Isotope production scenarioS

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The Design Study is aiming for:

- A beta-beam facility that will run for a "normalized" year of 10^7 seconds
- An integrated flux of 10 10^{18} anti-neutrinos (^{6}He) and 5 10^{18} neutrinos (^{18}Ne) in ten years running at γ=100

with

- 2 10^{13} ^{6}He atoms per second
- 8 10^{11} ^{18}Ne atoms per second

injected as neutral gas into the ECR source

Baseline scenario

- Driver: 2.2 GeV protons 100μA
- Production of He-6
  - $^{9}Be\ (n,\alpha)\ ^{6}He$
  - Spallation neutrons produced by protons on a metal converter
  - Neutrons energy: broad spectrum
  - BeO fiber around the converter
- Production of Ne-18
  - Spallation of Mg
  - MgO target 1m long

How far are we from these values?

- 2 10^{13} atoms/s of ^{6}He -> **1.8 10^{13} ions/s $^{6}He^{q+}$** *(90%!!)*
- 8 10^{11} atoms/s of ^{18}Ne -> **2.7 10^{11} ions/s $^{18}Ne^{q+}$** *(30%)*

- He-6 and Ne-18 beams are presently available at
  GANIL, DUBNA, ISOLDE, ISAAC, ….LLN

- After the ion source, the available intensity is
  at maximum **3 10^{8} ions/s** for **$^{6}He^{1+}$ (-> × 10^{5} !!!)**

  3 10^{8} ions/s for $^{18}Ne^{q+}$ (-> × 10^{3} !!!)

What for Ne-19 ($T_{1/2}$=17s) ?

- Goal: 1.6 10^{13} atoms/s injected as neutral in the src
- Presently available in LLN:

5 10^{11} atoms/s

with 200 µA of 30 MeV protons

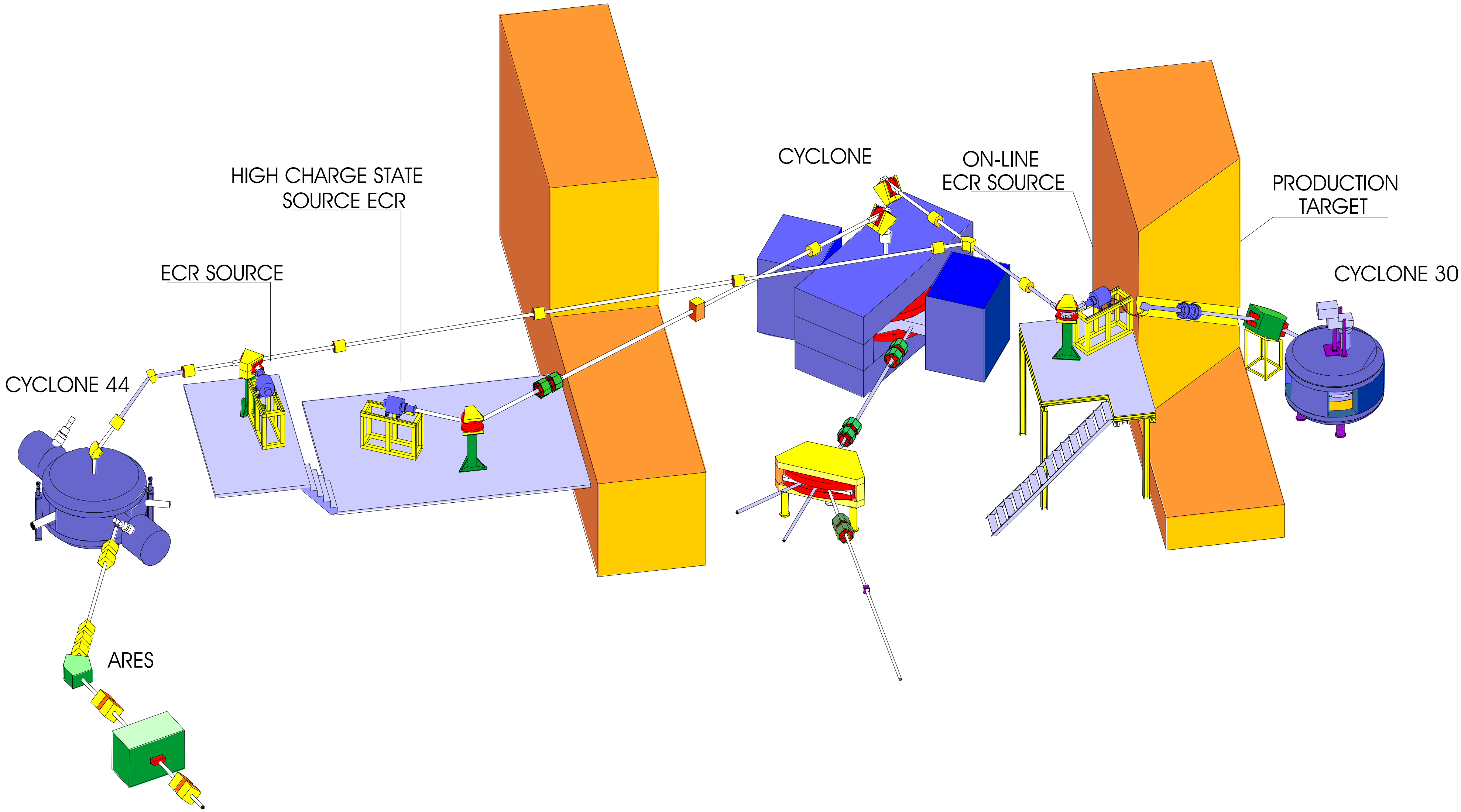
missing factor: 32

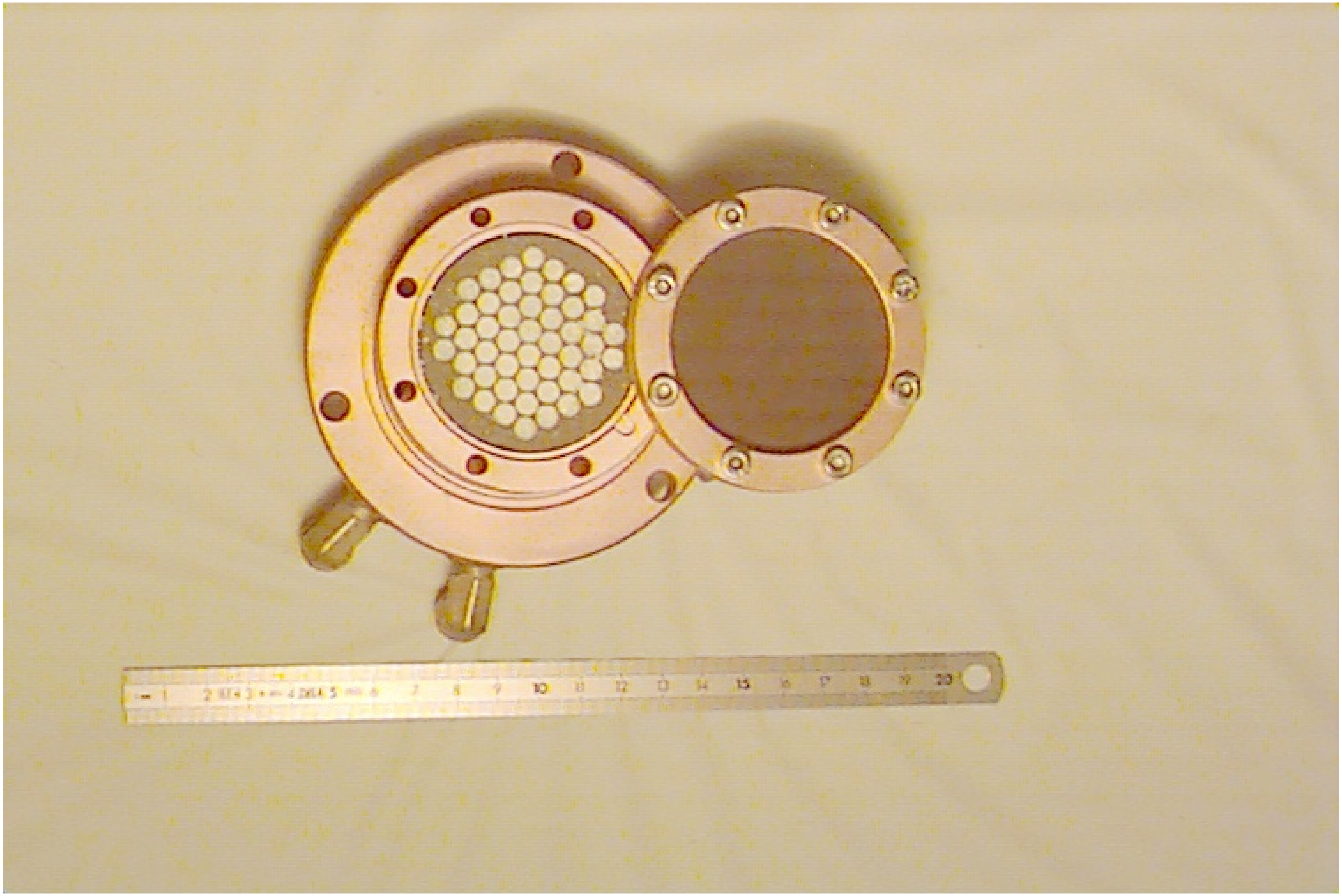
•-> ~ 6 mA proton beam at 30 MeV, could be ok!

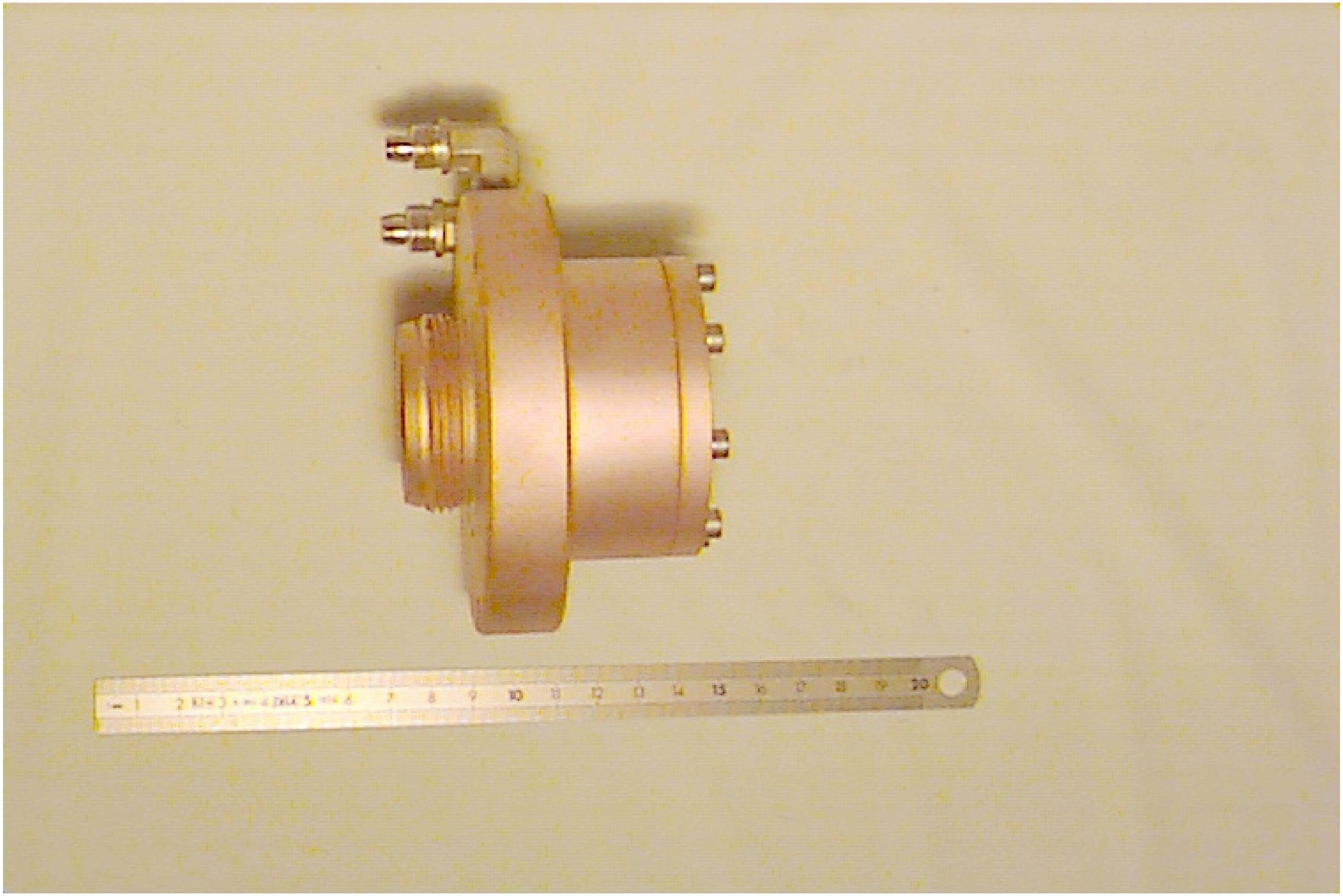
How do we produce Ne-19,Ne-18,He-6?

- **projectile: 30 MeV protons, high intensity: > 300 μA**
  -----> dedicated reactions
  →dedicated target: Li F
- **Ne-19 ?**
  $^{19}F\ (p,n)^{19}Ne$ threshold: 5 MeV
- **Ne-18** ?
  $^{19}F\ (p,2n)^{18}Ne$, threshold: 16 MeV
- **He-6** ?
  $^{7}Li\ (p,2p)^{6}He$ threshold: 10 MeV

The Louvain-la-Neuve Facility







Production target for Ne-19

- At LLN, the 6kW beam is spread over a diameter of 4 cm, to lower the power density.
- The present target is water cooled by the rear side only -> cooling ~ surface of the target
- For 180 kW, the beam shoud be spreaded over 22 cm to keep the same power density.
  -> seems feasible… for Ne-19!
- "Clean" target

Advantages of Ne-19 (from the low energy side point of view)

- Production

  (p,n) reaction: higher production yield

- Ionization: !!important!!

  because the lifetime is high (T1/2= 17s), the source can be separed from the target

  -> shielding

  -> a standart ECR source can be used

  with permanent magnet for the hexapole

  -> + cold trap between the target and the source

- Acceleration: Ne-19 could be stored during 8s

Other scenarios for He-6

- Projectile fragmentation of Li-7 (cfr Dubna)
  - Li-7 at 100 MeV/A on C: 8.0 mb for He-6
  - 1.7 10^{10} He-6/s for 1pμA of Li-7 (A. Villari Moriond-2003)
  - -> 2 pmA (?) of Li-7 ->3.4 10^{13} He-6 atoms/s
  - « clean » process
- ^{9}Be (n,α) ^{6}He
  - with deuteron beam + converter (SPIRAL2)
  - 40 MeV deuterons on C + Be
  - -> 5 mA d -> 10^{13} He-6 atoms/s (A. Villari Moriond-2003)
  - Could be tested at LLN first (10μA), at GANIL later

Conclusions

- **Close to the stability line**, like for He-6 and Ne-19, **a low energy beam** could be an alternative and **should be better investigated.**

- Advantages: relative simplicity
  -low energy driver but high intensity
  - specific targets
  -the activation problems are reduced
  -beam power -> target surface -> r × √power

- There is **place for improvements**

Brain storming at LLN: 2006

- Production scenarios
- Ionization
  - Ionization efficiency measurements for 50μs pulses?
  - 18 GHz, 28 GHz
  - Grenoble?, Catania?, Berkeley? RIKEN?
- R&D collaboration?
  - GANIL –DUBNA- LLN- ….?