^{-4}$  w.r.t.  $< I_{\text{bunch}} >_{\text{max}}$  or
    - Integrated signal  $> 2 \cdot 10^{-4}$  w.r.t.  $< I_{\text{beam}} >_{\text{max}}$
  - II. After main bunch:
    - $> 20$  ns as for 'I'
    - $< 20$  ns not reproducible w.r.t. bunch-to-bunch  
(i.e. not a reflection, introduces bias for satellites that are similar from b-2-b)
- Residual error given by reflections caused within WCM  
→ planned to be re-measure during LS-O