protoDUNE-SP channel status update

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Introduction

- protoDUNE-SP "bad" channels includes:
  - Unresponsive channels (no response to FE calibration pulser)
  - Open channels (low raw RMS, pulser OK)
  - Sticky channels (excessive stuck codes near baseline)
  - High raw RMS (ENC > 2000 e- before coherent noise removal)

  0.3% of 15,360 channels
- Channels were analyzed for any that changed status during the protoDUNE beam and cosmic runs
  - Run 4644 (9/24) through 8564 (7/27)
- Recent FE calibration pulser runs have been analyzed
  - Run 7877 and up

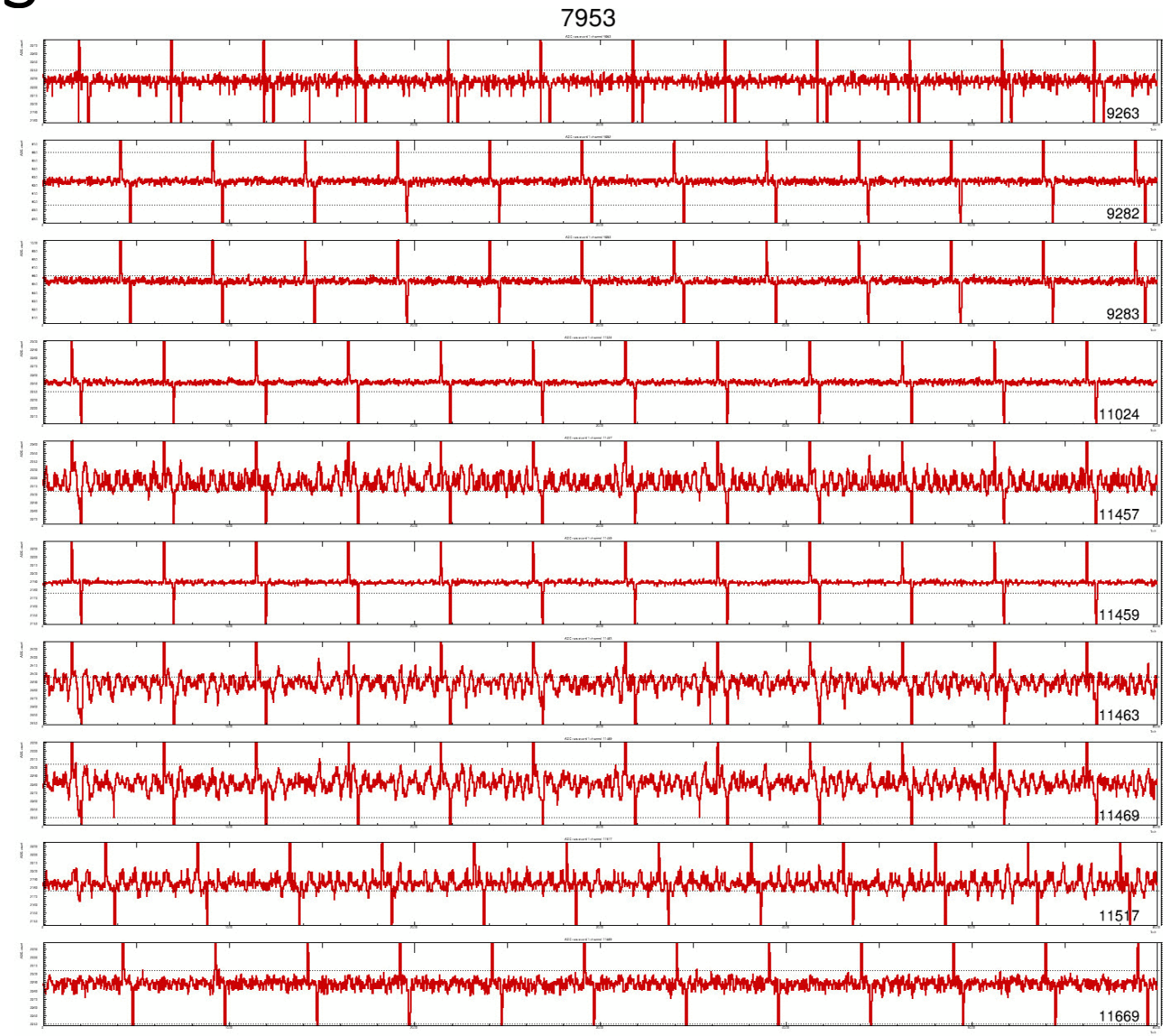
Bad to good channels

- 5 channels listed as open during the initial CE commissioning diagnosis have returned to normal RMS
- OK channels observe signal in beam/cosmic runs

APA	Channel	Beam Runs	Runs after beam	Channel list comments
6	9263	Sticky	Sticky	very sticky pedestal
	9282	Dead	Dead	Broken connection
	9283	Dead	Dead	Broken connection
1	11024	Dead	Dead	Broken connection
	11457	Dead	OK from 6118	Broken connection
	11459	Dead	Dead	Broken connection
	11463	Dead	OK from 8366	Broken connection
	11469	Dead until 5141 OK after	OK	Broken connection
	11517	Dead until 5141 OK after	OK	Broken connection
	11669	Dead	OK from 6118	Broken connection

Bad to good channels

- In recent pulser runs, all open channels respond to calibration pulse
- Suggests all 5 channels were open in front of the CE



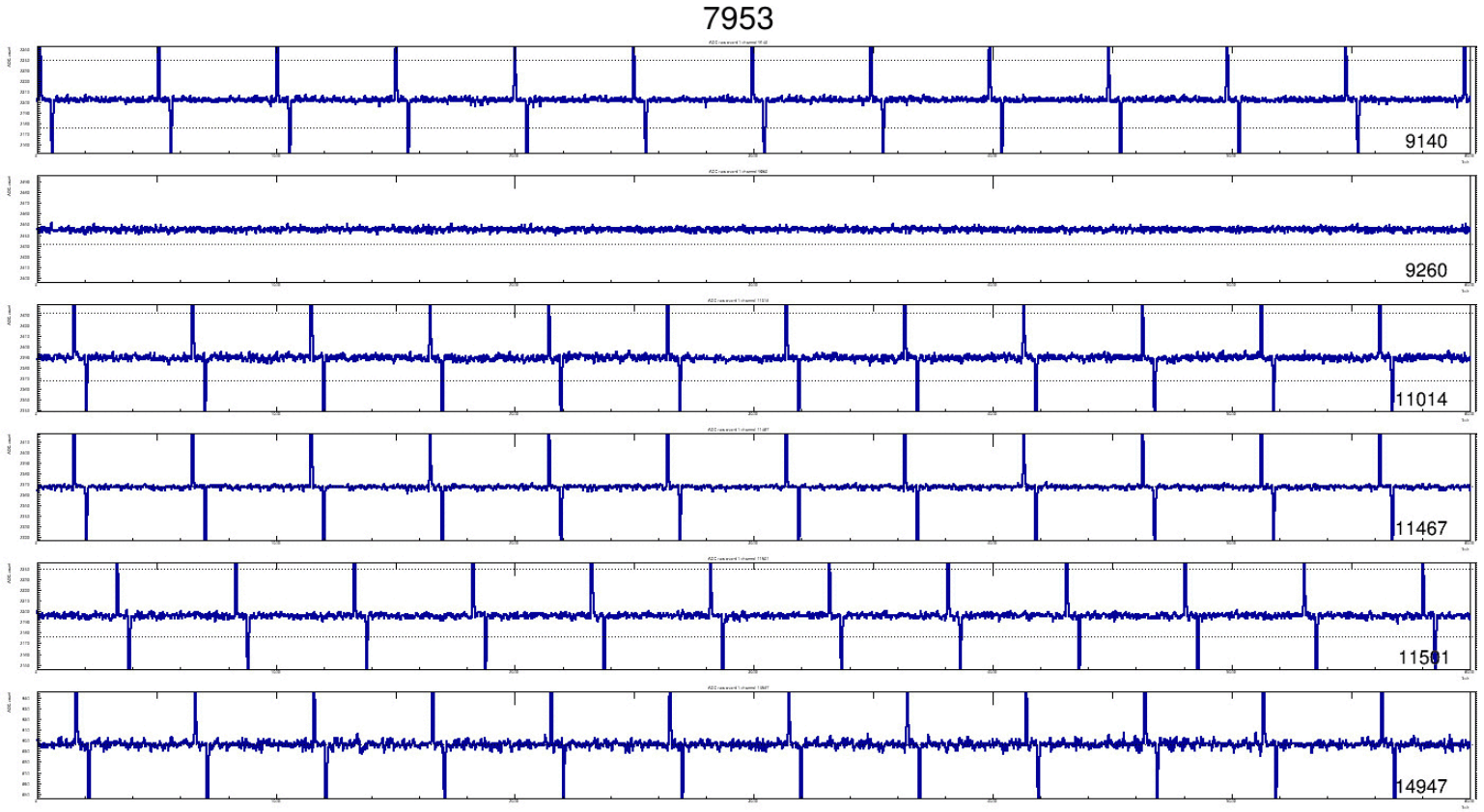
Good to bad channels

- 5 channels that functioned normally during initial diagnosis and beam data changed to low RMS in later runs
- 1 low RMS channel not listed as open during initial CE diagnosis was found

APA	Channel	Beam runs	Runs after beam
6	9140	OK	Dead at 8366 OK at 8401
	9260	OK	Dead from 6118
1	11014	OK	Dead from 8366
	11467	OK	Dead from 8366
	11501	OK	Dead from 8366
4	14947	Dead	Dead

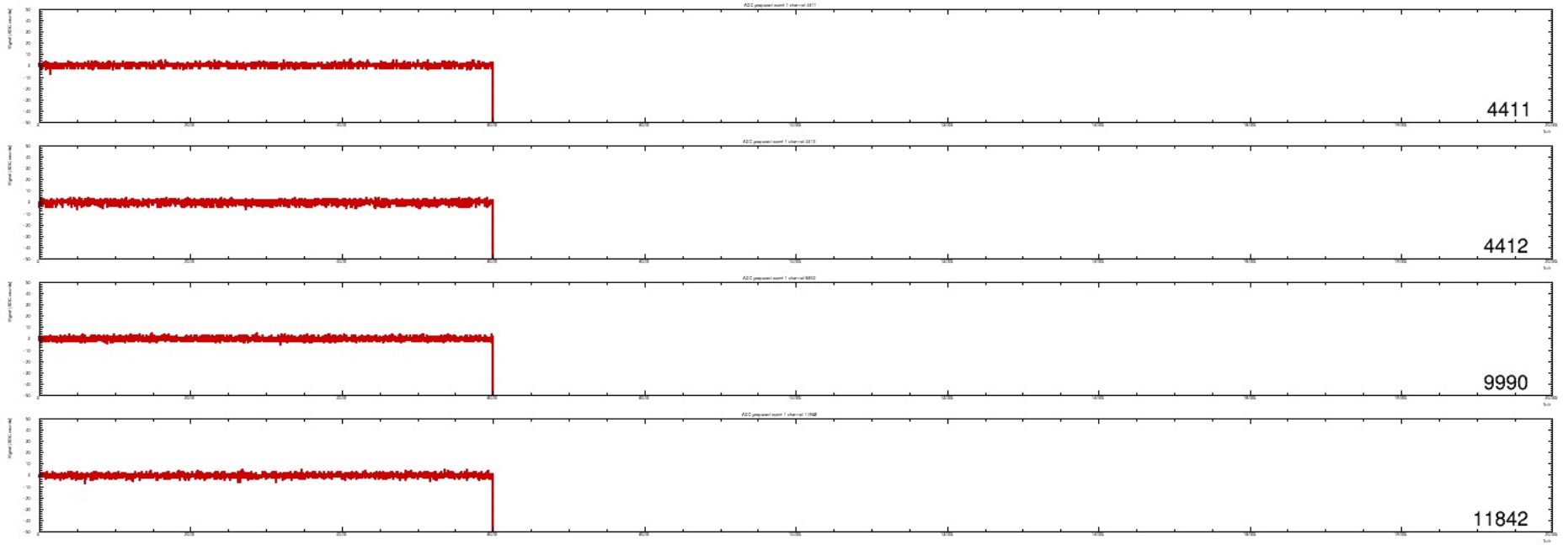
Good to bad channels

- In recent pulser runs, one of the new low RMS channels doesn't respond to the pulser
- Suggests 1 new channel is bad somewhere in the FE
- 5 new channels are open in front of the CE



Just bad

- Four channels that were unresponsive in the CE after initial cathode HV ramp remain unresponsive in recent pulser runs



Summary

- In beam and cosmic runs:
  - 5 channels with open connections were found to restore a normal level of RMS and signal
  - 5 channels with normal level of RMS became open in front of the CE
- In recent pulser runs:
  - 1 channel appears to have become unresponsive in the electronics
- Currently a total of 5 channels are unresponsive in the CE: 0.03%
- Analysis of earlier pulser runs is ongoing