

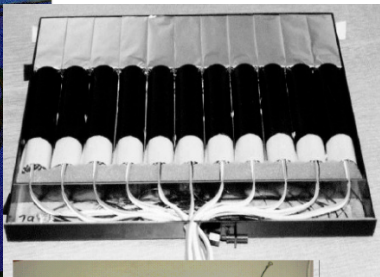
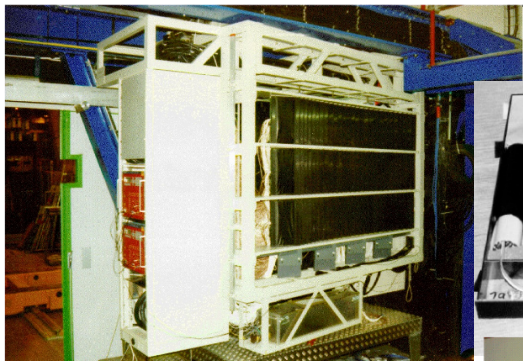
Upgrade of the NA61/SHINE TOF system based on a MRPCs for the NICA experiments

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for the MPD and NA61/SHINE collaborations

Joint Institute for Nuclear Research

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Old NA61/SHINE TOF-LR system

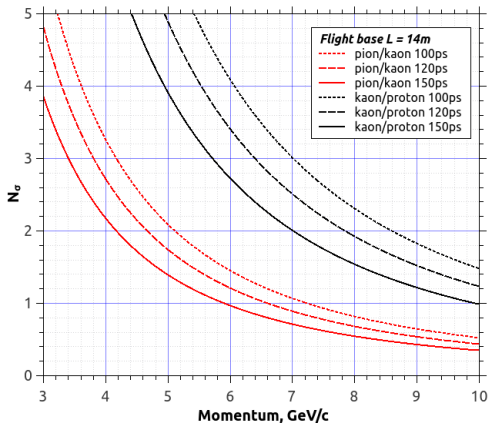


NA61/SHINE TOF-LR detector:

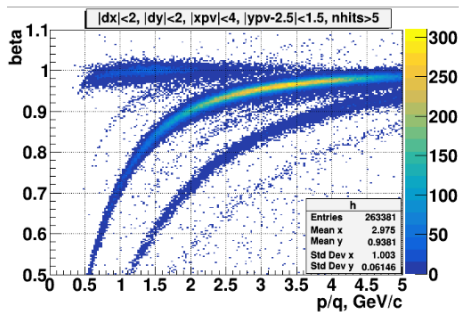
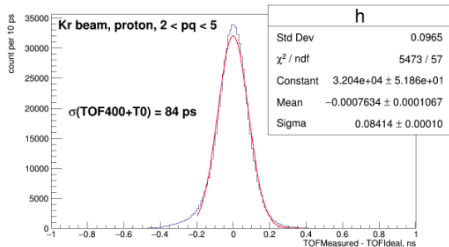
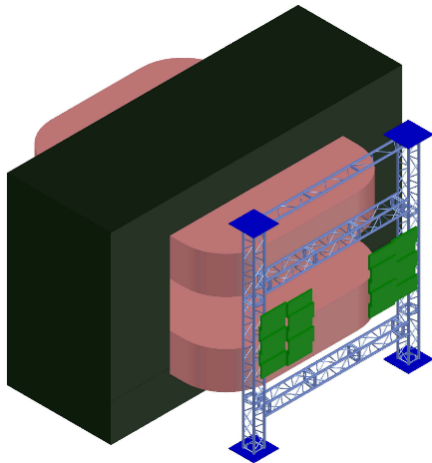
- 2 x 891 scintillator counters
- TOF-L (JINR contribution) put into operation in 1995-96
- Time resolution: ~ 75 ps

Requirements for the new TOF-LR system

- high efficiency ($> 95\%$);
- excellent intrinsic time resolution (< 75 ps);
- high granularity in order to keep the overall system occupancy below 10%;
- good position resolution to provide effective matching of the TOF hits with the Time-Projection Chambers (TPCs) tracks;
- low power dissipation in close proximity to TPCs.



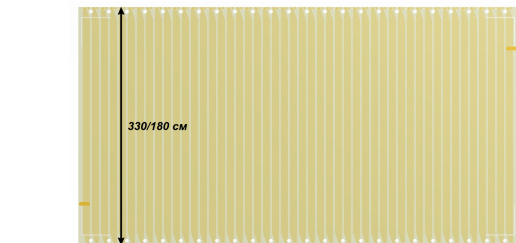
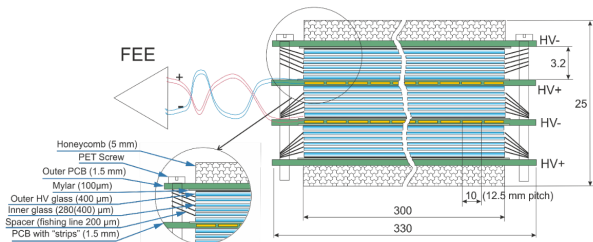
BM@N TOF400 overview



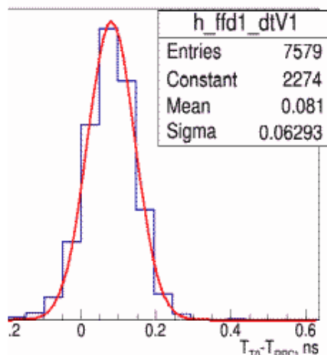
With correction.

Time resolution $\sim 100 \text{ ps}$

Triple-stack MRPC with strip readout (600x300/150 mm)



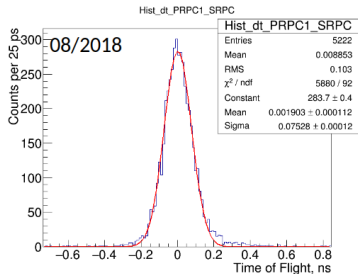
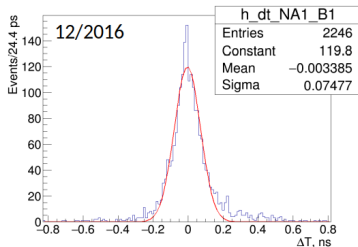
$$\sqrt{63^2 - 48^2} \approx 41 \text{ ps}$$



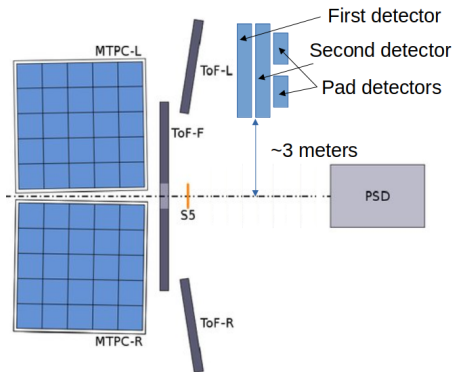
The best result

The wide MRPC is completely identical to BM@N-type TOF400 detector.

R&D for the new NA61/SHINE TOF-LR



$$\sigma_{2016} \approx \sqrt{75^2 - 58^2} \approx 47.5 \text{ ps}$$

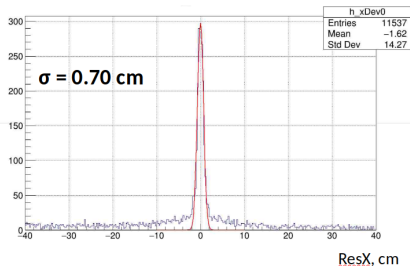


$$\sigma_{2018} \approx \sqrt{76^2 - 58^2} \approx 49 \text{ ps}$$

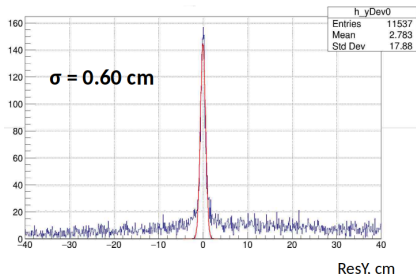
R&D for the new NA61/SHINE TOF-LR

Matching of TPC tracks to MRPC hits with NINO electronics

$$\sigma_X \sim \frac{\text{Strip pitch}}{\sqrt{12}} = \frac{1.25}{\sqrt{12}} \approx 0.36 \text{ cm}$$

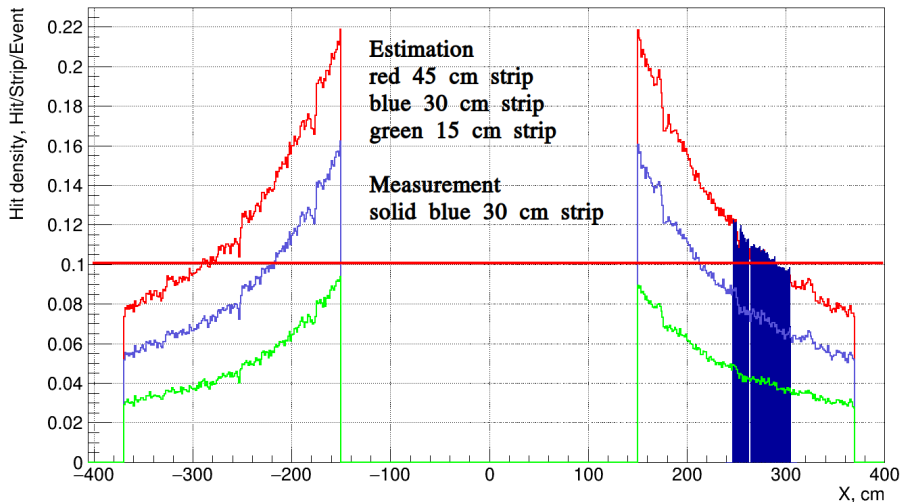


$$\sigma_Y \sim \sigma_{\text{electronics}}$$

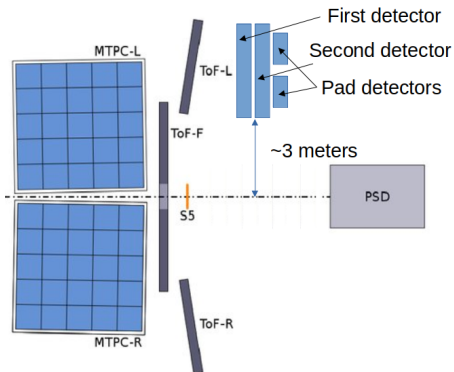
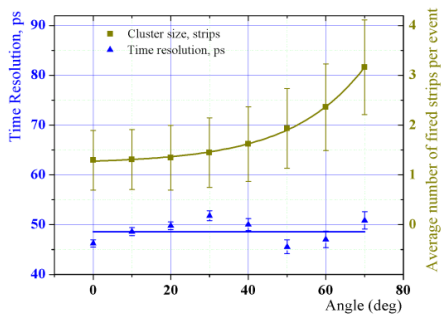


R&D for the new NA61/SHINE TOF-LR

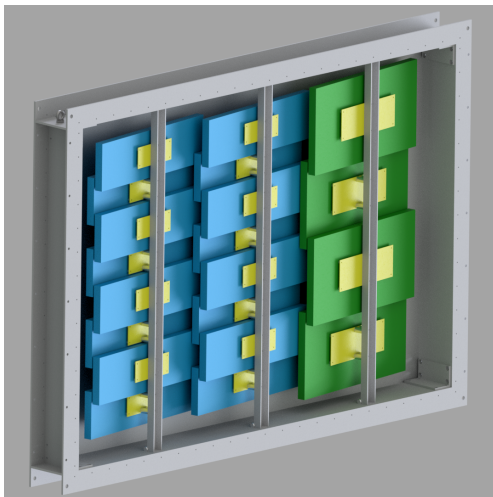
Occupancy estimation in Pb+Pb 158A GeV/c collision



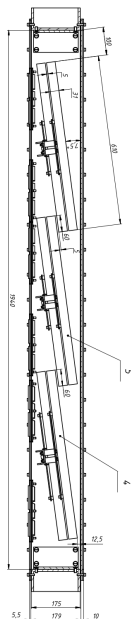
R&D for the new NA61/SHINE TOF-LR



Detector engineering design / Concept

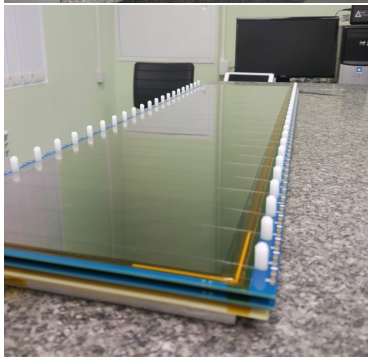


Manufacturing by "ATOM" at Dubna



Intersection with MPD mass production

- **The MPD is a main priority for mass production area**
- Small number of detectors for one wall (28/300). A 4w/28 are ready.
- Different technology of glass painting
- Different electronics
- Different soldering operation
- Materials are being prepared



Front-end & readout electronics

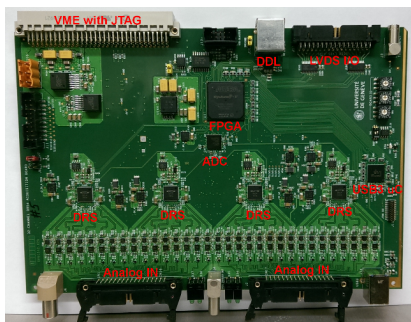
A DRS4 boards based system was considered as an optimal readout, which required new analogue front-end electronics.

Analogue amplifier

- Under R&D by V.Terechschenko (DLNP)

DRS4 module

- Custom DRS4 boards developed at University of Geneva
- Each board features 4 DRS chips, 32 analog channels in total
- 12 bit ADC is used



Gas system

Gas system will be produced by

CERN EP-DT-FS/Gas Team (Roberto Guida)

Gas system requirements:

- Total volume – 1 m³
- Number of modules – 2
- Gas mixture – C₂H₂F₄ / i-C₄H₁₀ / SF₆ (90%/5%/5%) or N₂
- Volume exchange/day – ~ 7
- Total flow rate – 300 nl/h
- Fresh gas flow rate – 3 nl/h
- Working pressure – < 3 – 5 mbar
- Tolerable O² content – 200 ppm
- Tolerable H²O content – 100 ppm

Power supplies

HV system requirements:

- Minimum number of differential \pm channels: 24 (40 det)
- Total current through the whole system ($\sim 5 \mu\text{A}$) (150 nA wide)(75 nA narrow)
- Precision of the current monitoring: $\sim 10 \text{ nA}$
- Multichannel structure
- Remote control
- Additional HV split up system

LV system is under design



Conclusion

- Upgrade of NA61/SHINE TOF system is progressing on schedule.
- BM@N-type MRPCs were tested and requested parameters were reached.
- Detectors production for NA61/SHINE established.
- DRS4 boards are suitable for data taking but new algorithms and front-end electronics are needed.
- R&D of new analogue electronics as well as LV system are under way.
- Gas system will be produced by CERN EP-DT-FS/Gas Team (Roberto Guida).

Thanks you and welcome!