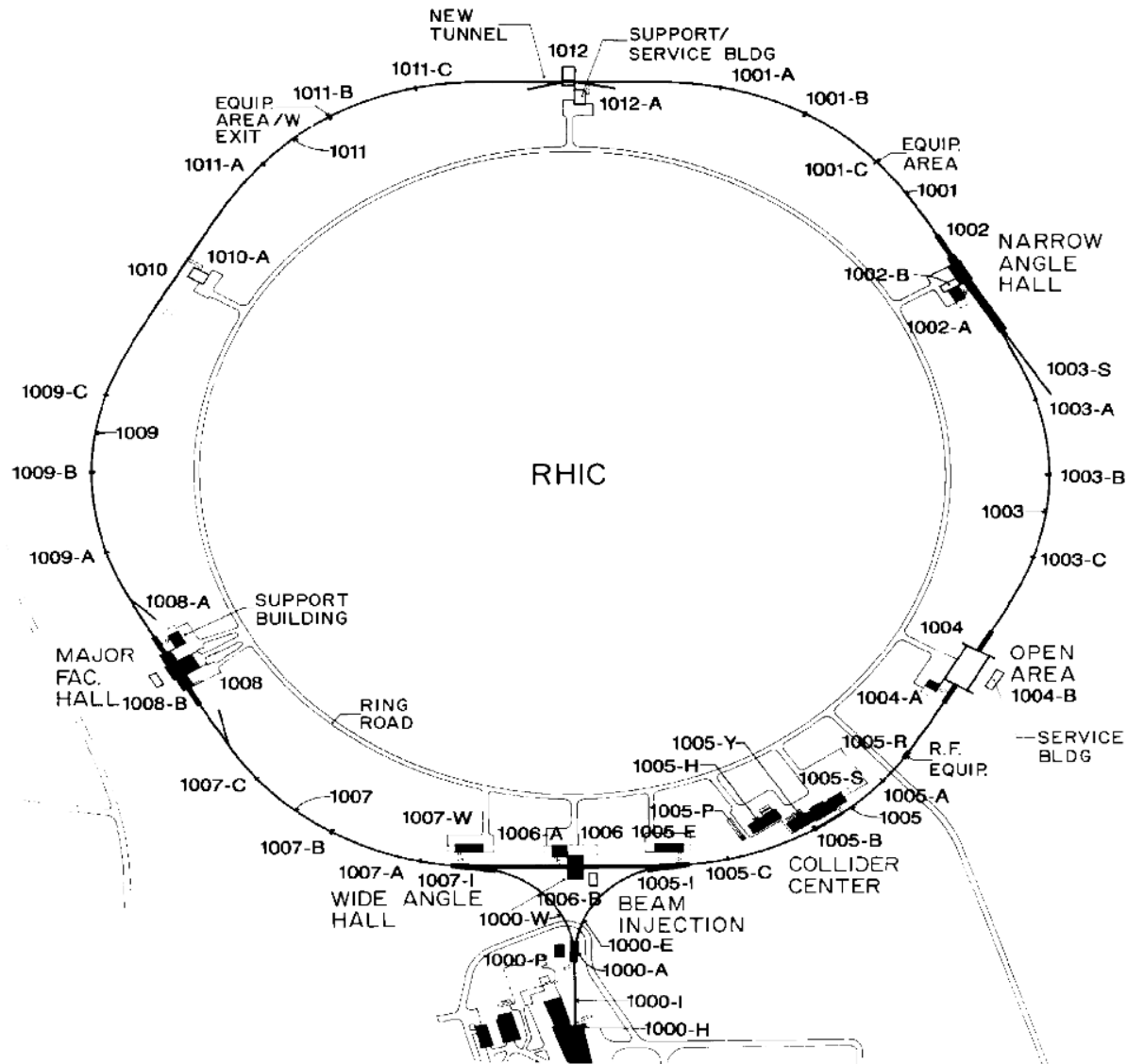


Radiation Effects during Zr+Zr/Ru+Ru Operation



RHIC Retreat
2018

July 13, 2018

John Morris



What alcove radiation effects can we expect during future runs?

Outline

- Some alcove radiation “background”
- Zr+Zr/Ru+Ru alcove radiation statistics
- Comparison with 100GeV Au runs
- Why were things so good in Zr/Ru run?
- Radiation effects during pp runs (very briefly)
- Radiation effects during low energy Au runs
- Results of 2017 FEC shielding experiment

Acknowledgements

Peter Ingrassia for accelerator availability stats

Al Marusic for memory upset diagnostic scripts

Vincent Schoefer for some ideas about beam conditions

Kevin Brown for shielding experiment slides and general consulting

Kin Yip for help with 2017 FEC shielding experiment

Controls Problems Caused by Alcove Radiation

From Kevin Brown 2016 retreat presentation...

- Network switches require frequent resets and even fail (2 replaced in Run 14, one replaced in Run 16)
- MADCs become corrupted and stop reporting
- Alcove FECs & WFGs still fail and require resets at a higher rate than in other locations
- QD & BPM FECs can still hang and require resets
- UPS units in alcoves have failed (11C & 5C)
- Fiber runs in RHIC tunnel darken
- Digi Terminal Servers need AC resets at times
- VME PSs still fail at times (rare)

Indicators of Alcove Radiation

1. Resets of network switches in alcoves

- Statistics gathered from fit application logs
- All resets included in statistics *
- Units for comparison – resets/week

2. Resets of Front End Computers (FECs) in alcoves

- Statistics gathered from fit application logs
- Resets for one of 4 standard errors included *
- Units for comparison – resets/week

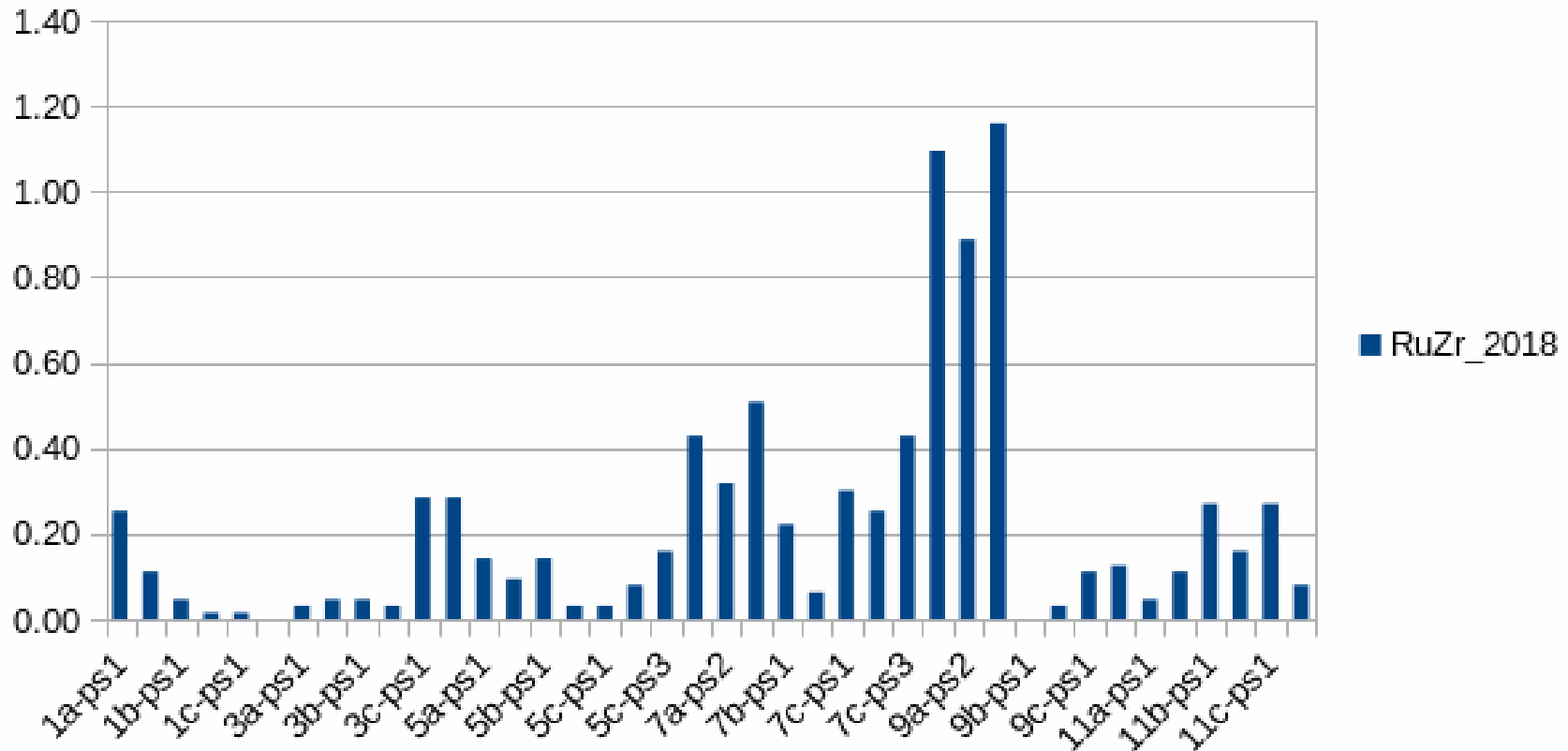
3. Single bit upsets in FEC memory in alcoves

- Repetitive pattern written in 2Mbytes of FEC RAM
- Since run16, patterns checked for changes on down-ramp of every store
- Units for comparison – upsets/day

Other data: beam intensity from Fill Data Analysis database, ramp and store counts from RHIC event link logs, accelerator availability numbers from Peter Ingrassia

Radiation Effects during Zr+Zr/Ru+Ru Operation

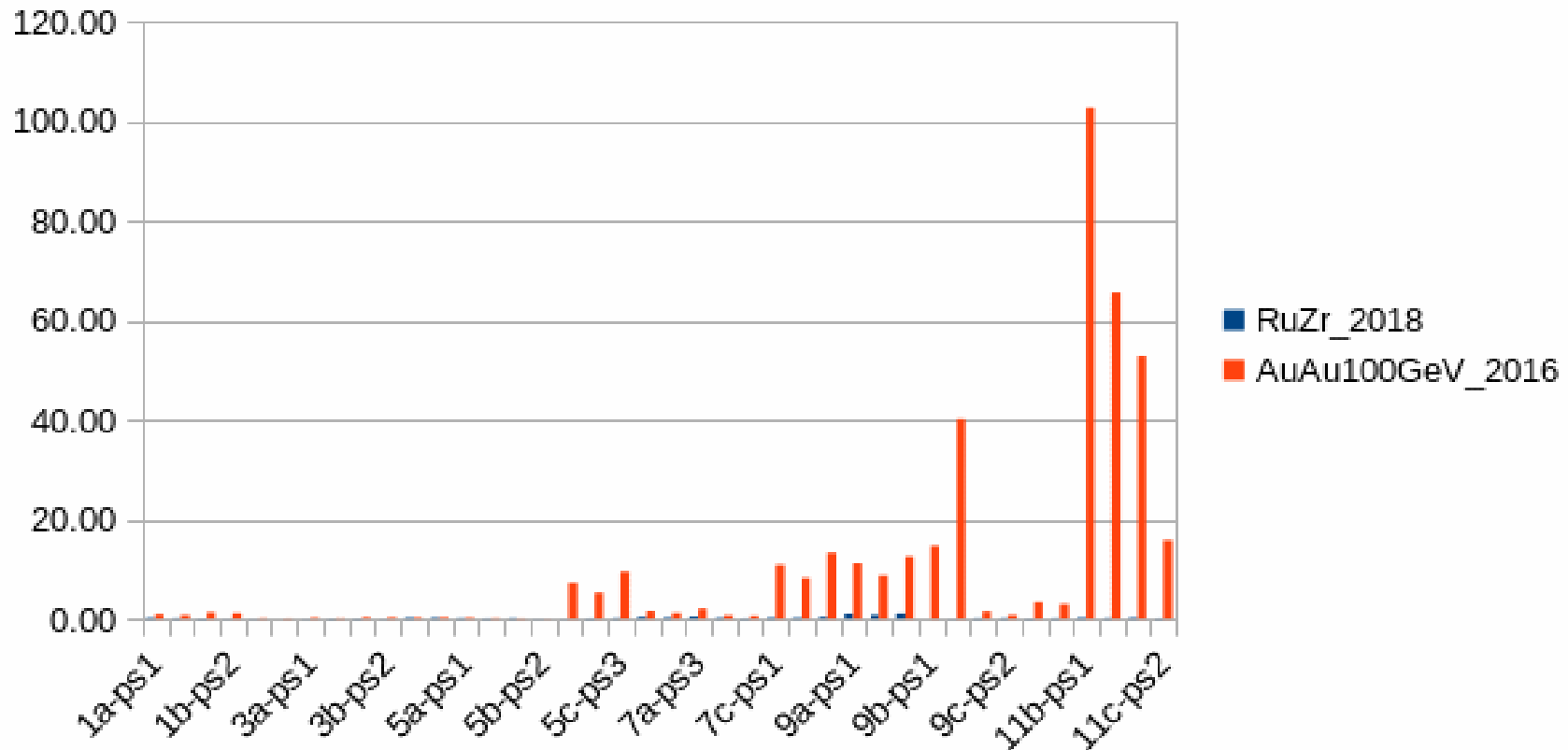
Diagnostic memory upsets per day by alcove



1 single alcove FEC reset. May not have been a true failure.
3 switch resets for troubleshooting during Au beam work.

Rad Effects - Zr+Zr/Ru+Ru along with 2016 100GeV Au+Au

Diagnostic memory upsets per day by alcove



Note scale change by two orders of magnitude

Comparison with 100GeV Au Runs

Run	Species	Ions (xE09)	Stores /Day	Ramps /Day	Ramp Eff	Aborts /Day	Mem Upsets /Day	Switch Resets /Week	FEC Resets /Week	Availability
run16	Au+Au	184	3.4	5.8	89.5	5.5	447	18.2	13.4	82.8
run14	Au+Au	136	2.8	4.3	92.3	2.8	-	12.5	10.1	86.2
run10	Au+Au	97	5.7	7.6	91.5	3.7	-	4.2	7.3	81.3
run16	d+Au	195	3.1	6.2	93.5	12.5	134	3.2	3.8	87.1
run15	pp+Au	158	3.4	10.7	87.8	5.1	-	6.1	5.6	87.3
run18	Ru+Ru Zr+Zr	93	1.9	3.0	96.6	4.5	9	0.0	0.1	92.5

Ru/Zr “best” in almost all categories

Why were things so much better in Zr/Ru run?

- NOT because of alcove equipment changes
- Relatively low intensity (# of ions comparable to run10 Au)
- Lighter ions (intrabeam scattering,...)
- Long stores (fewer injections and ramps)
- Good ramp efficiency
- Fewer beam aborts

- *Something particularly nice about Ru and Zr?*
- *Something particularly nasty about Au?*

Alcove Radiation Effects during Polarized Proton Runs

Run	Species	Energy (GeV)	Ions (xE09)	Stores /Day	Ramps /Day	Aborts /Day	Mem Upsets /Day	Switch Resets /Week	FEC Resets /Week	Availability
run16	Au+Au	100	184	3.4	5.8	5.5	447	18.2	13.4	82.8
run10	Au+Au	100	97	5.7	7.6	3.7	-	4.2	7.3	81.3
			pp (xE11)							
run17	pp+pp	254	17.9	2.8	4.7	5.6	17	1.3	1.5	85.6
run15	pp+pp	100	16.2	3.1	4.4	5.1	-	0.3	1.1	88.5
run15	pp+Al	100	18.5	3.4	10.9	4.5	-	1.0	1.5	85.6
			Ions (xE09)							
run18	Ru+Ru Zr+Zr	100	93	1.9	3.0	4.5	9	0.0	0.1	92.5

Alcove radiation effects during pp runs are mild compared to 100GeV Au runs, but still more than Ru+Ru and Zr+Zr running.

Alcove Radiation Effects during Low Energy Au+Au Runs

Run	Energy (GeV)	Ions (xE09)	Stores/Day	Ramps /Day	Aborts/Day	Mem Upsets/Day	Switch Resets / Week	FEC Resets / Week	Availability
run10	31.2	106	7.0	8.2	3.1	-	3.0	4.7	89.4
run17	27.2	156	3.9	6.0	3.9	96	4.1	1.6	88.5
run10	19.5	108	6.9	7.6	2.1	-	0.5	0.0	94.5
run18	13.5*	167	8.9	11.1	6.3	52	1.6	0.4	88.7
run14	7.3	115	11.8	0.2	2.4	-	0.5	0.9	86.6
run10	5.7	102	19.8	0.8	5.8	-	4.3	7.5	82.3
run10	3.85	46	62.3	0.6	1.9	-	0.8	2.5	90.1
run18	3.85	6.7	1.6	2.4	7.0	3	0.0	0.0	96.4

Maybe... Alcove radiation effects scale with energy with “polarized proton like” conditions at lower energies

* 27.2GeV running mixed with 13.5GeV running in run18
13 days of 5.7GeV and 36 days of 3.85GeV running in run10

Alcove Radiation Effects during Low Energy d+Au Runs

Run	Energy (GeV)	Au Ions (xE09)	Stores /Day	Ramps /Day	Aborts /Day	Mem Upsets /Day	Switch Resets /Week	FEC Resets /Week	Availability
run16	31.1	192	2.6	4.7	5.4	83	4.0	5.0	92.4
run16	19	183	3.5	4.9	5.0	36	1.4	1.4	93.4
run16	9.8	205	10.6	1.5	9.1	71	2.5	3.2	86.0

28 totals days of d+Au in run16

2017 FEC Shielding Experiment

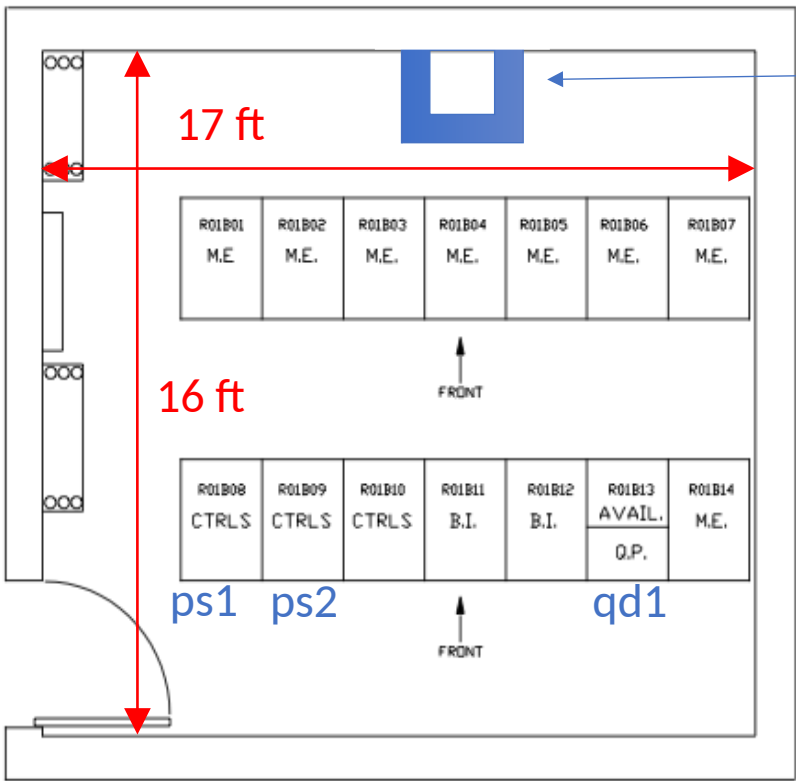
Prediction by Kin Yip

August 8, 2016 (message from Kin to Kevin Brown)

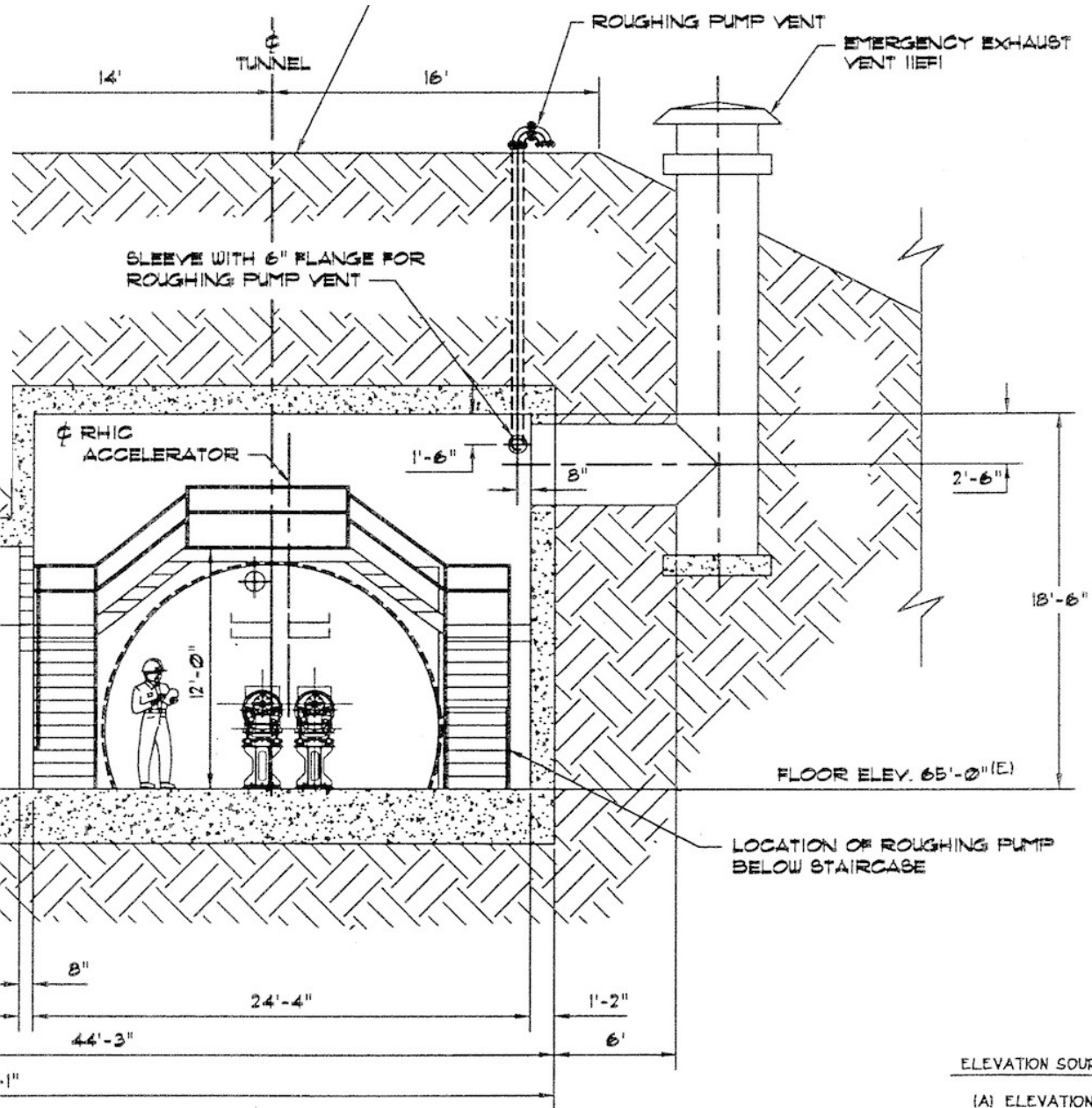
It seems that the concrete shielding of 1 foot all around my detecting spot (top bottom, side, front) would cause a reduction of the sum of fluxes of "neutron+photon" by a factor of almost 5 ! The shielding was what I showed you when you were in my office.

Kin

2017 FEC Shielding Experiment Alcove 7B



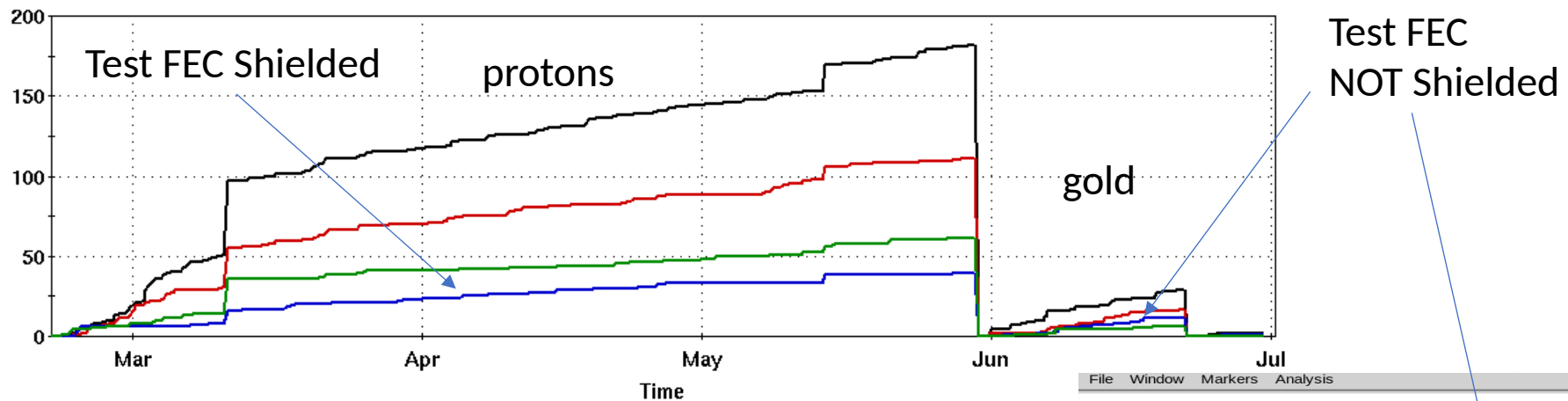
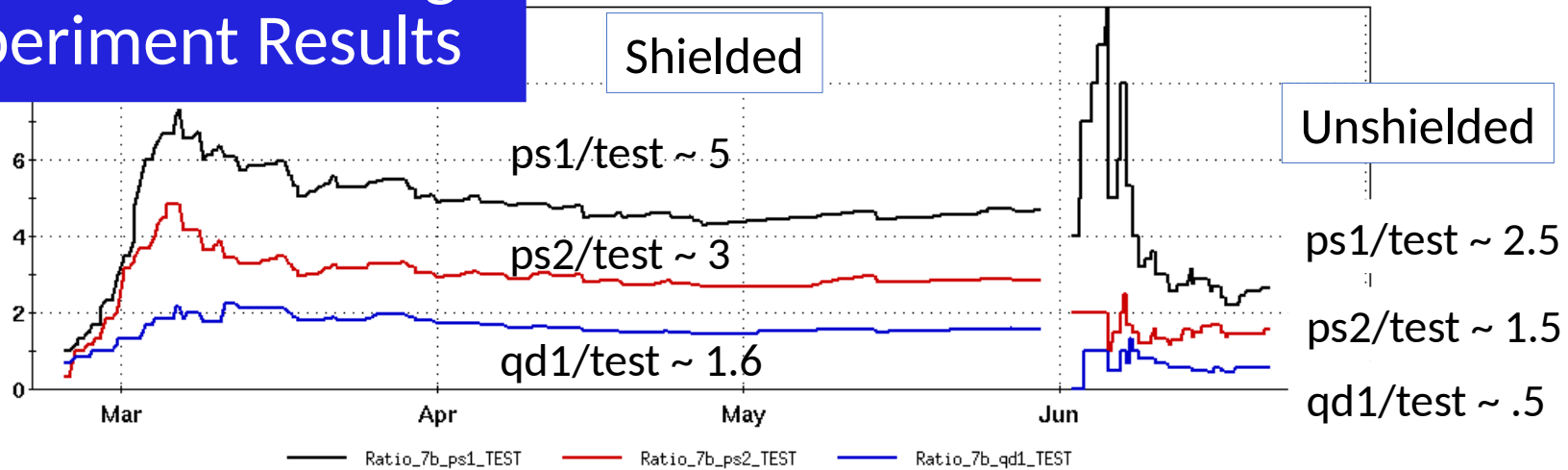
TEST FEC



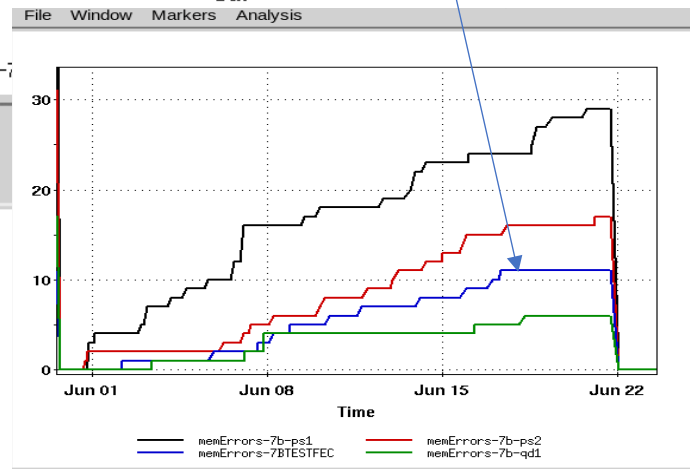
ELEVATION SOUR

(A) ELEVATION SURVEY - 11

2017 FEC Shielding Experiment Results



Attenuation of shielding for TESTFEC ~ 2



The End

2017 FEC Shielding Experiment Results

Attenuation of shielding for TESTFEC ~ 2

