TT Status Report

M. Dracos

- Scintillator strips
- Photodetectors
- Electronics
- Light injection system
- Module construction
- Schedule
- CERN Market Survey
- Tendering
- Construction and installation procedure

Scintillator news

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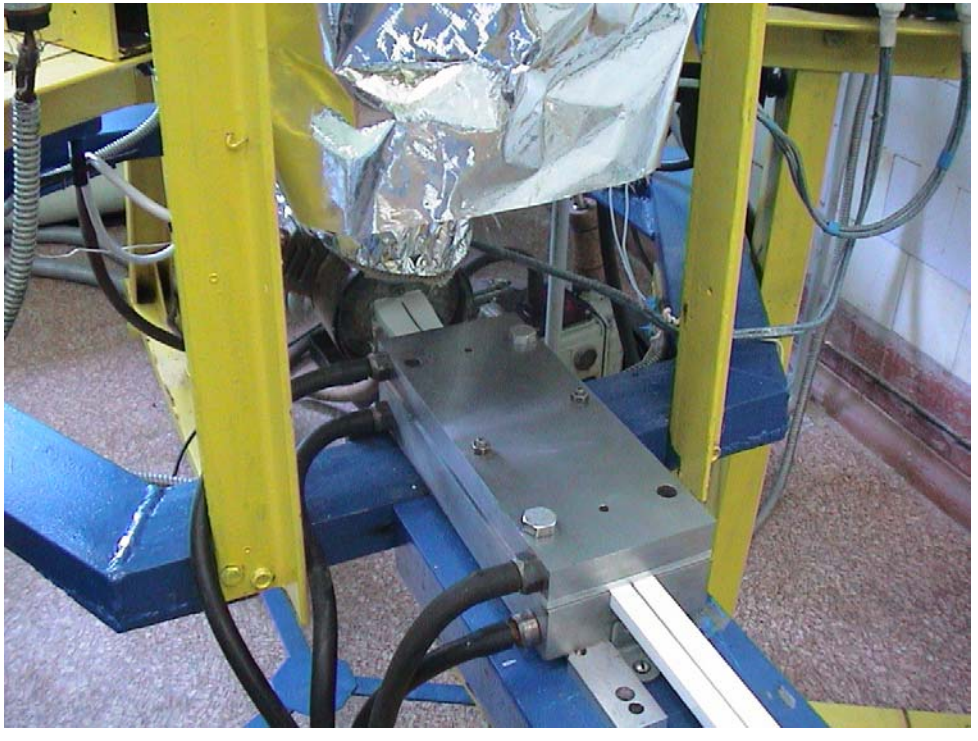
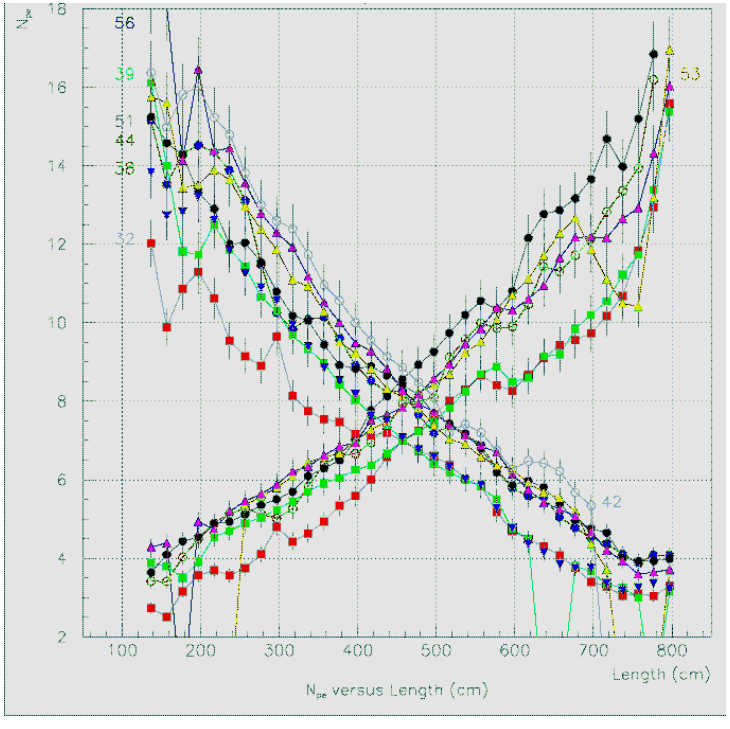
- Kharkov: 20 strips (7 m) at Strasbourg with different TiO_2 types and concentration:
  - High light yield: > 8 p.e !
  - Good geometry.
  - 600 strips ordered for the wall production.





Scintillator news

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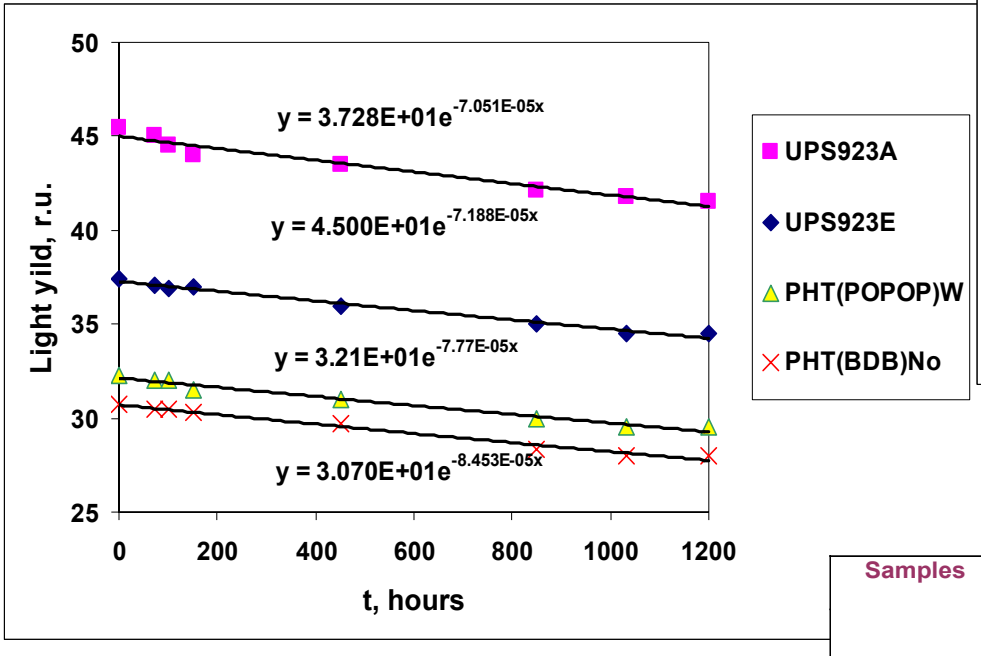
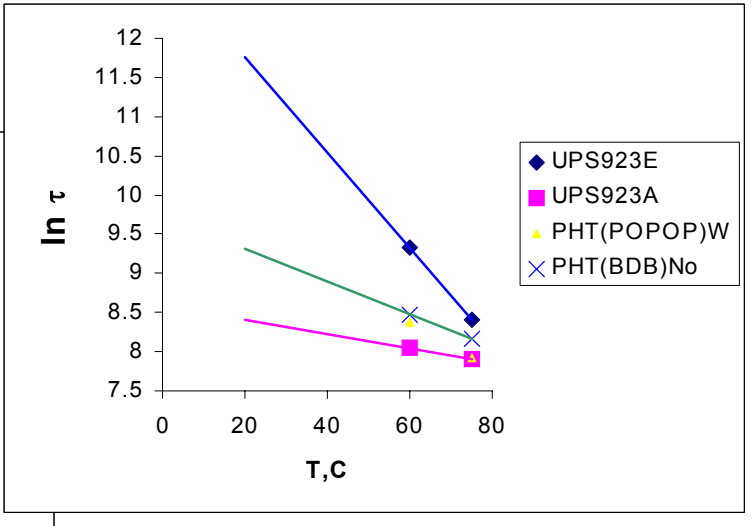
- Kharkov: **Aging studies**





$$\ln \tau_{20} = \frac{T_1(T_2 - T_{20})}{T_{20}(T_2 - T_1)} \ln \frac{\tau_1}{\tau_2} + \ln \tau_1$$

Samples	Bulk Attenuation length, cm	Light output, r.u.		Predicted service time, years	
		For samples without optical contact	For samples with optical contact	50% change Bulk Attenuation length	20% change Light output
UPS923E	70	37.4	66.5	8.3 (35)	11.3 (53.2)
UPS923A	145	45.5	77	8.8 (75)	9.3 (61.6)
PHT(POPOP)	14.5	32.3	46	8.7 (7.3)	11.0 (36.8)
PHT(BDB)	14.0	30.7	48.3	8.6 (7.0)	10.7 (38.6)

Scintillator news

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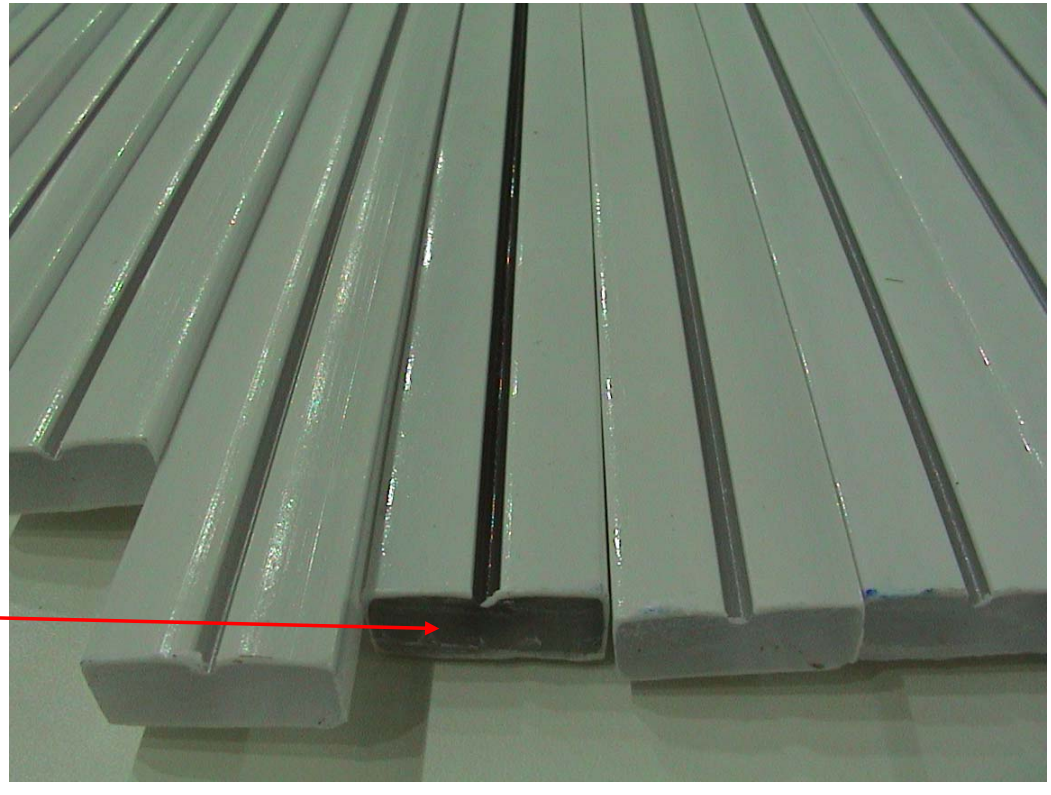
- Pol.Hi.Tech:
  - 64 co-extruded strips delivered at Strasbourg.
  - Strip geometry not good (groove too big, faces not planar, TiO_2 thickness not regular…).
  - Light yield very poor:

    < 2.5 p.e.
  - Offer for wall construction: 11.5 k€ for 200 strips → too expensive.



Scintillator news

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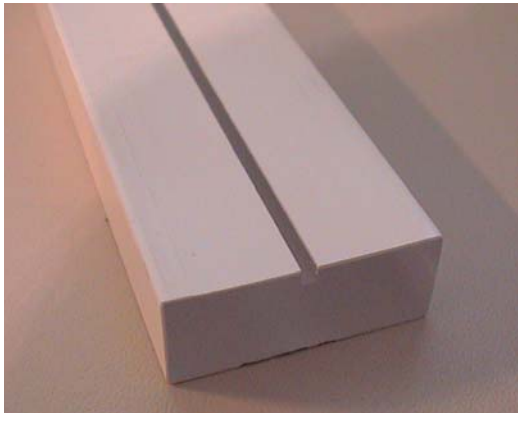
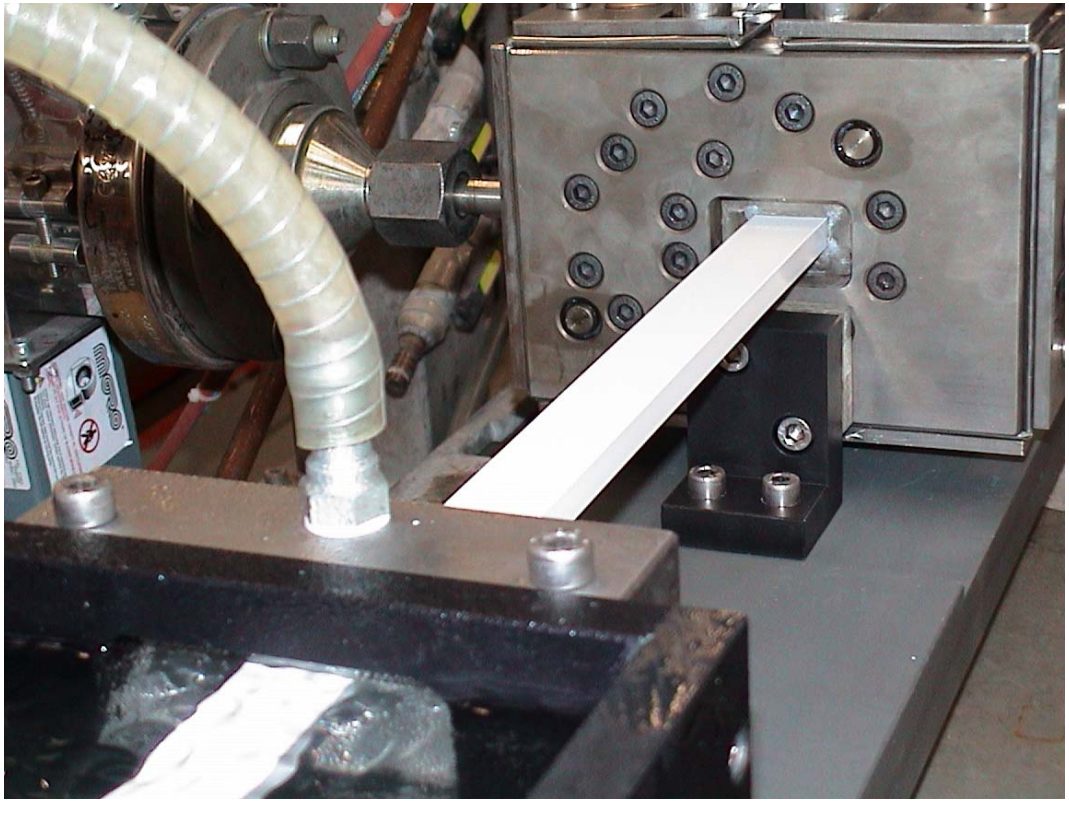
- Chemo Technique:
  - "Polystyrene" co-extruded strips delivered at Strasbourg.
  - Strip geometry: Very good.
  - Scintillator co-extruded strips before end of year.
  - Participation to the wall Construction if ready at time.
  - New strips > 6.5 p.e.





Scintillator news

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- Summary:

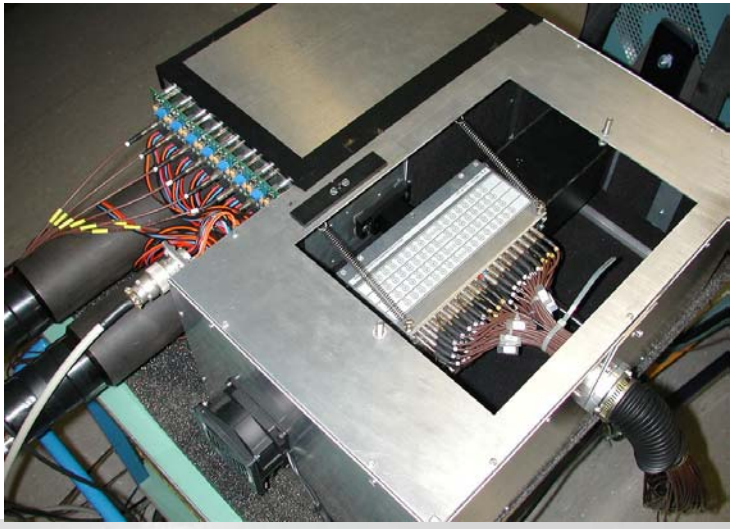
	Kharkov								Pol.Hi.Tech			C.T.
Strip number	32	38	39	42	44	51	53	56	P1	P2	P3	A20
<Npe> (middle of strip)	**7.2**	**7.6**	**7.15**	**8.9**	**8.2**	**8.55**	**8.15**	**8.2**	**2.5**	**1.2**	**< 1**	**6.6**
% TiO2	**24**	**18**	**18**	**24**	**18**	**24**	**24**	**24**	**2.5**	**2.5**	**2.5**	**15**

Photodetectors

M. Dracos

Testing device ready at Bern

- 8 LED-boxes, 8 fibers each = 64 fibers
  → minimum of 8 fibers lighted at the same time
- two LEDs per box
  → large dynamic range (200 per LED)
  → linearity measurement
- all 16 LEDs triggered individually
  → any combination possible
- two reference PMTs with Bi – sources
  → independence from long term stability



Photodetectors

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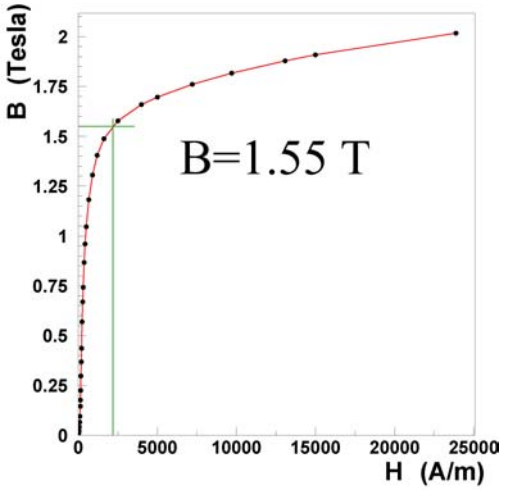
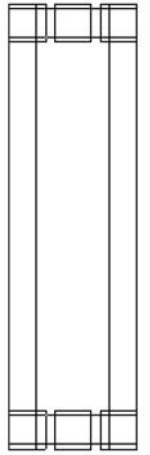
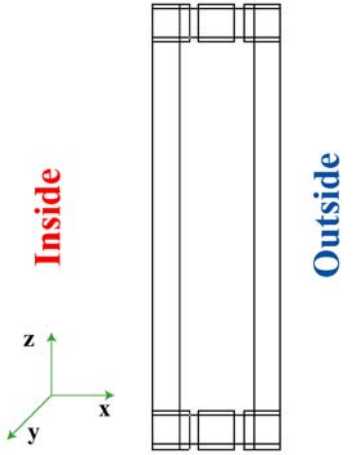
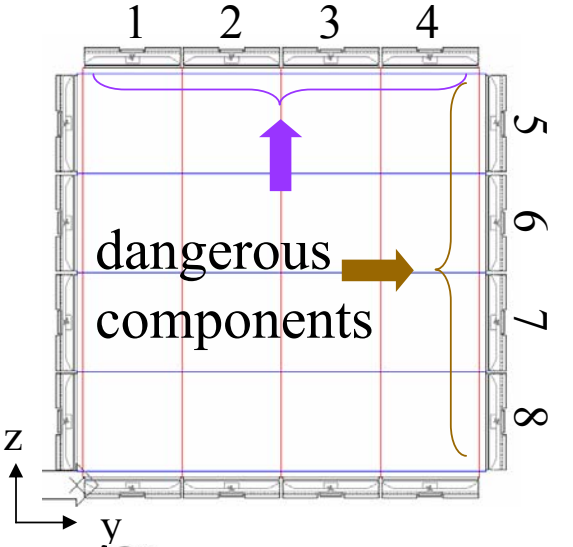
Problem: too strong fringe magnetic field around the PMT's!

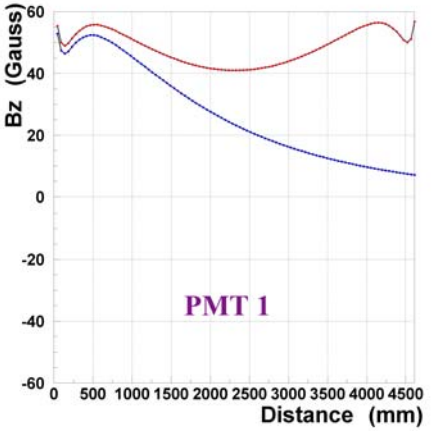


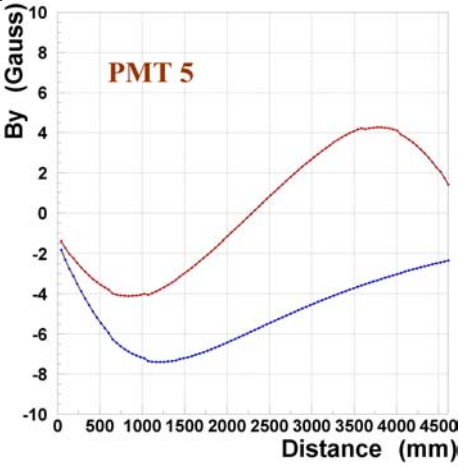






Most critical component:
⊥ photocathode
affordable up to 5 Gauss
Shielding probably
necessary: R&D under way.
More detailed simulation
is urgently needed.





Front End Electronics

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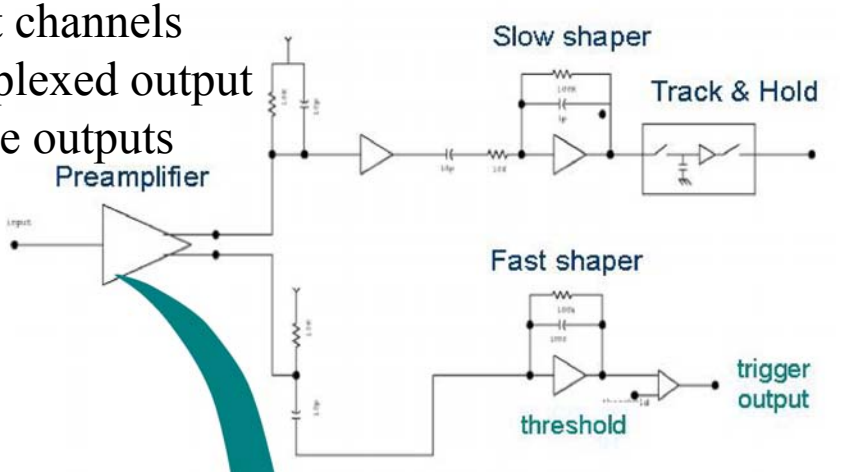
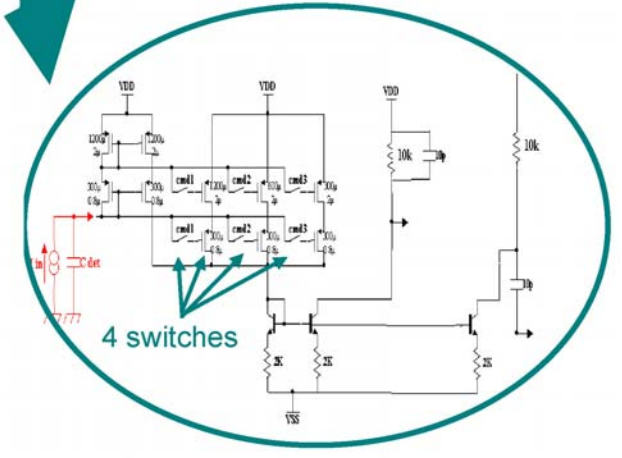
- **Chip Design** (Submitted FEB-02 / Received JUN-02)
  - Complete chip with 32 channels + 2 test channels
  - Ch01-32: 32 inputs / 1 trigger + 1 multiplexed output
  - Ch33 : powered separately / intermediate outputs
- **Preamplifier**
  - Variable Gain preamp: 1+[1,½,¼,1/8]
  - Current mirror architecture
- **Auto-trigger** (Comparator)
  - Fast Shaper: Peak time t_p=30 ns
  - Gain G ~ 800 mV / pC (1 p.e. = 160 fC @ 10^6)
- **Charge Measurement**
  - Slow Shaper: Peak time t_p= 120 ns
  - Gain G ~ 170 mV / pC
  - Track & Hold
  - Output multiplexer
  - Readout Frequency : 5MHz
- **Tested JUN to SEP-02 at LAL and at Bern**





Front End Electronics

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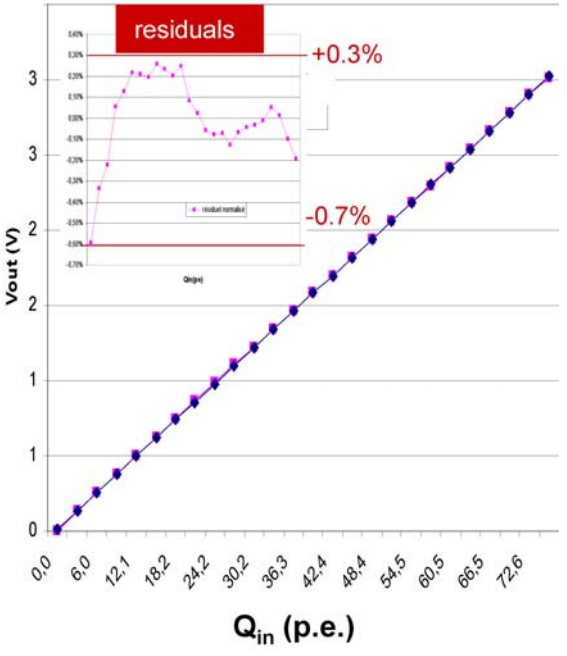
Measured characteristics — 32- channels chip

Auto Trigger

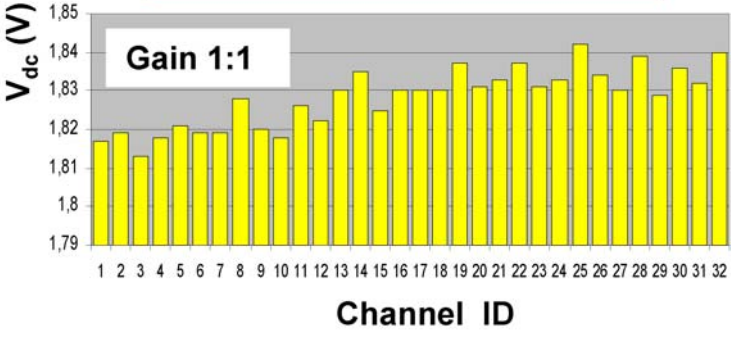
Pedestal spread	80 mV
Noise RMS	1 mV (<< 1.p.e.)
Comparator	fixed
Fast Shaper t_p	t_p=35 ns
Fast Shaper Gain	130 mV / p.e

Charge measurements

Dynamic range	[0-80] p.e.
Gain Correction	Operational (4 bits)
Pedestal spread	40 mV
Noise RMS	0.5 mV (<<1.pe.)
Slow Shaper t_p	t_p=100 ns
Slow Shaper Gain	27 mV / p.e.
Cross-talk	O(2%)



Offset slow shaper



Except for a comparator over-current problem, the chip performance fulfill the TT requirements.

To be improved: Pedestal spread, Threshold spread, Cross-talk.

Front End Electronics

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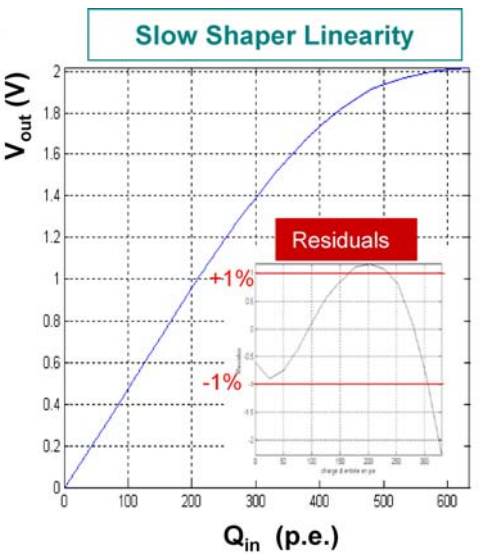
"Mecano" chip: New variable gain preamplifier, Low Impedance Z_{in}~70 Ω, Range 1-3 , 2 bits resolution (1,1/2), New Differential PMOS Fast shaper, New Differential Slow shaper.

Measured characteristics	"Mecano" chip (extra features)	32- channels chip
Auto Trigger		
Pedestal spread	< 4 mV	80 mV
Noise RMS	0.5-0.8 mV	1 mV (<< 1.p.e.)
Comparator		
Fast Shaper t_p	20 ns	t_p=35 ns
Fast Shaper Gain	250 mV/p.e	130 mV/p.e
Charge measurements		
Dynamic range	[0-300] p.e.	[0-80] p.e.
Gain Correction	Operational (2 bits)	Operational (4 bits)
Pedestal spread	< 1 mV	40 mV
Noise RMS	0.3 mV (<<1.pe.)	0.5 mV (<<1.pe.)
Slow Shaper t_p	t_p=190 ns	t_p=100 ns
Slow Shaper Gain	10 mV/p.e.	27 mV/p.e.
Cross-talk		O(2%)



Front End Electronics

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...on the way to the Final Design

1. **Version 1a ChipVersion 1a Chip** (Conservative Version):
   - no significant change wrt present 32-ch. chip design
   - Improvements in the Comparator Design:
     - Separate Voltage supply (analog / digital)
     - Re-size transistors etc...
   - Adjusted shapers parameters: Increase t_p
2. **Version 2 (improved) Chip** (Significant improvements):
   - Reduced pedestal spread
   - Reduced X-talk
   - Improved for low signals
   - **Main new features included**:
     - Version 1a comparator
     - Preamplifier with increased gain correction range (5 bits+1) allowing masking of "dead" channel (not only at trigger level)
     - Mecano Fast Shaper
     - Mecano Slow Shaper
     - Improved Track & Hold
     - Register to ID the triggerred channels
     - Injection lines (calibration)

Submitted 27-SEP
Expected FEB-03

Submitted JAN-03
(NOV-02 ?)
Expected MAY-03
(MAR-02 ?)

Light injection system

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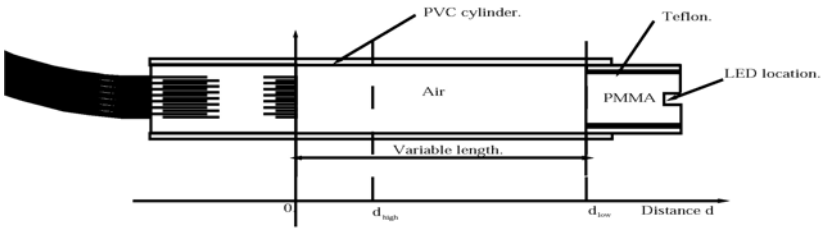
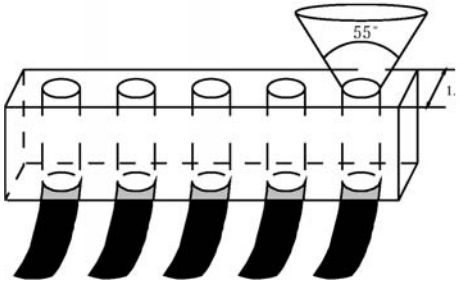
Light intensity variation

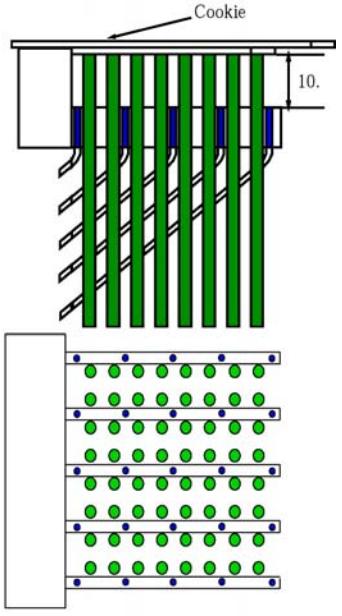


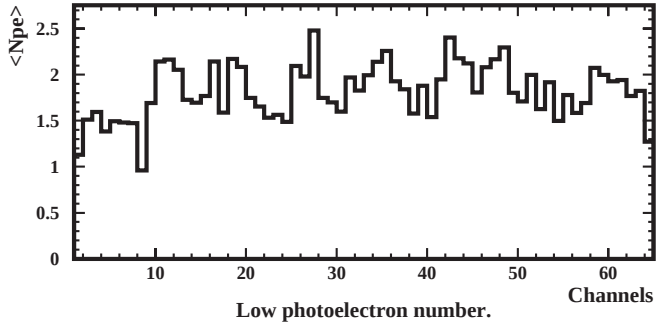
$N_{pe}(min)/N_{pe}(max)\sim 2.7$

High dynamical range

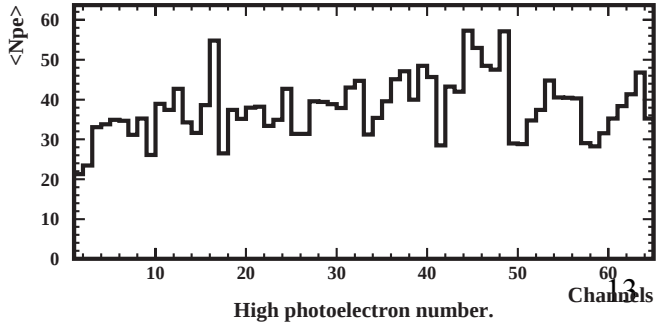
Light injector







Low photoelectron number.



High photoelectron number.

Light injection system

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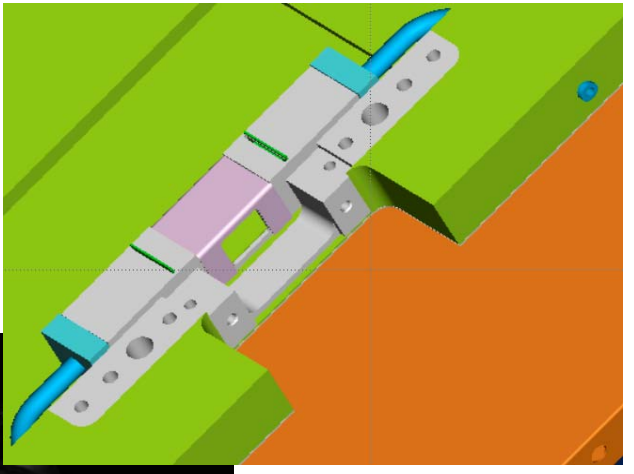
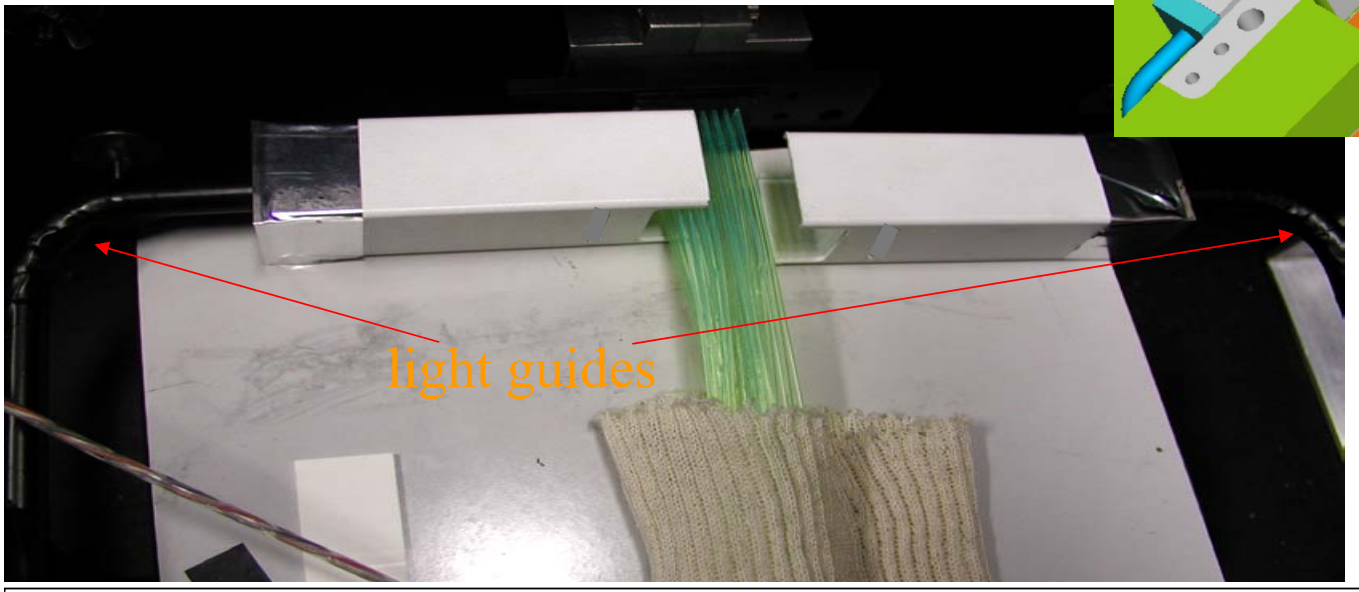
The “2 blue LED half-boxes” with light guides



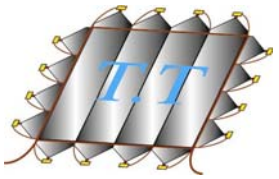


large dynamic range
(> 200 p.e.)

Results (light guides of 8 mm Ø):

< NPE> = 16.5 , rms = 4.0 , dispersion = **1.9** at V_{LED} = 3.5 V

Module production



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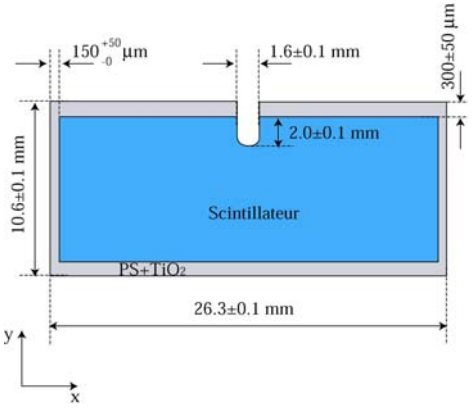
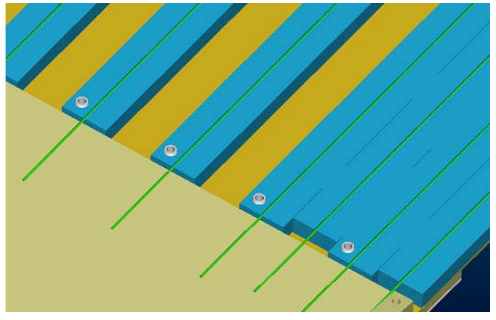
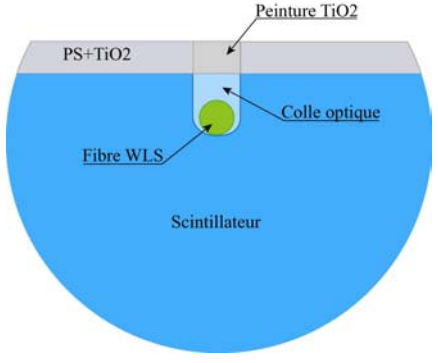
- Strip machining:
  - Right length (6867.4 mm)
  - Rivet holes (7,8 mm)
- Fibre gluing (1 mm)
  - Glue: 815C (MINOS)
  - TiO_2 paint on the groove
- Aluminium sheets preparation:
  - Already clean
  - Rivet holes already done
  - Double face adhesive application (0.9 mm thick)







Glue comparison

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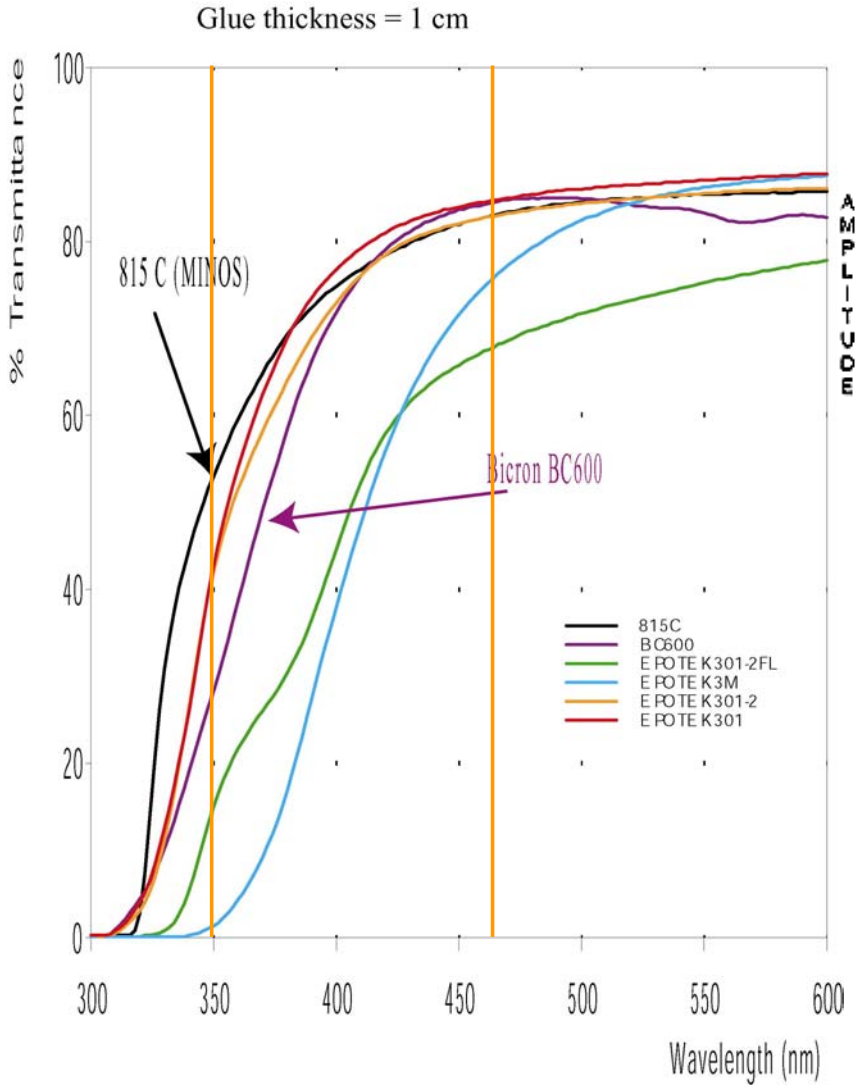
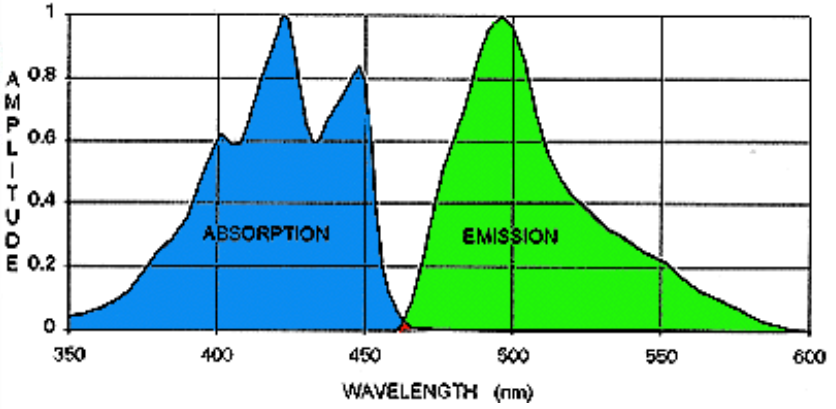
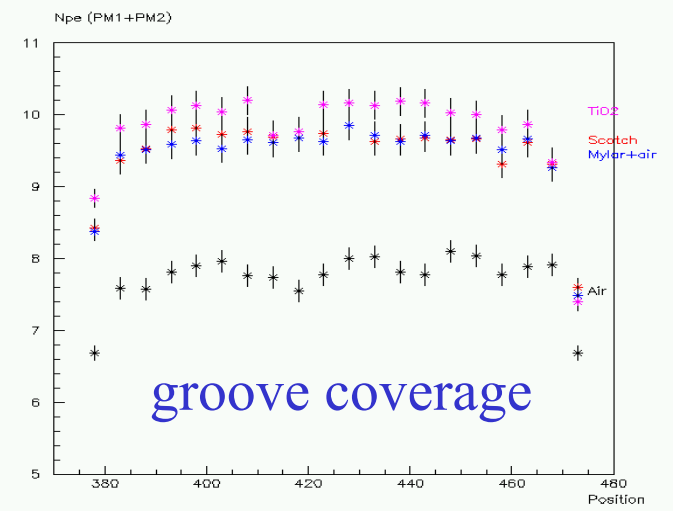


Fibre absorption/emission spectra





groove coverage

Module production

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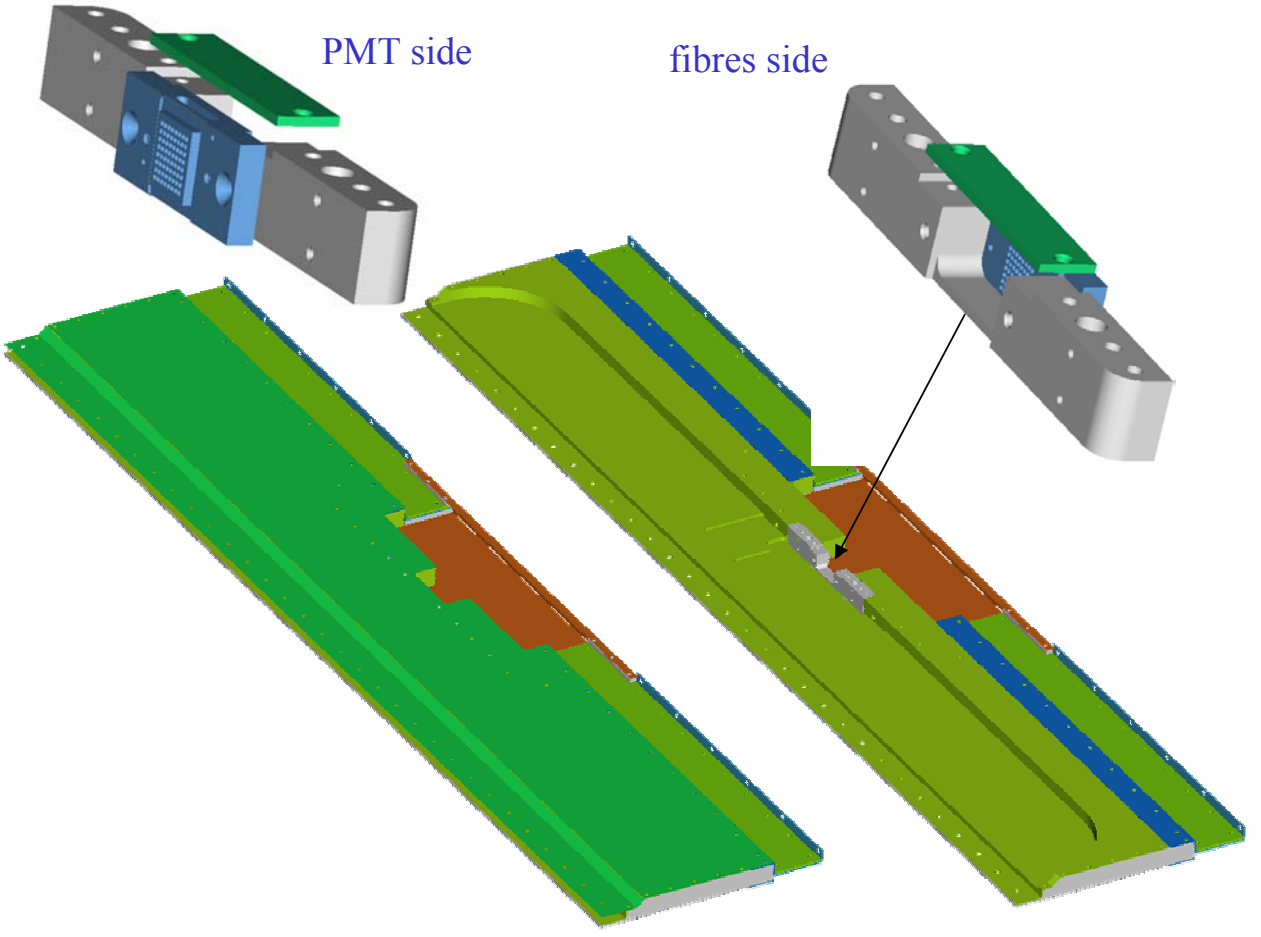
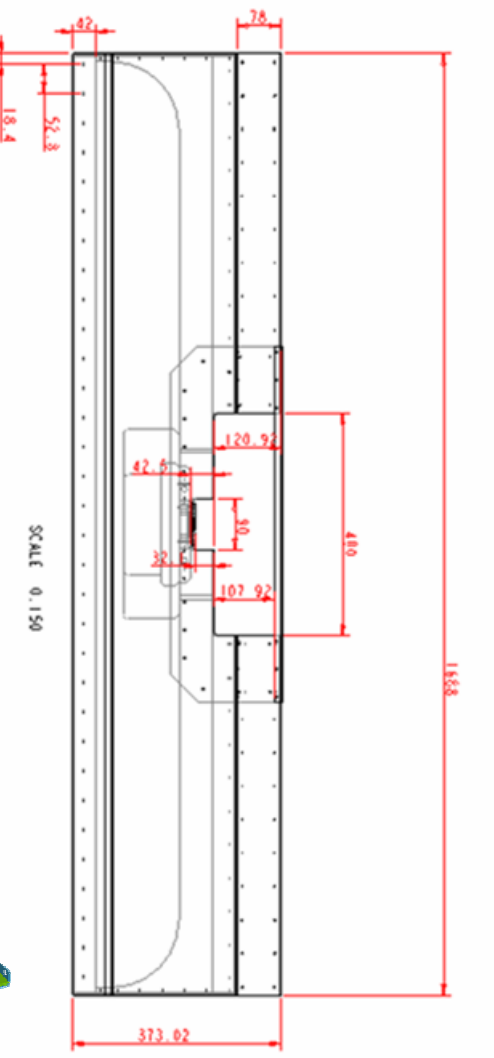
- End Caps alignment on horizontal table:





Module production

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- Strip positioning, alignment and gluing:
  - Reproducible overall module dimensions.
  - No surprise during the last strip positioning.
  - If broken fibre during strip installation or passing through cookie hole, easy strip replacement.

Remove the strings one after the others

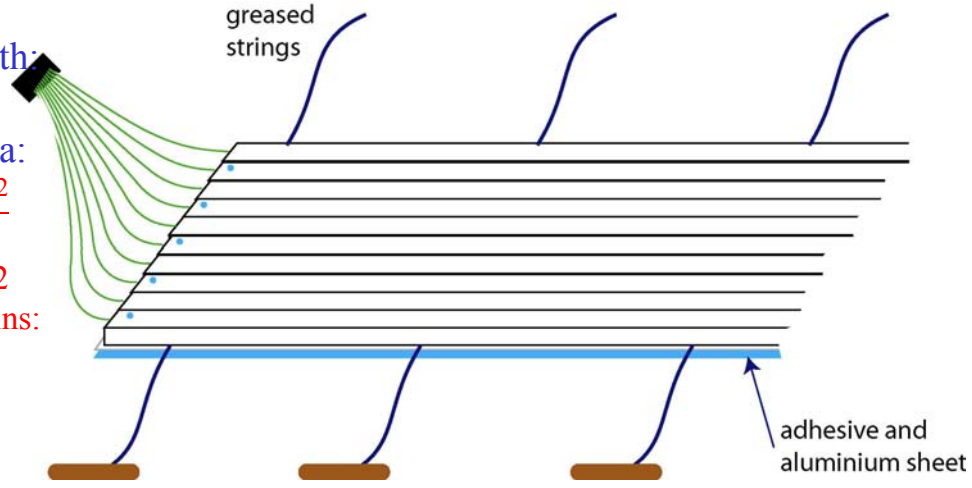
module width: 1689.5 mm
[64(26.3±0.1)-0.1±1 mm]
strip length: 256*(26.3+0.1)
+5*1+2*10+2*42=6867.4 mm

fixing system

margins

inside the end caps

module length: 7156.4 mm
sensitive area: 6763.4² mm²
(brick area: 6675.2x6739.2 mm² ➔ margins: 12.6 mm (v) 44.6 mm (h))



Module production

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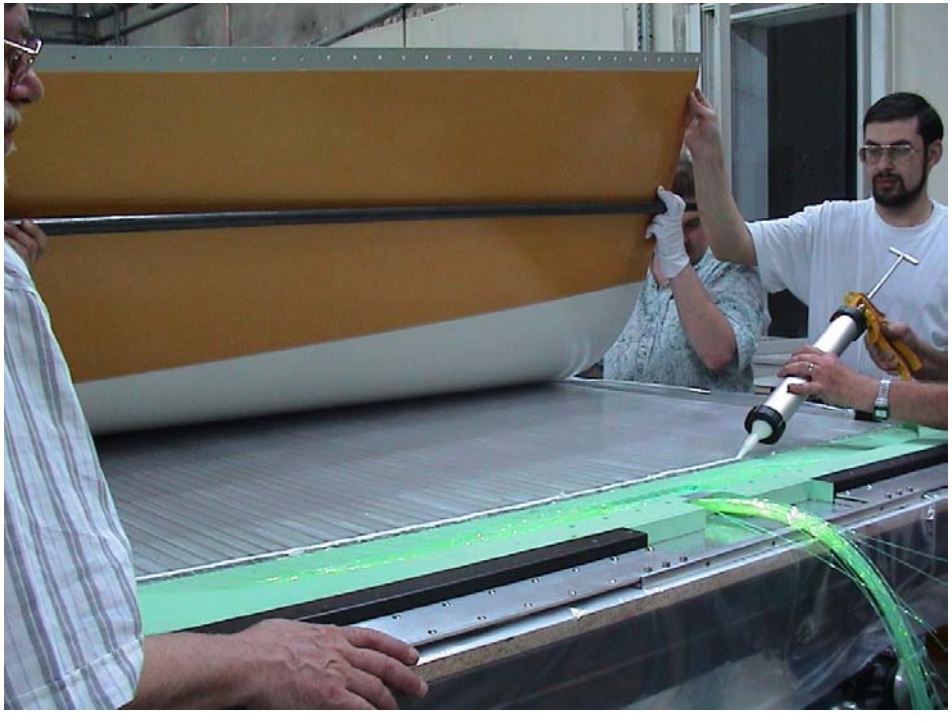
- Gluing of the fibres in the cookie:
  - 48 hours before polishing

- Closing of the module:



Pressure of 7.5 kPa (vacuum)

Module production

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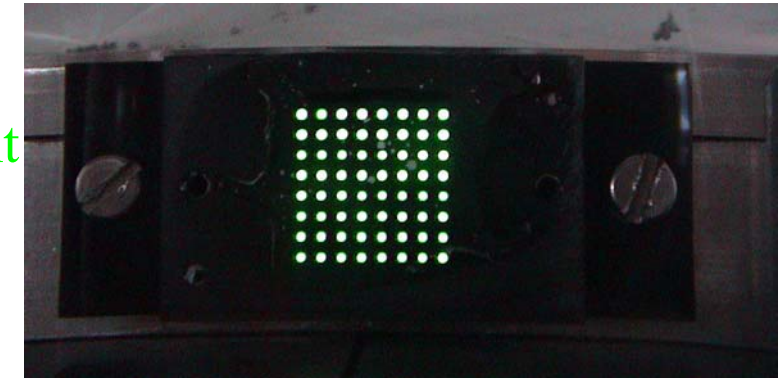
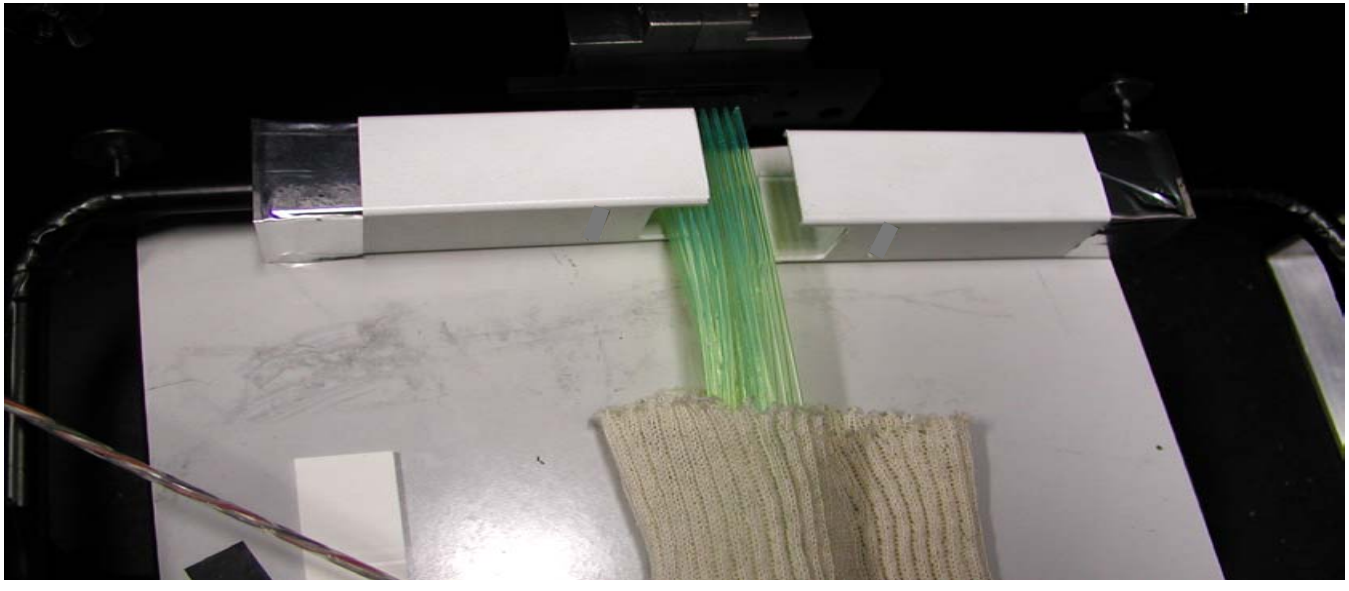
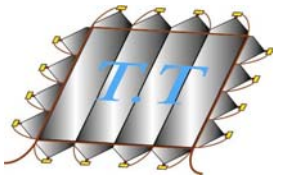
- Cookie polishing:
  - special tool under development



- Mounting of the light injection system:



Module production



M. Dracos

- Electronics and acquisition installation.
- Tests:
  - Light injector system test by pulsing it.
  - Light tightness.
  - Light yield using the electron spectrometer (one point per strip).
    - $<N_{pe}>$ over 128 measurements > 4.5 p.e.
    - never less than 3 p.e. on one strip.
  - Mechanical tests in horizontal and vertical position.
  - Tests of materials (strips, fibres…) by OPERA.

WAll production (Nov.)

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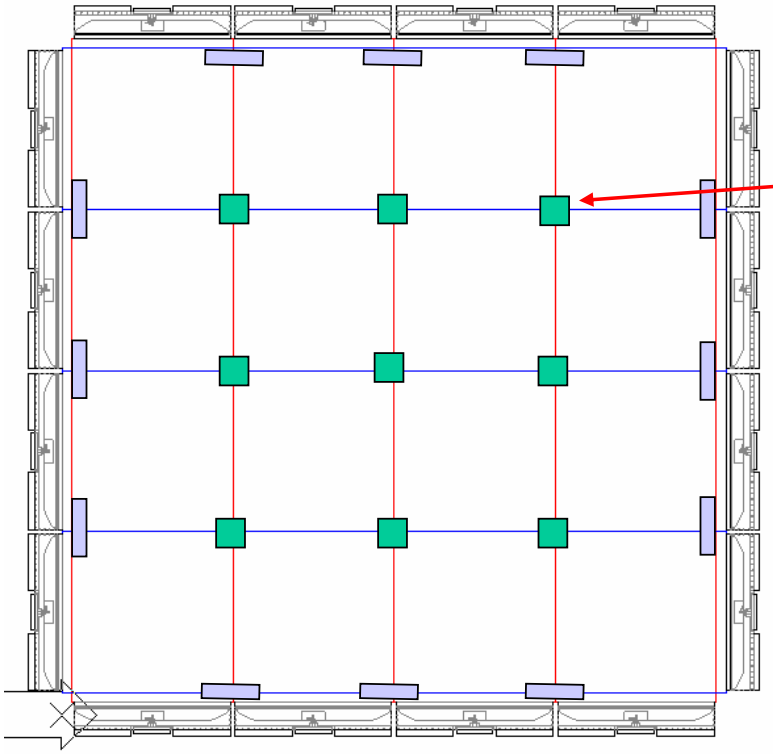
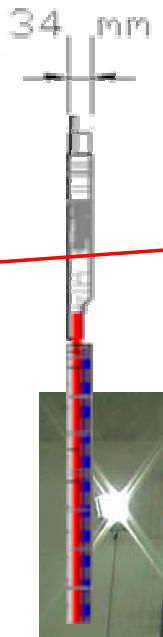
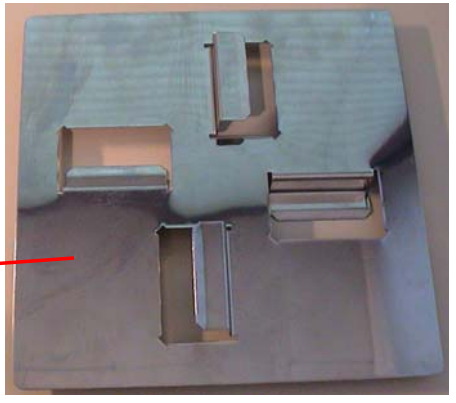


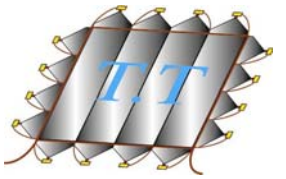




fixation between modules and between plans

- Test of the whole production and installation chain.

Wall production (Nov.)



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- Fibre : Kuraray (1 mm) √
- Coextruded strips : Kharkov (C.T.?) √ +
- End Caps : Aeriane √
- Aluminium sheets : 0.6 mm √
- Double-face adhesive : Macmount 2755 √
- Glue for fibres : EPON SHELL 815 C √
- Mechanical support : IReS √
- Cookies : Bern √
- Light inj. system : Brussels √ +
- PMT electronics : Bern √

Schedule

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Prepared in order to start installation the 17th of December 2003 (according to the "Plan for the construction of the OPERA detector document").

	Tendering		Ordering		Delivery	
	Start	End	Start	End	Start	End
	29/08/02	06/01/03	17/12/02	07/02/03	01/08/03	01/07/05
module constr.	29/08/02	05/11/02	17/12/02	15/01/03	01/11/03	01/07/05
strips	01/11/02	03/01/03	03/01/03	07/02/03	01/08/03	28/01/05
end-caps	01/11/02	03/01/03	03/01/03	07/02/03	01/09/03	28/01/05
Fibres	01/11/02	03/01/03	03/01/03	07/02/03	01/08/03	28/01/05
PMT's	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	01/08/03	04/08/04

Market Survey and Tendering

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- Market Survey through CERN:
  - End-caps
  - H.T. modules
  - Fibres
  - ~~PMT's (agreement of INFN is needed)~~

Ended the 27th of September

- Tendering:
  - Assembly of the modules: IN2P3 (end 5th of Nov.)
  - Scintillator strips : IN2P3 (starting soon)
  - End-caps : CERN (Brussels)
  - H.T. modules : CERN (Neuchâtel)
  - Fibres : CERN (Bern)
  - PMT's : CERN ? (INFN)

for VAT and custom taxes reasons

Construction and installation procedure

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- Module construction at the factory:
  - light yield tests using electron spectro. (one point/strip)
  - test of light injection system
  - mechanical tests
- Transportation to LNGS (probably through CERN)
- Final PMT's and electronics installation
- Calibration using electron spectro. (x-y table)
- Module installation
- Test using light injection system
- Cabling (for cables on the detector)

TT Prices

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Components	Units	Price/unit €	Quantity	Spares	Total k€	Total kCHF	%	Remarks	Institute
PMT	unit	1308.02	992	48	1360.34	**1998.1**	32.6%		INFN ■
Module production	module	1167	496	8	588.17	**863.9**	14.1%	For module production and tools	IN2P3 ?
Scintillator	Kg	7.73	63000	7000	541.10	**794.8**	13.0%	Raw materials and production	IN2P3 ?
End-caps	unit	500	992	28	510.00	**749.1**	12.2%		ULB ?
Fibers	m	1.45	294000	17000	450.95	**662.4**	10.8%	9.26 m/strip	Bern ■
H.T.	unit	100	992	48	104.00	**152.8**	2.5%	Integrated units	Neuchâtel ■
Coextrusion heads	unit	92000	1		92.00	**135.1**	2.2%	(44.0, 10.0, 38.0)	ULB, Bern, IN2P3
Prototype wall		76100	1		76.10	**111.8**	1.8%	(49.0, 24.1, 3.0)	IN2P3, ULB, Bern
Aluminium sheets	unit	62.8	992	48	65.31	**95.9**	1.6%	22.8 m^2/module (0.6 mm thick.)	IN2P3 ■
Transportation	travel	1400	40		56.00	**82.3**	1.3%	From prod. fact. to GS	IN2P3 ↗
Double face adhesif	m^2	3.61	11500	3500	54.15	**79.5**	1.3%	5 Kg/module	IN2P3 ■
Front-end electronics	channel	0.76	63488	6400	53.11	**78.0**	1.3%	↑ (cables…)	IN2P3
PCB	unit	41.4	992	48	43.06	**63.2**	1.0%		Bern
x-y tables	table	17000	2		34.00	**49.9**	0.8%	Gran Sasso+production factory	IN2P3
Transportation boxes	box	700	36		25.20	**37.0**	0.6%	4 modules/box	Bern ↗
Spectrometer tests		25000	1		25.00	**36.7**	0.6%	at production factory	Bern
Al sheets machining	unit	20	992	48	20.80	**30.6**	0.5%	32 holes at each side	IN2P3 ■
Spectrometers	unit	5000	3		15.00	**22.0**	0.4%	Gran Sasso+production factory	IN2P3
Tools		14000	1		14.00	**20.6**	0.3%	mainly for installation at Gran Sasso	IN2P3
Glue for fibers	Kg	26	480	40	13.52	**19.9**	0.3%	15 gr/strip	Neuchâtel
Fixation system	unit	16.25	744	56	13.00	**19.1**	0.3%	Fixation of horizontal to vertical modules	Bern ■
LED's	unit	8	992	108	8.80	**12.9**	0.2%	For light injection system	Bern
Light injection system	unit	5.23	992	48	5.44	**8.0**	0.1%	Light guide+pulser	Bern ↗
Cookies	unit	1.46	992	48	1.52	**2.2**	0.0%	Optical coupling with PMT's	Bern
(1 € =	1.4688	CHF)			4170.57	6125.7	100.0%		
IN2P3 (MoU=1550)=	1528.64								
Switz. (MoU=750)=	703.48			paid					
ULB (MoU=610)=	578.10								
INFN (MoU=1500)=	1360.34								

■ quotation
? tendering
↗ expected to increase

MoU(ULB+Switz.+IN2P3) = 2910 k€
Table(ULB+Switz.+IN2P3) = 2810.22 k€ contingency?

Questions from "Hilke" committee

M. Dracos

- Manpower for installation:
  - 2 physicists (postdocs) for calibration,
  - 4 technicians:
    - 2 shared with brick wall construction,
    - 1 provided by TT institutes,
    - 1 provided by LNGS (knowing well the local infrastructure, safety rules etc…)

- Space in hall B: For module calibration (10x5 m2 + crane).

- Quality control during production: see transparencies above.