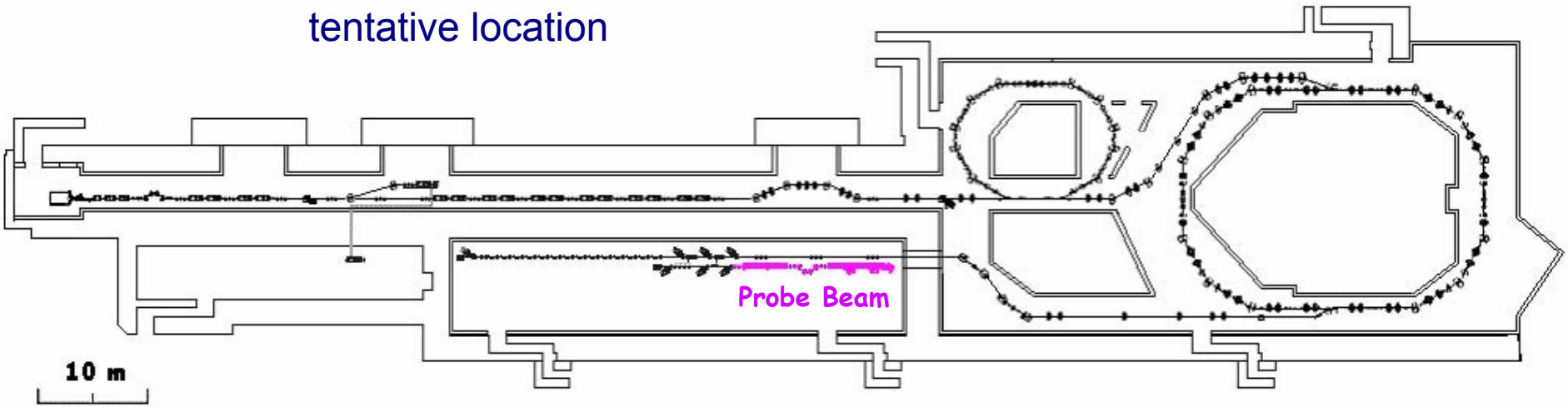
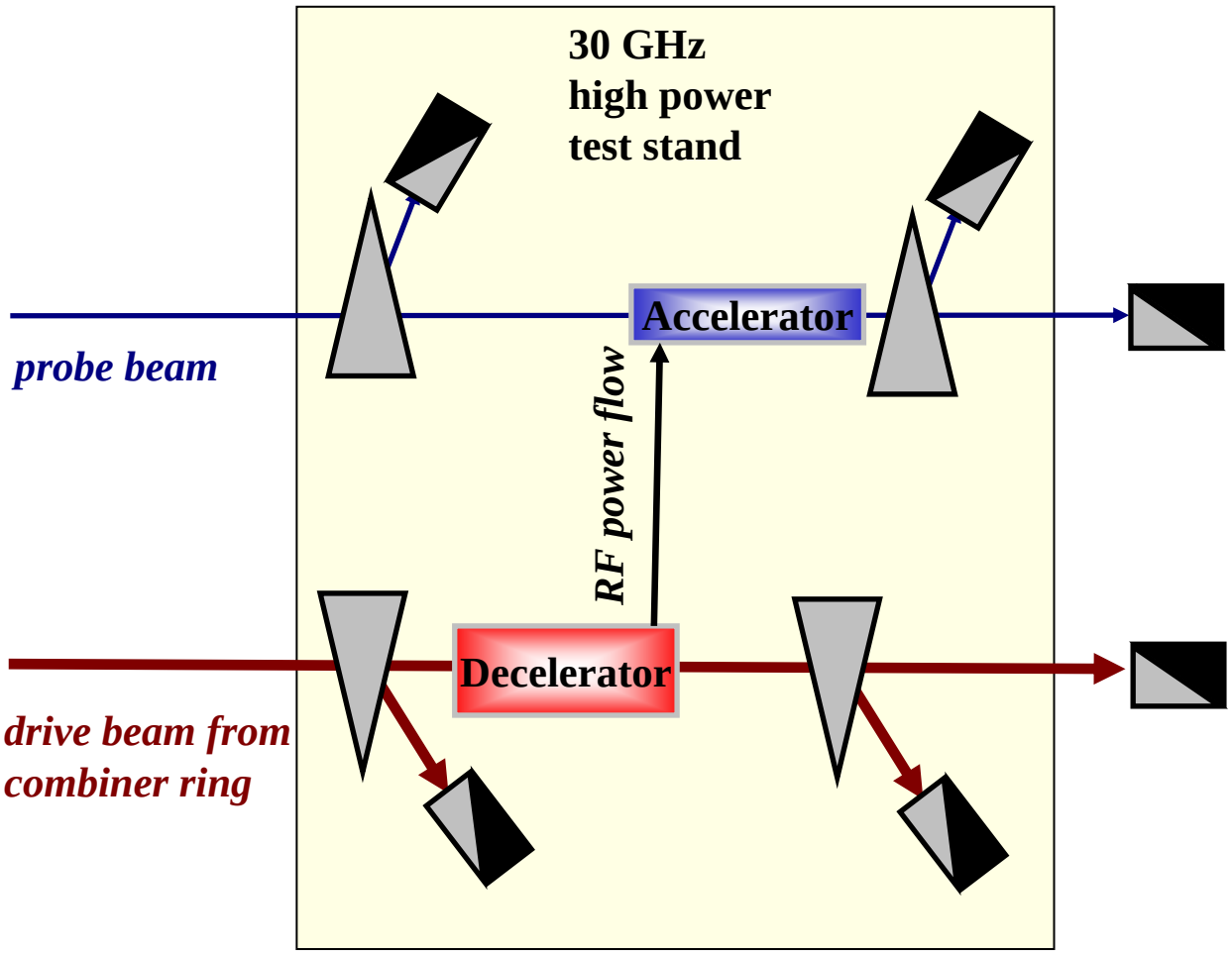
CTF3 WP4 - Probe Beam Linac

- **Location**
- **Applications**
- **Specification**
- **Preliminary design considerations**
- **Boundary conditions**

Probe beam linac,
tentative location



Probe beam, typical application



Probe beam applications

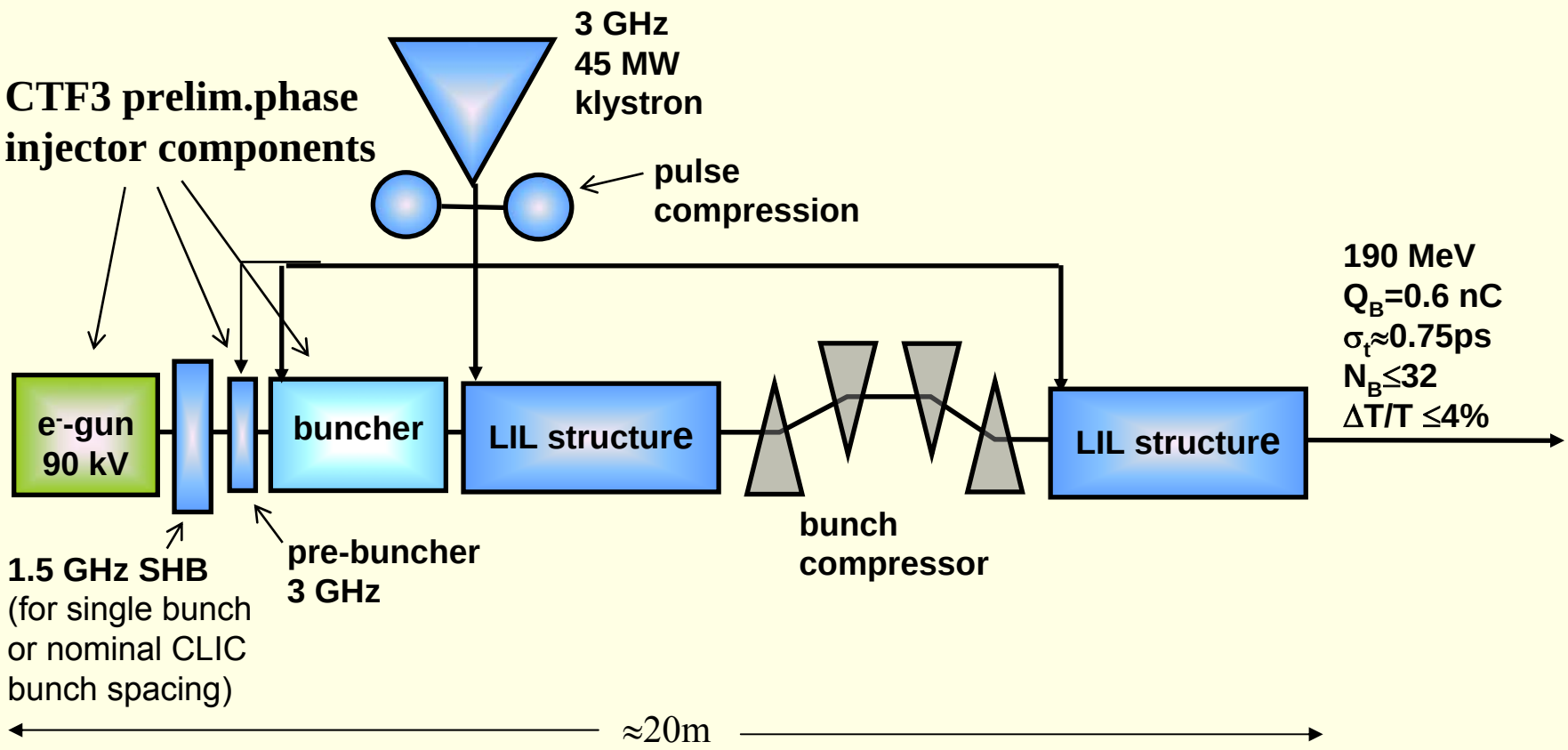
- Test acceleration with CLIC prototype acceleration structures (WP 2.2)
- Engineering test-bed for CLIC accelerator module (WP5)
- Cross check of 30 GHz RF power calibration
- Measure synchronous frequency of accelerating structures prototypes
- Monitor phase advance of 30 GHz accelerating structures during high power processing
- Measure higher order mode frequencies of accelerating structures prototypes
- Test-bed for CLIC main beam instrumentation
- Influence of RF-break downs on beam characteristics
- Measurement of timing stability between drive and probe beam
- Test CLIC beam loading compensation scheme
- Test damping of higher order modes in accelerating structure prototypes
- Test-bed for CLIC main beam instrumentation

Probe beam, specification

Parameters		Motivation
Energy	≈ 200 MeV	Avoid beam disruption in high RF fields
Normalised r.m.s. emittance	≙ 20 mm mrad	Fit in 30 GHz structure acceptance
Energy spread	≙ ± 2%	Measurement resolution
Bunch charge	0.6 nC	CLIC parameters
Bunch spacing	0.666 ns	
Number of bunches	Variable from 1-32	Measure 30 GHz structure transients
r.m.s. bunchlength	≙ 0.75 ps	Acceleration with 30 GHz

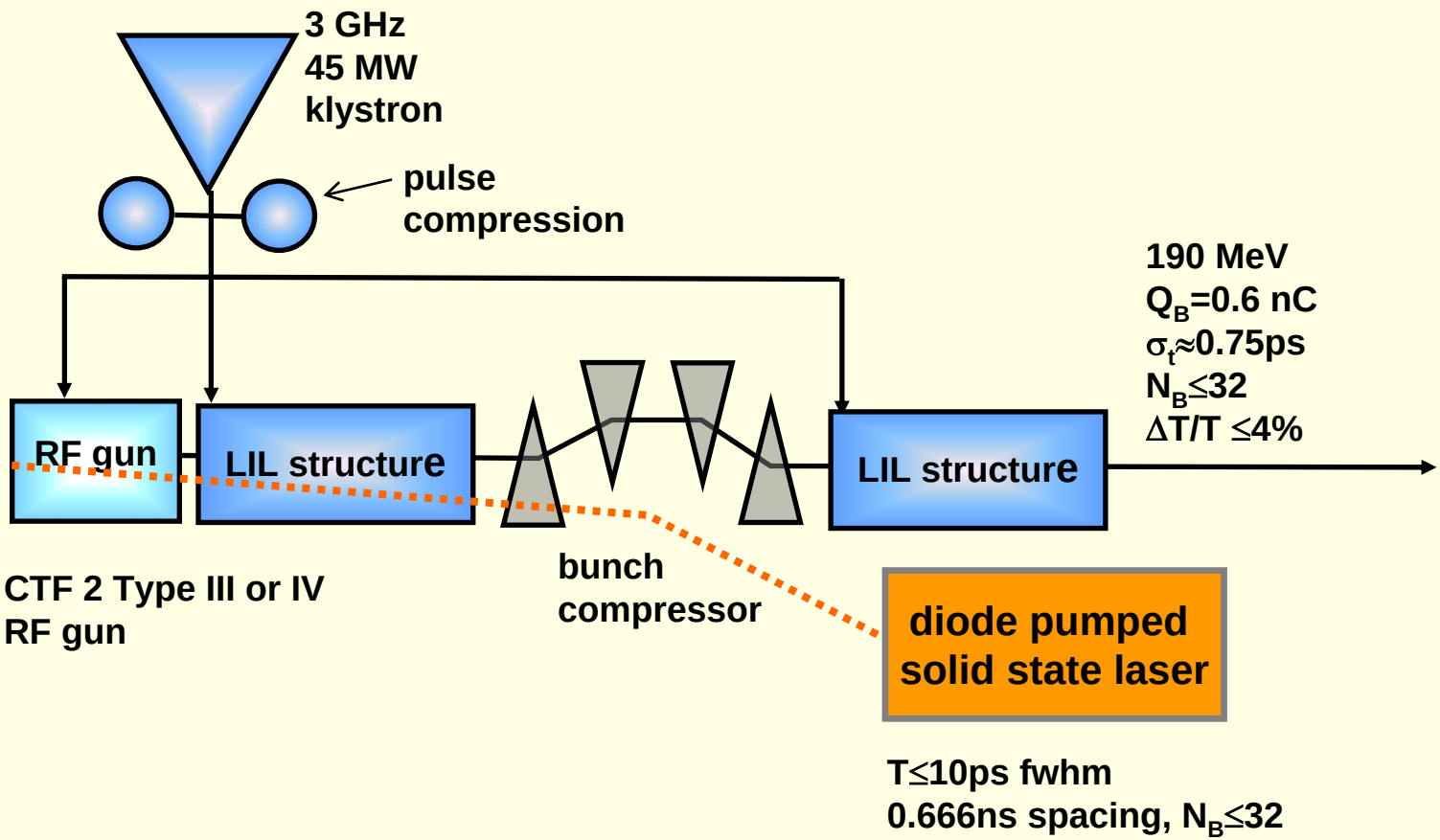
Preliminary design considerations, Version I

Probe beam source, thermionic gun scenario



Preliminary design considerations, Version II

Probe beam source, RF photo injector scenario



Boundary conditions

Schedule: **Has to be operational for spring 2008**
Maximum length: **About 20 m, determined by CLEX building**

Resource estimate: **1.6 MCHF and 9 m*y assuming thermionic version and**
(very, very preliminary) **reuse of various LIL equipment, without klystron & modulator**

What is available for re-use

- **Several LIL accelerating structures, 4.5 m each**
- **The 90 kV front end from CTF3 preliminary phase**
- **RF gun and cathode chamber from CTF II probe beam**
- **Klystron**
- **Several solenoids**

Reasoning for probe beam specifications

Beam Energy

The entry of a RF structure acts like a focusing length with

$$f = 2\frac{P_z}{E}$$

test structures with very high gradient $E \approx 200$ MV/m, keep $f \blacklozenge 2\text{m}$ to avoid beam disruption

➡ **$T \blacklozenge$ 200 MeV**

Beam emittance

30 GHz device of length L=2.0m, aperture d=3 mm to be tested with 4σ beam clearance

$$\varepsilon \le \frac{d^2\gamma}{64\,L}$$

➡ **$\varepsilon <$ 28 mm mrad**

Bunch length

Energy spread due to bunchlength $\quad \frac{\Delta T}{T} \approx 1 - \mathrm{Cos}\,2\pi\nu\sigma_t\,, \quad \frac{\Delta T}{T} < 1\%\,, \quad \nu = 30\ \mathrm{GHz}$

➡ **$\sigma_t \le$ 0.75 ps**