Concluding Remarks
VLVnT Workshop
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This is NOT thought to be the summary of summaries!

1) Where we are, where we want to go

- After almost 20 years: first νT's in sea water "ante portas"
- Everybody is enthusiastically anticipating the future
- But: until recently lack of coherence, no united effort
  - ➢ no backup by politics and funding agencies
  - ➢ no realistic roadmap to "the KM3 project"
  - ➢ support by astroparticle community subject to conditions
  - ➢ no chance to obtain world-wide consensus on

NEED FOR A CUBIC KILOMETER νT
IN THE MEDITERRANEAN

- NOW: the FP6 program has triggered a "unification process"
  - common effort to obtain funding
  - will it develop to a common effort to design and construct KM3?
- Time scale: given by "community lifetime" and competition with ice detectors
  - interest fades away if KM3 comes much later than IceCube
  - remember: IceCube ready by 2010
  - we better start NOW (even without EU money?!) . . .

Imagine we fail at this point: What would it mean?

A FUTURE WITHOUT A NORTHERN-HEMISPHERE νT?

HOW DULL !!!

2) Physics Objectives and Implications for KM3

Physics objectives of current & future nTs:

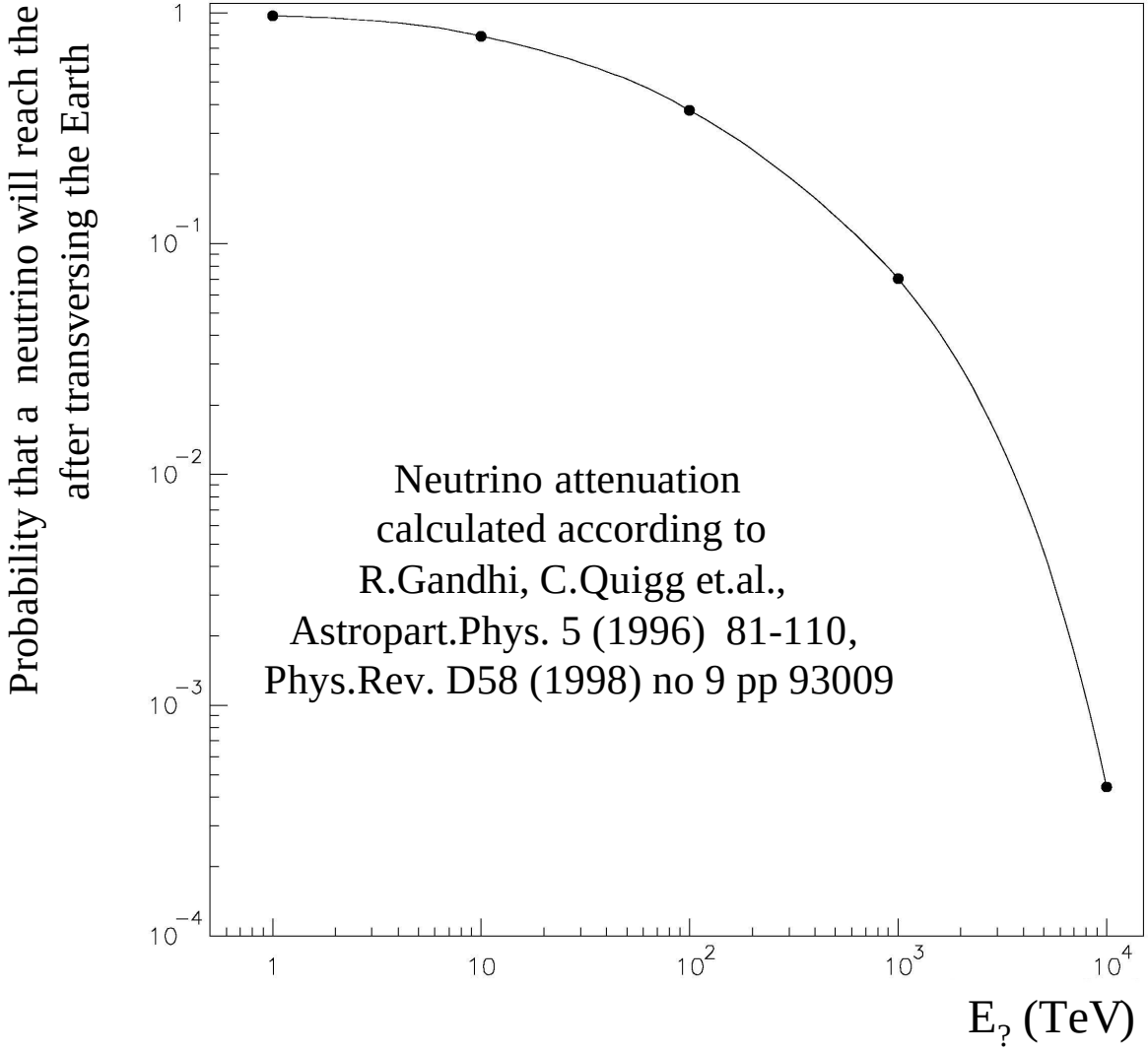
importance for KM3

- astrophysics: diffuse fluxes, point sources — ***
  - point sources: need good angular resolution, medium energies
  - diffuse fluxes: large energies
- dark matter ("low energies") — **
  - What happens, if LHC discovers something?
- neutrino oscillations — (*)
  - Probably covered by dedicated experiments
- others: — t.b.worked out

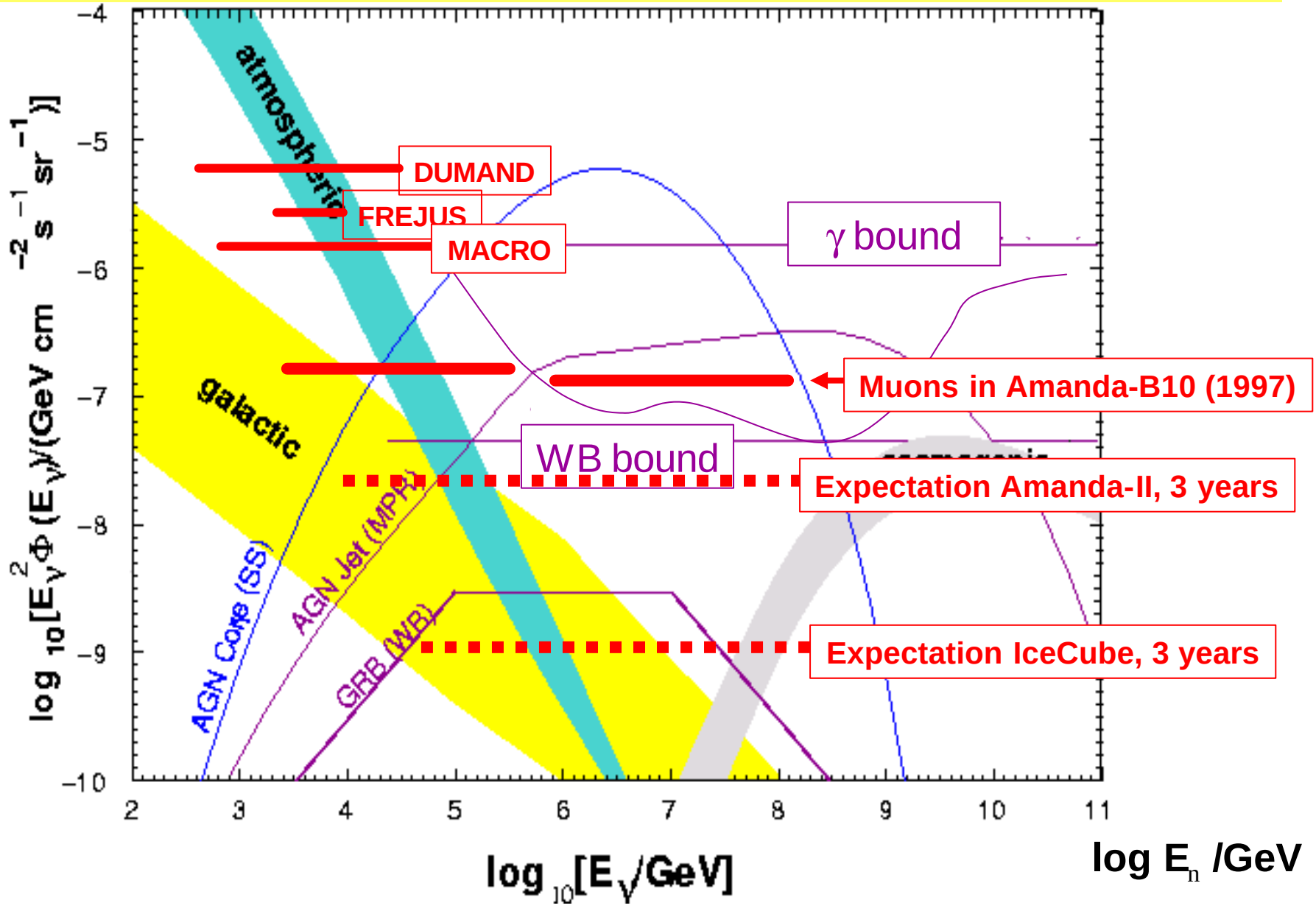
NEEDS DISCUSSION, ENERGY RANGE CRUCIAL FOR DESIGN !

=> Basic requirements:

- affordable !
- 4 pi acceptance ?



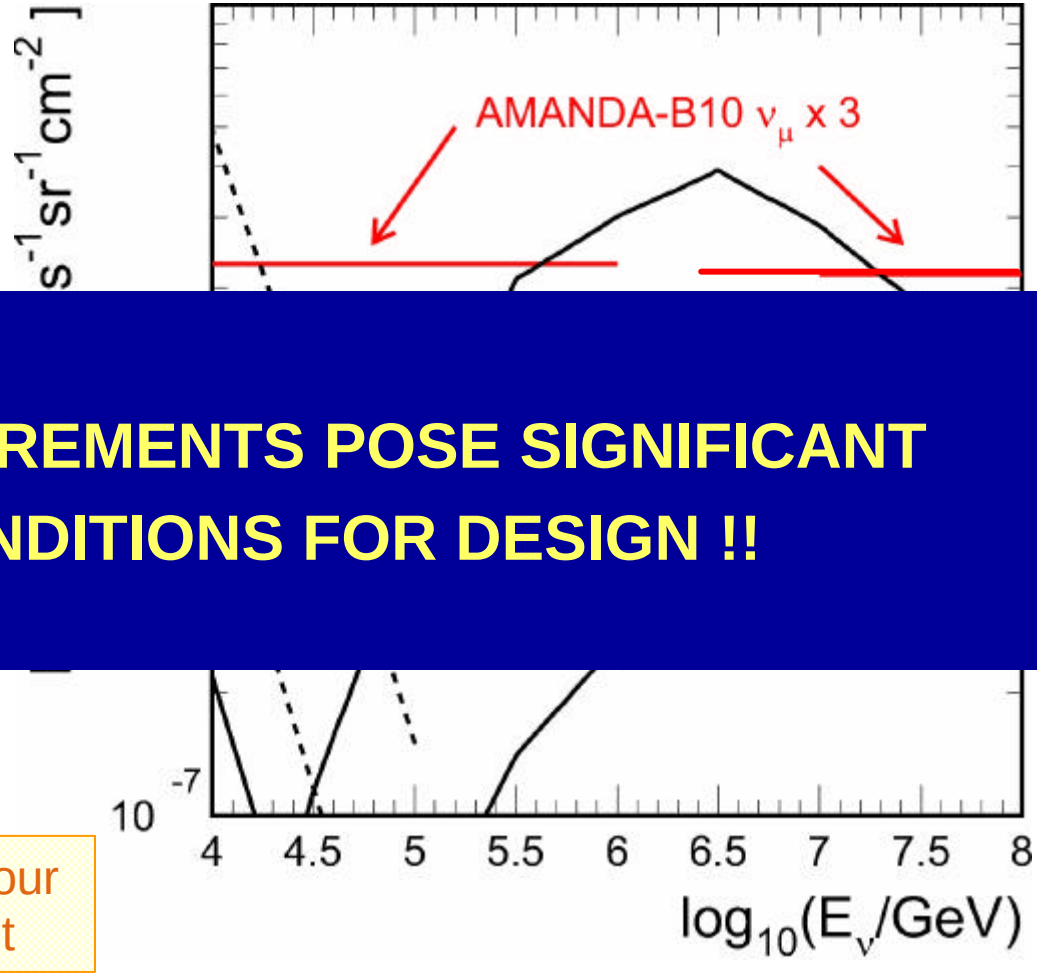
➢ extendable ? (must be able to react to new developments)



➢ sensitivity to muons AND to showers !
(also gains from "looking upward")

assuming $\nu_e:\nu_\mu:\nu_\tau = 1:1:1$ @ Earth

- multiplicative factor 3 applied for single ν_μ channel



=> ALL THESE REQUIREMENTS POSE SIGNIFICANT BOUNDARY CONDITIONS FOR DESIGN !!

2000 ν_μ analysis will yield all-flavour limit comparable to cascade limit

3) Lessons to be learned from current projects

- Lots of tested technological solutions

  - which of them can be used "as are"?

    Needs critical review !

  - offer basis for (some? many?) future developments

  - WARNING: existing solutions are well-tested, low-risk ...
    BUT may reduce acceptance for new, better approaches

- Make best use of experience gained!

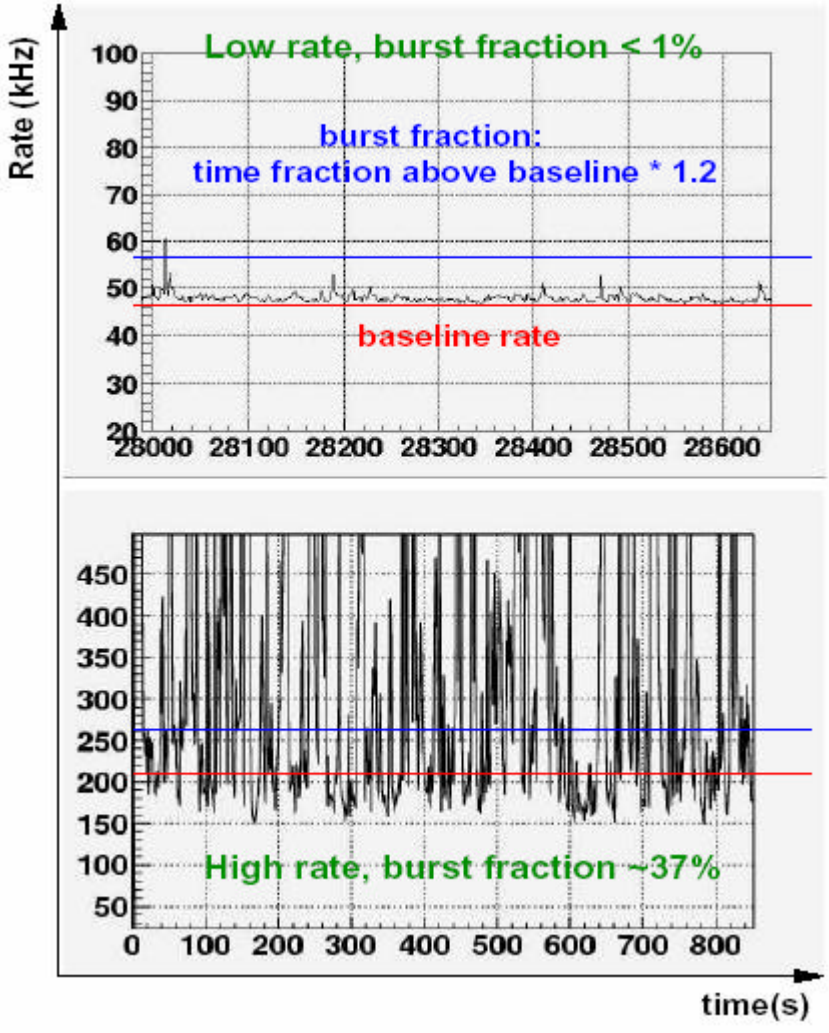
  ➢ crucial failures may appear where they are the least expected

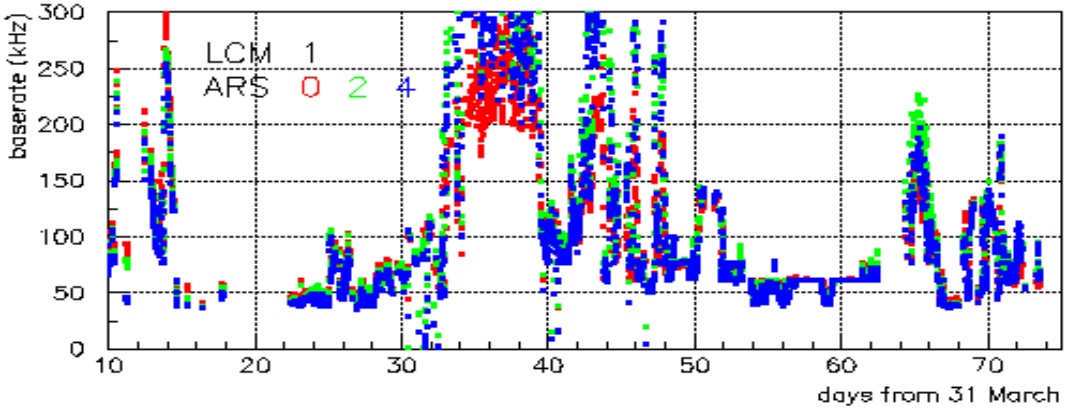
  - **complexity of detectors must be reduced**
  - **quality control and assurance will be a central topic**

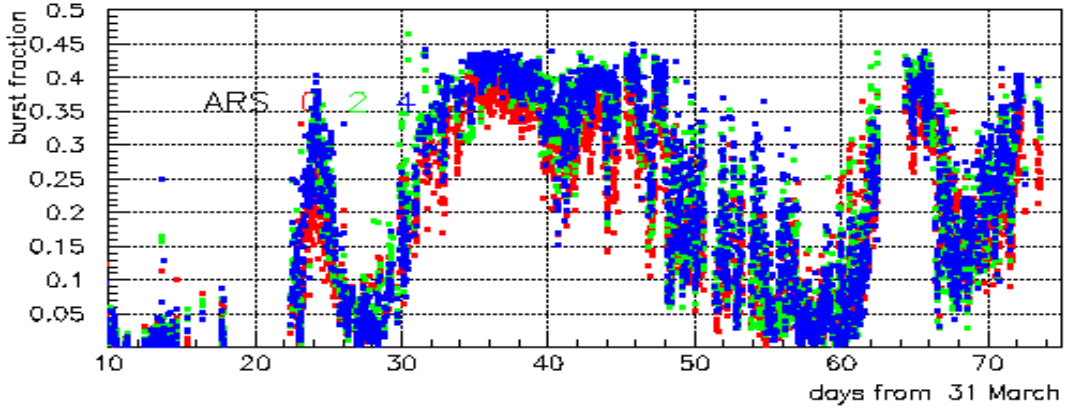
  ➢ time schedules are difficult to control
  but are crucial for the KM3 project

  - Imagine **construction and deployment take longer than the detector lifetime!** (IceCube: ~50%)
  - DANGER: **technical solutions outdated by ~10 years at construction time**
    (imagine building km3 with technology from 1990).

➢ understand well (better?) the environmental conditions







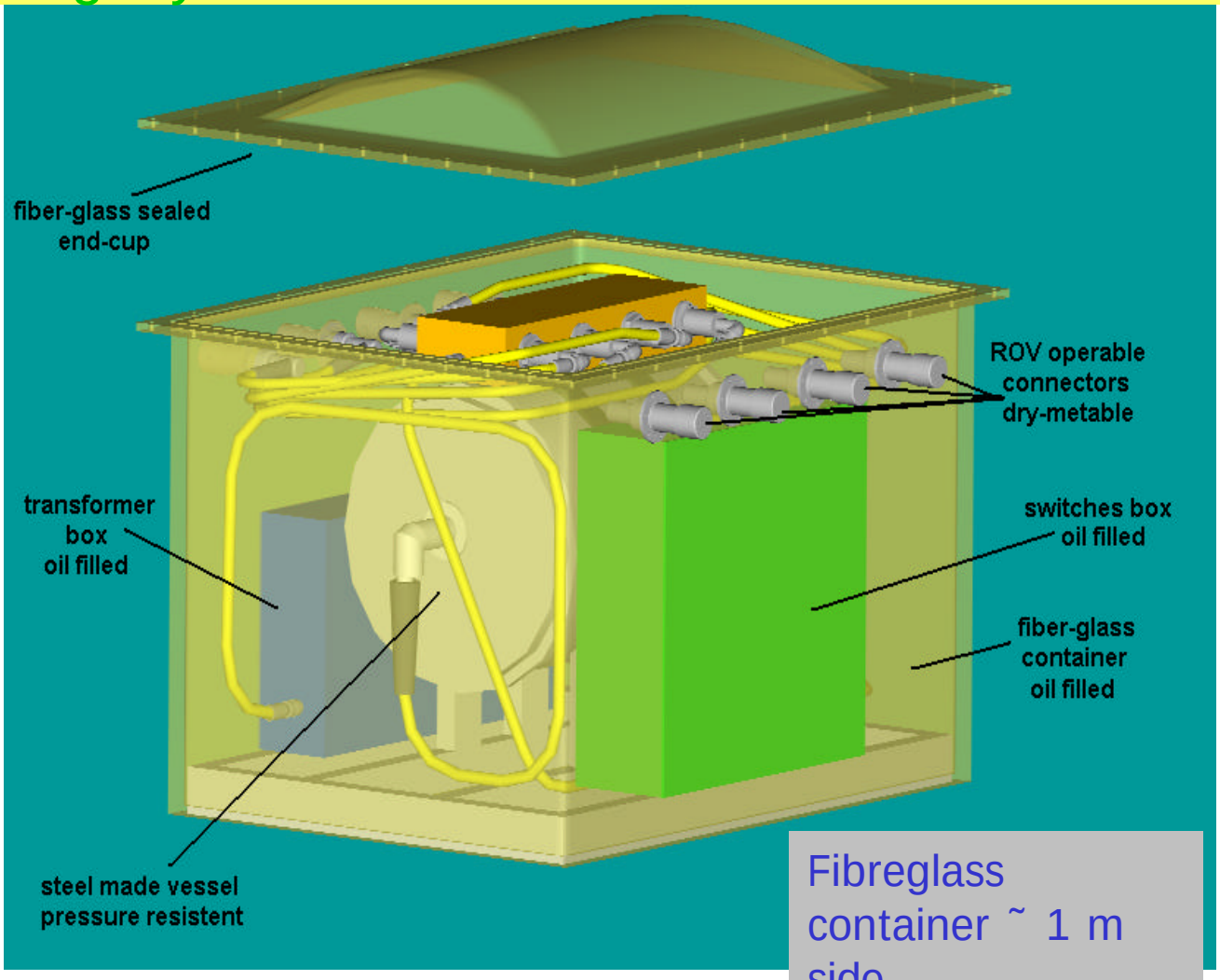
Large variability of rates and burst fraction

Essentially bioluminescence

More than 90% of time below 200 kHz

JB i

- a lot of interesting developments are under way, e.g. by NEMO



Fibreglass container ~ 1 m side

4) Asking Questions and Collecting Options ...

- **... is the most important task right now**

  since it helps us to identify problems, find solutions
  and to initiate / continue / intensify the necessary R&D steps

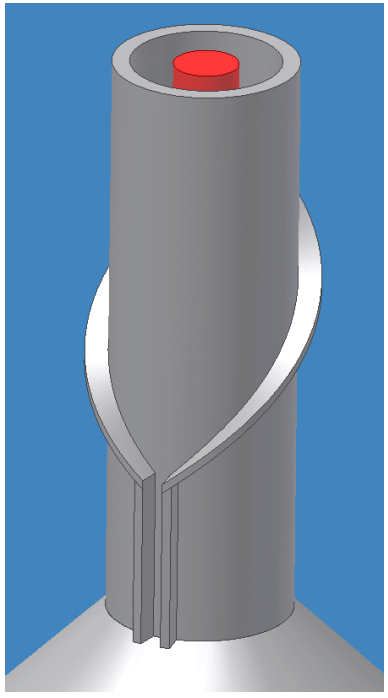
- **a selection of such questions/options (strongly interrelated!):**

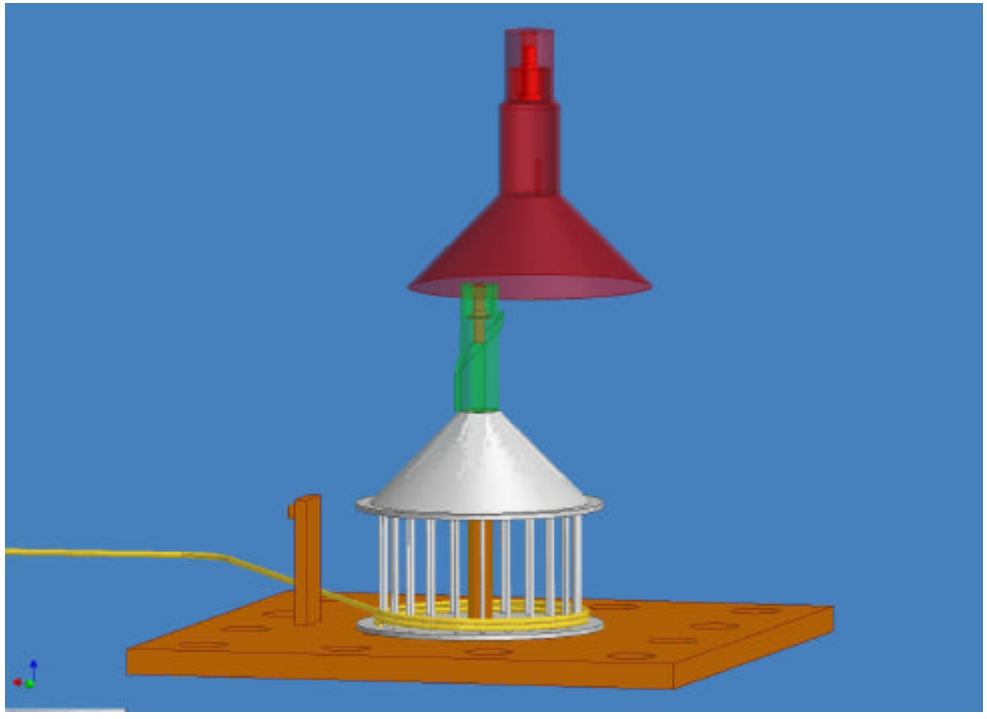
  => How will the detector look like?

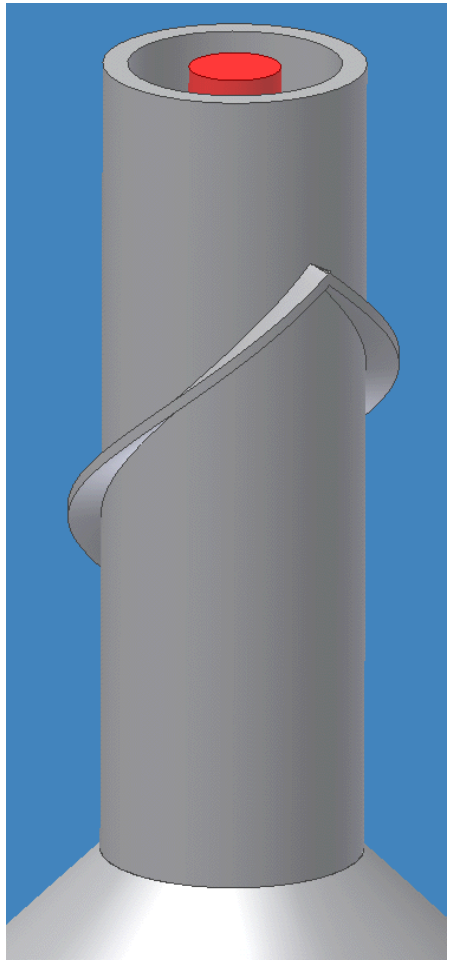
  - which structures are optimal?
  - dry or wet connections, or wet from top, or ...?
  - how to avoid single point failures?
  - star or linear or circular interconnection topologies or **. . .** ?
  - how to optimize architecture? **- needs thorough simulation!**

  => Sea operations are a major part of the project and
  must be considered from the very beginning

=> Dry or wet connections, or wet from top, or . . . ?







=> What materials to use?

- replacement(s) for titanium?
- composite solutions
- polyurethane encapsulation (as for hydrophones)?

=> Cables and connectors?

- connectors are extremely expensive –
  how to reduce number, in particular wet-matable ones
- reliability is crucial !

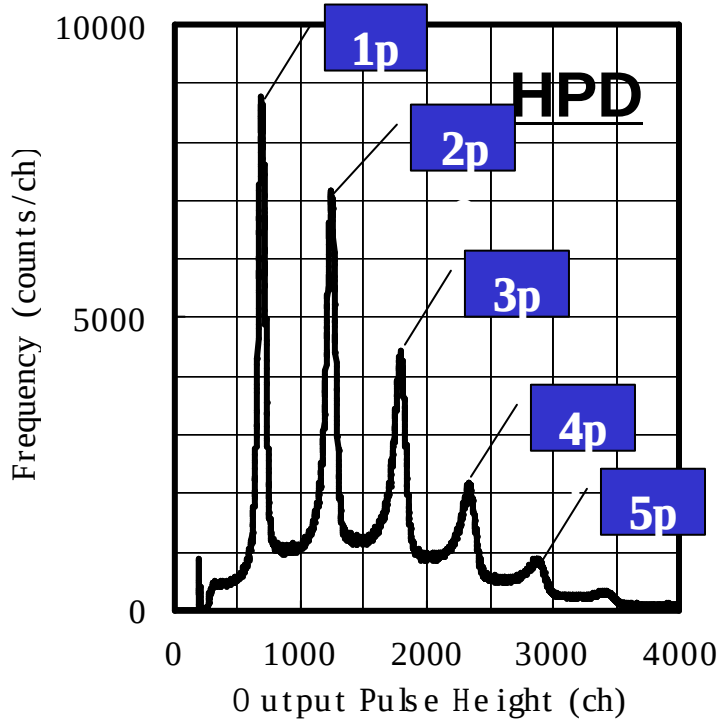
=> Which photodetectors?

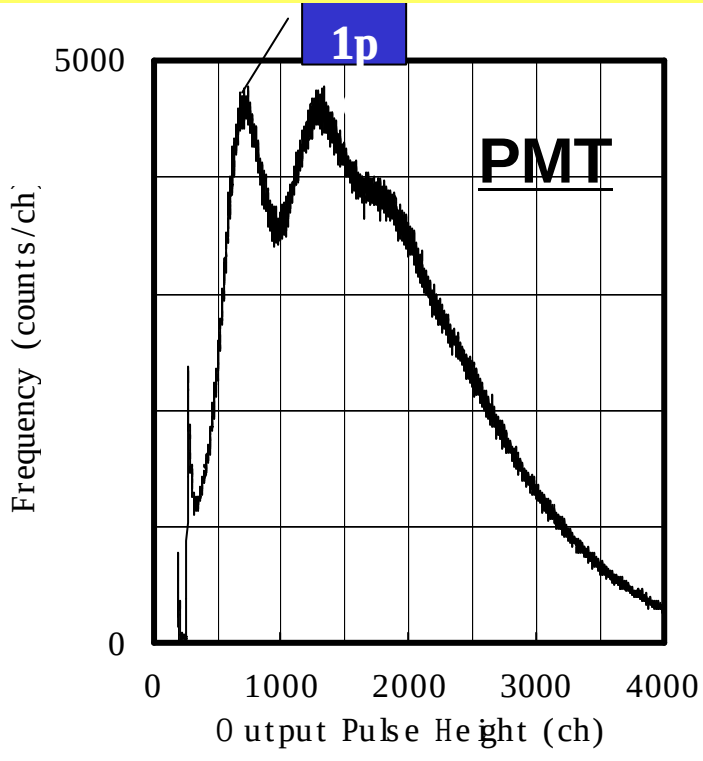
can we improve on:

quantum efficiency * sensitive area / cost ?

time resolution?

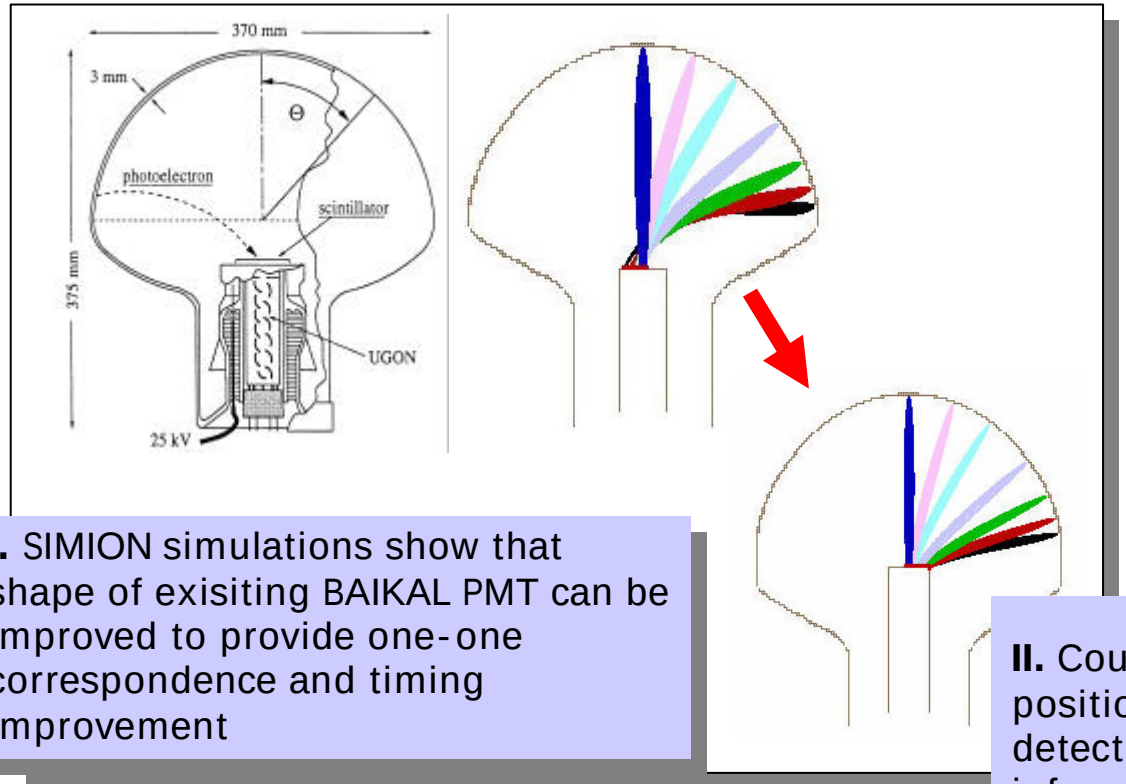
single photon electron resolution?





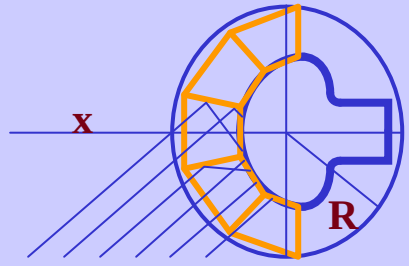
Remember: 10% larger PM distance @ same efficiency
=> ~ 30% more detector volume !

=> is directional sensitivity possible?

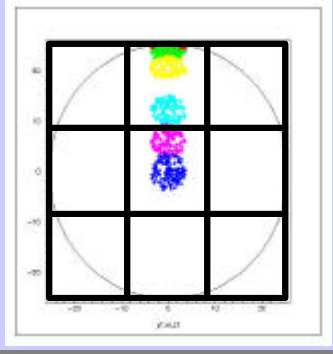


I. SIMION simulations show that shape of exisiting BAIKAL PMT can be improved to provide one-one correspondence and timing improvement

III. Coupling to a light guide system also provides information on the detected light direction



II. Coupling to a position sensitive detector provides information on the photoelectron emission point



=> How to get data to shore (and from shore to detector)?

- needs integrated concept for
  sensor – frontend electronics – data transport
  – technology on shore
- Promising approach using commercial optical solutions
- Can we send analogue signals to shore?

=> How do we calibrate the detector?

- are current calibration tools adequate/scalable/reasonable?
- is it feasible/helpful to separate detection and calibration units?
- do we need a surface array? How to decide and design it?

Cooperation with Industry

- **ν telescopes do and will need industrial partners for various components**
  - cables and connectors
  - IT solutions for data transport
  - photo sensors
  - glass spheres
  - deep-sea technology, . . .
- **Many companies followed invitation to VLVνT workshop**
  - mutual interest !?
  - we must find / maintain suitable “interfaces” to describe needs and problems
  - we astroparticle physicists must not re-invent the wheel, even if we are capable of doing so !
- **Integration of SME’s in Design Study is of strategic value and politically adequate**

Cooperation with other Scientific Partners

- **ESONET (biology, oceanography, environment, . . .)**
  - there seems to be a lot of potential for synergetic cooperation
  - we'll have to understand how to combine our interests without compromising our scientific goals

- **GRID**
  - mutual interest in cooperation !?
  - may provide solutions for a data analysis and reconstruction

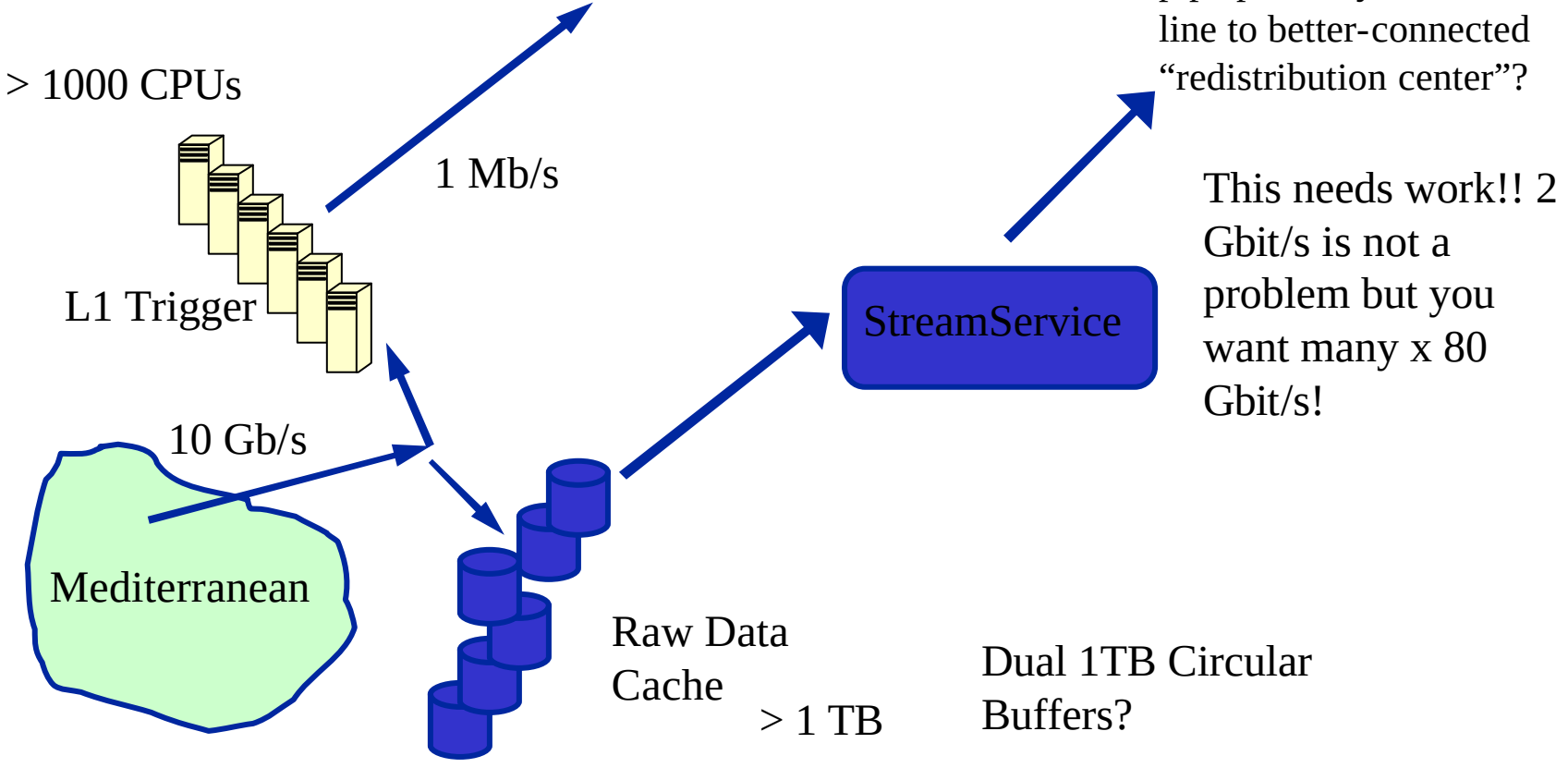
VLVνT Reconstruction Model

Grid data model applicable, but maybe not computational model …

- Distributed Event Database?
- Auto Distributed Files?
- Single Mass Store + “Thermal Grid”?

Grid useful here – get a lot but only when you need it!

All connections through single pipe probably bad. Dedicated line to better-connected “redistribution center”?



This needs work!! 2 Gbit/s is not a problem but you want many x 80 Gbit/s!

The Future

Design Study:

Call expected by 11.11.2003

Brussels deadline for proposal: 4. March 2004

ApPEC will review astroparticle proposal for DS's and possibly issue recommendations / priority list (meeting in Munich, 25.11.2003)

Jos Engelen: "KM3 project fits very well into DS frame"

If successful: provides funding for R&D studies (3 – 4 years)

Result can / should / must be a **technical design report**

=> start construction of detector thereafter

Site Decision

- decouple site decision from R&D work towards KM3

- for simulations, use "site" as "mathematical symbol" including
  - depth
  - distance to shore
  - water transparency
  - bioluminescence
  - sedimentation
  - . . .

- However, the final detector design needs the site decision
  => this sets the/a time scale !

We NOW have the HISTORICAL chance to realize KM3

No guarantee – but realistic possibility

LET ’S GO FOR IT !

- be open to all ideas and options
- solve open questions on scientific basis

Thanks to all who contributed to the workshop and will carry on the efforts towards KM3 !

- VLVνT Workshop was first in a series
  => next location and date to be announced soon

See you all there !