# SiPM POWER SUPPLY SYSTEM
# FINAL DESIGN REVIEW

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# WHO AM I

Dr. Nikolay Anfimov

- Ph.D. in Physics and Mathematics “Development and application of methods for studying photodetectors”
- Background in EM-calorimetry for COMPASS-II (CERN), APD and scintillator studying for NOvA (FNAL), 20-inches PMT scanning and testing for JUNO (China), SiPM testing for TAO (China), SiPM R&D.
- Head of the Sector of Experimental Methods, Experimental Department of Particle Physics, Dzhelepov Laboratory of Nuclear Problems, Joint Institute for Nuclear Research
- Start working at JINR in 2005

# OUTLINE

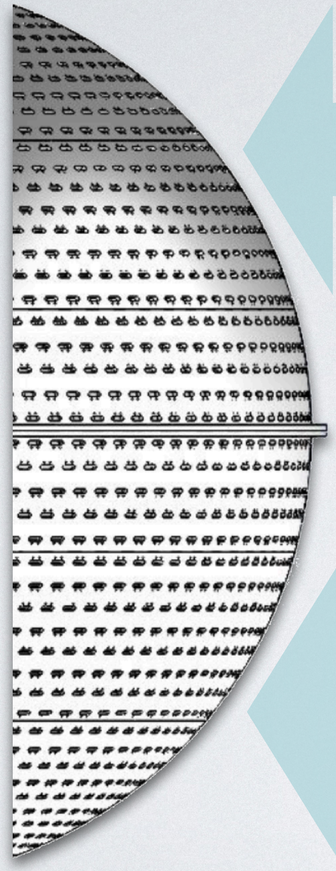
1. Requirements to SiPM PS system
2. Baseline design of SiPM PS system
3. Feedthrough for SiPM PS system
4. PS cost estimation
5. Progress and time schedule of SiPM PS system

# REQUIREMENTS

- Individual HV channel adjustment ~10 mV
- Operating voltage up to 120V (2 SiPM in series)
- Current ratings: ~ 100uA @ RT, < 1uA @ -50°C
- Voltage stability level ~ 30 mV (signal variation ~ 1% / Tile)
- VME 6U mechanics
- Power delivery @ -50°C, LAB-compatible
- Slow control (GUI interface)
- Power supply rack temperature stability ~2-3 deg.

# BASELINE PS SYSTEM DESIGN

## Copper shell
with tiles



Inner side of SS tank

Outer side of SS tank

2048 channels

2048 channels

Ribbon cables
(~4m long)
which splitted onto
pairs at their ends

2 x FEEDFROUGH

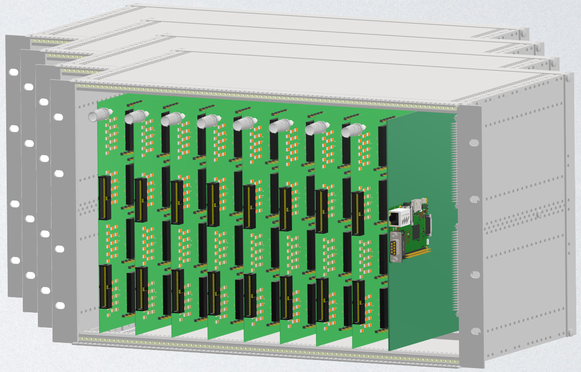
Ribbon cables
(~10m long)

2048 channels

2048 channels


## SiPM Power Supply

4 VME crates
16 modules each
4 control units
>4000 channels



+

External
constant current
power supply
(with SHV splitter)

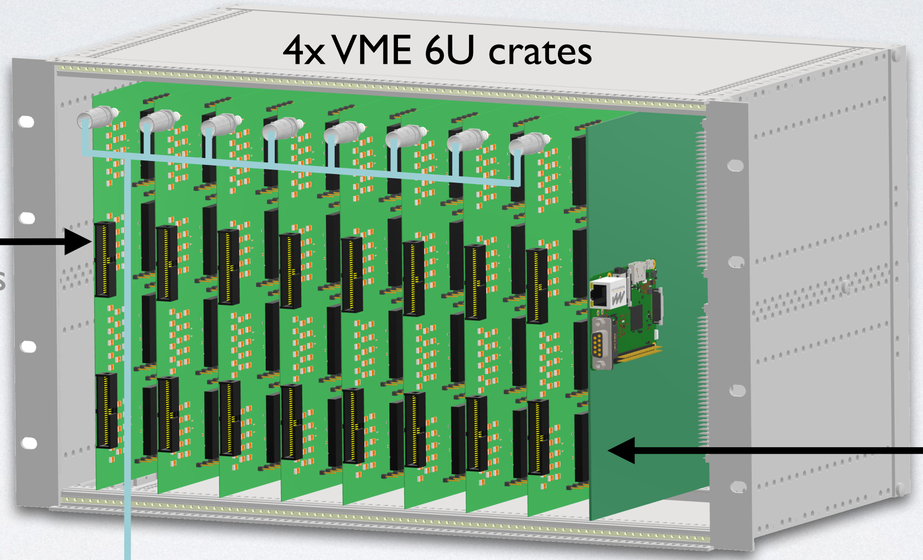
# PS UNIT TYPES & QUANTITY

32x power units / 4x control units
~4100 channels


128 channel
power supply
unit
VME 6U
PCB unit

8 power units (Better cooling)

Optionally 16 power units

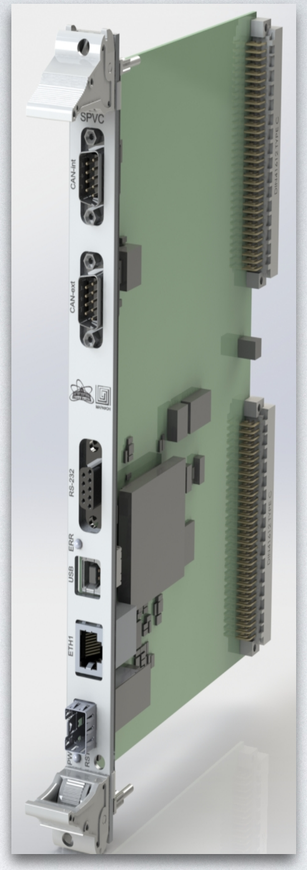



+

External
constant current
power supply
(SHV splitter)

120V

1 control unit

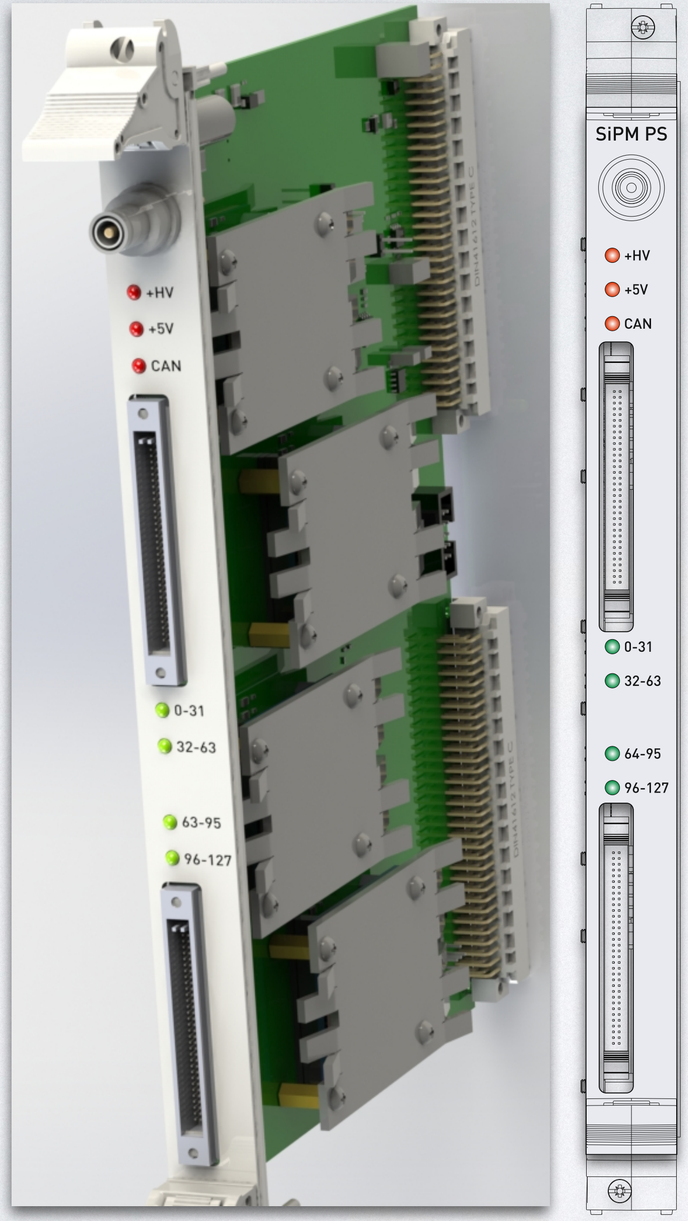



Control unit
VME 6U
PCB unit

# SPECIFICATION OF PS UNITS

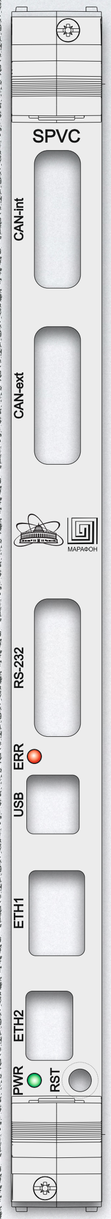
## Power unit

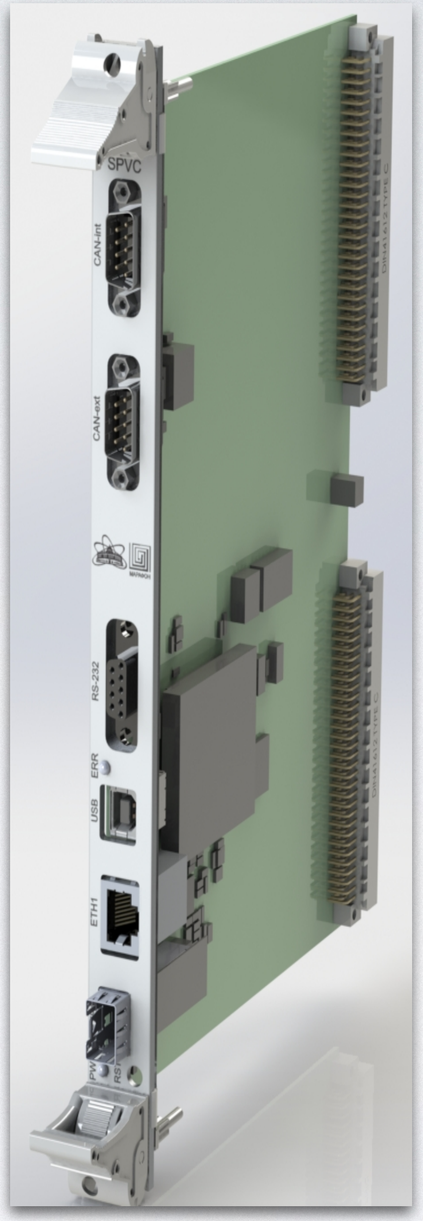
- VME mechanics
- 128 channels
- up to 200V/ch
- up to 550uA/ch
- 1xSHV connector
- 2x 68pin IDC connectors
- Output voltage monitor (24bit ADC)
- 4x 14bit DAC chips
- CANOpen protocol







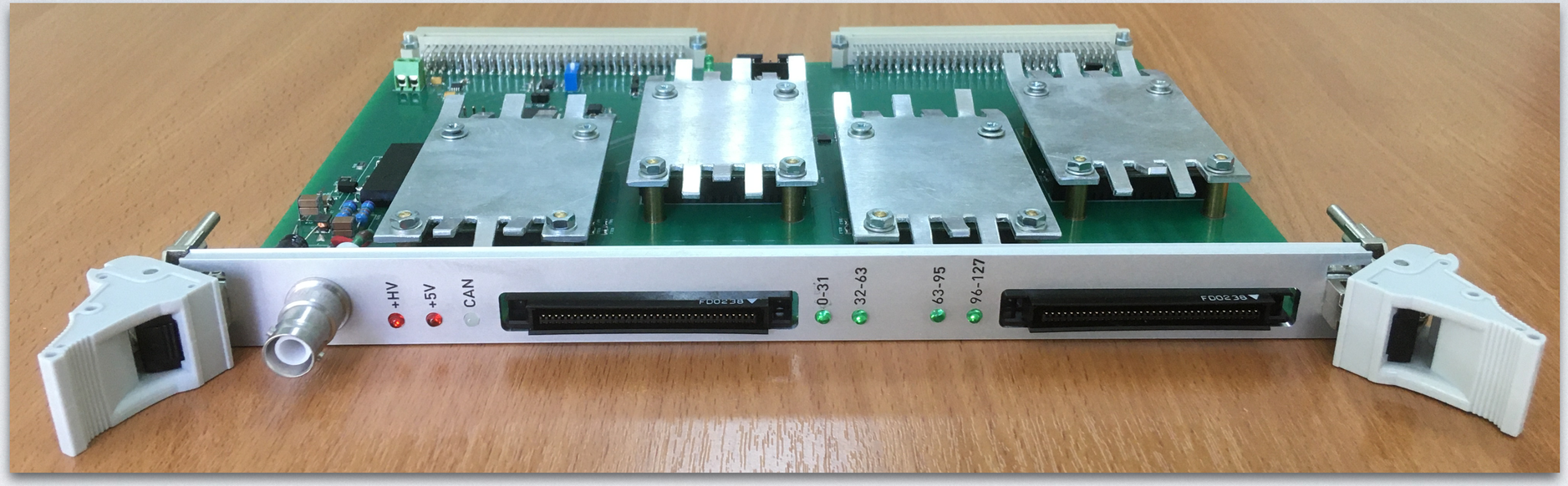



## Control unit

- VME mechanics
- Micro PC: phyCORE-i.MX7
- CAN-int, CAN-ext
- 2x connection interfaces: 1GBPS (SFP) and100MBPs (RJ45)
- COM port (RS232) and USB (B type) for direct access to the micro PC
- Reset button on the front panel
- 2x status LEDs (Power/Err)

# PILOT PROTOTYPES OF PS UNITS

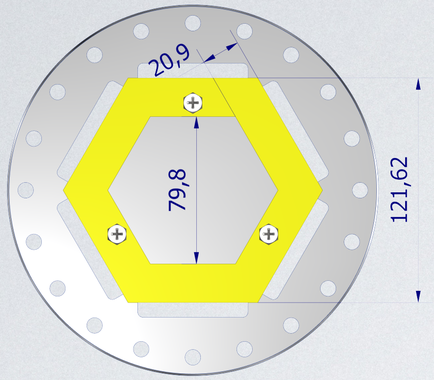


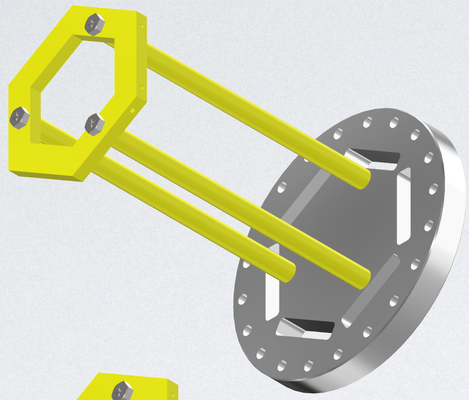

Power Unit

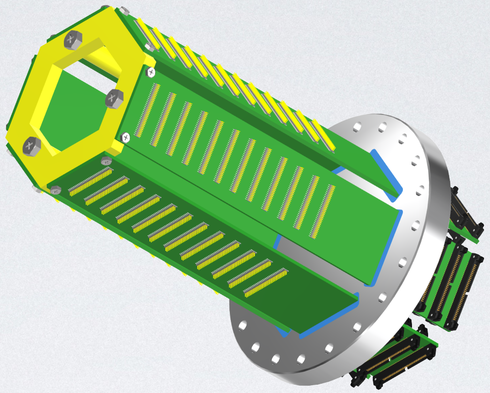

Control Unit

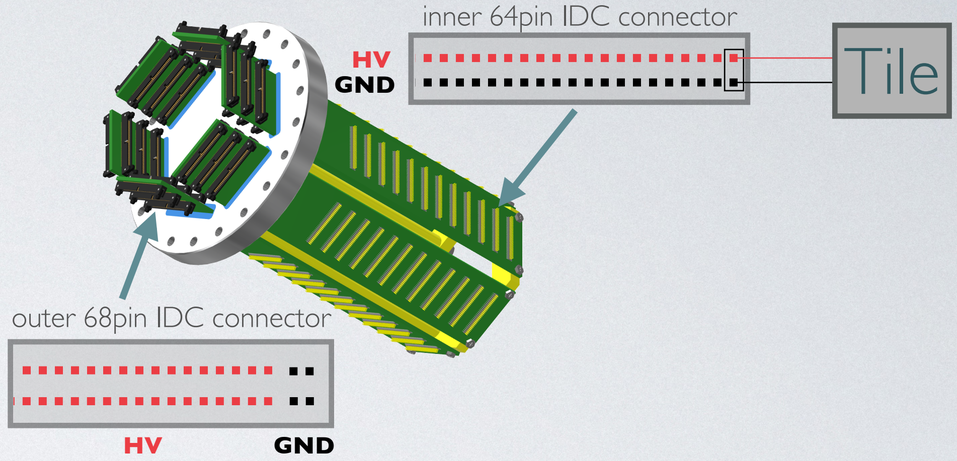
# BASELINE FEEDTHROUGH DESIGN

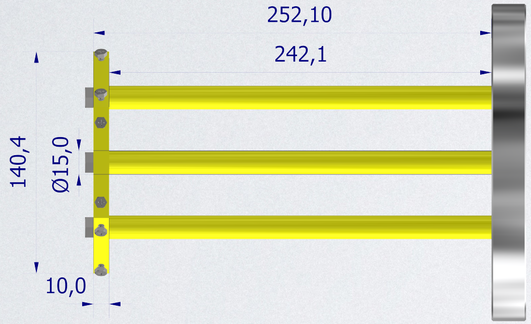
v8.0

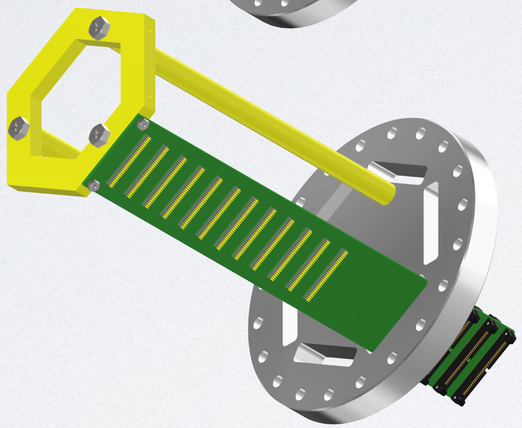


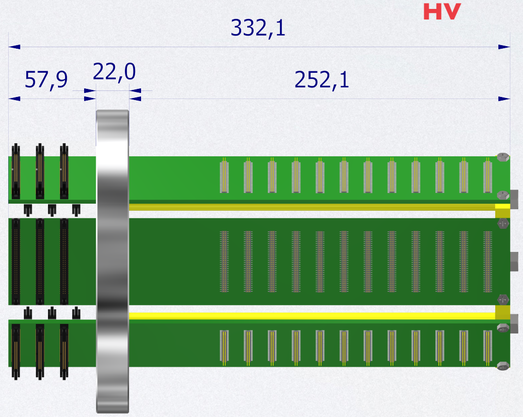


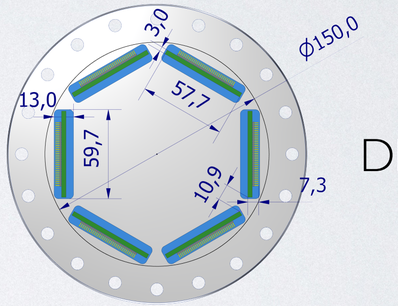


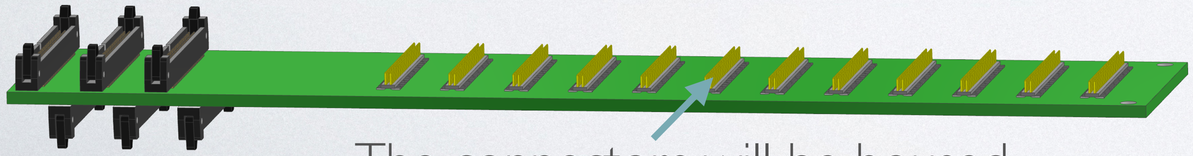
Support structure



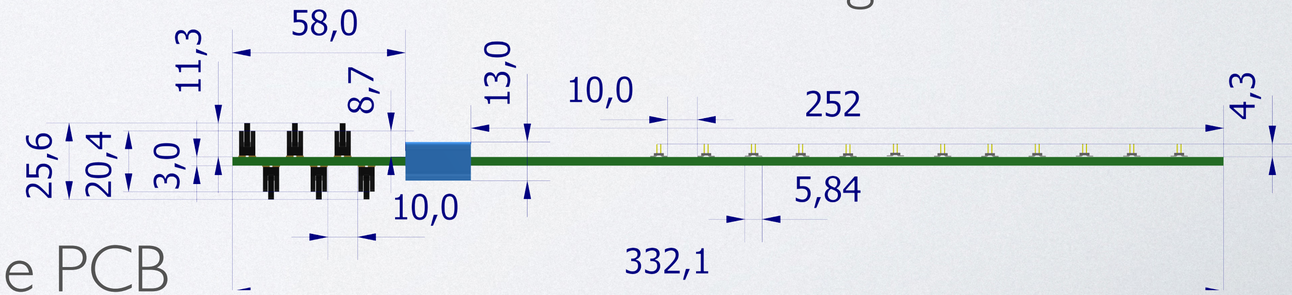




DN160 Flange

Assembled feedthrough

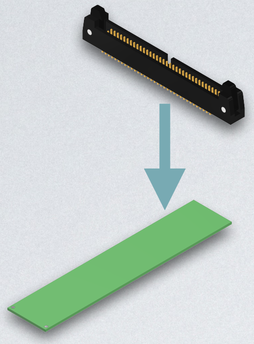


The connectors will be housed

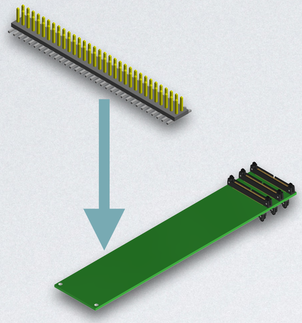



Single PCB

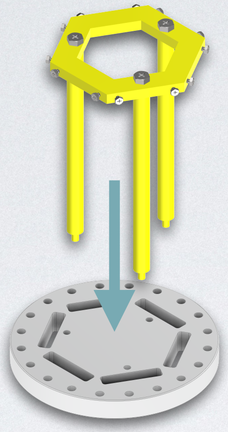
# MOUNTING PROCEDURE



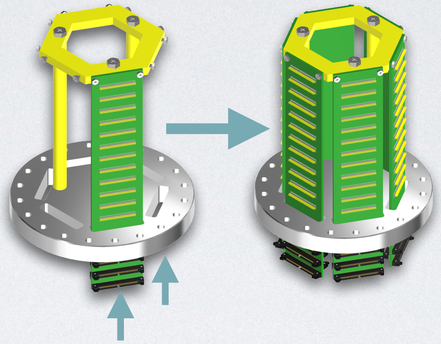
1) soldering of external housed connectors on the Feedthrough PCBs out of the flange



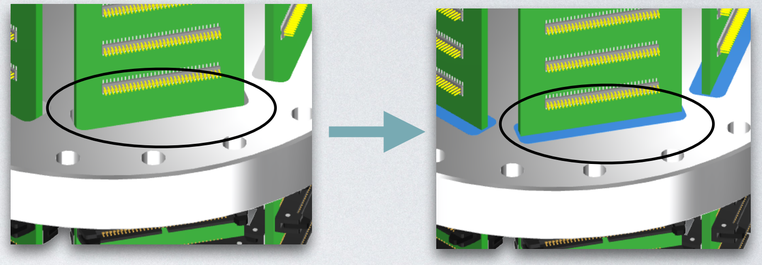
2) soldering of inner housed connectors on the Feedthrough PCBs out of the flange



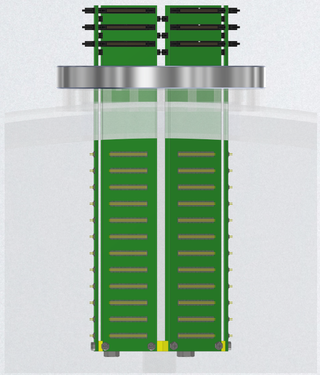
3) fixing of support structure on the flange



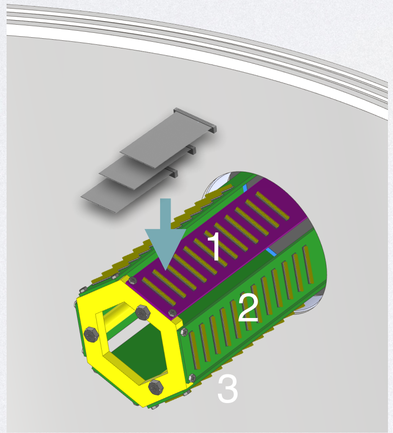
4) inserting of PCBs into the flange (inner connectors outward faced) and fixing them on the support structure with two bolts



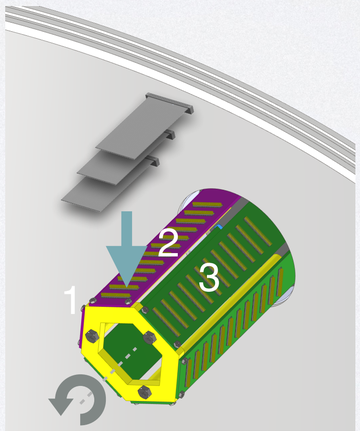
5) sealing of PCBs on the flange



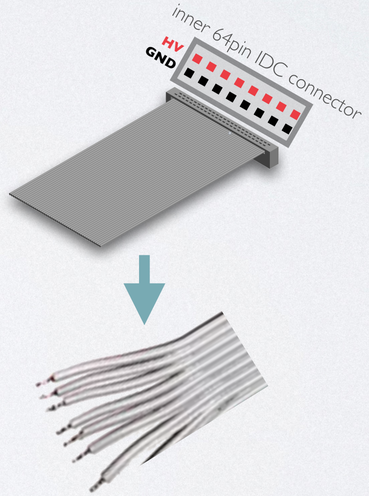
6) installing feedthrough onto the SS tank wall to have ability for soldering of inner ribbon cables at the upper side



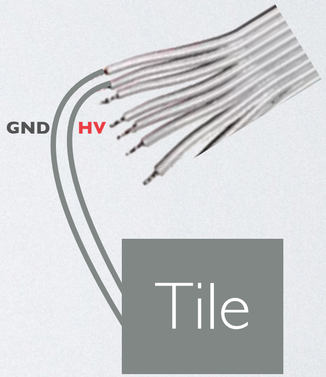

7) plugging of inner ribbon cables into connectors (or soldering cables) onto the PCB which is on the top side of feedthrough (optionally sealing), installation of clamps




8) rotating of feedthrough to have the next PCB at top position and repeating of 7th step




9) splitting of inner ribbon cables at the their ends onto pairs for each SiPM Tile




10) connecting of the pairs to its own tile

# PILOT PROTOTYPES OF PS FEEDTHROUGH


Single PS Feedthrough PCB

3 Feedthrough boards are ready: 2 - for upcoming prototype TAO test and 1 - for internal tests

# **PS** COST ESTIMATION

| Item | Unit price, k$ | Quantaty, pcs | Total, k$ |
|---|---|---|---|
| Power Unit | **3** (2) | 32 + 8 spare | **120** (80) |
| Control Unit | **3** (2) | 4 +1 spare | **15** (10) |
| Ext. constant PS (120V) | 2 | 4 + 1 spare | 10 |
| Crate | **8** (6) | 4 + 1 spare | **40** (30) |
| Cables, Connectors, Feedthroughs | - | - | 5 |
| Environmentals (Room with AC) | - | - | 15 |
| **Total** | - | - | **255** (150) **k$** |

# **PS** PROGRESS & TIME SCHEDULE

| | | |
|---|---|---|
| **Early 2022** | • PS board samples production & testing (JINR & Marathon)<br>• testing control software (CLI interface) | done<br>done |
| **June 2022** | • shipment of PS and controller samples to China | done |
| **Early 2022** | • calibration of PS samples (10 boards,CAN protocol)<br>• production of 3 PS Feedthrough samples | done<br>done |
| **Late 2022** | • control software developing for PS boards (CANOpen) | in progress |
| < 6 month | Full production of PS boards | China |
| < 6 month | Testing and calibration | China |

# SUMMARY

- System design maturity ~ 90%
- Prototyping ~ 70%
- Software maturity ~70%
- Export restrictions from Russia
  - Full production in China
- Total cost: ~150-250k$ (200k$ is booked at JINR)
- Silicon crisis: procurement in advance.