Status report NTA-MICE

Aggiornamento rispetto alla presentazione del 16-I-09 di Maurizio Bonesini

Riferimenti:

http://mice.iit.edu/micenotes/public/pdf/MICE0230/MICE0230.pdf
http://mice.iit.edu/mico/

MICE

Muon Ionization Cooling Experiment

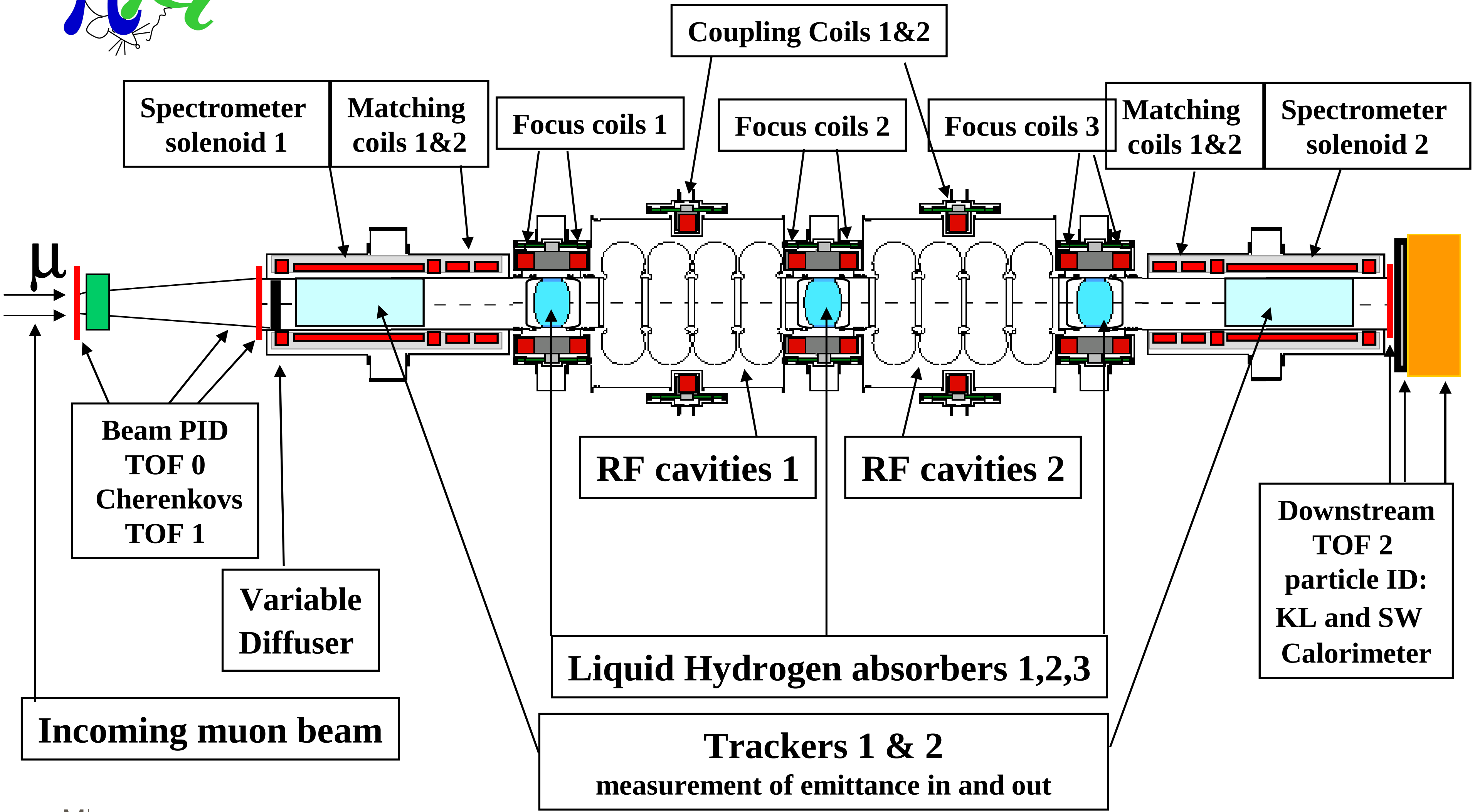
Il raffreddamento per ionizzazione è l'unica soluzione pratica per preparare i fasci ad alta brillanza necessari per una Neutrino Factory o Muon Collider.

MICE, in preparazione al RAL (UK), consiste in un fascio di μ e una cooling cell – che procura perdita di energia in idrogeno liquido alternata ad accelerazione in cavità RF - inserita tra due spettrometri magnetici con tracciatori a fibre scintilanti che ne misurano l'emittanza IN-OUT

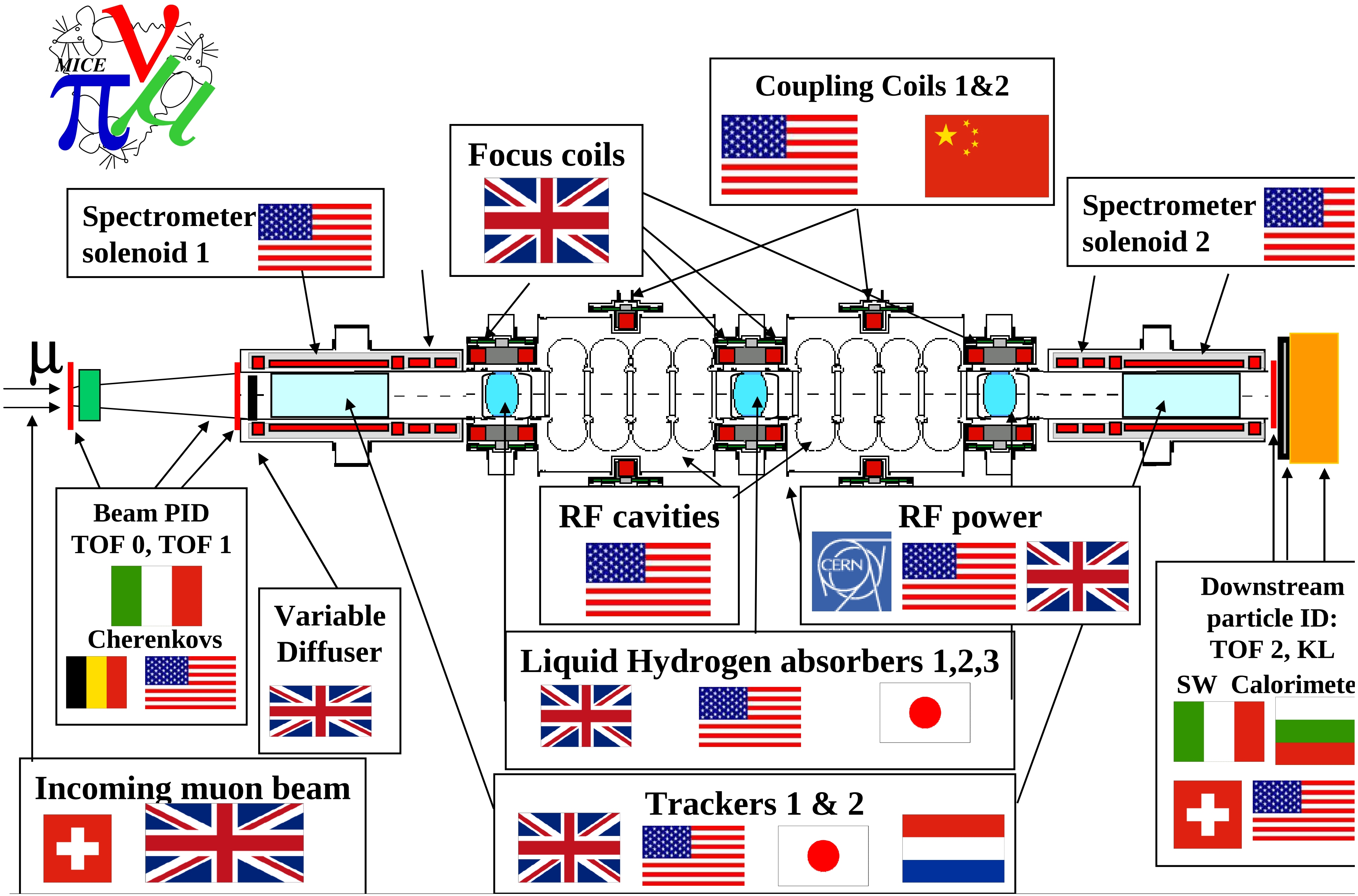
Un sistema di rivelatori di Tempo di Volo, Cerenkov e Calorimetri assicura la purezza del fascio di muoni

10% cooling of 200 MeV/c muons requires ~ 20 MV of RF
single particle measurements =>

measurement precision can be as good as $\Delta(\varepsilon_{out}/\varepsilon_{in}) = 10^{-3}$
never done before



MICE Collaboration across the planet



Requirements on detector systems for MICE

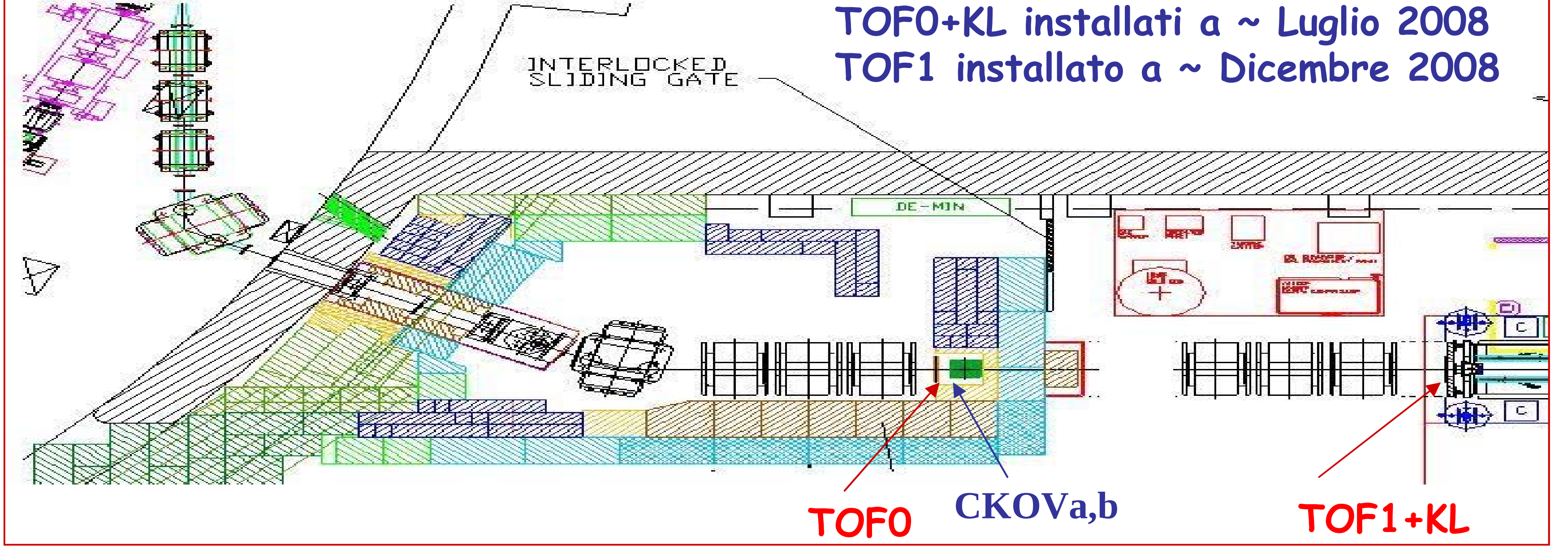
1. **Must be sure to work on muons**
   1.a use a pion/muon decay channel with 5T, 5m long decay solenoid
   1.b **reject incoming pions and electrons**
   TOF over 6m with 70 ps resolution + threshold Cherenkov
   1.c **reject decays in flight of muons**
   downstream PID (TOF2 + calorimeter set up)

2. Measure all 6 parameters of the muons x,y,t, x', y', β_z=E/Pz
   tracker in magnetic field, **TOF**, EMR
   Resolution on above quantities must be better than 10% of rms of beam at equilibrium emittance to ensure correction is less than 1%.
   + resolution must be measured

3. **Detectors must be robust** against RF radiation and field emission

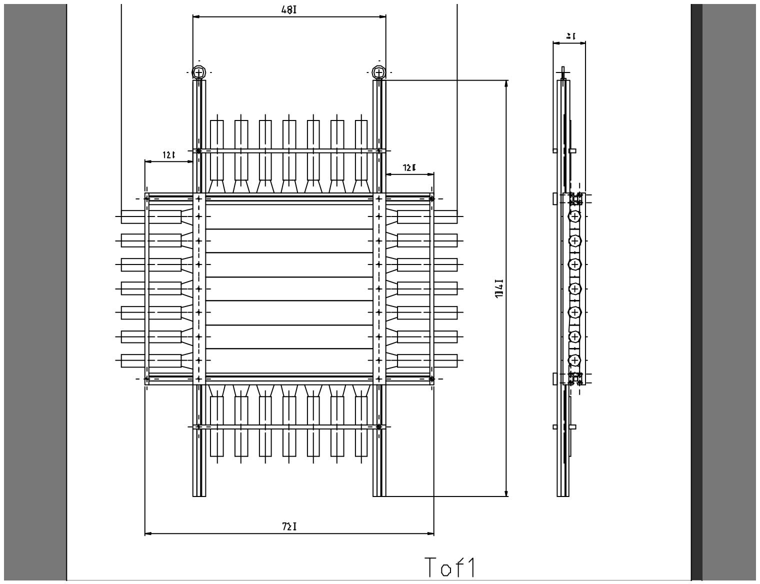
4. Detectors and DAQ system must be able to take about 500 muons per second in a duty cycle of 10^{-3} imposed by the RF acceleration system
   i.e. 500 particles recorded completely in a gate of 1ms each second

MICE Beamline- Phase1/2 Startup



TOF0+KL installati a ~ Luglio 2008
TOF1 installato a ~ Dicembre 2008

TOFs design



- **"conventional" X/Y scintillator structure with readout at both ends, to provide redundancy & intercalibration with inc. μ**
- **problem: choice of PMTs for high incident particle rate (1 MHz) and solenoid B fringe field**

$B_{//}$ ~ 200-300 G, B_{perp} ~ 1K G

Studies with fast conv. PMTS or fine-mesh PMTs

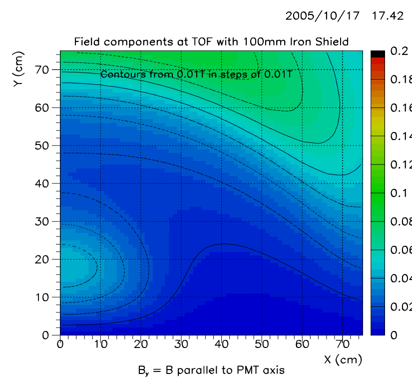


Figure 4: $B_{\parallel}$ at the position of TOF2 with the 100 mm iron shield.

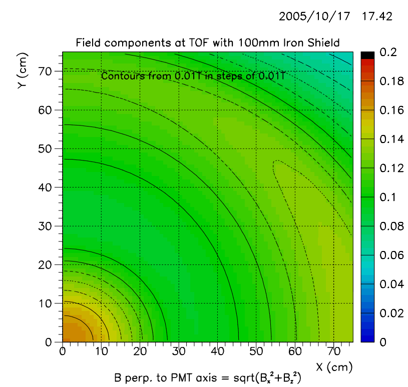


Figure 5: $B_{\perp}$ at the position of TOF2 with the 100 mm iron shield.

TOF stations system

- Exp trigger, upstream/downstream PID and measure of t vs RF
- Work in a harsh environment (high incoming particle rate, high fringe fields from solenoids, X rays from converted e^-)

with good timing performances (s_t~50 ps)

Tof resolution can be expressed as:

$$\sigma_t = \sqrt{\frac{\sigma^2_{scint} + \sigma^2_{PMT} + \sigma^2_{pl}}{N_{pe}} + \sigma^2_{elec}}$$

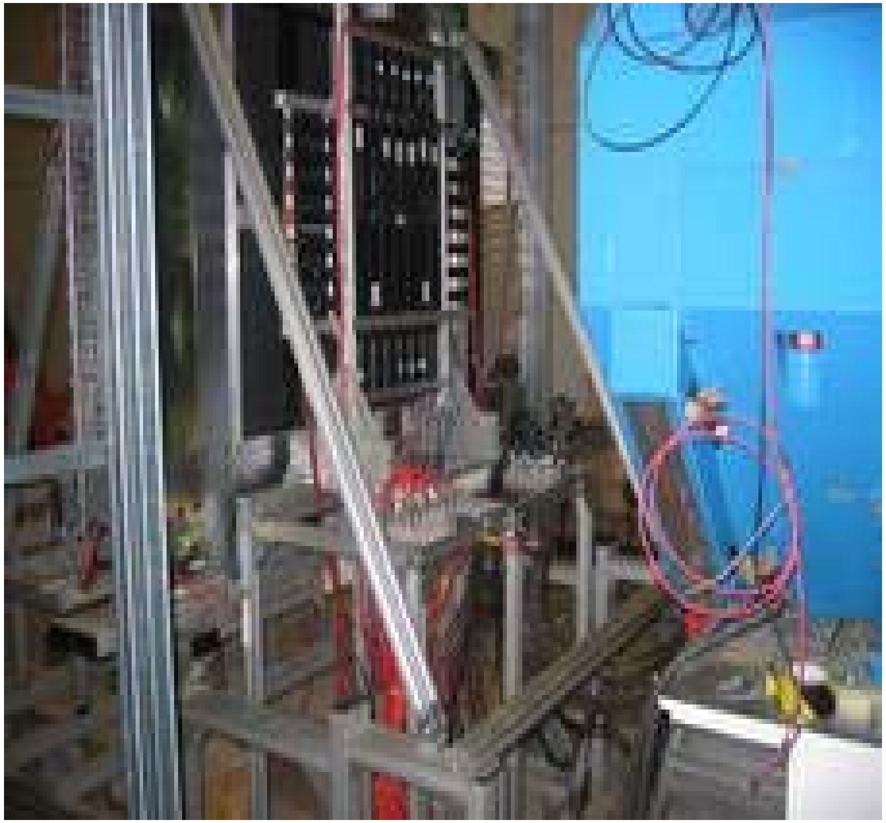
→ **Some points to look to have high resolution TOFs**

- σ_{pl} **dominated by geometrical dimensions ~√(L/Npe)**
- σ_{scint} ~ 50-60 ps **(mainly connected with produced number of γ's fast and scintillator characteristics, such as risetime)**
- σ_{PMT} **PMT TTS (typically 150-300 ps)**

+ ENVIRONMENT

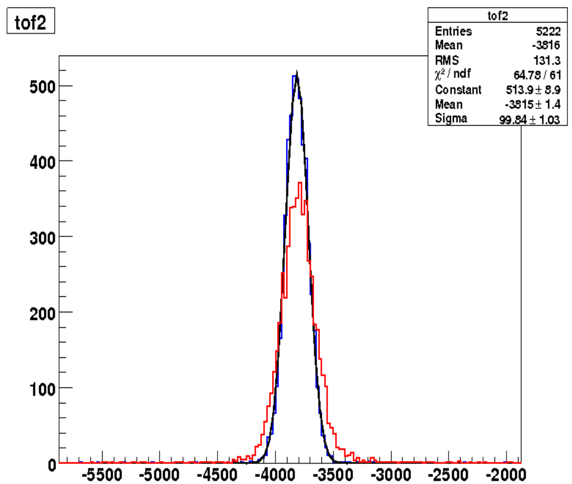
Upstream TOF Installation

TOF0 installation in final position inside DSA

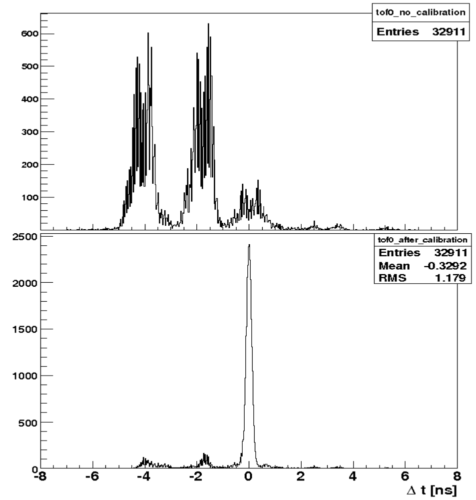


Temporary TOF1 + KL installation

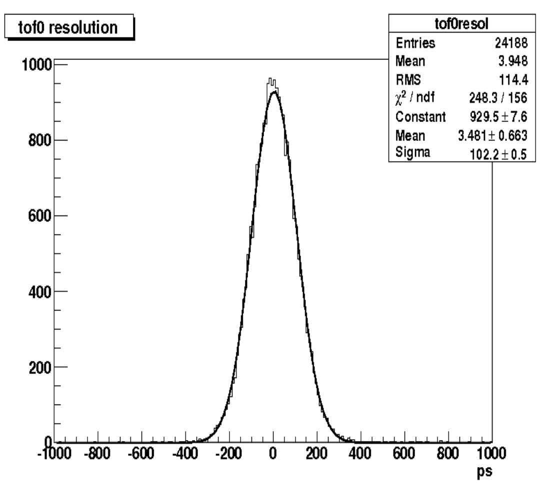
First results in beam for TOF0-TOF1

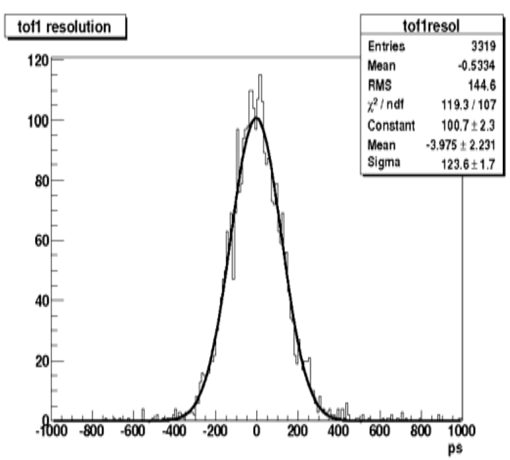


After time-walk correction + time calibration



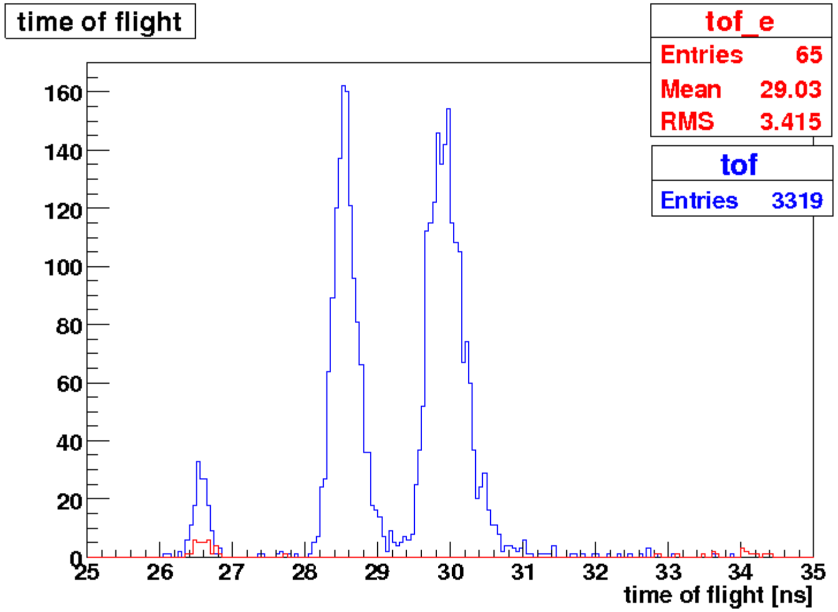
The time difference between the vertical and horizontal slabs in the same station can be used also to measure the time resolution obtained after the calibration.

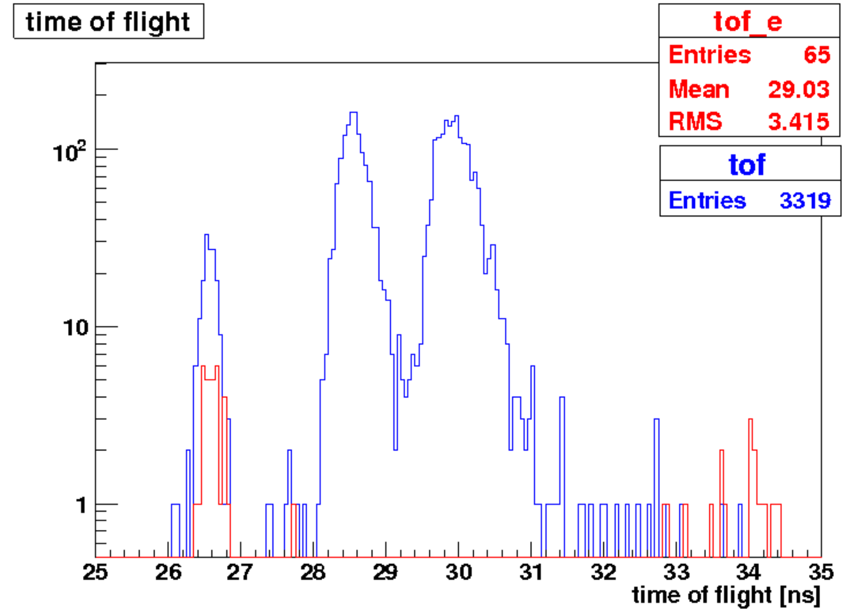




The resolution on the difference in the calibrated pixels in TOF0 (TOF1) is ~ 102 (124) ps.
This translates into ~ 51 (62) ps resolution for the full detector with crossed hor. and vert. planes

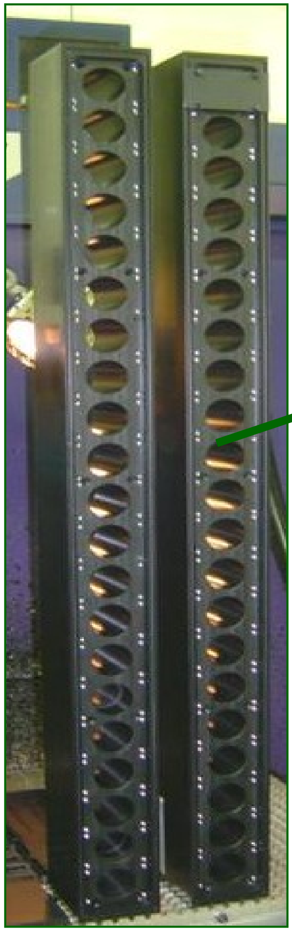
Time of flight spectrum



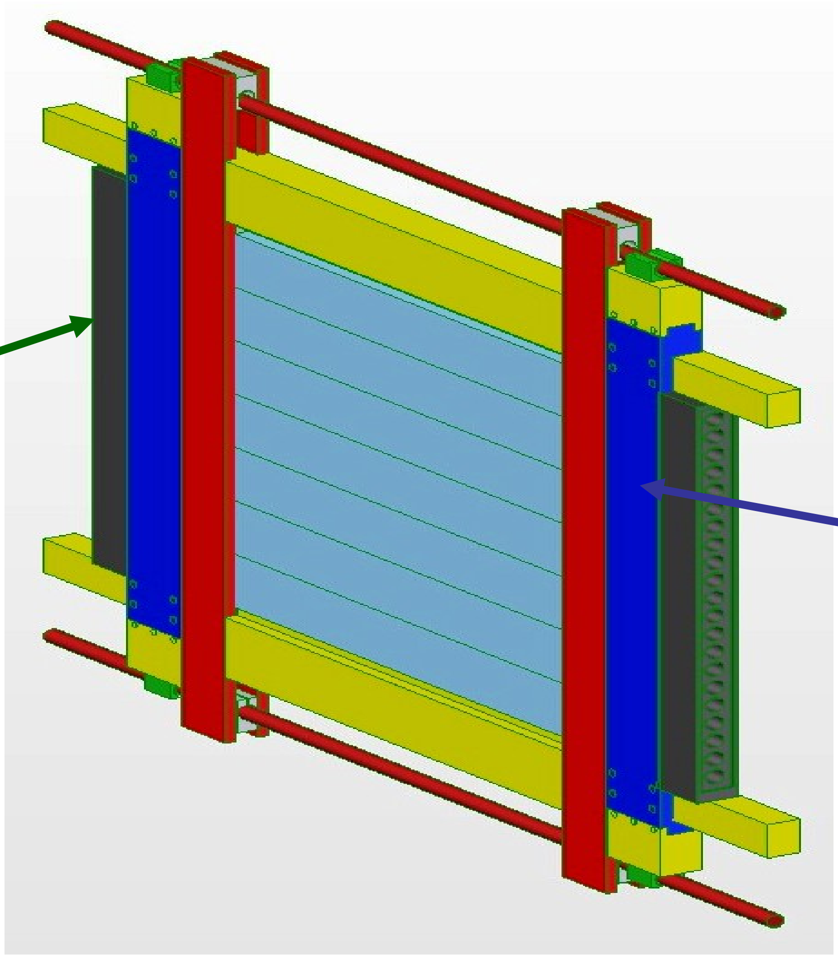


- Time of flight between TOF0 and TOF1 for the so called positron (red) and pion (blue) beams
- The first peak which is present in both distributions is considered as the time of flight of the positrons and is used to determine the absolute value of the time in TOF1. A natural interpretation of the other two peaks in the time of flight spectrum from the so called pion beam is that they are due to forward flying muons from pion decay and pions themselves, but the calculated time of flight of nominal 300 MeV/c pions is ~ 29.4 ns instead of ~ 30.0 ns, where the third peak maximum is positioned.
- This difference may be partly explained by the energy loss inside the TOF0 and the two upstream Cerenkovs, that amounts to ~ 17 MeV.

Layout of KL

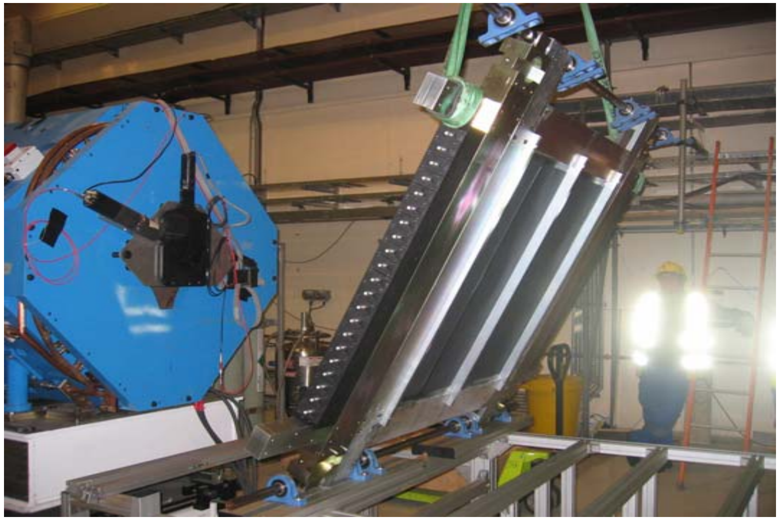


PVC bars for VD housing

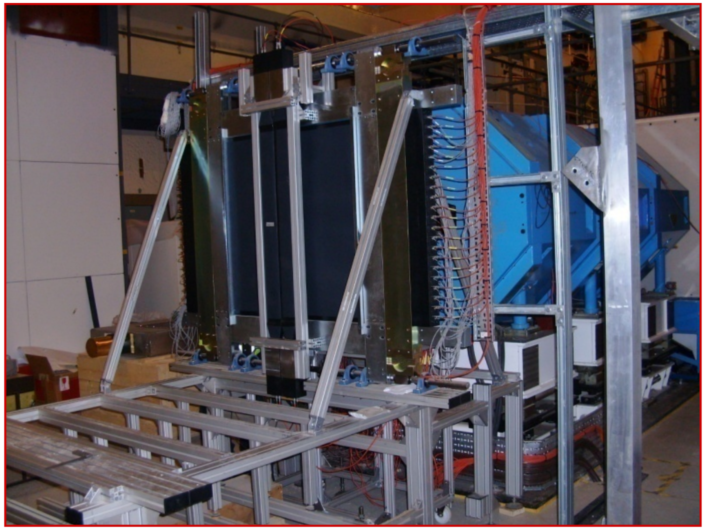


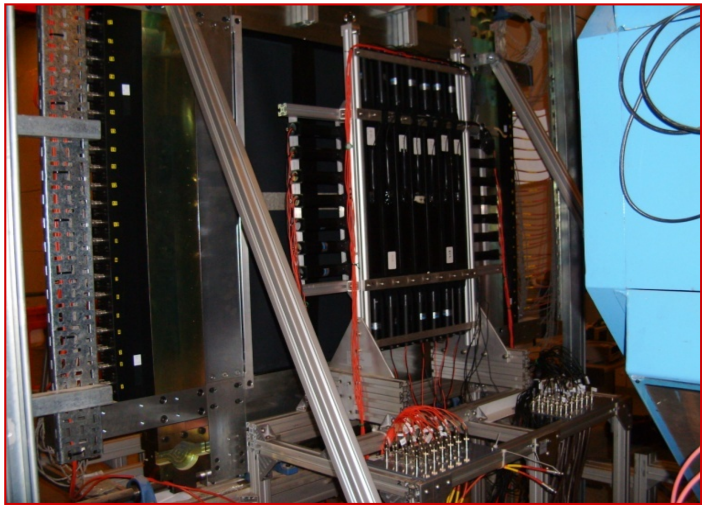
Iron bars for PMTs shielding

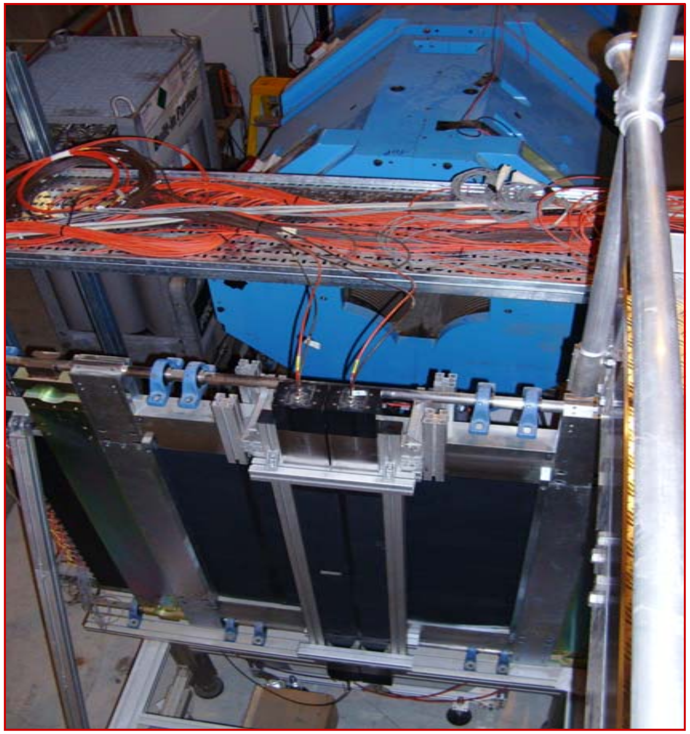
KL Installation at RAL



KL & TOF1 detectors at RAL



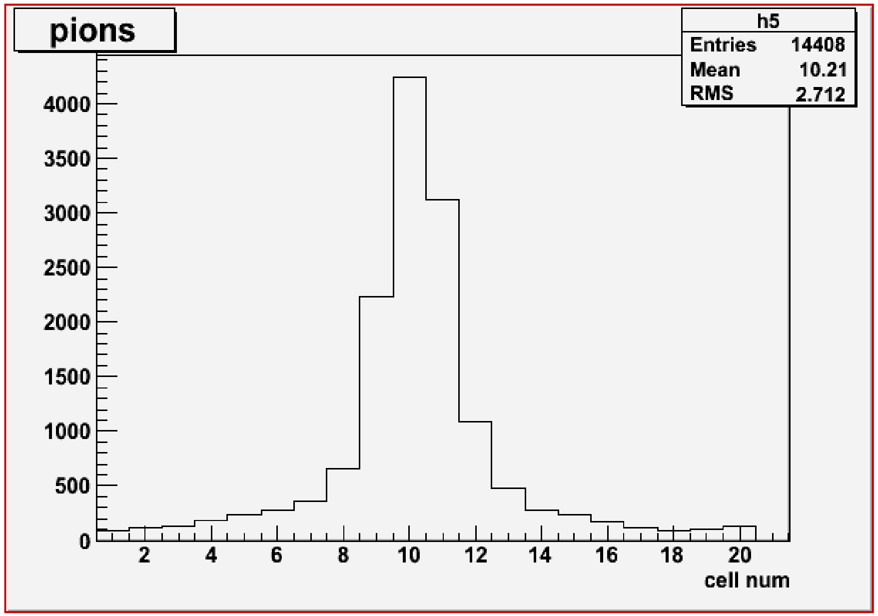


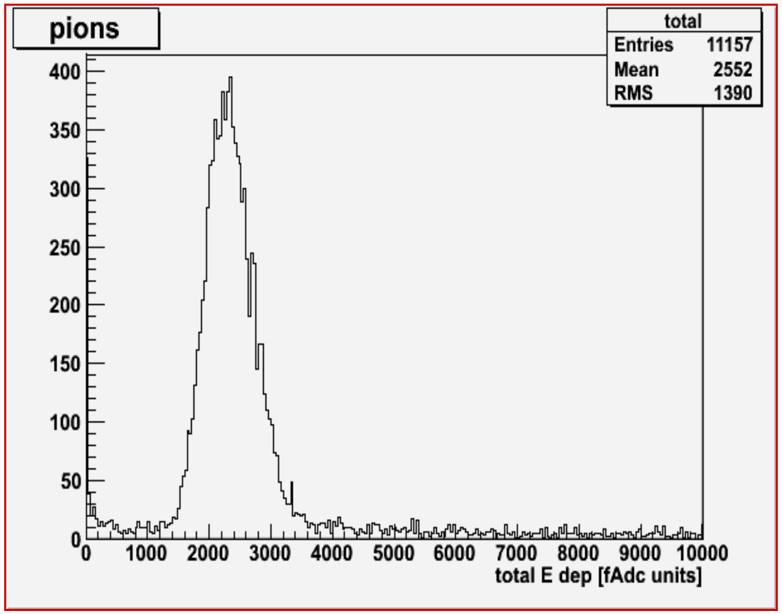


The first part of EMC,
(the Electron-Muon-Calorimeter)
formed by the electron identifier
KL (KLOE-Like lead-scintillating
fiber calorimeter) is now operating
"in symbiosis" with TOF1

KL commissioning (π^+)

At the beginning of November the KL detector has been exposed for the first time to the pion (300 MeV)

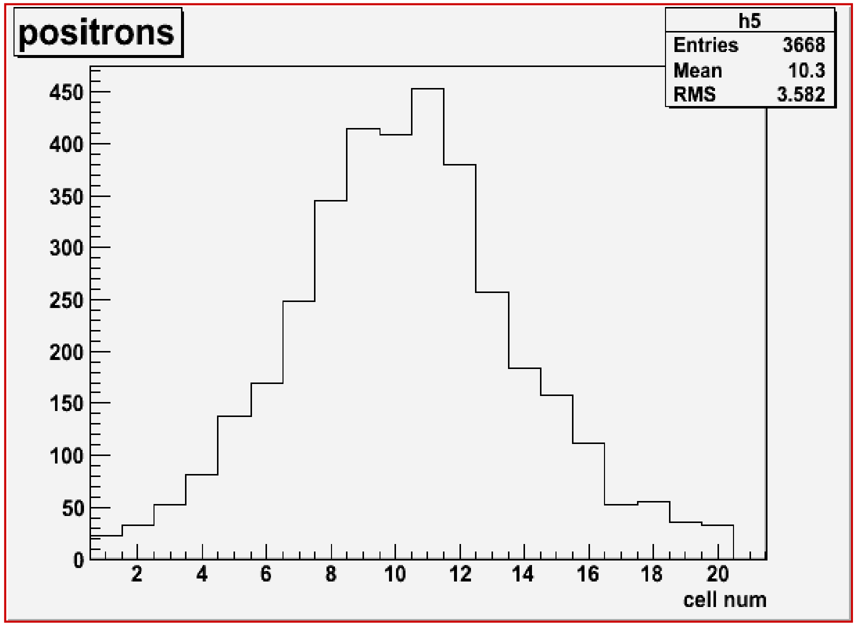


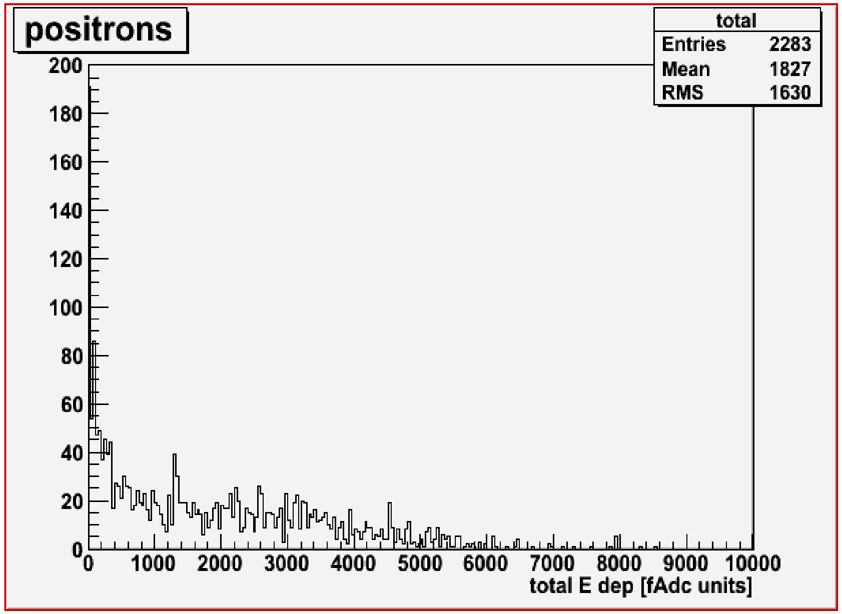


Results of FADCs monitoring data show the beam's profile and the energy reconstruction in agreement with the expected resolution

KL commissioning (e^+)

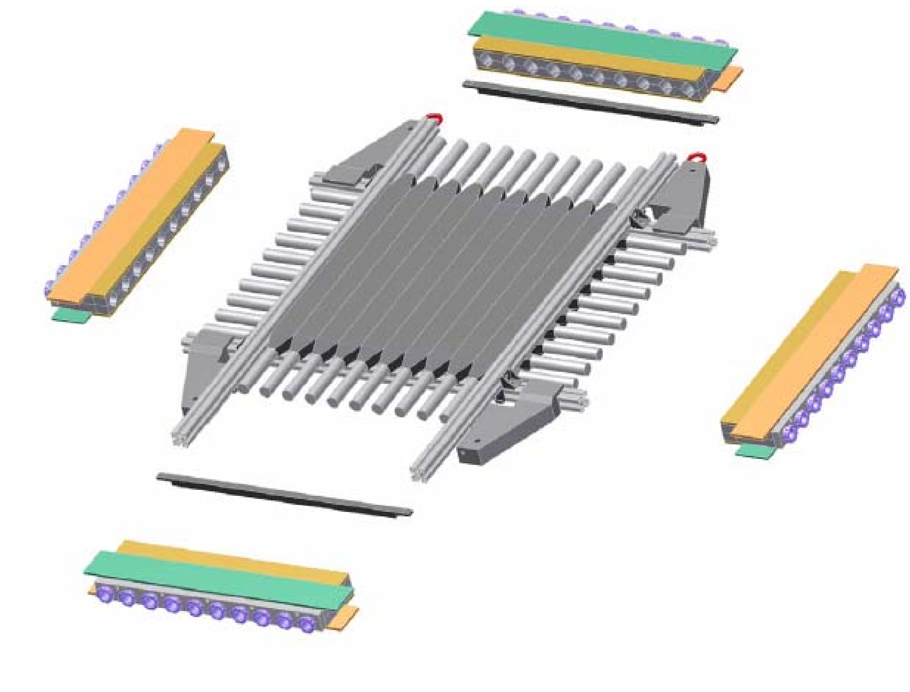
Last November the KL detector has been exposed also to the positrons (100 MeV)

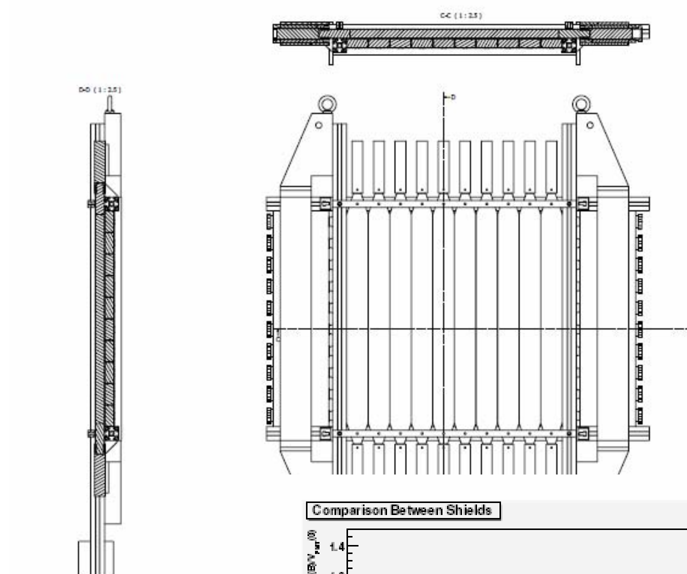


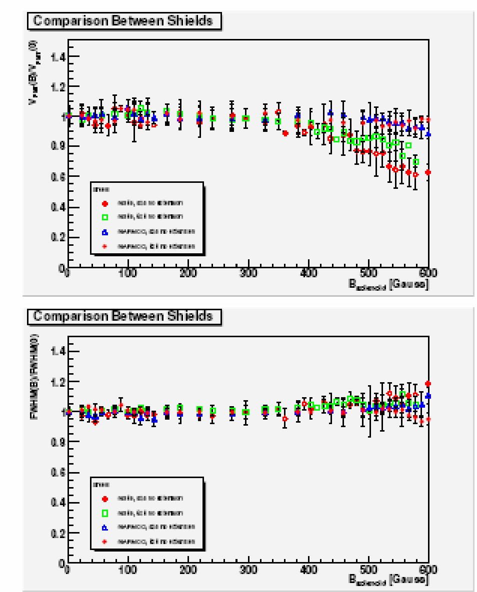


Results of FADCs monitoring data show the beam's profile (broader than π^+) and the energy reconstruction indicating that the positron beam is significantly degraded before reaching KL

TOF2 construction

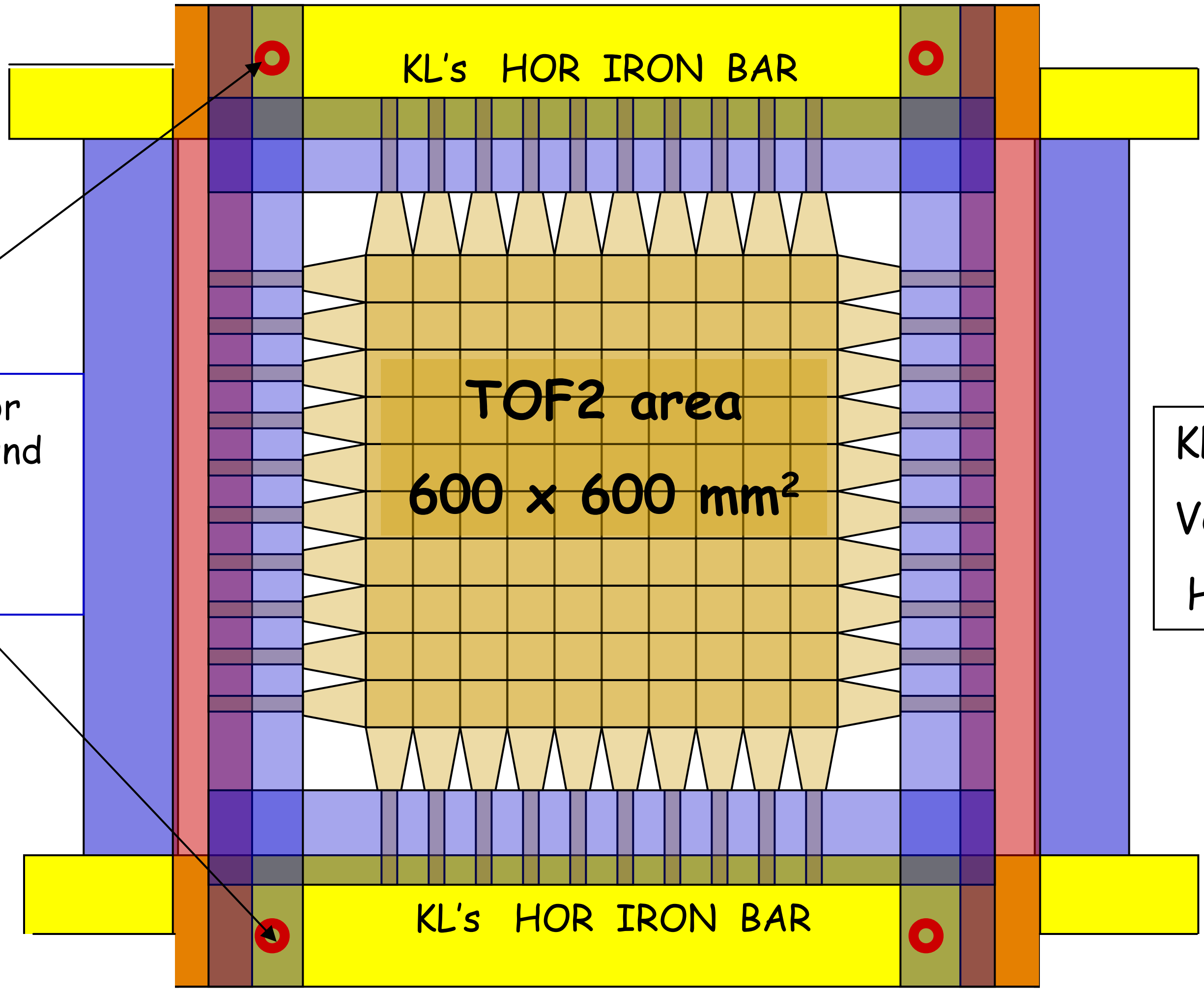






- for TOF2 **massive box ARMCO local shielding (D0-like)** solution
- PMT studies show solution is adequate..

Linking of TOF2 & KL shielding frames



Four holes for threaded round bars (to be made on the spot)

KL's area mm^2 :

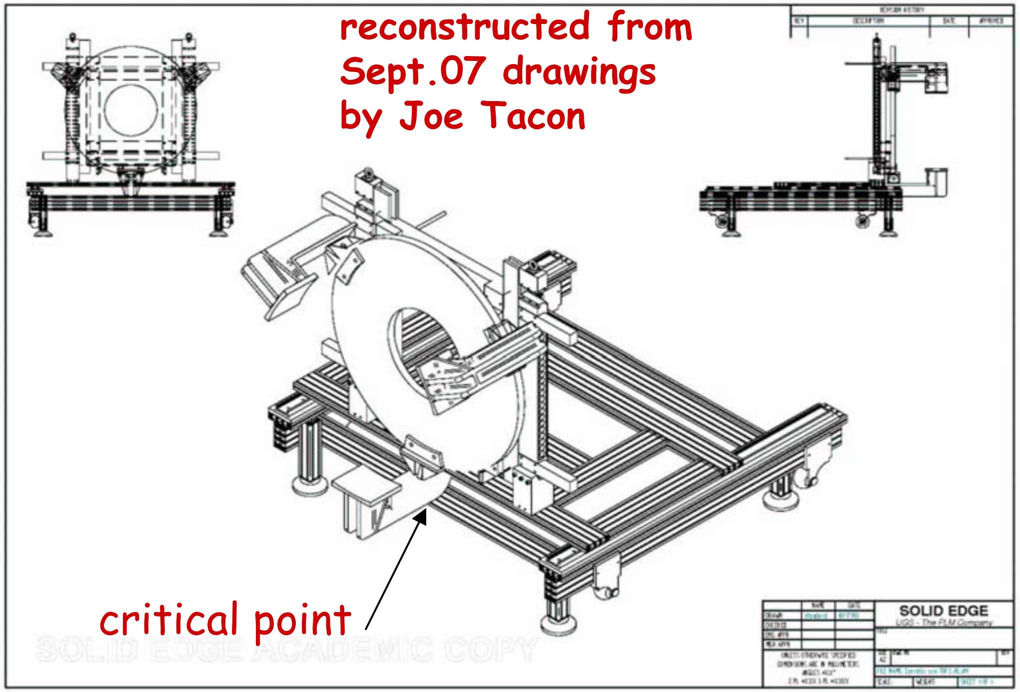
Vert = 924+4

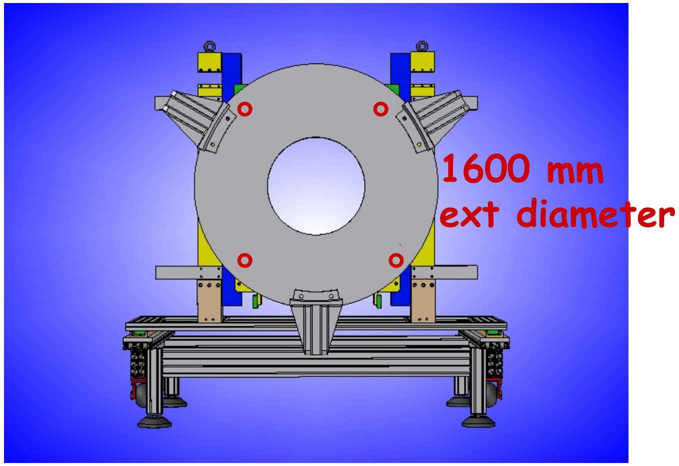
Hor = 932

Installation of TOF2 & KL & Virostek plate in the final downstream beam area

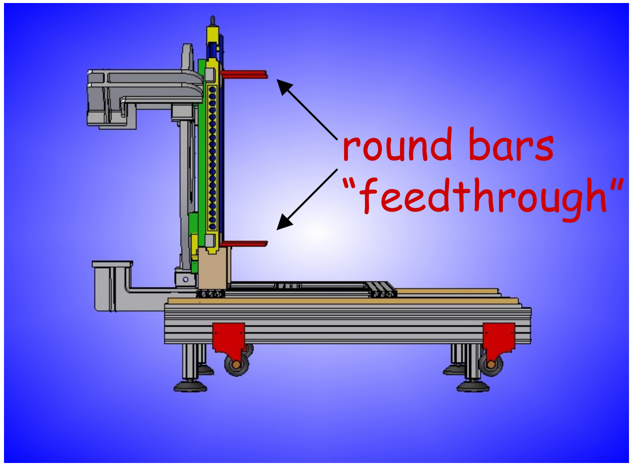
to be checked:

- Virostek plate linking (Wing)
- Brackets constraints (see drawing)
- Platform slot for trolley (Andy)

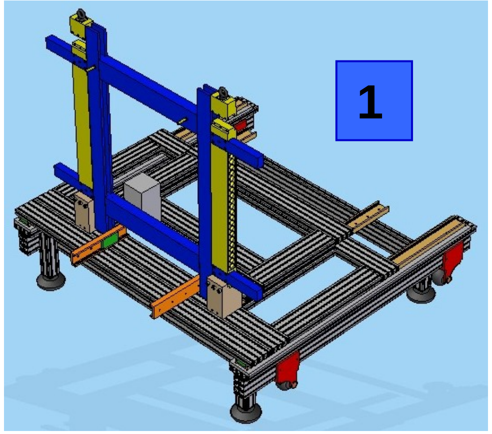


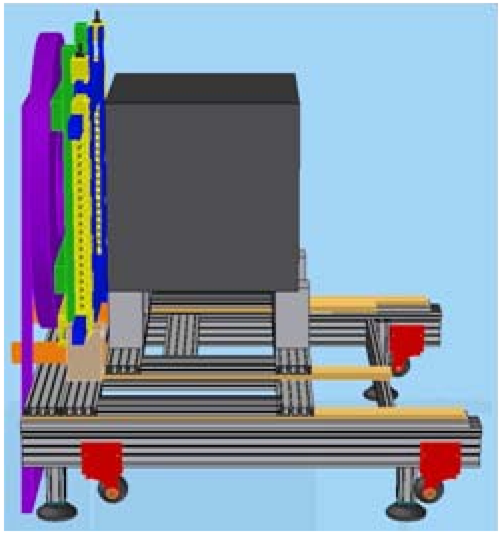


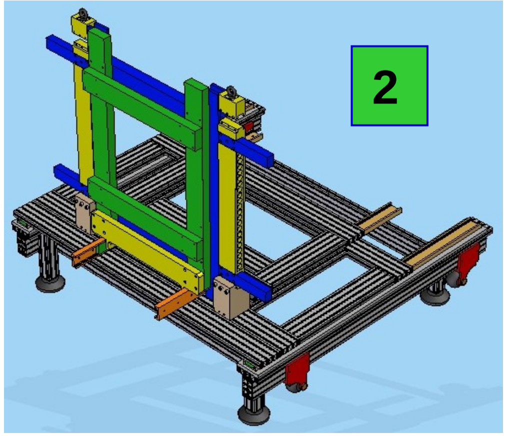
(lateral anchorages to the floor not shown)

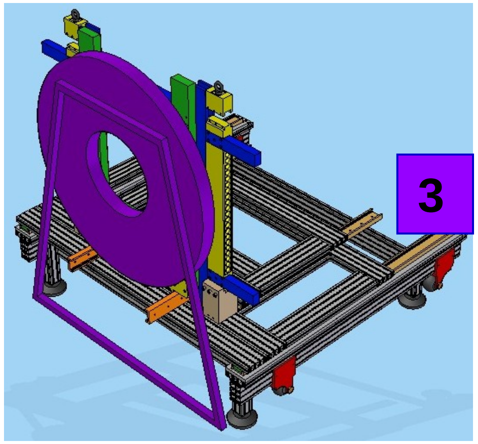


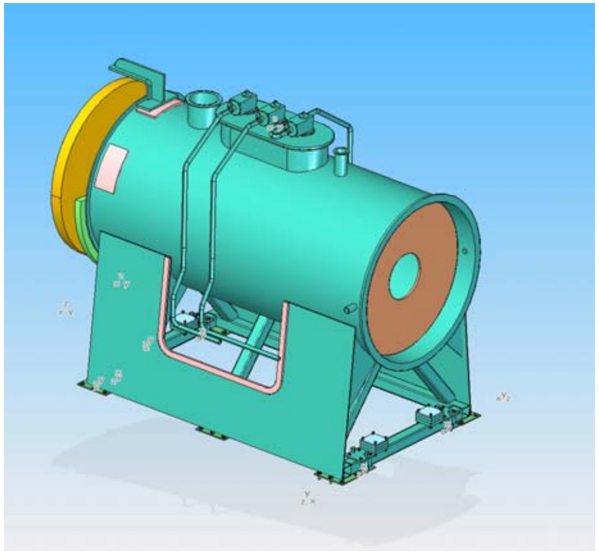
Assembling sequence of Downstream PID Detectors

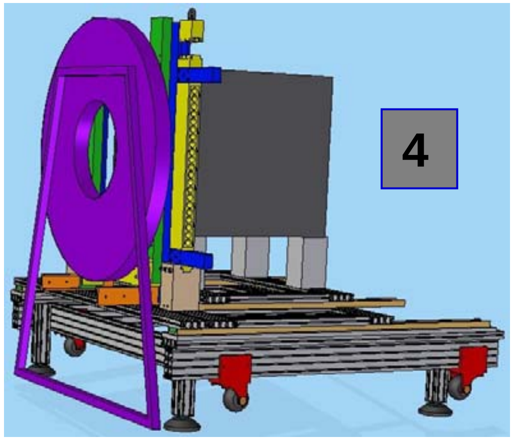












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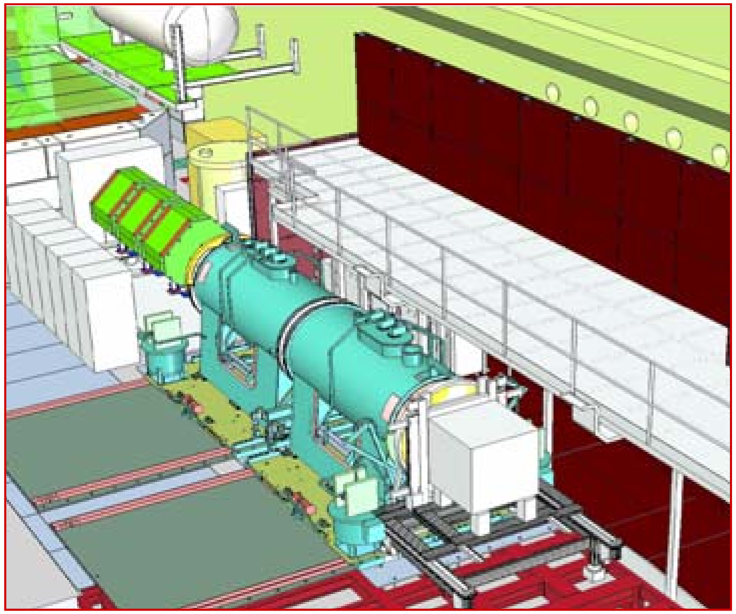
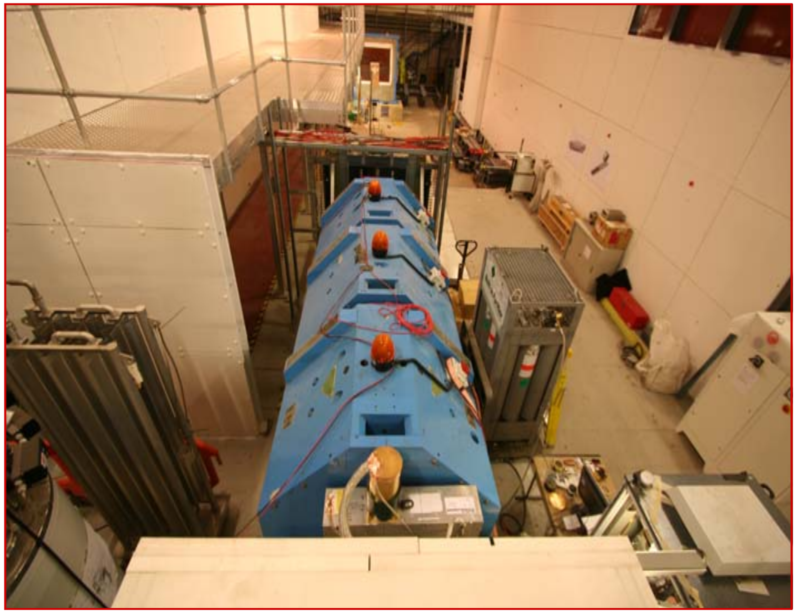
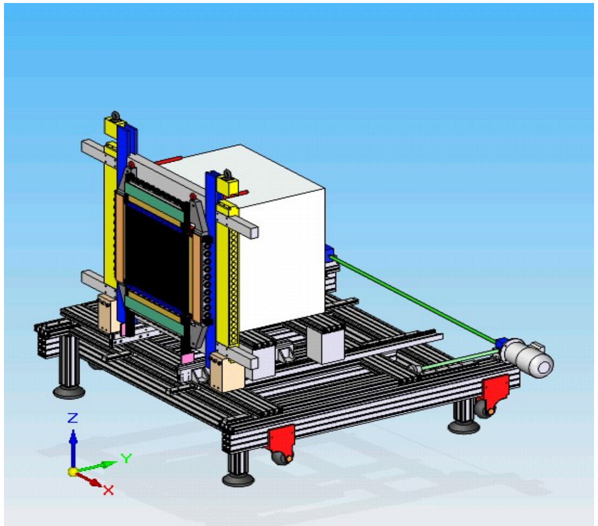
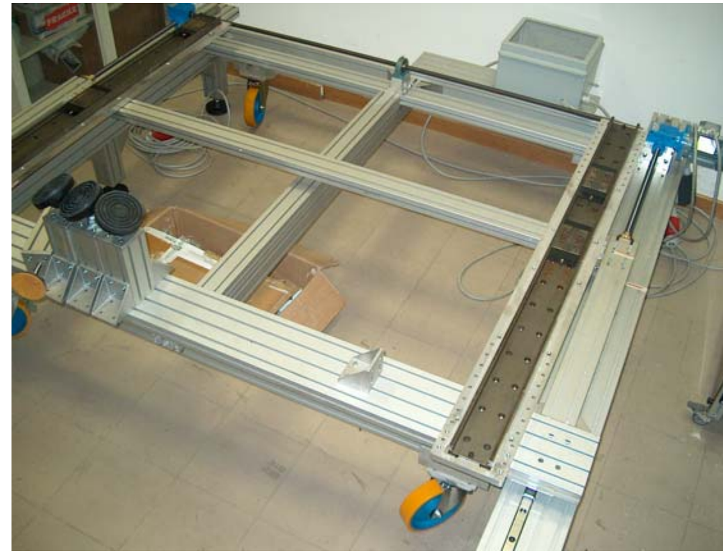
Downstream PID System





Carrello definitivo per "Downstream PID System"





Pronto per la
spedizione di agosto

Storia partecipazione INFN in MICE

- Iniziata nel 2006 in ambito Gr V per lo sviluppo di prototipi per il PID (TOF e EmCal) e attrezzature con un finanziamento complessivo ~250 K€

- Testbeam in luglio 2006 alla BTF dei LNF e inizio costruzione rivelatori finali nel 2007

- Contributo del RAL nel 2007 di ~ 200 K€ per sistemi di schermaggio e supporto-movimentazione meccanica PID (Rm3) e PMTs (MiB)
- Passaggio ad NTA nel 2008 (finanziamento complessivo ~ 100 K€)

- Installazione a RAL nell'estate del 2008 di TOF0&1 (MiB, Pv) e KL (KLOE-Light Calorimeter, Rm3) su carrello provvisorio

- Running esperimento fine 2008 con prima caratterizzazione del fascio π-e (no μ causa rottura del solenoide DSA)

Attivita' e Programma INFN nel 2009

- Intervento tecnico per rimuovere TOF1 e KL dalla beam-line e riposizionarli dopo installazione del primo spettrometro magnetico per run settembre
- Finalizzazione e montaggio schermaggi magnetici di TOF2
- Installazione di TOF2 e KL sul carrello definitivo del PID system a valle dello spettrometro magnetico
- Assemblaggio con disco di Virostek
(shielding del "secondo" spettrometro magnetico)
- Running esperimento (full electronics & DAQ) fino alla fine dell'anno
- Calibrazioni e running esperimento a RAL, con prima misura d'emittanza nel 2010

(Integrazione) Assegnazioni 2009

	Mi	ME	Consumi
MIB	-	4	14
Rm3	-	4	-
Pv	1	2	-

Necessari anche in considerazione di:

- **interventi tecnici straordinari**
- **riduzione supporto host lab (RAL) per installazione etc (manpower e consumables)**

ISTITUTO NAZIONALE DI FISICA NUCLEARE
Esercizio 2009

SITUAZIONE DELLE PROPOSTE DEL PROGETTO STRATEGICO "NUOVE TECNICHE DI ACCELERAZIONE" PER IL BILANCIO 2009

- per Sigla -

NOTE	SIGLA	Sez.	INTERNO		ESTERO		CONSUMO		SEM	TRASPORTI		PUB	CALCOLO		MAN.		INVENTARIO		APPARATI		TOT. PARZIALI		GENERALE
			Assegn.	S.J.	Assegn.	Sub-Jud	Assegn.	Sub-Jud		Assegn	S.J.		Assegn.	S.J.	Ass.	S.J.	Assegn.	Sub-Jud	Assegn.	Sub-Jud	Assegn.	Sub-Jud	
	NTA-MICE	MIB	2		15		22			2											41		41
	NTA-MICE	NA	1		5		1														7		7
	NTA-MICE	PV	2		9		2														13		13
	NTA-MICE	RM3	2		15		8			3											28		28
	NTA-MICE	TS	1		6		2														9		9
	Totale Sigla		8		50		35			5											98		98

Bilancio 2009 > Globale > NTA > Esperimento NTA-MICE > Riassuntivo assegnazioni

Sez. & Suf.	MI	Sj	ME	Sj	CON	Sj	SEM	Sj	TRA	Sj	PUB	Sj	MAN	Sj	INV	Sj	APP	Sj	TOTALE	Sj
MIB	3.0		24.0		24.0	35			2.0						15.0				68	35
	1.5		11.5		16.5	0.0			1.5						0.0				31.0	
NA	2.0		8.0		2.5														12.5	
	1.0		4.0		1.0														6.0	
PV	3.0		17.0		5.0												10.0		35	
	1.5		7.0		1.5												0.0		10.0	
RM3	4.0		24.0		10.0				3.0						15.0		8.0		64	
	1.5		11.0		6.0				2.0						0.0		0.0		20.5	
TS	2.0		8.0		5.0				3.0								15.0		33	
	1.0		4.5		1.5				0.0								0.0		7.0	
TOTALE	14		81		46.5	35			8						30		33		212.5	35
		14		81		81.5		0		8		0		0		30		33		247.5
	6.5		38		26.5				3.5						0		0		74.5	
		6.5		38.0		26.5		0.0		3.5		0.0		0.0		0.0		0.0		74.5