

PSD: weight and power

THE PSD GROUP

- ▶ The PSD is a **key detector** in HERD since it will provide measurements that are crucial both for charged cosmic-rays and for gamma-ray
 - ▶ All the space-born experiments have a PSD or ACD
- ▶ The PSD will provide one/two independent measurements of the **particle charge**
 - ▶ Together with the measurements of the SCD and the FIT will be a crucial part of the PID capability of HERD and will cover Z from proton to iron or even more
 - ▶ We need to have all the five sides equipped in order to reach the acceptance needed to extend our measurements up to the knee
- ▶ The PSD is **absolutely** needed to identify **gamma-rays**. Without the PSD we cannot do any kind of gamma-ray physics
 - ▶ Dark matter searches. *The gamma ray line signature - the smoking gun signature for DM*
 - ▶ Solar system, galactic and extra-galactic gamma-ray sources
 - ▶ Transient phenomena such as the e.m. counterpart of a GW
 - ▶ For all the above science item we need all the five sides equipped to increase the FOV (hunt for transients) and the acceptance
- ▶ The PSD could provide **timing information** (200-500ps resolution) that could be helpful for the SCD charge measurements
 - ▶ Of course, this will cost in terms of frontend power consumption

- ▶ PSD size (baseline in the HERDSoftware):
 - ▶ 1 TOP: 180x180cm
 - ▶ 4 SIDE: 160x100cm

- ▶ We are investigating three “Thickness Options” (tile: 0.5cm bar: 0.5/1.0cm)
 - A. 0.5 cm (1 layer of tiles)
 - B. 1.0 cm (2 layers of tiles or 2 layers X-Y of bars 0.5cm thick)
 - C. 2.0 cm (2 layers X-Y of bars 1.0cm thick)

- ▶ Taking into account only the weight of the scintillators
 - A. $\approx 50\text{kg}$ (1 TOP: 16kg – 1 SIDE: 8.5kg)
 - B. $\approx 100\text{kg}$ (1 TOP: 32kg – 1 SIDE: 17kg)
 - C. $\approx 200\text{kg}$ (1 TOP: 64kg – 1 SIDE: 34kg)

1 Plane of tiles (0,5 cm thick) OPTION A & B(2xA)

TOP

Scint. Weight:	16 kg
Wrapping Weight:	1 kg
Readout Weight:	6 kg
Mechanics:	10 kg

Total: 33kg

SIDE

Scint. Weight:	8 kg
Wrapping Weight:	0,5 kg
Readout Weight:	3 kg
Mechanics:	8 kg

Total: 20kg

1T + 4S: **113kg**

2 Plane of bars (0,5/**1,0** cm thick) OPTION B & **C**

TOP

Scint. Weight:	65/32.5 kg
Wrapping Weight:	2 kg
Readout Weight:	6 kg
Mechanics:	10 kg

Total: 50,5/**84**kg

SIDE

Scint. Weight:	32,5/16,2 kg
Wrapping Weight:	1 kg
Readout Weight:	3 kg
Mechanics:	8 kg

Total: 28,3/**44,5** kg

1T + 4S: **163/262** kg

To sum up

Option A $\approx$ 100 Kg

Option B $\approx$ 200 Kg

Option C $\approx$ 300 kg

- ▶ 1 Tile plane (0,5 cm) – OPTION A
 - ▶ Charge measurement
 - ▶ Different solutions under study (proper tile geometry, scintillating fiber ribbons,...) to guarantee the needed hermeticity to get efficient veto for photon physics
- ▶ 2 Tile planes (0,5 cm) – OPTION B
 - ▶ Two charge measurements
 - ▶ Good hermeticity
- ▶ 2 bar planes (0,5 cm) – OPTION B
 - ▶ Two charge measurement
 - ▶ Good hermeticity
 - ▶ Mechanical issue
 - ▶ We are working with mechanical engineer to find some workaround
- ▶ 2 bar planes (1,0 cm) – OPTION C
 - ▶ Two charge measurement
 - ▶ Good hermeticity

- ▶ We are assuming to have a frontend chip similar to the BETA chip that has been designed for the FIT that should have $< 0.4 \text{ mW/ch}$. In our estimation we are assuming **1 mW/ch** to be on the safe side.
- ▶ Each active element (bar or tile) has 4 readout channel (RO ch.)
- ▶ Front End Power consumption
 - ▶ **Tile plane**
 - ▶ 1 TOP: 1296 RO ch. – 1.3W
 - ▶ 1 SIDE: 640 RO ch. – 0.6 W
 - ▶ **1 TOP + 4 SIDE = 3,7 W**
 - ▶ **Bar planes (X+Y)**
 - ▶ 1 TOP: 480 RO ch. – 0,5 W
 - ▶ 1 SIDE: 352 RO ch. – 0.35 W
 - ▶ **1 TOP + 4 SIDE = 1,9 W**

▶ FERMI

▶ ACD

- ▶ top 1.7m x 1.7m, side 1.7m x 0.8m
- ▶ Total weight 280kg (all included: power supply, electronic, micrometeor shield, thermal blanket, plastic scintillators, scintillating fibers, PMTs)
- ▶ Total Power: 12W

▶ TKR

- ▶ 1 tower – 37x37x66cm – 33kg -10 W
- ▶ 16 tower – 526kg – 160W

▶ CAL

- ▶ 1 Cal – 96 CsI Crystal (2.7x2.0x32.6 cm) – 77kg
- ▶ 16 Cal – 1.2 Tons