Calorimeter Test Beam

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SuperB Detector Workshop I,
SLAC

Queen Mary
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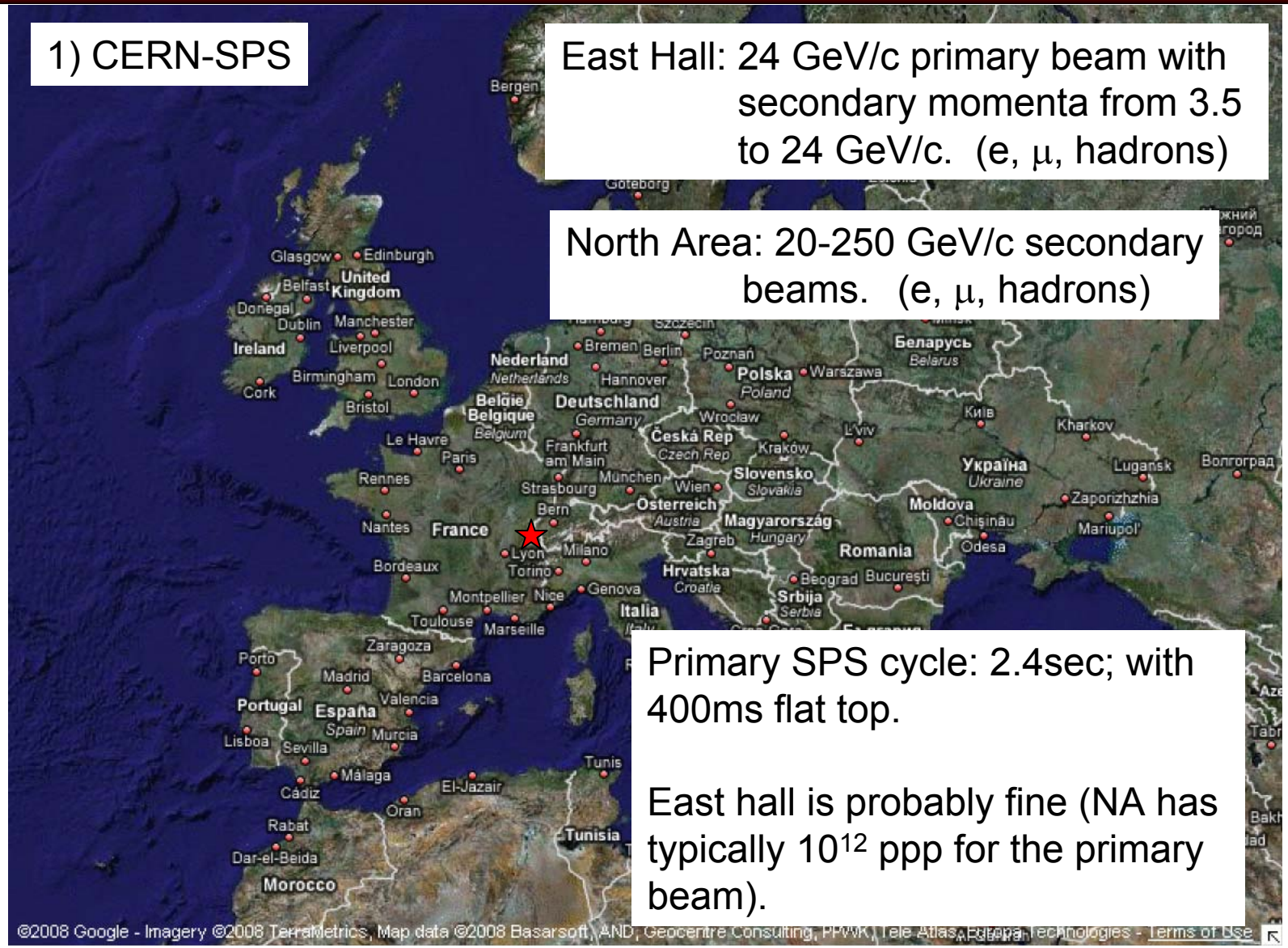
Outline

- Test beam site considerations:
  - CERN/DESY/Frascati/PSI
- BaBar Test beam
- Prototype issues
  - Crystal layout
  - Example Quotes
  - Photodetector
  - Readout / Trigger
- Timescale

Test beam site considerations

See http://ab-div-atb-ea.web.cern.ch

Test beam site considerations



See http://ab-div-atb-ea.web.cern.ch

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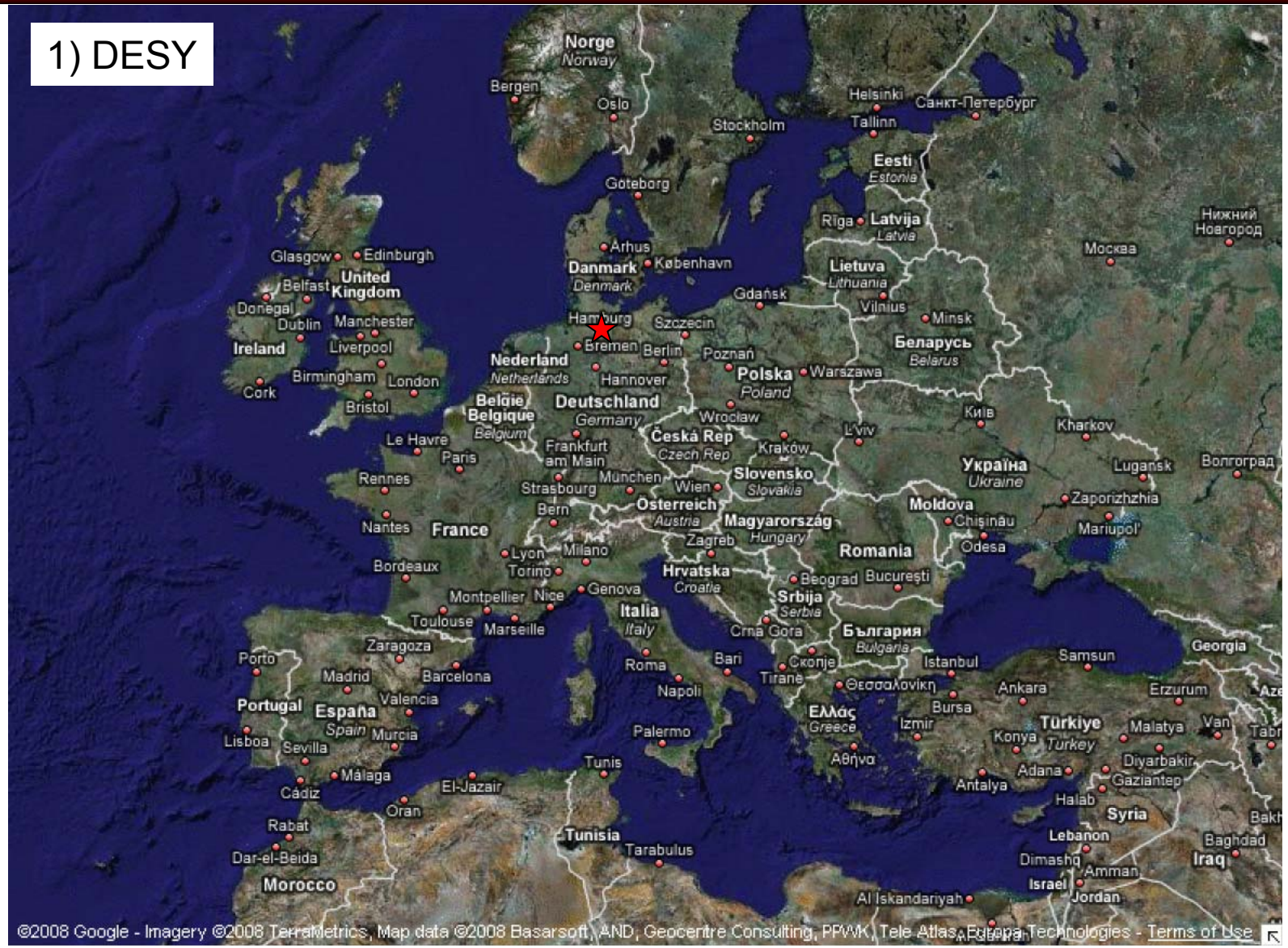
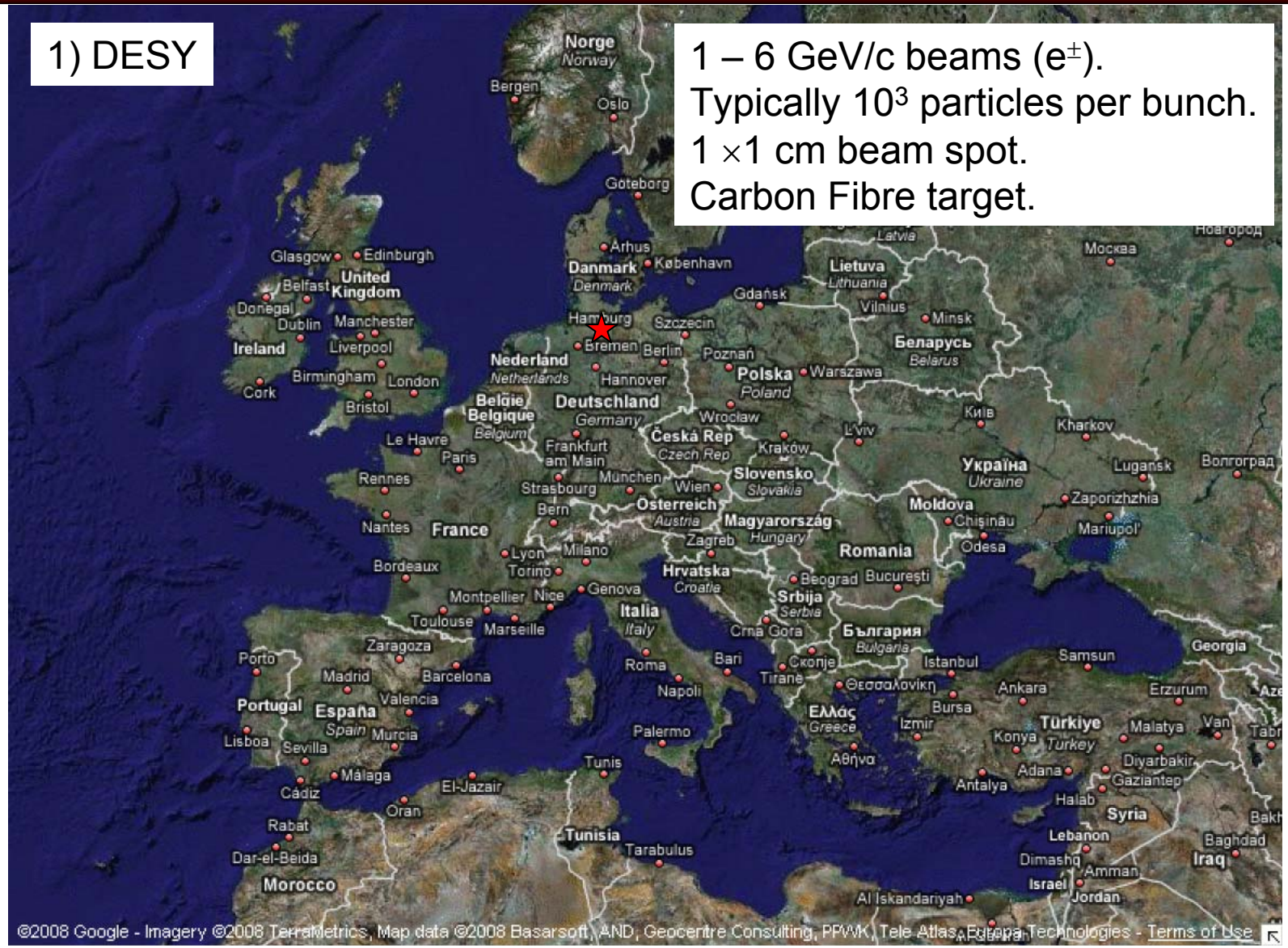


See http://adweb.desy.de/~testbeam/

Test beam site considerations



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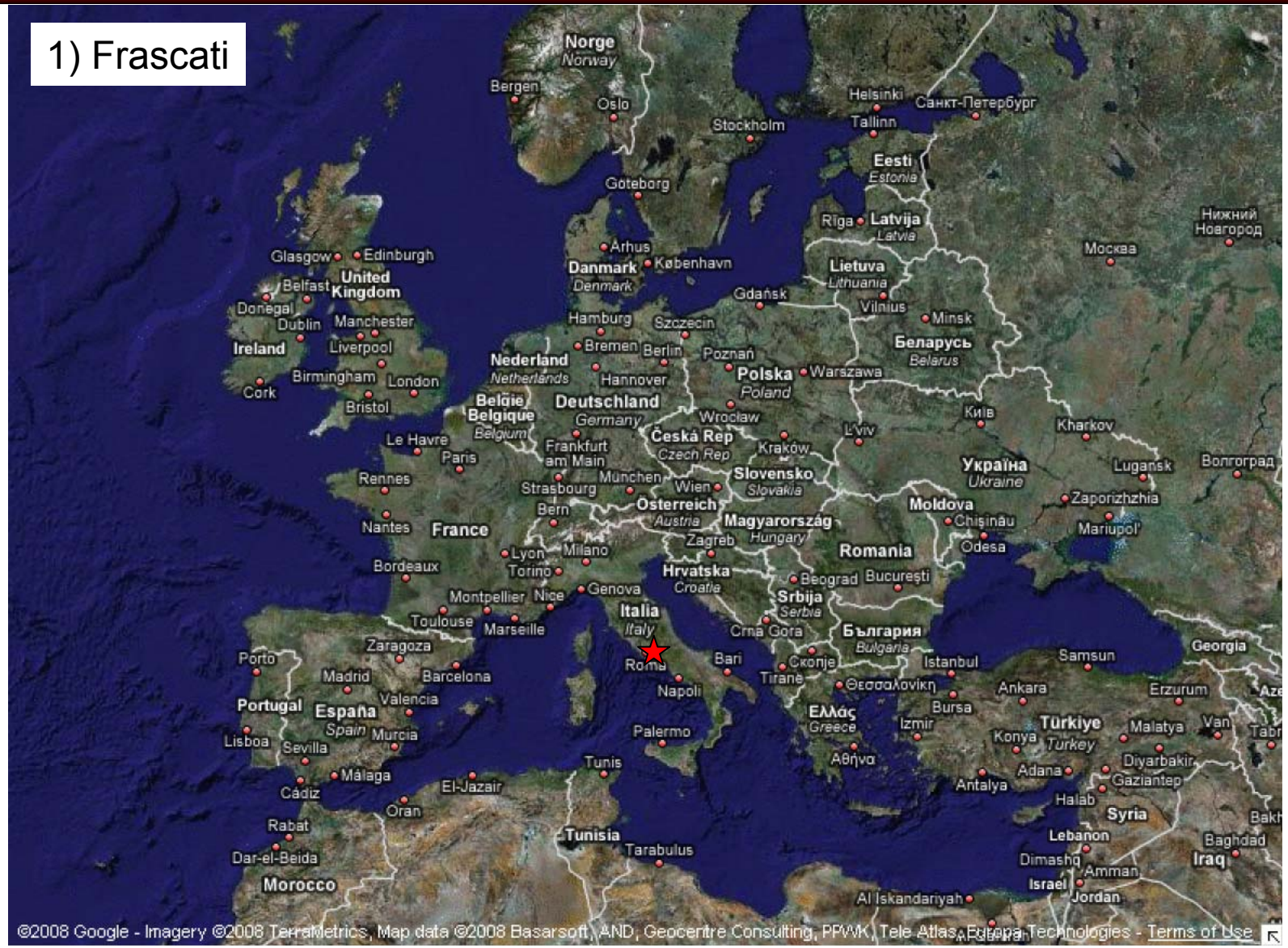


See http://www.lnf.infn.it/acceleratori/btf/

Test beam site considerations

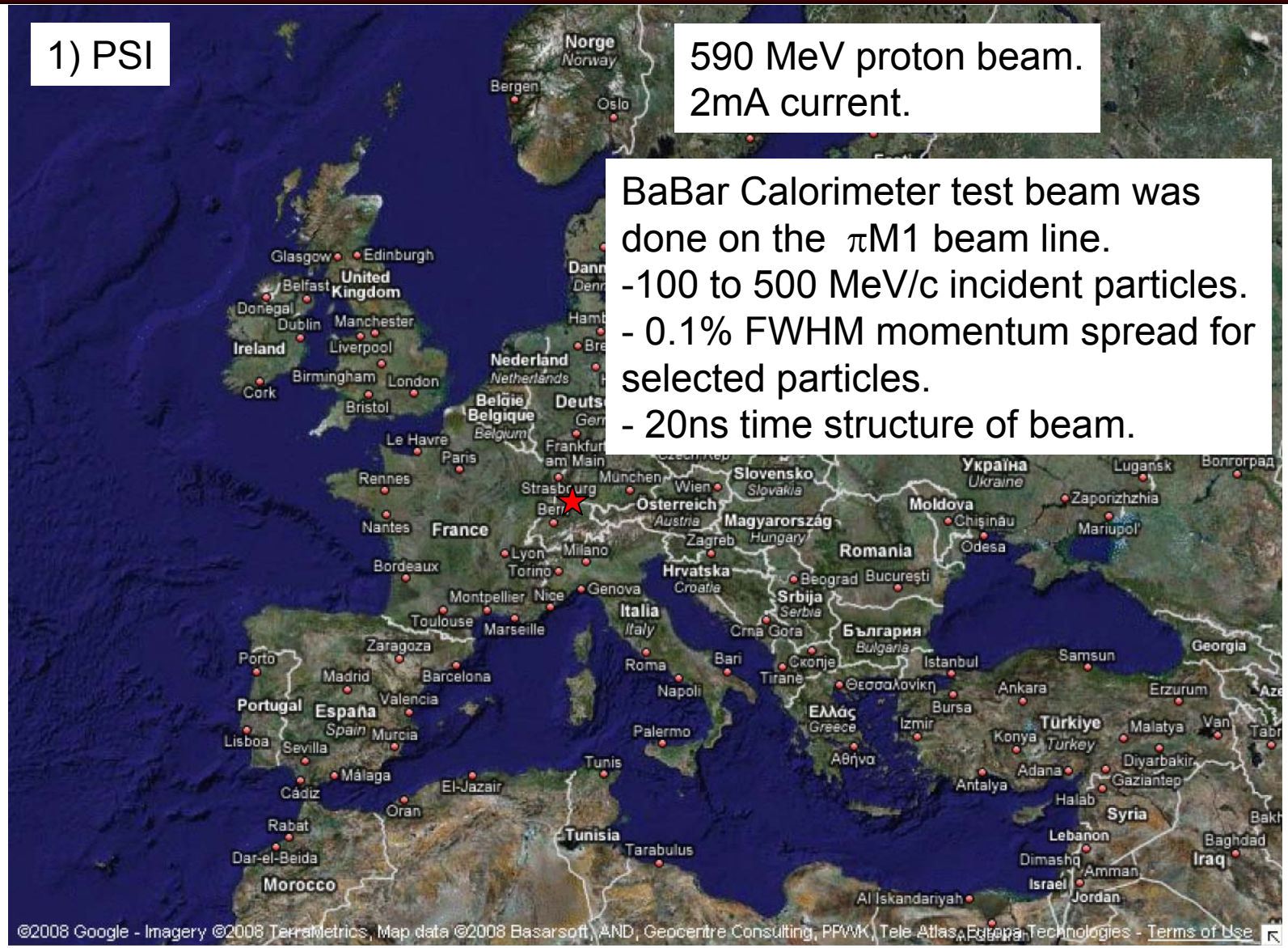
1) Frascati

25-750 MeV beams ($e^{\pm}$).
Typically 10^3 particles per pulse.
1-10 ns pulses at a 50Hz rate

See http://www.lnf.infn.it/acceleratori/btf/

Test beam site considerations

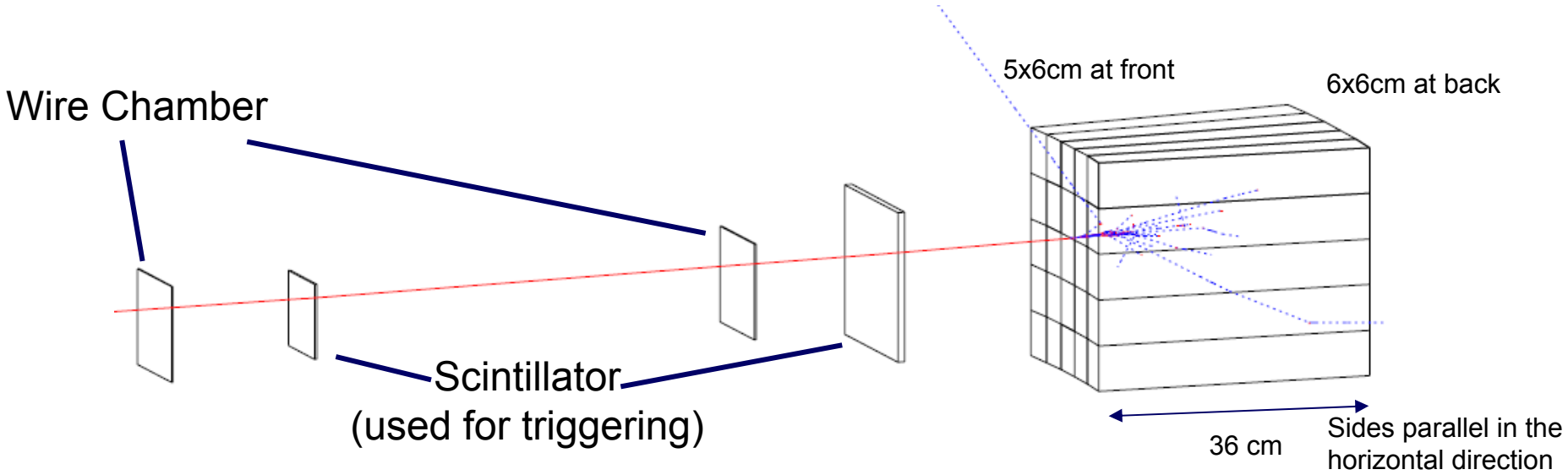
Test beam site considerations



See http://www.psi.ch/forschung/benutzerlabor_protonen_e.shtml

The BaBar Testbeam

- Projective geometry in 1 dimension.
- 5x5 matrix of CsI(Tl) crystals.



- The crystals were encased in a light and RF tight environmental box; on a turntable.
- Took data at several incident angles.

The BaBar Testbeam

- Used e / π beams from the beam line.
- Wire chambers and scintillators were in situ.
- Choice of two tables for rotating the calorimeter prototype.
- What could have been done better?
  - Instead of having a single long run for taking data; should have planned a short pilot run to get enough data to analyse and debug prototype, and then come back for more data.
  - The design had a problem with cross-talk between the power supplies used. This meant that data had to be recorded at low rates.

Prototype Issues

Crystal Layout

Crystal Layout

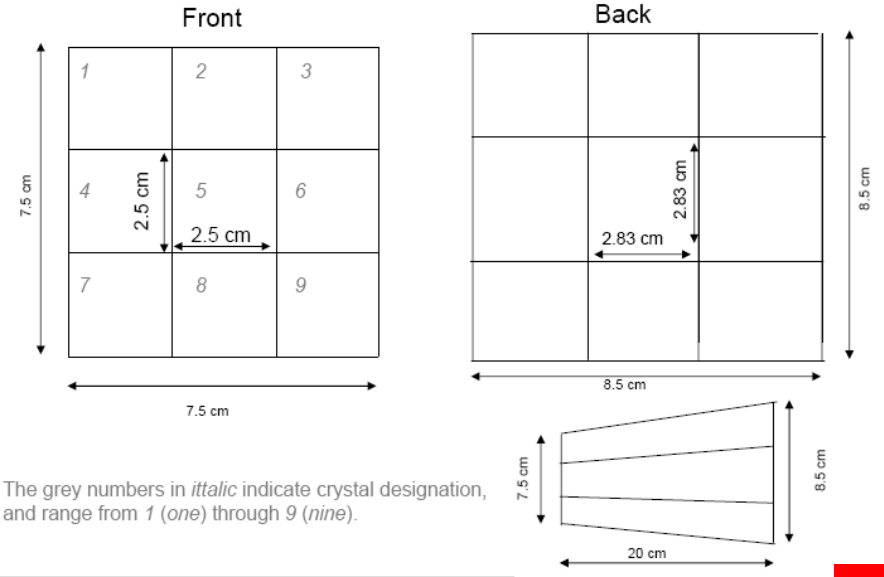
- Need a large enough prototype to contain a complete shower:
  - 5×5 or 7×7 crystals.
  - All LYSO vs LYSO core with CsI (or other cheaper material around the core).
  - Projective geometry of some kind vs non-projective geometry.
  - Need to figure out all pros and cons.

Crystal Layout

- Example: 3x3 projective LYSO core (surrounded by one or two layers of cheaper crystals).

LYSO Calorimeter Test-beam Possible Geometry

LYSO region of calorimeter will be a 3x3 array of crystals with a projective geometry as indicated here. Assume that the interaction point is a perpendicular distance of 1.5 meters from the surface of the crystals, and that the beam axis of the test beam experiment is co-incident with the axis of the central crystal:



The grey numbers in *ittalic* indicate crystal designation, and range from *1* (*one*) through *9* (*nine*).

All sizes in centimetres (cm) and all angles in radians (rad)
NOT TO SCALE

Just an example of a possible projective geometry:

Assumes:

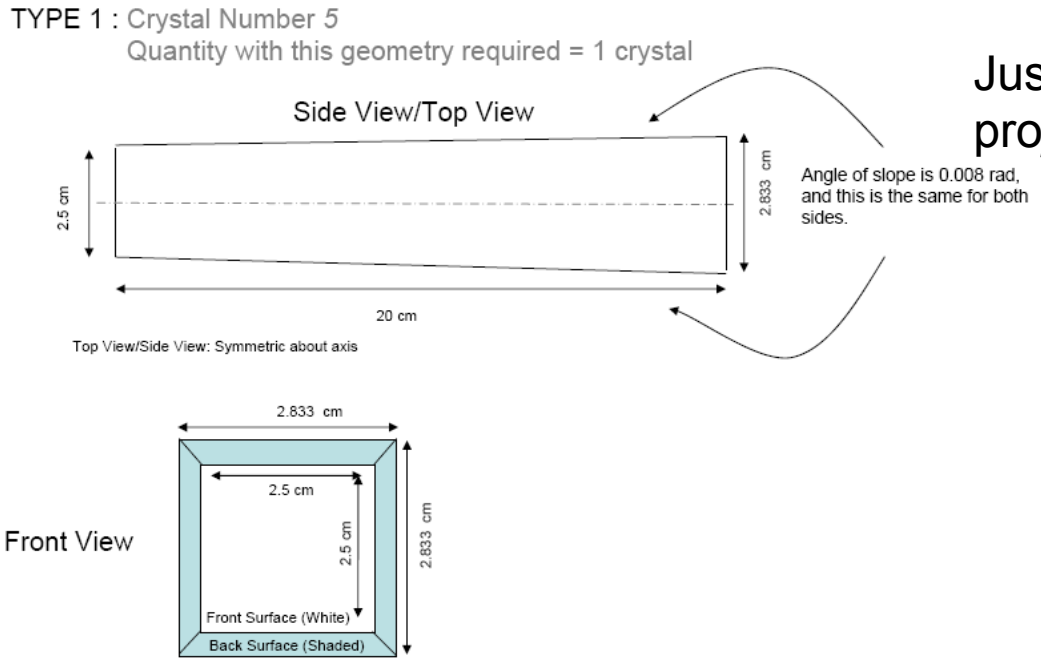
2.5x2.5 cm front crystal surface

'Beamspot' 1.5m from this surface to define projectivity.

NOTE: The goal is to build a 5x5 or 7x7 array of crystals, this layout was investigated in a failed attempt to exploit a funding opportunity.

Crystal Layout

- Example: 3x3 projective LYSO core (surrounded by one or two layers of cheaper crystals).



Just an example of a possible projective geometry:

Central crystal for a projective geometry.

NOTE: The goal is to build a 5x5 or 7x7 array of crystals, this layout was investigated in a failed attempt to exploit a funding opportunity.

Example Quotes

- 1) Non projective geometry: 9 crystals of 2.5x2.5x20cm:
  - All sides polished, LYSO
  - Cost for 9 crystals = 31 Kє
  - Timescale for delivery = 8 weeks
  - Timescale / cost for 49 crystals (est) = 16 weeks (4 months) / 167 Kє

- 2) Projective geometry outlined previously:
  - Cost for 9 crystals = 55.5Kє
  - Timescale for delivery = 4 months
  - Timescale / cost for 49 crystals (est) = ? 8 months / ? 111Kє

Quotes were aquired from Saint Gobain and SIPAT, and exclude tax and shipping. SIPAT were O(10% more expensive)

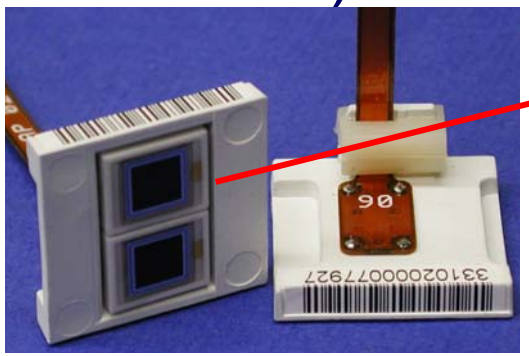
NOTE: The goal is to build a 5x5 or 7x7 array of crystals, this layout was investigated in a failed attempt to exploit a funding opportunity.

Prototype Issues

Photodetectors

Photodetectors

- Ren Yuan has been using Hamamatsu APDs (from CMS) for lab tests.



S8664-55 (5x5mm active area)
Single unit / 10+ cost 473 / 338 €

10x10mm device is also available:
Single unit / 10+ cost 1010 / 720 €
(might fit two on a crystal)

- Continue to use this chain for readout vs. start to investigate and adopt an alternative (also what is the cost at production level for such a readout?).
- Need to think longer term – what would we use for SuperB?

Prototype Issues

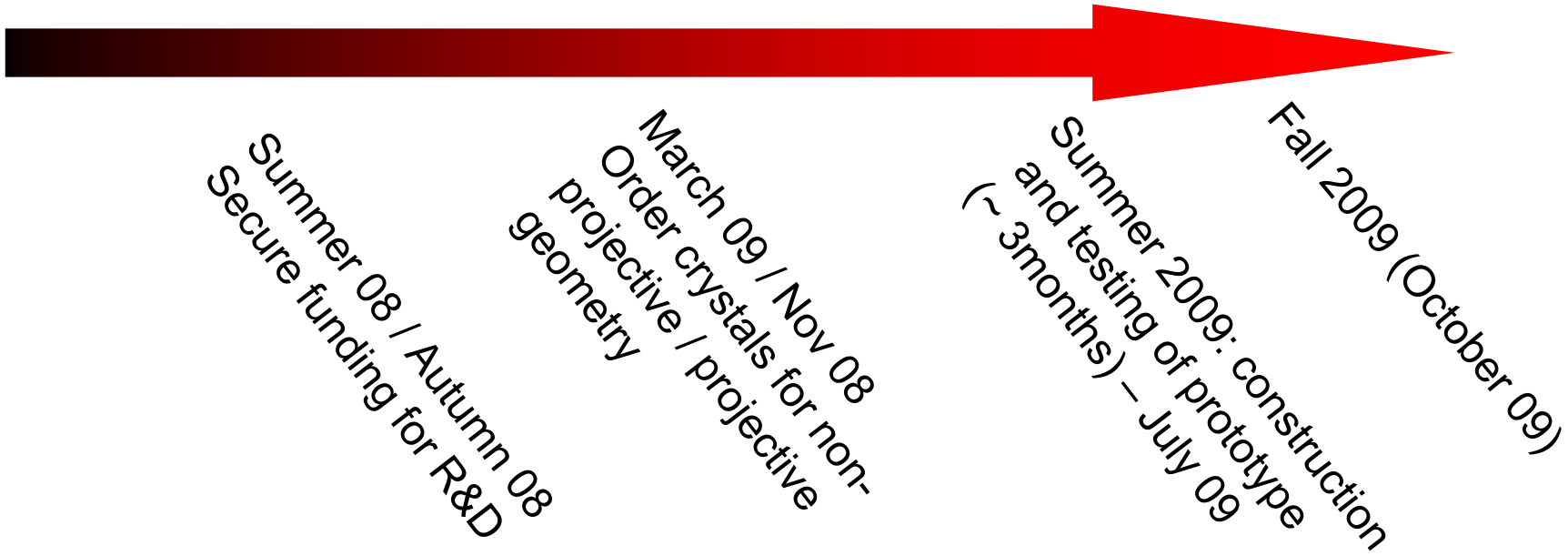
Readout/trigger

Readout / Trigger

- Trigger:
  - Site dependent. PSI/CERN probably have these already in place.
- Readout:
  - Currently using CMS readout …. If we use this for a testbeam then we save time.
    - BUT: can we use this for SuperB? If not – then it might be better to work toward a readout that would be similar/same as for SuperB.

Timescales (very rough)

- Aim to have a test-beam ~ fall 2009
  - Working backward, we would need to acquire funding for R&D soon.



  - Also means we should start to design the calorimeter prototype in the next 6-9 months.
  - Timescale is more relaxed if we don't want tapered crystals.

A crude beam test budget estimate

Item	Cost ($)
LYSO Crystal @ $15/cc	1875
LYSO Crystal @ $50/cc	6250
CMS type dual APD module 2 x Hamamatsu S6664-55	250
BABAR type photodiodes 2 x Hamamatsu S2744-08	500
Preamplifier/Shaper (per channel)	200
DAQ system	10000
Source carriage	1500
Beam test mounting structure	20000

Looks more like $5K per crystal (NP) or $9 K per crystal (P)

Looks more like $500 per channel
Is it cheaper to buy in the US?