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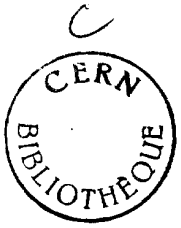
# R&D PROPOSAL FOR A FAST AND RADIATION HARD CRYSTAL CALORIMETER AT LHC



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## The Crystal Clear collaboration

## Addendum n° 2

***Abstract***

This addendum is an updated version of the following items :

- List of the collaborating institutes
- List of the collaborating members
- List of the firms or institutes involved in this R&D
- Milestones
- List of the different responsibilities and contributions

238123

# THE " CRYSTAL CLEAR " COLLABORATION

**California Institute of Technology , Pasadena , California , USA**
H. Newman , Z. Wei , R.Y. Zhu

**CERN , Geneva , Switzerland**
A. Hervé , P. Lecoq ( spokesman ) J. M. Le Goff

**INFN , Roma**
B. Borgia , F. Ferroni , E. Longo , M. Mattioli , F. De Notaristefani

**Laboratoire de Physico-chimie des Matériaux Luminescents**
**Université Claude Bernard , Lyon , France**
B. Moine , C. Pedrini

**LAPP , Annecy , France**
M. Lebeau , M. Schneegans , M. Vivargent

**Leningrad Nuclear Physics Institute , Leningrad , USSR**
V. Samsonov , V. Schegelski , V. Yanovski

**Physics Institute , RTWH Aachen , Germany**
K. Lubelsmeyer , D. Schmitz , W. Wallraff

**Also considering :**

Tata Institute of Fundamental Research , Bombay : P.K. Malhotra
CERN / LAA : G. Charpak , D. Scigocki , V. Peskov
Institut de physique nucléaire de Lyon IN2P3-CNRS : B. Ille
Lund University : L. Jönsson

# LIST OF COLLABORATING FIRMS AND INSTITUTES

• **For crystal R&D and production :**

**CEA Cadarache , France**
B. Bartoli , A. Maurel

**Crismatec , Grenoble , France**
J.Y. Gesland , H. Legal , J.C. Maréchal

**Consorzio Milano Ricerche , Milano , Italy**
F. Allegretti

**Dipartimento of Chimica Fisica , University of Milano , Italy**
S. Pizzini

**Optovac Inc. , North Brookfield , Massachusets , USA**
W. Sparrow

**Shanghai Institute of Ceramics , Shanghai , China**
J.K. Guo , G.Q. Hu , P.J. Li , D.Z. Sheng , Z.L. Xue , Z.W. Yin

**State Optics Institute , Leningrad , USSR**

• **For heavy glasses R&D and production :**

**Le Verre Fluoré , Rennes , France**
G. Mazé

**Université de Rennes , France**
M. Poulain

• **For cristallographic studies :**

**Leti (CENG) , Grenoble , France**

**Institut National Polytechnique , Grenoble , France**
G. Joubert

• **For mechanical characterization and processing :**

**Britte-France , Fillinges , France**

**Diamant-Boart , Ville d'Avray , France**

**Laboratoire National d'Essais , Trappes , France**

**Lampian S.A. , Gaillard , France**

**LGB , Villeurbanne , France**

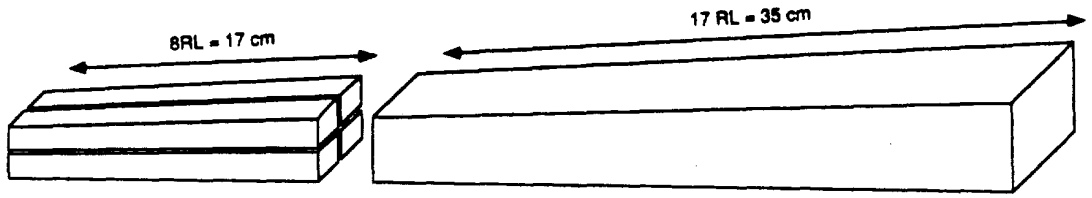
# MILESTONES

**• end of 91 :** Complete a 49 large BaF2 crystals array for the test beam

**• Mid 92 :** First conclusions on the different scintillators tested .

Select 1 or 2 for mass scale production and cost studies

**• End of 92 :** Complete a 5x5 supercrystals array (125 crystals) , BaF2 or CeF3 , to test the angular resolution with the segmented geometry




**PROPOSED CRYSTAL LAYOUT (BaF2 example)**

**• End of 93 :** Produce 100 crystals of the proposed choice

# AACHEN PARTICIPATION

**Responsibilities:**

- Photodetector studies for fast UV component of crystals
- Optical coupling to the crystals
- Monte Carlo simulations : detector geometry
  light collection
  e/h

**Contribution :**

- Financing of the R&D program on photodetectors
- 60 photodetectors for the 125 crystal test matrix in 92
- Testing equipment for the photodetectors
- Computer time in Aachen for Monte Carlo simulations

| | 90 | 91 | 92 | 93 | Total |
|---|---|---|---|---|---|
| **Scintillator production** | - | - | - | - | - |
| **Quality control** | - | - | - | - | - |
| **Readout** | 50 | 75 | 75 | 50 | **250** |
| **Mechanical structures** | - | - | - | - | - |
| ***TOTAL KSFR*** | ***50*** | ***75*** | ***75*** | ***50*** | ***250*** |

# LENINGRAD PARTICIPATION

**Responsibilities :**

- Prepare BaF2 or CeF3 test matrix for 92
- Coordinate R&D effort on CeF3 at the State Optics Institute
- Characterization of crystals produced at the State Optics Institute
- Development of low noise hybrid preamps for readout

**Contribution :**

- 4/5 of 100,000 $cm^3$ of crystals at 5 SFR/$cm^3$ ⇨ 400 kSFR (in roubles)
  1/5 paid in SFR by the collaboration
  *This includes 5x5 supercrystals (125crystals) for the 92 test matrix*
- Procurement of 125 hybrid preamps needed for the 92 test matrix
- Composite mechanical structure for the 92 test matrix
- Access to the 18MW nuclear reactor in Gatchina for neutron irradiation
- Optical characterization equipment

| | 90 | 91 | 92 | 93 | Total |
|---|---|---|---|---|---|
| **Scintillator production** | 100 | 100 | 100 | 100 | **400** |
| **Quality control** | - | - | - | - | **-** |
| **Readout** | 10 | 20 | 20 | 20 | **70** |
| **Mechanical structure** | - | 30 | 30 | - | **60** |
| ***TOTAL KSFR*** | ***110*** | ***150*** | ***150*** | ***120*** | ***530*** |

# CALTECH PARTICIPATION

**Responsibilities :**

- Prepare 49 crystals BaF2 test matrix for 91
- Coordinate R&D effort on BaF2 including associated readout
- Monte Carlo simulations : detector geometry
  light collection
  e/h

**Contribution :**

- 49 large BaF2 crystals (3.5$ / $cm^3$) + electronics for test matrix in 91
- 30 photodetectors for the 92 test matrix
- Computer time in Caltech for simulations

| | 90 | 91 | 92 | 93 | Total |
|---|---|---|---|---|---|
| **Scintillator production** | 90 | 90 | 20 | 20 | **220** |
| **Quality control** | - | - | - | - | - |
| **Readout** | 80 | 80 | 25 | 25 | **210** |
| **Mechanical structures** | - | - | - | - | - |
| ***TOTAL KSFR*** | ***170*** | ***170*** | ***45*** | ***45*** | ***430*** |

# ROMA PARTICIPATION

**Responsibilities :**

- Coordinate R&D effort on crystals in Italy
- Monte Carlo simulations : detector geometry
  light collection
  e/h

**Contribution :**

- Crystal growing equipment for Milano
- Computer time in Roma for simulations

| | 90 | 91 | 92 | 93 | Total |
|---|---|---|---|---|---|
| **Scintillator production** | 80 | 45 | To | - | **125** |
| **Quality control** | - | - | - | be | - |
| **Readout** | - | - | discus sed | | - |
| **Mechanical structures** | - | - | - | later | - |
| ***TOTAL KSFR*** | ***80*** | ***45*** | - | - | ***125*** |

# LYON (luminescent materials group) PARTICIPATION

**Responsibilities :**

- Study of the fundamental optical properties of the scintillators
- Optical tests in Lyon
- Optical tests at the Lure synchrotron radiation facility :
  absorption studies from 110 nm to 400 nm at temperatures ranging from 4.2°K to 300°K , to determine the excitation mechanism of the scintillators

**Contribution :**

- All facilities to study the static and dynamic properties of absorption and emission spectra of scintillators at all temperatures :

  Several continuous or pulsed lasers from 230 nm to 2 μm
  High performance spectrophotometers and monochromators
  Fast memory scopes and multichanel analysers
  Cryostats and ovens
  Photoconductivity bench
  Raman spectrometer
  RPE facility (electronic paramagnetic resonance)

***These already existing equipments represent a total investment of about 5 MSFR***

- Access to the Lure synchrotron radiation laboratory :

15 sessions of 16 hours each already approved for the end of 90

# ANNECY PARTICIPATION

**Responsibilities :**

- Study of the mechanical , optical and physical properties of the scintillators
- Study of the methods to have an optimum and uniform light collection
- Coordinate the work on a mechanical structure
- Optimization of the mechanical processing of the crystals or glasses

**Contribution :**

- One grinding machine (50μm precision) and 1 polishing machine
- One computer controled bench for crystal dimension and planarity control
- One 3 dim. computer controled bench for mech. structure measurement
- One spectrofluorimeter and different optical benches
- CAD facility (Euclid) and the MODULEF finite element software

***These already existing equipments represent a total investment of about 1.5 MSFR***

- 35 photodetectors for the 92 test matrix

**Additional money requested from LAPP (IN2P3) :**

| | 90 | 91 | 92 | 93 | Total |
|---|---|---|---|---|---|
| **Scintillator production** | 10 | 15 | To | - | **25** |
| **Quality control** | 10 | 10 | - | be | **20** |
| **Readout** | 15 | 15 | discus | sed | **30** |
| **Mechanical structures** | 5 | 15 | - | later | **20** |
| ***TOTAL KSFR*** | ***40*** | ***55*** | - | | ***95*** |

# CERN PARTICIPATION

**Responsibilities :**

- General coordination of this R&D program
- Coordination of the effort in the firms to produce crystal and glass samples
- Optical characterization of the different material studied
- Radiation damage studies

**Infrastructure:**

The ground floor of the building 27 had been equiped for the construction of the L3 BGO calorimeter with :
an assembly hall with a 5 tons crane
several dark rooms with various testing facilities installed :
- 1 grinding machine , 1 polishing machine , 1 spectrophotometer
- 1 spectrofluorimeter , 1 dimension measuring bench
- 1 thermoluminescence bench , 1 cosmics ray bench

***The ground floor of building 27 is requested from CERN***

**Manpower :**

The CERN / L3 support group (under A. Hervé) has gained a valuable experience through its active participation in the construction of the L3 BGO calorimeter

***10 to 20% of the ressources of the CERN / L3 support group is requested from CERN***

In addition , through the different students and fellow programs :

- ***1 fellow or scientific associate per year***
- ***1 VSNA or fellow per year***
- ***2 technical students per year***

**Test beam :**

An $e^-$ / $\pi$ beam : energy : 2 Gev up to at least 100 Gev (150 Gev better)
spectrometer with $\Delta p / p \leq 0.3\%$

Time request (as main user) :

- ***15 days at the end of 91***
- ***20 days at the end of 92***
- ***2 times 15 days in 93***

**Computer time :**

Most of the simulations will be done outside CERN . Therefore , there is

***no specific request for computer time allocation***

**Money request :**

| | 90 | 91 | 92 | 93 | Total |
|---|---|---|---|---|---|
| **Scintillator production** | 40 | 50 | 60 | 60 | **210** |
| **Quality control** | 40 | 50 | 50 | 50 | **190** |
| **Readout** | - | - | - | - | - |
| **Mechanical structures** | 10 | 10 | 10 | 20 | **50** |
| ***TOTAL KSFR*** | ***90*** | ***110*** | ***120*** | ***130*** | ***450*** |

# SUMMARY OF THE PARTICIPATIONS

| | 90 | 91 | 92 | 93 | Total |
|---|---|---|---|---|---|
| CERN | 90 | 110 | 120 | 130 | **450** |
| CALTECH | 170 | 170 | 45 | 45 | **430** |
| LAPP (ANNECY) | 40 | 55 | - | - | **95** |
| LNPI (LENINGRAD) | 110 | 150 | 150 | 120 | **530** |
| ROMA | 80 | 45 | - | - | **125** |
| RTWH AACHEN | 50 | 75 | 75 | 50 | **250** |
| *TOTAL KSFR* | ***540*** | ***605*** | ***390*** | ***345*** | ***1880*** |

**Nota :**

The allocations for 92 and 93 should be considered as indications only . No specific request has been made yet , and the exact contribution will depend very much on the results of the first 2 years .