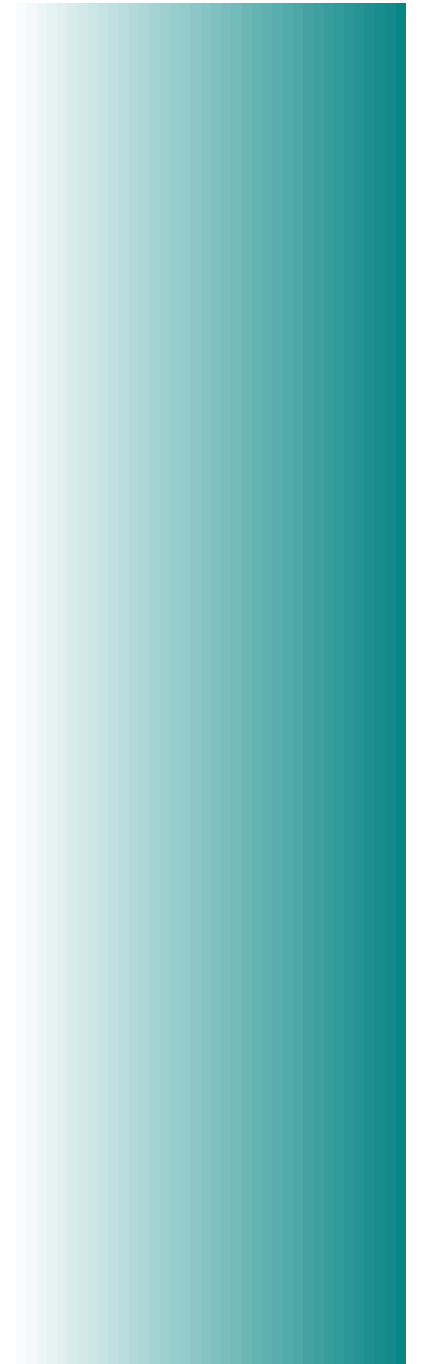




A LXe PET camera for neuro–science

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Collaboration



- ISN Grenoble (IN2P3 – UJF)
 - J. Collot , P. de Saintignon , S. Jan , E. Tournefier
- IRM – Michalon Hospital – Grenoble (INSERM – UJF)
 - J.F. Le Bas
- Nuclear medecine dept – Michalon Hospital – Grenoble (INSERM – UJF)
 - D. Fagret
- DTA – Air Liquide – associated
 - L. Amiot , P. Bravais , A. Cottereau

LXe is a known detection medium



- calorimeter projects for SSC and LHC
 - M. Chen et al., NIM A327(1993)187
 - J. Séguinot et al., NIM A354(1995)280
- 68 1 LXe TPC in Italy
 - G. Bressi et al., NIM A396(1997)76
- LXe TEP project in Portugal (charge & light)
 - V. Chepel , M. I. Lopes et al Calor99 , Lisbon

Goals



- commercial PET's: NaI , BGO (LSO in progress)
 - image resolution : $\approx 4-5$ mm (2mm)
 - sensitivity (phantom H_2O , $L=D=20$ cm) : 0.5–1%
 - counting rate : ≈ 1 MHz , coinc. time window : 10–15 ns
- Our goals:
 - image resolution : ≈ 2 mm
 - counting rate : ≈ 5 MHz , coinc. time window : 5 ns
 - but maybe not evything at the same time

Applications



FDG marked with ^{18}F

- Possible instruments :
 - high resolution TEP for human brain : **image reso. , speed ?**
 - Whole body TEP for cancer diagnostic : **speed**
 - μ PET's : **image resolution , speed ?**
 - ^{11}C PET for hadron therapy : **speed**

Scintillation properties



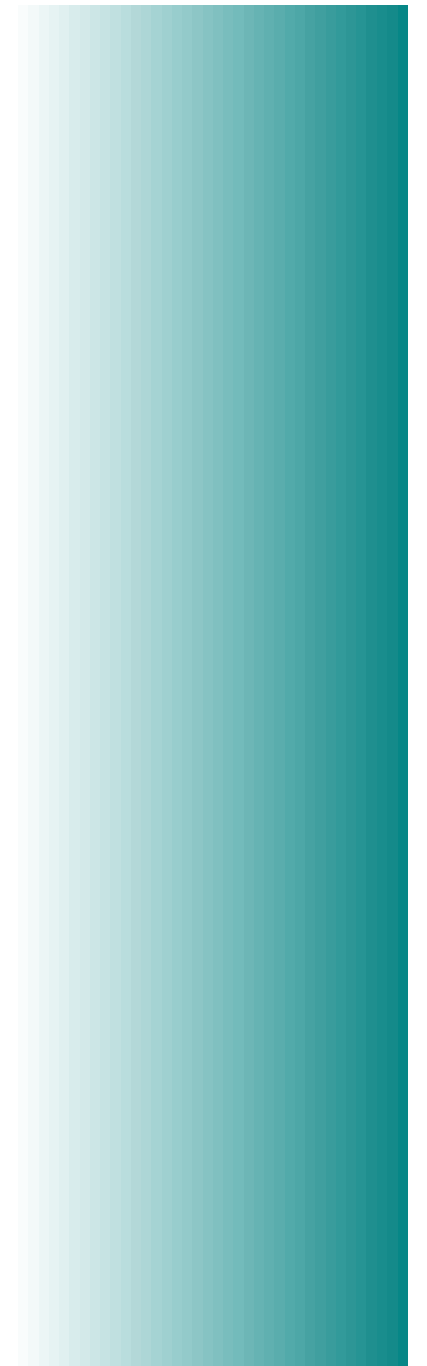
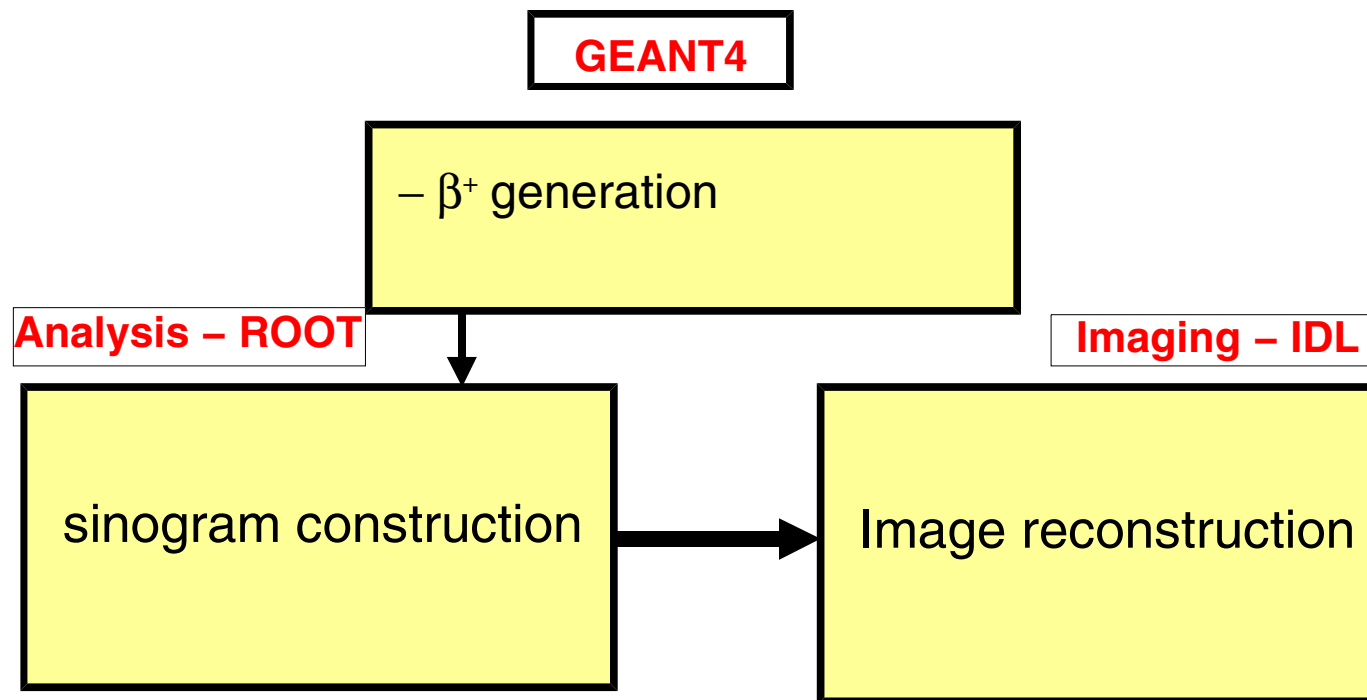
<i>Properties</i>	<i>LXe</i>	<i>NaI</i>	<i>BGO</i>	<i>LSO</i>
density (g cm ⁻³)	3,1	3,7	7,1	7,4
Z (effective)	54	51	74	
τ (ns)	3	230	300	40
photons /MeV	2,5–7,8 10 ⁴	4,3 10 ⁴	2,8 10 ⁴	3,2 10 ⁴
lambda (nm)	178	410	480	420
photo-fraction (%)	24	18	42	33

Cryogenic properties



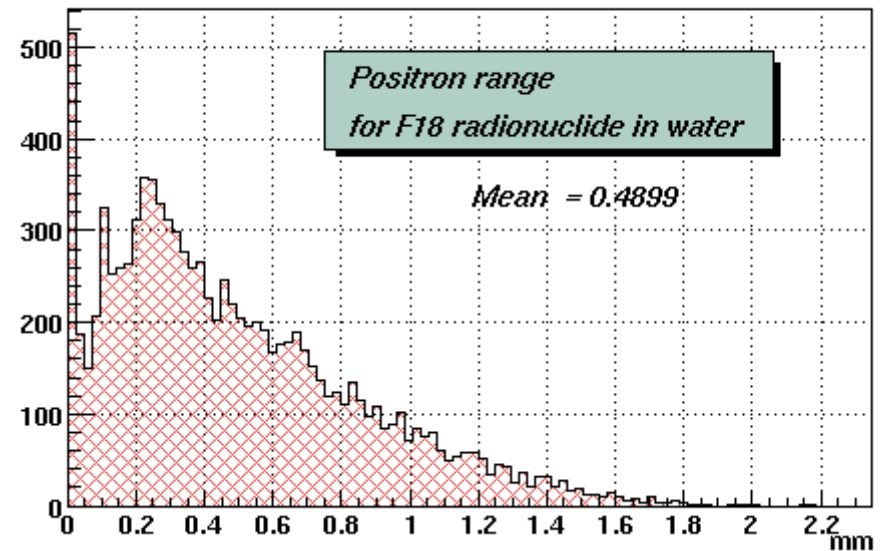
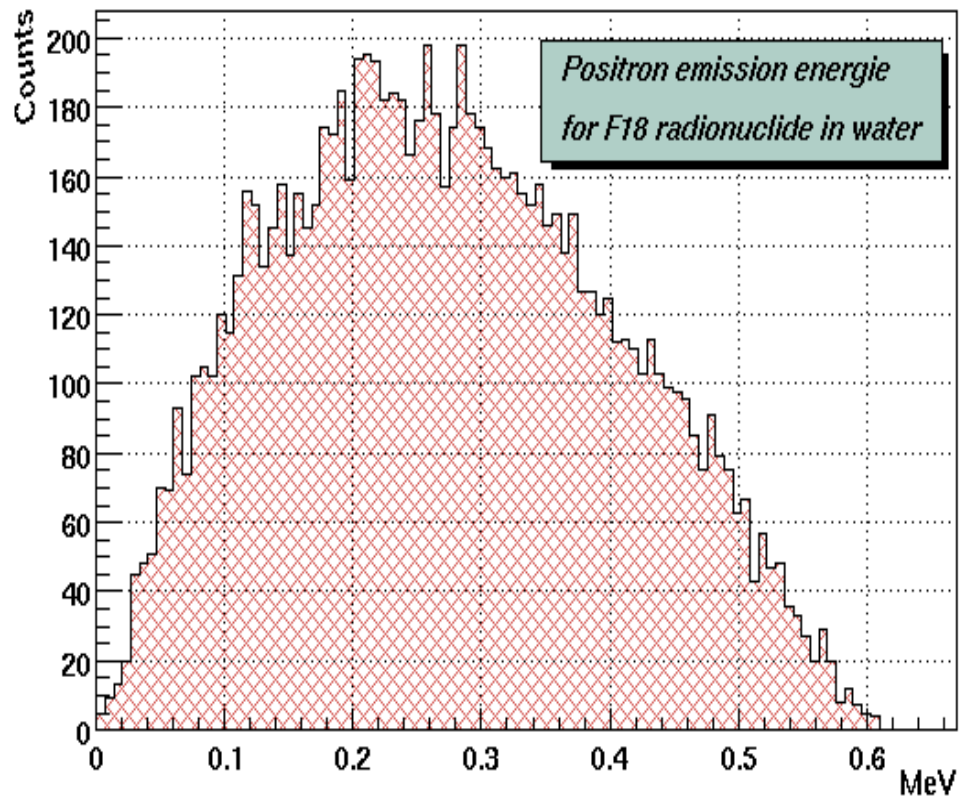
<i>Properties</i>	<i>LAr</i>	<i>LKr</i>	<i>LXe</i>
Z	18	36	54
A	39,9	83,8	131,29
Density (g cm ⁻³)	1,39	2,45	3,06
boiling T (K)	87,3	119,8	165
latent heat (kcal/l)	53,4	62	70,4
X ₀ (cm)	14,3	4,76	2,77
V(l) of gaz STP / 1 liter of liquid	779	655	522

Simulation chain



^{18}F spectrum

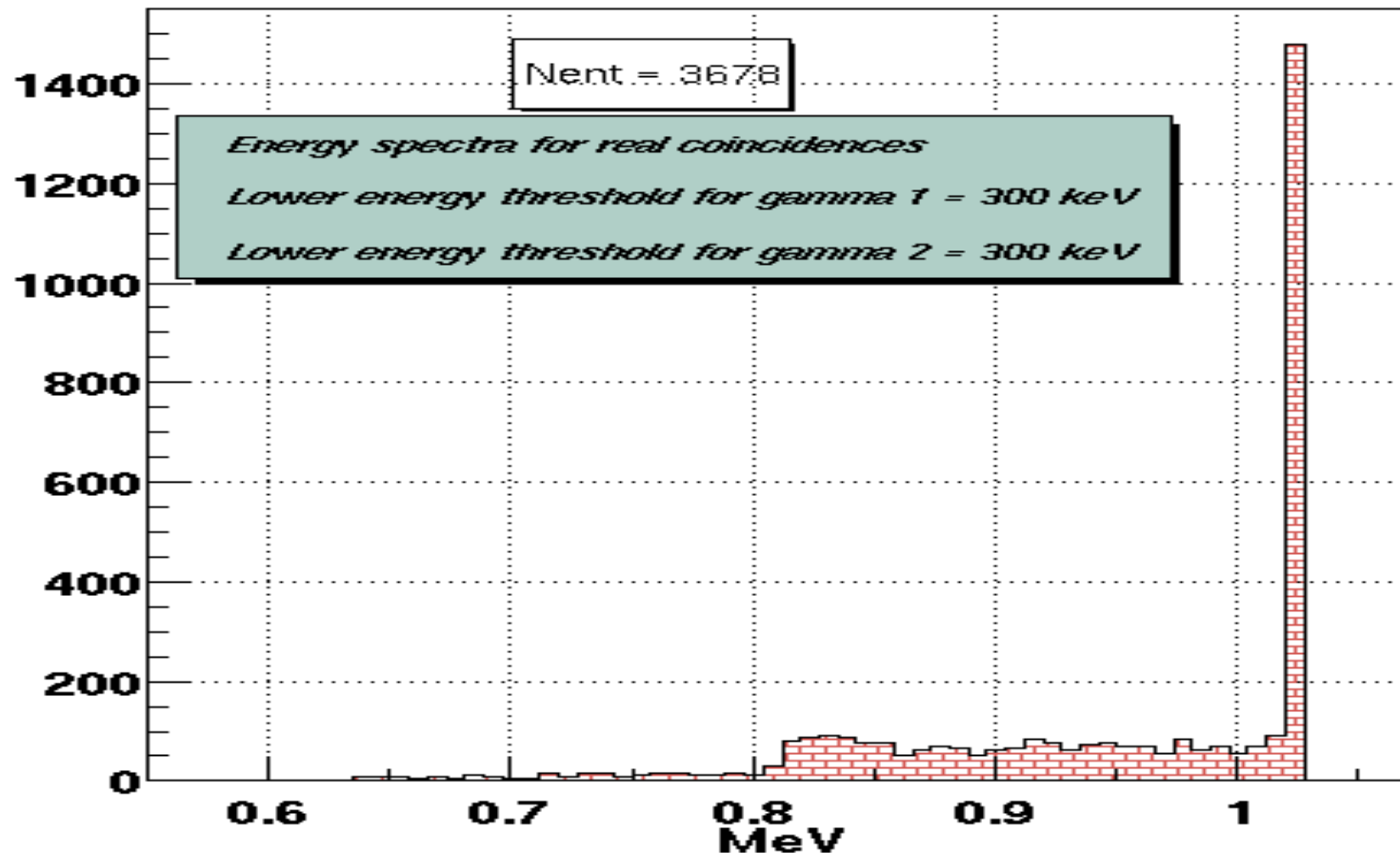
H2O Phantom $\Phi = 20\text{ cm}$, $L = 20\text{ cm}$



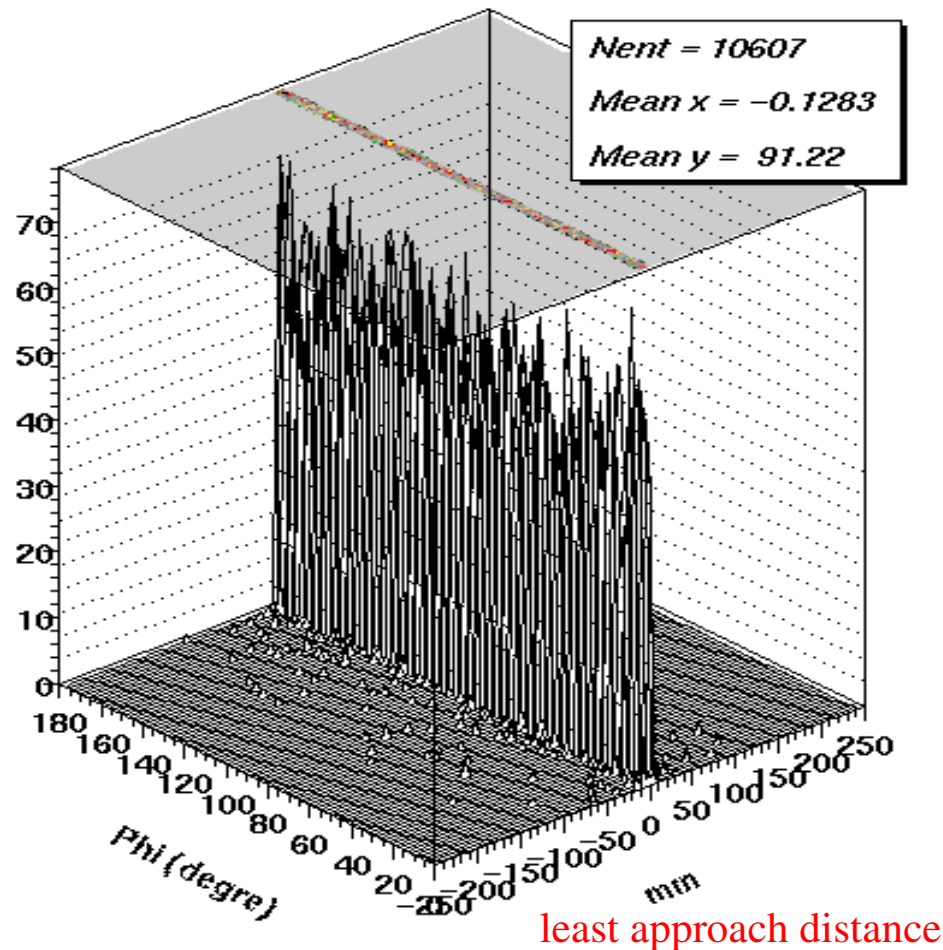
e^+ distance of flight

Deposited energy spectrum

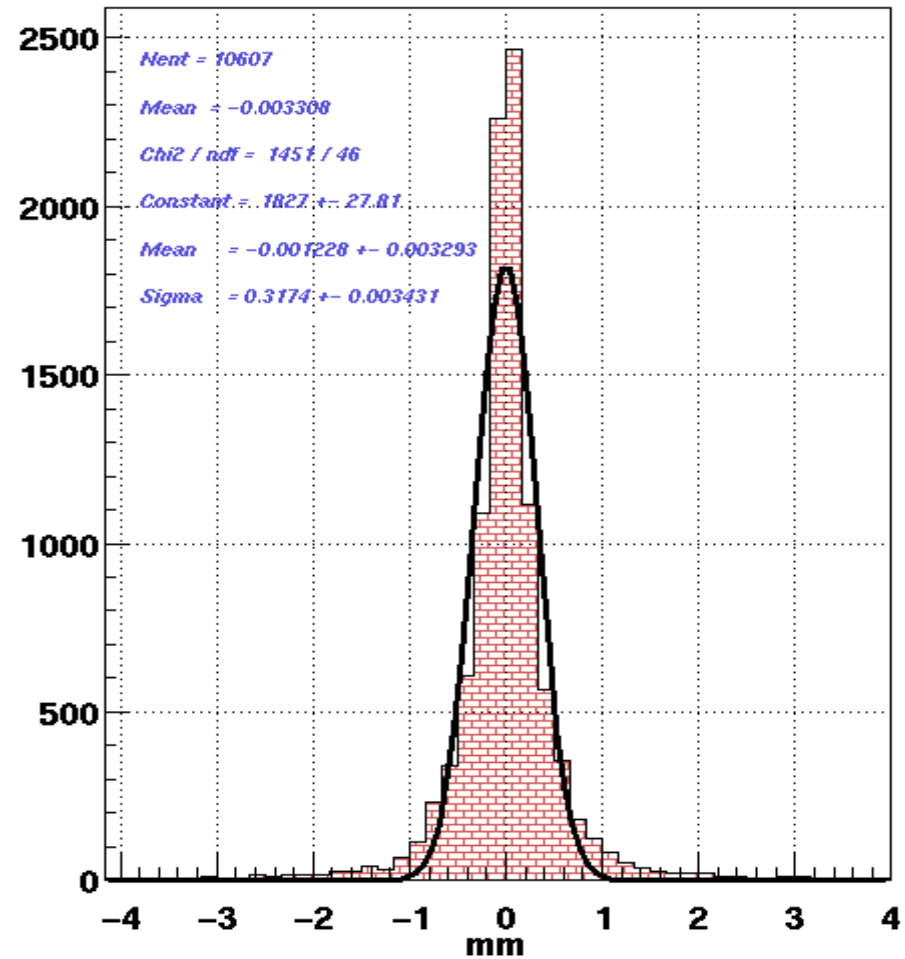
In a ring of $L = 20$ cm ,
 $\Phi = 50$ cm , $e = 5$ cm
 $V = 17$ l of LXe
no instrumental response
Study of physics limit



transaxial image resolution



$x = y = 0$
No segmentation
Study of physics limit

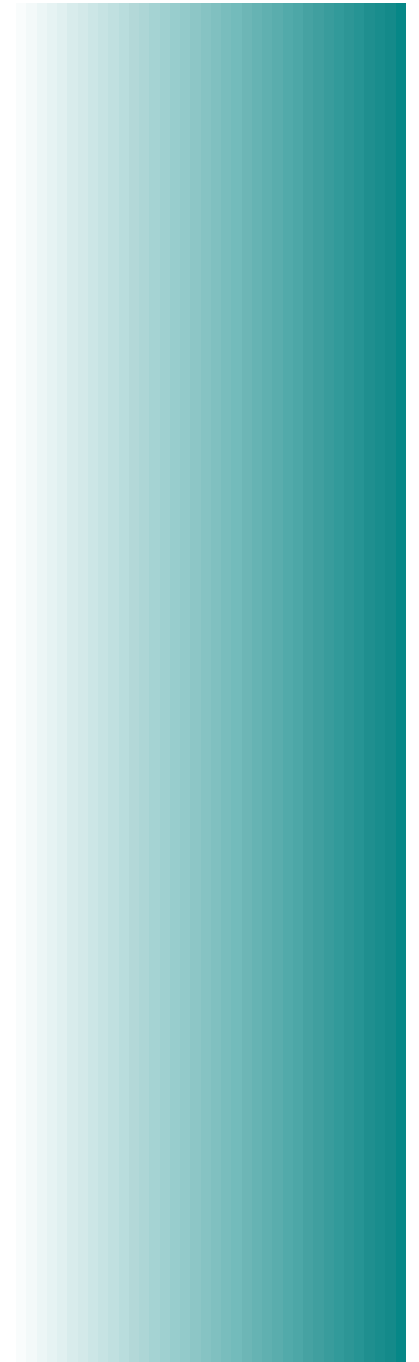


UV detection at 165 K



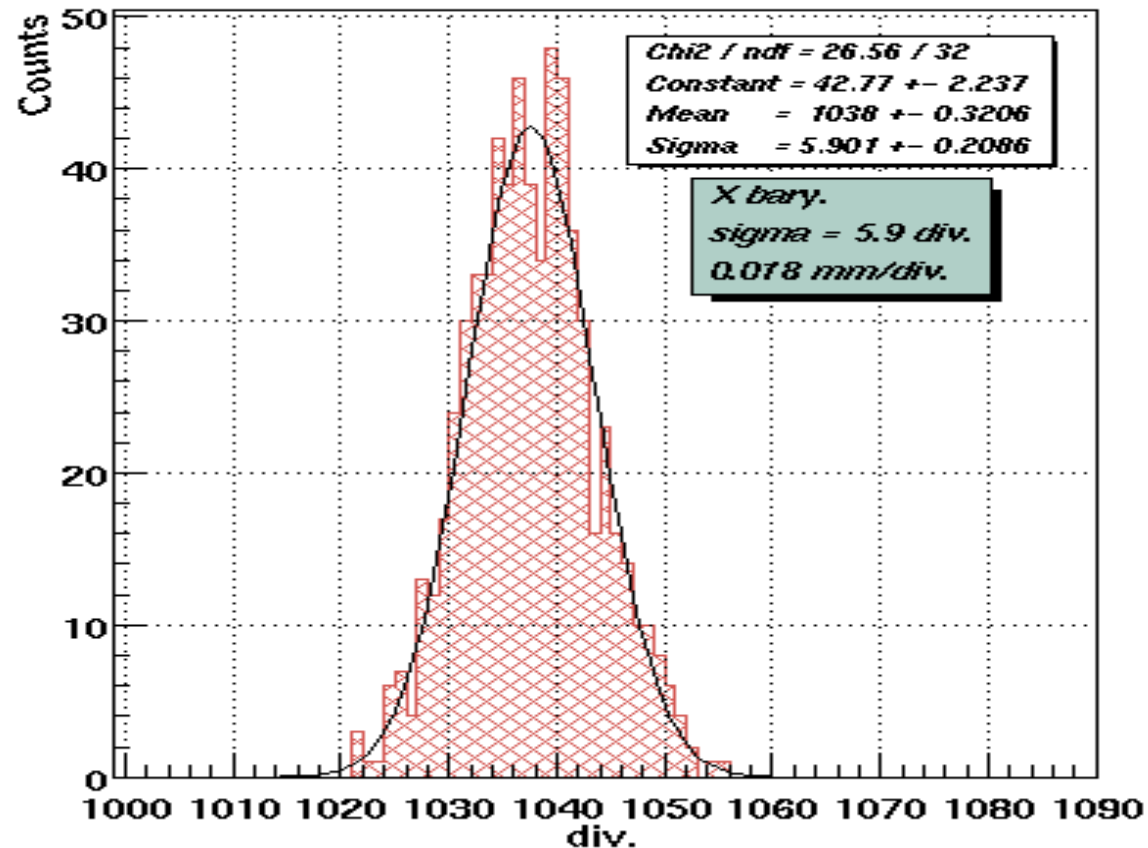
Challenging part of this project

- Photo tubes :
 - Hamamatsu R5900U-06-C12 – quartz window – RbCs photocathode – 8 + 8 cross-wire anode – 22mm x 22mm
- Photo diodes
 - Si photodiode + quartz window – APD ?
- Optical segmentation
 - Al tubes



Space resolution of photo tube

measured at $\lambda = 180 \text{ nm}$
at room temperature



$$\sigma = 0.1 \text{ mm}$$

Time Scale



- Test of PT's and Si diodes at 165 K : now
- cryostat ready
- pulsed UV injection chain ready
- LXe station : delivery Nov. 2000
- 3 l of LXe ordered (66 kFF)
- Small Cell (3 x 3 x 5 cm³) test : Feb 2001