This document should be used in conjunction with the data format document written for the TPC part of STAR, available on STAR DAQ’s local WWW page or the STAR DAQ page under “Software”. The original document needs to be changed as follows:

On page 5 of Version 1.10 the following should be added for the SVT to “The intermediate 0 to 4 letters…”:

- ANOD  SVT Anode

Then, after the description of the TPC related banks the following pages should be added (note that not all banks have been defined for the SVT. This is work in progress):
**SVTP (SVT Pointer Bank)**

**Format version: 2.0**
This short bank indicates the relative position and length of each SVT VME crate bank. Note that the SVT data do not contain clusters (space points) except for debugging purposes. These are found under GL3 under normal circumstances.

There are 4 sectors provided for in this bank, corresponding to the number of VME crates used in the SVT DAQ. During year 1, only the 2 odd-numbered sectors will be non-zero. [This transitional form is denoted by the header word **Format number = 1**.]

**Length** is 18 (8 data words).

**Contents:**

Data words 1-8: Offset (in words) from first word of the SVTP header to hyper sector contribution for sector 1 through 4, followed by length (in words) of each contribution. A hyper sector contribution is indicated by each offset. A zero signifies no contribution is present, e.g.,

- Sector 1 offset
- Sector 1 length
- Sector 2 offset
- Sector 2 length [= 0 for Format number = 1]
- Sector 3 offset
- Sector 3 length
- Sector 4 offset
- Sector 4 length [= 0 for Format number = 1]

**SVTSECP (SVT Sector Pointer Bank)**

This bank allows navigation among the banks containing the contributions from the various receiver boards corresponding to this hyper sector. The bank identification (1, 2, 3, or 4) indicates the sector.

**Length** in this header is 34 (24 data words).

Data words 1-24: Offset (words) from first word of SVTSECP header to the sector contribution for receiver boards 1…12. Receiver boards 1 – 6 correspond to the odd sector, 7 – 12 to the even sector. A zero signifies no contribution is present, e.g.,

- Word 1: Offset to receiver board 1 contribution
- Word 2: Length of receiver board 1 contribution
- Word 3: Offset to receiver board 2 contribution
- Word 4: Length of receiver board 2 contribution
- etc.

**Format number = 1**: (Year 1) Only odd sector banks will be present, each with 12 receiver boards. Receiver boards 1 – 6 correspond to the sector whose number appears in the Bank ID word, while boards 7 –
12 correspond to the sector whose number is one greater than the Bank ID.

Format number > 1: (After Year 1) All 4 sector banks will be present, each with 6 receiver boards.

SVTRBP (SVT Receiver Board Pointer Bank)
Ability to skip among sector contributions is provided by the next higher pointer bank (SVTSECP). The bank identification in the header corresponds to the receiver board number (1-12). Length in this header is 32 (22 data words).

Data word 1: Offset in words to the mezzanine board A pointer bank
Data word 2: Length in words of the mezzanine board A pointer bank
Data word 3: Offset in words to the mezzanine board B pointer bank
Data word 4: Length in words of the mezzanine board B pointer bank
Data word 5: Offset in words to the mezzanine board C pointer bank
Data word 6: Length in words of the mezzanine board C pointer bank
[Offset of 0 signifies a bank is not present]
Data words 7-22: Header as received via the fiber (64 bytes)

SVTMZP (SVT Mezzanine Board Pointer Bank)
The bank identification in the header corresponds to the mezzanine board number (1-3). Length in this header is variable; unused offset/length pairs may be omitted from the end of the list.

Data word 1: Offset in words to the SVTADCD bank (zero-suppressed ADC data)
Data word 2: Length in words of the SVTADCD bank
Data word 3: Offset in words to the SVTSEQD bank (sequence data)
Data word 4: Length in words of the SVTSEQD bank
Data word 5: Offset in words to the SVTADCX bank (index to ADC data and sequences)
Data word 6: Length in words of the SVTADCX bank
Data word 7: Offset in words to the SVTANODK bank (key to raw ADC, pedestal, RMS, configuration, and gain data)
Data word 8: Length in words of the SVTANODK bank
Data word 9: Offset in words to the SVTCPPR bank (raw cluster pointer pairs)
Data word 10: Length in words of the SVTCPPR bank
Data word 11: Offset in words to the SVTADCR bank (unsuppressed (raw) ADC data)
Data word 12: Length in words of the SVTADCR bank
Data word 13: Offset in words to the SVTMZCLD bank (cluster data - normally exported by SL3)
Data word 14: Length in words of the SVTMZCLD bank
Data word 15: Offset in words to the SVTCFGR bank (raw configuration data)
Data word 16: Length in words of the SVTCFGR bank
Data word 17: Offset in words to the SVTPEDR bank (raw pedestal data)
Data word 18: Length in words of the SVTPEDR bank
Data word 19: Offset in words to the SVTRMSR bank (raw pedestal RMS data)
Data word 20: Length in words of the SVTRMSR bank
Data word 21: Offset in words to the SVTGAINR bank (raw gain data)
Data word 22: Length in words of the SVTGAINR bank
Data word 23: Offset in words to the SVTBADR bank (bad channel list)
Data word 24: Length in words of the SVTBADR bank

[Offset of 0 signifies a bank is not present]

**SVTADCD (SVT Mezzanine ADC Data Bank)**
This bank contains only zero-suppressed ADC data.

Bank identification = 1,2,3 for mezzanine A, B, C.

**Format number**

0  zero suppressed data, uncompressed
1  zero suppressed data, compressed

Note that for compressed ADC data, this bank must be uncompressed before any of the information contained in SVTADCX, SVTSEQD can be applied to it.

**Contents: (format 0)**
Words 1...:  ADC data (packed 4 ADC values per word).
The last word is padded with trailing zeroes, if required.

**Contents: (format 1) Version 1.0**
Word 1:  number of encoded ADC values
Words 2-129:  encoding dictionary (one short per entry)
Words 130...  encoded ADC data

**SVTADCR (SVT Mezzanine ADC Raw Bank)**
This bank contains only unsuppressed ADC data. Only anodes 1 - 240 of each hybrid contain any valid data. Anodes 241 - 256 are only transferred from the RDO system for compatibility with the TPC.

Bank identification = 1,2,3 for mezzanine A, B, C.

**Format number**

0  unsuppressed data, uncompressed
1  unsuppressed data, compressed
2  unsuppressed data, uncompressed, new data order due to new RB firmware
3  unsuppressed data, compressed, new data order due to new RB firmware

Note that for compressed ADC data, this bank must be uncompressed before any of the information contained in SVTANODK can be applied to it.
**Contents: (format 0)**

Words 1 - 384: ADC data (packed 4 ADC values per word).

**Contents: (format 1) Version 1.0**

Word 1: number of encoded ADC values

Words 2-129: encoding dictionary (one short per entry)

Words 130... encoded ADC data

**SVTANODK (Mezzanine Anode Key Bank)**

This bank serves as a key to the sequences found in the SVTADCR, SVTCPDR, SVTPEDR, SVTRMSR, SVTCFGR, and SVTGAINR banks. The bank identification corresponds to the mezzanine board number (1-3). Each mezzanine processes data from 6 hybrids (half wafers). Each hybrid is uniquely identified by the sector number (1-24, as defined in the STAR geometry document), which configuration of the RDO system (3-3-3 wafer or 4-3-2 wafer system; this is uniquely identified by the position of the RDO on the TPC wheel, i.e. the sector number), transition board number within the sector (1-3), wafer number associated with the transition board (1-7, as defined in the STAR geometry document), and hybrid number (1, 2, as defined in the STAR geometry document). These numbers are combined into an 8-bit structure “hybridID” as follows:

<table>
<thead>
<tr>
<th>hybridID:</th>
<th>bit 7:</th>
<th>unused</th>
</tr>
</thead>
<tbody>
<tr>
<td>bits 6-5:</td>
<td>transition board number (1-3)</td>
<td></td>
</tr>
<tr>
<td>bits 4-2:</td>
<td>wafer number (1-7)</td>
<td></td>
</tr>
<tr>
<td>bits 1-0:</td>
<td>hybrid number (1,2)</td>
<td></td>
</tr>
</tbody>
</table>

Within a hybrid the anodes are ordered from 1 to 256 as defined in the STAR geometry.

**Length in this header is 22 (12 data words).**

Data word 1: number of bytes per ADC sequence
Data word 2: number of bytes per CPP sequence
Data word 3: number of bytes per PED sequence
Data word 4: number of bytes per RMS sequence
Data word 5: number of bytes per CFG sequence
Data word 6: number of bytes per GAIN sequence
Data word 7-12: hybrid: bits 31-24: barrel number (1 – 3) bits 23-16: ladder number (1 – 16) bits 15-12: hybrid number (1, 2) bits 11-8: wafer number (1 – 7) bits 7-0: hybridID (as defined above) (repeated 6 times).

Data word 13: number of pre time bins for sequences
Data word 14: number of post time bins for sequences
Data word 15: offset into pedestals for ASIC pedestal subtraction
**SVTADCX (Mezzanine ADC Index Bank)**
This bank is present only in conjunction with SVTADCD and SVTSEQD.

- **Data word 1:** hybridID
- **Data word 2:** offset (in bytes) into (uncompressed) SVTADCD bank to beginning of ADC data for this hybrid
- **Data word 3:** offset (in bytes) into SVTSEQD bank to beginning of SEQ data for this hybrid
- **Data words 4...:** repeat words (1-3) as necessary (up to 6 times)

**SVTCPKR (Cluster Pointer Pairs Raw Bank)**
The bank identification corresponds to the mezzanine board number (1-3).
**Length** in this header is 12299 (12289 data words). This bank contains the raw cluster pointers provided by the ASICs. Note that the least 7 bits are significant, and the remaining bit should be zero if the sequence is a valid one. The high order bit set to 1 marks invalid sequences. The anode and hybrid ID order are defined in the SVTCPPK bank.

- **Data word 1:** ASIC cluster finding parameters
  ```c
  struct {
    unsigned char thresh_lo;
    unsigned char thresh_hi;
    unsigned char n_seq_lo;
    unsigned char n_seq_hi;
  };
  ```
- **Data word 2-9:** start time bin (16 bits), stop time bin (16 bits) [anode 1]
- **Data word 10-17:** start time bin (16 bits), stop time bin (16 bits) [anode 2]
  ...
- **Data word 12289:** 8 words per anode, for anodes 1 - 1536

**SVTSEQD (Mezzanine Sequence Data Bank)**
This bank is present only in conjunction with SVTADCD.
**Bank identification** = mezzanine number

- **Data word 1-n:** sequence (packed 2/word)
  - **bit 15:** Switch (discriminates between 2 formats following)
    - **Switch = 0** bits 14-6: start time
    - **bit 5:** last sequence (this anode)
    - **bit 4-0:** sequence length
    - **Switch = 1** bits 14-0: s_an number = 256*hybridID + anode number
If \((\text{switch}==0)\) first member of union is used; else next 15 bits contain an anode number for the next sequence. For heavily populated hybrids, \(\text{switch}=0\). The assumption is that every anode has at least one sequence to report. The maximum sequence length, which can be accommodated in one unsigned short, is 32 time bins. If bit 5 is a ’1’ this signifies that the current sequence is the last for a given anode. The default is that the next sequence corresponds to the next anode in numerical sequence. If this is not the case, \(\text{switch}=1\) for the next unsigned short, together with the next anode number. Anode number = 255 ignore (dummy spacer to fill out bank).

The first sequence of the bank must start with \(\text{switch}=1\), as must the first sequence of every hybrid.

**SVTCFGR (Mezzanine Configuration Raw Bank)**

For the SVT this is not defined yet. Here is the TPC definition, left here to facilitate future editing…

This bank carries information derived from a configuration special event. The bank identification corresponds to the mezzanine board number (1-3).

**Length** in this header is 106 (96 data words).

Data word 1-96: \[
\begin{align*}
\text{struct} & \{ \\
\text{unsigned char FEE_id}; \\
\text{unsigned char FEE_id}; \\
\text{unsigned char FEE_id}; \\
\text{unsigned char FEE_id}; \\
\};
\end{align*}
\]

*struct repeated 96 times.*

The last word is padded with trailing zeroes, if required.

**SVTBADR (Mezzanine Bad Channel Bank)**

For the SVT this is not defined yet. Here is the TPC definition, left here to facilitate future editing…

This bank carries information derived from a configuration special event. The bank identification corresponds to the mezzanine board number (1-3).

**Length** in this header is variable.

Data word 1-n: \[
\begin{align*}
\text{struct} & \{ \\
\text{unsigned char row}; \\
\text{unsigned char pad}; \\
\}; \text{badChannel}[N];
\end{align*}
\]

*struct repeated \(N \) times (up to 384).*

The last word is padded with trailing zeroes, if required.

**SVTPEDR (Mezzanine Pedestal Raw Bank)**

This bank carries information derived from a series of pedestal special events. The bank identification corresponds to the mezzanine board number (1-3).

**Length** in this header is 49163 (49153 data words).
Data word 1: # events used in the calculation
Data word 2-49153: 8 bit pedestal values, packed 4 per word. The last word is padded with trailing zeroes, if required.

SVTRMSR (Mezzanine RMS Raw Bank)
This bank carries information derived from a series of pedestal special events. The bank identification corresponds to the mezzanine board number (1-3).
Length in this header is 49163 (49153 data words).
Data word 1: # events used in the calculation
Data word 2 - 49153: 8-bit pedestal RMS values, packed 4 per word as (RMS << 4). The last word is padded with trailing zeroes, if required.

SVTGAINR (Mezzanine Gain Raw Bank)
Check this one. I am not sure what the t0 means here…
This bank carries information derived from a series of gain special events. The bank identification corresponds to the mezzanine board number (1-3).
Length in this header is 1548 (1538 data words).
Data word 1: # events used in the calculation
Data word 2: mean gain in absolute ADC counts used in conjunction with the relative gains defined below.
Data word 3-1538: struct {
    UINT16 (t0 << 4);
    UINT8 (t0_RMS) << 4;
    INT8 (rel gain - 1) << 6;
};
The last word is padded with trailing zeroes, if required.

GL3 banks
The following banks are produced by GL3. (There are pointer banks, which still need to be defined...)

SVTSECLP (SVT Sector Cluster Pointer Bank)
This bank allows navigation among the banks containing the clusters (space points) for the various receiver boards corresponding to this sector. The bank identification (1,13) indicates the hyper sector.
Length in this header is 34 (24 data words).
Data words 1-24: Offset (words) from first word of SVTSECLP header to sector contribution for receiver boards 1,12, and length of the sector contribution. A zero signifies no contribution is present, e.g.,
    Word 1: Offset to sector 1 contribution
    Word 2: Length of sector 1 contribution
    Word 3: Offset to sector 2 contribution
    Word 4: Length of sector 2 contribution
    etc.
SVTRBCLP (SVT Receiver Board Cluster Pointer Bank)
Length in this header is 32 (22 data words). The bank identification in the header corresponds to the receiver board number (1-12).
Data word 1: Offset in words to the mezzanine board A clusters
Data word 2: Length in words of the mezzanine board A clusters
Data word 3: Offset in words to the mezzanine board B clusters
Data word 4: Length in words of the mezzanine board B clusters
Data word 5: Offset in words to the mezzanine board C clusters
Data word 6: Length in words of the mezzanine board C clusters
[Offset of 0 signifies no contribution.]
Data words 7-22: Header as received via the fiber (64 bytes)

SVTMZCLD (SVT Mezzanine Board Cluster Data Bank)
Length in this header includes all clusters representing the contribution of this SVT mezzanine board to the SL3. The bank identification in the header corresponds to the mezzanine board number (1-3).
Data word 1: Number of hybrids present in this bank
Data word 2: hybrid ID
Data word 3: # clusters this hybrid
Data word 4: struct centroids{
    unsigned short X centroid; /* units: 1/64 anode */
    unsigned short T centroid; /* units: 1/64 time bin */
};
Data word 5: unsigned short flags {
    Reserved; /* bits 7-15 */
    Centroid quality; /* bits 3-6 */
    Saturated ADC; /* bit 2 */
    Excessive time bin width; /* bit 1 */
    Excessive anode width; /* bit 0 */
};
unsigned short total charge;
{Repeat of words (4,5) as necessary
Repeat words (2,3),
....}
The last word is padded with trailing zeroes, if required.

Note that contributions corresponding to the same pad row, arising from different mezzanine boards may show up in different banks, due to the hardware distribution of pads to different mezzanines.
The SVT DAQ Raw Data Format

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Preliminaries
This document describes the content of the SVTADCR bank resulting from the “new”
receiver board firmware (as of November 2000).
The “natural” data format for the SVT is a quintuplet of numbers:

a) SVT Readout Board  0..23
b) SVT Mezzanine     0..2
c) Hybrid (aka DAQ ASIC)  0..5
d) Anode (aka ASIC channel)  0..239
e) Timebin            0..127

Ad a)
As long as the SVT DAQ is contained in only 2 VME crates DAQ organizes the SVT
in two “sectors” numbered 1 & 3 each containing 12 Receiver Boards numbered 1 through
12. The map to the natural SVT Readout Board Sequence is thus:

    if(DAQ_SECTOR == 1) SVT_RDO = (DAQ_RB-1) ;
    else SVT_RDO = 12 + (DAQ_RB-1) ;

Once the SVT DAQ starts using 4 VME crates the SVT “sectors” will be numbered
from 1 to 4 each containing 6 Receiver Boards numbered from 1 to 6. The map will be thus:

    SVT_RDO = (DAQ_SECTOR-1) * 6 + (DAQ_RB-1) ;

This won’t happen soon (if ever) though.

Ad b)
Since DAQ numbers Mezzanines from 1 to 3 the map to the SVT Mezzanines is
simply:

    SVT_MEZZ = DAQ_MEZZ - 1 ;

Ad c)
DAQ doesn’t use “hybrids” internally but instead uses ASICs numbered with capital
letters A to F. Each ASIC corresponds to one particular hybrid with the following map of the
data as it arrives on the optical fiber for one Mezzanine.
The “offset” corresponds to the byte offset from the start of the raw ADCR data to the start of data for the particular hybrid. Each hybrid thus occupies 0x8000 bytes or 128 timebins X 256 channels/anodes.

<table>
<thead>
<tr>
<th>Strobe</th>
<th>Upper 10 bits (of 20 bit GLink data)</th>
<th>Lower 10 bits (of 20 bit GLink data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ASIC D = Hybrid 3 Offset 0x18000</td>
<td>ASIC A = Hybrid 0 Offset 0x00000</td>
</tr>
<tr>
<td>1</td>
<td>ASIC E = Hybrid 4 Offset 0x20000</td>
<td>ASIC B = Hybrid 1 Offset 0x08000</td>
</tr>
<tr>
<td>2</td>
<td>ASIC F = Hybrid 5 Offset 0x28000</td>
<td>ASIC C = Hybrid 2 Offset 0x10000</td>
</tr>
</tbody>
</table>

…repeats…

Ad d)

Although the fiber data contains 256 anodes only the first 240 anodes have physical data. The rest is filler and should just be ignored.

Raw data format

The DAQ raw data format pertains to the following raw banks:

SVTADCR
SVTCPPR
SVTPEDR
SVTRMSR

SVTCPPR is somewhat special and will be discussed later. The other 3 banks have exactly the same sequencing and indexing and only the interpretation of the byte content differs: it’s either the actual ADC value, the actual Pedestal or the RMS multiplied by 16.

The packing and sequencing for the above mentioned 3 banks exists in two different flavors:

1) OLD Pre 2001. (i.e. during the 2000. data run)
2) NEW During and after 2001.

The formats differ in the anode and timebin sequencing for the above banks but NOT in the other aspects namely RDO, Mezzanine or hybrid sequencing. This stays the same as explained in Ad a)-c) above.
**Old Anode and Timebin sequencing/packing**

In the old (pre 2001.) sequencing the anode number can be recovered from the raw data index in the SVTADCR, SVTPEDR & SVTCPPR by simply doing:

```c
SVT_ANODE = RAW_BYTE / 128 ;
SVT_TIMEBIN = RAW_BYTE % 128 ;
```

I.e. the data was byte ordered with the following scheme:

```c
unsigned char adcr[6][256][128] ;
```

for 6 hybrids, 256 anodes and 128 timebins.

The CPP bank is somewhat special but can be accessed similarly as

```c
unsigned short cppr[6][256][16] ;
```

where number 6 indexes the hybrid, 256 the anode and 16 (2 X 8) indexes the start & stop timebin for 8 clusters.

**New Anode and Timebin sequencing/packing**

Due to the peculiarities of the new CPLD sequencing code in the Mezzanines, both the anode and timebin packing in the SVTADCR and the 2 others looks more complicated. Schematically it can be represented like this for one hybrid with 256 anodes (Axxx) and 128 timebins (Txxx):

<table>
<thead>
<tr>
<th>Address</th>
<th>Byte 3</th>
<th>Byte 2</th>
<th>Byte 1</th>
<th>Byte 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00000</td>
<td>A192:T0</td>
<td>A128:T0</td>
<td>A64:T0</td>
<td>A0:T0</td>
</tr>
<tr>
<td>0x00004</td>
<td>...</td>
<td>A128:T1</td>
<td>A64:T1</td>
<td>A0:T1</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>0x0007C</td>
<td>...</td>
<td>A128:T127</td>
<td>A64:T127</td>
<td>A0:T127</td>
</tr>
<tr>
<td>0x00080</td>
<td>...</td>
<td>A129:T0</td>
<td>A65:T0</td>
<td>A1:T0</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>A1:T1</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>A1:T127</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>A63:T0</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Thus the data cannot be compactly represented in C as in the old scheme above (1-1) but one needs a more algorithmic (but still trivial) approach using MODs and DIVs.

However, luckily the SVTCPPR data stays exactly the same as in the old data format (1-2).