TOFr safety review

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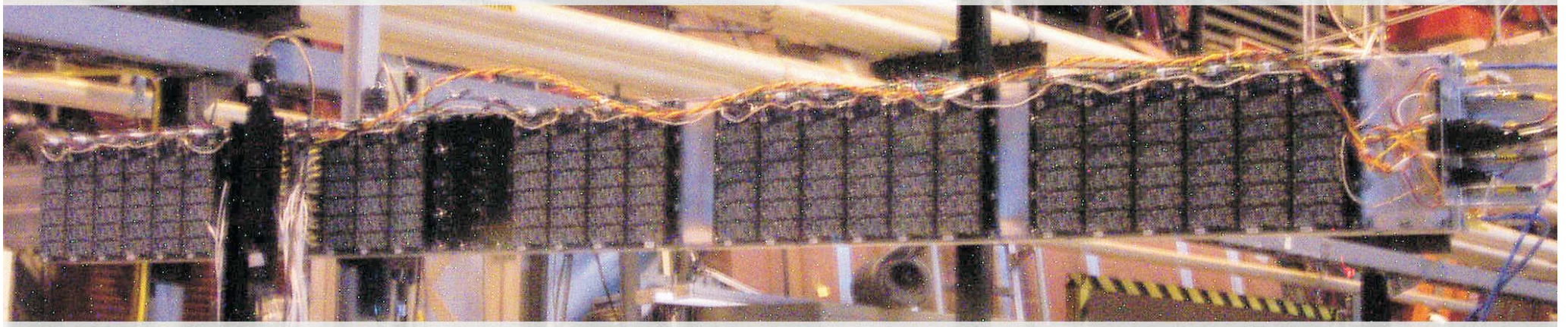
BNL, 7/29/2002



Introduction

• unlike STAR TOFp (BNL safety reviewed 12/16/1999)
and STAR pVPD (BNL safety reviewed 5/17/2000),
at the time of the TOFr safety review, TOFr *exists*.....

→ committee welcomed to come to 1006AB and view actual system....

• TOFr system operated smoothly and without incident at the AGS near E949 for 70 days...

regarding the proposed STAR installation:

• TOFr is not a separate independent subsystem - strongly tied to TOFp.
rack space shared with STAR TOFp
digitization by TOFp systems
STAR DAQ & TRG communication by TOFp systems

...technical differences between TOFp and TOFr:

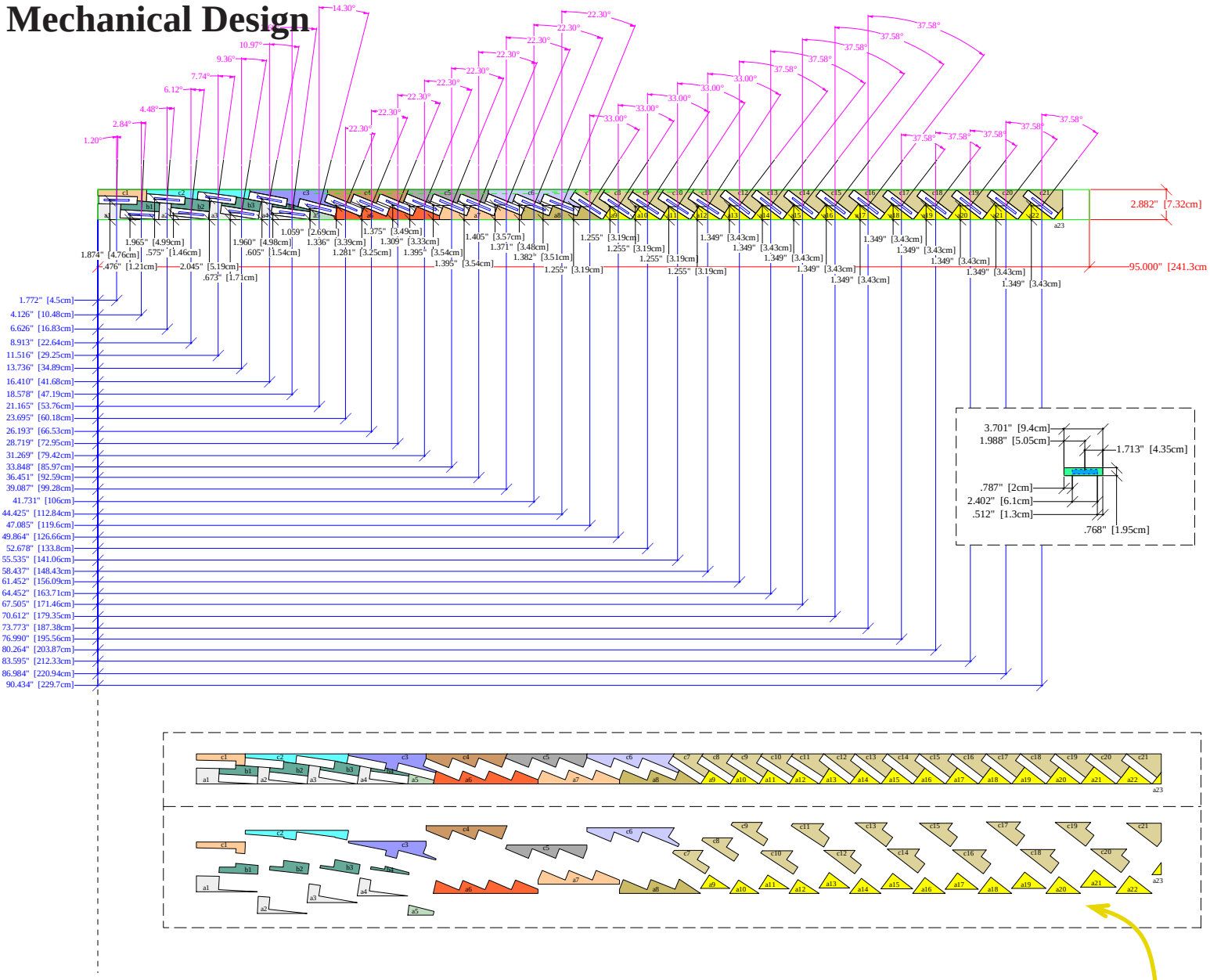
Detectors...	Scint+PMT *vs.* MRPC
HV System...	HVSys *vs.* CAEN
LV/FEE Systems...	Custom in both cases
Interior gas...	Air vs. Freon+isobutane+....

• TOFr is the first step towards a future large-area TOF system for STAR
...one implication w.r.t.TOFr and safety approval of a specific item.....

Outline:

- Mechanical aspects, detector design, tray design
- HV system...
- LV and FEE systems..
- Gas system...

Mechanical Design



Tray:

exactly the same as STAR CTB and TOFp...

50mil-thick welded Aluminum box...

Detectors are MRPCs (see next page)....

Tray is thus now a *gas volume*....

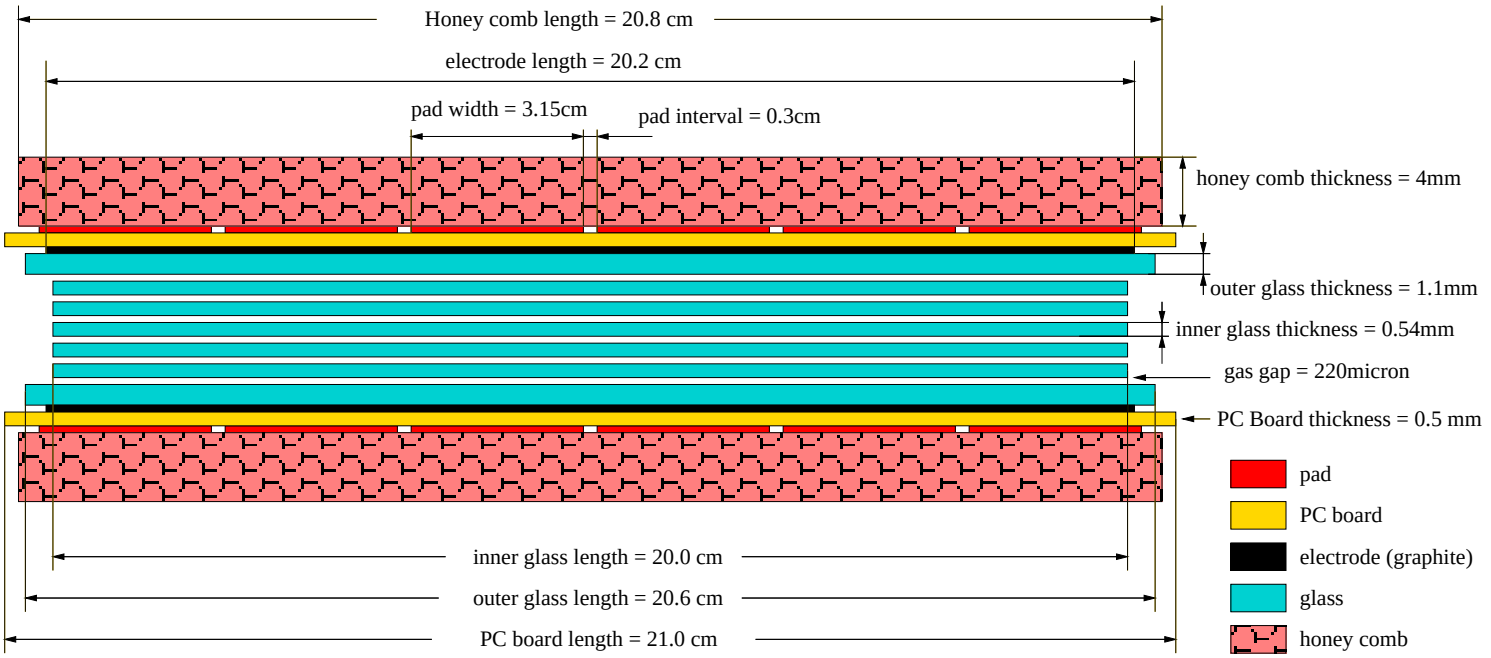
detectors and HV distribution inside the gas volume...

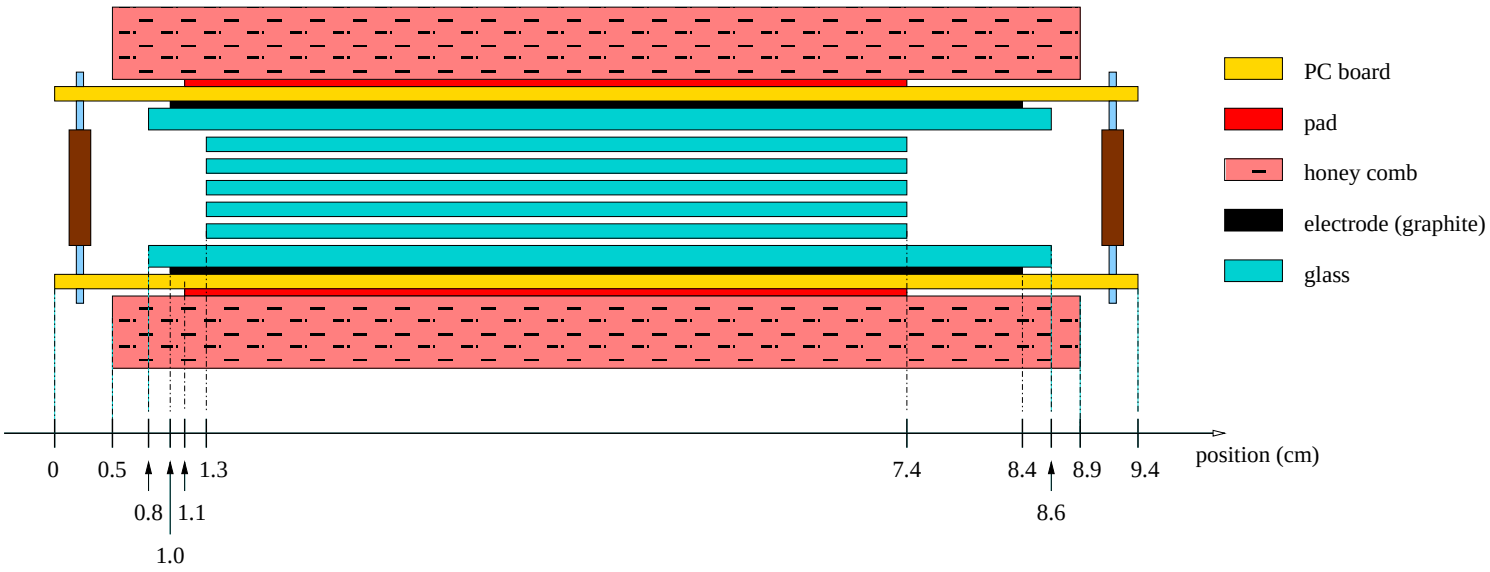
LV and FEE outside the gas volume...

Detectors held in 3-dim by specifically shaped ``hexcell" pieces....

Detectors

- Multigap Resistive Plate Chamber (MRPC)
- basically sandwich of glass plates inside an electric field
- field set up by ~15kV voltage difference across stack
  one side at +7.5kV, other side at -7.5kV
- detectors operate in 1atm mixture of
  freon R134A
  isobutane
  (SF6)
- mechanical strength provided by same hexcell as used to hold the detectors in the tray (see previous page)...





List of materials

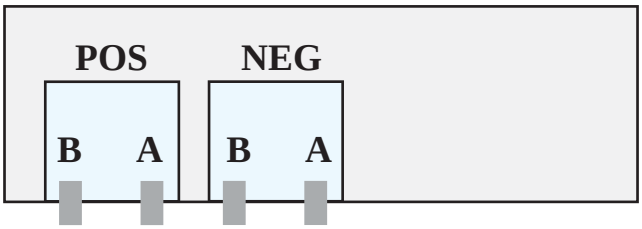
item	*material*	*dimensions*	*number*	*Notes*
MRPC detectors				
inner glass	float glass	0.55mm-thick, 6.1cm x 20.0cm	5/det	
outer glass	float glass	1.1mm-thick, 7.8cm x 20.6cm	2/det	for some dets, 1.82mm-thick
spacer	monofilament nylon fishing line	220µm OD	6/det	
HV layer	graphite tape	140µm-thick, 7.4cm x 20.2cm	2/det	
Mylar layer	mylar	350µm-thick, 8.4cm x 21.2cm		
Pad layer	FR4 PCB	1.55mm-thick, 9.4cm x 21.0cm	2/det	
covering	NOMEX hexcell	4mm-thick, 8.4" x 3.5"	2/det	
adhesive	RTV-157			
double-sided tape	generic	150µm-thick		
Tray				
feet	1/16"-thick Aluminum	2/tray	2	same as CTB and TOFp
standoff strips	UHMW polyethelyene	1mm-thick	6	same as CTB and TOFp
body	Aluminum	50mil-thick, welded sides	1	same as CTB and TOFp
interior covering	Kapton tape	1mil-thick	1 layer	
sawtooths	NOMEX hexcell	1/4"-thick, numerous shapes, each 2-4 sq. inches	~80/tray	
adhesive	RTV-157			
gaskets	1mm-thick neoprene	1mm-thick	5/tray	
feedthrough plates	FR4 PCB	1/8"-thick, 8.4" x 17.275"	5/tray	
machine screws	brass or SS	4-40, 6-32, and 8-32	hundreds	
sealant	permatex "blue RTV"			

Weight: ~55 lbs for fully loaded tray
~15 lbs for unsupported lengths of RG-316 signal cables
Total: ~70 lbs (significantly lighter than TOFp)

Interior Volume: ~95” x 3.5” x 8.5”
~40 liters

Tray leak tested using hand-held electronic freon sniffer....
no leaks found at sniffer’s highest sensitivity setting...
according to manufacturer’s calibration, this implies any leaking from TOFr is at a rate less than **0.4 L/yr.**

High Voltage Distribution



HV Mainframe
C.A.E.N. SY-127

HV Modules
C.A.E.N. A631 (8kV, 40mA, 4ch)
...or....
C.A.E.N. A630 (10kV, 40mA, 2ch)

Kings 1065

STAR Rack 1B-1 South

STAR Cable Trays

Reynolds 167-2669

Kings 1065

Inside TOFr Tray

Kings 1064

Rowe R790-1522

Silicon Fusion Tape at junctions

HV bus A (19 dets, ~1nA/det)

HV bus B (9 dets, ~2nA/det)

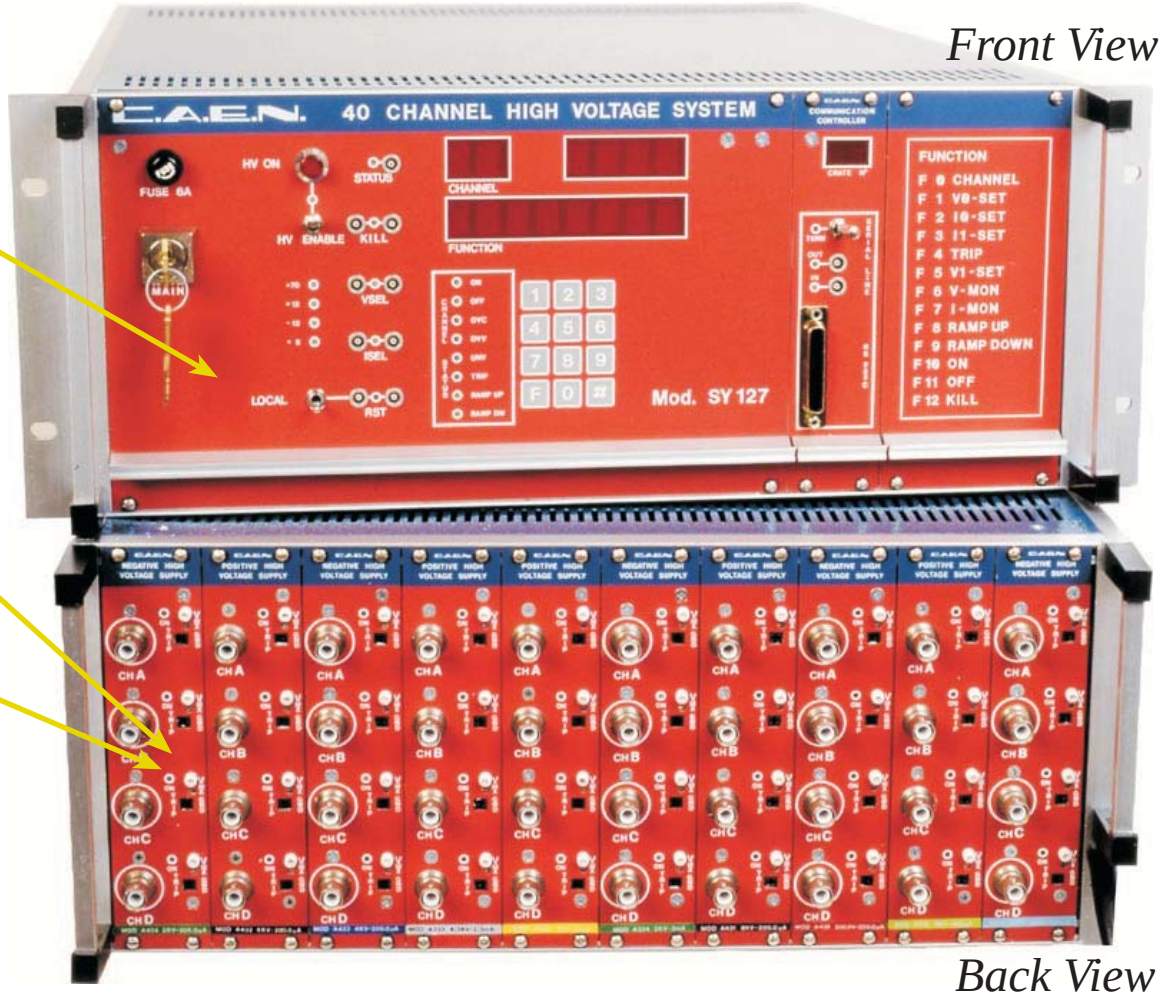
HV Modules

CAEN **SY127** is the only platform we know of that meets the requirements....

CAEN **A631** HV module
- 8kV, 40mA, 4ch
- 80mV ripple....
- SHV connectors..... (?!?!)

CAEN **A630** HV module
- 10kV, 40mA, 2ch
- 150mV ripple....
- Kings connectors.....

We *really* prefer the A631.
→ **RED FLAG** for the Safety Committee...



...the details on why we so prefer the A631 over the A630...

A630 (10kV, 40mA, 2ch)		**A631** (8kV, 40mA, 4ch)	
PRO	off-the-shelf w/ Kings 1064-2 connectors (10kV rated) → connector V rating exceeds max output of unit...	**PRO**	not overkill - 8kV max is perfect...
CON	it's overkill - maximum output is 10kV → absolute maximum needed for detectors is ~8kV.	**PRO**	best jitter spec available...
CON	twice the jitter...	**PRO**	cheaper: $2500 for 4ch module → ~$625 per output... (later scaled-up system is only ~35 k$.)
CON	expensive: $2700 for 2ch module → ~$1350 per output...	**PRO**	(most space efficient.)
	(and strictly speaking this one is not relevent for this review, but we note....	**CON**	output connectors are SHV... → BNL compliance not assured!!
CON	half as many channels per module → later scaled-up system uses twice the rack space. → later scaled-up system is ~75 k$.)		

The SHV Red Flag

SHV connectors as is are not approved @ BNL for 8kV use.....

numerous discussions w/ CAEN in last month:

- there's no ``built-in" mechanism to drop HV output if a SHV connector becomes unmated.... (can be done in software though, polling at ~60Hz...)
- Kings connectors do not fit in the A631 housing... suggested ``Macrotel" connectors (20kV)... but not available in the US.... also do not accept our Reynolds HV cable....
- (not this lab but...) in the past CERN has approved SHV connectors up to 8kV, provided connector is mated and closed and is assured to stay that way.

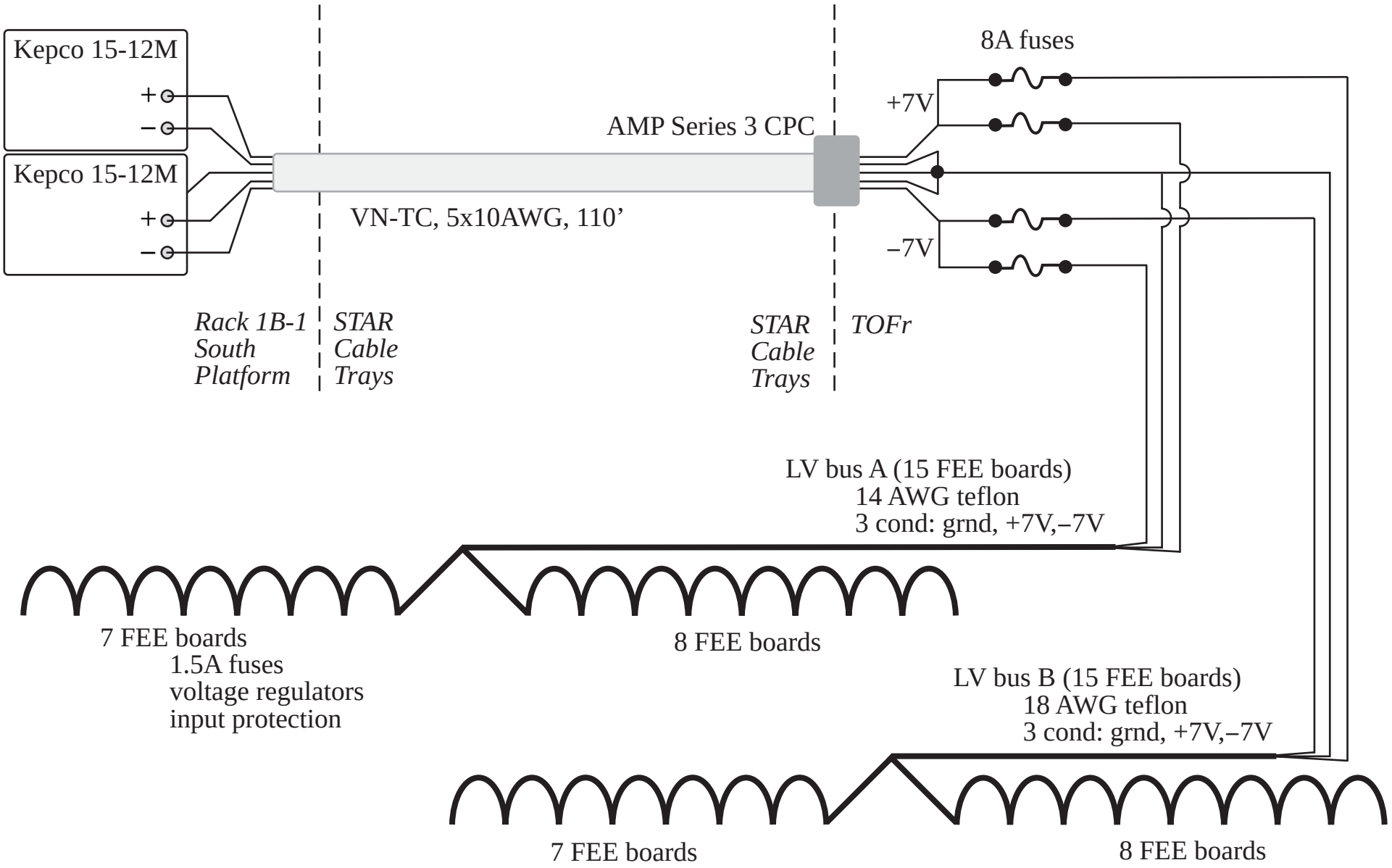
A comment from Yousef....
"I suspect that if you provide a mechanism that interlocks the HV should the SHV connectors become unmated, the committee might approve it. Finally, we need not necessarily approve practices that are followed at CERN."

as we really prefer the A631, we want to explore every possible option here that might allow it to be made compliant w/ the BNL safety rules... otherwise, we don sad faces and fall back to the A630....

A proposal follows..... (Maybe there are other options like this one that you can suggest)

- The connectors that will be mated and unmated most often, and are the most likely to become unmated accidentally, are those on the *detector* side not the supply side...
  On the detector side, 10kV-rated Kings connectors are used on the cable and tray feedthrough.
- A631 units are used with the factory default SHV connectors. The SHV to cable connection is inside a closed rack (1B-1 South).
- *There is installed some mechanical assurance that the SHV connectors do not become unmated. This mechanical assurance should be difficult & time-intensive to remove, and also provide strain relief.*
  e.g. Thick shrink-tubing is shrunken around each A631 SHV output after connector is mated.
  plus e.g. LOTO tags affixed to each covered SHV output to prevent removal of the mechanical assurance and then the connector itself....

Low Voltage Distribution and FEE



This is the same as the TOFp LV system except:

- Additional layer of fuses at tray entrance....
- 30 FEE boards instead of 10....
- LV distributed to FEE in two separate busses of 15 FEE boards each....

					Loads & Ratings				
					Nominal		Maximum		
Item	Component	Make	No.	Dim.	V	A	V	A	Other
	HV System								
	HV Power Supply								
1	Mainframe	CAEN SY127	1	19" x 4U					
2	Module, positive	CAEN A630 *	1 unit, 2ch	1 slot (9 or 19 dets)	7.5kV	<50nA	10kV	40 mA	
3	Module, negative	CAEN A630 *	1 unit, 2ch	1 slot (9 or 19 dets)	7.5kV	<50nA	10kV	40 mA	
	Cabling Platform->Tray								
4	Plugs	Kings 1065	8		7.5kV	<50nA	10kV		
5	Cable	Reynolds 167-2669	4	110ft, red	7.5kV	<50nA	20kV		
	Cabling On-Tray								
6	Jacks	Kings 1064	4		7.5kV	<50nA	10kV		
7	Cable, interior bus	Rowe R790-1522	2	10ft, 22AWG	7.5kV	<50nA	15kV	5A #	
8	Cable, detector leads		2/det, 60 total	~6in, 26AWG	7.5kV	<5nA		3A #	
9	Fusion Tape Insulation	Rowe GL30R67WO	~30		7.5kV	<50nA	400mV/mil*30mil		260 deg C
	LV & FEE System								
	LV Power Supply								
10	Pos	Kepco 15-12M	1	1/2 of 19" x 4U	7.9V	6.3A	15V	6.3+0.2A (12A max)	
11	Neg	Kepco 15-12M	1	1/2 of 19" x 4U	8.7V	11A	15V	11+0.2A (12A max)	
	Cabling Platform->Tray								
12	Connectors	Amp Series 3 CPC	2	Type XII contacts	9V	6.3A/11A		35A	
13	Cable	Belden generic VN-TC	1	110ft, 5x10 AWG	9V	6.3A/11A	600V	33A #	90 deg C
14	local overcurrent	3AG fuses	4					trip 8A	
	Cabling On-Tray								
15	Cabling, LVbusA	Essex E53446	15 boards	14AWG	7V	3.2A/5.5A	600V	17A #	90 deg C
16	Cabling, LVbusB	Belden 83029	15 boards	18AWG	7V	3.2A/5.5A	300V	10A #	200 deg C
17	Cabling, Daisy Chain	Belden 83029	7(8) boards	18AWG	6.5-7V	1.6A/2.8A	300V	10A #	200 deg C
	FEE Board (6ch)	Custom	30						
	Pos LV load per board		1 board, 6 ch		6.5V	0.21A	N/A	N/A	
	Neg LV load per board		1 board, 6 ch		6.5V	0.37A	N/A	N/A	
18	LV Connectors	Molex "KK"	1/board		6.5V	0.37A	250V	7A	
19	Signal Connectors	Johnson 135-3403-001	12/board	MMCX	1V (6.5V) **	20mA (150mA) **	170V		
	input protection	Agilent HSMS 2822					0.3V@PA		
	local overvoltage	Zeners & V. Regulators					10V		
	local overcurrent	Raychem "SMD"	2/board					trip 1.5A	hold 0.75A
	Cabling, Signals								
20	inner pigtails	e.g. Belden 8V28010	2/det, 60 total	2x26AWG twisted pair	1V	20mA (150mA) **	150V	1A	
21	outer pigtails	Belden 83284	400	RG-316, 26AWG, white	1V	20mA (150mA) **	900V	3A #	
22	long sections	Belden 9310	216	RG-58, 20AWG, black	1V	20mA (150mA) **	1400V	7.5A #	
23	connectors	BNC/Lemo/MMCX	544/288/400		1V	20mA (150mA) **			
	Threshold System								
24	power supply	HP 6217	1		6V	few µA	50V	250mA	
25	cabling Platform->Tray	Alpha Wire 6306	1	6x24AWG, shielded	6V	few µA	300V		80 deg C
26	connectors at tray end	AMP Series 2 CPC	1		6V	few µA	250V	1.8A	
27	cabling on-detector	e.g. Belden 83002	~30	3x26AWG, teflon	6V	few µA	600V	3A #	105 deg C
28	connectors on FEE	Molex 0.1" header type	1/FEE board		6V	few µA	250V	2A	100 deg C
	input protection	603 Series resistor	2/FEE board				250V	2.5A	
	RFI filter	.1µF to grnd	2/FEE board						

Notes:

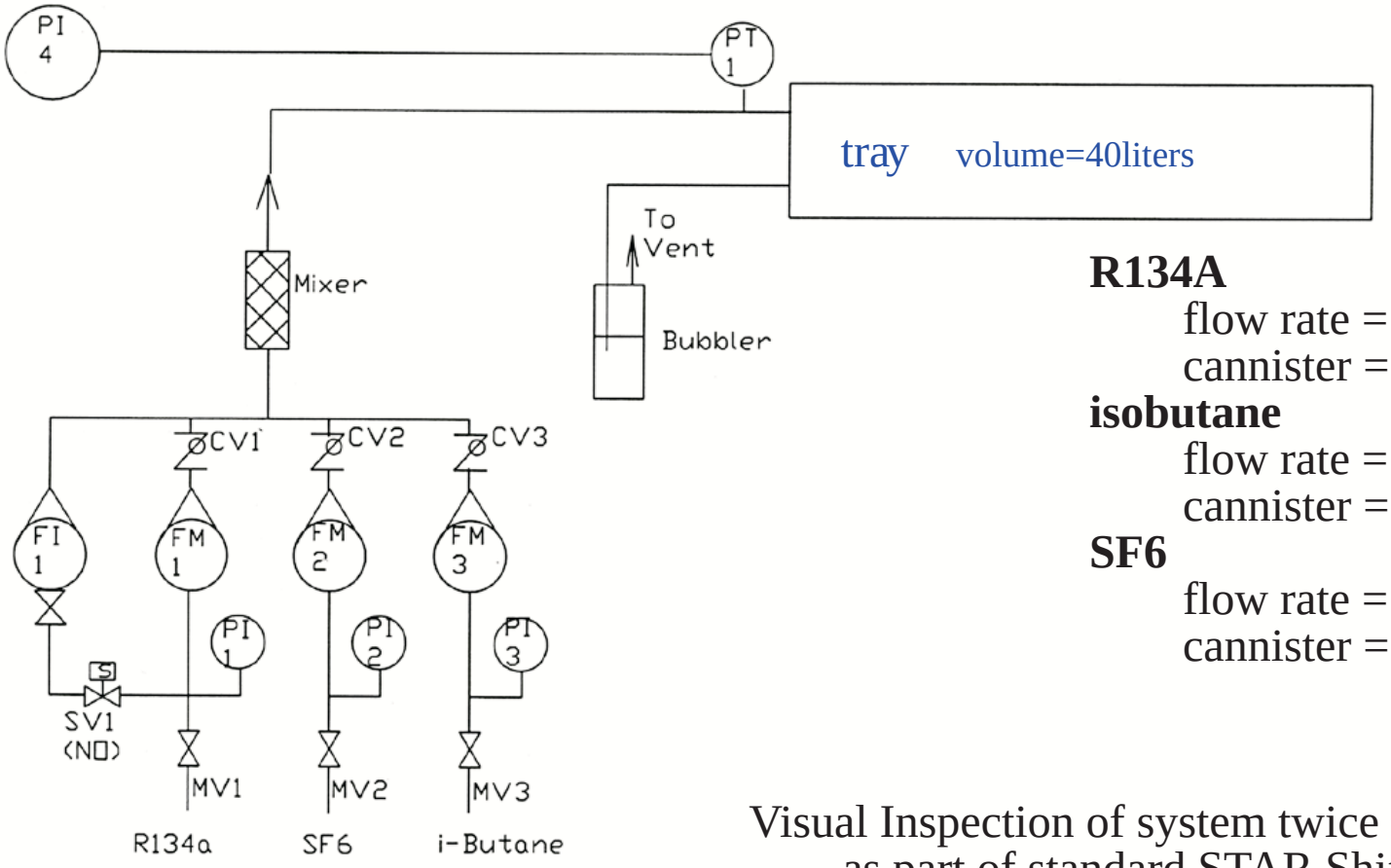
* CAEN A631 (8kV,40mA,4ch) has SHV connectors (5kV rated), CAEN A630 (10kV,40mA,2ch) has Kings 1064-2 connectors (10kV rated).

** Numbers in parentheseses are the values in an unobserved failure mode where the driver transistor and voltage regulator both fail.

Current ratings for generic "cable/conduit/bundle".

Gas System

MRPC operating gas mixture: 90% R134A, 5% isobutane, 0%–5% SF6
Off-the-shelf gas system.... based on Teledyne HFC-2002 M.F.C....
Prefer bottle installation indoors...
Long pipes are Stainless Steel, obtained from (decommissioned) STAR RICH detector.....



CV- check valve
MV-manual valve
FI-flow indicator
FM-mass flowmeter
PI-pressure indicator
SV-solenoid valve
PT-pressure transmitter

R134A
flow rate = 63 ccm
cannister = 125 lbs = 100day supply

isobutane
flow rate = 3.5 ccm
cannister = 10 lbs = 250day supply

SF6
flow rate = 0 ccm–3.5 ccm
cannister = 56 lbs = 580day supply

Visual Inspection of system twice every 8hrs
as part of standard STAR Shift Crew procedures...

re: venting....
• DAR-1 Air Toxic Assessment (Jeff Williams)...
• O.K. to vent outdoors assuming that the gas is being exhausted to atmosphere through a stack... (Mel Van Essendelft)